WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Water Quality Program Permit Writer's Manual

Publication Number 92-109
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Water Quality Program
Permit Writer's Manual

Prepared by:

Gary Bailey
Washington State Department of Ecology
Water Quality Program

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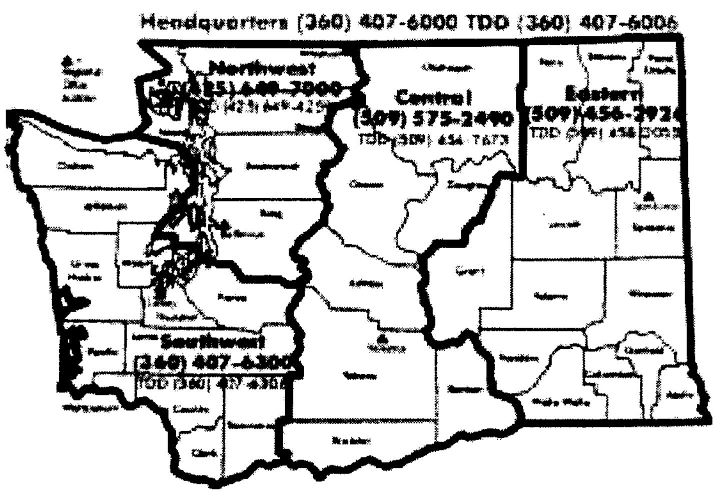

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If you have special accommodation needs or require this document in an alternative format, please call Donna Lynch at (360) 407-7529. The TDD number is (306) 407-6006. Email can be sent to dlyn461@ecy.wa.gov

Acknowledgements

This manual represents an effort by the Water Quality Program to improve it's point source pollution control program. Numerous people have contributed to the manual.

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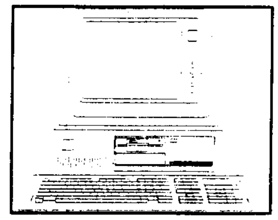
Everyone's efforts are appreciated.

Gary C. Bailey
Project Leader

Note to Permit Writers

There are visuals of a computer throughout the text of the manual. This indicates that there is some computer-related assistance available such as model permit language, model fact sheet language or spreadsheets to assist in calculations. The model language and spreadsheets are available on the network or from the Permit Development Services Section.



The manual is designed to be used in a binder and is formatted to accommodate revisions. This is a complete revision for July 2001 and all headers will have this date. The current version of the manual will be noted as the version date on the cover page and the Table of Contents header. Any significant revisions to sections of the manual will have a revision date in the section title in the Table of Contents.

Comments on the manual can be made at any time in writing, by telephone (360 407-6433) or Email (gbai461@ecy.wa.gov) to Gary Bailey.

Please direct any requests for the manual to the Program Development Services Section.

Note to Other Readers

This manual is a working document for people in the Department of Ecology who write wastewater discharge permits. It is available to the public on the Ecology web site or from a printing contractor. The manual will be updated and new sections added periodically. The manual is designed to be used in a binder and is formatted to accommodate revisions. Each chapter has a revision date in the heading. Each revision will contain a new Table of Contents. If you wish to be notified of revisions to the manual please mail the following registration notice form or use Email. You will then be notified of the availability and cost of revisions.

The Department of Ecology is interested in your comments on this manual. Please address your comments to GARY BAILEY, DEPT OF ECOLOGY, PO BOX 47600, OLYMPIA, WA 98504-7600. Email may be directed to gbai461@ecy.wa.gov.

Permit Writer's Manual

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GLOSSARY

DEFINING THE TERMS OF WASTEWATER PERMITS

401(a) CERTIFICATION - A requirement of Section 401(a) of the Clean Water Act that all federally issued permits be certified by the state in which the permit is issued. The state certifies that the proposed permit will comply with state water quality standards.

ACEC (ACUTE CRITICAL EFFLUENT CONCENTRATION) - The maximum concentration of effluent during critical conditions at the boundary of the zone of acute criteria exceedance assigned in the permit. If no zone of acute criteria exceedance is specified the acute critical effluent concentration shall be one hundred percent effluent.

ACUTE TOXICITY--The lethal effect of a compound on an organism that occurs in a short period of time, usually 48 to 96 hours.

ACUTE TOXICITY TEST - A toxicity test with the death of test organisms as the measured response.

AET (APPARENT EFFECTS THRESHOLD) - For a given quality-assured data set approved by the department, the highest sediment concentration of an individual chemical contaminant which is not associated with statistically significant biological effects (proposed WAC 173-204-020).

AKART - Acronym for "all known available and reasonable methods"..."to prevent and control"..."pollution" (RCW 90.48.010, RCW 90.48.520). (see Chapter IV)

ANTI-BACKSLIDING - A provision in the Federal Regulations (40 CFR 122.44) which says a reissued permit must be as stringent as the previous permit with some exceptions.

AVERAGE MONTHLY DISCHARGE LIMITATION - The highest allowable average of "daily discharges" over a calendar month. Calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month (40 CFR 122.2).

AVERAGE WEEKLY DISCHARGE LIMITATION - The highest allowable average of "daily discharges" over a calendar week. Calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week (40 CFR 122.2). Applicable only to municipal discharges.

BAT (BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE) - The wastewater treatment technology required to control toxic pollutants. Required to be in place by July 1, 1984, however, EPA has not completed the guidelines for all industries.

BCT (BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY) - This was the second step in defining treatment technology for conventional pollutants. A candidate technology must pass 2 cost tests which compare industrial costs to municipal costs of treatment. BCT was to be in place by July 1, 1984 but EPA did not complete guidelines for all industries.

BOILER PLATE LANGUAGE - see GENERAL CONDITIONS.

BMP (BEST MANAGEMENT PRACTICE) - Permit condition used in place of or in conjunction with effluent limits to prevent the discharge of pollutants. May include schedules of activities, prohibitions of practices, maintenance procedures, treatment requirements, operating procedures and practices.

BOD (BIOCHEMICAL OXYGEN DEMAND) - The quantity of substances present in a water or wastewater that utilizes oxygen to decompose. The test for BOD is to put a sample of water or wastewater in a sealed bottle with sewage bacteria and measure how much oxygen is used in 5 days.

BPJ (BEST PROFESSIONAL JUDGMENT) - The highest quality technical opinion developed by permit writer after consideration of all reasonably available and pertinent data or information which forms the basis for the terms and conditions of an NPDES permit. May also be called BEJ (Best Engineering Judgment). Authorized by Sec. 402(a)(1)(B) of the Clean Water Act.

BPT (BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE) - the first step of treatment technology identified by EPA for 52 categorical industries. The technology was identified by surveying the treatment technology in use and defining the best average performance. See section 301(b)(1)(A) of CWA.

BYPASS - The intentional diversion of waste streams from any portion of a treatment facility.

CCEC (CHRONIC CRITICAL EFFLUENT CONCENTRATION) - The maximum concentration of effluent during critical conditions at the boundary of the mixing zone assigned in the permit. Where no mixing zone is specified, the chronic critical effluent is one hundred percent effluent.

CERTIFICATION, 401(a) - See 401(a) CERTIFICATION.

CFR (CODE OF FEDERAL REGULATIONS) - A codification of the general and permanent rules published in the Federal Register by the Executive departments and agencies of the Federal Government. Environmental regulations are in Title 40.

CHRONIC TOXICITY TEST - A toxicity test which measures a sublethal effect such as failed fertilization, development, growth, or reproduction. Organism survival is also a measured endpoint in some chronic toxicity tests.

COD (CHEMICAL OXYGEN DEMAND) - A measure of the decomposable substances in water or wastewater which uses a chemical oxidant instead of bacteria as in the BOD test.

COMBINED SEWER OVERFLOW (CSO) - The event during which excess combined sewage flow caused by inflow is discharged from a combined sewer, rather than conveyed to the sewage treatment plant because either the capacity of the treatment plant or the combined sewer is exceeded.

COMPLIANCE SCHEDULE - A schedule of remedial measures included in a permit or an enforcement order, including an enforceable sequence of actions or operations leading to compliance with an effluent limitation, other limitation, prohibition, or standard. (CWA, 502)

CONVENTIONAL POLLUTANTS - Pollutants typical of municipal sewage and defined by Federal Regulation (40 CFR 401.16) as BOD, total suspended solids, fecal coliform, pH, and oil/grease.

CRITERIA - are the numeric values and the narrative standards that represent contaminant concentrations which are not to be exceeded in the receiving environmental media (surface water, ground water, sediment) to protect beneficial uses.

CRITICAL CONDITION - The time during which the combination of receiving water and waste discharge conditions have the highest potential for causing toxicity in the receiving water environment. This situation usually occurs when the flow within a water body is low, thus, its ability to dilute effluent is reduced.

DAILY DISCHARGE - The discharge of a pollutant measured during any 24-hour period that reasonably represents a calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the daily discharge is calculated as the total mass of the pollutant discharged during the day. For pollutants with limitations expressed in other units of measurement, the daily discharge is calculated as the average measurement of the pollutant throughout the day (40 CFR 122.2).

DEVELOPMENT DOCUMENT - A document prepared during the development of effluent guidelines by EPA which explains the methodology and data which was used to develop the guidelines.

DILUTION FACTOR - A measure of the amount of mixing of effluent and receiving water that occurs at the boundary of the mixing zone. Expressed as the inverse of the effluent fraction e.g., a dilution factor of 10 means the effluent comprises 10% by volume and the receiving water 90%.

DILUTION ZONE - see mixing zone.

DISCRETE SAMPLE - A single sample of wastewater taken at neither set time nor flow. Also known as a grab sample or single sample.

DMR (DISCHARGE MONITORING REPORT) - A report submitted by a permittee, (usually monthly) which gives the results of the effluent monitoring tests performed.

Do. or do. - Within the effluent limits sections of 40 CFR means ditto or the same as above.

DRAFT PERMIT - A document which indicates a decision to issue, deny, modify, revoke and reissue, terminate or reissue a permit. Usually is in the form of a permit and indicates a decision to issue, reissue, or modify a permit.

EARLY WARNING VALUES - act as a trigger in the groundwater standards to detect increasing contaminant concentrations prior to the degradation of a beneficial use.

EFFLUENT LIMITATION - Any restriction established by a permitting authority on quantities, rates, and concentrations of chemical, physical, biological pollutants discharged to waters of the state.

ENFORCEMENT LIMITS - the values assigned by the groundwater standards to a contaminant for the purposes of regulation. This limit assures that a criterion will not be exceeded.

EPA EFFLUENT GUIDELINES - (see Chapter IV)

EXCURSIONS - Violations of effluent limits or water quality standards.

FACT SHEET - A document prepared and issued with every permit which summarizes the activities and decisions on the permit and tells how the public may comment (40 CFR 124.8, 124.56).

FR (FEDERAL REGISTER) - The periodical of the U.S. government in which draft and final regulations are published.

GENERAL PERMIT - A permit to regulate storm water point sources or other category of point sources. A general permit is not specifically tailored for an individual discharger (40 CFR 122.28).

INDIRECT DISCHARGER or INDUSTRIAL USER - A discharger of wastewater to the sanitary sewer which is not sanitary wastewater or is not equivalent to sanitary wastewater in character.

INDUSTRIAL WASTEWATER--Water or liquid-carried waste from industrial or commercial processes, as distinct from domestic wastewater. These wastes may result from any process or activity of industry, manufacture, trade or business, from the development of any natural resource, or from animal operations such as feed lots, poultry houses, or dairies. The term includes contaminated storm water and, also, leachate from solid waste facilities.

INSPECTION, COMPLIANCE - WITHOUT SAMPLING - A site visit for the purpose of determining the compliance of a facility with the terms and conditions of its permit or with applicable statutes or regulations. The minimum requirements are specified in the Compliance Inspection Checklist (8/15/96).

INSPECTION, COMPLIANCE - WITH SAMPLING - Similiar to INSPECTION, COMPLIANCE - WITHOUT SAMPLING but includes as a minimum sampling and analysis for all parameters with permit limits for the purpose os ascertaining compliance with those limits. For municipal facilities this includes sampling of the influent to determine compliance with the 85% removal requirement. Additional sampling for other parameters may also be conducted.

INSPECTION, COMPLIANCE FOLLOW-UP - An inspection for the main purpose of verifying that a compliance issue required by a previous action (inspection, NOC, order) has been completed or initiated.

INSPECTION, COVERAGE - An inspection of an unpermitted facility for the purpose of determing if a permit is required or an inspection of a permitted facility to determine whether permit termination is appropriate.

INSPECTION, MULTIMEDIA COMPLIANCE - An INSPECTION, COMPLIANCE - WITHOUT SAMPLING or an INSPECTION, COMPLIANCE - WITH SAMPLING which is conducted on a metals mining facility that includes an assessment of dam safety and air permit compliance in accordance with the multimedia inspection checklist.

INSPECTION, OPERATOR OUTREACH - An inspection for the purpose of providing assistance to municipal treatment plant operators conducted by a Technical Assistance Officer designated under RCW 43.21A.085.

INSPECTION, OPERATION AND MAINTENANCE - A scheduled on-site visit to a sewage treatment plant to review operations, record keeping, personnel information and to make visual observations on the condition of a plant and its discharge. Any documented operations deficiencies will be noted and used to provide a basis for making recommendations for future operation and maintenance programs and activities at the plant.

INSPECTION, PRETREATMENT AUDIT - An audit of a municipal treatment facility and system for municipalities that have been delegated pretreatment program responsibilites. Conducted at least once every five years. The primary purposes are to determine compliance with the requirements of the municipalities' approved program and to assess the need for program improvements. Audits are conducted using EPA's "Control Authority Pretreatment Audit Checklist and Instruction."

INSPECTION, PRETREATMENT COMPLIANCE - An annual inspection of a municipal treatment facility and system for municipalities that have been delegated pretreatment program responsibilities. The primary purpose is to determine compliance with the requirements of the municipalities' approved pretreatment program. Inspections are conducted using the PCT Checklist and EPA's "Guidance for Conducting a Pretreatment Compliance Inspection."

INSPECTION, TECHNICAL ASSISTANCE VISIT - An inspection on a permitted facility for the sole purpose of providing compliance assistance to the permittee and where the permittee and the inspector have agreed to this purpose prior to or at the initiation of the inspection.

INTERFERENCE -- A discharge which, alone or in conjunction with a discharge or discharges from other sources, both:

Inhibits or disrupts the POTW, its treatment processes or operations, or its sludge processes, use or disposal and;

Therefore is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation) or of the prevention of sewage sludge use or disposal in compliance with the following statutory provisions and regulations or permits issued thereunder (or more stringent State or local regulations): Section 405 of the Clean Water Act, the Solid Waste Disposal Act (SWDA) (including title II, more commonly referred to as the Resource Conservation and Recovery Act (RCRA), and including State regulations contained in any State sludge management plan prepared pursuant to subtitle D of the SWDA), sludge regulations appearing in 40 CFR Part 507, the Clean Air Act, the Toxic Substances Control Act, and the Marine Protection, Research and Sanctuaries Act.

INTEGRATED FACILITY - A primary industry with operations covered by more than one subcategory of operation.

LOCAL LIMITS - Conditional discharge limits imposed by municipalities upon dischargers to their sewage treatment system.

MAJOR FACILITY - A facility discharging to surface water with an EPA rating score of > 80 points based on such factors as flow volume, toxic pollutant potential, and public health impact. EPA reviews these NPDES permits during issuance and tracks compliance with the permits.

MAXIMUM DAILY DISCHARGE LIMITATION - The highest allowable daily discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. The daily discharge is calculated as the average measurement of the pollutant over the day.(40 CFR 122.2).

MCL (MAXIMUM CONTAMINANT LEVEL) - are federally promulgated by the Environmental Protection Agency. These are enforceable health-based standards which means the maximum permissible level for a contaminant in ground water. These values reflect the effect of certain risk management factors such as laboratory confidence limits and economics.

MCLG (MAXIMUM CONTAMINANT LEVEL GOAL) - are health goals which are set at a level at which no known or anticipated adverse effects on the health of persons should occur and which allows for an adequate margin of safety. These limits do not take into account treatment technology and economics as the MCL's do.

MDL (METHOD DETECTION LIMIT) - the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

MGD (MILLION GALLONS PER DAY) - A unit of flow commonly used for wastewater discharges. One MGD is equivalent to 1.547 cubic feet/second.

MINOR PERMITS - Any NPDES permits which are not MAJOR PERMITS.

MIXING ZONE - An area, specified in a permit, which surrounds an effluent discharge point. This area is not required to meet water quality standards but must allow passage of aquatic organisms and not upset the ecological balance of the receiving water. The mixing zone specifications and conditions for authorization are given in WAC 173-201A.

NEW SOURCE - Any building, structure, facility, or installation from which there is or may be a discharge of pollutants, the construction of which commenced:

(a) After promulgation of standards of performance under section 306 of CWA which are applicable to such source, or

(b) After proposal of standards of performance in accordance with section 306 of CWA which are applicable to such source, but only if the standards are promulgated in accordance with section 306 within 120 days of their proposal (40 CFR 122.2).

NOEC (NO OBSERVED EFFECT CONCENTRATION) - The highest measured continuous concentration of an effluent or a toxicant that causes no observed effect on a test organism.

NONCONVENTIONAL POLLUTANTS - Any pollutants which are not defined as CONVENTIONAL POLLUTANTS or TOXIC POLLUTANTS. Includes pollutants such as COD, nitrogen, phosphorus, and fluoride.

NPDES - National Pollutant Discharge Elimination System (Section 402 of the Clean Water Act). The Federal wastewater permitting system for discharges to navigable waters. The authority for issuing these permits has been delegated to the State. NPDES permits issued by Washington permit writers are NPDES/state permits issued under both federal and state law.

NPDES NOTEBOOK - A notebook in every permitting section containing the current federal regulations pertaining to NPDES permitting.

NSPS (NEW SOURCE PERFORMANCE STANDARDS) - Effluent limitations that apply to those dischargers that qualify as new sources under 40 CFR 122.2 and 122.29.

PARTIES OF RECORD - People who have indicated an interest in a particular permit during the public notice of application and are kept informed of progress of the permit and future permit actions.

PASS THROUGH -- A discharge which exits the POTW into waters of the-State in quantities or concentrations which, alone or in conjunction with a discharge or discharges from other sources, is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation), or which is a cause of a violation of State water quality standards.

PCHB (POLLUTION CONTROL HEARINGS BOARD) - A 3-member board appointed by the governor to hear and decide appeals of Ecology's permits and orders. See Chapter XVI of this manual and Chapter 371-08 WAC.

PERMIT - An authorization, license, or equivalent control document issued by EPA or an approved state to implement the requirements of 40 CFR 122.2 and Parts 123 and 124. Permit includes any NPDES GENERAL permit. Permit does not include any proposed or draft permit which has not yet been the subject of public comment or EPA review, if necessary.

PERMIT, WASTEWATER DISCHARGE - A document prepared by a permitting authority (Federal Government, State Government, Local Government) which limits the pollutants to be discharged by the holder of the permit (Permittee).

pH - A measure of the acidity of water or wastewater. A pH of 7 is neutral. A pH less than 7 is acidic, and a pH greater than 7 is basic.

POINT SOURCE - Any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fixture, container, rolling stock, concentrated animal feeding operation, vessel, or other floating craft from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture.

POLLUTANT - Dredged soil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal and agricultural waste discharged into water.

POLLUTANT, CONSERVATIVE - Pollutants that are mitigated primarily by natural stream dilution after entering receiving bodies of waters. Included are pollutants such as heavy metals.

POLLUTANT, NON-CONSERVATIVE - Pollutants that are mitigated by natural biodegradation or other environmental decay or removal processes in the receiving stream after in-stream mixing and dilution have occurred.

POLLUTION – The man-made or man-induced alteration of the chemical, physical, biological and radiological integrity of water.

POLLUTION PREVENTION - Source reduction; or protection of natural resources by conservation; or increased efficiency in the use of raw materials, energy, water or other resources.

POTENTIAL SIGNIFICANT INDUSTRIAL USER--A potential significant industrial user is defined as an Industrial User which does not meet the criteria for a Significant Industrial User, but which discharges wastewater meeting one or more of the following criteria:

a. Exceeds 0.5 % of treatment plant design capacity criteria and discharges <25,000 gallons per day or;

b.Is a member of a group of similar industrial users which, taken together, have the potential to cause pass through or interference at the POTW (e.g. facilities which develop photographic film or paper, and car washes).

The Department may determine that a discharger initially classified as a potential significant industrial user should be managed as a significant industrial user.

POTW (PUBLICLY OWNED TREATMENT WORKS) - A sewage treatment plant and the collection system (40 CFR 122.2).

PQL (PRACTICAL QUANTIFICATION LIMIT) - is the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

PRECURSOR - A substance present in effluent that is not toxic in its present form (not listed). However, a precursor could change into or react to form a toxic compound.

PRETREATMENT - The treatment of wastewater to remove or reduce the concentration of pollutants prior to discharge to a municipal sewage system. May be a formal program (PRETREATMENT PROGRAM) which allows a municipality to issue permits for discharges to it's system under Federal and state authority.

PRIMARY INDUSTRY CATEGORIES - A group of 34 industry groups for which EPA has or will develop effluent guidelines (40 CFR Part 122 Appendix A).

PRIORITY POLLUTANT (TOXIC POLLUTANT) - A group of chemicals specifically listed in Federal Regulations and with priority for regulatory control (40 CFR 401.15).

PROCESS CONTROL MONITORING - An internal program whereby the permittee performs intermediate checks on the plant's operations to assess how efficiently the system is running.

PROCESS WASTEWATER - Any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product.

PROPOSED PERMIT - A State NPDES permit prepared after the close of the public comment period (and, when applicable, any public hearing and administrative appeals) which is sent to EPA for review before final issuance by the State. A PROPOSED permit is not a DRAFT permit (40 CFR 122.2).

PSES (PRETREATMENT STANDARDS EXISTING SOURCE) - Effluent limitations that apply to existing pretreatment dischargers.

PSNS (PRETREATMENT STANDARDS NEW SOURCE) - Effluent limitations that apply to pretreatment dischargers qualifying as new sources under 40 CFR 122.2. and 122.29.

SCHEDULE OF COMPLIANCE - See COMPLIANCE SCHEDULE.

SECONDARY STANDARDS - are numeric criteria within the groundwater standards designed to protect the public welfare. Limits are established for those constituents which will not adversely affect human health, but may affect the taste or odor of the water or cause discoloration of laundry or plumbing fixtures. Secondary standards are established for: chloride, color, copper, corrosivity, fluoride, foaming agents, iron, manganese, odor, pH, sulfate, total dissolved solids (TDS) and zinc.

SEDIMENT QUALITY STANDARDS - These standards identify sediment chemical concentration criteria, and biological toxicity criteria which correspond to no observable acute or chronic adverse effects on biological resources, and which do not pose a significant health threat to humans. The standards are used as a basis for identification of surface sediments that exceed these standards, and for limiting toxic discharges to waters of the state (WAC 173-204-010).

SELF-MONITORING PROGRAM - A program whereby a permittee is required through the NPDES permit system to maintain records and to report periodically on the amount and nature of the waste components in the effluent. The required information obtained by the permittee's self-monitoring program is reported to the permitting agency using a DISCHARGE MONITORING REPORT (DMR) on a regular schedule delineated in the permit.

SEPA (STATE ENVIRONMENTAL POLICY ACT) - A state law which requires an examination of the environmental effects of development projects. (RCW 43.21, Chapter 197-10 WAC)

SIGNIFICANT INDUSTRIAL USER (SIU) - 1) All industrial users subject to Categorical Pretreatment Standards under 40 CFR 403.6 and 40 CFR Chapter I, Subchapter N and; 2) Any other industrial user that: discharges an average of 25,000 gallons per day or more of process wastewater to the POTW (excluding sanitary, noncontact cooling, and boiler blow-down wastewater); contributes a process wastestream that makes up 5 percent or more of the average dry weather hydraulic or organic capacity of the POTW treatment plant; or is designated as such by the Control Authority on the basis that the industrial user has a reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement (in accordance with 40 CFR 403.8(f)(6)).

Upon finding that the industrial user meeting the criteria in paragraph 2, above, has no reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement, the Control Authority* may at any time, on its own initiative or in response to a petition received from an industrial user or POTW, and in accordance with 40 CFR 403.8(f)(6), determine that such industrial user is not a significant industrial user.

SINGLE SAMPLE - (See DISCRETE SAMPLE).

SOURCE REDUCTION - Any practice which eliminates or reduces the amount or use of hazardous substances, pollutants or contaminants that enter a waste stream or are released into the environment, including fugitive emissions, prior to recycling, treatment or disposal, and thereby reduces adverse public health and environmental effects associated with the release of such substances, pollutants or contaminants.

STATE WASTE DISCHARGE PERMIT - A wastewater discharge permit issued under State authority (Chapter 90.48 RCW) to control the discharge of pollutants to waters of the State. Generally issued for discharges to ground water and for industrial discharges to a municipal sewage system when that municipal system does not have a pretreatment program.

STATE WATERS - Lakes, rivers, ponds, streams, inland waters, underground waters, salt waters, and all other surface waters and watercourses within the jurisdiction of the state of Washington

STORMWATER - That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes, and other features of a storm water drainage system into a defined surface water body, or a constructed infiltration facility.

TDS - see TOTAL DISSOLVED SOLIDS

TECHNOLOGY-BASED EFFLUENT LIMIT - A permit limit for a pollutant which is based on the capability of a treatment method to reduce the pollutant to a certain concentration.

TI/RE (TOXICITY IDENTIFICATION/REDUCTION EVALUATION) - A set of procedures to identify the specific chemicals responsible for whole effluent toxicity.

TIERED TESTING - Any of a series of tests that are conducted as a result of a previous test's findings.

TOTAL DISSOLVED SOLIDS (TDS) - The material in water or wastewater that passes through a glass fiber filter. TDS is measured by Method 2540 C in Standard Methods.

TOXIC - Causing death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations in any organism or its offspring upon exposure, ingestion, inhalation, or assimilation.

TOXIC POLLUTANT – Those pollutants, or combinations of pollutants, including disease-causing agents, which after discharge and upon exposure, ingestion, inhalation or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will, on the basis of information available to the Administrator, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction) or physical deformations, in such organisms or their offspring. (listed at 40 CFR 401.15).

TOXIC SUBSTANCE (TOXICANT or TOXICS) - Poison or substance, which if present in sufficient quantity or concentration, is capable of producing a toxic response in a native or test organism.

TOXICITY - The quality or state of being TOXIC.

TOXICITY TEST - A procedure to determine the toxicity of a chemical or an effluent using living organisms. A toxicity test measures the degree of effect a specific chemical or effluent has on exposed test organisms.

TRE (TOXICITY REDUCTION EVALUATION) - A site-specific study conducted in a stepwise process designed to identify the causative agents of effluent toxicity, isolate the sources of toxicity, evaluate the effectiveness of toxicity control options, and then confirm the reduction in effluent toxicity.

TSD - Abbreviation for Technical Support Document for water quality-based toxics control (EPA/505/2-90-001), or

TSD - Abbreviation for a facility which recycles, reuses, reclaims,transfers, stores, treats, or disposes of dangerous wastes as defined in WAC 173-303.

TSS (TOTAL SUSPENDED SOLIDS) - Particulates in water or wastewater retained by a glass fiber filter. TSS is measured by tests as given in 40 CFR Part 136 and referenced as Residue - nonfilterable (TSS) or as given in Standard Methods (17th ed.) method 2540 D.

TTO (TOTAL TOXIC ORGANICS) - Organic chemicals listed within a specific category of discharge (such as electroplating Part 413). TTO is the summation of all quantifiable values of the organic chemicals greater than 0.01 milligrams per liter.

WATER QUALITY-BASED EFFLUENT LIMIT - A permit limit for a pollutant which limits the concentration such that it will not cause a violation of water quality standards.

UPSET--An exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the Permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, lack of preventative maintenance, or careless or improper operation.

WATER QUALITY STANDARDS - Numerical and narrative criteria to protect the beneficial uses of the States' waters. Includes conventional and toxic pollutants. (Chapter 173-201A WAC)

WET (WHOLE EFFLUENT TOXICITY) - The total toxic effect of an effluent measured directly with a toxicity test so that the interaction of all toxicants present in the effluent are assessed.

CHAPTER I. INTRODUCTION

This manual is a technical guidance and policy manual for permit writers who develop wastewater discharge permits in Washington State. Developing this manual was specified as task element P5 in the 1987 Puget Sound Water Quality Management plan and subsequent amendments. Maintenance and improvement of the manual is recommended in the final report of the Commission for Efficiency and Accountability in Government (1990).

The first version of this manual was issued in June, 1989. A 23-member advisory committee assisted the Department of Ecology (Ecology) for one year on policy issues identified in the manual. The advisory committee represented those interested in wastewater permits. An internal work group also assisted in the development of this manual.

The primary purposes of this manual are to enhance the quality and consistency of the wastewater discharge permits issued by Ecology and to improve the efficiency of the permitting process.

1. OBJECTIVES AND FUNCTIONS

The specific objectives and functions of this permit writer's manual are to:

Briefly review the legal history of wastewater permitting to provide permit writer's with a perspective on their role.

Define the requirements for permits in Washington. This manual integrates state and federal law, state and federal regulation and Ecology implementation policies. Permits reviewed for 401(a) certification must be consistent with procedures in this manual.

Ensure statewide consistency in permitting, especially for permits which require best professional judgement (BPJ) determinations.

Identify state and federal laws, regulations and policies relating to permitting.

Identify legal opinions of the Attorney General's Offices, rulings of the Pollution Control Hearing Board and rulings of other courts on permitting and permit related issues.

Gather collective knowledge of Ecology on permit writing.

Provide a central document to place new information, guidance, and requirements related to permitting.

Serve as a reference for experienced permit writers.

Train new permit writers. This manual is identified in the Permit Writers Training Strategy as a component of training for new permit writers. The manual will reduce the training time for new permit writers and the demand on experienced permit writers to train new permit writers.

Demonstrate to the regulated community and other interested public what the agency does in permitting a wastewater discharge.

This manual is a technical and philosophical compendium of the experienced permit writers in Ecology.

The manual is expected to be revised annually and therefore has been placed in a loose leaf format to facilitate revision. Revisions or additions to the manual may occasionally be made between annual revisions. These revisions and additions will be sent with a transmittal cover memo from the Program Manager explaining the need for revision and where the text is to be placed in the manual.

2. FORMAT FOLLOWS PROCESS

The manual's format follows the process of developing a wastewater discharge permit. Because of the complexity of the permitting process it is impossible to completely separate functions chronologically. For example, the public involvement chapter is one of the later chapters in the manual because historically public involvement occurred after the permit conditions were drafted. Public involvement now begins upon permit application.

In preparing the manual, we borrowed materials freely from EPA and from other states when appropriate. These materials are cited in the reference section. They are available from the Ecology library and they may also be obtained from the Program Development Services Section of the Water Quality Program.

2.1 Other References

The new permit writer should read and have on hand some reference documents related to permitting. Specifically, the permit writer should have copies of Water Pollution Laws and Regulations (a loose leaf collection of State law and regulation), the Code of Federal Regulations dealing with environmental regulation (40 CFR Parts 100-149 and 400-471), the NPDES notebook, and a current copy of the Clean Water Act. The permit writer should read Chapters 173-220, 173-216 WAC and study Chapter 90.48 RCW. The Technical Support Document for Water Quality-based Toxics Control (EPA 505/2-90-001) is required background reading for Chapters VI and VII.

3. SCOPE

The scope of this manual includes:

- Joint State/NPDES permits as issued under Chapter 90.48 RCW and The Federal Water Pollution Control Act.
- Municipal wastewater treatment plants
- Industrial/Commercial Facilities
- General Permits
- State waste discharge permits as issued under 90.48 RCW.
- Discharges to groundwater
- Discharges to municipal sanitary sewer systems as part of the state wide (undelegated) pretreatment program.

4. INSPECTIONS AND ENFORCEMENT

The issuance of a wastewater discharge permit leads to subsequent regulatory activities including inspections and enforcement. Guidance for those functions is provided in the Inspection Manual (June 92) and the Enforcement Manual: Guidelines and Procedures (July 90).

5. NOT REGULATION

This manual is not regulation and should not be cited as regulatory authority for any permit condition. This manual describes law and regulation pertaining to permitting. These laws and regulations must be followed to issue a legal permit. Where those laws and regulations are not explicit on implementation the manual describes a process for implementation. This process is a program decision for implementing the laws and regulations and typically has been subject to debate by permit writers and management. If the process does not fit a permitting circumstance, the permit writer can explore alternative processes as long as the law and regulation are met. Alternative processes require section supervisor approval prior to implementation.

6. A SHORT HISTORY LESSON

The point source water pollution control program in this state is based on both Federal and State law which evolved concurrently. The State of Washington began a formal pollution control program in 1945 with the creation of the Pollution Control Commission and enactment of RCW 90.48. The law did not allow strong enforcement. Pollution control was a negotiation process and required the state to demonstrate a water pollution problem and assign the cause of that problem to a specific discharger.

In 1948 the federal government passed the Water Pollution Control Act (PL 80-845). This law provided some funds for the design of municipal wastewater treatment plants and for study of water pollution problems. This law also required the U.S. Surgeon General, in cooperation with the states, to develop water pollution control programs for interstate waters. The Federal Water Pollution Control Act of 1956 (PL 84-660) and its 1961 amendments (PL 87-88) established federal grants for construction of municipal treatment plants.

The Water Quality Act of 1965 (PL 89-234) required states to adopt water quality standards for interstate waters and created a small agency, the Federal Water Pollution Control Administration (FWPCA). These federal laws generally required the states or federal government to demonstrate that a water quality problem had implications for human health or violated water quality standards. Enforcement was minimal because the burden of proof lay with the agencies: they had to demonstrate a direct link between a discharge and a water quality problem before enforcing on a discharger.

Meanwhile, Washington had adopted a waste water discharge permit system in 1955 (Chapter 90.48 RCW). This permit system was apparently not very effective in controlling pollution problems because in 1961 Washington requested assistance of the FWPCA in solving the problems with pulp mill discharges.

Increasing water pollution became apparent in the mid-1960's. Existing laws were not solving the problems. Two examples that reinforced this impression were Lake Erie, which suffered from severe eutrophication and toxic discharges, and the Cuyahoga River, which caught fire on several occasions. The Federal Government responded in 1970 by instituting a discharge permit system based on the authority of the Rivers and Harbors Act of 1899. This system was ineffective because it rapidly got tied up in litigation but it indicated increased Federal interest in controlling wastewater discharges by means of a permit system.

In 1971, the State of Washington enacted legislation which required dischargers to use, "all known, available, and reasonable methods of treatment prior to", discharge regardless of the quality of the water to which the wastes are discharged. This law, the Pollution Disclosure Act of 1971 (Chapter 90.52 RCW), signaled a change of philosophy in water pollution law. Instead of trying to assign responsibility for water pollution problems to particular dischargers, the state would require that all dischargers provide a high level of wastewater treatment regardless of the quality of water to which they discharged (technology-based control).

7. THE CLEAN WATER ACT

The Federal Government, in 1972, also adopted this philosophy of technology-based pollution control when it enacted The Federal Water Pollution Control Act Amendments of 1972 (PL 92-500). Despite the name of the law, it was essentially a new law. Since 1977, the law and its revisions have been popularly called The Clean Water Act (CWA or the Act). This law, in conjunction with our state laws, forms the basis and framework for our water quality regulatory program today. The objective of the law was, "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."

The Clean Water Act lists several goals and policies in Section 101 which show the Congressional intent for the Act. The best known is the goal that, "discharge of pollutants into navigable waters be eliminated by 1985." This goal wasn't reached, of course, but it still should be used as a principle for permitting. The Act had an interim goal for July 1, 1983: "water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water". This is known as the, "fishable, swimmable" goal.

Congress also recognized the issue of toxics and declared it "national policy that discharge of toxic pollutants in toxic amounts be prohibited".

Other policies in the Act addressed Federal financial assistance, area wide waste management plans, research and demonstration projects.

The Act also contains 4 important principles:

- Discharge of pollutants to navigable waters is not a right. A permit is required to use public resources for wastewater disposal.

- The discharge permit limits the amount of pollutants to be discharged.

- Wastewater must be treated with the best treatment technology which is economically achievable--regardless of the condition of the receiving water.

- Effluent limits are based on treatment technology but more stringent limits may be imposed if the technology-based limits do not prevent violations of water quality standards in the receiving water.

More specifically, the Act created a system for permitting wastewater discharges (Sec. 402). This system is known as the National Pollutant Discharge Elimination System (NPDES). The objective of this system is to implement the goals and policies of the Act.

Section 306 provided for the creation of federal standards of performance for wastewater treatment. This eventually resulted in effluent guidelines for major categories of industries.

Enforcement is provided in Section 309 of the Act. Both procedures and penalty amounts were explicitly stated. This strong enforcement language was also a major departure from previous legislation.

In 1973, Washington State's water pollution control law (Chapter 90.48 RCW) was amended to enable the state to apply to EPA for authority to administer the NPDES program. In November of 1973, Washington became one of the first states to be delegated the NPDES program.

Congress amended the Clean Water Act in 1977, 1981, and 1987. In 1977 the construction grants program was reauthorized, and Congress clarified its intent and focus for toxic pollutants. The categories of conventional and toxic pollutants were defined. The 1987 amendments created a schedule to end the federal commitment to the construction grant program, addressed storm water permits, water quality problems due to toxics, and sludge management. The major philosophical change in these latest amendments is a greater emphasis on water quality-based permitting for toxic pollutants. This assumed that all permits now comply with technology-based requirements.

8. TECHNOLOGY-BASED CONTROL

The permit writer should recognize that the environmental gains in point source pollution in this country in the 1970's and 1980's were largely due to the imposition of technology-based control and it remains the basis for both Federal and State law. There has been some discussion recently about utilizing the assimilative capacity of receiving waters to reduce the cost of wastewater treatment. This contradicts the legislative principles in the Clean Water Act and Chapter 90.48 RCW. Legislative and Congressional Policy recognizes that a manageable and equitable clean water program requires a technology-based program even though the treatment might be greater than required to meet water quality standards. Our stated public policy is to maintain the highest possible purity of public waters by minimizing pollutant discharges to the extent practicable--as opposed to allowing the maximum tolerable level of pollutant discharge.

Federal legislators also adopted a goal of total elimination of the discharge of process pollutants. The time stated for achieving the goal has passed but the language remained through several major amendments to the Act. This "zero discharge" goal obviously requires treatment in excess of that necessary to meet water quality standards.

There is no regulatory mechanism in this state for limiting the number of dischargers on a water body until the cumulative effect of the pollutants cause an interference with a designated use of that water, in other words, a violation of water quality standards. Requiring technology-based treatment, even though the treatment exceeds the requirements necessary to meet the water quality standards, may continually reduce the pollutant load from any source and postpone the necessity of allocating the waste load from each discharge to assure meeting water quality standards.

The technology-based approach also functions as a buffer for our incomplete understanding of the fate and effects of pollutants.

For further discussion of the legal and regulatory background of the permit program see Bellingham v. Ecology PCHB No. 84-211, and *The Clean Water Act of 1987* published by the Water Pollution Control Federation in 1987.

9. WATER QUALITY-BASED CONTROL

The 1987 CWA and subsequent regulation clarified an earlier principle of the CWA. The principle is that if there is determined, by scientifically valid methods, to be a potential for the violation of the water quality standards from a discharge, then that discharge must receive effluent limits. The effluent limits are to assure the effluent does not cause a violation of the water quality standards. The law does not require 100% certainty but requires a judgement of reasonable potential based on a rational process in order to impose limitations.

10. PERMIT WRITERS IMPLEMENT THESE LAWS AND REGULATIONS

The permit writers in the Department of Ecology are primarily located in the four regional offices and in the Industrial Section. Permit writers are engineers or environmental scientists.

The regional staff are responsible for both industrial and municipal permits. The Industrial Section writes permits for the largest industrial dischargers such as pulp mills, petroleum refineries and aluminum smelters.

Permit writers are actually point source pollution control managers with multiple responsibilities, therefore the terms permit writer and permit manager are used interchangeably in this manual.

Permit writers represent the people of the state and the country in limiting the amount of pollutants discharged from point source discharges. They must exercise a considerable amount of discretional authority.

Permit writers should expect to receive criticism from all groups interested in the permit program. Environmental groups often charge Ecology permit writers with not writing strong enough permits, for not keeping permits current and for not enforcing on permits. The regulated community often charges that permit requirements are unnecessary, overly stringent, and expensive.

Permit writers have a large amount of authority and responsibility, and this demands the exercise of good judgement. A good permit writer needs some things that are not in this manual, such as a strong commitment to the Department's mission, an internal sense of self-worth and self-satisfaction, confidence, and a good sense of humor to make it through the white water of the permit program.

11. PERMIT TOOLS

The Water Quality Program and the Environmental Assessment Program have developed several tools to assist permit writers. These tools include model permit language, model fact sheet language and spreadsheets for doing the calculations for water quality-based permitting. These tools are available for permit writers from the Program Development Services Section and are available in Outlook. The spreadsheets and permit shells are located at Outlook/Public Folders/All Public Folders/ECY/Water Quality Shells/. The spreadsheets are also available to the public through the Ecology home page on the Internet at http://www.ecy.wa.gov/programs/eap/pwspread/pwspread.html

CHAPTER II. AN OVERVIEW OF THE PERMITTING PROCESS

This chapter presents an overview of the permit, the permitting process, and permit modification. The regulatory view of a permit and the components of a permit are described. The process of writing a permit is described briefly in text and illustrated by the use of flow charts. The tasks identified within the flow charts are described in detail in subsequent chapters.

1. WHAT IS A WASTEWATER DISCHARGE PERMIT?

In it's simplest conceptual meaning a wastewater discharge permit is a legal document issued by a regulatory body that allows some entity to discharge wastewater. In reality, a wastewater discharge permit represents a complex regulatory program that incorporates hundreds of legal, engineering, and scientific decisions. A simple permit may be just a few pages long but a complex permit may be dozens of pages. A permit package which would give a reviewer a complete picture of the discharge consists of the application, the permit, and the fact sheet. The permit application documentation gives the permit writer most of the information necessary to produce the permit. The application requirements and detailed process are given in Chapter III.

The body of the permit has 3 distinct components:

- The cover page gives the name and location of the facility;
- The effluent limitations, monitoring requirements and other special conditions are in the main body of the permit and are derived for each individual permit or general permit;
- The general conditions are the last several pages of the permit.

Derivation of effluent limits, monitoring requirements and special conditions in permits is covered in detail in Chapters IV through XIII.

The general conditions, sometimes called standard conditions, are exactly the same within each category of permit. General conditions come directly from federal or state law or regulation or court interpretations of those laws and regulations. They are not subject to change by the permit writer. Some general conditions may not be applicable to some permittees because of the circumstance of their discharge but they are not removed from the permit. State wastewater discharge permits for discharge to ground water have different general conditions than wastewater discharge permits for discharge to surface water.

The fact sheet describes the discharge, the regulatory basis of the permit, and the decisions made on the permit. The requirements of the fact sheet and a fact sheet check list are given in Chapter XIV.

Permits are generally issued for the regulatory maximum period of 5 years. The permit writer may have occasion to issue a permit for less than 5 years and nothing prohibits this although dischargers generally prefer a 5-year permit. Permits may be administratively extended past their expiration date for a period of five years if an application for renewal has been properly submitted. The conditions of an extended permit remain in effect and are enforceable. A extended permit may not be modified.

2. THE PERMITTING PROCESS

The major components of wastewater discharge permitting are illustrated in Figure II-1. After receiving the application and making a decision to proceed on a permit, the permit writer reviews the application for completeness and accuracy. When the application is complete the permit writer derives the technology-based effluent limits. This is the core of the permit writer's task. Permit writers must always calculate technology-based effluent limits because they may be more stringent than water quality-based limits. The technology-based effluent limits are compared with effluent limits which are protective of surface or ground water or sediment quality standards (water quality-based limits). The most stringent of the two is placed in the permit. The effluent monitoring requirements and other conditions are placed in the permit. This proposed permit and fact sheet are reviewed internally, by the permittee and the public, and the permit is subsequently issued as a final permit.

The permitting process is illustrated in more detail in Figure II-2. This flow chart illustrates that the major steps of Figure II-1 are actually multistep processes. For example, the task of deriving technology-based effluent limits is separated into BCT, BAT, BPJ and AKART. Figure II-2 also functions as an index to later chapters because the sidebars list later chapters where the processes are discussed.

Figure II-1. Overview of the major components of the permitting process for all dischargers.

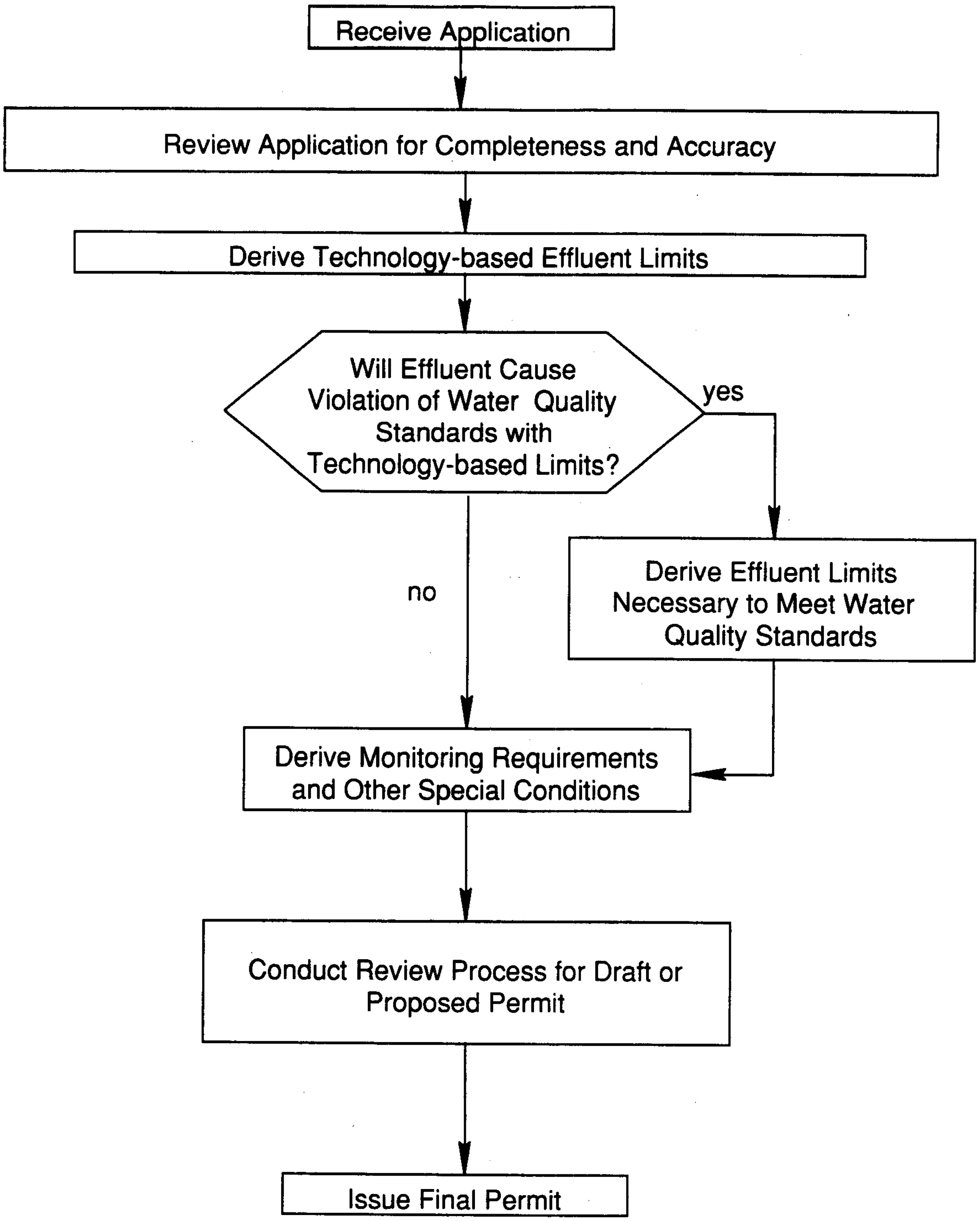

Figure II-2. The permitting process for industrial dischargers.

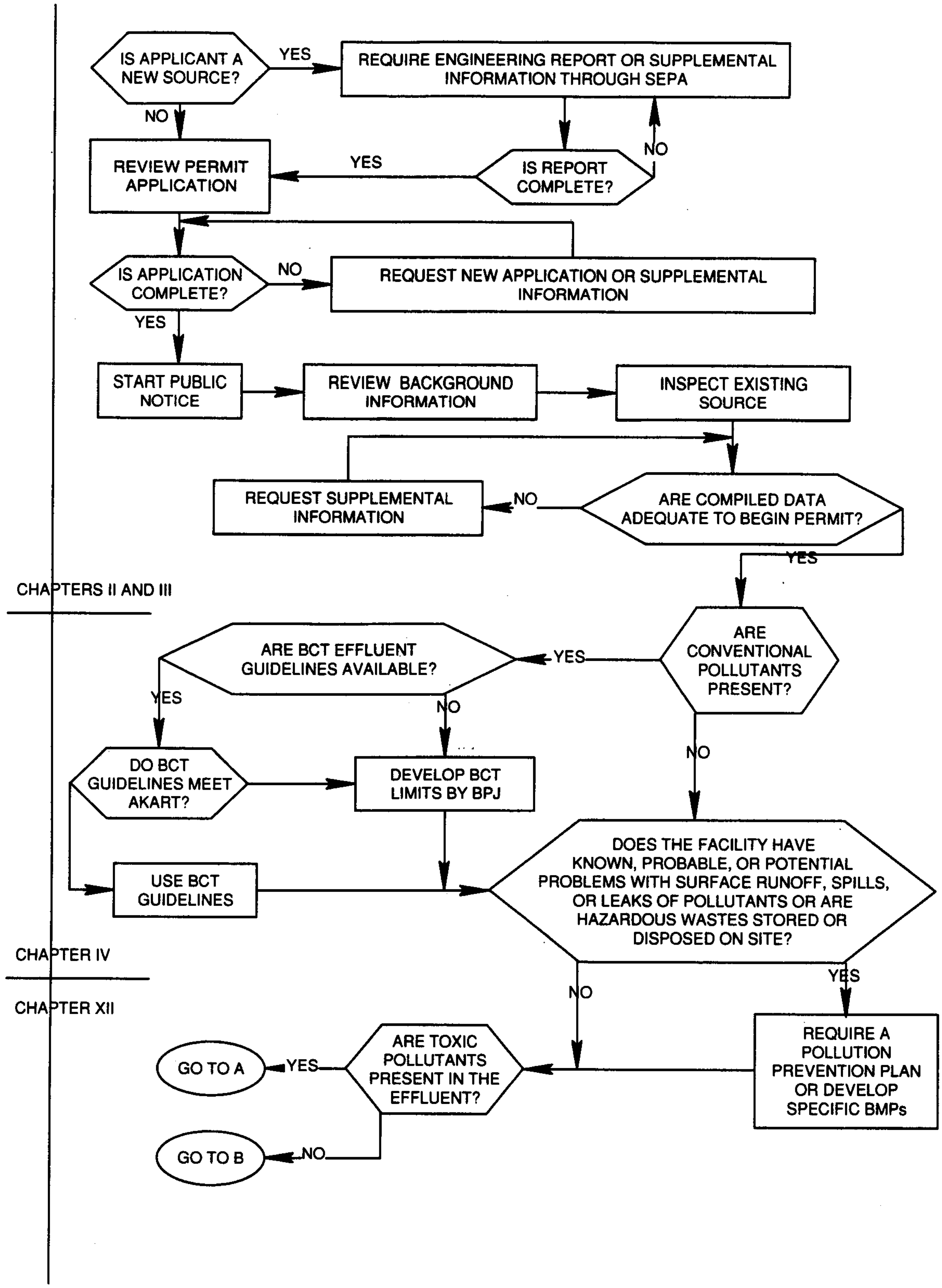

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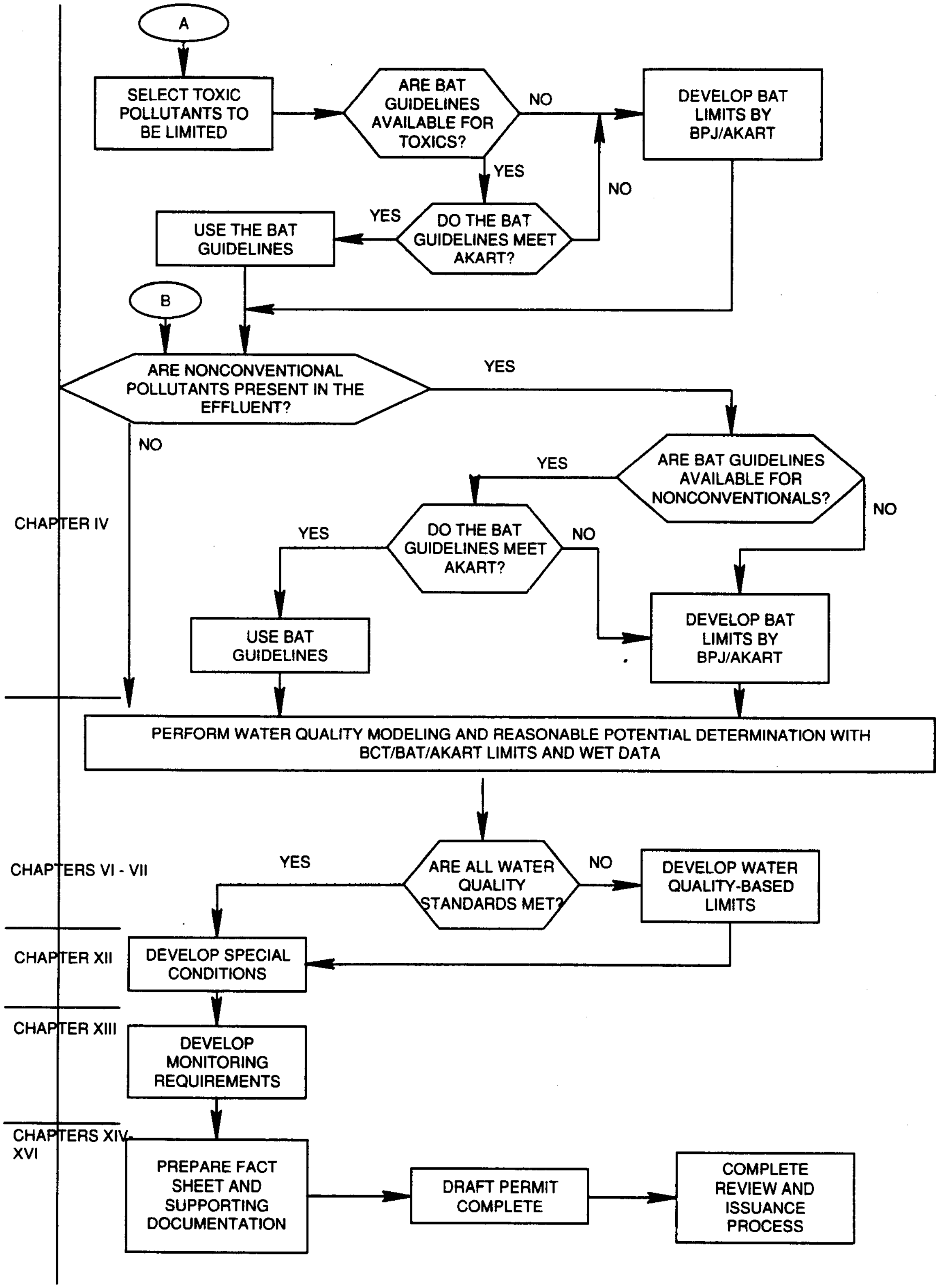
Figure II-2. Cont.



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3. MODIFICATION OF PERMITS

A permit modification may involve many of the same processes as developing a new permit. A term that has become synonymous with permit modification is "reopening the permit". Permit modifications may be initiated by Ecology, by the permittee, by the Pollution Control Hearings Board (PCHB), or by the public. Ecology may modify the permit for any of the causes listed in 40 CFR 122.62. Typically, Ecology modifies permits because of *alterations* of the facility (122.62 (a)(1)) or because of new *information* (122.62 (a)(2)) such as the effluent causing a violation of water quality standards. Other causes for modification are listed in 122.62.

If the permittee or the public wants the permit modified, they submit a letter to Ecology requesting the modification. Ecology may proceed with the modification as requested or deny the request. Any decision by Ecology on the modification may be appealed to the PCHB. When a permit is modified by Ecology, those portions of the permit that are modified are subject to appeal.

When the PCHB requests a permit modification, it is the result of a permit appeal and the PCHB remands the permit back to Ecology for change.

A permit modification may be minor or major. The definition of minor modification is found in 40 CFR 122.63. A permit modification is *minor* if it:

- Corrects typographical errors,
- Requires more frequent monitoring or reporting,
- Changes an interim compliance date in a compliance schedule, provided the new date is no more than 120 days later and it doesn't affect the final compliance date,
- Allows for a change of ownership or control of a facility,
- Changes the construction schedule for a new source discharger,
- Deletes a point source outfall when the discharge from that outfall stops, provided it doesn't cause a change at the other outfall(s), or
- Incorporates conditions of a POTW pretreatment program if the pretreatment program has been subject to public hearing.

Minor modifications do not require public notice but the modifications are sent to the parties of record. Any permit modification which goes beyond the above circumstances is a *major* modification and has the same requirements as a permit renewal including the public notice requirements. Modification does not change the expiration date of the permit.

A permit writer should consider *revocation and reissuance* of a permit when a major modification is required in order to extend the time until renewal. Anytime a permit is modified it may be revoked and reissued if the permittee agrees. Regulations (40 CFR 122.64) allow a permit to be revoked and reissued without permittee agreement for any of the following causes:

- Noncompliance with the permit
- Misrepresentation or failure to disclose facts during application of the permit,
- Discovery that the discharge is endangering human health or the environment,
- A change in any condition that requires either a temporary or permanent reduction or elimination of any discharge or sludge use or disposal practice controlled by the permit (for example, plant closure or termination of discharge by connection to a POTW).

When a permit is revoked and reissued the whole of the permit may be appealed.

4. GENERAL PERMITS - NEW AND RENEWAL

General permits are NPDES/state or state wastewater discharge permits that are developed for a category of discharger instead of an individual facility. General permits may be cost effective for the permit manager's time because of the large numbers of facilities that can be covered rapidly with a general permit. When deciding whether to do a general permit, consider the following:

- Are there a large number of facilities to be covered?
- Do they have similar production processes?
- Do they have similar process pollutants?
- Do only a small percentage have potential for water quality standards violations?

The decision to do a general permit is made after section or program deliberation and a program management decision.

5. THE GENERAL PERMIT DEVELOPMENT PROCESS

The following is the step-by-step process for developing a general permit.

- Identify a category of dischargers for the development of a general permit. The permitting section and the Water Quality Program must concur on the development of the permit.

- Post a public notice of the department's intent to develop a general permit.

  The scope of this public notice is largely left up to the permit manager, but must be done so as to inform interested and potentially affected persons.

  All persons who express an interest in the permit may request to be placed on a mailing list to receive notices of the draft and final permit.

  Start another mailing list. The list could be the same as the permit list above, or it could be the existing regional "interested persons" mailing list, or a new list specific to each general permit. The list will consist of people who want to know who is being covered under the general permit.

  If Ecology decides not to develop a general permit after the public notice of intent to issue a general permit, then Ecology will publish a notice to that effect.

- Draft the general permit, fact sheet, and application for coverage.

  The terms and conditions of a general permit are similar, and are developed in manner similar to the terms and conditions contained in an individual permit. The process includes, at a minimum, characterization of pollutants in the wastewater and the development of technology-based effluent limitations. General permits do not contain any site-specific or facility-specific requirements.

  A fact sheet is drafted on the general permit only, fact sheets will not be written for the facilities requesting coverage under a general permit.

  A separate application for coverage will be developed for each general permit.

- For NPDES and combined NPDES state waste discharge general permits only, the draft general permit, fact sheet and application for coverage must be submitted to EPA for a 90-day review.

- Prepare a small business economic impact analysis on the general permit. Contact the Water Quality Program Economist for assistance with this analysis.

- Complete a public notice, fact sheet, application for coverage, and the small business economic impact statement for the draft general permit. The public notice of the draft general permit includes:

  Publication of a short summary of the permit and the small business economic impact statement in the state register.

  Holding a minimum of one public hearing on the proposed general permit within the area covered by the general permit.

- After the close of the public comment period, prepare a response to comments and make any required changes to the permit as a result of comments received on the general permit. The response to comments becomes an attachment to the fact sheet.

- A public notice must be completed for the issuance of all general permits. A general permit is issued when signed by the program manager or appropriate regional water quality section head. Public notice of the issuance of a general permit must be done in a manner similar to the public notice of the draft permit, including publication in the state register.

- A general permit takes effect 31 days after a notice of the issuance of the general permit is published in the state register.

- Applications for coverage under a general permit:

  May be submitted any time following the public notice of the draft general permit, or at a later date as specified by the department.

  Do not require public notice unless the application is from a new operation or for operations previously under permit for which an increase in volume or a change in the character of the effluent is requested.

- Coverage under a general permit is automatic on the latter of the following:

The effective date of the permit;

31 days following the end of any public notice and public comment period on an application for coverage under the general permit;

31 days after receipt of a completed application for coverage; or

After a date specified in the general permit.

- Periodically, a list of facilities which have requested coverage under the general permit must be mailed out to people who have expressed an interest in who is being covered under the general permit. The frequency for listing these facilities should be proportional to the number of applicants but should not be less than once a year.

6. QA PROCESS

The consistency check for all proposed and draft permits will be performed through a combination of pre-issuance reviews at the originating section and at the Program Development Services Section (PDS).

The following procedure for centralized quality control associated with permit issuance was established by a memorandum from the Water Quality Program Manager (April 8, 1994). In recognition of factors unique to each office, implementation details of the required procedures for in-office internal quality assurance are left to each issuing office. The centralized quality control process will be adhered to for all NPDES and state waste discharge permits and major permit modifications issued by the Water Quality Program, Toxic Cleanup Program, Nuclear and Mixed Waste Management Program, Central Programs, Hazardous Waste and Toxics Reduction Program, and any other program issuing wastewater permits under the authority of RCW 90.48. Orders to be issued under the authority of RCW 90.48, which establish interim effluent limits, will also be submitted to the PDS for a quality control check. Actions initiated as "substantive requirements" of water quality permit requirements under CERCLA or MTCA will also undergo centralized quality control. Any variations to this procedure must be approved by the signatory authority who will convey the reason or cause for the variation to the WQP Manager prior to adoption of the specific procedure and issuance of the permit.

- Responsibility for Quality Permits

The ultimate responsibility for the content and quality of a permit rests with the supervisor signing the permit. The unit supervisor and the permit writer are responsible for briefing the supervisor signing the permit on all significant issues raised from central QA review, any EPA review, written review, and from an oral presentation. The resolution of these issues will be explained by the unit supervisor and the permit writer.

- Resolution of Disagreements

Disagreements on significant issues may occur between the PDS Permit QA Coordinator and the permit writer. A conference call or meeting involving the relevant unit supervisor, permit writer, and the QA Coordinator will be the first step towards resolution. If resolution does not occur, a conference call involving the relevant section supervisor and the PDS Supervisor will occur. The final decision rests with the permit signature authority. The supervisor with signature authority and the PDS supervisor will determine the need for further management involvement in the decision.

- Pre-Issuance Review

Peer Review through Document Distribution: Internal peer review of all Water Quality Program draft permits, modifications, and relevant orders will take place within the section or regional office. The draft permit and fact sheet are assigned to one or more other permit managers for comments and suggested changes and additions. Wastewater permits prepared by any program headquarters staff will be reviewed by the WQP PDS and regional staff, as appropriate. Cross-region and cross-program review is encouraged.

Peer Review through Oral Presentations: Peer review of most industrial and municipal permits through an oral presentation will occur at the local regional office, at a permit writer training session, or other suitable forum prior to issuance of the permit. Draft permits and other permit-like documents prepared by other programs will be presented at the regional office or other suitable in-house forum.

The oral presentations will be scheduled at least one week in advance. All Ecology wastewater permit writing programs and WQP regional sections are to be notified by the permit coordinator in advance, and all parties who express an interest are to receive a draft version of the permit and fact sheet prior to the presentation (The permit may still be under development so the content at the time of the presentation may vary).

PDS Central Permit QA/QC Review: Submittal of draft permit, any associated compliance order, fact sheet, and the permit application for PDS Central Permit QA/QC Review to the QA Coordinator in the PDS will occur prior to the Public Notice of Draft (PNOD). Ten days (two weeks) will be allowed for the quality control check of minors and three weeks will be allowed for major permits. The EPA review and PDS quality control check period should take place concurrently and before entity review for majors and general permits. Central quality control review will take place during or prior to any entity review period for state and minor permits.

The permit QA Coordinator will be reviewing as many permits as possible for consistency and fulfillment of policy, procedural, and legal requirements. The permit QA Coordinator will provide assistance to the permit writer in the form of constructive suggestions and advice on addressing relevant policy issues. A key role of the QA Coordinator will be to identify areas of inconsistency requiring new or revised policies, procedures, and guidance. Areas where lack of policies, procedures, and guidance are causing inefficiencies in permit issuance will be identified for management attention.

The PNOD may proceed after consideration of comments received from the peer reviews, central QC check, any EPA review peer reviews and compliance with the pre-issuance review procedures.

- Post Issuance PDS Central Review

  The QA Coordinator will randomly review final permits after issuance for consistency, use of common guidelines, and incorporation of internal and external comments. Special attention will be given to review of permit elements that are driven by new requirements.

- Communication of Findings

  When issues emerge that are of interest to permit managers, the permit QA Coordinator will communicate the issues to permit managers through memos, newsletters, training sessions, and other appropriate methods. Recommendations for changes to the permit shells will be routed to the chair of the Permit Writers' Work Group for inclusion in the shell update process.

  Issues involving the efficiency of permit writing and issues needing policy determinations or procedural guidance will be elevated immediately to program management by the PDS Supervisor.

  A summary of issues will be prepared by the Permit QA Coordinator and distributed prior to each permit writer training session. A discussion period may be scheduled at the session.

Issues that are specific to organizational units and that require supervisory attention will first be discussed with the appropriate unit supervisor and, when necessary, elevated to the PDS supervisor for resolution.

7. REVIEW BY PERMITTEE

Procedures

1. Permit writers shall inform permittees of significant changes to their renewed permits as early as possible in the permitting process.

2. The proposed fact sheet or permit and fact sheet shall be forwarded to the permittee for comment at least 30 days prior to the beginning of the formal public review period.

3. The permittee shall be made aware that the proposed permit conditions could be changed during the public review process.

4. The draft permit transmittal letter shall specify a date certain by which comments are due, and be clear that the permit issuance process will not be delayed if the date is not met.

5. For permit renewals with significant new changes, an opportunity for a meeting to occur two weeks or more after forwarding the proposed permit or fact sheet shall be offered to the permittee. The purpose of the meeting is to explain new or changed requirement, receive comments on factual content, and discuss the practicality of compliance schedules.

Waste discharge permits are now very complex documents, and new more complex requirements in reissued permits have become the norm. It is extremely important that effective permittee outreach occur to inform permittees of significant changes proposed in their permit as soon as possible. It is also important that the proposed permit and fact sheet be factually correct with respect to facility information such as discharge locations, and process description prior to the public review.

The permittee needs to know what the new permit requirements are and the basis for the requirements. The practicality of any proposed compliance schedules also needs to be discussed with the permittee prior to setting a proposed schedule in the public review draft.

Ecology is committed to implementing a more effective public involvement program and strongly supports public involvement in the review of and input on permit conditions during the public review.

If, during the public review period, members of the public wish to meet with Ecology staff to discuss new permit requirements and their basis, such a request should be granted. Early permittee involvement ensures a correct draft permit for public review and avoids unnecessary delays in the public issuance process. It also ensures that permittees are informed of the proposed permit requirements in a timely manner. The public has full access and opportunity during the public notice process to participate in the permit process.

8. EPA REVIEW

Draft individual NPDES permits for major dischargers should be sent to the EPA Washington Operations Office for review only during the public review process.

9. AN EXAMPLE PERMIT

New permit writers who are not familiar with permits should review several recent permits from their section files or contact the QA/QC person for some exemplary permits.

10. THE WATERSHED PROCESS

The Water Quality Program adopted the watershed model for issuing permits in 1993. Ecology is also currently adopting an agency watershed implementation model. When the agency/program model is completed it will be described here. In the interim permits will continue to be issued on a five year cycle in the Water Quality Program watersheds.

CHAPTER III. THE APPLICATION AND BACKGROUND REVIEW

This chapter covers the process of permit application and background review including categories of application, forms, and time frames for application. A flow chart showing the tasks for permit writers is included at the end of the chapter. The objective of permit application and background review is for the permit writer to become as knowledgeable as possible about the circumstances of discharge and the characteristics of the proposed effluent discharge.

1. WHO NEEDS PERMITS

Anyone who owns or operates a facility discharging or proposing to discharge wastewater to the state waters must apply for a wastewater discharge permit. State and Federal regulations require a facility to apply for a permit to discharge to surface waters at least 180 days prior to the initial discharge. This is not enough time to work through engineering reports for new dischargers or complex issues for existing dischargers. Permit writers should alert their permit applicants to the realistic schedules for permit issuance and renewal. Major permittees should be sent applications at the beginning of the fiscal year in which their permit expires. Most permits are now scheduled well in advance with the watershed process.

Application for a state waste discharge permit must be made 60 days prior to the date on which it is desired to begin discharge but for complex discharge situations 60 days is insufficient time to develop a permit.

Anyone who discharges wastewater or has a significant potential to discharge wastewater to the surface waters of the state must obtain a joint NPDES/state wastewater discharge permit (40 CFR 122.3). Ecology issues joint federal/state permits because the state's water pollution law requiring wastewater discharge permits preceded federal law.

Those exempted from obtaining an NPDES individual permit include:

- Anyone discharging domestic sewage only to a POTW,
- Anyone who is covered by a general permit,
- Discharge of sanitary sewage from vessels,
- Anyone discharging industrial and commercial wastewater to a POTW,

- Discharges of pollutants from nonpoint source agricultural and silvicultural activities,
- Return flows from irrigated agriculture,
- Any discharge in compliance with the instructions of an On Scene Coordinator, and
- Any discharge occurring under CERCLA (but discharges must meet substantive requirements)

State wastewater discharge permits are required by:

- Anyone who discharges waste materials from a commercial or industrial operation to the waters of the state or to a municipal sewage system (RCW 90.48.160) and,
- Any county or any municipal or public corporation operating or proposing to operate a sewage system which results in the disposal of waste material into the waters of the state (RCW 90.48.162).
- All lagoons containing wastewater, lined and unlined, require state waste discharge permits.

The exemptions for the requirement for state waste discharge permits include:

- Discharges to municipal sewerage systems of domestic wastewater (sanitary wastewater) from residential, commercial, or industrial structures;
- Any discharge to a municipal system which is already permitted (subject to review and limitation) by the local authority;
- Any discharge to a municipal system which is already permitted under a local pretreatment program (FWPCA sec.307).
- Discharges to municipal sewerage systems from commercial or industrial operations if the waste strength and characteristics are the same as domestic wastewater (if it's not easily degradable or if its high strength, then the permit writer should examine it in the permit process to assure the waste will not cause an upset at the treatment plant);
- Discharges which have an NPDES/state individual or general discharge permit for

discharge to surface water;

- Discharges from small on-site septic systems (design capacity less than or equal to 14,500 gallons per day) which discharge to the ground;

- Discharges from small (less than or equal to 3,500 gallons per day) aerobic, domestic treatment plants which discharge to the ground.

- Discharges during oil spill cleanup which have received prior authorization from Ecology.

- Discharges under the State of Washington Model Toxics Control Act.

- Discharges from LUST sites and vehicle and equipment washing under some circumstances (see below).

1.1 NPDES Permit Requirements for Non-discharging Facilities Which Have Zero Discharge Limitations in Effluent Limitation Guidelines

Federal law is clear that any discharge of pollutants to surface waters of the United States requires an NPDES permit. Federal regulations [40 CFR § 122.21(a)] also impose on any facility that "discharges or proposes to discharge" a clear "duty to apply" for an NPDES permit. EPA has issued guidance interpreting these regulations to impose a further duty to apply on certain facilities (such as concentrated animal feeding operations) that have a "potential to discharge." However, facilities that do not discharge, do not propose to discharge, and do not have the potential to discharge have no obligation to apply for or to obtain NPDES permits.

EPA has developed categorical effluent limitation guidelines for a number of industries. The purpose of these guidelines is to establish for these categories the minimum technology-based requirements in terms of effluent limits in NPDES permits. A number of these federal effluent limitation guidelines (such as those for the Wood Preserving – Boulton Subcategory [40 CFR Part 429, Subpart H] and the Sawmills and Planing Mills Subcategory [40 CFR Part 429, Subpart K]) establish "zero discharge" requirements for process wastewater pollutants. Federal regulations require permits and permit applications from these facilities if they propose to discharge or have the potential to discharge to surface waters.

A facility subject to a "zero discharge" effluent limitation guideline may seek NPDES permit coverage to take advantage of the "unavoidable bypass" and "upset" defenses available to facilities with NPDES permit coverage. To the extent that the facility operator is "proposing to discharge" during these bypass and upset events, such a permit application is appropriate (and may in fact be required by 40 CFR § 122.21(a)).

However, some facilities subject to effluent limitation guidelines may (because of topography, process, etc.) have no potential to discharge pollutants to waters of the United States. For these facilities, Ecology has decided to follow the process demonstrated in practice by EPA Region 10. No permits will be issued solely because the facility falls within a zero discharge subcategory. If the determination is made that there is a substantial probability of process water discharge to surface waters, an individual NPDES permit may be issued.

1.2 Independent Leaking Underground Storage Tank (LUST) Cleanup Sites

Independent Leaking Underground Storage Tank (LUST) cleanup sites are allowed an exemption from permits for short term discharges that meet high treatment standards. The following conditions apply:

- The proponent must submit a letter to Ecology. If the discharge is to a POTW, a copy of the letter must be delivered to the POTW. The letter shall include the following items:

    1. A project description, including treatment method, disposal method, rate of discharge (gpm), dates of discharge, and duration of discharge (days).
    2. Analytical data from an accredited laboratory showing analysis of pollutants of concern (see Table C following) from the proposed treatment system.
    3. A street map indicating the extent of the site, location of the treatment equipment, address of the site, and point of discharge to the sewer or storm drain.
    4. The name and telephone number of the project manager or person who should be contacted about the project.

- All discharges to ground water at LUST cleanup sites must also register with the state Underground Injection Control (UIC) program. The UIC coordinator will evaluate the registration and will refer the owner/operator to the regional permit coordinator if a permit is required.

- All long term discharges (>60 days) to surface waters must contact the regional office.

- All **long term** dischargers to ground water must submit an engineering report which includes a hydrogeological investigation.

- The facility must notify Ecology when the discharge stops or effluent quality meets level 2 and a permit is no longer required.

- For Independent LUST sites involving gasoline or diesel (only) go to Table A if there is a short-term discharge (<60 days), otherwise go to Table B for discharges longer than 60 days.

Table A
Short Term <60 day Discharge

Discharge Location	Conditions	Permit Type
Surface Water	Meet Table C level 1 treatment Local approval required if discharge is to municipal stormwater system	No permit required. These are typically tests of treatment methods.
POTW	Meet Table C level 1 treatment Local approval required	No permit required
Ground Water, hydraulically contained* on-site	Meet Table C level 1 treatment	UIC registration only No permit required
Ground Water, but not contained on-site	Option A: If meet Table C level 2 treatment Option B: Meet Table C level 1 treatment	UIC registration only No permit Temporary permit Discharge to an injection well is not allowed

*Hydraulically contained means that recharge rates are matched to local hydrogeologic conditions and pumping rates so the recharge fluid does not leave the site boundaries, but is recycled back to the pumping wells.

Table B
Long Term ≥60 day Discharge

Discharge Location	Conditions	Permit Type
Surface Water	Meet Table C level 1 treatment Local approval required if discharge is to municipal stormwater system	NPDES - Model Permit
POTW	Meet Table C level 1 treatment Local approval required	State Industrial User (IU) Temporary Permit
Ground Water, hydraulically contained on-site	Option A: Meet Table C level 2 treatment Option B: Meet Table C level 1 treatment	UIC Registration - No permit Temporary Permit
Ground Water, but not contained on-site	Meet Table C level 2 treatment	Temporary Permit

A facility manager may require a permit in a situation that otherwise may be exempted if monitoring and reporting is required.

Table C
Discharge Quality Maximum Concentration Levels

Parameter	Level 1	Level 2
pH	6.0 -9.0	6.5 -8.5
TPH-G	1 ppm	1 ppm
TPH-D	10 ppm	1 ppm
Total Lead	5.0 ppb	5.0 ppb
BTEX	100 ppb	N/A
Benzene	5.0 ppb	1.0 ppb
Toluene	N/A (see BTEX)	40 ppb
Ethylbenzene	N/A (see BTEX)	30 ppb
Xylene	N/A (see BTEX)	20 ppb

Level 1 limitations are performance and technology based (MTCA method A for lead).
Level 2 limitations are based on the ground water standards or MTCA method A value, whichever is more stringent.

1.3. Vehicle And Equipment Washing

Ecology will generally not require discharge permits for vehicle or equipment wash water to ground, to POTW's, or if it is non-discharging or regulated by the hazardous waste program. Instead of a permit, Ecology relies on education and outreach for these types of discharges. This education and outreach approach relies on the business community's cooperation in using Best Management Practices identified in *Vehicle and Equipment Washwater Discharges* (WQ-R-95-56). Permit writers should observe the following:

- A state wastewater discharge permit will not be issued to cover vehicle/equipment washing operations described in *Vehicle and Equipment Washwater Discharges* (WQ-R-95-56) if they are using BMPs consistent with this document.

- A state wastewater discharge permit may be issued under exceptional circumstances, such as, for a discharge to the ground over a sole source aquifer where there is reason to believe that the discharge needs to be controlled to protect the ground water resource. Also, where there is an obvious non-compliance with the appropriate BMPs, Ecology may require a wastewater discharge permit to prevent and/or control pollution from the discharge.

- Discharges to surface waters or to storm sewers require individual NPDES permits, however, in order to avoid the resource intensive process for an NPDES permit, alternatives to surface water or storm sewer discharges should be strongly encouraged where appropriate. Permits should only be issued where absolutely necessary to control pollution.

1.4. Petroleum Bulk Plants, SIC 5171

Facilities with product storage over 100,000 gallons should be issued an individual NPDES or State wastewater discharge permit. A model permit (NPDES Bulk Tank Farm Permit Shell-01.dot) is available in Outlook.

Facilities with product storage under 100,000 gallons are usually covered by the industrial stormwater general permit with a companion order to cover any monitoring and reporting requirements. An individual permit may also be issued.

2. APPLICATION FORMS

When it is determined that a facility needs a permit, the facility must make an application for a permit, however the determination is an appealable action and the facility must be allowed time to appeal. Applications are made on forms which are specific to the type of discharge. Discharges to surface waters are usually made on federal NPDES forms as shown in Table III-1.

There are also application forms for state waste discharge permits. These include:

- Application for POTW Discharges to Land,
- Application for Industrial Discharge to Land, and
- Application for Industrial Discharge to POTW (for POTWs without a delegated pretreatment program).

A general instruction page is used with each of these state application forms.

In the past an applicant could renew a permit by submitting a letter stating there had been no significant change at the facility during the term of the expiring permit. Federal Regulation changes in 1980 no longer allow the use of these letters for NPDES permits. An applicant must apply on a permit application form as given in Table III-1 or it's equivalent.

There is nothing in regulation that prohibits alternative applications as long as the minimum amount of information submitted is equivalent to that required by the federal application form. This is sometimes an issue for new facilities that submit engineering reports. An engineering report prepared in compliance with WAC 173-240 will have all of the information in the body of the report that is required on the permit form. In this case it is allowable to have the facility make out the first page, sign it, and attach it to the engineering report.

Table III-1. NPDES AND STATE PERMIT APPLICATION FORMS

Federal Forms

TYPE OF FACILITY	FORM
Municipally Owned Wastewater Treatment Plants	Form 2A
Commercial Facilities	
1. New Source	Forms 1 and 2D
2. New source with discharge of non-process waste water only	Forms 1 and 2E and follow up data
Industrial Facilities	
1. New Source	Forms 1 and 2D
2. New Source with discharge of non-process waste water only	Forms 1 and 2E and follow-up data
3. Existing Source	Forms 1 and 2C
4. Reapplication	Forms 1 and 2C
Mining	
1. New Source	Forms 1 and 2D and mining plan
2. Reapplication	Forms 1 and 2C
Feedlot	Forms 1 and 2B

Table III-1. (Cont).

Fish Hatchery	Forms 1 and 2B
Water Treatment	Forms 1 and 2D
Storm Water	Form 2F

State Forms

Industrial Discharge to Land	Ecology form 040-179
Industrial Discharge to a POTW	Ecology form 040-177
POTW Discharge to Land	Ecology form 040-178
Industry to Industry	Ecology form 040-177

3. APPLICATION PROCESS

The process of applying for a wastewater discharge permit is often frustrating for both the applicant and the permit writer. The key to making it go as smoothly as possible is to communicate the requirements for application as early and as in as much detail as possible. Many large industries are very knowledgeable about the permit process and only need direction on their specific application process. Smaller dischargers may require some background information on application requirements. For example, many smaller dischargers may not be familiar with the objective and process of whole effluent toxicity testing. The NPDES requirements for permit application are given in 40 CFR 122.21. The processes of application and background review are illustrated in Figures III-1 and III-2.

The permit application is reviewed by the permit writer for completeness and accuracy. Reviewing an application for completeness is a fairly simple task but there's only one way to do it. Go over it item by item, making sure each blank is filled in. Each part of the form should have the requested information or an indication that it is not applicable. The instructions for both the EPA forms and the state forms instruct the applicant to place an "NA" in a blank to show it has been considered but is not applicable. Many times an application is incomplete and the question is how to deal with it. Do not fill in any information yourself unless it's information commonly available from public sources. Substantial time is saved by simply getting the information over the telephone and then writing in the answer. This information will not be certified as correct by the person who signed the application. Send the application back to the applicant for completion if there is any uncertainty. This is the legally correct procedure.

Figure III-1. Permit Application Review

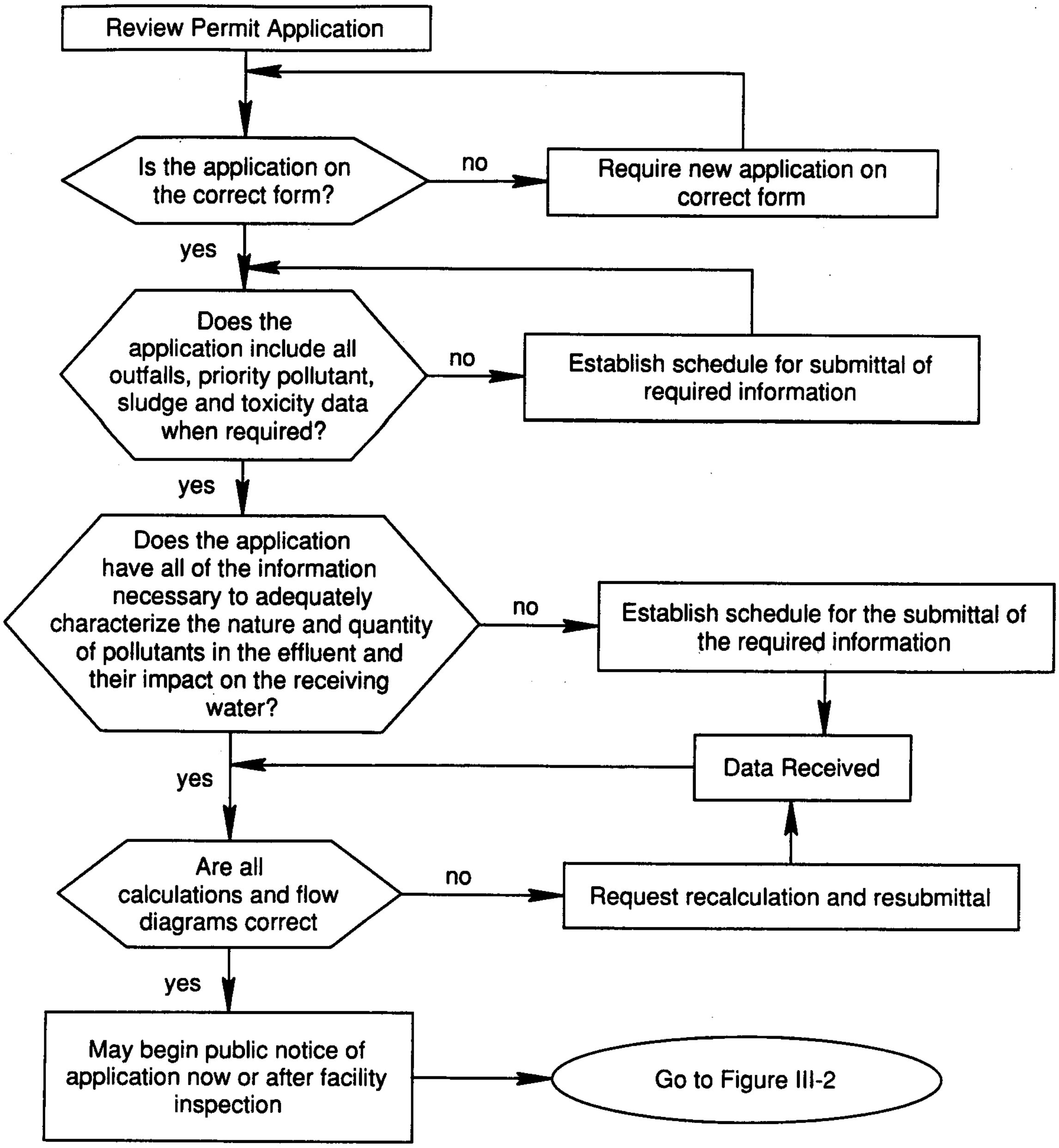

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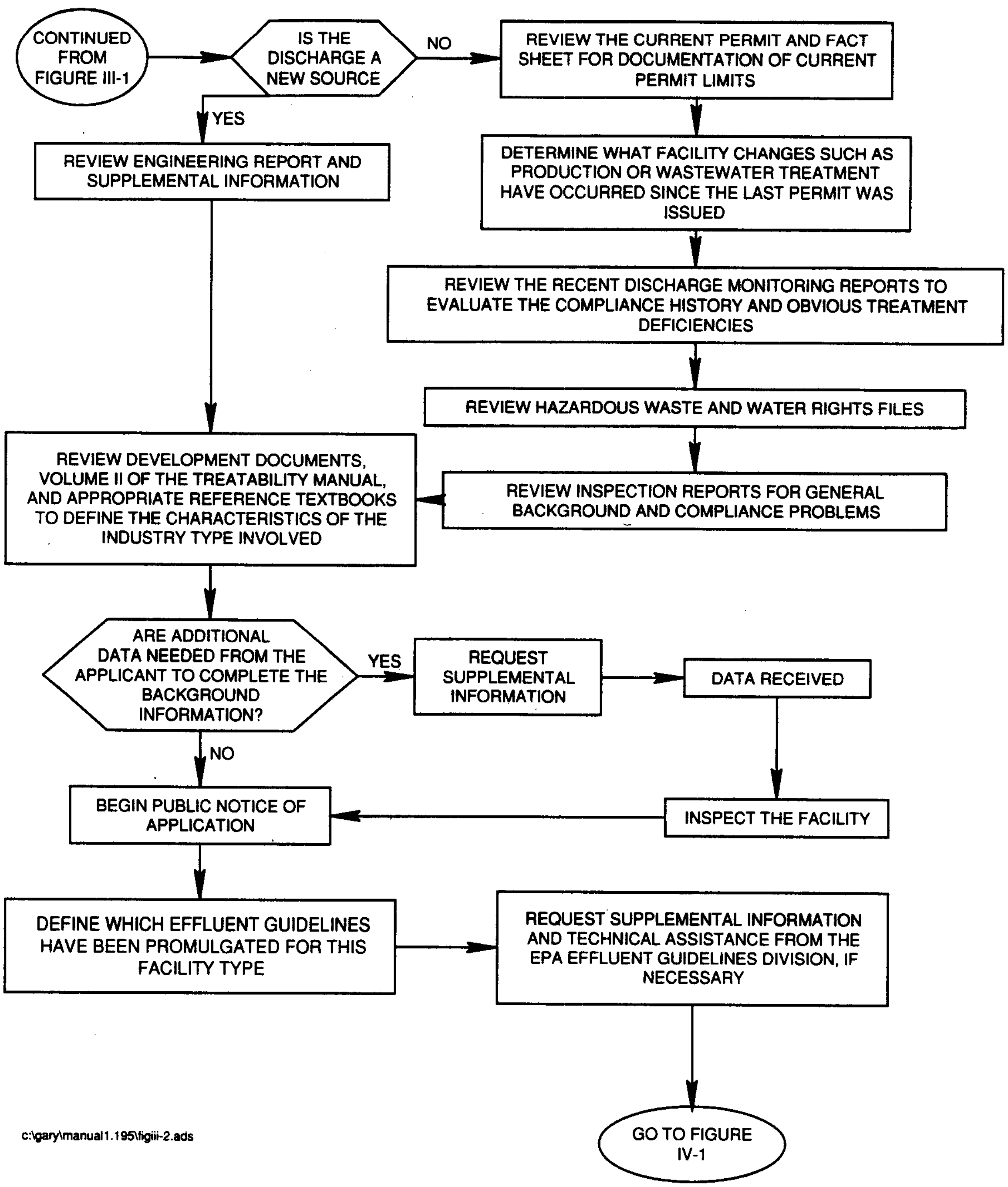
Figure III-2. Background Information Review



Some requirements that are often overlooked in applications are:

- Grab samples must be used for pH, temperature, cyanide, total phenols, residual chlorine, oil and grease, fecal coliform, and fecal streptococcus. All others are collected by 24-hour composite unless waived by Ecology. If the 24- hour composite sampling is waived, the applicant is then required to collect a minimum of 4 grab samples which are representative of the effluent. The 4 grab samples can be combined for analysis.

- Every applicant must submit data for BOD, COD, TOC, TSS, Temperature (winter and summer) and pH. Ecology may waive these test requirements if the applicant can demonstrate they are not necessary for characterizing the effluent.

- Primary industries have some mandatory testing requirements for toxic pollutants (40 CFR 122.21 Appendix D, Table I and Table II; also listed in Application Form 2C). Primary industries that are also small businesses [122.21(g)(8)] may be exempted from these testing requirements. Existing dischargers who believe certain pollutants may be present in their effluent must test for those pollutants (122.21 Appendix D, Table IV, Table V).

- Municipalities also have some mandatory application requirements for whole effluent toxicity and sludge. POTW's larger than 1 MGD or those with pretreatment programs are required to submit valid whole effluent biological toxicity testing. This requirement may be satisfied if the expiring permit contains a requirement for effluent characterization of whole effluent toxicity (see Chapter VI, Part 5). The permit writer should note the use of this option in the fact sheet.

The following are application requirements for municipalities under the form 2A.

NPDES Application Testing Requirements for municipalities < 0.1 MGD (a minimum of three values for each parameter collected within 4.5 years prior to submission of the application)

pH (min and max)
Flow rate
Temperature (Winter and Summer)
BOD (or CBOD)
Fecal Coliform
Total Suspended Solids

Additional NPDES Application Testing Requirements for municipalities ≥ 0.1 MGD (a minimum of three values for each parameter collected within 4.5 years prior to submission of the application).

Ammonia
Total Residual Chlorine
Dissolved Oxygen
Total Kjeldahl Nitrogen
Nitrate plus Nitrite Nitrogen
Oil and Grease
Phosphorus (Total)
Total Dissolved Solids

NPDES Additional Application Requirements for municipalities ≥ 1.0 MGD or with Pretreatment Program (a minimum of three values for each parameter collected within 4.5 years prior to submission)

Metals, Cyanide, Phenols, and Hardness
Volatile Organic Compounds
Acid-extractable Compounds
Base-neutral Compounds
Toxicity Testing:
quarterly testing in past year using two species
or
results from four acute or chronic tests performed at least annually within the four and one half years prior to application.

Upon request the applicant must submit other information which may be needed in deciding whether to issue a permit. The requested information may include additional quantitative data on the effluent or receiving water.

3.1 Reviewing an Application

When a permit application is completed it must be reviewed for accuracy. The accuracy of the permit application can be assessed by checking the numbers on the application, and, for existing dischargers, by reviewing the files and inspecting the facility.

- Everybody makes mistakes in arithmetic. Review the concentrations of pollutants reported in the effluent to make sure they're reasonable. Then add the flows to ensure the total is correct, and then do the mass loading calculations.

- Check the files for information. If the application is for an existing facility there is probably a large amount of information in the files. A reporting facility will have a previous permit file, discharge monitoring reports, correspondence and inspection reports.

In addition to the water quality files, there may be some good information in other files such as the Dangerous Waste files. The Dangerous Waste Regulations (Ch. 173-303 WAC) require anyone who generates, transports or treats dangerous waste to have an EPA/state identification number and to report their activities annually. There may also be some inspection reports in this file. The information in this file may indicate some pollutants or problems that need attention in the permit process. (See Section 8, following, which discusses the domestic sewage exclusion for hazardous waste.)

- Check to see if the facility has a water right and if it corresponds to the water use in the application.

- If you're new to the office, check with the complaint inspectors to see if there is a history of complaints on the facility.

- Check any additional information available on similar types of discharges (EPA Development Documents) to see if the reported effluent concentrations seem reasonable.

- Check with other permit writers in the agency who have permitted this type of facility to see if there are any special considerations in the application process.

- Inspect the facility. An existing facility that is being permitted should be inspected at least once, except those being permitted under a general permit. A facility inspection acquaints you with the facility, the people you'll be dealing with, and verifies the information in the permit application. If you're not an experienced inspector, review the Ecology Inspection Manual beforehand.

The things you want to determine or verify during this inspection are:

- The application's accuracy in describing the production processes,

- The number and type of outfalls (storm drains are frequently omitted),

- The raw materials and chemicals used,

- The operation and maintenance of the treatment equipment,
- Production, and
- The company attitude toward environmental compliance

Go over the facility from roof to basement. Air pollution equipment may be discharging pollutants to the roof, which washes off in the rain. Piping in basement areas may be neglected and have a potential for leakage. Pay particular attention to those things such as the need for spill prevention and housekeeping which can be used as preventative mechanisms in permits but which aren't described very well in permit applications. Take photographs of key processing areas or problem areas.

For those permit managers who have been dealing with a facility for a long time, this is a good time to take a fresh look and ask all the questions that you would ask if you were seeing the facility for the first time.

You may wish to include a sit-down meeting at this time to discuss the general direction of the new permit and any new regulatory requirements that might be included in the permit. Avoid discussion of specific numbers at this time.

If you have discovered inaccuracies in the application, point out the need to get correct information. Remind them of the statement on the signature block of the application if necessary.

4. APPLICATION AND EXPIRED PERMITS

4.1 NPDES

If a permittee has made "timely and sufficient application" for permit renewal, an expiring permit remains in effect until Ecology has either denied the application or issued a new permit (WAC 173-220-180(5)). Consequently, an expired NPDES permit remains in effect while Ecology reviews an application for a permit renewal, so long as the application is "timely and sufficient." Ecology must notify the permittee of the extension, by letter, that they have made timely and sufficient application and that the permit remains in effect until the permit is reissued or for another five years, whichever comes first.

4.2 State

A permittee must submit a satisfactory application at least 60 days prior expiration of an existing permit (RCW 90.48.170)(WAC 173-216-070). A satisfactory permit application consists of a completed form including the proper signature and any other information determined as necessary by the Department (WAC 173-216-070(4)). The existing permit remains in effect until the application has been finally determined by the Department (RCW 34.05.422(3)). In the event that Ecology takes no action on an application within 60 days, the applicant receives a temporary permit based on information on the application. The temporary permit is effective until Ecology acts on the application or for a period of five years. This process is illustrated for new and renewal state permits respectively in Figures III-3 and III-4.

4.3 Watershed Process

Public notice of applications and public notices of drafts may be conducted in one notice if they are done as part of the watershed permitting process (see fig. III-5).

Figure III-3. Application process for a new state wastewater discharge permit.

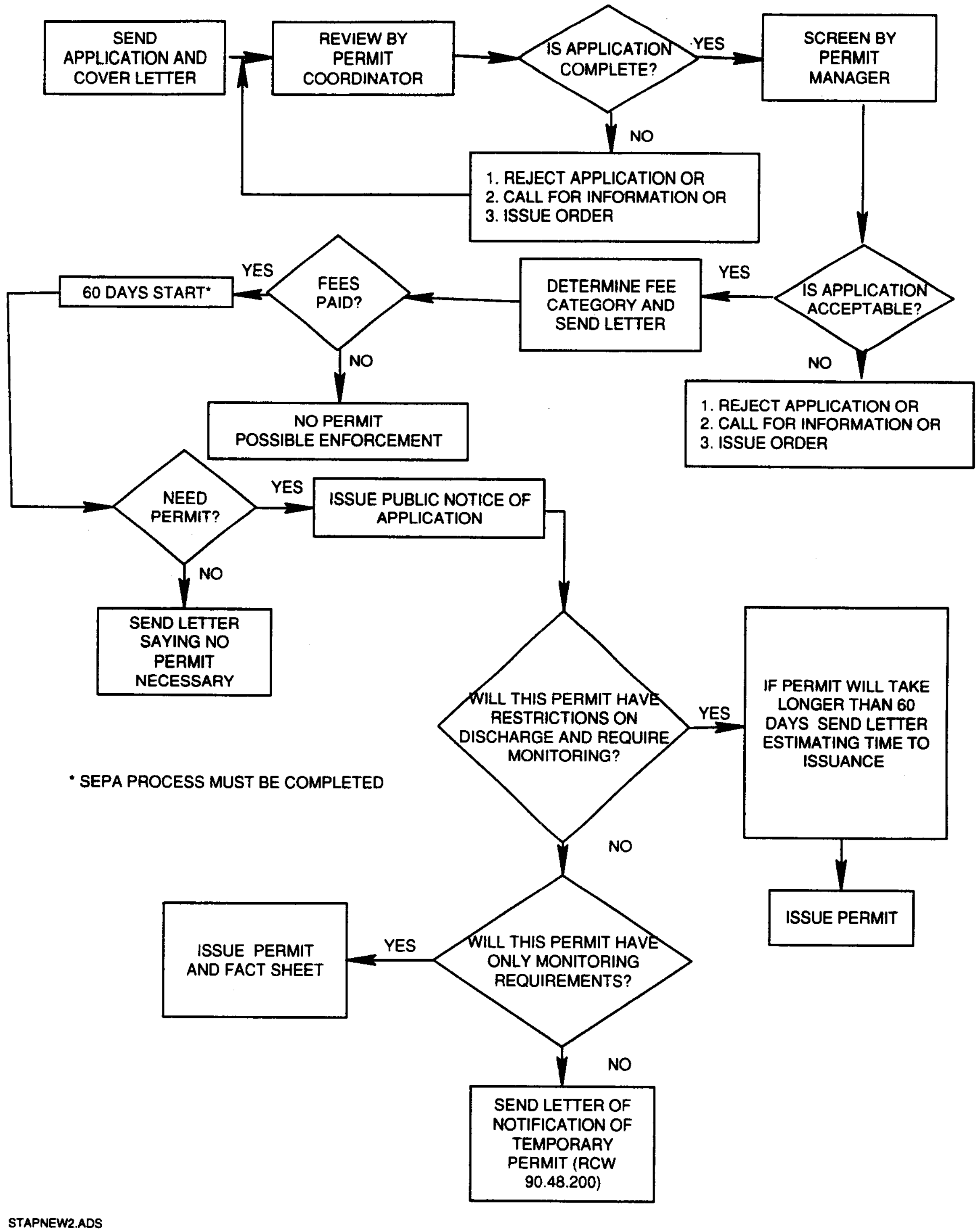


Figure III-4. Application process for renewal of a state wastewater discharge permit.

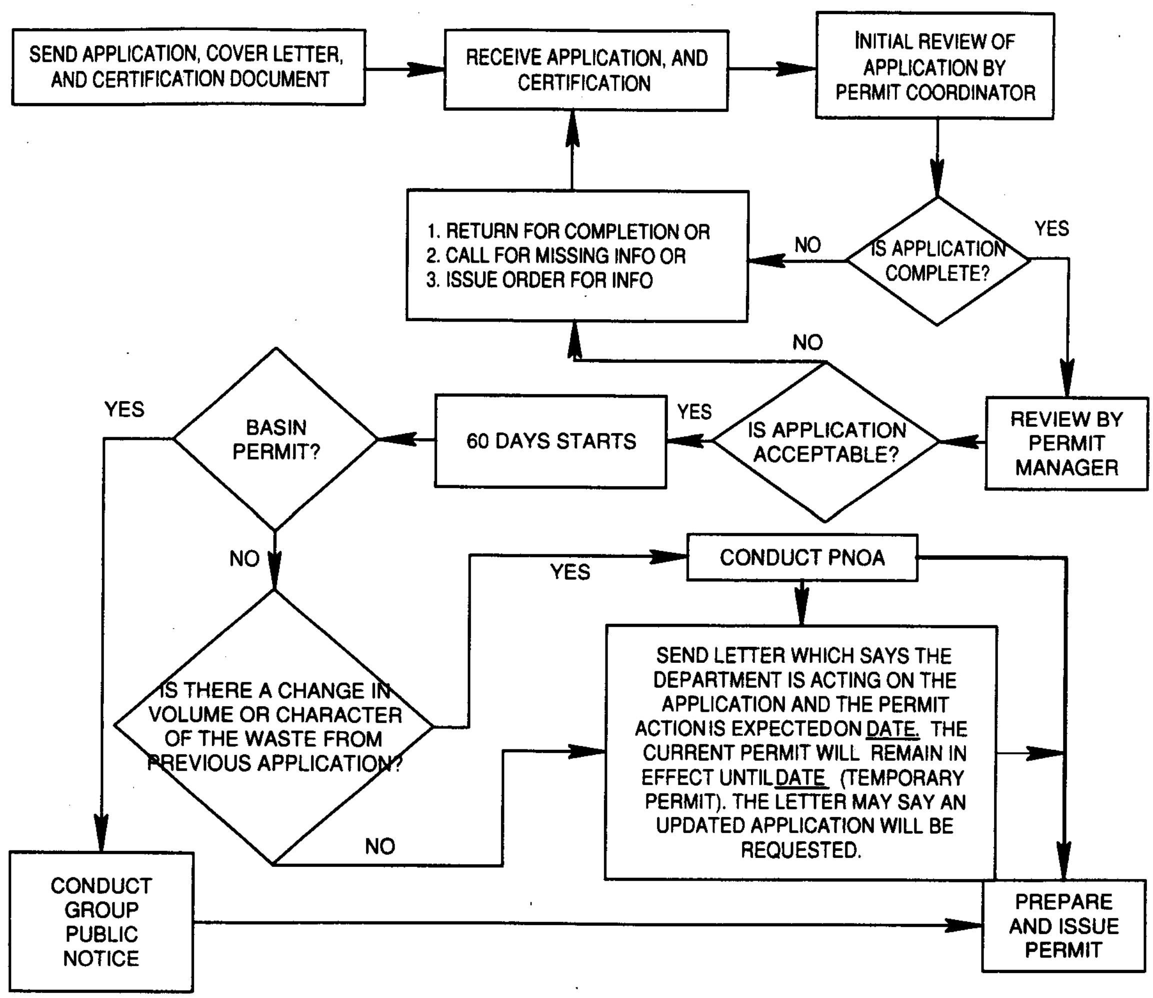
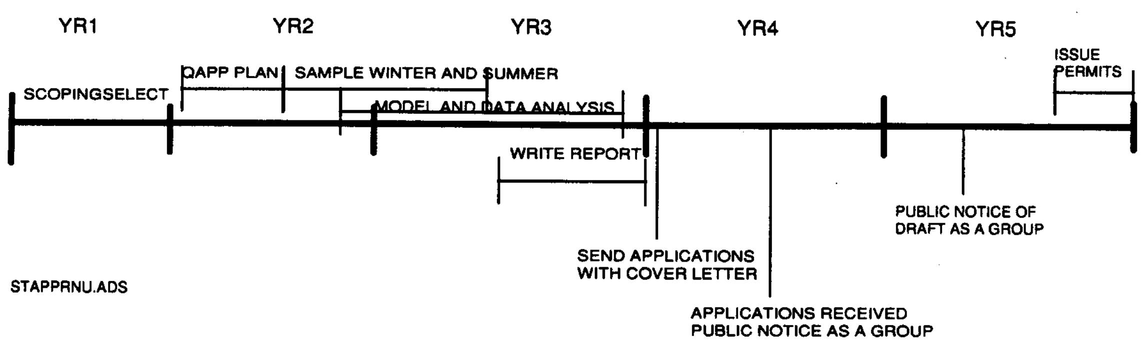


Figure III-5. Timing of Applications, Public Notice, and Permits in Watershed Permitting.



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5. APPLICATION FOR NEW PERMITS

5.1 NPDES

Applicants must submit an application at least 180 days before the date they wish to begin discharging or in sufficient time prior to commencement of discharge to allow the Department to formulate technology-based and water quality-based limitations. No discharge is authorized until the effective date of the permit.

5.2 STATE

Applicants must submit a satisfactory permit application at least 60 days before the date of the proposed discharge. The applicant will receive a temporary permit if Ecology fails to act upon the application within 60 days. The temporary permit is conditional upon the applicant having completed SEPA process. Any action within the 60-day period from the time of filing also prevents the temporary permit from becoming effective. An action would be a notification of the applicant that the application was not satisfactory.

6. TIME OF REAPPLICATION

All permittees must reapply for permits every five years (40 CFR 122.46(a)) (RCW 90.48.180). This includes temporary permits and permits extended during application if the application period extends for five years. An NPDES permit extended for 5 years during application must be reissued upon the second application.

7. CONFIDENTIALITY OF INFORMATION

A permit writer is occasionally requested to keep confidential the information obtained during the permit application process. A permit writer cannot grant confidentiality because the authority is vested only to the director or those delegated the authority by the director.
The federal regulations (40 CFR 122.7(c)) state that information required by NPDES application forms may not be claimed as confidential. Information not explicitly required on the NPDES forms and information required on forms for state waste discharge permits is subject to the state Public Disclosure Act codified in Chapter 42.17 RCW. Confidentiality is also addressed in Chapters 43.21A and 90.52 RCW.

The Public Disclosure Act generally makes all information normally submitted to Ecology as part of the permit process subject to public disclosure except "Valuable formulae, designs, drawings, and research data obtained by (Ecology) within 5 years of the request for disclosure when disclosure would produce private gain and public loss."

RCW 43.21A.160 provides that upon request, the director of Ecology may treat certain information furnished as confidential if such information relates to processes unique to the person providing the information, or if such information might adversely affect the competitive position of that person if released to the public, provided that such action would not be detrimental to the public interest.

RCW 90.52.020 states that Ecology shall provide proper and adequate procedures to safeguard the confidentiality of manufacturing processes. The confidentiality shall not extend to waste products discharged into the waters or air of the state.

The request for confidentiality must accompany the information for which the request is made. If the information is a part of the NPDES application form then no confidentiality can be granted. Other information is considered by the appropriate section head, as a delegate of the Director, as to whether it may be deemed confidential. The AG's have not provided guidance as to the interpretation of "public loss" or "detrimental to the public interest". Determination of "public loss" or "detrimental to the public interest" will be made on a case-by-case basis.

8. DOMESTIC SEWAGE EXCLUSION

In some instances industrial dischargers to POTW's are allowed to discharge dangerous waste if the waste is treatable in the POTW. The judgement on treatability is made by conferring with the regional hazardous waste and toxics reduction section.

Section E, question 7 of the permit application for discharge to a POTW asks if the wastewater to be discharged designates as a dangerous waste according to procedures in Chapter 173-303 WAC. The applicant may answer yes, no, or don't know. If the applicant answers yes they complete the following question 8 on the application which asks for the details on how the waste designated. In some cases it will be immediately apparent that some dangerous wastes cannot be discharged. For example, any wastewater that designates because of characteristics (ignitable, reactive, corrosive, TCLP) would not be allowed to be discharged without treatment. In other cases, such as with dilute listed waste or state-only toxic waste (see Appendix 3.1), it will not be immediately apparent if the discharge is allowable. In these instances the permit writer should confer with the regional hazardous waste and toxics waste reduction section.

If the applicant answers question 7 "no" or "don't know" the permit writer must use information from other parts of the application and from experience to judge the presence of dangerous waste in the wastewater. If dangerous waste potential exists the permit writer should confer with the regional hazardous waste and toxics waste reduction section about the course of action on the permit.

Dangerous waste discharges are subject to source reduction (pollution prevention) measures under

- HWTR interpretive policies for the Domestic Sewage Exclusion
- 40 CFR Part 403.12(p)(4), referenced in WAC 173-208

The permit writer should confer with Regional Hazardous Waste and Toxics Reduction staff for information on source reduction opportunities. In many cases, source reduction can offer the applicant a variety of attractive benefits.

Case study examples for some common pollutants:

1. Formaldehyde--treatable

Formaldehyde is an animal carcinogen, suspected human carcinogen, and mutagen which is a State toxic dangerous waste at 10% concentration. Fate modeling indicated that formaldehyde would probably be 84% biodegraded in an extended aeration activate sludge sewage treatment plant. King County has chosen to accept this waste based on its treatability (i.e., biodegradability) and low potential for interference.

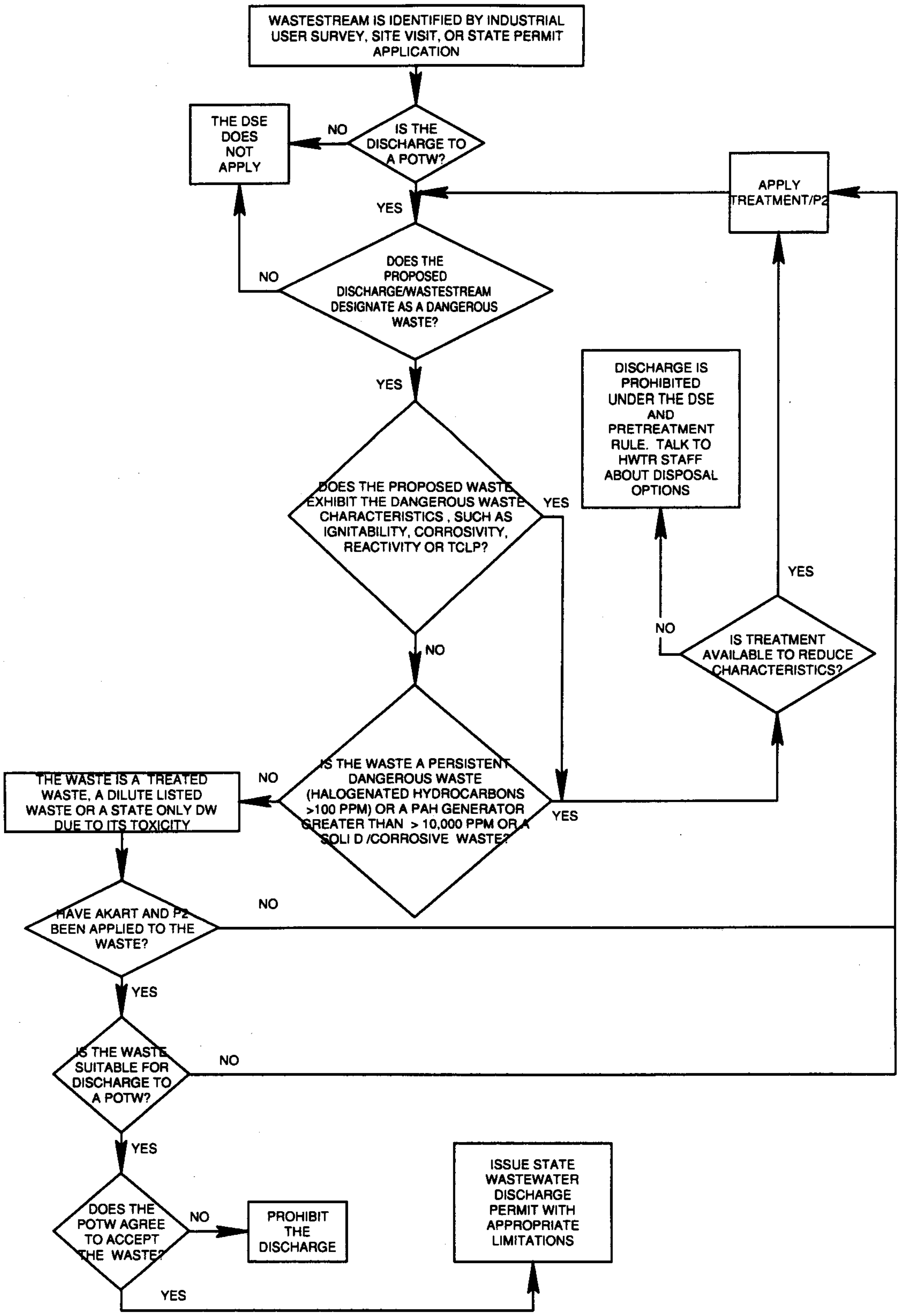
2. Antifreeze--recyclable

Ethylene glycol antifreeze is a State toxic waste that can be economically recycled through on-site filtration or off-site re-refining. Rather than accept this high-BOD waste, King County has established recycling of antifreeze as a best management practice.

3. Dry Cleaner Separator Water--dilute listed waste

Dry cleaner separator water is saturated with perchlorethylene (tetrachlorethene), a listed waste. Because the concentration of the solvent can range from 300 to 3000 mg/l, it does not meet the HWTR policy criteria for "dilute listed wastes" mentioned in the regulatory language of the domestic sewage exclusion. The WQ and HWTR programs have agreed not to allow disposal of separator water to the sewer.

Figure III-5. Interpreting the domestic sewage exclusion (DSE).



AR 032740

CHAPTER IV. DERIVING TECHNOLOGY-BASED EFFLUENT LIMITS

This chapter, chapter VI and chapter VII discuss the major task of writing a wastewater discharge permit - deriving the effluent limits. The effluent limits restrict the amount of pollutants that may be discharged. Effluent limits may be based on the technology which is available to treat the pollutants at a reasonable cost (technology-based) or they may be based on the effect of the pollutants in the receiving water (water quality-based), whichever is most stringent. Derivation of the effluent limits, whether they're based on technology, as discussed in this chapter or on water quality, as discussed in following chapters, is the core task of permit writing and often the most complex task.

Effluent limits are process control parameters or numbers which indicate that a process, which in this case is wastewater treatment, is functioning properly.

Not all of the pollutants in an effluent are limited with numeric limits. A pollutant may not require an effluent limitation if it meets all of the following:

- Its concentration is too low to be treated at a reasonable cost; and
- It can't be eliminated by production changes or best management practices; and
- There is no potential for causing surface or ground water quality or sediment quality standards violations; and
- It is not listed in regulations, such as effluent guidelines.

There are 2 general approaches to deriving technology-based effluent limits. A permit writer can use Federal effluent guidelines, if they are applicable and appropriate, or develop effluent limits specifically for an individual discharger or pollutant (case-by-case). In some cases a permit may contain both types of effluent limits.

This chapter discusses the derivation of technology-based effluent limits from the federal effluent guidelines, provides a step-by-step process on how they're used and details some problems with them. An example is provided to demonstrate the use of effluent guidelines. This chapter also discusses the development of technology based effluent limits on a case-by-case basis under federal and state authority.

Flow charts at the end of the chapter illustrate the process of developing technology-based effluent limits.

Adjustment of effluent limits to account for autocorrelation is discussed in Part 4 of this chapter.

1. EFFLUENT LIMITATION GUIDELINES

The Federal Water Pollution Control Act of 1972 (Clean Water Act) directed EPA to develop standards of performance (effluent limitations) for industrial categories. Specifically, the law required existing industrial dischargers to achieve "effluent limitations requiring the application of the best practicable control technology currently available (BPT)" by July 1, 1977. The law also required dischargers to achieve "effluent limitations requiring the application of the best available technology economically achievable (BAT)" by July 1, 1983. Other performance standards to be developed were new source performance standards (NSPS) for new direct dischargers and pretreatment standards for indirect dischargers. The Administrator (of EPA) was given one year to develop and implement these performance standards.

EPA was unable to complete all effluent guidelines within the statutory deadline due to technical problems and pressure from various trade associations. In addition, EPA did not fully address toxic discharges in the guidelines it did promulgate. As a result, in 1976, EPA was sued by several environmental groups for failing to accomplish the promulgation of effluent guidelines as directed in the Clean Water Act. The EPA and the environmental groups reached a settlement agreement which required EPA to develop a program and adhere to a schedule for promulgating BAT effluent guidelines, pretreatment standards and new source performance standards for 65 priority pollutants and classes of pollutants. This agreement was limited to a group of 21 major categories of industries which became known as the primary industries. These are listed in 40 CFR 122 Appendix A. This settlement was incorporated into the 1977 amendments of the Clean Water Act. The 1977 amendments also redefined BAT to include only toxic and nonconventional pollutants. The deadline for meeting BAT limits was 3 years after their promulgation but no later than July 1, 1987 (The 1987 amendments to the Clean Water Act have moved this deadline to March 31, 1989). The 1977 amendments also redefined BAT for conventional pollutants to become "best conventional pollutant control technology (BCT)." The deadline for achieving BCT was July 1, 1984 but the date was amended to become March 31, 1989.

When Congress enacted the 1977 amendments they also required that a cost test be applied to any treatment that was proposed for BCT (more on the cost test later, in the case-by-case permits section). The EPA developed and published the regulations for BCT in 1979. At the same time the EPA published BCT limits for 41 industrial subcategories. This 1979 regulation was challenged and the final BCT methodology was not adopted until 1986.

All of the proceeding is to show some of the gyrations on the way to achieving the intent of Congress to develop technology-based performance standards. It also helps to explain why some of the effluent guidelines, such as feedlots, contain BAT requirements for conventional pollutants or BCT limits that were never imposed. For more information on the history of the promulgation of effluent guidelines see Miller, et al. 1990.

1.1 A Summary of Some Treatment Standards as Currently Defined

BPT - Best Practicable control Technology currently available - applicable to conventional pollutants - to be achieved by July 1, 1977

BCT - Best Conventional pollutant control Technology (BCT) - the level of treatment that succeeds BPT for conventional pollutants. The deadline for achieving BCT was July 1, 1984 but was changed in the 1987 amendments to March 31, 1989.

BAT - Best Available Technology economically achievable - applicable to toxic pollutants. The deadline for achieving BAT was July 1, 1983 but was changed by the 1987 amendments to March 31, 1989.

We now have performance standards (effluent limitation guidelines) for 52 groups or categories of industries and over 1,000 performance standards for all the subcategories. EPA typically developed these performance standards after completing the following tasks:

- Performing a literature search to obtain the latest information on treatment processes;
- Conversing with regional and state staff with experience pertaining to the industry;
- Reviewing any comparable industrial limitations;
- Conducting industrial plant surveys to collect statistical data on operations;
- Conducting site visits, sampling, and evaluation of selected industrial sites;
- Soliciting public comment from industrial representatives and the public at large;

- Conducting an economic analysis of the impact of the identified treatment technology on the industry.

EPA estimated that it required 2-5 years to develop each set of standards. The cost for each set of standards ranged from 2 million to 20 million dollars for technical contractors plus between 3 and 25 person-years of EPA staff effort. The list of industries for which EPA has developed effluent guidelines is given in 40 CFR 122 Appendix A. The information that EPA developed is available in several forms. The most informative are the development documents prepared by EPA. These documents contain the technical and economic information from which the effluent guidelines were developed. The effluent guidelines are summarized in 40 CFR Parts 400-471.

1.2 Steps for Using Effluent Guidelines

STEP 1. Categorize the discharger.

To be able to use the effluent guidelines it's necessary to know what kind of processes are being done at the facility you're permitting. Then if you're lucky, the facility will fit cleanly into a category and subcategory.

STEP 2. Learn about the category of discharger.

To be able to write an effective permit, the permit writer must know the pollutants that are being discharged or have the potential to be discharged. This usually requires an understanding of the manufacturing processes that take place at a facility. There are several sources of information available to a permit writer to learn about an industry.

- The EPA Development Documents that were discussed previously are an excellent source of information. More recent literature is sometimes available. Contact the Ecology library for a search.

- EPA has industry experts located in Washington, D.C. and in the regional offices. EPA lists these experts in the training manual for the permit writing course. Call the Permit Development Services Section for assistance if you have difficulty finding or contacting these people.

- Trade associations for the category of discharger can be sources of information.

- The pre-permit inspection of the facility being permitted is informative. This inspection is most valuable if the permit writer has done some background work before the inspection.

STEP 3. Decide on category.

This is a decision point for the permit writer. The permit writer must decide after reading the development document, reviewing the application, and inspecting the facility whether the facility being permitted has essentially the same kind of manufacturing processes as described in the development document. If the manufacturing process and the pollutants which are generated have changed to the extent that it is no longer described in the development document, the permit writer must do case-by-case development of effluent limits. Outdated development documents may become more common as time goes by.

STEP 4. Decide on treatment.

This is another decision point for the permit writer. The permit writer must decide if the treatment process described in the development document is currently the best available. If it is not then the permit writer must do a case-by-case determination of the effluent limits.

STEP 5. Decide on the production base.

Most of the EPA effluent guidelines are mass limits based on production as opposed to concentration limits (see the example at the end of the chapter). Production-based limits cause a problem for permit writers in verifying the production base. The company may want to claim as high a production as possible to get higher effluent limits and thus not have to worry about compliance problems. The permit writer wants the production estimate to represent, as accurately as possible the production during the life of the permit. The Federal permit application asks the applicant for the facility maximum production but what the permit writer needs is an estimate of future average annual production. The derivation of the effluent guidelines incorporates an allowance for the daily and monthly variations. The best estimate of future production is generally the production of the past year. In some cases the past year may have been a boomer for them and the next few are going to be bust. In that case, by basing the effluent limits on the past years production you would be allocating more pounds of discharge than necessary. You may wish to use the highest years production of the last five years as the production base. If the company knows that there will be a substantial (25%) increase in production sometime during the course of the new permit, you may offer them alternate limits to be effective at the time they begin increased production. The company should have committed the capital expenditure and completed the design before alternate limits are used, otherwise, modify the permit at the time of increased production.

Production levels may be verified by checking the previous years monitoring data. Assuming that water usage is proportional to production, you should be able to detect any changes. The development document for the industry may have some water use/production data. The production data that you receive on the application is certified by the signature of the responsible official to be correct and subject to criminal enforcement if deliberately false. This creates a strong incentive for not falsifying information. That person should understand that any information submitted subsequently during the permit process is also certified. If you have a basis to suspect that any production information is incorrect, you may ask to review their books or ask for some other verification. The Water Quality Program economist may also be able to assist you in verifying production at a facility.

STEP 6. Apply the effluent guidelines to derive limits.

The final calculations of the effluent limitations should be done from the effluent guideline summaries found in 40 CFR Parts 400-471. Although the effluent limits in the development documents and the CFR are usually the same, the CFR's and the NPDES notebook are the most current regulatory version.

In this state there is another decision to be made at this point. The decision is whether the effluent guidelines also constitute all known, available and reasonable methods of treatment (AKART). AKART is discussed in detail in Part 3 of this Chapter. As a general rule, if the effluent guidelines for a particular category are 5 years old or less they will be AKART and this will be immediately apparent in reviewing the development document. If the effluent guidelines are between 5 and 10 years old they are probably AKART but the permit writer should review the treatability data base for a determination. If the effluent guidelines are over 10 years old, the permit writer should do at least an analysis of unit processes design and efficiencies to determine that the effluent guidelines constitute AKART.

1.3 Multiple Processes

For industries with only one process and relatively constant production, the production-based effluent limits are simple to calculate and monitor. Now consider the Seafood Processors as a good example of some problems with production-based effluent limits. In our state, many seafood processors work on a variety of seafood. A typical processor in the coastal area might work on shrimp, salmon, bottom fish, and crab. On any given day the processor might be working on one or all of these products depending on what's available and the market demand. Each of these products has production-based effluent limits within Part 408 - Canned and Preserved Seafood Processing Point Source Category for the pollutants TSS, oil/grease, and pH for existing sources. The treatment process identified as BPT treatment is screening of solids from the waste stream. Some product subcategories also include some management practices to reduce pollutants. To verify that the process is within the production-based effluent limits requires daily monitoring of effluent and a daily production report. The purpose of monitoring is to verify that the treatment process is working properly, therefore, some permit writers have simply placed requirements in the seafood permits for a daily check on the condition of the screen but with no effluent monitoring. This is contrary to regulations which require sampling at least once per year for those parameters in the effluent guidelines. This has also resulted in another problem because the permit writer has not built a data base to determine the potential for water quality standards violations from the discharges.

A similar difficulty exists with fruit and vegetable processors who run a mix of products and then treat the wastewater in a lagoon system with a 30-day detention. The effluent which is analyzed is not representative of the production process for that month.

1.4 Mass vs. Concentration

Effluent limits expressed as mass (pounds or kilograms per day) create an opportunity for inefficient operation of a treatment process so a permit writer should consider using concentration limits (milligrams per liter) in addition to the mass limits.

An example would be a company that has effluent limits for pollutant X of 390 pounds/day daily maximum and 260 pounds/day monthly average. These limits are based on annual production of widgets. The annual average flow is 0.9 MGD and the maximum daily flow is 1.6 MGD.

During periods of reduced production and flow (0.5 MGD) the company is able to reduce the efficiency of their treatment apparatus and still meet the monthly average mass limit of 260 pounds/day.

Under Average Production and Flow (0.9 MGD)
260 LBS/DAY /[(8.34)(0.9 MGD)] = 35 mg/L

Under Reduced Production and Flow (0.5 MGD)
260 LBS/DAY/[(8.34)(0.5 MGD)] = 62 mg/L

The number 8.34 in the formulas above is a conversion factor to get from pounds per million gallons to milligrams per liter. The first formula for Average Production and Flow with the units expressed as follows:

$$\frac{\frac{260 \bullet lb}{day}}{\frac{0.9 \bullet MG}{day}} x \frac{1 \bullet MG \bullet mg}{8.34 \bullet lb \bullet l} = \frac{34.64 \bullet mg}{l}$$

Unit cancellation results in mg/l. Note that MGD (millions of gallons per day), is expressed as MG divided by day(s) so day(s) will cancel correctly.

1.5 Some Solutions

The regulatory objective of effluent limits is to assure that the wastewater treatment process is being run as efficiently as possible. Some solutions to the problems identified above include the use of concentration limits, requiring a statement of production, specifying the efficiency of the treatment process and doing an annual balance.

In the example above the permit writer could have specified an effluent limit of 35 mg/L in addition to the 260 lbs/day limit. This would have forced continued efficiency during periods of reduced production. Incorporating concentration limits might discourage a facility from practicing water conservation. By reducing water usage in a process while continuing to provide good waste treatment the mass discharge might be reduced but the concentrations exceed monthly and daily limits, therefore, a permit writer who places concentration limits in a permit in addition to the mass limits, should allow some exclusion from those concentration limits if there is a demonstration of water conservation.

Another option for the permit writer is to specify treatment efficiency by mass and concentration. This is already incorporated into the municipal effluent limits for secondary treatment. The percent removal efficiency could be based on the design efficiency of the plant as specified in the approved engineering report.

A third option that is especially suitable for mixed production such as the seafood processors above is to require a statement of monthly production. This is commonly required in the permits for pulp mills which have a mix of products.

A fourth option to assure the efficient operation of the treatment process is to place some type of operating parameter as the daily control mechanism and then to run the balance sheet at the year end. This might be appropriate for the food processor example above. This option would be consistent with the way effluent limits were derived. As noted earlier, the production based effluent limits may have been derived on an annual basis and the monthly and daily limits calculated with the use of variability factors. This annual balance sheet creates a great deal of uncertainty for both the regulator and the regulated.

1.6 Outdated Effluent Guidelines

Frequently, the permit writer will find that the effluent guidelines are outdated such that the industrial processes or process pollutants are no longer accurately described. In this case the permit writer must derive effluent limits on a case-by-case basis as described previously in this chapter.

EXAMPLE IV-1 WOOL FINISHING EFFLUENT LIMITS

This example is a company that receives cleaned wool, wool yarn, and wool fabric and produces finished wool yarn and fabric. This example is typical of the type of problems encountered when using effluent guidelines.

This company belongs to the category of industries called "textile mills". For this company the category is apparent. For some industries it's not so easy to determine the industrial group. For an industry that's not obvious, the permit writer may be able to use the SIC (Standard Industrial Classification) code information that the company supplies on the permit application form. The SIC numerical system was originally developed and used by the Federal government for tax and data gathering purposes. EPA adopted it as part of their categorization system.

The Ecology library contains the EPA documents relating to the development of effluent limits for textile mills.

For this industry there are several documents dated from 1974 to 1982. The earliest document is called "Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the TEXTILE MILLS Point Source Category" (June 1974).

This 1974 document proposed BPT limits to be imposed by 1977, BAT limits to be imposed by 1983 and New Source Performance Standards (NSPS). The BAT parameters included fecal coliform and color (remember the discussion from the earlier section that BAT was initially for conventional pollutants). The proposed BAT guidelines were rescinded as a result of a successful challenge in court by the industry.

The next 2 documents were released by EPA in 1979. They are the "Proposed Effluent Limitations Guidelines, New Source Performance Standards and Pretreatment Standards for TEXTILE MILLS Point Source Category" and "Economic Impact Analysis of Proposed Effluent Limitations Guidelines...". These guidelines redefined the industry and added some additional subcategories. BAT was now defined by the CWA as control of toxic pollutants. For textiles BAT is defined as the existing BPT. The NSPS is changed in this document and the pretreatment standards are given.

These early documents are interesting from a historical perspective but the most pertinent and current document is the one released in 1982. This final "Development Document for Effluent Limitations Guidelines and Standards for the Textile Mills Point Source Category" EPA 440/1-82/022 contained very few changes from the 1979 proposed guidelines.

The effluent limitations are summarized in 40 CFR Part 410 which are reproduced on the following 2 pages. These regulations also include definitions that sometimes become important criteria for application of the regulations. Occasionally a question will arise that cannot be answered by reviewing the development document or the regulations. In this case the permit writer should also review the Federal Register in which the effluent limits were promulgated. Many times, the EPA response to comments will clarify the regulatory intent. These effluent guidelines were published in 47 FR 38819 on Sept. 2, 1982 as noted in the CFR's.

The current development document describes how the industry was categorized and subcategorized. In addition, there are sections on wastewater characteristics, the pollutants of concern, control and treatment technology, non-water quality aspects including costs, and recommendations for BPT, BAT, and NSPS effluent limits.

For more information about a particular aspect of the industry process, get the appropriate references listed in the development document and request a computer search from the department library for more recent papers. Contact the Program Development Services Section to see if there is someone there or elsewhere in Ecology knowledgeable about the industry.

The production processes at this example facility fit the subcategory called wool finishing. In this case, it's particularly easy to determine because there is a flow chart describing the process (Figure IV-1). The other subcategories that are described are wool scouring, low water use processing, woven fabric finishing, knit fabric finishing, carpet finishing, stock and yarn finishing, nonwoven manufacturing, and felted fabric processing.

The permit writer in this example reads the development document and inspects the facility. The permit writer decides that this particular woolen mill is adequately described by the development documents and the processes are essentially the same as described in the development document.

The company claims they are an integrated facility because in addition to being covered under wool finishing they are covered under the woven fabric finishing subcategory. A review of the development document reveals that wool and wool blends are not covered in the woven fabric finishing subcategory because fabric finishing was included as a process in the wool finishing subcategory. There is no additional discharge allowance on that basis.

EXAMPLE IV-1 (cont.)

THIS PAGE CONTAINS A REPRODUCTION OF THE CFR

§ 410.17 Effluent limitations representing the degree of effluent reduction attainable by the application of the best conventional pollutant control technology (BCT). [Reserved]

Subpart B—Wool Finishing Subcategory

§ 410.20 Applicability: description of the wool finishing subcategory.

The provisions of this subpart are applicable to process wastewater discharges resulting from the following types of textile mills: wool finishers, including carbonizing, fulling, dyeing, bleaching, rinsing, fireproofing, and other such similar processes.

§ 410.21 Specialized definitions.

In addition to the definitions set forth in 40 CFR part 401 and § 410.01 of this part, the following definition applies to this subpart:

(a) The term *fiber* shall mean the dry wool and other fibers as received at the wool finishing mill for processing into wool and blended products.

§ 410.22 Effluent limitations representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available (BPT).

(a) Except as provided in 40 CFR 125.30 through 125.32, any existing point source subject to this subpart must achieve the following effluent limitations representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available (BPT):

Pollutant or pollutant property	BPT limitations	
	Maximum for any 1 day	Average of daily values for 30 consecutive days
	Kg/kkg (or pounds per 1,000 lb) of fiber	
BOD_5	22.4	11.2
COD	163.0	81.5
TSS	35.2	17.6
Sulfide	0.28	0.14
Phenol	0.14	0.07
Total chromium	0.14	0.07
pH	(¹)	(¹)

¹ Within the range 6.0 to 9.0 at all times.

(b) Additional allocations equal to the effluent limitations established in paragraph (a) of this section are allowed any existing point source subject to such effluent limitations that finishes wool or blended wool fabrics through "commission finishing" as defined in § 410.01.

§ 410.23 Effluent limitation representing the degree of effluent reduction attainable by the application of the best available technology economically achievable (BAT).

(a) Except as provided in 40 CFR 125.30 through 125.32, any existing point source subject to this subpart must achieve the following effluent limitations representing the degree of effluent reduction attainable by the application of the best available technology economically achievable (BAT):

Pollutant or pollutant property	BAT limitation	
	Maximum for any 1 day	Average of daily values for 30 consecutive days
	Kg/kkg (or pounds per 1,000 lb) of fiber	
COD	163.0	81.5
Sulfide	0.28	0.14
Phenols	0.14	0.07
Total Chromium	0.14	0.07

(b) Additional allocations equal to the effluent limitations established in paragraph (a) of this section are allowed any existing point source subject to such effluent limitations that finishes wool or blended wool fabrics through "commission finishing" as defined in § 410.01.

EXAMPLE IV-1 (cont.)

§ 410.24 Pretreatment standards for existing sources (PSES).

Any existing source subject to this subpart that introduces process wastewater pollutants into a publicly owned treatment works must comply with 40 CFR part 403.

§ 410.25 New source performance standards (NSPS).

Any new source subject to this subpart must achieve the following new source performance standards (NSPS):

Pollutant or pollutant property	NSPS	
	Maximum for any 1 day	Average of daily values for 30 consecutive days
	Kg/kkg (pounds per 1,000 lb) of fiber	
BOD_5	10.7	5.5
COD	113.8	73.3
TSS	32.5	14.4
Sulfide	0.28	0.14
Phenols	0.14	0.07
Total Chromium	0.14	0.07
pH	(1)	(1)

Note: Additional allocations for "commission finishers" are not available to new sources.
[1] Within the range 6.0 to 9.0 at all times.

§ 410.26 Pretreatment standards for new sources (PSNS).

Any new source subject to this subpart that introduces process wastewater pollutants into a publicly owned treatment works must comply with 40 CFR part 403.

§ 410.27 Effluent limitations representing the degree of effluent reduction attainable by the application of the best conventional pollutant control technology (BCT). [Reserved]

Subpart C—Low Water Use Processing Subcategory

§ 410.30 Applicability: description of the low water use processing subcategory.

The provisions of this subpart are applicable to process wastewater discharges resulting from the following types of textile mills: yarn manufacture, yarn texturizing, unfinished fabric manufacture, fabric coating, fabric laminating, tire cord and fabric dipping, and carpet tufting and carpet backing. Rubberized or rubber coated fabrics regulated by 40 CFR part 428 are specifically excluded.

§ 410.31 Specialized definitions.

In addition to the definitions set forth in 40 CFR part 401 and § 410.01 of this part, the following definitions apply to this subpart:

(a) The term *general processing* shall mean the internal subdivision of the low water use processing subcategory for facilities described in § 410.30 that do not qualify under the water jet weaving subdivision.

(b) The term *water jet weaving* shall mean the internal subdivision of the low water use processing subcategory for facilities primarily engaged in manufacturing woven greige goods through the water jet weaving process.

§ 410.32 Effluent limitations representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available (BPT).

Except as provided in 40 CFR 125.30 through 125.32, any existing point source subject to this subpart must achieve the following effluent limitations representing the degree of effluent reduction attainable by the application of the best available technology economically achievable (BPT):

GENERAL PROCESSING

Pollutant or pollutant property	BPT limitations	
	Maximum for any 1 day	Average of daily values for 30 consecutive days
	Kg/kkg (pounds per 1,000 lb) of product	
BOD_5	1.4	0.7
COD	2.8	1.4
TSS	1.4	0.7
pH	(1)	(1)

[1] Within the range 6.0 to 9.0 at all times.

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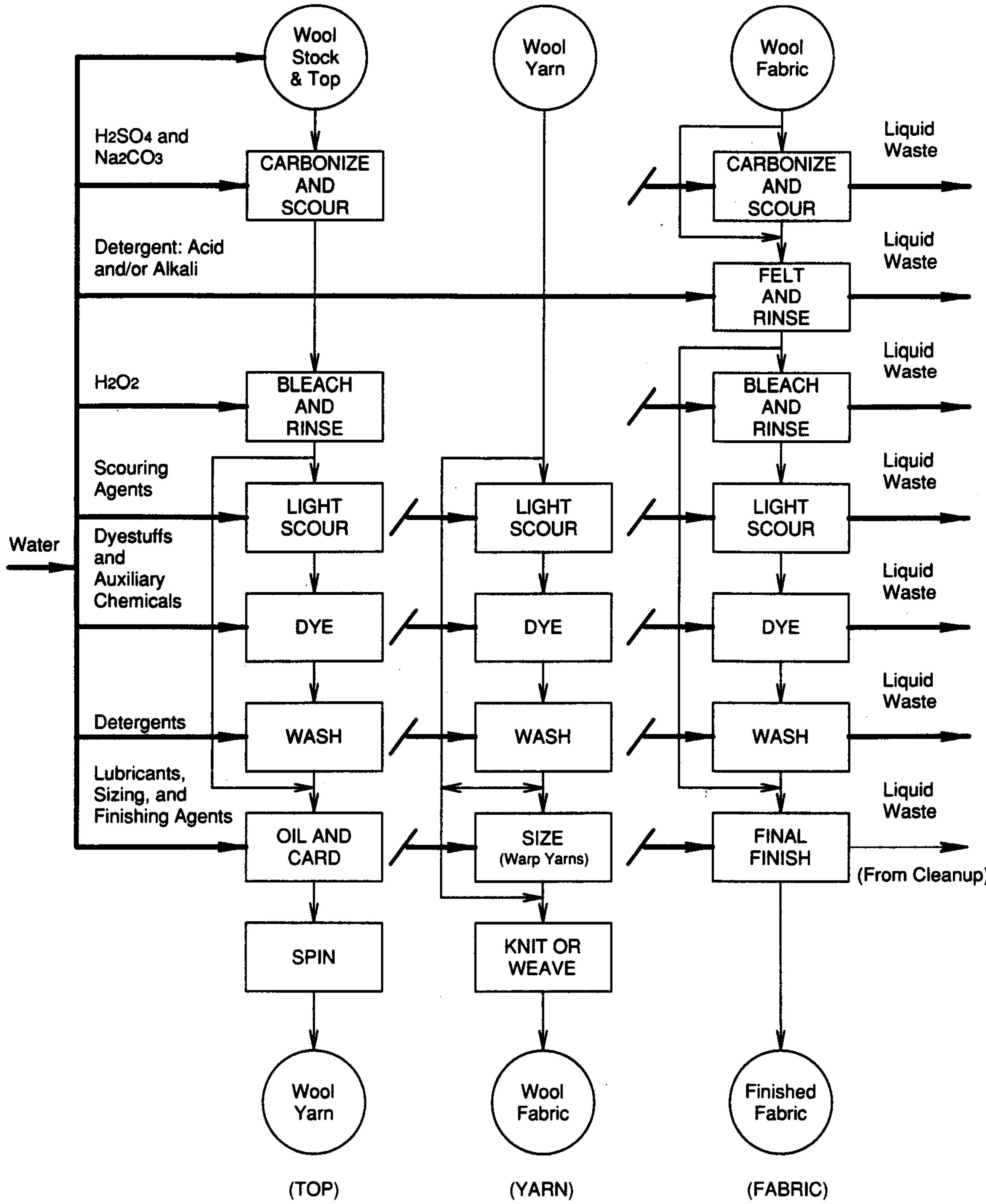
EXAMPLE IV-1 (cont.)

Figure IV-1



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EXAMPLE IV-1 (cont.)

When industry requests to be included in a different category that would allow higher pollutant discharge and the permit writer determines that the request is not justified, the reasons should be explained in the fact sheet.

The effluent limits for the wool finishing subcategory are given as pounds of pollutant per 1000 pounds of fiber processed (this type of limit is called a production-based effluent limit as opposed to a concentration limit). The regulated pollutants for BPT are BOD5, COD, TSS, Sulfide, Phenol, Total Chromium and pH. The regulated pollutants for BAT are COD, Sulfide, Phenols, and Total Chromium with the same effluent limits as for BPT. The limits for BCT haven't been promulgated. This is noted in 40 CFR 410.27 by the words "reserved".

A textile mill submits the following information on an application for permit renewal.

FORM 2C NPDES

EPA

U.S. ENVIRONMENTAL PROTECTION AGENCY
APPLICATION FOR PERMIT TO DISCHARGE WASTEWATER
EXISTING MANUFACTURING, COMMERCIAL, MINING AND SILVICULTURAL OPERATIONS
Consolidated Permits Program

I. OUTFALL LOCATION

For each outfall, list the latitude and longitude of its location [illegible] and the name of the receiving water.

A. OUTFALL NUMBER (list)	B. LATITUDE			C. LONGITUDE			D. RECEIVING WATER (name)
	1. DEG.	2. MIN.	3. SEC.	1. DEG.	2. MIN.	3. SEC.	

[redacted]

II. FLOWS, SOURCES OF POLLUTION, AND TREATMENT TECHNOLOGIES

A. Attach a line drawing showing the water flow through the facility. [illegible] operations contributing wastewater to the effluent, and treatment units [illegible] Construct a water balance on the line drawing by showing average flows between intakes, operations, treatment units, and outfalls. If a water balance cannot be determined (e.g., for certain mining activities), provide a pictorial description of the nature and amount of any sources of water and any collection or treatment measures.

B. For each outfall, provide a description of: (1) All operations contributing wastewater to the effluent, including process wastewater, sanitary wastewater, cooling water, and storm water runoff; (2) The average flow contributed by each operation; and (3) The treatment received by the wastewater. Continue on additional sheets if necessary.

1. OUTFALL NO. (list)	2. OPERATION(S) CONTRIBUTING FLOW: a. OPERATION (list)	b. AVERAGE FLOW (include units)	3. TREATMENT: a. DESCRIPTION	b. LIST CODES FROM TABLE 2C-1
001	Dye House	0.5 MGD	Activated Sludge	1 T 3 A
	Wool Mixing Department	300 GPD		
	Boiler House	10,000 GPD		
	Wool Finishing Department	0.3 MGD		
002	Waste Activated Sludge	8,000 GPD	Screened	1-T
			Land Irrigation	5-P
003	Sanitary Wastewater	24,000 GPD	None	XX
	Laboratory Wastewater	1,000 GPD		
004	Air Conditioning Condensate	7,000 GPD	None	XX
	Roof Drains			
	Storm Drains			
005	Storm Drains		None	XX
006	Air Conditioning Condensate	3,000 GPD	None	XX
	Roof Drains			
	Storm Drains			

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EXAMPLE IV-1 (cont.)

The company also indicates in their application that the maximum raw material usage at the facility is 19,500 pounds per day. The permit writer requests more information on the raw material usage, including some supporting data. The company replies that the 19,500 pounds includes the maximum daily usage and a planned increase during the next 5 years. The permit writer requests detailed raw material usage and tells the company the permit will be based on current production with a permit modification later, if necessary to accommodate increased production. The typical materials taken in for processing in the wool finishing operation are washed and dried wool (stock), yarn, and fabric. The applicant, mill X, submits information showing they receive and process 12,627 pounds of stock, 3,294 pounds of cloth, and 1,306 pounds of yarn per day. It receives the cloth and yarn from company mill Y located in another state. The applicant claims that the 3,294 pounds of cloth represent 3,765 pounds of original stock and the difference is wastage. Similarly they claim the 1,306 pounds of yarn represents 1,606 pounds of stock. The applicant claims 17,998 pounds as the production base (12,627 + 3,765 + 1,606). The permit writer allows 17,281 pounds as the production basis. The definition of fiber in 40 CFR 410.21 is wool and other fiber as received at the mill. The production base for facility X does not include material processed or partially processed at facility Y.

The effluent limits for the permit are calculated as:
22.4 X 17.281 = 387 pounds per day maximum BOD
11.2 X 17.281 = 193.5 pounds per day average BOD

and so on for the other parameters. Note that BAT limits are the same as BPT and that BCT limits have not been promulgated for this industry.

1.7 Integrated Facilities

In the previous example, if the facility X above also produced nonwoven fabric by an adhesive process, the facility would be an integrated facility and receive an additional effluent allowance in the nonwoven subcategory.

In the nonwoven subcategory, the limitation is based on pounds of product produced. Therefore, the facility in the example would have to separately track that wool fiber used for nonwoven production so as not to get dual credit.

1.8 Converting Performance to Limits

EPA derived the BPT limits for wool finishing mills by determining the pollutants produced and the potential treatment methods available for treating those pollutants. EPA then examined the performance of 2 existing "exemplary" biological treatment plants at wool finishing mills (BPT = average of the best for conventional pollutants). The average effluent concentrations from the 2 treatment plants were then increased by 50% to derive the 30-day average maximum limit. This 30-day limit was multiplied by 2 to derive the maximum daily limit.

Sometimes more sophisticated statistical methods were used for deriving effluent limits when the data were available. The first step was to determine if the data was normally distributed and if not then to do a transformation. The transformation if done correctly enabled the use of normal distribution statistical techniques. The data or transformed data were then used to calculate a mean and standard deviation. The effluent limits for daily maximum may be set at $Z + 3s$. The probability of any measurement randomly exceeding this limit is 0.00135, so any exceedence means the treatment process is not functioning properly.

Another method used to arrive at daily maximum limits was to derive a variability factor $V = (Z + 3s)/Z$ which was then multiplied by the annual average effluent concentration. The resultant number was the proposed daily maximum concentration. This variability factor may also be calculated by plotting the data on probit paper or using a computer program and finding the 50th and 99th percentile concentration. The variability factor V = 99th percentile concentration/50th percentile concentration.

Monthly or 30-day effluent limits may be set as $Z + 2s$ or by determining variability factors on monthly data.

Performance-based effluent limits may be derived using the formulas in Appendix E of the TSD (EPA 1991) and the observed data for the long term average (LTA).

EXAMPLE OF PERFORMANCE-BASED LIMITS

A permit writer proposes to issue a permit with water quality-based effluent limits for BOD and wants to derive performance-based limits as interim limits for a compliance schedule. The data base consists of 169 effluent values collected once per week. The summary statistics (calculated in Excel) are presented below.

UNTRANSFORMED		LOGNORMAL TRANSFORMED	
Mean	32.9941	Mean	3.2783
Standard Error	2.00885	Standard Error	0.0492
Median	26	Median	3.2581
Mode	22	Mode	3.091
Standard Deviation	26.115	Standard Deviation	0.6396
Sample Variance	681.994	Sample Variance	0.4091
Kurtosis	7.27301	Kurtosis	0.5068
Skewness	2.51836	Skewness	0.2898
Range	147	Range	3.2387
Minimum	6	Minimum	1.7918
Maximum	153	Maximum	5.0304
Sum	5576	Sum	554.03
Count	169	Count	169
Confidence Level(95.0%)	3.96584	Confidence Level(95.0%)	0.0971
95th percentile	98	95th percentile	
99th percentile	141	99th percentile	

Federal regulations require effluent limits be expressed as a maximum daily limit (MDL) and an average monthly limit (AML)(except municipal limits for conventional pollutants). The method for determining effluent limits from demonstrated performance is found in Appendix E of the TSD. The formulas have been incorporated into TSDCALC.XLW.

$$MAXIMUM\ DAILY\ LIMIT\ (X_{99}) = \exp\left[\mu_y + 2.326\sigma_y\right]$$

where

μ_y = *mean of* log*transformed data* =3.2783

σ_y =*standard deviation of* log*transformed data*=0.6396

Maximum Daily Limit (MDL) =exp(3.2783 + (2.326)(0.6396)) = 117.

The AVERAGE MONTHLY LIMIT (AML) depends on the number of samples that will be required per month for compliance monitoring. The following method is appropriate for 10 or fewer samples/month (Technical Support Document, Appendix E, Table E-2).

$$AVERAGEMONTHLY\ LIMIT(X_{.95}) = \exp\left(\mu_n + 1.645\,\sigma_n\right)$$

where

μ_y=mean of lognormal transformed data=3.2783

σ_y^2=variance of lognormal transformed data=0.4091

$$E(X) = \exp\left(\mu_y + 0.5\sigma_y^2\right) = \exp(3.2783 + 0.5(0.4091)) = 32.5524$$

$$V(X) = \exp\left(2\mu_y + \sigma_y^2\right)\left[\exp\left(\sigma_y^2\right) - 1\right] =$$

$$\exp(2 \cdot 3.2783 + 0.4091)[\exp(0.4091) - 1] = \exp(6.9657)[.505] = 535.126$$

$$\sigma_n^2 = \ln\left\{\frac{V(X)}{\left(n\left[E(X)\right]^2\right)} + 1\right\} = \ln\left\{\frac{535.126}{4(32.5524)^2} + 1\right\} =$$

$$\ln(1.1262) = 0.1188$$

$$\sigma_n = 0.3447$$

$$\mu_n = \ln\left(E(X)\right) - 0.5\sigma_n^2 = \ln(32.5524) - 0.5 \cdot 0.1188 = 3.4235$$

$$AML = \exp(3.4235 + 1.645 \cdot 0.3447) = 54.08$$

The average monthly limit (AML) when there are more than 10 samples per month for compliance is calculated as follows:

$$AML(X_{95}) = (X_n) + 1.645\left[V(X_n)\right]^{1/2}$$

where

μ_y = mean of lognormal transformed data = 3.2783

σ_y^2 = variance of lognormal transformed data = 0.4091

n = number of samples/month = 12

$$E(X_n) = E(X) = \exp\left(\mu_y + 0.5\sigma^2_y\right) = \exp(3.2783 + 0.5(0.4091)) = 32.55$$

$$V(X_n) = V(X)/n = \exp\left(2\mu_y + \sigma_y^2\right)\left[\exp\left(\sigma_y^2\right) - 1\right]/12 = 535.83/12 = 44.653$$

$$AML\left(X_{95}\right) = 32.55 + 1.645(44.653)^{1/2} = 43.5$$

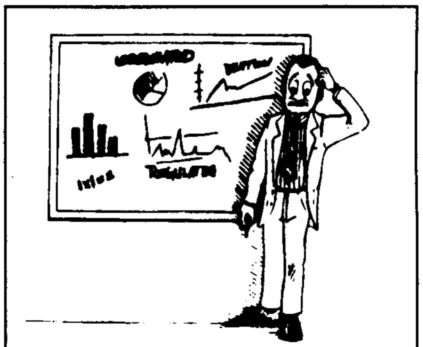
Effluent limits using these formulas can be calculated using TSDCALC.XLW.

In this example for effluent limits for BOD for a municipality the effluent limits would be as average monthly limits and average weekly limits instead of a daily maximum. The weekly average limit is the appropriate average monthly limit (44 or 54) times 1.5.

2. CASE-BY-CASE DERIVATION OF TECHNOLOGY-BASED EFFLUENT LIMITS

Technology-based effluent limits may be derived on an individual facility basis which is also called case-by-case or BPJ. Case-by-case limits may be developed under federal authority (40 CFR 125.3) or they may be developed under authority of the state law RCW 90.48 (AKART).

Case-by-case derivation of effluent limits may be on a facility basis and cover all pollutants or may be on a individual pollutant basis.



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BPJ PERMITTING

Case-by-case development of effluent limits for a individual facility follow the same process as EPA used for developing effluent guidelines for categories of dischargers. The permit writer can review any development document to reinforce the process described in this Part. Case-by-case development of effluent limits is a 2-part determination. The first part is an engineering determination and the second part is an economic determination.

Case-by-case derivation of effluent limits is necessary in the following circumstances:

- The facility being permitted has an effluent guideline but the industrial processes have changed to the extent that the process and the pollutants produced are no longer accurately described in the development document.

- The facility type does not have federal effluent guidelines. Some of the kind of facilities in Washington that do not have effluent guidelines are hazardous waste treaters, equipment manufacturers, waste oil reclaimers, industrial laundries, pharmaceutical manufacturers, barrel reclaimers, transportation facilities, some mining operations, water treatment plants, petroleum industry (other than refineries), chitin manufacturers, and some metallurgical manufacturers.

- The facility being permitted has a effluent guideline that accurately describes the manufacturing processes but has a pollutant or pollutants in the effluent that were not described in the development document.

The authority to develop and impose case-by-case or BPJ limits is given in the Clean Water Act Sec. 402 (a)(1). This section authorizes the EPA administrator to issue permits containing "such conditions as the Administrator determines are necessary to carry out the provisions of the Act".

The process of deriving case-by-case (BPJ) effluent limits is not described in federal regulations but the factors which must be considered are given in Sec. 304(b) of the CWA and 40 CFR 125.3(c)(2) and 40 CFR 125.3(d).

The general factors to be considered for BPJ permit limits are:

- The appropriate technology for the category or class of point sources of which the applicant is a member, based upon all available information; and

- Any unique factors relating to the applicant.

The specific considerations are:

1. FOR BPT REQUIREMENTS (Conventional Pollutants)

i) The total cost of application of technology in relation to the effluent reduction benefits to be achieved from such application;

ii) The age of equipment and facilities involved;

iii) The process employed;

iv) The engineering aspects of the application of various types of control techniques;

v) Process changes; and

vi) Non-water quality environmental impact (including energy requirements).

2. FOR BCT REQUIREMENTS (Conventional Pollutants)

i) The reasonableness of the relationship between the costs of attaining a reduction in effluent and the effluent reduction benefits derived;

ii) The comparison of the cost and level of reduction of such pollutants from the discharge from publicly owned treatment works to the cost and level of reduction of such pollutants from a class or category of industrial sources;

iii) The age of equipment and facilities involved;

iv) The process employed;

v) The engineering aspects of the application of various types of control techniques;

vi) Process changes; and

vii) Non-water quality environmental impact (including energy requirements).

3. FOR BAT REQUIREMENTS (Toxic Pollutants)

i) The age of equipment and facilities involved;

ii) The process employed;

iii) The engineering aspects of the application of various types of control techniques;

iv) Process changes;

v) The cost of achieving such effluent reduction; and

vi) Non-water quality environmental impact (including energy requirements).

The BAT factors have been briefly defined in EPA guidance as:

AGE OF EQUIPMENT AND FACILITIES - Age of the plant including manufacturing lines, sewer lines and wastewater treatment system.

PROCESS EMPLOYED - The manufacturing process(es) used, and/or the wastewater treatment process employed.

ENGINEERING ASPECTS OF THE APPLICATION OF VARIOUS TYPES OF CONTROL TECHNIQUES - The design, construction, cost, performance, reliability, etc., of the wastewater treatment processes.

COST OF ACHIEVING THE EFFLUENT REDUCTION - The capital and operating cost of attaining a specified effluent quality.

NON-WATER QUALITY ENVIRONMENTAL IMPACTS - The trade-offs associated with achieving a specified effluent quality including energy requirement; air pollution; hazardous waste generation; solid waste; etc.

There is no other federal guidance on case-by-case development of effluent limits. The EPA permit writers training course makes several points on case-by-case limits.

- These are best done with a team approach involving at least an engineer and an economist.

- Defensibility depends on a reasonable process and documentation of that process.

The permit writer has several useful tools for defining the appropriate treatment technology. These include engineering reports, the treatability manual, the abstracts of industrial permits, a computerized literature review, and technical assistance from the Permit Development Services Section.

The permitting process for new facilities in Washington State includes a requirement of dischargers to produce an engineering report in conformance with Chapter 173-240 WAC. This regulation (173-240-130-q) requires, "a statement, expressing sound engineering justification through the use of pilot plant data, results from other similar installations, and/or scientific evidence from the literature, that the effluent from the proposed facility will meet applicable permit effluent limitations and/or pretreatment standards." This may seem like a catch-22 situation for those industries not covered by effluent guidelines. The permit writer can't tell the industry what the permit limits will be until an engineering analysis is completed and the applicant can't make a statement as required until those limits are known. In these cases the permit writer should explicitly instruct the applicant to review all possible treatment technologies, quantify the expected concentration of pollutants from each identified treatment, detail the cost of each identified treatment and list the other environmental factors associated with each treatment method. This data in the engineering report will form the technical basis for the permit writer's BPJ determination of effluent limits.

Another useful tool for determining the appropriate treatment technology or verifying an engineering report is the Treatability Manual (EPA-600/2-82-001). The Treatability Manual is in 5 volumes. The individual volumes are;

Vol. I - Treatability Data
Vol. II - Industrial Descriptions

Vol. III -Technology for Control/Removal of Pollutants
Vol. IV - Cost Estimating
Vol. V - Summary

Volume I provides physical data for 202 chemical compounds, their occurrence patterns, and methods of treatment and/or removal (with references to Vol. III). Volume II is a summary of industrial descriptions from the development of effluent guidelines and describes only those industries for which there are guidelines. It describes manufacturing processes and the pollutants they produce. Volume III describes treatment technologies and their performance when treating industrial wastewater. The technologies include those which are widely used in treating industrial wastewater and those which are being used on a limited basis but have potential application in the removal of toxic pollutants from wastewater. The manual does not specify final effluent concentrations because those would be dependent upon individual wastewater characteristics and other factors.

EPA has continued to upgrade the Treatability Manual. The new data is being placed on a CD and a copy is available from the Program Development Services Section.

The permit writer may request a computer search of the literature for any pollutants or process and treatment methods from the Ecology library. The primary journals included in the search which include new treatment process data are the Journal of the Water Pollution Control Federation (now called Water Environment and Technology), the Sanitary Engineering Division of the ASCE, and the Purdue Industrial Waste Conference.

Those permit writers who may need further technical assistance in developing BPJ permit limits may request it from the Water Quality Program Development Services Section. Although problems unique to a region will most likely be solved by that region, some, because of their complexity, political impact, etc. will be viewed as high enough state priority to require the Program Development Services Section involvement.

The second major part of BPJ permitting is the task of determining the cost of the proposed treatment method. The cost is then subjected to a test for reasonableness. Reasonable is an economic test. The reasonable test for BCT is defined by federal regulation and the reasonable test for BAT is defined by Federal guidelines. These economic tests are reviewed in the following Part 3.

3. ALL KNOWN, AVAILABLE, AND REASONABLE METHODS OF TREATMENT (AKART)

This part discusses the phrase, "all known, available, and reasonable methods of treatment" or AKART, which occurs in state water quality law and regulation. This part clarifies the meaning of AKART as used by Ecology in the process of permitting wastewater discharges. Specifically, this part has sections which review law, regulation, PCHB decisions and individual permit instances in which AKART has been used or defined. Subsequent sections discuss engineering analysis and other tests for AKART. This part does not specify in detail the process of engineering analysis because it is assumed that any engineering analysis will be conducted by a qualified engineer. This part does give some detail on economic analysis but it is recommended that the permit writer contact the Program economist for assistance in conducting this analysis.

3.1. A Summary of AKART

AKART is a statement of legislative intent directed toward the goal of clean water.

AKART has been interpreted as a technology-based approach to limiting pollutants from wastewater discharges which requires an engineering judgement and an economic judgement. Because AKART encompasses a complex process of engineering and economic decision-making there can be no simple definition.

AKART allows the state to be more stringent than federal effluent guidelines but actually parallels parts of the CWA.

AKART has been defined in state regulation for some categories of dischargers.

A determination of AKART may be the same process as case-by-case permitting as given in 40 CFR 125.3 if a proposed permittee has no effluent guidelines.

Production increases greater than 10% should be treated as new source for defining effluent limitations for those dischargers with new source performance standards.

The discharge of pollutants already captured does not meet the intent of AKART.

AKART may be equivalent to the federal effluent guidelines or may be more stringent.

AKART means that effluent limits may be derived in consideration of the treatment performance of a similar facility.

AKART may be zero discharge.

An industrial/commercial indirect discharger should not be required to treat for BOD and solids discharged to a POTW as long as the POTW has the capacity to treat the waste.

The general requirements of an engineering report are specified in WAC 173-240. The actual analysis must be done by an engineer who is trained and experienced in wastewater treatment. Other scientists may assist in determining whether the report meets the AKART criteria. Case-by-case decisions on technology-based effluent limits for existing facilities must be reviewed and approved by an engineer.

Permit writers may carry out economic reasonableness tests for BPJ permits, however, the Water Division economist is available to conduct these analyses for permit writers.

Ecology has adopted EPA's BCT and BAT economic tests for AKART analysis.

The BCT economic reasonableness tests imply that the minimum treatment for conventional pollutants on a BPJ basis is secondary treatment with 85% removal of BOD and solids. A candidate treatment technology would be advanced secondary treatment. A new industry producing conventional pollutants but not covered by effluent guidelines would be required at a minimum to treat with secondary treatment as BPT. A candidate BCT treatment would be advanced secondary treatment.

3.2. AKART As Given In Law

In the regulatory scheme of things legislative bodies express their intent through law. Laws are generally not explicit as to how they should be implemented. Therefore, regulations are promulgated to clarify the implementation of the law. In some cases regulatory authorities must also provide guidance as an additional tool to implement the regulations.

AKART has not been explicitly defined in law. AKART has been defined in certain regulations and has been ruled upon by the Pollution Control Hearings Board (PCHB). The following discussion reviews the law and regulation in which the phrase AKART is used.

The phrase AKART is found in 3 statutes dealing with water pollution and water resources in Washington. The context of these statutes in which the phrase AKART occurs gives some indication of the legislative intent.

The introduction to this manual reviewed some of the legislative history of Chapter 90.48 RCW, Water Pollution Control. Section 010 of 90.48 states, "It is declared to be the public policy of the state of Washington to maintain the highest possible standards to insure the purity of all waters of the state consistent with public health and public enjoyment thereof, the propagation and protection of wild life, birds, game, fish and other aquatic life, and the industrial development of the state, and to that end require the use of **all known available and reasonable methods by industries and others to prevent and control the pollution of the waters of the state of Washington.**" AKART in this section of the law relates to industries and others preventing pollution so as not to affect other water uses and intrinsic values.

Chapter 90.48 RCW, section 520 states, "In order to improve water quality by controlling toxicants in wastewater, the department of ecology shall in issuing and renewing state and federal wastewater discharge permits review the applicant's operations and incorporate permit conditions which require **all known, available, and reasonable methods to control toxicants in the applicant's wastewater."** This section ties AKART to the control of toxics, improvement of water quality, and the issuance of wastewater discharge permits.

In the Pollution Disclosure Act of 1971, Chapter 90.52 RCW, section 040 states "Except as provided in RCW 90.54.020(3)(b), in the administration of the provisions of chapter 90.48 RCW, the director of the department of ecology shall, regardless of the quality of the water of the state to which wastes are discharged or proposed for discharge, and regardless of the minimum water quality standards established by the director for said waters, **require wastes to be provided with all known, available, and reasonable methods of treatment prior to their discharge or entry into waters of the state.**" This statute introduces the concept that AKART is required regardless of the quality of the receiving water.

In the Water Resources Act of 1971, Chapter 90.54 RCW, section 020 (3)(b) states, "Waters of the state shall be of high quality. **Regardless of the quality of the waters of the state, all wastes and other materials and substances proposed for entry into said waters shall be provided with all known, available, and reasonable methods of treatment prior to entry. Notwithstanding that standards of quality established for the waters of the state would not be violated, wastes and other materials and substances shall not be allowed to enter such waters which will reduce the existing quality thereof, except in those situations where it is clear that overriding considerations of the public interest will be served.**" This section of 90.54 continues on with technology-based treatment exemptions for wastewater discharges from municipal water treatment plants on the Chehalis, Columbia, Cowlitz, Lewis, and Skagit Rivers. This law explicitly states that AKART is required even if it results in more stringent treatment than required to meet water quality standards. This is the basic philosophical approach found in the Clean Water Act. Chapter 90.54 also contains the caveat not found in other statutes of an exemption for, "overriding consideration of the public interest."

3.3. AKART As Given In Regulation

The phrase AKART is also found in the regulations that implement the laws reviewed above. In these regulations the phrase may be defined, simply repeated or may be changed to indicate implementation process. In some cases the context of the regulation also indicates implementation.

The state's surface water quality standards, Chapter 173-201A, define AKART as, "represent(ing) the most current methodology that can be reasonably required for preventing, controlling, or abating the pollutants associated with a discharge." These water quality standards also require dischargers to achieve AKART before receiving a mixing zone and require AKART as a condition for exemption to the antidegradation condition.

The state wastewater discharge permit program is implemented by Chapter 173-216 WAC, State Waste Discharge Permit Program. WAC 173-216-020(1) states, "It shall be the policy of the department in carrying out the requirements of this chapter, to maintain the highest possible standards to ensure the purity of all waters of the state and to require the use of **all known, available and reasonable methods to prevent and control the discharge of wastes into the waters of the state.**"

WAC 173-216-050(3): "These exemptions" (to the requirement to obtain a state discharge permit) "shall not relieve any discharger from the requirement to apply **all known, available, and reasonable methods to prevent and control waste discharges to the waters of the state,**"...

WAC 173-216-110(1): "Any permit issued by the department shall specify conditions necessary to prevent and control waste discharges into the waters of the state, including the following, whenever applicable:
(a) **All known, available, and reasonable methods of prevention, control, and treatment**:"...

This regulation reiterates the phrase as found in law. The regulation notes that a discharger may be exempted from getting a permit but they are not exempt from AKART.

The state's surface water discharge permit program is implemented through Chapter 173-220 WAC, National Pollutant Discharge Elimination System Permit Program. This regulation refers to the statutes covered above and the technology-based processes of the CWA.

WAC 173-220-130(1): "Any permit issued by the department shall apply and insure compliance with all of the following, whenever applicable:

> (a) All known, available and reasonable methods of treatment required under RCW 90.52.040, 90.54.020(3)(b), and 90.48.520; including effluent limitations established under sections 301, 302, 306, and 307 of the FWPCA."

The state dangerous waste regulations, Chapter 173-303 WAC, which allow a (dangerous waste) permit by rule, condition that permit by rule upon meeting AKART. WAC 173-303-802 (5)(a): "The owner or operator of a totally enclosed treatment facility or an elementary neutralization or wastewater treatment unit that treats dangerous wastes shall have a permit by rule, except as provided in (b) of this section, if he:

(i) Has a NPDES permit, state waste discharge permit, pretreatment permit (or written discharge authorization from the local sewerage authority) and the permit or authorization provides for the use of **all known, available, and reasonable methods of prevention, control, and treatment of pollution pursuant to chapter 90.48 RCW, prior to discharge;"...**

The underground injection control program, Chapter 173-218 WAC sets forth the procedures and practices applicable to the injection of fluids through wells. This regulation specifies in 173-218-100 that: (1) Any permit issued by the department shall specify conditions necessary to prevent and control injection of fluids into waters of the state, including the following, whenever applicable: (a) **All known, available, and reasonable methods of prevention, control, and treatment**;.

Other state standards are the ground water standards, Chapter 173-200, and Sediment Management Standards Chapter 173-204 WAC. These 2 regulations also use the phrase AKART.

The Water Quality Standards for Ground Waters of the State of Washington, Chapter 173-200 WAC, implement Chapters 90.48 RCW and 90.54 RCW.

WAC 173-200-030 Antidegradation policy.
WAC 173-200-030(2)(c): "Whenever ground waters are of a higher quality than the criteria assigned for said waters, the existing water quality shall be protected, and contaminants that will reduce the existing quality thereof shall not be allowed to enter such waters, except in those instances where it can be demonstrated to the department's satisfaction that:
(i) An overriding consideration of the public interest will be served; and
(ii) All contaminants proposed for entry into said ground waters shall be provided with **all known, available, and reasonable methods of prevention, control, and treatment prior to entry.**"

WAC 173-200-050 Enforcement limit
WAC 173-200-050(3): "All enforcement limits shall, at a minimum, be based on **all known, available, and reasonable methods of prevention, control, and treatment.**"

WAC 173-200-050(3)(b)(iv): "When naturally nonpotable ground water exceeds a secondary contaminant criterion, an enforcement limit for a secondary contaminant may exceed a criterion when it can be demonstrated to the department's satisfaction that:"..."(D) **All known, available, and reasonable methods of prevention, control, and treatment will not result in concentrations less than the secondary contaminant criteria.**"

The Sediment Management Standards, Chapter 173-204 WAC expand the phrase to include best management practices.

WAC 173-204-120(c): "Whenever surface sediments are of a higher quality (i.e., lower chemical concentrations or adverse biological response) than the criteria assigned to said sediments, the existing surface sediment quality shall be protected and waste and other materials and substances shall not be allowed to contaminate such sediments or reduce the existing sediment quality thereof, except in those instances where:"..."(ii) all wastes and other materials and substances proposed for discharge that may contaminate such sediments are provided with **all known, available and reasonable methods of prevention, control, and treatment and/or best management practices;**"

WAC 173-204-400(2): "Permits and other authorizations of wastewater, storm water, and nonpoint source discharges to surface waters of the state of Washington under authority of chapter 90.48 RCW shall be conditioned so that the discharge receives **all known, available and reasonable methods of prevention, control and treatment, and best management practices prior to discharge**, as required by chapters 90.48, 90.52, and 90.54 RCW. The department shall provide consistent guidance on the collection, analysis, and evaluation of wastewater, receiving-water, and sediment samples to meet the intent of this section using consideration of the pertinent sections of the *Department of Ecology Permit Writer's Manual*, as amended, and other guidance approved by the department."

WAC 173-204-410(3):"Except as identified in subsection (6)(d) of this section, any person may apply for a sediment impact zone under the following conditions:
(a) The person's discharge is provided with **all known, available and reasonable methods of prevention, control, and treatment, and meets best management practices as stipulated by the department**;"...

WAC 173-204-410(6)(c): "Any person with a new or existing permitted storm water or nonpoint source discharge, which fully uses **all known, available and reasonable methods of prevention, control, and treatment, and best management practices as stipulated by the department** at the time of the person's application for a sediment impact zone, shall be required to meet the standards of WAC 173-204-400 through 173-204-420;"...

It is apparent from the language in both law and regulation that AKART is meant to be a technology-based requirement conditioned by a judgement of reasonableness. In this respect it shares the same characteristics of case-by-case or BPJ determinations specified in 40 CFR 125.3. This is discussed in more detail later.

3.4. AKART As State Treatment Standards

AKART has been defined explicitly as effluent limitations in some Ecology regulations for some categories of dischargers and some pollutants.

For domestic wastewater facilities the discharge standards are given in Chapter 173-221 WAC, Discharge Standards and Effluent Limitations for Domestic Wastewater Facilities

WAC 173-221-010(1): "The purpose of this chapter is to implement RCW 43.21A-010, 90.48.010, and 90.52.040 by setting discharge standards which represent "all known, available, and reasonable methods of prevention, control, and treatment for domestic wastewater facilities which discharge to waters of the state."

WAC 173-221 then defines treatment standards (effluent limits) for domestic wastewater treatment plants for the parameters of BOD, TSS, pH, and fecal coliform. This regulation was preceded by a PCHB decision regarding municipalities discharging to marine waters, which is discussed below.

Treatment standards are also defined in Chapter 173-221A WAC, Wastewater Discharge Standards and Effluent Limitations.

WAC 173-221A-010: "This chapter implements chapters 43.12A, 90.48, 90.52, and 90.54 RCW by setting minimum discharge standards which represent "known, available, and reasonable methods" of prevention, control, and treatment for industrial wastewater facilities that discharge to waters of the state."

This regulation currently defines treatment technology, treatment standards, and best management practices only for upland fin-fish facilities.

3.5. AKART As Defined By The Pollution Control Hearings Board (PCHB)

The PCHB has confirmed some of the individual permit determinations which were based on AKART. The board looks to these past decisions as guidance for future decisions. Discussed below are decisions made on marine discharging municipalities, New Source Performance Standards (NSPS) for production increases and the discharge of captured pollutants.

3.5.1. Marine Discharging Municipalities

The Clean Water Act Section 301(h) allows marine-discharging municipalities to obtain a variance from the requirement of secondary treatment. The variance is conditional upon 7 factors primarily dealing with water quality and upon concurrence of the state in which the discharge is located. In anticipation of several Washington municipalities applying for marine waivers, Ecology requested a formal AG opinion to the question "Under state law may a municipality discharge wastes from its sewerage system into Puget Sound, or other marine waters, without providing secondary treatment?" The response (AGO 1983 No. 23) reviewed the law as given previously in this section and then continued,

> "Such statutory directions to the Department of Ecology, however, clearly do bring into play the expertise of the department as administrator of the state's water pollution control system. Accord, Weyerhaeuser v. Southwest Air Pollution Control Authority, 91 Wn.2d 77, 586 p.2d 1163 (1978). The precise level of treatment required by those general standards involves, primarily, engineering determinations; i.e., as to what treatment methods are "known," what treatment methods are "available," and what treatment methods are "reasonable" with respect to the particular installation in light of the factual circumstances surrounding it.[19] To make those determinations a review must be conducted by the department of existing engineering technologies in order to enable it to decide which methods of treatment--including but not limited to "secondary treatment" as above defined--are suitable with respect to the waste situation involved in the particular case. Cf., Weyerhaeuser, supra.[20]

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19. The use of the encompassing word "all" indicates to us that the existing "state of the art" or "best available" treatment technologies are required to be used. Cf., Weyerhaeuser v. Southwest Air Pollution Control Authority, supra.

20. These determinations by the Department of Ecology are, of course, to be made in light of the foundation policy that "waters of the state" shall be of high quality and be maintained to the "highest possible standards to insure the purity of all waters of the state" consistent with various environmental and economic objectives. RCW 90.54.020(3)(b) and RCW 90.48.010.

Ecology denied the marine waivers on the basis that secondary treatment constituted all known, available and reasonable treatment for municipal dischargers. Ecology determined reasonableness for each of the municipalities on 3 factors: (1) planning status, (2) environmental or siting constraints, and (3) economics. The economics factor was an analysis of resulting rate structure after meeting secondary treatment and a comparison to rates in other municipalities in the state and nation. The PCHB concurred with Ecology that secondary treatment for marine discharging municipal treatment plants was AKART. The decision for Bellingham v. Ecology (PCHB No. 84-

211) contains a good discussion on technology-based treatment.

Footnote 20 above also mentions environmental objectives as a consideration of AKART. Environmental considerations are also a requirement given in federal regulations for case-by-case determinations. Unfortunately, there is no federal guidance on the process of making these environmental considerations. The environmental considerations required for BPT and BCT determinations were a consideration of the environmental effects of the pollutants in question.

3.5.2. New Source Performance Standards for Production Increases

Federal effluent guidelines allow a permit writer to grant an increase in pollutant discharge for production increases because the guidelines are production-based. The new source performance standards in federal regulations are more stringent than standards for existing source because new facilities can take advantage of new treatment methods and equipment and incorporate these into the design of the facility. In 1985 the Industrial Section issued a permit to Weyerhaeuser, Longview pulp mill complex which includes R-W Paper and NORPAC. The permit writer used new source performance standards to derive effluent limits for the 150 tons per day production increase at NORPAC and the 100 tons per day at R-W Paper and used AKART as the basis. Ecology argued that given the cost and planning required for anything except a marginal increase in production, a facility should also be planning and investing in its waste treatment to accommodate production increases. In this case the company did not have to make any capital investment to meet the new effluent limitations. The appellant Weyerhaeuser argued that the AKART standard was too uncertain. The PCHB found that the limits were "more stringent than federally required, but 'reasonable' as a matter of state law." As a general policy, wasteload increases greater than than 10% at facilities with applicable effluent guidelines should be considered as new source loading when defining effluent limitations.

3.5.3. Discharge of Captured Pollutants

In the early 1980's, Ecology discovered that an ITT Rayonier pulpmill was discharging clarifier solids to come up to it's permitted effluent limit for TSS. When Ecology reissued the permit, it contained a specific prohibition against discharge of sludge. The facility appealed this provision (PCHB No. 85-218), arguing that as long as they were meeting their technology-based effluent limits based on the federal effluent guidelines Ecology could not prohibit the discharge of sludge especially since Ecology could not prove water quality degradation. The mill also argued that the cost to deal with all their solids was excessive. Ecology argued that the discharge of pollutants already captured did not meet the intent of AKART. The PCHB ruled for Ecology.

3.6. Direct Definitions of AKART

Some legal rulings contained text that clarify the definitions of AKART. In the footnote number 19 of the marine discharge section above, for example, the Attorney General's office has defined "all" as indicating that the existing "state of the art" or "best available" treatment technologies are required to be used.

In PCHB 85-218 (ITT Rayonier v. Ecology), also discussed above, the board pointed to a decision by the Southwest Washington Air Pollution Control Authority (SWAPCA) for a definition of the terms "known" and "available":

> " ...SWAPCA may not require an applicant to develop new technology to advance the art of emission control. The "advance" must be "known" in the sense that it has been tested and found to control emissions effectively and efficiently. Under this test SWAPCA may not insist that an emission source be utilized as a proving ground for as yet untried control technology. An applicant must, however, incorporate into its proposal those control systems previously developed and presently available. 99 Wn.2nd at 81,82."

The issue of reasonableness was addressed in PCHB 84-211 (Bellingham v. Ecology) dealing with the marine waivers. The results of this case are discussed in the following section 3.11.

3.7. AKART Defined In Individual Permits

In individual permitting situations AKART may be equivalent to or more stringent than the federal effluent guidelines. A permit manager may examine a development document and available treatment technologies for a particular category of discharger and make a determination that the federal effluent limitations are AKART. This becomes more difficult as the effluent guidelines become dated and the manufacturing processes change. In some cases the manufacturing processes change to such an extent that they no longer fit those described in the development documents. As described in an earlier section, those effluent guidelines less than 5 years old will always be AKART for the pollutants described in the development document. For effluent guidelines between 5 and 10 years old, the permit manager should compare production processes, pollutants generated and treatment efficiencies at the facility with those in the development document and in the treatability data base. For effluent guidelines older than 10 years, the permit writer should do the previous analysis and review unit processes design if time allows.

In some cases Ecology permit writers have determined that a category of discharger is capable of better performance than specified under effluent guidelines. An example is continuously-monitored pH. Under federal regulations, if a pH limitation in a permit is technology-based and is continuously monitored, then a discharger may receive an exclusion from the permit limits for a period of 1 hour per excursion and a maximum monthly excursion period of 7 hours and 26 minutes (40 CFR 401.17). The federal regulations place no bounds on magnitude of the excursions. Ecology has issued permits which place outside limits on these excursions of 5.0-10.0 units for petroleum refineries and 4.0-9.5 units for pulp mills. The justification for these excursion limits was that water quality standards may be violated at extreme pH ranges, that extreme ranges would be a violation of the state's dangerous waste laws, and that the facilities were capable of achieving a narrower range (AKART). This determination was appealed but a settlement was reached on the issue.

An AKART determination may take into consideration the treatment performance at a similar manufacturing facility. In this situation the permit writer must assess the costs to the facility to achieve the increased treatment efficiency. Some of the factors to be analyzed are;

1. Are the production processes equivalent?

2. Does this facility have some site specific constraints that would prohibit the increased treatment efficiency?

3. And are the facilities of comparable age?

3.8. AKART Versus Case-by-Case

In the cases above where proposed effluent limits are more stringent than those promulgated in the federal effluent guidelines, the effluent limits are based on the authority of RCW 90.48 (AKART). Federal regulations are not explicit as to whether or not case-by-case determinations should be made in every permitting circumstance, whereas, the language in 90.48 clearly indicates that all discharges are to be treated with all known, available and reasonable methods. Technology-based limitations based on AKART may have a compliance schedule placed in the permit instead of in a compliance order.

In the case of a facility without effluent guidelines, a permit writer must make concurrent decisions on case-by-case under federal regulations (40 CFR 125.3) for BCT (conventional pollutants), BAT (toxics/nonconventional pollutants) and AKART. This process is covered in the previous section of this manual. In this situation because the permit writer will be using the same cost tests for economic achievability, case-by-case and AKART determinations are equivalent. In this situation the compliance schedule must be put in a companion enforcement order.

3.9. Zero Discharge

The permit writer may determine that for some permits AKART is zero discharge. Although there is no explicit statement in RCW 90.48 equivalent to the "zero discharge" goal of the Clean Water Act, both of these laws have a technology-based principle which, when followed to the logical conclusion lead to zero discharge, when achievable and reasonable.

3.10. AKART For Pretreatment

The pretreatment program parallels the surface discharge program. Municipal treatment plants are designed to treat domestic sewage. The uses to be protected at the treatment plant are biological functioning of the biomass and uses of the biosolids (sludge). Local limits are designed in part to protect these uses and are equivalent to water quality-based limits for surface discharges to prevent violations of the water quality standards. The categorical (pretreatment) effluent limitations are equivalent to the technology-based effluent limitations in federal regulations for surface dischargers.

All indirect dischargers must be examined for AKART in the permitting process because there is no exemption in law for indirect dischargers. Determining AKART for indirect dischargers is the same process as described previously. If the discharger is a categorical discharger the permit writer must determine the applicability of the effluent guidelines. A permit writer may derive limits that are more stringent than the effluent guidelines on the basis of AKART. If the discharger is not a categorical discharger the permit writer must do an engineering and economic analysis to determine appropriate technology-based effluent limits on a case-by-case basis.

Since POTW's are designed to treat BOD and solids, an industrial/commercial discharger should not be required to treat for BOD and solids if the municipality has the capacity to treat the waste.

3.11. Engineering Analysis for All Known and Available

The general requirements for the engineering analysis for all known and available is specified in WAC 173-240 as requirements of an engineering report. The process of engineering analysis is not given in Chapter 173-240 WAC, however, one of the requirements of this regulation is that the engineering report be prepared under the supervision of a licensed engineer unless the requirement is waived by Ecology. The review and analysis of this report by Ecology must also be done by an engineer who is trained and experienced in wastewater treatment. Scientists in the permit unit may contribute to the determinations in an engineering report but an engineer must make the judgement on the question of whether the treatment system proposed meets the AKART criteria. Case-by-case decisions on technology-based effluent limits for existing facilities must also be reviewed and approved by an engineer.

One point made earlier is important to review here. The PCHB in it's citation of the SWAPCA decision indicated that Ecology can not require permittees to develop new treatment technology. That does not mean that treatment methods must be demonstrated for each kind of discharger. For example, if a discharger has a process not described in the effluent guidelines or elsewhere and which produces the pollutant BOD, and if the BOD concentration and degradation rates are similar to domestic wastewater, then biological treatment process and secondary treatment efficiencies are applicable to that discharger.

3.12. Economic Tests To Define Reasonable

The section describes how to conduct the economic evaluation for deriving effluent limits by case-by-case or by AKART.

Performing the economic reasonableness tests requires estimates of the costs of the proposed treatment technologies; estimates of pollutant removal levels; and profit, cost and revenue data. The permittee is responsible for providing any data needed by the permit writer to make a decision. For new dischargers the cost and pollutant removal estimates for the proposed treatment technologies should be included in the engineering report submitted under WAC 173-240. This section covers the information permit writers need from dischargers before deciding on economic reasonableness.

Permit writers can use this section and the other reference documents to carry out economic reasonableness tests for BPJ permits, however, the Water Quality Program economist is available for consultation or to conduct these analyses for permit writers.

As mentioned earlier, Ecology has adopted EPA's economic reasonableness tests. Ecology may develop it's own tests in the future. There are 3 federal economic reasonableness tests corresponding to 3 levels of treatment: (1) BPT (2) BCT, and (3) BAT. The New Source and Pretreatment tests are identical to the BAT test.

For indirect dischargers, both AKART and federal pretreatment regulations define the effluent limits. The economic factors in setting pretreatment effluent limits are discussed later in this section.

For dischargers to ground water, AKART alone defines the effluent limits. No Federal law or regulation defines treatment standards for ground water dischargers.

BPT ECONOMIC REASONABLENESS TEST

BPT was the first level of treatment identified in the CWA and is applicable only to conventional pollutants. BPT costs are also used in the economic achievability tests for BCT and BAT levels of treatment. BPT treatment for conventional pollutants is used as the base cost for BAT treatment for toxics and nonconventional pollutants because treatment for conventional pollutants is effective in varying degrees for removing toxic pollutants. The BPT economic reasonableness test is authorized by section 304(b)(1)(B) of the CWA. Among the factors that the permit writer must consider in setting BPT effluent limits is:

> "...the total cost of application of technology in relation to the effluent reduction benefits to be achieved from such application..." (40 CFR 125.3(d)(1).

The BPT economic reasonableness test is intended to be a cost-benefit test and benefits are measured in terms of amounts of pollutants removed.

EPA writes that:

> "The cost-benefit inquiry for BPT is a limited balancing, committed to EPA's discretion, which does not require the Agency to quantify benefits in monetary terms....In balancing costs in relation to effluent reduction benefits, EPA considers the volume and nature of existing discharges, the volume and nature of discharges expected after application of BPT, the general environmental effects of the pollutants, and the cost and economic impact of the required pollution control level." (47 FR 23263).

Thus, there is no single, precisely-defined BPT economic reasonableness test. The economic factors considered in determining BPT can vary from industry to industry.

According to an EPA economist, in setting BPT effluent limitations, EPA weighed more heavily the cost per pound of pollutants removed by the treatment technology than the effect of the annual cost of the treatment technology on the profitability of the plant (although some weight is given to the effect on profitability). The cost per pound of pollutants removed is intended to be a cost-benefit measure. By considering cost per pound, total cost in relation to pollution reduction is considered.

The intent of the BPT cost-benefit requirement is to avoid requiring wastewater treatment "where the additional degree of effluent reduction is wholly out of proportion to the costs of achieving such marginal level of reduction..." Costs cannot be wholly disproportionate to benefits.

For at least a few industries EPA used the "inflection" or "knee of the curve" method as the economic reasonableness test for BPT effluent limits. For each industry, "cost-effectiveness" diagrams were constructed which graphed the total cost of various treatment technologies against the percentage of pollutants removed by each technology. These graphs show that the marginal cost per percentage of pollutants removed rises as the total percentage of the pollutants removed rises. The BPT effluent limitations "were set at the point where the costs per percent (of) pollutant reduction took a sharp break upward toward higher costs per percent of pollutant removed". The cost per percent of pollutant reduction is called the marginal cost of pollutant removal.

However, the "knee of the curve" test is not <u>the</u> BPT economic reasonableness test. The U.S. Fifth Circuit Court of Appeals rejected the argument that the CWA <u>required</u> the use of the "knee of the curve" cost test in setting BPT effluent limits. The court wrote that:

> "The CWA contains no specific statutory language establishing a BPT "knee of the curve" test or any other quantitative cost-benefit ratio test for BPT.... The courts of appeal have consistently held that Congress intended Section 304(b) to give the EPA broad discretion in considering the cost of pollution abatement in relation to its benefits and to preclude the EPA from giving the cost of compliance primary importance."

Section 304(b) of the CWA requires EPA to establish BPT effluent limits. The CWA does not require that the knee of the curve test be used. The knee of the curve test can be used in combination with other tests. EPA does have to consider costs in relation to benefits in some manner.

For each development document, an accompanying economic analysis is written. The economic analysis estimates the impact of the proposed effluent limits (BPT, BCT, BAT, NSPS, etc.) on the affected industry. The economic analysis includes estimates of the regulation's impact on prices, production, employment, profits, and the industry's ability to finance expansion. The ability of the industry to pass costs on to consumers through price increases is also considered. The economic analysis is one of the determinants of the effluent limits (for an example, see 47 FR 23269).

For example, in setting BPT effluent limits, the development documents often make estimates of the impact of the cost of the BPT technology on product prices. The size of the price impact is one determinant of the BPT technology. Technologies with low price impacts are more economically achievable.

In conclusion, there is no single, precisely-defined BPT economic reasonableness test.

BCT ECONOMIC REASONABLENESS TEST

Best Conventional Technology (BCT) effluent limits only apply to the 5 conventional pollutants: BOD, TSS, pH, fecal coliform, and oil and grease.

BCT always provides control of conventional pollutants at least as stringent as that provided by BPT. BCT effluent limits cannot be less stringent that BPT limits. If no BCT treatment technology exists or if it is economically unreasonable, then BCT is set equal to BPT.

The BCT economic reasonableness test is the only federal or state test that is precisely defined in regulations.

The BCT economic reasonableness test is described in 40 CFR 125.3(d)(2)(i) and (ii). In writing case-by-case or BPJ permits for BCT technology, among the factors that the permit writer must consider are:

1. " The reasonableness of the relationship between the costs of attaining a reduction in effluent and the effluent reduction benefits derived.

2. The comparison of the cost and level of reduction of such pollutants from the discharge from publicly owned treatment works (POTW) to the cost and level of reduction of such pollutants from a class or category of industrial sources." Section 304(b)(4)(B) Clean Water Act.

The details of the BCT economic reasonableness test were published in 51 FR 24973-86 (July 9, 1986). This includes the BCT economic reasonableness test methodology.

The BCT economic reasonableness test considers whether it is "cost-reasonable" for an industry to control conventional pollutants to a level more stringent than BPT effluent limitations. The test compares a permit holder's cost of removing conventional pollutants beyond BPT to a POTW's cost of removing conventional pollutants beyond secondary treatment. The test is a cost-benefit test because it compares costs and benefits (benefits are measured by the amount of pollutants removed).

The BCT economic reasonableness tests imply that the minimum treatment for conventional pollutants on a BPJ basis is secondary treatment with 85% removal of BOD and solids. A candidate treatment technology would be advanced secondary treatment. A new industry producing conventional pollutants but not covered by effluent guidelines would be required at a minimum to provide secondary treatment as BPT. A candidate BCT treatment would be advanced secondary treatment.

Conducting the BCT Test

The following BCT test was promulgated as regulation to define a cost test. EPA subsequently used the test to examine those industries that already had promulgated BPT effluent limits. This test requires that BPT technology and costs to have previously been calculated.

Conducting the BCT test as promulgated requires performing two tests:

1. POTW cost-comparison test.

2. Industrial cost-effectiveness test.

Both of these tests are intended to be cost-reasonableness tests. They implement 40 CFR 125.3(d)(2)(i) and (ii) and section 304(b)(4)(B) of the Clean Water Act. The tests are shown as a flow charts in Figures IV-5, IV-6 and in Tables IV-1 and IV-2.

The proposed BCT technology must pass both tests for it to be economically reasonable. If it passes one test but fails the other, then it is not economically reasonable.

Performing the 2 BCT tests requires the calculation of 2 marginal costs:

1. The annual marginal cost of the existing or proposed BPT treatment technology (MBPT).

2. The annual marginal cost of the proposed BCT treatment technology (MBCT).

The marginal costs are in annual dollars per pound of BOD and TSS removed units (51 FR 24975).

To calculate these 2 marginal costs requires 2 annual total cost estimates:

1. The annual total cost of the existing or proposed BPT treatment technology (TBPT).

2. The annual total cost of upgrading the BPT technology to the proposed BCT treatment technology (TBCT).

The 2 total costs are annual costs.

In addition, the 2 annual pollutant removal amounts are estimated:

1. The amount of BOD and TSS removed annually by the BPT treatment technology in pounds (PBPT).

2. The additional amount of BOD and TSS removed annually by upgrading the BPT technology to the proposed BCT technology in pounds (PBCT).

To calculate marginal costs, the annual pounds of BOD and TSS removed by the BPT and BCT treatment technologies must be estimated. Annual amounts of BOD and TSS removed by the BPT and BCT treatment technologies are measured in pounds per year units. The pounds of BOD and TSS are added together.

In general, only the amounts of BOD and TSS removed by the various treatment technologies are used in calculating annual amounts of pollutants removed. The amounts of the other 3 conventional pollutants (oil and grease, pH, and fecal coliform) removed should not be included. They should not be included because when EPA calculated the cost benchmarks it only used the amounts of BOD and TSS removed. The chief reason that EPA did not include fecal coliform and pH in the calculation is that these 2 pollutants cannot be measured in pounds.

However, EPA says that the pounds of oil and grease removed may also be included in the calculation of annual amounts pollutants removed when appropriate "in the context of the industry and technology" (51 FR 24973).

EPA calculated total annual amounts of BOD and TSS removed using the following method using actual data or the monthly maximum effluent limit.

FIGURE IV-2. The BCT Cost Test.

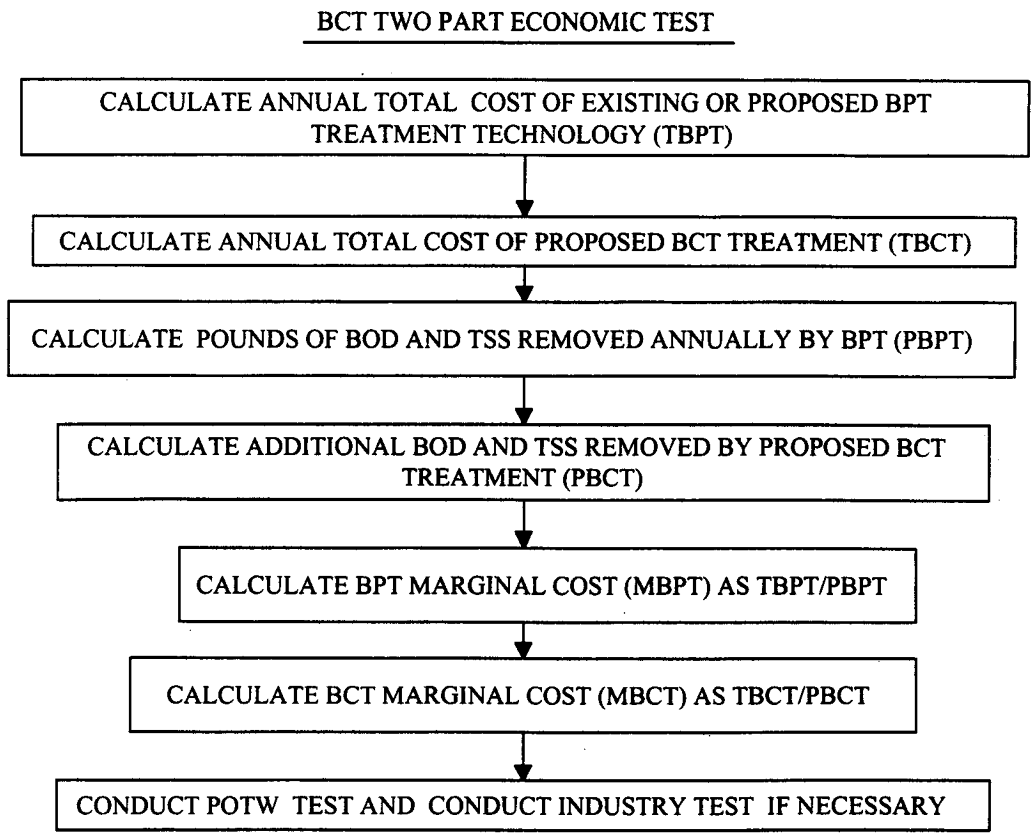
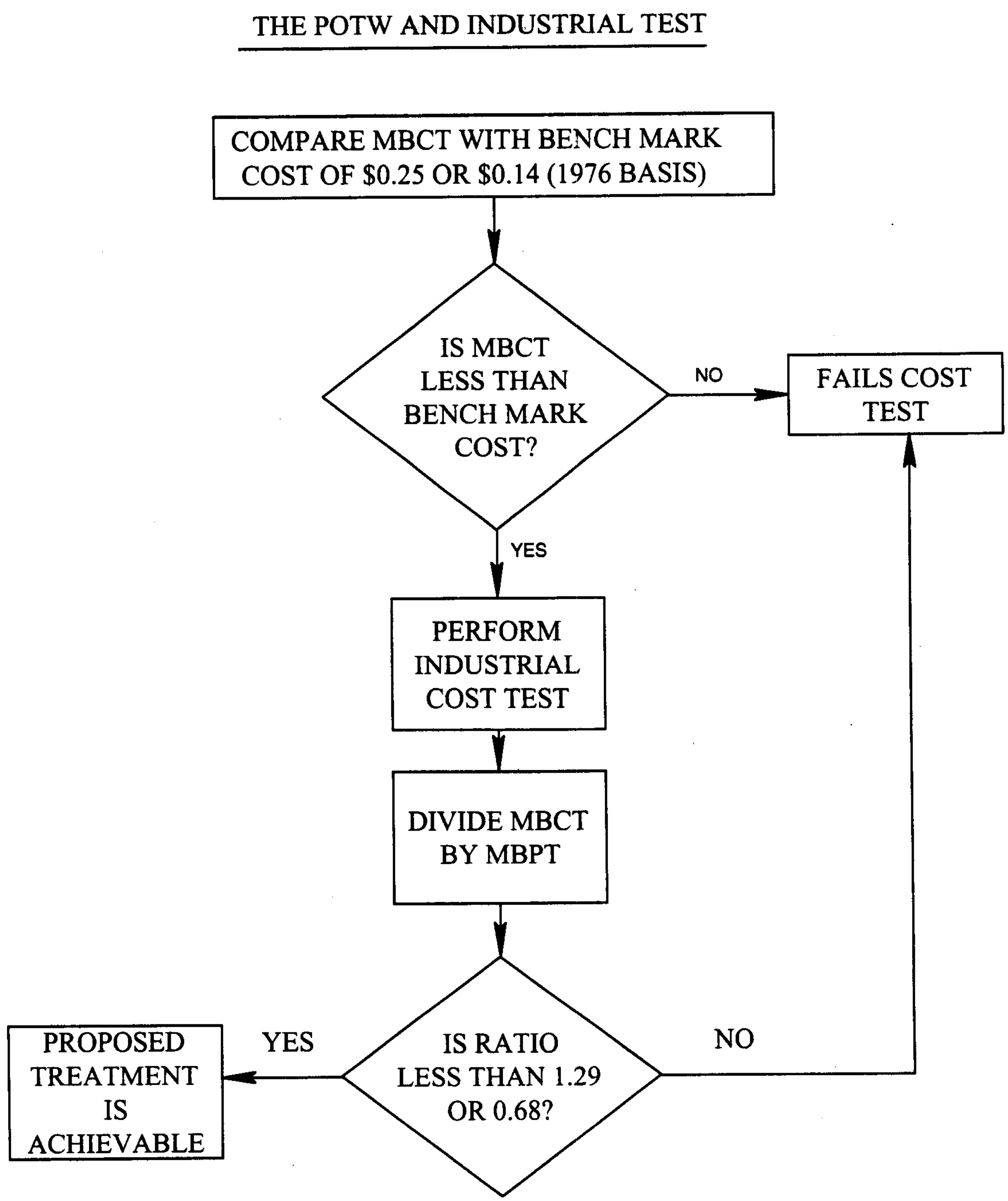


FIGURE IV-3. The POTW and Industrial Cost Tests for BCT.



Treatment processes for which long-term pollutant removal data is available (long-term means at least 12 months), actual long-term pollutant removal data (or data on pollutant concentrations in the effluent of the various treatment processes) should be used to calculate the amount of BOD and TSS removed annually.

For treatment processes for which long-term pollutant removal data is unavailable, the maximum 30 day BPT effluent limits for BOD and TSS effluent limits should be used to calculate the amount of BOD and TSS removed annually.

For both types of processes (those with and those without long-term data) pollutant loadings of the raw wastewater should be estimated from actual data. (For more information on how to calculate amounts of pollutants removed by treatment processes, see 51 FR 24983 and 51 FR 24985-6.)

Marginal Costs

The marginal costs are in annual dollars per pound of BOD and TSS removed units.

To calculate the marginal cost of BPT treatment: divide the BPT annual costs by the BPT annual weight in pounds of conventional pollutants removed.

To calculate the marginal cost of BCT treatment compute the following ratio:

1. Numerator: The annual total cost of upgrading the BPT technology to the proposed BCT technology.
2. Denominator: The additional amount of BOD and TSS removed annually by upgrading the BPT technology to the proposed BCT technology.

The POTW Cost-Comparison Test

The POTW cost-comparison test is the first part of the cost-reasonableness test. It compares the industry's cost of removing additional pounds of conventional pollutants (beyond BPT) to a POTW's cost of removing additional pounds of conventional pollutants (beyond secondary treatment).

The POTW benchmarks were calculated in 1986. They are expressed in 1976 prices. These benchmarks must be updated to the year in which the proposed BCT technology cost estimate is made. If old benchmarks were used, the benchmarks would be too low (because construction and operation costs are constantly rising) and too many proposed BCT treatment technologies would be rejected as economically not achievable.

EPA published a table that updated the benchmarks through 1985 (51 FR 24985). EPA has not formally updated the benchmarks past 1985. However, it can give help in updating them (cost indices, etc.).

TABLE IV-1. THE POTW COST-COMPARISON TEST

POTW COST-COMPARISON TEST

<u>TO PERFORM THE POTW COST-COMPARISON TEST, COMPARE THE FOLLOWING 2 MARGINAL COSTS:</u>

1. The permit holder's annual marginal cost per pound of pollutant removed when upgrading its treatment process from BPT to the proposed BCT treatment technology.

2. An average-size POTW's annual marginal cost per pound of pollutant removed when upgrading from secondary treatment to advanced secondary treatment. Secondary treatment is defined as 30 mg/L of BOD and TSS. Advanced secondary treatment is defined as 20 mg/L of BOD and TSS.

   Use the following figures for the POTW's annual marginal cost (51 FR 24985-6):

   A. $.25 (in 1976 dollars) when the proposed BCT treatment process has long-term pollutant removal data (here, long term means at least 12 months). This figure is referred to as the "first tier POTW benchmark."

   B. $.14 (in 1976 dollars) when the proposed BCT treatment process does not have long-term pollutant removal data. This figure is referred to as the "second tier POTW benchmark."

If the permit holder's marginal cost exceeds the appropriate POTW marginal cost benchmark, then the proposed BCT treatment process is <u>not</u> economically reasonable. If the permit holder's marginal cost is less than or equal to the appropriate POTW marginal cost threshold, then the proposed BCT treatment process <u>is</u> economically reasonable.

The Industrial Cost-Effectiveness Test

The industrial cost-effectiveness test is intended to be a test of the proposed BCT technology's cost-effectiveness. It compares the industry's costs of attaining a reduction in pollution with the pollution reduction benefits derived. See the following Table IV-2 for the test.

The POTW benchmarks were calculated in 1986. They are expressed in 1976 prices. They do not have to be updated to the year in which the proposed BCT technology's cost estimate is made. EPA (47 FR 49199) stated that the benchmarks for the industrial cost-effectiveness test would not be indexed for cost changes over time because any such changes would be small. The ratios are the ratios of the marginal cost of upgrading a secondary STP to advanced secondary to the marginal cost of building a secondary STP. It is unlikely that ratio will change much over time because the cost indices for secondary and advanced secondary STPs should be nearly identical.

The proposed BCT technology must pass both tests for it to be economically reasonable. If it passes one test but fails the other, then it is not economically reasonable.

If the proposed technology fails one or both tests, then BCT is set equal to BPT.

Table IV-2. The Industrial Cost-Effectiveness Test.

INDUSTRIAL COST-EFFECTIVENESS TEST

TO PERFORM THE INDUSTRIAL COST-EFFECTIVENESS TEST, COMPARE THE FOLLOWING 2 RATIOS OF MARGINAL COSTS:

1. The permit holder's ratio of marginal costs. This ratio is intended to be a measure of the candidate BCT treatment's cost-effectiveness. It is the ratio of the following 2 marginal costs:

   A. Numerator: The permit holder's marginal cost per pound of additional pollutants removed when upgrading its treatment process from BPT to the proposed BCT treatment process.

   B. Denominator: The permit holder's marginal cost per pound of pollutant removed when upgrading its treatment process from no treatment (raw waste) to BPT.

2. A POTW benchmark ratio of marginal costs. This ratio is referred to as the "industry cost benchmark." This is the ratio of the following two marginal costs:

   A. Numerator: The marginal cost per pound of pollutant removed when a POTW upgrades from secondary treatment to advanced secondary treatment.

   B. Denominator: The marginal cost per pound of pollutant removed when a POTW upgrades from no treatment (raw sewage) to secondary treatment.

   Use the following figures for the POTW benchmark ratio (51 FR 24985-6):

   A. 1.29 (calculated using 1976 dollars) when the proposed BCT treatment process has long-term pollutant removal data (here, long term means at least 12 months).

   B. 0.68 (calculated using 1976 dollars) when the proposed BCT treatment process does not have long-term pollutant removal data.

If the permit holder's ratio exceeds the POTW benchmark ratio, then the proposed BCT treatment process is not economically reasonable. If the permit holder's ratio is less than or equal to the POTW benchmark ratio, then the proposed BCT treatment process is economically reasonable.

BAT ECONOMIC REASONABLENESS TEST

BAT is Best Available Technology Economically Achievable and is applicable to toxics and non-conventional pollutants.

In setting BPJ effluent limits for BAT treatment technologies, 40 CFR 125.3(d)(3)(v) states that "the cost of achieving such effluent reduction" must be considered. This regulation repeats a portion of section 304(b)(2) of the Clean Water Act, which defines BAT. Even though the CWA does not list pollution reduction benefits among the factors that must be considered in determining BAT, they are considered by EPA when determining BAT. Therefore, the relationship between the cost of BAT and the pollution reduction achieved by the installation of BAT is also considered. An EPA permit writing expert has defined the cost of achieving the effluent reduction as the capital and operating cost of attaining a specified effluent quality.

The CWA does not require a comparison of costs and benefits. EPA writes:

"The statutory assessment of BAT "considers" cost, but does not require a balancing of costs against pollution reduction benefits...In developing the BAT limitations, however, EPA has given substantial weight to the reasonableness of costs. The Agency has considered the volume and nature of discharges, the volume and nature of discharges expected after application of BAT, the general environmental effects of the pollutants, and the costs and economic impact of the required pollution control levels" (47 FR 23263).

Costs and benefits do not have to be compared. However, EPA does consider the cost of the pollutant reduction achieved by BAT technology in setting BAT effluent limits. Thus, it does compare costs and benefits (as measured by pollutant reduction) in determining BAT. However, economic achievability is given more weight.

With regard to the BAT economic achievability test, the U.S. Fifth Circuit Court of Appeals wrote:

> "Both Congress and the Supreme Court have made clear that in setting BAT, the EPA is not required to compare the costs against the benefits of pollution reduction in the same manner as the EPA is required to do in setting BPT standards". (p. 250, Chemical Manufacturers Association vs. USEPA)

The court also wrote that section 301(b)(2)(A), which defines BAT, differs from section 301(b)(1)(A), which defines BPT, in that it does not state that costs shall be considered in relation to effluent reduction. No cost-benefit test is required by the CWA (p. 250, Chemical Manufacturers Association vs. USEPA). In setting BAT effluent limits, EPA must only consider their "economic achievability."

BAT Economic Achievability Tests

The BAT economic achievability tests are described in federal guidelines--not in federal or state regulations. EPA's Guidance Manual for Estimating the Economic Effects of Pollution Control Costs describes these tests. EPA emphasizes that this manual is not regulation or policy. Therefore, Ecology must determine the specific methods that it will use to evaluate economic achievability and to justify those methods. Ecology could use methods other than the federal tests if it has legitimate reasons for using them.

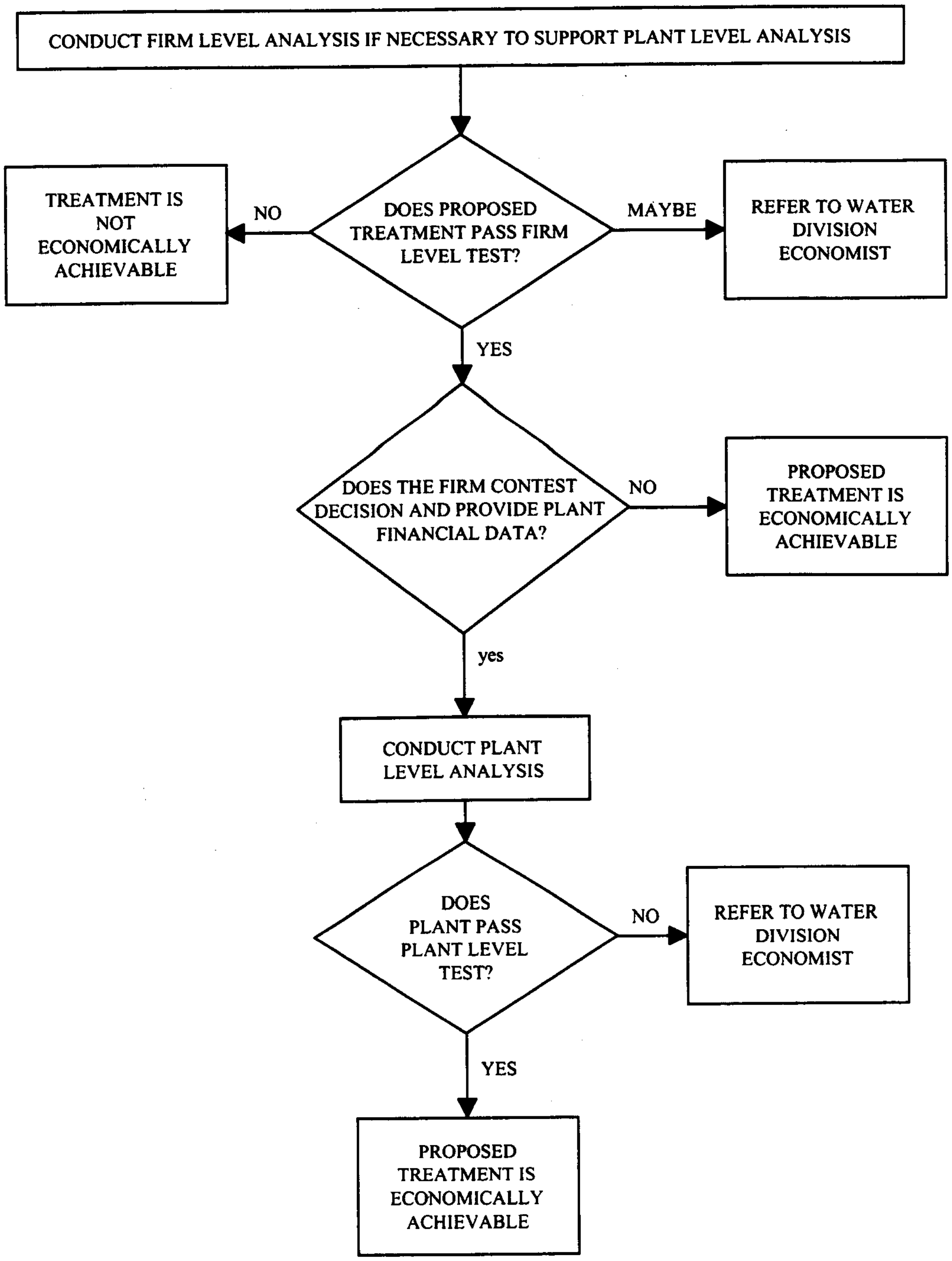
EPA's Guidance Manual defines a treatment technology to be economically achievable if its use would not cause the plant to shut down. That is, the technology is economically achievable if its annual cost is less than the plant's annual profits.

EPA's Guidance Manual uses a 3-stage approach to determining economic achievability:

1. First, perform a firm-level test.
2. If the control technology passes the firm-level test, but the permit holder protests that the technology is not economically achievable, then perform a plant-level test.
3. If the firm-level test is inconclusive, then a plant closure analysis must be conducted.

The BAT economic achievability test is shown in Figure IV-7.

Figure IV-4. Sequence of Analysis for Determining Economic Achievability for BAT.



The plant-level test makes the most sense economically. It is more precise than the firm-level test. However, plant-level tests are difficult to do because plant-level data is limited and confidential. Therefore, the Guidance Manual recommends doing the firm-level test first because, in some cases, it is possible to conduct it with publicly-available data on the firm's balance sheet, income statement, and stock prices.

However, in most cases it is either impossible or a waste of time to perform the firm-level test for 2 reasons:

1. For most permit holders, the firm-level test is difficult to do because few of them are publicly held corporations. Therefore, no publicly available balance sheet or stock market data exists. In many cases, because the firm is so small, the firm will equal the plant.

2. Any permit holder with any business sense will demand that the plant-level economic achievability test be performed in any case, because he/she, as a profit-maximizer, is interested in the profitability of the plant. A profit-maximizing firm owner has no interest in subsidizing the wastewater treatment costs of one plant with profits earned by the remainder of his/her firm.

The primary justification for conducting the firm-level test is that the data needed to perform the test is publicly available from sources such as Moody's Industrial Manual and from stock prices. However, very few Washington permit holders (especially small- and medium-sized companies) are publicly owned. Thus, few have stock that is publicly traded. Few permit holders are listed in Moody's and similar publications. There is no other publicly available data. Therefore, for these firms, permit holders must provide the data needed to conduct firm-level tests.

In cases where the firm is identical to the plant, a plant-level test is the same as a firm-level test, therefore, call it a plant-level test.

Even when there is publicly available data, a firm-level test will usually yield a meaningless answer that will be immediately disputed by the permit holder. There is little point in estimating the impact of the annual cost of a proposed BAT treatment system for a Weyerhaeuser plant on the total worldwide profits of the Weyerhaeuser Co. It is obvious that the impact will be tiny. It is also obvious that Weyerhaeuser will immediately point out that it is concerned with the profitability of each of its facilities and is not interested in subsidizing one plant with profits from its other plants. Therefore, it will want a plant-level test to be conducted.

Generally the firm-level test should not be conducted except in the situation discussed below where it is used to compliment the plant-level test.

Firm-Level Test

The firm-level test examines whether the firm as a whole can afford the treatment technology. It is performed using publicly available balance sheet and stock market data.

There are 7 different firm-level tests. They all estimate the impact of the cost of pollution control equipment on a financial ratio. Among the tests are: the current ratio, which is the ratio of current assets to current liabilities; Beaver's ratio, which is the ratio of cash flow to total debt; the debt/equity ratio; and the market-to-book ratio.

The Guidance Manual suggests that if the firm-level test shows that the proposed BAT treatment technology is not economically achievable for the firm, then it is not economically achievable for the plant. This is not always true because the firm-level test may give misleading results. It is possible that the plant is making large profits, while the firm as a whole has low profits. Losses in some of the firm's plants offset profits in others. In such a situation, the firm-level test would indicate that the proposed BAT technology is economically unreasonable, when, in fact it was reasonable.

If the firm-level test shows that the proposed BAT treatment technology is economically achievable, the owner may contest this determination. The owner may contend that the BAT technology will make the plant unprofitable to operate. If the determination is contested, the owner must provide plant-level data for the plant-level test.

In some cases (especially when the permit holder has only one plant), the firm-level tests can be used to supplement the plant-level test. They can provide information that the plant-level test does not. In most cases the data needed to perform the firm-level tests will have to be provided by the permit holder. Because there are several firm-level tests and because performing them is complicated, instructions for conducting them are not included here. See the Guidance Manual for instructions.

As explained earlier, in most cases the firm-level test is meaningless and will probably be disputed by the permit holder. In addition, for many firms, balance sheet and stock price data which is required to perform the firm-level test is not publicly available. Therefore, the firm-level test should only be performed to compliment the plant-level test.

Plant-Level Test

There are 3 plant-level tests. All the plant-level tests ask the same question: would the plant's earnings before taxes be greater than zero if it installed the proposed BAT technology? That is, would the plant be driven out of business by the cost of the BAT technology?

The 3 plant-level tests are:

1. Earnings test
2. Gross margin test
3. Revenue test

According to EPA, only 1 of the plant-level tests needs to be done because the 3 tests are essentially the same, differing only in the amount of data that they require the firm to provide. The three tests require data from the plant's income statement and estimation of the annual cost of the proposed BAT treatment technology.

It is important to note that all three of the BAT plant-level economic achievability tests are conservative. They assume that the permit holder cannot pass any portion of the cost of the BAT treatment equipment on to its customers. The cost is assumed to come completely out of its profits. The tests assume that the cost of the pollution control equipment is an additional cost but that revenue is constant. Generally, this assumption is incorrect for many of the industries that hold permits because the permit holder will be able to pass along a portion or all of the cost, thus lowering the impact of the cost of the treatment equipment on its profits. The more that water pollution control regulations are consistent throughout the U.S., the easier it is for the permit holder to pass the costs on. Therefore, this economic achievability test is biased in favor of the permit holder.

The permit holders are responsible for providing the cost, earnings, and revenue data needed to perform the economic achievability test. If they refuse to supply the data, then it should be assumed that the treatment technology is economically achievable.

Plant Closure Analysis.

If the plant-level tests do not provide conclusive answers, then a detailed plant closure analysis must be conducted. This is a much more detailed and therefore, more valid and expensive-- examination of the impact of the cost of the treatment technology on the plant's economic viability. It is a job for a consultant.

The EPA Guidance Manual states:

The plant-level tests are intended and designed as screening tests rather than rigorous and definitive evaluations of a plant's ability to afford pollution control costs. If the test results indicate that pollution controls would impose severe economic impacts, then a more detailed plant closure analysis would be necessary. This would entail working closely with the plant and corporate accountants to gather information on a variety of costs, revenues, and accounting procedures. Information on salvage values of equipment as well as projections of future economic conditions may be desirable or required.

Data Requirements for Plant-Level Test

If the owner does not think that a treatment technology proposed by Ecology is economically reasonable and wants a plant-level test conducted, he/she must provide the data needed to conduct the economic achievability tests.

The permit holders are responsible for providing all the data needed to perform the economic achievability tests. They must supply 2 types of data:

1. Cost estimate for upgrading the treatment technology from BPT to the proposed BAT technology.

2. Data from its income statement.

Pollution Control Equipment Cost Estimate

All 3 BAT plant-level economic achievability tests require estimates of the annual cost of the proposed BAT treatment technology. This cost is the cost of upgrading from BPT to BAT treatment. For the BAT test, the total annual cost of upgrading from BPT or proposed BPT to the proposed BAT treatment technology is used. Marginal costs per unit of pollutant removed are not used in the BAT tests.

Ecology may propose a BAT treatment process based on the fact that a competitor of the permittee had a similar process. If the permittee disputes this type of comparison they must submit data to show why they are substantially different from their competitor.

The plant-level tests use before-tax annual costs.

Income Statement Data

The permit holder must provide plant-level income statement data--revenue, costs, and earnings--for the most recent 3 years (The EPA Guidance Manual only uses data from the most recent year's income statement). If it does not collect this data at the plant level, it must do the best job it reasonably can in constructing accurate income statements for the plant.

The permit holder must provide the following income statement data:

1. Revenue

2. Cost of Goods Sold
   A. Cost of materials
   B. Direct labor costs
   C. Production overhead costs (indirect labor, rent, energy, etc.)
   D. Extraordinary costs should not be included.

3. Corporate Overhead Costs Assigned to the Plant
   A. Selling, general, and administrative expense.
   B. Interest expense
   C Depreciation on common property
   D. Etc.

The permit holder must supply documentation to verify the data. For example, state excise tax returns, federal income tax returns, tax schedules, etc.

For plants that are owned by companies with several facilities, income tax returns and schedules will usually lump together the revenue, cost, and earnings data for all the facilities. In such cases, income tax forms will be worthless for verifying plant-level revenue and cost data. Ecology will then have to rely on accounting records. Such records might be biased by the permit holder. There is little Ecology can do about this, short of auditing the firm.

There are several problems that will be faced in obtaining accurate plant-level data:

- Pant-level data is usually confidential.

- Sometimes firms do not collect plant-level revenue and cost data. Many companies do not keep revenue data at the plant level. Instead, they maintain some cost records at the plant level but record revenues at the division or firm level.

- Corporate overhead costs are not usually allocated to individual plants. And when they are, biases may exist in the allocation method.

- Non-standard accounting procedures used internally by the firm can make it difficult to verify cost and revenue data.

- Firms may bias the plant's costs and revenues. It is essentially impossible to audit the cost and revenue data for accuracy.

- Transfer prices for inputs purchased by the plant from other parts of the firm can be biased upward in order to increase costs.

- Transfer prices for goods sold by the plant to other parts of the firm may be biased downward in order to reduce revenue.

The BAT plant-level economic achievability tests are performed using the following tests which are calculated using income statement data:

- Earnings before taxes test (EBT) = revenues minus the costs of goods sold and corporate overhead
- Gross margin test = revenues minus costs of goods sold
- Revenue test

Performing the Plant-Level Tests

The earnings test is the most accurate plant-level BAT test. Therefore, if the data is available, it is the test that should be performed. The earnings test asks the question: would the plant's earnings before taxes be greater than zero if it installed the proposed BAT technology?

The earnings test analyzes a plant's earnings before taxes (EBT) and determines if the EBT would be positive after installation of pollution control equipment.

The earnings test requires data that may not normally be collected at the plant level. Therefore, its application may be limited. The gross margin test and the revenue test require less data and, therefore, can be used in more situations.

Table IV-3. The BAT Earnings Test.

EARNINGS TEST
TO PERFORM THIS TEST CALCULATE: Earnings before taxes minus the annual cost of proposed BAT technology
• If this number is greater than zero, the proposed BAT treatment technology is economically achievable. • If this number is less than zero, the proposed BAT technology is not economically achievable. • If this number is equal to zero (or near zero), then the test is inconclusive. A plant closure analysis must be carried out.

If the earnings test is inconclusive, the other 2 plant-level tests will not help to determine whether or not the proposed technology is economically achievable. All 3 tests are identical except that the gross margin and revenue test use less accurate data than the earnings test uses. Tests performed using less accurate data cannot help provide a conclusive answer when the test using the most accurate data (the earnings test) does not provide a conclusive answer.

Gross Margin Test

According to the EPA Guidance Manual, if the earnings test cannot be performed because cost data that allocates corporate overhead costs to individual plants is not available, then either the gross margin test or the revenue test should be performed. There is no need to perform both. As explained below the 2 tests are equivalent except for the data requirements.

Gross margin is equal to revenue minus the cost of goods sold. It is a measure of the plant's profit before deducting corporate overhead costs. The gross margin test avoids the problem of accurately allocating corporate overhead to the plant. This test is a less accurate test of economic achievability than the earnings test because an estimate of the plant's corporate overhead is used instead of actual data.

The gross margin test assumes that the firm's EBT-to-gross margin ratio is equal to its industry's EBT-to-gross margin ratio. The test uses the firm's gross margin and the industry's EBT-to-gross margin ratio to estimate the firm's EBT (multiply the firm's gross margin by the industry's EBT/gross margin to yield the estimate of the firm's EBT). It then compares the cost of the BAT technology to the firm's estimated EBT. So, the gross margin test is an earnings test that uses estimated earnings rather than actual earnings.

Table IV-4. The Gross Margin Test for BAT.

GROSS MARGIN TEST
TO PERFORM THE GROSS MARGIN TEST CALCULATE: 1. Ratio of the annual cost of the proposed BAT technology to the firm's gross margin. 4. Ratio of the industry's average EBT to the industry's average gross margin. The industry average EBT and gross margin are obtained from Robert Morris Associates' Annual Statement Studies. They are available for 4-digit SIC codes.
• If the first ratio is less than the second ratio, then the proposed BAT treatment technology is economically achievable. • If the first ratio is greater than the second ratio, then the proposed BAT treatment technology is not economically achievable. • If the first ratio is equal (or approximately equal) to the second ratio, then the test is inconclusive. A plant closure analysis must be carried out.

If the gross margin test is inconclusive, the revenue test will not help to determine whether or not the proposed technology is economically achievable. Both tests are essentially the same except that the revenue test uses less accurate data than the gross margin test does. A test performed using less accurate data cannot help provide a conclusive answer when the test using the more accurate data (the gross margin test) does not provide a conclusive answer. However, if not enough data is available for the BAT earnings test or the gross margin test, then the revenue test can be used.

Revenue Test

The EPA Guidance Manual suggests that if the earnings test cannot be performed because accurate cost data for the plant is not available, then the revenue test should be performed. This test has easy-to-meet data requirements.

The revenue test completely avoids the problem of collecting accurate cost data for the plant. It does not require any data on production or overhead costs. It only uses the plant's revenue. The disadvantage of this is that the revenue test is a less accurate test of economic achievability than either the earnings test or the gross margin test.

The revenue test assumes that the firm's EBT-to-revenue ratio is equal to its industry's EBT-to-revenue ratio. The test uses the firm's revenue and the industry's EBT-to-revenue ratio to estimate the firm's EBT (multiply the firm's revenue by the industry's EBT/revenue to yield the estimate of the firm's EBT). It then compares the cost of the BAT technology to the firm's estimated EBT. So, the revenue test is an earnings test that uses estimated earnings rather than actual earnings.

Table IV-5. The Revenue Test for BAT.

REVENUE TEST
TO PERFORM THE REVENUE TEST CALCULATE: 5. Ratio of the annual cost of the proposed BAT technology to the firm's revenue. 6. Ratio of the industry's average EBT to the industry's average revenue. The industry average EBT and revenue are obtained from Robert Morris Associates' Annual Statement Studies. They are available for 4-digit SIC codes.
• If the first ratio is less than the second ratio, then the proposed BAT treatment technology is economically achievable. • If the first ratio is greater than the second ratio, then the proposed BAT treatment technology is not economically achievable. • If the first ratio is equal (or approximately equal) to the second ratio, then the test is inconclusive. A plant closure analysis must be carried out.

NSPS ECONOMIC REASONABLENESS TEST

In setting New Source Performance Standards (NSPS), section 306(b)(1)(B) of the CWA requires that EPA "take into consideration the cost of achieving such effluent reduction." This language is identical to that which specifies how costs are to be considered in defining BAT.

In setting NSPS effluent limits for toxic and conventional pollutants discharged by chemical manufacturers, EPA used the BAT economic test. The U.S. Fifth Circuit Court of Appeals agreed with EPA that use of the BAT test in setting NSPS effluent limits was required by the CWA (p. 262, Chemical Manufacturers Association vs. USEPA).

Therefore, BAT economic achievability analysis is also applicable to NSPS.

The cost of installing a given level of treatment in a new plant (NSPS) should be less than the cost of installing it in an existing plant (BCT and BAT). Therefore, the economic reasonableness test for NSPS should be easier to pass than the test for BPT and BAT.

PRETREATMENT ECONOMIC REASONABLENESS TEST

In setting Pretreatment Standards for Existing Sources (PSES) and Pretreatment Standards for New Sources (PSNS), EPA stated:

> "The legislative history of the 1977 Act (i.e. the CWA) indicates that pretreatment standards are to be technology-based and analogous to the best available technology for removal of toxic pollutants" (47 FR 23264).

That is, PSES and PSNS are analogous to BAT.

However, in setting PSES and PSNS effluent limits, EPA also considered:
The cost of application of technology in relation to the effluent reduction and other benefits achieved from such application (47 FR 23264).

This criterion is similar to that used in setting BPT effluent limits. It is a cost-benefit test.

The U.S. Fifth Circuit Court of Appeals wrote that the CWA requires that pretreatment standards be "based on BAT or more stringent criteria" (p. 196, Chemical Manufacturers Association vs. USEPA). The court also wrote that the PSES pretreatment standards are:

> ..."technology-based and are analogous to the BAT effluent-limitation guidelines for the removal of toxic pollutants--that is, they are intended to represent the best available technology that is economically achievable by indirect dischargers" (p. 244, Chemical Manufacturers Association vs. USEPA).

In addition, the court wrote that the PSES standards are equivalent to BAT standards and, therefore, are to be set in accordance with section 304(b)(2)(B) of the CWA, which lists the factors that must be considered in determining BAT (p. 249, Chemical Manufacturers Association vs. USEPA).

Therefore, the BAT economic achievability test is applicable for pretreatment effluent limits.

The cost of installing a given level of treatment in a new plant (PSNS) should be less than the cost of installing it in an existing plant (PSES). Therefore, the economic reasonableness test for PSNS should be easier to pass than the test for PSES.

ECONOMIC REASONABLENESS TESTS FOR SEWAGE TREATMENT PLANTS REQUESTING MARINE WAIVERS

In denying the municipal sewage treatment plants' (POTWs) applications for marine waivers discussed earlier, Ecology used the following criteria to determine "reasonable methods of treatment" for AKART for municipal POTWs' discharges to marine waters:

- Status of planning needed to proceed with the proposed method of treatment.
- Environmental or siting constraints.
- Economic factors.

The PCHB accepted Ecology's use of these 3 criteria to determine reasonableness. The PCHB also wrote:

> "The economic aspect of the reasonableness criterion of the State Standard is, we conclude, defined by two propositions: (1) whether secondary treatment for the source would involve significantly greater costs than for others obliged to obtain the same levels of treatment, and (2) whether secondary treatment is within the economic ability of the source to meet the costs of treatment.

EPA's refusal to consider the second of these propositions in industrial variances was upheld in National Crushed Stone Association, supra. But, underlying this conclusion was the realization that a single plant unable to come up to industry-wide standards can simply cease operations. This is a luxury municipal sewage treatment facilities do not enjoy. The sewage must go someplace. Therefore, in interpreting the state law requirement for reasonableness as to municipalities, we think it is appropriate to include "ability to pay" factor. Cf. Weyerhaueser v. Southwest Air Pollution Control Authority, 91 Wn.2nd 77, 586 P.2d 1163 (1978)."

Here the PCHB is defining a test for economic reasonableness.

The first proposition (1) applies to both industrial and municipal permit holders. A proposed treatment technology is economically reasonable if its cost is "similar" to the cost to other dischargers with the same level of treatment (the other dischargers may or may not be in the same industry). One measure of cost is cost per pound of pollutants removed. Another measure--which is applicable to STPs--is cost per user.

"Similar" is not precisely defined. It does not mean identical. Costs can be either above or below other dischargers' costs. If they are below, then they are definitely reasonable. And even if they are above other dischargers' costs they can still be reasonable as long as they are not too far above.

The second of the PCHB's propositions (2) considers whether the cost of the treatment technology is within the permit holder's ability to pay. For an industrial discharger, the impact of the cost of the treatment technology on the discharger's profitability is examined. Impact on profitability may be considered in BAT analysis, but not in BCT or BPT analysis. The PCHB held that only the first proposition is relevant in determining economic reasonableness for industrial dischargers when the AKART level is the same as the BCT level. For municipalities, ability to pay is measured by the impact of the treatment technology's cost on user rates.

In setting AKART effluent limits, pollution reduction benefits (as measured by amounts of pollution reduction) are also to be considered. Greater amounts of pollution reduction make a given level of cost more reasonable.

Water Quality Financial Assistance

Ecology takes economic factors into account when dealing with municipal POTWs in the Centennial Clean Water Fund (CCWF) and the State Revolving Fund (SRF). Ecology's Water Quality Financial Assistance Program (WQFAP) administers both these funds.

The CCWF makes grants and loans to public bodies for water pollution control activities and facilities. Economic achievability or ability to pay is one of the determinants of the size of loan or grant that a municipality may receive.

Among the rating criteria for allocating CCWF grants and loans to marine dischargers (this includes POTWs, CSOs, and storm water dischargers) is the monthly residential user charge that would result from construction of the project without any state assistance (see Chapter IV of WQFAP's Centennial Clean Water Fund: Program Guidelines).

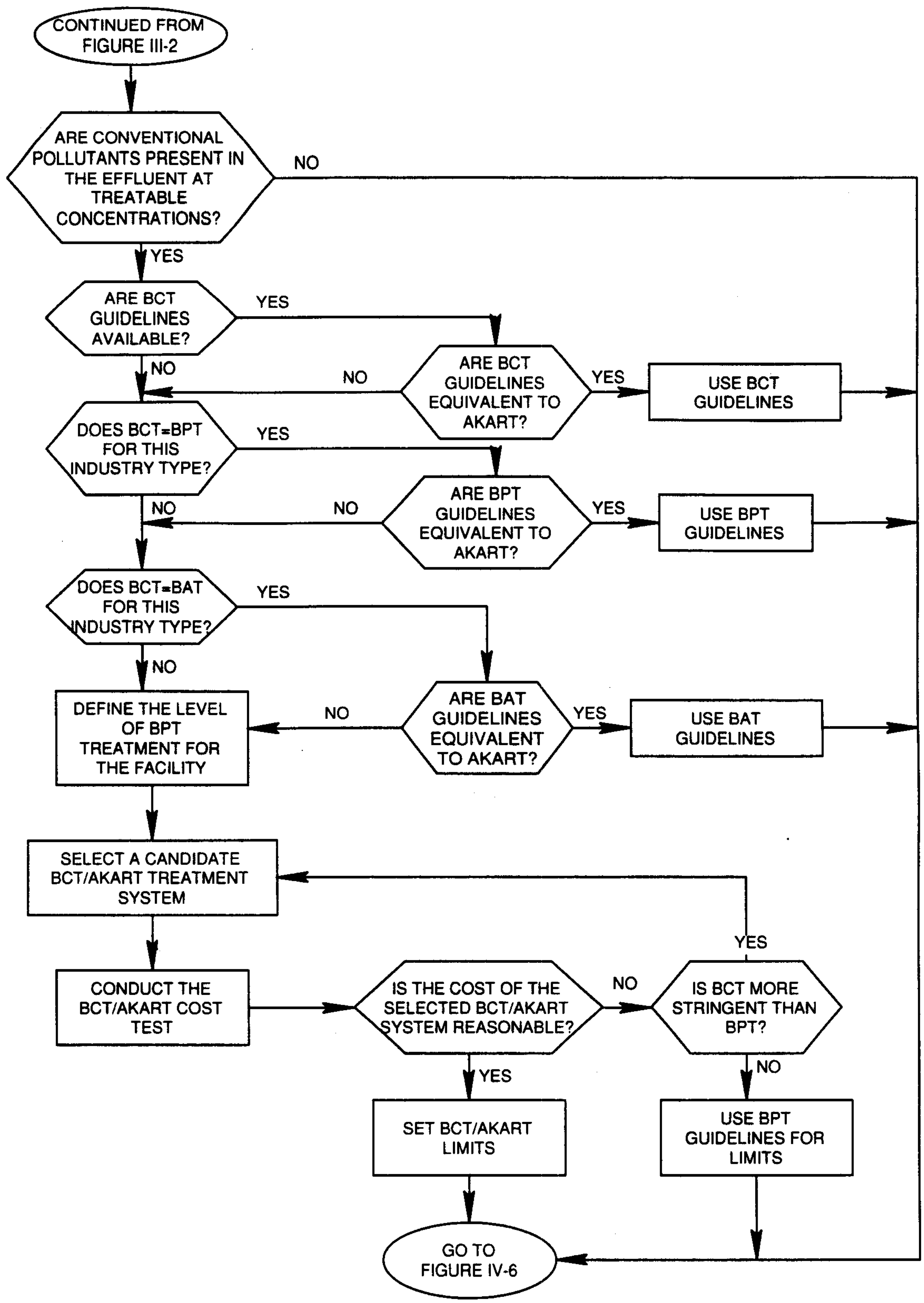
In addition, under the CCWF, public bodies may receive "supplemental financial hardship assistance" when project costs cause user charges to exceed 1.5% of the municipality's median household income. In some cases, other information--for example, unemployment rates--may be used to establish financial hardship. Chapter IV of the Centennial Clean Water Fund: Program

Guidelines contains more detailed information on how economic factors determine loan and grant amounts.

The impact of project costs on rate payers is also a rating criteria for making loans from the State Revolving Fund. If project costs without financial assistance would cause a municipality's user charges to exceed 1.5% of its median household income, WQFAP will try to award sufficient funding to bring the user charge down to 1.5 %.

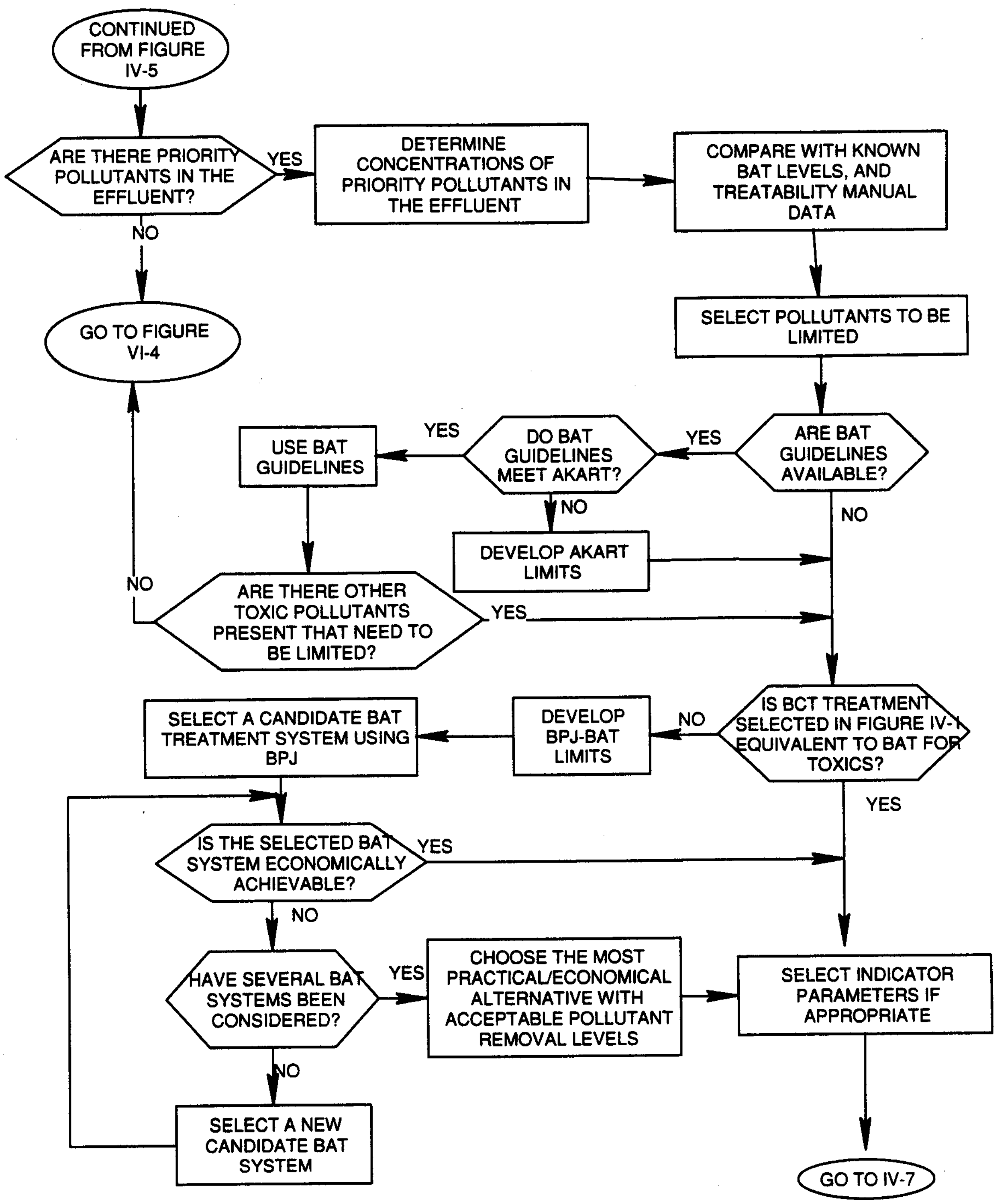
EPA Affordability Guidelines. EPA's Construction Grants Program had several affordability guidelines for municipal sewer user charges. They ranged from 1.0% of median household income for low-income communities to 1.75% of median household income for high income communities. The guidelines were used to determine whether a project was a "high cost" project. The guidelines are the source of the 1.5% threshold used by WQFAP.

Figure IV-5. Deriving BCT Limits for Conventional Pollutants.



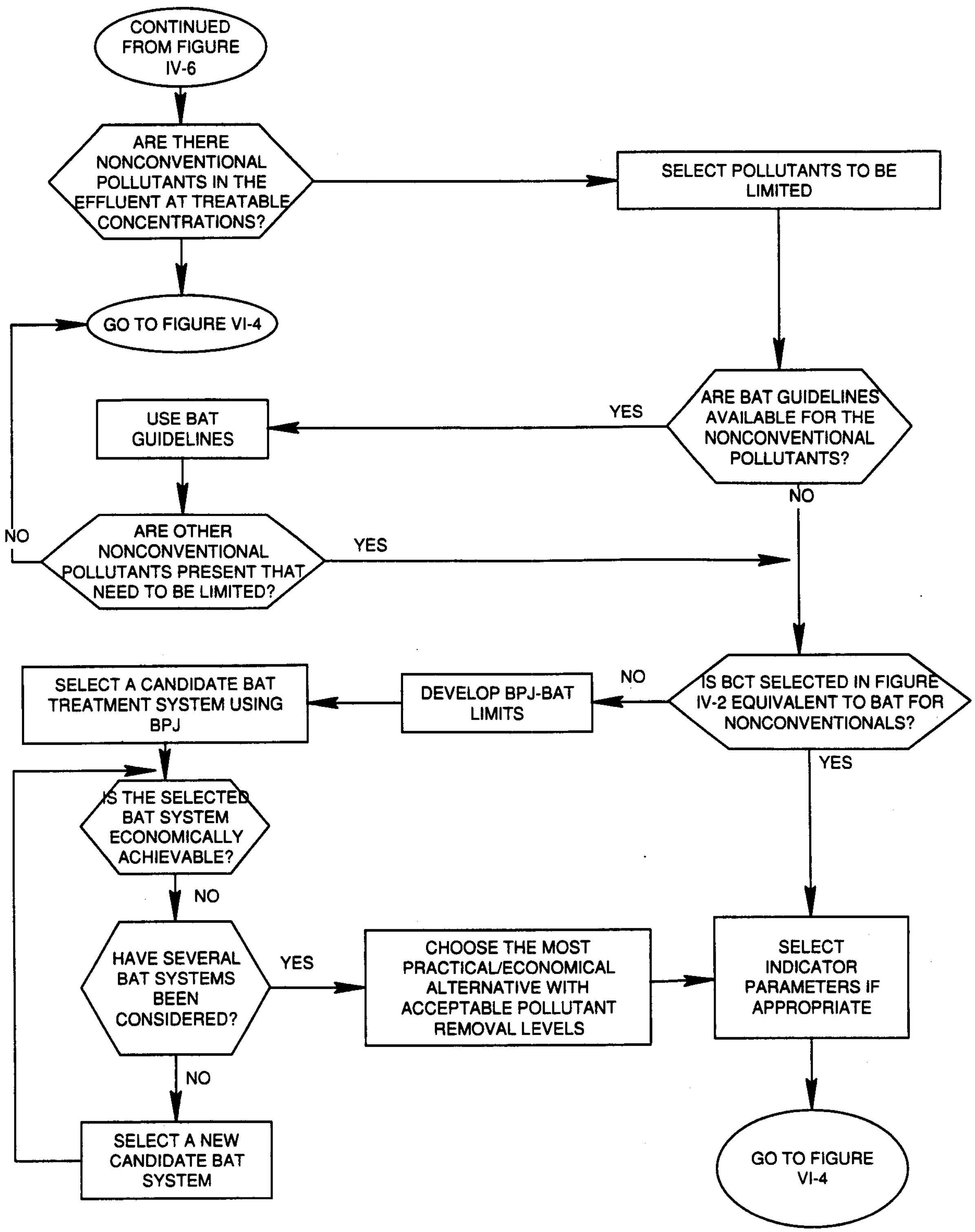
AR 032809

Figure IV-6. Deriving BAT Limits for Toxic Pollutants.



AR 032810

Figure IV-7. Deriving BAT Limits for Nonconventional Pollutants



4. ADJUSTMENT OF EFFLUENT LIMITS FOR AUTOCORRELATION

This part discusses the process of adjustment to the monthly average effluent limit in cases where the effluent data is not independent. This part is based on two technical memoranda from Jeanette L. Kranacs, Mathematical Statistician, and Henry Kahn, Chief, Statistical Analysis Section of the Engineering and Analysis Division, U.S.E.P.A. (March 20, 1996, June 25, 1996). Background material is presented in Gilbert (1987) and Box and Jenkins (1976). The example in Appendix 4 is from a request to the Ecology Industrial Section.

Applicability - This adjustment is applicable only to water quality-based effluent limits and case-by-case technology-based effluent limits. It is not applicable to effluent limits derived from effluent guidelines. It is applicable only to the average monthly limitation.

Process - The permit writer may evaluate effluent data for autocorrelation in the course of developing effluent limits or a permittee may request an adjustment of an effluent limitation. The Permit Management Section will provide assistance in evaluating autocorrelation.

Background

The Technical Support Document for Water Quality-based Toxics Control (EPA 505/2-90-001, Appendix E) discusses the problem of correlated effluent data when deriving effluent limits and presents techniques for adjusting monthly average effluent limitations based upon an analysis of autocorrelation.

What is autocorrelation and why does it result in an increase in effluent limits

When calculating statistics such as mean and variance from a data set there is a presumption of normal distribution and independence. If the data are not normally distributed they can be transformed to approximate a normal distribution so that statistics may be derived using techniques based on normal theory. If the data are not independent (i.e. each value is correlated to the value preceding and following) then the calculated mean will be lower than the true mean of the sample distribution. In wastewater treatment processes with hydraulic detention times of several days, the daily sample values are usually correlated. If sample values are correlated then a correction process must be used to derive the correct mean. Monthly average effluent limits developed on a case-by-case basis (water quality or technology based) are dependent on the mean so that an adjustment to the mean results in a different monthly average effluent limitation. Correction for autocorrelation results in a smaller effective sample size, a numerically higher mean and corresponding higher monthly effluent limitation.

When EPA develops effluent guidelines they conduct an analysis for autocorrelation and adjust the effluent limitations accordingly.

Accurate Estimates of Autocorrelation

If x_1. x_2, ..., x_n denotes a series of equally spaced measurements, Box and Jenkins (1976) indicate that the most satisfactory method of estimating the lth lag autocorrelation, ρ_l is

$$\rho_l = \frac{\sum_{t=1}^{n-l}(x_t - \bar{x})(x_{t+1} - \bar{x})}{\sum_{t=1}^{n}(x_t - \bar{x})^2}$$

In practice, at least n=50 measurements are needed to obtain accurate estimates of the ρ_l for lags l = 1, 2, ..., K, where K should not exceed n/4 (Gilbert 1987). Therefore, a 30 day lag requires a data base (n) of 30 x 4 = 120. Because it's difficult to predict what the maximum lag will be before data collection and because a 30 day autocorrelation may be allowed, the permit writer should specify a data requirement of 120 data points collected over a year. These should be collected as daily samples for a month and the 4 months should be seasonally representative. This will allow for an analysis of seasonally effected autocorrelation.

Most of the time we would expect significant autocorrelation to occur in biological treatment plants rather than physical/chemical treatment because of the longer hydraulic residence time. The significant autocorrelation should be within the range of one to three times the hydraulic residence time. Autocorrelation that occurs at lag periods longer than 3 times the hydraulic residence time should be suspect and may simply be a characteristic of the data set. Gilbert (1987) cautions that the analysis for autocorrelation assumes that the underlying process being measured does not cycle, does not have long-term trends, does not make sudden jumps in magnitude or change its autocorrelation coefficient over time. If the significant autocorrelation factors are not continuous (i.e. 1 day, 2 days, 3 days, and up to the maximum significant lag) the facility must provide some engineering explanation of why the autocorrelation is discontinuous, otherwise Ecology will not approve it. Discontinuous autocorrelation lags indicates some periodicity (cycling) that is process related.

Monitoring Frequency

The collection of data to assess autocorrelation and the autocorrelation coefficient allows the permit writer to derive a monitoring frequency which is characteristic of the discharge. The procedure is illustrated in the example in Appendix 4. The number of measurements, n, required to estimate the mean μ by the sample mean X with the prescribed accuracy, d, and 100(1-α)%

confidence is

$$n = D\left(1 + 2\sum_{l=1}^{n-1} \rho_l\right)$$

where ρ_l includes only the significant autocorrelations

and

$$D = \left(\frac{z_{1-\frac{\alpha}{2}}\,\sigma}{d}\right)^2$$

with σ^2 estimated by

$s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \overline{x})^2$ and $z_{\left(1-\frac{\alpha}{2}\right)} = \left(1-\frac{\alpha}{2}\right)$ percentile of the standard normal distribution.

CHAPTER V. MUNICIPAL EFFLUENT LIMITATIONS AND OTHER REQUIREMENTS

1. INTRODUCTION

The largest category of discharger which has technology-based effluent limits is the municipal treatment plants. This chapter discusses the technology-based effluent limits for municipal plants and some other requirements for municipalities such as biosolids, and CSO control.

The Department of Ecology has quantitative discharge standards for domestic wastewater facilities (i.e. municipal sewage treatment plants) which discharge to surface waters. The standards are codified in chapter 173-221 WAC. Prior to this rule, Washington state generally used federal standards as published first on August 17, 1973 [38 FR 22298] and codified in 40 CFR Part 133. The regulation was extensively revised in 1984, and amended again in 1985 and 1989. See Table V-l for a history of the federal rule.

In 1984, when the federal government amended its secondary treatment requirements, individual states had the option of applying those regulations or establishing more stringent requirements. Ecology decided to establish an ad hoc committee to study the options and make recommendations.

After hearing committee recommendations, Ecology adopted a state regulation defining secondary treatment requirements.

This section explains how to determine technology-based permit limits for conventional pollutants (BOD5, TSS, pH, fecal coliform) discharged by domestic wastewater treatment facilities. When reviewing a permit application or renewal, the permit writer must first determine the proper technology-based limits. Then the writer must decide if these limits are stringent enough to ensure that water quality standards are not violated in the receiving water. If they are not, then water quality-based limits must be developed. Guidance for making that decision is provided in chapter VI.

Domestic Wastewater treatment facilities are also subject to other permitting requirements such as whole effluent toxicity testing and monitoring of receiving water and sediments. Please refer to other chapters for these topics.

Table V-1. SECONDARY TREATMENT REGULATION - 40 CFR 133

Date (Federal Register)	Applicability	Action	Parameter	Limit	Citation
August 17, 1973 (38 FR 22298)	All secondary facilities	initial definition	BOD5	30 mg/L, 30-day avg 45 mg/L, 7-day avg 85% removal, 30 day avg	133.102(a)
			SS	30 mg/L, 30-day avg, 45 mg/L, 7-day avg 85% removal, 7-day avg	133.102(b)
			FC	200/100 ML, 30-day avg 400/100 ML, 7-day avg	133.102(c)
			pH	6.0 to 9.0	133.102(d)
	Secondary facilities with combined sewers, during wet weather	revise limits	BOD5 SS	% removal discretionary % removal discretionary	133.103(a) 133.103(a)
	Secondary facilities with industrial wastes	revise limits	BOD5	Proportional adjustment of 30-day and 7-day concentration and load limits, but not % removal	133.103(b)
			SS	Proportional adjustment of 30-day and 7-day concentration and load limits, but not % removal	133.103(b)
July 26, 1976 (41 FR 30788)	All secondary facilities	delete	FC	--	
		revise definition	pH	--	
October 7, 1977 (42 FR 54665)	WSP less than 2 mgd	revise limit	SS	State-determined, EPA-adopted	133.103(c)
September 20, 1984 (49 FR 36986)	TF, WSP	revise limits	BOD5	45 mg/L, 30-day avg 65 mg/L, 7-day avg	133.105(a)(1)&(2)
			SS	45/mg/L, 30-day avg 65 mg/L, 7-day avg	133.105(b)(1)&(2)
September 20, 1984 (49 FR 36986)		allow ASR's	BOD5	State-determined EPA-approved	133.105(d)
			SS	State-determined EPA-approved	133.105(d)
	All WSP	remove 2 mgd cap	SS	State-determined, EPA-adopted	133.103(c)
	All secondary facilities	allow use of CBOD5 for BOD5	CBOD5	25 mg/L, 30-day avg 40 mg/L, 7-day avg 85% removal, 30-day avg	133.102(a)(4)
June 3, 1985 (50 FR 23382)	TF, WSP	revise limits	BOD5 SS	65% removal, 30-day avg 65% removal, 30-day avg	133.105(a)(3) 133.105(b)(3)
	Secondary facilities with separate sewers, less concentrated influent during wet or dry weather	revise limits	BOD5 SS	% removal discretionary % removal discretionary	133.103(d) 133.103(d)
January 27, 1989 54 FR 4224)	Secondary facilities with combined sewers, less concentrated influent during dry weather	revise limits	BOD5 SS	% removal discretionary % removal discretionary	133.103(e) 133.103(e)

Before writing domestic wastewater permits, a permit writer should be familiar with WAC 173-221 Sections 10-50.

2. TECHNOLOGY-BASED WASTEWATER DISCHARGE STANDARDS

TASK OUTLINE FOR STANDARD TECHNOLOGY-BASED PERMIT LIMITS

(Following the rules in WAC 173-221-040.)

1. Unless a facility qualifies for an alternative discharge standard or effluent limitation, listed in Section 050, its discharge must meet the following standards.

Pollutant Parameter	30-day Average Concentration	7-day Average Concentration	Daily	7- and 30-day Average Load Limits
Biological Oxygen Demand (BOD5)	30 mg/L	45 mg/L	NA*	lbs/day (see Step 3)
Total Suspended Solids (TSS)	30 mg/L	45 mg/L	NA	lbs/day (see Step 3)
Fecal Coliform (geometric means)	200 organisms/ 100 mL	400 organisms/ 100 mL	NA	NA
pH			6-9 standard units	NA

* Not applicable.

2. In addition, the 30-day average percent removal for BOD5 and TSS shall not be less than 85%.

3. Determine the maximum allowable 30-day (monthly) average pounds per day of BOD5 and TSS as follows:

Influent:

Refer to the Ecology approved plans and specifications. They should include a table which specifies the design, maximum month influent BOD5 and TSS loadings. Include those in the permit. If no record exists, consider requiring an engineering report to determine the design capacity of the plant. Alternatively, use the historical capacity listed in previous permits or set a capacity based on the historical discharge monitoring reports (DMRs).

Task outline (cont.)

- Effluent:

Specify the lower number obtained by 1 of these 2 methods:

a) Multiply 30 mg/L by 8.34 and by the design flow as expressed in million gallons per day (mgd) for the maximum flow month in the design year. The result is in lbs./day.

b) Multiply the Ecology approved, design maximum month influent loading (lbs/day) by .15 (fifteen/hundredths).

Method (b) results in a lower number when, for example, the influent BOD5 is below 200 mg/L or CBOD5 is used in place of BOD5.

Refer to the most recent engineering report and plans and specifications which Ecology has approved for the maximum month design flow and loading. For permit compliance, remember that the permittee must still achieve 85% removal of every monthly average influent concentration and every monthly influent mass loading. Therefore a permittee may discharge less than the maximum allowable 30-day average lbs/day and still violate its permit.

4. Determine the 7-day (weekly) average load limits by multiplying the 30-day limits by 1.5. The result is expressed in lbs/day.

5. Finally, permittees can qualify for pH effluent limits outside the allowable range of 6-9, if they can meet all 3 conditions listed in Subsection 040(3).

6. Determine whether the technology-based limits derived above (including pH) will cause water quality standards violations in the receiving water (Chapter VI).

Note: Federal and state regulations refer to 30-day and 7-day average limits, not monthly and weekly average limits. For ease of permit writing and compliance monitoring, permits are typically written in terms of monthly and weekly averages.

3. ALTERNATIVE WASTEWATER DISCHARGE STANDARDS

The secondary treatment regulation (WAC 173-221-050) allows alternative effluent limitations in 5 cases:

- Trickling filters
- Waste stabilization ponds
- Facilities with combined sewers
- Weak influent sewage
- CBOD5 in lieu of BOD5

The state rule also includes alternative discharge standards for the above, but adds additional restrictions in each case. The next page describes conditions a municipality must meet to qualify for any alternative limit. Following that are background and explanations for each alternative discharge standard and a task outline for determining the appropriate alternative effluent limitation. The permit writer should be familiar with the background section before using the corresponding task outline.

3.1 Conditions for Receiving Alternative Effluent Limitations

3.1.1 Discussion of Section 050(5)

In order to qualify for any of the alternative effluent limitations of WAC 173-221-050(1-4), a municipality must prove compliance with the 6 conditions in 050(5). Therefore, those conditions, a, b, and d are explicitly required by federal regulation. Condition a requires that the alternative limit not cause a water quality violation. For condition b, note that the phrase "effluent concentrations consistently achievable through proper operation and maintenance" is defined in Section 030 (Definition #11). For condition d, check the design criteria sheet of the facility's plans and specifications.

Ecology has added condition c to the list. This prevents issuing alternative limits to a facility which cannot achieve 30/30 mg/L BOD5/TSS because of interference by industrial wastewater.

USEPA did not intend alternative limits for such cases. The federal industrial pretreatment regulation, 40 CFR Part 403, allows states to require a pretreatment program for any size facility if industrial wastewater interferes with attaining permit effluent limitations.

Condition e requires the permittee to analyze whether alternative limits should be seasonal rather than year-round. Here are 2 examples.

- Facilities may have less concentrated influent wastewater only during certain winter months. Any reduced percent removal limit should be applied only to those months.

- Some ponds may have difficulty meeting the 30 mg/L BOD5 limit during certain months (e.g. winter time when biological activity is slow). If a review of the historical record shows a consistent pattern, consider alternative limits just for those months.

Finally, condition f requires a municipality to meet all other permit requirements and conditions.

3.2 Trickling Filters

3.2.1 Discussion of Section 050(1)

The trickling filters which were constructed and/or expanded prior to November 1984 can qualify for alternative effluent limitations. In this case, the effluent limitations for BOD and TSS are set on a case-by-case basis, according to past performance. However, effluent limitations shall not exceed 45 mg/L BOD5 and 45 mg/L TSS on a 30-day average. Table V-2 is a list of trickling filters in the state which may qualify for alternative effluent limitations.

Rule 050(1) is more restrictive than the federal rule in 2 ways.

First, it applies only to trickling filters which meet definition #23 in Section 030. The definition excludes trickling filters which have a supplemental biological treatment system, other than waste stabilization ponds, for the principal wastewater stream.

In recent years, engineers have developed various ways of combining trickling filters with suspended growth, i.e. activated sludge systems. These systems have proven to be cost effective and reliable. When designed properly, they are capable of achieving 30/30 mg/L BOD5/TSS effluent and better. Ecology requires that such systems achieve those limits. Note that trickling filter/waste stabilization pond combinations (built before Nov. '84) can qualify for alternative effluent limitations allowed under Section 030. Any trickling filter may still qualify for alternative limits as allowed under Section 050(3), (4), and (6). These systems will still have periodic problems with algae in the effluent. The algae are reported as suspended solids.

Secondly, the rule does not allow alternative limits for trickling filters constructed and/or expanded after November 1984. That is the effective date of the 1984 federal secondary treatment rule revisions. Recent advances in trickling filter design and technology have made these systems more efficient pollutant removers. Synthetic medias, and proper hydraulic and organic loading designs are examples of these advances. New trickling filters are capable of achieving 30/30 mg/L BOD5/TSS and thus should not be eligible for alternative discharge standards. This position is consistent with the USEPA Science Advisory Board.

The November 1984 cutoff date is appropriate because it coincided with the effective date of USEPA's regulations. When Ecology was proposing its secondary treatment rule, no municipalities in the state had expanded or constructed trickling filters since November 1984. Most of the existing trickling filters in the state were built between 1930 and 1960. Some of these qualify for alternative effluent limitations because they are not consistently achieving 30/30 mg/L BOD5/TSS and 85% removal. However, most are achieving those limits the majority of the time and Ecology expects them to continue to do so. When these facilities need replacing because of population growth or age, the new systems should meet the 30/30 and 85% standards. The permit writer must use judgment when deciding whether a rehabilitation project at such a facility is sufficiently extensive that 30/30 and 85% should apply.

One reason for requiring new trickling filters to achieve 30/30 is the recent concern about toxicants in effluents. In general, the amount of toxicant removal by a conventional secondary treatment plant is proportional to its removal of conventional (BOD, TSS) pollutants. Trickling filters designed for 30/30 will be better suited to deal with toxicity-based limits.

3.2.2 TASK OUTLINE FOR DETERMINING TRICKLING FILTER BOD5/TSS EFFLUENT LIMITS

1. Does the facility meet definition #23 of Section 030?

   Yes - Go to 2

   No - Use Section 040. Sections 050(3), 050(4), and (6) may also apply if requested by the applicant.

2. Was the facility constructed or did it have its most recent significant rehabilitation before November 1984?

   Yes - Go to 3

   No - Use Section 040. Sections 050(3), (4), and (6) may also apply if requested by the applicant.

3. Determine BOD5 and TSS "effluent concentrations consistently achievable.." per definition #11 of Section 030, then find the percent removal value.

Procedure:

Examine at least the last few years of discharge monitoring reports for average monthly effluent concentrations and percent removals. Do not use effluent data for months during which the facility had equipment failure, operator error, overloading, or other extenuating circumstances. Review the permit file for any information which may indicate that certain data are inaccurate. Do not use those data. Class I and II inspection reports, Roving Operator Trainer reports, and memos of conversations are examples of information sources.

Determine the effluent concentration and percent removal which have been achieved 95% of the time. The following table indicates which data points represent the 95th percentile values.

Number of Acceptable	95th Percentile Values	
Monthly Avg. Values	Percent Removal	Concentration
24-35	2nd lowest value	2nd highest value
36-59	3rd lowest value	3rd highest value
above 60	4th lowest value	4th highest value

Task outline (cont.)

4a. Is the 95th percentile value for TSS or BOD5 less than 45 mg/L?

Yes - Propose the 95th percentile value as the monthly effluent limit. Proceed to 4b.

No - Propose 45 mg/L as the limit. Proceed to 4b.

4b. Is the 95th percentile value for percent removal greater than 65%?

Yes - Use the percent removal value as the monthly effluent limit. Proceed to 5.

No - Use 65% as the monthly effluent limit. Proceed to 5.

Note: You can have different percent removal limits for BOD5 and TSS.

5. Does the facility meet all 6 requirements of Section 050(5)? (See above.)

Yes - Use the limits obtained in 4. Proceed to 6.

No - Use Section 040 or Section 050(6)(a).

6. Determine maximum monthly average weight per day of BOD5 and TSS effluent loading by:

   a) Multiplying the facility's approved design year maximum month flow as expressed in million gallons per day by the concentrations determined in 4, and by 8.34; or,

   b) Multiplying the Ecology approved, design maximum month influent loading by the quantity (1 minus the % removal limit (from 4b and expressed as a decimal)). The result is expressed in lbs/day. Use the lower number (6a or 6b) as the effluent limit. Proceed to 7.

7. Determine the effluent weekly average concentration and loading limits by multiplying the monthly values by 1.5. However, the maximum acceptable weekly concentration limits are 65/65 mg/L BOD5/TSS.

8. Determine whether the technology-based limits derived above will cause water quality standard violations in the receiving water. If they will, see Chapter VI on water quality-based effluent limits.

Table V-2. TRICKLING FILTERS ISSUED NPDES PERMITS IN WASHINGTON

Western Washington.	Design Capacity, mgd
McCleary	0.25
Rainier State School	0.42
Federal Way - Redondo	3.6
Fort Lewis	7.6
Castle Rock	0.50
Centralia	4.5
Chehalis	4.5
Columbia Academy	0.04
Eastern Washington.	
College Place	0.91
Dayton	0.45
Eastern State Hospital	0.4
Endicott	0.15
Garfield	0.2
Lakeland Village	0.2
Lind	0.15
Palouse	0.21
Pasco	4.25
Pomeroy	0.25
Prosser	0.50
St. John	0.12
Sunnyside	2.2
Walla Walla	10.8

Note: This list does not include Yakima, Lynden, Mt. Vernon, Bremerton, or Des Moines which have (or will have) supplemental biological treatment.

3.3 Waste Stabilization Ponds

3.3.1 Discussion of Section 050(2)

Waste stabilization ponds which either have design capacity below 2 million gallons per day (mgd) or have received the Department of Ecology's approval for a greater design capacity, prior to the effective date of the regulation (11/12/87), can qualify for alternative limits. Permit writers should determine effluent limitations for individual waste stabilization ponds on a case-by-case basis according to past performance. However, effluent limitations shall not be set higher than 45 mg/L BOD5 and 75 mg/L TSS on a 30-day average, and 65 mg/L BOD5 and 112 mg/L TSS on a 7-day average. Table V-3 lists ponds in western Washington which may qualify for alternative effluent limitations. Table V-4 lists ponds in eastern Washington which may qualify.

The USEPA secondary treatment regulation applies to all ponds. It does not include design capacity restrictions. Ecology added 4 conditions:

a. In 1977, USEPA published a regulation (see Table V-1) which allowed ponds under 2 million gallons per day (mgd) capacity to exceed the 30 mg/L TSS requirement. By that regulation, USEPA established the TSS requirement for such ponds on a state-by-state basis. For each state, USEPA made the TSS limit a concentration which 90% of the ponds in that state were achieving. In 1977, a survey of lagoon effluent quality set that concentration limit at 75 mg/L.

USEPA figured that ponds under 2 mgd probably served towns of under 10,000 population. Such towns, they reasoned, should not be required to operate and maintain a treatment system more complex than a simple pond system. However, those ponds could not always achieve 30 mg/L TSS. Rather than requiring each small town which had a pond treatment system to change to a different system, EPA allowed higher TSS limits for ponds.

Ecology agrees with this approach, and will continue to allow small municipalities the option of constructing and keeping ponds as their treatment system. Forcing these communities to more complex systems would be counterproductive. Such systems would require more intensive operation and maintenance (highly qualified operators working longer hours). In the short run, lack of qualified operators and funds would result in poor operation, maintenance, and poor effluent quality. Ultimately it would mean a financial burden which USEPA and Ecology contend is not necessary or reasonable.

b. USEPA used similar arguments for justifying alternative BOD5 limits for ponds. Ecology concurs, and will continue to require engineers to design ponds using state of the art techniques to achieve 30 mg/L BOD5. However, if despite proper design a pond under 2 mgd design capacity does not achieve 30 mg/L BOD5, the permit writer can change the effluent limits for that facility. The permit writer should require the facility to achieve that which it has proven it can achieve. No permit should have an average monthly discharge effluent limit above 45 mg/l BOD5.

c. USEPA now allows these higher effluent limits for all ponds regardless of size. They have done so because the Clean Water Act legislative history does not necessarily indicate that Congress intended to limit alternative standards to small communities.

Ecology is not constrained by the federal congressional record. Municipalities over 10,000 population should have the ability and the financial wherewithal to construct and operate a facility which can achieve 30/30 mg/L BOD5/TSS. Therefore, any new ponds with design capacity equal to or greater than 2 mgd must meet those limits.

In addition, if a municipality with a pond system expands such that it exceeds the 2 mgd ceiling, it must treat that portion of the flow over 2 mgd to the 30/30 mg/L BOD5/TSS standard. However, if a municipality expands its total treatment capacity above 2 mgd by replacing the old pond system with a new pond system, it must treat all of the flow to the 30/30 mg/L BOD5/TSS. These various permitting situations are described in steps 1 to 9 of the next section (*3.3.2, Task outline for determining waste stabilization ponds BOD5/TSS effluent limits*).

d. Municipalities which have Ecology-approved pond systems of greater than 2 mgd design capacity can also qualify for alternative effluent limitations. Again, Ecology wants to allow those munici palities which have invested in a pond treatment system to continue to use that investment. However, the provisions of state law which require all known available and reasonable technology (AKART) dictate that more complex treatment systems capable of achieving 30/30 mg/L BOD5/TSS are reasonable for larger municipalities. Therefore, any flows exceeding the pond system design capacity approved prior to December 12, 1987, must be treated to meet the 30/30 mg/L BOD5/TSS standard.

3.3.2 TASK OUTLINE FOR DETERMINING WASTE STABILIZATION PONDS' BOD5/TSS EFFLUENT LIMITS

Permitting Situation	Start at this Step
New Pond under 2 mgd,	Step 1
Existing Pond under 2 mgd,	
renewal application for same capacity	Step 3
renewal application for greater capacity < 2 mgd	Step 1
renewal application for greater capacity ≥ 2 mgd	Step 8
Pond ≥ 2 mgd, capacity approval by Ecology after 12/87	Step 2
Existing Pond ≥ 2 mgd, renewal application for capacity ≥ 2 mgd	Step 9

1. The first 5-year permit limits shall be 30 mg/L BOD5 and the TSS concentration which Ecology is using to satisfy definition #25. Until notified otherwise, use 75 mg/L TSS for the 30-day average, and 112 mg/L TSS for the 7-day average. The applicant should submit a design based on achieving 30 mg/L BOD5 and minimizing TSS. The design review should use the Criteria for Sewage Works Design and nationally recognized design manuals as standards for proper design.

   Percent removal limits for BOD5 or CBOD5 shall be 85% unless Section 050(3) and/or (4) apply. No percent removal applies to TSS.

2. Use Section 040 for this and all renewal permits. Section 050(3), (4), and (6) may also apply if requested by the applicant.

3. Determine BOD5 and TSS "effluent concentrations consistently achievable..." per definition #11 of Section 030.

Procedure:

Examine at least the last 2 years of discharge monitoring reports for average monthly effluent and percent removals. Do not use effluent data for months during which the facility had equipment failure, operator error, overloading, or other extenuating circumstances. Review the permit file for any information which may indicate that certain data are inaccurate. Do not use those data. Examples of information sources are Class I and II inspection reports, Roving Operator Trainer reports, and memos of conversations.

Determine the effluent concentration and percent removal which have been achieved 95% of the time. The table below indicates which data points represent the 95th percentile values.

Task outline (cont.)

Number of Acceptable	95th Percentile Values	
Monthly Avg. Values	Percent Removal	Concentration
24-35	2nd lowest value	2nd highest value
36-59	3rd lowest value	3rd highest value
above 60	4th lowest value	4th highest value

4a. Is the BOD5 value less than 45 mg/L?

Yes - Propose that value as the monthly effluent limit and proceed to 4b.

No - Propose 45 mg/L as the limit and proceed to step 4b.

4b. Is the TSS value less than 75 mg/L?

Yes - Propose it as the monthly effluent limit and proceed to 4c.

No - Propose 75 mg/L as the limit and proceed to step 4(c).

4c. Is the percent BOD5 removal determined in 5, greater than 65%?

Yes - Propose it as the monthly limit.

No - Propose 65%.

5. Does the facility meet all 6 requirements of Section 050(5)? (See review of that section.)

Yes - Use the limits obtained above in 4. Proceed to 6.

No - Use Section 040, or Section 050(6)(a) if requested by applicant.

Note: One of the conditions of Section 050(5) is the identification of effluent concentrations consistently achievable through proper operation and maintenance. The permit writer should have already checked the permit file, as explained in Step 3 above, for indications of inaccurate data. The permit writer should also check whether the facility is being operated in accordance with the Operation and Maintenance Manual.

For pond systems, the writer should particularly note whether the manual includes any

Task outline (cont.)

recommendation for frequency of sludge removal from the ponds, or whether it indicates an acceptable sludge depth. Prior to considering any alternative limits, the permit writer should require the applicant to verify the extent of sludge accumulation. Significant accumulations can be the reason for declining performance.

If the Operation and Maintenance Manual is silent on sludge accumulation and dredging, the permit writer will have to use judgement in deciding when dredging of the pond is necessary. If the existing pond system has extensive accumulations in one or more ponds which are likely affecting the quality of the effluent, require dredging as soon as possible. Review the long term effluent quality records to note if a gradual decrease (corresponding to the sludge accumulation) in treatment efficiency has occurred. If so, give the pond system higher effluent limits (based on the last few years of data) for the time period up to the dredging, and lower limits (based on pond performance years when sludge accumulations were low) for the remaining time of the 5-year permit. Permit limits at the next renewal should be based on pond performance after the dredging.

Finally, the permit writer should include periodic sludge depth monitoring in the pond system as a condition of the permit. Such a condition is included in the recommended monitoring schedule for lagoons.

6. Determine maximum monthly average (lbs/day) of BOD5 and TSS effluent loading limits by:

   (a) Multiplying the facility's approved design year maximum month flow (as expressed in million gallons per day) by the concentrations determined in 4 above, and by 8.34; or,

   (b) for BOD5 only, multiplying the Ecology approved, design maximum month influent loading by the quantity (1 minus the % removal limit [expressed as a decimal] determined in 4(c) above). The result is expressed in lbs./day. For BOD5, use the lower number obtained by method a or b.

7. Determine the weekly average concentration and loading limits by multiplying the monthly values by 1.5. However, the weekly average BOD5 concentration limits should not exceed 65 mg/L; and the weekly average TSS concentration limits should not exceed 112 mg/L.

8. Case I: If all the flow is treated by the ponds, use Section 040. Sections 050(3), (4), and (6) may also apply, if requested by the applicant.

Case II: The applicant plans to use its existing ponds for its previously approved flow capacity. In this case, follow the instructions in Steps 3 through 7 to determine the permit limits. The

Task outline (cont.)

remaining flow must be treated in a separate facility which meets the requirements of Section 040. Section 050(3), (4), and (6) may also apply if requested by the applicant.

Case III: The applicant plans to expand the existing pond capacity up to 2 mgd and take higher flows to a separate facility. Design the pond for 30 mg/L BOD5. The first 5-year permit limits should be a 30-day average of 30 mg/L BOD5, 75 mg/L TSS; and a 7-day average of 45 mg/L BOD5, 112 mg/L TSS for the pond. The separate facility shall have permit limits required under Section 040. Section 050(3), (4), or (6) may also apply if requested by the applicant. The pond may qualify for alternative effluent limitations in subsequent permits.

9. This step applies only to the following pond systems:

Everett
Longview
Montesano
Marysville

The applicant has the option of proposing a system(s) which meets limits under Case A or Case B.

Case A: If the proposal is to use the existing ponds within the previously approved design capacity, use the procedure outlined in Steps 3 through 7 above. Any additional flow over the previously approved capacity must be treated in a separate facility whose effluent limits shall be based upon Section 040. Section 050(3), (4), and (6) may also apply if requested by the applicant.

Case B: If the proposal is to expand the design capacity of the pond system, use Section 040. Section 050(3), (4), and (6) may also apply if requested by the applicant.

10. Determine whether the technology-based limits derived above will cause water quality standard violations in the receiving water. If they will, see Chapter VI on water quality-based effluent limits.

Table V-3. DOMESTIC WASTEWATER LAGOONS AND WASTE STABILIZATION PONDS ISSUED NPDES PERMITS IN WESTERN WASHINGTON

Northwest Region	Design Capacity, mgd
Everett	17.0
Marysville	1.2
Ferndale	1.5
Snohomish	1.0
Stanwood	0.5
Snoqualmie	0.27
Black Diamond	0.15
Concrete	0.1
Rosario Resort	0.07
Fisherman's Bay, Lopez Island	0.03
Blake Island State Park	0.01
Monroe Honor Farm	0.006
Larrabee State Park	Not Available (NA)
Warm Beach Campground	0.040
Echo Glen Children Center (DOC)	0.037

Southwest Region	
Ocean Shores	6.7
Longview	2.7
Montesano	2.1
Whidbey Island Naval Air Station	1.0
Washougal	0.8
South Bend	0.69
Raymond	0.67
Eatonville	0.45
Orting	0.38
Elma	0.35
Cathlamet	0.20

Table V-3 (cont.)

Toledo	0.135
Vader	0.13
Mossyrock	0.12
Carbonado	0.1
Woodbrook - Cowlitz County	0.09
Ryderwood - Cowlitz County	NA
Wilkeson	0.07
Pacific Beach Sewer District #5	0.059

Southwest Region

Maple Lane School - DSHS	0.025
Cedar Creek (Littlerock)	0.025
Clallam Bay (DOC)	0.14
Clearwater (Jefferson County)	0.043
McNeil Island Camp.	NA
McNeil Island Prison	NA
Larch Mountain Correction Center (DOC)	NA
Indian Island - U.S. Navy	0.01

Table V-4. DOMESTIC WASTEWATER LAGOONS AND WASTE STABILIZATION PONDS ISSUED NPDES PERMITS IN EASTERN WASHINGTON

Eastern Region	Design Capacity, mgd
Oakesdale	0.25
Othello	2.0
Rosalia	0.075
Albion	0.12
Colfax	0.6
Cheney	1.5
Chewelah	0.32
Colville	1.2
Medical Lake, Town of	0.24
Metaline	0.045
Metaline Falls	0.31
Rockford	0.05
Wilbur	0.35
Colton	0.06
Central Region	
Cashmere	0.68
Cle Elum	2.5
Ronald	0.3
Roslyn	1.4
South Cle Elum	0.07
Kittitas, City of	0.28
Goldendale	1.5
Harrah	0.09
Kennewick	8.7
Wishram	0.1

3.4 Facilities with Combined Sewers

3.4.1 Discussion of Section 050(3)

Facilities which receive flow from combined sewers during wet weather can qualify for alternative monthly percent removal limits. During such wet weather conditions, the facility may be excused from achieving any predetermined percent removal requirement or may have a percent removal limit which is lower than otherwise allowed.

During rainfall events, sewage treatment facilities which serve combined sewers can receive widely fluctuating influent flow rates and influent pollutant concentrations. These fluctuations are due to the intrusion of storm water to the sewer system. In some situations the influent concentrations are so dilute that achieving 85% or any other predetermined percent removal per Section 050(1) or (2) is not possible. The fluctuations can also cause inaccurate computation of the 85% removal requirement. In many cases, the wide fluctuations prevent the establishment of a minimum (below 85%) percent removal requirement which the treatment system would be expected to achieve regardless of any flow situation.

This section of the regulation differs from USEPA's rule because we define "wet weather" (See definition #30 in WAC 173-221-030). We want the option to restrict application of this waiver to the time period immediately surrounding rainfall events.

In all cases first verify whether the applicant has a significant combined sewer area in its collection system. Refer to the definition of combined sewers (#5). Verify that the sewers were originally designed to serve a storm water and sanitary sewage function; and that the combined sewer area is allowed by local ordinance. The following is an inclusive list of those which to have combined sewer systems as of December 1988. Please contact the Program Development Services Section if any municipalities request to be added to this list.

Seattle	Port Angeles
METRO	Mt. Vernon
Everett	Bremerton
Spokane	Olympia
Bellingham	Anacortes
Snohomish	

Note that municipalities should not build, nor should Ecology approve, any new combined sewers. All new construction must have separate sanitary and storm sewers. New building construction in a combined sewer area can place storm water into the combined system. However, all municipalities with combined sewers must comply with Chapter 173-245 WAC for reducing combined sewer overflows. Any new storm drainage from new construction must not delay achievement of compliance with Chapter 173-245 WAC. The municipality should have an Ecology approved CSO plan with a schedule for CSO control compliance.

For communities with secondary treatment, review the DMRs to see if a minimum percent removal requirement for wet weather months is identifiable. For municipalities still at primary treatment, consider no percent removal requirement for the traditional wet weather months until secondary treatment is on line for at least a couple years. This should give sufficient data to identify plant capabilities.

A municipality may choose to comply with Chapter 173-245 WAC regarding CSO control by transporting and treating high wet weather flows at the central domestic wastewater treatment plant. For these situations in particular, the permit writer can grant relief from the monthly percent removal requirement. However, federal rules do not allow relief from the monthly and weekly concentration limits. If any municipality wishes to control their CSOs in this way, but is concerned about meeting their monthly concentration limits, please consult the Program Development Services Section about making inquiries to USEPA.

3.4.2 CSO Treatment Facilities (173-245-090 (1) (a) (ii))

If the municipality has chosen at-site treatment facilities (e.g. primary treatment and disinfection) for CSO control, the permit writer can choose to permit the facility under the same permit as that for the secondary treatment plant, or write a separate permit. In either case, the permit should include numerical limits for the discharge, flow capacity limits for the facility, and reporting requirements.

The numerical limits must at a minimum address the definition of "primary treatment " given in WAC 173-245-020, i.e. settleable solids not exceeding 0.3 ml/l/hr and not less than 50% removal of total suspended solids. The permit writer has some discretion in how to write the numerical permit limits. They can apply and be enforced on a yearly, monthly, or per event basis. That which is reasonable to achieve should be required. Refer to Chapter XII-2.4 for monitoring guidance.

The permit should also note that "the total treated and untreated annual discharge from an at-site treatment plant shall not increase above the baseline annual" level (WAC 173-245-090(1)(a)(ii).

3.4.3 TASK OUTLINE FOR DETERMINING PERCENT REMOVAL LIMITS FOR COMBINED SEWER SYSTEMS

1. The applicant may request the alternative limit and submit supporting documentation for that request. The permit writer is not obliged to initiate any adjustment without a equest.

2. Determine whether the applicant meets the requirements of Section 050(5) (discussed earlier in this chapter).

   Yes - Proceed to 3.

   No - Use Section 040, or Section 050(6)(a) if requested by the applicant.

2. Determine whether the facility is capable of 85% removal on a monthly basis in spite of the combined sewage flow.

   Yes - Use 85%. Go to 6.

   No - Go to 4.

3. If 85% removal is not reasonable, determine whether a lower percent removal is consistently achievable.

   Yes - Use the lower, consistent percent removal as the limit. Go to 5.

   No - Delete the percent removal requirement during wet weather conditions. Go to 5.

4. Include a condition which lists the specific months for which a lower or no percent removal limit applies. For example, delete the requirement for November through April, the rainiest months.

   Word the condition such that the percent removal requirement does apply for any month which does not receive significant rainfall or snow melt, (e.g. a dry December).

   Also state that this condition does not relieve the permittee from operating the treatment facility as efficiently as possible. Cross reference the standard condition that requires this.

5. Determine whether the percent removal limit determined above will be sufficient to prevent water quality standard violations in the receiving water. If not, determine

Task outline (cont.)

what percent removal will achieve the standards. Chapter VI on water quality-based effluent limits may be helpful.

3.4.4. Definition of a CSO Event

RCW 90.48.480 requires "the **greatest reasonable reduction** of combined sewer overflows at the earliest possible date". Chapter 173-245 WAC defines the **greatest reasonable reduction** as "the control of each CSO such that an average of one untreated discharge may occur per year".

The process of CSO control is given in the Criteria for Sewage Works Design (Ecology 98-37 WQ), however, that document does not define storm (event), overflow event or averaging period. A definition of event is necessary for large communities with numerous overflow sites and frequent overflows to design facilities for collection and treatment.

- A CSO event may be defined as the overflow or multiple overflows of a CSO outfall occurring within a 24 hour period (option 1 below).
- A CSO event may be defined by a 24 hour minimum inter-event time for a CSO outfall (option 5 below).
- One rainfall storm event causes only one CSO event.
- The averaging period may be one year or the five year permit term.

Defining Some Terms

Combined Sewer Overflow (CSO) – an event during which excess combined sewage flow caused by inflow is discharged from a combined sewer, rather than conveyed to the sewage treatment plant because either the capacity of the treatment plant or the combined sewer is exceeded.

Inter-Event Time (IET) – The dry period or time steps between storm or CSO events.

Minimum Inter-Event Time (MIET)– The amount of dry time or non-overflow time required to indicate a storm event or CSO event is independent (CV $\approx$ 1).

Storm Duration – The time from the first wet time step at the beginning of the storm event to the last wet time step ending the event.

Storm Event – A period of rainfall separated from other wet time steps by a dry period equal to or greater than the minimum precipitation inter-event time.

Storm Inter-Arrival Time – The time from the beginning of one storm event to the beginning of the next storm event. (Equal to one storm duration and one inter-event time).

Threshold Rainfall – The amount of rainfall necessary to cause runoff. In the Portland Oregon area this varies from 0.05 to 0.1 inch, depending on length of the storm.

Wet Time Steps – A time increment in a precipitation record in which a measurable amount of precipitation occurs. The measurable amount may be defined as threshold rainfall.

Options Considered For Defining Event

1. **Any overflow or multiple overflows in a specific interval of time (e.g. 24 hours) is considered an event.**
   This is the simplest option and may be appropriate for small CSO communities with few overflows and that are close to compliance with the one per year requirement. This option may be applicable where the engineering analysis is relatively straight forward and the solution may be as simple as additional storage or I and I correction. The advantage of this option is that it does not require analysis of regional precipitation, CSO system response to storm events and derivation of a design storm.

   This option doesn't provide the statistical tools to predict the return period (probability) of a storm event of a certain magnitude.

   The current regulatory practice for larger sewer systems required to design to a certain return period is to link the definition of overflow event to the definition of storm event. Linking overflow events to storm events provides engineers with a mechanism for determining return periods of storm events and subsequent design of control structures. The following options 2 through 5 (based on Nicholson and Adderley, 1994) are contingent upon linking the definition of a CSO event to the definition of a storm event.

2. **Sewer System-Based Definition**:
   Under this definition, a storm event is considered to end when the sewer system has processed or discharged the wet weather flows.

   It is difficult to justify use of this definition for facilities planning because the system performance will change as controls are put in place. Systems with storage or systems affected by rain-induced infiltration also cause difficulties with using this system because the overflow may continue long past the end of the precipitation. This problem is discussed in more detail later.

3. Best Professional Judgement IET:

This definition relies heavily on the expertise, local knowledge, and preferences of the individual(s) developing the event definition. Typical values recommended for various projects include 1 hour, 3 hours, 6 hours, 12 hours, 24 hours, and 48 hours of dry time between storms (precipitation IET) or outfall discharges (CSO IET).

4. Duration-Volume Design Criteria:

An event is considered over when a specific amount of time has elapsed (6 hours to 3 days) since the rainfall stopped, or when a certain depth or volume of rainfall has occurred (0.5 inch to 3 inches).

The problem with this definition is that design storms based on return periods developed from this storm definition may be misleading. A 10-year, 24-hour design storm may generate a 100-year CSO or a 1-year CSO depending on the soil moisture conditions and available storage in the system at the time the design storm occurred.

5. Statistical Independence:

This definition is used when the probabilistic return frequency of events is important to the design, operation, or evaluation of the system. A frequency analysis has as its underlying assumption that the events (storms, CSO flows) are independent of one another, i.e., there is no joint probability linking one event to any other event. Such a definition helps prevent facilities from being undersized. The drawback of this definition is that the methods required to determine the statistical independence are somewhat difficult to use. This method has been used for the City of Portland (Nicholson and Adderley 1994) and for the EPA national model (Woodward-Clyde Consultants 1989). This method has also been examined for use in Seattle (Lukas and Merrill, 1996) and Spokane (Mau, 1999). The method is based on a paper by Restrepo-Posada and Eagleson (1982).

Additional desirable criteria considered for selecting the most appropriate storm/CSO event definition are:

1. Incorporates the local hydrology patterns
2. Provides results that are appropriate for use in frequency analysis
3. Is objective and defensible and
4. Provides results that are reasonable and useful.

Why Not Use The EPA National Definition Of Storm Event?

An analysis of 40 years of rainfall data from 138 gages across the U.S. was conducted by Woodward-Clyde (1989). This analysis defined precipitation inter-event times required to define independent storm events. The IET for the Eastern US was six hours, 20 hours for the mid-country, and 300 hours for the arid southwest. This analysis did not specify an IET for the Pacific Northwest. Woodward-Clyde (1989) recommended that a uniform 6-hour minimum IET be used nationwide to assure a common basis throughout the country. Nicholson and Adderly (1994) say that a 6-hour IET may be used for the design of small-scale storm water facilities but should not be used for design of large-scale CSO control facilities in the Pacific Northwest.

Precipitation events in the Pacific Northwest have different characteristics than events in other parts of the country. Rainfall in the Pacific Northwest is characterized by long-duration, low-intensity storms and it may be difficult to identify individual storms. Several analysts have demonstrated a 6-hour IET is not applicable for defining a storm event in the Pacific Northwest.

Defining CSO Event By Defining Storm Event (Option 5 Statistical Independence)

The process as described in the paper by Restrepo-Posado and Eagleson (1982) utilizes long-term precipitation data, typically hourly records. The following description of the process is taken from Nicholson and Adderley (1994).

In rainfall frequency analysis, the return period of a storm of a given volume or peak intensity is based on the assumption that the volume or peak intensity of each storm is independent. A sufficient condition that assures independence between peak storm volumes and peak intensities is when the inter-event times (dry times) between storms is independent as well. Establishing independence between storm events is done by assuming the rainfall data represent continuous time (t) divided into a sequence (i = 1 to n) of discrete subintervals of duration (Δt, 1 hour if hourly record). The variable X_i (i = 1 to n) is defined as depth of rainfall occurring in each interval i. At each time interval, a test is made to determine if rain occurred ($X_i > 0$) or no rain occurred ($X_i = 0$). Then a second variable that characterizes the occurrence of rain or event function, Y_i, is defined as:

$Y_i = 1$ for $X_i > 0$
$Y_i = 0$ for $X_i = 0$

If the storm events as represented by Y_i are independent of each other, then the series will fit a Poisson distribution, $P_x = e^{-\lambda} \frac{\lambda^x}{x!}$, and the dry periods between the events (the precipitation inter-event times) are exponentially distributed. One of the characteristics of a Poisson distribution is that the mean (m) and the standard deviation (s) are the same, and the coefficient of variation (CV = s/m) equals one. The test for independent storm events is conducted by calculating the coefficient of variation (CV) of the IETs and comparing it to one.

This simplified method is applicable up to the point where overlapping begins to occur. Overlapping means that the storm as modeled actually contains several storms grouped into one large event. Overlapping is prevented by keeping the ratio of the storm duration and the storm inter-arrival rate (time from the beginning of one storm to the beginning of the next storm) much less than 1.0:

(Storm Duration)/(Storm Duration + Inter-Event Time) << 1.0

An additional requirement is that the method must be applied to data that are homogenous or belong to the same seasonal weather patterns. The data must be analyzed by months and grouped into seasons with similar patterns.

The authors of this procedure noted that it was empirical and inexact but useful in many design situations.

The statistical independence technique for defining event resulted in a precipitation MIET for the Portland area of 18 hours for winter and 48 hours for summer. A combined precipitation MIET of 24 hours was recommended (Nicholson and Adderley, 1994) for the Portland area.

An analysis of rainfall from the SeaTac Airport resulted in a precipitation MIET of 15 hours for winter and 36 hours for summer. A combined precipitation MIET of 18 hours was recommended (Lukas and Merrill, 1996).

An analysis of the Spokane rainfall record showed independent events at a MIET of 24 hours (Mau, 1999).

The basic assumption of this procedure is that the definition of an independent storm event also defines a CSO event and that only one CSO event will occur during one storm event. Therefore, if the rainfall event is defined, then a CSO event is also defined. During a storm event, the rainfall intensity will vary over the duration of the storm. At certain times in the storm when the rain falls at an intense rate, CSO discharges may occur. A discharge may occur at the beginning of the storm, stop, and then begin again at the end of the storm. The assumption that a rainfall event defines a CSO event means that these intermittent flows are considered one CSO event.

Defining Event By Overflows

The simplest method to define a CSO using the statistical-based procedure is to define a CSO by equating the CSO IET to the precipitation MIET so that any CSO's that were separated by a period longer than the precipitation MIET would be deemed separate events (one storm event can only cause one CSO event). CSO communities would measure compliance by measuring the beginning and ending of each CSO.

Lucas and Merrill (1996) point out a potential problem with this approach as illustrated in the following figure of actual precipitation record and resulting computer simulated overflows at the Martin Luther King Way (MLK) CSO.

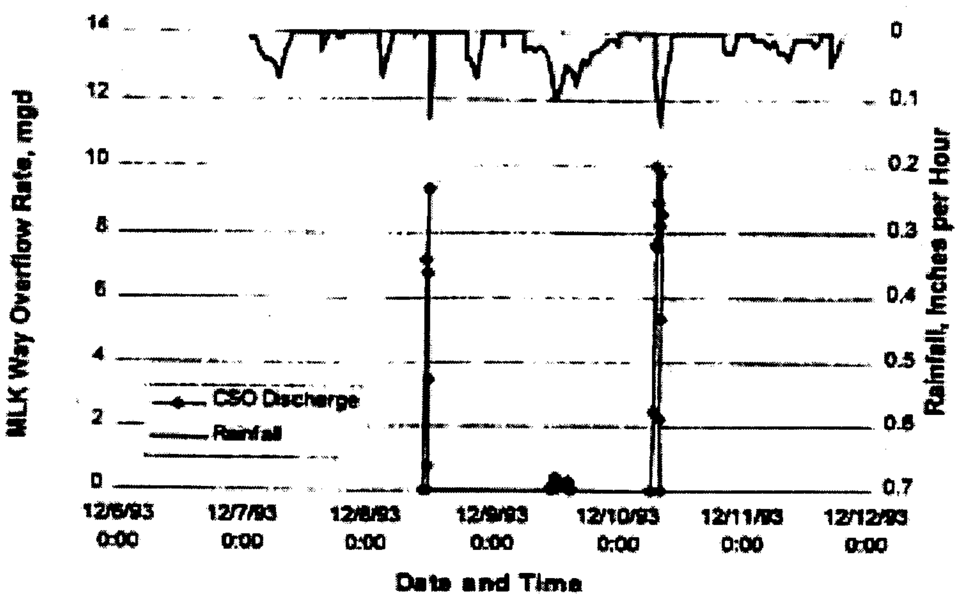


Figure 1. An illustration from Lucas and Merrill (1996) comparing rainfall and CSO inter-event periods.

This figure shows a series of precipitation events that have been classed as one event based on an 18-hour precipitation MIET. The three CSO overflows are separated by more than 18 hours and would be classified as three overflow events if we simply used the precipitation MIET as the CSO MIET. Lucas and Merrill (1996) propose an alternative in which they use the simulation model to predict the number of overflows for the MLK overflow for the period of the precipitation record (Table 1). The CSO IET is analyzed for varying periodicity (3 hours, 6 hours, etc.) and the resulting number of overflows. For the SeaTac precipitation data, an 18-hour precipitation MIET caused a simulated 3805 precipitation events (81.8/year) for the 46.5 period of record. Of these 3805 precipitation events, 802 (17.3/year) caused simulated overflow events. The analysis of the CSO IETs showed that a 40-hour (interpolated) CSO IET caused an equivalent number (802) overflow events for the period of record. They recommend, for the MLK overflow, the use of 48-hour CSO MIET for administrative convenience. A 48-hour CSO MIET results in an average of 17 CSO events/year at MLK. This CSO process and the inter-event number were based on the assumptions that the Carkeek CSO permit had defined Ecology's future processes for CSO's. Specifically, that future CSO permits would be written to require reporting of CSO discharge without regard to the causative rainfall and Ecology would require reporting of CSO discharges on a calendar day basis.

Table 1. Inter-Event Analysis Results – Martin Luther King Way CSO and SeaTac Airport Rainfall (from Lukas and Merrill, 1996).

Minimum inter-event, hr.	MLK Overflow		SeaTac Rainfall				Rainfall Events Causing Overflow (Simulated)	
	No. of Events in 46.5 year record	Events per year	No. of Events in 46.5 year record	Events per year	Summer inter-event C.V.	Winter inter-event C.V.	No. of Events in 46.5 year record	Events per year
3	1196	25.72	9458	203.40	1.87	1.63	1048	22.54
6	1103	23.72	6668	143.40	1.57	1.32	961	20.67
9	1047	22.52	5448	117.16	1.42	1.17	900	19.35
12	999	21.48	4706	101.20	1.33	1.07	862	18.54
15	967	20.8	4202	90.37	1.26	1.00	836	17.98
18	943	20.28	3805	81.83	1.21	0.94	802	17.25
24	884	19.01	3216	69.16	1.12	0.85	742	15.96
30	849	18.26	2744	59.01	1.06	0.78	687	14.77
33	831	17.87	2555	54.95	1.02	0.75	660	14.19
36	821	17.66	2409	51.81	1.00	0.73	639	13.74
48	771	16.58	1904	40.95	0.92	0.63	571	12.28
60	725	15.59	1533	32.97	0.84	0.57	497	10.69
72	679	14.60	1311	28.19	0.79	0.52	450	9.68
84	633	13.61	1138	24.47	0.75	0.49	408	8.77
96	600	12.90	999	21.48	0.72	0.46	379	8.15
120	559	12.02	751	16.15	0.65	0.41	314	6.75
144	527	11.33	589	12.67	0.59	0.39	270	5.81
168	485	10.43	475	10.22	0.55	0.38	224	4.82

Note that the precipitation IET of 18 hours contains 17 storm events/year but a predicted 20 CSO events/year. While this analysis may be valid for counting the number of overflows now, this analysis is not applicable to other systems and does not predict the probability of this problem when overflows approach the required one per year. Ecology believes this difference between events will become negligible as CSO frequency approaches one per year and therefore no adjustment on a policy basis is necessary for overflows into the inter-event period.

Definition of Event

For smaller communities with few overflow points and infrequent overflows a CSO event may be counted as any 24-hour period when a CSO discharge or multiple discharges occur. This prevents having to do a regional precipitation analysis and modeling of the CSO system to derive a design storm.

For large communities with numerous overflow points and frequent overflows, a CSO event is defined as a 24 hour minimum inter-event time for a CSO outfall

Averaging Period and Compliance Options

(Reserved)

3.5 Facilities with Less Concentrated Influent Wastewater

3.5.1 Discussion of Section 050(4)

The facilities which receive less concentrated influent wastewater than normally received by domestic wastewater facilities can qualify for alternative limits. The influent wastewater must have a BOD5 concentration less than 167 mg/L. In such cases, the facility may apply for a lower percent removal requirement than the 85% from Section 040 or the minimum 65% for trickling filters and waste stabilization ponds (BOD5 only).

The 85% removal requirement was originally established to achieve 2 basic objectives:

1. to encourage municipalities to remove high quantities of infiltration and inflow (I/I) from their sanitary sewer systems, and

2. to prevent intentional dilution of influent wastewater. However, in facilities with dilute influent which is not attributable to high quantities of I/I or intentional dilution, the percent removal requirement will result in forcing "advanced treatment". Advanced treatment generally refers to additional treatment processes (e.g., filtration, chemical addition, or 2-stage biological treatment) which achieve significantly greater pollutant removals than secondary treatment processes alone. Ecology concurs with USEPA, that it is not reasonable or cost effective to require advanced treatment in these cases.

However, the USEPA regulation does not accomplish objective (1) above. Despite establishing 3 conditions (see 40 CFR 133.103(d) and WAC 173-221-050(4)(b)(i-iii)) to qualify, a municipality could still qualify despite grossly high levels of I/I. The federal regulation would allow such a municipality to claim that it is more effective to transport and treat such flows--at a reduced percent removal--than to correct. This could result in increasing total weight of pollutants discharged and neglecting adequate sewer system maintenance. To prevent this situation, Ecology has added a fourth condition (See 050(4)(b)(iv). That condition requires a municipality to submit a program aimed at controlling I/I. Ecology has approval authority over the program. The permit writer should incorporate the program into the conditions of the NPDES permit.

3.5.2 TASK OUTLINE FOR DETERMINING LOWER PERCENT REMOVAL LIMITS FOR LESS CONCENTRATED INFLUENT WASTEWATER

1. The permittee must request and submit supporting documentation for the permit writer's review. The documentation should include I/I analyses, and sewer system surveys, performed to meet federal requirements (as referred to in 2.c. below). The daily historical rainfall record and historical daily sewage flows should be provided with these studies.

2. Determine whether the permittee qualifies under Section 050(4)(b).

a. Does the facility meet its effluent concentration limits and the mass loading limits based on those effluent concentration limits for BOD5 (or CBOD5) and TSS as established in Section 040 and 050(1) and (2)?

Yes. Proceed to b.

No. Does not qualify. The permit should include the requirements of Section 040 or section 050(1) or (2). If the permittee cannot immediately comply, issue an administrative order requiring submission of a plan and schedule to achieve compliance (e.g. build more capacity).

b. Have the average influent concentrations of BOD5 and TSS generally been below 167 mg/L in the months for which the permittee has requested lower percent removal limits? (Review at least a few years worth of data.)

Yes. Proceed to c.

No. Does not qualify. Section 040, or Section 050(1) or (2) applies.

c. Is the less concentrated influent the result of "excessive" I/I?

The permit applicant must use the USEPA pamphlet document "I/I Analysis and Project Certification" for proposing what is "excessive" I/I. When computing the costs of transporting and treating the sewage, include the present cost (capital and operation and maintenance) of whatever technology would be necessary to achieve the limits allowed by Section 040, or Section 050(1), or (2), whichever is applicable. Any overflow of sewage is deemed excessive I/I.

If the answer to c. is yes, the applicant does not qualify for a lower percent removal limit. Issue a permit with the standard percent removal requirement (Section 040 or Section 050(1) or (2)),

and propose a sewer rehabilitation program and schedule as a condition of the permit or within
Task outline (cont.)

an administrative order. You will probably need additional guidance for determining reasonable rehabilitation schedules. The minimum goal of the rehabilitation program would be to eliminate "excessive" I/I.

When the "excessive" I/I is eliminated, the applicant can get lower percent removal limits in accordance with #4 below, if they agree to further sewer rehabilitation as outlined in #4.

If the answer to c. is no, proceed to 3.

3. Does the facility meet all the requirements of Section 050(5)? (See task outline for this,earlier in this chapter.)

   Yes, proceed to 4.

   No, does not qualify.

4. Propose a lower percent removal effluent limitation which the applicant has demonstrated it can meet 95% of the time. This % removal limit can be less than 65% for certain lagoons and trickling filters. Use DMR data as explained in Step 3 of the task outline for determining trickling filler BOD5/TSS effluent limits. Make a note in the permit that whenever the monthly influent concentration exceeds 167 mg/L, 85% removal is the permit limit.

5. If the applicant ever exceeds the USEPA screening criteria of 120 gallons per capita per day (7-14 day average for sewage plus infiltration) or 275 gallons per day (highest daily flow recorded during a storm event--includes sewage flow plus I/I), propose a sewer rehabilitation program and schedule as conditions of the permit. Alternatively, keep the permit condition worded in general terms and place the specific schedule of activities in an administrative order.

   The goal must be to eliminate sufficient I/I quantities such that the influent sewage BOD5 and TSS concentrations exceed 167 mg/L. Thereafter, the standard percent removal requirements of Sections 040 and 050(1) and (2) would once again apply and should be written into the next permit renewal.

   If the permittee rehabilitates the sewer and gets flows below the USEPA screening criteria, yet the BOD5 and TSS concentrations do not exceed 167 mg/L on a monthly average, propose a lower percent removal effluent limitation.

   For trickling filters (BOD5 and TSS) and waste stabilization ponds (BOD5) which also qualify for percent removal limitations between 85 and 65% under Sections 050(1) and (2), the sewer rehabilitation goal should be to reduce I/I below the USEPA screening criteria, or to raise the influent concentrations such that the facility no longer meets 050(4)(b)(ii) ie. the influent concentrations are above 167 mg/L and therefore Section 040 or Section 050(1) or (2) applies. If during the rehabilitation program, the flows are reduced below the USEPA screening criteria, yet the BOD5 and TSS concentrations do not rise above 167 mg/L, propose a lower percent removal limitation based on Section 050(1) or (2).

3.6 Substitution of CBOD5 For BOD5

3.6.1 Discussion of Section 050(6)

The facility owner/operator can request and the Department can approve substitution of *carbonaceous BOD5* (CBOD5) for the standard BOD5 limitation. In such cases, the Department may substitute a 25 mg/L CBOD5 limit for a 30 mg/L BOD5 limit.

USEPA has extensively studied the use of a CBOD5 limit in lieu of a BOD5 limit. They concluded that a 25 mg/L CBOD5 limit is effectively equivalent to a 30 mg/L BOD5 limit. We agree. A detailed explanation for this substitution is in the preamble to 40 CFR part 133 as published on September 20, 1984.

Using CBOD5, a municipality could discharge more oxygen-demanding nitrogenous material than when using BOD5. This is likely if a facility can't prevent partial nitrification.

Nitrification is the conversion of organic nitrogen and ammonia-nitrogen (nonoxidized) to nitrate (oxidized). It occurs by chemical action or by certain microorganisms which consume nonoxidized nitrogen getting into the water. These organisms use large amounts of oxygen when consuming organic nitrogen and ammonia-nitrogen (both unoxidized) and converting them to nitrate (oxidized). When this process is underway (partial nitrification), it creates a high BOD. Once nitrification is complete, there is very little oxygen-demanding nitrogenous material left.

Using the BOD5 test, facilities have to either keep nitrifying microorganisms out (prevent partial nitrification), or wait for them to completely nitrify the water before discharge. Using CBOD5 however, facilities can discharge partially nitrified water, even with its high nitrogenous oxygen-demand.

Notably, unless Ecology identified a problem in receiving water quality, a facility has no obligation to remove nitrogenous oxygen-demanding substances from its wastewater. USEPA's longstanding 30 mg/L BOD5 effluent limit was not intended to force removal of nitrogenous pollutants. It was intended for carbonaceous pollutants. The newer federal rule and Chapter

173-221 WAC clarify that intent, and eliminate the need for facilities to remove these nitrogenous pollutants. This need exists at some facilities only because the nitrogenous pollutants gave a false indication of poor facility performance.

3.6.2 TASK OUTLINE FOR DETERMINING CBOD5 LIMITS

1. The permittee must request the change.

2. Is the facility a waste stabilization pond or trickling filter as defined in Section 030, which has requested or received alternative BOD5 or CBOD5 limits?

   Yes - Go to 3.

   No - Issue new permit limits of 25 mg/L CBOD5 for the monthly average; and 40 mg/L for the weekly average. Refer to the explanation (earlier in this chapter) of Section 040 to determine monthly and weekly load limits. Percent removals are based on CBOD in the influent and effluent.

3. Have the permittee submit at least one year's worth of influent and effluent data for CBOD5, BOD5, and ammonia nitrogen.

   a. Try to establish a ratio between BOD5 and CBOD5, (for example, the BOD5/CBOD5 could be 1.2/1) for months with low or moderate nitrification.

   b. Determine the "effluent BOD5 concentration consistently achievable through proper operation and maintenance." See task outlines for Section 050(1) or (2).

   c. Determine corresponding CBOD5 concentration for the BOD5 value determined above by using the ratio established in 3a.

   d. Is the corresponding monthly average CBOD5 concentration limit less than 40 mg/L?

      Yes - Use it as the new CBOD5 limit.

      No - Use 40 mg/L as the new CBOD5 limit.

   e. Determine the weekly average CBOD5 limit by multiplying the number obtained in d. by 1.5.

   f. Refer to the explanation in this chapter for Section 040 for guidance in determining influent and effluent load limits for CBOD5. Remember to use the CBOD5 influent and effluent concentrations determined above.

g. Determine percent removal requirements similarly to the procedures explained earlier for trickling filters and waste stabilization ponds respectively.

NOTE: Whenever effluent CBOD5 limits are given, the permit must also be changed to require influent CBOD5. The 85% removal requirement applies to the CBOD5 effluent as compared to the CBOD5 influent.

When designing biological aeration tanks, it's still appropriate to use BOD5, and in many cases, nitrification-demand requirements for determining aeration capacity.

3.7 Defining Compliance with 85% Removal

Compliance with the 85% removal standard of secondary treatment is defined as the 30-day average influent concentration (AIC) minus the 30-day average effluent concentration (AEC) divided by the 30-day influent concentration (AIC):

(AIC - AEC)/ AIC.

This method of calculation is consistent with the regulatory intent of the performance standard as a long-term average performance standard. This method gives a percentage that is a fraction of a percent higher than if calculated as the average of the daily percent removals.

This determination comes from federal regulations, 40 CFR Part 133 (definitions).

40 CFR 133.101(b) 30-day average. The arithmetic mean of pollutant parameter values of samples collected in a period of 30 consecutive days.

40 CFR 133.101(j) percent removal. A percentage expression of the removal efficiency across a treatment plant for a given pollutant parameter, as determined from the 30-day average values of the raw wastewater influent pollutant concentrations to the facility and the 30-day average values of the effluent pollutant concentrations for a given period of time.

40 CFR 133.102 Secondary treatment

(a) BOD_5

(3) The 30-day average percent removal shall not be less than 85%

(b) SS

(3) The 30-day average percent removal shall not be less than 85%

3.7.1. STEP Systems

Section 2 of this chapter pointed out that federal and state regulations require POTW's to remove 85% of BOD and solids of the influent wastewater. This removal requirement is difficult to assess in a STEP systems which utilize septic tanks as part of the treatment system. This part presents a process for dealing with STEP systems.

RECOMMENDATIONS

A NPDES discharge permit and fact sheet for a POTW with a STEP system should include the following:

1. The permit should contain the appropriate effluent concentration limits and percent removal requirements from WAC 173-221-040 or 050 (1) or (2).

2. The 85% BOD_5 removal requirement in the permit should be footnoted with the following:

   The permittee will be presumed to be in compliance with the percent removal requirement in the permit if the permit effluent concentration limit is met and there is no excessive inflow and infiltration (I/I). Infiltration is excessive when the highest 7-14 day average daily dry weather flow is greater than 120 gallons per capita per day. Inflow is excessive when the highest recorded daily flow during a storm event is greater than 275 gallons per capita per day or when hydraulic overloading of the treatment plant occurs.

3. The permit should require monitoring and reporting of the influent BOD_5 and the percent BOD_5 removal accomplished at the central treatment plant.

4. The fact sheet should explain that as long as the permit effluent concentration is met and neither USEPA criteria (120 gallons per capita per day for the highest 7-14 day average, and 275 gallons per capita per day for the highest 24-hour average) are exceeded, the permittee will be presumed to be in compliance with the percent removal requirement in the permit.

5. The fact sheet should also explain that if either USEPA criteria are exceeded the permittee will be required to implement a rehabilitation program to reduce I/I. The program will be agreed upon between Ecology and the permittee and the details (schedule, work plan, financial commitment) will be incorporated into an administrative order.

6. The permit should require annual reporting of the highest 7-14 day average daily dry weather flow rate and the highest 24-hour per capita daily flow rate.

7. The permit should require the permittee to institute or continue an adequate operation and maintenance program for the entire sewage system including the septic tanks in the STEP system.

BACKGROUND

Septic tanks remove settleable solids and provide a limited amount of digestion of organic matter of domestic wastewater. When used as part of a STEP system, properly operated and maintained septic tanks can achieve some degree of BOD_5 removal and thus reduce wastewater BOD_5 loading to the sewage treatment plant downstream. The reported mean effluent BOD_5 concentrations from domestic septic tanks range from 120 to 240 mg/l (USEPA 1980). Based on limited data, the influent BOD_5 concentration to the central sewage treatment plant of a Western Washington municipality (Montesano) with septic tank effluent pumps discharging to a pressure conveyance system was found to be around 180 mg/l.

For POTWs that receive domestic sewage after treatment in septic tanks (STEP system), the BOD_5 removal in the septic tanks is considered an integral part of the treatment process for BOD_5 removal. Since it is impractical to measure the actual influent BOD_5 to the septic tanks, compliance with the 85 percent BOD_5 removal requirement of the secondary treatment rule may be assumed if the effluent concentration meets 30 mg/l, and if there is no excessive inflow and infiltration (I/I). In this case excessive infiltration is defined as exceedance of the USEPA screening criterion of 120 gallons per capita per day (average daily dry weather flow -- highest average daily flow recorded over 7-14 day period of seasonal high ground water); excessive inflow is exceedance of the USEPA criterion of 275 gallons per capita per day (highest daily flow recorded during a storm event for wastewater plus I/I); or any occurrence of treatment plant hydraulic overload. If the USEPA screening criteria for I/I are not exceeded, the presumption is that the raw sewage influent would be at least 200 mg/L if the septic tanks were not present. These screening criteria apply regardless of whether the I/I can be cost-effectively removed (see section 3.5 of this chapter).Therefore, complying with the 30 mg/L effluent BOD5 concentration limit means that the 85% removal requirement is also achieved.

Since the sewage conveyance system is under pressure, ground water intrusion (infiltration) into the public sewer should not be a factor for weak influent. However infiltration can occur through sewers connecting the buildings to the septic tanks and through possible cracks in the tanks. The report required under (6) above should be sufficient to allow the permit writer to make an assessment of excessive infiltration.

3.8 Operation and Maintenance (O & M) Manual

The NPDES permit special condition "Operation and Maintenance of Municipal Facilities" requires the permittee to keep an approved O & M manual at the treatment plant. The approved O & M manual must be updated as needed and a copy of the updated portions be submitted to the Department for review and approval. Failure to keep an approved and updated O & M manual at the treatment plant is a permit violation and subject to enforcement. The permit writer should talk with his/her supervisor concerning the appropriate enforcement measures needed.

4. THE NATIONAL MUNICIPAL POLICY AND STATE REQUIREMENTS

USEPA has established a National Municipal Policy to get municipal sewage treatment plants to comply with the Federal Clean Water Act (i.e., either do secondary treatment or meet water quality-based effluent limits). Because Ecology has assumed NPDES permit authority, it has adopted a "State of Washington Policy and Strategy for Municipal Wastewater Management" (see the Water Quality Technical Guidance Manual). This "Policy and Strategy" explains how Ecology will implement the National Municipal Policy.

In summary, the National Municipal Policy states that the municipalities are responsible for complying with federal and state requirements by the earliest possible date. Lack of federal or state financial assistance (grants or loans), does not excuse the municipality from compliance. Ecology must identify and list which municipalities are not in compliance, and issue an enforcement schedule for each. Most municipalities on the list are those which applied for, but were denied waivers from secondary treatment. These municipalities have received an administrative or court order which includes a schedule for construction of secondary treatment facilities. For an updated copy of the list, contact the Program Development Services Section.

The strategy for getting municipalities to comply includes:

A. Assessing Municipal Problems: assess and rank municipal compliance problems.

B. Developing an Implementation Plan: identify and schedule actions necessary to move each municipality towards compliance (e.g., offering technical assistance, issuing a permit, etc.).

C. Educating the Public: inform elected officials, public works officials, and others about sewage issues.

D. Regulating: identify those regulatory actions necessary to implement the "Policy and Strategy". Such actions are identified for each case and could include: reviewing plans, issuing permits, training and certifying operators, completing industrial pretreatment program responsibilities, monitoring compliance, and enforcing.

E. Assisting Financially: provide financial assistance with the available resources.

F. What the Permit Writer Should Do:

For municipalities which have an administrative or court ordered schedule, do not change those orders without coordinating with the Program Development Section.

For municipalities which should be added to the list, contact the Program Development Services Section so that your regulatory actions are reflected on a revised "Policy and Strategy List."

5. BIOSOLIDS (SLUDGE)

(RESERVED)

CHAPTER VI. WATER QUALITY-BASED EFFLUENT LIMITS FOR SURFACE WATERS

Permit writers must consider the impact of every proposed discharge to surface waters on the quality of the receiving water and specifically consider how the discharge may affect the use of the receiving water. In some cases, this consideration may reveal that permit limits which are based on a treatment technology are not sufficiently stringent to protect water quality. In these cases, new permit limits must be developed, or alternative disposal methods or locations must be found. This chapter deals with developing effluent limits for the protection of aquatic life. Human health protection is covered in Chapter VII.

To evaluate the effect an effluent has on a receiving water, a permit manager must use:

- the water quality criteria and standards described below in Section 1,
- the mixing zone criteria described below in Section 2, and
- a method for predicting impact and defining effluent limits for numeric criteria described below in Section 3.

The permit writer should keep in mind that the requirement for imposing effluent limitations for the protection of water quality does not require a demonstration of impact beyond any doubt but only that there is a determination of reasonable potential determined by a rational and scientific process.

In some cases water quality-based effluent limits will be below quantitative levels. Section 4 describes how to deal with this situation.

Evaluating an effluent's effect on a receiving water includes an evaluation of whole effluent toxicity (WET). Section 5 presents Ecology's approach for dealing with whole effluent toxicity.

Additional guidance on determining effluent mixing is presented in Appendix 6.

1. WATER QUALITY CRITERIA AND STANDARDS

Water quality criteria are estimated threshold concentrations for specific pollutants which are based on scientific data about adverse effects to aquatic life or human health. These criteria address human health effects, toxicity to aquatic organisms, bioaccumulation potential, or an adverse effect on some other beneficial water use. These criteria may be single numbers, a concentration range, or a narrative statement.

The first water quality criteria developed under direction of the Federal Water Pollution Control Act (Clean Water Act) were published over 20 years ago and have since been revised several times. The Clean Water Act directs EPA to continue developing and revising these criteria, and EPA now plans to publish 10 final water quality criteria documents every year.

The methods used for deriving the criteria have changed over the years. The different methods that EPA has used are published as appendices to the current criteria (Gold Book EPA 440/5-86-001). The criteria have become increasingly complex as EPA tries to incorporate all the factors which affect toxicity including exposure patterns or characteristics. The current numeric criteria for aquatic life protection usually have 3 components:

- magnitude or concentration,
- duration - averaging period for exposure to the chemical in question, and
- frequency - the number of times that the criteria may be exceeded within a given time frame without permanently affecting the aquatic communities. Three years is used as the period of time for aquatic community reestablishment.

Each of these components is defined for short-term (acute) and long-term (chronic or sublethal) effects.

The current EPA criteria for zinc, for example, are:

> **"freshwater aquatic organisms and their uses should not be affected unacceptably if the 4-day average (duration) concentration of zinc (in µg/L) does not exceed the numerical value given by $(.986)(e^{(0.8473[\ln(\text{hardness})]+0.7614)})$ (concentration) more than once every three years on the average (frequency) and if the 1-hour average (duration) concentration (in µg/L) does not exceed the numerical value given by $(.978)(e^{(0.8473[\ln(\text{hardness})]+0.8604)})$ (concentration) more than once every three years on the average (frequency). For example, at hardness of 50, 100, and 200 mg/L as $CaCO_3$, the 4-day average concentrations**

> **of zinc are 32, 105, and 188 µg/L respectively, and the 1-hour average concentrations are 35, 114, and 206 µg/L. If the striped bass is as sensitive as some data indicate, it will not be protected by this criterion... Saltwater aquatic organisms and their uses should not be affected unacceptably if the four-day average concentration of zinc does not exceed 81 µg/L more than once every 3 years on the average and if the 1-hour average concentration does not exceed 90 µg/L more than once every 3 years on the average."(Values are from FR Vol. 60, No. 86, May 4, 1995)**

The criteria for toxic pollutants, including zinc, have separate development documents which provide a detailed review of the data used to develop the criteria. These documents are available from the Department of Ecology Library, the Environmental Assessment Program, and from the EPA Region X library in Seattle.

The criteria for toxic pollutants are not static. EPA will continue to refine these numbers to incorporate new research data and risk methods.

1.1 The Water Quality Standards Define the Beneficial Uses and Incorporate Criteria

Water quality standards for Washington's surface waters are codified in Chapter 173-201A WAC, Water Quality Standards for Surface Waters of the State of Washington (Water Quality Standards) and in 40 CFR 131 (FR 57, No. 2461, Dec. 22, 1992), the National Toxics Rule. The National Toxics Rule does not apply to those substances which are already included in our Water Quality Standards. The Water Quality Standards consist of 3 key parts.

The first part of the standards is a categorization system of water bodies based on the expected beneficial uses of those water bodies. Washington's highest classification is Class AA (extraordinary) and the lowest is Class C.

The second part of the standards is the water quality criteria deemed necessary to support the uses described for each class. The criteria within a classification are numerical values or narrative statements. The conventional and historical parameters are dissolved oxygen, fecal coliform, dissolved gas saturation, temperature, pH, and turbidity. Toxic substances are addressed through both narratives statement and numerical criteria. These criteria apply to all classes of waters. The toxic criteria are taken from the current National Recommended Water Quality Criteria (EPA 822-Z-99-001, April 1999). Many of the numerical values are dependent on other water quality parameters such as pH, temperature and hardness. Some values have duration periods specified as instantaneous values, 1-hour averages, 24-hour averages or 4-day averages.

Silver is given in our standards as an instantaneous value not to be exceeded. Implementation of silver is the same as an acute one hour average exposure.

The chronic aquatic life criteria for mercury is based on accumulation of methylmercury in aquatic organisms. If effluent limits for mercury are based on the chronic aquatic life criterion (chronic WLA drives the limits) then the permit may allow the permittee to do fish tissue analysis to demonstrate compliance with the water quality standards. Contact the PM Section for suggested permit language.

EPA has recommended a change in the freshwater chronic criteria for ammonia. Ecology will adopt this change during the current triennial review. In the meantime, permit writers should use the higher criteria and if the chronic criteria drives the limits, the permit writer should explain it's use in the fact sheet. The current criteria is given in the permit tools TSDCALC.XLS and NH3FRESH.WK1.

In addition to the specific numerical criteria, the State Water Quality Standards state that the Gold Book may be used as a source of information for determining the toxicity of substances not specifically listed in the standards.

The key narrative criteria of the Water Quality Standards are:

- Toxic, radioactive, or deleterious material concentrations shall be below those which may adversely affect characteristic water uses, cause acute or chronic conditions to the aquatic biota, or adversely affect public health; and

- Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

The third part of the Water Quality Standards is the antidegradation policy statement which has 5 components:

- existing beneficial uses will be maintained,

- no degradation is allowed in waters of national ecological importance, and

- when natural conditions are lower than the criteria assigned, the natural conditions constitute the criteria,

- if water quality is higher than the assigned criteria, the existing level is protected.

- short-term modification to (excursions from) the standards are allowed.

The Water Quality Standards also contain some specific directives for permit managers. These include the requirements that:

- Permits be conditioned such that the discharge will not cause a violation of the standards [WAC 173-201A-060(5)],

- Permits are subject to modification if a permitted discharge is discovered to be causing a violation of the standards [WAC 173-201A-060-(5)(b)], and

- No waste discharge is allowed to: the Cedar River (RM 21.6 to headwaters), the Green River (RM 59.1 to headwaters), Mill Creek (RM 25.2 to headwaters), the Sultan River (RM 9.4 to headwaters), the Tolt River (RM 6.9 to the headwaters), the Union river and tributaries (RM 6.9 to the headwaters), and the Wishkah River and tributaries (RM 32.0 to the headwaters) [WAC 173-201A-130]. These river sections are preserved as sources of drinking water.

There are also many other special waterbody-specific special conditions listed in Sections 130 and 140 concerning fecal coliform, temperature and dissolved oxygen.

EPA has promulgated criteria to protect human health for 91 substances. These criteria apply to the states waters and are amendments to 40 CFR 131 (FR 57, No. 2461, Dec.22, 1992)(see Chapter VII).

1.2 Conversion Factors and Translators for Metal Criteria

In the 1992 revision of the Washington Water Quality Standards, the metals criteria were changed from being expressed as total recoverable to dissolved. The conversion was accomplished using the **conversion factors** recommended by EPA at the time. The conversion did not make the criteria more or less stringent but simply expressed them in the form believed to be toxic. These conversion factors become part of the formula for calculating the criteria. The current criteria are given in permit tool TSDCALC.XLW.

Conversion of the metal criteria to the dissolved form created a problem for permit writers because federal regulation (40 CFR 122.45(c)) requires that effluent limitations for metals be in the form of total recoverable. The permit writer then needs a **translator** to conduct a determination of reasonable potential or derive effluent limits. EPA (1993) recommended three options for developing a translator. These included: 1. use of measured fraction of dissolved/total recoverable metal in the receiving water, 2. use of a translator of one (assumes all of the total recoverable metal in the effluent becomes dissolved in the receiving water), or 3. use of TSS data from the receiving water to calculate fractions by the use of partioning models.

Ecology permit writers should use one of the following as a translator, in the following order of priority depending on the circumstances: 1). Use the measured fraction of dissolved to total recoverable measured in the receiving water during critical condition. 2). If there is no data on the dissolved fraction in the receiving water but there is TSS data on the receiving water use the TSS-dissolved fraction relationship described in Table VI-A1 below for copper and zinc. Use the appropriate fraction for Cd and Pb from Table VI-A1. 3). If there is no receiving water data on ratios or on TSS, use the appropriate dissolved fraction from Table VI-A1 for cadmium, copper, lead and zinc. For other metals, use the conversion factor as the translator. TSDCALC.XLW will calculate the appropriate translator (see Appendix VI).

Table VI-A1. Recommended estimates of the 90th and 95th percentiles of ambient dissolved fractions (f_d) of Cd, Cu, Pb, and Zn based on data from rivers in Washington (regressions assume TSS in mg/l).(from Pelletier, 1996)

	90th percentile of f_d*	*95th percentile of* f_d
Cd		0.943
Cu	if seasonal TSS<6.7 mg/L: 1	if annual TSS<11.4 mg/L: 1
	if seasonal TSS ≥ 6.7 mg/L: $1.91*TSS^{-0.341}$	if annual TSS ≥ 11.4 mg/L: $2.29*TSS^{-0.341}$
		0.996
Pb		0.466
Zn	if seasonal TSS<4.9 mg/L: 1	if annual TSS<12.5 mg/L: 1
	if seasonal TSS ≥ 4.9 mg/L: $1.44*TSS^{-0.231}$	if annual TSS ≥ 12.5 mg/L: $1.79*TSS^{-0.231}$
		0.996

*The 90th percentile values are used if the TSS data is from the critical season. The 95th percentile values are used if the data are not stratified by season.

In the example of deriving water quality-based effluent limits that follows later in this chapter, the conversion factor was used as the translator.

2. THE POINT OF COMPLIANCE OF THE WATER QUALITY STANDARDS

The Water Quality Standards allow the use of mixing zones for discharges that would otherwise exceed the water quality criteria for aquatic life. Mixing zones are areas where the water quality standards may be exceeded but they are small enough so as not to interfere with beneficial uses. Mixing zones are a regulatory recognition that the concentrations and effects of most pollutants diminishes rapidly after discharge due to dilution. They are established in a manner which limits the duration of exposure for organisms passing through the effluent plume in order to minimize the risk from each discharge. The water quality standards for chronic protection must be met at the boundary of this zone and beyond. A smaller zone in which acute criteria may be exceeded can also be authorized. This zone must be small enough to limit exposure times and therefore not cause acute mortalities or interfere with passage of aquatic organisms in the water body.

An intermediate goal in point source pollution control which is consistent with the CWA goal of zero discharge is the elimination of the need for a mixing zone.

The water quality standards do not prohibit a permit writer from granting a mixing zone for a shore discharge, but shore areas are important biological areas. A permit writer should be sure that granting of the mixing zone on a shoreline will not cause biological effects as specified in the regulation. This may require a demonstration on the part of the permittee in some cases.

2.1 GENERAL CONSIDERATIONS FOR MIXING ZONES

The authorization of a mixing zone (chronic) is subject to some conditions, as given in the Water Quality Standards.

1. The allowable size and location shall be established in discharge permits or orders.

A discharger does not receive a mixing zone unless it is specifically authorized. Any discharger whose effluent exceeds the water quality criteria and has not been authorized a mixing zone is in violation of the water quality standards. For marine waters the permit writer should authorize, as necessary, some distance around the point of discharge and place this in the permit. The fact sheet should discuss the distance, the dilution factor that results from this distance and the method of deriving the dilution factor. For fresh water, the permit writer should authorize some distance or some volume fraction of the receiving water, whichever is more stringent, and discuss the selection in the fact sheet.

2. The discharger shall be required to fully apply AKART prior to being authorized a mixing zone.

This is the technology-based limit process described in Chapter IV. In some instances a pollutant may not have been addressed in the derivation of the technology-based limits for a discharger. For example, municipal discharges have technology-based limits in regulation and this has been determined to be AKART (Chapter 173-221 WAC). This regulation does not address ammonia or chlorine and therefore ammonia and chlorine should be addressed on a water quality basis. When a permit writer is using a state-promulgated effluent guideline for compliance with AKART, any pollutants not addressed must be dealt with on a water quality basis. This would not apply to cases where there was a promulgated effluent guideline that was not applicable because of changes or differences in process from that described in the development document. In these instances, technology-based effluent limits would be developed on a case-by-case basis.

3. Consider critical discharge conditions.

The receiving water critical condition is generally defined in the Water Quality Standards. Design conditions are discussed in more detail later in this section.

4. Not cause loss of sensitive or important habitat, ...

Generally, permit managers have little data on the physical and biological characteristics of the receiving water and must meet the intent of this section by limiting the size of the mixing zone. In addition, there is no established process for making this determination.

5. Not exceed criteria past the boundary of the mixing zone

The process of deriving effluent limits described later in this chapter will ensure the water quality standards are not exceeded past the mixing zone boundary or flow restriction.

6. The mixing zone size and the pollutant concentrations shall be minimized.

There is currently no routine procedure for minimizing the size of the mixing zone. The permit writer may authorize the maximum size allowable under the discharge situation. In some discharge situations, the permit writer may choose to authorize a mixing zone less than the maximum because of encroachment onto sensitive habitat or overlap of a mixing zone. A permit writer may also elect to calculate the size of the mixing zone required under design conditions and authorize a zone smaller than the maximum.

A mixing zone is sized for the pollutant with the largest potential to violate water quality standards.

7. Maximum size specifications (Chronic)

In rivers and streams the maximum mixing zone boundary is 300 feet downstream plus water depth at critical condition. The dilution factor to use in calculating effluent limits for protection of the chronic criteria is the more restrictive of 25% of the flow at critical condition or the center line dilution factor occurring at the downstream boundary of the authorized mixing zone (Fig VI-1).

In estuaries the maximum mixing zone boundary is 200 feet plus water depth at MLLW in any horizontal direction (Fig. VI-2).

In oceanic waters the maximum mixing zone boundary is 300 feet plus water depth at MLLW in any horizontal direction (Fig. VI-3).

8. Zone of acute criteria exceedence.

This zone can only be authorized if it will not create a barrier to the migration or translocation of indigenous organisms to a degree that has the potential to cause damage to the ecosystem. There are currently no formalized criteria or process for determining if this will occur. If a permit is conditioned such that acute criteria are not exceeded past the boundary of this zone it can be assumed in the absence of information to the contrary that it will not cause a barrier.

In rivers and streams the maximum size of this zone is the more restrictive of the mixing occurring at 10% of the mixing zone distance (centerline) or 2.5% of the flow at critical condition.

In estuaries and oceanic waters the maximum size of this zone is 10% of the mixing zone horizontal distance. There is no vertical limitation on this zone.

DETERMINING MIXING

A mixing zone may be a boundary around a point of discharge and a permit writer must know or be able to estimate the amount of mixing which occurs inside that area to determine the potential for a violation of the water quality standards and to derive effluent limitations if necessary.

The permit writer has 3 basic options for determining the amount of mixing occurring within a mixing zone:

1. Use a computer hydraulic simulation model to predict the amount of mixing. A permit writer has several models available for use if the input data is available or can be reasonably estimated. These models are discussed in Section 4.4 of the TSD. EILS must be consulted before using these models unless the permit writer has a strong background in modeling.

2. Require the mixing analysis to be done within the permit. A permit writer may run a model using the best available data for determination of reasonable potential but also require a permittee to do a mixing analysis as a requirement of a regulatory order or as a requirement in the permit.

3. Require the mixing analysis as a part of the permit application. If a permit writer knows that a permit will be done in the next fiscal year, the mixing and other data necessary for making water quality determinations can be requested well in advance. The data that could be requested are mixing data, effluent data and ambient receiving water data. Producing this data may be beneficial to the discharger. For example, the multiplication factor for making a "reasonable potential" determination decreases with increasing number of data points.

Requiring the analysis as an order or permit application will slow the issuance of the permit. Requiring the analysis as a permit condition may mean the permit will have to be modified when the analysis is completed if it leads to a different conclusion than what the permit conditions are based on. Beginning with FY 98 basin permits, mixing data should be available for doing those permits (see 3.3.6 following).

Saltwater discharges are modeled using steady state analysis and hydraulic models. These models require data on discharge depth, effluent flow rates, density of effluent, density gradients in the receiving water, ambient current speed, ambient current direction and outfall characteristics such as port size, spacing and orientation. The model output includes the dimensions of the plume at each integration step, time of travel to points along the plume centerline, and the average dilution at each point.

Mixing models are changing rapidly. The currently recommended models for most situations is the EPA PLUMES, CORMIX, UDKHDEN (version 2.7) and site specific analysis using the formulas in Chapter 5 of Fisher, *et al* (1979). Guidelines for the selection of the appropriate model are given in Appendix VI.

In those permitting situations where input data is not available, the permit manager should require the permittee to develop the data and run the appropriate model. The requirements may be in an order, as a part of the permit application or within the permit. The EAP program can also do this as part of an enhanced Class II inspection or as a requested project.

Where the hydraulic conditions at the discharge point are complex such as in the tidal reach of a river, a dye or tracer study should be used to confirm the model output at the chronic compliance boundary.

The mixing analysis should determine centerline or minimum mixing at the compliance zone boundaries for unidirectional flow situations and flux average for multidirectional flow situations such as tidal areas.

For flowing fresh water the water quality standards require, for chronic mixing, the more stringent of the dilution factor that results from the mixing at the boundary of the assigned mixing zone at critical condition (usually 7Q10 flow) or effluent mixing with 25% of the 7Q10 flow. For acute mixing, the allowed mixing is the more stringent of the mixing that occurs at the boundary of the acute compliance zone (10% of the chronic zone) at 7Q10 condition or 2.5% of the 7Q10. Exceptions to the size criteria for mixing zones (including the percent flow limitation) may be made in those circumstances where:

- the engineering report for the discharge was approved before Nov. 24, 1992, or
- where altering the size configuration would result in greater protection, or
- where the effluent provides a greater benefit than removing it, if removing it is the only option, or
- where the exceedance is clearly necessary to accommodate important social or economic development.

Before an exception can be made, it must be demonstrated to Ecology that

- AKART is applied
- all other options that are **economically achievable** are being utilized and
- granting the exception would not have the **reasonable potential** to cause a loss of sensitive or important habitat, substantially interfere with the existing or characteristic uses of the water body, result in damage to the ecosystem, or adversely affect public health.

AKART is covered in Chapter IV, Part 3. Guidance for the permit writer is being developed to determine **economically achievable** and **reasonable potential**. Until that guidance is available, a permit writer who makes a determination that a larger mixing zone is required or the percent of flow limitations are not applicable should discuss, in the fact sheet, the determinations of AKART, economically achievable options, and receiving water impacts. This determination should be discussed with the Watershed Planning Section.

SHELLFISH PROTECTION

Ecology has a shellfish protection strategy in cooperation with the Department of Health (Ecology 1984). Permit writers for marine dischargers should consult with DOH Shellfish Program to determine if the outfall is located in the general vicinity of shellfish resources, to gather other information about the discharge site, and to discuss dilution modeling.

The Shellfish Program of the Department of Health (DOH) is responsible for establishing prohibited areas around the outfalls of wastewater dischargers in waters located near shellfish production areas. DOH utilizes many of the same assumptions used by Ecology in the selection of critical receiving water and effluent flow conditions. However, the area of interest to DOH for such discharges is far-field. Therefore, the results of modeling or field studies which stop at the edge of dilution zones are often inadequate in providing appropriate information to DOH in establishing shellfish prohibited areas in the far field. Where shellfish beds are in the area of the discharge, the results from computer models or field studies should be extended to the farther field (usually in terms of several hundreds of yards). This initial screening may indicate a need to require the permittee to obtain additional information on receiving water conditions beyond the boundary of the dilution zone.

The Department of Health is also concerned about the discharge of human viral pathogens to shellfish beds from municipal treatment plants. They have asked that Ecology permit writers consider the following in developing municipal wastewater discharge permits:

The efficiency of UV disinfection decreases with increasing tube age.

The standard UV dosage is 16 milliwatt-seconds per square centimeter, however, some reactivation of bacteria occurs with dosages less than 30 milliwatt-seconds per square centimeter.

The use of detention time in the discharge pipe may be considered when deriving effluent limits for chlorine.

MISCELLANEOUS

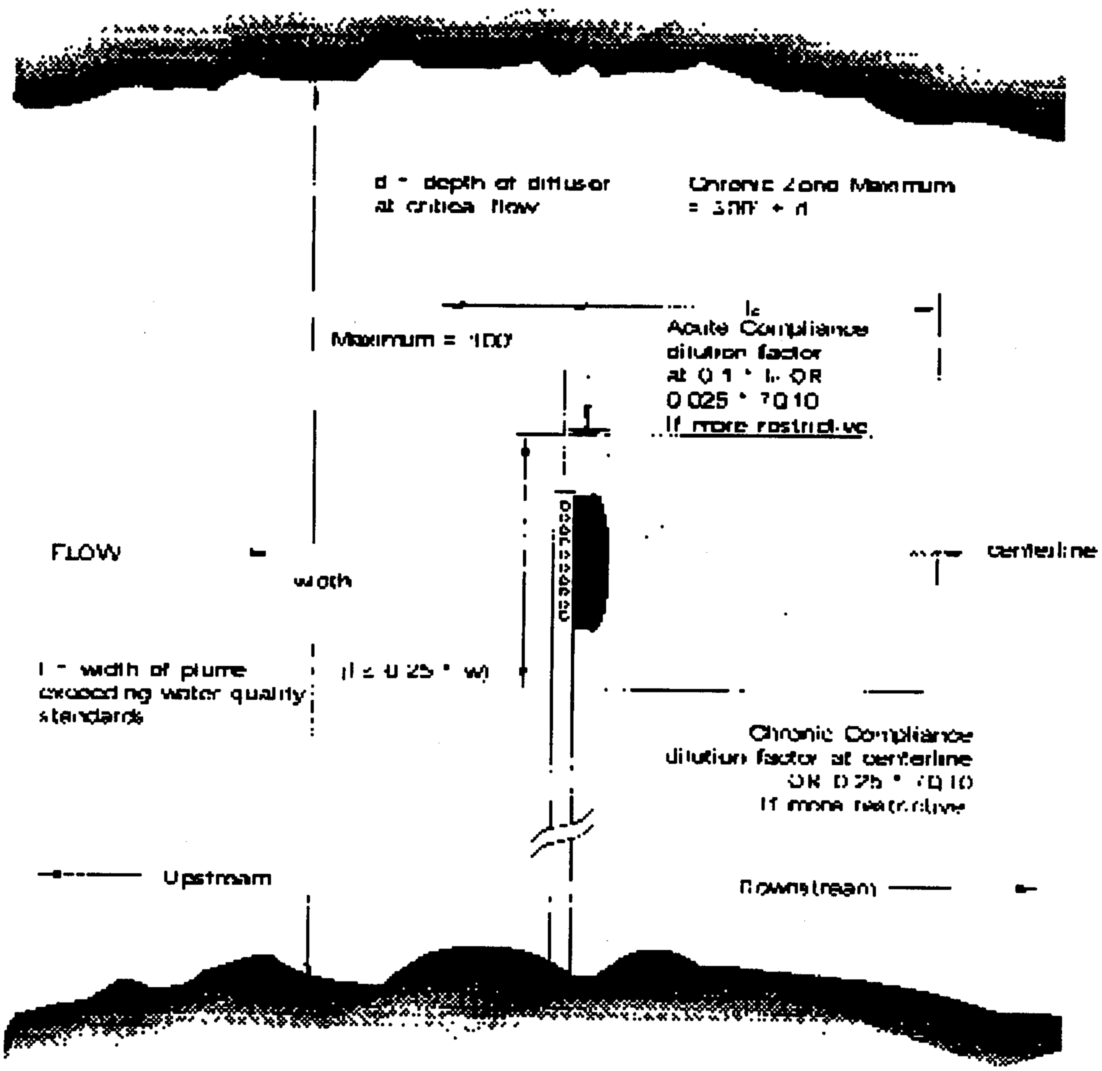
Water Quality Standards in Tidal Rivers - In tidal rivers in which the salt water wedge reaches the discharge point, the permit manager may apply the salt water criteria.

Alternatively the permit writer may apply the following process if the information is available:

> Where 95 percent of the vertically averaged daily maximum salinity values are less than or equal to one part per thousand the freshwater criteria are applied. Exceptions to this include dissolved oxygen in which the marine criteria apply at any point where the salinity is one ppt or greater and fecal coliform in which the marine criteria apply where the salinity is 10 ppt or greater.

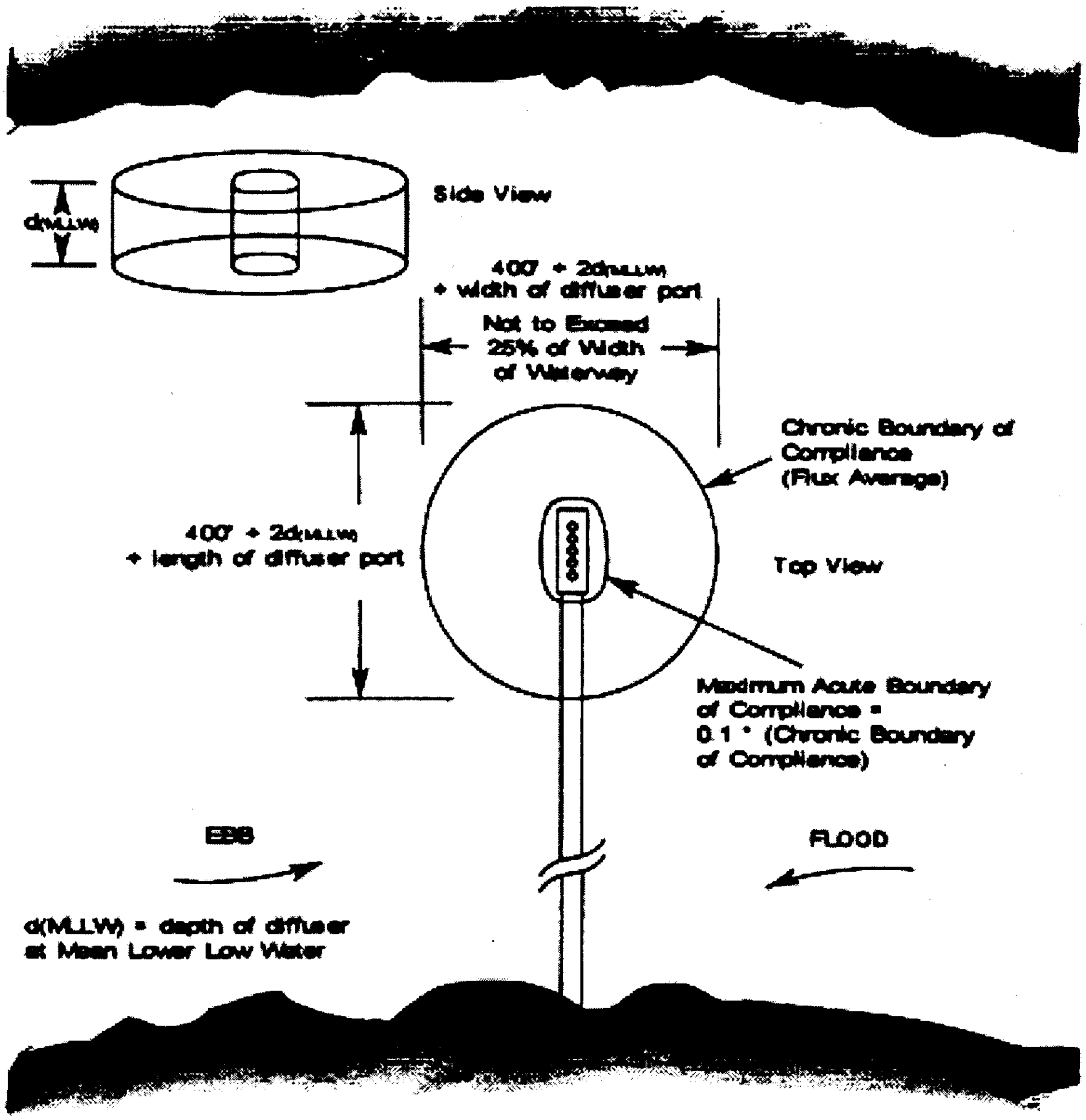
Reflux in Tidal Rivers - In tidal rivers, some of the effluent that is discharged is carried back upstream during the flood tide (reflux). In conducting a mixing analysis for a tidal river, the permit manager should model as an outgoing current and then assume reflux reduces the dilution factor by 1/2. This is based on Ecology's studies of these situations. The permittee may supply information to show the factor is something else in their situation.

Figure VI-1. Mixing zones in rivers.



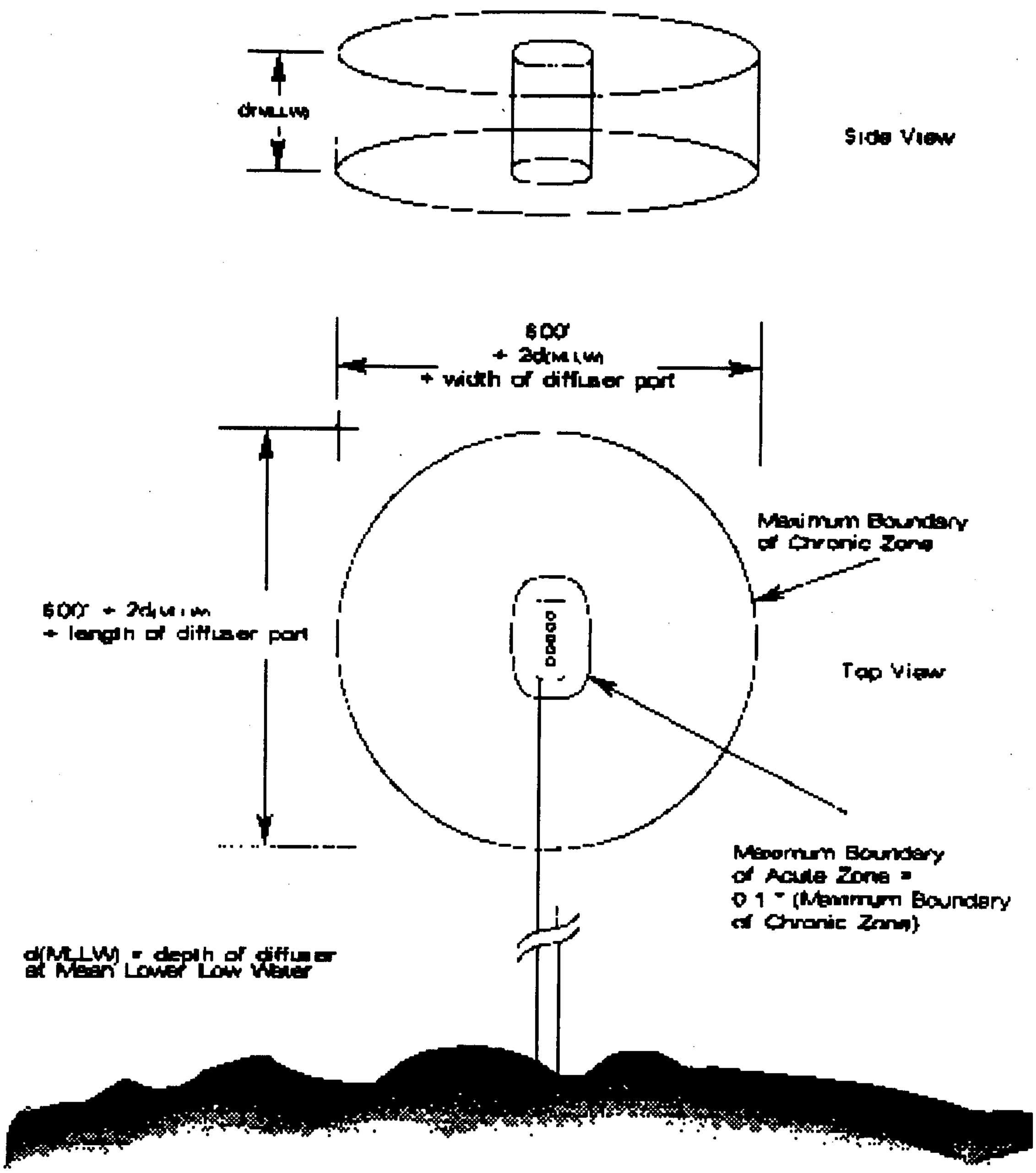
AR 032870

Figure VI-2. Mixing zones in estuaries.



AR 032871

Figure VI-3. Mixing zones for oceanic discharges.



3. PREDICTING IMPACTS AND DEFINING EFFLUENT LIMITS FOR NUMERIC CRITERIA

The permit manager must make several decisions when developing effluent limits for a permit. One decision, noted previously, is whether or not technology-based effluent limits for a pollutant will protect the quality of the receiving water.

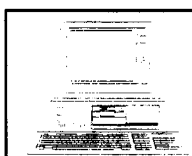
Generally, 2 types of analyses are done by the permit manager to predict impacts. One type of analysis is for pollutants such as BOD or nutrients which may cause an impact some distance from the point of discharge and for which mixing zones are not applicable. The other type of analysis examines the concentrations of specific pollutants or effects of pollutants within or at the edge of the mixing zone or the assigned dilution factor. These pollutants may be specific conventional, nonconventional, or toxic compounds.

3.1 THE WATER QUALITY IMPACT OF BOD AND NUTRIENTS

3.1.1 BOD

Biochemical oxygen demand (BOD) causes a depletion of dissolved oxygen in receiving water and consequently causes negative impacts on aquatic life and water quality in general. Many of the existing municipal and industrial permit conditions in Washington are based upon consideration of the water quality impact of BOD. In these cases, the treated effluent met the technology-based limitations but the small volume of receiving water warranted additional consideration.

In some cases, the dischargers were required to install advanced treatment to produce a lower effluent concentration of BOD. In other cases, they were required to change their point of discharge to new outfall locations or to land application during low flow periods.


DOSAG

The model used to predict dissolved oxygen deficit from BOD is the Streeter-Phelps equation. The Streeter-Phelps equation has the basic form as follows:

AR 032873

Streeter-Phelps Equation:

$$D_t = DO_{sat} - DO_t$$
$$= [K_2BOD_u ? (K_1 - K_2)](10^{-K_2t} - 10^{-K_1t}) + D_o(10^{-K_1t})$$

where:

D_t = dissolved oxygen deficit at any time t (days).
DO_{sat} = the dissolved oxygen level at saturation
DO_t = the dissolved oxygen level at any time t (days)
BOD_u = ultimate carbonaceous BOD of the stream immediately after mixing.
K_1 = reoxygenation rate constant (K_r).
K_2 = deoxygenation rate constant (K_d).
D_o = dissolved oxygen deficit immediately after mixing.

The impact of BOD is determined at the critical condition. The critical condition (design flow) for flowing freshwater is usually the 7-day average low flow with a recurrence interval of 10 years (7Q10). The critical period for marine waters is determined on a site-specific basis. The effluent design flow for industrial discharges is the highest monthly average flow for the past three years over the months when the 7Q10 is likely to occur. The effluent design flow for municipalities depends on how close to the design flow the facility is operating. For those municipalities that are operating within 15% of the design capacity or are experiencing a rapid population growth use the dry weather design flow. For those facilities that are operating well below design flow and are expected to have a stable population over the permit cycle, use a projected average dry weather flow for the five year period. The projected flow can be estimated from trend analysis or population projections from the engineering report.

This model is for a determination of reasonable potential for violation of the dissolved oxygen criteria. If the model indicates a probable violation of the dissolved oxygen criteria in the receiving water, the permit writer should contact EILS program for assistance in verification of the model or confirmation with more sophisticated models.

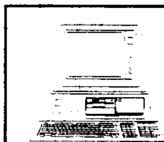
3.1.2 Nutrients

Nutrients are another class of pollutants which would be examined for impacts at some point away from the discharge. The special concern is for those water bodies quiescent enough to produce strong algae blooms. The algae blooms create nuisance conditions, dissolved oxygen depletion, and toxicity problems (i.e. red tides or blue-green algae). High nutrient concentrations can also create nuisance conditions in flowing waters. The impact of nutrients is very difficult to predict and usually there are several point and nonpoint sources contributing to a nutrient problem. The Gold Book does contain some guidelines for phosphorus loading to freshwater streams and reservoirs. A permit manager should point out any suspected nutrient problems to the unit and section supervisor. Suspected water quality problems due to nutrients are best handled by a TMDL process conducted by EAP.

3.2 Other Specific Pollutants - Conventional and Nonconventional

This section addresses dissolved oxygen, fecal coliform, pH, turbidity, temperature, total dissolved gas and aesthetics. The design flow for dissolved oxygen, fecal coliform, pH, turbidity, and temperature is the maximum monthly flow which may be estimated for existing facilities by using the discharge data for a period of the last three years for the months in which the critical flow is likely to occur.

3.2.1 Dissolved Oxygen



IDOD

An effluent may cause a violation of the dissolved oxygen criteria near the point of discharge from 2 components. If the effluent is low in dissolved oxygen it may cause a violation of the the dissolved oxygen criteria near the point of discharge from mixing with receiving water. The effluent may also have chemical components which cause rapid oxygen depletion called Immediate Oxygen Demand (IDOD). For most discharges the IDOD is not significant relative to the effect of mixing of the effluent, containing a low concentration of dissolved oxygen, with the receiving water.

The process for calculating dissolved oxygen concentration following initial dilution is a simple mixing calculation found in EPA (1985) and EPA (1982). This process requires data on the dissolved oxygen concentration of the effluent and the receiving water at the critical period. The point of compliance is the chronic mixing zone boundary and the receiving water design concentration is the 10th percentile dissolved oxygen concentration.

3.2.2 Fecal Coliform

Fecal coliform is limited on a technology basis in municipal permits to 200 colonies/100 ml as a monthly geometric mean and 400 as a weekly geometric mean. This limit is based on the performance of standard disinfection treatment processes. It is a promulgated performance standard in Chapter 173-221 WAC.

The water quality standards for fecal coliform are quantified on a geometric mean of the number of colonies per 100 mL. They are based on the probable exposure to pathogenic bacteria.

The standards are:

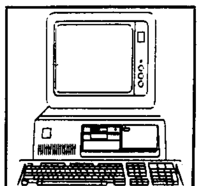
Class AA, freshwater-	50/100 mL
marine-	14/100 mL
Class A, freshwater-	100/100 mL
marine-	14/100 mL
Class B, freshwater-	200/100 mL
marine-	100/100 mL
Class C, marine-	200/100 mL
Lake class, freshwater-	50/100 mL

The point of compliance for the fecal coliform standard is at the boundary of the chronic mixing zone if one is allowed. The design flow for application of the standard is the 7Q10 low flow for flowing freshwater and the 50th percentile current velocity for marine.

A municipal permittee meeting the technology-based limitations would require minimal dilution to be able to meet the water quality standards for fecal coliform.

3.2.3 pH

The pH in most permits in Washington is limited to a range of unless pH has been defined by the federal effluent guidelines as a process pollutant. The range of pH 6 to 9 in permits for most dischargers is based on the demonstrated performance of simple equalization or neutralization. Unless pH is a process pollutant, the discharge of effluent outside this range generally indicates spills or treatment plant upset.



PHMIX2

The criteria for pH in the water quality standards restrict the pH change caused by a source to 0.5 units (0.2 units for Class AA). The point of compliance with the pH standard is the boundary of the chronic dilution zone at 7Q10 or critical condition.

The resultant pH of a mixture of 2 flows is calculated by processes described in EPA (1988).

Modeling of freshwater discharges is usually unnecessary unless the effluent pH is above 8 and the receiving water is poorly buffered or unless the volume of the discharge is very large.

Source-caused pH changes are seldom a problem in salt water because of the high buffering capacity of sea water, however, large volume dischargers with extreme pH ranges, such as 3 to 11, should be required to do receiving water studies to determine receiving water effects.

3.2.4 Turbidity

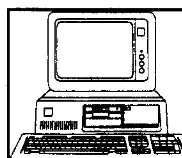
Turbidity is not a parameter generally considered in point source discharges except for water treatment backflush wastewater. Control of particulates as total suspended solids in an effluent usually results in low turbidity, however, depending on the size of the particulates and the pore size of the filter media used to determine TSS, some effluents may cause some turbidity in the receiving waters while meeting TSS limits. Turbidity does not have a linear response to dilution. Any data that indicates a violation of water quality standards should be verified in the receiving water.

3.2.5 Dissolved Gas Supersaturation

The Watershed Management Section monitors compliance with dissolved gas supersaturation. Dam operators can control dissolved gas by controlling the amount of spillage. The design condition for dissolved gas is the 7Q10 high flow (7Q10hf). During these very large natural runoff events, the resulting high flows make it impossible for dam operators to abate for dissolved gas. Guidelines for deriving the 7Q10 high flow are presented in Appendix 6.7.

3.2.6 Temperature

Temperature in the water quality standards is limited in 2 ways. Each classification has an upper temperature limit and a maximum allowable rise. For example, in class AA freshwater the maximum temperature is 16.0?C and the maximum allowable temperature rise is 23 ÷ (background temperature + 5). When natural conditions exceed 16.0^{0}C the allowable waterbody temperature rise is limited to 0.3^{0}C. The point of compliance with the temperature standards is at the edge of the chronic mixing zone at the critical condition. The critical condition for temperature is when ambient temperature of the receiving water is the highest.


PHMIX2

Any large thermal sources should be required to demonstrate compliance with water quality standards by field verification during low flows, high temperature conditions.

3.2.7 Aesthetics

The Water Quality Standards require that aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste. These values will, of course, be mostly considered for new discharges or when a complaint has been received on an existing discharge. Examples of measures that could be required of a discharger to preserve aesthetic values include:

- control of oil sheens,

- submerged discharges, and
- locating the discharge away from sensitive locations/persons.

3.3 Deriving Effluent Limits for Toxic Pollutants

Defining water quality impacts and developing effluent limits is usually more complex for toxic pollutants than for the other pollutants. As noted in the earlier discussion on water quality criteria and standards, the toxic numerical criteria are given at 2 levels (acute and chronic) each of which contains 3 components (magnitude, duration, and frequency). The analysis to predict water quality impacts and thus to define effluent limits must be conducted for both acute and chronic criteria in order to define the most limiting one. Many of the criteria for toxic pollutants are variable and depend on receiving water conditions. This section covers these subjects and others and presents an example of how to develop effluent limits for toxic pollutants.

Whole effluent toxicity (WET) is evaluated separately and explained in Section 5 of this chapter. After determining a technology-based limit for a toxic pollutant, the permit manager must decide if the limit will cause the discharge to meet the water quality standards. Federal regulations require the permit manager to determine whether a discharge has a reasonable potential to violate water quality standards and if so to place a water quality-based effluent limit in the permit (40 CFR 122.44). To determine this, the permit manager must know the criteria, the background concentration, the point of compliance, design flows for the receiving water and effluent flow, how to deal with multiple pollutants and effluent variability and the process of developing an effluent limit.

The EPA document, *Technical Support Document for Water Quality-based Toxics Control* EPA/505/2-90-001, is the basic reference document for the rest of this chapter and it is assumed that the permit manager has read it. The rest of this chapter will focus on Washington's process and will not review the background material which is presented in the Technical Support Document.

3.3.1 Point of Compliance

The points of compliance for toxic pollutants are the same as discussed previously in this chapter. A permit manager may authorize a mixing zone as necessary with the size and other restrictions as specified in the water quality standards for acute and chronic criteria.

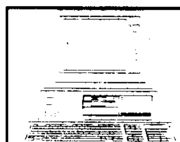
3.3.2 Design Flows

The design flows for effluent and receiving water has been discussed above for some pollutant parameters. They are summarized in Table VI-1.

The traditional receiving water design flow or critical condition for steady state modeling of pollutant discharge such as BOD to freshwater is the 7-day low flow period with a recurrence interval of 10 years (7Q10). This flow is typically when the least amount of mixing occurs, temperature is the highest, and dissolved oxygen is the lowest. Ecology will use the 7Q10 as the design flow for the acute and chronic toxic criteria also. The permit manager should use this design flow unless another design flow is more suitable.

For saltwater discharges the critical mixing condition is defined according to the characteristics of the receiving water such as tidal exchange, river inflow, stratification by temperature and salinity, the characteristics of the outfall location, and the characteristics of the effluent such as temperature and salinity. It may be necessary to run a computer simulation of the discharge and receiving water to determine critical condition.

3.3.3 Criteria Vary With Background Conditions


AMMONIA
NH3SALT

Some criteria vary with other chemical or physical parameters. For example, the aquatic life criteria for some metals in freshwater vary with hardness of the receiving water. The criteria for ammonia varies with temperature and pH. The critical period for ammonia is often difficult to calculate because the criteria varies on the 2 parameters. The EA Program or the Program Development Services Section can assist if the permit manager has difficulty.

3.3.4 Multiple Pollutants

Each toxic pollutant in a single discharge is considered independently. Many toxic pollutants are interactive but any additive or synergistic effects are difficult to predict. Interactive effects in a single effluent will be detected with whole effluent toxicity testing. The chance for interactive effects is reduced by not allowing overlap of acute compliance zones and by not allowing the overlap of mixing zones for the same parameters.

3.3.5 Effluent Variability

A permit manager must have an estimate of variability to incorporate into the calculation of a permit limit. The estimator of variability which is most commonly used is the coefficient of variation (CV). The CV is the ratio of the standard deviation to the mean. The best estimate of effluent variability can be derived from a set of results from random effluent samples for the toxic parameter. As a general rule of thumb, because the distribution of values from wastewater treatment is non-normally distributed, any number of samples less than 10 is probably not valid as a predictor of distribution.

A permit writer may be able to obtain a value for variability from the development document for the category of discharger.

A CV of 0.6 is recommended by EPA if no other estimate is available.

3.3.6 Background (Receiving Water) Data

Permit writers and watershed coordinators, during the watershed scoping process should identify the need for background water quality data for the basin waters. Information and data necessary to develop a water quality-based permit should be requested from the discharger by letter or order in year two of the basin cycle. This gives ample time to budget and hire a contractor, if necessary.

Table VI-1. Applicable criteria/design conditions for determining the acute and chronic dilution factors for aquatic life.

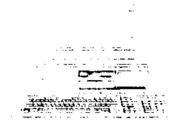
Design Conditions for Mixing Zone/Ratio Analysis - Aquatic life Criteria		
Parameter	**Mixing Zone**	**Critical Design Condition**
Plant Effluent Flow - Municipal	Acute	The critical plant effluent flow, for those plants operating at less than 85% of the dry weather design flow during the critical period, is defined as the highest daily maximum plant effluent flow for the past three years during the critical flow or when the critical condition is likely to occur. If the facility is operating between 85 and 100% of dry weather design flow during the critical period then use a peaking factor applied to dry weather design to determine acute design flow. The peaking factor is a ratio of daily maximum to monthly average flows derived from actual plant data during critical period. A peaking factor may also be available in the engineering report for the facility.
	Chronic	The critical plant effluent flow is defined as the dry weather design flow if the facility is operating between 85 and 100% of design during the critical period. If the facility is operating at less than 85% of design flow during the critical period the critical plant effluent flow is defined as the highest monthly average plant effluent flow for the past three years during the critical flow or when the critical condition is likely to occur.
Plant Effluent Flow - Industrial	Acute	The critical plant effluent flow is defined as the highest daily maximum plant effluent flow for the past three years during the critical flow or condition is likely to occur. If plant effluent flows are expected to increase during the life of the permit, the highest daily maximum flow must be estimated.
	Chronic	The critical plant effluent flow is defined as the highest monthly average plant effluent flow for the past three years during the critical flow or condition is likely to occur. If plant effluent flows are expected to increase during the life of the permit, the highest average monthly flow must be estimated.
Receiving Water (Characteristics)	Acute and Chronic-Freshwater	The critical receiving water current velocity is defined as the current velocity at both the 7-day low flow and high flow periods with a recurrence interval of 10 years (7Q10 by the appropriate statistical method). The diffuser depth is defined as the depth at the 7Q10 low flow period.
	Acute - Saltwater	The critical receiving water current velocity is defined as the critical 10th and 90th percentile current velocities derived from a cumulative frequency distribution analysis. The current velocity frequency distribution analysis should be conducted, at minimum, over one neap and spring tide cycle. The critical ambient density profile is defined as the density profile that results in the lowest mixing. The diffuser depth is defined as the depth at MLLW. For estuaries, the diffuser depth is defined for low-water slack and low river flow conditions.
	Chronic - Saltwater	The critical receiving water current velocity is defined as the 50th percentile current velocity derived from a cumulative frequency distribution analysis. The current velocity frequency distribution analysis should be conducted, at minimum, over one tidal cycle. The critical ambient density profile is defined as the density profile that results in the lowest mixing. The diffuser depth is defined as the depth at MLLW.

Miscellaneous Design Conditions for Mixing Zone/Ratio Analysis		
Parameter	**No. of Data Points**	**Methodology**
Maximum expected Receiving Water Concentration (Analytical Data)	1 to 20	The geometric mean of the receiving water values should be multiplied by a factor of 1.74 to estimate the 90th percentile. This value should then be used in conjunction with the plant effluent data to evaluate reasonable potential to cause an exceedance of the criteria for aquatic life protection and derive effluent limits.
	Over 20	The critical background receiving water value is defined as the 90th percentile value derived from a cumulative frequency distribution analysis. This 90th percentile background value should be used in conjunction with the plant effluent data to evaluate reasonable potential to cause a violation of the criteria for aquatic life protection and derive effluent limits.
Maximum Expected Effluent Concentration (Analytical Data)	1 to 20	Assume a coefficient of variation (CV) of 0.6 and use the reasonable potential multiplying factors from Table 3-2 of the TSD (page 57) to estimate the maximum expected effluent concentration. This value should then be used in conjunction with the background receiving water data to evaluate a reasonable potential to cause a violation of the citeria for aquatic life/human health protection and derive effluent limits.
	Over 20	Calculate CV and use the reasonable potential multiplying factors from Table 3-2 of the TSD to estimate the maximum expected effluent concentration. This derived effluent value should then be used in conjunction with the background receiving water data to evaluate a reasonable potential to cause a violation of the citeria for aquatic life/human health protection and derive effluent limits.
Dilution Factor unidirectional flows	N/A	Centerline for acute and chronic dilution.
Dilution Factor marine and rotating direction	N/A	Flux average for acute and chronic
Reflux	N/A	Assume reflux reduces the dilution factor by 1/2 in the absence of site-specific data.

Mixing Zone/Ratio Analysis - Point of Compliance	
Parameter	**Point of Compliance**
pH, DO, Fecal Coliform, Temperature	Compliance at the edge of the chronic mixing zone.
Human Health Criteria	Compliance at the edge of the chronic mixing zone.
Whole Effluent Toxicity and Numeric Criteria	Compliance at the edge of the acute dilution zone for acute WET/numeric criteria and at the edge of the mixing zone for chronic WET/numeric criteria.

Chronic design conditions are used for both the initial mixing and the far-field mixing calculations.

3.3.7 Determining Reasonable Potential



TSDCALC
REASPOT

Ecology has adopted EPA's (1991) process of determining reasonable potential including their statistical assumptions for estimating the 95th percentile value from a limited data set of effluent data.

The current version of the TSD (1991) documents EPA's assumptions in determining the multipliers to derive the 95th percentile effluent concentration based on a limited sample. The earlier version of the TSD (EPA 1985) presented a more detailed explanation of the derivation of the effluent multiplier.

An alternate method for estimating quantiles from limited data sets with an assumed log normal distribution is presented in Gilbert (1987). This method produces an estimate of an upper percentile value that is a maximum likelihood estimator which is proportional to the geometric mean. This estimator is lower for limited data sets than the EPA estimator and is used for estimating the 90th percentile receiving water concentration when making determinations of reasonable potential for aquatic life criteria. The details of this method are given in Appendix 6.

The calculations for determining reasonable potential are shown in an example in 3.3.11.

3.3.8 Calculating the Effluent Limits

TSDCALC

Water quality-based effluent limits are calculated by the two-value wasteload allocation process as described on page 100 of the TSD (EPA, 1991) and shown below.

1. Calculate the acute wasteload allocation WLA_a by multiplying the acute criteria by the acute dilution factor. Calculate the chronic wasteload allocation (WLA_c) by multiplying the chronic criteria by the chronic dilution factor.

   WLA_a = (acute criteria × acute zone dilution factor) - (background concentration × (acute zone dilution factor - 1))

   WLA_c = (chronic criteria × chronic zone dilution factor) - (background concentration × (chronic zone dilution factor - 1))

2. Calculate the long term averages (LTA_a and LTA_c) which will comply with the wasteload allocations WLA_a and WLA_c.

   $$LTA_a = WLA_a \times e^{[0.5\sigma^2 - z\sigma]}$$

where:

$\sigma^2 = \ln[CV^2 + 1]$

$z = 2.326$

$LTA_c = WLA_c \times e^{[0.5\sigma^2 - z\sigma]}$

where:

$\sigma^2 = \ln[(CV^2 + 4) + 1]$

$z = 2.326$

3. Use the smallest LTA of the LTA_a or LTA_c to calculate the maximum daily effluent limit and the monthly average effluent limit.

Maximum Daily Limit = MDL

$$MDL = LTA x\, e^{(Z\sigma - 0.5\sigma^2)}$$

where:

$\sigma^2 = \ln[CV^2 + 1]$

$z = 2.326$ (99th percentile occurrence probability)

LTA = smallest long term average (LTA_a or LTA_c)

Average Monthly Limit = AML

$$AML = LTA x\, e^{(Z\sigma_n - 0.5\sigma_n^2)}$$

where:

$\sigma^2 = \ln[(CV^2 \div n) + 1]$

n = number of samples/month

$z = 1.645$ (95th percentile occurrence probability)

LTA = smallest long term average (LTA_a or LTA_c)

The numeric water quality standards and the dilution factors define wasteload allocations (WLA) for pollutants. The WLA's are numbers not to be exceeded in order to protect aquatic life. In the statistical world, however, there is no such thing as 100% certainty. The Department uses an estimate of variability (coefficient of variation or CV) for these parameters in the effluent to define a distribution of values with a long term average (LTA) such that there is a one percent probability (0.01) of exceedence of the WLA. There are two long term averages defined for each parameter. One for acute and one for chronic. Effluent limits for each parameter are defined for the more limiting of the acute LTA or the chronic LTA. Effluent limits are control parameters to determine when a process is out of control. A process is out of control when the extreme values are higher than expected (expressed as the daily maximum limit) or the average is higher than expected (expressed as the monthly average limit). The 95% percentile (0.05 probability) used in calculating the average limit and the 99% percentile (0.01 probability) is used in calculating the daily maximum. These probabilities are the probability of determining the process is out of control when in fact the process is still in control.

The 95th percentile (0.05 probability) is used for calculating the average limit for the following reasons:

1. Exceedance of an average (average limit) indicates a more serious potential for environmental harm than exceedance of a daily maximum. Even so, the Department rarely enforces the occasional exceedance of monthly average limit. Typically, enforcement occurs after several consecutive violations of the monthly average limit or when both the daily maximum and the monthly average have been exceeded. This effectively reduces the probability of false noncompliance to something far less than 0.05.

2. The Department also uses the 95th percentile (0.05 probability) because this is a recommendation of EPA in the Technical Support Document.

3. The 95th percentile (0.05 probability) for monthly average was used for development of technology-based effluent limits when EPA developed the industrial effluent guidelines and secondary treatment standards.

The above formulas may also be used to derive performance-based limitations where the long term average (LTA) is the demonstrated performance and assuming the data is log normally distributed.

3.3.9 Seasonal Effluent Limitations

The permit writer may elect to develop seasonal effluent limitations for a discharger, especially in those situations where meeting water quality-based effluent limitations has a high operational cost and there is a considerable difference of magnitude between the seasonal limits. Generally, seasonal effluent limitations are developed on a semi-annual or quarterly basis.

3.3.10 Dynamic Modeling

The use of dynamic modeling is an acceptable alternative to the static modeling discussed above in those situations where the discharger is willing to meet the data requirements and submit the analysis for approval. A discussion of the three main type of dynamic modeling techniques is given in the TSD (EPA 1991).

3.3.11 TMDL'S and WLA'S

The wasteload allocations (WLA's) which are used to derive effluent limits may be derived on an individual permit basis or they may be determined by a basin TMDL determination.

Federal and state regulations require permits be conditioned so as to meet the water quality standards. In the absence of a basin TMDL and WLA, the permit writer must do an individual WLA to comply with regulations.

Occasionally, the permit writer will discover that the background receiving water concentration exceeds the aquatic life or human health criteria or the waterbody will already be listed for the pollutant on the 303(d) list. In these cases the permit writer should limit the pollutant to meet the criteria for the receiving waterbody in the effluent and grant a compliance schedule in the permit, if necessary. If the permit writer discovers, during the process of writing a permit for a facility, that the waterbody is not meeting standards the Watershed Management Section should be notified. The waterbody will be listed for a TMDL.

3.3.12 An Example of Effluent Limit Derivation for Metals

The following subsection describes the process of deriving effluent limitations for metals. The process is similar for other toxic pollutants.

Effluent Characterization

The following dischargers will be required to characterize their effluent for metals upon application:

Industrial
- all majors
- those with metals as a product or a component of their manufacturing process and those with potential to have metals in their effluent
- those discharging to a water body listed on the 303(d) list for non-attainment of metals

Municipal
- all over 1 MGD
- all with SIU's
- those discharging to water bodies on the 303(d) list for non-attainment of metals

Any discharger with valid data showing metals in concentrations exceeding the water quality criteria must be evaluated for reasonable potential to exceed the water quality standards in the receiving water. If a reasonable potential to exceed water quality standards is determined, an effluent limit is required.

The following elements are necessary in order to make a determination of reasonable potential:

Effluent Data. A larger data base on effluent quality will provide a better determination of reasonable potential. The 95th percentile effluent concentration is used to make a determination of reasonable potential. For small effluent data bases (≤20), use table 3.2 of EPA (1991) to estimate the 95th percentile concentration. This table assumes effluent data are lognormally distributed. For data bases greater than 20, calculate the 95th percentile value by using EXCEL® or some other spreadsheet software on lognormal transformed data.

Background Metals Data: If the number of data points is between one and twenty, the geometric mean should be multiplied by a factor of 1.74. This estimates the 90th percentile of a lognormal distribution with a CV of 0.6 (Gilbert 1987). If the data base is larger than 20 the calculated 90th percentile value of lognormal transformed data should be used as the background value. The data must be in the dissolved form. Concentrations reported as total recoverable can be converted to the dissolved form by use of the translator.

Background Hardness: Use the lowest hardness value observed during critical conditions if there are 20 values or less. If the data consists of more than 20 values calculate the 10th percentile value (lognormally transformed).

Metal Criteria: The metal criteria are calculated as dissolved using WAC 173-201A. TSDCALC.XLW (CRITERIA.XLS) will calculate the metal criteria.

AN EXAMPLE OF REASONABLE POTENTIAL DETERMINATION APPROACH -- A DISCHARGE OF EFFLUENT CONTAINING METALS TO A RIVER

This example is presented for acute criteria only for ease of presentation. In determining reasonable potential, both acute and chronic must be calculated. This process is also applicable to other pollutants.

Facility Characteristics:

* Metal Plating Plant
  - Discharge rate of 0.034 cfs
  - Mixing limited by acute zone percent flow
  - River 7Q10 flow is 13.0 cfs
  - Acute zone dilution factor is 9.6
  - Effluent data reflects technology-based treatment in place.

STEPS TO MAKING REASONABLE POTENTIAL DETERMINATION:

1. CALCULATE BACKGROUND WATER QUALITY

RECEIVING WATER SAMPLE RESULTS DURING CRITICAL CONDITIONS:

Sample Results for:	Copper as dissolved (μg/l)	Copper as total recoverable (μg/l)	Lead as dissolved (μg/l)	Hardness mg/l
	2.21	2.33	.035	117
	2.02	2.15	.053	123
	1.01	1.05	.104	109
	2.19	2.31	.09	119
	2.92	3.11	.05	**75.3**
	2.04	2.13	-	76
Mean =	**2.07**	**2.18**	**0.066**	
Geometric Mean =	**1.97**	**2.08**	**0.061**	
***Background Value =**	**3.94**		**0.106**	**75.3**

* Based on 1.74 times the geometric mean. The geometric mean is calculated by taking the logarithm of each value, summing the logarithms, dividing the sum by the number of measurements and then taking the antilog of the result.

General Background Rule for Metals:

If 1-20 data points - multiply the geometric mean by 1.74 to estimate the 90th percentile;
If >20 data points - calculate the 90th percentile.

2. DETERMINE THE TRANSLATOR

In-stream data were available for copper which showed a dissolved to total recoverable ratio of 2.07/2.18 = 0.95. This ratio is used as the translator for copper.

The translator for lead in the absence of total recoverable measurements or TSS data is 0.34. This is the 90th percentile value from Washington State water quality data (Pelletier 1996).

The translator is used to predict the amount of metal (as total recoverable) in the effluent that will become dissolved fraction in the receiving water.

3. CALCULATE THE CRITERIA

The acute criteria for copper (as dissolved) is given in Chapter 173-201A WAC as $(0.96)(e^{(0.9422(\ln(\text{hardness}))-1.464})$. At a hardness of 75.3 mg/l, the copper (dissolved) criteria is 13.0 µg/l.

The acute lead criteria for lead (as dissolved) is also given in Chapter 173-201A WAC as $(1.46203 - ((\ln \text{hardness})(0.145712)))(\exp^{(1.273(\ln(\text{hardness}))-1.460})$. At a hardness of 75.3, the criteria is 47.4.

4. CALCULATE THE MAXIMUM EXPECTED EFFLUENT CONCENTRATION (MEC):

EFFLUENT SAMPLE RESULTS AS TOTAL RECOVERABLE METAL (µg/l):

Copper	Lead
1317	467
1092	621
1073	565
2664	---
GM = 1424	GM = 547

Effluent samples are used to estimate the **Maximum Expected Concentration (MEC)** as follows:

(1) The **coefficient of variation (CV)** and the **number of data points (ND)** are used to determine a multiplier from Table 3-2 of EPA (1991).

(2) The **highest value (HV)** in the data set is multiplied with the identified multiplier value (i.e., TSD multiplier).

(3) The resulting product estimates the **maximum expected concentration** (MEC) of the toxic pollutant in the effluent (95th percentile, 95% confidence level). See the following:

USE OF MULTIPLIER VALUES AND HIGHEST EFFLUENT CONCENTRATION VALUES TO DERIVE MAXIMUM EXPECTED CONCENTRATION:

POLLUTANT	CV	ND	MULTIPLIER	HV	MEC
Copper	0.6	4	**2.6**	**2664**	**6926**
Lead	0.6	3	**3.0**	**621**	**1863**

In this case the MEC values are as total recoverable because the highest value is given as total recoverable.

5. DETERMINING REASONABLE POTENTIAL TO EXCEED STANDARDS

In order to make a determination of reasonable potential, it's necessary to convert the effluent metal concentrations to dissolved and compare them with the dissolved metal criteria. The maximum expected effluent values (as total recoverable) are multiplied by the translator to convert to the maximum expected effluent concentration as dissolved.

The following equation is used to determine the concentration at the edge of a mixing zone:

$$((MEC*translator) + (MECB \times (DF - 1))) \div DF = CP$$

where:

MEC = *MAXIMUM EXPECTED CONCENTRATION (MEC) OF THE POLLUTANT IN THE EFFLUENT.*

MECB = *MAXIMUM EXPECTED BACKGROUND CONCENTRATION (MECB) AT TIME OF CRITICAL CONDITION.*

Metals must be in the dissolved form.

DF = *MIXING ZONE DILUTION FACTOR (DF)* (for either the chronic or acute zone, depending on the calculation).

CP = *CONCENTRATION OF THE POLLUTANT (CP) AT THE EDGE OF THE MIXING ZONE.*

If the resultant concentration at the edge of the mixing zone (CP) exceeds the water quality criterion (WQC), there is a reasonable potential (RP) and an effluent limit is imposed:

POLLUTANT	MEC	MECB	DF	CP	WQC	RP?
Copper	6926	3.43	9.6	688.5	13.0	YES
Lead	1863	.106	9.6	66.1	47.4	YES

The above example results in a determination of reasonable potential and effluent limits being required for copper and lead. TSDCALC (REASPOT.XLS) will perform this calculation

EXAMPLE FOR DETERMINING WHEN MORE DATA MAY BENEFIT A DISCHARGER

In some cases the predicted concentration at the edge of the mixing zone may be only slightly higher than the criteria and it appears that increasing the amount of effluent data may alter the result (because of a lower multiplier). Using an alternate and less conservative predictor of the 95th percentile effluent concentration will give the permit writer an indication if this is likely to occur. The value of 2.1 times the geometric mean is an alternate, less conservative, estimator of the 95th percentile value of the lognormal distribution. It assumes a CV of 0.6 (see appendix 6 for the basis of this estimator.

The example for reasonable potential is repeated below using the alternate estimator.

Facility Characteristics:(same as above)

STEPS TO MAKING REASONABLE POTENTIAL DETERMINATION:

1. CALCULATE BACKGROUND WATER QUALITY (same as above)

2. CALCULATE AMBIENT WATER QUALITY CRITERIA (WQC) (same as above)

3. CALCULATE MAXIMUM EXPECTED CONCENTRATION (MEC) BASED ON A MULTIPLIER OF 2.1 TIMES THE GEOMETRIC MEAN (GM):

USE OF MULTIPLIER VALUES AND HIGHEST EFFLUENT CONCENTRATION VALUES TO DERIVE MAXIMUM EXPECTED CONCENTRATION:

POLLUTANT	CV	ND	MULTIPLIER	HV OR GM	MEC
Copper	0.6	4	**2.6***	**2664**	**6926**
Copper	0.6	4	**2.1♦**	**1424**	**2990**
Lead	0.6	3	**3.0***	**621**	**1863**
Lead	0.6	3	**2.1♦**	**547**	**1149**

*From EPA (1991) Table 3-2
♦ From Gilbert (1987)

4. DETERMINING REASONABLE POTENTIAL TO EXCEED STANDARDS (same as above)

If the resultant concentration at the edge of the mixing zone (CP) exceeds the water quality criterion (WQC), there is a reasonable potential (RP):

POLLUTANT	MEC	MECB	DF	CP	WQC	RP?
Copper	6926	3.43	9.6	688.5	13.0	YES
Copper	2990	3.43	9.6	299.0	13.0	**YES**
Lead	1863	0.106	9.6	66.1	47.2	YES
Lead	1149	0.106	9.6	40.8	47.2	**NO**

In this case it appears that lead may, with more or better data, drop out of the reasonable potential determination. Copper is unlikely to drop out. In this case it may be better for the facility to direct it's efforts toward other options for removal or treatment or determining the water effects ratio.

3.3.13 EFFLUENT LIMITS

Derive effluent limits for those pollutants that are determined to have a reasonable potential (to violate the water quality standards). Effluent limits are also derived using the criteria as total recoverable. The process for deriving limits was described earlier and the calculations are available in spreadsheets. Figure VI-4 illustrates the process of compliance.

3.3.14 COMPLIANCE SCHEDULES

If the permittee can not immediately comply with the effluent limits the permit writer may allow a compliance schedule with interim limits. The interim limits and compliance schedule are placed in the permit. The interim limits may be based on existing performance and calculated by using PERFORMLIM in TSDCALC.XLW.

If the schedule for permit issuance schedule allows, the permit writer may request the permittee to do the following analysis on a voluntary basis as a part of the permit application.

The compliance schedule will direct the permittee to do ultra-clean sampling and analysis of effluent and receiving water. The guidance for ultra-clean sampling and analysis is available from EPA (1995). The receiving water sampling is necessary because historic data on metals is biased on the high side. For industrial dischargers and municipal dischargers that receive industrial wastewater, the compliance schedule should also require a determination of the source of the metals and opportunities for reduction.

The ultra-clean analysis of effluent and receiving water and any source reduction may result in lower concentrations of metals. If this results in a determination of no "reasonable potential", then the effluent limits and interim limits may be removed from the permit by permit modification. This will not violate the anti-backsliding provision of the Clean Water Act because this constitutes new information which if available at the time of permit issuance would have caused a different action (no limits).

3.3.15 SITE RATIO AND WATER EFFECTS RATIO

If the ultra-clean analysis and source examination still indicates the permittee cannot comply with the limits, the permittee may perform a site-specific water quality criteria adjustment factor. This can be done through establishing a site ratio of dissolved to total recoverable metal, or by establishing a site water effects ratio. A permittee who elects to do a site metals ratio study or a water effects study must submit a study plan for approval before conducting the study. The permit writer should check with Watershed Management Section before advising a discharger to conduct a metals ratio study. In some water bodies there may be no practical advantage in conducting the study.

The guidance for conducting a study to establish a site ratio or water effects ratio is also available as draft EPA guidance.

3.3.16 LARGER MIXING ZONES

If the permittee conducts the site ratio study or the water effects ratio study and the results show the permittee still cannot meet the final effluent limits then the permittee may request an exception to the mixing zone size as allowed and conditioned by WAC 173-201A-100(12) and (13). The guidance for the economic and ecological tests is currently being developed.
The permittee may also conduct a Use Attainability Analysis to demonstrate the classification for the waterbody is inappropriate. This option will require a set of studies to demonstrate the natural potential of the waterbody to support beneficial uses and the ability of the point and nonpoint source dischargers to control pollutants to those waters. It is unlikely that a single discharger would elect to conduct this type of analysis.

3.3.17 INTERIM INTERPRETATION OF WATER QUALITY STANDARDS FOR EXISTING MUNICIPAL DISCHARGES (less than 0.5 MGD) TO INTERMITTENT STREAMS

Section 1 of this chapter discussed how the current water quality standards classify waterbodies. The water quality standards are currently being revised to adopt a use-based classification system. In a use-based system, the numeric criteria will be specific for protection of the uses for a particular waterbody. In the interim, Ecology has decided to apply the use-based concept to small municipal dischargers to intermittent streams.

Intermittent lowland streams typically receive a Class A designation by default. The Class A designation includes numeric criteria to protect for benefical uses such as salmonid spawning and rearing. The beneficial uses which occur in intermittent streams were not directly assessed and incorporated into the development of the state's current numeric water quality criteria.

Facility managers should evaluate the impacts of a municipal effluent upon the characteristic uses of the intermittent and perennial portion of the stream. The impacts are compared to the beneficial effects of the effluent going to a stream reach that would otherwise be dry.

In order to protect characteristic uses associated with intermittent streams during flow and non-flow periods, and to provide small municipal dischargers with options for treatment and disposal, the facility manager should require the facility to evaluate the following alternatives treatment options.

1. A treatment/disposal system that meets all numeric criteria and characteristic uses for Class A streams. This may require removal of the discharge from the stream either seasonally or completely.

2. A treatment/disposal system that protects the characteristic uses in the intermittent stretch and both the numeric criteria and characteristic uses in the perennial stretch. This option requires the evaluation of treatment technology commonly available which exceeds secondary treatment and which produces the following effluent quality (as monthly averages):

BOD and TSS - 15 mg/l

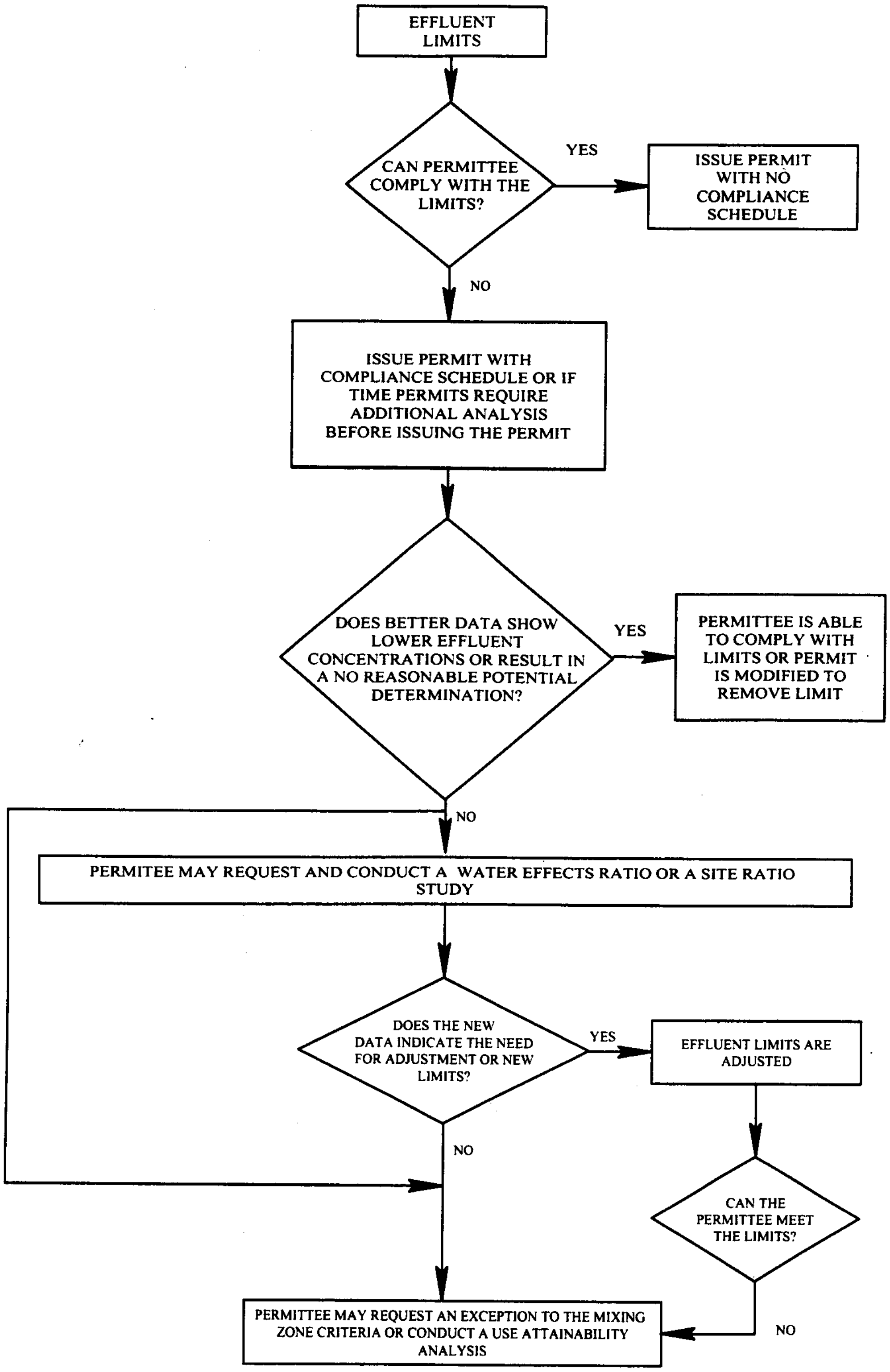
Total Ammonia - 1 mg/l

if costs for achieving 1 mg/l are disproportionate to costs for achieving BOD and TSS Ecology may allow total ammonia average of 2 mg/l.

If Chlorine is used for disinfection, dechlorination is required. The facility should evaluate other disinfection methods.

If treatment option 2 is chosen, the discharge should be modeled or instream sampling required of the facility to demonstrate that all numeric criteria are met at the point of perennial flow.

Figure VI-4. Compliance with water quality-based effluent limits.



4. EFFLUENT LIMITS BELOW QUANTITATION

Water quality-based effluent limits are often too low for laboratories to measure. This part outlines an approach to assess compliance with those effluent limits that are below the levels of quantitation. The approach is primarily for organic and metallic toxicants, but can be adapted for use with other chemicals. Chemical-specific concentration levels that can be used for compliance assessment are presented, as well as guidance on how to tailor those levels to fit regulatory concerns regarding the possible impacts of the discharge. Compliance levels are expected to change over time as analytical methods improve and as we gather more data on laboratory performance.

This section of the Permit Writer's Manual is only applicable to effluent limits at low concentrations. *In most cases, compliance with effluent limits can be measured without the use of low-level analytical techniques*. Dischargers occasionally have requested laboratories to provide low-level analyses of samples when the permit compliance level could have been more appropriately measured with a less sensitive technique at lower cost. In some of these cases the samples had concentrations too high to be measured with sensitive instruments. Although the discharger can request a laboratory to measure at any level, Ecology permits should only require specific quantitation levels when it is necessary to quantify at low levels. In other cases, the permit should require only a specific EPA Method.

4.1 Introduction

Effluent limits based on water quality standards are often at very low concentrations (in the range of parts per billion to parts per quadrillion). Laboratory analytical methods approved for use in the NPDES program are often not capable of measuring chemical concentrations at the concentrations of the permit limits. In many cases we are unable to determine if pollutants contained in discharges are at concentrations that merit concern, and when we set an effluent limit, we are often unable to determine if that limit is being exceeded. Until recently, most regulators and dischargers had used the method detection limit (MDL, as defined in 40 CFR Part 136, Appendix B) to determine compliance (all data at or above the MDL have been considered adequate for assessing compliance and supporting enforcement actions). The MDL, however, is the level above which a chemical's presence or absence can be detected, and provides limited information with regard to quantitation. The low concentrations of many of the aquatic life-based and human health-based standards has made the issue of quantitation important to both the regulator and the discharger.

4.2 Implementation - NPDES and State Permits

Three different situations will be common with permit limits for toxins:

1. *The daily maximum/monthly average effluent limit is greater than the quantitation level (QL), which is larger than the method detection level (MDL) (i.e., limit > QL > MDL).* In this case compliance with the permit limit can be assessed by a comparison to the QL. Any measure above the QL can be quantitatively compared to the permit limit.

2. *The effluent limit falls between the QL and the MDL (i.e., QL > limit > MDL).* In this case, compliance is evaluated by comparison with the QL. Measurements below the QL may be in compliance, and measurements in this range will not support enforcement of daily maximum limits. When calculating averages, all measures at or above the MDL should be used and all data below the MDL should be counted as zero.

3. *The effluent limit is less than the QL and the MDL (i.e., QL > MDL > limit).* In this case if the compliance measurement is below the QL, the sample may be in compliance, and is usually not enforced. When calculating averages, all measures at or above the MDL should be used and all data below the MDL should be counted as zero.

The choice of the method specified in the permit for compliance monitoring should be based on the effluent limit. For instance, with an arsenic effluent limit of 300 ug/L it would *not* be necessary to require a sensitive analytical method (e.g. AA/GH MDL = 2 µg/L, or, GFAA MDL = 1 µg/L; see Table IV-2), and the less sensitive ICP method (ICP MDL = 53 ug/L; see IV-2) could be used.

Precision and accuracy data are needed to both determine compliance and to support enforcement actions. Precision is monitored by analyzing duplicate samples or subsamples, and measures reproducibility of the measurement system. It may be expressed as a percent difference. The permit should specify that the Department's precision goal is +/- 20% (this is the precision goal of the Manchester Environmental Laboratory, and is a specification for work done under the EPA Contract Laboratory Program). During assessment of compliance with permit requirements, the permit manager should confer with staff in the Permit Development Services Section (Water Quality Program) or with the Manchester Environmental Laboratory or QA/QC sections of the E.I.L.S. Program.

Accuracy is specified in the methodology for each parameter and expressed as percent recovery. The discharger must ensure that the laboratory conducting their analyses is producing relatively accurate data, and that the method criteria should be met in all cases. This can be done by running check standards with their samples frequently enough to ensure that the methods are yielding accurate measurements. Permits should specify that check standards be analyzed at least once per day on any machine used for analysis. In order to better assess quantitation, it is critical that check standards be at concentrations that are at the QL, and that check standards are prepared independently from calibration standards. The check standard recovery data should be submitted with the DMR.

4.3 Background Information

Two types of quantitation levels are in common use. The first type is the Method Detection Limit times a numeric factor, which results in a quantitation level such as the Practical Quantitation Limit (PQL). The numeric factor functions as a safety factor in that it confers a greater degree of confidence in measured values. PQLs are used in Ecology's groundwater quality standards. The second type of quantitation level commonly used is the Contract Required Quantitation Levels (CRQLs) listed in the EPA Contract Laboratory Program (CLP). The CRQLs are a list used historically in EPA's groundwater and waste programs for laboratory contracts, and have been routinely used to measure concentrations at waste sites. The advantage of these levels is that numerous laboratories throughout the country provide the services, but the levels specified are not always based on the use of the most sensitive analytical test methods that EPA has approved for the NPDES permitting program. Both quantitation types have advantages in a regulatory program. Using the Method Detection Limit times a safety factor is straight forward and easy to understand, and is widely used in many regulatory programs throughout the country. The CLP values are also well known to the regulatory community, and are attainable for many labs. However, with each quantitation type, certain regulatory issues can increase or decrease the cost of the compliance monitoring program for dischargers and regulators.

4.4 Choosing a Quantitation Level

Using a quantitation level based on the method detection limit times a numeric factor can result in permit requirements for specific quantitation levels based on the use of the most sensitive methods that EPA or the state have approved. In many cases the most sensitive methods allowed are the only methods that provide a reasonable measure of compliance with low-concentration effluent limits. If those methods are not available from local labs but are required in permits, dischargers face the situation of being out of compliance with permit requirements. The issue of method availability can be addressed by allowing the discharger a time schedule to provide the required methods.

Effluent matrices can also affect the MDL of an analysis. If a discharger cannot provide a required Method Detection Limit or quantitation level because the matrix of their particular effluent causes interferences with the analysis, the discharger also could face non-compliance because of inability to provide a quantitation level required in a permit. This situation can be addressed by allowing the discharger to develop a matrix-specific quantitation level. If a discharger suspects that the quantitation level cannot be attained in its effluent because of matrix effects (e.g., high salinity), the discharger could run a laboratory spike of their sample matrix along-side an unspiked sample. If the recovery in the laboratory spike is poor, the discharger may need to develop an effluent specific MDL and quantitation level. Development of a matrix specific detection limit should only be allowed if the discharger can show that problems attaining the method detection limit are due to matrix effects and not to poor laboratory performance. Based on data from Wisconsin and communication with the State of New York, matrix effects are not a large problem.

The USEPA CRQLs were designed to address drinking water and waste issues. Because of this they are often not sensitive enough to determine compliance with many low concentration effluent limits. This is, in many cases, due to specification of methods that are less sensitive than many of the methods approved for use in the NPDES program. However, because the analytical methods for many organics result in quantitation levels that are variable on a chemical-by-chemical basis, it is not possible to use a constant factor to calculate a quantitation level for organics. Because of this, the CRQLs from the CLP (as modified in Table VI-2) are appropriate to use at this time for quantifying many measurements of organics. If measurements at lower concentrations are needed to assess compliance, the permit manager could review the approved methods and their detection levels in Table VI-3. If a more sensitive method exists, the permit manager should contact the organics chemist at the Manchester Environmental Laboratory to determine reasonable quantitation levels to put in the permit.

The organics methods used in the CLP are also appropriate for screening purposes, such as routine priority pollutant scans submitted as monitoring requirements or with permit applications. A "detect" on a priority pollutant scan can be used to support a reasonable potential determination when developing effluent limits.

Metals. Method detection limits have not been developed for metals. Instead, instrument detection limits (IDLs) are available for each method. Information from the states of California and Wisconsin indicate that the instrument detection limits can be met as method detection limits. Communication with some laboratories within the state of Washington indicate that instrument detection limits can be met as method detection limits for metals. This means that the steps in the method, such as digestion, etc. cause no additional interference in the analysis of the sample. Thus, it is recommended that the permit manager equate the instrument detection limit values with method detection limit values. The MDL (= IDL) times a numeric factor should be used as a quantitation level for assessing compliance with effluent limits for metals. Based on the calculation of the MDL in 40 CFR 136, a factor of four (MDL x 4 = quantitation level) results in a +/- 25% uncertainty (+/- 3 standard deviations at the 99% confidence level) that a measure is true. This approach should be used when setting quantitation levels for effluent limits. Using a "factor-driven" quantitation level to assess compliance with effluent limits is consistent with practices used in Ecology's regulation of groundwater.

The MDL (as defined in 40 CFR 136) and quantitation level (QL) can be calculated as follows:

Method Detection Level (MDL) set at 99% confidence level = 3.14 x (standard deviation of 7 replicate spiked samples in reagent water or a specific matrix) *

4 x MDL = Quantitation Level +/- 25% This equals a range of from 3 x MDL to 5 x MDL.

* 3.14 (the student's t value for n=7 at 99% confidence level) was rounded off to the nearest whole number as it was carried through the sequence of equations.

METALS ENFORCEMENT LEVELS

For metals, enforcement of daily maximum limits should be assessed at the 5 x MDL level (= QL; see Table VI-2) to provide maximum confidence in any assessment of non-compliance. For calculating average measures, all data above the MDL should be used. Data below the MDL should be reported as zero and used as zero in the calculation of average measures. This approach does not imply that laboratories can measure concentrations of zero, but instead is a regulatory strategy to address use of data below detection.

ORGANICS ENFORCEMENT LEVELS

Organics. For organics, the values from the EPA Contract Laboratory Program (as modified in Table VI-2) should be used as quantitation levels. If measurements at lower concentrations are needed to assess compliance, the permit manager should review the EPA approved methods and their detection levels in Table VI-3. If a more sensitive method exists, the permit manager should contact the organics chemist at the Manchester Environmental Laboratory to determine reasonable quantitation levels to put in the permit. For ease of permitting, the quantitation levels based on the CRQLs should also be abbreviated as QLs.

The specific quantitation levels recommended in this guidance will change over time. We are conferring with chemists who represent dischargers, consulting firms, and research organizations to more precisely identify quantitation levels for each constituent and each method. The quantitation levels recommended here should prove attainable by most dischargers, and protective of most surface waters. Those dischargers unable to attain the recommended QLs may be allowed to develop matrix specific quantitation levels or given time schedules to attain appropriate laboratory services.

COMPLIANCE SCHEDULES

Dischargers should be allowed time schedules in permits to provide required quantitation levels if local labs cannot provide them, and should be allowed to develop matrix specific quantitation levels if their effluent matrices cause analytical interference. In order to qualify for development of a matrix specific quantitation level, the discharger must show that it is matrix effects, and not lack of a laboratory's ability to perform a method, that is effecting the MDL. This demonstration can be made by providing laboratory performance data showing all information needed to calculate the needed MDL, as defined in 40 CFR 136. Measures below the QL *should not* be used for enforcement of daily maximum permit limits, all measures above the QL *should* be used to assess compliance with daily maximum permit limits. All sample measurements and supporting QA/QC data should be submitted to Ecology. **All data below the MDL should be counted as zero when averaging or calculating mass loading.**

The approach outlined above will (1) reduce the uncertainty dischargers are faced with if data below quantitation levels were used to assess compliance, (2) provide dischargers with schedules to provide laboratory services and the ability to determine matrix specific effects from their effluents, (3) promote high quality laboratory services in a reasonable time frame, (4) provide the agency with data reasonable to use in enforcement, and (5) provide receiving waters with protection by specifying the best approved methods for measuring compliance.

The quantitation levels recommended here for monitoring compliance with effluent limits were developed to make enforcement actions "sure": that is, the QLs provide a margin of safety with regard to certainty of measurements. Some measurements below the QL will be accurate, but will have greater uncertainty. The QLs here should not be applied to measurements of receiving waters. Receiving water measurements should undergo a greater degree of scrutiny, and perhaps use of alternative analytical and statistical techniques to pinpoint estimates of toxin concentrations.

4.5 Application to Substances Other than Toxics

The approach outlined above can be applied to constituents other than organic and metallic toxics, such as sulfides and residual chlorine. However, there is no "proven" list of quantitation levels for other chemicals. If detection and quantitation are at issue for these other chemicals, the permit manager should confer with the Permit Development Services Section and the Manchester Environmental Laboratory to determine the appropriate methods, the expected MDLs, and possible complications that could occur with the analysis.

This document is expected to change over time to reflect increasing knowledge. Calculation of matrix specific MDLs may cause the Department to adjust the currently specified QLs (Tables VI-2 and VI-3). In addition, development and approval of new analytical methods may cause the QL values to change.

Table VI-2. QUANTITATION LEVELS AND THEIR SOURCES

ORGANIC COMPOUNDS

	QL(μg/L)[1,2]	EPA METHOD
DIOXIN		
2,3,7,8-Tetrachloro-dibenzo-- p-dioxin (TCDD)[3]	.00001	1613
VOLATILE COMPOUNDS		
Acrolein[4]	50	624
Acrylonitrile[4]	50	624
Benzene[4]	10	624
Bis(Chloromethyl) Ether	10	624
Bromoform[5]	10	624
Carbon Tetrachloride[5]	10	624
Chlorobenzene[5]	50	624
Chlorodibromomethane[5]	10	624
Chloroethane[6]	10	624
2-Chloroethyl vinyl ether[4]	50	624
Chloroform[5]	10	624
Dichlorobromomethane[5]	10	624
Dichlorodifluromethane	10	624
1,1-Dichloroethane[5]	10	624
1,2-Dichloroethane[5]	10	624
Dichloroethylene[5]	10	624
1,2-Dichloropropane[5]	10	624
1,3-Dichloropropylene[5]	10	624
Ethylbenzene[5]	10	624
Bromomethane[6]	50	624
Chloromethane[6]	50	624
Methylene Chloride[5]	20	624

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Table VI-2. (cont.)

1,1,2,2-Tetrachloroethane[5]	10	624
Tetrachloroethylene[5]	10	624
Toluene[5]	10	624
1,2-trans-Dichloroethylene[5]	10	624
1,1,1-Trichloroethane[5]	10	624
1,1,2-Trichloroethane[5]	10	624
Trichloroethylene[5]	10	624
Trichlorofluoromethane	10	624
Vinyl Chloride[5]	10	624
ACID COMPOUNDS		
2-Chlorophenol[5]	10	625
2,4-Dichlorophenol[5]	10	625
2,4-Dimethylphenol[7]	10	625
2 methyl 4,6-dinitrophenol[8]	50	625
2,4-Dinitrophenol[5]	50	625
2-Nitrophenol[6]	20	625
4-Nitrophenol[5]	50	625
4 chloro-3-methylphenol[5]	10	625
Pentachlorophenol[5]	50	625
Phenol[5]	10	625
2,4,6-Trichlorophenol[5]	10	625
BASE/NEUTRAL COMPOUNDS		
Acenaphthene[5]	10	625
Acenaphthylene[5]	10	625
Anthracene[5]	10	625
Benzidine[4]	50	625
Benzo(a)anthracene[5]	10	625
Benzo(a)pyrene[5]	10	625
3,4-Benzofluoranthene[5]	10	625

Table VI-2. (cont.)

Benzo(ghi)perylene[6]	20	625
Benzo(k)fluoranthene[5]	10	625
Bis(2-chloroethoxy) methane[5]	10	625
Bis(2-chloroethyl) ether[5]	10	625
Bis(2-Chloroisopropyl) Ether		
Bis(2-Ethylhexyl) Phthalhalate[5]	10	625
4-Bromophenyl phenyl ether[5]	10	625
Butyl benzyl Phthalate[5]	10	625
2-Chloronapthalene[5]	10	625
4-Chlorophenyl phenyl ether[5]	10	625
Chrysene[5]	10	625
Dibenzo (a,h) anthracene[6]	20	625
1,2-Dichlorobenzene[5]	10	625
1,3-Dichlorobenzene[5]	10	625
1,4-Dichlorobenzene[5]	10	625
3,3'-Dichlorobenzidine[6]	50	625
Diethyl Phthalate[5]	10	625
Dimethyl Phthalate[5]	10	625
Di-n-Butyl Phthalate[5]	10	625
2,4-Dinitrotoluene[5]	10	625
Di-n-octyl Phthalate[5]	10	625
1,2-Diphenylhydrazine[4]	20	625
Fluoranthene[5]	10	625
Fluorene[5]	10	625
Hexachlorobenzene[5]	10	625
Hexachlorobutadiene[5]	10	625
Hexachlorocyclopentadiene[5]	10	625
Hexachloroethane[6]	20	625
Indeno (1,2,3-cd) pyrene[6]	20	625

Table VI-2. (cont.)

Isophorone[5]	10	625
Naphthalene[5]	10	625
Nitrobenzene[5]	10	625
N-nitrosodimethylamine[6]	50	625
N-nitrosodi-n-propylamine[6]	20	625
N-nitrosodiphenylamine[6]	20	625
Phenanthrene[5]	10	625
Pyrene[5]	10	625
1,2,4-Trichlorobenzene[5]	10	625
PESTICIDES[1]		
Aldrin[5]	.05	608
Alpha-BHC[5]	.05	608
Beta-BHC[5]	.05	608
Gamma-BHC (Lindane)[5]	.05	608
Delta-BHC[5]	.05	608
Chlordane[5]	.2	608
4,4'-DDT[5]	.1	608
4,4'-DDE (p,p-DDX)[5]	.1	608
4,4'-DDD (p,p-TDE)[5]	.1	608
Dieldrin[5]	.1	608
Alpha-endosulfan[5]	.1	608
Beta-endosulfan[5]	.1	608
Endosulfan sulfate[5]	.1	608
Endrin[5]	.1	608
Endrin aldehyde[5]	.1	608
Heptachlor[5]	.05	608
Heptachlor epoxide[5]	.05	608
(BHC-hexachlorocyclohexane)		
PCB-1242[5]	1.0	608
PCB-1254[5]	1.0	608
PCB-1221[5]	1.0	608
PCB-1232[5]	1.0	608

PCB-1248[5]	1.0	608
PCB-1260[5]	1.0	608
PCB-1016[5]	1.0	608
Toxaphene[5]	5.0	608

Notes:

[1] QL = Quantitation Level; in most cases the QL is taken directly from the EPA Contract Laboratory Program's Contract Required Quantitation Levels (CRQLs)

[2] Values for which no CRQL exist, or for which the Minimum Level is greater than the CRQL, were taken from *Region 6 Development of Minimum Quantification Levels, Region 6 EPA, 1991*

[3] QL = ML of 10, EPA Method 1624/1625

[4] QL based on ML from EPA method

[5] QL = CRQL

[6] QL = ML; ML is higher than CRQL

[7] QL = CRQL; no ML established in method

[8] QL = CRQL; CRQL is higher than ML

Table VI-3. Methods, detectors, method detection levels and instrument detection levels, and quantitation levels for methods approved by USEPA for use in the NPDES permit program. All data is in ug/L unless otherwise specified. Instrument detection levels are presented for metals, and method detection levels are presented for organics.

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL (Ftnt. 12)
METAL					
Antimony	204.1	FAA	200		1000
	204.2	GFAA	3		15
	200.7	ICP	32		160
Arsenic	206.3	AA/GH	2		10
	206.2	GFAA	1		5
	200.7	ICP	53		265
	206.4	Colorimetric	10		50
Beryllium	210.1	FAA	5		25
	210.2	GFAA	0.2		1
	200.7	ICP	0.3		1.5
	Ftnote 1	Colorimetric	5		25
	Ftnote 2	DCP	0.3		1.5
Cadmium	213.1	FAA	5		25
	213.2	GFAA	0.1		0.5
	200.7	ICP	4		20
	Ftnote 3	Colorimetric	20		100
	Ftnote 2	DCP	5		25
Chromium	218.1	FAA	50		250
	218.3	FAA/CE	1		5
	218.2	GFAA	1		5
	200.7	ICP	7		35
	Ftnote 4	Colorimetric	200		1000
	Ftnote 2	DCP	2		10
Chromium +6, Dissolved	218.4	FAA/CE	8		40
	Ftnote 4	Colorimetric	200		1000

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL (Ftnt. 12)
Copper	220.1	FAA	20		100
	220.2	GFAA	1		5
	200.7	ICP	6		30
	Ftnote 5	Colorimetric	10		50
	Ftnote 2	DCP	2		10
Lead	239.1	FAA	100		500
	239.2	GFAA	1		5
	200.7	ICP	42		210
	Ftnote 6	Colorimetric	3		15
	Ftnote 2	DCP	7		35
Mercury	245.1 or 245.2	Cold Vapor	0.2		1
Nickel	249.1	FAA	40		200
	249.2	GFAA	1		5
	200.7	ICP	15		75
	Ftnote 7	Colorimetric	2000		10000
	Ftnote 2	DCP	2		10
Selenium	270.3	FAA	2		10
	270.2	GFAA	2		10
	200.7	ICP	75		375
Silver	272.1	FAA	10		50
	272.2	GFAA	0.2		1
	200.7	ICP	7		35
	Ftnote 9	Colorimetric	2		10
	Ftnote 2	DCP	4		20
Thallium	279.1	FAA	100		400
	279.2	GFAA	1		4
	200.7	ICP	40		160
Zinc	289.1	FAA	5		25
	289.2	GFAA	0.05		0.25
	200.7	ICP	2		10

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL (Ftnt. 12)
	Ftnote 10	Dithizone	100		500
	Ftnote 11	Zincon	20		100
	Ftnote 2	DCP	6		30
Cyanide (total)	335.2	Titrimetric	20		
	335.3	Spectrophotom etric	200		
DIOXIN					
2,3,7,8-Tetrachloro-dibenzo-p-dioxin (TCDD)	1613	HRGC/HRMS		10 ppq	10 ppq
	613	GC/MS	0.002		
VOLATILE COMPOUNDS					
Acrolein	603	GC/FID	0.7		
	624/1624	GC/MS		50 = ML (Ftnote 13)	50
Acrylonitrile	603	GC/FID	0.5		
	624/1624	GC/MS		50 = ML	50
Benzene	602	GC/PID	0.2		
	624/1624	GC/MS	4.4		17.6
Bromoform	601	GC/HECD	0.2		
	624	GC/MS	4.7		
	1624	GC/MS		10 = ML	10
Carbon Tetrachloride	601	GC/HECD	0.12		
	624	GC/MS	2.8		
	1624	GC/MS		10 = ML	10
Chlorobenzene	601	GC/HECD	0.25		
	602	GC/PID	0.2		
	624	GC/MS	6		
	1624	GC/MS		10 = ML	10
Chlorodibromomethane	601	GC/HECD	0.09		
	624	GC/MS	3.1		
	1624	GC/MS			

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL (Ftnt. 12)
Chloroethane	601	GC/HECD	0.52		
	624	GC/MS			
	1624	GC/MS		50 = ML	50
2-Chloroethyl vinyl ether	601	GC/HECD	0.13		
	624	GC/MS			
	1624	GC/MS		10 = ML	10
Chloroform	601	GC/HECD	0.05		
	624	GC/MS	1.6		
	1624	GC/MS		10 = ML	10
Dichlorobromomethane	601	GC/HECD	0.1		
	624	GC/MS	2.2		
	1624	GC/MS		10 = ML	10
1,1-Dichloroethane	601	GC/HECD	0.07		
	624	GC/MS	4.7		
	1624	GC/MS		10 = ML	10
1,2-Dichloroethane	601	GC/HECD	0.03		
	624	GC/MS	2.8		
	1624	GC/MS		10 = ML	10
Dichloroethylene	601	GC/HECD	0.13		
	624	GC/MS	2.8		
	1624	GC/MS		10 = ML	10
1,2-Dichloropropane	601	GC/HECD	0.04		
	624	GC/MS	6		
	1624	GC/MS		10 = ML	10
1,3-Dichloropropene					
cis-1,3-Dichloropropene	601	GC/HECD	0.34		
	624	GC/MS	5		
	1624	GC/MS			
trans-1,3-Dichloropropene	601	GC/HECD	0.2		
	624	GC/MS			

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL (Ftnt. 12)
	1624	GC/MS		10 = ML	10
Ethylbenzene	602	GC/PID	0.2		
	624	GC/MS	7.2		
	1624	GC/MS		10 = ML	10
Bromomethane	601	GC/HECD	1.18		
	624	GC/MS			
	1624	GC/MS		50 = ML	50
Chloromethane	601	GC/HECD	0.08		
	624	GC/MS			
	1624	GC/MS		50 = ML	50
Methylene Chloride	601	GC/HECD	0.25		
	624	GC/MS	2.8		
	1624	GC/MS		10 = ML	10
1,1,2,2-Tetrachloroethane	601	GC/HECD	0.03		
	624	GC/MS	6.9		
	1624	GC/MS		10 = ML	10
Tetrachloroethylene	601	GC/HECD	0.03		
	624	GC/MS	4.1		
	1624	GC/MS		10 = ML	10
Toluene	602	GC/PID	0.2		
	624	GC/MS	6		
	1624	GC/MS		10 = ML	10
1,2-trans-Dichloroethylene	601	GC/HECD	0.1		
	624	GC/MS	1.6		
	1624	GC/MS		10 = ML	10
1,1,1-Trichloroethane	601	GC/HECD	0.03		
	624	GC/MS	3.8		
	1624	GC/MS		10 = ML	10
1,1,2-Trichloroethane	601	GC/HECD	0.02		
	624	GC/MS	5		

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL (Ftnt. 12)
	1624	GC/MS		10 = ML	10
Trichloroethylene	601	GC/HECD	0.12		
	624	GC/MS	1.9		
	1624	GC/MS		10 = ML	10
Vinyl Chloride	601	GC/HECD	0.18		
	624	GC/MS			
	1624	GC/MS		10 = ML	10
ACID COMPOUNDS					
2-Chlorophenol	604	GC/FID	0.31		
	604	GC/ECD	0.58		
	625	GC/MS	3.3		
	1625	GC/MS		10 = ML	10
2,4-Dichlorophenol	604	GC/FID	0.39		
	604	GC/ECD	0.68		
	625	GC/MS	2.7		
	1625	GC/MS		10 = ML	10
2,4-Dimethylphenol	604	GC/FID	0.32		
	604	GC/ECD	0.63		
	625	GC/MS	2.7		
	1625	GC/MS		10 = ML	10
2 methyl 4,6-dinitrophenol	604	GC/FID	16		
	625	GC/MS	24		
	1625	GC/MS		20 = ML	20
2,4-Dinitrophenol	604	GC/FID	13		
	625	GC/MS	42		
	1625	GC/MS		50 = ML	50
2-Nitrophenol	604	GC/FID	0.45		
	604	GC/ECD	0.77		
	625	GC/MS	3.6		
	1625	GC/MS		20 = ML	20

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL (Ftnt. 12)
4-Nitrophenol	604	GC/FID	2.8		
	604	GC/ECD	0.7		
	625	GC/MS	2.4		
	1625	GC/MS		50 = ML	50
4 chloro-3-methylphenol	604	GC/FID	0.36		
	604	GC/ECD	1.8		
	625	GC/MS	3		
	1625	GC/MS		10 = ML	10
Pentachlorophenol	604	GC/FID	7.4		
	604	GC/ECD	0.59		
	625	GC/MS	3.6		
	1625	GC/MS		50 = ML	50
Phenol	604	GC/FID	0.14		
	604	GC/ECD	2.2		
	625	GC/MS	1.5		
	1625	GC/MS		10 = ML	10
2,4,6-Trichlorophenol	604	GC/FID	0.64		
	604	GC/ECD	0.58		
	625	GC/MS	2.7		
	1625	GC/MS		10 = ML	10
BASE/NEUTRAL COMPOUNDS					
Acenaphthene	610	HPLC	1.8		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
Acenaphthylene	610	HPLC	2.3		
	625	GC/MS	3.5		
	1625	GC/MS		10 = ML	10
Anthracene	610	HPLC	0.66		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL (Ftnt. 12)
Benzidine	605	HPLC	0.08		
	625	GC/MS	50		
	1625	GC/MS		50 = ML	50
Benzo(a)anthracene	610	HPLC	0.013		
	625	GC/MS	7.8		
	1625	GC/MS		10 = ML	10
Benzo(a)pyrene	610	HPLC	0.023		
	625	GC/MS	2.5		
	1625	GC/MS		10 = ML	10
Benzo(ghi)perylene	610	HPLC	0.076		
	625	GC/MS	4.1		
	1625	GC/MS		20 = ML	20
Benzo(k)fluoranthene	610	HPLC	0.017		
	625	GC/MS	2.5		
	1625	GC/MS		10 = ML	10
Bis(2-chloroethoxy) methane	611	GC	0.5		
	625	GC/MS	5.3		
	1625	GC/MS		10 = ML	10
Bis(2-chloroethyl) ether	611	GC	0.3		
	625	GC/MS	5.7		
	1625	GC/MS		10 = ML	10
Bis(2-Ethylhexyl) Phthalate	611	GC	2		
	625	GC/MS	2.5		
	1625	GC/MS		10 = ML	10
4-Bromophenyl phenyl ether	611	GC/HECD	2.3		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
Butyl benzyl Phthalate	606	GC/ECD	0.34		
	625	GC/MS	2.5		
	1625	GC/MS		10 = ML	10

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL (Ftnt. 12)
2-Chloronapthalene	612	GC/ECD	0.94		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
4-Chlorophenyl phenyl ether	611	GC/HECD	3.9		
	625	GC/MS	4.2		
	1625	GC/MS		10 = ML	10
Chrysene	610	HPLC	0.15		
	625	GC/MS	2.5		
	1625	GC/MS		10 = ML	10
Dibenzo (a,h) anthracene	610	HPLC	0.03		
	625	GC/MS	2.5		
	1625	GC/MS		20 = ML	20
1,2-Dichlorobenzene	601	GC/HECD	0.15		
	602	GC/PID	0.4		
	612	GC/ECD	1.14		4.56
	624	GC/MS			
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
1,3-Dichlorobenzene	601	GC/HECD	0.32		
	602	GC/PID	0.4		
	612	GC/ECD	1.19		
	624	GC/MS			
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
1,4-Dichlorobenzene	601	GC/HECD	0.24		
	602	GC/PID	0.3		
	612	GC/ECD	1.34		
	624	GC/MS			
	625	GC/MS	4.4		
	1625	GC/MS		10 = ML	10

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL (Ftnt. 12)
3,3'-Dichlorobenzidine	605	HPLC	0.13		
	625	GC/MS	16.5		
	1625	GC/MS		50 = ML	10
Diethyl Phthalate	606	GC/ECD	0.49		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
Dimethyl Phthalate	606	GC/ECD	0.29		
	625	GC/MS	1.6		
	1625	GC/MS		10 = ML	10
Di-n-Butyl Phthalate	606	GC/ECD	0.36		
	625	GC/MS			
	1625	GC/MS		10 = ML	10
2,4-Dinitrotoluene	609	GC/ECD	0.02		
	625	GC/MS	5.7		
	1625	GC/MS		10 = ML	10
Di-n-octyl Phthalate	606	GC/ECD	3		
	625	GC/MS	2.5		
	1625	GC/MS		10 = ML	10
1,2-Diphenylhydrazine	1625	GC/MS		20 = ML	20
	(This method not specified as approved in 40 CFR Part 136, but ML. provided in Method 1625)				
Fluoranthene	610	HPLC	0.21		
	625	GC/MS	2.2		
	1625	GC/MS		10 = ML	10
Fluorene	610	HPLC	0.21		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
Hexachlorobenzene	612	GC/ECD	0.5		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
Hexachlorobutadiene	612	GC/ECD	0.34		

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL (Ftnt. 12)
	625	GC/MS	0.9		
	1625	GC/MS		10 = ML	10
Hexachlorocyclopentadiene	612	GC/ECD	0.4		
	625	GC/MS			
	1625	GC/MS		10 = ML	10
Hexachloroethane	612	GC/ECD	0.03		
	625	GC/MS	1.6		
	1625	GC/MS		10 = ML	10
Indeno (1,2,3-cd) pyrene	610	HPLC	0.043		
	625	GC/MS	3.7		
	1625	GC/MS		20 = ML	20
Isophorone	609	GC/FID	5.7		
	609	GC/ECP	15.7		
	625	GC/MS	2.2		
	1625	GC/MS		10 = ML	10
Naphthalene	610	HPLC	1.8		
	625	GC/MS	1.6		
	1625	GC/MS		10 = ML	10
Nitrobenzene	609	GC/FID	3.6		
	609	GC/ECD	13.7		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
N-nitrosodimethylamine	607	GC/NPD	0.15		
	625	GC/MS			
	1625	GC/MS		50 = ML	50
N-nitrosodi-n-propylamine	607	GC/NPD	0.46		
	625	GC/MS			
	1625	GC/MS		20 = ML	20
N-nitrosodiphenylamine	607	GC/NPD	0.81		
	625	GC/MS	1.9		

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL (Ftnt. 12)
	1625	GC/MS		20 = ML	20
Phenanthrene	610	HPLC	0.64		
	625	GC/MS	5.4		
	1625	GC/MS		10 = ML	10
Pyrene	610	HPLC	0.27		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
1,2,4-Trichlorobenzene	612	GC/ECD	0.05		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
PESTICIDES					
Aldrin	608	GC/ECD	0.004		
	625	GC/MS	1.9		
Alpha-BHC	608	GC/ECD	0.003		
	625	GC/MS			
Beta-BHC	608	GC/ECD	0.006		
	625	GC/MS	4.2		
Gamma-BHC (Lindane)	608	GC/ECD	0.004		
	625	GC/MS			
Delta-BHC	608	GC/ECD	0.009		
	625	GC/MS	3.1		
Chlordane	608	GC/ECD	0.014		
	625	GC/MS			
4,4'-DDT	608	GC/ECD	0.012		
	625	GC/MS	4.7		
4,4'-DDE (p,p-DDX)	608	GC/ECD			
	625	GC/MS	0.004		
			5.6		
4,4'-DDD (p,p-TDE)	608	GC/ECD	0.011		
	625	GC/MS	2.8		

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL (Ftnt. 12)
Dieldrin	608	GC/ECD	0.002		
	625	GC/MS	2.5		
Alpha-endosulfan	608	GC/ECD	0.014		
	625	GC/MS			
Beta-endosulfan	608	GC/ECD	0.004		
	625	GC/MS			
Endosulfan sulfate	608	GC/ECD	0.066		
	625	GC/MS	5.6		
Endrin	608	GC/ECD	0.006		
	625	GC/MS			
Endrin aldehyde	608	GC/ECD	0.023		
	625	GC/MS			
Heptachlor	608	GC/ECD	0.003		
	625	GC/MS	1.9		
Heptachlor epoxide	608	GC/ECD	0.083		
(BHC-hexachlorocyclo-	625	GC/MS	2.2		
'hexane)					
PCB-1242	608	GC/ECD	0.065		
	625	GC/MS			
PCB-1254	608	GC/ECD		1.0 = USEPA CLP CRDL	1
	625	GC/MS			
PCB-1221	608	GC/ECD		1.0 = USEPA CLP CRDL	1
	625	GC/MS	30		120
PCB-1232	608	GC/ECD		1.0 = USEPA CLP CRDL	1
	625	GC/MS			
PCB-1248	608	GC/ECD		1.0 = USEPA CLP CRDL	1
	625	GC/MS			
PCB-1260	608	GC/ECD		1.0 = USEPA	1

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL (Ftnt. 12)
				CLP CRDL	
	625	GC/MS			
PCB-1016	608	GC/ECD		1.0 = USEPA CLP CRDL	1
	625	GC/MS			
Toxaphene	608	GC/ECD	0.24		
	625	GC/MS			

Footnotes:

1. Method 309.B, Standard Methods for the Examination of Water and Wastewater, 16th Edition
2. Direct Current Plasma (DCP) Optical Emission Spectrometric Method for Trace Elemental Analysis of Water and Wastes, Method AES0029." 1986, Applied Research Laboratories Inc., 24911 Avenue Stanford, Valencia, CA 91355.
3. Method 310.B, Standard Methods for the Examination of Water and Wastewater, 16th Edition
4. Method 312.B, Standard Methods for the Examination of Water and Wastewater, 16th Edition
5. Method 313.B, Standard Methods for the Examination of Water and Wastewater, 16th Edition
6. Method 316.B, Standard Methods for the Examination of Water and Wastewater, 16th Edition
7. Method 321.B, Standard Methods for the Examination of Water and Wastewater, 16th Edition
8. Methods 323B or 323.C, Standard Methods for the Examination of Water and Wastewater, 16th Edition
9. Method 319.B, Standard Methods for the Examination of Water and Wastewater, 14th Edition
10. Method 328.C, Standard Methods for the Examination of Water and Wastewater, 16th Edition
11. Zinc, Zincon Method, Method 8009, Hach Handbook of Water Analysis, 1979, pages 2-231 and 2-333, Hach Chemical Company, Loveland, CO 80537.
12. Quantitation Levels. When published quantitation levels or performance levels are available those levels are used directly as QLs. Otherwise, QLs are equal to five times the MDL for metals.

    Quantitation Levels for organics (for methods other than presented in Table IV-2) should be developed in consultation with the organics chemist at the Manchester Environmental Laboratory and the Program Development and Support Unit.
13. Minimum Level. Defined by EPA (40 CFR Part 136,App. A, Meth. 1624, 1625) as "the minimum level at which the entire GC/MS system must give recognizable mass spectra (background corrected) and acceptable calibration points."

HRGC	High Resolution Gas Chromatography
HRMS	High Resolution Mass Spectrometry
GC	Gas Chromatography
MS	Mass Spectrometry
GC/FID	Gas Chromatography/Flame Ionization Detector
GC/PID	Gas Chromatography/Photoionization Detector
GC/HECD	Gas Chromatography/Electron Capture Detector (halogenated organics)
GC/ECD	Gas Chromatography/Electron Capture Detector
HPLC	High Performance Liquid Chromatography
GC/NPD	Gas Chromatography/Nitrogen-Phosphorus Detector

5. WHOLE EFFLUENT TOXICITY (WET)

5.1 Permit Writer's Task Summary

This subsection is a brief summary of how permit writers implement Chapter 173-205 WAC, Whole Effluent Toxicity Testing and Limits for different permitting situations. The following subsections of 5.2 through 5.16 describe the rule and implementation processes in more detail.

Existing Permits Containing WET Monitoring Derived Before the Rule was Effective

Permit managers should:

- Review existing permits containing WET monitoring to make sure the testing meets all the requirements for effluent characterization under the rule (see subsections 5.6, 5.12, and 5.15.3) so the permittee doesn't have to repeat effluent testing unnecessarily. Change of species or updating test procedures is a minor modification of the permit if test frequency does not decrease. Permit writers should check with the Permit Management (PM) Section about characterization requirements if they are uncertain of the requirements under the rule.

New Permits Without Prior Characterization

Permit managers should:

- Evaluate the discharge for need for effluent characterization (see subsection 5.5)

- Decide on species to require in the permit (see subsection 5.12).

- Decide on the monitoring frequency (see Chapter XIII, Section 4)
- Decide on the use of rapid screening tests (see subsection 5.10).
- Use model language in the permit.
- Contact the PM Section for assistance with non-compliance or reviewing a TI/RE plan.

Permit Renewals with Previous Characterization According to the Rule

Permit managers should:

- Contact the PM Section for the WET data record (see subsection 5.15)
- Decide if additional characterization is required (see subsection 5.5)
- Decide if a permittee with a WET limit no longer needs that limit (see subsection 5.8)

5.2 Introduction

Chapter 173-205 WAC, Whole Effluent Toxicity Testing and Limits (the WET rule), became effective November 6, 1993. The goal of the WET rule is the eventual elimination of the discharge of toxics in toxic amounts. The WET rule establishes a procedure for deriving whole effluent toxicity limits in accordance with RCW 90.48.520, 40 CFR 122.44(d), and 40 CFR 122.44(e) for inclusion into NPDES permits. The rule implements the requirement for all known, available, and reasonable methods of prevention, control, and treatment of toxicants and assures the attainment of state water quality standards.

This guidance explains WET requirements and helps readers locate WET rule sections pertinent to each issue. It will be helpful to refer to the text of the WET rule while using this Section of the *Permit Writer's Manual.* The WET rule contains the authoritative language on the WET requirements and should be consulted directly in order to make correct decisions. This guidance directs the reader to the section of the WET rule applicable to each subject discussed below.

The determination of WET testing frequency is in Chapter XIII. Monitoring Guidelines. The WET rule has not changed the ranking system or the monitoring frequencies from the previous version of the *Permit Writer's Manual.*

The WET rule has also not changed the requirement in 40 CFR 122.21(j) that POTWs with design influent flows greater than or equal to 1 mgd and POTWs required to develop pretreatment programs must submit WET test results with each permit application. The WET rule has a similar requirement to this federal rule. All permittees required by the WET rule to do WET testing must submit WET test results with each permit application unless they are monitoring for compliance with WET limits or are conducting rapid screening testing (WAC 173-205-030(8)). (See Subsections 5.6 and 5.9 below for discussions of compliance monitoring or rapid screening testing.)

The conceptual process of incorporating WET into NPDES permits is shown in Figure VI-4 and discussed in the following text. The stepwise process is shown in Figure VI-5.

1. The process of implementing WET begins with an NPDES permit application. The application can be for a new NPDES permit or for renewal of an existing permit. Only NPDES permits are covered by the WET rule.

2. Section 173-205-040 of the WET rule contains a list of circumstances under which a discharge is required to be characterized for WET. These circumstances define discharges with a risk for aquatic toxicity. Permits for discharges which fit any of these circumstances will contain requirements for WET characterization. Permits for discharges which do not fit any of the circumstances will not require WET testing.

3. WET testing usually begins with an effluent characterization in the first year of the permit term. Effluent characterization establishes the baseline toxicity level and determines the need for WET limits. Every sample during effluent characterization will be tested with all of the WET tests listed in the permit (multiple species testing).

4. The permit will require that the permittee determines at the end of effluent characterization whether the WET performance standards have been met for acute and chronic toxicity. The performance standard for acute toxicity is a median of at least 80% survival in 100% effluent with no single test showing less than 65% survival in 100% effluent. The performance standard for chronic toxicity is no toxicity in a concentration of effluent representing the edge of the acute mixing zone. Permittees meeting performance standards will not get WET limits or compliance monitoring (will go straight to 7 on the diagram).

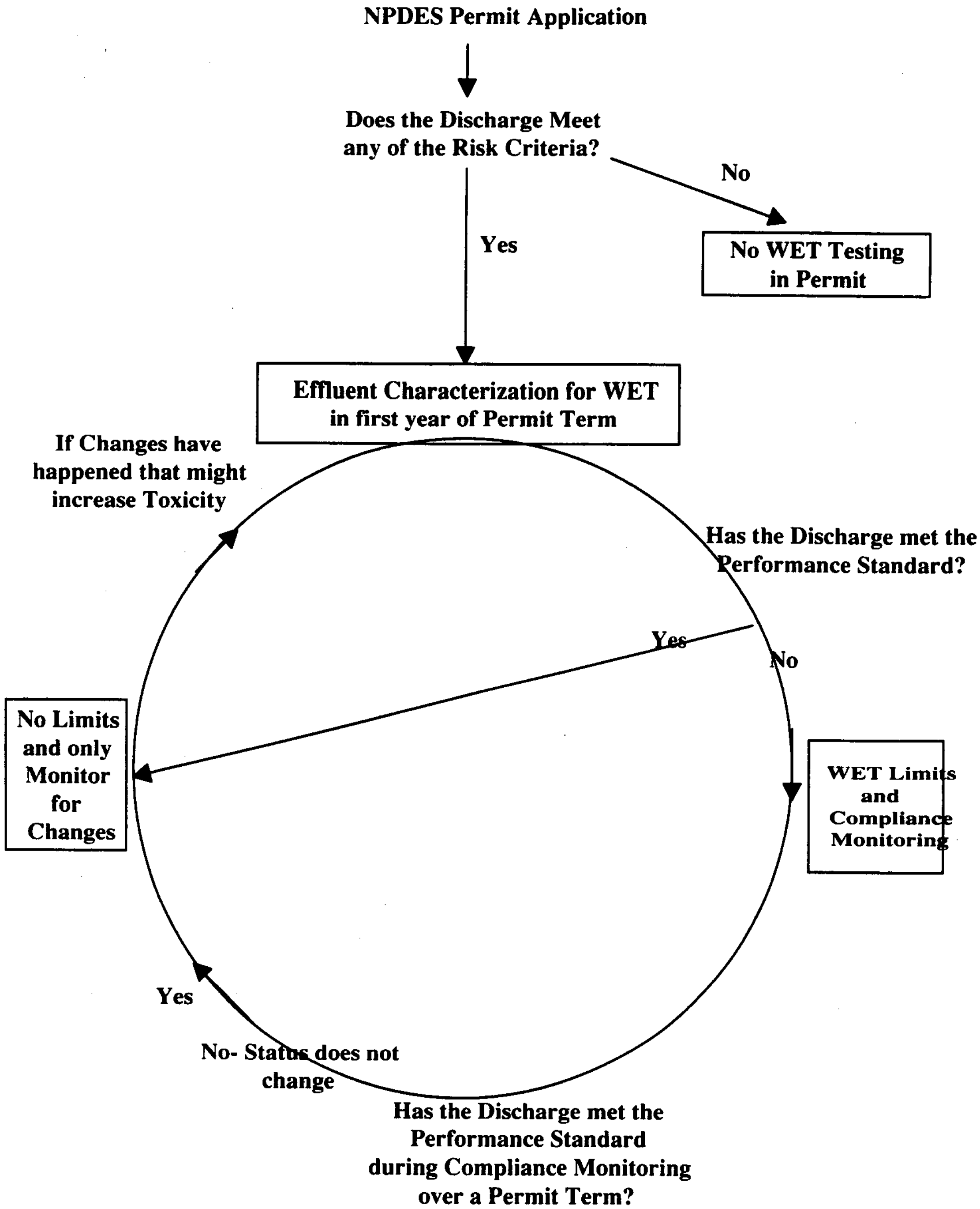
5. Those permittees not meeting a performance standard during effluent characterization will receive WET limits. WET limits are the same as other permit limits. The permit will require monitoring to determine compliance with the WET limit. Failing to comply with a WET limit will trigger additional WET testing and possibly other enforcement actions.

6. The effluent characterization is not the only time for a permittee to demonstrate that WET limits are not needed. The WET rule does not intend that WET limits are permanent. If a permittee with a WET limit meets the performance standard for a permit term, then the WET limit will not be placed into subsequent permits. By attaining a higher level of toxicity control necessary to meet the performance standard, the permittee has allowed the WET limit and compliance monitoring to be removed from the permit. The permittee's cost and liability are lower.

7. Permittees who have attained the performance standards can remain indefinitely without WET limits or compliance monitoring. The only WET testing requirement will be WET test results submitted with each permit application or rapid screening testing during the permit term.

8. If changes have occurred which might increase toxicity, then the next permit will contain a requirement for a new effluent characterization. The new effluent characterization will start the process over again at STEP 3. WET limits could result from a new effluent characterization or the permittee could go back to STEP 7 with no WET limits.

Figure VI-5. The conceptual process of implementing WET.



The flowchart on the following page also presents the permit requirements for WET. The flowchart is linear rather than circular and contains more detail. Figure VI-6 illustrates the compliance process for WET.

5.3 The Purpose of Whole Effluent Toxicity Testing

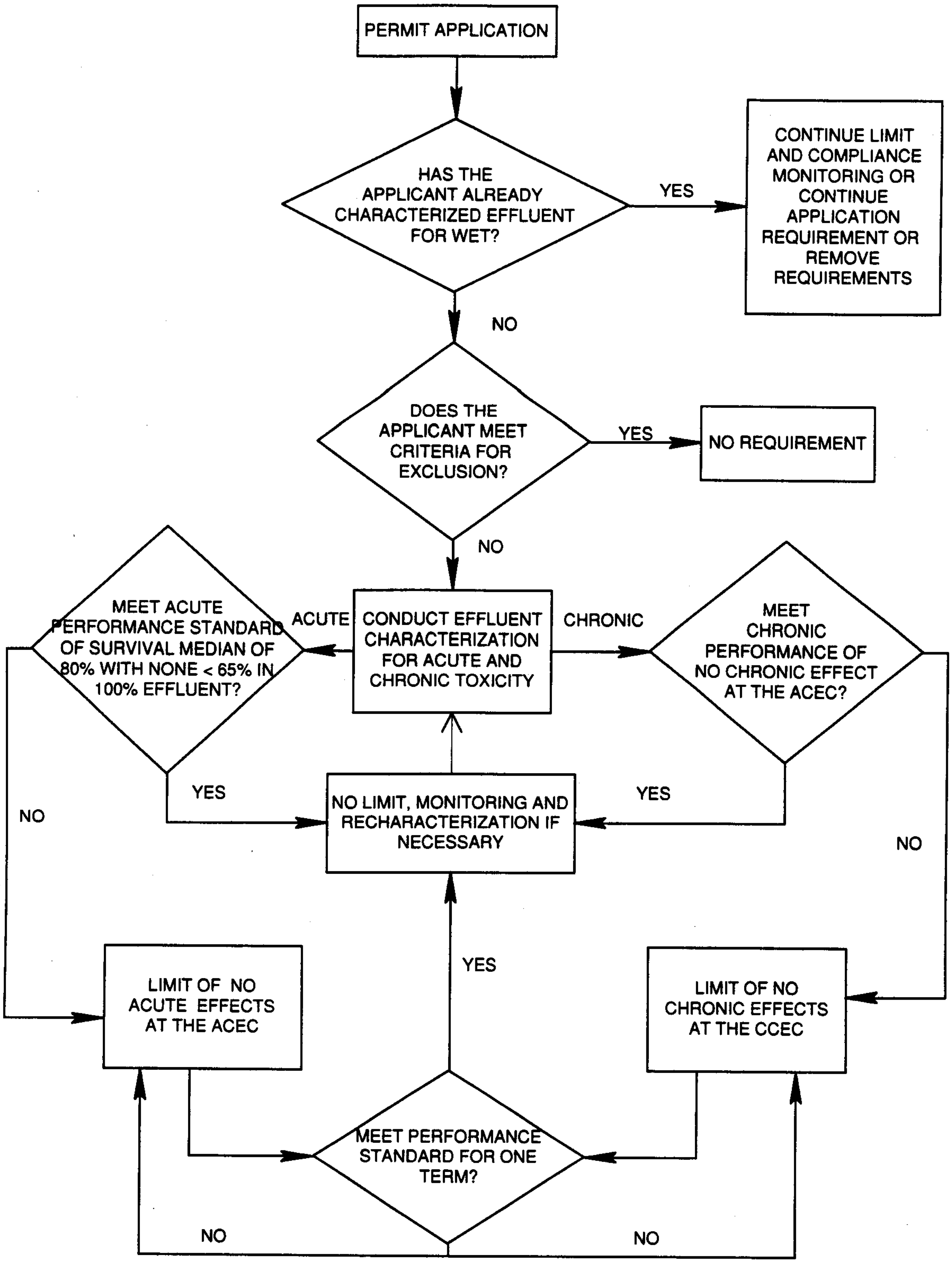
Whole effluent toxicity is the total toxicity of an effluent measured directly with a toxicity test. WET testing is necessary because EPA cannot develop water quality criteria for every one of the thousands of possible toxic pollutants in wastewater discharges. WET testing is also the only method available to permit managers for assessing the toxic interaction of pollutants in wastewater. WET testing is used in NPDES permits for the following purposes:

- *To assess and limit WET to levels allowable under the state Water Quality Standards.* The state's water quality standards prohibit ambient toxicity (WAC 173-201A-040(1), WAC 173-201A-030). The water quality standards also establish the point of compliance; there is no ambient toxicity allowed past the edge of an approved mixing zone (WAC 173-201A-100). The main purpose of Chapter 173-205 WAC is to characterize effluents for WET in order to establish whether a reasonable potential exists to violate this prohibition against ambient toxicity. If a reasonable potential exists, a permit limit is required on WET (WAC 173-205-050(2)(a)). The WET rule also describes how to monitor for WET limits based on the prohibition against ambient toxicity outside of approved mixing zones (WAC 173-205-070(1) and (2)).

- *To serve as a broad spectrum indicator of increases in effluent toxicity.* Analyzing effluents for every possible toxic chemical which might increase unexpectedly would be too expensive. The expense of conducting a large number of chemical analyses is magnified by the high monitoring frequency necessary to be able to react in a reasonable length of time to stop a toxic discharge. A rapid screening test can be an indicator of a large number of toxic chemicals without the expense of analyzing for them individually. Rapid screening tests are relatively quick and cheap so that monitoring frequencies can be set high enough to detect increases in WET within a reasonable length of time (WAC 173-205-030(5) and WAC 173-205-120(2)).

- *To assess and limit WET on a technology basis.* Technology-based limits on acute WET may be placed into permits on a case-by-case basis (WAC 173-205-130). These technology-based acute limits are not required to be put into permits, and a technology-based acute limit will only be placed into a permit as a last resort when a permittee has ignored the offer to remove the water quality-based acute WET limit as an incentive to eliminate acute WET. WAC 173-205-130 does not provide for technology-based WET limits for categories of dischargers or for chronic WET.

Figure VI-6. Wet requirements for permits



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5.4 The Purpose of Effluent Characterization

Effluent characterization is used to establish whether a reasonable potential exists pursuant to 40 CFR 122.44(d)(1)(v) which would require a WET limit. Acute and chronic WET are evaluated separately for a reasonable potential to violate the water quality standards. Permittees who cannot meet the WET performance standards have demonstrated a reasonable potential for ambient toxicity and need WET limits (WAC 173-205-020 and in WAC 173-205-050(2)(a)). Effluent characterization is also used to establish a baseline toxicity level (WAC 173-205-050(2)(b)). The effluent characterization process lasts for one year (WAC 173-205-020 and WAC 173-205-050(1)). During the year of effluent characterization, each effluent sample is tested with all WET test species listed in the permit. This multiple species testing provides an assessment of effluent toxicity in order to provide protection to as many different types of receiving water organisms as possible. See Subsection 5.12 for guidance on WET test species selection.

5.5 Determining the Need for Effluent Characterization

Effluent characterizations for WET are required when:

- A discharge has never before been characterized for WET and has one or more of the risk factors in WAC 173-205-040(1). These factors include the presence of hazardous substances (Table VI-4) at the facility which could be released to the wastewater system, the presence of toxic pollutants in the effluent for which there are no water quality criteria, or toxicity detected in the past by WET testing.

- A discharge that has been characterized for WET subsequently experiences changes in process or discharge characteristics (WAC 173-205-060(1) or (3)).

- A new WET test has been approved pursuant to WAC 173-205-050(1)(d) that would measure effluent toxicity better than the WET tests used in the original effluent characterization. The discharge will then be characterized using only the new WET test (WAC 173-205-060(5) and (6)).

Effluent characterizations for WET are not required when:

- The discharge has none of the risk factors in WAC 173-205-040(1) and is excluded by WAC 173-205-040(2).

- The discharge has none of the risk factors in WAC 173-205-040(1) and the permit manager has made a determination the effluent doesn't have the potential to have toxic substances in toxic amounts (WAC 173-205-040(2)(h)).

- The effluent receives at least 1000:1 dilution at the edge of an approved mixing zone (chronic only) (WAC 173-205-040(3)).

- The permittee is monitoring for compliance with a WET limit using species rotation, additional characterizations for WET are not required (WAC 173-205-060(4)).

No additional effluent characterization is required for a discharge that has experienced a change if the permittee has made a demonstration that the change has not increased toxicity (WAC 173-205-060(2)).

Other effluent characterization requirements:

- Characterization for WET may be delayed for existing facilities that are under a compliance schedule to implement technology-based controls or to achieve compliance with water quality-based effluent limits (WAC 173-205-030(4)).

- Effluent characterizations conducted in a previous permit (i.e. before the WET rule) need not be repeated as long as the information is adequate to make all determinations in WAC 173-205-050(2) (WAC 173-205-030(5)(b)). Remember that WAC 173-205-060 would require an additional effluent characterization if changes have occurred since the first characterization. The determinations in WAC 173-205-050(2)(a) can be made as long as the results of the effluent characterization include the percent survival in 100% effluent for every acute test and the NOEC for every chronic test. WAC 173-205-050(2)(b) also requires that an effluent characterization generate point estimates (LC_{50}, EC_{50}, etc.) to use in establishing a baseline toxicity level, but this requirement is flexible. WET tests conducted for effluent characterization in previous permits must be from EPA manuals (WAC 173-205-050(1)(d)). Consult with the Permit Development Services Section if any non-EPA test was used.

  Previous permits did not require that permittees submit information for determining compliance with the power standards defined in WAC 173-205-020 and did not require that WET tests be repeated when they didn't meet the power standards. The best strategy for a permit manager when a permittee may have avoided a chronic WET limit because effluent characterization tests did not meet the chronic statistical power standard is to increase the amount of chronic WET tests that are required to be submitted with the permit application (WAC 173-205-030(8)) or to require chronic rapid screening tests in accordance with WAC 173-205-030(5) or WAC 173-205-120(2). Subsection 5.6 describes the power standards in detail.

- Effluent characterization may include WET tests conducted on ambient water collected downstream of the discharge or using ambient water collected upstream of the discharge as dilution water (WAC 173-205-030(6)). Permit managers should exercise caution in requiring the use of ambient water in WET testing and should consult with the Permit Development Services Section and EILS prior to doing so.

5.6 Determining Compliance with WET Limits

SPECIES ROTATION. Because changes in an effluent can change the relative sensitivity of the WET test species listed in the permit, species will be rotated during compliance monitoring. The rotation schedule need not have an equal testing frequency for all of the species. If one species was clearly the most sensitive during effluent characterization, then the rotation schedule should use the most sensitive species for all monitoring except for one test a year with the other species. The model permit language allows Ecology to notify a permittee of the rotation schedule. If the rotation schedule is not specified by Ecology, then the permit language directs the permittee to test the species in the order listed in the permit.

ACUTE WET LIMITS. Compliance with an acute WET limit requires a demonstration of no acute toxicity in a concentration of effluent equal to the acute critical effluent concentration (ACEC)(WAC 173-205-070(1)). The ACEC is defined as the maximum concentration of effluent during critical conditions at the boundary of the zone of acute criteria exceedance (WAC 173-205-020). A demonstration of no acute toxicity at the ACEC means that there is no ambient acute toxicity outside of the zone of acute criteria exceedance.

CHRONIC WET LIMITS. Compliance with a chronic WET limit requires a demonstration of no chronic toxicity in a concentration of effluent equal to the chronic critical effluent concentration (CCEC) (WAC 173-205-070(2)). The CCEC is defined as the maximum concentration of effluent during critical conditions at the boundary of the mixing zone (WAC 173-205-020). A demonstration of no chronic toxicity at the CCEC means that there is no ambient chronic toxicity outside of the mixing zone.

STATISTICALLY SIGNIFICANT DIFFERENCES IN RESPONSE. The scientifically correct way to make a demonstration of no toxicity is to demonstrate that the ACEC or the CCEC in a WET test has no statistically significant difference in organism response from the control. The control is laboratory water that is known to be nontoxic to test organisms. If there is a statistically significant difference in response between the ACEC or CCEC and the control, then toxicity has been demonstrated. If there is no statistically significant difference in response, then it can be assumed that there is no toxicity at the ACEC or CCEC and that the permittee has complied with the performance standard or the WET limit.

HYPOTHESIS TESTING. Statistical significance means that the difference in response between a control and the ACEC or CCEC is likely to be due to toxicity and not to test variability. The statistical technique for making this determination is a hypothesis test. A hypothesis test is the mathematical technique for comparing the average response of the replicates of the ACEC or CCEC to the average response of the control replicates at the end of a WET test in order to determine if there is a statistically significant difference in response within a level of confidence such as 95% that the difference is due to toxicity and not variability.

FALSE POSITIVE TEST RESULTS. When a statistically significant difference in response is due to test variability and not to toxicity, the WET test has produced a false positive result. However, a confidence level of 95% does not mean that 1 in 20 (5%) of failed WET tests is a false positive. The confidence level only approximates the worst case false positive rate which exists when the two values being compared are relatively close together. The further apart these values are, the less likely are false positive results. In other words, if all of the organisms in the ACEC die and none die in the control, the probability that the statistically significant difference in response is a false positive is closer to 0 in 20 than 1 in 20. The overall false positive rate is less than 1 in 20 and is almost always less than the overall false negative rate. To prevent most false positive test results, the model permit language raises the confidence level to 99% when the differences in response are small.

DEFINITION OF INVALID TESTS AND ANOMALOUS TEST RESULTS. Invalid WET tests occur when the lab does not follow the test method or when the results do not meet the validation criteria in the test method. Permittees are obligated to assure that all tests are valid because the permit requires that only the results of valid tests be submitted. The Permit Development Services Section reviews WET test results to see that they are based on valid tests.

Anomalous test results happen when the lab appears to have conducted the WET test in accordance with the test method, but the results are unreliable according to review criteria. There is no requirement for permittees to attempt to identify anomalous WET test results. All valid WET test results must be submitted whether anomalous or not. See Subsection 5.11 for a discussion of permittee identification of anomalous test results.

The Permit Development Services Section will be reviewing WET test results and screening out anomalous test results. Anomalous test results will not be used for compliance determinations (WAC 173-205-070(5)(c)). Most anomalous test results will be identified by the lack of a good concentration-response relationship. In most cases if the toxic response does not increase with increases in the concentration of effluent, then the test is considered to be anomalous. Permittees will usually be required to take another sample and repeat the WET test when results are anomalous.

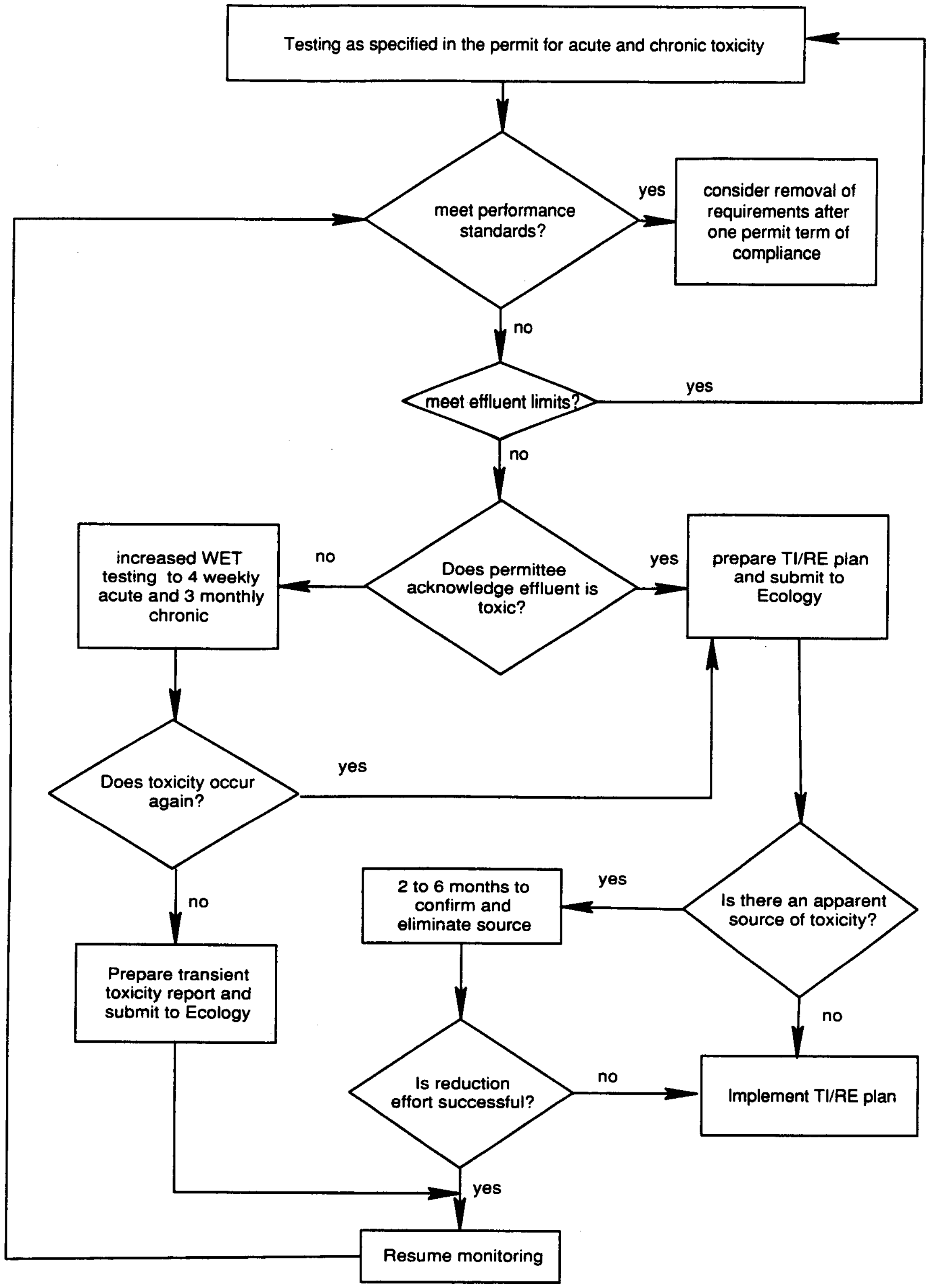
FALSE NEGATIVE TEST RESULTS AND THE POWER STANDARDS. Sometimes variability across replicates will prevent a large difference in response (in other words, a toxic effluent) from being detected as statistically significant. False negatives happen easily when the number of replicates is low and the lab is not careful in conducting the WET test. Chapter 173-205 WAC handles false negatives through the establishment of power standards. Several parts of the WET rule require that toxicity tests meet the power standards (WAC 173-205-050(1)(f)(ii), WAC 173-205-050(2)(a)(iii)(A), WAC 173-205-070(4), and WAC 173-205-120(2)(c)). The acute statistical power standard and the chronic statistical power standard are defined in WAC 173-205-020. The acute statistical power standard says that acute toxicity tests must be able to detect a minimum of a 30% difference in survival between the ACEC and a control as statistically significant. The chronic statistical power standard says that chronic toxicity tests must be able to detect a minimum of a 40% difference in response between the ACEC or CCEC and a control as statistically significant. If a WET test does not meet the appropriate statistical power standard, then the permittee will be required to immediately resample the effluent and repeat the toxicity test with the number of replicates increased in order to meet the statistical power standard.

5.7 Noncompliance, Transient Toxicity Reports, and TI/RE Plans

ADDITIONAL TESTING AND TRANSIENT TOXICITY REPORTS.(Fig. VI-7). When a permittee fails a routine compliance test for a WET limit, then additional testing is immediately required to assess and confirm the continuing presence of toxicity (WAC 173-205-090(1)). WET testing of 4 additional weekly samples are required following noncompliance with an acute WET limit and 3 additional monthly samples following noncompliance with a chronic WET limit (WAC 173-205-090(1)). If only the routine compliance test is failed, then the permittee is required to prepare a transient toxicity report on the possible causes and prevention of the toxicity. Compliance with the permit limit is restored with the first additional sample that passes the compliance test. Compliance with all WET testing provisions of the permit is accomplished by passing all of the additional testing following a routine compliance test failure and submitting an acceptable transient toxicity report. The contents of a transient toxicity report are described in WAC 173-205-100(1).

TI/RE PLANS. If any toxicity test fails the compliance test during the additional monitoring, then the permittee must submit a TI/RE plan to Ecology within sixty days of the last additional sample (WAC 173-205-100(2)). The TI/RE plan will be based on procedures in the latest versions of the EPA guidance documents for conducting toxicity reduction evaluations or toxicity identification evaluations (WAC 173-205-100(2)(b)). However, the TI/RE plan need not include any procedure from the EPA manuals that is not necessary to the goal of controlling the discharge of WET by the permittee (WAC 173-205-100(2)(b)(i)). Ecology may approve any modifications or additions to the EPA procedures that will improve the ability to identify or reduce toxicity (WAC 173-205-100(2)(b)(ii)). Thepermittee is required to implement the TI/RE plan immediately upon notification by Ecology of plan approval (WAC 173-205-100(3)). Model permit language specifies an administrative order as the means to notify a permittee to implement a TI/RE. The Permit Development Services Section will assist in reviewing TI/RE plans and in writing administrative orders to implement TI/RE plans.

Figure VI-7 Compliance Process for WET



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5.8 Removal of WET Limits

A WET limit is eligible for removal upon permit renewal if the permittee has demonstrated compliance with the WET performance standard associated with that limit for at least the last 3 consecutive test years following effluent characterization or for an entire subsequent permit term, and has not made any changes within the last three years which would otherwise require additional effluent characterization (WAC 173-205-120(1)).

Removing a WET limit under this provision of Chapter 173-205 WAC is a good idea for the following reasons:

- *It protects the environment.* Concentration-response curves are steep and toxicity decreases rapidly with dilution. As a consequence, toxicity is often undetectable at the ACEC or CCEC. This means that WET limits will be easily met by most dischargers. However, when the concentration of toxic chemicals increases in the effluent, then toxicity increases quickly. Toxicity (especially acute toxicity) tends to behave as if there was a threshold where one side is safe and the other side is very adverse to aquatic organisms. A larger margin of safety is a good idea under these circumstances. Offering to remove these WET limits provides a strong incentive to do more to control toxicity than is required to meet the water quality standards. The performance standards provide a margin of safety for the environment to meet the goal of RCW 90.48.520.

- *It is fair.* Other permittees conducted a similar or smaller amount of WET testing during effluent characterization and did not receive a WET limit in the first place. If a permittee can meet the same performance standard measured with at least as much WET testing over a longer period of time as other permittees did who received no WET limits, then that permittee also has no reasonable potential to violate the water quality standards.

- *It fits into the system for regulating WET in Chapter 173-205 WAC.* Chapter 173-205 WAC recognizes that the evaluation of WET is an ongoing process that encompasses more than just dividing permittees into two groups: those with WET limits and those without WET limits. Chapter 173-205 WAC also has provisions for rapid screening tests, for additional effluent characterizations, for permittee evaluations of facility changes, and for technology-based acute WET limits. All of these provisions are enhanced by or dependant on WET limit removal.

5.9 Determining the Need for Rapid Screening Tests

RAPID SCREENING TESTS. A rapid screening test is a screening toxicity test on one hundred percent effluent or some other high concentration of effluent in order to detect unanticipated increases in toxicity. Examples of rapid screening tests include twenty-four hour EPA acute tests, acute toxicity tests using rotifers produced from cysts, bacterial bioluminescence tests (Microtox®), and two-day life cycle tests with rotifers. See Subsection 5.13 for guidance on rapid screening test selection.

RAPID SCREENING TESTS WHEN WET LIMITS ARE REMOVED. Permit managers may condition the nonassignment of a WET limit with a requirement for routine monitoring with a rapid screening test (WAC 173-205-120(2)). A permit manager must place rapid screening tests into a permit if there is the potential for an event at the facility which could result in a toxic discharge that would otherwise go unnoticed (WAC 173-205-120(2)(a)(ii)). The permit manager should consider the potential for treatment system upsets, control equipment failures, spills, accidental releases to the wastewater system, or any other event which could result in a toxic discharge. If a permittee refuses to accept rapid screening tests in the permit, leave the WET limit in place. Chemical monitoring may also be required to assess increases in effluent toxicity under some circumstances.

RAPID SCREENING TESTS AND ADDITIONAL EFFLUENT CHARACTERIZATIONS. Rapid screening testing can be beneficial for the permit manager and the permittee. Toxicity caused by a facility change can easily be determined if a permittee is routinely doing rapid screening tests.

THE RESULT OF RAPID SCREENING TESTING. Whenever a rapid screening test is failed, the permittee must immediately retest with all of the acute or chronic toxicity tests used in the last permit with WET (WAC 173-205-120(2)(d)). There are no rapid screening test effluent limits. Toxicity detected by a rapid screening test must be confirmed by the traditional EPA-style WET tests. The results of these acute or chronic toxicity tests conducted in response to a rapid screening test will be evaluated to determine the need for a new WET characterization in the next permit or the need for immediate administrative orders to implement the regulatory process which begins in WAC 173-205-090.

OTHER USES OF RAPID SCREENING TESTS. Rapid screening tests may be required of any permittee (WAC 173-205-030(5)). This means that, in addition to evaluating changes in the toxicity of discharges which have no WET limits, rapid screening tests can be used during effluent characterization to develop a correlation with the WET tests or in a permit with WET limits to raise the monitoring frequency. Compliance with WET limits is never measured with a rapid screening test. They can be required at a higher monitoring frequency than the WET tests and can be used to trigger the WET tests when needed.

5.10 Technology-Based WET Limits

PROCESS. A permit manager may place the WET performance standard for acute toxicity into permits as a limit on a case-by-case basis pursuant to 40 CFR 125.3(d)(3) (WAC 173-205-130(2)). 40 CFR 125.3(d)(3) contains the list of factors which must be considered in setting case-by-case BAT limits. There are six of these site-specific factors. These include: the age of equipment, the process employed at the facility, changes to the process required to meet the performance-based limit, engineering aspects of the control techniques, and the cost of achieving the performance-based limit. These considerations require the assistance of the Permit Development Services Section.

TIMING. The performance-based acute toxicity limit in WAC 173-205-130(2) will not be automatically applied to all permittees in a category, but will only be imposed on a case-by-case basis after several years have passed during which permittees are encouraged to meet the performance standards solely through the incentive of offering to remove WET limits and compliance monitoring from the permit. The determination to impose a performance-based WET limit will not occur until after a water quality-based acute WET limit has been assigned, after at least one permit term of monitoring for compliance with the water quality-based WET limit, after a similar permittee has met the acute toxicity performance standard, and after consideration of the site-specific factors listed in 40 CFR 125.3(d)(3). Because these steps must occur before the determination is made to impose a performance-based limit, the delay will be at least five years before such a limit is placed in a permit unless such a limit was already in place before Chapter 173-205 WAC became effective.

5.11 Options for Permittees

5.11.1 Conducting WET Tests

There are three options for permittees:

- Permittees may conduct any toxicity test using a full dilution series (WAC 173-205-030(9)). Many permittees who commented on the draft Chapter 173-205 WAC were concerned that language in WAC 173-205-050(1)(f) and WAC 173-205-070(1) and (2) would be used by Ecology to prevent WET tests from being run with a dilution series of at least 5 effluent concentrations and a control. This full dilution series would protect the permittee by allowing anomalous test results to be identified by examining the concentration-response relationship. As a result of this permittee concern, language was inserted that makes clear that permittees may conduct any WET test using a dilution series.

- A permit manager may approve the request of a POTW discharging less than 0.5 mgd or a small business as defined in RCW 43.31.025(4) to conduct WET testing as effluent screening tests using 100% effluent for the acute toxicity tests and the ACEC for the chronic toxicity tests (WAC 173-205-050(1)(f)). A small business is defined as a business entity which is owned and operated independently from all other businesses, which has the purpose of making a profit, and which has 50 or fewer employees (RCW 43.31.025). Effluent screening tests are WET tests that are conducted as a screen for toxicity in 100% effluent or the ACEC. No other effluent concentrations (except the control) are tested until toxicity has been detected in the effluent screening test. This saves the permittee some money as long as the effluent is usually nontoxic; the effluent screening tests are about two-thirds to one-half the cost of a full dilution WET test. However, since the quality of the information is lower and repeating tests frequently is more expensive, it would be best to limit this option to dischargers that are likely to be nontoxic.

- The WET rule requires that samples, dilution water, and test solutions be handled as specified in the test method or the permit (WAC 173-205-080(1)(b). Permittees who received permits prior to the effective date of Chapter 173-205 WAC may request approval of alternate samples, dilution water, or test solutions (WAC 173-205-080(1)(c)).

5.11.2 Notification of an Anomalous Test Result

Ecology will be reviewing WET test results to see if these results are anomalous and should not be used for compliance determinations (WAC 173-205-070(5)(b)). Examples of anomalous WET test results include tests with a lower toxic response at higher effluent concentrations and concentration-response curves with no slope. A review for these kinds of WET test results will protect permittees from the consequences of noncompliance with a WET limit when the WET test itself was responsible for the appearance of noncompliance.

If the permittee believes that a compliance test failure will be identified by Ecology as an anomalous test result, the permittee may send Ecology notification with the compliance test result that the compliance test result might be anomalous and that the permittee intends to take only one additional sample for toxicity testing and wait for notification from Ecology before completing the additional monitoring required in WAC 173-205-090(1). The notification must identify the reason for considering the compliance test result to be anomalous. The permittee must complete all of the additional monitoring required by WAC 173-205-090(1) as soon as possible after notification by Ecology that the compliance test result was not anomalous. Ecology may determine any compliance test result to be anomalous regardless of whether it was accompanied by permittee notification that it may be anomalous.

5.11.3 Conducting a TI/RE

There are three options for permittees:

- A permittee may proceed directly to a TI/RE and not perform the additional testing (WAC 173-205-090(4)). Permittees that choose this option save themselves the expense of the additional monitoring and lessen the time between first detecting WET in excess of a limit and taking action to achieve compliance.

- If any WET test fails the compliance test during the additional monitoring conducted in accordance with WAC 173-205-090(1), then the permittee shall submit a plan for a TI/RE (WAC 173-205-100(2)). As a part of this plan, the permittee may request that Ecology allow up to six months before beginning the TI/RE for facility personnel to attempt to control the most likely sources of toxicity through efforts such as changes in plant operation, replacement of a toxic material used in the facility, or improvement of best management practices (WAC 173-205-100(2)(a)). Ecology approves the request in writing, and if the attempt is successful, then the permittee and Ecology are saved the time and expense of TI/RE plan review and implementation. However, since time and effort will be wasted if the attempt is unsuccessful, requests should only be approved for attempts that have a good chance of success.

- Ecology may approve the interruption of a TI/RE if toxicity has disappeared (WAC 173-205-110(1)). The permittee then returns to the routine monitoring schedule and takes enough extra sample each time to begin a TI/RE if the effluent fails the compliance test. If toxicity testing shows compliance with WET limits for one year after interruption of the TI/RE, then the permittee may cease taking the extra sample (WAC 173-205-110(2)). The approval letter for the TI/RE interruption should inform the permittee of the option to cease taking the extra sample after one year of compliance.

5.12 Species Selection for WET Testing

5.12.1 Acute WET Test Species

Selecting acute WET test species is fairly simple. Effluents with a risk for aquatic toxicity are tested at a minimum for toxicity to a fish, an invertebrate, and any appropriate plant (WAC 173-205-050(1)(a)). Because EPA has not provided any test for acute toxicity to plants, effluents can only be tested for acute toxicity with a fish and an invertebrate. If the effluent itself is freshwater, freshwater species are always used for acute WET testing regardless of the salinity of the receiving water. The saltwater and freshwater acute WET tests do not differ significantly in sensitivity. Freshwater WET tests are more readily available and more convenient for TI/REs.

CHOICE OF INVERTEBRATE. Daphnids are the standard freshwater invertebrate test organisms. The permittee or lab can choose the most convenient daphnid species (*Daphnia pulex*, *Daphnia magna*, or *Ceriodaphnia dubia*). The sensitivities to toxicity of these three species are similar.

CHOICE OF FISH. Fathead minnow are recommended for acute WET testing for several reasons. Fathead minnows are sensitive test organisms; they were more sensitive than rainbow trout tested using the DOE 80-12 procedure. EPA has developed the freshwater WET testing program around the use of fathead minnows for fish testing. There is much more effluent testing with fathead minnows than with any other fish. More labs around the country have experience with fathead minnow WET testing or fathead minnow toxicity identification/reduction evaluations (TI/REs) than any other fish. The national experience with fathead minnow TI/REs is much more extensive than with rainbow trout.

TI/REs will be more difficult and expensive with rainbow trout. The volume of effluent that must be sampled, shipped, and fractionated is much larger for a rainbow trout WET test or TI/RE than it is for fathead minnow. EPA protocols require about 20 times the volume of effluent for rainbow trout testing than fathead minnow testing. For example, it might require 5 liters of effluent for a fathead minnow TI/RE and 100 liters for a rainbow trout TI/RE. Taking a representative sample of 100 liters of effluent, shipping it, and performing the chemical manipulations required in a TI/RE will be more difficult and expensive to accomplish than it would be with 5 liters of effluent.

If you have decided to require acute WET testing with rainbow trout in order to provide direct protection of salmonids, it is recommended that:

- The permit manager also require fathead minnow testing so that any TI/RE can be performed with fathead minnow. Each sample during effluent characterization will be tested using both of the fish and this information can be used to guide the fathead minnow TI/RE in protecting rainbow trout.

- The permit manager use WAC 173-205-060(5) to require any permittee who tested with rainbow trout using the DOE 80-12 or ASTM procedure to conduct an additional effluent characterization using the EPA rainbow trout method. Rainbow trout testing using DOE 80-12 or ASTM has been shown to be significantly less sensitive than fathead minnow testing according to EPA methods. The latest EPA acute testing manual has a method for rainbow trout testing which will be more sensitive than fathead minnow, but occasionally there will be no trout available that meet the size and age requirements of the EPA method.

ACUTE TESTING OF SALINE EFFLUENTS. If the effluent is too saline for freshwater organisms, contact the Permit Development Services Section to discuss acute WET tests with saltwater organisms.

5.12.2 Chronic WET Test Species

Unlike the situation with acute WET testing, the chronic WET tests required for discharges to saltwater differ from the chronic WET tests required for discharges to freshwater. Permits for discharges to freshwater should have requirements for freshwater chronic WET tests, and permits for discharges to saltwater or brackish water should have requirements for saltwater chronic WET tests. Exceptions to this recommendation are allowable but should be discussed with the Permit Development Services Section.

FRESHWATER CHRONIC WET TEST SPECIES. Chronic WET test species selection is fairly simple for discharges to freshwater. EPA recommends testing with a fish, an invertebrate, and a plant and has provided only one of each for freshwater chronic WET testing (fathead minnow, *Ceriodaphnia*, and *Selenastrum*). Effluents with a risk for aquatic toxicity be tested at a minimum for toxicity to a fish, an invertebrate, and if appropriate, a plant (WAC 173-205-050(1)(a)).

There would be no decisions involved in selecting the freshwater chronic WET test species if testing with a plant was always appropriate. *Selenastrum* is often less sensitive than animals in WET tests. This means that there is frequently no gain in environmental protection from including a plant test for discharges to freshwater. In addition, *Selenastrum* tests suffer from nutrient enhancement which can mask or confuse the measurement of effluent toxicity. Being unicellular, *Selenastrum* can also rebound from toxicity as the few resistant cells proliferate without competition after elimination of the sensitive cells. *Selenastrum* can be affected by color in the effluent or by small differences in the amount of micronutrients. Probably in response to these deficiencies, EPA has spent little effort developing the *Selenastrum* test or TI/RE procedures. However, if you suspect that an effluent might be toxic to plants, *Selenastrum* is your only choice. Any clearly toxic response in an effluent test using *Selenastrum* is a good indication of toxicity to plants, and this information is important for protecting the receiving environment.

SALTWATER CHRONIC WET TEST SPECIES. The selection of chronic WET test species for discharges to saltwater is complex for two main reasons:

- The reproduction of multicellular organisms in a marine environment usually begins with broadcast fertilization resulting in very small embryos and larvae which drift with the plankton. These early life stages of marine organisms are very sensitive to toxicity, and are a part of the life cycle of most marine organisms including oysters, kelp, halibut, and crabs to name a few examples. EPA has provided a larger list of chronic WET tests for discharges to saltwater so that testing with these very sensitive early life stages could be required.

- EPA originally developed chronic WET tests for discharges to marine waters with east coast organisms. The transition to west coast organisms is occurring now. West coast and east coast species may be used for testing but permittees are instructed to primarily use the west coast species. The east coast species are included as an alternative if the lab cannot find enough west coast test organisms. Eventually, the east coast species will be abandoned for good. This is being done to reduce the risk of the release of non-indigenous species or diseases.

Standard Fish and Invertebrate

Topsmelt (*Atherinops affinis*) or Silverside minnow (*Menidia beryllina*)

West coast mysid (Holmesimysis costata) or east coast mysid (*Mysidopsis bahia*)

The chronic WET tests with these two species should be included in all permits for discharges to saltwater. The level of protection provided by these two tests is similar to the protection provided by the freshwater chronic tests. The mysid test is an excellent test. When EPA studied the toxicity of 13 effluents from a wide variety of sources, they found the *Mysidopsis bahia* test to be the most sensitive of the tests in the marine chronic toxicity test manual 31% of the time. Another study found the *Mysidopsis bahia* test to be 42-times more sensitive than the average fish and crustacean in EPA's database of toxicity test results used in the development of the marine water quality criteria. When the minnow and mysid provide less than adequate protection, the permit should also contain a fertilization test, an embryo-larval development test, or a plant reproduction test. Permits containing WET testing requirements for only the fish and mysid do meet the minimum requirement of WAC 173-205-050(1)(a).

Embryo-Larval Development Test

Pacific oyster (*Crassostrea gigas*, April-September)

Blue mussel (*Mytilus sp.*, October-March)

The bivalve embryo-larval development test is recommended for discharges to ecosystems of special importance or fragility. Put this chronic WET test into a permit along with the standard fish and invertebrate test when there is a risk of toxicity to sensitive larval life-stages of marine organisms or to organisms that have similar life stages. This test is especially appropriate for discharges to areas where mollusks are or could be cultivated or for discharges to breeding grounds for important marine organisms. The bivalve test is also appropriate for discharges to inlets or bays with poor circulation or for larger discharges with a tendency to stratify. This chronic WET test is perhaps the most sensitive of all the tests.

Fertilization Test

Sea urchin (*Strongylocentrotus purpuratus*, November-April)

Sand dollar (*Dendraster excentricus*, May-October)

The echinoderm (Sea urchins, sand dollars, sea stars) fertilization test has some advantages over the other WET tests. The combination of high sensitivity and short duration (one hour) is unique to this test. Very small volumes of effluent can be tested successfully and one spawning yields enough material for many tests. TI/REs with the echinoderm fertilization test are likely to be more convenient and successful than with other WET tests because of these advantages. The echinoderm fertilization test is an excellent rapid screening test. It is recommended that permit managers require the echinoderm fertilization test when a balance between high sensitivity and ease of use are important. Otherwise, the bivalve test is usually more sensitive and can be less variable.

Plant Reproduction Test

Kelp (*Champia parvula*)

If the discharge is to an area with kelp beds, water shallow enough to admit sunlight, or to a rocky area that would be capable of supporting kelp, then the plant reproduction test should be considered. This plant reproduction test is a sensitive test and lacks most of the disadvantages of *Selenastrum*.

5.13 Rapid Screening Test Selection

5.13.1 Acute Rapid Screening Tests

Rotifer, *Brachionus sp.* (ASTM E 1440-91). The rotifer test is a 24-hr acute test using rotifers hatched from cysts. Tests with organisms hatched from cysts are less expensive because no time or materials are consumed by maintaining a culture. This rotifer test is common in Europe and is accepted by ASTM. The rotifer test is a sensitive test (except to insecticides) and can be used in freshwater or saltwater.

24-hr EPA screening tests. If the permittee is uncomfortable with the rotifer test, you might consider the EPA 24-hr screening tests instead of the rotifer. The 24-hr EPA acute tests are conducted using the same EPA manual and species that were used for effluent characterization.

5.13.2 Chronic Rapid Screening Tests

Bacterial bioluminescence test (Microtox® or approved alternate).

Microbics is modifying the Microtox® software to do the statistical test required by WAC 173-205-120(2)(c). Microbics is also modifying the Microtox® protocol to screen more than one effluent sample at a time. The ability to test samples from several permittees at one time will lower the cost of Microtox®. Microtox® is already a relatively inexpensive test and the new protocol will eventually bring the cost down even lower. This low cost will allow very high monitoring frequencies if necessary.

Snell, Terry W. 1992. A 2-d Life Cycle Test With The Rotifer *Brachionus calyciflorus*. *Environ. Toxicol. Chem.* 11:1249-1257.

The chronic rotifer test is a good alternative to Microtox®. Whereas the relevance of Microtox® has been questioned, the chronic rotifer test has great ecological relevance. The rotifer test measures the intrinsic rate of population increase. Measuring the intrinsic rate of population increase simultaneously evaluates both mortality and fecundity. The chronic rotifer test is as ecologically relevant as any EPA chronic tests and about as sensitive as the *Ceriodaphnia* chronic test. Because it starts with rotifer cysts, uses small volumes of effluent, and only takes two days, it will be less expensive than EPA chronic tests. The rotifer test may not be sensitive to insecticides.

Echinoderm Fertilization Test, *West Coast Marine Species Chronic Protocol Variability Study*, PTI Environmental Services, February 1994.

The combination of high sensitivity and short duration (one hour or less) is unique. Very small volumes of effluent can be tested successfully. One spawning yields enough material for many tests. The echinoderm fertilization test can be an excellent rapid screening test. Because the echinoderm fertilization test uses the same test protocol whether conducted for characterization, compliance monitoring, or as a rapid screening test, it is especially convenient. The exposure duration should be shortened to 20 minutes for the rapid screening test. Permit managers should realize that the cost of this rapid screening test will be variable depending on the lab and the availability of echinoderms.

5.14 Samples for WET Testing

5.14.1 Advantages of Grab Samples

The toxicity of an effluent sample begins changing at the time of sampling. Often the toxicity decreases, but it can also increase. These changes continue throughout the holding time. Composite sampling lengthens the holding time by 24 hours and allows more changes in toxicity to occur. In addition, composite samplers contain a large amount of surface area which enhances toxicant adsorption or reaction. The compositing process makes it difficult to prevent the escape of volatile toxicants. Changes in dissolved gases during compositing cause changes in pH ultimately affecting the chemistry and toxicity of the sample.

Grab samples provide the most accurate measurement of toxicity by minimizing changes. Grab samples are taken quickly with a minimum of equipment. They are then immediately sealed in a container with little or no void space, cooled to 4 C, and sent directly to the lab for toxicity testing.

5.14.2 Advantages of Composite Samples

If toxicity varies unpredictably over a day, grab samples will not be representative unless the monitoring frequency is increased. (If toxicity varies unpredictably over a time period longer than a day, then 24-hr composite sampling will also not be representative.) In addition, permittees can sometimes deliberately schedule grab sampling for times when the effluent is less likely to be toxic.

24-hr composites provide a representative sample of effluent toxicity. The toxicity highs and lows over a day are all represented in the sample. Composite samples are sometimes more difficult for permittees to schedule for periods of low toxicity.

5.14.3 Recommended Sampling Technique

If the effluent chemistry or toxicity is consistent over time, use grab samples. If sampling can be scheduled for times of typical or peak effluent toxicity, use grab samples.

If grab samples will not be representative of effluent toxicity, use 24-hr composite sampling.

5.14.4 Sampling Chlorinated Effluents

Samples for WET may be taken before the chlorinator (or dechlorinated if this is not possible) for discharges which can meet water quality-based effluent limits for chlorine and have an ACEC below 25% effluent. If the ACEC is 25% effluent or higher, the effluent is sampled after the chlorinator. This extra control on chlorine is warranted because of the effluent-dominated receiving water condition.

5.15 Managing Effluent Characterization Results

5.15.1 Whole Effluent Toxicity Information Management Service

The whole effluent toxicity test information management service (WETTIMS) is a system for maintaining quality records of WET test results with the goal of providing complete and accurate information for use in regulatory determinations. The Water Quality Program purchased TOXIS in order to be able to provide this service to permit managers and permittees. TOXIS is computer software that creates a record in a database of each toxicity test and can automatically perform the statistical procedures in the EPA test manuals. TOXIS also allows queries of the database to produce tables of the WET test results for each permittee.

WETTIMS has two stages. The first stage of the management system is getting quality records of each permittee's WET test results into the database. Achieving quality records requires a review of each WET test, entry of the test into TOXIS, and performance of the proper statistics. After the record of WET test results is completed for a permittee, then the database can be queried to produce a table of effluent characterization test results that will assist permittees and permit managers during permit renewal. The production of an accurate table of the numbers to be used for regulatory determinations for each permittee is the second stage of the information management system.

Permit managers should utilize the services of the Permit Development Services Section for information management of WET. The PM Section evaluates every test before entering into the data base. Data entered into TOXIS is assured of using the proper statistics. Only WET test results produced from the WETTIMS database should be considered accurate.

The PM Section will, upon request, provide summary data of their test results to permittees. Therefore, it is essential that all WET data be entered into TOXIS and that permittees and permit managers receive the same summary information.

5.15.2 Getting Complete Effluent Characterizations

If an effluent characterization is not adequate for making regulatory determinations under the WET rule, there are several possible solutions. For example, every permittee who is regulated under the WET rule, has no WET limits, and conducts no rapid screening testing is required to submit a set of WET tests with each permit application [WAC 173-205-030(8)]. Most of the permittees currently fit this situation, and when they are informed of the requirement to submit a set of WET tests with the permit application, the WET tests could be chosen to complete any inadequate effluent characterization. The PM Section can advise permit managers on how to use this requirement to supplement inadequate effluent characterizations with a minimum of extra effort by permittees. This assistance is most valuable if permit managers contact the PM Section six months prior to the application time.

5.15.3 Switching Permittees To Appropriate WET Testing

For permits issued prior to the effective date of the WET rule, the best way to improve the permittee's chance of producing an adequate effluent characterization is to switch any inappropriate WET testing over to appropriate testing. Many existing permits contain requirements for routine monitoring after effluent characterization. When the use of inappropriate WET testing methods makes it necessary, a letter can be sent to the permittee switching the routine WET testing to appropriate test methods [See WAC 173-205-080(1)(c)]. These letters should be sent as soon as possible. These changes in test method are not likely to increase the cost of the monitoring.

The test review sheets from the PM Section are good guides as to what test methods need changed. The two most common circumstances where a change in WET test method is needed are:

- For all chlorinated effluents, review WAC 173-205-080 and section 5.14.4 above to determine whether to test unmodified final effluent, test dechlorinated final effluent, or test a sample taken just prior to the chlorinator. Send a letter switching the permittee over to the correct sample handling procedure. Any acute WET test using fish must be a 96-hour static-renewal test conducted according to the EPA/600/4-90/027F. Switch all WDOE 80-12 or ASTM acute testing with fish to the EPA manual. Switch all 48-hour acute fish tests to 96-hour static-renewal tests.

Any acute WET test using fish must be a 96-hour static renewal test conducted according to the EPA/600/4-90/027F. Switch all WDOE 80-12 or ASTM acute testing with fish to the EPA manual. Switch all 48-hour acute fish tests to 96-hour static-renewal tests.

Table VI-4 . Chemical screening list for WET testing. (40 CFR 403, Appendix C)

Acenaphthene
Acenaphthylene
Acetaldehyde
Acetic acid
Acetic acid (2,4-dichlorophenoxy)
Acetic acid, lead(2+) salt
Acetic acid, (2,4,5-trichlorophenoxy)
Acetic anhydride
Acetone cyanohydrin
Acetyl bromide
Acetyl chloride
Acrolein
Acrylonitrile
Aldrin
Allyl alcohol
Allyl chloride
Aluminum sulfate
Ammonia
Ammonium acetate
Ammonium benzoate
Ammonium bicarbonate
Ammonium bichromate
Ammonium bifluoride
Ammonium bisulfite
Ammonium carbamate
Ammonium carbonate
Ammonium chloride
Ammonium chromate
Ammonium citrate, dibasic
Ammonium fluoborate
Ammonium fluoride
Ammonium hydroxide
Ammonium oxalate
Ammonium silicofluoride
Ammonium sulfamate
Ammonium sulfide
Ammonium sulfite
Ammonium tartrate
Ammonium thiocyanate
Amyl acetate
Aniline
Antimony pentachloride
Antimony potassium tartrate
Antimony tribromide
Antimony trichloride
Antimony trifluoride
Antimony trioxide
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Arsenic
Arsenic disulfide
Arsenic oxide As2O3
Arsenic oxide As2O5
Arsenic pentoxide
Arsenic trichloride
Arsenic trioxide
Arsenic trisulfide
Asbestos
Barium cyanide
Benz[a]anthracene
1,2-Benzanthracene
Benzenamine
Benzene
Benzene, 1-bromo-4-phenoxy-
Benzene, chloro-
Benzene, chloromethyl-
1,2-Benzenedicarboxylic acid, dioctyl ester
1,2-Benzenedicarboxylic acid, [bis(2-ethylhexyl)]-
1,2-Benzenedicarboxylic acid, dibutyl ester
1,2-Benzenedicarboxylic acid, diethyl ester
1,2-Benzenedicarboxylic acid, dimethyl ester
Benzene, 1,2-dichloro-
Benzene, 1,3-dichloro-
Benzene, 1,4-dichloro-
Benzene, 1,1'-(2,2-dichloroethylidene)bis[4-chloro-
Benzene, dimethyl
1,3-Benzenediol
Benzene, hexachloro-
Benzene, hexahydro-
Benzene, hydroxy-
Benzene, methyl-
Benzene, 2-methyl-1,3-dinitro-
Benzene, 1-methyl-2,4-dinitro-
Benzene, nitro-
Benzene, 1,1'-(2,2,2-tri-chloroethylidene)bis[4-chloro-
Benzene,

1,1'-(2,2,2-trichloroethylidene) bis[4-methoxy-
Benzidine
Benzol[a]anthracene
Benzo[b]fluoranthene
Benzo(k)fluoranthene
Benzo[j,k]fluorene
Benzoic acid
Benzonitrile
Benzo[ghi]perylene
Benzo[a]pyrene
3,4-Benzopyrene
Benzoyl chloride
1,2-Benzphenanthrene
Benzyl chloride
Beryllium
Beryllium chloride
Beryllium fluoride
Beryllium nitrate
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
(1,1'-Biphenyl)-4,4'diamine
[1,1'-Biphenyl]-4,4'diamine, 3,3'dichloro-
Bis (2-chloroethyl) ether
Bis (2-ethylhexyl)phthalate
Bromoform
4-Bromphenyl phenyl ether
1,3-Butadiene, 1,1,2,3,4,4-hexachloro-
2-Butenal
Butyl acetate
Butylamine
Butyl benzyl phthalate
n-Butyl phthalate
Butyric acid
Cadmium
Cadmium acetate
Cadmium bromide
Cadmium chloride
Calcium arsenate
Calcium arsenite
Calcium carbide
Calcium chromate
Calcium cyanide
Calcium cyanide Ca(CN)2
Calcium dodecylbenzenesulfonate
Calcium hypochlorite
Camphene, octachloro-
Carbaryl
Carbofuran
Carbon disulfide
Carbon tetrachloride
Carbonic dichloride
Chlordane
Chlordane, alpha & gamma isomers
Chlordane, technical
CHLORINATED BENZENES
CHLORINATED ETHANES
CHLORINATED NAPHTHALENE
CHLORINATED PHENOLS
Chlorine
CHLOROALKYL ETHERS
Chlorobenzene
4-Chloro-m-cresol
p-Chloro-m-cresol
Chlorodibromomethane
Chloroethane
2-Chloroethyl vinyl ether
Chloroform
beta-Chloronaphthalene
2-Chloronaphthalene
2-Chlorophenol
o-Chlorophenol
4-Chlorophenyl phenyl ether
Chlorosulfonic acid
Chlorpyrifos
Chromic acetate
Chromic acid
Chromic acid H2CrO4, calcium salt
Chromic sulfate
Chromium
Chromous chloride
Chrysene
Cobaltous bromide
Cobaltous formate
Cobaltous sulfamate
Copper
Coumaphos
Cresol(s)
Cresylic acid
Crotonaldehyde
Cupric acetate
Cupric acetoarsenite
Cupric chloride
Cupric nitrate
Cupric oxalate
Cupric sulfate
Cupric sulfate, ammoniated
Cupric tartrate
Cyanogen chloride

Cyanogen chloride (CN)Cl
Cyclohexane
Cyclohexane, 1,2,3,4,5,6-hexachloro-,
(1 alpha,2alpha,3beta,4alpha,5alpha,6beta)-
1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-
2,4-D Acid
2,4-D Ester
2,4-D, salts and esters
DDD
4,4' DDD
DDE
4,4' DDE
DDT
4,4'DDT
Diazinon
Dibenz[a,h]anthracene
1,2:5,6-Dibenzanthracene
Dibenzo[a,h]anthracene
Dibutyl phthalate
Di-n-butyl phthalate
Dicamba
Dichlobenil
Dichlone
Dichlorobenzene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
m-Dichlorobenzene
o-Dichlorobenzene
p-Dichlorobenzene
3,3'-Dichlorobenzidine
Dichlorobromomethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethylene
1,2-Dichloroethylene
Dichloroethyl ether
Dichloroisopropyl ether
Dichloromethoxy ethane
2,4-Dichlorophenol
Dichloropropane
1,2-Dichloropropane
Dichloropropane-Dichloropropene (mixture)
Dichloropropene
1,3-Dichloropropene
2,2-Dichloropropionic acid
Dichlorvos
Dicofol
Dieldrin
Diethylamine
Diethylhexyl phthalate
Diethyl phthalate
Dimethylamine
2,4-Dimethylphenol
Dimethyl phthalate
Dinitrobenzene (mixed)
4,6-Dinitro-o-cresol and salts
Dinitrophenol
Dinitrotoluene
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-octyl phthalate
1,2-Diphenylhydrazine
Diphosphoric acid, tetraethyl ester
Di-n-propylnitrosamine
Diquat
Diuron
Dodecylbenzenesulfonic acid
Endosulfan
alpha - Endosulfan
beta - Endosulfan
Endosulfan sulfate
Endrin
Endrin aldehyde
Endrin, & metabolites
Epichlorohydrin
Ethanal
Ethane, 1,2-dibromo-
Ethane, 1,1-dichloro-
Ethane, 1,2-dichloro-
Ethane, 1,1'-oxybis[2-chloro-
Ethane, 1,1,2,2-tetrachloro-
Ethane, 1,1,1-trichloro-
Ethane, 1,1,2-trichloro-
Ethene, chloro-
Ethene, 2-chloroethoxy-
Ethene, 1,1-dichloro-
Ethene, 1,2-dichloro- (E)
Ethene, tetrachloro-
Ethene, trichloro-
Ethion
Ethylbenzene
Ethylenediamine
Ethylenediamine-tetraacetic acid (EDTA)
Ethylene dibromide
Ethylene dichloride
Ethylidene dichloride
Ferric ammonium citrate
Ferric ammonium oxalate
Ferric chloride

Ferric fluoride
Ferric nitrate
Ferric sulfate
Ferrous ammonium sulfate
Ferrous chloride
Ferrous sulfate
Fluoranthene
Fluorene
Formaldehyde
Formic acid
Fumaric acid
2-Furancarboxaldehyde
2,5-Furandione
Furtural
Guthion
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
Hexachlorobutadiene
HEXACHLOROCYCLOHEXANE (all isomers)
Hexachlorocyclohexane (gamma isomer)
Hexachlorocyclopentadiene
Hexachloroethane
Hydrazine, 1,2-diphenyl-
Hydrochloric acid
Hydrocyanic acid
Hydrofluoric acid
Hydrogen chloride
Hydrogen cyanide
Hydrogen fluoride
Hydrogen sulfide
Hydrogen sulfide H2S
Indeno(1,2,3-cd)pyrene
Isophorone
Isoprene
Isopropanolamine dodecylbenzenesulfonate
Kepone
Lead
Lead acetate
Lead arsenate
Lead chloride
Lead fluoborate
Lead fluoride
Lead iodide
Lead nitrate
Lead stearate
Lead sulfate
Lead sulfide
Lead thiocyanate
Lindane
Lithium chromate
Malathion
Maleic acid
Maleic anhydride
Mercaptodimethur
Mercuric cyanide
Mercuric nitrate
Mercuric sulfate
Mercuric thiocyanate
Mercurous nitrate
Mercury
Methanamine, N-methyl-
Methanamine, N-methyl-N-nitroso-
Methane, bromo-
Methane, chloro-
Methane, dichloro-
Methane, tetrachloro-
Methane, tribromo-
Methane, trichloro-
Methanethiol
Methoxychlor
Methyl bromide
Methyl chloride
Methyl chloroform
Methylene chloride
2-Methyllactonitrile
Methylmercaptan
Methyl methacrylate
Methyl parathion
Mevinphos
Mexacarbate
Monoethylamine
Naled
Naphthalene
Naphthalene, 2-chloro-
Naphthenic acid
Nickel
Nickel ammonium sulfate
Nickel chloride
Nickel hydroxide
Nickel nitrate
Nickel sulfate
Nitric acid
Nitrobenzene
Nitrogen dioxide
Nitrogen oxide NO2
Nitrophenol (mixed)
o-Nitrophenol
p-Nitrophenol
2-Nitrophenol

4-Nitrophenol
N-Nitrosodimethylamine
N-Nitrosodiphenylamine
Nitrotoluene
Oxirane, (chloromethyl)-
Paraformaldehyde
Parathion
Pentachlorophenol
Perchloroethylene
Phenanthrene
Phenol
Phenol, 2-chloro-
Phenol, 4-chloro-3-methyl-
Phenol, 2,4-dichloro-
Phenol, 2,4-dimethyl-
Phenol, 2,4-dinitro-
Phenol, methyl-
Phenol, 2-methyl-4,6-dinitro-
Phenol, 4-nitro-
Phenol, pentachloro-
Phenol, 2,4,5-trichloro-
Phenol, 2,4,6-trichloro-
Phosgene
Phosphoric acid
Phosphorothioic acid,
O,O-dimethyl O-(4-nitrophenyl) ester
Phosphorus
Phosphorus oxycloride
Phosphorus pentasulfide
Phosphorus sulfide
Phosphorus trichloride
Plumbane, tetraethyl-
Potassium arsenate
Potassium arsenite
Potassium bichromate
Potassium chromate
Potassium cyanide
Potassium cyanide (K(CN)
Potassium hydroxide
potassium permanganate
1-Propanamine, N-nitroso-N-propyl-
Propane, 1,2-dichloro-
Propanenitrile, 2-hydroxy-2-methyl-
Propane, 2,2'-oxybis[2-chloro-
Propargite
2-Propenal
1-Propene, 1,3-dichloro-
2-Propenenitrile
2-Propenoic acid, 2-methyl-, methyl ester
2-Propen-1-ol
Propionic acid
Propionic anhydride
Propylene dichloride
Propylene oxide
Pyrene
Pyrethrins
Quinoline
Resorcinol
Selenium
Selenium dioxide
Selenium oxide
Silver
Silver nitrate
Silvex (2,4,5-TP)
Sodium
Sodium arsenate
Sodium arsenite
Sodium bichromate
Sodium bifluoride
Sodium bisulfite
sodium chromate
Sodium cyanide
Sodium cyanide Na (CN)
Sodium dodecylbenzenesulfonate
Sodium fluoride
Sodium hydrosulfide
Sodium hydroxide
Sodium hypochlorite
Sodium methylate
Sodium nitrite
Sodium phosphate, dibasic
Sodium phosphate, tribasic
Sodium selenite
Strontium chromate
Strychnidin-10-one
Strychnine, & salts
Styrene
Sulfur monochloride
Sulfur phosphide
Sulfuric acid
Sulfuric acid, dithallium (1+) salt
2,4,5-T acid
2,4,5-T amines
2,4,5-T esters
2,4,5-T salts
2,4,5-T
TDE
Tetraethyl lead
Tetraethyl pyrophosphate
Thallium

Thallium (1) sulfate
Thiomethanol
Toluene
Toxaphene
2,4,5-TP acid
2,4,5-TP esters
Trichlorfon
1,2,4-Trichlorobenzene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene
Trichloroethylene
Trichlorophenol
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
Triethanolamine dodecylbenzenesulfonate
Triethylamine
Trimethylamine
Uranyl acetate
Uranyl nitrate
Vanadium oxide V205
Vanadium pentoxide
Vanadyl sulfate
Vinyl chloride
Vinyl acetate
Vinyl acetate monomer
Vinylidene chloride
Xylene (mixed)
Xylenol
Zinc
Zinc acetate
Zinc ammonium chloride
Zinc borate
Zinc bromide
Zinc carbonate
Zinc chloride
Zinc cyanide
Zinc cyanide Zn(CN)2
Zinc fluoride
Zinc formate
Zinc hydrosulfite
Zinc nitrate
Zinc phenosulfonate
Zinc phosphide
Zinc silicofluoride
Zinc sulfate
Zirconium nitrate
Zirconium potassium fluoride
Zirconium sulfate
Zirconium tetrachloride

Table VI-5. Industry Categories of 40 CFR Part 122, Appendix A.

Industrial Category	40 CFR part
Aluminum Forming	467
Asbestos Manufacturing	427
Battery Manufacturing	461
Builder's Paper and Board Mills	431
Carbon Black Manufacturing	458
Centralized Waste Treatment	437
Coil Coating and Canmaking	465
Copper Forming	468
Electrical and Electronic Components	469
Electroplating	413
Feedlots	412
Ferroalloy Manufacturing	424
Fertilizer Manufacturing	418
Glass Manufacturing	426
Grain Mills	406
Ink Formulation	447
Industrial Laundries	441
Inorganic Chemicals	415
Iron and Steel Manufacturing	420
Landfills and Incinerators	437
Leather Tanning and Finishing	425
Metal Finishing	433
Metal Molding and Casting	464
Metal Products and Machinery Phase 1	438
Metal Products and Machinery Phase 2	438
Nonferrous Metal Forming and Metal Powders	471
Nonferrous Metals Manufacturing	421
Organic Chemicals, Plastics, and Synthetic Fibers	414
Paint Formulation	446
Paving and Roofing Material	443
Pesticide Formulation, Packaging and Repacking	455
Petroleum Refining	419
Pharmaceutical Manufacturing	439
Porcelain Enameling	466
Pulp, Paper and Paperboard	430/431
Rubber Manufacturing	428
Soap and Detergent Manufacturing	417
Steam Electric Power Generating	423
Sugar Processing	409
Timber Products Processing	429
Transportation Equipment Cleaning	442

CHAPTER VII. DERIVING WATER QUALITY-BASED EFFLUENT LIMITS FOR PROTECTION OF HUMAN HEALTH

Our water quality standards now include 91 numeric human health-based criteria that permit writers must consider when drafting an NPDES permit. These criteria were promulgated for the state by the U.S.EPA in its' National Toxics Rule (Fed. Reg., V. 57, No. 246, Tuesday, December 22, 1992). Permit writers must consider whether a discharge has a reasonable potential to violate these criteria. The criteria are listed in Table VII-1 and in TSDCALC.

This section outlines the process of conducting an initial screening and conducting a reasonable potential determination for these chemicals, as well as how to determine monitoring requirements and compliance schedules. This guidance complies with the NTR but Ecology is considering promulgating it's own human health rule which may change the criteria or the implementation process. The process of determining a reasonable potential for human health-based criteria exceedances parallels the procedure currently used for aquatic life-based criteria (Chapter VI). The decision path for human health-based permitting is illustrated in Figure VII-1.

1. WATER QUALITY CRITERIA - BACKGROUND

The human health-based water quality criteria incorporate several exposure and risk assumptions. These include (1) a 70-year lifetime of daily exposures, (2) a 6.5 gm/day ingestion rate for fish or shellfish, (3) 2 liters/day ingestion rate for drinking water, and a one-in-one-million excess cancer risk for carcinogenic chemicals. In general, these exposure assumptions will provide a safe level of protection for most individuals. On the other hand, the criteria do not account for additive or synergistic effects of multiple contaminants on human health, and they contain the assumption that 100% of exposures come from ingesting fish, shellfish, or waters from surface water sources, thus no account is taken of exposures resulting from air, other foodstuffs, or groundwater-derived or public drinking water supplies.

Human health criteria are derived by equations that reflect both technical information and policy decisions. Many issues associated with establishing human health criteria are complex and controversial, but the basic equation and concepts used to derive the criteria are simple.

The equations for two chemicals, the first a cancer-causing chemical (carcinogen) and the second a toxic chemical (but not cancer-causing), as well as explanations of the inputs to the equations, are described below. The basic formulas used to derive the two criteria below are used for all of the EPA human health-based criteria.

Carcinogen: Dioxin

Dioxin is a chemical found worldwide in waters, foods, and human tissues. The sources of dioxin vary, and the chemical is known to form during combustion, and as a by-product of certain industrial processes. In this country much attention has focussed on the pulp and paper mill industry, a source of dioxin to surface waters. The dioxin criterion discussed here was published in 1984, and is the criterion issued to the state by the EPA. The EPA is currently revising the criterion to reflect new data that show effects other than cancer at very low exposure levels.

$$\text{DIOXIN CRITERION} = \frac{\text{RISK X WT X LS}}{[\text{WCR + (BCF X FCR) X CPF] X DE}}$$

<u>RISK</u>: The excess additional cancer risk tolerated from dioxin.

<u>WT</u>: The weight of the average adult in the United States.

<u>LS</u>: The average life span of a person in the United States.

<u>WCR</u>: The daily water consumption rate of an average person.

<u>BCF</u>: The bioconcentration factor. The amount of dioxin that concentrates in fish from living in contaminated water.

<u>FCR</u>: The average daily fish consumption rate in the United States.

<u>CPF</u>: The cancer potency factor - derived from animal tumor and worker incident studies.

<u>DE</u>: The duration of exposure a person may have to the chemical being regulated.

While some agreement exists over the scientific defensibility of the formula itself, strong debate exists on the specific values assigned as inputs.

EPA assigned default values to each factor used in the equation based on laboratory tests, national surveys, and simplifying assumptions. Using specific default values for each factor in an equation is called "point estimation". Below are the point estimates used to calculate the dioxin criterion:

RISK	1-in-a-million additional risk of an individual developing cancer
WT	70 kilograms (about 155 pounds)
LS	70 years
WCR	2 liters per day
BCF	5,000
FCR	6.5 grams per day (about 1/4 of an ounce)
CPF	156,000
DE	70 years

As input parameters change the final criterion can get either larger or smaller. The safe water quality criterion calculated using the above values is .014 parts-per-quadrillion (PPQ) of dioxin to protect waters used for fishing alone, and .013 PPQ to protect waters used for both fishing and drinking water.

Toxic Non-Carcinogen: Antimony

Antimony is a common metal whose uses include battery, flame retardant, and fireworks manufacturing. Antimony enters the aquatic environment from several sources, including wastewaters from some mining and manufacturing operations and municipal sewage treatment plants.

$$\text{ANTIMONY CRITERION} = \frac{\text{RFD x WT}}{\text{WCR + (FCR x BCF)}}$$

WCR: The daily water consumption rate of an average person.

BCF: The bioconcentration factor. The amount of antimony which concentrates in fish from living in contaminated water.

FCR: The average daily fish consumption in the United States.

WT: The weight of the average adult in the United States.

RFD: The reference dose 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 negative health effects during a lifetime. RFDs may also contain factors ("uncertainty factors") that increase the protectiveness of the criterion if the data used to develop the RFD were from lab animals instead of humans, or if other sources of uncertainty exist in the database.

WT	70 kilograms (about 155 pounds)
WCR	2 liters per day
BCF	1
FCR	6.5 grams per day (about 1/4 of an ounce)
RFD	.0004 mg/kd/day

As input parameters change, the final criterion can get either larger or smaller. The safe water quality criterion calculated using the above values is 4,300 parts-per-billion (ppb) of antimony to protect waters used for fishing alone, and 14 ppb to protect waters used for both fishing and drinking water.

The criteria address a combination of cancer and non-cancer effects. If a chemical has both cancer and non-cancer effects, the effect that results in the most stringent criteria is the criteria issued in the NTR. The NTR contains criteria for protecting the uses of (1) fish and shellfish consumption, and (2) a combination of fish and shellfish consumption and drinking water ingestion. In general, the criteria to protect for fish and shellfish consumption should be applied to marine waters, and the criteria to protect for fish and shellfish consumption as well as drinking water should be applied to freshwaters. The uses of the particular water body that are designated in WAC 173-201A should be reviewed when this determination is made.

Table VII-1. Criteria for toxic pollutants, and their bases (cancer or non-cancer effects).

Chemical and CAS No.[1]	Carcinogen = C, Non-Carcinogen = N	Water & Organisms Criterion (ug/L)	Organisms only Criterion (ug/L)
antimony 7440360	N	14	4300
arsenic (criterion for inorganic form only) 7440382	C	0.018	0.14
mercury 7439976	N	0.14	0.15
nickel 7440020	N	610	4600
thallium 7440280	N	1.7	6.3
cyanide 57125	N	700	220000
asbestos 1332214	Based on MCL	7,000,000 fibers/L	
2,3,7,8 - TCDD 1746016	C	0.000000013	0.000000014
acrolein 107025	N	320	780
acrylonitrile 107131	C	0.059	0.66
benzene 71432	C	1.2	71
bromoform 75252	C	4.3	360
carbon tetrachloride 56235	C	0.25	4.4
chlorobenzene 108907	N	680	21000
chlorodibromomethane 124481	C	0.41	34
chloroform 67663	C	5.7	470
dichlorobromomethane 75274	C	0.27	22
1,2-dichloroethane 107062	C	0.38	99
1,1-dichloroethylene 75354	C	0.057	3.2
1,3-dichloropropylene 542756	N	10	1700
ethylbenzene 100414	N	3100	29000
methyl bromide 74839	N	48	4000
methylene chloride 75092	C	4.7	1600
1,1,2,2-tetrachloroethane 79345	C	0.17	11

Chemical and CAS No.[1]	Carcinogen = C, Non-Carcinogen = N	Water & Organisms Criterion (ug/L)	Organisms only Criterion (ug/L)
tetrachloroethylene 127184	C	0.8	8.85
toluene 108883	N	6800	200000
1,1,2-trichloroethane 79005	C	0.6	42
trichloroethylene 79016	C	2.7	81
vinyl chloride 75014	C	2	525
2,4-dichlorophenol 1208312	N	93	790
2-methyl-4,6-dinitrophenol 534521	N	13.4	765
2,4-dinitrophenol 51285	N	70	14000
pentachlorophenol 87865	C	0.28	8.2
phenol 108952	N	21000	4600000
2,4,6-trichlorophenol 88062	C	2.1	6.5
anthracene 120127	N	9600	110000
benzidine 92875	C	0.00012	0.00054
benzo(a)anthracene 56553	C	0.0028	0.031
benzo(a)pyrene 50328	C	0.0028	0.031
benzo(b)fluoranthene 205992	C	0.0028	0.031
benzo(k)fluoranthene 207089	C	0.0028	0.031
bis(2-chloroethyl)ether 111444	C	0.031	1.4
bis(2chloroisopropyl)ether 108601	N	1400	170000
bis(2-ethylhexyl)phthalate 117817	C	1.8	5.9
chrysene 218019	C	0.0028	0.031
dibenzo(a,h)anthracene 57303	C	0.0028	0.031
1,2-dichlorobenzene 95501	N	2700	17000
1,3-dichlorobenzene 541731	N	400	2600
1,4-dichlorobenzene 106467	N	400	2600

Chemical and CAS No.[1]	Carcinogen = C, Non-Carcinogen = N	Water & Organisms Criterion (ug/L)	Organisms only Criterion (ug/L)
3,3'-dichlorobenzidine 91941	C	0.04	0.077
diethyl phthalate 84662	N	23000	120000
dimethyl phthalate 131113	N	313000	2900000
di-n-butyl phthalate 84742	N	2700	12000
2,4-dinitrotoluene 121142	C	0.11	9.1
1,2-diphenylhydrazine 122667	C	0.04	0.54
fluoranthene 206440	N	300	370
fluorene 86737	N	1300	14000
hexachlorobenzene 118741	C	0.00075	0.00077
hexachlorobutadiene 87683	C	0.44	50
hexachlorocyclapentadiene 77474	N	240	17000
hexachloroethane 67721	C	1.9	8.9
indeno(1,2,3-cd)pyrene 193395	C	0.0028	0.031
isophorone 78591	C	8.4	600
nitrobenzene 98953	N	17	1900
n-nitrosodimethylamine 62759	C	0.0007	8.1
n-nitrosodiphenylamine 86306	C	5	16
pyrene 129000	N	960	11000
aldrin 309002	C	0.00013	0.00014
alpha-BHC 319846	C	0.0039	0.013
beta-BHC 319857	C	0.014	0.046
gamma-BHC (lindane) 58899	C	0.019	0.063
chlordane 57749	C	0.00057	0.00059
4,4'-DDT 50293	C	0.00059	0.0006
4,4'-DDE 72559	C	0.00059	0.00059
4,4'-DDD 72548	C	0.00083	0.00084
dieldrin 60571	C	0.00014	0.00014

Chemical and CAS No.[1]	Carcinogen = C, Non-Carcinogen = N	Water & Organisms Criterion (ug/L)	Organisms only Criterion (ug/L)
alpha-endosulfan 959988	N	0.93	2
beta-endosulfan 33213659	N	0.93	2
endosulfan sulfate 1031078	N	0.93	2
endrin 72208	N	0.76	0.81
endrin aldehyde 7421934	N	0.76	0.81
heptachlor 76448	C	0.00021	0.00021
heptachlor epoxide (BHC) 1024573	C	0.0001	0.00011
PCB-1242 (Arochlor 1242) 53469219	C	0.00017[a]	0.00017[a]
PCB-1254 (Arochlor 1254) 11097691	C	0.00017[a]	0.00017[a]
PCB 1221 (Arochlor 1221) 11104282	C	0.00017[a]	0.00017[a]
PCB-1232 (Arochlor 1232) 11141165	C	0.00017[a]	0.00017[a]
PCB-1248 (Arochlor 1248) 12672296	C	0.00017[a]	0.00017[a]
PCB-1260 (Arochlor 1260) 11096825	C	0.00017[a]	0.00017[a]
PCB-1016 (Arochlor 1016) 12674112	C	0.00017[a]	0.00017[a]
toxaphene 8001352	C	0.00073	0.00075

[1] CAS numbers are three part numbers with a single digit last number, a two digit number preceding the last number and the first part is variable from two to five digits. The CAS number for toxaphene above may be represented as 8001-35-2.

[a]. This criterion applies to total PCBs (e.g., the sum of all congener or isomer or homolog or Aroclor analyses)

2. IMPLEMENTATION - OVERVIEW

The process for developing an effluent limit based on human health (Fig. VII-1) parallels the existing process for developing aquatic life-based limits. However, there are some differences in the procedures used to determine whether a discharge will have a reasonable potential determination made for the human health-based criteria. These include two steps where the discharge is evaluated for (1) likelihood of discharging chemicals of concern, and (2) an evaluation by the agency of whether that discharge is a high priority in the permitting scheme or not.

The process of performing a reasonable potential determination is similar to that used for evaluating aquatic impacts as indicated by chronic aquatic life-based criteria. The differences between the two are the model inputs used to represent the critical flow conditions, the criterion values, and the probability values. Other input data, such as the default value for the coefficient of variation of effluent variability and statistical confidence level remain the same.

3. SCREENING AND PRIORITIZATION

Screening and prioritizing discharges to determine whether a reasonable potential determination should be made is a two step process.

Step 1. After receipt of an NPDES application, the application should be screened o determine if it is a "low risk" discharge or a discharge undergoing modification. <u>These discharges will be omitted from implementation at the present time.</u> "Low risk" discharges include non-process cooling waters without biocides, gravel mining operations without asphalt processes, or other facilities where the permit writer has data or process knowledge to indicate that chemicals regulated under the human health criteria are absent. This determination must be made based on data or process information pointing to absence of chemicals, and cannot be based on a lack of data indicating the presence of chemicals. Discharges undergoing technology based upgrades or improvements that are required by an Ecology order or permit (as specified below) will be omitted in order to allow the effluent to stabilize under the new treatment regime. These discharges will be considered for human health-based limits after their upgrades are completed. These discharges include all industrial storm water dischargers covered under the department's general industrial storm water permit and all municipal storm water discharges. If a discharger is in the planning phase of upgrades in response to an Ecology requirement, the discharger should be told that the effluent will be evaluated for impacts to human health after the upgrades are completed. This will allow the discharger to make plans for more extensive upgrades or process changes earlier on, if desired, and may result in cost savings. After a discharge has been evaluated based on the above criteria, the applicant will either be given no further consideration for human health-based permitting at the present time, or will go on to a second prioritization step.

Step 2. If the screening step results in a "likelihood" finding, the application should be reviewed to determine whether the discharge is a high priority in agency permitting. Those discharges termed "high priority" will go on to have a full reasonable potential determination made on them. The following discharges are classed as high priorities:

1. All major dischargers;

2. Discharges for which existing data or knowledge of processes indicates the known or probable presence of chemicals with human health-based criteria: or,

3. Facilities discharging to a receiving water that is 303(d) listed for a chemical with human health-based criteria, and that chemical is expected to be in the effluent.

If a discharge fits into any of the three groups described above, a reasonable potential determination must be conducted for that discharge. If a discharge does not fit into the groups described above, the application should not be considered further for human health-based effluent limits, but the permit writer should consider requiring submittal of a priority pollutant scan with the next permit application.

4. THE REASONABLE POTENTIAL DETERMINATION

The following section reviews the design criteria for making a determination of reasonable potential of a violation of the water quality criteria for human health. A summary of these is presented in Table VII-2.

4.1 Which Criteria?

A reasonable potential determination is conducted for each chemical in a discharge that (1) has an associated human health-based criterion, and (2) has been found (or is known to exist) in the discharge during the last permit cycle

4.2 Effluent and Background Concentration

Use the 50th percentile effluent concentration. If there is less than 10 effluent data points use a multiplier on the highest effluent concentration to estimate the 50th percentile concentration. If there is more than 10 values use the cumulative percentile calculation at a 95% confidence to derive the 50th percentile (Excel).

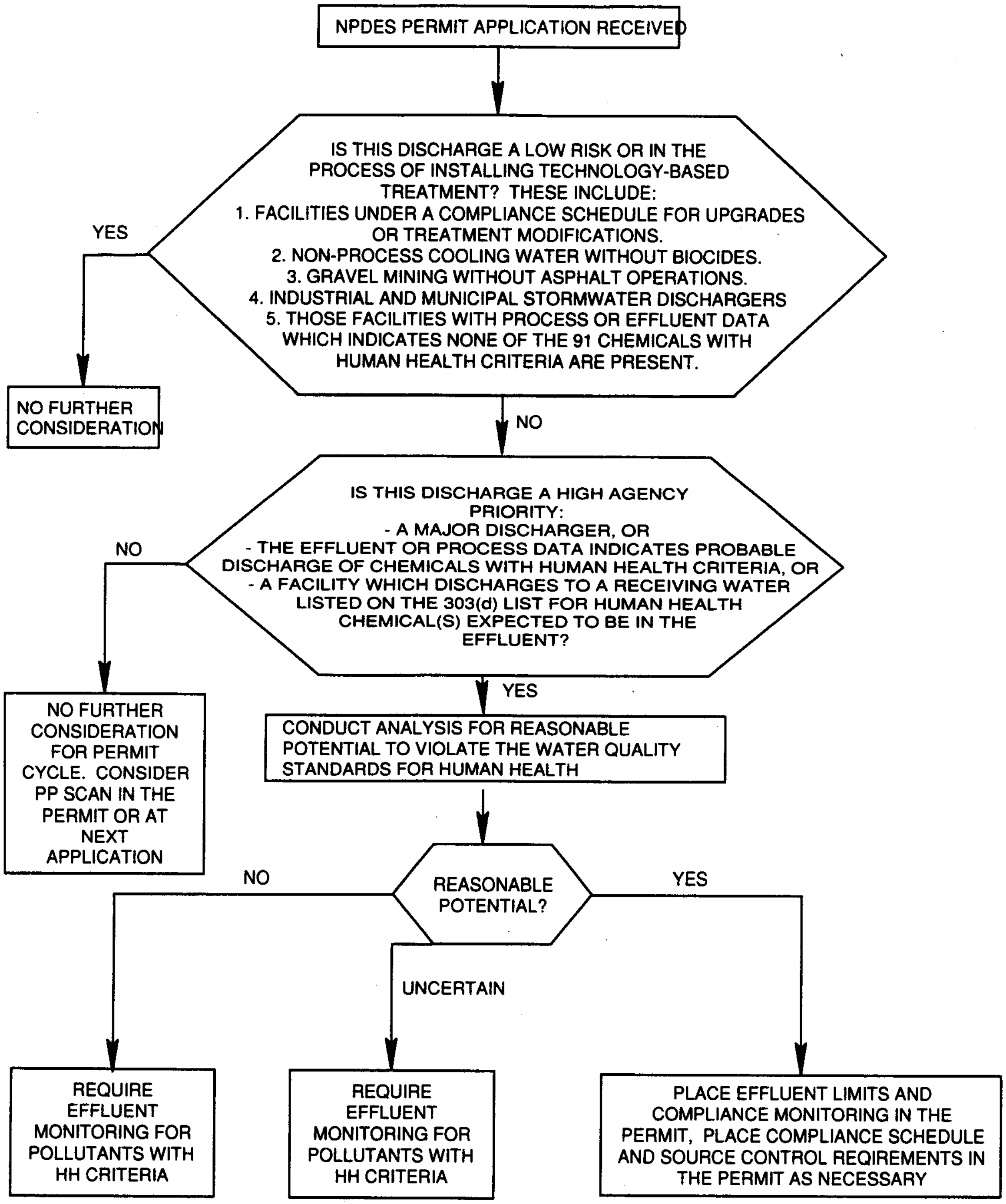
For background concentration(s), use 0 for value(s) below the MDL and use the MDL for values between the MDL and the QL. For multiple data points use the geometric mean

4.3 Mixing Zones

The NTR allows states to use mixing zones already placed in state standards, or to default to an application of the criteria at the "end-of-pipe"(40 CFR 131.36(c)(2)(i).

Washington's Water Quality Standards (Chapter 173-201A WAC) specifies mixing zone sizes for acute and chronic criteria. The mixing zone specified for chronic aquatic life-based criteria will be used for the human health-based criteria. This mixing zone allows for some dilution when calculating effluent limits, but is still protective of human health.

Figure VII-1. Process for Implementing Human Health Criteria.



4.4 Plant Design Flows

The following plant design flows should be used when conducting a human health-based reasonable potential determination. Note that the flows differ depending on whether the criterion is based on cancer or non-cancer effects (see Table VII-1 to determine this).

Carcinogens

Municipal Effluent - Use the annual average design flow as specified in the engineering report, permit application, or a projection of the average annual flow over the life of the permit.

Industrial Effluents - Use the annual average flow based on the permit application or DMR analysis.

Non-carcinogens

Municipal Effluent - Use the dry weather design flow if the facility flows are within 15% of design capacity. If the facility is operating well below design during the critical receiving water period, and there is no substantial projected increase in flows for the period of the next permit, then use the historical flow as defined by the highest monthly average flow for the past three years during the time of year when the critical receiving water period is likely to occur.

Industrial Effluents - Use the historical flow as defined by the highest monthly average flow for the past three years during the period when the critical receiving water flow is most likely to occur. If flows are expected to increase during the life of the permit the highest average monthly flow must be estimated.

4.5 Critical Flow Conditions

The NTR specifies that critical receiving water flow conditions in a state's standards may be used to determine effluent limits for human health criteria. WAC 173-201A-020 allows the state flexibility when determining the critical condition for riverine systems ("...may be assumed equal to the 7Q10 flow event unless determined otherwise by the department") and contains a narrative statement that can be used to determine a marine critical condition.

The flows used to conduct a reasonable potential determination are specified below, and follow the guidance in the NTR as closely as possible. Note that different flows are specified for criteria based on cancer effects and non-cancer effects.

Carcinogens

Freshwater Critical Condition - Use the harmonic mean flow for the representative period of record. The representative period is the period that best represents flows as they now exist. For instance, if a dam was constructed that modified flows, use data from the time after the dam was constructed to determine the critical flow.

Marine/Estuarine Critical Condition - Use the median velocity taken over one tidal cycle or from as many tidal cycles as are available in the period of record.

Non-carcinogens

Freshwater Critical Condition - Use the 30Q5 if available or use the 7Q10 as an estimate of the 30Q5.

Marine/Estuarine Critical Condition - Use the median velocity taken over one tidal cycle or from as many tidal cycles as are available in the period of record.

4.6 Coefficient of Variation of Effluent Concentration

Use 0.6, as is used for aquatic life-based permitting, or the best available estimate.

4.7 Dilution Factor

Use a value derived from a reliable model (as is used for aquatic life-based permitting) or from an ambient dilution study or use percent of flow if that is more stringent. If reliable values are not available, estimate flows or use percent of flow to determine reasonable potential and then insert a requirement in the permit for the discharger to provide a reliable dilution value to the department no later than the next permit reapplication (see Chapter XIII, Monitoring).

4.8 Statistical Confidence Level

Use an alpha equal to 0.05 when calculating reasonable potential.

4.9 Background Data on Chemical Concentrations

Use available background data on chemical concentrations in the water column, or use zero as a default value if reliable data are not available.

Table VII-2. Design conditions for water quality-based permitting of human health criteria.

Design Conditions for Mixing Zone/Ratio Analysis - Human Health Criteria		
Parameter	**Pollutant**	**Critical Design Condition**
Facility Effluent (Flow)	Carcinogen	The design effluent flow is defined as the annual average flow based on the engineering report, permit application or DMR analysis.
	Non-carcinogen	The design effluent flow is defined as the highest monthly average plant effluent flow for the past three years during the critical flow or when critical condition is likely to occur. If plant effluent flows are expected to increase during the life of the permit, the highest average monthly flow must be estimated.
Receiving Water (Characteristics)	Carcinogen - Freshwater	The design receiving water current velocity is defined as the current velocity at the harmonic mean flow for the representative period of record. The diffuser depth is defined as the depth at the harmonic mean flow.
	Non-carcinogen - Freshwater	The design receiving water current velocity is defined as the current velocity at the 30-day low flow period with a recurrence interval of 5 years (30Q5) if available or at 7Q10. The diffuser depth is defined as the depth at the 30Q5 or 7Q10 low flow period.
	Carcinogen - Saltwater	The design receiving water current velocity is defined as the 50th percentile current velocity derived from a cumulative frequency distribution analysis. The current velocity frequently distribution analysis should be conducted, at minimum, over one tidal cycle. The design ambient density profile is defined as the density profile that results in average mixing. The diffuser depth is defined as the depth at MLLW. For estuaries, the diffuser depth is defined as the smaller of the median water depth at either the ebb tide or the flood tide during the critical receiving water period.
	Non-carcinogen - Saltwater	The design receiving water current velocity is defined as the 50th percentile current velocity derived from a cumulative frequency distribution analysis. The current velocity frequency distribution analysis should be conducted, at minimum, over one tidal cycle. The design ambient density profile is defined as the density profile that results in average mixing. The diffuser depth is defined as the depth at MLLW. For estuaries, the diffuser depth is defined as the smaller of the median water depth at either the ebb tide or the flood tide during the critical receiving water period.

Miscellaneous Design Conditions for Mixing Zone/Ratio Analysis

Parameter	No. of Data Points	Methodology
Receiving Water Background Concentration (Human Health)	N/A	The geometric mean of receiving water concentrations is used to determine reasonable potential. If background is between the MDL and the QL use the MDL. If the background concentration is below the MDL, use 0. If no background data is available use 0.
Effluent Concentration (Human Health)	N/A	Use the 50th percentile effluent concentration. If there is less than 10 effluent data points use the following multipliers (see box following) on the highest effluent concentration to estimate the 50th percentile concentration. If there is more than 10 values use the cumulative percentile calculation at a 95% confidence to derive the 50th percentile (Excel).
Dilution Ratio Unidirectional flow (freshwater)	N/A	Flux average
Dilution Ratio Multidirectional flow (marine)	N/A	Flux average
Reflux	N/A	Assume reflux reduces the dilution factor by 1/2 or use site-specific data.
The point of compliance with the human health criteria is the boundary of the chronic mixing zone.		
Chronic design conditions are used for both the initial mixing and the far-field mixing calculations.		

NUMBER OF EFFLUENT SAMPLES FOR DETERMINING REASONABLE POTENTIAL FOR HUMAN HEALTH CRITERIA	FACTORS BY WHICH TO MULTIPLY THE HIGHEST EFFLUENT CONCENTRATION VALUE TO ESTIMATE THE 50TH PERCENTILE VALUE (CV = 0.6, 95% CONFIDENCE)
1	2.5
2	1.5
3	1.2
4	1.0
5	0.9
6	0.9
7	0.8
8	0.8
9	0.7
10	0.7
The values in this table were calculated using EPA's method (TSD, Section 3.3.2) of estimating quantile values from a limited data set presumed to be log normally distributed.	

5. RESULTS OF THE REASONABLE POTENTIAL DETERMINATION

The reasonable potential determination will result in three possible outcomes. These are "yes", "no", or "can't determine". The following paragraphs explain how to set up permit requirements for the three possible results.

5.1 Yes, a Reasonable Potential Exists to Exceed Water Quality Standards

If the reasonable potential determination shows that there is a potential for one or more water quality criteria to be exceeded, then effluent limits should be placed in the permit for the constituent(s) of concern (TSDCALC.XLW). The effluent limits are calculated by setting the average monthly limit equal to the WLA and using Table 5-3 of the TSD (99^{th} and 95^{th} percentile) to calculate the maximum daily limit. The permit should also contain a compliance schedule if one is needed. The length of the compliance schedule should be evaluated individually for each facility. The permit should also contain source control requirements in order to ensure that efforts to comply with the permit limits in a timely manner are being made. These source control requirements should be set out in a phased approach. For instance, initial requirements should be to evaluate sources of pollutants, and examine ways to control those sources. That phase should be followed by requirements to implement methods of control. The timing of the requirements will differ from facility to facility. In some cases, where sources are already known and may be easily controllable, short compliance schedules may be appropriate. In other cases, unknown sources or reduction issues may make a longer compliance schedule appropriate. Source reduction requirements should be aimed at pollution prevention, and, if possible, not be aimed at treatment methods that would involve large capital expenditures by dischargers. Compliance schedules should be shorter if fishing, shellfishing, or drinking water uses of the receiving water body are known or suspected to be impaired.

5.1.1. Compliance Monitoring

Permits with effluent limits should also contain requirements for priority pollutant scan monitoring during wet and dry seasons of years three and four of the permit. Effluent limits must be monitored at least once yearly. The recommended frequency is one/month.

5.2 No, a Reasonable Potential Does Not Exist to Exceed Water Quality Standards

If the results of the reasonable potential indicate that an exceedance of water quality standards is unlikely to occur, the permit should not contain effluent limits. The permit should, however, contain requirements for priority pollutant scan monitoring once during the wet and once during the dry seasons of year three of the permit. This information should be submitted with the next permit application. In addition, other information may be needed to more clearly make a reasonable potential determination at the next permit reissuance. These will be factors that are acceptable for decision making at this time, but about which valid biological or engineering issues still need to be addressed. For instance, using a river model program to estimate dilution is frequently acceptable, but in some cases the physical characteristics of the river (e.g., river bottom topography, curvature of river) make a field dilution study desirable to validate the model. In this case, although a reasonable potential determination can be made with the available data, the permit should contain requirements for a field dilution study to calibrate or verify modeling work.

5.3 The Result of the Reasonable Potential Determination is Ambiguous, or, "Can't Determine".

The result "can't determine" will likely result from poor or incomplete effluent data, background data or unreliable dilution estimates. If this outcome occurs the permit should be issued with requirements to conduct two priority pollutant scans during year three of the permit, one during the wet season and one during the dry season. These data should be submitted with the appropriate DMRs. In addition, the permit should contain requirements to provide data to clarify any other factors leading to the "can't determine" finding. For instance, if the reasonable potential determination does not yield a reliable "yes" or "no" result because of unreliable dilution information, the permit should require that a dilution study be performed during the permit cycle, with data available, at latest, with the next permit application.

6. ANALYTICAL METHODS

Table VII-3 shows the analytical methods that should be used for general priority pollutant scans. These analyses are grouped by chemical classes, and not on a chemical-by-chemical basis. In general, it is not effective to require an individual and different method for each chemical in a priority pollutant scan. Instead, the usual default will be to require the most sensitive analytical method for a particular chemical analysis that will measure a suite of chemicals (e.g., Method 608 for pesticides). In order to determine the most cost effective analytical methods for monitoring priority pollutants, the relevant measurement values for discharges that get over 100:1 dilution were compared to the measurement values needed for discharges that would have zero dilution. This comparison indicated that, while some criteria chemicals could be analyzed using less expensive methods if discharges had large amounts of dilution, many criteria are at such low concentrations that the most sensitive analytical methods are needed even if large amounts of dilution are present. These low level criteria exist within all chemical classes of the regulated chemicals. Tables VII-3 and VII-4 indicate the analytical methods that could be required for each criteria chemical for discharges with greater than 100:1 dilution and discharges with less than 100:1 dilution. These chemical specific methods may be useful for compliance monitoring.

Table VII-3. Recommended methods for monitoring priority pollutant scans in wastewater.

Chemical Type	Analytical Method
Metals	GFAA, cold vapor for mercury (see Table VII-2 for specific method numbers)
Cyanide	EPA 335.2
Dioxin*	EPA 1613*
Volatile Compounds	EPA 601, 602, and 603, or, EPA 624
Base/Neutral/Acids	EPA 604, 605, 606, 607, 609, 610, 611, and 612, or, EPA 625
Pesticides	EPA 608

Table VII-4. Monitoring water and tissue-based quantitation levels. Methods, detectors, method detection levels and instrument detection levels, and quantitation levels for methods approved by USEPA for use in the NPDES permit program. All data is in µg/L unless otherwise specified. Instrument detection levels are presented for metals, and method detection levels are presented for organics.

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
METAL					
Antimony	204.1	FAA	200		1000
	204.2	GFAA	3		15
	200.7	ICP	32		160
Arsenic	206.3	AA/GH	2		10
	206.2	GFAA	1		5
	200.7	ICP	53		265
	206.4	Colorimetric	10		50
Beryllium	210.1	FAA	5		25
	210.2	GFAA	0.2		1
	200.7	ICP	0.3		1.5
	Ftnote 1	Colorimetric	5		25
	Ftnote 2	DCP	0.3		1.5
Cadmium	213.1	FAA	5		25
	213.2	GFAA	0.1		0.5
	200.7	ICP	4		20
	Ftnote 3	Colorimetric	20		100
	Ftnote 2	DCP	5		25
Chromium	218.1	FAA	50		250
	218.3	FAA/CE	1		5
	218.2	GFAA	1		5
	200.7	ICP	7		35
	Ftnote 4	Colorimetric	200		1000
	Ftnote 2	DCP	2		10

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
Chromium +6, Dissolved	218.4	FAA/CE	8		40
	Ftnote 4	Colorimetric	200		1000
Copper	220.1	FAA	20		100
	220.2	GFAA	1		5
	200.7	ICP	6		30
	Ftnote 5	Colorimetric	10		50
	Ftnote 2	DCP	2		10
Lead	239.1	FAA	100		500
	239.2	GFAA	1		5
	200.7	ICP	42		210
	Ftnote 6	Colorimetric	3		15
	Ftnote 2	DCP	7		35
Mercury	245.1 or 245.2	Cold Vapor	0.2		1
Nickel	249.1	FAA	40		200
	249.2	GFAA	1		5
	200.7	ICP	15		75
	Ftnote 7	Colorimetric	2000		10000
	Ftnote 2	DCP	2		10
Selenium	270.3	FAA	2		10
	270.2	GFAA	2		10
	200.7	ICP	75		375
Silver	272.1	FAA	10		50
	272.2	GFAA	0.2		1
	200.7	ICP	7		35
	Ftnote 9	Colorimetric	2		10
	Ftnote 2	DCP	4		20
Thallium	279.1	FAA	100		400
	279.2	GFAA	1		4

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
	200.7	ICP	40		160
Zinc	289.1	FAA	5		25
	289.2	GFAA	0.05		0.25
	200.7	ICP	2		10
	Ftnote 10	Dithizone	100		500
	Ftnote 11	Zincon	20		100
	Ftnote 2	DCP	6		30
Cyanide (total)	335.2	Titrimetric	20		
	335.3	Spectrophotometric	200		
DIOXIN					
2,3,7,8-Tetrachloro-dibenzo-p-dioxin (TCDD)	1613	HRGC/HRMS		10 ppq (EPA specifies a minimum level of 10 ppq be used for quantitation)	10 ppq
	613	GC/MS	0.002		
VOLATILE COMPOUNDS					
Acrolein	603	GC/FID	0.7		
	624/1-624	GC/MS		50 = ML (Ftnote 13)	50
Acrylonitrile	603	GC/FID	0.5		
	624/1-624	GC/MS		50 = ML	50
Benzene	602	GC/PID	0.2		
	624/1-624	GC/MS	4.4		17.6
Bromoform	601	GC/HECD	0.2		
	624	GC/MS	4.7		

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
	1624	GC/MS		10 = ML	10
Carbon Tetrachloride	601	GC/HECD	0.12		
	624	GC/MS	2.8		
	1624	GC/MS		10 = ML	10
Chlorobenzene	601	GC/HECD	0.25		
	602	GC/PID	0.2		
	624	GC/MS	6		
	1624	GC/MS		10 = ML	10
Chlorodibromomethane	601	GC/HECD	0.09		
	624	GC/MS	3.1		
	1624	GC/MS			
Chloroethane	601	GC/HECD	0.52		
	624	GC/MS			
	1624	GC/MS		50 = ML	50
2-Chloroethyl vinyl ether	601	GC/HECD	0.13		
	624	GC/MS			
	1624	GC/MS		10 = ML	10
Chloroform	601	GC/HECD	0.05		
	624	GC/MS	1.6		
	1624	GC/MS		10 = ML	10
Dichlorobromomethane	601	GC/HECD	0.1		
	624	GC/MS	2.2		
	1624	GC/MS		10 = ML	10
1,1-Dichloroethane	601	GC/HECD	0.07		
	624	GC/MS	4.7		
	1624	GC/MS		10 = ML	10
1,2-Dichloroethane	601	GC/HECD	0.03		
	624	GC/MS	2.8		
	1624	GC/MS		10 = ML	10

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
Dichloroethylene	601	GC/HECD	0.13		
	624	GC/MS	2.8		
	1624	GC/MS		10 = ML	10
1,2-Dichloropropane	601	GC/HECD	0.04		
	624	GC/MS	6		
	1624	GC/MS		10 = ML	10
1,3-Dichloropropene					
cis-1,3-Dichloropropene	601	GC/HECD	0.34		
	624	GC/MS	5		
	1624	GC/MS			
trans-1,3-Dichloropropene	601	GC/HECD	0.2		
	624	GC/MS			
	1624	GC/MS		10 = ML	10
Ethylbenzene	602	GC/PID	0.2		
	624	GC/MS	7.2		
	1624	GC/MS		10 = ML	10
Bromomethane	601	GC/HECD	1.18		
	624	GC/MS			
	1624	GC/MS		50 = ML	50
Chloromethane	601	GC/HECD	0.08		
	624	GC/MS			
	1624	GC/MS		50 = ML	50
Methylene Chloride	601	GC/HECD	0.25		
	624	GC/MS	2.8		
	1624	GC/MS		10 = ML	10
1,1,2,2-Tetrachloroethane	601	GC/HECD	0.03		
	624	GC/MS	6.9		
	1624	GC/MS		10 = ML	10

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
Tetrachloroethylene	601	GC/HECD	0.03		
	624	GC/MS	4.1		
	1624	GC/MS		10 = ML	10
Toluene	602	GC/PID	0.2		
	624	GC/MS	6		
	1624	GC/MS		10 = ML	10
1,2-trans-Dichloroethylene	601	GC/HECD	0.1		
	624	GC/MS	1.6		
	1624	GC/MS		10 = ML	10
1,1,1-Trichloroethane	601	GC/HECD	0.03		
	624	GC/MS	3.8		
	1624	GC/MS		10 = ML	10
1,1,2-Trichloroethane	601	GC/HECD	0.02		
	624	GC/MS	5		
	1624	GC/MS		10 = ML	10
Trichloroethylene	601	GC/HECD	0.12		
	624	GC/MS	1.9		
	1624	GC/MS		10 = ML	10
Vinyl Chloride	601	GC/HECD	0.18		
	624	GC/MS			
	1624	GC/MS		10 = ML	10
ACID COMPOUNDS					
2-Chlorophenol	604	GC/FID	0.31		
	604	GC/ECD	0.58		
	625	GC/MS	3.3		
	1625	GC/MS		10 = ML	10
2,4-Dichlorophenol	604	GC/FID	0.39		
	604	GC/ECD	0.68		
	625	GC/MS	2.7		

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
	1625	GC/MS		10 = ML	10
2,4-Dimethylphenol	604	GC/FID	0.32		
	604	GC/ECD	0.63		
	625	GC/MS	2.7		
	1625	GC/MS		10 = ML	10
2 methyl 4,6-dinitrophenol	604	GC/FID	16		
	625	GC/MS	24		
	1625	GC/MS		20 = ML	20
2,4-Dinitrophenol	604	GC/FID	13		
	625	GC/MS	42		
	1625	GC/MS		50 = ML	50
2-Nitrophenol	604	GC/FID	0.45		
	604	GC/ECD	0.77		
	625	GC/MS	3.6		
	1625	GC/MS		20 = ML	20
4-Nitrophenol	604	GC/FID	2.8		
	604	GC/ECD	0.7		
	625	GC/MS	2.4		
	1625	GC/MS		50 = ML	50
4 chloro-3-methylphenol	604	GC/FID	0.36		
	604	GC/ECD	1.8		
	625	GC/MS	3		
	1625	GC/MS		10 = ML	10
Pentachlorophenol	604	GC/FID	7.4		
	604	GC/ECD	0.59		
	625	GC/MS	3.6		
	1625	GC/MS		50 = ML	50
Phenol	604	GC/FID	0.14		
	604	GC/ECD	2.2		

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
	625	GC/MS	1.5		
	1625	GC/MS		10 = ML	10
2,4,6-Trichlorophenol	604	GC/FID	0.64		
	604	GC/ECD	0.58		
	625	GC/MS	2.7		
	1625	GC/MS		10 = ML	10
BASE/NEUTRAL COM-POUNDS					
Acenaphthene	610	HPLC	1.8		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
Acenaphthylene	610	HPLC	2.3		
	625	GC/MS	3.5		
	1625	GC/MS		10 = ML	10
Anthracene	610	HPLC	0.66		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
Benzidine	605	HPLC	0.08		
	625	GC/MS	50		
	1625	GC/MS		50 = ML	50
Benzo(a)anthracene	610	HPLC	0.013		
	625	GC/MS	7.8		
	1625	GC/MS		10 = ML	10
Benzo(a)pyrene	610	HPLC	0.023		
	625	GC/MS	2.5		
	1625	GC/MS		10 = ML	10
3,4-Benzofluoranthene					
Benzo(ghi)perylene	610	HPLC	0.076		
	625	GC/MS	4.1		

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
	1625	GC/MS		20 = ML	20
Benzo(k)fluoranthene	610	HPLC	0.017		
	625	GC/MS	2.5		
	1625	GC/MS		10 = ML	10
Bis(2-chloroethoxy) methane	611	GC	0.5		
	625	GC/MS	5.3		
	1625	GC/MS		10 = ML	10
Bis(2-chloroethyl) ether	611	GC	0.3		
	625	GC/MS	5.7		
	1625	GC/MS		10 = ML	10
Bis(2-Ethylhexyl) Phthalate	611	GC	2		
	625	GC/MS	2.5		
	1625	GC/MS		10 = ML	10
4-Bromophenyl phenyl ether	611	GC/HECD	2.3		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
Butyl benzyl Phthalate	606	GC/ECD	0.34		
	625	GC/MS	2.5		
	1625	GC/MS		10 = ML	10
2-Chloronapthalene	612	GC/ECD	0.94		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
4-Chlorophenyl phenyl ether	611	GC/HECD	3.9		
	625	GC/MS	4.2		
	1625	GC/MS		10 = ML	10
Chrysene	610	HPLC	0.15		
	625	GC/MS	2.5		
	1625	GC/MS		10 = ML	10

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
Dibenzo (a,h) anthracene	610	HPLC	0.03		
	625	GC/MS	2.5		
	1625	GC/MS		20 = ML	20
1,2-Dichlorobenzene	601	GC/HECD	0.15		
	602	GC/PID	0.4		
	612	GC/ECD	1.14		4.56
	624	GC/MS			
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
1,3-Dichlorobenzene	601	GC/HECD	0.32		
	602	GC/PID	0.4		
	612	GC/ECD	1.19		
	624	GC/MS			
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
1,4-Dichlorobenzene	601	GC/HECD	0.24		
	602	GC/PID	0.3		
	612	GC/ECD	1.34		
	624	GC/MS			
	625	GC/MS	4.4		
	1625	GC/MS		10 = ML	10
3,3'-Dichlorobenzidine	605	HPLC	0.13		
	625	GC/MS	16.5		
	1625	GC/MS		50 = ML	10
Diethyl Phthalate	606	GC/ECD	0.49		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
Dimethyl Phthalate	606	GC/ECD	0.29		
	625	GC/MS	1.6		

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
	1625	GC/MS		10 = ML	10
Di-n-Butyl Phthalate	606	GC/ECD	0.36		
	625	GC/MS			
	1625	GC/MS		10 = ML	10
2,4-Dinitrotoluene	609	GC/ECD	0.02		
	625	GC/MS	5.7		
	1625	GC/MS		10 = ML	10
Di-n-octyl Phthalate	606	GC/ECD	3		
	625	GC/MS	2.5		
	1625	GC/MS		10 = ML	10
1,2-Diphenylhydrazine	1625	GC/MS		20 = ML	20
	(This method not specified as approved in 40 CFR Part 136, but ML provided in Method 1625).				
Fluoranthene	610	HPLC	0.21		
	625	GC/MS	2.2		
	1625	GC/MS		10 = ML	10
Fluorene	610	HPLC	0.21		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
Hexachlorobenzene	612	GC/ECD	0.5		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
Hexachlorobutadiene	612	GC/ECD	0.34		
	625	GC/MS	0.9		
	1625	GC/MS		10 = ML	10
Hexachlorocyclopentadiene	612	GC/ECD	0.4		
	625	GC/MS			
	1625	GC/MS		10 = ML	10
Hexachloroethane	612	GC/ECD	0.03		

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CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
	625	GC/MS	1.6		
	1625	GC/MS		10 = ML	10
Indeno (1,2,3-cd) pyrene	610	HPLC	0.043		
	625	GC/MS	3.7		
	1625	GC/MS		20 = ML	20
Isophorone	609	GC/FID	5.7		
	609	GC/ECP	15.7		
	625	GC/MS	2.2		
	1625	GC/MS		10 = ML	10
Naphthalene	610	HPLC	1.8		
	625	GC/MS	1.6		
	1625	GC/MS		10 = ML	10
Nitrobenzene	609	GC/FID	3.6		
	609	GC/ECD	13.7		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
N-nitrosodimethylamine	607	GC/NPD	0.15		
	625	GC/MS			
	1625	GC/MS		50 = ML	50
N-nitrosodi-n-propylamine	607	GC/NPD	0.46		
	625	GC/MS			
	1625	GC/MS		20 = ML	20
N-nitrosodiphenylamine	607	GC/NPD	0.81		
	625	GC/MS	1.9		
	1625	GC/MS		20 = ML	20
Phenanthrene	610	HPLC	0.64		
	625	GC/MS	5.4		
	1625	GC/MS		10 = ML	10
Pyrene	610	HPLC	0.27		

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
1,2,4-Trichlorobenzene	612	GC/ECD	0.05		
	625	GC/MS	1.9		
	1625	GC/MS		10 = ML	10
PESTICIDES					
Aldrin	608	GC/ECD	0.004		
	625	GC/MS	1.9		
Alpha-BHC	608	GC/ECD	0.003		
	625	GC/MS			
Beta-BHC	608	GC/ECD	0.006		
	625	GC/MS	4.2		
Gamma-BHC (Lindane)	608	GC/ECD	0.004		
	625	GC/MS			
Delta-BHC	608	GC/ECD	0.009		
	625	GC/MS	3.1		
Chlordane	608	GC/ECD	0.014		
	625	GC/MS			
4,4'-DDT	608	GC/ECD	0.012		
	625	GC/MS	4.7		
4,4'-DDE (p,p-DDX)	608	GC/ECD			
	625	GC/MS	0.004		
4,4'-DDD (p,p-TDE)	608	GC/ECD	0.011		
	625	GC/MS	2.8		
Dieldrin	608	GC/ECD	0.002		
	625	GC/MS	2.5		
Alpha-endosulfan	608	GC/ECD	0.014		
	625	GC/MS			
Beta-endosulfan	608	GC/ECD	0.004		

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
	625	GC/MS			
Endosulfan sulfate	608	GC/ECD	0.066		
	625	GC/MS	5.6		
Endrin	608	GC/ECD	0.006		
	625	GC/MS			
Endrin aldehyde	608	GC/ECD	0.023		
	625	GC/MS			
Heptachlor	608	GC/ECD	0.003		
	625	GC/MS	1.9		
Heptachlor epoxide	608	GC/ECD	0.083		
(BHC-hexachlorocyclo-	625	GC/MS	2.2		
'hexane)					
PCB-1242	608	GC/ECD	0.065		
	625	GC/MS			
PCB-1254	608	GC/ECD		1.0 =USEPA CLP CRDL	1
	625	GC/MS			
PCB-1221	608	GC/ECD		1.0 =USEPA CLP CRDL	1
	625	GC/MS	30		120
PCB-1232	608	GC/ECD		1.0 =USEPA CLP CRDL	1
	625	GC/MS			
PCB-1248	608	GC/ECD		1.0 =USEPA CLP CRDL	1
	625	GC/MS			
PCB-1260	608	GC/ECD		1.0 =USEPA CLP CRDL	1
	625	GC/MS			
PCB-1016	608	GC/ECD		1.0 =USEPA CLP CRDL	1

CHEMICAL	Method Number	Detector	Method IDL or MDL	Published quantitation level	QL[12]
	625	GC/MS			
Toxaphene	608	GC/ECD	0.24		
	625	GC/MS			

Footnotes

1. Method 309.B, Standard Methods for the Examination of Water and Wastewater, 16th Edition

2. Direct Current Plasma (DCP) Optical Emission Spectrometric Method for Trace Elemental Analysis of Water and Wastes, Method AES0029." 1986, Applied Research LaboratoriesInc., 24911 Avenue Stanford, Valencia, CA 91355.

3. Method 310.B, Standard Methods for the Examination of Water and Wastewater, 16th Edition

4. Method 312.B, Standard Methods for the Examination of Water and Wastewater, 16th Edition

5. Method 313.B, Standard Methods for the Examination of Water and Wastewater, 16th Edition

6. Method 316.B, Standard Methods for the Examination of Water and Wastewater, 16th Edition

7. Method 321.B, Standard Methods for the Examination of Water and Wastewater, 16th Edition

8. Methods 323B or 323.C, Standard Methods for the Examination of Water and Wastewater, 16th Edition

9. Method 319.B, Standard Methods for the Examination of Water and Wastewater, 14th Edition

10. Method 328.C, Standard Methods for the Examination of Water and Wastewater, 16th Edition

11. Zinc, Zincon Method, Method 8009, Hach Handbook of Water Analysis, 1979, pages 2-231 and 2-333, Hach Chemical Company, Loveland, CO 80537.

12. Quantitation Levels. When published quantitation levels or performance levels are available those levels are used directly as QLs. Otherwise, Qls are equal to five times the MDL for metals. Quantitation Levels for organics (for methods other than presented in Table IV-2) should be developed in consultation with the organics chemist at the Manchester Environmental Laboratory and the Program Development Services Section.

13. Minimum Level. Defined by EPA (40 CFR Part 136,App. A, Meth. 1624, 1625) as "the minimum level at which the entire GC/MS system must give recognizable mass spectra (background corrected) and acceptable calibration points."

CHAPTER VIII. DERIVING WATER QUALITY-BASED EFFLUENT LIMITATIONS FOR THE PROTECTION OF GROUND WATER QUALITY

In Washington, any commercial or industrial operation discharging wastewater to ground must have a discharge permit. The permit writer, in developing that permit, must consider the effect of the discharge on the quality of ground water.

1. GROUND WATER CRITERIA AND STANDARDS

The Water Quality Standards for Ground Waters of the State of Washington (Chapter 173-200 WAC) are similar to the water quality standards for surface waters. They define the beneficial uses to be protected, they specify the concentrations of chemicals to protect the beneficial uses, they have an antidegradation section, and they generally define the point of compliance.

The implementation process for the ground water standards is found in *Implementation Guidance for the Ground Water Quality Standards*, Ecology Publication 96-02.

1.1 Numeric Criteria

The numeric criteria within the ground water standards are divided into I. Primary and Secondary Contaminants and Radionuclides and II. Carcinogens. Section 173-200-040(2)(b)(iii) says that the criteria for primary, secondary and radionuclides are automatically updated as other state and federal rules are amended.

The Implementation Guidance indicates that any new substance identified as a carcinogen will have a criteria derived by using formulas and risk assumptions given in the guidance.

Ecology has subsequently decided that the criteria will remain as the promulgated values in Chapter 173-200 and will change only as a result of rule revision.

2. ASSESSING THE IMPACTS OF COMMUNITY ON-SITE SEWAGE SYSTEMS ON GROUND WATER QUALITY

2.1 Overview:

On-site sewage systems using community drainfields are prevalent in Western Washington. The question of how to apply the Ground Water Quality Standards is an emerging issue for those systems which are under Ecology's authority and for those which are regulated by the health departments. Applying the criteria established in Chapter 246-272 WAC (On-Site Sewage System Regulations) will not necessarily achieve compliance with the Ground Water Quality Standards (Chapter 173-200 WAC). The on-site sewage system regulations are designed to protect public health; the goal is not necessarily ground water protection. These regulations contain siting criteria which are established to assure that all the components of a system can physically fit onto a site. This regulation does not address the ability of an aquifer to assimilate contaminants released from these systems. The Ground Water Quality Standards are designed to protect ground water from any activity that has a potential to impact water quality. This includes discharges from both individual and community on-site sewage systems.

The Ground Water Quality Standards must be considered for all developments that propose to treat and dispose of wastewater on-site. Even if a state waste discharge permit is not required, the Ground Water Quality Standards still apply to on-site sewage systems. Proposals should be critically reviewed by evaluating the assumptions and verifying the calculations. All numbers used in these calculations must either be referenced by data, literature or rationale.

Ground Water Quality Standards:
The Ground Water Quality Standards contain an antidegradation policy which is designed to protect the existing quality of ground water when the quality is higher than the criteria assigned to those waters. Contaminants will not be allowed to degrade existing water quality unless two tests are met. The first test is that all known, available, and reasonable methods of prevention, control, and treatment is applied prior to discharge (AKART). AKART for community on-site sewage systems relies on a combination of both treatment and density. The second test to be applied is that the discharge shall be in overriding consideration of the public interest. Ecology has determined that this test is met if the ***combination of treatment and density results in a maximum of 2 mg N/l increase over background concentrations, as long as it does not cause the criteria to be exceeded.***

2.2 Model for Calculating Impacts to Ground Water Quality:

This model estimates the impacts to ground water quality from an on-site sewage systems. It incorporates site specific hydrogeologic characteristics and acts to dilute the effluent with precipitation and ground water flowing underneath the site. The Ground Water Quality Standards protect all ground water; therefore, the emphasis goes beyond simply protecting drinking water from a water supply source, to protecting the resource as a whole. The following equations are designed to establish mixing zone boundaries. This model dilutes the effluent with the recharge water that falls on the drainfield and mixes this infiltrating water with the ground water downgradient of the drainfield up to the property boundary within the uppermost 20 feet of the aquifer. This option takes into account the natural assimilative capacity of the aquifer by incorporating hydrogeologic parameters to evaluate ground water quality in the uppermost aquifer.

The number derived using the equation is directly effected by the level of treatment the wastewater receives prior to being discharged, and the area over which the contaminants can be assimilated. The numbers used in this model should be based on site specific conditions or values cited in the literature.

Mass Balance Mixing Model:

Equations	Description
$V_R = A_D R\ (0.00170788)$	Calculates the volume of precipitation that falls over the drainfield area.
$N_I = \dfrac{V_R N_R + V_W N_W (1\text{-}d)}{V_R + V_W}$	Calculates the total nitrogen loading to the aquifer from the effluent and the precipitation.
$V_I = V_R + V_W$	Calculates the total volume of water which is infiltrated from the drainfield.
$Q = KibW_A\ (7.48052)$	Calculates the volume of ground water flowing underneath the property.
$N_{GW} = \dfrac{Q N_B + V_I N_I}{Q + V_I}$	Calculates the total nitrogen concentration in ground water at the property boundary after the infiltration water mixes with ground water.

*The variables in these equations are defined in Table 1.

Model Assumptions:
The following assumptions should be used in this model unless other values are appropriate and rationale can be provided to substantiate their use:

Table 1. Variables used in Calculating Nitrate Impacts to Ground Water:

Variables	*Units*	*Recommended Literature Values*
Volume of recharge over drainfield (V_R)	gpd	
Area of drainfield (A_D)	ft^2	
Volume of recharge (R)	in/yr	
Total nitrogen concentration from drainfield area (N_I)	mg/l	
Nitrate concentration in precipitation (N_R)	mg/l	0.24 mg N/l
Volume of wastewater (V_W)	gpd	
Total nitrogen concentration in wastewater (N_W)	mg/l	60 mg N/l
Denitrification rate in subsurface (d)	%	10%
Volume of infiltration from drainfield area (V_I)	gpd	
Aquifer discharge (Q)	gpd	
Hydraulic conductivity of aquifer (K)	ft/day	
Hydraulic gradient (i)	ft/ft	
Depth of mixing in aquifer (b)	ft	20 ft
Width of aquifer (W_A)	ft	
Downgradient ground water nitrogen concentration (N_{GW})	mg/l	
Nitrate concentration of upgradient gw (N_B)	mg/l	
Flow per household (w)	gpd	113 gpd/household
Number of homes (n)		

gpd = gallons per day
mg/l = milligrams per liter
ft = feet
in/yr = inches per year

The values listed in Table 1 are typical values which are referenced in recent literature. The rationale for some of these values are explained below. These are the appropriate assumptions which should be used in the model.

Depth of Mixing within the Aquifer: Most ground water flow equations assume that complete mixing and dilution occurs throughout the full extent of the aquifer. However, the majority of nitrogen in ground water will reside in the uppermost 20 feet of the uppermost aquifer with concentrations decreasing as the depth increases, (Kramer, 1987). Ground water mixing is a slow process and is not as dynamic as surface water. Most ground water is stratified which is reflective of local dispersion and diffusion. Perkins (1984) determined that the nitrate level in the uppermost zones are from anthropogenic sources and are related to waste disposal activities. Consequently, contaminants discharged from the on-site system will not be equally distributed over the entire property, or be equally combined with all ground water underneath the site. In most hydrologic scenarios, complete mixing will not occur vertically throughout the full extent of the aquifer. Therefore, a boundary condition is established to limit mixing to the uppermost 20 feet of the aquifer.

Denitrification Rate: Denitrification requires very specific environmental conditions, including anaerobic conditions, in order for nitrate to be converted. A denitrification rate of 10 % should be assumed unless rationale or references can be provided to substantiate why a different rate is appropriate.

Volume of Wastewater: The average person uses 45 gallons per day (EPA, 1980), (Canter and Knox, 1985), (Miller, 1980), and there is an average of 2.5 people per household (Office of Financial Management, 1991). Therefore the average volume of water released to the subsurface is 113 gpd/household.

Nitrogen Loading: Typical domestic sewage nitrogen concentrations range from 35 to 100 mg N/1, (EPA, 1980). A median value for use in this model is approximately 60 mg N/l, (EPA, 1980). Perkins (1984), and Kaplan (1987), also recommend using 60 mg N/1 as a typical average nitrogen value contained in domestic sewage. Total nitrogen is considered since organic nitrogen and ammonia will readily convert to nitrate in most aerobic environments.

Nitrogen Concentration in Precipitation: Precipitation typically contains very low concentrations of nitrogen. Hem (1985) consolidated the results from six different studies ranging from 0.02 mg N/1 to 0.62 mg N/1. The mean value, 0.24 mg N/1, is an appropriate value to use in the absence of site specific information.

Options for Discharge:

The Ground Water Quality Standards establish a ground water criteria of 10 mg N/1. This number delineates when a beneficial use has been exceeded. However, it is not the goal. Antidegradation protects background water quality [WAC 173-200-030(2)(c)]. The mass balance mixing model accounts for dilution by precipitation and ground water flow. Therefore, the impacts to ground water quality can be estimated by using this model with site specific values or with the recommended literature values. A substantial increase in contaminant concentrations is defined as an increase of 2 mg N/l over background conditions or if the criteria has been exceeded. A substantial increase in ground water quality can be mitigated by one of the following options:

- Connect the system to a sanitary sewer.
  This option should be considered if the aquifer is vulnerable, if the project proposes a high density development, or if the development is in close proximity to surface waters.

- Reduce the density of the development.
  The density of the development could be reduced to minimize the impact to the aquifer to a maximum increase of 2 mg N/1 above background conditions.

- Provide additional treatment prior to discharge to the drainfield.
  Advanced treatment can be applied to the wastewater prior to being discharged to the drainfield to reduce the contaminant loading to the aquifer. The level of treatment should minimize the impact to the aquifer to a maximum increase of 2 mg N/1 above background conditions.

$$N_W = \frac{N_{GW}(Q + V_I) - N_B Q - N_R V_R}{V_W(1 - d)}$$

The level of treatment that is necessary to protect ground water can be calculated using the above equation and by setting $N_{GW} = N_B + 2$ mg N/1.

$$N_{GW} = \frac{QN_B + V_I N_I}{Q + V_I} \quad \text{(eq. 1)}$$

The variables are explained in the following print-out from the spreadsheet used to calculate the nitrogen from a housing development.

This spreadsheet predicts the downgradient N concentration from a housing development		
The values in lines 6 through 10 are recommended values from the literature.		
Variables	***Units***	***Input Values***
INPUT VALUES		
Nitrate concentration in precipitation (N_R)	mg/l as N	0.24
Total Nitrogen concentration in wastewater (N_W)	mg/l as N	60
Denitrification rate in subsurface (d)	%	0.1
Depth of mixing in the aquifer (b)	ft	20
Flow per household (w)	gpd	113
Area of drainfield (A_D)	ft^2	1000
Width of the aquifer (W_A)	ft	10000
Hydraulic conductivity of the aquifer (K)	ft/day	0.5
Hydraulic gradient (i)	ft/ft	0.5
Amount of recharge (R)	in/yr	50
Proposed Number of homes (n)		130
Nitrate concentration of upgradient ground water (N_B)	mg/l	1
OUTPUT VALUES		
Volume of precipitation over drainfield (V_R)	gpd	85.4
Volume of wastewater (V_W) = w·n	gpd	14690
Volume of infiltration from drainfield area (V_I) = V_R + V_W	gpd	14775
Aquifer discharge (Q) = K·i·b·W_A·7.48052	gpd	374026
Total Nitrogen Concentration from drainfield area (N_I) =	mg/l	53.69
(V_R·N_R) + (V_W·N_W·(1-d))/V_R +V_W		
Downgradient ground water nitrogen concentration		
from proposed number of homes N_{GW} = Q_{NB} +$V_I N_I$/Q + V_I	mg/l	3.00

Equation 1 above is expanded as follows:

$$N_{GW} = \frac{QN_B + V_1 N_1}{Q + V_1}$$

$$N_{GW} = \frac{QN_B + (V_R + V_W)(N_I)}{Q + (V_R + V_W)}$$

$$N_{GW} = \frac{QN_B + (V_R + (n * w)) \times \left(\frac{V_R N_R + V_W N_W (1-d)}{V_R + V_W} \right)}{Q + (V_R + (n * w))}$$

CHAPTER IX. DERIVING EFFLUENT LIMITS FOR THE PROTECTION OF AQUATIC SEDIMENTS

Permit managers must consider the effect of a proposed discharge to surface waters on the quality of aquatic sediments and limit the concentrations of pollutants that cause an exceedance of the sediment quality standards (SQS).

This chapter acquaints the permit writer with the basis of the sediment quality standards and defines the permit writer's initial tasks of implementing the standards. This chapter is derived from a more comprehensive document called the *Sediment Source Control Standards User Manual* (Ecology 1993). Permit managers who become involved in authorizing sediment impact zones (SIZ) or deriving effluent limits based on the sediment quality standards should read the *Sediment Source Control Standards User Manual* to understand those procedures.

This chapter outlines the permit writers tasks for implementing the sediment management standards, discusses the sediment quality standards, presents the overall approach for implementing the sediment source control standards including the authorization of the SIZ and then discusses in more detail the narrative and technical screening conducted by permit writers. Sediment monitoring guidance is located in Section 7 of Chapter XIII Monitoring Guidelines.

1. PERMIT WRITER'S TASKS

For permits to Puget Sound

Complete the narrative evaluation sheet and the technical evaluation sheets, send a copy of the completed sheets when submitting the draft permit for QA review, and discuss the results in the fact sheet. Require baseline monitoring or monitoring for model runs if indicated by the evaluation. Consult with the Sediment Management Unit (SMU) on the specifics of the monitoring requirements. Compare monitoring results with the sediment quality standards.

For permits to other marine waters

Complete the narrative evaluation sheets and the technical evaluation sheets, attach copies of the completed sheets to the draft permit for QA review, and discuss the results in the fact sheet. Require baseline monitoring or monitoring for model runs if indicated by the evaluation. Consult with the Sediment Management Unit on the specifics of the monitoring requirements. Compare sediment quality data with the sediment quality standards on a case-by-case basis.

For permits to low saline waters

Complete the narrative and technical evaluation sheets and send a copy of the completed sheets with the draft permit for QA review. Require sediment-related monitoring or other sediment requirements only after consultation with the SMU.

For permits to fresh water

Evaluate the possibility of sediment contamination on a pollutant-specific and facility-specific basis. Contact the SMU before placing any sediment-related requirements in permits.

2. THE SEDIMENT MANAGEMENT STANDARDS

Several state laws provide Ecology with the authority to address sediment contamination issues in Washington State waters. The most important of these laws, for purposes of implementing the Sediment Management Standards, is the Water Pollution Control Act, Chapter 90.48 of the Revised Code of Washington (RCW). The Water Pollution Control Act provides Ecology with the authority to regulate point and nonpoint source discharges in order to limit discharge-related impacts to sediment quality. The Sediment Management Standards rule (Chapter 173-204 WAC) was developed by Ecology to:

- Establish chemical, biological, and other criteria as standards for the quality of sediments to protect beneficial uses and human health. These specific criteria values within the Sediment Management Standards are called the Sediment Quality Standards (SQS). The SQS are equivalent to the numerical criteria in the surface water quality standards.

- Apply the sediment quality standards (SQS) as the basis for the management and reduction of pollutant discharges

- Provide a management and decision process for the cleanup of contaminated sediments.

Additional background information on the development of and rationale for the Sediment Management Standards is available in the *Final Environmental Impact Statement for the Washington State Sediment Management Standards* (Ecology 1990).

The Sediment Management Standards address three main issues.

First, the rule establishes a narrative sediment quality goal defined as no acute or chronic adverse effects on biological resources and no significant health risk to humans caused by sediment contamination. The SQS establish the long-term management goal for the quality of sediments throughout the state. The SQS are defined by:

- Numerical chemical concentration criteria (chemical concentration criteria for Puget Sound marine sediment quality are provided in WAC 173-204-320(2))

- Biological effects criteria (biological effects criteria for Puget Sound marine sediment quality are provided in WAC 173-204-320(3))

- Human health criteria (currently under development); WAC 173-204-320(4) and (5)).

Sediments that exceed the SQS criteria are predicted to have adverse effects on biological resources or to pose significant human health risks. The SQS criteria may be revised as new data are developed regarding the toxicity of contaminants in sediments to human health and the environment.

A significant difference between the SQS and the surface water quality standards is that the SQS can be superceded by a demonstration that no significant biological effects are occurring. A discharger who finds that the SQS are exceeded at the point of discharge may elect to let the results stand as an exceedance of the criteria or, alternatively, to conduct biological testing to show compliance with the standards.

TABLE IX-1. MARINE SEDIMENT QUALITY STANDARDS AND SEDIMENT IMPACT ZONE MAXIMUM ALLOWABLE CONTAMINATION LEVELS FOR PUGET SOUND[a]

Chemical Parameter	SQS	SIZ_{max}
Metals (mg/kg dry weight)		
Arsenic	57	93
Cadmium	5.1	6.7
Chromium	260	270
Copper	390	390
Lead	450	530
Mercury	0.41	0.59
Silver	6.1	6.1
Zinc	410	960
Nonionizable Organic Compounds (mg/kg organic carbon[b])		
Aromatic Hydrocarbons		
Total LPAH[c]	370	780
Naphthalene	99	170
Acenaphthylene	66	66
Acenaphthene	16	57
Fluorene	23	79
Phenanthrene	100	480
Anthracene	220	1,200
2-Methylnaphthalene	38	64
Total HPAH[d]	960	5,300
Fluoranthene	160	1,200
Pyrene	1,000	1,400
Benz[a]anthracene	110	270
Chrysene	110	460
Total benzofluoranthenes[e]	230	450
Benzo[a]pyrene	99	210
Indeno[1,2,3-c,d]pyrene	34	88
Dibenzo[a,h]anthracene	12	33
Benzo[g,h,i]perylene	31	78
Chlorinated Benzenes		
1,2-Dichlorobenzene	2.3	2.3
1,4-Dichlorobenzene	3.1	9
1,2,4-Trichlorobenzene	0.81	1.8
Hexachlorobenzene	0.38	2.3

Chemical Parameter	SQS	SIZ_{max}
Phthalate Esters		
Dimethyl phthalate	53	53
Diethyl phthalate	61	110
Di-*n*-butyl phthalate	220	1,700
Butyl benzyl phthalate	4.9	64
Bis[2-ethylhexyl]phthalate	47	78
Di-*n*-octyl phthalate	58	4,500
Miscellaneous		
Dibenzofuran	15	58
Hexachlorobutadiene	3.9	6.2
N-nitrosodiphenylamine	11	11
PCBs	12	65
Ionizable Organic Compounds (µg/kg dry weight; parts per billion)		
Phenol	420	1,200
2-Methylphenol	63	63
4-Methylphenol	670	670
2,4-Dimethylphenol	29	29
Pentachlorophenol	360	690
Benzyl alcohol	57	73
Benzoic acid	650	650

Note: HPAH - high molecular weight polycyclic aromatic hydrocarbon
LPAH - low molecular weight polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
SIZ_{max} - Sediment Impact Zone maximum allowable contamination level (WAC 173-204-420)
SQS - Sediment Quality Standards (WAC 173-204-320)

[a] Where laboratory analysis indicates a chemical is not detected in a sediment sample, the detection limit should be reported. Where chemical criteria in this table represent the sums of individual compounds (e.g., total LPAHs and total HPAHs) or groups of isomers (e.g., total PCBs), and a chemical analysis identifies an undetected value for one or more individual compounds or groups of isomers, the detection limit should be used for calculating the sum of the respective compounds or groups of isomers.

[b] The listed values represent concentrations in parts per million "normalized" on a total organic carbon basis. To normalize to total organic carbon, the dry-weight concentration for each parameter is divided by the decimal fraction representing the percent total organic carbon content of the sediment.

(Footnotes continued on following page)

[c] The total LPAH criteria are to be compared to the sum of the concentrations of the following LPAH compounds: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. 2-Methylnaphthalene is not included in the LPAH definition. The total LPAH criteria are not the sums of the corresponding criteria listed for the individual LPAH compounds.

[d] The total HPAH criteria are to be compared to the sum of the concentrations of the following HPAH compounds: fluoranthene, pyrene, benz[a]anthracene, chrysene, total benzofluoranthenes, benzo[a]pyrene, indeno[1,2,3-c,d]pyrene, dibenzo[a,h]anthracene, and benzo[g,h,i]perylene. The total HPAH criteria are not the sums of the corresponding criteria listed for the individual HPAH compounds.

[e] The total benzofluoranthenes criteria are to be compared to the sums of the concentrations of the b, j, and k isomers of benzofluoranthene.

The numerical chemical concentration criteria and biological effects criteria presently contained in the rule (WAC 173-204-320(2) and (3)) apply only to marine sediments in Puget Sound. Similar criteria for other marine sediments and for freshwater and low-salinity sediments of Washington State are currently being developed by Ecology (WAC 173-204-320(1)(c), 173-204-330, and 173-204-340). Until such criteria are adopted into the Sediment Management Standards, rule compliance with the narrative standard for other marine, freshwater, and low-salinity sediments will be determined on a case-by-case basis. This document presents a process for such case-by-case determinations in Part 4.4.

Second, the Sediment Management Standards set forth a process for managing sources of sediment contamination (WAC 173-204-400 through 173-204-420). The SSCS specifically address the following aspects of this process:

- A requirement that discharges with the potential to impact receiving sediments have received all known, available, and reasonable methods of prevention, control, and treatment (AKART) prior to discharge, and/or the application of best management practices (BMPs), as appropriate

- Monitoring procedures for evaluating the potential for a discharge to impact the receiving sediments

- Procedures for determining whether a discharge is eligible for a sediment impact zone (SIZ), which would allow contamination in the receiving sediments to exceed the SQS

- If a SIZ is to be authorized, methods for determining appropriate restrictions (e.g., on the allowable areal extent or level of contamination and biological effects)

- SIZ renewal, maintenance, and closure requirements.

Although the SSCS allow eligible discharges to cause receiving sediments to exceed the SQS, the SSCS also set forth specific chemical and biological criteria (WAC 173-204-420) that define the maximum level of chemical contamination or biological effects above the SQS that will be allowed within an authorized SIZ. This ceiling on chemical contamination and biological effects is referred to as the SIZ maximum allowable contamination level, or SIZ_{max}.

Third, the Sediment Management Standards set forth a decision process for identifying contaminated sediment sites and determining appropriate cleanup responses (WAC 173-204-500 through 173-204-590). Natural recovery is recognized as a viable response option for sediments that are expected to recover unaided to at least the minimum cleanup level within a 10-year time frame. Natural recovery to the SQS may take more than 10 years.

There should be consistency in the levels of sediment contamination and biological effects that will be allowed to remain in the environment following source control measures and cleanup at contaminated sediment sites. For this reason, the same numerical chemical concentration criteria and biological effects criteria have been established for the maximum level of chemical contamination or biological effects allowable within an authorized SIZ (i.e., SIZ_{max}; WAC 173-204-420) and the maximum level of chemical contamination or biological effects allowable once cleanup is complete (i.e., MCUL; WAC 173-204-520). These standards have been set at chemical concentrations or biological effects levels established by the narrative sediment quality regulatory goals that correspond to a "minor adverse effects level" (equal to or higher than the SQS).

The narrative goal of the Sediment Management Standards has also been formulated to be consistent and compatible with the sediment quality goals of the Puget Sound Dredged Disposal Analysis (PSDDA) program, which addresses the management and disposal of sediments dredged as part of navigational maintenance or construction activities. Consistency is established by setting the SIZ_{max}, CSL, and MCUL at chemical concentrations and biological effects levels that are as similar as possible to the PSDDA guidelines for unconfined, open-water disposal of dredged material (i.e., PSDDA Site Condition II). Exact correspondence is currently not possible because slightly different sets of biological tests and test interpretation guidelines are used for the two programs. For the purpose of testing sediments under the various sediment management programs, the Puget Sound Estuary Program protocols (PSEP 1991c) provide consistent procedures for sediment sampling, chemical analyses, and biological testing, but the interpretation of the results is program-specific.

3. OVERVIEW OF THE PROCESS

Figure IX-1 provides an overview of the permitting process and authorization of a SIZ. For the sake of simplicity, the process depicted in Figure IX-1 is linear. However, the actual decision-making process followed by permit managers and SMU staff has multiple decision points and pathways, which are described in greater detail in subsequent sections of this chapter and in the *Sediment Source Control Standards Users Manual*. In addition, some of the steps illustrated in Figure IX-1 are actually implemented in a phased or iterative manner, which is not easily represented in this linear flowchart (e.g., the evaluation of the potential for sediment impacts may include both generalized and site-specific computer model runs, which are conducted before and after, respectively, the request for a SIZ application). This section only discusses in detail the part of the process up to the application of the SIZ.

In the following subsections, the primary provisions and requirements of the SSCS with respect to the sediment source control standards permitting process are described. This process generally follows the 10-step process outlined in WAC 173-204-400(1)(a)–(j), but the order of discussion in the following subsections has been modified slightly to correspond to the permitting process as implemented by the WQP. The subsections of the rule corresponding to each step are indicated. When appropriate, reference is made to subsequent chapters of this manual for implementation guidance.

3.1 Evaluation of the Potential for a Discharge to Impact Receiving Sediments (WAC 173-204-400(1)(a))

A screening-level evaluation of the potential for a discharge to cause sediment impacts is conducted when a permit application is accepted for a new or existing discharge. The screening-level evaluation, which consists of both narrative and technical evaluations, is described in Section 4.

If the screening-level evaluation indicates that it is unlikely that the discharge would adversely impact the receiving sediments, the permit is issued or renewed without sediment monitoring, a SIZ authorization, or sediment quality-based effluent limits. The evaluation sheets are sent to the SMU.

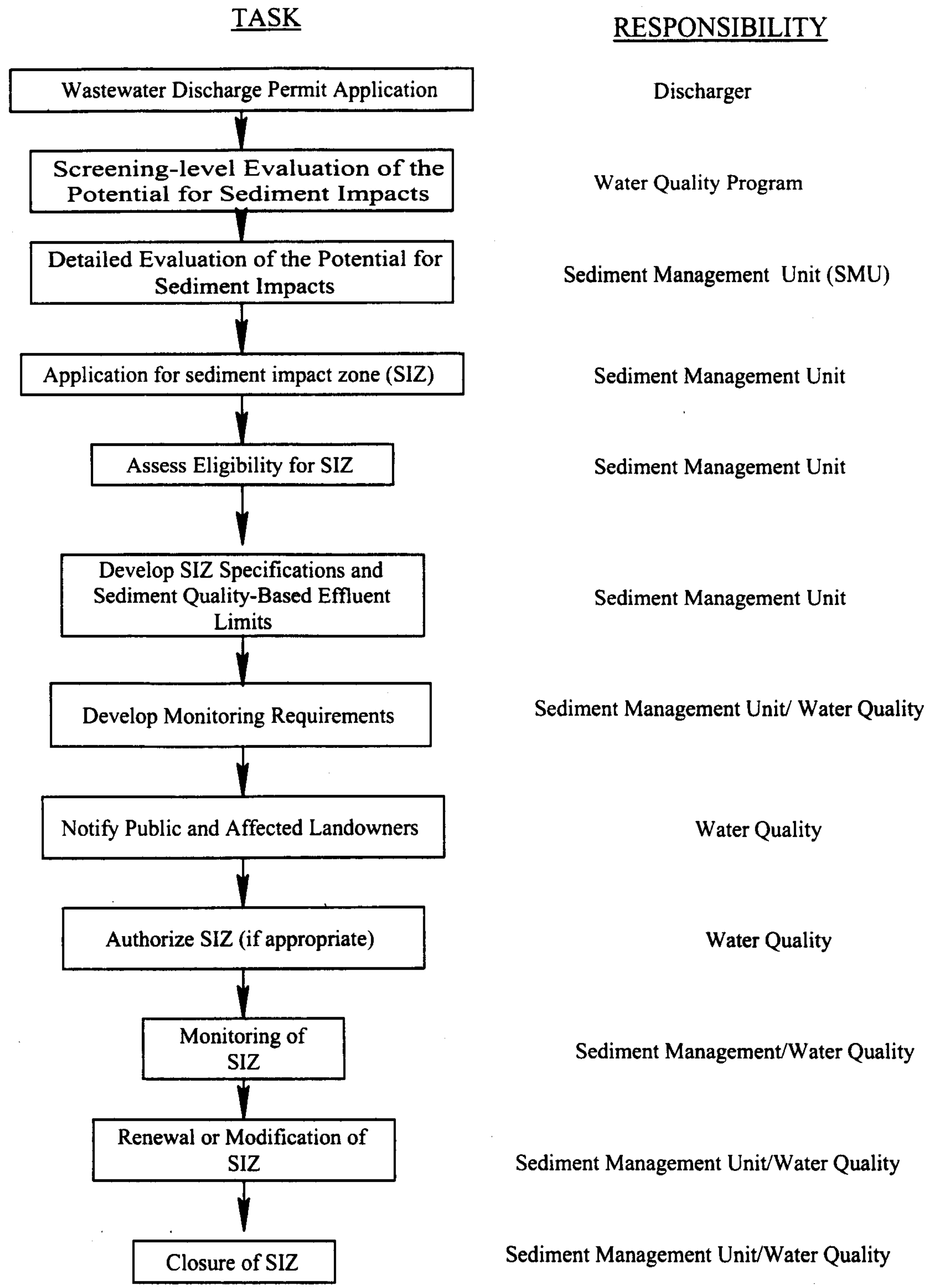
If the screening-level evaluation indicates a potential for a discharge to adversely impact receiving sediments the sediment-related information is forwarded to the SMU with the evaluation sheets. The SMU then runs a generalized SIZ computer model(s) (such as the Cornell Mixing Zone Expert System [CORMIX], or Water Quality Analysis Simulation Program

[WASP]) using readily available information. The purpose of this generalized model run is to determine whether the discharge has the potential to cause an exceedance of the SQS numerical criteria (Table IX-1) within a 10-year period from the date of Ecology's evaluation of the ongoing discharge or the starting date of the proposed discharge, whichever is later (WAC 173-204-415(2)).

If there is evidence of an SQS violation, if sufficient data are available, and if the discharge is from a priority facility (see Figure IX-1), a site-specific model run will also be performed. Additional data required for either the generalized or site-specific model runs may be requested from the discharger. The results of these model runs and application of the SMU's best professional judgment provide the basis for predicting the potential for a discharge to result in sediment impacts. The generalized and site-specific model runs are described in the *Sediment Source Control User Manual.* In some cases, a compliance schedule may be established during the period required for collection of additional data to support application of the models.

In addition to the modeling data, monitoring data may be used to evaluate the potential for a discharge to cause an exceedance of the SQS. Guidance on the use of monitoring data for this purpose is provided in Chapter XIII Section 7.

Figure IX-1. Overview of process and responsibilities for the protection of aquatic sediments.



3.2 Application for a SIZ (WAC 173-204-400(1)(b))

If the results of the generalized SIZ computer model run indicate that the discharge has the potential to impact sediments, Ecology will require an application for a SIZ. WAC 173-204-200(22) defines a SIZ as:

> . . . an area where the applicable sediment quality standards of WAC 173-204-320 through 173-204-340 are exceeded due to ongoing permitted or otherwise authorized wastewater, storm water, or nonpoint source discharges, and authorized by the department within a federal or state wastewater or storm water discharge permit, or other formal department authorization.

By the authority of WAC 173-204-415(4)(a), Ecology may require a discharger to submit any information needed to run the SIZ models (simulating sediment contamination over a 10-year period) to determine whether a SIZ is necessary and to determine the areal extent and location of the SIZ associated with the discharge. The SMU is responsible for requesting and evaluating applications for SIZs. SIZ application procedures are described in the *Sediment Source Control Standards Users Manual*. When an application is received, the SMU will notify the Washington Department of Natural Resources (DNR) Division of Aquatic Lands, U.S. Army Corps of Engineers (Corps), and any port districts whose aquatic lands may be included within the proposed SIZ (WAC 173-204-415(2)(f)).

3.3 SIZ Eligibility Requirements (WAC 173-204-400(1)(c) and (f))

Once a SIZ application is received, the discharge must be evaluated to determine whether it is eligible for a SIZ. The SMU is responsible for the eligibility evaluation.

All discharges are required to be operating with AKART and/or BMPs in place, as appropriate, or to be on a compliance schedule to meet these requirements, as a condition of a discharge authorization (Chapters 90.48, 90.52, and 90.54 RCW). This issue will, therefore, be addressed early in the discharge permitting process, regardless of the potential for the discharge to cause an impact to receiving sediments. However, to determine whether a new discharge or one not yet operating with AKART/BMPs in place will adversely impact receiving sediments, AKART/BMPs must be identified and assessed in the initial screening evaluation. Chapter IV of this manual should be consulted for guidance on the process of determining AKART/BMPs for a given discharge. This evaluation will be conducted before a permit application is forwarded to the SMU for SIZ evaluation.

WAC 173-204-415(3) requires the discharger to submit to Ecology information concerning the location of the proposed SIZ. This section also requires that SIZs authorized by Ecology avoid whenever possible, and minimize adverse impacts to, areas of special importance. A SIZ must also be authorized in a manner consistent with the antidegradation policy of the state, as set forth in WAC 173-204-120.

The areal extent of a SIZ will be determined based on the results of the modeling and the application of the SMU's best professional judgment. When the model results indicate that a SIZ may impact an area of special importance or property owned by someone other than the discharger, it may be necessary to alter the discharge characteristics (e.g., by relocating the discharge, reducing effluent loading) to avoid impacting such areas.

3.4 Development of SIZ Specifications (WAC 173-204-400(1)(d),(e), and (g))

After determining that the discharge is eligible for a SIZ, detailed model simulations are run using site-specific information provided in the SIZ application. The CORMIX and WASP models, or other SIZ model(s) can be used. The SMU is responsible for application of contaminant fate and transport modeling to the discharge.

The site-specific model run is used to reduce the uncertainty associated with the generalized model run, develop SIZ specifications, and evaluate the potential for the discharge to exceed the SIZ_{max} numerical criteria over a 10-year period from the date of Ecology's evaluation of an ongoing discharge or the start date of a proposed discharge, whichever is later (WAC 173-204-415(4)). The site-specific model may also be used to establish sediment quality-based effluent limits necessary to achieve acceptable levels of sediment quality. WAC 173-204-415(4) specifies that the models be run by Ecology or by the discharger, as required by Ecology.

In addition to the modeling data, monitoring data may be used to evaluate the potential for a discharge to cause an exceedance of the SIZ_{max} numerical criteria. Guidance on the use of monitoring data for this purpose is provided in Chapter XIII Section 7.

As stated in WAC 173-204-415(1)(e), SIZs authorized by Ecology shall include the minimum practicable surface area, not to exceed the surface area allowed by WAC 173-204-415(4). WAC 173-204-415(4) in turn requires that the location of the SIZ, its areal extent, and the degree of allowable effects within the SIZ be determined by applying the SIZ models (CORMIX, WASP, and/or other SIZ model[s] approved by Ecology) as limited by the standards of that section, and by application of best professional judgment.

Any overlap of the SIZs for two or more discharges predicted through the use of the SIZ models or based on best professional judgment will be authorized only in the event that the SIZ_{max}

chemical and biological criteria are not exceeded as a result of the overlap. If multiple discharges would result in sediment contamination above the SIZ_{max}, a wasteload allocation process would be necessary (WAC 173-204-415(4)(b)(ii)). The SMU is responsible for running the SIZ models for this purpose and will work with Ecology's Environmental Assessment Program and the WQP in developing wasteload allocations.

WAC 173-204-415(1)(f) also requires that the chemical concentrations and biological effects levels within an authorized SIZ be maintained at the lowest levels possible. Ecology is required to consider the relationship between environmental effects, technical feasibility, and cost in determining the minimum practicable chemical concentration and biological effects levels, within the range of contamination that will be allowed in an authorized SIZ. In no case should the adverse effects to biological resources within an authorized SIZ exceed the minor adverse effects level as a result of the discharge, as determined by the procedures set forth in WAC 173-204-415(5). This activity is the responsibility of the SMU.

3.5 SIZ Monitoring and Maintenance Requirements (WAC 173-204-400(1)(i))

All SIZ authorizations should include monitoring and maintenance requirements designed to ensure that the specifications included in the authorization are not violated. Such requirements should include sediment and effluent monitoring and procedures for maintenance restoration of sediments (i.e., if the discharge results in sediment contamination or biological effects that exceed the maximum levels allowed in the SIZ authorization, capping or dredging of the contaminated sediments may be required). Permit managers and SMU staff jointly develop monitoring and maintenance requirements.

3.6 Public Notice and Landowner Notification Procedures (WAC 173-204-400(1)(h))

In accordance with WAC 173-204-415(1)(j), all proposed SIZ authorizations are subject to public notice, comment, and hearing procedures as required by the state laws and regulations applicable to the specific discharge. When determining the need for, location, and/or design of the SIZ, Ecology is required to consider all comments received during public review of the application. The permit manager is responsible for public notice and landowner notifications. However, as discussed above, the SMU will also notify DNR, the Corps, and affected port districts early in the process of reviewing a SIZ application. The discharger should also be encouraged to make an early effort to identify and coordinate with the potentially affected landowner(s).

In some cases, an authorized SIZ will be located on property owned or used by someone other than the source discharger. Recognizing that the potential sediment impact resulting from the discharge may be of concern to the other individual(s), WAC 173-204-415(2)(e) requires that Ecology and the discharger make a reasonable effort to identify and notify all landowners, adjacent landowners, and lessees potentially affected by the proposed SIZ. Under the authority of WAC 173-204-415(2)(e)(viii), affected landowners, adjacent landowners, and lessees may comment on a proposed SIZ. Any such comments are to be submitted in writing to Ecology within 30 days from the date of receipt of the notification letter, or by an extended due date approved by Ecology. WAC 173-204-415(5)(e) also requires that affected landowners be given the opportunity to review all SIZ maintenance action plans before the action is implemented.

3.7 Renewal, Modification, and Elimination of Authorized SIZs Over Time (WAC 173-204-400(1)(j))

The goal of Ecology is to manage source control activities to reduce and ultimately eliminate adverse effects on biological resources and significant threats to human health resulting from sediment contamination (WAC 173-204-410(1)(a)). In support of that goal, it is Ecology's policy to minimize the number, areal extent, and adverse effects of all authorized SIZs, with the intent to eliminate the existence of all SIZs whenever practicable (WAC 173-204-410(1)(b)). This goal will be achieved through modification of existing SIZ specifications and by limiting the renewal of SIZs when possible. However, the rule addresses exceptions to this general policy by requiring that Ecology consider environmental effects, technical feasibility, and cost in determining when it is practicable to minimize or eliminate a SIZ.

WAC 173-204-415(8) sets forth the conditions under which a SIZ authorization may be renewed. These conditions include:

- When the discharge is operating with AKART/BMPs in place

- When the discharger demonstrates that the discharge activities comply with the SSCS and with the existing SIZ authorization

- When the discharger demonstrates that a reduction in the areal extent of the SIZ and/or the level of contamination within the SIZ is not practicable, and therefore the SIZ cannot be reduced or eliminated.

WAC 173-204-415(7) specifically authorizes Ecology to modify a SIZ authorization under the following conditions:

When the nature of the discharge activity has changed

When new information indicates that a modification of the SIZ authorization is appropriate

When the standards or regulations upon which the permit was based have changed

When there is an advancement in technology that applies to the discharge under consideration.

This section should be interpreted to provide Ecology with the authority to both restrict and relax SIZ specifications, as appropriate, based on a consideration of environmental effects, technical feasibility, and cost, consistent with the requirements of the SSCS.

Guidance for determining whether it is practicable to modify or eliminate a SIZ, whether SIZ maintenance activities should be required, or whether a SIZ should be renewed at the end of the permit cycle without modification is provided in the *Sediment Source Control Standards Users Manual*. SMU staff and permit managers share the responsibility for this determination. Permit managers will conduct an initial screening of the renewal application. If it appears that a SIZ authorization should be modified, the renewal application will be forwarded to the SMU for a detailed evaluation.

3.8 Closure and Restoration of SIZs (WAC 173-204-400(1)(I))

WAC 173-204-415(6) requires that all SIZ authorizations include a SIZ closure plan. The purpose of this plan is to identify the method or methods of cleanup that the discharger will implement upon closure of the SIZ. The responsibility for overseeing SIZ closure and restoration activities will be determined by Ecology on a case-by-case basis.

4. SCREENING-LEVEL EVALUATION OF POTENTIAL FOR SEDIMENT IMPACTS

The general process for determining whether a SIZ is needed and for developing SIZ specifications is illustrated in Figure IX-2. The first step in this process is for the permit manager to perform a screening-level evaluation of whether the discharge has the potential to impact sediment quality. This chapter describes the screening-level evaluation, which includes both narrative and technical evaluations.

Screening-level evaluations are required for all marine surface water discharges to determine their potential to cause an exceedance of the SQS numerical criteria.

4.1 Initiation of Activities

In the initial stages of the permitting process, three general categories of activities are initiated by the permit manager that relate to sediment quality impacts:

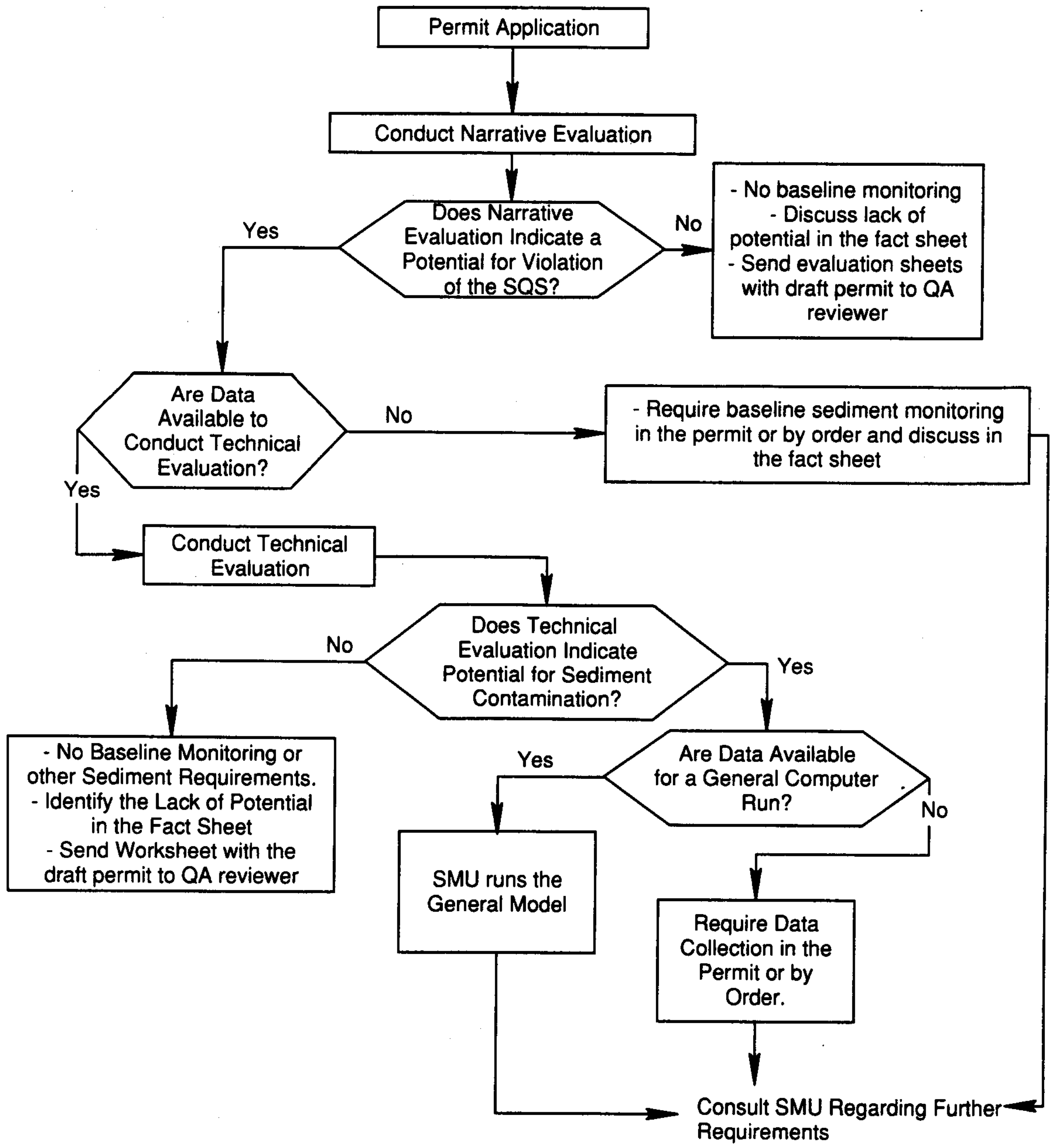
- **Assess Status of Source Control**—The status of source control activities is routinely assessed to determine whether AKART and BMPs are in place. If the facility has not yet achieved AKART/BMPs, a compliance schedule should be developed, and estimates should be made of effluent characteristics (including contaminant concentrations) to be achieved with AKART/BMPs.

- **Perform Screening-Level Evaluation of the Potential for Sediment Impacts**—Existing information on the qualitative and quantitative characteristics of the facility, discharge, and receiving environment is reviewed to determine whether there is a potential for a discharge to cause sediment quality impacts.

- **Evaluate Baseline Monitoring Data**—Available baseline monitoring data for sediments and receiving water in the vicinity of the discharge should be identified and reviewed. If the screening-level evaluation indicates the potential for a discharge to cause sediment impacts, and if available baseline data are inadequate, additional baseline monitoring may be necessary. Monitoring data and other local sediment data (e.g., data in the SMU SEDQUAL database) will also be used at a number of decision points in the SIZ development process.

These activities are discussed below.

Figure IX-2. Screening-level Evaluation of Potential for Sediment Impacts



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4.1.1 Assess Status of Source Control

WAC 173-204-400(2) requires all permits or other authorizations for wastewater, stormwater, and nonpoint source discharges to surface waters of the state to be conditioned so that the discharger is operating with AKART and/or BMPs prior to discharge, as required by Chapters 90.48, 90.52, and 90.54 RCW. Thus, all regulatory actions taken under the Sediment Management Standards are based on the assumption that the discharger either is operating with AKART and/or BMPs in place, or is on a compliance schedule to meet these requirements. Chapter IV should be consulted for guidance on the process of identifying AKART/BMPs for the various types of discharges.

Ecology recognizes that it may take some time for an existing discharge to come into compliance with the requirements of AKART. If a discharge of this type has the potential to impact receiving sediments before coming into compliance with AKART, a SIZ may be authorized while a compliance schedule is being implemented. If receiving sediments become contaminated above the level allowed within the SIZ before AKART is in place, Ecology may require the discharger to conduct maintenance restoration of the impacted sediments before or as part of the SIZ authorization.

The permit manager should also document recent changes in treatment processes and assess time trends in discharge loading characteristics. If a compliance schedule is to be implemented for the achievement of AKART/BMPs, it will be necessary to estimate effluent characteristics (including contaminant concentrations) to be achieved with AKART/BMPs for SIZ modeling and authorization.

In addition to the AKART/BMP requirement, WAC 173-204-415(1)(d) requires that the discharger adequately addresses alternative waste reduction, recycling, and disposal options. The permit manager is responsible for verifying this requirement, which would normally be addressed in the discharger's solid waste plan, spill plan, and/or pollution prevention plan.

4.1.2. Perform Screening-Level Evaluation of the Potential for Sediment Impacts

The initial screening-level evaluation of the potential for a discharge to impact receiving sediments is based primarily on readily available qualitative and quantitative information. The evaluation consists of two parts, a narrative evaluation and a technical evaluation.

In general, facilities handling or producing known contaminants that are commonly associated with pollution problems are considered to have a potential for causing sediment contamination and will generally undergo a detailed evaluation by the SMU. If relevant contaminant loading data are available for the discharge, screening equations can be applied as part of the technical evaluation, and a preliminary assessment of the potential for sediment impacts can be made.

Facilities that have been in place and discharging wastewater at a steady rate for several years can also be evaluated through direct measurement of chemical concentrations or biological effects in the receiving sediments. If no sediment contamination or biological effects are found, it may be assumed that there is little potential for sediment contamination to occur in the future unless the loading rate is expected to increase. Alternatively, if a discharger is being granted an increase in permitted contaminant loading rates, evaluation of existing sediment conditions may not be sufficient, and the detailed evaluation may be necessary.

Once the screening-level evaluation is complete, the worksheets should be filed with the permit application and a copy of the worksheets forwarded to the SMU. If the screening-level evaluation indicates that there is little or no potential for sediment impacts, the permit manager may determine that no specific sediment-related provisions need to be included in the discharge permit. If there is considered to be a potential for sediment impacts, the permit manager should evaluate available baseline monitoring data, or, if available baseline monitoring data are inadequate, the discharger should be required to collect the necessary baseline monitoring data (see Part 4.1.3).

The narrative and technical evaluation steps are described in detail in subsections 4.2 and 4.3, which include worksheets that can be used in the evaluation.

4.1.3. Evaluate Baseline Monitoring Data

The results of any baseline sediment quality monitoring, if available, should be reviewed by the permit manager to establish baseline sediment quality conditions. These monitoring data, as well as available regional monitoring data from other programs (e.g., data in the SMU SEDQUAL database), should be reviewed early in the permitting process to identify any additional monitoring that may be required and to identify data that may be used to evaluate the need for a SIZ.

In the sediment source control process, early evaluation of available baseline monitoring data is important because it assists in identifying sediment contaminants that may have been contributed by other permitted or unpermitted (and possibly historical) discharges. In addition, this evaluation may enable Ecology to identify the single or multiple ongoing discharges contributing to sediment contamination in a given area, and thus to regulate these discharges as appropriate.

In cases where no baseline monitoring has previously been conducted and the result of the screening-level evaluation is a judgment that the discharge has the potential to cause sediment impacts, a requirement for baseline monitoring should be included in the permit. The permit manager is responsible for developing baseline monitoring requirements, where appropriate, with assistance of the SMU. In cases where there are also insufficient data available to run even the generalized SIZ model, additional monitoring requirements should be included in the permit for the collection of the necessary data. Guidance on the development of monitoring requirements to support use of the models is also provided in Chapter XIII.

In cases where there is a potential for sediment impacts and the needed monitoring data have not yet been collected, the permit may be issued or renewed without a SIZ authorization, but with the requirement for appropriate monitoring to be conducted early in the permit cycle. Once the necessary monitoring has been completed, the data can be used to complete the detailed evaluation of the potential to cause sediment impacts. If the result of the detailed evaluation is that a SIZ is needed, the permit can then be modified to authorize a SIZ.

4.2 Narrative Evaluation of the Potential for Sediment Impacts

The narrative evaluation may be used to identify facilities that have a low potential for sediment impacts, based on the general characteristics of the facility and the nature of the discharge. Facilities identified as having a low potential for sediment impacts by the narrative evaluation need not be evaluated using the more detailed technical evaluation. The permit manager should conduct the narrative evaluation by filling out the narrative evaluation worksheet (Figure IX-3). If the facility has any of the characteristics identified in Item 1 of the worksheet, its discharge is considered to have the potential for causing adverse sediment impacts. If the discharge is one of the types identified in Item 2 of the worksheet, or if the facility has none of the characteristics identified in Item 1 of the worksheet, the discharge is not considered to have a potential for causing adverse sediment impacts. The permit manager should indicate in response to Item 3 whether or not the discharge is considered to have the potential to cause adverse sediment impacts.

Although a definitive assessment of a discharge's eligibility for a SIZ can only be made after the development of SIZ specifications, it is appropriate as part of the narrative evaluation to provide a preliminary indication of whether the discharge would be eligible for a SIZ. One of the criteria for authorization of a SIZ is that it not adversely effect an area of special importance and that it be in the public interest. The permit manager should make this determination during the narrative evaluation and indicate to the SMU if the discharge is eligible for a SIZ.

4.3. Technical Evaluation of the Potential for Sediment Impacts

If the narrative evaluation identified the facility as having the potential for sediment impacts and if the necessary data are available, the screening-level evaluation should also include a technical evaluation, as described below. This evaluation uses readily available information on the discharge, along with any baseline monitoring data, to determine whether there is a potential for the SQS numerical criteria to be exceeded in the receiving sediments. If there are insufficient data to conduct the technical evaluation, the discharger will be required to provide the data necessary to further evaluate the need for a SIZ (see Chapter XIII, Section 7).

To date, SQS numerical criteria have only been promulgated for marine sediments within Puget Sound. Hence, the technical evaluation procedures described in this section currently apply only to discharges to Puget Sound marine environments. Use of these procedures for evaluating discharges to non-Puget Sound marine environments may be appropriate based on the case-by-case application of best professional judgment by the permit manager, with guidance from the SMU. Until SQS numerical criteria for sediments in freshwater and low-salinity environments are developed, other evaluation procedures will have to be used for discharges to those environments (see Subsection 3.4).

If there are chemicals of concern in a marine discharge that have SQS numerical criteria (see Table IX-1), the permit manager should complete the technical evaluation worksheets and attach them to the narrative evaluation. If the discharge is of concern, but not enough data are available to complete the technical evaluation or the chemicals of concern do not have SQS numerical criteria, the permit application should be forwarded to the SMU for a case-by-case evaluation.

4.3.1 Methods of Evaluation

Sediment contaminant concentrations can be measured directly or can be estimated using a variety of sampling methods. These methods include sampling particles or sediments in sumps, drains, or the receiving environment, or sampling suspended particulate matter in the water column or suspended solids in an effluent entering the receiving water. In addition, the results of biological tests may be used to evaluate the potential for impacts to sediments. Alternatively, data on the total chemical concentrations in an effluent can be used to estimate the chemical concentrations associated with discharged particles. Once sediment or particle chemistry has been determined, the concentrations can be compared directly to the SQS numerical criteria to evaluate whether a discharge has the potential to cause an exceedance of the standards. Methods for sampling sediment and suspended particulate matter are described in greater detail in Chapter XIII.

Figures IX-3 through IX-7 provide worksheets for completing the technical evaluation. In addition to information provided in the permit application, existing effluent monitoring data and baseline monitoring data should be reviewed and used in the evaluation. The following four types of data may be used (see Sections 1–4 of the technical evaluation worksheet):

Chemical Concentrations in Source Sediments and Effluent Suspended Solids — These data include the concentrations of chemicals in sediments that may accumulate at points within the facility downstream of any treatment processes (e.g., ditch, outfall, sump) or the concentrations of chemicals associated with suspended solids in the effluent. Because these data are most closely related to source characteristics, this section of the worksheet should always be completed if such data are available.

Chemical Concentrations in Receiving Sediments and Settling Particulate Matter in the Water Column — Baseline monitoring data or other data on receiving sediments near the point of discharge are most useful in evaluating potential impacts from a source that has been ongoing at a similar level of discharge for 5 years or more. If such data are available near existing outfalls, this section of the worksheet should be completed, unless there is sufficient reason to believe that receiving sediments would only be contaminated due to historical or ongoing sources unrelated to the discharge. This section of the worksheet should also be completed if there are data available on the chemistry of settling particulate matter obtained from sediment traps in the receiving water column, and if there is sufficient reason to believe that the material obtained from those sediment traps is associated with the discharge.

Biological Test Data for Receiving Sediments — These data include baseline monitoring data or other biological tests performed on sediments collected near the outfall. This section of the worksheet should be completed if the appropriate types of biological tests have been conducted, unless there is sufficient reason to believe that receiving sediments would only be contaminated due to historical or ongoing sources unrelated to the discharge.

Effluent Monitoring Data — Effluent monitoring data (i.e., total chemical concentrations in the effluent) can also be used to estimate the potential for sediment impacts, although the relationship between these data and the potential for sediment impacts is less direct than for the types of data described above. This section of the worksheet should be completed if representative effluent data are available, and may be especially useful if the discharger proposes a new or substantially different type of discharge than has been present in the past.

Each of the sections of the worksheet are independent, and any one of the sections alone may indicate the potential for sediment contamination. However, if more than one type of data is available, each applicable section of the worksheet should be completed. This additional information will assist the SMU in performing the subsequent detailed evaluation.

Figures IX-3 through IX-8 are on the following pages IX-24 through IX-30.

Figure IX-6. Screening-Level Evaluation of the Potential for Sediment Impacts. Section 2. Chemical Concentrations in Receiving Sediments and Settling Particulate Matter in the Water Column.

Figure IX-7. Screening-Level Evaluation of the Potential for Sediment Impacts. Section 3. Biological Test Data for Receiving Sediments.

Figure IX-8. Screening-Level Evaluation of the Potential for Sediment Impacts. Section 4. Effluent Monitoring Data.

Screening-Level Evaluation of the Potential for Sediment Impacts

Part A. Narrative Evaluation

Applicant:____

Waste Discharge Permit No.:________________________________

Location:____

1. A discharge is generally considered not to have a risk for causing adverse sediment impacts if the facility is
   - ☐ a freshwater discharge to marine water,
   - ☐ has secondary wastewater treatment or equivalent and
   - ☐ discharges to an area with an average tidal velocity of 1 cm/sec or greater.

   If all three of these are not applicable proceed to 2.

2. A discharge is generally considered to have a risk for causing adverse sediment impacts if the facility meets any of the following criteria (check any that apply and attach a brief explanation):
   - ☐ Uses, stores, produces as a product or waste, or transfers any hazardous substance listed in 40 CFR 302.4, with a statutory code of 1 or 2, [referring to Sections 311(b)(4) or 307(a) of the Clean Water Act] unless:

     The facility is designed and managed so that these substances are kept fully physically separated at all times, including spills or any other accidental release, from any part of the wastewater collection, treatment, or discharge system or stormwater system; or

     The amount of any hazardous substance at the facility is never more than the statutory reportable quantity listed in 40 CFR 302.4.
   - ☐ Discharges any chemical pollutant listed in Appendix D of 40 CFR Part 122, Table II, in its effluent *(attach a list of any such pollutants known to be discharged).*
   - ☐ Has a reasonable potential to violate water quality standards for any pollutant in Appendix D of 40 CFR Part 122, Table III *(attach a list of any such pollutant known to be discharged).*
   - ☐ Discharges other potentially deleterious substances, such as any of the following *(check any that apply)*:

     _____ Solid inorganic materials (e.g., paint chips, slag)
     _____ Radionuclides
     _____ Other *(describe)*
   - ☐ Belongs to any industry category identified in 40 CRF Part 122, Appendix A.
   - ☐ Is a municipal facility that receives a discharge from any industry category identified in 40 CFR Part 403, Appendix C.
   - ☐ Any facility with whole effluent toxicity detected during the last five years based on:
     - Less than 80 percent survival in 100 percent effluent; or
     - The no observed effects concentration for chronic toxicity being less than or equal to the acute critical effluent concentration; and
     - Not attributable to a known chemical
   - ☐ Any facility with suspected sediment toxicity because of apparent damage to aquatic biota in the immediate vicinity of the discharge.
   - ☐ Any other discharge that Ecology determines has the potential to include toxic substances that may accumulate in the sediment.

3. The following types of discharges **(check if applicable)** are generally not believed to have a potential for causing adverse sediment impacts unless one of the above factors, in item 2, applies:
   - ☐ Once-through noncontact cooling water without biocides

- ☐ Municipal plants discharging less than one-half million gallons per day of effluent that are regulated only for conventional pollutants
- ☐ Drinking water treatment plants
- ☐ Sand and gravel mining operations
- ☐ Sump pump discharges of ground water or rainwater
- ☐ Construction dewatering
- ☐ Fish hatcheries and other aquaculture
- ☐ Boiler blowdown
- ☐ Any other discharger that Ecology determines does not have the potential to discharge toxic pollutants

3. Based on the narrative evaluation above, is there a potential for sediment impacts from this discharge?
   - ☐ Yes. If yes, answer the following question.
   - ☐ No
4. Is there a preliminary indication that the discharge would be eligible for a SIZ?
   - ☐ Yes
   - ☐ No. If no, describe the reason(s) the discharge may be ineligible.

Permit Manager: ______________________ Date:__
(print name)

____
(Signature)

Screening-Level Evaluation of the Potential for Sediment Impacts

Part B. Technical Evaluation

Applicant:____

Waste Discharge Permit No.:___________________________________

Location:____

SUMMARY

Worksheets Attached:	Potential for Sediment Impact? YES	NO	No Available Data
☐ Section 1. Source Sediments	☐	☐	☐
☐ Section 2. Sediment Chemistry	☐	☐	☐
☐ Section 3. Sediment Biological Tests	☐	☐	☐
☐ Section 4. Effluent Chemistry	☐	☐	☐

Permit Manager: ____________________________ Date:__

(print name)

____

(Signature)

Section 1

Chemical Concentrations in Source Sediments and Effluent Suspended Solids

Types of Data:

- ☐ Ditch Sediments
- ☐ Sump Sediments
- ☐ Outfall Sediments
- ☐ Effluent Suspended Solids

Number of Samples:____________________

Analyte Groups:

Detected Analytes	Maximum Concentration (mg/kg)[a]	SQS (mg/kg)[a]	Exceeds SQS? YES	Exceeds SQS? NO	Number of Samples Exceeding SQS
1.			☐	☐	
2.			☐	☐	
3.			☐	☐	
4.			☐	☐	
5.			☐	☐	
6.			☐	☐	
7.			☐	☐	
8.			☐	☐	
9.			☐	☐	
10.			☐	☐	
11.			☐	☐	
12.			☐	☐	
13.			☐	☐	
14.			☐	☐	
15.			☐	☐	
16.			☐	☐	
17.			☐	☐	
18.			☐	☐	
19.			☐	☐	
20.			☐	☐	

[a] ***mg/kg dry weight or organic carbon normalized, as appropriate (see Section 3.3.3).***

Section 2

Chemical Concentrations in Receiving Sediments and Settling Particulate Matter in the Water Column

Types of Data: Number of Samples:______________________

☐ Receiving Sediments

Analyte Groups:

☐ Settling Particulate Matter in the Water Column

Detected Analytes	Maximum Concentration (mg/kg)[a]	SQS (mg/kg)[a]	Exceeds SQS? YES	NO	Number of Samples Exceeding SQS
1.			☐	☐	
2.			☐	☐	
3.			☐	☐	
4.			☐	☐	
5.			☐	☐	
6.			☐	☐	
7.			☐	☐	
8.			☐	☐	
9.			☐	☐	
10.			☐	☐	
11.			☐	☐	
12.			☐	☐	
13.			☐	☐	
14.			☐	☐	
15.			☐	☐	
16.			☐	☐	
17.			☐	☐	
18.			☐	☐	
19.			☐	☐	
20.			☐	☐	

Is there reason to believe that historical or other ongoing sources of contamination unrelated to the discharge may have contributed to the exceedances of SQS shown? If so, explain below:

[a] *mg/kg dry weight or organic carbon normalized, as appropriate (see Section 3.3.3).*

Section 3

Biological Test Data for Receiving Sediments

Type of Test		Total Number of Stations	Exceeds SQS? YES	NO	Number of Stations Exceeding SQS
☐ Amphipod Bioassay		______	☐	☐	______
☐ Larval Bioassay					
Type	______	______	☐	☐	______
	______	______	☐	☐	______
	______	______	☐	☐	______
	______	______	☐	☐	______
☐ Benthic Infauna		______	☐	☐	______
☐ Neanthes Bioassay		______	☐	☐	______
☐ Microtox® Bioassay		______	☐	☐	______

Is there reason to believe that historical or other ongoing sources of contamination unrelated to the discharge may have contributed to the exceedances of SQS shown? If so, explain below:

Section 4

Effluent Monitoring Data

Number of Samples:____________________________________

Average TSS (mg/L):____________________________________

Analyte Groups:

Detected Analytes	Average Concentration (μg/L)	C_p (mg/kg)[a]	SQS (mg/kg)[a]	Exceeds SQS? YES	Exceeds SQS? NO
1.				☐	☐
2.				☐	☐
3.				☐	☐
4.				☐	☐
5.				☐	☐
6.				☐	☐
7.				☐	☐
8.				☐	☐
9.				☐	☐
10.				☐	☐
11.				☐	☐
12.				☐	☐
13.				☐	☐
14.				☐	☐
15.				☐	☐
16.				☐	☐
17.				☐	☐
18.				☐	☐
19.				☐	☐
20.				☐	☐

C_p Concentration of a contaminant associated with suspended solids in the effluent

[a] *mg/kg dry weight or organic carbon normalized, as appropriate (see Section 3.3.3).*

4.3.2. Instructions for the Technical Evaluation Worksheet

The following sections provide further explanations and instructions for completing each section of the technical evaluation worksheet. This worksheet should be completed along with the narrative evaluation worksheet and filed with the permit application. A copy of the worksheet should be forwarded to the SMU. Any data used in the screening-level evaluation should also be forwarded to the SMU with the worksheet; these data will be used in the subsequent detailed evaluation. The permit manager should also provide the SMU with electronic and hard copies of water quality dilution zone model runs, spreadsheets, and any other data and information used to assess compliance with water quality and sediment quality standards.

If neither the narrative nor the technical evaluations indicate that a discharge has the potential to cause sediment impacts, the permit should be issued or renewed by the permit manager without a SIZ authorization or sediment quality-based effluent limits. No sediment monitoring should be required in the permit. The permit manager should identify the lack of potential for sediment impacts in the fact sheet accompanying the permit.

Because the screening-level evaluation (including the narrative and technical evaluations) is highly conservative, it may indicate the potential for impacts for certain facilities where no actual impact would occur. Therefore, if either the narrative or technical evaluation indicates that a discharge has a potential for sediment impacts, the discharge will be further evaluated by the SMU.

Summary Page

The summary page is shown in Figure IX-4. To complete the summary page, the permit manager should perform the following steps:

1. In the space provided, fill in the name of the applicant, the waste discharge permit number, and the location of the existing or proposed discharge (e.g., latitude and longitude or state plane coordinates; attach a map showing the discharge, if available) or attach those from the fact sheet.

2. Review available data for the permit, including data provided in the permit application, existing effluent monitoring data, and baseline monitoring data, to determine what types of data are available for the evaluation. Check the appropriate boxes to indicate which types of data are used in the evaluation.

3. Fill out and attach the appropriate worksheets.

4. Summarize the results of the evaluation on the summary sheet by checking the "yes," "no," or "no available data" box for each worksheet used.

5. Sign and date the worksheet.

6. Attach all data used in the evaluation and forward the worksheet to the SMU. Include a copy of the worksheet in the permit file for the applicant.

Section 1. Chemical Concentrations in Source Sediments and Effluent Suspended Solids

The potential for a discharge to cause an exceedance of the SQS in adjacent sediments can be evaluated by directly comparing SQS numerical criteria with concentrations of contaminants in sediments that may accumulate at points within the facility downstream of any treatment processes (e.g., ditch, sump, outfall). Sediments collected from such locations are likely to be more indicative of source characteristics than are receiving sediments in the immediate vicinity of the point of discharge, because the latter may be affected by other factors, including historical contamination, contributions from other sources, and burial by and mixing with natural sediments.

If there are no sediments present in ditches, sumps, or outfalls, or if these sediments have not been sampled, it may be possible to collect suspended solids in the effluent and determine their chemical concentrations. Methods for the collection of suspended solids in the effluent are discussed in Chapter XIII Secton 7. Care must be taken to collect a sample that is representative of the effluent.

The worksheet for Section 1 is shown in Figure IX-4. To complete the worksheet for Section 1, the permit manager should perform the following steps:

1. Indicate the type of data available and the number of samples collected. Also note the analyte groups (e.g., metals, semivolatile organic compounds) that were analyzed. If source sediments were analyzed, any available information (qualitative or quantitative) on the grain size of the sediments sampled should be appended to the worksheet.

2. In the first column, list the detected analytes for which SQS numerical criteria are available (Table IX-1).

3. List the maximum concentration measured for each analyte. If the SQS numerical criteria for the contaminants measured are listed in mg/kg organic carbon, the organic carbon normalization procedure described in Part 4.3.3 must be completed before comparing the data to the criteria. Otherwise, concentrations should be listed in mg/kg dry weight.

4. Compare the maximum concentrations detected to the SQS numerical criteria listed in Table IX-1. Check the appropriate boxes to indicate whether the criteria are exceeded. For each contaminant, also indicate the number of samples for which the contaminant exceeds the criteria. If any of the sample concentrations exceed the SQS numerical criteria, there is a potential for sediment impacts from the discharge.

5. Attach the completed worksheet to the summary page.

Section 2. Chemical Concentrations in Receiving Sediments and Suspended Particulate Matter in the Water Column

If there are no sediments associated with the source pathway (e.g., sediments do not accumulate at points within the facility downstream of any treatment processes), surface sediments near the point of discharge can be collected and analyzed. If surface sediment sampling is used to assess contaminant concentrations, only the uppermost sediment horizon (i.e, 0–2 cm), reflecting the most recently deposited sediments, should be collected. Because receiving sediments respond relatively slowly to changes in source characteristics, receiving sediment data should not be used unless the discharge being evaluated is an existing source that has been discharging at a similar rate for at least 5 years.

Because bottom sediments respond slowly to changes in source characteristics, sampling of suspended particulate matter in the water column may provide a more reliable method for verifying the effects of a discharge on receiving sediments. However, suspended particulate matter in the water column (receiving environment) may also be mixed with particles from other sources or facilities (potentially including resuspended bottom sediments). Sampling of suspended particulate matter in the water column can be performed over a period of time using a sediment trap. Because sediment traps collect only settling particles in the water column, use of sediment traps is the most appropriate sampling method for evaluating the impact on sediment quality of particulate matter settling out of the water column. This sampling technique is discussed in greater detail in Chapter XIII Section 7.

The worksheet for Section 2 is shown in Figure IX-5. To complete the worksheet for Section 2, the permit manager should perform the following steps:

1. Indicate the type of data available and the number of stations at which samples were collected. Also note the analyte groups (e.g., metals, semivolatile organic compounds) that were analyzed.

2. In the first column, list the detected analytes for which SQS numerical criteria are available (Table IX-1).

3. List the maximum concentration measured for each analyte. If the SQS numerical criteria for the contaminants measured are listed in mg/kg organic carbon, the organic carbon normalization procedure described in Part 4.3.3 must be completed before comparing the data to the criteria. Otherwise, concentrations should be listed in mg/kg dry weight.

4. Compare the maximum concentrations detected to the SQS numerical criteria listed in Table IX-1. Check the appropriate boxes to indicate whether the criteria are exceeded. For each contaminant, also indicate the number of stations at which the contaminant exceeds the criteria. If any of the sample concentrations exceed the SQS numerical criteria, there is a potential for sediment impacts from the discharge.

5. Explain in the space provided whether there is any reason to believe that historical contamination and/or the presence of other ongoing sources may have contributed to the SQS exceedances listed.

6. Attach the completed worksheet to the summary page.

Section 3. Biological Test Data for Receiving Sediments

Use of biological test data for receiving sediments is the most direct way of evaluating whether sediment impacts are occurring, because such tests directly measure adverse effects on organisms of interest. However, because receiving sediments respond relatively slowly to changes in source characteristics, this section of the worksheet should only be used if the discharge being evaluated is an existing source that has been discharging at a similar rate for at least 5 years.

SQS biological effects criteria for Puget Sound have been established for the following types of tests (WAC 173-204-315):

- Amphipod bioassay (*Rhepoxynius abronius*)
- Larval bioassays:
  - Pacific oyster (*Crassostrea gigas*)
  - Blue mussel (*Mytilus edulis*)
  - Purple sea urchin (*Strongylocentrotus purpuratus*)
  - Sand dollar (*Dendraster excentricus*)

- Benthic infauna
- Juvenile polychaete bioassay (*Neanthes arenaceodentata*)
- Microtox® bioassay (*Photobacterium phosphoreum*)

Therefore, only these types of biological data can be used in the screening-level evaluation.

The worksheet for Section 3 is shown in Figure IX-6. To complete the worksheet for Section 3, the permit manager should perform the following steps:

1. Indicate the type(s) of biological tests for which data are available. List the number of stations at which samples were collected for each test.

2. Compare the results of each test to the SQS biological effects criteria for that test listed in Table IX-2. To compare observed adverse effects to the SQS biological effects criteria, it must first be determined whether the effects observed are statistically significant. The permit applicant should perform this test. If this information is not provided, contact the SMU for instructions or assistance in interpreting the results of biological tests.

3. Check the appropriate boxes to indicate whether the SQS biological effects criteria are exceeded. For each test, also indicate the number of stations that exceed the SQS biological effects criteria. If the sediments exceed the SQS biological effects criteria for one or more of the tests, there is a potential for sediment quality impacts.

4. Explain in the space provided whether there is any reason to believe that historical contamination and/or the presence of other ongoing sources may have contributed to the SQS exceedances listed.

5. Attach the completed worksheet to the summary page.

Section 4. Effluent Monitoring Data

If appropriate data are not available to conduct the evaluations in worksheet Sections 1–3, the results of effluent chemical analyses can be used as an indicator of whether that discharge has the potential to result in exceedance of the SQS numerical criteria near the outfall. Because effluent sampling and analysis is a standard part of NPDES permit requirements, such data may be available when sediment quality data are not. To use effluent data as an indicator of potential contamination in sediments, a relationship must be derived between effluent and sediment quality.

This part of the evaluation uses effluent monitoring data to provide an estimate of potential sediment quality near a point of discharge. The equation used in the evaluation is based on the assumption that for contaminants likely to accumulate in the sediments, and for which there are SQS numerical criteria, most of the total contaminant concentration in an effluent (or in the receiving water) will be found on the suspended solids fraction. This assumption may not be applicable to certain classes of contaminants (i.e., highly soluble contaminants). Furthermore, this equation does not directly predict the impact of the effluent on sediments around the point of discharge, and it does not account for dilution of the effluent by ambient water during initial mixing or for dilution of effluent suspended solids by particles from other sediment sources.

However, the concentration of a contaminant associated with suspended solids in the effluent (C_p) derived using this equation can be directly compared with the SQS numerical criterion for that contaminant. For chemicals with SQS numerical criteria that are normalized to organic carbon (i.e., nonpolar, nonionizable organic compounds), the additional normalization for organic carbon (i.e., dividing the dry-weight contaminant concentration for the suspended solids fraction by the organic carbon content of the suspended solids fraction) should be applied (see Part 4.3.3.).

C_p can be estimated from effluent monitoring data as follows:

$$C_p = \frac{C_t}{TSS} x 10^6$$

where:

C_p = concentration of contaminant associated with suspended solids in the effluent (mg/kg dry weight)

C_t = total concentration of contaminant in the effluent (mg/L)

TSS = total suspended solids in the effluent (mg/L)

10^6 = conversion factor (mg/kg).

If all contaminant concentrations on the suspended solids in the effluent are less than or equal to the SQS numerical criteria, the screening criterion is passed.

This equation incorporates the assumption that all contaminants are associated with suspended solids (or particulate organic carbon) in the effluent. This is a conservative assumption intended to provide an environmentally protective analysis; therefore, it may be possible using this equation to screen out a number of discharges with very little expenditure of time and resources.

There are two scenarios in which this equation may be overly conservative. First, if most of the contaminants are expected to be in the dissolved form, this equation could greatly overestimate the concentration of a contaminant associated with suspended solids. Second, if the concentration of TSS is very low, the concentrations of contaminants associated with the suspended solids may appear to be very high, and the screening criterion may be failed. However, in the latter scenario there may or may not be significant loading of contaminants to the sediments in the immediate vicinity of the point of discharge. In either of these two scenarios, the permit manager should contact the SMU for guidance on the appropriate course of action.

It should be noted that this equation may be of only limited applicability for effluents that have very low TSS concentrations (e.g., biological treatment of municipal wastewater may yield a TSS concentration of only 10–30 mg/L). Depending on the magnitude of the SQS numerical criteria for individual contaminants, the total contaminant concentration in the effluent necessary to cause an exceedance of the criteria may be at or below commonly achievable detection limits in cases of low TSS concentrations (e.g., at a TSS concentration of 30 mg/L, a total arsenic concentration of greater than 1.7 μg/L would cause exceedance of the SQS numerical criterion for arsenic). For contaminants with higher SQS numerical criteria, use of the equation may still be valuable for effluents with low TSS concentrations.

The worksheet Section 4 is shown in Figure IX-7. To complete the worksheet Section 4, the permit manager should perform the following steps:

1. Indicate the number of samples collected and the analyte groups (e.g., metals, semivolatile organic compounds) that were analyzed. The WQP typically recommends that 10 samples be collected over a period of time to adequately characterize the nature and variability of a discharge's effluent quality. For the purposes of this screening-level evaluation, the results of the analysis of at least 10 samples should be evaluated. If fewer samples are available, they should still be evaluated, although the conclusion should be qualified.

2. Determine the average concentration of TSS in the effluent and note it in the space provided.

3. In the first column, list the detected analytes for which SQS numerical criteria are available (Table IX-1).

4. Determine the average concentration of each contaminant in the effluent samples and write the averages in the space provided.

5. For each contaminant, divide the average concentration by the average TSS to get C_p. For contaminants whose SQS numerical criteria are in mg/kg organic carbon, convert C_p from mg/kg dry weight to mg/kg organic carbon, as described in Part 3.3.3. Fill in the C_p values in the space provided.

6. Compare C_p values to the SQS numerical criteria listed in Table IX-1. Check the appropriate box for any contaminants for which C_p exceeds the criteria. If any of the contaminants exceed SQS numerical criteria, there is a potential for sediment quality impacts.

7. Attach the completed worksheet to the summary page.

4.3.3. Organic Carbon Normalization

The SQS numerical criteria for nonpolar, nonionizable, organic contaminants are listed in units of mg/kg organic carbon. However, sediment data are often reported in mg/kg dry weight. C_p is also derived in units of mg/kg dry weight. To convert chemical concentrations expressed as mg/kg dry weight to mg/kg organic carbon for comparison to SQS, the following equation is used:

$$\text{mg/ kg organic carbon} = \frac{\text{mg/ kg dry weight}}{\text{TOC}}$$

where:

TOC = percent total organic carbon of sediments or suspended solids (expressed as a decimal; i.e., 1% TOC = 0.01).

For this screening-level analysis, a total organic carbon (TOC) value of 1 percent may be assumed in the absence of discharge-specific TOC data. In Puget Sound reference area sediments, TOC values range from 0 to 6.1 percent, with a median of 1.4 percent (Pastorok et al. 1989).

4.4 Alternative Procedures for the Technical Evaluation of the Potential for Sediment Impacts in Freshwater, low Salinity, and Non-Puget Sound Marine Environments

As described in Subsection 3.3, the current absence of promulgated SQS numerical criteria for sediments in freshwater, low-salinity, and non-Puget Sound marine environments necessitates the use of alternative procedures for the technical evaluation of the potential for sediment impacts. This section describes technical evaluation procedures for discharges into each of those environments. After SQS numerical criteria are promulgated for those environments, other evaluation procedures will be developed by Ecology.

4.4.1. Technical Evaluation Procedures for Discharges to Freshwater Environments

Currently, the Sediment Management Standards have neither SQS numerical criteria nor biological effects criteria for freshwater sediments. However, sediment quality values are available from other sources (e.g., Ecology's FSEDCRIT report, Appendix D of the *Sediment Source Control Standards User Manual*), and Ecology has two recommended freshwater sediment bioassays for evaluating sediment impacts around existing discharges to freshwater environments. Therefore, there are tools available for use, on a case-by-case basis using best professional judgment, in evaluating the potential for sediment impacts in the vicinity of discharges to freshwater environments. These tools require sediment monitoring data from the depositional environment in the vicinity of the discharge.

Ecology's FSEDCRIT report includes numerical sediment quality values for a number of metals and organic compounds in freshwater sediments. These values were assembled from several sources, including the U.S. Environmental Protection Agency (EPA), other states, and Canadian agencies. While not directly applicable to Washington State freshwater sediments, they can be used, with supporting documentation, on a case-by-case basis using best professional judgment with the assistance of the SMU for identifying sediments likely to exhibit adverse effects.

Ecology currently recommends the following sediment bioassays for identifying biological impacts in freshwater sediments (Bennett and Cubbage, 1992):

- Amphipod bioassay (*Hyalella azteca*)
- Microtox® bioassay (*Photobacterium phosphoreum*).

The protocols for these bioassays (ASTM 1990; PSEP 1991a) do not include test sediment interpretation values. For the amphipod bioassay, the SMU recommends that to be considered indicative of a potential sediment impact, the test sediment should exhibit mortality that is significantly higher (t-test, $P \leq 0.05$) than the reference sediment and the test sediment mortality should exceed 25 percent (on an absolute basis). For the Microtox® bioassay, to be considered indicative of a potential sediment impact, the mean light output of the highest concentration of the test sediment should be less than 80 percent of the mean light output of the reference sediment, and the two means should be significantly different (t-test, $P \leq 0.05$).

In cases where there are existing sediment data (either sediment concentrations of chemicals for which there are sediment quality values in the FSEDCRIT report, or the results of sediment bioassays), the permit manager has the option of conducting the technical evaluation on a case-by-case basis using best professional judgment or forwarding the permit application materials to the SMU for them to perform the technical evaluation. If the permit manager elects to conduct the technical evaluation, the concentrations of sediment contaminants (if available) can be compared with the appropriate FSEDCRIT sediment quality values (selected with guidance from the SMU) using the worksheet Section 2 (Figure IX-5), modified accordingly. If the results of one or both sediment bioassays are available, they can be reported on the worksheet Section 3 (Figure IX-6), modified accordngly. The permit applicant should generally perform the tests of statistical significance for these bioassays. If this information is not provided, the permit manager should contact the SMU for instructions or assistance in interpreting the results.

In the absence of existing sediment data from the vicinity of a discharge to a freshwater environment, there are no technical procedures (equivalent to those used for screening Puget Sound marine sediments) for evaluating the potential for sediment impacts based only on chemical concentrations in source sediments and particles (i.e., worksheet Section 1; Figure IX-4) or on effluent monitoring data (i.e., worksheet Section 4; Figure IX-7). If the narrative evaluation indicated the potential for sediment impacts, and if only those data types are available (or if no data at all are available), the permit manager should issue or renew the permit with a requirement for the collection of baseline monitoring data (including sediment chemistry and sediment bioassays) so that an evaluation of sediment impacts can be made at a later date.

After the baseline monitoring data become available, the technical evaluation can be completed by the permit manager or by the SMU. This may occur during the next permit review cycle or at an earlier date, at the discretion of the permit manager.

4.4.2. Technical Evaluation Procedures for Discharges to Low-Salinity Environments

Currently, the Sediment Management Standards have neither SQS numerical criteria nor biological effects criteria for low-salinity sediments. Unlike the situation for freshwater sediments, however, there are no sediment quality values currently available from other sources. Application of the SQS numerical criteria for Puget Sound marine sediments to low-salinity sediments may be inappropriate. Similarly, the biological effects tests applicable to Puget Sound marine sediments may not be applicable to low-salinity sediments. Therefore, there are currently no technical evaluation procedures applicable to low-salinity sediments that can be performed by the permit manager. Hence, all permit applications received for discharges to such environments should be forwarded to the SMU for further evaluation, until such time as appropriate criteria and technical evaluation procedures are developed. On a case-by-case basis using best professional judgment, the SMU may choose to apply the Puget Sound marine sediment chemical criteria or biological effects tests to low-salinity sediments.

4.4.3. Technical Evaluation Procedures for Discharges to Non-Puget Sound Marine Environments

Currently, the Sediment Management Standards have neither SQS numerical criteria nor biological effects criteria for non-Puget Sound marine sediments. As in the case of low-salinity sediments, there are also no sediment quality values currently available from other sources. However, the SMU is of the opinion that, until such time as criteria are developed specifically for non-Puget Sound marine sediments, the corresponding criteria developed for Puget Sound marine sediments can be used, on a case-by-case basis using best professional judgment, for evaluating the potential for sediment impacts in those environments. Hence, the technical evaluation for discharges to non-Puget Sound marine environments can in the interim be conducted by the permit manager using the same procedures as developed for Puget Sound marine sediments (see Subsection 4.3).

CHAPTER X. PRETREATMENT PROGRAM

The permit writer must be aware of the pretreatment program because it affects both municipal and industrial user (IU) permits. The following sections provide an overview of the pretreatment program, and define the roles and responsibilities of the regional permit writer.

1. STATUTORY SUMMARY

The discharge of pollutants from non-domestic sources into publicly owned treatment works (POTWs) can cause pass through or interference at the POTW. Congress decided that the most feasible solution to this problem was to regulate discharges from non-domestic users and, where necessary, require pretreatment by these users to remove pollutants from their wastewaters prior to discharge into to a POTW. The Clean Water Act (CWA) focuses pretreatment requirements on the control of toxic pollutants by establishing national pretreatment standards for all non-domestic users. In other parts of the CWA, Congress assigned the primary responsibility for enforcing national pretreatment standards to POTWs.

To implement the mandate of the CWA, the EPA first issued the General Pretreatment Regulations for Existing and New Sources of Pollution (40 CFR Part 403) on June 26, 1978. The regulations have undergone several amendments since June of 1978. The regulations establish procedures, responsibilities, and requirements for the EPA, state and local governments, and industry.

The state has additional authority for controlling discharges to POTW's through RCW 90.48 and chapter 173-216 WAC. This authority is reviewed in Chapters II and III.

The federal pretreatment regulations (40 CFR 403.8(a)) require that "any POTW (or combination of POTWs operated by the same authority) with a total design flow greater than 5 million gallons per day (mgd) and receiving from Industrial Users pollutants which Pass Through or Interfere with the operation of the POTW or are otherwise subject to Pretreatment Standards will be required to establish a POTW Pretreatment Program unless the NPDES State exercises its option to assume local responsibilities as provided for in 403.10(e). The Regional Administrator (EPA) or Director (Ecology) may require that a POTW with a design flow of 5 mgd or less develop a POTW Pretreatment Program if he or she finds that the nature or volume of the industrial influent, treatment process upsets, violations of POTW effluent limitations, contamination of municipal sludge, or other circumstances warrant in order to prevent Interference with the POTW or Pass Through."

In Washington state, POTWs with design flows of greater than 5 MGD, but without many significant industrial users (SIUs), might not be required to have a full pretreatment program. In such cases, Ecology assumes local responsibility to implement all aspects of the pretreatment program, including issuing permits to SIUs. POTWs with design flows less than 5 mgd can be required to establish a pretreatment program if Ecology determines that non-domestic wastes may cause upsets, sludge contamination, or violations of the POTW's NPDES permit conditions. Regional offices, in consultation with the Water Quality Permit Development Services Section, will decide whether or not a full or partial pretreatment program should be required of a particular POTW. For POTWs with design flows above 5.0 mgd, at the time of (re)issuance of an NPDES permit, the permit writer should discuss pretreatment status in the fact sheet.

2. OBJECTIVES OF THE PRETREATMENT REGULATIONS

There are four objectives of the pretreatment program:

1. To prevent the introduction of pollutants into POTWs which will interfere with the operation of a POTW, including interference with the use or disposal of municipal sludge. Municipal wastewater treatment systems are designed to treat domestic wastewater. The introduction of industrial wastes may adversely affect these systems. For example, the bacteria in activated sludge treatment systems can be inhibited by toxic pollutants. The result is interference with the treatment process, which means that the domestic and industrial wastes may not receive adequate treatment before being discharged into the receiving stream;

2. To prevent the introduction of pollutants into POTWs which will pass through the treatment works or otherwise be incompatible with such works. Even if pollutants do not interfere with the treatment systems, they may pass through POTWs without being adequately treated because the systems are not designed to remove them;

3. To improve opportunities to recycle and reclaim municipal and industrial wastewaters and sludges. The removal of certain pollutants (particularly metals) by the POTW's treatment system may result in contamination of sludges accumulated in the system. Such contamination can limit the POTWs sludge management alternatives and increase the cost of sludge disposal; and

4. To protect POTW workers from exposure to hazardous conditions. For example, industrial wastes can produce poisonous gases, such as hydrogen sulfide.

3. STATE PRETREATMENT PROGRAM SUMMARY

The purpose of the state pretreatment program is to ensure that local government and industry comply with the federal and state pretreatment requirements.

Ecology oversees the approved POTW pretreatment programs of municipalities that have been delegated pretreatment program authority. Eight Washington municipalities have approved POTW pretreatment programs and have been delegated pretreatment authority. Currently, the pretreatment program is administered locally by METRO (Seattle metropolitan area including Renton and Bellevue), Everett, Lynnwood, Pierce County, Spokane, Vancouver, and Richland. The pretreatment program is in the process of being delegated to LOTT (Lacey, Olympia, Tumwater and Thurston County), and Tacoma is being re-delegated under state authority. The delegated cities currently have a total of 259 industrial users under permit.

The activities that a permit writer may do for POTW pretreatment program delegation and oversight will include evaluating the need for a POTW to develop a pretreatment program, and recommending applicable candidates to the PSMT. Permit writers will also ensure that appropriate pretreatment conditions are reflected in the POTW's NPDES permit.

Regional offices will generally be responsible for POTW pretreatment program development, program approval and delegation, Ecology's oversight functions, and Ecology's enforcement procedures for failure of a delegated municipality to adequately implement its pretreatment program. Depending on the region, the permit writer may also be given certain of these responsibilities.

Oversight of the POTW pretreatment programs consists of pretreatment compliance inspections (PCIs), report and application review, and program audits. PCIs are conducted annually except during an audit year. Audits are conducted once every five years. Pretreatment reports are required annually from each delegated city.

All of the locally delegated pretreatment programs have the basic elements of the program required by the pretreatment program regulations. Each local program has:

1) The legal authority to apply and to enforce the requirements of the program.

2) Developed procedures to ensure compliance with the requirements of a pretreatment. program.

3) Sufficient resources and qualified personnel to carry out the authorities and procedures.

4) Developed local limits.

5) Developed an enforcement response plan.

6) A current listing on hand of their significant industrial users.

Ecology applies and enforces pretreatment requirements on IUs when a locally delegated POTW pretreatment program does not exist. Ecology's program for direct inspection and control of IUs includes processes and procedures for developing local limits, updating and maintaining user inventories, permitting, reviewing reports and plans, compliance tracking and monitoring, inspections, and enforcement.

Ecology has not completely implemented all the basic elements of the program, nor has Ecology incorporated the federal 1990 pretreatment rule amendments into its pretreatment program for non-delegated municipalities. Statewide procedures and regulations need to be written or amended to incorporate the latest federal regulatory changes. The report entitled *Analysis and Recommendations for Processes and Procedures Required for the Pretreatment Program* (Feb 1994) summarizes the needs of Ecology's pretreatment program. As these procedures and rules are developed they will be placed in the Permit Writer's Manual.

4. PRETREATMENT PROGRAM ROLES AND RESPONSIBILITIES

THIS SECTION RESERVED

5. NATIONAL PRETREATMENT STANDARDS

The general pretreatment regulations establish "prohibited discharge standards" and "categorical pretreatment standards" to control pollutant discharges into POTW's. Prohibited discharge standards apply to all industrial and commercial establishments connected to POTW's. Categorical pretreatment standards apply to the users in 36 specific industrial categories. In addition, POTW's are required to establish local pollutant discharge limitations (local limits) where necessary to protect the environment, sludge use, and the functioning of the collection system and treatment works.

5.1 Prohibited Discharges

Prohibited discharge standards protect the POTW operations by prohibiting the discharge of:

- Waste materials that pass through the treatment works untreated or interfere with its operation or performance;
- Pollutants which create a fire or explosion hazard in the sewers or treatment works, including, but not limited to, waste streams with a closed cup flashpoint of less than 140°F (60°C) using test methods specified in 40 CFR 261.21;
- Pollutants which will cause corrosive structural damage to the POTW, but in no case discharges with pH lower than 5.0, unless the works is specifically designed to accommodate such discharges;
- Solid or viscous pollutants in amounts which will cause obstruction to the flow in the POTW resulting in interference;
- Any pollutant, including oxygen demanding pollutants (BOD, etc.) released in a discharge at a flow rate and/or pollutant concentration which will cause interference with the POTW;
- Heat in amounts which will inhibit biological activity in the POTW resulting in interference, but in no case in such quantities that the temperature at the treatment works exceeds 104°F (40°C) unless the Approval Authority approves alternate temperature limits;
- Petroleum oil, non-biodegradable cutting oil, or products of mineral oil origin in amounts that will cause interference or pass through;
- Pollutants which result in the presence of toxic gases, vapors, or fumes within the POTW in a quantity that may cause acute worker health and safety problems;

- Any trucked or hauled pollutants, except at discharge points designated by the POTW.

Additionally, in Washington, chapter 173-216 WAC prohibits the discharges to POTWs of:

- Clean storm water, non-contact cooling water in significant volumes, and other clean wastewaters that could significantly affect hydraulic loading;
- Wastes with a pH greater than 11.0;
- Dangerous wastes, as prohibited by chapter 173-303 WAC.

5.2 Categorical Standards

Each categorical pretreatment standard is published by EPA as a separate regulation. Categorical pretreatment standards are found with the effluent guidelines in the 400 series of 40 CFR. The standards contain limitations for pollutants commonly discharged within each specific industrial category. All industries regulated by a particular category are required to comply with these standards, no matter where they are located in the United States. Facilities covered by categorical standards must comply with any more stringent local limits, state standards, or prohibitive standards. Chapter IV, Part 3 of this manual contains a discussion of AKART as it applies to the pretreatment program.

5.3 Local Limits

Where specific prohibitions or limits on pollutant parameters are developed by a POTW or Ecology, such limits are deemed Pretreatment Standards for the purposes of section 307(d) of the Clean Water Act.

Local limits for indirect dischargers are analogous to water quality based limits for direct dischargers. Each is developed to be protective of the system receiving the wastewater or treated wastewater. The categorical pretreatment standards are technology based limits for discharge to a POTW. Local limits must be developed if the categorical standards are not protective enough for a particular POTW.

Categorical standards and local limits are distinct and complementary types of pretreatment standards. Categorical standards provide a nationally uniform degree of water pollution control. Local limits provide an additional degree of control based on site specific requirements.

Guidance on how to develop local limits will eventually be a part of this chapter of the Permit Writer's Manual. If you have questions on how to develop local limits, and for a copy of the federal guidance already available, please contact the state pretreatment coordinator. See the monitoring chapter of this manual for a discussion of what monitoring requirements should be included in a POTW's NPDES permit for the development and updating of local limits.

6. RELATIONSHIP OF THE PRETREATMENT PROGRAM TO THE NPDES PROGRAM

The Federal pretreatment regulations require all states that administer NPDES programs to oversee and coordinate the development of pretreatment programs.

Ecology regional offices notify POTWs that they are required to develop local pretreatment programs (40 CFR 403.10(f)(2)(i)). A compliance schedule is incorporated into the NPDES permit when the permit is reissued or modified (403.10(f)(2)(iii)). The compliance schedule outlines milestones and dates for program completion. Municipalities are allowed up to a year to submit a local program proposal to Ecology. Thus, the development and implementation of a pretreatment program is an integral and enforceable component of the POTW's NPDES permit. The compliance schedule requires each POTW to develop and document the necessary authorities, information, and procedures to implement its local program. The typical program elements specified in the compliance schedule are the following:

- Industrial User Survey - the POTW must identify and evaluate the non-domestic dischargers to its treatment system. Ecology has an Industrial User Survey guidance manual. Contact the state pretreatment coordinator for assistance.

- Legal Authority - Development of a Sewer Use Ordinance and Interlocal Agreement that allows the POTW to legally apply and enforce the requirements of the General Pretreatment Regulations and any other federal, state, or local standards and requirements needed to control non-domestic dischargers. An evaluation by the municipality's legal representation that all requisite authority exists is also required.

- Compliance Monitoring Procedures - the POTW must develop procedures for monitoring its industrial users to determine compliance and noncompliance with pretreatment standards, permits, and other requirements.

- Procedures - the POTW must develop administrative procedures to implement its pretreatment program. One example of such procedures is an enforcement response plan.

- Resources - the POTW must have sufficient resources (funds, equipment, and personnel) to operate an effective and ongoing program.

- Local Limits - the municipality develops effluent limitations to protect the treatment plant operation, prevent pass through and interference, and to protect worker safety and sludge quality.

The local program is developed and carried out by the POTW with guidance and assistance from Ecology. The pretreatment program developed by the POTW must be at least as stringent as the State Waste Discharge permitting program, chapter 173-216 WAC.

Once the local pretreatment program has been reviewed and approved by Ecology and EPA, a public notice is issued. The municipal NPDES permit must then be modified or reissued to incorporate the approved program as an enforceable part of the permit. Ecology must also delegate State Waste Discharge permitting authority to the municipality while retaining an oversight function. This is required under RCW 90.48.165. These procedures should happen concurrently.

The municipality must operate the local program as outlined in the approved program document and pretreatment conditions in the permit, and must report to the state in accordance with the permit conditions.

Ecology has designated individuals in each region and a state pretreatment coordinator in the Permit Development Services Section to serve as the pretreatment experts. The regional pretreatment expert and the state coordinator should be consulted before including pretreatment conditions on any NPDES permit. The pretreatment requirements in the municipal NPDES permit must include conditions requiring proper program implementation, submission of an annual report, and monitoring requirements. All permit writers should be familiar with the requirements of the Pretreatment Program because the requirements will become an integral part of some municipal NPDES permits.

AKART must be considered when drafting State Waste Discharge permit conditions. For example, AKART has been determined to prohibit the approval of removal credits (40 CFR Part 403) in the state of Washington.

POTWs without pretreatment programs, but over 5 MGD, may be required, through NPDES permits, to develop and implement some pretreatment elements. These include:

- Industrial User Survey;

- Local Pollutant Discharge Limits; and

- Accidental Spill Prevention Program.

Some municipalities may also elect to develop local pollutant discharge limits without it being required by Ecology. Permit writers should always inquire about local limits when writing a permit for an industry discharging to a POTW. Those local limits will be the effluent limits if they are more stringent than federal or state effluent guidelines.

There are numerous guidance manuals available which address pretreatment issues which may be obtained through the regional or state pretreatment coordinators.

7. SELECTION AND DELEGATION OF PARTIAL PRETREATMENT PROGRAMS

The process and procedures for partial pretreatment program delegation described in this section will be interim. The decision to delegate a partial program is a subset of the entire pretreatment program delegation decision making process. The need for a process and procedure for full or partial pretreatment delegation was one of many procedures identified in the *Analysis and Recommendations for Processes and Procedures Required for the Pretreatment Program* (February 1994) report. However, the full or partial pretreatment program selection and delegating process and procedures were not identified as one of the top five needed processes and procedures. The pretreatment work group agreed that to develop the entire pretreatment delegation process and procedures at this time would be inconsistent with the decisions already made on priorities. A compromise was made to address the emerging need now for a process and procedures for selecting and delegating municipalities for a partial pretreatment program. It is in this context that the following process and procedures have been developed; and that they will be interim until the entire pretreatment program delegation processes and procedures can be developed.

7.1 Introduction

Selection of municipalities for delegation of a pretreatment program is made as part of the overall strategy for managing the IUs in this state. The federal regulations set a minimum number of inspection and sampling events that must be conducted at an IU facility. It is also sometimes desirable to conduct more than the minimum required inspection and sampling activities. However, total workload and limited resources make it nearly impossible for Ecology to conduct more than the minimum inspection and monitoring events. Partial delegation should result in an enhanced regulatory presence beyond what Ecology can currently provide. Partial delegation will also serve to increase the ability of a municipality to be delegated fully later.

This document establishes the process and procedures for selecting a municipality for a partial pretreatment program and for delegating the program responsibilities.

The final responsibility for the selection and scope of a new partial program delegation rests with the Program Manager. To support that decision, the following procedures and selection criteria have been established for the Regions to follow. The procedures and criteria are meant to provide some degree of consistency between the Regions, while allowing for unique situations and resource constraints. Each procedure and criterion should be addressed in the Region's recommendation for partial delegation. Any additional criteria used should also be explained in the recommendation.

The process of selecting and delegating a partial program will require a significant commitment of resources. The Regions will be providing guidance and technical assistance, and reviewing documents. This commitment should be reflected in the regional work plan and/or program plan. The Regions should take the necessary steps to see that this is done.

7.2 Selection and Delegation Procedures

7.2.1 Evaluation Phase

The following selection criteria are intended to provide a framework upon which to base the decision to delegate a partial program. The Region's initial evaluation and recommendation to the Program Manager should be conducted using these criteria.

1) The municipality should be in general agreement with the concept of assuming the pretreatment program responsibilities being considered for delegation.

    What Ecology is seeking through partial delegation is a cooperative working agreement with the municipality. A working agreement that both enhances Ecology's efforts and provides the municipality more local control and involvement in dealing with IUs.

    The only reason the municipality is not being delegated full pretreatment program responsibilities is that Ecology has chosen to assume local responsibilities as provided for in § 403.10(e). If Ecology had not chosen to assume local pretreatment program responsibilities, then the municipality would have been required to develop a full program. Therefore, Ecology may delegate pretreatment program responsibilities even if the municipality may not be agreeable. However, there are obvious benefits if the municipality accepts the partial delegation willingly.

2) An assessment should be made by the Region to determine whether the municipality could be more effective than Ecology at accomplishing the tasks being assigned to the municipality.

   For example, the POTW may be experiencing problems with pass through, interference, sludge quality, or receiving water quality that might be controlled more effectively by the municipality.

3) Evaluate the workload for Ecology that will be associated with the partial delegation process.

   The primary pretreatment program functions to consider under a partial delegation are: IU surveys, inspecting, monitoring, evaluating noncompliance, developing local limits, and issuing discharge authorizations or contracts to minor IUs. Historically, the responsibility of conducting IU surveys has been required of municipalities through conditions in NPDES permits. The IU survey responsibility is unique in this regard.

   Issuing permits to and enforcement on SIUs are the only two pretreatment responsibilities that are never part of a partial program.

   First, the workload associated providing the guidance and technical assistance to the municipality should be estimated by the Region. The municipality may be required to obtain qualified personnel, develop procedures, draft a sewer use ordinance (SUO), or develop local limits. The Region may need to assist the municipality with all of these activities. This workload estimation should be done just as it is when estimating workload during the normal program planning process. The number and type of IUs should be considered when determining the functions to be delegated.

   Next, the workload associated with the new oversight activities should be estimated by the Region. This could be significant if the municipality will need a lot of technical assistance during the early stages of adjusting to the new responsibilities. The pretreatment coordinator or regional pretreatment focal points can provide reasonable estimates for the oversight activities.

4) The municipality should be capable of assuming the responsibilities being delegated.

   The municipality should have or be capable of obtaining sufficient resources. An assessment should be made by the Region of the budgetary capabilities of the municipality. Include in the assessment a description of the mechanism by which the funding will be acquired.

   The municipality should have or get qualified personnel. The Region should evaluate the experience level of the personnel, and make sure the capabilities of the personnel can match the responsibilities to be delegated.

5) Jurisdiction and legal authority should exist to carry out any delegated responsibilities.

If jurisdiction or legal authority do not exist, the Region should assess whether the municipality can obtain them. A commitment from the municipality to obtain legal authority should be obtained prior to making the final decision to proceed with the delegation phase.

7.2.2 Selection Approval Phase

The Region's selection evaluation and recommendation should be give to the Program Manager for approval to go ahead with the partial delegation. Once approval is given, the Regions should begin the delegation phase.

7.2.3 Delegation Phase

The following procedures should be followed when proceeding with a partial delegation.

1) Place the municipality on a schedule to develop procedures and obtain resources and qualified personnel.

The Region should formally notify the municipality of the pretreatment functions that will be delegated, and identify any procedures that need to be developed. The Region should place the municipality on a schedule to develop the procedures and obtain resources and qualified personnel. The schedule should be placed in an order.

The municipality should be required to develop procedures to ensure compliance with the requirements of a partial delegation. The Region should assist the municipality with this task, and evaluate the adequacy of the procedures prior to final recommendation for partial delegation. The procedures will be similar to the procedures developed by fully delegated pretreatment programs. Assistance with the development of procedures is available from the state pretreatment coordinator.

2) Ensure the municipality has jurisdiction and legal authority necessary to carry out any delegated responsibilities.

The Region should ensure that there will be enabling language in the municipality's SUO to provide the legal authority to carry out the responsibilities given to the municipality. In most cases, the municipality will probably have to modify its SUO to accept delegation. In come cases multijurisdictional agreements may have to be entered into with contributing jurisdictions. Contact the state pretreatment coordinator for a copy of a model SUO and assistance with developing a SUO or multi-jurisdictional agreements.

3) Public notice requirements.

No public noticing of a partial delegation is required. If the regions want to inform the public of the new role for the municipality, they can do so as part of the public notice the next time the municipality's NPDES permit is renewed.

4) Notify IUs of the transfer of responsibilities that results from partial delegation.

There will be a need to notify IUs that the municipality will be acting on Ecology's behalf. Ultimately, this should be accomplished by placing language in the IU permit that defines how the municipality and the IU will be interacting.

It may not be practicable to open the IU's permit at the time the municipality is delegated. If this is the case, the IU should be notified of any new procedures through a joint letter from the municipality and Ecology.

5) Document the municipality's roles and responsibilities.

A general listing of the municipality's roles and responsibilities as part of a partial program should ultimately be placed in the municipality's NPDES permit. It may not be practicable to open the municipality's NPDES permit at the time of delegation. If this is the case, the municipality's roles and responsibilities should be placed in an administrative order.

If more specific procedures are desired they can be placed in a memorandum of agreement (MOA). Contact the state pretreatment coordinator for assistance with developing MOAs.

7.2.4 After Delegation

1) Ecology regional pretreatment staff will be responsible for oversight of the partial program.

A majority of the oversight will be accomplished through the routine contact between the municipality and the regional staff. The municipality and the regional staff will be coordinating pretreatment activities so that both sides are kept informed of the other's activities within the jurisdiction of the municipality. Ideally, the IUs should perceive a seamless regulatory presence.

In addition, the municipality shall be required to submit an annual report that summarizes the municipalities activities during the reporting period.

2) Modify the municipality's NPDES permit to include the partial pretreatment program permit conditions.

Incorporating the partial pretreatment program permit conditions into the municipality's NPDES permit will still need to be done if it was not practicable at the time of delegation. This should be done the next time the permit is renewed.

3) Modify the IU permits to include language on how the IU will be interacting with the municipality and, notify the municipality of any new or reissued IU permits as they are developed.

The IU permits will still need to be modified if this was not practicable at the time of the delegation. The Regions should place language in the IU permits that defines how the IU will be interacting with the municipality. This should be done when an IU permit is renewed. Coordinate any new IU permit or renewed permit with the municipality.

7.2.4 The EPA's involvement in the process of delegating a partial program

The EPA was involved in the development of these procedures, but does not have a direct role in the actual delegation of a partial pretreatment program. The EPA's involvement in partial program delegation was provided for during the development of these procedures. By providing the EPA with an opportunity to be involved in establishing how Ecology will implement partial programs, any cause for the EPA to be concerned with how Ecology manages partial delegations should have been eliminated.

There is no formal role for the EPA in the selection and delegation of a partial program under the federal pretreatment regulations. There are no regulatory requirements that specify the involvement of the EPA in partial program delegation. The municipality is simply acting as Ecology's duly appointed agent as provided for in Chapter 90.48 RCW.

Keep in mind the EPA will still have the opportunity to comment on any partial delegation when we place the partial program conditions in a municipality's NPDES permit..

CHAPTER XI. CROSS-MEDIA CONSIDERATIONS IN SETTING EFFLUENT LIMITS

(RESERVED)

CHAPTER XII. ALTERNATIVES AND ADDITIONS TO NUMERICAL EFFLUENT LIMITS

There are alternative mechanisms to numerical effluent limits which can be used in permits to regulate the discharge of pollutants. These alternative mechanisms are authorized by federal and state law for use in both NPDES and state permits. These mechanisms include general conditions, special conditions and best management practices.

1. GENERAL CONDITIONS

The general conditions, standard conditions, or boilerplate of a permit are those permit conditions that are based on federal or state law or regulation. They delineate the legal, administrative, and procedural requirements of the permit. In many cases they are direct quotes of the regulations. Most of the federal regulations for the General Conditions are found in 40 CFR 122.41 and 122.42. In the Washington State permit format most of the General Conditions are placed in the back of a permit. The General Conditions are the same for every type of NPDES permit and are not changed by permit writers. The General Conditions for state discharge permits are based on state law and regulation. The importance of the General Conditions should not be underestimated just because they are standardized. The general conditions are very stringent permit conditions.

1.1 The General Conditions for NPDES Permits

The following text is the wording found in individual NPDES permits.

S1. DISCHARGE LIMITATIONS

A. Process Wastewater Discharges

All discharges and activities authorized by this permit shall be consistent with the terms and conditions of this permit.

The discharge of any of the following pollutants more frequently than, or at a level in excess of, that identified and authorized by this permit shall constitute a violation of the terms and conditions of this permit.

The discharge of any pollutant not specifically authorized by this permit in concentrations which violate receiving water quality standards established under section 307(a) of the Act or Chapter 173-201A WAC, shall also be a violation of this permit and the Act.

Beginning on the effective date of this permit and lasting through the expiration date, the Permittee is authorized to discharge (specified wastestream) at the permitted location(s) subject to complying with the following limitations:

B. Sampling and Analytical Procedures

Samples and measurements taken to meet the requirements of this permit shall be representative of the volume and nature of the monitored parameters, including representative sampling of any unusual discharge or discharge condition, including bypasses, upsets and maintenance-related conditions affecting effluent quality.

Sampling and analytical methods used to meet the monitoring requirements specified in this permit shall conform to the latest revision of the *Guidelines Establishing Test Procedures for the Analysis of Pollutants* contained in 40 CFR Part 136 or to the latest revision of *Standard Methods for the Examination of Water and Wastewater* (APHA), unless otherwise specified in this permit or approved in writing by the Department of Ecology (Department).

S3. REPORTING AND RECORDKEEPING REQUIREMENTS

The Permittee shall monitor and report in accordance with the following conditions.

The falsification of information submitted to the Department shall constitute a violation of the terms and conditions of this permit.

A. Reporting

The first monitoring period begins on the effective date of this permit. Monitoring results shall be submitted monthly. Monitoring data obtained during each monitoring period shall be summarized, reported and submitted on a Discharge Monitoring Report (DMR) form provided, or otherwise approved, by the Department. DMR forms shall be received by the Department no later than the 15th day of the month following the completed monitoring period, unless otherwise specified elsewhere in this permit. Priority pollutant analysis data shall be submitted no later than forty-five (45) days following the monitoring period. The report(s) shall be sent to the Department of Ecology, ______________________________________, Washington ________.

All laboratory reports providing data for organic and metal parameters shall include the following information: sampling date, sample location, date of analysis, parameter name, CAS number, analytical method/ number, method detection limit (MDL), laboratory practical quantitation limit (PQL), reporting units and concentration detected.

Discharge Monitoring Report forms must be submitted monthly whether or not the facility was discharging. If there was no discharge during a given monitoring period, submit the form as required with the words "no discharge" entered in place of the monitoring results.

B. Records Retention

The Permittee shall retain records of all monitoring information for a minimum of three (3) years. Such information shall include all calibration and maintenance records and all original recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit. This period of retention shall be extended during the course of any unresolved litigation regarding the discharge of pollutants by the Permittee or when requested by the Department.

C. Recording of Results

For each measurement or sample taken, the Permittee shall record the following information: (1) the date, exact place, method, and time of sampling or measurement; (2) the individual who performed the sampling or measurement; (3) the dates the analyses were performed; (4) who performed the analyses; (5) the analytical techniques or methods used; and (6) the results of all analyses.

D. Additional Monitoring by the Permittee

If the Permittee monitors any pollutant more frequently than required by this permit using test procedures specified by Condition S2. of this permit, then the results of such monitoring shall be included in the calculation and reporting of the data submitted in the Permittee's DMR.

E. Noncompliance Notification

In the event the Permittee is unable to comply with any of the terms and conditions of this permit due to any cause, the Permittee shall:

1. Immediately take action to stop, contain, and cleanup unauthorized discharges or otherwise stop the noncompliance, correct the problem and, if applicable, repeat sampling and analysis of any noncompliance immediately and submit the results to the Department within thirty (30) days after becoming aware of the violation;

2. Immediately notify the Department of the failure to comply; and

3. Submit a detailed written report to the Department within thirty (30) days (five (5) days for upsets and bypasses), unless requested earlier by the Department. The report shall contain a description of the noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

Compliance with these requirements does not relieve the Permittee from responsibility to maintain continuous compliance with the terms and conditions of this permit or the resulting liability for failure to comply.

S4(INDUSTRIAL, S5 MUNICIPAL). OPERATION AND MAINTENANCE

The Permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed by a Permittee only when the operation is necessary to achieve compliance with the conditions of this permit.

S4.B. Bypass Procedures

Bypass, which is the intentional diversion of waste streams from any portion of a treatment facility, is prohibited, and the Department may take enforcement action against a Permittee for bypass unless one of the following circumstances (1, 2, or 3) is applicable.

1. Bypass For Essential Maintenance Without the Potential to Cause Violation of Permit Limits or Conditions.

   Bypass is authorized if it is for essential maintenance and does not have the potential to cause violations of limitations or other conditions of this permit, or adversely impact public health as determined by the Department prior to the bypass. The Permittee shall submit prior notice, if possible at least ten (10) days before the date of the bypass.

2. Bypass Which is Unavoidable, Unanticipated and Results in Noncompliance of This Permit.

   This bypass is permitted only if:

(a) Bypass is unavoidable to prevent loss of life, personal injury, or severe property damage. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass.

(b) There are no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, stopping production, maintenance during normal periods of equipment downtime (but not if adequate backup equipment should have been installed in the exercise of reasonable engineering judgement to prevent a bypass which occurred during normal periods of equipment downtime or preventative maintenance), or transport of untreated wastes to another treatment facility.

(c) The Department is properly notified of the bypass as required in condition S3E of this permit.

3. Bypass Which is Anticipated and has the Potential to Result in Noncompliance of This Permit

The Permittee shall notify the Department at least thirty (30) days before the planned date of bypass. The notice shall contain (1) a description of the bypass and its cause; (2) an analysis of all known alternatives which would eliminate, reduce, or mitigate the need for bypassing; (3) a cost-effectiveness analysis of alternatives including comparative resource damage assessment; (4) the minimum and maximum duration of bypass under each alternative; (5) a recommendation as to the preferred alternative for conducting the bypass; (6) the projected date of bypass initiation; (7) a statement of compliance with SEPA; (8) a request for modification of water quality standards as provided for in WAC 173-201A-110, if an exceedance of any water quality standard is anticipated and (9) steps taken or planned to reduce, eliminate, and prevent reoccurrence of the bypass.

For probable construction bypasses, the need to bypass is to be identified as early in the planning process as possible. The analysis required above shall be considered during preparation of the engineering report or facilities plan and plans and specifications and shall be included to the extent practical. In cases where the probable need to bypass is determined early, continued analysis is necessary up to and including the construction period in an effort to minimize or eliminate the bypass.

The Department will consider the following prior to issuing an administrative order:

(a) If the bypass is necessary to perform construction or maintenance-related activities essential to meet the requirements of this permit.

(b) If there are feasible alternatives to bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, stopping production, maintenance during normal periods of equipment down time, or transport of untreated wastes to another treatment facility.

(c) If the bypass is planned and scheduled to minimize adverse effects on the public and the environment.

After consideration of the above and the adverse effects of the proposed bypass and any other relevant factors, the Department will approve or deny the request. The public shall be notified and given an opportunity to comment on bypass incidents of significant duration, to the extent feasible. Approval of a request to bypass will be by administrative order issued by the Department under RCW 90.48.120.

S4.C. Duty to Mitigate

The Permittee is required to take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit that has a reasonable likelihood of adversely affecting human health or the environment

S4.D. Notification of New or Altered Sources (POTW only)

The Permittee shall submit written notice to the Department whenever any new discharge or a substantial change in volume or character of an existing discharge into the POTW is proposed which: (1) would interfere with the operation of, or exceed the design capacity of, any portion of the POTW; (2) is not part of an approved general sewer plan or approved plans and specifications; or (3) would be subject to pretreatment standards under 40 CFR Part 403 and Section 307(b) of the Clean Water Act. This notice shall include an evaluation of the POTW's ability to adequately transport and treat the added flow and/or wasteload, the quality and volume of effluent to be discharged to the POTW, and the anticipated impact on the Permittee's effluent.(40 CFR 122.42(b)).

G1. SIGNATORY REQUIREMENTS

All applications, reports, or information submitted to the Department shall be signed and certified.

A. All permit applications shall be signed by either a responsible corporate officer of at least the level of vice president of a corporation, a general partner of a partnership, or the proprietor of a sole proprietorship.

B. All reports required by this permit and other information requested by the Department shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

1. The authorization is made in writing by a person described above and submitted to the Department, and

2. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility, such as the position of plant manager, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

C. Changes to authorization. If an authorization under paragraph B.2. above is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph B.2. above must be submitted to the Department prior to or together with any reports, information, or applications to be signed by an authorized representative.

D. Certification. Any person signing a document under this section shall make the following certification:

"I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

G2. RIGHT OF INSPECTION AND ENTRY

The Permittee shall allow an authorized representative of the Department, upon the presentation of credentials and such other documents as may be required by law:

A. To enter upon the premises where a discharge is located or where any records must be kept under the terms and conditions of this permit;

B. To have access to and copy at reasonable times and at reasonable cost any records required to be kept under the terms and conditions of this permit;

C. To inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, methods, or operations regulated or required under this permit; and

D. To sample or monitor at reasonable times any substances or parameters at any location for purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act.

G3. PERMIT ACTIONS

This permit may be modified, revoked and reissued, or terminated either at the request of any interested person (including the permittee) or upon the Department's initiative. However, the permit may only be modified, revoked and reissued, or terminated for the reasons specified in 40 CFR 122.62, 122.64 or WAC 173-220-150 according to the procedures of 40 CFR 124.5. The following are causes for terminating this permit during its term, or for denying a permit renewal application:

A. Violation of any permit term or condition;

B. Obtaining a permit by misrepresentation or failure to disclose all relevant facts;

C. A material change in quantity or type of waste disposal;

D. A determination that the permitted activity endangers human health or the environment or contributes to water quality standards violations and can only be regulated to acceptable levels by permit modification or termination. [40 CFR part 122.64(3)].

E. A change in any condition that requires either a temporary or permanent reduction or elimination of any discharge or sludge use or disposal practice controlled by the permit. [40 CFR part 122.64(4)]

F. Nonpayment of fees assessed pursuant to RCW 90.48.465.

G. Failure or refusal of the permittee to allow entry as required in RCW 90.48.090.

The following are causes for modification but not revocation and reissuance except when the permittee request or agrees:

H. A material change in the condition of the waters of the state;

I. New information not available at the time of permit issuance that would have justified the application of different permit conditions;

J. Material and substantial alterations or additions to the permitted facility or activities which occurred after this permit issuance;

K. Promulgation of new or amended standards or regulations having a direct bearing upon permit conditions, or requiring permit revision;

L. The Permittee has requested a modification based on other rationale meeting the criteria of 40 CFR part 122.62;

M. The Department has determined that good cause exists for modification of a compliance schedule, and the modification will not violate statutory deadlines.

N. Incorporation of an approved local pretreatment program into a municipality's permit.

The following are causes for modification or alternatively revocation and reissuance:

O. Cause exists for termination for reasons listed in A. through G. of this section and the Department determines that modification or revocation and reissuance is appropriate.

P. The Department has received notification of a proposed transfer of the permit. A permit may also be modified to reflect a transfer after the effective date of an automatic transfer (General Condition G8) but will not be revoked and reissued after the effective date of the transfer except upon the request of the new permittee.

G4. REPORTING A CAUSE FOR MODIFICATION

The Permittee shall submit a new application, or a supplement to the previous application, along with required engineering plans and reports, whenever a material change to the facility or in the quantity or type of discharge is anticipated which is not specifically authorized by this permit. This application shall be submitted at least sixty (60) days prior to any proposed changes. The filing of a request by the Permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not relieve the Permittee of the duty to comply with the existing permit until it is modified or reissued.

G5. PLAN REVIEW REQUIRED

Prior to constructing or modifying any wastewater control facilities, an engineering report and detailed plans and specifications shall be submitted to the Department for approval in accordance with Chapter 173-240 WAC. Engineering reports, plans, and specifications shall be submitted at least one hundred eighty (180) days prior to the planned start of construction. Facilities shall be constructed and operated in accordance with the approved plans.

G6. COMPLIANCE WITH OTHER LAWS AND STATUTES

Nothing in this permit shall be construed as excusing the Permittee from compliance with any applicable federal, State, or local statutes, ordinances, or regulations.

G7. DUTY TO REAPPLY

The Permittee shall apply for permit renewal at least 180 days prior to the specified expiration date of this permit.

G8. TRANSFER OF THIS PERMIT

In the event of any change in control or ownership of facilities from which the authorized discharge emanate, the Permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Department.

(1) Transfers by Modification

Except as provided in paragraph (b) below, this permit may be transferred by the Permittee to a new owner or operator only if this permit has been modified or revoked and reissued (under 40 CFR 122.62(b)(2), or a minor modification made under 40 CFR 122.63(d) , to identify the new Permittee and incorporate such other requirements as may be necessary under the Clean Water Act.

(2) Automatic Transfers

This permit may be automatically transferred to a new Permittee if:

(1) The Permittee notifies the Department at least 30 days in advance of the proposed transfer date;

(2) The notice includes a written agreement betrween the existing and new Permittees containing a specific date transfer of permit responsibility, coverage, and liability between them; and

(3) The Department does not notify the existing Permittee and the proposed new Permittee of its intent to modify or revoke and reissue this permit. A modification under the subparagraph may also be minor modification under 40 CFR 122.63. If this notice is not received, the transfer is effective on the date specified in the written agreement.

G9. REDUCED PRODUCTION FOR COMPLIANCE

The Permittee, in order to maintain compliance with its permit, shall control production and/or all discharges upon reduction, loss, failure, or bypass of the treatment facility until the facility is restored or an alternative method of treatment is provided. This requirement applies in the situation where, among other things, the primary source of power of the treatment facility is reduced, lost, or fails.

G10. REMOVED SUBSTANCES

Collected screenings, grit, solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall not be resuspended or reintroduced to the final effluent stream for discharge to State waters.

G11. DUTY TO PROVIDE INFORMATION

The Permittee shall submit to the Department, within a reasonable time, all information which the Department may request to determine whether cause exists for modifying, revoking, and reissuing, or terminating this permit or to determine compliance with this permit. The Permittee shall also submit to the Department upon request, copies of records required to be kept by this permit. (40 CFR 122.41(h))

G12. OTHER REQUIREMENTS OF 40 CFR

All other requirements of 40 CFR 122.41 and 122.42 are incorporated in this permit by reference.

G13. ADDITIONAL MONITORING

The Department may establish specific monitoring requirements in addition to those contained in this permit by administrative order or permit modification.

G14. PAYMENT OF FEES

The Permittee shall submit payment of fees associated with this permit as assessed by the Department.

G15. PENALTIES FOR VIOLATING PERMIT CONDITIONS

Any person who is found guilty of willfully violating the terms and conditions of this permit shall be deemed guilty of a crime, and upon conviction thereof shall be punished by a fine of up to ten thousand dollars ($10,000) and costs of prosecution, or by imprisonment in the discretion of the court. Each day upon which a willful violation occurs may be deemed a separate and additional violation.

Any person who violates the terms and conditions of a waste discharge permit shall incur, in addition to any other penalty as provided by law, a civil penalty in the amount of up to ten thousand dollars ($10,000) for every such violation. Each and every such violation shall be a separate and distinct offense, and in case of a continuing violation, every day's continuance shall be deemed to be a separate and distinct violation.

G16. UPSET

Definition – "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the Permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

An upset constitutes an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limitations if the requirements of the following paragraph are met.

A Permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs or other relevant evidence that: 1) an upset occurred and that the Permittee can identify the cause(s) of the upset; 2) the permitted facility was being properly operated at the time of the upset; 3) The Permittee submitted notice of the upset as required in condition S3.E. and 4) the Permittee complied with any remedial measures required under S5 of this permit.

In any enforcement proceeding the Permittee seeking to establish the occurrence of an upset has the burden of proof.

G17. PROPERTY RIGHTS

This permit does not convey any property rights of any sort, or any exclusive privilege. . The issuance of this permit does not authorize any injury to persons or property or invasion of other private rights, or any infringement of State or local law or regulations.

G18. DUTY TO COMPLY

The Permittee shall comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Clean Water Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application.

G19. TOXIC POLLUTANTS

The Permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish those standards or prohibitions, even if this permit has not yet been modified to incorporate the requirement.

G20. PENALTIES FOR TAMPERING

The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than two years per violation, or by both. If a conviction of a person is for a violation committed after a first conviction of such person under this Condition, punishment shall be a fine of not more than $20,000 per day of violation, or by imprisonment of not more than four (4) years, or by both.

G21. REPORTING PLANNED CHANGES

The Permittee shall, as soon as possible, give notice to the Department of planned physical alteration or additions to the permitted facility, production increases, or process modification which will result in: (1) the permitted facility being determined to be a new source pursuant to 40 CFR 122.29(b); (2) a significant change in the nature or an increase in quantity of pollutants discharged; or (3) a significant change in the Permittee's sludge use or disposal practices. Following such notice, this permit may be modified or revoked and reissued pursuant to 40 CFR 122.62(a) to specify and limit any pollutants not previously limited. Until such modification is effective, any new or increased discharge in excess of permit limits or not specifically authorized by this permit constitutes a violation.

G22. REPORTING ANTICIPATED NON-COMPLIANCE

The Permittee shall give advance notice to the Department by submission of a new application or supplement thereto at least one hundred and eighty (180) days prior to commencement of such discharges, of any facility expansions, production increases or other planned changes, such as process modifications, in the permitted facility or activity which may result in noncompliance with permit limits or conditions. Any maintenance of facilities, which might necessitate unavoidable interruption of operation and degradation of effluent quality, shall be scheduled during noncritical water quality periods and carried out in a manner approved by the Department.

G23. REPORTING OTHER INFORMATION

Where the Permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Department, it shall promptly submit such facts or information.

G24. REPORTING REQUIREMENTS APPLICABLE TO EXISTING MANUFACTURING, COMMERCIAL, MINING AND SILVICULTURAL DISCHARGERS

The Permittee belonging to the categories of existing manufacturing, commercial, mining or silviculture must notify the Department as soon as they know or have reason to believe:

(1) That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant which is not limited in this permit, if that discharge will exceed the highest of the following "notification levels":

(i) One hundred micrograms per liter (100 µg/l);

(ii) Two hundred micrograms per liter (200 µg/l) for acrolein and acrylonitrile; five hundred micrograms per liter (500 µg/l) for 2,4-dinitrophenol and for 2-methyl-4,6-dinitrophenol; and one milligram per liter (1 mg/l) for antimony.

(iii) Five (5) times the maximum concentration value reported for that pollutant in the permit application in accordance with 40 CFR 122.21(g)(7); or

(iv)The level established by the Director in accordance with 40 CFR 122.44(f)

(2) That any activity has occurred or will occur which would result in any discharge, on a non-routine or infrequent basis, of a toxic pollutant which is not limited in this permit, if that discharge will exceed the highest of the following "notification levels":

(i) Five hundred micrograms per liter (500µg/L)

(ii) One milligram per liter (1 mg/L)

(iii) Ten (10) times the maximum concentration value reported for that pollutant in the permit application in accordance with 40 CFR 122.21(g)(7); or

(iv) The level established by the Department in accordance with 40 CFR 122.44(f).

G25. COMPLIANCE SCHEDULES

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than fourteen (14) days following each schedule date.

1.2 The General Conditions for State Permits

G1. DISCHARGE VIOLATIONS

The Permittee shall at all times be responsible for continuous compliance with the terms and conditions of this permit. Failure to comply with the terms and conditions of this permit constitutes a violation of RCW 90.48.144. Such violations may result in orders, directives or penalties being issued by the Department.

G2. PROPER OPERATION AND MAINTENANCE

The Permittee shall at all times be responsible for the proper operation and maintenance of any facilities or systems of control installed to achieve compliance with the terms and conditions of the permit. Where design criteria have been established, the Permittee shall not permit flows or waste loadings to exceed approved design criteria.

G3. REDUCED PRODUCTION FOR COMPLIANCE

The Permittee shall control production or discharge to the extent necessary to maintain compliance with the terms and conditions of this permit upon reduction of efficiency, loss, or failure of its treatment facility until the treatment capacity is restored or an alternative method of treatment is provided. This requirement applies in the situation where, among other things, the primary source of power for the treatment facility is reduced, lost, or fails.

G4. NONCOMPLIANCE NOTIFICATION

In the event the Permittee is unable to comply with any of the permit terms and conditions due to any cause, the Permittee shall:

A. Immediately take action to stop, contain, and cleanup unauthorized discharges or otherwise stop the violation, and correct the problem;

B. Immediately notify the Department of the failure to comply; and

C. Submit a detailed written report to the Department within 30 days, unless requested earlier by the Department, describing the nature of the violation, corrective action taken and/or planned, steps to be taken to prevent a recurrence, and any other pertinent information.

Compliance with these requirements does not relieve the Permittee from responsibility to maintain continuous compliance with the terms and conditions of this permit or the resulting liability for failure to comply.

G5. RIGHT OF ENTRY

Representatives of the Department shall have the right to enter at all reasonable times in or upon any property, public or private, for the purpose of inspecting and investigating conditions relating to the pollution or the possible pollution of any waters of the state. Reasonable times shall include normal business hours; hours during which production, treatment, or discharge occurs; or times when the Department suspects a violation requiring immediate inspection. Representatives of the Department shall be allowed to have access to, and copy at reasonable cost, any records required to be kept under terms and conditions of the permit; to inspect any monitoring equipment or method required in the permit; and to sample the discharge, waste treatment processes, or internal waste streams.

G6. FACILITY CHANGE

The Permittee shall submit a new application, or a supplement to the previous application, along with required engineering reports and engineering plans and specifications, whenever a new or increased discharge or change in the nature of the discharge is anticipated which is not specifically authorized by this permit. The application shall be submitted at least 60 days prior to any proposed changes. Submission of the application does not relieve the Permittee of the duty to comply with the existing permit until it is modified or reissued.

G7. PLAN REVIEW REQUIRED

Prior to constructing or modifying any wastewater control facilities, an engineering report and engineering plans and specifications shall be submitted to the Department for approval in accordance with Chapter 173-240 WAC. Facilities shall be constructed and operated in accordance with the approved plans.

G8. PAYMENT OF PERMIT FEES

The Permittee shall pay the required wastewater discharge permit fees assessed in accordance with Chapter 173-224 WAC. The Department may terminate this permit for nonpayment of fees or late-payment penalties.

G9. PERMIT TERMINATION

A permit shall be subject to termination upon 30 days notice in writing if the Department finds:

A. That it was procured by misrepresentation of any material fact or by lack of full disclosure in the application;

B. That there has been a violation of the conditions thereof; or

C. That a material change in quantity or type of waste disposal exists.

G10. PERMIT MODIFICATION

This permit may be modified in whole or in part for the following causes:

A. Violation of any permit term or condition;

B. Obtaining a permit by misrepresentation or failure to fully disclose all relevant facts;

C. A material change in quantity or type of waste disposal; or

D. A material change in the condition of the waters of the state affected by this permit.

The Department may also modify this permit, including the schedule of compliance or other conditions, if it determines good and valid cause exists, including promulgation or revisions of categorical standards.

G11. COMPLIANCE WITH OTHER LAWS AND STATUTES

Nothing in the permit shall be construed as excusing the Permittee from compliance with any applicable federal, state, or local statutes, ordinances, or regulations.

G12. REMOVED SUBSTANCES

Collected screenings, grit, solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall not be resuspended or reintroduced to the effluent stream for discharge.

G13. PERMIT TRANSFER

This permit is automatically transferred to a new owner or operator if:

A. A written agreement between the old and new owner or operator containing a specific date for transfer of permit responsibility, coverage, and liability is submitted to the Department; and

B. The Department does not notify the Permittee of the need to modify the permit.

Unless this permit is automatically transferred according to section A. above, this permit may be transferred only if it is modified to identify the new Permittee and to incorporate such other requirements as determined necessary by the Department.

G14. DUTY TO REAPPLY

The Permittee must reapply, for permit renewal, at least 60 days prior to the specified expiration date of this permit.

2. SPECIAL CONDITIONS

Special conditions are requirements placed in permits without limits. They may be similar to Best Management Practices (discussed in the next part) but are generally smaller in scope and may lead to permit limits. Special conditions are enforceable.

Since special conditions are specific to individual permits, it's difficult to define them in general terms. Some examples of special conditions follow.

1. An old complex industrial facility was found on one occasion to be leaking process wastewater under the building which then flowed to a small stream. The plumbing at the facility was old and in need of repair. In one instance at this facility, process wastewater was plumbed to a line carrying and discharging non-contact cooling water. This error occurred because the maintenance people were unsure of which pipes were carrying wastewater. These problems occurred near permit renewal time. The permit writer wrote a special condition in the new permit that required the facility to upgrade the piping in some areas, to produce a pipe routing diagram, and to conduct a weekly inspection for leaky wastewater plumbing to prevent any further discharges.

2. A sawmill discharged yard runoff and non-contact cooling water which went to a ditch and then to a small stream. There was no receiving water data on the temperature or flow for the stream. The permit writer placed a special condition in the permit which required a temperature study in the receiving water during the summer low flow to determine if the discharge was violating water quality standards. The special condition included language to alert the permittee that the new information could be used as a basis to modify the permit and place temperature limits in it if necessary to meet water quality standards. (See also Chapter XIII - Receiving Environment Monitoring)

3. POLLUTION PREVENTION AND BEST MANAGEMENT PRACTICES (BMPs)

This section describes Ecology's process of pollution prevention within the Water Quality Program and how to incorporate best management practices into permits.

3.1 Pollution Prevention

Pollution prevention is a priority for the agency and the Water Quality Program. It is inherent in the goals of the Clean Water Act (zero discharge) and was one of the five goals in the strategic plan the Water Quality Program adopted in 1992.

Pollution prevention has been defined by Ecology as source control of pollutants.

The implementation of pollution prevention into the permit program is based on the premise that pollution prevention makes both environmental and economic sense. People will choose to make their products or provide their services in less polluting ways if they know they have a choice and it appears economical. Permits can be used to nudge people to look at viable alternatives, to provide incentives for prevention over treatment or to provide a legally binding framework for a project of interest to both the department and the permittee. Permits should not be used to mandate expensive studies of impractical alternatives or to mandate zero discharge where it is not required and it is not cost effective. The permit should be used as a tool to drive practical economical preventative approaches.

Implementation measures include:

Zero Discharge - Permit managers should require permittees to consider and investigate options for zero discharge in engineering reports where that option appears viable.

Reduced Monitoring - Reward exemplary performance, especially as a result of source control efforts, by reducing monitoring requirements (see Chapter XIII, Section 1.3.2).

Cross Media Shift of Pollutants - Coordinate your actions at facilities with other Ecology and local government actions to prevent cross media shifts of pollutants when feasible.

When developing technology-based effluent limits on a case-by-case basis or when developing water quality-based limits, the permit manager should identify those situations where there is a significant shift of pollutants to some other media such as air or land. These situations should be discussed and documented with the appropriate Ecology media programs to look for a mutual solution.

Watershed Scoping - Include a pollution prevention section in watershed scoping documents and in watershed workshops with Shorelands and Water Resources look for source reduction and water conservation opportunities.

3.2 Best Management Practices

NPDES permits have traditionally focused on chemical-specific numerical effluent limits. To improve water quality, the Act provides for water pollution controls, such as Best Management Practices, to supplement effluent limitations guidelines. Pursuant to RCW 90.48 and sections 304 and 402 of the Act, BMPs may be incorporated as permit conditions. In the context of the NPDES program, BMPs are actions or procedures to prevent or minimize the potential for the release of pollutants or hazardous substances in significant amounts to surface waters. BMPs, although normally qualitative, are most effective when used in conjunction with numerical effluent limits in NPDES permits.

Section 402(a)(1) of the Act allows the Administrator to prescribe conditions in a permit determined necessary to carry out the provisions of the Act, such as BMPs. The discharges to be controlled by BMPs are plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage.

BMPS are intended to complement other regulatory requirements imposed by RCRA, OSHA, the Clean Air Act, and SPCC plans for hazardous substances. Pursuant to section 311 of the Act, EPA has promulgated (40 CFR Part 151) requirements that SPCC plans prevent discharges of hazardous substances from facilities subject to NPDES permitting requirements. The guidelines proposed for hazardous substances SPCC plans are very similar to those required for oil SPCC plans in the Oil Pollution Prevention Regulations (40 CFR Part 112). The NPDES BMP regulation has also been structured to be similar to the highly successful oil SPCC regulation. Even though the State of Washington has no statutory authority to enforce federal SPCC plan requirements, the NPDES permitting program and state law (RCW 90.48.010 and RCW 90.48.520) allow state permit writers to address appropriate spill prevention requirements as permit conditions.

EPA has promulgated the BMP regulation as 40 CFR Subpart K (44 FR 32954-5). Industries regulated by Subpart K must develop a BMP program and submit it with their permit application.

3.3 Scope of BMPs

Any activity which is associated with the industrial manufacturing or treatment process is subject to BMPs. The federal BMP program is only concerned with toxic or hazardous chemical discharges. The State of Washington's BMP program is broader and covers the discharge or potential discharge of any substance which would affect water quality. All activities or sources at the plant should be examined to determine if there is a reasonable potential for equipment failure (e.g., spillage or leakage), natural conditions (e.g., plant site runoff or drainage from raw material storage), or other circumstances (e.g., sludge or waste disposal) which could result in the discharge of a significant amount of pollutants or hazardous substances to receiving waters. For the State of Washington, receiving waters include both surface waters and ground water. These activities or sources usually include: material storage areas, loading and unloading areas; plant site runoff; in-plant transfer, process, and material handling areas; and sludge disposal areas.

Material storage areas include storage areas for toxic and hazardous chemicals which may be raw materials, intermediates, final products or by-products. Included are liquid storage vessels that range in size from large tanks to 55-gallon drums; dry storage in bags, piles, bins, silos, and boxes; and gas storage in tanks and vessels.

Loading and unloading operations involve the transfer of materials to and from trucks or railcars but not in-plant transfers. These operations include pumping of liquids or gases from truck or railcar to a storage facility or vice versa, pneumatic transfer of dry chemicals to or from the loading or unloading vehicle, transfer by mechanical conveyor systems, and transfer of bags, boxes, drums, or other containers from vehicles by forklift trucks or other materials handling equipment.

Plant runoff is generated principally from rainfall on a plant site. Runoff from material storage areas, in-plant transfer areas, loading and unloading areas, and sludge disposal sites potentially could become contaminated with toxic pollutants and hazardous substances. Heavy metals from sludge (disposal sites are of special concern). Fallout, resulting from the plant air emissions which settle on the plant site, may also contribute to contaminated runoff. Contaminated runoff may reach a receiving body of water through overland flow, drainage ditches, storm or noncontact cooling water sewers, or overflows from combined sewer systems. Contaminated runoff can enter ground water by infiltrating through the soil or through recharge zones in surface waters.

In-plant transfer areas, process areas, and material handling areas encompass all in-plant transfer operations from raw material to final product. Various operations could include transfer of liquids or gases by pipelines including devices such as pumps, valves and fittings; movement of bulk materials by mechanical conveyor-belt systems; and forklift truck transport of bags, drums, and bins. All transfer operations within the process area with a potential for release of toxic pollutants and hazardous substances to other than the process wastewater system are addressed in this grouping.

Sludge and other waste handling areas are potential sources of contamination of receiving waters. These operations include landfills, pits, ponds, lagoons, and deep-well injection sites. Depending on the construction and operation of these sites there may be a potential for leachate containing toxic pollutants or hazardous substances to seep into the ground water, or for liquids to overflow to surface waters from these disposal operations. BMP requirements are not intended to duplicate the requirements of RCRA. Actions taken for compliance with RCRA may be referenced in the BMP plan submitted with the permit application.

Any facility with an RCRA permit will already have plans addressing BMP requirements (e.g., contingency plans, personnel training plans, inspections and maintenance, security, reporting and records, compatibility testing, and housekeeping procedures). However, the RCRA requirements will usually be applied only to areas involved in the treatment, storage or disposal of hazardous waste. So these RCRA procedures may need to be expanded to meet BMP requirements.

3.4 Minimum Requirements for the BMP Plan

BMPs may include some of the same practices used by industry for pollution control, SPCC plans for oil and hazardous substances, safety programs, fire protection, protection against loss of valuable raw materials or products, insurance policy requirements or public relations. The minimum requirements of a BMP Plan are listed in Table 1 and are divided into 2 categories: general requirements and specific requirements.

Table XI-1. MINIMUM REQUIREMENTS OF A BMP PLAN

A. General Requirements

1. Name and location of facility
2. Statement of BMP policy and objectives
3. Review by plant manager

B. Specific Requirements

1. BMP Committee
2. Risk Identification and Assessment
3. Structural Modifications
4. Reporting of BMP Incidents
5. Materials Compatibility
6. Good Housekeeping
7. Preventive Maintenance
8. Inspections and Records
9. Security
10. Employee Training

3.4.1 General Requirements

The BMP plan should be organized and described in an orderly narrative format. A description of the facility, including the plant name, the type of plant, processes used, and the products manufactured should be included in the BMP plan. A map showing the location of the facility and the adjacent receiving waters also should be part of the plan. Any available data about site soils or ground water conditions should also be included. Specific objectives for the control of toxic pollutants and hazardous substances should be included in a statement of corporate policy. The plan should be reviewed by the plant manager.

3.4.2 Specific Requirements

Each of the 9 specific requirements listed in Table IV-1 should be addressed in the BMP plan. The size and complexity of the BMP plan will vary with the size, complexity, and location of the facility. It is anticipated that the length and detail of the BMP plan will be commensurate with the quantity of toxic and hazardous chemicals on site and their opportunity for discharge. The fundamental goal of the BMP plan is determining the potential for toxic and hazardous chemicals to reach receiving waters, and taking appropriate preventive measures.

3.4.3 BMP Committee

The BMP Committee is a group of individuals within the plant organization which is responsible for developing the BMP plan and assisting the plant management in its implementation, maintenance and updating. The scope of activities and responsibilities of the BMP Committee should include all aspects of the facility's BMP plan, such as identifying toxic and hazardous materials handled in the plant; identifying potential spill sources; establishing incident reporting procedures; developing BMP inspection and records procedures; reviewing environmental incidents to determine and implement necessary changes to the BMP plan; coordinating plant incident response cleanup and notifying authorities; establishing BMP training for plant personnel; and aiding interdepartmental coordination in carrying out the BMP plan. Other committee duties could include reviewing both new construction and changes in processes or procedures at the facility relative to spill prevention and control.

The plan should contain a clear statement of the management's policies and responsibilities related to BMPs. Authority and responsibility for immediate action in the event of a spill should be clearly established and documented in the BMP plan, with the Committee indirectly involved in that responsibility. The Committee should advise management on the technical aspects of environmental incident control, but should not impede the decision-making process for preventing or mitigating spills and incidents. Management should, of course, review and support the BMP plan.

The size and composition of the BMP Committee should be appropriate to the size and complexity of the plant, and to the specific toxic and hazardous chemicals handled at the plant. Facility personnel knowledgeable in spill control and waste treatment such as environmental specialists, production foreman, safety and health specialists, and any treatment plant supervisor should be included. In some small plants, the committee might consist of the one manager or engineer assigned responsibility for environmental control. For very small facilities, the Committee function might even have to be fulfilled by competent engineers or managers from the corporate staff or the nearest large plant.

A list of personnel on the BMP Committee should be included in the BMP plan. The list should have the office and home telephone numbers of the Committee members, and the names and phone numbers of backup or alternate people.

3.4.4 Risk Identification and Assessment

The areas of the plant that are subject to BMP requirements should be identified by the BMP Committee. Each such area should be examined for the potential risks for discharges of toxic pollutants or hazardous substances to receiving waters. Any existing physical means (dikes, diversion ditches, etc.) of controlling such discharges also should be identified.

The areas described above should be clearly indicated on a plant plot plan or drawing. A simplified materials flowsheet showing major process operations can be used to indicate the direction and quantity of materials flowing from one area to another. Areas with the potential for ground water contamination via subsurface infiltration or surface water recharge after spills should be identified and indicated on site drawings. The direction of flow of potential spills and surface runoff should also be estimated based on site topography and indicated on the plant site drawings. Dry chemicals that are either toxic pollutants or hazardous substances should be evaluated if they have the potential to reach surface or ground waters in significant quantities via rainfall runoff, for example.

A hazardous substance and toxic chemical inventory (materials inventory) should be developed as part of the "Risk Identification and Assessment." The detail of the materials inventory should be proportionate to the quantity of toxic pollutants and hazardous substances on site and their potential for reaching the receiving waters (both surface and ground water). For example:

1. The plant has determined that materials stored in bulk quantities at a tank farm have a high potential for reaching the receiving waters via surface runoff or subsurface infiltration in the event of structural failure or overfills. Therefore, the materials inventory for the tank farm should be detailed, and should provide the identity, quantities, and locations of each material.

2. The plant has determined that materials stored in small quantities at the research laboratory have a low potential for reaching the receiving waters. Therefore, the materials inventory for the laboratory could be minimally detailed, and may not include the identity, quantity, or location of each material but might include an estimate of the total quantity of toxic and hazardous materials stored and would provide the location of the laboratory. The rationale for the "low risk" nature of the laboratory would be provided in this part of the BMP plan.

3. The plant has determined that materials used in a batch operation in the manufacturing process have a high potential for reaching the receiving water. The plant supplies a variety of products through the batch operation process to accommodate fluctuations in public demand. Consequently, the materials used for the batch process vary from week to week, often times unexpectedly. Therefore, the materials inventory for the batch operation should be detailed but remain flexible. The inventory might include the identification of each material expected for use, and the maximum quantity of material expected for use, and the maximum quantity of material that the batch process can handle. The materials inventory could be updated to include any material substitutions unanticipated at the time of the original inventory.

The examples above illustrate the flexibility of the materials inventory. A materials inventory should be part of the "Risk Identification and Assessment" of every BMP plan but the detail of the inventory will vary with the size and complexity of the plant, the quantities of toxic and hazardous chemicals on-site, and the potential for those materials to reach surface waters.

The materials inventory and other useful technical information should be made available to the BMP Committee but may require separate filing from the BMP plan documents to protect proprietary information or trade secrets. This data may include physical, chemical, toxicological and health information (e.g., technical bulletins or material safety data sheets) on the toxic pollutants and hazardous substances handled; the quantities involved in various operations; and the prevention, containment, mitigation, and cleanup techniques that would be used in the event of a discharge.

Materials planned for future use in the plant should be evaluated for their potential to be discharged in significant amounts to receiving waters. Where the potential is high, the same type of technical data described above should be obtained.

3.4.5 Structural Modifications

An important element of BMP implementation involves actual physical changes to the facility which prevent the potential release of a pollutant. These physical changes include overflow and overfill controls, secondary containment systems, ground water protection barriers, and emergency cut-offs. The purpose of these structural modifications to the facility is to confine potential pollutants to those portions of the facility where they belong by preventing spills, stopping spills that have started, or containing spills that have already happened. Because these structural modifications are physical changes, they do not need human intervention to work effectively. However, this does not mean that these devices are "fool proof" and do not need to be a part of other elements of BMP such as facility inspection programs, employee training or spill drills.

Overflow and overfill controls prevent spills in pipes, process vessels or storage tanks by stopping or rerouting flow when the unit is full or flow is blocked. The principle is the same as the pumps in gas stations which sense the level of gasoline in your car and shut-off when the tank is full. These devices sense the fluid level or the line pressure and automatically stop or reroute flow before the point of spillage. Liquids can be rerouted back to their source, to another vessel such as a process or storage tank or to secondary containment.

Secondary containment is a facility's extra storage capacity that automatically receives a spill from a process or storage unit. This extra storage capacity can be provided by earthen dikes, concrete pads, walls or curbing, concrete sumps, or a tank connected down gradient of the potential spill source. Secondary containment holds a spill safely until facility personnel can recover or dispose of the spilled material. A secondary containment device must be capable of holding more than the volume of the largest spill possible at the facility (for example, capable of holding more than the volume of the largest tank in a tank farm or 40% of the total volume of all drums which can be stored in a drum storage area). The permit writer should realize that other environmental programs such as SPCC or RCRA will have specific requirements on the volumes of many secondary containment systems.

Ground water protection barriers are made of natural or artificial materials designed to stop spills from infiltrating through the soil to contaminate ground water. Natural materials used as ground water protection barriers are usually clays that are placed in a layer between the source of the spill and the soil overlaying the ground water. Artificial materials take the form of impermeable synthetic liners which are placed under the spill source. These ground water protection barriers can be used as back-up for secondary containment in the event of an overflow or a structural failure such as a crack in a concrete drum storage pad, or they can be used in combination with secondary containment such as lining the bottom of a diked area around a tank farm. These devices are also useful for lining containment basins for stormwater which could be contaminated or for areas such as loading docks which are subject to frequent small spillage. Of course, ground water protection barriers are routinely installed under surface impoundments, waste piles and landfills.

Emergency cutoffs include many of the overflow/overfill control devices, but also include other types of control. One such device is the emergency cutoff for an entire industrial process that occurs when the wastewater or air pollution control system fails. A related type of emergency cutoff shuts down an industrial operation when internal pressures, chemical reactions or ambient vapors threaten an explosion at a facility. Other emergency cutoff systems shut storm sewer systems when a monitor has detected gasoline vapors or when special organic absorbents swell and block a sewer in reaction to solvents. Emergency cutoffs can also be installed to stop the discharge from a failed pollution control device such as a wastewater plant or air pollution scrubber.

Any of these structural modifications made to physically prevent the release of a pollutants from a facility must be included in all of the related BMP activities such as inspections, maintenance, personnel training, and spill drills. A disconnected or neglected device will not work in the event of a spill. If facility personnel do not know about the functioning of the device, they cannot properly maintain or inspect it. Without training and spill drills which include the devices, personnel may misinterpret the cause of an emergency cutoff or may release material from secondary containment prematurely. Just because these structural devices operate automatically, does not mean that they can be left out of all other BMP elements. The BMP plan must describe these physical devices and outline their routine inspection and maintenance in addition to including them in personnel training and spill drills.

3.4.6 Reporting of BMP Incidents

A BMP incident reporting system is used to keep records of incidents such as spills, leaks, runoff and other improper discharges. The system minimizes recurrence, expedites containment or cleanup activities, and complies with legal requirements. Reporting procedures defined by the BMP Committee should include these 3 elements upon discharge:

1. Immediately notify appropriate plant personnel so they can initiate prompt action.

2. Write formal reports for management to review. Management should evaluate the BMP incident and consider revising the BMP plan accordingly.

3. (By law) Notify governmental and environmental agencies if a spill or other discharge reaches surface water or ground water.

The reporting system should designate the means for reporting incidents to responsible company and government officials. The names, office telephone numbers, and home telephone numbers of key employees ranked in order of responsibility should be listed for immediate reporting of BMP incidents to plant management personnel involved in implementation of emergency response plans.

The communications system should be described which is available for notification of an impending or actual BMP incident. Reliable communications with the person directly responsible is necessary to expedite immediate action for preventing, containing, or initiating cleanup of a discharge. Such a communication system could include telephone, radio, or alarm systems that could signal the location of an incident. Provisions to maintain communications in the event of a power failure must be addressed.

Written reports on all BMP incidents should be submitted to the plant's BMP Committee and plant management for review. Written reports should include the date and time of the discharge, weather conditions, nature of the materials involved, duration, volume, cause, environmental problems, countermeasures taken, people and agencies notified, and recommended revisions to the BMP plan involving changes to the plant operating procedures and/or equipment to prevent recurrence.

Procedures and important information should be outlined in the BMP plan for inclusion in reports of BMP incidents to federal, state, and local regulatory authorities. In some circumstances, notifying authorities such as municipal sewage treatment works, drinking water treatment plants, and fish and wildlife commissions may be desirable. The BMP plan should list the individuals who are responsible for notifying these authorities. The telephone numbers of these authorities and of people in the plant who need to be notified should also be listed in the BMP plan. The phone numbers should be reviewed periodically for accuracy and might actually be used in the course of a "spill drill."

3.4.7 Materials Compatibility

Incompatibility of materials can cause equipment failure through corrosion, fire, or explosion. Equipment failure can be prevented by ensuring that the materials of construction for containers handling hazardous substances or toxic pollutants are compatible with the containers' contents and surrounding environment.

Materials compatibility encompasses 3 aspects: compatibility of the chemicals being handled with the materials of construction of the container, compatibility of different chemicals upon mixing in a container, and compatibility of the container with its environment. The specific requirement of "Materials Compatibility" in the BMP plan should provide procedures to address these aspects in the design and operation of the equipment on site handling toxic and hazardous materials.

The BMP plan documentation on materials compatibility should describe the engineering practices already used in the plant, and should summarize these existing practices with regard to corrosion and other aspects of material compatibility. Specific consideration should be given to procedures and practices for the mixing of chemicals which might result in fire, explosion or unusual corrosion. Thorough cleaning of storage vessels and equipment before use with another chemical should be standard practice to avoid unexpected reactions or releases of hazardous material. Coatings or cathodic protection should be considered for protecting a buried pipeline or storage tank from corrosion.

Where applicable, material testing procedures should be described in the BMP plan. Proposed substitutions for currently used toxic or hazardous chemicals should be studied to determine whether they are compatible with the construction materials of the existing containers. The procedures utilized by the plant or an outside contractor to perform the materials compatibility study should be documented. Materials compatibility situations which are covered by the RCRA hazardous waste regulations should be referred to in the BMP plan.

3.4.8 Good Housekeeping

Good housekeeping is essentially the maintenance of a clean, orderly work environment and contributes to the overall facility pollution control effort. Periodic training of employees on housekeeping techniques for those plant areas where the potential exists for discharges reduces the possibility of incidents caused by mishandling of chemicals or equipment.

Examples of good housekeeping include neat and orderly storage of bags, drums, and piles of chemicals; prompt cleanup of spilled liquids to prevent significant runoff to surface water or infiltration to ground water; sweeping, vacuuming, or other cleanup of accumulations of dry chemicals as necessary to prevent them from reaching receiving waters; and provisions for storage of containers or drums to keep them from protruding into open walkways or pathways.

Maintaining employee interest in good housekeeping is a vital part of the BMP plan. Methods for maintaining good housekeeping goals could include regular housekeeping inspections by supervisors and higher management; discussions of housekeeping at meetings; and publicity through posters, suggestion boxes, bulletin boards, slogans, incentive programs, and employee publications.

3.4.9 Preventive Maintenance (PM)

An effective preventive maintenance (PM) program is important to prevent spills or releases. A PM program involves inspection and testing of plant equipment and systems to uncover conditions which could cause breakdowns or failures which result in significant discharges of chemicals to receiving waters. The program should prevent breakdowns and failures by adjustment, repair, or replacement of items. A PM program should include a suitable records system for scheduling tests and inspections, recording test results, and facilitating corrective action. Most plants have existing PM programs which provide a degree of environmental protection. It is not the intent of the BMP plan to require development of a redundant PM program. Instead, the objective is to have qualified plant personnel and the BMP Committee evaluate the existing plant PM program and recommend to management those changes, if any, needed to address BMP requirements.

A good PM program should include the following: (1) identification of equipment or systems to which the PM program should apply; (2) periodic inspections or tests of identified equipment and systems; (3) appropriate adjustment, repair, or replacement of items; and (4) maintenance of complete PM records on the applicable equipment and systems.

The BMP plan documentation on PM may include a list of procedures, examples of record keeping, a list of the principal systems to which the PM program is applicable, and directions for obtaining the records for any particular system included or referred to in the BMP plan. In general, it will be adequate to refer to the scope of existing PM procedures and location of PM records.

3.4.10 Inspections and Records

The purpose of the inspection and records system is to detect actual or potential BMP incidents. The BMP plan should include written inspection procedures and optimum time intervals between inspections. Records to show the completion date and results of each inspection should be signed by the appropriate supervisor and maintained for a period of 3 years. A tracking (followup) procedure should be instituted to assure that adequate response and corrective action have been taken. The record keeping portion of this system can be combined with the existing spill reporting system in the plant.

While plant security and other personnel may frequently and routinely inspect the plant for BMP incidents, these people are not necessarily capable of assessing the potential for such incidents. Certain inspections should be assigned to designated qualified individuals, such as maintenance personnel or environmental engineering staff.

The inspection and records system should include those equipment and plant areas identified in the "Risk Identification and Assessment" portion of the BMP plan as having the potential for significant discharges. To determine the inspection frequency and inspection procedures, competent environmental personnel should evaluate the causes of previous incidents and assess the probable risks for incidents. Furthermore, the nature of chemicals handled, materials of construction, and site-specific factors including age, inspection techniques, and cost-effectiveness should be considered.

Qualified plant personnel should be identified to inspect designated equipment and plant areas. Typical inspections should include examination of pipes, pumps, tanks, supports, foundations, dikes, and drainage ditches. Records should be kept to determine if changes in preventive maintenance or good housekeeping procedures are necessary.

Material storage areas for dry chemicals should be inspected for evidence of, or the potential for, wind blowing which might result in significant discharges.

Liquid storage areas should be inspected for leaks in tanks, for corrosion of tanks, for deterioration of foundations or supports, and for closure of drain valves in containment facilities. Inspections could include the examination of seams, rivets, nozzle connections, valves, and connecting pipelines. Storage tanks should be inspected for evidence of corrosion, pitting, cracks, abnormalities, and deformation and such evidence should then be evaluated.

For in-plant transfer and materials handling of liquids, inspections should include visual examination for evidence of deterioration of pipelines, pumps, valves, seals and fittings. The general condition of items such as flange and expansion joints, pipeline supports, locking valves, catch or drip pans, and metal surfaces also should be assessed.

For loading and unloading operations, inspections during transfer of materials would permit immediate response if an incident occurred. The conditions of pipelines, pump, valves, and fittings for liquid transfer systems and pneumatic conveying systems used for transferring dry chemicals should be inspected. Inspections (together with monitoring) should be used to ensure that the transfer of material is complete before flexible or fixed transfer lines are disconnected prior to vehicular departure. Before any tank car or tank truck is filled, the lower most drain valve and all outlets of such vehicles should be closely examined for evidence of leakage and, if necessary, tightened, adjusted, or replaced. Before departure, all tank cars or tank trucks should be closely examined to ensure that all transfer lines are disconnected and that there is no evidence of leakage from any outlet.

For plant runoff, inspect the integrity of the stormwater collection system and the diversion or overflow structures, and ensure that the drain valves and pump for diked areas are properly closed. The plant sewer and storm sewer system should be periodically surveyed to ensure that toxic and hazardous pollutants are not discharged in significant amounts. Inspections also should include diked areas to ensure that hazardous and toxic chemicals are not discharged from inside diked areas to waterways. Any liquid, including rainwater runoff, should be examined, and where necessary, analyzed, before being released from the diked areas to a receiving water. The permit should include site-specific methods for determining whether rainwater has received contamination. For examples, a facility handling acids could check to see that the pH of the rainwater is close to neutral, or a facility handling oils could check for a sheen on the rainwater before discharge. If inspection reveals any indication of contamination, then the rainwater must be analyzed and properly treated before discharge.

Visual inspections should include examinations for leaks, seepage, and overflows from land disposal sites such as spray fields, pits, ponds, lagoons, and landfills. Other procedures and inspection techniques should be considered on a site-specific basis. Any inspections made or records kept to comply with a solid waste permit may be included in the BMP plan by reference.

Emergency equipment and supplies for spill control or fire fighting must be inspected to ensure that equipment is in good condition and supplies are adequate. The communication system must also be inspected.

3.4.11 Security

A security system is needed to prevent accidental or intentional entry to a plant which might result in vandalism, theft, sabotage or other improper or illegal use of plan facilities that could possibly cause a BMP incident. Most plants have security system to prevent unauthorized entry leading to theft, vandalism, sabotage or a spill. The BMP plan should describe those portions of the existing security system which ensure that chemicals or other pollutants are not discharged either accidentally or deliberately to receiving waters in significant quantities.

The BMP Committee, plant security manager, plant engineer or other qualified plant personnel should evaluate the coverage of the existing security system over those areas of the plant identified by the "Risk Identification and Assessment" as having the potential for significant discharges. They should recommend to plant management any changes necessary to improve the security system.

Examples of security measures include: routine patrol of the plant by security guards in vehicles or on foot; fencing to prevent intruders from entering the plant site, good lighting; vehicular traffic control; a guardhouse or main entrance gate, where all visitors are required to sign in and obtain a visitor's pass; secured or locked entrances to the plant; locks on certain valves or pump starters; and television surveillance of appropriate plant sites, such as plant entrance, and loading and unloading areas.

Whenever possible, security personnel should be instructed to observe leaks from tanks, valves, or pipelines while patrolling the plant and also be informed of the procedures to follow when a spill or other discharge is detected. Many plants use contractor or plant security personnel who may not be qualified or may not have time to carry out such surveillance. In such cases, the surveillance can be incorporated in the "Inspection and Records" specific requirement and should be conducted by production or environmental staff.

3.4.12 Employee Training

Employee training programs should result in personnel, at all levels of responsibility, having a complete understanding of the BMP plan. Employee training meetings should be conducted at least annually to ensure adequate understanding of the objectives of the BMP plan and the individual responsibilities of each employee. Typically, these meetings could be a part of routine employee meetings for safety or fire protection. Such meetings should highlight previous spill events or failures, malfunctioning equipment components, and recently developed BMP precautionary measures. Training sessions should review the BMP plan and associated procedures. Just as fire drills are used to improve an employee's reaction to a fire emergency, spill or environmental incident drills may serve to improve the employee's reactions to BMP incidents. Large or complex facilities are required to conduct spill drills on a quarterly or semi-annual basis. Smaller facilities are strongly encouraged to conduct spill drills too. Spill drills also serve to evaluate the employees' knowledge of BMP-related procedures, and are a fundamental part of employee training.

Adequate training in a particular job and process operation is essential for understanding potential discharge problems. Knowledge of specific manufacturing operations and how discharges could occur, or have occurred in the past, is important in reducing human error that can lead to BMP incidents.

The training program must include the protocol used to report discharges to the people responsible for implementing countermeasures. In addition, personnel involved in spill response should be trained to use cleanup materials such as sorbents, gelling agents, foams, and neutralizing agents. They should also be educated in safety precautions, in the side effects of the chemicals they are working with, and in possible chemical reactions. Operating manuals and standard procedures for process operations should include appropriate sections on the BMP plan and the spill control program and must be readily available for reference.

The BMP plan must contain records showing the dates, names and positions of the employees trained and also include the lesson plans, subject material covered, and instructors' names and positions. BMP-related training may be combined with other forms of training, such as safety, fire prevention, or RCRA required training.

In addition to permanent personnel, contractors or temporary personnel should be trained in procedures for preventing BMP incidents since these individuals may be unfamiliar with the normal operating procedures or location of equipment (pipelines, tanks etc.) at the facility. Adequate supervision of contractor maintenance personnel should be provided to minimize the possibility of BMP incidents resulting from damaging equipment such as buried pipelines. This supervision or training must be described in the BMP plan.

3.5 Specific BMPs

Ecology has developed specific BMPs for vehicle and equipment washing (WQ-R-95-56) and for prevention of pollution from storm water discharge in the Puget Sound Basin (Ecology 91-75)

3.6 Spill Plans Required by Others

Some facilities are required by other laws to have spill plans. The following Table XII-1 lists the facilities that are required to have spill plans for oil and petroleum products under RCW 90.56. These spill plans are reviewed by the Spill Program.

Table XII-1. Facilities Covered by the Spill Program's Spill Policy and Planning Section Oil Spill Regulations/RCW 90.56

Plan ID*	Facility Name	Plan ID	Facility Name
NW006	Arco Terminal, Seattle	NW029	Rainier Petroleum, Seattle
NW008	Arco Refinery, Ferndale	NW025	Richardson Fuel, Lopez Island
NW028	Ballard Oil Co. Seattle		Russells at Orcas Landing, Orcas Is.
NW011	Tosco Refining Co., Ferndale		
SW004	Tosco Refining Co., Port Angeles	NW015	Scott Paper Co., Everett
NW005	Tosco Refining Terminal, Renton	NW001	Seattle Steam, Seattle
SW002	Tosco Refining, Tacoma	NW002	Tesoro Northwest, Anacortes
SW006	Buckeye Pipeline, Tacoma	NW020	Shell, Seattle
NW013	Burlington Environmental, Seattle	SW012	Simpson Tacoma Kraft, Tacoma
SW003	Cenex, Vancouver	SW013	Sound Refining, Tacoma
ER006	Chevron Pipeline, Pasco	SW010	Superior Oil, Tacoma
NW007	Chevron Point Wells, Seattle		
NW007	Chevron Richmond Beach, Seattle	SW005	Tosoro Refining, Vancouver
ER002	Chevron USA, Pasco	NW003	Equilon Enterprises LLC, Anacortes
ER007	Conoco Tank Farm, Spokane	NW010	Equilon Enterprises LLC, Seattle
ER007	Conoco Tank Farm, Spokane	NW010	Equilon Enterprises LLC, Seattle
NW024	Covitch Williams Co., Seattle	ER003	Tidewater (Columbia River), Clarkston
SW016	Daishowa American Paper, Port Angeles	ER004	Tidewater (Snake River), Pasco
ER001	Exxon, Spokane	NW018	Times Oil, Seattle
NW009	GATX, Seattle	NW016	Trans Mountain Pipeline, Bellingham
NW027	Island Petroleum Serv., Friday Harbor	NW019	Unocal, Edmonds
		SW011	Unocal, Tacoma
SW001	James River, Camas	SW009	US Oil & Refining, Tacoma
SW014	Longview Fibre Company, Longview	SW007	Weyerhauser, Longview
NW004	Manchester Naval Supply, Manchester	NW023	Wilkens Distributing Co., Bremerton
SW017	McNeil Island, Steilacoom	NW023	Wilkens Distributing Co., Pt. Orchard
NW014	Naval Air Station, Whidbey Island	ER007	Yellowstone Pipeline, Spokane

* The plan ID indicates which region is reviewing the plan. Copies of those plans are available at that regional office. Copies of all plans are available at HQ by contacting the Spills Program.

4. CERTIFIED OPERATORS AT INDUSTRIAL SITES WITH DOMESTIC WASTEWATER TREATMENT FACILITIES

Many industrial facilities have small domestic wastewater treatment facilities at the site or treat small quantities of domestic wastewater with the industrial wastewater. The personnel who work at these treatment facilities must be certified in accordance Chapter 173-230 WAC (Certification of Operators of Wastewater Treatment Plants). This regulation was primarily intended for municipal wastewater treatment plants but it applies to any wastewater treatment plant treating domestic wastewater. The level of certification ranges from OIT (operator-in-training) to Group IV. The level of certification required is in accordance with the size and complexity of the wastewater treatment facility. Wastewater discharge permits for industrial facilities treating domestic wastewater should include a requirement for a certified operator. Permit managers who are uncertain of the classification of a facility should call Tammy McClure, the operator certification coordinator, for assistance. Inspections of these facilities should verify the operator is certified and that the certification is of the proper level.

XIII. MONITORING GUIDELINES

This chapter presents guidance and provides the technical references and the few statutory references which a permit writer should consider when establishing the special permit conditions for frequency of sampling, sample types, sampling locations and the analytical methods in a wastewater discharge permit. The seven sections of this chapter include:

1. The general considerations of self monitoring.
2. POTW monitoring (excluding land application).
3. Industrial and commercial facility monitoring.
4. WET testing monitoring.
5. Storm water monitoring.
6. Receiving environment monitoring.
7. Sediment monitoring
8. Summary checklist.

> "Monitoring is truly the cornerstone of the NPDES program. It is the primary means of ensuring that the permit limitations are met. It is also the basis for enforcement actions against permittees who are in violation of their permit limits."

Having so stated in the opening of its primary permit-writing training manual, EPA dedicates four pages of a 100 page training manual to the topic of monitoring (EPA, 1987d). There is little explicit guidance which provides the permit writer with a framework for decisions relating to monitoring. This chapter informs the permit writer of what methods to follow to establish monitoring conditions in a permit.

EPA directed the states to require recording and reporting of monitoring results:

> "All permits shall specify requirements concerning the proper use, maintenance, and installation, when appropriate, of monitoring equipment or methods (including biological monitoring methods when appropriate). All permits shall specify required monitoring including type, intervals, and

frequency sufficient to yield data which are representative of the monitored activity including when appropriate, continuous monitoring" (40 CFR 122.48).

"In addition to §122.48, the following monitoring requirements:

(1) To assure compliance with permit limitations, requirements to monitor:

(i) The mass (or other measurement specified in the permit) for each pollutant limited in the permit;

(ii) The volume of effluent discharged from each outfall;

(iii) Other measurements as appropriate including pollutants in internal waste streams under §122.45(i); pollutants in intake water for net limitations under §122.45(f); frequency, rate of discharge, etc., for noncontinuous discharges under §122.45(e); pollutants subject to notification requirements under 122.42(a); and pollutants in sewage sludge or other monitoring as specified in 40 CFR part 503; or as determined to be necessary on a case-by-case basis pursuant to section 405(d)(4) of the CWA.

(iv) According to test procedures approved under 40 CFR part 136 for the analyses of pollutants having approved methods under that part, and according to a test procedure specified in the permit for pollutants with no approved methods.

(2) Requirements to report monitoring results with a frequency dependent on the nature and effect of the discharge, but in no case less than once a year..." (40 CFR 122.44[i])

The two citations quoted above give the permit writer extreme flexibility in monitoring, from yearly to continuous. The most important requirement is that the data "are representative of the monitored activity."

Washington State regulations provide more detailed requirements.

" (1) Monitoring.

(a) Any discharge authorized by a permit may be subject to such monitoring requirements as may be reasonably required by the department, including the installation, use, and maintenance of monitoring equipment or methods (including, where appropriate, biological monitoring methods). These monitoring requirements would normally include:

(i) Flow (in gallons per day);

(ii) Pollutants (either directly or indirectly through the use of accepted correlation coefficients or equivalent measurements) which are subject to reduction or elimination under the terms and conditions of the permit;

(iii) Pollutants which the department finds could have a significant impact on the quality of surface waters; and

(iv) Pollutants specified by the administrator, in regulations issued pursuant to the FWPCA, as subject to monitoring.

(b) Each effluent flow or pollutant required to be monitored pursuant to (a) of this subsection shall be monitored at intervals sufficiently frequent to yield data which reasonably characterizes the nature of the discharge of the monitored effluent flow or pollutant. Variable effluent flows and pollutant levels may be monitored at more frequent intervals than relatively constant effluent flows and pollutant levels which may be monitored at less frequent intervals.

(c) Monitoring of intake water, influent to treatment facilities, internal waste streams, and/or receiving waters may be required when determined necessary by the department to verify compliance with net discharge limitations or removal requirements, to verify that proper waste treatment or control practices are being maintained, or to determine the effects of the discharge on the surface waters of the state...

(3) Reporting of monitoring results.

(a) The permittee shall periodically report (at a frequency of not less than once per year) on the proper reporting form, the monitoring results obtained pursuant to monitoring requirements in a permit. In addition to the required reporting form, the department at its discretion may require submission of such other results as it determines to be necessary." [WAC 173-220-210]

"(1) Any permit issued by the department shall specify conditions necessary to prevent and control waste discharges into the waters of the state, including the following, whenever applicable:

(g) Any appropriate monitoring, reporting and recordkeeping requirements as specified by the department, including applicable requirements under sections 307 and 308 of FWPCA" [WAC 173-216-110]".

The nature and effect of the discharge are important factors in determining monitoring frequency and so it is important that the discharge be adequately characterized. The permit writer should recognize the costs of monitoring while deciding how much is enough for an adequate characterization.

Consulting with individuals, including the permittee, who are knowledgeable about the facility or type of operation will save time on appeals, enforcement and future permit renewal or modification efforts. A prime source of information about a facility is the inspector who deals with the facility or similar facilities.

1. GENERAL CONSIDERATIONS OF A SELF-MONITORING PROGRAM

The general considerations apply to all facilities in the wastewater permit program administered by the Washington State Department of Ecology. Exceptions and additional considerations are explained in the chapter sections for POTWs, industrial facilities, storm water and for receiving environment monitoring. The general considerations are presented in this section in the following sequence:

- Objectives of monitoring.
- Parameters to monitor.
- Frequency of monitoring.
- Special monitoring strategies.
- Sampling and testing methods.
- Sampling locations.
- Data validation, management and reporting.
- Quality assurance and quality control.

All permits must require monitoring of effluent in order to determine if the facility is in compliance with the permit. The permit must state the sampling location, frequency, methods of analyses, and sample type for each parameter with limits. Parameters without limits may be monitored as required by the department. Internal process control monitoring may be required of dischargers exhibiting noncompliance. Tiered monitoring and indicator parameters should be used when appropriate.

The variability of the effluent is one of the most important factors in establishing monitoring frequency, particularly for industrial dischargers, and therefore the degree of monitoring frequency is dependent on the characterization of the effluent. The characterization should ideally occur as a part of the renewal or application process. A high frequency monitoring study is presented as a means of effluent characterization. High frequency monitoring, usually within a tiered framework or as a special study, is recommended to characterize effluent.

1.1 Establish Monitoring Objectives

The main purpose of self monitoring requirements is to determine compliance with effluent limits and other permit conditions. Monitoring may also be required in order to gather information necessary to derive an effluent limit, determine if a limit is necessary or to determine impacts on the receiving environment.

The parameters, frequency of monitoring, and sampling locations for POTWs are listed in Tables XIII-1(A-E) and XIII-2(A-M). The limits and monitoring strategies for POTWs are standardized and based on Best Conventional Treatment for pollutants generally associated with municipal sewage treatment plants (Section 2. POTW Monitoring). Industrial or commercial facilities which have the same type of treatment system, in particular a secondary biological process, should receive similar monitoring requirements for the pollutants listed. POTW monitoring frequency for permit conditions based on water quality standards and toxic discharges must be derived separately.

Discussion and guidance on requirements for monitoring compliance with whole effluent toxicity are found in Section XIII-4. The permit writer should use the guidance presented in this chapter to determine the monitoring frequency, the level of detail required and the relevancy of the testing results toward evaluating the potential for environmental harm from the effluent.

The permit writer should be able to justify the monitoring requirements on the basis of the value of the data. Know how the data may be used. The most useful, valid and cost-effective data are generated when the purpose or monitoring objectives of monitoring are understood. Some general objectives include:

- To determine compliance with technology-based and water quality-based effluent limits.

- To determine adequacy of 0 & M procedures.

- To determine specific impacts on water or sediment quality.

- To determine effectiveness of source control measures and BMPs.
- To determine baseline or background conditions in the receiving environment.
- To determine the variability of the wastewater as a prerequisite to establishment of monitoring schedules.
- To characterize the wastewater for determining the need for additional limits.

1.2 Parameters to Monitor

All parameters with effluent limits must have monitoring requirements. Additional parameters to monitor will depend on the monitoring objectives explained previously.

Monitoring flow rates is important for determining loading and is required in all NPDES permits [40 CFR 122.44(i)]. Methods and techniques of flow measurement are explained in the *Water Quality Inspection Manual*, Ecology, 1992.

1.2.1 Effluent Monitoring

The pollutant parameters to be monitored in effluent are based on application data, history of the facility discharge, pollutants discharged from similar facilities and any applicable EPA development documents. Minimum parameters for POTWs are outlined in Section XIII-2.

The permit may require monitoring of pollutants in the effluent for reasons other than to determine compliance with effluent limits. The general objectives stated in section 1.1 contain many objectives other than the compliance objective. For example, the objective "to determine effectiveness of source control measures" only indirectly determines compliance. BMPs may be followed as required in the permit but the BMPs may not be adequate to prevent undesirable effects. The monitoring becomes a feedback mechanism to fine tune the BMPs. Another important objective is to gather information to determine if further effluent limits are necessary. The authority to require monitoring is derived from Section 308 of the FWPCA and 90.48.260 RCW.

The discharger may be required to monitor for pollutants which the permit writer knows or suspects to be present in the discharge, even those not listed in the permit application. Additional parameters to monitor include toxic chemicals or substances that could upset the treatment system. These substances could be introduced from raw materials, compounds resulting from chemical interactions, or impurities in raw materials including solvents.

1.2.2 Process Control and In-Plant Monitoring

"Monitoring of intake water, influent to treatment facilities, internal waste streams, and/or receiving waters may be required when determined necessary by the department to verify compliance with net discharge limitations or removal requirements, to verify that proper waste treatment or control practices are being maintained, or to determine the effects of a discharge on the surface waters of the state." (WAC 173-220-210[1][c])

Process control monitoring refers to monitoring of internal waste streams in order to verify that proper waste treatment or control practices are being maintained. In-plant monitoring refers to monitoring at internal sample points due to the inability or impracticality to apply limits or conditions at the typical point of compliance.

Process Control Monitoring--Process control monitoring may be included in an enforcement order when a facility has been out of compliance with its permit. Process control monitoring should not be a requirement in the permit in most circumstances. The permit manager may select certain internal waste streams for monitoring which can generate data to assist the discharger in efficient operation of the treatment system. An enforcement order may also specify monitoring to assist in identifying pollutant sources. Reasonable cause for internal process control monitoring includes:

- Enforcement action for permit noncompliance when the monitoring is intended to identify the source or cause of noncompliance.
- Evaluating pollutant inputs from various functional areas of the facility as part of a Toxicity Identification Evaluation (TIE), a BMP for pollutant identification or quantification or the application of a performance standard for a process employed.
- Other circumstances to verify that proper waste treatment or control practices are being maintained (e.g, the certification period for a grant related project or as a condition of a demonstration or experimental project)

The wastewater treatment process will determine the types of process control monitoring needed. For industries with biological treatment systems and wastewater characteristics and flows that are similar to comparable POTWs, the monitoring frequency can follow the schedules of Table XIII-2(A-M). For physical and chemical treatment systems, the permit manager should review any development document for the industrial category, the treatability manuals and other engineering literature for information regarding parameters to use for process control monitoring.

In-Plant Monitoring--Under both federal (40 CFR 122.45[h]) and state regulation (Ch. 173-220-210 [1][c] WAC), in-plant monitoring may be required as a permit condition. In-plant monitoring for industries may be required at the discretion of the permit writer when reasonable cause exists and the cause is explained in the fact sheet. In-plant monitoring may be required:

- When the sample at final discharge is not characteristic of undiluted effluent because of dilution from other parts of the plant (and to determine whether the waste flow is being diluted to meet effluent limits).

- When interferences among pollutants at the point of discharge would make detection or quantification impractical.

- When the final discharge point is inaccessible (but make every effort to require accessibility).

- When determining chlorination efficiency.

1.2.3 Indicator Parameters

Indicator parameters may be used in certain instances when a close correlation exists between concentrations of pollutants in a wastestream. Indicator tests or observations can be useful in determining the effectiveness of the treatment process. Indicator parameters can be used only for well documented processes where the effluent concentration of an easily measured component parallels the concentration of a component more difficult to measure or detect. The correlation must be consistent over the range of varying raw material input to the system. A treatment process that reduces the concentration of the indicator in equal or less proportion to the contaminant of concern is essential.

Limits on indicators may not be used as a substitute for federally promulgated technology-based limits or limits developed on a case-by-case basis on parameters in the discharge. Contaminants of interest in the effluent for which no limits are specified can be monitored by an indicator when a positive correlation is established. There are correlations between some parameters which allow tests for one parameter to indicate the relative value of another parameter. A procedure for calculating correlations is located in the *Handbook for Sampling and Sample Preservation of Water and Wastewater*, EPA, 1982b, p.146. Computer software packages such as Excel™, the agency standard spreadsheet software calculates correlation coefficients. In many cases significant correlations exist between the following parameters:

- BOD and TOC
- Chlorides and Conductivity
- Total Dissolved Solids and Conductivity
- Acidity, Alkalinity and pH
- Hardness, Calcium, and Magnesium

Besides the cost considerations, indicator tests are also advantageous if they give quicker feedback for process control testing. An example would be analyzing TOC instead of 5 day BOD if a reasonably consistent mathematical relationship is established through special comparison studies. BOD is not always the most useful indicator of oxygen demand because of the long incubation time required to obtain a meaningful result. Once a correlation has been established, the TOC measurements can be translated to BOD. *Monitoring the effluent for an indicator cannot substitute for monitoring on a parameter which has an established effluent limitation.*

The utility of an indicator must be explained in the fact sheet. The explanation should be based on:

- Similarities between causative pollutants and a convenient monitoring parameter (e.g, monitoring Total Petroleum Hydrocarbon to indicate control of polynuclear aromatic hydrocarbons where the removal technology equally reduces the concentration of both or preferentially reduces the PAH component).

- The effectiveness of a particular treatment process and a control parameter for that process (e.g., limits on TOC to ensure proper performance of an activated carbon process).

Indicators might be appropriate for an industry that generates a waste stream containing metals in which the relative concentration of metal pollutants does not vary because of consistent raw material composition and internal process control. An internal process control parameter could be monitored to assure process stability. One metal could serve as an indicator for most other metals. TSS has been used by EPA as an indicator of toxics for some effluent guidelines.

Where there is no water quality criterion for a specific pollutant which causes or contributes to an excursion above a narrative criterion, the permit writer may establish effluent limits and monitor an indicator parameter. The permit should require all effluent and ambient monitoring necessary to show that the limit on the indicator continues to attain and maintain applicable water quality standards [40 CFR 122.44(d)(1)(vi)(C)].

1.3 Monitoring Frequency

"Each effluent flow or pollutant...shall be monitored at intervals sufficiently frequent to yield data which reasonably characterizes the nature of the discharge of the monitored effluent flow or pollutant. Variable effluent flows and variable pollutant concentrations may be monitored at more frequent intervals than relatively constant effluent flows and pollutant concentrations which may be monitored at less frequent intervals" [WAC 173-220-210(1)(b)].

The frequency of sampling should result in the production of data that provide a reasonable characterization of the effluent. Reasonableness can be demonstrated on the basis of the value of data collected. A primary value of the data is the establishment of effluent variability, an important factor in calculating discharge limits, determining compliance and establishing the basis for monitoring frequency. Routine compliance monitoring frequency may be adjusted to reflect the variability. The intent is to establish a frequency of monitoring which will detect most events of noncompliance without requiring needless or burdensome monitoring.

For example, at equivalent average flow rates, a large lagoon system which is not susceptible to short circuiting requires less frequent monitoring than an overloaded treatment facility which experiences fluctuating flow rates due to infiltration or large batch discharges from an industrial user on the system. The large lagoon should have a relatively low coefficient of variation (CV = population standard deviation divided by the population mean: sd/mean) compared to the facility receiving batch discharges.

1.3.1 Establishing Monitoring Frequency

The frequencies for monitoring pollutants from a POTW with limits based on a performance standard are presented in Section 2 of this chapter. The permit writer should consider these as minimum frequencies.

The frequencies for monitoring pollutants for informational purposes, for performance-based limited pollutants from non-POTWs or for water quality-based effluent parameters from any facility should be derived at the discretion of the permit-writer by one of the two following methods.

Method 1. Estimate the variability of the concentration of the parameter by reviewing DMRs and the record of similar dischargers. In addition to the estimated variability, other factors for determining sampling frequency include:

- Size and design capacity of facility
- Type of treatment
- Compliance history
- Number of pollutant sources from a facility
- Cost of monitoring relative to the discharger's capability and benefits obtained
- Environmental significance of pollutants
- Receiving water quality (including dilution effects)
- Detection limits and analytical precision/accuracy
- Production schedule of the facility (seasonal, daily, etc.)
- Plant washdown or cleanup schedule

- Number of monthly samples used in developing the permit limit
- Batch type process and discharge or continuous operation

These factors and other facility-specific factors used to determine monitoring frequency should be presented and discussed in the permit fact sheet.

Method 2. See Appendix 13.2

1.3.2 Tiered Monitoring

The *Puget Sound Water Quality Management Plan*, Puget Sound Water Quality Authority, 1991 states:

> "Monitoring requirements included in permits shall be tiered so that if initial (baseline) sampling discloses no problems, a reduced monitoring scheme may then apply. Likewise, if initial (baseline) sampling indicates the possibility of problems, a more frequent and/or more comprehensive monitoring schedule would apply. Initial monitoring schemes shall be set to ensure that enough data is collected to determine if additional discharge limits should be set."

The concept of tiered monitoring should be considered for all permits. It is a permit program goal to require sufficient monitoring to meet the objectives mentioned earlier but to avoid excessive monitoring. Tiered monitoring requires that implementation of additional monitoring methods or reduction of certain monitoring frequencies be based on the results of previous monitoring. This step-wise approach could lead to lower monitoring costs for the permittee while still providing an adequate degree of protection for the receiving environment and human health. The term "tiering" for this chapter means a reduction or increase in frequency of monitoring within a permit cycle. The conditions for increase and decrease are explained in the permit.

The recommendation at this time is to consider tiering only for parameters with established limits. Monitoring for information should be done in the context of a "Special Study" with a definite beginning and ending established in the permit.

The use of tiering should be restricted to a one-time reduction in monitoring frequency with no provision for reversion to the high frequency in the permit. If the permit manager feels that a reversion to high frequency is warranted, require the reversion through an administrative order or a subsequent permit modification (minor modification).

The application of tiering will generally be left to the judgement of the permit writer. Justification for the level or degree of monitoring required in the permit should be presented in the fact sheet. The time frames associated with establishment of the baseline monitoring period should be determined by the permit writer. The initial (baseline) monitoring period should reflect the environmental consequence and the likelihood of presence of the pollutant(s). If tiering is also used to generate variability and LTA data, these needs should be considered in establishing the schedule.

Until there is sufficient data available by the methods stated previously, require a minimum of 10 observations every month for all pollutants of concern for which there are limits specified as explained in the *TSD* (EPA, 1991). The permit writer should require that data be accumulated until the level of variability is established. One approach would be to request that semi-weekly to daily monitoring results of effluent parameters be submitted in addition to the routine DMRs during the early months of the permit cycle. Analysis of this data would indicate whether monitoring frequency can be reduced while maintaining adequate characterization of the effluent. This strategy should be explained briefly in the fact sheet. Once variability is established, monitoring frequency should be based on the confidence that effluent limit excursions will be detected.

The total cost of monitoring for toxic pollutants could be reduced by requiring a high initial monitoring frequency that is reduced if the permittee consistently meets the limit. The overall purpose of such requirements is to first establish a compliance history using a relatively high monitoring frequency and then reduce the frequency if they routinely comply with permit conditions. The requirements should be specified in the permit.

An example of a decrease in monitoring is a requirement to test for chemicals such as volatile organics monthly or bimonthly in the first year of a permit cycle, then reduction to annually if no volatiles of concern as specified in the permit are detected. This strategy may suffice if the permit writer has doubts about information presented in an application or if improvements in pollutant control are expected which reduce the likelihood of discharge of volatiles.

The triggers for the tiered elements of a permit must be well defined in the permit and explained in the fact sheet. For the above example, the simplest approach is to state the trigger in a footnote in the special condition for monitoring frequencies. The footnote should explain to what frequency the tiered parameter will revert if not detected or not found to be at a level of concern. The numeric "level of concern" must be defined in the permit and explained in the fact sheet. The reduction or elimination of monitoring should also be contingent upon the permittee requesting approval from Ecology. The regional DMR data input coordinator must be in the paper trail loop of "approval of frequency or parameter-change" in order to be able to track these changes.

It is convenient to begin the permit cycle with baseline monitoring which specifies a high frequency of monitoring for the wide variety of pollutants suspected to be present. Elimination or reduction of monitoring can be accomplished through compliance and discharge at levels of non-concern and after written approval from the permit manager.

An increase in monitoring frequency or scope of monitoring is usually more difficult to administer. The trigger for increased monitoring would need to be established and explained. Except for relatively simple triggers for additional types of monitoring or increased frequency, the recommended approach for an additional monitoring schedule is to issue an administrative order based on noncompliance with the permit. The few instances where additional monitoring may be required do not justify the resource investment involved in satisfying all possibilities or contingencies in the permit text.

A common example of an increase in monitoring is a requirement to test an effluent for toxic chemicals when the effluent violates a WET limit. This is discussed further in Chapter VI.

1.3.3 Monitoring Reduction for Exemplary Performance

Another concept related to tiered monitoring is the reduction of monitoring frequency for demonstrated good performance. This process is generally applied at the time of permit renewal and the monitoring frequency is reduced from some baseline frequency. The following guidance is adopted from EPA guidance (EPA memorandum from Robert Perciasepe and Steven A. Herman to Regional Administrators, April, 1996). The guidance is applicable to NPDES permitted discharges, State permitted discharges, and discharges to a POTW.

Criteria for Exclusion

Facilities whose owners or operators have been criminally convicted under any Federal or State environmental statute of falsifying monitoring data or of committing violations which presented an imminent and substantial endangerment to public health or welfare will not receive any reductions. These facilities may be eligible at any time Ecology determines there has been a wholesale change in ownership and management from those convicted.

Facilities whose owners or operators have been convicted of any other criminal violation under any Federal or State environmental statue will not receive any reductions for at least 5 years from the time of conviction.

Facilities where an individual employed by the permittee, but not the permittee itself, was convicted of a criminal violation under any Federal or State environmental statute, will be eligible for reduced monitoring frequency provided the permittee discovered and self-disclosed the violation, and took prompt action to correct the root cause in order to prevent future criminal violations.

Facilities involved in civil environmental, judicial actions brought by the State are eligible for consideration of reduction 1 year after completion of injunctive relief and payment of penalty.

Facilities involved in administrative actions are eligible for consideration after the permittee has complied with Administrative Order (AO) requirements, and payment of any assessed penalty.

A permittee that is issued an AO, in conjunction with reissuance of its permit, to extend a compliance schedule, may be eligible if the permittee is in compliance with the interim milestones and schedule in the AO.

For example, in order to comply with a newly promulgated effluent guideline, an industrial sector may be required to install a new technology. Some facilities may not be able to attain the new technology immediately so an AO is issued at the time the facility's permit is reissued. The AO sets a compliance schedule to allow the permittee additional time to install the technology needed to meet the new effluent guideline limitation.

Facilities are not eligible for monitoring reduction for any parameter that exceeds a one percent noncompliance during the past two years. Noncompliance includes monthly average, weekly average or daily maximum.

Other permit noncompliance such as failure to submit a DMR or other permit submittals should be considered before authorizing a reduction.

Facilities are not eligible for monitoring reduction until at least one permit cycle from the time of restoration of lab accreditation if the accreditation was lost for not performing to standards.

Facilities are not eligible for monitoring reduction until at least two years from the time of a Class II inspection in which it was found the facility was submitting invalid results.

Monitoring reduction for effluent data which has not been continuously reported over the two year period, interrupted or discontinuous data, intermittent, short-term, and batch discharges must be considered on a case by case basis. These will require performance data for longer than two years to determine a long term average.

New dischargers will be eligible for reduced monitoring after meeting the two year compliance requirement. Normally, the reduced monitoring provisions would be applied after one permit cycle of five years and at permit reissuance.

Permit writers should evaluate the discharge situation when considering monitoring reduction. For example, discharges to a shellfish area should generally not be considered for reduction in fecal coliform monitoring and discharge to an AA water body generally should not be considered for reduction in toxics monitoring. Permit writers should also evaluate the prospect of the permittee maintaining good performance during the life of the permit. A municipal treatment plant that is lightly loaded but is expected to be near capacity by the end of the permit term would probably not be meeting the performance criteria by the end of the permit term. Similarly, an industrial facility which demonstrates good performance for the past two years because of greatly reduced production would not be a good prospect for maintaining good performance if production increased during the term of the permit.

Procedures

Reduction of monitoring frequency will generally be granted at time of permit renewal by examination of performance in the two years preceding renewal. The amount of reduction is dependent upon the ratio of performance for the last two years to the monthly average effluent limitation (Table XIII-1A1). The baseline monitoring frequency is the frequecy in the current permit.

Monitoring reduction will be granted during the permit term at the request of the permittee and as appropriate. Monitoring reduction during a permit term is a major modification and requires public notice. Each request for modification must include documentation from the permittee demonstrating eligibility. Permit managers will track the number of requests for modification and the disposition of those requests.

Table XIII-1A1. Allowable Monitoring Frequency Based on Ratio of Long Term Effluent Average to the Average Monthly Limit (AML)

Baseline	Ratio of Long Term Average to the AML			
Monitoring	75-66%	65-50%	49-25%	≤25%
7/wk	5/wk	4/wk	3/wk	1/wk
6/wk	4/wk	3/wk	2/wk	1/wk
5/wk	4/wk	3/wk	2/wk	1/wk
4/wk	3/wk	2/wk	1/wk	1/wk
3/wk	3/wk	2/wk	1/wk	1/wk
2/wk	2/wk	1/wk	2/mo	1/mo
1/wk	1/wk	1/wk	2/mo	1/2mos
2/month	2/mo	2/mo	2/mo	1/quarter
1/month	1/mo	1/mo	1/quarter	1/6mos

Note: See above eligibility requirements.

Facilities which satisfy the entry criteria but are not experiencing discharges of 75% or less of their permitted levels of water quality-based parameters may still be eligible for reductions in monitoring/reporting frequencies. Monitoring will only be reduced for such parameters if the applicant can demonstrate a coefficient of variation (ratio of standard deviation to the mean) of 0.20 or less and no monthly average limit violation for the two year averaging period. Reduction will be allowed as shown in Table XIII-1A2 below.

Table XIII-1A2. Allowable Monitoring Reduction With a Ratio of Long Term Effluent Average to Monthly Average Limit 100-76% and a CV of 0.2 or Less.

Baseline Monitoring	Reduced Monitoring
7/wk	6/wk
6/wk	5/wk
5/wk	4/wk
4/wk	4/wk
3/wk	3/wk
2/wk	2/wk
1/wk	1/wk
2/month	2/month
1/month	1/month

Permittees that receive monitoring frequency reductions in accordance with Table XIII-1A1 or Table XIII-1A2 are still expected to take all appropriate measures to control both the average level of pollutants of concern in their discharge (mean) as well as the variability of such parameters in the discharge (variance), regardless of any reductions in monitoring frequencies granted from the baseline levels. To remain eligible for these reductions, the permittee may not have any violations for effluent limitations of the parameters for which reductions have been granted or failure to submit DMRs, or may not be subject to a new formal enforcement action. For facilities that do not maintain performance levels, Ecology may require increased monitoring by minor permit modification or Administrative Order.

Background material on the statistical derivation of the reduction allowance is presented in the original EPA memo. This material is reproduced in Appendix XIII. Permit writers may wish to alert permittees that this background material points out that the probability of reporting a violation increases as the monitoring frequency decreases in some cases.

1.4. Baseline Monitoring Frequencies

The permit writer must establish a baseline monitoring frequency in order to determine any allowable reduction for good performance. The baseline monitoring frequency may be established by using:

1. The POTW monitoring frequencies given in Section 2 of this chapter.
2. The original monitoring frequency in the permit before any reduction for performance was granted.
3. The statistical formulas given in Appendix 13 Part 2.

A baseline must be established each time a reduction in monitoring frequency is granted (usually at time of renewal). For example, the first time POTW is granted a reduction in monitoring, the baseline is the monitoring frequency in the expiring permit (assuming that the monitoring frequency is consistent with Section 2 of this Chapter). At the time of next renewal the baseline frequency would be based on the appropriate tables in Section 2 and not on the reduced monitoring frequency in the permit. Similarily, if an industrial discharger is granted a reduction in monitoring, then at the time of the next renewal the reduction is based on the original frequency before the reduction was granted or on a frequency calculated by the statistical formulas in Appendix 13.

Monitoring reductions should be stated in the fact sheet for future reference.

1.5 Special Monitoring Strategies

Routine effluent and facility monitoring can meet some of the objectives stated at the beginning of this chapter but some objectives are best met through the use of special timing strategies and studies. Special studies are typically for a single purpose and are conducted during a limited time frame within the permit cycle. Section XIII-6 on receiving environment monitoring also discusses considerations relevant to special studies of the receiving environment.

1.5.1 Stratified Sampling

Uniform sampling intervals may not always be the best approach, considering the cyclic variations in water quality and effluent variability. Stratifying a sampling program into different time periods may result data more suited to characterizing the impact of the discharge.

An example is to require increased monitoring frequency during critical receiving water periods to measure potential impacts to water quality. Seasonal monitoring schedules could be applied. This type of sampling scheme has been used by Ecology for determining compliance with some water quality based effluent limits. More frequent sampling may be required during the receiving water's critical flow, with less intensive monitoring during the rest of the year. Such an approach could be taken for scheduling toxicity testing. Variable sampling frequency could also be used to allocate sampling to periods of peak production or times of largest effluent variation.

1.5.2 Unusual Sampling Frequencies

A unique approach is to require that certain parameters traditionally monitored at a frequency of quarterly or twice annually be monitored under a non-traditional schedule such as "once every fifth month," which results in one monitoring event for each calendar month of a five year permit cycle. This method of scheduling frequencies supplies a degree of randomness. True random sampling is usually difficult to administer.

1.5.3 Studies to Determine Effluent Variability, A High Frequency Study

The variability can be established by a special monitoring study conducted prior to permit renewal or during an early portion of the permit cycle. The survey should cover a span of discharge which represents the range of effluent quality and quantity. The sampling frequency on which the data are based should be frequent enough to cover a time span of discharge which considers the swings in effluent quality and quantity. A high frequency study required by the permit should specify the time frame within which the study is to be conducted.

An alternative to a specific permit requirement is to require that the same type of data be generated through a permit-required engineering report. The report should involve an intense analysis that demonstrates the variation or CV, the co-dependence of variables and the mean or LTA of the pollutant concentrations in the discharge.

The generic factors available for estimating variability listed in section 1.3.1.A should be considered in establishing the schedule for the high frequency study.

This strategy should be explained briefly in the fact sheet. Once variability is established, monitoring frequency should be based on the confidence that effluent limit excursions will be detected.

1.6 Sampling and Testing Methods

Monitoring requirements in the permit should specify the sampling frequency, the sample type (grab, composite or continuous) and the analytical methods for each parameter. A permit condition should require the use of sampling and analytical methods conforming to 40 CFR Part 136.

Detailed information for developing the sampling program is found in the publication, *Monitoring Industrial Wastewater*, EPA, 1973. The information is also applicable to POTWs. Test procedures which are approved for NPDES monitoring are listed in Tables IA-ID of 40 CFR 136 (12/11/92 update). The tables include methods published in:

Methods for the Chemical Analysis of Water and Wastewater, EPA 600/4-79-020.

Standard Methods for the Examination of Water and Wastewater, 17th Edition, APHA.

Annual Book of ASTM Standards, Volumes 11.01 and 11.02.

Methods for Analysis of Inorganic Substances in Water and Fluvial Sediments, USGS, 1989.

Methods for the analysis of organic chemicals are published in 40 CFR 136, Appendix A and for the analysis of metals by inductively coupled plasma-atomic emission spectroscopy (ICP-AES) in Appendix C. Specific requirements and guidance for toxicity testing (bioassays) are included in Chapter 173-205 WAC, Whole Effluent Toxicity Testing and Limits and are explained in section XIII-4.

Some parameters and samples may require special considerations. Parameters which have no approved testing method in Part 136 can be tested and reported. The permit should specify the test method and include a reference. Contact the EA program for assistance in selecting test methods. The method itself should be included as an appendix to the fact sheet if the method is not readily available to the permittee. An example is saltwater samples, which may require modifications to the approved methods to avoid matrix interferences from the high salt content.

Approved analytical methods for parameters usually include sampling and handling requirements. Refer to Ecology's *Laboratory User's Manual* for information regarding sample preservation and handling.

The sample type will depend on:

- The parameter to be monitored. To determine appropriate sample types consult 40 CFR Part 136, *Standard Methods* or other approved methods;

- The temporal and pollutant concentration variability of the discharge; and

- The type of limit. Limits based on instantaneous or one hour values may be sampled using grab sampling techniques. Limits based on average values or daily maximums may be sampled using time or flow proportional composite samples. This is acceptable for certain conventional pollutants, nutrients, and bioaccumulative pollutants, for which percent removal and total loading to the receiving water are of concern.

1.6.1 Discrete Grab or Sequential Grab Samples

A grab sample is an individual sample collected in less than 15 minutes time. It represents more or less "instantaneous" conditions.

Use grab samples when:

- The wastewater characteristics are relatively constant.

- The parameters to be analyzed are likely to change with storage such as temperature, residual chlorine, soluble sulfide, cyanides, phenols, microbiological parameters and pH.

- The parameters to be analyzed are likely to be affected by the compositing process such as oil & grease and volatiles.

- Information on variability over a short time period is desired.

- Composite sampling is impractical or the compositing process is liable to introduce artifacts of sampling.

- The spatial parameter variability is to be determined. For example, variability through the cross section and/or depth of a stream or a large body of water.

- Effluent flows are intermittent from well-mixed batch process tanks. Sample each batch dumping event.

Grab samples can measure maximum effect only when the sample is collected during flows containing the maximum concentration of pollutants toxic to the test organism.

Another type of grab sample is sequential sampling. A special type of automatic sampling device collects relatively small amounts of a sampled waste stream, with the interval between sampling either time or flow proportioned. Unlike the automatic composite sampler, the sequential sampling device automatically retrieves a sample and holds it in a bottle separate from other automatically retrieved samples. Many individual samples can be stored separately in the unit, unlike the composite sampler which combines aliquots in a common bottle. This type of sampling is effective for determining variations in effluent characteristics over short periods of time.

1.6.2 Composite Samples

A composite sample consists of a series of individual samples collected over time into a single container, and analyzed as one sample. There are two general types of composites and the permit writer should clearly express which type is required in the permit:

- Time composite samples collect a fixed volume at equal time intervals and are acceptable when flow variability is not excessive. Automatically timed composited samples are usually preferred over manually collected composites. Composite samples collected by hand are appropriate for infrequent analyses and screening.

- Composite samples can be collected manually if subsamples have a fixed volume at equal time intervals when flow variability is not excessive.

- Flow-proportional compositing is usually preferred when effluent flow volume varies appreciably over time. The equipment and instrumentation for flow-proportional compositing have more downtime due to maintenance problems.

- When manually compositing effluent samples according to flow where no flow measuring device exists, use the influent flow measurement without any correction for time lag. The error in the influent and effluent flow measurement is insignificant except in those cases where extremely large volumes of water are impounded, as in reservoirs.

Use composite samples when:

1. Determining average concentrations, or

2. Calculating mass loading/unit of time.

There are numerous cases where composites are inappropriate. Samples for some parameters such as pH, residual chlorine, temperature, cyanides, volatile organics, microbiological tests, oil and grease, and total phenols should not be composited. They are also not recommended for sampling batch or intermittent processes. Grab samples are needed in these cases to determine fluctuations in effluent quality.

For bioassays, composite samples are used unless it is known that the effluent is most toxic at a particular time. Some toxic chemicals are short-lived, degrading rapidly, and will not be present in the most toxic form after lengthy compositing even with refrigeration or other forms of preservation. Require grab samples for bioassays to be taken under those circumstances.

In the absence of an expressed sampling protocol in regulation, the duration of the compositing time period and frequency of aliquot collection is established by the permit writer. Whether collected by hand or by an automatic device, the time frame within which the sample is collected should be specified in the permit. The number of individual aliquots which compose the composite should also be specified. NPDES application requirements specify a minimum of four aliquots for non-stormwater discharges lasting four or more hours. The sampling procedures for general pretreatment specify a minimum of twelve aliquots for 24-hour composites.

1.6.3 Continuous Monitoring

Continuous monitoring is another option for a limited number of parameters such as TOC, temperature, pH, conductivity, fluoride and dissolved oxygen.

Reliability, accuracy and cost vary with the parameter. Continuous monitoring can be expensive, so continuous monitoring will usually only be an appropriate requirement for the most significant dischargers with variable effluent. The environmental significance of the variation of any of these parameters in the effluent should be compared to the cost of continuous monitoring equipment available.

The regulations concerning pH limits allow for a period of excursion when the effluent is being continuously monitored (40 CFR 401.17). Continuous monitoring or labor-intensive periodic monitoring by grab sampling is necessary where pH excursions are allowed.

1.7 Determining the Sampling Location

The permit writer must determine permanent sampling locations, and identify them in the monitoring requirements. The permit applicant should provide a description of the effluent outfall location and in most cases, a line drawing and description of the flows and processes involved in wastewater treatment.

The point at which a sample is collected can make a large difference in the monitoring results. Important factors to consider in selecting the sampling station are:

- The flow at the sampling station should be measurable.
- The sampling station should be easily and safely accessible.
- The sample must be truly representative of the effluent during the time period which is monitored. The wastewater should be well mixed, such as near a Parshall flume or at a location in a sewer with hydraulic turbulence. Weirs tend to enhance the settling of solids immediately upstream and the accumulation of floating oil or grease immediately downstream. Such locations should be avoided for sampling.

It is often convenient to combine a flow measurement station with a sampling station. When flumes are used for flow measurement, the sample is usually well mixed.

Effluent samples should be collected at the most representative site downstream from all entering waste streams. Sampling of POTWs for conventional pollutants and nutrients (except for BOD) should be collected downstream of any chlorination or disinfection units.

Separate samples should be taken if two outfalls are used and the effluent which enters the outfalls comes from different parts of the plant.

If there is no practical way to sample the effluent, the permit must require that the permittee establish an appropriate effluent monitoring station for determining flow rates and compliance with effluent limits.

The location of sample sites for receiving environment and benthos testing vary with each discharger and the dimensions of any mixing or sediment impact zone. More detail can be found in Section 6.

1.8 Quality Assurance/Quality Control

The data gathered in self-monitoring programs provides information to decision makers on the quantity and quality of the effluent, the adequacy of operation and maintenance procedures, and the potential for discharges to affect receiving waters. Given the importance of monitoring data in assessing compliance and in assessing whether receiving waters may be affected, it is important that the processes involved in generating monitoring data be standardized, comparable among dischargers, and free from practices that would generate inaccurate or faulty data. A quality assurance or quality control program can help to ensure that data meet the above requirements.

> "Quality assurance (QA) has been described as a system of activities that assures the producer or user of a product or a service that defined standards of quality with a stated level of confidence are met. Quality control (QC) differs in that it is an overall system of activities that controls the quality of a product or service so that it meets the needs of users. In other words, QC consists of the internal (technical), day to day activities, such as use of QC check samples, spikes, etc., to control and assess the quality of the measurements, while QA is the management system that ensures an effective QC system is in place and working as intended." (Keith, 1991)

The objective of quality assurance for a self-monitoring program is to ensure the production and reporting of valid results. Valid and useful results are those that answer a question or provide a basis on which a decision can be made (Keith, 1991). Within Ecology's regulation of self-monitoring data, the QA of a discharger's self-monitoring program is examined by different groups within Ecology. The EA Program's laboratory accreditation group oversees the QA/QC program for laboratories. Permitted dischargers are required to have their samples analyzed by labs accredited by the state. As part of the laboratory accreditation process, labs must develop an approved QA/QC plan that addresses laboratory operations. In addition, with few exceptions, dischargers will use specified and standardized methods (40 CFR 136) to measure compliance with permit limitations. These methods are specified in discharge permits by reference to use of Part 136 methods.

In most cases, dischargers are not required to submit formal QA plans addressing sampling technique because sampling technique is generally uncomplicated, and can be easily checked by inspectors during Ecology inspections. Poor sampling technique is likely to result in sample contamination, which is generally to the disadvantage of dischargers. However, because some dischargers with low dilution now have water quality based effluent limits that are in the low parts per billion range, it is important to ensure that sample collection techniques do not introduce contamination, and that data can be verified (e.g., by use of appropriate blank samples).

Contamination can be introduced by improper cleaning of sampling vessels, during sampling, or during handling and analysis of the sample in the lab. The laboratory that is preparing sampling bottles and analyzing samples will generally depend on the person who does samples to minimize contamination in the field. If you suspect that sample contamination is occurring at any point in the process of sampling and analysis, you should first discuss your concerns with the discharger. In most cases, since sample contamination is not to the benefit of the discharger, they will try to determine on their own if a problem exists (e.g., a small corroded area on a composite sampler at one municipal discharge was adding from 10-20 ppb of excess nickel to effluent samples, but was found after several weeks of examining all possible sources of contamination). If this is not effective, you may need to require a formal Ecology inspection with split samples analyzed by the state, or even a formal requirement for a full QA/QC sampling plan. When assessing potential sample contamination, it is also a good idea to discuss the contaminants with the staff at the Manchester Environmental Laboratory to attempt to rule out common laboratory contaminants as being present in the discharge.

Flow data is not compromised by sample contamination, but data verification is important to consider when collecting flow measurements during inspections. In some cases flow measurements cannot be safely verified because of the position of the flow measurement device. In other cases the flow measurement device may not be properly constructed, so there is doubt about the measurements produced by the device (e.g., a weir may not be level, thus the original engineering calculations used to gauge flow on the weir may not be appropriate for use with the structure as built). Data verification for flow devices should be approached carefully, because in many cases the cost of verification can be great. In some cases documentation showing proper calibration can be presented as a flow verification (inexpensive option), but in other cases complex models may be the only way to provide verification. If there is reason to believe that flow data is suspect, the permit manager should evaluate whether flow data is a highly critical parameter to verify for the discharger at the time. If the discharge is nearing capacity, approaching a water quality based concentration limit, or mass loading limits (total mass per day or year) have been imposed on the discharge, measurement of flow may be critical. In those cases, flow verification, even if costly, should be strongly considered, and may be required. The permit writer should use his/her best professional judgement when making the determination of whether a flow verification is needed.

If there is a need for the discharger to submit a QA/QC plan for all or a portion of a self-monitoring program (e.g., if contamination is suspected), the following elements should be included in the plan:

1. Project Description - Outlines the scope of the monitoring project.

2. Responsibilities - Identifies the responsibilities of personnel in implementing the QA plan.

3. Quality Assurance Objectives - Identifies the monitoring objectives including quantitative objectives for generating and measuring data in terms of accuracy, precision, completeness, representativeness, and compatibility.

4. Sampling Procedures - Describes the following for each measurable variable:

   - Guideline used to select sample site.
   - Specific sampling procedures (including chain of custody requirements).
   - Information for special containers, conditions for preparation of sampling equipment and containers.
   - Sampling preservation methods and holding times.

5. Calibration Procedures, References, and Frequencies - Identifies the procedures for properly maintaining the accuracy and precision of field and laboratory equipment, and for properly obtaining, using, and storing analytical standards.

6. Analytical Procedures - Identifies standard procedures for sample analysis by reference, and describes specialized procedures in detail.

7. Data Reduction, Validation, and Reporting - Provides the data reduction scheme for measurement data, including equations used for calculations, criteria used to validate data integrity, and methods used to identify and treat abnormal data or statistical outliers.

8. Internal Quality Control Checks and Frequency - Identifies all procedures used to assess quality during sample collection and analysis, including the uses and frequency of replicates, spikes, blanks, surrogate samples or reference materials, control charts, and calibration materials.

9. Quality Assurance Audits - Describes procedures used to determine the effectiveness of the QA program and its implementation.

10. Preventative Maintenance Procedures and Schedules - Details procedures for maintaining equipment in a ready state, including lists of critical spare parts.

11. Procedures and Deliverables for Data Validation - Provides a compilation of routine data analysis techniques used to assess data precision and accuracy, representativeness, comparability, and completeness of the measured parameters.

12. Corrective Action - Identifies predetermined limits for data acceptability beyond which corrective action is necessary,, the specific corrective action to be taken for out-of-control data (including action in response to system and performance audits), and the individual responsible for each corrective action.

Additionally, the QA Section of the EA Program has prepared an Ecology publication "Guidelines and Specifications for Preparing Quality Assurance project Plans", which specifically addresses issues faced by Ecology when sampling in Washington State. Permit writers should consult these guidelines as well as consider the items listed above.

State and federal regulations require laboratories used in the NPDES program to analyze performance evaluation samples using the analytical methods in 40 CFR Part 136. The Manchester Environmental Laboratory can provide a list of accredited laboratories and the analyses they are accredited for to the permit writer. Additional sampling information is given in *Handbook for Sampling and Sample Preservation of Water and Wastewater*, EPA 600/4-82-029). Flow measurement is discussed in *Monitoring Industrial Wastewater* (EPA, 1973). By specifying, in a permit, a particular method to use for self-monitoring, any QA/QC procedures included in that method become permit requirements. Whenever QA/QC standards are not met, the analyses should be repeated until the specified level of performance is met. The reasons for inadequate QA/QC should be explained by the permittee when retesting is not possible. The EA Program or Headquarters staff should be contacted to help review this information.

1.9 Data Management

The format of data submitted to Ecology can directly influence how that data is interpreted, therefore it is critical that data be given to Ecology in a format most suitable for the data's intended use. The information obtained by the permittee's self-monitoring program is submitted to the permitting agency using a Discharge Monitoring Report (DMR) with a standardized format. The DMR is submitted to Ecology on a regular schedule stated in the permit. Special reports may be required in a permit, in which case the permit writer must designate the frequency and format of the report. In all cases, the data must be presented in an organized and clear manner, and if necessary, supporting data may be required (e.g., duplicate measures, spike recoveries, etc.). These reporting requirements should be specified in the special conditions section of the permit, enforcement order, or application requirements notification.

Reporting requirements for WET are given in the canary book (Ecology Publication No. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria*). This manual which provides instructions to labs and includes our detailed test review criteria, and is now referenced in the acute and chronic WET language in the permit shells. Dischargers should instruct labs to follow the instructions for both testing and reporting in the canary book and in the EPA toxicity test manuals referenced in the permit language. WET test reports are rejected for serious omissions or deviations from these instructions. The test review system has been in place for several years now and the labs are familiar with it and its consequences.

The other routine monitoring data required in the permit will be entered into a computerized database located at each Region's office. This database is called the Water Permit Life Cycle System (WPLCS). The WPLCS will generate compliance reports determining whether or not dischargers are in compliance. Even though the WPLCS will generate compliance reports, the permit manager may still find it useful to inspect the DMRs because of the information they contain, including data on effluent variability and trends in changing effluent quality. All special reports should be reviewed by the permit writer or appropriate staff at Headquarters or at the EA Program.

Other considerations concerning data interpretation (e.g., quantitation levels) are discussed in Chapter VI-4 Effluent Limits Below Quantitation.

2. POTW MONITORING

Regulatory agencies are more involved in the day-to-day operation of POTWs than with industrial plants. Some examples of this are the regulatory requirements for operation and maintenance (O&M) plans and O&M inspections, operator certification requirements, and historical process control monitoring requirements. This involvement is largely due to the history of public funding for construction of POTWs and the protection of that investment.

POTWs are a single, large category of discharger for which monitoring guidance has evolved over time. The tests, sample points, frequencies, and sample types listed in the accompanying tables represent the level of monitoring which seeks to balance the minimum cost to the discharger while assuring the permit manager that the POTW is being operated correctly and is meeting the conditions of its permit.

This section builds on the previous General Considerations section to provide the permit writer more specific guidance for writing a permit for a POTW. Land application monitoring information is covered in *Implementation Guidance for the Ground Water Quality Standards* (Ecology 96-02). The following information is included in this section:

- Influent and Effluent Monitoring for:
  - Compliance with limits, treatment efficiency,
  - Sludge,
  - Pretreatment requirements, and
  - Whole Effluent Toxicity Testing

- Process Control
  - Use in response to significant noncompliance with limits
  - If required, implement in a permit, with an Order or as a requirement for O&M Manual update

- Sludge Monitoring
  - Satisfy new Part 503 Regulation requirements
  - Satisfy pretreatment requirements

- Combined Sewer Overflows
  - Provides guidance on CSOs monitoring
  - Defines CSO event

- Monitoring Bypasses
  - Provides guidance on sampling bypassed flows

2.1 Influent and Effluent Monitoring of POTWs

2.1.1 General

Tables XIII-1(A-E) contain the recommended minimum influent, effluent, and sludge monitoring frequencies for various types of POTWs. These tables are organized according to treatment method and design flow. For clarity, each table is divided into several types of monitoring such as compliance, sludge, WET testing, and pretreatment.

For conventional pollutants, the minimum recommended frequency for compliance monitoring in Tables XIII-1 (A-E) is 1/week. This minimum frequency is suggested for two reasons:

1. It is a reasonable minimum frequency for monitoring compliance with effluent limits.

2. It fulfills the implicit weekly reporting requirement associated with the seven-day average discharge standards described in Chapter 173-221 WAC and 40 CFR 133.102. ""Seven-day average" means the arithmetic mean of pollutant parameter values for samples collected in a period of seven consecutive days."

Since the tables represent the minimum recommended frequencies rather than the median recommended frequencies, it is more likely that more monitoring will be required than less. If significantly more or less than the recommended monitoring is required for a particular facility, this should be discussed in the fact sheet. Reasons for more monitoring may include:

- Frequent upset.

- Poor O&M performance.

- Discharge to a sensitive environment.

- A coefficient of variation is greater than 0.6 (EPA,1991).

- Periods of significant non-compliance.

Reasons for less monitoring may include:

- POTW operating significantly below effluent limits

- Non-continuous discharge (seasonal)

- Long detention time (e.g. lagoons)

- Good O&M performance

- Good history of compliance with limits (inspection reports, DMRs)

POTWs are required to sample both the influent and effluent streams for BOD_5 and Total Suspended Solids in order to determine the removal efficiencies. Secondary treatment is generally defined as 85% removal of TSS and BOD_5 with a maximum limit of 30 μg/l each although exceptions do exist for waste stabilization ponds and trickling filters as discussed in Chapter V, Municipal Effluent Limitations and Other Requirements.

Flow may be measured as either inflow or outflow. The sampling point chosen should be specified in the permit. However, for some lagoon systems, due to rainfall or evaporation, both influent and effluent flow measurement may be required. Also for lagoons, effluent flow measurements are preferred for determining compliance with effluent limits.

The permit writer should attempt to identify the period of peak discharge into the POTW from the commercial and industrial users expected to be discharging any pollutants of concern and then specify monitoring frequencies and sample types that will include the period of peak industrial discharge. Monitoring during times of peak commercial and industrial discharge will increase the likelihood of detecting the presence of any toxic pollutants which are or maybe of concern.

The choice of sampling techniques for chemical-specific analyses is dependent on the type of compounds to be measured (e.g., grab sampling for volatile organic compounds, pH, cyanide, oil and grease, dissolved oxygen and phenols). More guidance is provided in the *Laboratory Users Manual*, Ecology, 1991b, the *Handbook for Sampling and Sample Preservation of Water and Wastewater*, EPA-600/4-82-029, EPA, 1982b, the *Water Quality Program Inspection Manual*, Ecology, 1992, *Standard Methods for Examination of Water and Wastewaters*, 17th Edition, pp. 1-37 and 1-38, and Chapter XIII-1.5 & 1.6 of this manual.

2.1.2 Influent Monitoring

The influent must be sampled (BOD_5,TSS) and measured (flow) ahead of the point of entry of recycle flows such as digester supernatant, filter backwash, sludge thickener subnatant or supernatant, and any other in-plant recycle flows. Also, influent samples should generally be collected just downstream of the coarse screens or grit chamber but may include sampling points such as:

- The upflow siphon following a comminutor (in absence of grit chamber).
- The upflow distribution box following pumping from main plant wet well.
- Aerated grit chamber.
- Flume throat (assuming no impact on flow measurement).
- Pump wet well.

BOD_5 and TSS monitoring frequency in the influent should usually correspond with effluent monitoring frequency to determine compliance with percent removal requirements. However, influent monitoring may sometimes be at a higher frequency than effluent monitoring such as when influent flows into a lagoon cannot match the evaporative loss.

For parameters other than BOD_5 and TSS, any influent monitoring frequency should consider the variabilities in wastewater flow and characteristics, the quantity and quality of industrial input to the facility, and if the influent monitoring is being required for local pretreatment limits development or updating.

If multiple waste streams enter the plant and a representative sample cannot be collected, a flow-proportional composite sample of the various inflows may be used for influent analysis.

2.1.3 Effluent Monitoring

Effluent samples for POTWs should be collected downstream of any chlorination/dechlorination units or other disinfection units, with the exception of BOD and perhaps WET testing.

Post-chlorination BOD_5 samples should be dechlorinated and reseeded as described in *Standard Methods for the Examination of Water and Wastewater*, 17th Edition. The sample for the BOD_5 test, usually a refrigerated composite, may be drawn prior to chlorination to avoid the inhibiting effect of chlorine on biological oxidation. This would require two effluent composite samplers (pre- and post-chlorination) which may represent a significant expense for some smaller POTWs.

WET testing samples should be taken following the protocols in Section 4 of this Chapter.

Separate samples should be taken if multiple effluent outfalls representing different treatment modes are present. For example, a parallel system with several treatment processes with different treatment efficiency requirements such as a trickling filter or lagoons and aeration basin, RBC, etc. Multiple discharges from equivalent treatment processes need not be analyzed separately provided there is a common effluent outfall that represents the combined total effluent discharge.

A lagoon with a long retention time may require lagged collection of effluent samples relative to influent samples for the purpose of determining compliance with the percent removal requirement, particularly if a review of historical data indicates a wide seasonal or periodic variation in influent concentrations (e.g. seasonal industrial input). A dye study should be used to decide whether it makes sense to require a lag time or not.

Samples should be collected during "typical" discharge periods. An evaluation of the condition of the facility's treatment system can be made by comparing the effluent sample concentrations of BOD, TSS, and other pollutants to long-term historical averages and/or permitted values for these parameters.

2.1.4 Pretreatment

2.1.4.1 Introduction

The purpose of the state pretreatment program is to apply and enforce pretreatment standards and requirements on industrial and commercial dischargers into publicly owned treatment works (POTWs). This is performed directly by Ecology or by delegated local authorities with Ecology oversight.

The intent of the federal pretreatment regulations (40 CFR part 403) is to pass on the federal pretreatment program requirements to qualified municipalities. In terms of implementation, Ecology is operating a dual program; namely oversight for approved programs and direct permitting authority per WAC 173-216 for all other industrial and commercial dischargers to non-delegated pretreatment POTWs. Presently, eight Washington municipalities have been delegated pretreatment authority, with two additional programs being developed.

2.1.4.2 What is a pretreatment POTW?

A pretreatment POTW is any POTW required by 40 CFR 403.8(a) to develop a pretreatment program. The federal pretreatment regulations (40 CFR 403.8(a)) require that:

> "Any POTW (or any combination of POTWs operated by the same authority) with a total design flow greater than 5 million gallons per day (mgd) and receiving from Industrial Users pollutants which Pass Through or Interfere with the operation of the POTW or are otherwise subject to Pretreatment Standards will be required to establish a POTW Pretreatment Program unless the NPDES State exercises its option to assume local responsibilities as provided for in 403.10(e). The Director may require that a POTW with a design flow of 5 MGD or less develop a POTW Pretreatment Program if he or she finds that the nature or volume of the industrial influent, treatment process upsets, violations of POTW effluent limitations, contamination of municipal sludge, or other circumstances warrant in order to prevent Interference with the POTW or Pass Through."

Ecology has chosen not to require all of the pretreatment POTWs in Washington State to develop local pretreatment programs. The federal pretreatment regulation 40 CFR 403.10(e) allows Ecology to assume the responsibility for implementing the POTW Pretreatment Program requirements set forth in 403.8(f) in lieu of requiring the POTW to develop a Pretreatment Program. The municipalities for which Ecology has assumed responsibility of implementing the POTW Pretreatment Program are those with Significant Industrial Users (SIUs) that have State Waste Discharge to POTW Permits. SIUs are defined in 40 CFR 403.3(t) as:

> "All industrial users subject to Categorical Pretreatment Standards under 40 CFR 403.6 and 40 CFR Chapter I, Subchapter N; and, any other industrial user that: discharges an average of 25,000 gallons per day or more of process wastewater to the POTW; contributes a process wastestream which makes up 5 percent or more of the average dry weather hydraulic or organic capacity of the POTW treatment plant; or is designated as such by the Control Authority".

There are delegated and non-delegated pretreatment POTWs. Pretreatment POTWs are POTWs that are required by 40 CFR 403.8(a) to develop pretreatment programs or have programs run for them by Ecology. Ecology operates a dual program of direct permitting per WAC 173-216 of industrial users in non-delegated pretreatment POTWs and oversight of delegated POTWs. All pretreatment POTWs are subject to the requirements of 40 CFR part 403, whether Ecology or the municipality assume local responsibilities.

2.1.4.3 Monitoring for local limit development

The federal pretreatment regulation 403.8(f)(4) requires pretreatment POTWs to develop local pollutant discharge limitations for any pollutants which cause Pass Through or Interference, or demonstrate they are not necessary. This requirement to develop local limits becomes Ecology's in the non-delegated pretreatment POTWs.

All pretreatment POTWs, both delegated and non-delegated, are required to have influent, effluent, and sludge sampled for toxic pollutants in order to characterize the industrial input and to determine if pollutants are or have the potential to interfere with the treatment process or pass through the plant to sludge or the receiving water. The monitoring data are used by Ecology or the municipality to develop technically defensible local limits which commercial and industrial users must meet.

A delegated POTW must conduct monitoring to support the development of local limits as a condition of it's POTW Pretreatment Program. For non-delegated pretreatment POTWs, the permit writer may choose to have the POTW conduct the monitoring for Ecology so that local limits can be developed by Ecology for the non-delegated POTWs. Measurement of pH, Oil and Grease, priority pollutants (metals and organics), and any other pollutants likely to be present from commercial or industrial users are used as indicators to determine the need for local limits.

The list of priority pollutants to be monitored for is contained in 40 CFR part 122, Appendix D, Table II (organics) and Table III (metals and cyanide). Other toxic pollutants which should be monitored for if likely to be present are listed in 40 CFR part 122, Appendix D, Table V.

In addition to quantifying pH, oil and grease, and all priority pollutants, a reasonable attempt should be made to identify all other substances and quantify all pollutants shown to be present by gas chromatograph/mass spectrometer (GC/MS) analysis per 40 CFR 136, Appendix. A, Methods 624 and 625. Determinations of pollutants should be attempted for each fraction which produces identifiable spectra on total ion plots (reconstructed gas chromatograms). Determinations should be attempted from all peaks with responses 5% or greater than the nearest internal standard. The 5% value is based on internal standard concentrations of 30 μg/l, and must be adjusted downward if higher internal standard concentrations are used or adjusted upward if lower internal standard concentrations are used. Non-substituted aliphatic compounds may be expressed as total hydrocarbon content. Identification shall be attempted by a laboratory whose computer data processing programs are capable of comparing sample mass spectra to a computerized library of mass spectra containing at least sixty-thousand (60,000) compounds, with visual confirmation by an experienced analyst. (Note: The current National Institute of Standards and Technology GC/MS computerized library of mass spectra, covers 62,000 compounds. The phone number of the NIST Office of Standards Data is 301-975-2208). For all detected substances which are determined to be pollutants, additional sampling and appropriate testing shall be conducted to determine concentration and variability, and to evaluate trends (refer to "Determining Reasonable Potential", Chapter VI).

Local limits development requires one year of data collection. To develop local limits, the permit writer should require that each pretreatment POTW establish a data base from sampling and analysis over one year. Sampling will include both wet and dry weather flows. The sample locations, types, and frequencies are specified in the matrix below and apply to all pollutants as discussed in this section on monitoring for local limit development.

Matrix of monitoring requirements for local limits development

Location	Sample Type	Frequency[b]
Raw Influent	24 hour composite[a]	Once quarterly
Primary Clarifier Effluent	24 hour composite[a]	Once quarterly concurrently with influent
Final Effluent	24 hour composite[a]	Once quarterly concurrently with influent
Sludge	Grab	Taken within 30 days following influent sampling

*a. Cyanide, Volatile Organics, and Phenols must be taken as a minimum of 4 grab samples and separately analyzed in place of each 24 hour composite.

*b. The days selected for sampling shall be on days when industrial flow to the POTW is expected to be at a maximum and rotated quarterly (e.g., first quarter sample Monday, second quarter sample Tuesday, etc.).

At a minimum, Ecology should require all pretreatment POTWs to establish local limits for pH, oil and grease, the priority pollutant metals, cyanide, and phenols.

A pretreatment POTW is required to analyze for priority pollutants and any other toxic pollutants likely to be present. After local limits have been established, it is recommended that the monitoring frequency for toxic pollutants not be less than annually for toxic organics and not less than quarterly for toxic metals, unless reduced monitoring can be justified.

For additional information of identifying pollutants of concern, the permit writer is encouraged to consult the EPA *Guidance Manual of the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program*, (EPA, 1987a).

2.1.4.4 Monitoring for updating of local limits

The federal pretreatment regulation 403.5(c) requires pretreatment POTWs to continue to update local pollutant discharge limitations for any pollutants which cause Pass Through or Interference. This requirement to update local limits becomes Ecology's in the non-delegated pretreatment POTWs.

The POTW should continue to survey its commercial and industrial users to find out what toxic metals and organics are reasonably expected to be present in its influent at detectable levels and then analyze its plant influent, effluent, and sludge for those pollutants. A reasonable attempt should be made to identify all other substances and quantify all pollutants shown to be present by GC/MS analysis per 40 CFR 136, Appendix. A, Methods 624 and 625. Determinations of pollutants should be attempted for each fraction which produces identifiable spectra on total ion plots (reconstructed gas chromatograms). Determinations should be attempted from all peaks with responses 5% or greater than the nearest internal standard. The 5% value is based on internal standard concentrations of 30 µg/l, and must be adjusted downward if higher internal standard concentrations are used or adjusted upward if lower internal standard concentrations are used. Non-substituted aliphatic compounds may be expressed as total hydrocarbon content. Identification shall be attempted by a laboratory whose computer data processing programs are capable of comparing sample mass spectra to a computerized library of mass spectra containing at least sixty-thousand (60,000) compounds with visual confirmation by an experienced analyst. (Note: The current National Institute of Standards and Technology GC/MS computerized library of mass spectra, covers 62,000 compounds. The phone number of the NIST Office of Standards Data is 301-975-2208). For all detected substances which are determined to be pollutants, additional sampling and appropriate testing shall be conducted to determine concentration and variability, and to evaluate trends (refer to "Determining Reasonable Potential", Chapter VI).

All pretreatment POTWs, both delegated and non-delegated, are required to continue monitoring influent, effluent, and sludge for toxic pollutants in order to characterize the industrial input and to determine if pollutants are or have the potential to interfere with the treatment process or pass through the plant to sludge or the receiving water. The monitoring data is used by Ecology or the municipality to update the local limits for commercial and industrial users. The remainder of this section on pretreatment monitoring will focus on the monitoring requirements for pretreatment POTWs with established local limits.

A delegated POTW must conduct monitoring to support the update of it's local limits as a condition of it's POTW Pretreatment Program. For non-delegated pretreatment POTWs, the permit writer may choose to have the POTW conduct the monitoring for Ecology so the local limits can be updated. This section, including Tables XIII-1C, D, and E, establishes the monitoring that should be conducted for updating of local limits. Measurement of pH, Oil and Grease, priority pollutants (metals and organics), or any other pollutants of concern that are likely to be present from commercial or industrial users are used as indicators to determine compliance with local limits or the need for additional local limits.

The list of priority pollutants to be monitored for is contained in 40 CFR part 122, Appendix D, Table II (organics) and Table III (metals and cyanide). Other toxic pollutants which should be monitored for if likely to be present are listed in 40 CFR part 122, Appendix D, Table V.
A pretreatment POTW is required to analyze for priority pollutants and any other toxic pollutants likely to be present. After local limits have been established, it is recommended that the monitoring frequency for toxic pollutants not be less than annually for toxic organics and not less than quarterly for toxic metals, unless reduced monitoring can be justified.

For additional information of identifying pollutants of concern, the permit writer is encouraged to consult the EPA *Guidance Manual of the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program*, (EPA, 1987a).

Table XIII-1A. RECOMMENDED MINIMUM MONITORING FOR POTWs DISCHARGING TO SURFACE WATERS

For: 1. All Treatment Plants < 0.1 MGD Average Design Flow

Monitoring Type (Plant category)	Test	Sample Pt.	Frequency	Sample Type
Compliance (1)	Flow, mgd	Infl. or Fin. Eff.	Continuous	Measurement
"	pH	Final effluent	5/week	Grab
"	BOD_5	Infl.; Fin. Eff.[a]	1/week; 1/week	24-hr. Composite
"	TSS	Infl.; Fin. Eff.	1/week; 1/week	24-hr. Composite
"	Tot. Res. Cl_2	Chlorinated Eff.[f], Fin. Eff.[g]	5/week	Grab
"	Fecal Coliform	Fin. Eff.	1/week [c]	Grab
Sludge	See Chapter XIII-2.3, Table XIII-3	See Chapter XIII-2.3, Table XIII-3	See Chapter XIII-2.3, Table XIII-3	
WET Test.	See Chap. XIII-4	Final Eff.		

(See also reapplication requirements for NH3, TKN, NO2+NO3, O+G, Total P, and TDS in ChIII, Sec.6)

Table XIII-1B. RECOMMENDED MINIMUM MONITORING FOR POTWs DISCHARGING TO SURFACE WATERS--

For: 1. **Trickling Filter Plants < 0.5 MGD Average Design Flow**
2. **RBC Plants < 0.5 MGD Average Design Flow**
3. **Sewage Lagoons < 0.5 MGD Average Design Flow**

Monitoring Type (Plant category)	Test	Sample Pt.	Frequency	Sample Type
Compliance (1,2,3)	Flow, mgd	Infl. or Fin. Eff.	Continuous	Measurement
"	pH	Final effluent	Daily	Grab
"	BOD_5	Infl.; Fin. Eff.[a]	1/week; 1/week	24-hr. Composite
"	TSS	Infl.; Fin. Eff.	1/week; 1/week	24-hr. Composite
"	Tot. Res. Cl_2	Chlorinated Eff.[f], Fin. Eff.[g]	Daily	Grab
"	Fecal Coliform	Fin. Eff.	1/week [c]	Grab
Sludge (1,2,3)	See Chapter XIII-2.3, Table XIII-3	See Chapter XIII-2.3, Table XIII-3	See Chapter XIII-2.3, Table XIII-3	
Sludge (Type 3)	Sludge Depth	Each Cell, numerous locations	2/year	Measurement
WET Test.	See Chap. XIII-4	Final Eff.		

(See also reapplication requirements for NH3, TKN, NO2+NO3, O+G, Total P, and TDS in ChIII, Sec.6)

Table XIII-1C. RECOMMENDED MINIMUM MONITORING FOR POTWs DISCHARGING TO SURFACE WATERS--

For: 1. Trickling Filter Plants 0.5-2.0 MGD Average Design Flow
2. RBC Plants 0.5-2.0 MGD Average Design Flow
3. Sewage Lagoons > 0.5 MGD Average Design Flow
4. Activated Sludge Plant < 2.0 MGD Average Design Flow
5. Oxidation Ditches

Monitoring Type (Plant category)	Test	Sample Pt.	Frequency	Sample Type
Compliance (1,2,3,4,5)	Flow, mgd	Infl. or Fin. Eff. [b]	Continuous	Measurement
"	pH	Final effluent	Daily	Grab
"	BOD_5	Infl.; Fin. Eff.[a]	2/week; 2/week	24-hr. Composite
"	TSS	Infl.; Fin. Eff.	2/week; 2/week	24-hr. Composite
"	Tot. Res. Cl_2	Chlorinated Eff.[f], Fin. Eff.[g]	Daily	Grab
"	Fecal Coliform	Fin. Eff.	2/week [c]	Grab
Sludge (1,2,3,4,5)	See Chapter XIII-2.3, Table XIII-3	See Chapter XIII-2.3, Table XIII-3	See Chapter XIII-2.3, Table XIII-3	
Sludge (Type 3)	Sludge Depth	Each Cell, numerous locations	2/year	Measurement
WET Test. (1,2,3,4,5)	See Chapter XIII-4	Final Eff.		
(See also reapplication requirements for NH3, TKN, NO2+NO3, O+G, Total P, and TDS in ChIII, Sec.6)				
Pretreatment (1,2,3,4,5) (see 2.1.4)	Oil and grease, pH, priority pollutant metals, and cyanide	Influent Final effluent Sludge	Quarterly[d] Quarterly[d] 1 taken within 30 days after influent sample	24 hour composite[e] except grab for O&G 24 hour composite[e] Grab
	Priority pollutant organics and other toxic pollutants likely to be present	Influent Final effluent Sludge	Annually[d] Annually[d] 1 taken within 30 days after influent sample	24 hour composite[e] 24 hour composite[e] Grab

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Table XIII-1D. RECOMMENDED MINIMUM MONITORING FOR POTWs DISCHARGING TO SURFACE WATERS--

For: 1. Trickling Filter Plants > 2.0 MGD Average Design Flow
2. RBC Plants > 2.0 MGD Average Design Flow
3. Activated Sludge Plant 2.0 - 5.0 MGD Average Design Flow

Monitoring Type (Plant category)	Test	Sample Pt.	Frequency	Sample Type
Compliance (1,2,3)	Flow, mgd	Infl. or Fin. Eff.	Continuous	Measurement
"	pH	Final effluent	Daily/ Continuous	Grab/ Measurement
"	BOD_5	Infl.; Fin. Eff.[a]	3/week; 3/week	24-hr. Composite
"	TSS	Infl.; Fin. Eff.	3/week; 3/week	24-hr. Composite
"	Tot. Res. Cl_2	Chlorinated Eff.[f], Fin. Eff.[g]	Daily	Grab
"	Fecal Coliform	Fin. Eff.	3/week [c]	Grab
Sludge (1,2,3)	See Chapter XIII-2.3, Table XIII-3	See Chapter XIII-2.3, Table XIII-3	See Chapter XIII-2.3, Table XIII-3	
WET Test. (1,2,3)	See Chapter XIII-4	Final Eff.		
(See also reapplication requirements for NH3, TKN, NO2+NO3, O+G, Total P, and TDS in ChIII, Sec.6)				
Pretreatment (1,2,3) (see 2.1.4)	Oil and grease, pH, priority pollutant metals, and cyanide	Influent Final effluent	Quarterly[d] Quarterly[d]	24 hour composite[c], except grab for O&G

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Monitoring Type (Plant category)	Test	Sample Pt.	Frequency	Sample Type
Pretreatment (1,2,3) (see 2.1.4)		Sludge	1 taken within 30 days after influent sample	24 hour composite[e] Grab
	Priority pollutant organics and other toxic pollutants likely to be present	Influent	Annually[d]	24 hour composite[e]
		Final effluent	Annually[d]	24 hour composite[e]
		Sludge	1 taken within 30 days after influent sample	Grab

Table XIII-1E. RECOMMENDED MINIMUM MONITORING FOR POTWs DISCHARGING TO SURFACE WATERS

For:1. Activated Sludge Plants > 5.0 MGD Average Design Flow

Monitoring Type (Plant category)	Test	Sample Pt.	Frequency	Sample Type
Compliance (1)	Flow, mgd	Infl. or Fin. Eff.	Continuous	Measurement
"	pH	Final effluent	Continuous	Measurement
"	BOD_5	Infl.; Fin. Eff.[a]	5/week; 5/week	24-hr. Composite
"	TSS	Infl.; Fin. Eff.	5/week; 5/week	24-hr. Composite
"	Tot. Res. Cl_2	Chlorinated Eff.[f], Fin. Eff.[g]	Daily	Grab
"	Fecal Coliform	Fin. Eff.	Daily [c]	Grab
Sludge (1)	See Chapter XIII-2.3, Table XIII-3	See Chapter XIII-2.3, Table XIII-3	See Chapter XIII-2.3, Table XIII-3	
WET Test. (1)	See Chapter XIII-4	Final Eff.		
(See also reapplication requirements for NH3, TKN, NO2+NO3, O+G, Total P, and TDS in ChIII, Sec.6)				
Pretreatment (1) (see 2.1.4)	Oil and grease, pH, priority pollutant metals, and cyanide	Influent Final effluent	Quarterly[d] Quarterly[d]	24 hour composite[c], except grab for O&G. 24 hour composite[c]
Pretreatment		Sludge	1 taken within	Grab

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Monitoring Type (Plant category)	Test	Sample Pt.	Frequency	Sample Type
(1) (see 2.1.4)			30 days after influent sample	
	Priority pollutant organics and other toxic pollutants likely to be present	Influent	Annually[d]	24 hour composite[e]
		Final effluent	Annually[d]	24 hour composite[e]
		Sludge	1 taken within 30 days after influent sample	Grab

NOTES:

[a]. Samples for BOD_5 analysis may be taken before or after the disinfection process. If taken after, the sample must be dechlorinated and reseeded.

[b]. Influent flow must be provided if the permittee requests relief from 85% removal requirement as allowed in WAC 173-221-050. Influent flow monitoring is recommended for all lagoons to track influent loading.

[c]. Sampled concurrently with Total Residual Chlorine (before dechlorination, if applicable).

[d]. The days selected for sampling shall be rotated annually or quarterly (e.g., first quarter sample Monday, second quarter sample Tuesday, etc.). If the facility has undergone screening and prioritization for human health criteria the testing must be done during a wet season and a dry season.

[e]. Cyanide, Volatile Organics and Phenols must be taken as a minimum of 4 grab samples and separately analyzed in place of each 24 hour composite.

[f]. Sampled before dechlorination, if applicable.

[g]. Sampled after dechlorination, if applicable.

DEFINITIONS:

"Continuous" means readings are being taken and recorded at all times.

"Daily" in these tables is equivalent to 7 days/week.

"Final Effluent" means wastewater which is exiting, or has exited, the last treatment process or operation. Typically, this is after or at the exit from the chlorine contact chamber or other disinfection process.

"Grab" means an individual sample collected in less than fifteen minutes.

"Influent" means the raw sewage flow excluding any sidestreams returned to the headworks of the plant.

"24-hour composite" means a series of individual samples collected over a 24 hour period into a single container, and analyzed as one sample.

2.2 Process Control Monitoring

2.2.1 General

Process control monitoring provides a check on the efficiency of the treatment process and it allows the operator to make adjustments to optimize the process efficiency. It was commonly required as a permit condition in the past, especially for those facilities having difficulty complying with their permit limitations. Recently however, several factors have combined to limit the use of process control monitoring in permits:

1. Workload considerations emphasizing effluent limit compliance.
2. A general reluctance to initiate enforcement for noncompliance with permit process control parameters.
3. An internal policy memorandum suggesting process control monitoring be left out of permits (Stan Springer, July, 1990).
4. Language in Puget Sound Water Quality Plan Element P-8 suggesting that permit managers "leave most of the in-plant process control monitoring to the discretion of the discharger except in cases of significant non-compliance, as necessary to meet permit effluent limits."

Process control monitoring should not be required in permits. This type of monitoring is best implemented as part of an enforcement action for non-compliance and may be placed in an order. Routine process control monitoring may also be implemented through the submission of an updated O&M Manual.

2.2.2 Tables XIII-2(A-M)

These tables present suggested process control monitoring for POTWs applicable to O&M manual revision and administrative orders. Because process control monitoring is applicable to relatively few facilities and tends to be facility specific, it should be a matter of the professional judgement of the permit manager in consultation with the permittee. Frequencies should be established that allow for the minimum amount of resource investment for the discharger while assuring the best available treatment.

It may be advantageous to require a short-term intensive survey in order to determine appropriate sampling times and frequencies, and to establish possible correlations between parameters such as TOC and BOD_5, or BOD_5 and $CBOD_5$. Daily sampling for one to two months during both the wet season and dry season is recommended for short-term studies. In the long run, conducting a short-term study may save the POTW from sampling more frequently than necessary or sampling during non-representative times. If a correlation is determined between TOC and BOD_5, the permit writer may allow the permittee to substitute TOC tests for BOD_5 for process control. This allows the operator to respond quickly with process adjustments. The COD can also be related empirically to BOD_5 or TOC but the Manchester Laboratory has recommended the use of alternative equivalent methods (BOD_5 and TOC) to eliminate the generation of highly toxic hazardous waste. A method for determining a correlation between parameters may be found in chapter four of the *Handbook for Sampling and Sample Preservation of Water and Wastewater*, EPA,1982b. The topic of indicators is presented in Chapter XIII-1.

POTWs with industrial pretreatment programs or significant industrial input require more extensive in-plant testing if current or expected concentrations of pollutants in the influent are detrimental to the secondary process. (e.g., priority pollutant analysis of primary effluent, in addition to the influent, is warranted to determine whether interference will result).

When sampling waste streams within the POTW, sampling points that are most representative of the process area (e.g., the common channel for secondary clarifiers) should be chosen and unwanted waste streams should be avoided. For branching flows, samples should be taken ahead of the branching point, or from each stream after the branching point.

Samples on the aeration basin influent in the activated sludge process must be taken ahead of the point of entry of the recycle sludge. Sampling points should be located where the flow stream is well mixed.

In addition to sampling at the established process control locations, other unit processes may be sampled periodically when the variability of a parameter adversely affects the efficiency of a unit process. The basis for additional monitoring should be explained in the fact sheet.

Samples should be collected from channels at mid-channel and mid-depth where the flow is turbulent, well-mixed, and the settling of solids is minimal. Sampling should avoid skimming the water surface, or dragging the channel bottom. The sampling of wastewater for immiscible liquids, such as oil and grease, requires special attention and no specific rule can be given for selection of the most representative site because of wide range of conditions encountered in the field.

Sampling locations may be specified in an order or O&M Manual using a schematic flow diagram of the treatment process that shows the direction of flow between the processes, and shows all recycle flows. All sampling points should be identified on the schematic diagram. Include final sludge and/or other solids disposal where applicable. List all tests, sampling methods, frequencies, and sample types with the monitoring requirements.

The timing and frequency of sampling should be based on the relative complexity of the influent and the processes, as opposed to the design capacity of the facility.

If additional information is needed for process control monitoring for individual processes, Table 5.2 in the *Handbook for Sampling and Sample Preservation of Water and Wastewater*, EPA, 1982b, includes minimum sampling recommendations for each treatment process.

Table XIII-2A. SUGGESTED PROCESS CONTROL MONITORING FOR POTWs APPLICABLE TO O&M MANUAL REVISION AND ADMINISTRATIVE ORDERS-- For: Activated Sludge Plants < 2 MGD Average Design Flow

Test	Sample Pt.	Frequency	Sample Type
Flow, mgd Instantaneous	RAS	2/week	Measurement
pH	Primary Effluent Aeration Basin Digester(s) (An/A)[a] Digester Feed Sludge (An/A)	5/week 5/week 5/week Daily	Grab
BOD_5	Primary Effluent	2/week	Grab
TSS	Primary Effluent Aeration Basin(MLSS) RAS WAS	2/week 2/week 2/week 1/event	Grab
Dissolved O_2	Influent Final Effluent Aeration Basin(s) Primary Effluent Digester (A)	Daily Daily Daily 5/week Daily	Grab
Temperature	Influent Digester(s) (An/A)	Daily Daily	Measurement
Chlorine Usage	(Effluent Disinfection)	Daily	Measurement
30 Minute Settleometer	Activated Sludge	2/week	Grab
SVI, Loading Index	Aeration Basin	2/week	Grab
Mean Cell Res. Time	Calculation	2/week	
Volatile Acids	Digester (An)	1/week	Grab
Alkalinity	Digester (An)	1/week	Grab
Gas Analysis & Vol.:CO_2	Digester(s) (An)	Daily	Grab
% Total Solids	Digester Feed Sludge Digester (An/A) Stabilized Sludge	1/week [a] 1/week [a] 1/week [a]	Grab

Test	Sample Pt.	Frequency	Sample Type
Volume & lbs. to Waste	WAS Primary Sludge	Per Event Per Event	Measurement
Sludge Blanket Depth	Secondary Clarifiers	Daily	Measurement

Additional Process Control Monitoring To Consider

Ammonia	Influent Aerators (Mixed Liquor) Final Effluent	1/week 1/week 2/week	Grab
Nitrate	Aerators (Mixed Liquor)	1/week	Grab
Settleable Solids	Influent Final Effluent	2/week 2/week	Grab
Vol. Suspended Solids	Aeration Basin	2/week	Grab
Food/Mass	Calculation	2/week	
Centrifuge Spin	Aeration Tank Conc. Return Sludge Conc. Waste Sludge Conc.	3/week 3/week 3/week	Grab

Table XIII-2B. SUGGESTED PROCESS CONTROL MONITORING FOR POTWs APPLICABLE TO O&M MANUAL REVISION AND ADMINISTRATIVE ORDERS

For: Activated Sludge Plants Between 2-5 MGD Average Design Flow

Test	Sample Pt.	Frequency	Sample Type
Flow, mgd Instantaneous	RAS	Daily	Measurement
pH	Primary Effluent Aeration Basin Digester(s) (An/A) Digester Feed Sludge (An/A)	Daily Daily Daily Daily	Grab
BOD_5	Primary Effluent	3/week	Grab
TSS	Primary Effluent Aeration Basin(MLSS) RAS WAS	3/week 3/week 3/week 1/event	Grab
Dissolved O_2	Influent Final Effluent Aeration Basin(s) Primary Effluent	Daily Daily Daily Daily	Grab
Temperature	Influent Digester(s) (An/A)	Daily Daily	Measurement
Chlorine Usage	(Effluent Disinfection)	Daily	Measurement
30 Minute Settleometer	Activated Sludge	5/week	Grab
SVI, Loading Index	Aeration Basin	3/week	Grab
Mean Cell Res. Time	Calculation	5/week	
Vol. Acids	Digester (An)	2/week	Grab
Alkalinity	Digester (An)	2/week	Grab
Gas Analysis & Vol.: CO_2	Digester(s) (An)	Daily	Grab
% Total Solids	Digester Feed Sludge Digester(s) (An/A)	3/week [b] 3/week [b]	Grab

Test	Sample Pt.	Frequency	Sample Type
	Stabilized Sludge	3/week [b]	
Volume & lbs. to Waste	WAS Primary Sludge	Per Event Per Event	Measurement
Sludge Blanket Depth	Secondary Clarifiers	Daily	Measurement

Additional Process Control Monitoring To Consider

Ammonia	Influent Aerators (Mixed Liquor) Final Effluent	2/week 2/week Daily	Grab
Nitrate	Aerators (Mixed Liquor) Clarifier Effluent	2/week 2/week	Grab
Settleable Solids	Influent Final Effluent	5/week 5/week	Grab
Vol. Suspended Solids	Aeration Basin	2/week	Grab
Food/Mass	Calculation	3/week	
Centrifuge Spin	Aeration Tank Conc. Return Sludge Conc. Waste Sludge Conc.	5/week 5/week 5/week	Grab

Table XIII-2C.SUGGESTED PROCESS CONTROL MONITORING FOR POTWs APPLICABLE TO O&M MANUAL REVISION AND ADMINISTRATIVE ORDERS--

For: Activated Sludge Plants > 5 MGD Average Design Flow

Test	Sample Pt.	Frequency	Sample Type
Flow, mgd Instantaneous	RAS	Daily	Measurement
pH	Primary Effluent Aeration Basin Digester(s) (An/A) Digester Feed Sludge (An/A)	Daily Daily Daily Daily	Grab
BOD_5	Primary Effluent	5/week	Grab
TSS	Primary Effluent Aeration Basin(MLSS) RAS WAS	5/week 5/week 5/week 1/event	Composite Grab Grab Grab
Dissolved O_2	Influent Final Effluent Aeration Basin(s) Primary Effluent	Daily Daily Daily Daily	Grab
Temperature	Influent Digester(s) (An/A)	Daily Daily	Measurement
Chlorine Usage	(Effluent Disinfection)	Daily	Measurement
30 Minute Settleometer	Activated Sludge	Daily	Grab
SVI, Loading Index	Aeration Basin	5/week	Grab
Mean Cell Res. Time	Calculation	5/week	
Volatile Acids	Digester(s) (An)	3/week	Grab
Alkalinity	Digester (An)	3/week	Grab
Gas Analysis & Vol.: CO_2	Digester(s) (An)	Daily	Grab
% Total Solids	Digester Feed Sludge Digester(s) (An/A)	5/week [b] 5/week [b]	Grab

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Test	Sample Pt.	Frequency	Sample Type
	Stabilized Sludge	5/week [b]	
Volume & lbs. to Waste	WAS Primary Sludge	Per Event or Daily	Measurement
Sludge Blanket Depth	Secondary Clarifiers	Daily	Measurement

Additional Process Control Monitoring To Consider

Ammonia	Influent Aerators (Mixed Liquor) Final Effluent	2/week 2/week Daily	Grab
Nitrate	Aerators (Mixed Liquor) Clarifier Effluent	2/week 2/week	Grab
Settleable Solids	Influent Final Effluent	Daily Daily	Grab
Vol. Suspended Solids	Aeration Basin	2/week	Grab
Food/Mass	Calculation	5/week	
Centrifuge Spin	Aeration Tank Conc. Return Sludge Conc. Waste Sludge Conc.	Daily Daily Daily	Grab

Table XIII-2D. SUGGESTED PROCESS CONTROL MONITORING FOR POTWs APPLICABLE TO O&M MANUAL REVISION AND ADMINISTRATIVE ORDERS--

For:Package Aeration Plants < 0.1 MGD Average Design Flow

Test	Sample Pt.	Frequency	Sample Type
Flow, mgd Instantaneous	RAS	2/week	Measurement
TSS	Mixed Liquor RAS WAS	2/week 2/week 1/event	Grab
Dissolved O_2	Influent Final Effluent Aeration Basin(s) Digester (A)	5/week 5/week 5/week 5/week	Grab
Temperature	Aeration Basin(s)	5/week	Measurement
Chlorine Usage	(Effluent Disinfection)	5/week	Measurement
30 Minute Settleometer	Mixed Liquor	2/week	Grab
SVI, Loading Index	Aeration Basin	2/week	Grab
Mean Cell Res. Time	Calculation	2/week	
% Total Solids	Unstabilized Sludge Digester(s) (An/A) Stabilized Sludge	1/month [b] 1/month [b] 1/month [b]	Grab
Volume & lbs. to Waste	WAS Primary Sludge	Per Event Per Event	Measurement
Sludge Blanket Depth	Secondary Clarifiers	Daily	Measurement

Additional Process Control Monitoring To Consider

Ammonia	Influent Aerators (Mixed Liquor) Final Effluent	1/week 1/week 2/week	Grab
Settleable Solids	Final Effluent	2/week	Grab
Food/Mass	Calculation	2/week	
Centrifuge Spin	Aeration Tank Conc. Return Sludge Conc. Waste Sludge Conc.	2/week 2/week 2/week	Grab

Table XIII-2E. SUGGESTED PROCESS CONTROL MONITORING FOR POTWs APPLICABLE TO O&M MANUAL REVISION AND ADMINISTRATIVE ORDERS

For: Oxidation Ditches

Test	Sample Pt.	Frequency	Sample Type
Flow, mgd Instantaneous	RAS WAS	2/week per event	Measurement
pH	Ditch Digester(s) (An/A)	Daily 3/week	Grab
TSS	Aeration Basin (MLSS) RAS WAS	2/week 2/week per event	Grab
Dissolved O_2	Influent Final Effluent Aeration Basin(s) Digester (A)	Daily Daily Daily 2/week	Grab
Temperature	Influent	Daily	Measurement
Chlorine Usage	(Effluent Disinfection)	Daily	Measurement
30 Minute Settleometer	Activated Sludge	2/week	Grab
SVI, Loading Index	Aeration Basin	2/week	Grab
Mean Cell Res. Time	Calculation	2/week	
% Total Solids	Unstabilized Sludge Digester(s) (An/A) Stabilized Sludge	1/week [b] 1/week [b] 1/week [b]	Grab
Volume & lbs. to Waste	WAS Primary Sludge	Per Event Per Event	Measurement
Sludge Blanket Depth	Secondary Clarifiers	Daily	Measurement

Additional Process Control Monitoring To Consider

Ammonia	Influent Aerators (Mixed Liquor) Final Effluent	1/week 1/week 2/week	Grab
Nitrate	Mixed Liquor Clarifier Effluent	1/week 1/week	Grab
Settleable Solids	Final Effluent	2/week	Grab
Food/Mass	Calculation	2/week	
Centrifuge Spin	Aeration Tank Conc. Return Sludge Conc. Waste Sludge Conc.	3/week 3/week 3/week	Grab
Alkalinity	Influent Clarifier Effluent	1/week 1/week	Grab

Table XIII-2F. SUGGESTED PROCESS CONTROL MONITORING FOR POTWs APPLICABLE TO O&M MANUAL REVISION AND ADMINISTRATIVE ORDERS--

For: Trickling Filter Plants ≤ 0.5 MGD Average Design Flow

Test	Sample Pt.	Frequency	Sample Type
Flow, mgd Instantaneous	Trickling Filter Recycle	Daily	Measurement
pH	Primary Effluent Filter Effluent Digester(s) (An/A) Digester Feed Sludge (An/A)	5/week 5/week 5/week 1/week	Grab
TSS	Aeration Basin (MLSS) RAS WAS	2/week 2/week per event	Grab
Dissolved O_2	Influent Final Effluent Primary Effluent Filter Effluent Aerobic Digester (A)	Daily Daily 2/week 2/week Daily	Grab
Temperature	Influent Digesters (An/A)	Daily Daily	Measurement
Chlorine Usage	(Effluent Disinfection)	Daily	Measurement
30 Minute Settleometer	Activated Sludge	2/week	Grab
SVI, Loading Index	Aeration Basin	2/week	Grab
Mean Cell Res. Time	Calculation	2/week	
Volatile Acids	Digester (An)	1/week	Grab
Alkalinity	Digester (An)	1/week	Grab
Gas Analysis & Vol.: CO_2	Digester(s) (An)	5/week	Grab
% Total Solids	Digester Feed Sludge Digester(s) (An/A) Stabilized Sludge	1/week [b] 1/week [b] 1/week [b]	Grab
Volume & lbs. to Waste	Waste Primary Sludge	Per Event Per Event	Measurement

Test	Sample Pt.	Frequency	Sample Type
	Filter Sludge		
Sludge Blanket Depth	Secondary Clarifiers	Daily	Measurement
Recirculation Ratio	Filter Effluent/ Filter Influent	1/week	Measurement

Additional Process Control Monitoring To Consider

Ammonia	Influent Final Effluent	1/week 2/week	Grab
Settleable Solids	Trickling Filter Eff. Final Effluent	2/week 2/week	Grab

Table XIII-2G. SUGGESTED PROCESS CONTROL MONITORING FOR POTWs APPLICABLE TO O&M MANUAL REVISION AND ADMINISTRATIVE ORDERS--

For: Trickling Filter Plants 0.5-2.0 MGD Average Design Flow

Test	Sample Pt.	Frequency	Sample Type
Flow, mgd Instantaneous	Trickling Filter Recycle	Daily	Measurement
pH	Primary Effluent Filter Effluent Digester(s) (An/A) Digester Feed Sludge (An/A)	5/week Daily 5/week Daily	Grab
TSS	Aeration Basin (MLSS) RAS WAS	2/week 2/week per event	Grab
Dissolved O_2	Influent Final Effluent Primary Effluent Filter Effluent Digester (A)	Daily Daily 2/week 2/week Daily	Grab
Temperature	Influent Digesters (An/A)	Daily Daily	Measurement
Chlorine Usage	(Effluent Disinfection)	Daily	Measurement
30 Minute Settleometer	Activated Sludge	2/week	Grab
SVI, Loading Index	Aeration Basin	2/week	Grab
Mean Cell Res. Time	Calculation	2/week	
Volatile Acids	Digester (An)	1/week	Grab
Alkalinity	Digester (An)	1/week	Grab
Gas Analysis & Vol.: CO_2	Digester(s) (An)	Daily	Grab
% Total Solids	Digester Feed Sludge Digester(s) (An/A) Stabilized Sludge	1/week [b] 1/week [b] 1/week [b]	Grab
Volume & lbs. to	Waste Primary Sludge	Per Event	Measurement

Test	Sample Pt.	Frequency	Sample Type
Waste	Filter Sludge	Per Event	
Sludge Blanket Depth	Secondary Clarifiers	Daily	Measurement
Recirculation Ratio	Filter Effluent/ Filter Influent	Daily	Measurement

Additional Process Control Monitoring To Consider

Ammonia	Influent Final Effluent	1/week 2/week	Grab
Nitrate	Influent Final Effluent	1/week 1/week	Grab
Settleable Solids	Trickling Filter Eff. Final Effluent	2/week 2/week	Grab

Table XIII-2H. SUGGESTED PROCESS CONTROL MONITORING FOR POTWs APPLICABLE TO O&M MANUAL REVISION AND ADMINISTRATIVE ORDERS

For: Trickling Filter Plants > 2.0 MGD Average Design Flow

Test	Sample Pt.	Frequency	Sample Type
Flow, mgd Instantaneous	Trickling Filter Recycle	Daily	Measurement
pH	Primary Effluent Filter Effluent Digester(s) (An/A) Digester Feed Sludge	Daily Daily Daily Daily	Grab
BOD_5	Primary Effluent	3/week	Grab
TSS	Primary Effluent	3/week	Grab
Dissolved O_2	Influent Final Effluent Primary Effluent Filter Effluent	Daily Daily Daily Daily	Grab
Temperature	Influent Digesters (An/A)	Daily Daily	Measurement
Chlorine Usage	(Effluent Disinfection)	Daily	Measurement
Volatile Acids	Digester (An)	2/week	Grab
Alkalinity	Digester (An)	2/week	Grab
Gas Analysis & Vol.: CO_2	Digester(s) (An)	Daily	Grab
% Total Solids	Digester Feed Sludge Digester(s) (An/A) Stabilized Sludge	3/week [b] 3/week [b] 3/week [b]	Grab
Volume & lbs. to Waste	Waste Primary Sludge Filter Sludge	Per Event Per Event	Measurement
Sludge Blanket Depth	Secondary Clarifiers	Daily	Measurement

Additional Process Control Monitoring To Consider

Ammonia	Influent Final Effluent	2/week Daily	Grab
Nitrate	Influent Final Effluent	2/week 2/week	Grab
Settleable Solids	Trickling Filter Eff. Final Effluent	3/week Daily	Grab
Total Solids	Supernatant	3/week	Grab

Table XIII-2I. SUGGESTED PROCESS CONTROL MONITORING FOR POTWs APPLICABLE TO O&M MANUAL REVISION AND ADMINISTRATIVE ORDERS--

For: Sewage Lagoons < 0.5 MGD Average Design Flow

Test	Sample Pt.	Frequency	Sample Type
pH	Each Cell	1/week	Grab
Dissolved O_2	Influent Final Effluent Each Cell	2/week 2/week 1/week	Grab
Temperature	Influent Each Cell	2/week 1/week	Measurement
Chlorine Usage	(Effluent Disinfection)	Daily	Measurement
Lagoon Depth	Each Cell	1/week	Measurement

Additional Process Control Monitoring To Consider

Ammonia	Influent Final Effluent	1/week 2/week	Grab
Settleable Solids	Final Effluent	1/week	Grab
Dissolved O_2	Lagoon Profile	1/month	
Precipitation/Evaporation	On-site	Daily	

Table XIII-2J. SUGGESTED PROCESS CONTROL MONITORING FOR POTWs APPLICABLE TO O&M MANUAL REVISION AND ADMINISTRATIVE ORDERS--

For: Sewage Lagoons > 0.5 MGD Average Design Flow

Test	Sample Pt.	Frequency	Sample Type
pH	Each Cell	Daily	Grab
Dissolved O_2	Influent Final Effluent Each Cell Lagoon Profile	2/week 2/week 1/week 1/month	Grab
Temperature	Influent Each Cell	2/week 1/week	Measurement
Chlorine Usage	(Effluent Disinfection)	Daily	Measurement
Lagoon Depth	Each Cell	1/week	Measurement

Additional Process Control Monitoring To Consider

Ammonia	Influent Final Effluent	1/week 2/week	Grab
Nitrate	Influent Final Effluent	1/week 1/week	Grab
Settleable Solids	Final Effluent	2/week	Grab
Precipitation/Evaporation	On-site	Daily	

Table XIII-2K. SUGGESTED PROCESS CONTROL MONITORING FOR POTWs APPLICABLE TO O&M MANUAL REVISION AND ADMINISTRATIVE ORDERS--

For: RBC Plants < 0.5 MGD Average Design Flow

Test	Sample Pt.	Frequency	Sample Type
pH	Primary Effluent RBC Tank Digester(s) (An/A) Digester Feed Sludge	5/week 5/week 5/week 1/week	Grab
Dissolved O_2	Influent Final Effluent Primary Effluent RBC Tank Effluent	Daily Daily 2/week 2/week	Grab
Temperature	Influent Digester(s) (An/A)	Daily Daily	Measurement
Chlorine Usage	(Effluent Disinfection)	Daily	Measurement
Volatile Acids	Digester (An)	1/week	Grab
Alkalinity	Digester (An)	1/week	Grab
Gas Analysis & Vol.: CO_2	Digester(s) (An)	5/week	Grab
% Total Solids	Digester Feed Sludge Digester(s) (An/A) Stabilized Sludge	1/week [b] 1/week [b] 1/week [b]	Grab
Volume & lbs. to Waste	Waste Primary Sludge Waste RBC Sludge	Per Event Per Event	Measurement
Sludge Blanket Depth	Secondary Clarifiers	Daily	Measurement

Additional Process Control Monitoring To Consider

Ammonia	Influent Final Effluent	1/week 2/week	Grab
Settleable Solids	Final Effluent	2/week	Grab
Soluble BOD_5	Primary Effluent RBC Tank Effluent	1/week 1/week	Grab
Load Cell		1/week	Report
Dissolved O_2 Profile	RBC Tank	1/week	Grab
Bio-Growth Observations	RBC	1/week	

Table XIII-2L. SUGGESTED PROCESS CONTROL MONITORING FOR POTWs APPLICABLE TO O&M MANUAL REVISION AND ADMINISTRATIVE ORDERS--

For: RBC Plants 0.5-2.0 MGD Average Design Flow

Test	Sample Pt.	Frequency	Sample Type
pH	Primary Effluent RBC Tank Digester(s) (An/A) Digester Feed Sludge (An/A)	Daily Daily Daily 1/week	Grab
Dissolved O_2	Influent Final Effluent Primary Effluent RBC Tank Effluent	Daily Daily 2/week 2/week	Grab
Temperature	Influent Digester(s) (An/A)	Daily Daily	Measurement
Chlorine Usage	(Effluent Disinfection)	Daily	Measurement
Volatile Acids	Digester (An)	2/week	Grab
Alkalinity	Digester (An)	2/week	Grab
Gas Analysis & Vol.: CO_2	Digester(s) (An)	Daily	Grab
% Total Solids	Digester Feed Sludge Digester(s) (An/A) Stabilized Sludge	3/week [b] 3/week [b] 3/week [b]	Grab
Volume & lbs. to Waste	Waste Primary Sludge Waste RBC Sludge	Per Event Per Event	Measurement
Sludge Blanket Depth	Secondary Clarifiers	Daily	Measurement

Additional Process Control Monitoring To Consider

Ammonia	Influent Final Effluent	1/week 2/week	Grab
Settleable Solids	Final Effluent	2/week	Grab
Soluble BOD_5	Primary Effluent RBC Tank Effluent	1/week 1/week	Grab
Load Cell		1/week	Report
Dissolved O_2 Profile	RBC Tank	1/week	Grab
Bio-Growth Observations	RBC	1/week	

Table XIII-2M. SUGGESTED PROCESS CONTROL MONITORING FOR POTWs APPLICABLE TO O&M MANUAL REVISION AND ADMINISTRATIVE ORDERS--

For: RBC Plants > 2.0 MGD Average Design Flow

Test	Sample Pt.	Frequency	Sample Type
pH	Primary Effluent RBC Tank Digester(s) (An/A) Digester Feed Sludge	Daily Daily Daily 1/week	Grab
BOD_5	Primary Effluent	3/week	Grab
TSS	Primary Effluent	3/week	Grab
Dissolved O_2	Influent Final Effluent Primary Effluent RBC Tank Effluent	Daily Daily Daily Daily	Grab
Temperature	Influent Digester(s) (An/A)	Daily Daily	Measurement
Chlorine Usage	(Effluent Disinfection)	Daily	Measurement
Volatile Acids	Digester (An)	2/week	Grab
Alkalinity	Digester (An)	2/week	Grab
Gas Analysis & Vol.: CO_2	Digester(s) (An)	Daily	Grab
% Total Solids	Digester Feed Sludge Digester(s) (An/A) Stabilized Sludge	3/week [b] 3/week [b] 3/week [b]	Grab
Volume & lbs. to Waste	Waste Primary Sludge Waste RBC Sludge	Per Event Per Event	Measurement
Sludge Blanket Depth	Secondary Clarifiers	Daily	Measurement

Additional Process Control Monitoring To Consider

Ammonia	Influent Final Effluent	1/week 2/week	Grab
Settleable Solids	Final Effluent	2/week	Grab
Soluble BOD_5	Primary Effluent RBC Tank Effluent	1/week 1/week	Grab
Load Cell		1/week	Report
Dissolved O_2 Profile	RBC Tank	1/week	Grab
Bio-Growth Observations	RBC	1/week	

NOTE:

[a]. An = anaerobic, A = aerobic

[b]. "Digester feed" or "unstabilized" sludge samples may be taken when wasting from primary and secondary clarifiers to an aerobic digester, anaerobic digester, or sludge drying beds. "Stabilized sludge" samples can be taken when wasting from the sludge treatment recommended in the schedule.

2.3 POTW Sludge Monitoring and Special Conditions

Sludge (biosolids) disposal and the associated monitoring is a program separate from the NPDES permit process and codified in 40 CFR 503. Ecology has not received delegation from EPA to operate this program so it is currently being run by USEPA. Ecology may require sludge monitoring in permits in order to develop local limits under authority of 40 CFR 403 (see Chapter X, Section 6).

The following section is reserved to describe Ecology's biosolids program when delegation is received from USEPA.

2.3.2 Sampling of Sewage Sludge

For flowing sludge, collect samples at the measuring weirs, or at another point where the sludge is well mixed.

Recommended sludge sampling locations are:

- Primary Sludge--Draw sludge from the settling tank hoppers into a well or pit before pumping, mix well and then collect a representative sample directly from this well. Alternatively, collect samples from openings in pipe near the sludge pumps or from the pump itself.

- Activated Sludge--Collect samples at the pump suction well, the pump or adjacent piping or the point of discharge of the return sludge to the primary effluent. The sample point should be located in a region of good agitation to maintain the suspension of solids.

- Digested Sludge--Collect samples at the point of the discharge of the digester drawoff pipe to the drying beds or the drying equipment. For batch sludges in digesters, collect samples from a mixed sink which is fed through lines attached at different levels in the digester. Be certain to remove sludge accumulated in the lines prior to sampling. For batch sludges in tanks, mix thoroughly if possible and collect samples. Collect samples at various depths and locations in the tank. Mix samples together prior to analysis.

- Bed Dried Sludge--Collect equal sized samples at several points within the bed without including sand. mix thoroughly.

- Filtered Sludge--Collect equal size portions at the filter discharge.

The variability of sludge creates a need for frequent initial sampling in order to determine sampling frequencies. Samples should be composited, and should consist of at least 3 individually obtained samples. Batch operations should be sampled at the beginning, middle and end of a discharge, or more frequently if high variability is suspected. Tapped lines should also be sampled in three separate intervals because of variations in the sludge at the drawoff source (i.e., clarifier, digester, etc.). Sludges treated in aerobic or anaerobic digesters have long detention times within the digesters. Therefore, sampling should be no more frequent than the detention time of the digester.

Collect grab samples when analyzing for a parameter which is unstable, for example ammonia, or when analysis is required as soon as possible (e.g., sludge volume index test for activated sludge samples).

Analysis of composite samples is recommended in all other situations to reduce effects of sludge variability. Use at least three individual samples to form the composite. Wherever possible, collect frequent grab samples and composite according to flow rate.

Use manual sampling techniques in most situations unless special adaptations can be made for reliable automatic samplers. Automatic samplers have problems because of high fouling potential due to the solids content of the wastewater.

2.4 Combined Sewer Overflows

WAC 173-245-090(1) requires municipalities with combined sewer overflows (CSO's) to make an annual report to Ecology. The annual report must discuss three topics:

1. The past year's frequency and volume of combined sewage discharged from each CSO site, or group of CSO sites in close proximity.

2. The past year's CSO reduction accomplishments.

3. The projects planned for the next year.

To report on #1 above, the WAC requires field monitoring. The extent of field monitoring necessary should be agreed upon in advance by Ecology and the municipality. The agreement should be formalized by incorporating the monitoring schedule within the appropriate NPDES permit when it is renewed.

The purposes of the monitoring are to determine whether any CSO is increasing in volume or frequency over the "baseline annual" condition (see WAC 173-245-020), and to determine the success of CSO reduction efforts. Any increase triggers a requirement to accomplish additional CSO reduction (WAC 173-245-090(1)(a).

Actual flow recording equipment in each discharge location is preferable. If the discharge is not accessible to flow recording equipment, establish a relationship between flow in the sewer trunkline and flow in the discharge pipe to which the trunk overflows. If the discharger can establish a relationship between frequencies and quantities of overflows among a group of CSO's, then monitoring at one of the locations can suffice. Note that all parties should agree to these indirect measurements as satisfactory to determine compliance with the requirements of WAC 173-245-090(1).

As described in Chapter V, Section 3.4.2, if the municipality has chosen at-site treatment facilities (e.g. primary treatment and disinfection) for CSO control, the permit writer can choose to permit the facility under the same permit as that for the secondary treatment plant, or write a separate permit. In either case, the permit should include numerical limits for the discharge, flow capacity limits for the facility, and reporting requirements. The influent and effluent during each storm event must be sampled for total suspended solids. The effluent during each storm event must be sampled for settleable solids. The sample types can be flow- or time-weighted composites for the time of the discharge. Flow-weighted is preferable since it will more accurately estimate actual discharge quality and quantity over the discharge.

The *Water Quality Technical Guidance Manual*, (Ecology, 1990b), provides additional guidance on how to interpret and implement the regulations on CSOs.

2.5 Monitoring Bypasses

When emergency bypasses are made to a different outfall or discharge point, due to high inflows or treatment plant problems, separate samples of the bypassed flows should be taken (*Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters*, EPA 430/9-82-010, EPA, 1982a).

Reporting of bypasses (and by implication monitoring) is required in 40 CFR 122.41 (l) and (m). Noncompliance that endangers health or the environment must be reported including "any unanticipated bypass which exceeds any effluent limitation in the permit." In certain emergency situations, when all available manpower is required to correct the problem, monitoring the bypass may be difficult or even impossible. However, data on the total amount of wastewater bypassed and limited conventional pollutants such as BOD_5 and TSS may be helpful in understanding the effects of a bypass. Fecal coliforms in particular should be sampled because this test can provide both an indication of the concern to public health and, in certain situations, the amount of dilution afforded to the raw sewage by I/I. If the bypass occurs at a location where sampling is difficult, grab samples may substitute for composite samples.

Approved anticipated bypasses, which require notification of the Department and may require a water quality modification, should also include monitoring for limited conventional parameters (*Criteria for Sewage Works Design*, Section 1.44, Ecology, 1985).

3. INDUSTRIAL AND COMMERCIAL FACILITY MONITORING

The general considerations from part 1 of this chapter apply to all facilities discharging under the terms of wastewater permits issued by the department. Knowledge of the general considerations is necessary in order to write a permit in accordance with department guidelines. The topics which are expanded and exceptional for industrial and commercial facilities are presented in this section. This section is not intended to absolutely apply to indirect dischargers (industrial users) although some of the principles will apply. The topics discussed are:

1. Influent monitoring

2. Effluent monitoring frequency

The monitoring strategy of industrial and commercial wastewaters, because of the many different types of facilities, is less amenable to categorization than POTW monitoring. The operational processes that generate wastewater and the resultant effluents are much more diverse in industrial and commercial facilities. Individual wastewaters vary significantly with industry type and facility. Also, the influent pollutants may not be treated by biological treatment. Toxic and nonconventional pollutants are often the factors limiting the efficiency of wastewater treatment for industries.

For facilities with conventional pollutants that have biological treatment similar to POTWs, use the monitoring frequencies of Tables XIII-1(A-E) for facilities of comparable flows. Dairy products and other food processors may fit this approach.

The permit must contain monitoring requirements for all pollutants in the effluent with limits. Regulation states that the frequency of monitoring must result in a reasonable characterization of the nature of the discharge. A reasonable characterization should produce the variability and quantity of pollutant concentrations or loadings in the effluent as described earlier in Chapter XIII-1.3.

3.1 Influent Monitoring

Depending on the treatment process used, it may be beneficial to require an industry to monitor influent to the treatment process and the facility. Influent monitoring may be necessary when there is a change in process or treatment technology, when the source of effluent toxicity or violations of permit conditions are unknown, or when the influent process water is known or suspected to contain unusually high concentrations of a contaminant. Evaluating the removal efficiencies for certain pollutants may help to trace the sources of problems, and may be used to determine whether a facility is meeting AKART by comparing with treatment efficiencies of similar facilities or treatment systems.

Effluent limits based on treatment technology can be influenced by the quality of influent. Upon request of the discharger, credits for input water under certain conditions may be applied to the calculation of pollutants generated by the industrial process. This is only the case for technology-based limits and does not apply to water quality based limits. The permit must specify the frequency and sample point for data on input water. This should be concurrent with sampling frequencies for effluent sampling parameters where this is a factor. (40 CFR 122.45[g])

3.2 Effluent Monitoring

The most prevalent monitoring required by wastewater discharge permits is the monitoring at point of compliance, the effluent outfall. Until recently this was usually the only monitoring required for industries. There are virtually no regulations and little guidance for establishing frequency of monitoring.

An exception is found in the pretreatment regulations, 40 CFR Part 403.12. Significant Industrial Users (SIUs) must report results of wastewater analyses at least semi-annually to the Control Authority. The Control Authority is Ecology for all state waste discharge permits issued to Industrial Users.

Generally the permit writer is faced with a decision to either increase frequency over past permits and face the wrath of the permittee or imitate the monitoring requirements from other accepted permits.

Other than the SIUs, there is no fixed guidance from EPA on establishment of monitoring frequencies for industrial or commercial facilities.

> "The decision on the monitoring frequency is case-specific and needs to consider a number of factors, including those listed below:

- Type of treatment process, including retention time
- Environmental significance and nature of the pollutant or pollutant parameter
- Cost of monitoring relative to the discharger's capabilities and benefit obtained

- Compliance history
- Number of monthly samples used in developing the permit limit
- Effluent variability

Based upon an array of data analyzed for both individual chemicals and whole effluent toxicity, and independent of other considerations, EPA has observed that ideally 10 or more samples per month provides the greatest statistical likelihood that the average of the various monthly values will approach the true monthly LTA value. In practice, however, selection of monitoring frequencies will need to consider the previously mentioned factors and arrive at a reasonable compromise of the appropriate considerations" (*TSD*, pg. 113, EPA, 1991)

A facility not given to extreme fluctuations can be adequately regulated by selecting a frequency based on the single high-frequency monitoring study explained in Section XIII-1.4.3. Armed with enough data, the permit writer can calculate limits, establish the projected LTA, and determine a protective monitoring frequency capable of detecting a violation of the limits within a certain degree of confidence.

When needed to establish frequency of monitoring, the single high frequency monitoring study should occur during the application phase of the permit but this is not always possible. Some dischargers are too slow or lack the initiative to supply the data outside the structure of the permit. In these cases the permit writer should include a requirement in the permit which requires the discharger to conduct the high-frequency study during a critical phase of production. The high frequency monitoring study should be conducted at each permit cycle for some dischargers, unless other factors are present. The use of DMR and other data in lieu of the high frequency monitoring study is explained in Section 1.3.1. High frequency monitoring during the fourth year of a typical five year permit cycle will supply variability information for the renewal of the permit.

4. WET TESTING MONITORING

4.1 Recommended Test Frequency for Characterization

Whole effluent toxicity tests are relatively expensive. Therefore, the test frequency should be related to the probability of any discharger having whole effluent toxicity. The following table ranks some factors associated with the discharger or the receiving water. A permit manager may use other factors to increase or decrease the rank of any discharge. A permit manager may also change the relative weight of the factors listed. All factors considered should be explained in the fact sheet.

Table XIII-4 DISCHARGE RANKING SYSTEM

Applicant:__________ NPDES Permit #

A. Toxicity Likelihood (Circle the scores for all that apply.)

1. 5 points — Uses, stores, produces as a product or waste, or transfers hazardous substances listed in 40 CFR 302.4 with a statutory code of 1 or 2 with adequate Best Management Practices (adequate secondary containment, good housekeeping, good employee training, thorough self-inspection, sufficient emergency planning and spill control equipment, etc.)

2. 20 points — Uses, stores, produces as a product or waste, or transfers hazardous substances listed in 40 CFR 302.4 with a statutory code of 1 or 2 with inadequate Best Management Practices (no or undersized secondary containment, poor house-keeping, little employee training, poor self-inspection, little emergency planning, insufficient spill control equipment, history of spills which have reached receiving water, etc.)

3. 15 points — Discharges in the effluent any toxic pollutant listed in Appendix D of 40 CFR Part 122

4. 15 points — Discharger belongs in an industry category identified in 40 CFR Part 122, Appendix A

5. 15 points — Discharger is a municipal facility which receives a discharge from any industry category identified in Appendix C of 40 CFR Part 403, unless the municipality has an adequate pretreatment program which establishes and enforces local limits

6. 10 points — Any facility with toxicity detected during past acute toxicity testing based on less than 80% survival in 100% effluent

7. 15 points — Any facility with known or suspected receiving water impacts

Sum of scores in part A:

Table XIII-4 . Cont.

B. Potential For Impact

1. Average Annual Discharge Flow Volume (Circle one score.)*

a. 5 points — Flow < 0.5 mgd

b. 10 points — Flow 0.5 mgd to 12.5 mgd

c. 15 points — Flow 12.5 mgd to 25 mgd

d. 20 points — Flow 25 mgd to 37.5 mgd

e. 25 points — Flow 37.5 mgd to 50 mgd

f. 30 points — Flow > 50 mgd

2. Chronic Critical Effluent Concentration at Edge of Mixing Zone (Circle one score. If not known, estimate or double the score in category B)*

a. 1 point — CCEC < 0.1% effluent

b. 5 points — CCEC = 0.1% effluent to 2% effluent

c. 10 points — CCEC = 2% effluent to 4% effluent

d. 15 points — CCEC = 4% effluent to 6% effluent

e. 20 points — CCEC = 6% effluent to 8% effluent

f. 25 points — CCEC = 8% effluent to 10% effluent

g. 30 points — CCEC > 10% effluent

Sum of scores in part B:

C. Multiply the sum of scores from part A by the sum of scores in part B to rank the discharge:

Table XIII-4 . Cont.

D. Discharge Ranks*

Rank 1- greater than 2500 points

Rank 2- 1500 points to 2500 points

Rank 3- 750 points to 1500 points

Rank 4- 100 points to 750 points

Rank 5- less than 100 points

*Borderline values go to any adjacent group at the discretion of the permit manager.

Table XIII-4 . Continued

TESTING FREQUENCY

DISCHARGE RANK	EFFLUENT CHARACTERIZATION	
	Acute Toxicity	Chronic Toxicity
RANK 1	6/year, 1 fish 1 invert.	6/year, 1 fish 1 invert. 1 algal*
RANK 2	6/year, 1 fish 1 invert.	4/year, 1 fish 1 invert. 1 algal*
RANK 3	4/year, 1 fish 1 invert.	4/year, 1 fish 1 invert.
RANK 4	4/year, 1 fish 1 invert.	2/year, 1 fish 1 invert.
RANK 5	2/year, 1 fish 1 invert.	2/year, 1 fish 1 invert.

* optional at permit manager's discretion

4.2 Sampling

Samples for whole effluent toxicity testing may be composite or grab samples. Twenty four hour composite samples are recommended except:

a. when the permit manager has reason to believe that the effluent is significantly more toxic at a certain time of day,

b. when the permit manager suspects that toxicity may be lost by the compositing process (for example, chlorine or volatile organics vaporizing out of solution, or surfactants adsorbing to the composite sampler),

c. or when the toxicity testing will require a sample volume in excess of composite sampler volume which is usually about five gallons. Grab samples can be composited in these cases.

Samples taken for toxicity testing should be cooled to 4 degrees Celsius and sent to the lab immediately. The lab should begin the toxicity testing as soon as possible but no later than 36 hours after the time that sampling was begun.

Sampling should be evenly spaced during the year and timed to catch the maximum seasonal variation. For example, if sampling frequency is 2/year, then these should be taken in the summer and winter.

5. STORM WATER MONITORING

The Clean Water Act did not exempt storm water from regulation. Storm water is considered wastewater and if it flows in a conveyance it is a point source discharge. Storm water discharges have not been regulated in a consistent manner under the Clean Water Act because of funding limitations and because control mechanisms and monitoring requirements are different from other point sources.

As other point source pollution sources came under control, it was apparent that storm water was often the cause of non-attainment of the water quality standards. The 1987 amendments to the Act explicitly required storm water permits. These storm water requirements have been clarified in EPA rule making. The regulatory history of storm water pollution control is reviewed in 56 FR 40948 (August 16, 1991). Storm water is unique in that EPA has established that the implementation of best management practices constitutes BCT/BAT for storm water discharges associated with industrial activity. The fact sheet to the EPA industrial storm water permit says that BMP's identified in pollution prevention plans substitute for numeric limitations for the general class of industrial storm water.

Ecology has several types of storm water permits and the monitoring requirements are different for each type.

5.1 Types of Storm Water Permits

5.1.1 Industries with Effluent Guidelines That Include Storm Water

EPA has promulgated effluent guidelines for some industries which include storm water requirements. The following industrial categories have storm water requirements:

- Cement Manufacturing
- Feedlots
- Fertilizer Manufacturing
- Petroleum Manufacturing
- Steam Electric
- Coal Mining
- Ore Mining and Dressing
- Mineral Mining and Processing
- Asphalt Emulsion

These categories of dischargers have effluent limitations in regulation and they address either "non-process wastewater" or wastewater from material storage piles. Even though some of these limitations specify the design storm (i.e. 10 year 24 hour storm) they do not specify monitoring frequency. Therefore the only regulatory monitoring requirement is the minimum of once per year as specified in 40 CFR 122.44(i)(2). These categories of dischargers receive individual permits which cover storm water discharges. The permit writer for one of these categories of discharge must review the development document to determine which waste streams are covered in the effluent limitations. If a permit writer finds that a waste stream in one of these categories of discharge is not covered by the effluent guidelines, the effluent limitations for that waste stream are developed on a case-by-case basis.

5.1.2 Industries With Effluent Guidelines

Some industries with effluent guidelines for the process wastewater have storm water that mixes with the process wastewater before the point of discharge. The permit typically includes both types of wastewater. An example of this type is the timber products processing category. These categories of dischargers would generally receive individual permits that include effluent limitations developed on a case-by-case basis for the storm water component.

5.1.3 Industries Without Effluent Guidelines but With Existing Individual Permits

These are usually industries that have permits because of some demonstrated water quality problem from storm water runoff or because they are a remedial cleanup site. This category of discharger has an individual permit that contains storm water effluent limitations developed a case-by-case basis.

5.1.4 Industrial Baseline General Permit

Ecology issued a general permit for industrial storm water on November 18, 1992. This general permit requires the permittees to develop and implement a pollutant reduction plan and conduct an annual self inspection but does not require wastewater characterization or effluent monitoring. This is a three year permit. Ecology will be developing criteria for issuance of industry specific general permits and criteria for issuing individual permits in the next three years.

5.1.5 Municipal General Permit

Ecology has issued a general storm water permits to municipalities with a population greater than 250,000 and to municipalities with populations between 100,000 and 250,000.

5.1.6 Dual Permits

A permit writer who is permitting an industrial facility may find the previous permit or the effluent guidelines do not cover storm water discharge at the facility. This facility must have submitted a Notification of Intent (NOI) to be covered under the Industrial Baseline Storm Water General permit if it is included in the regulations. Most industries are included in the SIC codes that require storm water permits.

A facility should not be removed from coverage under the Baseline General Permit unless the permit manager considers the pollution control approach or the timing of the general permit to be inappropriate for that facility. Ecology will not charge a facility a fee for coverage under the storm water general permit if they have an individual permit. The Baseline Storm Water permit may be inappropriate for facilities which the permit manager has reason to believe may be having significant water quality impacts, or where the discharge is a "significant contributor of pollutants" (40 CFR 122.28(b)(2)(i)(G)).

Some industries may not be required to be covered under the general permit but the permit manager has reason to believe the storm water discharge from the facility is causing pollution and therefore requires control. These facilities would be issued an individual permit.

If the permit manager decides to remove a facility from dual coverage and address the storm water discharge within an individual permit, the wastewater characterization process must meet the requirements in federal regulations.

Federal regulations require submission of form 2F (40 CFR 122.26(c)) for characterizing the amount and nature of the storm water. This form requires submission of sampling data and an assessment of the site. This form is appropriate for facilities which the permit writer wants to obtain storm water quality data now rather than waiting until about 1997 under the Baseline Storm Water General Permit.

If the permit manager wants to include storm water in an individual process waste water permit, but doesn't want to wait until the form 2F is submitted before issuing the permit, the monitoring requirements of form 2F should be included in the monitoring requirements of the permit. The other option is a permit requirement to submit a form 2F and to comply with the sampling requirements of the storm water regulations.

5.2 Wastewater Characterization for Industrial Storm Water

The storm water regulations contain some specific requirements for characterizing storm water pollutant concentrations and loading. Permit managers should require these sampling processes in individual permits so as to be consistent with the regulations. The requirements for storm water sampling are contained in *NPDES Storm Water Sampling Guidance Document* (EPA 833-B-92-001). This document should be referenced in permits requiring storm water characterization.

The regulations require a grab sample for the first flush of the precipitation event during the first 30 minutes of a discharge and a flow-weighted composite for the rest of the storm event. The first flush grab sample is not required if the storm water is from a detention basin with a detention time of 24 hours or more. The flow weighted composite samples must be collected during the first three hours of the discharge or the entire period of discharge if less than three hours in length.

The regulations also specify the pollutants to be analyzed in each sample.

The first flush sample must be analyzed for:

- Oil/grease,
- pH,
- BOD,
- COD,
- TSS,
- Total P,
- Nitrate and nitrite nitrogen,
- Total Kjeldahl nitrogen,
- Any pollutant in the facilities effluent guideline,
- Any additional pollutants that are in the facility's permit including those for the purpose of characterization of the process waste stream, and
- Any pollutant that the applicant denotes as believed to be present on the form 2F.

The composite sample must be analyzed for all the parameters in the first flush sample except oil/grease and pH unless they happen to be parameters given in the permittees individual permit. For certain industries EPA's General Industrial Storm Water Permit specifies pollutant parameters to be monitored (refer to Table XIII-5).

The storm water regulations are explicit on the storm event to be sampled to characterize the storm water discharge. The storm event must produce 0.1 inch of precipitation and occur at least 72 hours from the last 0.1 inch of precipitation. The duration and total precipitation for the storm event should be from 0.5 to 1.5 times the average or median storm event for the area.

The regulations also require that the permittee measure flow rate, estimate volume for the storm event sampled and provide the method of flow estimation. The permittee must also provide:

- The date and duration (in hours) of the storm event(s) sampled.
- The rainfall measurements or estimates of the storm event (in inches) which generated the sampled runoff.
- The duration between the storm event sampled and the end of the previous measurable storm event.

The sample volume is not specified in regulation but is contingent upon the number of pollutants to be analyzed. The samples generally should be a minimum of four liters for the first grab and three liters for the composite sample.

The regulations do not require an automatic sampler for storm water but they do place a restriction on manual sampling. Samples collected manually for composite samples must be taken once in each hour for three hours and at least 15 minutes apart. The EPA guidance document contains a good discussion of the advantages and disadvantages of automatic versus manual sampling. The document also presents several strategies for sampling to meet the intent of the regulations.

5.3 Compliance Monitoring

The frequency of compliance monitoring is based upon the permit managers best professional judgement. The permit manager should review the general considerations for determining the frequency of compliance monitoring given in the earlier sections of this chapter. For industries listed in Table XIII-5, the permit writer should use the monitoring frequencies required by EPA as the minimum monitoring frequencies.

For some storm water discharges the first flush flow may contain many times the concentration of pollutants than sometime later in the storm event. The first flush concentration may also be dependent upon the season. An industry that has a large amount of deposition from air pollutants would have the highest concentration of pollutants in the first heavy rain of the fall. This time of the year is also a low flow period for streams that are dependent upon ground water recharge.

The short term biological impact (acute toxicity) would be greatest at this time and a grab sample of the first heavy fall rain would be the best predictor of impact. Grab samples are not as important in facilities with storm water storage basins with long detention times.

For effluent limits based on treatment, composite samples are important for determining average performance. Composite samples are better at predicting loading of pollutants to a water body.

The permit manager should consider using tiered monitoring as discussed in an earlier section of this chapter. The reduction of monitoring frequency could be based upon compliance with effluent limits or upon a demonstrated reduction of pollutants attributable to implementation of Best Management Plans.

Table XIII-5. EPA STORM WATER GENERAL PERMIT POLLUTANT PARAMETERS

Type of Facility	Type of Storm Water Discharge	Parameters	Monitoring Frequency	Reporting Frequency
EPCRA, Section 313 Facilities subject to Reporting Requirements for Water Priority Chemicals	Storm water discharges that come into contact with any equipment, tank, container, or other vessel or area used for storage of a Section 313 water priority chemical, or located at a truck or rail car loading or unloading area where a section 313 water priority chemical is handled	Oil and Grease, BOD5, COD, TSS, Total Kjeldahl Nitrogen[1], (NH_3-N, NO_3+NO_2-N)[3] Total Phosphorus, pH, acute whole effluent toxicity[2], any Section 313 water priority chemical for which the facility reports.	Semi-annual	Annual
Primary Metal Industries (SIC 33)	All storm water discharges associated with industrial activity	Oil and Grease, COD, TSS, pH, acute whole effluent toxicity[2], Total Recoverable Lead, Total Recoverable Cadmium, Total Recoverable Copper, Total Recoverable Arsenic, Total Recoverable Chromium, and any pollutant limited in an effluent guideline to which the facility is subject.	Semi-annual	Annual
Land Disposal Units/Incinerators/ BIFs	Storm water discharges from active or inactive land disposal units without a stabilized cover that have received any waste from industrial facilities other than construction sites; and storm water discharges from incinerators and BIFs that burn hazardous waste	Total Recoverable Magnesium, Magnesium (dissolved), Total Kjeldahl Nitrogen, COD, TDS, TOC, Oil and Grease, pH, Total Recoverable Arsenic, Total Recoverable Barium, Total Recoverable Cadmium, Total Recoverable Chromium, Total Cyanide, Total Recoverable Lead, Total Mercury, Total Recoverable Selenium, Total Recoverable Silver, acute WET [2]	Semi-annual	Annual

Table XIII-5. EPA STORM WATER GENERAL PERMIT POLLUTANT PARAMETERS

Type of Facility	Type of Storm Water Discharge	Parameters	Monitoring Frequency	Reporting Frequency
Animal Handling/ Meat Packing Facilities	Storm water discharges from animal handling areas, manure management areas, production waste management areas exposed to precipitation at meat packing plants, poultry packing plants, facilities that manufacture animal and marine fats or oils.	BOD5, Oil and Grease, COD, TSS, Total Kjeldahl Nitrogen (TKN), (NH_3, NO_3,NO_2)[3], Total Phosphorus, pH, Fecal Coliform	Annual	Retain on site.
Chemical and allied Product Manufacturers/Rubber Manufacturers (SIC 28 & 30)	Storm water discharges that come into contact with solid chemical storage piles	Oil and Grease, COD, TSS, pH, any pollutant limited in an effluent guideline to which the facility is subject.	Annual	Retain on site.
Automobile Junkyards	Storm water discharges exposed to: a) over 250 auto/truck bodies with drivelines, 250 drivelines, or any combination thereof b) over 500 auto/truck units c) over 100 units dismantled per year where automotive fluids are drained or stored.	Oil and Grease, COD, TSS, pH, any pollutant limited in an effluent guideline to which the facility is subject.	Annual	Retain on site.
Lime Manufacturing Facilities	Storm water discharges that have come into contact with lime storage piles	Oil and Grease, COD, TSS, pH, any pollutant limited in an effluent guideline to which the facility is subject.	Annual	Retain on site.
Oil-Fired Steam Electric Power Generating Facilities	Storm water discharges from oil handling sites	Oil and Grease, COD, TSS, pH, any pollutant limited in an effluent guideline to which the facility is subject.	Annual	Retain on site.

Table XIII-5. EPA STORM WATER GENERAL PERMIT POLLUTANT PARAMETERS

Type of Facility	Type of Storm Water Discharge	Parameters	Monitoring Frequency	Reporting Frequency
Cement Manufacturing Facilities and Cement Kilns	All storm water discharges associated with industrial activity (except those from material storage piles that are not eligible for coverage under this permit)	Oil and Grease, COD, TSS, pH, any pollutant limited in an effluent guideline to which the facility is subject.	Annual	Retain on site.
Wood Treatment Facilities [4]				
Industrial Facilities with Coal Piles	Storm water discharges from coal pile runoff	Oil and Grease, pH, TSS (TOC)[3], Total Recoverable Copper, Total Recoverable Nickel, Total Recoverable Zinc	Semi-annual	Annual
Battery Reclaimers	Storm water discharges from areas for storage of lead acid batteries, reclamation products, or waste products, and areas used for lead acid battery reclamation	Oil and Grease, COD, TSS, pH, Total Recoverable Copper, Total Recoverable Lead, (Cd)[3]	Semi-annual	Annual
Airports (with over 50,000 flight operations per year)	Storm water discharges from aircraft or airport deicing areas	Oil and Grease, BOD5, COD, TSS, pH, and the primary ingredient used in the deicing materials	Annual	Retain on site

Table XIII-5. EPA STORM WATER GENERAL PERMIT POLLUTANT PARAMETERS

Type of Facility	Type of Storm Water Discharges	Parameters	Monitoring Frequency	Reporting Frequency
Coal-fired Steam Electric Facility	Storm water discharges from coal handling sites (other than runoff from coal piles which is not eligible for coverage under this permit)	Oil and Grease, pH, TSS, Total Recoverable Copper, Total Recoverable Nickel, Total Recoverable Zinc	Annual	Retain on site.
Ready-mix Concrete Facilities	All storm water discharges associated with industrial activity	Oil and Grease, COD, TSS, pH, any pollutant limited in an effluent guideline to which the facility is subject	Annual	Retain on site.
Ship Building and Repairing Facilities	All storm water discharges associated with industrial activity	Oil and Grease, COD, TSS, pH, any pollutant limited in an effluent guideline to which the facility is subject, (Total Recoverable Copper, Organo-tins)[3]	Annual	Retain on site.

Notes:

[1] A discharger is not subject to the monitoring requirements provided the discharger makes a certification for a given outfall, on an annual basis, under penalty of law, that material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, industrial machinery or operations, significant materials from past industrial activities, or, in the case of airports, deicing activities, that are located in areas of the facility that are within the drainage area of the outfall are not presently exposed to storm water and will not be exposed to storm water for the certification period.

[2] A discharger may, in lieu of monitoring for acute whole effluent toxicity, monitor for pollutants identified in Tables II and II of Appendix D of 40 CFR Part 122 that the discharger knows or has reason to believe are present at the facility site. Such determinations are to be based on reasonable best efforts to identify significant quantities of materials or chemicals present at the facility.

[3] Recommendations by the Washington Department of Ecology.

[4] The Department of Ecology has developed a model permit for this industry. Consult the Program Development Services Section for more information.

6. RECEIVING ENVIRONMENT MONITORING

Requirements to monitor receiving environments are a necessary component of some NPDES permits. Most receiving environment monitoring programs will be aimed at determining (1) the background concentrations of parameters in the receiving environment, and (2) the dilution available in the ambient environment for a proposed or existing discharge. A much less common need will be the requirement for assessment of impacts in receiving environments (please refer to the specific section on the media you are concerned with to determine when this need may exist). Effluent limits that are calculated using appropriate data from dilution studies and ambient background level studies should not cause impacts to the aquatic life, drinking water, or sediment uses upon which the state's Water Quality Criteria are based. However, in some cases concerns will arise that prompt the permit writer to consider whether a monitoring survey to assess impacts is necessary. These cases are most likely to occur when beneficial uses that are not yet assigned protective criteria are concerned (e.g. wildlife uses).

The arrangement of this chapter is as follows:

1. The regulatory authority DOE can use to require monitoring (6.1 General Considerations for Monitoring Receiving Environments);

2. Guidance to use when determining when and how to require effluent dilution and ambient background monitoring (6.1 General Considerations for Monitoring Receiving Environments); and,

3. Considerations to be aware of when a study to assess impacts to receiving environments may be necessary (in almost all circumstances the permit writer will work with the E.A. Program and the appropriate headquarters section to develop these requirements).

    1. What circumstances may prompt you to consider monitoring (6.1.1).

    2. How to determine if monitoring is needed (6.1.1 and 6.1.2).

    3. The steps needed to logically develop or review a receiving environment survey to get the greatest amount of useful data in the most cost effective way (6.1.3 through 6.1.5). This section also advises on when the EILS Program and Headquarters should be consulted within the course of determining environmental monitoring requirements, and what type of assistance you can expect from those groups.

Note: Throughout this section the permit manager is directed to contact both EAP and headquarters when determining the specifics of simple or complex receiving environment surveys. This has been emphasized because of the need to assure thorough understanding of the goals of surveys by all parties participating in their design. During the design of complex surveys, headquarters will assist the permit manager to clearly transmit the goals of a receiving environment monitoring project to EAP, and will work to ensure that EAP understands the regulatory need for studies, and the way in which data will be used. This process is recommended as one way of "translating" survey needs between the more regulatory requirement-based permit managers and the environmental assessment-based group at EAP. This should expedite a more thorough review of survey proposals and result in more effective monitoring programs.

6.1 General Considerations for Monitoring Receiving Environments

Environmental monitoring commonly includes surveys of surface and ground water, sediments and soils, and biota. In the State of Washington, major NPDES dischargers are likely to be required to perform some type of receiving environment monitoring. Minor dischargers may also be required to monitor receiving waters. By far the most frequent need for monitoring will be prompted by a lack of information of discharge specific dilution and ambient background concentrations of pollutants or other water quality parameters (e.g., hardness or pH). Other factors that could prompt the need for additional monitoring would likely be founded on a concern that the existing water quality criteria (based on toxicity to aquatic life and benthic invertebrates, and, drinking water concerns) are not providing adequate protection for other designated beneficial uses in waters of the state.

The decision to require or not require receiving environment monitoring must be explained in the fact sheet. Ecology has the regulatory authority to require surface water, sediment, soil, and groundwater monitoring. Regulatory authority for receiving environment monitoring is described below.

STATE AUTHORITY

Our state authority derives from RCW 90.48 and is expressed in Chapters 173-220 and 173-216 WAC.

Chapter 173-220 is explicit in the authorization to require receiving water monitoring.

WAC 173-220-210(1)(c).

> "(c) Monitoring of intake water, influent to treatment facilities, internal waste streams, and/or receiving waters may be required when determined necessary by the Department to verify compliance with net discharge limitations or removal requirements, to verify that proper waste treatment or control practices are being maintained, or to determine the effects of the discharge on the surface waters of the state."

The state regulatory authority for receiving environment monitoring for ground discharges is clear but not explicit.

WAC 173-216-110 (1)(g).

"(1) Any permit issued by the Department shall specify conditions necessary to prevent and control waste discharges into the waters of the state, including the following, whenever applicable:

(g) Any appropriate monitoring, reporting and record keeping requirements as specified by the Department, including applicable requirements under sections 307 and 308 of FWPCA;"

The WAC includes language that specifically allows Ecology to require environmental monitoring information as part of a permit application:

WAC 173-216-070 (4)(c).

"(4) The requirement for a permit application will be satisfied, if the discharger files:

(c) Any other information determined as necessary by the Department."

WAC 173-216-080 (1)(c) and (d).

"(1) Any information submitted pursuant to this chapter may be claimed as confidential.... Claims of confidentiality for the following information will be denied:

(c) description of proposed receiving waters;

(d) description of quality and quantity of receiving water; and..."

FEDERAL AUTHORITY

Ecology is authorized to implement the Clean Water Act by RCW 90.48.260 which states:

"The Department of Ecology is hereby designated as the State Water Pollution Control Agency for all purposes of the Federal Clean Water Act as it exists on February 4, 1987, and is hereby authorized to participate fully in the programs of the act as well as take all action necessary to secure to the state the benefits and to meet the requirements of the act."

Ecology's authority under RCW 90.48.260 allows it to exercise whatever powers it needs "to meet the requirements" of the Clean Water Act. Whenever the Clean Water Act requires certain authority of an NPDES state, Ecology has that authority. The Clean Water Act, in 33 U.S.C. § 1342, requires that states be able to issue permits which apply federal effluent limitations and "[t]o inspect, monitor, enter, and require reports to at least the same extent as required in Section 1318..." 33 U.S.C. § 1342(b).

Section 308 of The Clean Water Act as Amended by the Water Quality Act of 1987, Public Law 100-4 [33 U.S.C. § 1318] states, in part:

> "Whenever required to carry out the objective of this Act, including but not limited to (1) developing or assisting in the development of any effluent limitation, or other limitation, prohibition, or effluent standard, pretreatment standard, or standard of performance under this Act; (2) determining whether any person is in violation of any effluent limitation, or other limitation...
>
> > (a) the Administrator shall require the owner or operator of any point source to (i) establish and maintain such records, (ii) make such reports, (iii) install, use, and maintain such monitoring equipment or methods (including, where appropriate, biological monitoring methods), (iv) sample such effluent (in accordance with such methods, at such locations, at such intervals, and in such manner as the Administrator shall prescribe), and (v) provide such other information as he may reasonably require;"

The federal regulation which comes from this section of law is 40 CFR 122.41(h) which states:

> "(h) Duty to provide information. The permittee shall furnish to the Director, within a reasonable time, any information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit."

The legal test of monitoring and testing under the federal Clean Water Act demands only that the monitoring or testing be reasonably required for some purpose under the Act - including that of developing any new effluent limitation.

COURT OPINIONS ON SEC. 308

Referring to Sec. 308, the circuit court in Natural Resources Defense Council v. U.S. Environmental Protection Agency, 822 F.2d at 119, (D.C. Cir. 1987) commented upon the broad discretion granted by the statute:

> The breadth of this statutory grant of authority is obvious. In our view, the statute's sweep is sufficient to justify broad information disclosure requirements relating to the Administrator's duties, as long as the disclosure demands which he imposes are "reasonable."

In United States Steel v. Train, 556 F.2d 822, 850 (7th Cir. 1977), the company argued that an NPDES permit provision requiring a study of the impact of cooling water intake structures on aquatic life was unreasonable. The court rejected the argument saying:

> U.S. Steel's argument that, even if applicable, the permit provision is unreasonable must also be rejected. Not even a "rough cost-benefit analysis" is necessary as a basis for the requirement that the company conduct a study of the impact of the present cooling-water intake structures on aquatic life in Lake Michigan. Such a study, intended to assist EPA in developing 316(b) effluent limitations, is well within the agency's 308 [33 U.S.C. § 1318] authority.

The court's reasoning that "not even a 'rough cost-benefit analysis' is necessary" is important, because it confirms that there is no requirement in the statute that the cost of the monitoring must somehow be proportional to the value of the data expected to be obtained. These determinations are left to the discretion of the permitting agency.

Permitting agencies not only have broad discretion on whether to require monitoring, but the choice of what particular test to require is perhaps even more a matter of agency discretion. Courts only require that the agency's choices in the scientific arena be "rational" - that is, that these choices have some scientific support. If the agency's choice has scientific support, a court will not attempt to substitute its judgement for that of the agency by weighing the merits and demerits of competing scientific approaches. These limitations on review of Clean Water Act scientific judgements are discussed in Reynolds Metals Company v. U.S. Environmental Protection Agency, 760 F.2d 549, 558-59 (4th Cir. 1985):

> The scope of our review is further colored by the policy of the Clean Water Act and the sophisticated data evaluations mandated by that lengthy and complicated statute. The Act expresses a congressional insistence to eliminate water pollution within a short time-span... Further, technological and scientific

> issues, such as those presented in this case, are by their very nature difficult to resolve by traditional principles of judicial decision making. For this reason "[w]e must look at the decision not as the chemist, biologist or statistician that we are qualified neither by training nor experience to be, but as a reviewing court exercising our narrowly defined duty of holding agencies to certain minimal standards of rationality." More specifically, we note that an agency's data selection and choice of statistical methods are entitled to great deference, and its conclusions with respect to data and analysis need only fall within a "zone of reasonableness."

The court went on to note, "[a]s frequently has been written, we do not sit as a scientific body minutely comparing competing research methods and results." 760 F.2d at 560.

This echoes the sentiments expressed in the earlier opinion in Weyerhaeuser Company v. Costle, 590 F.2d 1011, 1026 (D.C. Cir. 1978):

> Where existing methodology or research in a new area of regulation is deficient, the agency necessarily enjoys [a] broad discretion to attempt to formulate a solution to the best of its ability on the basis of available information."... Indeed, the mere fact that the counsel on both sides in this suit could draw upon the opinions of diverse experts sitting virtually at their elbows during preparation of their briefs, while we are faced to decide between their resulting arguments on the basis of our "generalists" judicial backgrounds, argues for restraint on our part. In sum, unless we are quite certain of our basis for doing so, we must be slow to overturn the Agency's judgement, whichever way it may incline, when Congress has required it to act quickly and decisively despite the lack of exact data.[Citations omitted; footnotes omitted.]

The cases provide some "real world" examples of how these standards of review are applied. In Natural Resources Defense Council v. U.S. Environmental Protection Agency, supra, the court was reviewing an EPA requirement that each NPDES permit applicant provide EPA with a list of "any toxic pollutant which the applicant currently uses or manufactures as an intermediate or final product or byproduct." Industry argued that this requirement was invalid because EPA was authorized only to regulate toxic discharges and not toxics which may be involved only in some intermediate manufacturing step. The court stated, "[t]he indications are abundant that EPA was intended to possess broad latitude in identifying and regulating suspected toxics." EPA had identified three reasons for requiring the information: (1) to make sure that the effluent limitations in the permit covered the right toxicants; (2) to provide guidance on what to test for in the effluent; and (3) to aid setting "best management practices" that might be imposed to prevent spills. The court found these reasons sufficient to require the information under 33 U.S.C. § 1318.

A final example of a federal case construing 33 U.S.C. § 1318 is American Petroleum Institute vs. Environmental Protection Agency, 787 F.2d 965, 978 (5th Cir. 1986). In this case, the court rejected a challenge to use of a bioassay test in making NPDES permit determinations:

> The nub of the industry's contention is that the bioassay test, based on a four-day long exposure of critical marine fauna to drilling mud, creates a completely unrealistic situation which would never occur in nature because of the rapid dispersion of drilling mud from an offshore platform as a result of simple dilution, currents, and storms...
>
> API's suggestion that the dynamic ocean environment would never result in the extended exposure to drilling mud contemplated by the 96-hour LC-50 test commends itself to common sense. On the other hand, API concedes that test to be perhaps the most widely accepted benchmark for toxicity evaluations by EPA. Therefore, EPA has not selected a patently irrational methodology to measure the relative toxicity of generic Mud No.1. Under such circumstances, we are required to resist API's attempts to substitute our judgement for that of the agency...and must sustain its choice.[Citations omitted.]

The court in American Petroleum Institute, supra, used the approach which Ecology believes defines the criteria for determining if receiving environment is appropriate. These criteria are: (1) Are the test(s) required in the permit or as part of the permit application being imposed for an allowable purpose under state law or under 33 U.S.C. § 1318 (that is, to carry out some objective of the Clean Water Act)? Typically these purposes are to require the permittee to monitor for information for permit development or to demonstrate the discharge is not causing harm. (2) Are the specific test methods "reasonable," in that they have scientific support?

The permit writer should be clear these questions are answered in the fact sheet when requiring receiving environment monitoring.

Common Monitoring Requirements:

The two most common reasons to consider and require receiving environment monitoring are:

- To attain data on ambient conditions in receiving waters for use in calculating effluent limits, and;
- To determine flows and dilution in the vicinity of the discharge (i.e., field verification of mixing zone models).

By far the most common reason to require receiving environment monitoring is to provide background data to use when permit limits are calculated. These data can be required upon application, or can be specified in the preceding permit as a special study. Both options have advantages and disadvantages. Requesting ambient data upon application, especially if the request is not specific as to detection limits, QA/QC, and sampling locations and depths, can result in submittal of data that are not appropriate to use in limit calculation. Requiring background data within a permit can result in an additional work-load for the permit manager if study plans need review and approval. The recommended approach is to require a special study as a permit requirement. Ideally, as many of the data reporting requirements as possible should be incorporated into the requirement. Studies should address the most necessary types of data needed for effluent limit calculation, including temperature, hardness, and/or toxins measures. Copies of all data and reports should be submitted to the Basin Planning and Standards Section for incorporation into statewide reports.

There are two general ways to place receiving water studies in permits, permit applications, and enforcement orders. The first method is to describe the sampling program in detail in the permit. In many cases this is the best method for simple studies that will be conducted by the permittee (e.g. measuring copper concentration at one ambient background site to determine the concentration of copper in ambient water during critical flow conditions, or, estimating dilution near the discharge point). When using this method, the permit manager should specify any applicable sampling and analytical protocols to be used, as well as sample location and timing. The specific protocols for these simple studies, for different environmental media, can be found in the media-specific sections at the end of this chapter.

The second method is to specify the study objectives and to allow the permittee to submit draft and final study plans, acceptable to Ecology, within a specified time period (e.g., within 90 days of permit issuance). It is important to note that discussing the need to conduct receiving monitoring studies with the discharger and other interested parties during the permitting process can help to formulate survey objectives early-on, and will help the discharger by giving them early warning that they must start to budget for a sampling program. This is the best approach for studies that are conducted by a consultant for the permittee. If the permit manager requires the permittee to submit a sample plan, the qualifications of the people doing the work should be submitted for approval. The study plan should address the variables and information needs associated with fulfilling the objective. All study plans must be approved by Ecology. When the second method of requiring a study is used, the permit manager should discuss the specific problem, the study objectives, and any constraints of the study with the Program Development Services Section (or other appropriate headquarters group) and EAP. Experts on commercial laboratory and permittee analytical capabilities are in the Quality Assurance Section in the EA Program.

Infrequent Monitoring Requirements:

The third and least common reason to consider requiring receiving environment monitoring is to determine whether the permitted discharge is causing a detrimental impact to the environment in the vicinity of the discharge (i.e., environmental assessment).

Effluent data are often the first indicator that a receiving environment may be undergoing damage due to discharges, thus effluent quality should be characterized before a receiving environment study is required. Environmental monitoring should focus on effects that could be caused by chemicals and other properties that are present in the effluent. In some cases biological or chemical effects may already be identified in a receiving water (e.g., abnormal blooms or die-off of algae, deleterious concentrations of toxins in wildlife, or, exceedances of state standards and associated ambient toxicity). If any of these occur, the main focus of a receiving water survey will be to gather data to assist Ecology to identify the cause(s) of the impact. Studies that can determine cause and effect in natural systems are generally difficult to design, and expensive to finance. Studies to determine complex cause and effect issues should always be discussed with the PSMS and the EILS Program in order to clarify objectives and determine the most effective sampling design. In addition, the permit writer may wish to consult the following documents when planning and considering a monitoring program: *Guidelines and Specifications for Preparing Quality Assurance Plans*, (Ecology, 1991a) and, *Technical Guidance for Assessing the Quality of Aquatic Environments in Washington State*, (Ecology, 1990a)

A general process for deciding whether to require a receiving environment study to determine impacts consists of the following steps (Baker and Wolff, 1987):

1. Define and clarify the problem (what is the major concern you are interested in?) (Section 6.1.1)

2. Specify objectives and constraints (Section 6.1.2)

3. Develop alternative strategies (solutions) that address objectives and constraints (alternative sample designs including parameters to be monitored, sampling locations, methodologies for sample collection and analysis, and timing and frequency of sampling) (Section 6.1.3)

4. Evaluate the alternative sampling designs (Section 6.1.4)

5. Choose the best sampling design (Section 6.1.5)

This process is discussed in more detail below (Sections 6.1.1 through 6.1.5).

6.1.1 Define and Clarify the Problem

For our purposes, an environmental study is a way of addressing a problem with one or more effluents. Defining the specific problem you are concerned with is critical to the success of the project. Some examples of problems you may find include:

- High levels of fecal coliform in publicly used shellfish beds near a municipal discharge point.
- Detectable mercury concentrations in an effluent that discharges to a quiescent and organic-rich environment, leading you to suspect sediment or organismal accumulation.
- You do not have background data to use when calculating effluent limits for copper and nickel.
- Repeated acute toxicity violations lead you to suspect that ambient effects are occurring outside the mixing zone for acute toxicity.
- You discover that effluent conveyed through a storm drain is directly entering a rocky intertidal area at low tide, and you wish to determine the areal extent of the effluent in the intertidal zone.
- Fish kills or other events occur downstream of a discharge.
- Dredge spoils from a ditch contain elevated concentrations of certain pollutants.
- Contamination that is characteristic of dairy farms is found in a drinking water well located downgradient from a large dairy.

Sampling should focus directly on the suspected or observed problems. Sampling of surface waters and sediments is discussed below. More details on sampling these and other media can be found in sections 6.3 through 6.6.

The decision to require the permittee to monitor the receiving environment should be based on a knowledge or indication that the discharge may be adversely affecting the receiving environment. This knowledge or indication will generally come from effluent monitoring data or from observable impairment of the environment. The following are cases for which receiving environment monitoring could be considered:

1. **Problem:** The facility discharges to a 304(1) water body.

   Comment: Point source discharges that contribute to Water Quality Standards violations will be identified in technical reports being prepared for each of the water bodies on the 304(l) short list. The "short list" is comprised of water bodies that do not meet the Water Quality Standards due to point source discharges of toxins. Facilities that discharge to these water bodies, and especially those facilities identified as contributing to these standards violations, could be required to perform receiving environment monitoring that is focused on effects caused by the toxin of concern. This could include ambient toxicity testing, water chemistry, bioaccumulation studies, and others. When deciding if impact assessment is necessary, the permit writer should consider whether monies spent on addressing the listing are better spent in clarifying the problem (monitoring) or on reducing discharges of problem pollutants.

2. **Problem:** The facility discharges chemicals that meet technology- and water quality-based limits but is suspected of causing problems because of the high sensitivity of an indigenous species in the receiving environment.

   Comment: A facility may be meeting technology- and water quality-based limits but be discharging to a receiving water which traditionally serves as a spawning habitat for a species which is particularly sensitive to a component of the effluent. If environmental surveys are proposed, monitoring may be concentrated on seasons in which resident organisms are particularly sensitive to effluent. With this particular problem, however, it may be possible to satisfy concerns with the receiving water by doing toxicity tests with species that are closely related (e.g. same genus and habit) to the indigenous species of concern, instead of trying to identify impacts in the receiving environment. Although toxicity tests are costly, environmental monitoring programs that adequately address both physical and biological variability in a natural system (i.e. the data is good enough to answer the original question instead of yielding an ambiguous result because of high variability) can be much more expensive.

3. **Problem:** The facility is associated with periodic spills or the discharge of high concentrations of toxins.

   Comment: The purpose of sediment and water column monitoring in this case would be to determine whether degradation of the receiving environment has occurred due to occasional discharge of highly concentrated contaminants. Permits issued for combined sewer overflows and storm drains would fall into this category. The timing of receiving water sampling is critical for detecting effects from storm events. Of particular interest are violations of acute criteria associated with storm water in well flushed areas, and violations of chronic criteria that last days, weeks, or longer in poorly flushed areas (e.g., estuarine areas removed from major flushing currents or lacking significant riverine inflow).

4. **Problem:** Facility expansions, production increases, or process modifications are proposed that may result in new or substantially increased discharges of pollutants or a change in the nature of the discharge.

   Comment: Permittees in this category are required to submit a new application or supplement to the previous application. The information submitted with the application or supplement should indicate expected changes in effluent quality or quantity. Permit managers will use that information to determine if the change in the facility could result in discharge of effluent that could potentially impact the environment. The proper receiving environment data collected before and after the proposed change occurs could help to identify environmental impacts caused by the change. If an environmental survey is required, the sampling program should focus on effects that are expected to occur due to the changes in effluent. In many cases the use of dilution information and ambient background data to calculate effluent limits will provide enough reassurance to reduce the need for impact assessment.

5. **Problem:** A facility is suspected of discharging effluent that may be causing or contributing to observed environmental impacts such as recurring algae blooms or fish kills. A facility is discharging to a water body on the 305(b) list or suspected of contributing to violations of water quality standards in the receiving environment.

   Comment: When trying to draw cause and effect relationships (e.g., fish kill caused by a specific effluent discharge) it is critical to gather as much operational data on the discharge as possible. Review of operational data may indicate periodic presence of toxins in effluent that are not caught by self monitoring (e.g., filter backflush and disinfection that has not been dechlorinated prior to discharge), and review of monitoring data may indicate levels of chemicals that could drive receiving water to develop toxic conditions during critical periods or in certain downstream areas (e.g., depletion of oxygen caused by excessive BOD). This information can sometimes lower the cost of environmental surveys by focusing the objectives toward the effects most likely to occur.

6. **Problem:** A facility's discharge is a source of ongoing public concern regarding the actual or potential effects on the biota of the receiving environment.

   Comment: When the concern is due to the location of the discharge in or near a sensitive receiving environment, benthic biota, sediment, bioaccumulation, or water column studies may be appropriate. If the public is concerned, the permit manager should try to clarify the specific concerns of the public (e.g., mercury uptake and toxicity to wildlife; uptake of toxins by fish and shellfish that may cause a hazard to human health; public believes the environment in the area of discharge does not get any flushing, and consequently toxins may be accumulating to levels dangerous to either humans or other biota). In some cases, these fears may be allayed by reviews of existing information. Sometimes a review of existing information will prompt the permit manager to suspect that the public concerns are based on realities, or will bring up other concerns with the area. In that case environmental surveys should be required. Because of the environmental and political complexities associated with surveys prompted by widespread public involvement, the permit manager should confer with the Program Development Services Section, EAP, and any applicable resource agencies before formulating specific sampling objectives.

Complex receiving environment monitoring should not be required of facilities that discharge effluents that have little potential to impact the environment and do not fall under a category listed above. For example, facilities that discharge into areas with strong currents would have no accumulated bottom sediments. However, even these facilities may be required to sample background water chemistry to establish data on which to base permit limits, or to measure bioaccumulation of toxins, or to perform other specific studies.

6.1.2 Specify Monitoring Objectives and Constraints

Specific monitoring objectives state the variables that are to be observed, and the time frame or time period during which the observations should occur. Several objectives may develop from thoughtful consideration of the initial problem. Clearly expressed and specific objectives are critical to proper sampling design and use of data. In addition, when you define monitoring objectives and constraints, it is important to determine what the regulatory outcome of the monitoring will be. If the data you gather is intended to result in modification of a discharge permit, then you should clearly define the result that will trigger a permit modification. Examples of objectives include:

- To determine the concentrations of priority pollutant metals in the receiving water before a new facility commences discharging.

- To determine if concentrations of lead and zinc in the receiving water are exceeding water quality criteria during low flow months.

The following is an example of a specific monitoring objective to determine compliance with sediment quality standards:

- To determine if the concentrations of cadmium, lead, zinc and mercury in sediments near the outfall are exceeding the sediment quality standards during year four of the issued permit.

Other constraining factors can limit the way in which specific objectives are addressed and may be both scientific and operational (Baker and Wolff, 1987). An example of an objective and some discharge-specific constraints are illustrated in the following example:

Objective: Determine a background copper concentration in ambient waters to use when calculating an effluent limit.

Constraints: Sampling must occur during critical conditions (low flow).

Data must be collected and analyzed using ultra-clean techniques.

Preconcentration of samples must be done if copper concentrations are below the levels of detection using graphite furnace AA.

Because of time constraints, the permit manager is willing to calculate the limit based on samples collected over one summer that occurs during a drought period.

In some cases you will address problems that deal with more than one environmental media, such as assessing sediments and water in the same area, or determining sediment toxicity and sediment chemistry. If more than one media is being tested, be sure to formulate your objectives and constraints in such a way as to best address all media. In many cases you will use data from one media to interpret the data from another media (sediment chemistry data can help interpret causes of sediment toxicity). In such cases try to coordinate the sample sites, sampling times, and choice of parameters for measurement to make them as useful and comparable as possible.

6.1.3 Develop Alternative Sampling Strategies that Address Objectives and Constraints.

When the problem has been defined, and the objectives and their constraints have been clearly and precisely set out, alternative sampling strategies to address the objectives and constraints should be developed. In effect, this means that several different ways of answering the same question may exist, and these should be developed and designed in detail. If you require the discharger to submit a sampling plan, they will submit one or more of the potential sampling designs. In most cases you will first consider the chemical and physical parameters you want to sample, the analytical methods to measure them, and then the general location of the sample sites. Are you interested in sediment toxicity caused by cadmium accumulation in sediments? Is the area subject to dredging, currents, navigation, or high winds? Can the area be safely sampled? Are there rip tides, can divers be used, or can benthic grabs be safely used in the area? What are the windows of safety for sampling (not at rip tides, not during afternoon high winds, etc...). What is the direction and speed of groundwater flow? In other words, how will you design your sampling program to fit the environment and environmental compartment you are interested in (i.e., determine it's statistical design to fit your specific sampling objectives)? Some of these concerns are discussed below:

Chemical and Physical Parameters--The choice of the appropriate physical and chemical parameters to sample for in a particular study are directly dependent on the problem, objectives, and constraints that have been previously defined. It is important that sampling be focussed in order to (1) produce data adequate to answer the question you are asking, and (2) to minimize the amount of useless or ambiguous data collected in the study. It is also important to enhance the comparability of the data that is collected with data collected in other sampling programs. In order to enhance data comparability, there are specific chemical and physical measurements that should be taken with each sample that you collect. Lists of required analyses for each sampling media (receiving waters on surface, receiving waters in subsurface, sediments, etc....) are described in sections 6.2 through 6.6. In some cases the parameter you are monitoring will be included in the list of required analyses. At other times the usefulness of the data you are interested in will be enhanced by collecting data on all parameters in the required list of analyses.

Sampling and Analytical Methods--After you decide on the parameters you wish to measure in the samples, decide the specific methods to be used for sample collection and chemical analysis. These include preparation of sampling containers, detailed field protocols, and specifying analytical methods. Specific protocols have been developed for most media (e.g., *Recommended Protocols for Measuring Metals in Puget Sound Water, Sediment and Tissue Samples*, Tetra Tech, Inc., 1986a). The protocols that should be used for specific types of receiving environment monitoring are described in sections 6.2 through 6.6. In some cases you may want to use different methods than those in the specified sampling protocol (e.g., ultra-clean sampling for metals in surface waters, preconcentration of metals in order to yield lower detection limits). In those cases the analytical methods you wish to use should be referenced. The practical aspects of finding labs who can perform alternative analytical methods should be discussed with the PDS section and the EA Program. In other cases you may wish to specify changes in sample replication or collection methods to fit the particular media, site, and statistical analysis of a particular survey. Any changes in sample collection methods should be clearly described.

Sampling Locations--In most cases, such as sampling for background data, it will **not** be difficult to choose sampling sites. The sites will be in "clean" areas of water bodies (or other media), or they will be at the edge or just outside of a designated mixing zone. The size of the mixing zone will be determined during effluent limit calculation. In many cases the study you require may be a field verification of a mixing zone model that has been used to calculate limits. These types of studies have straight-forward survey designs. However, some surveys will address more complex objectives, in which case **the design should always be discussed with the PDS Section (or other appropriate sections at headquarters) and with the EA Program. In many cases those groups will help formulate or review alternative test designs for the permit manager.**

Consider the Statistical Analyses--In some cases no statistical analyses will be necessary, as in cases where one sample is being collected for direct comparison of chemical concentrations in the environment with state standards.

If you are considering a complex monitoring survey, the sample locations you choose, and the spacial configuration of those sites, will in large part depend on the statistical analysis you choose to use. For example, if you are comparing a far-field station to a near-field station, you might choose to use the Student's t-test to distinguish between stations. If you are interested in looking at a larger area with numerous stations, you might choose to use one of the many analysis of variance tests, followed by multiple comparison testing, and your station locations would be set up with proper replication and siting. A consideration of which statistical analyses to use will force you to define a testable hypothesis (e.g., mercury concentrations in sediment are elevated at the discharge point as compared to surrounding "clean" areas at the p=0.05 level), and choose the proper statistical procedure to interpret the data you collect (e.g., T-test, parametric two-way ANOVA for use with random box design). Specific design considerations for each media (surface waters, ground waters, sediments, etc....) are discussed in sections 6.2 through 6.6. (Note: You may wish to refer to a statistical text when determining a sample design. Sokal and Rohlff, 1981, *Biometry*, Second Edition, has good coverage of most statistics you will be interested in.) **Remember that complex designs should always be discussed with the EA Program, and the headquarters section that addresses the media you are sampling. In many cases these groups will assist you to formulate and review test designs.**

Your consideration of statistical analyses will include review of other similar studies whose data may indicate the likely distributions or variability of data in certain areas. For instance, you may discover from looking at USGS sediment monitoring data from an area you are interested in that (1) mercury data are log normally distributed, (2) that mercury concentrations should be normalized for organic carbon, and (3) that three replicates of superficial sediments per station will adequately assess variability so that station to station differences can be determined. Existing data can prove invaluable when designing sampling programs. In most cases, however, existing data will not be available for you to use, in which case you will have to decide how to handle the unknown variability of the parameter you are measuring.

Variability: Variability can be caused by several factors, including variability introduced during sampling and sample analysis, and by temporal and spacial components.

Sources of temporal variability include cyclic flow patterns of municipal treatment plants, tidal cycles, seasonal cycles, El Nino southern oscillation cycles, and dredging schedules. Spacial variability occurs over small (e.g., within one scoop of sediment) to large (e.g., within Puget Sound) distances, with both vertical and horizontal components.

When dealing with sources of variability it is best to minimize the variability by controlling (equalizing) as many factors as possible. Variability introduced during sampling and analysis can be controlled to a large degree by standardizing the sampling and analytical techniques used within and among sampling surveys. Use of the Puget Sound Protocols will help to reduce variability and enhance comparability of data. Reducing variability can also take the form of including temporal controls (e.g., collect all samples at high slack tide on the same day or on consecutive days) or spacial controls (e.g., sample unpolluted reference sites to determine "background " conditions, take enough replicates to characterize each station, and only collect oxidized sediment layer). These types of controls will all result in more useful data by limiting variability and enhancing comparability. Ideally, your sampling design will control for as many variables as possible. In the long run, a thorough consideration of sources of variability and ways to try to minimize variability is likely to save money, either by pointing out effective ways to sample, or by pointing out that some problems may be too complex to affordably answer. Sample replication is frequently a point of controversy when designing surveys.

Sample replication is often necessary to adequately characterize the variability at a site and is often expensive, thus it is a source of controversy. Remember that reducing the number of replicates can lead to collection of data that yields ambiguous interpretations, and is frequently useless for regulatory decisions. If it turns out that a monitoring program that can adequately answer a question is too costly to consider, then the permit manager should rethink the original problem and objectives. At this point communication with other parties is particularly important. The permit manager should consider discussion with the EA Program, the appropriate headquarters section, other state and federal regulatory agencies, state and federal resource agencies, academia, and any other interested party. Brainstorming with other persons can lead to new perspectives on how to address a question, or can lead to solutions that could be found more easily in other environmental compartments, or at less cost. In many cases other monitoring options may exist that can adequately respond to the concern.

6.1.4 Examine the Alternative Sampling Designs

After generating detailed sampling designs, the permit manager should evaluate the effectiveness and cost of the different designs, whether submitted by a discharger or developed by Ecology. It is critical at this point to first weed out any designs that appear to have a likelihood of yielding ambiguous data (i.e., that may not give you enough data to answer the question you are asking). Secondly, consider cost. Will two studies yield equally useful data on which to base a decision, but one is much less costly than the other? If so, recommend the one of lesser cost. In most cases (e.g. gathering background ambient data to use in the calculation of permit limits) cost will not be prohibitive. However, if the cost of the survey that will yield useful data is out of proportion to the magnitude of the problem being addressed, try to find another way to "ask the question" (e.g., can less frequent tissue accumulation studies be substituted for frequent water column monitoring for mercury?), and generate sampling designs for use with the new question. Can a less expensive study be done in a lab that will also address the real problem being considered? And will the public, resource agencies, and Ecology feel comfortable with the data generated? Ecology has a regulatory mandate, as part of their NPDES delegation, to fulfill the pertinent requirements of the Clean Water Act and to assure compliance with permit limits, and Ecology must ensure that it has appropriate data to make regulatory decisions that will be protective of water quality and beneficial uses.

6.1.5 Choose the Best Sampling Design

At this point in the five-step process of planning/reviewing an environmental survey, the permit manager should have already examined the problem thoroughly, developed precise and well thought out objectives and criteria, evaluated effluent quality and operations, and be familiar with the advantages and disadvantages of alternative sampling designs. The permit manager, after conferring with the EA Program and the appropriate Ecology headquarters section, should choose the best study design, and require that study as part of a permit application, as a permit requirement, or in an enforcement order.

6.2 Surface Water Monitoring

6.2.1 Parameters

When requiring receiving water monitoring, all samples should be measured for the following characteristics:

Temperature,
Dissolved oxygen,
Conductivity if freshwater, or, salinity if estuarine/marine
Turbidity or light transmittance at depths,
pH
Salinity or Hardness

These data will add to the comparability of data collected in monitoring programs conducted throughout the state. Other parameters that you choose for measurement should be directly related to the objective and the specific conditions of the study. These may include the following:

Nutrients
Fecal coliform
Chlorophyll-a
BOD_5, COD or TOC
Water column profiles
Ambient toxicity tests
Toxic pollutants (metals, volatile organics, priority pollutants, other)

Water column dilution, currents, etc.
Others

In many cases receiving water studies will be required to determine if the Water Quality Standards are being met in the water column. Each water body classification has water quality standards for the following parameters:

Temperature
Dissolved oxygen
pH
Turbidity
Fecal coliform
Total dissolved gas

In addition, water quality standards based on aquatic toxicity have been developed for the following toxic substances:

Aldrin/Dieldrin
Ammonia
Cadmium
Chlordane
Chlorine
Chloropygifos
Chromium 3+
Chromium
Copper
Cyanide
DDT & metabolites
Endosulfan
Endrin
Heptachlor
Lindane
Lead
Mercury
Nickel
Parathion
PCBs
Pentachlorophenol
Selenium
Silver
Toxaphene
Zinc

All water body classifications are required to meet standards based on aquatic toxicity. Human health-based criteria for 91 toxic compounds have been issued to the state by the EPA. If those chemicals are detected in effluent at concentrations that merit concern, either tissue bioaccumulation or water column studies may be required. Guidance on setting limits based on human health is given in Chapter VII.

Ambient toxicity should be measured with organisms that tolerate the natural salinity of the water body. This will allow a truer measure of toxicity in the water column than if samples undergo salinity modification. For example, ambient brackish waters should be measured with organisms tolerant of brackish salinities, instead of requiring addition of artificial salts to enable use of a marine organism not tolerant of brackish salinities. Always choose the test organism that will require the smallest amount of sample modification.

6.2.2 Sampling Locations

Water quality criteria apply at the end-of-pipe unless a mixing zone is established. If a mixing zone is established, its spacial boundaries will be specified in the permit. The mixing zone boundary can be set between the discharge point and the distance limits specified in WAC 173-201A. If the objective of the receiving water survey is to determine background concentrations of toxins (or other characteristics) to use in the calculation of effluent limits, locate the sampling station as near to the discharge as possible, but in an area not effected by the discharge of any effluents. In most circumstances this will be an easy and straightforward task. However, the task may become complex in poorly flushed areas of estuarine circulation (tidal cycles that dilute effluent with previously discharged effluent from the same source), or where multiple effluents are discharged into the same water body. In complex areas, waste-load allocations may be necessary to allocate discharge capacity to numerous discharges. If this type of situation exists, contact the Program Development Services Section at headquarters.

In order to accurately set sampling station locations that address the survey objectives, it may be necessary to field-verify computer models of mixing and dilution in receiving waters. Typical situations where this could occur are in shallow areas effected by both tidal currents and regularly occurring strong winds (e.g., wind may move effluent plume into areas that are not predicted by models), in rivers with "side bank" discharges, or in areas where accumulation of toxins in sediments does not match the pattern of effluent flow predicted by models. A dilution study can include use of floats, dyes, salts, and other devices, can include samples from all depths, and can last from hours to weeks (or longer). A natural component of the effluent may be used if the differential between the concentration in the effluent and receiving water is large. In most cases, however, a dye is added to the effluent in proportion to the effluent flow. The specific type of study you choose to require will depend directly on the types of questions you plan to ask in any future receiving water surveys, and on the physical characteristics of the discharge area. The EA Program should be contacted before specific dilution study methods are determined. The information from dilution studies will prove useful when used to locate sampling stations.

Depending on the specific objectives of the receiving water survey, the following sampling location considerations may apply:

Rivers --

1. Reference or control stations may be located upstream from the discharge point, but downstream from other sources of pollutants or dilution (e.g., other discharges or tributaries). Data from reference or control stations can be compared to data collected from stations at or below the point of discharge, or for calculating effluent limits.

2. Stations chosen to assess the effectiveness of effluent limits (i.e., whether or not Water Quality Standards are being exceeded) are generally located downstream of the discharge point, in an area where complete mix of the effluent occurs. The boundaries of the mixing zone used in setting effluent limits will be specified in the permit and fact sheet. Sampling this area is important when determining whether narrative criteria, as measured by ambient toxicity, are being met.

3. Stations located downstream from the discharge point and mixing zone can provide data to assess the instream effects caused by discharges. Your list of considerations when selecting downstream sampling stations and depths might include the following:

   - The different densities of the wastewater constituents, such as floating oils, or settling suspended solids.
   - The distribution of the wastewater constituents in the receiving water, resulting from either poor mixing or stratification (for example, vertical distribution patterns which may need to be determined).
   - Public beaches, shellfish beds, eelgrass beds or other biologically productive areas that may be affected by the discharge of pollutants.
   - Chemical or biological reactions, such as growth of algae in upper layers of the water which may cause changes in pH, or exertion of a BOD sag miles downstream of the discharge.
   - The convenience and accessibility for sampling the area.

These types of information will help focus your choice of sampling site to a particular place and time that best address the objectives and constraints of the survey. In general, only complex receiving water surveys will require the use of sample stations located downstream of mixing zones.

Marine or Estuarine Systems --

Sampling tidally influenced environments is almost always more complex than sampling unidirectional-flow river systems. In most cases the selection of sampling stations for marine or estuarine receiving waters will follow the same general riverine principles of control stations and full mix station, with practices adapted to the tidal marine environment. Additional factors to consider include tidal cycles, current patterns, bottom currents and counter-currents, stratification, climatic conditions, seasonal fluctuations, dispersion of discharges, wind induced surface currents, and multi-depth sampling. If a problem develops that may be caused by a marine/estuarine discharger, and that problem can only be addressed by a complex receiving water survey, it is appropriate to perform a dilution study prior to choosing sample sites.

Water current and chemical data for some areas of Puget Sound exist. It would be worthwhile to consult any studies conducted by the Coast Guard, the Corps of Engineers, NOAA, USGS, universities, or private research done in areas you are focussing on. That data can help you determine whether initial surveys (preliminary surveys that will give you enough information to set up the real receiving water survey) are necessary. The EA Program may be able to provide some references. Marine and estuarine sampling will require some kind of station positioning method.

Considerable stratification can occur in estuaries because of the differing densities of saltwater and freshwater. Freshwater flows enter estuaries as point source discharges, as sheets of storm water runoff, and in rivers and other smaller tributaries. Freshwater is more buoyant than salt water, and will rise to the surface unless it is entrained in a current underneath a salt water layer. It is essential to determine the extent of stratification when starting a survey of an unknown estuarine area. This can be done by determining salinity at different locations and depths over tidal cycles and over seasons. Because stratification is important to know about when calculating effluent limits and when designing a field survey, it should always be considered during survey design. Stratification is not difficult to measure, but the field time and gear needed to measure stratification can be expensive. If data indicating the extent of stratification is not available, the permit writer should require the discharge to provide the information only for times of maximum concern.

It is possible for stratification to occur in one part of an estuary and not in another. A wedge of fresh river water overriding more dense saltwater is a specific mechanism of stratification commonly seen at and in the vicinity of river mouths. In that situation, when the discharge of pollution is in the saltwater layer, the contamination will be concentrated near the bottom of the freshwater wedge at the flood tide. Where stratification is suspected, samples at different depths will be needed to measure vertical distribution. Dilution studies will generally be needed to determine plume movement and dispersion during times of stratification. These studies should generally be conducted under the perceived "worst case" dilution conditions (e.g., time of least flushing flows, accounting for low slack tides and ebb tides).

6.2.3 Specify Methods for Sample Collection and Analysis

The general sampling methods for receiving water surveys conducted within Puget Sound are detailed in the *Puget Sound Protocols*. The analytical methods chosen for a specific survey should, as far as possible, be consistent with both the Puget Sound Protocols and the Ambient Monitoring Program. In some cases other methods may be more appropriate to address the survey's objective.

The choice of specific field methods and equipment used to collect samples will in large part be determined by the type of representative sample required to address the survey objectives, and the chosen analytical methods. In almost all cases grab samples will be collected because of the limited availability, expense, and vandalism problems associated with in-situ composite samplers. Determine the depth of sampling based on the position of the plume and the particular chemicals or physical properties you are interested in. Equipment preparation and type should follow the guidance in the Puget Sound Protocols. If you are planning to measure many different constituents of the sample, make sure that the sample collection gear fulfills the specifications of all the different analyses. This might mean collecting more than one sample per station. In all cases, parameters that are subject to change during storage (dissolved gases, residual chlorine, soluble sulfide, temperature and pH) should be determined in the field.

Unless a special data need arises, samples collected from Puget Sound for metals determinations should follow the sample collection, analytical methods and the QA/QC procedures outlined in the *Recommended Protocols for Measuring Metals in Puget Sound Water, Sediment and Tissue Samples* (1986a). The sample collection methods for water column samples provides guidance for using water bottle samplers that also applies to sampling the water column of fresh waters.

In general, water column samples collected for analysis of toxins have not been collected with replication. This has in large part been due to cost considerations. In situations where water column concentrations are compared to the Water Quality Standards, lack of replication may not be particularly important. However, in more complex surveys the statistical design of the survey will drive any data interpretation. An estimate of the sample variance is frequently needed for a statistical test powerful enough to yield useful data, and more than one sample is needed to estimate the sample variance. The needed replication cannot accurately be known without a characterization of the variability of the constituent of concern in the water body, which can be a prohibitively expensive task. Additionally, other sources of variability that affect the system are often uncharacterized (e.g., local currents). The Permit Manager should be aware that small-scale spacial variability of toxins in waters are not well characterized, and studies conducted without replication lack an estimate of the sample variance of the parameter, which can hinder interpretation of sampling results. **Always discuss the design of complex receiving water studies with the EA Program and the appropriate headquarters unit.**

Dilution studies should be conducted using methods in the following references:

USGS. 1985. Kilpatrick, F.A., and Cobb, E.D., Measurement of Discharge Using Tracers. Chapter A16. *Techniques of Water-Resources Investigations of the USGS*, Book 3, Application of Hydraulics. U.S. Department of the Interior. Reston, VA.

USGS. 1986. Wilson, J.F., Cobb, E.D., Kilpatrick, F.A. Fluorometric Procedures for Dye Tracing. Chapter A12. *Techniques of Water-Resources Investigations of the USGS*, Book 3, Application of Hydraulics. U.S. Department of the Interior. Reston, VA.

Doneker, R.L. and Jirka, G.H. 1990. Cormix1: An expert system for Hydrodynamic mixing zone analysis of Conventional and Toxic Submerged Single Port Discharges. USEPA, Environmental Research Laboratory, Athens, GA. EPA/600-3-90/012.

Akar, P.J. and Jirka, G.H. 1990. Cormix2: An Expert System for Hydrodynamic Mixing Zone Analysis of Conventional and Toxic Multiport Diffuser Discharges. USEPA Environmental Research Laboratory, Athens, GA. Draft, July 1990.

Yearsley, J. 1991. *Diffusion in near-shore and riverine environments*. USEPA Region 10. EPA 910/9-87-168.

Also review the material in Appendix 6.

6.2.4 Specify the Timing and Frequency for Sampling

Predictable variations in the quantity and quality of effluent, as well as seasonal variations in the receiving water, will help to establish the timing and frequency for a receiving water sampling program. In most cases a "worst case" scenario will be of interest, which for the majority of river dischargers will be at low summertime flows. For estuarine dischargers worst case could correspond to times of minimum flushing and maximum stratification.

Some data interpretation difficulties may occur when determining compliance with water quality standards that were developed with toxicity test exposure periods ranging from instantaneous maximum (silver) to 4-day averages (e.g., zinc). If you collect one grab sample on one day, is that sufficient to determine compliance with a standard that was developed with a 4-day average exposure? In general, because one-time grab samples are the type of data which is most practical and least expensive to collect, those data will be directly compared to Water Quality Standards to assess compliance. If the discharger is not willing to use one sample to measure water body compliance, the discharger should be allowed and encouraged to sample multiple times over an appropriate time period to collect data that is even more representative for comparison to the Water Quality Standards.

6.3 Sediment Monitoring

The protocols for sediment monitoring, as well as when sediment monitoring is necessary, are discussed in Section 7.

6.4 Crop/Soil/Vadose Monitoring

The Criteria for Sewage Works Design states that for land application, background soil samples sufficient to characterize the field area shall be tested prior to land application. Additional soil samples shall be collected and retained permanently to allow the original soil to be physically compared with the soil after application begins. The depth to the permanent ground water table shall be determined.

Chemical data on the soil will be analyzed on an annual basis for a possible build-up of heavy metals, salts, a pH change, or any other parametric change that may indicate a reduction in soil renovation capacity or fertility.

6.5 Groundwater Monitoring

See Chapter VIII

6.6 Biological Surveys

Some of the various types of surveys commonly used to assess effects of pollution on biota include ambient water and sediment toxicity testing, analyses of benthic infaunal populations and communities, measures of bioaccumulation in resident or transplanted organisms, analyses of fish populations, and a variety of sub-lethal physiological, histopathological, and biochemical biomarkers (e.g., production of metallothionen and metal binding proteins, or, lesions in skin, ovary, liver, or other organs). The types of monitoring commonly encountered in NPDES monitoring programs include toxicity testing, benthic infaunal surveys, and measures of bioaccumulation.

Guidance for monitoring sediment toxicity and benthic infaunal populations and communities is given in the *Sediment Source Control Users Manual*, Ecology, 1993. Guidance addressing bioaccumulation testing will be addressed during an upcoming rule-making on human health-based water quality criteria. Bioaccumulation testing guidance for purposes other than to address human health are currently being developed, and will be inserted in this section when they are complete. Before that time, if characteristics of an effluent lead to the conclusion that problems exist that can most efficiently be addressed using bioaccumulation testing, the permit writer should contact the Program Development Services Section to discuss appropriate sample designs and organisms.

6.7 Data Compatibility

As required in the 1991 Puget Sound Water Quality Plan, monitoring data shall be gathered using the "*Puget Sound Protocols* (Tetra Tech, 1986b) when available". In addition, dischargers shall use "data management systems compatible with the Puget Sound Ambient Monitoring Program".

7. SEDIMENT MONITORING

This section discusses the monitoring associated with the protection of aquatic sediments from waste water discharges. Specifically this section discusses:

- The general types of monitoring that may be conducted in support of the sediment source control process
- The different types of monitoring data that are applicable to the sediment source control process and their differing objectives
- Methods for the collection of monitoring data
- Factors to be considered in the development of appropriate monitoring requirements
- Interpretation of the monitoring results in light of the monitoring objectives.

Permit managers who have permittees which require sediment impact zones (SIZ) should review the *Sediment Source Control Standards User Manual* for more detail on monitoring associated with sediment impact zones.

7.1. General Types of Monitoring in the Sediment Source Control Process

There are four general types of monitoring that may be conducted in support of the sediment source control process:

- **Baseline monitoring —** Conducted prior to authorization of a SIZ to collect information that will be used in determining whether such an authorization is likely to be necessary.

- **SIZ application monitoring —** Conducted to collect information to support application of the SIZ models.

- **Maintenance monitoring —** Conducted during the term of a permit that includes an authorized SIZ, with the intent to determine whether the SIZ should be renewed, reduced, or eliminated; to determine whether areas of special importance have been adversely impacted by the discharge; and to determine the conditions for SIZ reauthorization.

- **Closure monitoring —** Conducted following closure of a SIZ to demonstrate successful restoration of sediment quality.

Baseline monitoring, SIZ application monitoring, maintenance monitoring, and closure monitoring are the responsibility of the discharger. The need for and extent of each of these types of monitoring will vary depending on discharge- and site-specific characteristics. In certain cases, it may be possible for the discharger to use data previously collected in other monitoring programs in lieu of conducting baseline monitoring.

In addition to these four general types of monitoring conducted in support of the sediment source control process, there are other situations in which additional monitoring may be appropriate. For example, Ecology or an interested third party may conduct additional monitoring to assess discharge or receiving environment conditions independent of the assessment provided by the discharger. In the event Ecology determines that modification of the conditions of the SIZ authorization is necessary, the discharger may also conduct additional monitoring to rebut the conclusions of Ecology's determination.

7.2 Monitoring Objectives

Monitoring objectives vary with the type of monitoring being conducted. The objectives for the four general types of monitoring are described below.

7.2.1. Baseline Monitoring

The primary objective of baseline monitoring is to collect information to confirm a best professional judgment decision of the potential to violate the SQS. The data will be used in determining whether a SIZ authorization is likely to be necessary. Such data may be used for:

- Application of simple screening tools (e.g., information on the nature of the wastewater to be discharged, based either on knowledge of the type of facility or on actual chemical analyses of the wastewater)

- Definition of baseline environmental conditions in the vicinity of the discharge (e.g., chemical or biological characteristics of the sediments).

Baseline monitoring data can also be used to identify other potential contaminant sources in the area or to relieve the discharger from liability for sediment contamination contributed by other permitted or unpermitted (and possibly historical) discharges.

7.2.2. SIZ Application Monitoring

The objective of SIZ application monitoring is to collect the necessary data to support the use of generalized or site-specific models to predict future sediment conditions under specific discharge scenarios (e.g., more detailed information on characteristics of the wastewater as well as on physical and chemical conditions in the receiving environment). In cases where an existing, permitted point source has been discharging at a similar flow and wastewater quality for a sufficiently long period (e.g., 10 years), there is reason to believe steady-state contaminant concentrations may have been reached. In such cases, existing sediment conditions alone may indicate whether there is a need for a SIZ in the absence of detailed modeling.

7.2.3 Maintenance Monitoring

The objectives of maintenance monitoring are to collect data necessary to:

- Determine whether the SIZ should be renewed, reduced, or eliminated

- Determine whether areas of special importance have been adversely impacted by the discharge

- Determine the conditions for SIZ reauthorization.

Such monitoring may include chemical and/or biological assessments of conditions within the SIZ to demonstrate that the maximum allowable contaminant concentrations and/or biological effects levels have not been exceeded within the SIZ. Assessments of chemical and/or biological conditions in areas beyond the SIZ may also be used to demonstrate that the spatial limits of the authorized SIZ have not been exceeded.

7.2.4. Closure Monitoring

For instances of SIZ closure that involve active cleanup, the objective of closure monitoring is to demonstrate that the cleanup was successful at restoring sediment quality to acceptable levels (i.e., to contaminant concentrations and/or biological effects levels below SQS) within the SIZ. For instances of SIZ closure that involve natural recovery of the sediments, the objective of closure monitoring is to verify predictions regarding the efficacy of natural processes in restoring sediment quality to acceptable levels within the SIZ.

7.3. Types of Monitoring Data

There are several types of monitoring data that are applicable to the sediment source control process:

- Physical data on the receiving environment
- Chemical data on the receiving environment
- Biological data on the receiving environment
- Physical data on the wastewater discharge
- Chemical data on the wastewater discharge
- Whole-effluent toxicity test data.

Some types of monitoring data may be useful for only one phase of the sediment source control process. For example, physical monitoring of the receiving environment may be required to provide input for the SIZ models used to determine whether a SIZ should be authorized for a given discharge, but may not be necessary after a SIZ is authorized. Other types of monitoring data may be useful for all phases of the sediment source control process. For example, chemical or biological monitoring of the receiving environment may be required to determine whether a SIZ should be authorized, to demonstrate compliance with conditions of an authorized SIZ, or to document successful remediation of sediment contamination following SIZ closure. The various types of monitoring data and the potential uses of the data are described in greater detail below.

7.3.1. Physical Data on the Receiving Environment

Data on physical conditions in the receiving environment may be useful in determining whether sediment impacts are likely to occur. For example, physical evidence of a high-energy, nondepositional receiving environment in the vicinity of the discharge would suggest that sediment impacts are unlikely to occur.

Data on physical conditions in the receiving environment are also collected to support application of the SIZ models. The types of physical data that may need to be collected include vertical profiles of the density of the receiving water (generally calculated from the temperature and salinity of the receiving water), water depth, bottom topography, ambient current velocities, particulate concentrations in the water column, ambient sedimentation rates, and physical characteristics of the sediments (e.g., sediment grain size). The SIZ models can be run with varying degrees of site-specific data. In some cases, default values for many of the model input parameters can be used, while in other cases, detailed site-specific data are required to run the models. Guidance on the appropriate data requirements for various types of SIZ model runs is provided in the *WASP Application Guidance Manual* (Ecology, in preparation).

7.3.2. Chemical Data on the Receiving Environment

The collection of sediment chemistry data may be important for several reasons. Data on contaminant concentrations in the sediments around an existing discharge that are collected during baseline monitoring can be compared with the SQS numerical criteria to determine whether there is a need for a SIZ. If none of the contaminants exceed the SQS numerical criteria, and there has been neither a substantial change in the wastewater composition or flow over the past several years nor an expected change in the next 10 years, then it is unlikely that a SIZ will be needed. Exceedances of the SQS numerical criteria, however, suggest the need for further analyses to determine whether a SIZ will be required. Exceedances of the SQS numerical criteria would not necessarily require authorization of a SIZ because:

- The exceedances of SQS numerical criteria may be historical or otherwise unrelated to the discharge in question

- Modeling may indicate that sediment contaminant concentrations are expected to be below SQS numerical criteria within 10 years

- The discharge may not be eligible for a SIZ.

In the event that site-specific data are needed for running the SIZ model(s), it will likely be necessary to measure existing sediment contaminant concentrations.

In certain circumstances, it may be appropriate to collect data on subsurface as well as surface sediment quality conditions. Contaminant concentrations in subsurface sediments may be used to investigate changes associated with increases or decreases in contaminant loading over time, and may be important in establishing sedimentation rates that may be used in evaluating the efficacy of natural recovery.

Sediment chemistry data will also be useful for both maintenance and closure monitoring. The contaminant concentrations in sediments within an authorized SIZ will be monitored to determine whether there are any exceedances of applicable limits (i.e., SIZ_{max} or other limits established specifically for that SIZ). Contaminant concentrations in sediments beyond the authorized SIZ will also be monitored to determine whether there are any exceedances of SQS numerical criteria. Finally, contaminant concentrations in the sediments following SIZ closure will be monitored to evaluate whether the predicted reductions in contaminant concentrations following natural recovery, or the target contaminant concentrations following active restoration, are achieved.

7.3.3. Biological Data on the Receiving Environment

Biological monitoring data, which consist of information on the abundances of naturally occurring benthic infaunal organisms and the results of sediment bioassays, are used for two basic purposes in the sediment source control process. First, WAC 173-204-315 allows for the use of acute and chronic effects biological tests to confirm designation of Puget Sound marine sediments using the procedures described in WAC 173-204-310(2). Sediments that have either passed or failed the initial designation procedures based on compliance with the SQS numerical criteria may be subject to confirmatory designation using these biological tests. The results of these biological tests may override the initial designation based on sediment chemistry alone. Hence, confirmatory testing using these biological tests may be important in determining the potential need for a SIZ. If the sediments around a wastewater discharge have one or more chemicals that exceed the criteria of WAC 173-204-320(2), these sediments would be designated as failing the SQS and the discharge would be considered for authorization of a SIZ, unless the results of the biological tests indicate the absence of adverse effects. Conversely, even if the sediments pass the chemical criteria of WAC 173-204-320(2), there may be reason(s) to conduct biological tests on the sediments (e.g., if there are potentially toxic chemicals known to be present in the sediments for which there are no SQS numerical criteria). Failure of one or more of the biological tests would result in the designation of the sediments as failing the SQS, and the discharge would be considered for authorization of a SIZ.

Second, biological tests are used in the sediment source control process to identify the maximum biological effects level that may be authorized within a SIZ. The SIZ_{max} biological effects levels can be established using one of two methods (see Table IX-2). While designation of sediments as failing the SQS requires only one of the biological tests of WAC 173-204-315 to be failed by the criteria of WAC 173-204-320(3), the SIZ_{max} biological effects level is exceeded when any two of the biological tests exceed the criteria of WAC 173-204-320(3). Alternatively, the SIZ_{max} biological effects level is also considered to be exceeded when any one of the biological tests exceeds the criteria of WAC 173-204-420(3), each of which requires a greater biological effect than the corresponding criteria of WAC 173-204-320(3).

7.3.4. Physical Data on the Wastewater Discharge

The collection of physical data on the wastewater discharge will likely be necessary to provide input for the SIZ models. The types of physical data likely to be needed include:

- the flow of the discharge (to estimate total loading to the receiving water),
- the density of the wastewater (generally calculated from the measured or estimated temperature of the wastewater if the salinity of the wastewater approximates that of fresh water, or from both the temperature and salinity if it does not), and
- the concentration of suspended solids in the wastewater. Physical processes such as flocculation and coagulation may affect the concentration of suspended solids following discharge to the receiving environment, but these processes are not presently addressed in the SIZ models.

As previously indicated, the SIZ models can be run with varying degrees of site-specific data. In some cases, default values for many of the model input variables can be used, while in other cases, detailed site-specific data are required to run the models. Guidance on the appropriate data requirements for various types of SIZ model runs is provided in the *WASP Application Guidance Manual* (Ecology, in preparation).

7.3.5. Chemical Data on the Wastewater Discharge

Data on the chemical characteristics of the wastewater may be used for several purposes. Data on the concentrations of chemical contaminants in the wastewater that are routinely collected as part of NPDES monitoring may be used in simple screening tools to determine whether the discharge has the potential to cause exceedances of the SQS numerical criteria. The data required for this purpose include the concentrations of any of the contaminants in the wastewater for which there are SQS numerical criteria, as well as the concentration of suspended solids in the wastewater. These data may also be used in the SIZ models to evaluate the need for a SIZ. Data on the concentrations of chemical contaminants in the wastewater may also be used to verify that the discharge is achieving AKART or some other level of required treatment defined on the basis of achievable wastewater concentrations. Finally, data on the concentrations of chemical contaminants in the wastewater may be used to identify contaminants that may be targeted for investigation in monitoring of the receiving water or sediments.

7.3.6. Whole-Effluent Toxicity Test Data

Data on whole-effluent toxicity may be useful for assessing the likelihood of adverse biological effects in the sediments. This is especially true when the same organisms (e.g., bivalve larvae) were used in the whole-effluent toxicity tests as would be used in assessing sediment impacts. If a toxic effect was demonstrated in a whole-effluent toxicity test, this may suggest the need for biological testing of the sediments in the vicinity of the discharge, especially if the cause of the toxicity is not apparent.

7.4. Methods for Collecting Monitoring Data

This section briefly describes the methods appropriate for collecting various types of monitoring data. In cases where the methods have been described in other documents, appropriate references to those documents are provided. For methods that are not well documented, additional details are provided, although the level of detail is necessarily brief.

7.4.1. Physical Monitoring of the Receiving Environment

Data on physical conditions in the receiving environment collected to support application of the SIZ models may include vertical density profiles, ambient current velocities, ambient suspended particulate matter concentrations, sedimentation rates, sediment grain size, water depth, and bottom topography. Methods for collecting these data are described briefly in the following sections.

Vertical Density Profiles

Vertical density profiles, which may be necessary for detailed discharge modeling, are typically generated from temperature and salinity data. Temperature and salinity (or conductivity) are generally measured electronically using submersible probes (e.g., conductivity-temperature-depth devices, or CTD) lowered from a boat. In some cases, temperature may be measured using reversing thermometers, and salinity may be determined by returning the samples to the laboratory for measurement with a salinometer. Recommended procedures for measuring temperature and salinity are described in PSEP (1991b). Measurements should be made over the entire water column at the site of the discharge and at sufficient intervals to provide representative data for periods of maximum and minimum stratification.

Ambient Current Velocities

Ambient current velocities are typically measured using current meters. Multiple current meters are usually arrayed along a taut-line mooring, which is deployed in the immediate vicinity of an outfall. Records of currents are typically made over periods of several weeks; the period of monitoring should take into account the possible effects of variations in both tidal influences and nontidal influences (e.g., wind-induced currents), and should be scheduled to include periods of both spring and neap tides.

Ambient Suspended Particulate Matter Concentrations

Determination of ambient suspended particulate matter concentrations normally entails collection of water samples from the water column and analysis for TSS. Sample collection and analytical procedures are described in PSEP (1991b). If ambient TSS data are required, the sampling strategy should address the temporal and spatial variability of this variable, which is likely to be high.

Sedimentation Rates

The most common method of estimating sedimentation rates is through the use of sediment traps, which are cylinders, closed at the bottom, that are placed vertically in the water column to collect settling particulate matter (see U.S. GOFS [1989] and Norton [1990] for descriptions of sediment trap design and use). Sedimentation rates (i.e., the rate at which particulate matter settles out of the water column) should not be confused with sediment accumulation rates (i.e., the rate at which sediments accumulate on the bottom after accounting for loss functions such as resuspension and biodegradation). Because sediment traps are routinely left in place for up to 3 months and occasionally for up to 6 months, they are useful for characterizing average loadings of suspended solids from an intermittent or variable source, such as a storm drain, as well as for characterizing local area sedimentation rates. The advantage of sediment traps is that they collect particulate matter settling out of the water column before it is commingled with sediments on the bottom. The primary disadvantage is that the particulate matter collected is from all sources, both natural and anthropogenic, and not just from the discharge of interest.

Sediment traps should be used in areas that do not receive heavy boat traffic. The traps should be placed close to the source, far enough above the bottom that sediment resuspension will not substantially dilute the particulate matter from the source that is found in the trap. Traps are typically poisoned with sodium azide, mercuric chloride, or salt to minimize biotransformation of organic chemicals. However, a poison should be selected that does not interfere with the analytes of interest. To minimize preservation concerns, valves that prevent entry of zooplankton into the traps have been incorporated into recent sediment trap designs.

Sediment Grain Size

Determination of sediment grain size may be important in assessing the potential for sediment deposition and in modeling sediment resuspension. Sample collection and analysis procedures are described in PSEP (1986). The sampling strategy should take into account spatial differences in sediment grain size, as well as temporal differences that may occur, especially in areas with seasonal differences in flow regime.

Water Depth and Bottom Topography

In cases where relatively detailed bathymetric charts exist for the vicinity of a discharge, sufficient information on water depth and bottom topography may already be available. In other cases, it may be necessary to conduct a bathymetric survey, generally using echosounding equipment, to provide such information.

7.4.2. Chemical Monitoring of the Receiving Environment

Chemical monitoring of the receiving environment may be used to evaluate existing sediment quality, to provide input for the SIZ models, to evaluate historical changes in contaminant loading, and to use for both maintenance and closure monitoring. Chemical monitoring includes conventional sediment variables, sediment contaminant concentrations, and concentrations of contaminants associated with suspended particulate matter. Methods for the collection of these data are described briefly in the following sections.

Conventional Sediment Variables

Measurement of conventional sediment variables is valuable to help interpret the concentrations of sediment contaminants. TOC, for instance, should be measured whenever the concentrations of nonionizable organic compounds are to be measured, because the SQS numerical criteria for those compounds are TOC-normalized. Acid-volatile sulfides (AVS) should be measured whenever the concentrations of metals are to be measured, because AVS data are useful for interpreting the toxicity of metals in sediments. Analysis of ammonia is also potentially useful for interpreting bioassay results. Guidelines for the collection of sediment samples and for the analyses of conventional sediment variables are provided in PSEP (1986).

Sediment Contaminant Concentrations

To determine whether sediment samples contain any contaminants at concentrations above the SQS or to use contaminant concentrations for input to the SIZ models, the sediments should be analyzed for all contaminants for which there are SQS numerical criteria and for all contaminants that are either known or suspected to be present in the wastewater of a subject discharge. There may be other potentially toxic contaminants known or suspected to be in the subject wastewater for which there are presently no criteria (i.e., "other toxic, radioactive, biological, or deleterious substances," see WAC 173-204-320(5)). These contaminants should also be analyzed for, using methods to be determined on a case-by-case basis, because their presence in the sediments may necessitate the assessment of the concentration below which they would have no adverse effects.

Guidelines for the collection of sediment samples are provided in PSEP (1986). Metals should be analyzed according to the guidelines provided in PSEP (1989a), and organic compounds should be analyzed according to the guidelines provided in PSEP (1989b). Recommended sample preparation methods, cleanup methods, analytical methods, and detection limits for sediments are presented in Table XIII-6. It is important that subsamples of sediment samples analyzed for nonionizable organic compounds be analyzed for TOC as well in order to normalize the resulting concentrations by their TOC contents. It is also important that the analytical laboratory be instructed to employ all necessary methods to attempt to achieve the recommended detection limits.

Concentrations of Contaminants Associated with Suspended Particulate Matter

It is expected that it will rarely be necessary to directly measure the concentrations of contaminants associated with suspended particulate matter in the receiving environment. This information might be necessary in cases where it is not practical to directly measure the concentrations of contaminants in wastewater suspended solids and the information is needed for the application of screening procedures or modeling techniques. If such information is necessary, the use of filtration or continuous centrifugation may be considered to collect the suspended solids, although neither method may be practical because of the large volumes of water that must be filtered or centrifuged. Alternatively, concentrations of contaminants associated with suspended particulate matter in the receiving water may be measured using sediment traps to collect the particulate matter; these methods have been successfully employed in Commencement Bay waterways by Norton (1990).

Table XIII-6 . Recommended Sample Preparation Methods, Cleanup Methods, Analytical Methods and Detection Levels for Sediments.

Chemical	Recommended Sample Preparation Methods[a]	Recommended Sample Cleanup Methods[b]	Recommended Analytical Methods[c]	Recommended Detection Limits[d] (g/kg)
Metals				
Arsenic	PSEP	--	7060/7061	100
Cadmium	PSEP	--	7130/7131	100
Chromium	PSEP	--	7190/7191	5,000
Copper	PSEP	--	7210	100
Lead	PSEP	--	7420/7421	100
Mercury	--[e]	--	7471	10
Silver	PSEP	--	7760	100
Zinc	PSEP	--	7950	200
Nonionizable Organic Compounds				
LPAH Compounds				
Naphthalene	3540/3550	3640/3660	8270/1625C	10
Acenaphthylene	3540/3550	3640/3660	8270/1625C	10
Acenaphthene	3540/3550	3640/3660	8270/1625C	10
Fluorene	3540/3550	3640/3660	8270/1625C	10
Phenanthrene	3540/3550	3640/3660	8270/1625C	10
Anthracene	3540/3550	3640/3660	8270/1625C	10
2-Methylnaphthalene	3540/3550	3640/3660	8270/1625C	10
HPAH Compounds				
Fluoranthene	3540/3550	3640/3660	8270/1625C	10
Pyrene	3540/3550	3640/3660	8270/1625C	10
Benz[a]anthracene	3540/3550	3640/3660	8270/1625C	10
Chrysene	3540/3550	3640/3660	8270/1625C	10
Total benzofluoranthenes[f]	3540/3550	3640/3660	8270/1625C	10
Benzo[a]pyrene	3540/3550	3640/3660	8270/1625C	10
Indeno[1,2,3-c,d]pyrene	3540/3550	3640/3660	8270/1625C	10
Dibenz[a,h]anthracene	3540/3550	3640/3660	8270/1625C	10
Benzo[g,h,i]perylene	3540/3550	3640/3660	8270/1625C	10
Chlorinated Benzenes				
1,2-Dichlorobenzene	3540/3550	3640/3660	8270/1625C/8240	10
1,4-Dichlorobenzene	3540/3550	3640/3660	8270/1625C/8240	10
1,2,4-Trichlorobenzene	3540/3550	3640/3660	8270/1625C/8240	10
Hexachlorobenzene	3540/3550	3640/3660	8270/1625C	10
Phthalate Esters				
Dimethyl phthalate	3540/3550	3640/3660	8270/1625C	10
Diethyl phthalate	3540/3550	3640/3660	8270/1625C	10
Di-*n*-butyl phthalate	3540/3550	3640/3660	8270/1625C	10
Butyl benzyl phthalate	3540/3550	3640/3660	8270/1625C	10
Bis[2-ethylhexyl]phthalate	3540/3550	3640/3660	8270/1625C	10
Di-*n*-octyl phthalate	3540/3550	3640/3660	8270/1625C	10

Chemical	Recommended Sample Preparation Methods[a]	Recommended Sample Cleanup Methods[b]	Recommended Analytical Methods[c]	Recommended Detection Limits[d] (g/kg)
Miscellaneous Extractable Compounds				
Dibenzofuran	3540/3550	3640/3660	8270/1625C	10
Hexachlorobutadiene	3540/3550	3640/3660	8270/1625C	10
N-nitrosodiphenylamine	3540/3550	3640/3660	8270/1625C	10
PCBs				
PCB Aroclors	3540/3550	3620/3640/3660	8080	1
Ionizable Organic Compounds				
Phenol	3540/3550	3640/3660	8270/1625C	10
2-Methylphenol	3540/3550	3640/3660	8270/1625C	10
4-Methylphenol	3540/3550	3640/3660	8270/1625C	10
2,4-Dimethylphenol	3540/3550	3640/3660	8270/1625C	10
Pentachlorophenol	3540/3550	3640/3660	8270/1625C	50
Benzyl alcohol	3540/3550	3640/3660	8270/1625C	50
Benzoic acid	3540/3550	3640/3660	8270/1625C	50
Other Analyses				
Ammonia	--[g]	--	Plumb (1981)	100
Grain size	--[g]	--	Plumb (1981)	1%
Organic carbon, total	--[g]	--	9060	0.1%
Sulfides, acid volatile	--[g]	--	U.S. EPA (1991)	0.1 mole/g
Sulfides, total	--[g]	--	Plumb (1981)/9030	100
Oil and grease	--[g]	--	PSEP	10,000
Total solids	--[g]	--	PSEP	0.1% (wet wt)
Total volatile solids	--[g]	--	PSEP	0.1%

[a] Recommended sample preparation methods are: PSEP - Puget Sound Estuary Program (PSEP 1989a)
Method 3500 series - sample preparation methods from SW-846 (U.S. EPA 1986) and updates.

[b] Recommended sample cleanup methods are: Method 3600 series - sample cleanup methods from SW-846 (U.S. EPA 1986) and updates.

[c] Recommended analytical methods are: Method 7000, 8000, and 9000 series - analytical methods from SW-846 (U.S. EPA 1986) and updates
Method 1625C - isotope dilution method (U.S. EPA 1989)
Plumb (1981) - U.S. EPA/U.S. Army Corps of Engineers Technical Report EPA/CE-81-1
PSEP - Puget Sound Estuary Program (PSEP 1986)
Acid volatile sulfide method for sediment (U.S. EPA 1991).

[d] In order to achieve the recommended detection limits for organic compounds, it may be necessary to use a larger sample size (approximately 100 g), a smaller extract volume for gas chromatography/mass spectrometry analyses (0.5 mL), and one of the recommended sample cleanup methods, as necessary, to reduce interference. Detection limits are on a dry weight basis unless otherwise indicated.

[e] The sample digestion method for mercury is described in the analytical method (Method 7471, SW-846 [U.S. EPA 1986] and updates).

[f] Total benzofluoranthenes represent the sum of the b, j, and k isomers.

[g] Sample preparation methods for sediment conventional analyses are described in the analytical methods.

7.4.3. Biological Monitoring of the Receiving Environment

Biological testing to assess existing sediment quality, to establish the maximum biological effects level within an authorized SIZ, or to assess compliance with the SIZ authorization may include the conduct of sediment bioassays or the assessment of the naturally occurring community of benthic infauna in sediment samples. Methods for conducting these biological tests are described briefly in the following sections.

Sediment Bioassays

Four of the biological tests that can be applied to assessments of marine sediment quality in the sediment source control process are sediment bioassays, including:

Acute Effects Tests

- **Amphipod**—A 10-day acute sediment bioassay that assesses mortality of the amphipod *Rhepoxynius abronius*

- **Larval**—Any one of several acute sediment bioassays that assess mortality and/or abnormality of larvae of the following organisms:

  - Pacific oyster, *Crassostrea gigas*

  - Blue mussel, *Mytilus edulis*

  - Purple sea urchin, *Strongylocentrotus purpuratus*

  - Sand dollar, *Dendraster excentricus*

Chronic Effects Tests

- **Juvenile polychaete**—A 20-day sublethal sediment bioassay that assesses decreases in growth of the juvenile polychaete *Neanthes arenaceodentata*

- **Microtox® saline extract**—A 15-minute bioassay that assesses decreased bioluminescence of the bacteria *Photobacterium phosphoreum* exposed to a saline extract of the sediment sample. Although conducted for a relatively short period of time and therefore generally considered to be an acute test, the Sediment Management Standards consider the Microtox® bioassay to be a surrogate chronic test because of its high sensitivity.

Guidelines for the collection of sediment samples and for the conduct of these bioassays are provided in PSEP (1991a).

In addition to the chronic sediment bioassays listed above, the assessment of benthic infaunal abundance (see below) is also considered to be a chronic biological test.

For confirmatory designation of marine sediments, WAC 173-204-310(2)(a) requires that the sediments be tested using two of the acute effects biological tests and one of the chronic effects biological tests. For establishing the SIZ_{max} biological effects level, WAC 173-204-420(3)(a) also requires that the sediments be tested using two of the acute effects biological tests and one of the chronic biological effects tests. In establishing the SIZ_{max} biological effects level, however, the only applicable chronic effects tests to choose from are the benthic infaunal abundance and juvenile polychaete tests.

Assessment of Benthic Infauna

As indicated above, the fifth biological test that can be applied to assessments of sediment quality in the sediment source control process is assessment of the naturally occurring community of benthic infauna in samples of the sediment of interest. This chronic effects test assesses statistically significant alterations in the abundances of the following major taxa: Crustacea, Mollusca, and Polychaeta. Guidelines for the collection and analysis of benthic infaunal samples are provided in PSEP (1987b).

7.4.4. Physical Monitoring of the Wastewater

Physical data on the wastewater to be collected to support application of the SIZ models may include the concentration of suspended solids in the wastewater, discharge flow, and wastewater density. Methods for collecting and analyzing these data are described briefly in the following sections.

Concentration of Suspended Solids in the Wastewater

The concentration of suspended solids in the wastewater may be needed for the use of simple screening tools and as input to the SIZ models. It is typically reported as the TSS content. The collection of samples for analysis of TSS should reflect knowledge of discharge conditions that are likely to result in temporal variability of the TSS content of the wastewater. Multiple samples are recommended to gain some idea of the variability of TSS content, which for some types of discharges may be extremely high. The analysis of TSS is conducted by filtering a sample of the wastewater, drying the filter, and weighing the filter by standard methods (APHA 1989; Method 209C).

Discharge Flow

Information on the flow of the discharge is needed to estimate contaminant loading to the receiving environment and for use in the SIZ models. Flow is typically monitored and reported for most permitted wastewater discharges, regardless of whether they are under consideration for authorization of a SIZ. Flow can be measured *in situ* using a variety of methods. There are two major categories of methods for measuring flow: direct-discharge and velocity-discharge (Metcalf & Eddy 1979). The direct-discharge methods are used most frequently, and relate the rate of discharge to one or two easily measured variables, employing devices such as weirs, Parshall flumes, Venturi meters, and magnetic flow meters. Flow should preferably be measured downstream of all treatment processes, although flow measurements upstream of the treatment processes are common for municipal wastewater treatment plants and may be used in the absence of downstream measurements. The most useful flow measurements are those made continuously and recorded automatically because they provide a temporal record of flow variations.

Wastewater Density

Wastewater density is needed as input for the modeling of initial dilution (e.g., in PLUMES or CORMIX). Although wastewater density could be measured directly, it is more typically calculated based on the temperature of the wastewater, assuming the salinity of the wastewater approximates that of fresh water. Unless the characteristics of an individual discharge suggest otherwise (e.g., for a brine discharge), wastewater density may be calculated based on temperature alone. Temperature may be measured using either a thermometer or a thermistor. Methods are discussed in APHA (1989; Method 212). Measurements of temperature should take into account any temporal variability that is likely to occur (e.g., based on seasonal changes or changes in treatment processes).

7.4.5. Chemical Monitoring of the Wastewater

Data on the chemical characteristics of the wastewater may include both contaminant concentrations in whole wastewater samples as well as contaminant concentrations in wastewater suspended solids. Such data may be used in simple screening procedures, as input to the SIZ models, as verification of achievement of specific wastewater treatment levels, or as evidence of contaminants that should be investigated in the receiving environment. Methods for the collection of these data are described briefly in the following sections.

Contaminant Concentrations in Whole Wastewater Samples

Contaminant concentrations in whole wastewater samples may be used in simple screening tools (see Chapter 4) or to estimate contaminant loading to the receiving environment. Routine analyses of EPA priority pollutant metals and organic compounds are included as monitoring requirements for many permitted discharges, regardless of whether they are under consideration for authorization of a SIZ. Wastewater samples may be collected as grabs, or as time-averaged or flow-weighted composites; the latter are generally preferred because they integrate variations in contaminant concentrations over short time scales (e.g., 24 hours). If there is likely to be substantial variability in wastewater quality over a longer time period (e.g., because of seasonal variations in stormwater runoff), it may be desirable to sample at various time intervals to gain an understanding of the range of wastewater quality. Methods for the analysis of EPA priority pollutant metals are presented in U.S. EPA (1987); methods for the analysis of EPA priority pollutant organic compounds are presented in U.S. EPA (1988a).

Contaminant Concentrations in Wastewater Suspended Solids

If data are needed on the contaminant concentrations associated with wastewater suspended solids, sufficient solid sample must be collected to analyze for the contaminants of interest, and this may represent a technical challenge if the concentration of suspended solids is relatively low. One method under development for obtaining a sample of suspended solids from a wastewater sample is to pass the water through a high-speed, continuous centrifuge. This method is capable of retaining all the suspended solids present in the water. The use of a centrifuge will normally require continuous collection at the discharge facility for greater than a 24-hr period. Because this procedure would involve collection of suspended solids over a relatively short time period, its best use would be to characterize sources that are continuous and relatively stable. Alternatively, a periodic monitoring program could be employed. Use of a continuous centrifuge for the collection of wastewater suspended solids is still under development by Ecology, and there is currently no approved protocol for this procedure.

A less costly method of obtaining suspended solids from wastewater is filtration. However, compared to the centrifuge method, filtration is time consuming, technically difficult, and may not be appropriate for use when a large water sample is needed to collect the required amount of solids for analysis. A discussion of the relative merits of the centrifuge and filtration methods can be found in Horowitz (1986). Methods for analysis of suspended solids samples are discussed in Tetra Tech (1986). Ecology (1991a) provides details on collection and analysis of suspended solids using a centrifuge.

7.5. Development of Appropriate Monitoring Requirements

This subsection describes the factors to be considered in the development of baseline, SIZ application, maintenance, and closure monitoring requirements.

Pursuant to WAC 173-204-400(5), Ecology is authorized to specify in discharge permits the locations and methods for collection and analysis of representative samples of wastewater, receiving water, and sediments that will be required of the discharger. In determining the appropriate monitoring requirements, WAC 173-204-400(6) requires Ecology to consider the following factors as they relate to the potential for the discharge to violate the SQS:

- Discharge suspended solids characteristics
- Discharge contaminant concentrations, flow, and loading rates
- Sediment chemical concentrations and biological effects levels
- Receiving water characteristics (e.g., vertical density profiles, ambient current velocities)
- The geomorphology of sediments
- Cost mitigating factors such as the available resources of the discharger
- Other factors determined necessary by Ecology.

General issues to be considered in the development of monitoring requirements for all permitted discharges are discussed in other sections of this chapter.

The process for establishing monitoring requirements described in the other sections applies to all permitted discharges, whether or not they have the potential for impacting sediments or they are being considered for authorization of a SIZ. Certain aspects of the monitoring requirements pertinent to the sediment source control process overlap with aspects of the monitoring requirements for permitted discharges in general, and, in fact, certain information needs in the sediment source control process may already have been filled through the collection of monitoring data under an existing permit. In other cases, the information needs of the sediment source control process may be distinct and therefore require the collection of new and/or different types of monitoring data.

7.5.1. Development of Baseline Monitoring Requirements

The development of baseline monitoring requirements is the responsibility of the permit manager, with guidance and assistance from the SMU, as necessary. The baseline monitoring requirements should be described in detail in the discharge permit, or, in some cases, in a companion order.

If the result of the narrative and technical evaluations (Chapter IX) is a judgment that the discharge does not have the potential for causing sediment impacts, collection of baseline monitoring data may not be necessary. For discharges identified by the narrative and technical evaluations as having the potential for sediment impacts, there is expected to be a range of required baseline monitoring. In some cases, although there may be a potential for sediment impacts, the combination of discharge and receiving environment characteristics (e.g., a relatively small discharge with low levels of most priority pollutants, discharging to an environment not known to have sediment impacts, in the absence of other nearby discharges) is such that any sediment impacts would not likely be severe or widespread. In such cases, the only required baseline monitoring may be chemical analyses of sediments in the immediate vicinity of a marine discharge, or chemical analyses of sediments and sediment bioassays in the immediate vicinity of a freshwater discharge. In cases where sediment impacts might be expected to be more severe or widespread (e.g., a relatively large discharge with high levels of a number of priority pollutants, discharging to an environment known to have water and/or sediment quality problems, in the presence of other nearby discharges), more extensive baseline monitoring may be required.

Under certain circumstances, the need for baseline monitoring data may already have been satisfied by previous studies. In such cases, the evaluation of the need for a SIZ can proceed without further data collection. In other cases, the collection of additional baseline monitoring data will be necessary to confirm whether there are exceedances of SQS in the vicinity of the discharge. If the data needs are relatively minor (e.g., collection and chemical analysis of a few surface sediment samples), the discharger may be required to collect the data prior to evaluation of the need for a SIZ. If, however, the data needs are extensive, the baseline monitoring requirements should be specified in the renewed permit (in the case of previously permitted discharges) or in the initial permit (for previously unpermitted discharges). By including the baseline monitoring requirements in the permit, issuance of the permit will not be unnecessarily delayed while an evaluation of the need for a SIZ is conducted. Authorization of a SIZ, if deemed appropriate, can then occur at a later time after the baseline monitoring data become available and are evaluated.

In developing baseline monitoring requirements for an individual discharge, it is important to understand that the intent is only to determine whether currently there are exceedances of SQS in the vicinity of the discharge, and whether they appear to be caused by the discharge. Baseline monitoring is not intended to accurately delimit the area over which there are exceedances of SQS, or to definitively tie those exceedances to the discharge. Baseline monitoring should therefore be able to detect exceedances of SQS near the discharge and then to determine whether such exceedances are of greater magnitude near the discharge or of a more general, areawide nature, which might suggest contaminant inputs from other local sources.

For small discharges with only a low likelihood of sediment impacts, an array of only six stations may suffice if they are located along a transect extending from the point of discharge to a point downstream (in the direction of predominant current flow) sufficiently far away from the discharge to be beyond likely effects of the discharge. If flow is unidirectional (e.g., in a river), it may suffice to have one station of the transect upstream of the discharge to define ambient conditions. If flow is bidirectional (e.g., as in many Puget Sound marine environments where tidal currents predominate), the six stations might be arranged along a transect spanning the discharge along the axis of predominant current flow. Given the diversity of possible discharge scenarios, it is not appropriate to give generic guidance on the appropriate spacing of the stations along a transect. However, the spacing should take into account both the volume of the discharge and the velocity of currents in the vicinity of the discharge.

For larger discharges with a high likelihood of sediment impacts, or for discharges to more complex receiving environments, it may be necessary to have two to three transects, each with six stations extending out from the point of discharge. Once again, it is not appropriate to give generic guidance on the appropriate spacing of the stations along a transect, but the spacing should take into account both the volume of the discharge and the velocity of currents in the vicinity of the discharge.

Selection of appropriate baseline monitoring parameters is dependent on the nature of the discharge. For most marine discharges, it will be appropriate to collect surface sediment samples and analyze them for the contaminants for which there are SQS numerical criteria. Depending on how thoroughly the effluent has been characterized, it may be appropriate to analyze the surface sediments for additional contaminants, especially any known to be present in the effluent and considered potentially toxic to aquatic life. The sediment samples from the various stations should be analyzed individually and not composited with those from other stations, so that it will be possible to investigate contaminant gradients as evidence of the source of the contaminants.

If chemical analysis of the sediments in the vicinity of a marine discharge reveals exceedance(s) of the SQS numerical criteria, consideration should be given to requiring biological testing, because the results of biological tests may override a decision based on sediment chemistry alone. Biological testing may also be appropriate for marine discharges if there are potentially toxic chemicals in the effluent for which there are no SQS numerical criteria. In Puget Sound marine environments, the biological testing should include two acute tests and one chronic test (see Part 7.4.3) for the available tests to choose from). In non-Puget Sound marine environments, it may be appropriate to use the same tests as for Puget Sound marine environments, but this decision should only be made on a case-by-case basis, with guidance from the SMU. In freshwater environments, baseline monitoring should always include biological testing with the *Hyalella azteca* and Microtox® sediment bioassays. Appropriate biological tests for low-salinity environments have not yet been identified, but may be selected by the SMU on a case-by-case basis.

7.5.2. Development of SIZ Application Monitoring Requirements

The development of SIZ application monitoring requirements is the responsibility of the SMU. A detailed description of the SIZ application monitoring requirements will be provided to the permit manager by the SMU, to be forwarded to the discharger.

7.5.3. Development of Maintenance Monitoring Requirements

The development of maintenance monitoring requirements is the responsibility of the SMU. A detailed description of the maintenance monitoring requirements will be provided to the permit manager by the SMU for inclusion in the permit.

7.6. Interpretation of Monitoring Results

This section describes procedures for interpreting monitoring results for various purposes in the sediment source control process.

7.6.1. Evaluation Criteria for Designation of Sediments as Passing or Failing the Sediment Quality Standards

Initial designation of sediments as passing or failing the SQS is made on the basis of chemical contaminant concentrations (WAC 173-204-310(1)). Sediments with chemical contaminant concentrations equal to or less than all the applicable chemical and human health criteria are designated as not having adverse effects on biological resources or posing a significant threat to human health. Sediments having one or more chemical contaminants at concentrations greater than the applicable chemical or human health criteria are designated as having adverse effects on biological resources or posing a significant threat to human health.

Whether the sediments pass or fail the initial designation based on chemical criteria alone, they are potentially subject to confirmatory designation (see WAC 173-204-310(2)) using the applicable biological testing procedures of WAC 173-204-315. To confirm the designation of these sediments, they should be tested using two of the acute effects biological tests and one of the chronic effects biological tests (for brief descriptions of these tests, see Part 7.4.3 above). The biological test results for control and reference sediments must meet the performance standards of WAC 173-204-315(2). A sediment sample is determined to have an adverse effect on biological resources, and therefore is designated as failing the SQS, when any one of the biological tests demonstrates the results listed in the SQS column of Table IX-2, notwithstanding the initial designation based on sediment contaminant concentrations alone. If the sediment sample does not demonstrate any of the results listed in the SQS column of Table IX-2, it is designated as passing the SQS, notwithstanding the initial designation based on sediment contaminant concentrations alone.

For marine sediments containing other toxic, radioactive, biological, or deleterious substances, Ecology will identify appropriate test interpretation standards for initial and confirmatory designation. Because these procedures have not yet been developed by Ecology, they are not currently discussed in this manual.

7.6.2. Evaluation Criteria for SIZ_{max} Biological Effects Level

The maximum sediment contaminant concentrations allowed within an authorized SIZ as a result of a permitted or otherwise authorized discharge are presented in Table IX-1, and are referred to as SIZ_{max}. Biological effects within an authorized SIZ are also not to exceed a "minor adverse effects level," which is defined on the basis of the results of biological tests. To determine compliance with the SIZ_{max} biological effects criteria, the sediment should be tested using two of the acute effects biological tests and one of the chronic effects biological tests (see Part 7.4.3). The biological tests employed for demonstrating compliance with the SIZ_{max} biological effects criteria of WAC 173-204-420(3) are the same as those used in biological testing for confirmatory designation, except that the Microtox® test is omitted as one of the options for a chronic test. The biological test results for control and reference sediments must meet the performance standards of WAC 173-204-315(2). The sediments are determined to exceed the SIZ_{max} biological effects criteria when any two of the biological tests exceed the criteria of WAC 173-204-320(3) or when any one of the tests demonstrates the results shown in the SIZ_{max} biological effects criteria column of Table IX-2.

If, in a given area, the nonanthropogenically affected (i.e., natural background) sediment quality is of a lower quality (i.e., having higher contaminant concentrations, causing an adverse biological response, or posing a greater threat to human health) than allowed within an authorized SIZ, the existing sediment chemical and biological quality criteria will be identified on an areawide basis, as determined by Ecology, and used in place of the SIZ_{max} criteria of WAC 173-204-420.

8. SUMMARY CHECKLIST

Monitoring Program Checklist

1. Have all the possible sampling matrices been considered?

    - Influent
    - Internal waste streams
    - Treated process wastewater (effluent)
    - Particulates
    - Nonprocess wastewater
    - Sludge
    - Storm water
    - Receiving environment
        - Water
        - Sediment
        - Biota
        - Groundwater
    - CSOs
    - Bypasses

2. Are there any water-quality based limits or considerations?

    - Numerical criteria
    - Narrative criteria (toxicity)
    - Beneficial uses (fishable, swimmable)

3. Where do the process wastes end up?

    - Surface waters
    - Land (application)
    - Ground water
    - Underground injection
    - Landfills

4. Is there sufficient data to characterize the effluent? Are any special studies needed?

    - For statistical comparisons (temporal and spatial)?
    - To establish sampling frequencies?
    - Are all constituents characterized?
    - How variable is the effluent?

5. Is there sufficient data to characterize the potential impact on the receiving environment?

   - Is there existing ambient data?
   - Is data needed for modeling?

6. Specify parameters to be monitored

   - To meet limits
   - To create baseline data
   - For surveys
   - Indicators
   - Evaluate acute/chronic toxicity

7. Specify in permit:

   - Sampling locations
   - Timing and frequency for sampling
   - Sample collection and analytical methodologies
   - QA/QC
   - Data reporting requirements.

8. Will any of the monitoring data be used to trigger an action?

   - Effluent biomonitoring
   - Survey results
   - Receiving environment monitoring
   - Local limits policy
   - Tiered sampling
     - Increase/decrease -monitoring frequency
     - Add/eliminate parameters from sampling program

9. What is the size, treatment technology and compliance history of the facility?

10. Does the facility discharge into Puget Sound?
    - Plan elements for majors

CHAPTER XIV. FACT SHEETS AND DOCUMENTATION

This chapter discusses the regulatory requirements for fact sheets.

As in any process of complex decisions and calculations, documentation is valuable. In the permit process the documentation occurs in a fact sheet. A fact sheet sets forth the principal facts and the significant legal, procedural and policy decisions considered in preparing the permit. Some of the content of fact sheets is directed by federal and state regulation and some content is dictated by good project management.

1. FEDERALLY REQUIRED FOR SELECTED PERMITS

The federal NPDES regulations (40 CFR 124.8, 124.56) require a fact sheet for

- every major NPDES facility or activity,
- every draft permit that incorporates a variance or requires an explanation under 124.56(b),
- every draft permit which is the subject of widespread public interest or raises major issues,
- every Class I sludge management facility,
- every permit that includes a sewage sludge land application plan, and for
- every permit that includes a variance.

2. STATE REQUIREMENTS FOR ALL PERMITS

The State regulations for surface discharge (WAC 173-220-060) are much simpler - every permit must have a fact sheet.

The state regulation requires that fact sheets at a minimum will summarize the following:

- The type of facility or activity which is the subject of the application;
- The location of the discharge in the form of a sketch or detailed description;
- The type and quantity of the discharge, including at least the following:
    - The rate or frequency of the proposed discharge,
    - For thermal discharges, the average summer and winter temperatures, and
    - The average discharge in pounds per day, or other appropriate units, of any pollutants which are present in significant quantities or which are subject to limitations or prohibition by state or federal regulation;
- The conditions in the proposed permit;
- The legal and technical grounds for the draft permit determination, including an explanation of how conditions meet both the technology-based and water quality-based requirements of state and federal law;
- The effluent standards and limitations applied to the proposed discharge;
- The applicable water quality standards, including identification of the uses for which receiving waters have been classified;
- How the draft permit addresses use or disposal of residual solids generated by wastewater treatment;
- The procedures for the formulation of final determinations (in more detailed form than that given in the public notice) including:
    - The 30-day comment period required by WAC 173-220-050(2);

- ♦ Procedures for requesting a public hearing and the nature thereof; and

- ♦ Any other procedures by which the public may participate in the formulation of the final determinations.

- RCW 90.48.520 requires the control of toxicants (specific chemicals and overall toxicity) in permits. This should be discussed in the fact sheet.

3. PUGET SOUND PLAN REQUIREMENTS

The Puget Sound Water Quality Management Plan (11/90) requires that in the fact sheet accompanying each draft major permit:

> "Ecology shall clearly explain how the draft permit fulfills the goal of reducing and eventually eliminating harm from toxic contaminants in Puget Sound, including a summary of the information used to determine which limits on specific toxicants and/or overall effluent toxicity should be included in the permit."

The plan also requires a discussion in the fact sheet of 4 types of monitoring;

- sediments in the vicinity of every significant outfall,
- particulate fraction of the effluent,
- acute and chronic toxicity of the effluent and sediments near the outfall,
- biota surveys in the vicinity of each significant outfall,
- water quality at the boundary of the dilution zone.

The plan requires a discussion of why these 5 monitoring requirements were not included if applicable.

4. FEDERALLY REQUIRED DETAILS

The Federal Regulations also require:

- The name and telephone number of a person to contact for more information
- Any calculations or other necessary explanation of the derivation of specific effluent limitations and conditions, including a citation to the applicable effluent limitation guideline and the reasons why they are applicable or an explanation of how the alternate effluent limitations were developed.
- An explanation of the reasons for including any of the following conditions in a permit:
    - Limitations to control toxic pollutants
    - Limitations on internal waste streams
    - Limitations on indicator pollutants
    - Limitations set on a case-by-case basis
- For every permit to be issued to a treatment works owned by a person other than a State or municipality, an explanation of the decision on regulation of the users (whether to issue a separate permit)
- For every permit that includes a sewage sludge land application plan, a brief description of how each of the required elements of the land application plan are addressed in the permit.

5. FACT SHEET CONSIDERATIONS

The fact sheet serves a legal requirement and informs a new permit writer of the history of the permit. Since the fact sheet is a summary, the permit writer may also wish to submit an internal memorandum to the file on some issues too lengthy or not appropriate for the fact sheet but which may be useful in the next permitting period. Ecology often spends a considerable amount of time debating a permit issue which then becomes an assumption upon which the permit conditions are based. Documenting the decision process may prevent a repeat of the debate in 5 years when the permit is up for reissuance.

EPA is required to maintain an administrative record on their permits to document the decision process. This type of procedure is useful for all permit writers. The permit writer should document every permit as if it were going to an appeal hearing and as if someone new would be reissuing the permit in 5 years.

The time of writing the fact sheet is an individual preference. Some experienced permit writers write a fact sheet before actually drafting the permit conditions, others do it after drafting the permit.

The permit writer should use language in the fact sheet that is understandable to a non-technical person. Public and permittee support for Ecology's permitting actions is increased if the issues are clearly presented in the fact sheet.

Significant comments made on a draft permit in writing or by comment at a public hearing must receive a response. The response is presented in a document called a Response to Comments. The Response to Comments becomes an addendum to the fact sheet. The original fact sheet may or may not be modified to reflect permit changes as a result of comment.

6. FACT SHEET FORMATS

The Permit Workgroup maintains model fact sheets for NPDES permits. These are available on Outlook.

CHAPTER XV. PUBLIC INVOLVEMENT

The permit writer must allow the public to observe and influence the decision-making process involved in developing a permit. The timing of public involvement was discussed in Chapters II and III. Some of the mechanisms for public involvement are the State Environmental Policy Act (SEPA), public notice of permits, and public hearings. The public involvement processes may be difficult and time-consuming but the permit writer is a public representative and the process is an opportunity to demonstrate that we are doing a good job of representing the public interest. Some public involvement tasks are required by law.

1. SEPA

A permit writer may become involved in the SEPA process and may occasionally become the lead for new dischargers. SEPA requirements are given in Chapter 43.21C RCW and Chapter 197-11 WAC.

Regulation exempts reissuance or modification of any wastewater discharge permit from the SEPA process as long as the permit contains conditions no less stringent than federal effluent limitations and/or state rules and regulations. The exemption applies only to existing discharges, not to new source discharges. To conform with the intent of SEPA, an existing, unpermitted discharge must undergo SEPA review during the permitting process.

The environmental review process under SEPA generally begins when someone submits a permit application to an agency or when an agency proposes some activity, policy, plan, ordinance, or regulation. A typical situation for a new discharger is to submit a request for a building permit to a municipality or county. That municipality or county then becomes the lead agency on SEPA. However, if they feel the environmental issues are too complex, they may request some other agency such as Ecology to take the SEPA lead. Most small projects are covered by a checklist and a Determination of Nonsignificance. These projects go into a review list circulated by the SEPA office. Large projects may require an Environmental Impact Statement.

If a discharger moves into an existing facility and doesn't need a building permit, the permit writer may become the lead on SEPA. If the only environmental issue is a proposed wastewater discharge which is controlled by treatment, there should not be a need for an environmental impact statement. The permit applicant will complete an environmental checklist and determination of nonsignificance. The signatory authority on the determination of nonsignificance is the person responsible for signing the permit. For multi-program situations in the regional offices, the regional director may be the lead and signatory. The permit writer should consult Ecology's Responsible Official's Notebook for SEPA - February 1989 for more information on SEPA.

2. PUBLIC NOTICE OF PERMIT ACTIONS

Ecology uses a common public involvement process for NPDES permits, new state wastewater discharge permits, and renewal of state wastewater discharge permits for facilities with an increase in volume or change in nature of the wastewater. Renewals of state wastewater discharge permits that do not have an increase in volume or a change in nature of the wastewater do not require public notice of application or public notice of draft permit.

Public notices of permit actions will be widely circulated to increase public awareness and encourage public participation early in the permit process.

Ecology assumes that costs associated with public notifications of permit actions and other costs of administering the public involvement procedures constitute a portion of the total costs incurred to administer the water quality permit program and are, therefore, fee eligible expenses.

Ecology will administer all public notices and advertisements to ensure that they are published in a timely and consistent manner.

Public notices of application and of draft permit may be done on a batch basis for applications and permits associated with basin permitting.

3. PUBLIC NOTICE OF APPLICATION (PNOA)

PNOAs for both new discharges and renewal of permits will be published in a major newspaper in the geographical area of the discharge.

PNOAs will be published by Ecology as a

- legal classified advertisement, to be published at least once each week for 2 consecutive weeks, and as
- mailings of PNOAs sent to persons on the general mailing list who have indicated an interest in receiving such information. Also as
- a display advertisement, to be published one time, concurrent with the first legal classified advertisement for permits likely to have a high degree of public interest.

PNOAs will use consistent wording and format to identify the types of information that Ecology would like to receive from the public and is able to consider in permit decision-making.

In addition to public notice, Ecology is required to notify the director of the Department of Fisheries and Wildlife and the secretary of Department of Social and Health Services of the application for a permit.

4. PERMITTEE RECEIVES PROPOSED PERMIT

The proposed draft fact sheet or draft permit and draft fact sheet shall be forwarded to the permittee for comment at least 30 days prior to the beginning of the formal public review period. The transmittal letter for the proposed draft shall specify a date by which comments are due and shall notify the permittee that the permit issuance process will not be delayed if the date is not met. The permittee must be made aware that the proposed permit conditions could be changed during the public review process. If the proposed draft permit is significantly different than the previous permit the permit writer shall offer the permittee an opportunity to meet. The purpose of the meeting is to explain new or changed requirements, receive comments on factual content, and discuss the practicality of compliance schedules.

5. PUBLIC NOTICE OF DRAFT PERMIT (PNOD)

Ecology will publish PNODs as legal classified advertisements at least once in the same major paper in which the PNOA was published.

PNOD's will also be distributed by mail to "parties of record." Parties of record are those persons who responded to the PNOA or who have otherwise requested that they be informed about the development of a specific permit.

Ecology may also issue news releases and other informational materials to announce the availability of the draft permit for public review.

The comment period following a PNOD will normally be 30 days from the date of the latest notice. The comment period can be extended any time the permit section supervisor determines that an extension of the comment period will result in greater or more meaningful public input, or in any other circumstances the permit section supervisor deems appropriate.

6. DISTRIBUTION OF DRAFT AND FINAL PERMIT MATERIALS

Ecology will mail 1 copy of the draft permit, final permit, and fact sheet to parties of record or to any other party requesting such information. One copy of the application will be mailed upon request.

Draft and final permits, fact sheets, and other permit-related information will be made available for public review and copying at the Ecology office from which the draft or final permit was issued.

- Draft permits will normally be retained in the permit file and made available for review and comment only until the Final Permit has been issued.

Ecology will bear the cost of copying and mailing draft or final permits and accompanying fact sheets to parties of record or others requesting copies of the same as part of its public outreach/education program on a 1-copy-per-requestor basis only. Additional copies will be supplied as specified in Ecology Policy 10-30, *Requests for Ecology Records*. Free copies are available only for permits which are being developed or considered for renewal.

- Copies of permit-related information other than draft or final permits and accompanying fact sheets will be made available for viewing and copying at the Ecology regional office which developed the permit. Copies of permit-related materials will be provided by mail as long as requests clearly specify the materials desired.

Draft and final permits and fact sheets and other permit-related materials will also be made available, at the discretion of the permit section supervisor, at repositories in appropriate public buildings (e.g., libraries, town hall) for the duration of the comment period.

7. PUBLIC INFORMATIONAL MEETINGS AND WORKSHOPS

Informational meetings or workshops will be held any time the permit section supervisor deems them appropriate to inform the public about a permit or permit-related issues, to facilitate public discussion of permit issues, and to generate more informed, more pertinent public comment on permit issues.

Holding discretionary informational meetings neither precludes the need for formal hearings, nor creates a demand that formal hearings be held.

- Informational meetings are not required permit procedures. Therefore, informational meetings require no extension of the public comment period. However, the comment period can be extended at the discretion of the permit section supervisor.

7.1. Informational Meetings Preceding Hearings

Informational meetings are required prior to holding public hearings.

- Meetings should be held at least 1 week prior to a hearing to allow the public time to study the information provided in meetings and to allow the public time to prepare well-considered formal comments or responses.

- A brief meeting should also be held immediately prior to a hearing to answer questions and address unresolved issues prior to accepting formal testimony, including those hearings for which informational meetings are held at an earlier date.

7.2. Public Notice of Informational Meetings

Public Notices of Informational Meetings will normally be included within Notices of Public Hearing. However, when a Public Hearing is not planned or when inclusive notices are not practical, a Public Notice of Informational Meeting will be

- published at least 1 time in a major newspaper with circulation in the geographic area of the discharge, and

- distributed to parties of record by mail.

The content and format of Public Notices of Informational Meetings will be essentially the same as that used to advertise Notice of Public Hearing.

8. HEARINGS

Ecology will hold formal public hearings whenever the permit section supervisor deems that there is sufficient interest and a likelihood of meaningful public comment on a permit to warrant hearings. (Note that regulations may require public hearings under some circumstances.)

8.1. Public Notice of Hearing

A Public Notice of Hearing will be published at least once in a major newspaper with circulation in the geographical area of the discharge. The public notice will be published at least 30 days prior to the hearing.

The Notice of Hearing will also be mailed to parties of record at least 30 days prior to the hearing.

Notices of Hearing will use a standard format and language which will, at a minimum

- outline permit issues to be discussed,
- establish time and place of hearings,
- include the name of a contact person at Ecology who can supply information or assistance,
- clearly state that testimony can be considered only if it pertains to the conditions of the named permit,
- outline the extent of Ecology's authority and interest in the permit, and
- instruct interested parties on getting their issues placed on the hearing agenda.

Whenever practical, a second Notice of Hearing should be issued 10-14 days prior to the meeting to encourage greater participation.

8.2. Hearing Officer

A hearing officer will be appointed by the permit section supervisor for each hearing. It will be the hearing officer's responsibility, in cooperation with the permit manager, to prepare the agenda, and conduct the meeting according to the agenda and the established procedures for holding a hearing (distributed by the Ecology Office of Education and Information).

9. PUBLIC NOTICE OF PERMIT ISSUANCE

Notices of issuance will be mailed by Ecology to parties of record.

10. PUBLIC NOTICES OF OTHER ACTIONS

Notices of appeals of permits will be mailed to parties of record, as will decisions on appeals.

Major modification, suspension (state permits), and revocation (for cause other than cessation of discharge), of a wastewater discharge permit each require public review and comment. Therefore:

- Ecology will publish a notice of intent to modify, suspend, or terminate a permit as a legal classified advertisement in a major newspaper with general circulation in the geographical area of discharge.
- Ecology will notify parties of record, by mail, of the department's intent to make a major modification to, or to suspend or revoke a permit.
- All subsequent public notification will be implemented using the same procedures as outlined for new discharges and permit renewals in the previous sections. This includes notice of draft major modifications and may include informational meetings or public hearings and notice of resolution of the permit action taken.

11. WHEN TO GO BACK TO PUBLIC NOTICE WITH A REVISED DRAFT PERMIT

There are no regulations requiring Ecology to repeat public notice on a draft permit after it has been revised, however, to meet the intent of public notice requirements a revised draft permit should go back to public notice under either of the following conditions:

1. When a significant revision to the draft originally public noticed has taken more than 9 months to complete and there were comments from the first public notice. The draft should also go back to EPA for approval if the permit is a major.

or

2. If new information causes the effluent limits or loading to increase.

If an issue is discussed in the first draft and new information submitted by the public causes changes in the permit conditions, then another public notice is not necessary. However, if the change is lower limitations, the permit writer should inform the permittee before issuing the permit.

CHAPTER XVI. APPEALS AND VARIANCES

A wastewater discharge permit is an administrative action of the Department of Ecology and is subject to both state administrative hearings and court appeals.

Variances are exceptions to the law.

1. APPEAL OF THE FINAL PERMIT TO THE POLLUTION CONTROL HEARINGS BOARD (PCHB)

1.1 The PCHB

The PCHB is an independent agency of the state of Washington, composed of 3 members appointed by the governor for terms of 6 years. The members are qualified by experience or training in environmental matters. At least 1 member is a lawyer, and not more than 2 members are of the same political party.

The function of the board is to hear appeals of permit actions (issuance, modification, denial), orders, rules, or regulations of Ecology or the air pollution control board. The regulatory requirements of the PCHB are given in Chapter 371-08 WAC.

1.2 Appeal Process

A permit writer may be involved in PCHB appeals of permits, orders, and penalties.

The general process of appeal is:

1. The permit, order, or penalty is issued by the Department

2. The recipient has 30 days to appeal to the PCHB with a copy served to Ecology

3. Upon receipt of a correct appeal the board will set a hearing date. The hearing date is usually 4 to 6 months from the time of appeal. The filing of an appeal does not stop the requirements of the permit or order. However, the appealing party may also request a stay of the requirements of the permit or order until the time the appeal is decided. The PCHB

will ask Ecology to respond to the request for stay and may schedule a separate hearing on the request. The PCHB has the option of moving the appeal hearing date up and hearing both issues.

4. The hearing is held and a decision is issued.

1.2.1 AG Cooperation

The Attorney General's office will assign an assistant AG to work on the appeal. The assistant AG is the state's representative in the appeal and the permit writer serves as the technical consultant. The permit writer should be aware that the assistant AGs have a very heavy case load and they work with a large body of federal and state laws in several programs. The permit writer may first have to convince the assistant AG of the technical and legal merits of the appealed permit. If the permit fact sheet and other decision documentation is done correctly (see Chapter XIV) this should be an easy task. The attorney is the legal expert but you are the permit and water quality expert. The permit writer may have to teach the assistant AG about water quality in the process of justifying the permit. Preparation of a good permit fact sheet will save time here. The permit writer will also be responsible for preparing the submittals of evidence (documents and photos). A complete permit file will expedite this task.

1.2.2 Conferences Before the Hearing

Two types of conferences may be held before the hearing. One type is an optional informal conference in which a PCHB member is a facilitator. The purpose of the meeting is to see if an agreement can be reached before going to hearing. The outcome of the meeting may be a settlement, no settlement, or an agreement to continue settlement proceedings. The PCHB has the authority to order these meetings, but they usually do so only if requested by one of the parties.

If the case proceeds to hearing, a prehearing conference will be held to lay the legal ground rules for the hearing. This conference may be held at the end of an informal conference or by telephone.

1.2.3 Deposition and Testimony

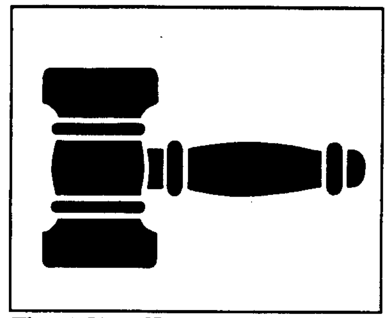
A permit writer may be required to give a deposition, in which the appellant attorney conducts the questioning that would otherwise occur in the hearing. The deposition is transcribed and presented as evidence. The appellant attorney may ask some of the same questions at the hearing.

After your deposition is transcribed, you'll have an opportunity to read it and make any corrections you believe are appropriate. It's extra work but worth the effort. There are no perfect transcripts and some are absolute disasters, especially if they concern technical matters. Never waive the right to read and sign your transcript.

During the hearing in front of the PCHB, the permit writer will be examined and cross-examined by the appellant attorney and the assistant AG.

1.2.4 PCHB Determination

Sometime after the conclusion of the hearing the PCHB will issue a final determination and order. This may take up to a year. Either party in the hearing may then request a reconsideration of the final determination. After review of the case the PCHB will issue a decision and order. This decision and order may be appealed to a state superior court and thence appealed to the federal supreme court, if necessary.



The AG's office and the Program Development Services Section have material to assist you in depositions and hearings.

The PCHB has specific regulatory authority for wastewater discharge permits. If the PCHB determines, upon appeal, that a permit is invalid in any respect it will direct Ecology to reissue the permit in accordance with the directive and any applicable federal or state law.

1.2.5. Assistance

Staff in the Program Development Services Section have time allotted to assist in permit appeals.

2. VARIANCES

2.1 The Federal Variances

The Clean Water Act provides a mechanism for modifying requirements of the Act in exceptional cases. These modifications are called variances. There are very specific provisions which must be met by an applicant before a variance may be granted. As the term implies, a variance is an exceptional situation. A permit writer might never work on a variance but should know what they are and the general procedure for handling them.

Variances are requested during the rulemaking period or during the first permit period after completion of the rulemaking.

2.1.1 Economic 301(c) (No guidance developed by EPA)

Section 301 (c) provides for a variance for non-conventional pollutants from BAT effluent guidelines due to economic factors. The variance may also apply to non-guideline limits (40 CFR 122.21(m)(2)(ii). The request for the variance from effluent limitations developed from BAT guidelines is normally filed by the discharger during the public notice period for the draft permit. Other filing time periods may apply as specified in 40 CFR 122.21(m)(2). The application for the variance must show that the modified requirements will

- represent the maximum use of technology within the economic capability of the owner/operator, and

- result in further progress toward the "no discharge goal".

The cost tests for evaluating this variance request are the same as given in the BPJ permitting for BAT. The applicant must pass these cost tests and, in addition, show compliance with BPT limitations and water quality standards.

2.1.2 Water Quality 301(g) (No guidance developed by EPA)

The CWA provides for a variance from BAT effluent guidelines for ammonia, chlorine, color, iron, and total phenols. The discharger must file a variance application which meets the following requirements:

- The modified requirements must result in compliance with BPT limits, pretreatment guidelines, or water quality standards of the receiving stream, whichever is applicable.

- No additional treatment will be required of other point or non-point source dischargers as a result of the variance approval.

- And the modified requirements will not interfere with attainment or maintenance of water quality to protect public water supplies, protection and propagation of a balanced population of shellfish, fish, and wildfowl, and allow recreational activities in and on the water. Also, the modified requirements will not result in quantities of pollutants which may reasonably be anticipated to pose an unacceptable risk to human health or the environment, acute or chronic toxicity, or synergistic properties.

This variance request requires the discharger to perform water quality monitoring for toxicity, human health effects and dilution. It may also require the development of site-specific water quality criteria.

If a discharger wants both a 301(g) variance and a 301 c variance, the requests must be submitted and considered together.

2.1.3 POTW Discharge to Marine Waters 301(h) (40 CFR Part 125, Subpart G)

This section allows POTW'S that discharge to marine waters a conditional exemption from secondary treatment. The variance is conditional upon meeting water quality standards, conducting receiving water monitoring, limiting the discharge of toxics through pretreatment of industrial wastes, and providing primary treatment.

2.1.4 Innovative Technology 301(k) (40 CFR Part 125, Subpart C)

This section provides an extension of the deadline for compliance with effluent guidelines for up to 2 years if the discharger meets the following criteria:

- Uses an innovative production process that will result in an effluent reduction greater than required.
- Installs an innovative control technique that is likely to reduce the effluent below required levels.
- Achieves the required BAT effluent limits with an innovative system which is expected to cost significantly less.
- This system must also have the potential for industry-wide application.

A process should have been used less than 5 years to qualify as innovative. Industry-wide application is defined as being applicable to 2 or more facilities in 1 or more industrial category.

2.1.5 Fundamentally Different Factors 301(n) (40 CFR Part 125,Subpart D)

This section provides for variances based upon fundamentally different factors (FDF). FDF variances for direct dischargers are available from effluent guidelines for BPT, BCT, and BAT if the individual facility is found to be fundamentally different from the factors considered in establishing the effluent guidelines. Approval of a FDF variance can result in an effluent limitation which is less stringent for a particular pollutant than would result from application of the national effluent guidelines. The FDF variance must be requested by the discharger within 180 days from the time an effluent limit is promulgated or revised. No FDF variance can be approved if it results in violations of water quality standards.

2.2 The State Requirements

The Clean Water Act allows state requirements to be more stringent than federal requirements. The State of Washington has language in its water pollution law which is technology-based (see discussion of all known, available, and reasonable treatment (AKART) in Chapter IV). This language may negate the use of the CWA variances in this state. A good example is the 301(h) variance for municipal discharges to marine waters. Several Puget Sound municipalities were preparing to apply for marine waivers (authorized by the 1977 amendments to the CWA) and were discharging to marine waters with primary treatment. In 1984, the Department of Ecology determined that primary treatment did not conform to state law, specifically, the discharges did not provide AKART. That decision was appealed by the cities to the PCHB. The PCHB ruled that AKART for municipal discharges was secondary treatment.

REFERENCES

Chapter references include references from corresponding appendices.

CHAPTER I.

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APPENDIX 1

1. INDEX TO NPDES REGULATIONS

Appendix A

APPENDIX 4.

I. AUTOCORRELATION

The background material for this example is presented in Chapter IV, Part 4.

Adjustment of Monthly Average Effluent Limitations for Autocorrelation.
The Department of Ecology required an industrial discharger to monitor its cyanide discharge for several years prior to permit renewal. The data is presented below in Table AP4-1. The data indicated a reasonable potential for violation of the water quality standards and the necessity of a water quality-based effluent limit in the new permit. The facility requested an adjustment of the average monthly effluent limit due to autocorrelation. The request and data were passed on to USEPA for assistance in evaluating the autocorrelation. Calculation of autocorrelation involves two steps: 1. calculation of autocovariance and then 2. using the autocovariance to calculate the significant autocorrelation coefficients. These coefficients are used in calculating the monthly average effluent limitation.

An example is presented to show the process but the example shows a one week cycle and would probably not be granted an adjustment to the effluent limit. The facility used in this example applied for an autocorrelation adjustment but also provided the data for a higher site-specific water quality criteria for cyanide. With the higher criteria, they no longer showed a reasonable potential or required an effluent limit.

Table AP4-1. Effluent cyanide data.

DATE	Cyanide ug/l	DATE	Cyanide ug/l	DATE	Cyanide ug/l
3/2/90	38	7/3/90	15	12/16/93	79
3/3/90	70	7/5/90	10	12/22/93	38
3/4/90	50	7/10/90	11	12/29/93	47
3/5/90	66	7/12/90	10	01/05/94	27
3/6/90	52	7/17/90	3	01/12/94	33
3/7/90	35	7/19/90	5	01/19/94	28
3/14/90	40	7/24/90	3	01/26/94	42
3/15/90	47	7/26/90	4	02/02/94	29
3/22/90	3	8/1/90	5	02/09/94	37
3/23/90	23	8/2/90	5	02/16/94	87

3/27/90	2	8/7/90	5	02/23/94	44
3/30/90	18	8/16/90	3	03/01/94*	70
4/3/90	35	8/20/90	4	03/02/94	45
4/4/90	30	8/23/90	4	03/09/94	43
4/5/90	32	8/28/90	3	04/06/94	20
4/6/90	34	8/30/90	5	04/13/94	12
4/9/90	39	4/1/91	60	04/19/94	15
4/12/90	44	4/8/91	10	04/27/94	26
4/17/90	48	03/26/93	60	05/04/94	22
4/19/90	51	03/30/93	56	05/11/94	23
4/25/90	64	04/02/93	58	05/18/94	16
4/26/90	33	04/06/93	40	05/25/94	21
4/29/90	70	04/08/93	74	06/01/94	19
4/30/90	34	04/12/93	66	06/08/94	17
5/8/90	15	04/19/93	52	06/15/94	15
5/10/90	13	04/22/93	37	06/30/94	23
5/15/90	20	04/25/93	39	07/06/94	20
5/17/90	20	05/10/93	21	07/13/94	15
5/22/90	23	05/12/93	13	7/20/94	11
5/24/90	18	05/14/93	12	7/27/94	10
5/29/90	8	6/1/93*	20	8/3/94	14
5/31/90	12	06/16/93	13	8/10/94	10
6/5/90	10	06/18/93	11	8/17/94	4
6/7/90	2	06/21/93	9	8/24/94	13
6/12/90	2	06/24/93	13	8/31/94	8
6/14/90	2	07/10/93	19	9/7/94	35
6/19/90	23	07/12/93	18	9/14/94	26
6/21/90	17	07/14/93	12	9/21/94	38
6/26/90	13	07/16/93	15	9/28/94	46
6/28/90	14	07/29/93	20	10/5/94	5
		08/04/93	13	10/11/94	6

DATE	Cyanide ug/l
10/18/94	4
10/26/94	4
11/2/94	35
11/9/97	44
11/17/94	34
11/22/94	35
11/30/94	26

12/7/94	43
12/14/94	53
12/21/94	30
12/28/94	34
1/5/95	34
1/11/95	53
1/26/95	46
2/1/95	41
2/8/95	49
2/15/95	24
2/22/95	19
3/1/95	32
3/8/95	33
3/15/95	22
3/29/95	23

Calculation of Autocovariance Estimates

The cyanide data consists of 144 individual daily composite samples representing concentration measurements taken during the period March 2, 1990 to March 29, 1995. Days with no samples are considered missing observations. For purposes of calculating the autocovariances, let z_1, z_2, ..., z_N denote the N concentration measurements. The following formula (Box & Jenkins, 1976, p.32) was used to calculate the estimate of the autocovariance:

$$C_k = \frac{1}{N}\sum_{t=1}^{N-k}(Z_t - \bar{Z})(Z_{t+k} - \bar{Z})$$

where,

N = number of observations = 144

k = lag between observations in days = 0,1,...,30

t = the day, where

t = 1 = March 2,1990

t = 2 = March 3,1990

t = 3 = March 4,1990

•

•

•

t = 1854 = March 29,1995

Days on which concentration amounts were not reported are considered to be missing observations. Therefore only those values of t where data has been reported will be used to calculate autocovariances.

The following lists t=1 through t=13 and gives some calculation examples:

value of t	date	concentration amount
1	3/2/90	38
2	3/3/90	70
3	3/4/90	50
4	3/5/90	66
5	3/6/90	52
6	3/7/90	35
7 – 12	3/8/90 - 3/13/90	missing
13	3/14/90	40

The mean of the concentration amounts for the entire data set is:

$$\overline{Z} = \frac{1}{N}\sum_{t=1}^{N-k} Z_t = 26.9653$$

Note: Only use those values of t where concentration amounts exist.

Calculations for a lag of one day using all measurements one day apart(i.e., k=1). For example:

value of t	calculation
1	(38-26.9653)(70-26.9653) = 474.875
2	(70-26.9653)(50-26.9653) = 991.291
3	(50-26.9653)(66-26.9653) = 899.153
4	(66-26.9653)(52-26.9653) = 977.222
6 - 13	*
•	•
•	•
•	•
1853	*
N = 144	Sum of contributions = 5759.7696

Autocovariance of lag two = 8784.0864/144 = 61.0006

* concentration amount two days from this value of t is missing and therefore cannot contribute toward an autocovariance for a lag of two. Concentration values two days apart must exist to be included in the calculation of the autocovariance for lag two.

It is recommended (Box & Jenkins, 1976, p.33) that k not be larger than N/4. In our case, we recommend that k not be larger than 30 since the limits are calculated on a monthly basis. The estimate of the *k*th lag autocorrelation is

$$r_k = \frac{C_k}{C_o}$$

The number of observations used to estimate r_k and c_k need not be equal. Therefore missing data are not a problem, however missing data does prevent standard time series modeling. Estimates of autocovariance and autocorrelation for lags 1-30 are given in Table AP4-2.

A lag of 7 indicates the autocorrelation for observations 7 days apart. (For example, successive Mondays would have a lag of 7, successive Tuesdays would have a lag of 7, etc.)

Table AP4-2. Estimates of Autocovariance and Autocorrelation: Lags 0-30

Lag	Autocovariance	Autocorrelation
0	367.117	
1	39.9984	0.10895
2	61.0006	0.16616
3	33.7574	0.09195
4	44.5250	0.12128
5	37.6707	0.10261
6	49.7120	0.13541
7	101.503	0.27649
8	27.0599	0.07371
9	39.8864	0.10865
10	28.6923	0.07816
11	16.0746	0.04379
12	32.0776	0.08738
13	61.6921	0.16804
14	75.6883	0.20617
15	8.7124	0.02373
16	18.3915	0.05010
17	16.0578	0.04374
18	-4.7897	-0.01305
19	17.2813	0.04707
20	9.6339	0.02624
21	68.9943	0.18794
22	0.4231	0.00115
23	19.9909	0.05445
24	-0.0996	-0.00027
25	-1.4486	-0.00395
26	18.0623	0.04920
27	9.7315	0.02651
28	57.6594	0.15706
29	-0.4159	-0.00113
30	14.6503	0.03991

Significance of Autocovariances

Using

$$\text{var}[r_k] = \frac{1}{N}$$

to approximate the variance of the autocorrelations (Box & Jenkins, 1976, p.35), where N = 144, the approximate variance is 0.006944. The corresponding approximate standard error is 0.083307. The approximate standard error is compared to the autocorrelations (Box & Jenkins, 1976, p.36). In cases where the autocorrelation is greater than two standard deviations (0.166614) the autocovariance was considered significant. Autocovariances for lags 2, 7, 13, 14, and 21 were significant. Adjustment for the lag 2 autocorrelation was not made in our limitation calculations because daily monitoring would be required to implement such limits properly and the permit writer had indicated a requirement of weekly monitoring.

Calculation of Limits

Calculation for limits using the covariance of lags 7, 14, and 21 days follows:

$$\text{Var[Mean(X)]} = (1/16)[4 * \text{Var(X)} + 6 * 0.27649\ \text{Var(X)} + 4 * 0.20617\ \text{Var(X)} + 2 * 0.18794\ \text{Var(X)}]$$

$$= .25\ \text{Var (X)} + 0.10368\ \text{VAR (X)} + 0.05154\ \text{Var (X)} + 0.02349\ \text{Var (X)}$$
$$= 0.42871$$

1. Performance-based Limit
   a. Calculate μ and σ as above as the mean and standard deviation of the ln(CN) values.

$$\mu_y = 2.96442$$
$$\sigma_y = 0.91308$$
$$\sigma_y^2 = 0.83372$$

b. Calculate the estimated mean and standard deviation of the CN values as:

$$E(X) = \exp(\mu_y + \sigma_y^2/2)$$

$= \exp(2.96442 + 0.83372/2)$
$= \exp(3.38128)$
$= 29.40839$

$Var(X) = \exp(2 * \mu_y + \sigma_y^2) * [\exp(\sigma_y^2) - 1]$
$= \exp(2 * 2.96442 + 0.83372)$
$* [\exp(0.83372) - 1]$
$= \exp(6.76256) * [\exp(0.83372) - 1]$
$= (864.85339) * (1.30187)$
$= 1125.9266$

c. Calculate the estimated mean and variance of the average of 4 weekly CN values used in a monthly average. Include the autocovariance effect.

$n = 4$
$\sigma_4^2 = \ln\{0.42871 * Var(X) / E[(X)]^2 + 1\}$
$= \ln\{(0.42871 * 1126 / [29.4]^2) + 1\}$
$= \ln 1.55848$
$= 0.44371$

$\mu_4 = \ln(E(X)) - 0.5\sigma_4^2$
$= \ln(29.4) - 0.5 * (0.44371)$
$= 3.38099 - 0.22186$
$= 3.15913$

d. Calculate the 95th percentile monthly average limit

$X_{.95} = \exp\{\mu_4 + 1.645\sigma_4\}$
$= \exp\{3.15913 + 1.645(0.66611)\}$
$= \exp\{4.25488\}$
$= 70.44836$

e. Calculate the 99th percentile daily average limit

$X_{.99} = \exp\{\mu_y + 2.326\sigma_y\}$
$= \exp\{2.96442 + 2.326(0.91308)\}$
$= \exp\{5.08824\}$
$= 162.10496$

2. Calculating the limit based on the proposed site specific acute water quality standard for CN of 9.85μg/l.

a. WLA = (9.85 μg/l)(13) = 128 μg/l

b. Calculate the LTA using the CV calculated from the lognormal distribution

$$CV = [\exp(\sigma_y^2) - 1]^{0.5}$$
$$= [\exp(0.83372) - 1]^{0.5}$$
$$= 1.30187]^{0.5}$$
$$= 1.14100$$

$$\sigma_2 = \ln(CV^2 + 1)$$
$$= \ln(1.14100^2 + 1)$$
$$= \ln(2.30188)$$
$$= 0.83373$$

$$LTA = WLA \{\exp[0.5\sigma^2 - z\sigma]\}$$
$$= 128 \{\exp[0.5(0.83373) - 2.326(0.91309)]\}$$
$$= 128 \{\exp[-1.70698]\}$$
$$= 128 \{0.18141\}$$
$$= 23.22048$$

c. Calculate the MDL and the AML

$$MDL = LTA \{\exp[z\sigma - 0.5\sigma^2]\}$$
$$= 23.22048 \{\exp [2.326(0.91309) - 0.5(.83373)]$$
$$= 23.22048 \{\exp [1.70698]\}$$
$$= 23.22048 \{5.51229\}$$
$$= 127.99801$$

$$AML = LTA \{\exp[z\sigma_4 - 0.5\sigma_4^2]\}$$
$$\sigma_4^2 = \ln [(0.42871)CV^2 + 1]$$
$$= \ln [(0.42871)(1.14100)^2 + 1]$$
$$= \ln [1.55813]$$
$$= 0.44349$$

$$AML = 23.22048 \{\exp[(1.645)(0.66595) - (0.5)(0.44349)]$$
$$= 23.22048 \{\exp[0.87375]\}$$
$$= 23.22048 \{2.39588\}$$
$$= 55.63348$$

Table AP4-3 illustrates the different results obtained when considering no autocorrelation, autocorrelation at lag 7, autocorrelation at lags 7 and 14, and autocorrelation at lags 7, 14, and 21. The limits increase with the amount of autocorrelation included in the calculation. Positive autocorrelation increases the variance which increases the limit.

Table AP4-3. Comparison of Limit

Lags Considered Significant	Performance-Based AML	Water Quality- Based AML	σ_4^2
None (Independent)	47.3	48.5	.282
Lag 7	66.9	52.8	.378
Lags 7 and 14	69.4	54.8	.424
Lags 7,14,21	70.5	55.6	.444

Note: MDL's are the same no matter how many lags are considered significant. For the Performance based limit it would be 159.3 and the water quality-based limit is 128

APPENDIX 6

1. GUIDANCE FOR CONDUCTING MIXING ZONE ANALYSES

The key products from a mixing zone analysis are the dilution factors. They are used in conjunction with the water quality criteria for calculating reasonable potentials and effluent limits. There are aquatic life-based water quality criteria and human health-based water quality criteria. The former are applied at both the acute and chronic boundaries; the latter are (presently) applied at the chronic boundary. The processes for conducting aquatic life-based analyses and human health-based analyses parallel each other. The differences are in the choice of mixing zone boundaries, and the selection of reasonable worst-case versus average values for the various parameters used in the analyses - as explained in the next section. The permit manager should be consulted about the need for a human health-based analysis.

Steady-state models are the most frequently used tools for conducting mixing zone analyses. However, in some circumstances the primary tool may be a dye study - with a model filling a secondary role. One such circumstance would be when it's apparent that an effluent plume doesn't develop normally (for any number of reasons): The dilution factors must then be measured directly in the field. But, they're the dilution factors for one set of effluent and receiving water conditions only, and a model may still be necessary for analyzing other sets of conditions that are quite different from those present during the dye study. The most appropriate model to use will be the one that validates best against the dye results.

This Guidance provides the specific, detailed information that is needed to select the correct values for the effluent and receiving water parameters, select the appropriate model, and determine when a dye study should be used. It is not a stand alone user's manual or a "cookbook". It's essential to have a working knowledge of how water quality-based effluent limits are developed in Washington state. This knowledge can be gained through reading and understanding the *Water Quality Standards for Surface Waters of the State of Washington* (in particular the subparts on **Toxic Substances** and **Mixing Zones**) and the Department of Ecology's *Permit Writer's Manual* (in particular Chapters VI and VII) - and through experience. That's why this guidance is an appendix to Chapter VI.

This Guidance fills in most of the knowledge gaps so that consultants and permit managers will be able to operate and communicate from the same, uniformly high, level of understanding and expertise needed to produce quality products. Placing this guidance in the *Permit Writer's Manual* and on the Internet (http://www.ecy.wa.gov/programs/eap/pwspread/pwspread.html) ensures that it's a living document that is continually updated as more experience and feedback occurs. As with the *Permit Writer's Manual*, it's expected that ample justification will be provided whenever the guidance is not followed.

1.1 Selecting Aquatic Life-Based And Human Health-Based Values for Parameters

Aquatic life-based analyses involve the concept of determining reasonable worst-case values for various parameters because the durations established for these water quality criteria are one-hour (acute) and four-day (chronic). There are two types of human health-based water quality criteria: Those based on non-cancer effects and those based on cancer effects. The same concept of reasonable worst-case applies in non-cancer analyses as applies in aquatic life-based analyses. The concept of average values applies to carcinogenic human health-based analyses because the duration established for these criteria is the average life span of a person.

The term reasonable worst-case refers to a selected value for a specific effluent or receiving water parameter, (*e.g.*, reasonable worst-case current). Critical condition refers to a scenario involving reasonable worst-case parameters, which has been set up to run in a mixing zone model; (*e.g.*, critical condition scenario to determine mixing at the chronic boundary). Steady-state mixing zone models are usually applied using a combination of parameters (*e.g.*, effluent flow, current speed, depth, density, etc.) packaged to simulate either a critical or an average condition. It's understood that each critical condition (by itself) has a low probability of occurrence. Discharges to tidally-influenced rivers where a saltwater wedge is present may warrant special consideration of critical conditions which are known to occur simultaneously (*e.g.*, during low tides, the predominance of freshwater may always create a well-mixed profile; while during high tides a stratified profile may always exist).

A mixing zone analysis should include a sensitivity analysis. A sensitivity analysis is a series of scenarios organized such that only one reasonable worst-case parameter in each scenario is changed while all others are held constant in a logical progression. Figure 1 is an example of a sensitivity analysis.

Those reasonable worst-case and average parameters that are required input to a model are discussed in subsections 1.1-1.7. Subsections 1.8 and 1.9 discuss other parameters which aren't essential to using the models, but are essential ingredients in a complete mixing zone analysis. Subsection 1.10 addresses two other factors which must be considered before arriving at the correct dilution factors for the acute and chronic boundaries: The Standards require that mixing zones not occupy more than a certain percentage of the channel width and that the effluent flowrate not utilize more than a certain percentage of the available receiving water flowrate in the process of dilution. So actually, the dilution factor to use when determining whether the effluent contributes to acute or chronic toxicity must be the lowest one of three that can be generated for both the acute and chronic boundaries.

1.2 Municipal Effluent Flowrate

For analyses at the acute boundary, the flow-rate to use depends on how close to design capacity the plant is presently operating. If the plant is operating at less than 85% of the dry weather design flow during the critical season, then the flow-rate to use is the highest daily maximum plant effluent flow for the past three years during the season in which the critical flow or condition is likely to occur. If the facility is operating between 85 and 100% of dry weather design flow during the critical season, then use a peaking factor applied to dry weather design to determine acute design flow. The peaking factor is a ratio of daily maximum to monthly average flows derived from actual plant data during the critical season. A peaking factor may also be available in the engineering report for the facility.

For critical condition analyses at the chronic boundary, the flow-rate to use depends on how close to design capacity the plant is presently operating. If the plant is operating at less than 85% of dry weather design flow during the critical season, then the flowrate to use is the highest monthly average plant effluent flow for the past three years during the season in which the critical flow or condition is likely to occur. If the facility is operating between 85 and 100% of dry weather design flow during the critical season, then use the dry weather design flow. For average condition (human health-based) analyses, the flow-rate to use is the annual average design flow as specified in the engineering report, permit application, or projection of annual average flow over the life of the permit by analyzing Discharge Monitoring Report (DMR) data.

1.3 Industrial Effluent Flowrate

For analyses at the acute boundary, the flowrate to use is the highest daily maximum flow for the past three years during the season in which the critical flow or condition is likely to occur. If plant effluent flows are expected to increase during the life of the permit, the highest daily maximum flow must be estimated.

For critical condition analyses at the chronic boundary, the flowrate to use is the highest monthly average flow for the past three years during the season in which the critical flow or condition is likely to occur. If plant effluent flows are expected to increase during the life of the permit, the highest average monthly flow must be estimated. For average condition (human health-based) analyses, the flow-rate to use is the annual average design flow based on permit application or DMR analysis.

1.4 At Site CSO Treatment Facility Flowrate

For analyses at the acute boundary, the flow rate to use is the highest equivalent twenty-four average for the past three years during the season in which the critical flow or condition is likely to occur. If plant effluent flows are expected to increase during the life of the permit, the highest daily maximum flow must be estimated.

For critical condition analyses at the chronic boundary, the flow rate to use is the highest equivalent monthly average flow (total volume of all discharge events in a month divided by the total hours of discharge in that month) for the past three years during the season in which the critical flow or condition is likely to occur. If plant effluent flows are expected to increase during the life of the permit, the highest average monthly flow must be estimated. For average condition (human health-based) analyses, the flow-rate to use is the annual equivalent average flow based on permit application or DMR analysis.

1.5 Intermittent Effluent Flowrate

For analyses at both the acute and chronic boundaries, it is necessary to use an instantaneous flow when the effluent flowrate is intermittent. (Steady-state (averaged) effluent flowrates are a commonly accepted approximation of inherent variability - but only for continuous discharges). The reasonable worst-case flowrate to use is the maximum that can occur - whether through pumps or gravity flow. The resultant model generated dilution factor for the acute boundary must then be adjusted upward by a ratio of maximum flowrate to one-hour, time-averaged flowrate (if the maximum flowrate occurs for less than one hour); and the resultant dilution factor for the chronic boundary must then be adjusted upward by a ratio of maximum flowrate to four-day, time-averaged flowrate.

1.6 Stormwater Flowrate

For analyses at the acute boundary, the flowrate to use in western Washington is the average of the peak one-hour flowrate generated by the two-year, six-hour storm event. For analyses at the chronic boundary, the flowrate to use in western Washington is an estimate of the average run-off generated by the two-year, 72-hour storm event (Ecology, 1993) (Ecology, 1995). Guidance for other areas of the state is evolving.

1.7 Current

For aquatic life-based analyses at both the acute and chronic boundaries in unidirectional waters, both low flow and high flow condition currents should be used. The low flow velocity to use is that which occurs with the 7-day low flow period with a recurrence interval of 10 years (7Q10 by the appropriate statistical method). The high flow velocity to use is that which occurs with the 7Q10 high flow. For non-carcinogenic human health-based analyses, the current velocity associated with a 30Q5 flow should be used if available - or a 7Q10. For carcinogenic human health-based analyses, the velocity associated with the harmonic mean flow for the representative period of record should be used. These can usually be calculated if a cross-sectional profile of the channel bottom has been measured.

Determining the reasonable worst-case current in tidally-influenced water is deceptively difficult. It is true that dilution factors at the hydrodynamic mixing zone boundary (also referred to as the end of initial dilution or near-field) are increased by increased current velocities (assuming other variables are held constant). Conversely, the lower the current velocity, the lower the dilution factor at the end of initial dilution. Early EPA guidance (*e.g.*, that guidance written for the 301(h) waiver application process) suggested that currents approaching zero contributed to critical condition scenarios. However, what is true at the hydrodynamic mixing zone boundary is not necessarily true at a regulatory mixing zone boundary - because the two are not synonymous. (Refer to Figure 5 in the 3PLUMES User's Manual (EPA, 1994) for confirmation of this statement).

Roberts' Froude number (F) is a dimensionless number which characterizes the importance of current velocity relative to the buoyancy flux. It evolved from research into plume behavior and mixing in marine waters. As a dependent variable, it is calculated automatically whenever a case is set up in the 3PLUMES model and appears in the [**Roberts' F**] cell on the 3PLUMES interface. Small values of the Roberts' Froude number signify little effect of current on mixing. According to Roberts (1991) the current exerts no effect on dilution if Roberts' $F < 0.1$. (Refer to section **3.2 Range of the Experiments** for additional information).

For analyses at the acute boundary in tidally-influenced water, the velocity to use is the critical 10th percentile velocity. This is defined as both the 10th and the 90th percentile velocities derived from a cumulative frequency distribution analysis. The distribution analysis should be produced from a data set consisting of periodic readings taken by an instrument deployed over a neap and spring tide cycle. In the absence of a comprehensive field data set, a sensitivity analysis should be run using a wide range of possible velocities which could reasonably occur for any 1-hour duration. The velocity which produces the lowest dilution should be considered the critical velocity.

For analyses at the chronic boundary in tidally-influenced water, the critical velocity is defined as the 50th percentile current velocity derived from a cumulative frequency distribution analysis. In the absence of a comprehensive field data set, a sensitivity analysis should be run using a wide range of velocities, any of which could reasonably occur as the average velocity for any 4-day duration. The velocity which produces the lowest dilution should be considered the critical velocity.

1.8 Depth

For aquatic life-based analyses at both the acute and chronic boundaries in unidirectional water, use the depth of the port(s) at the 7Q10 low flow period. For non-carcinogenic human health-based analyses, use the depth at 30Q5 or 7Q10. For carcinogenic human health-based analyses, use the depth at the harmonic mean flow. These can usually be calculated if a cross-sectional profile of the channel bottom has been measured.

For analyses at both the acute and chronic boundaries in marine water (sea level), use the depth of the port(s) at Mean Lower Low Water (MLLW) - the depth given on most nautical charts.

For analyses at both the acute and chronic boundaries in upstream tidally-influenced riverine waters, use the depth of the port(s) at MLLW during a 7Q10 low flow period.

[Note: EPA mixing zone models should be used advisedly when the depth is less than 5 times the plume diameter. Refer to **3.5 Boundary Conditions**.]

1.9 Stratification

The density profile to use in aquatic life-based analyses is the one that results in the least mixing. Generally, this is either the minimum or maximum stratification, defined as follows: "Minimums" are characterized by profiles that extend to the same depth as the outfall with (1) the smallest differential between sigma-t values at the bottom and top of the profile; and (2) collectively, the highest sigma-t values. "Maximums" are characterized by profiles that extend to the same depth as the outfall with (1) the largest differential between sigma-t values at the bottom and the plume trapping depth; and (2) collectively, the lowest sigma-t values. Some profiles which are profoundly nonlinear warrant more thoughtful consideration.

The density profile to use in human health-based analyses is the one that results in average mixing. This is determined as follows: (1) Generate the dilution factors for the two profiles (minimum and maximum), (2) calculate the reciprocal of the dilution factors to convert them to effluent concentrations, (3) calculate the average of the reciprocal dilution factors (average effluent concentration), and (4) calculate the reciprocal of the average effluent concentration and use that as the harmonic mean dilution factor.

In Puget Sound, changes in density correlate most closely to changes in season (Glenn and Giglio, 1997). Minimum stratifications frequently occur in October, while maximum stratifications frequently occur from May 1-July 15. There is little or no correlation between changes in stages of tide and changes in profiles. The natural tendency, when selecting best-available regional data sets, is to pick the one which is in close proximity to the discharger location. However, "similarity in physical characteristics of the two areas" should receive equal weight with "proximity to the discharger location" as a criterion. This is true with current as well as stratification profiles.

[Note: The manufacturer of SEABIRD field monitoring equipment has proprietary software for downloading, analyzing, and presenting salinity-temperature-depth (STD) data from Ecology's Ambient Monitoring Program. SEAPLOT is a module of this software which may prove useful for quickly reviewing the graphs of stratification profiles from a large STD data set.]

1.10 Pollutants of Concern

All toxic effects testing has some degree of uncertainty associated with it. The more limited the amount of test data available, the larger the uncertainty. A statistical approach has been developed to better characterize the effects of receiving water and effluent variability and reduce uncertainty in the process of deciding whether to require an effluent limit.

The statistical approach to use when determining the background concentration in the receiving water for aquatic life-based analyses depends on the number of data points. For 20 or fewer samples, the geometric mean of the receiving water values should be multiplied by a factor of 2 to estimate the 90th percentile. This estimated background value should then be used in conjunction with the plant effluent data to evaluate reasonable potential to cause an exceedance of the criteria for aquatic life protection and to derive effluent limits.

For 21 or more samples, the reasonable worst-case value is the 90th percentile value derived from a cumulative frequency distribution analysis. This derived background value should be used in conjunction with the plant effluent data to evaluate reasonable potential to cause a violation of the criteria for aquatic life protection and to derive effluent limits.

The statistical approach to use when determining the background concentration for human health-based analyses when there are multiple data points is the geometric mean. Use 0 for value(s) below the MDL and use the MDL for values between the MDL and the QL.

The statistical approach to use when determining the concentration in the plant effluent for aquatic life-based analyses also depends on the number of data points. For 10 or fewer samples, assume a coefficient of variation (CV) of 0.6 and use the reasonable potential multiplying factors to calculate the highest effluent value. These factors can be found in Table 3-2 of the TSD (EPA, 1991) or calculated using the algorithm in Ecology's Excel spreadsheet called TSDCALC.XLW (Internet address - http://www.ecy.wa.gov/programs/eap/pwspread/pwspread.html). This estimated value should then be used in conjunction with the background receiving water data to evaluate a reasonable potential to cause a violation of the criteria for aquatic life/human health protection and to derive effluent limits.

For 11 or more samples, calculate the CV and use the reasonable potential multiplying factors to calculate the highest effluent value. These factors can be found in Table 3-2 of the TSD or calculated using the algorithm in TSDCALC.XLW . This estimated effluent value should then be used in conjunction with the background receiving water data to evaluate a reasonable potential to cause a violation of the criteria for aquatic life/human health protection and to derive effluent limits.

The statistical approach to use when determining the concentration in the plant effluent for human health-based analyses is to use the 50th percentile concentration. If there are less than 10 data points use a multiplier on the highest concentration to estimate the 50th percentile concentration. (The multipliers can be found in Table VII-2 of the *Permit Writer's Manual*). If there are more than 10 values use the cumulative percentile calculation at a 95% confidence to derive the 50th percentile (Excel).

1.11 Other Parameters

Temperature, pH, and hardness are the most noteworthy examples of other parameters, which are necessary ingredients in toxic effects testing; and are not considered pollutants of concern for purposes of this guidance. When selecting a reasonable worst-case value for temperature and pH, use the 90th percentile value derived from a cumulative frequency distribution analysis of a complete data set. For hardness, use the lowest value. A complete data set should include at least three years of DMR or ambient data corresponding to the "critical design period" (*i.e.*, the period of time within the year or season which corresponds to the most likely occurrence of the design flow). If annual data (from all months) are used to select the value, then the 95th or 5th percentile value from the frequency distribution should be used. For limited data sets (n<20) the upper or lower percentile values can be estimated by methods in Gilbert (1987).

Dissolved oxygen concentration is another parameter which may need to be analyzed at the chronic boundary. A critical condition may occur when effluent becomes a relatively high percentage of the receiving water flowrate. The 10th percentile value for effluent D.O. concentration should be input to a mass-balance equation. Such an equation is available from Ecology in the Excel workbook called PWSPREAD (the particular spreadsheet is IDOD2).

1.12 Other Factors

The subpart pertaining to mixing zones in the Water Quality Standards restricts the width of a water body that can be "occupied" by both the acute and chronic mixing zones to twenty-five percent. Implementation of this restriction involves generating a dilution factor (DF) at a lateral boundary, which is located such that the width of the specified mixing zone does not occupy more than 25% of the channel width. The Channel width must be determined during a 7Q10 (in freshwater), MLLW (in sea level marine water), or combination thereof (in upstream tidally-influenced riverine waters). The dilution factor can be generated in one of two ways: (1) Use a model and note the DF associated with the plume diameter at the point where the plume has spread to one of the lateral boundaries; or (2) use dye and measure the DF at the lateral boundary(ies). The more restrictive is the appropriate DF.

This same subpart of the Standards restricts the flowrate in rivers and streams that can be "utilized" by a chronic mixing zone to 25% and by an acute mixing zone to 2.5%. Formulation of this dilution factor for an entire receiving water involves solving the volume fraction equation:

$$DF = \frac{(Q_{amb} + Q_e)}{Q_e} \tag{1}$$

where

Q_{amb} is the flowrate of a receiving (ambient) water; and

Q_e is the flowrate of effluent.

The ambient portion must be reduced by the appropriate percentage to give the amount available for dilution before the equation is solved for DF.

2.0 UNDERSTANDING INITIAL DILUTION THEORY

2.1 General

The general theory behind wastefield formation is easily understood. Visualize wastewater discharged horizontally as a jet from a single round port or a series of jets from ports spaced at equal distances along a diffuser. If the wastewater has a lower density than the surrounding water, then the resulting buoyancy force deflects the jet(s) upward forming plumes which are swept downstream by the current. The plume(s) entrain ambient water as they rise, causing them to be diluted and decreasing the density difference between them and the ambient. If the ambient is stratified, then its density at the depth of the ports is greater than near the surface. The greater density ambient water is entrained initially, and the rising, expanding plumes can reach a level where their density is the same as the surrounding water (*i.e.*, neutral buoyancy). This is the trapping depth.

If the receiving water is unstratified, then its density is the same throughout the water column. In marine water the plume will always surface - if it remains intact. In freshwater the plume will nearly always surface. (Ambient temperatures equal to or less than 4 degrees Centigrade may generate exceptions. Refer to section **3.8 Nascent Density and Buoyancy**).

The more specific theory behind initial dilution is less easily understood. It applies downstream from the port(s) until the turbulent kinetic energy generated by the buoyancy and momentum of the discharge dissipates. This is commonly referred to as the hydrodynamic mixing zone, initial dilution, or the near-field. (The term initial dilution will be used because near-field is defined and used differently in section **6.0 Conducting a Dye Study**). Generally, initial dilution ceases because a layer boundary (water surface or trapping depth) is encountered. At the end of initial dilution, the wastefield is said to be established. The established wastefield then passes into "far-field". Designers of the outfall can usually affect what occurs in the hydrodynamic mixing zone, but have little or no control over what occurs in the far-field.

All initial dilution models are based on the conservation principles of mass, momenta, and energy. The most important principle is that of conservation of mass - the equation of continuity. In mixing zone modeling it's better understood as the entrainment equation. Different models use different conceptual "building blocks" for constructing their plumes along the trajectory. But regardless, the initial mass of the plume building block plus that added, or entrained, over some discrete period of time has to be conserved (*i.e.*, there has to be a mass balance).

Another important aspect of a mass balance involves knowing the effect of water movement, which is determined with the conservation of momentum principle. Like the mass balance approach, accounting is undertaken for fluid momentum in a defined building block. Horizontal momentum is conserved. It is the product of building block mass and horizontal velocity and is increased by the horizontal momentum of the fluid that is entrained in the same period of time. Vertical momentum is not conserved but is altered by buoyancy, which arises from the density difference between the building block and the ambient water. Kinetic and thermal energy are conserved.

2.2 The Conceptual Dilution Factor

The volume fraction equation (Refer to section **1.10 Other Factors,** equation (1)) is the simplest formulation of the dilution factor. Q_{amb} was defined somewhat differently in equation (1) than it will be defined here; it is replaced by Q_a in the following equation:

$$DF = \frac{(Q_a + Q_e)}{Q_e} \tag{1a}$$

where,

Q_a is the volume flux of receiving (ambient) water entrained in the plume from an outfall at some sampling point in the plume; and
Q_e is the volume flux of effluent in the plume.

The Q_a value is easier to visualize than to obtain directly, *i.e.*, it is extremely difficult to measure at any sampling point that might be chosen in the plume. What can be measured directly in the plume is the concentration of a pollutant of concern (or a dye tracer) at any sampling point whose location

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is a known measured distance from the outfall. Call this concentration (C_p). The background concentration in the ambient water (C_a) and the concentration being discharged in effluent (C_e) can also be measured.

To understand initial dilution theory it is necessary to formulate the dilution factor using the basic mass balance equation:

$$(Q_a * C_a) + (Q_e * C_e) = (Q_a + Q_e)C_p \tag{2}$$

The volume fluxes (including the Q_a that's so difficult to measure) can be factored out of the equation by algebraic manipulation:

> If the % effluent is represented by the term X; then the % ambient water which has been entrained in the plume of effluent that emerged from the outfall must be (1-X), because the sum of the two is 100% of the water in the plume. Substituting (1-X) for Q_a and X for Q_e (and understanding from equation (1) that 1 / X = DF) gives
>
> $$DF = \frac{(C_e - C_a)}{(C_p - C_a)} \tag{3}$$

A DF calculated using equation (3) is an empirical result for the particular sampling point where the C_p value is measured.

An initial dilution model generates dilution factors using outfall, effluent, and receiving water characteristics supplied to it. Each DF that prints out is for a particular calculated distance as the model iterates along the plume trajectory away from the outfall. Depending on the model used, the DF (and C_p) may be calculated simply using the volume fraction equation, or the C_p may be calculated as an actual, effective diluted concentration (depending on whether the model accepts C_e and C_a as inputs).

Rearranging equation (3) gives

$$C_p = C_e\left(\frac{1}{DF}\right) + C_a\left(1 - \left(\frac{1}{DF}\right)\right) \tag{4}$$

Again depending on the model used, the printout may occur repeatedly reflecting the model's iterative process along the plume trajectory or it may occur only upon completion of initial dilution. Whatever the capability of the model, it is imperative that its generated C_ps can be validated, *i.e.*, compared to measured C_ps at the same distance from the outfall to establish how well the model is simulating the plume. A dye tracer is generally better for this task because dye can be measured *in situ* with a fluorometer.

2.3 Theoretical Models

The two theoretical models discussed in detail in this Guidance are UM and UDKHDEN. They both solve the equations of fluid motion and mass transport using an integration scheme in which they march forward in discrete increments along the trajectory of the buoyant jet (prompting the phrase "jet-integral models", which often appears in the literature). UM is a Lagrangian model and uses a time increment; UDKHDEN is an Eulerian model and uses a distance increment.

The basic model building block in UM is the wafer-shaped plume element; in UDKHDEN it's the control volume. In theoretical modeling terms the building block mass is incremented by the amount of fluid that flows over the outside boundary of the building block during each time or distance increment. The theoretical models, using these analytical tools, are capable of yielding fair approximations for the turbulent-flow problems encountered in mixing zone analyses. But, this particular field (*i. e.,* the field of fluid mechanics) is more heavily involved with empirical work than are other fields because these analytical tools are not capable of yielding exact solutions to many of the problems.

2.4 Empirical Models

A considerable amount of experimental evaluation has been done using dynamic similitude (models and towing tanks in the laboratory) and dimensional analysis. This led to the development of empirically-derived curve fit equations to make dilution predictions and verify accuracy of the theoretical models. Eventually, the graphs and equations in the original papers were codified and became useful models in their own right.

The empirical models, like RSB and CORMIX, predict initial dilution by stringing together a series of building blocks called length scales. Each length scale evolves from an empirically-derived curve-fit equation and is, literally, a distance along the trajectory where one parameter predominates (*i.e.*, controls the flow). Once strung together by this analysis, the length scales should describe the relative importance of all parameters - discharge volume flux, momentum flux, buoyancy flux, ambient crossflow, and density stratification - throughout the trajectory. For example, the solution for a pure jet can be applied as an approximate solution to that portion of a buoyant jet in a crossflow where jet momentum dominates the flow. Likewise, the results for a pure plume can be applied to the buoyancy-dominated regions for the buoyant jet. The length scales are linked by "appropriate transition conditions" to create a path for the trajectory through completion of initial dilution. These transition conditions are relative unknowns and a cause for concern.

2.5 Average Versus Centerline

When conducting mixing zone analyses it is necessary to have an elementary understanding of the difference between average and centerline plume concentrations (and dilutions) and the role of each in modeling. In theoretical models average concentrations are integral to the integration scheme, center-of-mass of the building block, and total mass flux. Centerline concentrations become important when determining the potential for acute toxicity to organisms.

Plume velocities in a cross section of each building block (perpendicular to the path of the trajectory) resemble a bell-shaped curve. Concentrations, on the other hand, do not resemble a bell-shaped curve (*i.e.*, peak concentrations do not occur at the same location as the center-of-mass). Therefore, an average concentration involves weighting the concentration distribution by the velocity distribution. This average may be referred to as either a "top hat" or "flux-average", depending upon how it is formulated in a particular model. It is the value to be multiplied by the total plume volume flux to get total mass flux, which is passed on to the farfield algorithm.

In theoretical models, the ratio between centerline and average concentration varies between $\sqrt{2}$ (1.44) (for a fully-merged line plume) and 1.94 (for round plumes). It depends on a number of factors: The type of bell-shaped curve employed by a particular model (two examples are 3/2 power profile and Gaussian), the plume geometry, where the building block is on the trajectory relative to the point of discharge, and whether the individual plumes have merged. Models employing the 3/2 power profile may deliver more accurate ratios because that curve better "feathers" the cross-section into complete ambient.

It is difficult to quantify the relationship between average and centerline values based on empirical measurements. Average dilution is difficult to measure in the laboratory, and virtually impossible to measure in the field since it is necessary to define the plume boundary and know the velocity distribution over the plume cross-section. Some direct measurements of average dilutions by Roberts (1991) indicate that the average may differ by only 10 to 20% from the centerline in stagnant currents and is 0% when Roberts' $F < 0.1$. When initial dilution ends due to contact with a layer boundary the distinction between average and centerline ends soon afterward. There is no longer an elliptical plume - it becomes more rectangular.

For aquatic life-based analyses at both the acute and chronic boundaries in unidirectional water, centerline values should be used. For all other analyses flux-average values should be used. All comparisons of outputs between models must use centerline values.

3.0 CHOOSING AN INITIAL DILUTION MODEL

3.1 Descriptions

Five models are described: Three are theoretical (UM, UDKHDEN, and VSW), and two are empirical (RSB and CORMIX). UM is the current version of the earlier models UOUTPLM (vintage 1979) and UMERGE (vintage 1985). It acts as a two-dimensional model for single ports, though a pseudo-three-dimensional version is employed when there is a multiport diffuser with potential merging. It uses the 3/2 power profile to calculate the ratio and determine the centerline concentration as a function of the top hat concentration that it predicts. The ratio changes continuously with each integration step along the trajectory (EPA, 1994). Merging is simulated with the reflection technique (Turner, 1970). (Refer also to section **3.5 Boundary Condition(s)**).

It is showcased when there are multiple (1) densities/currents/pollutant concentrations with depth (up to 11), (2) cases that must be run, and/or (3) ports that are co-flowing (*i.e.*, discharging in the direction of the current). It terminates automatically (ending initial dilution) when the surface is reached, but will also terminate at the command of the modeler when: (1) the vertical velocity of the plume becomes negative (trapping), (2) an "overlap" message appears, or (3) it's asked to "pause" upon reaching one of any number of other predetermined conditions. It can then transition smoothly to a farfield algorithm (Refer to section **5.1 FARFIELD**).

Two shortcomings of UM are its (1) inability to recognize and address lateral boundary constraints (Refer to section **3.5 Boundary Condition(s)**), and (2) inadequacy in simulating three-dimensional plume trajectories. (Refer to section **3.6 Extreme Horizontal Angle**). It is set up and run through the 3PLUMES interface, available from EPA's Center for Environmental Assessment Modeling (CEAM) in Athens GA.

UDKHDEN should generate similar predictions to UM in those situations where the discharge port(s) are oriented horizontal and parallel to the current (Refer to section **3.6 Extreme Horizontal Angle**). However, it is a three-dimensional model, and if the plume bends in a three-dimensional trajectory, then predictions will be less conservative but more accurate than UM. It considers either single or multiport discharges at an arbitrary horizontal angle into a stratified, flowing current. The current speed and density can vary with depth. It terminates when the surface is reached, the plume reaches its maximum rise height, or when errors are encountered. It does not transition to a farfield algorithm, but this is not a problem (Refer to section **5.0 CHOOSING A FARFIELD MODEL**). Presently, it must be obtained through one of its developers - Professor Lorin Davis at Oregon State University.

VSW stands for Very Shallow Water. It is the only initial dilution model that will provide reliable results when the depth approaches three pipe diameters - or less. It is one of three models that operates out of the 3PLUMES interface. VSW employs the reflection technique (Turner, 1970), which is the same algorithm employed by UM to simulate merging of multiple plumes. A user's manual for VSW can be found at Appendix 6.2 of the Permit Writer's Manual.

RSB is an updated version of ULINE which is based on experimental studies of multiport diffusers in marine water as described in Roberts (1991). Its strengths are: (1) It is set up and run through the 3PLUMES interface, so that many cases can be run quickly and compared to UM results; (2) it simulates opposing-port diffusers; and (3) the user is advised whenever the model is operating outside the range of the experiments. (Refer to section **3.2 Range of the Experiments**). One present shortcoming of RSB is that it does not provide dilution factors for distances prior to the end of initial dilution, although it does transition smoothly to the same farfield algorithm employed by UM. It uses a constant centerline-to-flux-average ratio of 1.15. RSB is also available from CEAM.

CORMIX stands for CORnell MIXing zone models. The package consists of CORMIX1, CORMIX2, and CORMIX3 for the analysis of submerged single port discharges, submerged diffusers, and surface discharges, respectively. EPA's decision to proceed with the development of CORMIX was an attempt to exploit accumulated laboratory and field experience to compile a set of methods and empirical models to bridge the gaps that were evident in theoretical modeling at that time. The system was designed for the non-specialist model user, so that plume predictions could be made without having prior knowledge about dilution modeling.

Representing a stratification profile is limited to two layers (*i.e.*, inputting densities at bottom, one intermediate depth, and top). A discontinuity in a profile (*e.g.*, a thermocline) can be represented by inputting two densities at this intermediate depth. Nevertheless, this limits its effectiveness in marine waters where maximum stratifications are usually nonlinear. The top density does not have to be at the water surface if it's known that the plume is trapping. Another concern is its infrequent, but unpredictable, creation of plume trajectories with discontinuities. These may be due to the transition conditions. (Refer to section **2.4 Empirical Models**).

> "CORMIX1 & CORMIX2 near-field simulations now use the jet integral model CORJET for simulations. A few simulation modules still do use 'empirical' approach, but these cases are now in the minority" (Doneker, 1997).

The strengths of this model are its ability to acknowledge the effects of boundary constraints and gravitational collapse. The initial dilution modules in CORMIX generate only centerline values. It is available through EPA's CEAM in Athens GA.

UM should perform well for a majority of the critical condition scenarios encountered - particularly in tidally-influenced waters. It can also be used frequently for the purpose of comparing dilutions with the other models. Appendix 1 of the 3PLUMES User's Manual (EPA, 1994) and part III MATHEMATICAL MODELS OF INITIAL DILUTION, subpart B. EPA Models, found in Roberts (1991) are excellent general references to consult. The following sections (3.2 - 3.8) discuss specific circumstances and outfall configurations which might influence which model is selected or how a particular mixing zone analysis is conducted.

3.2 Range of the Experiments

"Empirical models are most effective when prototype and model variables and conditions match closely. When they do not, the predictions can degrade substantially. In other words, it is often difficult to extrapolate to conditions which were not included in the experimental design [range of experiments] on which the models are based. Since it is often not clear to the user when extrapolation occurs, this can be a real problem" (EPA, 1994). Inaccurate extrapolations are manifested in the form of discontinuities in the plume trajectory.

The authors of RSB went through a careful consideration of the possible critical condition scenarios which their model might be expected to analyze before choosing the range of experiments (Roberts *et al*, 1989). The studies were conducted with the following experimental configuration: (1) A straight diffuser consisting of horizontally discharging round ports which were uniformly spaced; (2) ports discharging from both sides of the diffuser through T-shaped risers; (3) marine water - both density-stratified and well-mixed; (4) current at an arbitrary angle relative to the diffuser axis; and (5) individual plumes merging rapidly. As a result, there is a straightforward approach to determining whether the model will be operating within this range:

> The two length scale ratios $\frac{l_m}{l_b}$ and $\frac{s}{l_b}$ are diffuser parameters which characterize the significance of source momentum flux and port spacing, respectively. (Refer to section **2.0 UNDERSTANDING INITIAL DILUTION THEORY** for an explanation of length scales and fluxes). Note that these length scale ratios encompass all of the "diffuser" parameters: jet exit velocity, port diameter, port spacing, effluent density, and ambient stratification. The model is operating within its range of "diffuser" parameters when:
>
> $$0.31 < \frac{s}{l_b} < 1.92 \text{ , and}$$
>
> $$0.078 < \frac{l_m}{l_b} < 0.5$$
>
> Roberts' Froude number (F) is a more important parameter. The tests were run at differing current speeds to obtain F in the range 0 (zero current speed) to 100. As was stated in section **1.5 Current**, values of F < 0.1 signify no effect of current on dilution.

The effect of current also depends on its direction relative to the diffuser axis (Θ is the horizontal angle). Tests were run with $\Theta = 90^\circ$, 45° and 0° (parallel to the current).

The length scale ratios, F, and Θ for each scenario are included in the output for each RSB model run. It then becomes a simple matter to determine whether the model is operating within its capability. Consideration should be given to using Figure 13 in Roberts (1991) (included as Figure 2) if the length scale ratios $\frac{l_m}{l_b}$ and $\frac{s}{l_b}$ are less than 0.2 and 0.3, respectively. The normalized equation on the x-axis of the graph must be solved for S_m - the minimum initial dilution.

[Note: The volume flux per unit length of diffuser (q) is easily calculated. The Roberts Froude number (F)[Roberts F], buoyancy flux per unit length of diffuser (b)[buoy flux], and Brunt-Vaisalla frequency (N)[N (freq)] needed to solve for S_m are included on the interface among the "red" cells. The "red" cells can also be used to calculate other fluxes, length scales, and length scale ratios].

The authors of the CORMIX family of plume models have recently released a technical report which may contain information on the tow-tank arrangement and procedures used during their experiments (Jirka *et al*, 1996a). Information from this report will be provided in a future update to this Guidance. Presently there is no straightforward approach to determining whether the model will be operating within its range of experiments on any particular analysis.

CORMIX2 uses the "equivalent slot diffuser" concept and thus neglects the details of the individual jets issuing from each diffuser port and their merging process. It assumes that the flow emerges from a long slot discharge with equivalent dynamic characteristics (Jirka *et al*, 1996b). Thus, mixing is based on the plume characteristics after the individual ports have merged.

3.3 Densimetric Froude Number Less Than 1 or Negative

The densimetric Froude number is the ratio of the momentum to the buoyancy of the plume. If the Froude number is less than 1, then the plume separates from the bottom of the port orifices allowing ambient water to flow into the diffuser. This may also occur in marine waters if the total area of the port orifices exceeds 70% of the diffuser cross-sectional area. Either of these two conditions will result in unbalanced flows, and the diffuser section must be evaluated hydraulically as a manifold prior to completing the mixing zone analysis (Ecology, 1997).

The 3PLUMES interface signals this condition in several ways: (1) The input cell [Froude #] contains the number; and (2) the output from the run may contain the message "absolute value Froude # < 1, potential diffuser intrusion", or the message "begin overlap". UM should generate accurate results with either a marine or freshwater ambient as the Froude Number approaches zero - provided the correct conditions are described to it. RIVPLUM5 or FARFIELD may be a better choice in some unidirectional receiving waters. (Refer to section **5.0 CHOOSING A FARFIELD MODEL**).

[Note: UDKHDEN has a built-in safeguard which causes it to terminate and display an "IHLF-11" error message when the Froude number is less than 2.5 and it cannot provide an accurate answer.]

If the Froude Number is negative, then the effluent is more dense than the ambient water. The plume may hit bottom (Refer to section **3.5 Boundary Condition(s)**); or perform even more atypical (Refer to section **3.8 Nascent Density and Buoyancy**).

3.4 Overlap Condition

This condition is associated with highly buoyant plumes (*i.e.*, when the upward curvature of the plume is great). As UM iterates through the curvature the bottom portions of consecutive plume building blocks (elements) actually overlap, resulting in physically unreal negative volume and negative mass. The radius of each element, and entrainment, are overestimated. Plumes that perform in this manner and surface will usually protrude upstream from the outfall. Output from a UM run which is performing through this condition will contain the error message "begin overlap". The results from UM should not be used unless the following information appears in the output after the message: (1) An "end overlap" message indicating the cessation of the condition causing the error, and (2) relatively little change in the dilution between the "begin overlap" and "end overlap" messages.

[Note: It may be necessary to invoke the ^R command in order to force the model to simulate through the "end overlap" message to maximum rise. This will allow the comparison to be made between dilutions at the beginning and end of overlap.]

Refer to section **3.2 Range of the Experiments** to determine whether RSB can be used under those conditions when UM should not be used.

3.5 Boundary Condition(s)

Boundary conditions are side, surface, and/or bottom constraints which interfere with entrainment of receiving water into the plume. Banks, levees, docks, shallow water, port(s) discharging directly on the bottom, and confined embayments are all examples. The concern is whether the model will reflect these interferences accurately by limiting the entrainment. An additional consideration is whether the constraints are more likely to affect initial dilution or farfield entrainment.

If side boundaries are in close proximity such that initial dilution entrainment is likely to be affected, then CORMIX should be used exclusively - provided there do not appear to be discontinuities. CORMIX simply gives a cautionary message acknowledging attachment to the side boundary, but does not proceed to calculate adjusted dilutions. Side boundaries may become interferences in the farfield phase of the plume, such as when the plume attaches to the bank downstream in a unidirectional river or stream. Then it may be appropriate to use RIVPLUM5, if the attachment (or close proximity) affects horizontally transverse spreading of the mixed effluent. Otherwise, the Constant Eddy algorithm may be appropriate. (Refer to section **5.0 CHOOSING A FARFIELD MODEL**).

It is suggested that all of the models except VSW be used with caution in shallow waters (*i.e*., less than five pipe diameters deep) and not be used at all if it is very shallow water (*i.e*., less than three plume diameters deep). VSW is the best choice. If UM is used, consideration should be given to using the "Pause" command to force the model to terminate initial dilution when the plume width is the same as the depth of water (The plume is no longer entraining properly). RIVPLUM5 is a very good alternative in unidirectional waters. (Refer to section **5.0 CHOOSING A FARFIELD MODEL**). If the discharge is actually to the surface of the receiving water (*e.g*., during mean lower low water (MLLW)), then either VSW or CORMIX3 should be used. Justifying the model chosen is advised.

Plumes that surface inside one or both of the two regulatory boundaries are a common occurrence in estuarine receiving waters because of the additional buoyancy. The surface is the one boundary condition that all five models signal decisively. However, simulations from that point to either or both of the regulatory boundaries may be suspect. (Refer to section **4.0 UNDERSTANDING FARFIELD THEORY**).

UM will issue a "-> bottom hit" message when the extremities of the plume element intersect the bottom. The bottom is assumed to be either (1) at a distance below the port equal to the port elevation [port elev], or (2) at the deepest ambient depth (in the column headed [depth] on the interface) - whichever is greater. Often times this constraint can be ignored or eliminated. Frequently it is the downstream portion of the plume which hits the bottom. Since this is not the primary entraining surface of the plume, the condition can be ignored, as long as it isn't violated excessively. The condition can be eliminated by increasing the deepest ambient depth (in the [depth] column), as long as it is reasonable to do so, *e.g*., anytime there is a positive gradient to the bottom in the direction of the plume trajectory.

3.6 Extreme Horizontal Angle

The horizontal angle is defined as the angle between the axis of the diffuser and the current (*i.e.*, an angle of 90 degrees simulates a situation where the effluent plume(s) and current are co-flowing). The dialogue box on the 3PLUMES interface indicates that UM is valid over angles ranging from 45 to 135 degrees; it can also be used advisedly for angles between 20 and 45 degrees, and 135 and 160 degrees. It's most accurate at 90 degrees because UM is a two-dimensional model. The effect of changing the direction of the current simply reduces the spacing between ports, invoking a pseudo-three-dimensional version. UDKHDEN may be a better choice the further away from 90 degrees the horizontal angle is because it's a true three-dimensional model.

It is recommended that RSB be used for multi-port diffusers in marine water - particularly if the diffuser is an opposing-port configuration. (Refer to section **3.7 Opposing-port Diffuser Configuration**). It evolved from an EPA model (ULINE), which was designed to simulate multi-port configurations where upstream plumes are bent over by the current to interact with downstream plumes. (These zero and 180 degree horizontal angle situations are termed line plumes). It may also be the model of choice for many other horizontal angles, including negative (*i.e.*, a counter-flowing situation).. However, it must perform within its range of experiments. (Refer to section **3.2 Range of the Experiments**).

UM can be adapted to simulate line plumes in freshwater - and in marine water when RSB is not appropriate. The procedure to follow is relatively straightforward: Run UM to simulate one plume (using the actual flowrate from only one of the ports in the diffuser). Assume that it is the most upstream plume. The output from this case will provide enough information about the plume trajectory so that an estimate can be made of the horizontal distance this plume will travel before merging with the plume from the next downstream port. The output will also provide the average concentration within the plume at this point of merging. This concentration is then input as the ambient pollutant concentration [amb conc] to the UM case for the next downstream port. The procedure is completed for this particular critical condition scenario when the last downstream port in the sequence is simulated.

In order for this procedure to accurately simulate line plumes, the interaction among upstream and downstream plumes must be quite thorough. This can be determined by examining the output from the first UM run to see whether the plume is sufficiently strongly bent over to envelop most of the downstream plume's trajectory. This procedure is explained in a citation by Frick (1996). It may sometimes be advisable to compare dilutions from several models and provide justification for the one chosen.

[Note: Horizontal angle is defined differently in UDKHDEN.]

3.7 Opposing-port Diffuser Configuration

Opposing-port diffuser configurations have ports discharging in opposite directions. The configuration may consist of paired ports which are directly opposite each other or staggered ports, which are all equal distance apart but alternate from one side to the other. In a current, the upstream plumes create a counter-flowing situation wherein they frequently bend over and merge with downstream plumes. UM assumes that the diffuser is configured with all ports on one side, the downstream side, creating a co-flowing situation. The counter-flowing situation resulting in cross-diffuser merging is not simulated explicitly.

The preferred approach to modeling these configurations in freshwater is to simply divide the diffuser length by the total number of segments (*i.e.*, total number of ports minus one). The quotient is the appropriate spacing; this number should be entered in the cell [spacing] on the 3PLUMES interface. The number of ports is entered in the cell [# ports]. The simulation offered by UM will be quite good if the Roberts' Froude number (F) is > 0.1 because at this current speed the plumes from opposite sides of the diffuser merge rapidly.

The preferred approach in marine water is to use RSB - if it will be operating within its range of experiments. (Refer to section **3.2 Range of the Experiments**). It is based on experiments conducted in the lab using opposing-port diffusers. However, RSB does require a minimum of 3 ports in the diffuser; and it presently does not provide dilution factors for intermediate points prior to the end of initial dilution. The latter will not be a problem when initial dilution ends inside the acute boundary.

Another acceptable approach for either fresh or marine water involves simulating only downstream ports. However, it is best used with paired port configurations. This necessitates doubling the flow per port (assuming there is an even number of ports in the diffuser) and increasing the diameter of the ports to maintain approximately the same densimetric Froude number. With this approach only the downstream ports would be used when determining spacing and number of ports. This method may give better simulations than the preferred freshwater approach if the Roberts' Froude number (F) is < 0.1. However, a cautionary message will sometimes appear stating that far-field results are unreliable because the plumes did not merge prior to the end of initial dilution.

3.8 Nascent Density and Buoyancy

It is well understood that the density of water is not a linear function of temperature or salinity, *e.g.*, water expands below about four degrees Celsius. However, it is not well understood that the non-linear response of water density to changes in temperature and salinity can cause surprising and unanticipated changes in plume behavior. A thermally buoyant freshwater plume discharged to unstratified freezing freshwater will initially rise, as expected, before unexpectedly sinking to the bottom. The plume will rise only briefly before becoming denser than the ambient and beginning to sink because, as the plume entrains ambient water and cools, it eventually acquires a temperature at which fresh water is at or near maximum density. In another situation, a highly buoyant plume may rise less than a less buoyant plume. These phenomena are known as the nascent density effect.

Nascent buoyancy effects also occur under many combinations of ambient and effluent salinities and temperatures. A high salinity plume, *e.g.*, a blended effluent such as desalination brine and sewage, may sink briefly before becoming less dense than the ambient and beginning to rise - reversing buoyancy. The citation mentioned below contains several additional examples involving freshwater discharges to the Columbia River.

The linear density assumption is a popular theoretical and empirical simplification in most models. The latest version of UM (8/7/95) is a non-linear model which will simulate nascent conditions. A draft citation by Frick *et al* (1995) is an excellent reference on this subject.

4.0 UNDERSTANDING FARFIELD THEORY

It is reasonable to always assume that the plume's motion in the ambient receiving water is turbulent. Spreading takes place much faster in turbulent flow than in laminar flow. Farfield begins with gravitational collapse (also referred to as buoyant spreading or density current). This is characterized by lateral spreading of the plume along the layer boundary while it is being advected by the ambient current. Plume thickness probably decreases during this phase; the mixing rate is relatively small.

Following gravitational collapse, the remainder of farfield mixing is best explained by either the theory of turbulent diffusion or shear flow dispersion. Turbulent diffusion employs the turbulent mixing equation of Brooks (1960), wherein the coefficient describing the rate of spread of the plume increases with the size of the plume. The best known facet of this theory is the celebrated "4/3 Power Law" - which says that the diffusion coefficient is proportional to the 4/3 power of the size of the plume. In reality, the Law only applies in homogeneous turbulence far from any boundaries.

Shear flow dispersion employs the longitudinal dispersion equation of Taylor (1954) by the method of Fischer *et al* (1979). The theory common to all shear flow is that spreading in the direction of flow is caused primarily by the velocity profile in the cross section. The mechanism Taylor analyzed is often referred to as the "shear effect". It gives a reasonably accurate estimate of the rate of longitudinal dispersion in rivers, and a partial estimate of longitudinal disperison in estuaries.

5.0 CHOOSING A FARFIELD MODEL

The two empirical, initial dilution models discussed earlier do account for gravitational collapse. This phenomenon was observed during the tow-tank experiments, and plume performance during this phase was measured and factored into the empirical equations. Gravitational collapse is not accounted for in the three theoretical , initial dilution models or the two farfield models discussed in this section. It may be included in a later version of the forthcoming Windows Interface for Simulating Plumes (WISP) - the next generation of UM and its farfield component. The 3PLUMES interface presently allows the modeler to choose the diffusivity coefficient (the [far dif] cell). (Refer to section **5.1 FARFIELD**).

There are two farfield models which are presently recommended for use. They are code named FARFIELD and RIVPLUM5. Each can serve as a stand-alone mixing zone model when warranted by the situation and has been set up in spreadsheet format to accommodate this (Internet at http://www.ecy.wa.gov/programs/eap/pwspread/pwspread.html).

FARFIELD also serves as the farfield algorithm in the 3PLUMES interface, so that it operates in conjunction with UM and RSB by taking the plume diameter delivered to it at the cessation of initial dilution. This may change in the future, since RSB presently accounts for gravitational collapse and the UM/FARFIELD interface does not.

The appropriate farfield model to use in a particular mixing zone analysis depends on the combination of conditions involved:

1. The receiving water is sufficiently deep such that a plume will form and pass through the initial dilution phase without "Froude number less than 1", "overlap", or "boundary constraint" problems. Use FARFIELD as the algorithm (*i.e.*, the version in 3PLUMES interface). (Refer to **5.1 FARFIELD.**)

2. The receiving water is shallow and unidirectional; the effluent is thoroughly mixed surface to depth (*i.e.*, no defined plume); and the discharge is a single port or short diffuser. Use RIVPLUM5. (Refer to **5.2 RIVPLUM5.**)

3. There is/are bank constraint(s). Use RIVPLUM5, provided the conditions in 2. above are also met. (Refer to **5.2 RIVPLUM5.**)

4. Other shallow receiving waters (with no bank constraints) which occur with all other combinations of effluent plumes and discharger configurations. Use FARFIELD as a stand-alone model. (Refer to **5.1 FARFIELD**). A three-dimensional advective dispersion equation may also be appropriate.

5.1 FARFIELD

FARFIELD calculates dilution using the method of N.H. Brooks (1960). Four variations have been set up as spreadsheets in an EXCEL workbook - FARFIELD.XLS. The spreadsheets are:

- 3PLUMES algorithms;
- Brook's exponential diffusivity (4/3 power law);
- Brook's linear diffusivity; and
- Brook's constant (eddy) diffusivity.

The "3PLUMES algorithms" spreadsheet calculates dilutions by assuming either an exponential increase, a linear increase, or a constant diffusivity - just as the other three spreadsheets do. Linear diffusivity was added to the two algorithms already incorporated in the 3PLUMES interface in order to make it the same package that is offered by the other three spreadsheets. Its utility is in allowing direct comparisons to be made between dilutions at the regulatory boundaries as generated by one or the other of the models in 3PLUMES and dilutions generated by other initial dilution models which have no far-field algorithm, *e.g.*, UDKHDEN.

The default value for the dispersion coefficient in the 3PLUMES interface, the [far dif] cell, is 0.0003 $m^{2/3}$/sec. For areas of high energy dissipation and where there are no constraints, *e.g.*, a large, relatively deep embayment, then the value 0.000453 $m^{2/3}$/sec can be used. In less turbulent situations, it may be as low as 0.0001 $m^{2/3}$/sec.

The exponential increase is referred to as the 4/3 Power Law in the output from 3PLUMES. It is Richardson's Law, which is basically only applicable in situations where there is unobstructed spread of the plume. It is reasonable to assume that the spread is unobstructed if the plume diameter at all locations on its trajectory is less than 1/10 the distance to the nearest side boundary. It is unreasonable to assume that diffusivity will increase exponentially when the plume can only spread along a nearby side boundary. Provided this boundary does not act as a constraint (as discussed in section **3.4 Boundary Condition(s)**), it is reasonable to assume that it will increase as the first power of the plume width (*i.e.*, linearly). Dilutions generated by the Constant Eddy Diffusion algorithm should be used in all other situations.

To understand why "3PLUMES algorithms" differs from the other spreadsheets, it is necessary to understand the motivation of the authors of the interface. They felt it was important that users of the interface should have to input only one dispersion coefficient in the [far dif] cell; but still be able to receive the output from two far-field algorithms - the 4/3 Power Law and the Constant Eddy. This resulted in some coding changes in the initial steps of the algorithms (including linear diffusivity), where the dispersion coefficient in the [far dif] cell is converted for the first and only time to the diffusivity coefficient used in the Brook's equation. The dispersion coefficient is multiplied by (the width of the plume field at the end of initial dilution)$^{4/3}$. The 4/3 Power Law is described by R.A. Grace (1978).

Following these initial steps, the diffusivity coefficient is either (1) continuously increased according to the 4/3 power of the width of the plume field at the end of the previous iteration, (2) continuously increased according to the first power of the width of the plume field at the end of the previous iteration, or (3) held constant according to the zero power of the width of the plume field at the end of the previous iteration. Each algorithm then inserts its coefficient into a modified Brooks' Equation, as described in the text associated with equations 66-73 of the User's Manual (EPA, 1994).

Each of the other three spreadsheets contains one of the algorithms; they are also based on Brook's Equation. Their utility is that they're purer forms, unencumbered by the slight inaccuracies associated with the need to input a single dispersion coefficient to an interface. All of these far-field algorithms are much simpler and rudimentary than the initial dilution models. The quality of the estimates should not, in general, be expected to be as high as the initial dilution models. Consequently, if better methods for estimating the far-field dilutions are available they should be used.

User instructions for the input section of FARFIELD.XLS are available in another appendix to this chapter and on the Internet at the address given earlier. The user does not need to enter or change any values or formulas in the Output Section. The spreadsheets calculate dilution along the trajectory of the plume and at the specified mixing zone boundary. Optional calculation of pollutant concentrations assuming first-order decay rates is also provided.

5.2 RIVPLUM5

The spreadsheet RIVPLUM5.XLS calculates dilution using the theory of Taylor (1954) by the method described in Fischer *et al,* (1979) and referred to in EPA's Technical Support Document (1991). It is a one-dimensional model that calculates dilution at a specified point of interest downstream in a river. The calculation for dilution factors incorporates the boundary effect of shore lines using the method of superposition. This model is based on the assumption that the discharge is: (1) a single point source, which is most appropriate for single port or short diffusers, or side-bank discharges; and (2) completely and rapidly mixed vertically, which usually only occurs in shallow rivers. If the diffuser length occupies a substantial portion of the stream width, or the discharge is not vertically mixed over the entire water column within the acute mixing zone, an alternative model should be used. The spreadsheet also includes optional calculation of the effective origin of a wastewater source. User instructions for the input section are available in another appendix to this chapter and on the Internet at the address mentioned earlier in this text.

6.0 CONDUCTING A DYE STUDY

There are four primary objectives that justify conducting a dye study:

1. Confirm the presence of an eddy.

2. Quantify dilution.

3. Quantify far-field accumulation (reflux).

4. Develop a far-field diffusivity coefficient.

It is advisable to conduct a reconnaissance survey before the main field work. If the receiving water is tidally-influenced, then the survey should be conducted at the same time in the neap or spring tide cycle and covering the same stages of tide as will be covered during the dye injection. Consideration should be given to deploying a meter to record time, current speed and direction, and depth of water during the survey in order to develop a thorough understanding of anomalies that may be occurring between published tide data and actual field data. Consider taking a cross-section of the channel bottom, if appropriate. These data will allow accurate times to be established for dye injection and measurement. It will also afford an opportunity to set up and run some preliminary cases; which, in turn, will provide some early estimates of plume performance, *e.g.*, trapping depth and horizontal distance to the end of initial dilution.

Concentration of dye in effluent, total loading, and duration of injection deserve careful consideration. Each varies in importance depending upon the objectives of the study, and is discussed below for each objective. A draft plan of study explaining the methods and QA/QC to be employed should be submitted to the Department for review and approval following the reconnaissance survey and prior to initiation of the study.

6.1 Confirm the Presence of an Eddy

If the objective of the study is to simply confirm the presence of an eddy, then concentration, loading, and duration of injection are all relatively unimportant. It's only necessary that the path of the plume can be traced. If, on the other hand, it is necessary to know the mixing ratio in the eddy in order to determine it's contribution, then concentration, loading and duration may all be important.

6.2 Quantify Dilution

It may be important to validate a model using a dye study and one set of conditions. This may be the only feasible alternative if critical condition scenarios that need to be examined are quite different from the set of conditions present during the dye study (*e.g.*, future growth). Calibration may also be the only feasible alternative (*e.g.*, tide-flex diffuser). Validation and calibration, while admittedly unpredictable exercises, may serve to increase confidence in model performance.

A constant dye concentration in effluent is important. Total loading is not important *per* se; however, it is important that effluent flowrate be at or near its reasonable worst-case. Duration is relatively unimportant. In tidally-influenced waters, injection and measurements should begin after the start of an ebb tide stage. By using this timing it may be possible to capture one critical condition scenario.

The most appropriate location to take the measurements for comparing dilutions from the dye study and a model is at the end of the hydrodynamic mixing zone, particularly if the end follows rapid surfacing of the plume in shallow water. (Refer to section **3.5 Boundary Condition(s)**). The best way of determining the location is via a reconnaissance survey in conjunction with preliminary model runs, using the set of conditions that will be encountered during the field work.

A dye study may be the only reliable way to quantify dilutions if boundary constraints are such that all model results will be suspect. A critical condition scenario may include a rapidly surfacing plume with upstream protrusion and/or side boundaries that are affecting entrainment and dilution. (Refer to **3.5 Boundary Condition(s)**). Measurements would be taken at both the acute and chronic boundaries.

A dye study may also be the most reliable way to quantify dilutions at a lateral boundary when the width of a mixing zone is restricted to 25% of the channel width. (Refer to section **1.10 Other Factors**). The field work should be conducted when conditions are as close as possible to critical.

In this situation, a constant concentration in effluent and duration of injection are important. Total loading is relatively unimportant, *per se*; however, it is important that effluent flowrate be at or near its reasonable worst-case. In tidally-influenced waters, injection and measurements should begin soon after the start of a Lower Low Water slack at sea level during a neap tide or soon after a small flood if it's riverine. This affords the best opportunity to capture a critical condition scenario.

[Note: It can be assumed that upstream protrusion does not occur whenever the Roberts' F is > 0.1.]

6.3 Quantify Far-field Accumulation (Reflux)

This objective warrants considerable discussion because it's difficult to accomplish. Tidal currents may cause effluent to accumulate in the receiving water surrounding an outfall in a tidal river or estuary. The receiving water may also contain background concentrations of pollutants from sources other than effluent. Various methods are available to account for the accumulation of effluent and ambient background sources when determining potential to exceed water quality criteria or estimating waste load allocations.

There are three methods which are acceptable to Ecology. Two of the methods involve a dye study. Total loading and duration are important factors in both methods; concentration in the effluent can vary during application. The third method involves simply accepting a default value for reflux in lieu of conducting a dye study. Detailed guidance for conducting the methods and mass-balance equations follow.

Far-field accumulation of effluent may be estimated based on either of two methods:

•Method 1: the USGS superposition method (Hubbard and Stamper, 1972) may be used by injecting the tracer during one tidal day and measuring continuously at a fixed monitoring station to determine maximum concentrations during succeeding days until the tracer is undetectable; or

•Method 2: the Jirka method (EPA, 1992) may be used by injecting the tracer over several tidal cycles (usually five or more) until a quasi-maximum steady state is reached. Concentrations of the tracer are usually monitored continuously at a fixed monitoring station.

In addition to two methods of tracer injection, two alternative schemes for locating monitoring stations are acceptable:

•Alternative 1: tracer concentrations are measured in the near-field at the mixing zone boundary in the approximate centerline of the effluent plume; or

•Alternative 2: tracer concentrations are measured in the far-field at some considerable distance from the effluent plume at a position that is representative of the source of dilution water for the plume.

Either the superposition or Jirka methods may be used to conduct the tracer studies for both Alternatives 1 and 2. A third method is also proposed if a tracer study is not conducted:

•Method 3: A default correction which can be used as an approximation of far-field accumulation will be based on recommendations by EPA (1992).

A number of terms which will be used during this discussion need to be defined.

near-field: at the chronic mixing zone boundary in the approximate center-line of the effluent plume.

far-field: at some considerable distance from the effluent plume at a position that is representative of the source of dilution water for the plume.

V: initial maximum effluent concentration (volume fraction of effluent; *e.g.* 5 percent effluent corresponds to V of 0.05) during first tidal cycle prior to influence of far-field accumulation from previous tidal cycles.

$\overline{V}$: quasi-steady-state maximum effluent concentration (volume fraction of effluent; *e.g.* 5 percent effluent corresponds to $\overline{V}$ of 0.05) after several tidal cycles result in equilibrium with far-field accumulation.

r_d: return rate of dye or effluent mass discharged in the previous tidal cycle as defined in EPA (1992).

DF: initial effluent dilution factor (reciprocal of volume fraction of effluent; *e.g.*

5 percent effluent corresponds to DF of 20) during first tidal cycle prior to influence of far-field accumulation from previous tidal cycles. DF may be estimated using a model (e.g. PLUMES) or by near-field tracer measurement. DF is usually determined at critical conditions.

$\overline{DF}$: quasi-steady-state effluent dilution factor (reciprocal of volume fraction of effluent; *e.g.* 5 percent effluent corresponds to $\overline{DF}$ of 20) after several tidal cycles (usually 5 or more cycles) result in equilibrium with far-field accumulation. $\overline{DF}$ is usually determined at critical conditions.

C_p: pollutant concentration measured as a flux-average value in the plume at the mixing zone boundary. (Refer to section **2.5 Average versus Centerline**).

C_e pollutant concentration in effluent discharged from the outfall pipe.

C_a: pollutant concentration in upstream ambient receiving water (*i.e.*, away from the influence of far-field accumulation).

WLA: effluent concentration to use for Waste Load Allocation (acute or chronic) for derivation of water quality-based permit limits.

WQC: pollutant concentration for water quality criteria (acute or chronic).

Mass Balance Equations for Alternative 1

If the tracer monitoring station is located in the near-field, then the following mass-balance equations are appropriate:

- calculate Jirka's r_d from near-field $\overline{V}$ and V (based on equation 22 in (EPA, 1992)):

$$r_d = \frac{\left(\overline{V} - V\right)}{\overline{V}} \quad (5)$$

- calculate the near-field $\overline{DF}$ (acute or chronic boundary), including the effect of far-field accumulation of effluent, from model or tracer estimates of DF and estimated r_d in the previous step (based on equation 22 in (EPA, 1992)):

$$\overline{DF} = DF\left(1 - r_d\right) \quad (6)$$

- The following equation is appropriate to calculate pollutant concentrations (C_p) at the mixing zone boundaries for comparisons with water quality criteria. Near-field dilution is corrected for far-field accumulation of effluent in the previous step. The following equation incorporates the effect of ambient background (C_a) from sources of pollutants other than effluent. Estimates of C_e may also include a reasonable potential multiplier using methods in chapter VI of this Manual. Pollutant concentrations (C_p) are estimated as follows (based on equation 9 in (EPA, 1994):

$$C_p = C_e\left(\frac{1}{\overline{\overline{DF}}}\right) + C_a\left(1 - \left(\frac{1}{\overline{\overline{DF}}}\right)\right) \tag{4a}$$

- calculate acute and chronic WLAs:

$$WLA = WQC * \overline{\overline{DF}} - C_a\left(\overline{\overline{DF}} - 1\right) \tag{7}$$

Example:

Given: near-field V = .02 (2 percent effluent); near-field $\overline{V}$ = .07 (7 percent effluent).

Calculation of near-field $\overline{\overline{DF}}$ including far-field accumulation of effluent:

$$r_d = \frac{(.07-.02)}{.07} = .7143;\quad DF = \frac{1}{.02} = 50;\ \text{therefore, near-field } \overline{\overline{DF}} = 50(1-.7143) = 14.3$$

Mass Balance Equations for Alternative 2

If the tracer monitoring station is located in the far-field, then the following mass-balance equations are applicable:

•calculate near-field DF, excluding the far-field accumulation of effluent, from a mixing zone model or from an additional near-field tracer monitoring station (*e.g.* near-field DF = reciprocal of near-field V)

•calculate the near-field $\overline{\overline{DF}}$ (acute or chronic boundary), including the effect of far-field accumulation of effluent, by mass balance with near-field DF from the previous step and far-field $\overline{V}$ (based on equation 8 in (EPA, 1994)):

$$\overline{\overline{DF}} = \frac{DF}{\left(1 + \overline{V}(DF - 1)\right)} \tag{8}$$

The following equation is appropriate to calculate pollutant concentrations (C_p) at the mixing zone boundaries for comparisons with water quality criteria. Near-field dilution is corrected for far-field accumulation of effluent in the previous step. The following equation incorporates the effect of ambient background (C_a) from sources of pollutants other than effluent. Estimates of C_e may also include a reasonable potential multiplier using methods in chapter VI of this Manual. Pollutant concentrations (C_p) are estimated as follows (based on equation 9 in (EPA, 1994)):

$$C_p = C_e\left(\frac{1}{\overline{DF}}\right) + C_a\left(1 - \left(\frac{1}{\overline{DF}}\right)\right) \tag{4a}$$

- calculate acute and chronic WLAs:

$$WLA = WQC * \overline{DF} - C_a\left(\overline{DF} - 1\right) \tag{7}$$

Example:

Given: near-field DF=50 from PLUMES model excluding far-field accumulation of effluent; far-field $\overline{V}$=.051 (5.1 percent effluent) from tracer study using super-position method.

Calculation of near-field $\overline{DF}$ including far-field accumulation of effluent:

near-field $\overline{DF} = \frac{50}{\left(1 + .051(50 - 1)\right)} = 14.3$

Mass Balance Equations for Method 3

If it is decided to use a default correction for far-field accumulation, then the following mass balance equations are applicable:

- estimate default for Jirka's r_d = 0.5 from EPA (1992).

- calculate the near-field $\overline{DF}$ (acute or chronic boundary), including the effect of far-field accumulation of effluent, from model or tracer estimates of DF and estimated r_d in the previous step (based on equation 22 in (EPA, 1992)):

$$\overline{DF} = DF\left(1 - r_d\right) \tag{6}$$

- The following equation is appropriate to calculate pollutant concentrations (C_p) at the mixing zone boundaries for comparisons with water quality criteria. Near-field dilution is corrected for far-field accumulation of effluent in the previous step. The following equation incorporates the effect of ambient background (C_a) from sources of pollutants other than effluent. Estimates of C_e may also include a reasonable potential multiplier using methods in chapter VI of this Manual. Pollutant concentrations (C_p) are estimated as follows (based on equation 9 in (EPA, 1994):

$$C_p = C_e\left(\frac{1}{\overline{DF}}\right) + C_a\left(1-\left(\frac{1}{\overline{DF}}\right)\right) \qquad (4a)$$

- calculate acute and chronic WLAs:

$$WLA = WQC * \overline{DF} - C_a\left(\overline{DF} - 1\right) \qquad (7)$$

Example:

Given: r_d=0.5; DF=50

Calculation of $\overline{DF}$: $\overline{DF} = 50(1 - 0.5) = 25.$

6.4 Develop a Farfield Diffusion Coefficient

[RESERVED].

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A SENSITIVITY ANALYSIS FOR THE PORT ANGELES WWTP

showing Critical Condition Scenarios

Case number	Design considerations at WWTP flowrate	diffuser	MZ boundary	flowrate	Reasonable worst-case current	strat/de
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	3.3 MGD	13 @ 4 inch	acute	13.4 MGD	10th percentile	10% (well-r
2	"	"	"	"	"	"
3	"	"	"	"	"	90% (max-
4	"	"	"	"	"	"
5	"	"	"	"	90th percentile	10% (well-r
6	"	"	"	"	"	90% (max-
7	"	"	chronic	5.3 MGD	50th percentile	10% (well-r
8	"	"	"	"	"	"
9	"	"	"	"	"	90% (max-
10	"	"	"	"	"	"
11	"	13 @ 6 inch	acute	13.4 MGD	10th percentile	10% (well-r
12-20	"	"				
21	"	tide flex valves	acute	13.4 MGD	10th percentile	10% (well-r
22-30	"	"				
31	? MGD	13 @ 6 inch	acute	21 MGD	10th percentile	10% (well-r
32-40	"	"				

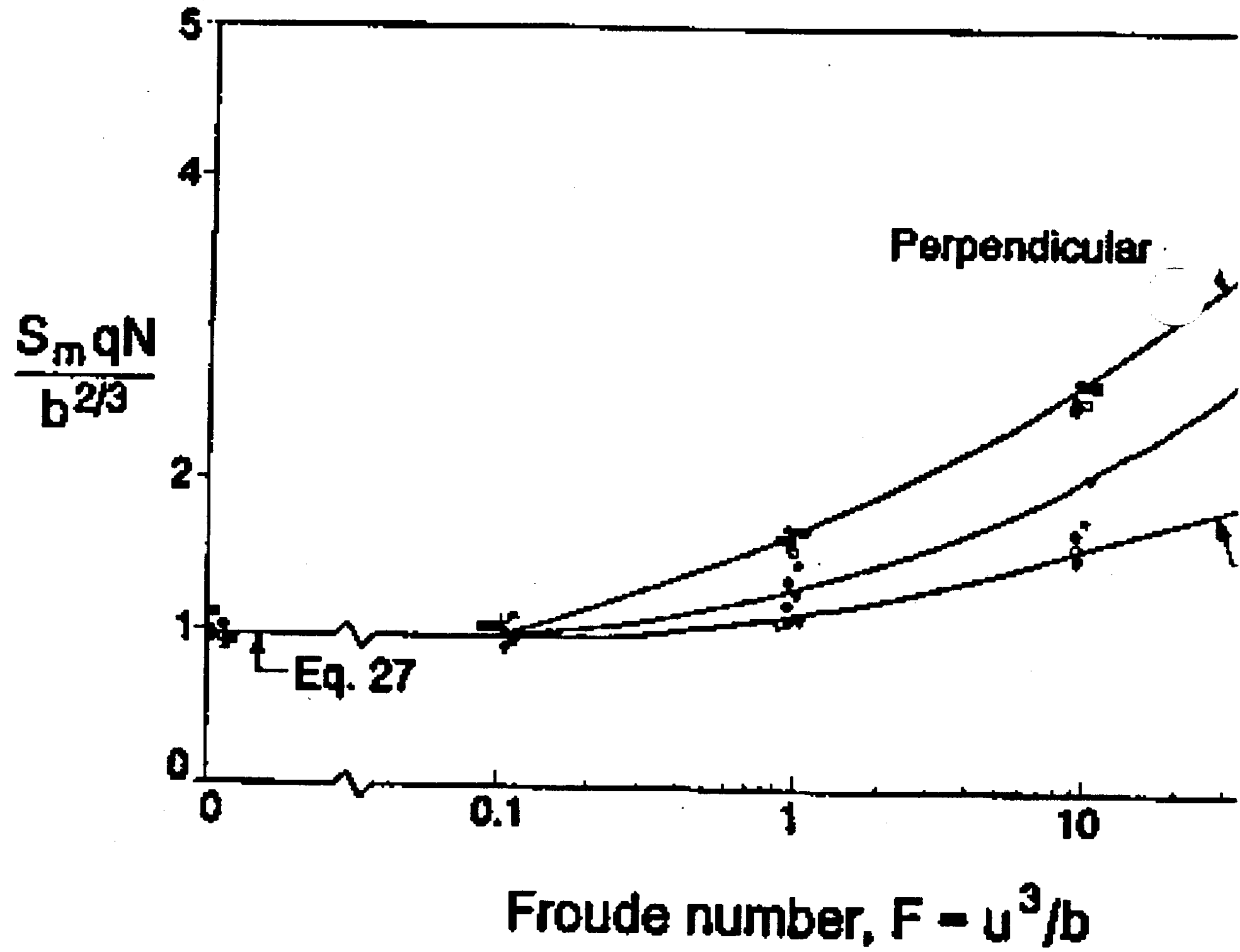

FIGURE 13. Minimum initial dilution for discharges from line diffusers into a stratified [illegible]
P. J. W., Snyder, W. H., and Baumgartner, D. J., *J. Hydraul. Eng. ASCE.*, 115(1), 1, [illegible]

8.0 USER'S MANUAL FOR THE VERY SHALLOW WATER (VSW) MIXING ZONE MODEL

8.1 Introduction

Single port discharges in shallow water or at the surface are frequently encountered in Washington state. There are numerous examples of wastewater treatment plant discharges through outfalls to shallow streams, and irrigation return water is an example of the latter. In the User's Manual for 3PLUMES (EPA, 1994), it states that "....plume models were developed for deep water discharges and modelers are not confident in extrapolating verification data from deep water situations to shallow water applications" - defined on page 150 of the Manual as, "less than three plume diameters deep. Under some circumstances where the standard plume models seem inappropriate, the UM model (one of two models in the 3PLUMES interface) may be specially configured and run to provide dilution estimates. This special configuration of UM is referred to as the Very Shallow Water (VSW) algorithm.

This User's Manual first presents the theory behind VSW and then steps through the actual process which was followed in analyzing the mixing and dilution available to the city of Sumner, Washington. The following discussion of the theory was excerpted from materials provided by Walt Frick of EPA's Center for Environmental Assessment Modeling (CEAM) in Athens GA. The VSW algorithm is contained in present versions of the 3PLUMES software, but all discussion pertaining to theory and use was omitted from the User's Manual because the algorithm is not yet officially supported by EPA.

8.2 Shallow Water, Surface Discharge Plume Theory

The reflection technique (Turner, 1970) is built into the UM model merging algorithm. By making the appropriate adjustments to the input data, the algorithm can be applied to shallow water, surface discharge problems. When this is done, the ability to predict the trajectory is lost. However, often this is not a problem because the possibilities for trajectory development are limited by the shallow water, surface discharge and the resulting geometric constraints.

First, it should be understood that for diffusers the merging algorithm works on the basis of symmetry; *i.e.*, a series of identical sources is assumed to exist such that a vertical plane of symmetry may be established between any two ports near the center of the diffuser. Relative to this plane, each side of the diffuser appears identical and the plane may be regarded as a reflecting mirror. When two such planes are established, one on each side of a chosen port, the plume problem may be isolated from the rest of the diffuser. The central idea is that whatever a plume loses to the other side of such a "reflection" plane it gains back from its identical neighbor, for no net loss or gain. To complete the technique, all that is needed are the equations to limit the mass between the two planes and to adjust the entrainment surfaces to account for the loss of entrainment surface where the plume contacts a plane.

To make the connection to shallow water, surface discharge problems, it is only necessary to appreciate the exact parallelism between the vertical reflecting planes and the surface and bottom (or a horizontal plane elevated above the surface a distance equal to the depth of the water) of the shallow water, submerged discharge problem. Thus, the merging problem, when it is laid on its side, is largely equivalent to the shallow water, surface discharge problem, at least with respect to the entrainment (dilution) process.

However, the rotation from vertical to horizontal is not appropriate for the plume trajectory problem. Consequently, the analogy is strictly valid only when the discharge is a horizontal jet, *i.e.*, a "plume" which has no buoyancy (densimetric Froude number > 9). Furthermore, because UM is a two-dimensional model, is strictly valid only for co-flowing jets. In order to maintain consistency with these assumptions, the ambient should be weakly stratified or unstratified. Nevertheless, useful results can be obtained when these conditions are not fully met; but, the quality degrades as the departure from these ideal conditions increases.

The geometry of a mid-depth discharge to shallow water is shown in Figure 1a. The geometry of a surface discharge is given in Figure 1b.

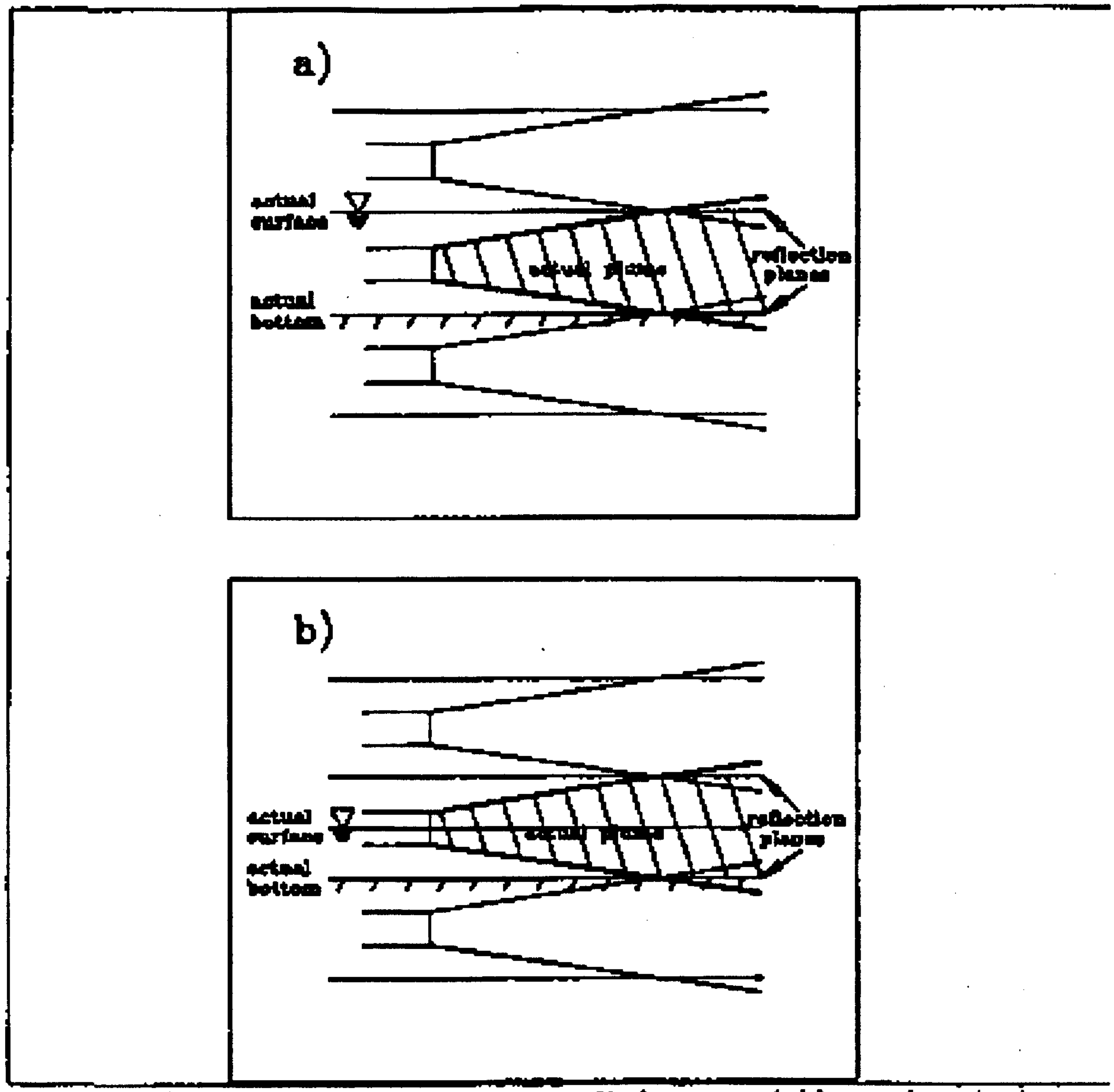

Figure 1. Geometry of a) a shallow water discharge, and, b) a surface discharge.

8.3 The City of Sumner Example

A Total Maximum Daily Load (TMDL) study has been completed for the Puyallup River system, indicating that Waste Load Allocations (WLAs) will be necessary in portions of the system for some pollutants. Ammonia among others, is a pollutant of concern. Given the large number of existing NPDES permits (20), a basin-wide evaluation of the need for water quality-based permits has begun.

The City of Sumner discharges into the White River, 140 feet upstream from the confluence with the Puyallup River. Their permit must be modified to include water quality-based effluent limits. The City wants to ensure that ample credit is given for mixing provided at the confluence. However, this may be irrelevant if toxicity at the acute boundary governs.

The wastewater treatment plant discharges through a 24 inch outfall anchored at mid-channel in 1.37 m of water. Reasonable worst-case parameters for the effluent are: a flow of 3.42 MGD, temperature of 19.9°C., and ammonia concentration of 25 mg/L. The 7Q10 flowrate in the White River is 437 cfs, which gives a width and average depth of 41.5 m and 0.70 m, respectively; velocity is 0.40 m/sec. At this low flow, the temperature of the River is 17.4°C., pH is 9.1 mg/L (apparently due to attached algae), and the background concentration of ammonia is 0.07 mg/L.

Sumner makes a good example for demonstrating the reflection technique and the Very Shallow Water (VSW) algorithm. Call up the 3PLUMES interface screen. The default filename (found on the help line) is **plmstuff.var**. The filename can be readily changed by invoking <get **W**ork file>, [CTRL **W**] from the main menu and creating a filename for this project. Do that now; use the filename **sumner.var**. **Plmstuff.var** will simply be saved by 3PLUMES and remain unused. Before inputting the data, invoke the <configu**Re** models>, [CTRL **R**] command and set up the configuration string NTNO0. (The first letter of the 5 letter configuration code should always be toggled to "N" to signify ambient "off", because this technique requires two (and only two) lines of ambient data.)

Enter the input data as shown in Figure 2. Reasons for some of the data, which don't seem logical now, should be clear as the example progresses. Remember to simplify the conversion from one unit to another by using <units **K**onversion>, [CTRL **K**] in order to input [**tot flow**] and [**plume dia**] without having to convert the units

Sept 8. 1993, 9:00:03 ERL-N PROGRAM PLUMES April 26, 1993 Case. 1 of 1

Title Sumner WWTP: Ammonia/Chronic/3.42 MGD/7Q10

tot flow	# ports	port flow	spacing	effl sal	effl temp	far inc	far dis
0.1498	1		1000	0	18.9	9.144	92.8
port dep	port dia	plume dia	total vel	horiz vel	vertl vel	asp coeff	print frq
1.067	0.6096					0.1	500
port elev	ver angle	cont coef	effl den	poll conc	decay	Froude #	Roberts F
0.3046	0	1		25	5.21e-6		
hor angle	red space	p amb den	current	far dif	far vel	K:vel/cur	Stratif #
90			0.43	0.000453	0.4		
depth	current	density	salinity	temp	amb conc	N (freq)	red grav.
0	0.43		0	17.4	0.07		
1.36	0.43		0	17.3	0.07	buoy flux	puff-ther
						jet-plume	jet-cross
						plu-cross	jet-strat
						plu-strat	
						hor dis >=	

CORMIX1 flow category algorithm is turned Off

Help: F1. Quit: <esc>. Configuration: NTNOO File: sumner.var

Figure 2. Independent variables (data input through keyboard).

Data is input in the usual way <u>except</u> that changes may have to be made to the stratification and buoyancy parameters in order to better conform to the reflection theory assumptions. The ambient should be minimum stratification, *i.e.*, the bottom and surface temperatures (and salinities) should be basically identical. The bottom layer is made slightly colder (denser) to avoid undefined cells from appearing elsewhere; and the temperature and salinity of the effluent flow produce a largely non-buoyant plume. In summary, the [**effl den**] cell and ambient [**density**] cells should contain values that are very nearly equal.

Ordinarily it is a good idea to sketch out the tentative sensitivity analysis (*i.e.* the list of cases to be run) ahead of time when using the VSW algorithm . This helps to ensure that cases to be run later, which may involve changing only one or two independent variables, are created before VSW is implemented. As you will see, implementing VSW introduces artificial numbers into many of the cells, and the original data is lost to that case.

At this point it's appropriate to interpret some language from the Washington State water quality standards pertaining to mixing zones. The dilution factor to use when determining whether Sumner's effluent causes chronic toxicity must be the lowest one of three generated as follows:

- at the longitudinal boundary, which is located downstream from the discharge 300 feet plus the depth of the port(s)[**port dep**];

- at a lateral boundary, which is located such that the width of the mixing zone does not occupy more than 25% of the channel width;

- such that the effluent flowrate is no more than 25% of the flowrate available for dilution.

The dilution factor to use when determining whether Sumner's effluent causes acute toxicity must be the lower one of two generated as follows:

- at the longitudinal boundary, which is located downstream from the discharge at a distance equal to 10% of the length of the chronic mixing zone;

- such that the effluent flowrate is no more than 2.5% of the flowrate available for dilution.

After examining the data in Figure 2, a question may arise about the [**far dis**] of 92.8 m. This is 304.5 feet, which is the maximum length of the chronic mixing zone for Sumner and, therefore, the farthest distance to which the analysis needs to extend. Note that this extends beyond the confluence of the two rivers and all model results will have to be reassessed if a chronic criterion is determined to be limiting. Use 0.40 m/sec for the far-field velocity [**far vel**]. This also must be considered a temporary assumption because it extends beyond the confluence. The [**depth**] for the last line of ambient data (1.38 m in this example) should be greater than the sum of [**port dep**] + [**port elev**]. The densimetric Froude number [**Froude #**] (a dependent variable calculated by the model) is greater than 1 - which is important.

Assume that the list of cases to be run has already been sketched out, and that two cases will be needed to examine ammonia chronic toxicity and two for ammonia acute toxicity. Make one extra case for each as a backup. Use <go to Case>, [CTRL **C**] (or [**Page Up**]) to create 3 more copies of Case 1. Now make several of the necessary changes in Case 4 ([**title**], [**current**]) in order to produce an acute case; then create two copies of Case 4 in Cases 5 and 6. After you are done, use the [CTRL **C**] command again to return to Case 1.

Use<shallow/surface **Z**>, [CTRL **Z**] from 3PLUMES' drop down main menu to implement the VSW algorithm. When the input screen (window) appears, answer the question by pressing [S] to choose the surface/bottom option. After the choice is made, an additional cell appears for inputting the width of the stream: **Input effective channel width (m):** ______.

Input 30 meters. Comparing width and average depth of the White River, and depth of outfall suggests that the effective channel width is ~ 30 m, much less than the channel width of the wetted perimeter (41.5 m).

The input screen is now updated as shown in Figure 3. Notice that the title has been changed by the addition of the letters ^ZS to the beginning of the title string (CTRL(^)Z for the command and 'S' for surface/bottom discharge). This is a reminder that 3PLUMES has changed some of the cells in order to prepare the data for running in the reflection mode. The affected cells are the **[tot flow]**, **[port flow]**, **[spacing]**, **[port dep]**, **[port dia]**, **[plume dia]**, **[red space]**, and (bottom) **[depth.**

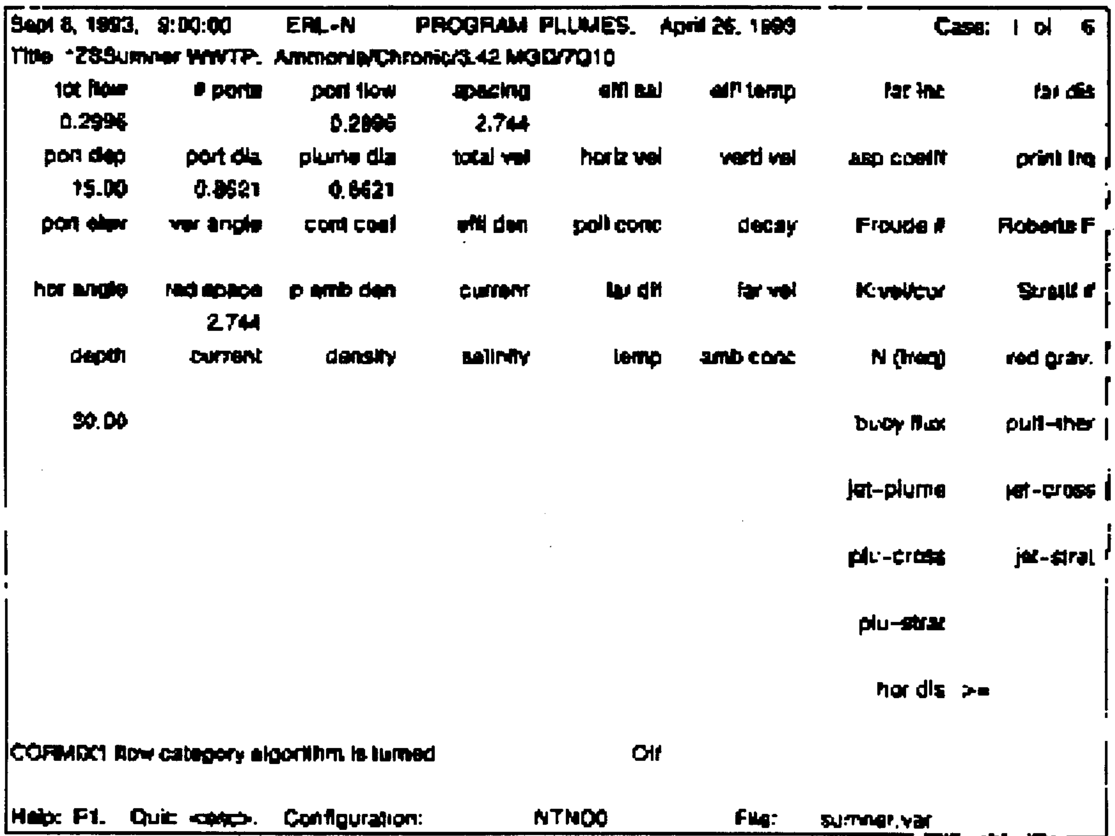

Figure 3. Variables that are altered by reflection technique algorithm.

Notice that **[port dep]** (15.00 m) is now half the width of the stream, and the bottom **[depth]** is equal to the width of the stream (30 m). The bottom and surface substitute for the vertical planes of the merging plume problem. Obviously, plume buoyancy and stratification would be not only meaningless because the dimensions have been changed, but would introduce trajectory motion which would interfere with the proper execution of the plume model.

The spacing distance is now 2.744 m, or twice the total depth of the stream. This must be true because otherwise the plume, which is at the surface (or bottom), would be on the reflection plane and symmetry would be broken. This problem is overcome by doubling the total flow with half of the flow discharging into the imaginary layer above the surface of the water. The port diameter is adjusted accordingly so that the basic momentum properties of the plume (for example, the total velocity) are not changed. This assures that the dynamics of the problem are treated consistently. Note that the diameter is multiplied by the square root of 2 so that the area of the port is doubled.

Next, run VSW by using the [CTRL **U**] command. A prompt on the dialogue line will ask for the desired form of output: printer, console or disk file. Output to the printer. Results of the simulation are shown in Figure 4. Some interpretation of the results is in order. Note, first of all, that the total stream flow is 32.9 m^3/sec (30x2.74x0.40); therefore, since the effluent flow is 0.2996 m^3/sec, the maximum dilution that can be achieved is 111:1. Thus, any predictions beyond the point of a dilution equal to 111:1 should be ignored.

```
Sep 8, 1995,   9:30:23  ERL-N PROGRAM PLUMES, Apr 26, 1993   Case:   1 of  6
Title   '25Sumner WWTP:  Ammonia/Chronic/3.42 MGD/2010                non-linear
 tot flow   # ports port flow    spacing  effl sal effl temp   far inc   far dis
  0.2996          1    0.2996      2.744       0.0      19.9     9.146      92.6
 port dep  port dia plume dia total vel horiz vel vertl vel asp coeff print frq
    15.00    0.8621    0.8621     0.5133    0.5135     0.000      0.10       500
port elev ver angle cont coef  effl den poll conc     decay  Froude # Roberts F
   0.3048       0.0       1.0    -1.712        25  5.21e-6     7.976     47.61
hor angle red space p amb den p current   far dif   far vel K:vel/cur Stratif #
       95     2.744    -1.223      0.43  0.000453       3.4     1.394  0.001045
    depth   current   density  salinity      temp  amb conc  N (freq) red grav.
      0.0      0.43    -1.232       0.0      17.4      0.07  0.002415  0.004806
       30    0.4300    -1.216       0.0      17.3      0.07 buoy flux puff-ther
                                                             0.001440     3.368
                                                            jet-plume jet-cross
                                                                6.472    0.9139
                                                            plu-cross jet-strat
                                                              0.01811     12.75
                                                            plu-strat
                                                                17.89
                                                             hor dis>=

CORMIX1 flow category algorithm is turned off.
 0.2996 m3/s, 6.838 MGD, 10.58 cfs.                       >0.0 to 100 m3/s range
Help: F1.  Quit: <esc>.  Configuration:NTH00.  FILE: sumner.var;
UM INITIAL DILUTION CALCULATION (non-linear mode)
 plume dep plume dia poll conc  dilution   CL conc   hor dis
        m         m                                       m
    15.00    0.8621     25.00     1.000     25.00     0.000
    15.00    0.8651     24.83     1.007     25.00   0.09226 -> bottom hit
    13.76     2.763     2.898     8.811     9.263     22.82
 -> surface reflection begins
    10.83     8.165    0.8491     31.98     1.758     75.48
    7.370     36.96    0.4904     59.27    0.9328     149.1 -> bank(s) reach
FARFIELD CALCULATION (based on Brooks, 1960, see guide)
Farfield dispersion based on wastefield width of      14.96m
   --4/3 Power Law--   -Const Eddy Diff-
     conc  dilution      conc  dilution  distance        Time
                                                m       sec   hrs
   0.4895      59.4    0.4893      59.4     146.3     12.98   0.0
```

Figure 4. Model run at [print frq] of 500.

The theoretical model, UM, conserves momentum - in this case the combined momentum of both the entrained fluid and the effluent fluid. This assumption appears to work well in deep, unconfined water; but here, frictional and other open channel flow effects, which are ignored in the theoretical model, play a role in subtracting momentum from the stream. Hence, these predictions should be used with caution. Nevertheless, the user has some idea when the plume spreads vertically throughout the water column and the surface is hit. This is the point at which the plume reflects off the two planes. The output refers to it as -> surface reflection begins (at 22.82 m downstream).

More interpretation of the data is needed in order to help in developing an effluent limit and a mixing zone for Sumner. Remember that the length of the chronic mixing zone cannot exceed 92.8 m; AND, therefore, length of the acute zone cannot exceed 9.28 m. However, the model didn't provide a fine enough resolution in the output data to clearly interpret the data at a horizontal distance of either 92.8 or 9.28 m. But, the capability is there!

Move to Case 2 by using [CTRL **C**]. Changing the **[print frq]** number from 500 to 25 will provide the needed resolution. Lines of output will occur more frequently, i.e., less meters of **[hor dis]** will be traveled by the plume for each calculated **[dilution]** and **[poll conc]**. Rerun UM just as was done for Case 1, and the results for Case 2 should look like those in Figure 5.

Sep 8, 1993, 10:11:53 ERL-N PROGRAM PLUMES, Apr 26, 1993 Case: 2 of 6
Title "Z9Summer WWTP: Ammonia/Chronic/3.62 MGD/781C non-linear

tot flow	# ports	port flow	spacing	effl sal	effl temp	far inc	far dis
0.2996	1	0.2996	2.744	0.0	19.9	9.144	92.8
port dep	port dia	plume dia	total vel	horiz vel	vertl vel	asp coeff	print frq
15.00	0.8621	0.8621	0.5133	0.5135	0.000	0.10	25
port elev	ver angle	cont coef	effl den	poll conc	decay	Froude #	Roberts F
0.3048	0.0	1.0	-1.712	25	5.21e-6	7.974	47.61
hor angle	red space	p amb den	p current	far dif	far vel	K:vel/cur	Stratif #
90	2.744	-1.225	0.43	0.000453	0.4	1.194	0.001045
depth	current	density	salinity	temp	amb conc	N (freq)	red grav.
0.0	0.43	-1.232	0.0	17.4	0.07	0.002413	0.004806
50	0.4300	-1.216	0.0	17.3	0.07	buoy flux	puff-ther
						0.001440	1.368
						jet-plume	jet-cross
						6.472	0.9119
						plu-cross	jet-strat
						0.01811	12.75
						plu-strat	
						17.89	
						hor dis>=	

CORMIX1 flow category algorithm is turned off.
47.61 0 to 1000 range
Help: F1. Quit: <esc>. Configuration:ATNO0. FILE: summer.var;
UM INITIAL DILUTION CALCULATION (non-linear mode)

plume dep	plume dia	poll conc	dilution	CL conc	hor dis	
m	m				m	
15.00	0.8621	25.00	1.000	25.00	0.000	
15.00	0.8651	24.83	1.007	25.00	0.09226	-> bottom hit
14.98	0.9519	21.03	1.189	25.00	1.399	-> bottom hit
14.94	1.050	17.70	1.414	25.00	2.803	-> bottom hit
14.88	1.155	14.89	1.681	25.00	4.146	-> bottom hit
14.81	1.270	12.54	1.999	25.00	5.493	-> bottom hit
14.73	1.395	10.55	2.378	25.00	6.894	-> bottom hit
14.63	1.530	8.884	2.827	25.00	8.386	-> bottom hit
14.53	1.677	7.482	3.362	22.62	10.00	-> bottom hit
14.42	1.837	6.303	3.998	19.51	11.78	-> bottom hit
14.29	2.011	5.311	4.755	16.80	13.74	
14.16	2.200	4.477	5.654	14.44	15.92	
14.00	2.405	3.776	6.726	12.38	18.37	
13.84	2.629	3.186	7.996	10.59	21.12	
13.74	2.765	2.896	8.011	9.243	22.82	
* surface reflection begins						
13.65	2.890	2.690	9.509	7.921	24.30	
13.43	3.253	2.274	11.31	6.059	28.19	
13.16	3.719	1.923	13.45	4.783	32.91	
12.84	4.299	1.628	15.99	3.840	38.61	
12.46	5.010	1.380	19.02	3.122	45.48	
12.01	5.873	1.172	22.62	2.562	53.73	
11.47	6.914	0.9985	26.90	2.117	63.62	
10.83	8.165	0.8401	31.98	1.758	75.48	
10.06	9.663	0.7251	38.04	1.466	89.72	
9.149	11.45	0.6209	45.23	1.227	106.9	
8.065	13.59	0.5332	53.79	1.029	127.6	
7.370	14.96	0.4904	59.27	0.9328	141.1	-> bank(s) reach

FARFIELD CALCULATION (based on Brooks, 1960, see guide)
Farfield dispersion based on wastefield width of 14.96m

--4/3 Power Law--		-Const Eddy Diff-				
conc	dilution	conc	dilution	distance	Time	
				m	sec	hrs
0.4893	59.4	0.4893	59.4	146.3	12.98	0.0

Figure 5. Model run at [print frq] of 25.

It is now possible to tell with more certainty that the dilution factor (DF) is about 40 and the number in the column **[poll conc]** is about 0.7 at the longitudinal dimension of the chronic mixing zone. The DF at 9.28 m is about 3 and the **[poll conc]** is about 8; obtained by interpolating between rows of data on the output. (Incidentally, interpolate with reservation because it's not a linear relationship.) If more accurate numbers are needed, it is better to lower the **[print frq]** number even further.

The chronic criterion for ammonia (using reasonable worst-case values for pH and temp) is 0.87 mg/L and the acute criterion is 4.5 mg/L. Comparison to the **[poll conc]** numbers generated in Case 2 shows that the chronic criterion won't be violated, but the acute will be. So, it's obvious that the City can't continue to discharge ammonia at a concentration of 25 mg/L. BUT, since a TMDL has been completed, comparison to water quality criteria won't suffice. However, more modeling could still be needed: If the chronic criterion for another pollutant of concern is the most limiting and it becomes necessary to reevaluate dilution due to the confluence of the rivers. That will be revisited later.

Earlier, some specific language from the Washington State standards was mentioned because it included other factors which must be considered when conducting mixing zone analyses. Examining the two other chronic factors:

(1) Twenty-five percent of channel width: The width of the mixing zone is about 10 m (0.25x41.5m). Scanning down the values in the output column headed **[plume dia]** in Figure 5 to a width (diameter) of about 10 meters gives the DF of about 40;

(2) Twenty-five percent of flowrate available for dilution: The formula for calculating the volumetric dilution factor is

$$DF = (Q_{amb} + Q_{eff}) / Q_{eff},$$

where Q represents flowrate (in cfs) available for dilution: ambient (109) and effluent (5.29), giving an allowable dilution of 21.6 - less than the dilution calculated by the model.

Examining the one other acute factor:

(1) Two-point-five percent of flowrate available for dilution:

$$DF = (Q_{amb} + Q_{eff}) / Q_{eff},$$

where Q represents flowrate (in cfs) available for dilution: ambient (10.9) and effluent (5.29).

This provides a dilution of only 3.06 - which becomes the limiting dilution for use in calculating WLAs and effluent limitations.

Effluent and ambient concentrations of ammonia were included in the input to the model, but in the final analysis plume concentrations weren't the overriding consideration.
The extra cases created in **sumner.var** weren't needed because acute was limiting and it wasn't necessary to analyze the plume at and beyond the confluence. We could use <make New file>, [CTRL N] to move just the useful cases into another file for better file management.

8.4 References

Ecology, 1994. *Permit Writer's Manual*, Department of Ecology, Water Quality Program, Olympia WA 98504, as later amended.

EPA, 1994. *Dilution Models for Effluent Discharges,* U.S. Environmental Protection Agency, EPA/600/R-94/086, Washington, D.C.

Turner, D.B., 1970. *Workbook of atmospheric dispersion estimates.* Office of Air Programs, Publication No. AP-26, USEPA, Research Triangle Park, North Carolina.

9.0 SPREADSHEETS FOR WATER QUALITY-BASED NPDES PERMIT CALCULATIONS

Updated July 2000 by Greg Pelletier

Several spreadsheets were developed by the Washington State Department of Ecology to aid NPDES permit writers. These spreadsheets are referred to in Ecology's Permit Writer's Manual (Department of Ecology Publication Number 92-109). Several of the spreadsheets are in separate Lotus 1-2-3 WK1 files and also have been combined and reformatted into an Excel 5 workbook.

- DOSAG2.WK1: This spreadsheet calculates critical sag of dissolved oxygen downstream from a point source using the Streeter-Phelps equation.

- IDOD2.WK1: This spreadsheet calculates concentrations of dissolved oxygen at a mixing zone boundary accounting for dilution of dissolved oxygen and initial dissolved oxygen demand.

- NH3FRES2.WK1: This spreadsheet calculates freshwater un-ionized and total ammonia criteria from temperature and pH from the formulas modified by EPA which were adopted in the 1995 revision to the state water quality standards.

- NH3SALT.WK1: This spreadsheet calculates saltwater total ammonia criteria from temperature, pH, and salinity to meet the un-ionized ammonia criteria.

- PHMIX2.WK1: This spreadsheet calculates the pH of a mixture of two sources for temperature, pH, and alkalinity.

- RIVPLUM5.WK1: This is a simple dilution model for rivers based on the method in chapter 5 of the book "Mixing in Inland and Coastal Waters" by H.B. Fischer et al. (1979, Academic Press Inc.)

- PWSPREAD.XLS: This Excel 5 file contains the following spreadsheets as described above:
  - dosag2
  - idod2
  - nh3fres2
  - nh3fresh
  - nh3salt
  - phmix2
  - rivplum5

- FARFIELD.XLS *(requires the Analysis ToolPak Add-In under the "Tools/Add-Ins"* *menu)*: This Excel 5 workbook calculates far-field mixing of a plume using the method of N.H. Brooks (1959, "Diffusion of Sewage Effluent in an Ocean Current," in "Waste Disposal in the Marine Environment", edited by E.A. Pearson, pp, 246-267, Pergamon Press, New York, NY.) This workbook is useful for estimating dilution beyond the range of near-field models such as UDKHDEN or PLUMES/UM using Brook's 4/3-power law, linear diffusivity, and constant diffusivity algorithms.

- TSDCALC9.XLW is a workbook composed of several spreadsheets. It is used for reference and for developing water quality-based permit limits. The individual spreadsheets contained in TSDCALC are:
  - criteria.xls
  - ammoniafw.xls
  - reaspot.xls
  - limit.xls
  - performlim.xls
  - human-h.xls

  The spreadsheets CRITERIA.XLS and AMMONIA.XLS contain or calculate water quality criteria. REASPOT.XLS and LIMIT.XLS determine reasonable potential (to violate the water quality standards) and calculate effluent limits. PERFORMLIM.XLS calculates performance-based effluent limitations and accounts for autocorrelation if known. HUMAN-H.XLS determines reasonable potential and calculates effluent limits for human health pollutants.

9.1 Detailed Descriptions and User Instructions

Spreadsheet DOSAG2.WK1

Revised October 19, 1993

This spreadsheet calculates the critical dissolved oxygen sag and concentration downstream from a point source load of BOD in a river using the Streeter-Phelps equations. The method used is documented in EPA/600/6-85/002a (Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water). This spreadsheet is recommended for use as a screening tool to determine the potential for dissolved oxygen standards to be violated. DOSAG2.WK1 may be overly simplistic for deriving limits for effluent BOD. If DOSAG2.WK1 suggests the dissolved oxygen sag is close to or below the water quality standard, then a more sophisticated model such as QUAL2E or WASP5 should be used to derive appropriate effluent limits. Those water quality models are designed to more accurately simulate water movements, mass transport, and water column processes.

User Instructions for the Input Section

Step 1: Enter the permittees effluent characteristics, including permitted discharge and maximum (e.g, weekly) 5-day BOD (referred to as CBOD5 for "carbonaceous" 5-day BOD). Carbonaceous 5-day BOD is less than the total 5-day BOD if nitrification occurs during the test. The minimum national standards for carbonaceous 5-day BOD in effluent after secondary treatment are a monthly average of 25 mg/L and weekly average of 40 mg/L (40 CFR Part 133). Guidance for determining if carbonaceous 5-day BOD should be substituted for total 5-day BOD is contained in Ecology's Permit Writer's Manual (section V-3.6).

Nitrogenous BOD (NBOD) should also be estimated if it is significant (*e.g.* if nitrification is not significant during secondary treatment). NBOD can be estimated as:

NBOD = 4.57 * (Ammonia N + Organic N)

where concentrations of NBOD, ammonia N and organic N are expressed in mg/L. Effluent temperature and dissolved oxygen for the analysis are also entered at this step. The spreadsheet may be used to estimate the maximum permissible effluent CBOD5 and NBOD that will meet the water quality standards for dissolved oxygen. A trial and error solution is necessary for this purpose. Trial values of effluent CBOD5 and NBOD may be entered until the dissolved oxygen at the critical sag meets the water quality standard.

Step 2: Enter receiving water characteristics. These will generally be conditions at the 7Q10 discharge. Upstream CBOD5, NBOD, dissolved oxygen and temperature at the design river flow (*e.g.*, 7Q10) should be entered. The local channel elevation and channel slope (*e.g.*, from USGS topographic maps) downstream from the discharge should also be entered. Downstream average channel depth and velocity at the design flow should be entered also.

If no receiving water data are available, it would be desirable to collect data. Channel cross-sections of depth and velocity can be measured during the critical season. If measurements are not taken near critical conditions, then Manning's equation may be used to estimate velocity and depths from the measurements. Several cross-sections proceeding downstream from the discharge may be needed to characterize the river to the point of critical sag if velocities and depths are not uniform. Dye studies to measure travel time may be useful if velocities are variable. If significant tributaries, groundwater inflows, or other pollutant loads occur before the predicted critical sag point, then a more sophisticated model should be used (*e.g.* QUAL2E).

Measurements of water quality (*e.g.* dissolved oxygen, ammonia, BOD) in the receiving water from upstream and at intervals downstream to the critical sag point are also desirable for model calibration. If the model is applied without sufficient data to demonstrate calibration, then the model should mainly be used to screen for potential violation of standards. If effluent BOD is required to be more restrictive than current technology-based limits, then calibration data are probably needed. Separate calibration and verification data sets taken on different dates may be needed in many cases where the accuracy of the model is in question.

Step 3: Enter the reaeration rate (base e) at 20 degrees C in cell D27. Suggested values using empirical equations referenced in EPA/600/6-85/002a are given below cell D27 for guidance in selecting an appropriate value. If the calculated values are used, select the most appropriate equation based on applicable depth and velocity (*e.g.*, if depth is <1 to 2 feet, then use the value shown from the Tsivoglou-Wallace equation).

Step 4: Enter the BOD decay rate (base e) at 20 degrees C in cell D36. A calculated value based on the Wright and McDonnell equation referenced in EPA/600/6-85/002a is provided and may be entered in cell D36 at Step 4 if desired.

User Instructions for the Output Section

The user does not need to change or enter any values or formulas in the Output Section. The travel time and distance to critical sag, deficit at critical sag, and dissolved oxygen concentration at critical sag are displayed in the Output Section.

Spreadsheet IDOD2.WK1

Revised October 19, 1993

This spreadsheet calculates the dissolved oxygen concentration at a mixing zone boundary from dilution of dissolved oxygen in the effluent and ambient background and immediate dissolved oxygen demand of the effluent. The method used is presented in EPA/600/6-85-002b (Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water - Part II Revised 1985) and EPA/430/9-82-011 (Revised Section 301(h) Technical Support Document).

User Instructions for the Input Section

Step 1: Specify the dilution factor for effluent at the chronic mixing zone boundary. This value should represent dilution at critical conditions if the spreadsheet is being used for developing NPDES permit limits. The dilution factor used should represent the reciprocal of the volume fraction of effluent present at the mixing zone boundary (see Permit Writer's Manual section VI-2.1).

Step 2: Enter the background dissolved oxygen concentration in the receiving water. The 10th percentile during the critical season is recommended as a reasonable worst case. If no data are available it would be desirable to collect data describing background dissolved oxygen concentrations during the critical season (*e.g.* upstream from the discharge to a river).

Step 3: Enter the effluent dissolved oxygen concentration. The 10th percentile during the critical season is recommended as a reasonable worst case.

Step 4: Enter the immediate dissolved oxygen demand (IDOD) of the effluent if known. The IDOD represents the oxygen demand of reduced substances which are rapidly oxidized (*e.g.* sulfides to sulfates). If the effluent contains measurable dissolved oxygen, then the IDOD may be negligible. If IDOD is to be determined experimentally, the procedures in Standard Methods 1979 edition could be followed. However, the method was omitted from Standard Methods in the

1985 edition because of concerns about the accuracy of the test.

User Instructions for the Output Section

The user should not enter or change the value or formula in the output section. The dissolved oxygen at the mixing zone boundary is presented in the output section.

Spreadsheet NH3FRES2.WK1

Revised December 12, 1994 (NH3FRES2.WK1)

NH3FRES2.WK1 contains the formulas modified by EPA that were adopted in the 1995 revision of the state water quality standards. The spreadsheet also calculate the amount of un-ionized ammonia present in a sample if total ammonia, temperature, and pH are known.

User Instructions for the Input Section

Step 1: Specify the temperature (design condition at the mixing zone boundary) for which un-ionized ammonia criteria or concentrations are to be estimated. If the spreadsheet is being used to calculate criteria for a NPDES permit limit, the 90th percentile temperature during the critical season is recommended for a reasonable worst-case condition. If no data are available it may be desirable to collect data during the critical season to describe temperature at the mixing zone boundary.

Step 2: Specify the pH (design condition at the mixing zone boundary) for which un-ionized ammonia criteria or concentrations are to be estimated. If the spreadsheet is being used to calculate criteria for a NPDES permit limit, the 90th percentile pH during the critical season is recommended for a reasonable worst-case condition. If no data are available it may be desirable to collect data during the critical season to describe pH at the mixing zone boundary.

Step 3: Specify the sample total ammonia concentration if known. Entering a value here only affects Output Step 2 (calculation of un-ionized ammonia present in a sample). No input is required at this step if the spreadsheet is being used only to calculate criteria from temperature and pH (*i.e.* values entered at this step do not affect criteria calculations).

Step 4: Specify "Acute TCAP" according to the Gold Book (enter 20 if salmonids are present; 25 if salmonids are absent).

Step 5: Specify "Chronic TCAP" according to the Gold Book (enter 15 if salmonids are present; 20 if salmonids are absent).

User Instructions for the Output Section

The user should not enter or change any values or formulas in the Output Section. The spreadsheet calculates the amount of un-ionized ammonia present in a sample at Output Step 2 if the sample total ammonia was specified at Input Step 3. Output Step 3 provides the acute and chronic criteria for un-ionized ammonia expressed in ug/L as NH3-N. Output Step 4 provides the acute and chronic criteria for total ammonia expressed in ug/L as NH3-N.

Spreadsheet NH3SALT.WK1

Revised October 19, 1993

This spreadsheet calculates water quality criteria for ammonia in saltwater using the method specified in EPA 440/5-88-004 (Ambient Water Quality Criteria for Ammonia (Saltwater)-1989).

User Instructions for the Input Section

Step 1: Specify the temperature (design condition at the mixing zone boundary) for which un-ionized ammonia criteria are to be estimated. If the spreadsheet is being used to calculate criteria for a NPDES permit limit, the 90th percentile temperature during the critical season is recommended for a reasonable worst-case condition. If no data are available it may be desirable to collect data during the critical season to describe temperature at the mixing zone boundary.

Step 2: Specify the pH (design condition at the mixing zone boundary) for which un-ionized ammonia criteria to be estimated. If the spreadsheet is being used to calculate criteria for a NPDES permit limit, the 90th percentile pH during the critical season is recommended for a reasonable worst-case condition. If no data are available it may be desirable to collect data during the critical season to describe pH at the mixing zone boundary.

Step 3: Specify the salinity (design condition at the mixing zone boundary) for which un-ionized ammonia criteria are to be estimated. If the spreadsheet is being used to calculate criteria for a NPDES permit limit, the 10th percentile salinity during the critical season is recommended for a reasonable worst-case condition. If no data are available it may be desirable to collect data during the critical season to describe salinity at the mixing zone boundary.

User Instructions for the Output Section

The user should not enter or change any values or formulas in the output section. The acute and chronic criteria are expressed three ways: 1) as unionized ammonia in mg/L as NH3 at Output Step 5; 2) as total ammonia in mg/L as NH3 at Output Step 6; and 3) as total ammonia in mg/L as NH3-N at Output Step 7. For derivation of total ammonia waste load allocations and comparisons with effluent total ammonia data, it is recommended that the criteria be expressed as total ammonia in mg/L as NH3-N for simplicity. [Note: the criteria in EPA 440/5-88-004 Tables 2 and 3 are for total ammonia as mg/L as NH3, which should be multiplied by 0.822 to convert to mg/L as NH3-N.]

Spreadsheet PHMIX2.WK1

Revised October 19, 1993

This spreadsheet calculates the pH of a mixture of two flows using the procedure in EPA's DESCON program (EPA, 1988. Technical Guidance on Supplementary Stream Design Conditions for Steady State Modeling. EPA Office of Water, Washington DC). The major form of alkalinity is assumed to be carbonate alkalinity. Also, alkalinity and total inorganic carbon are assumed to be conservative.

User Instructions for the Input Section

Step 1: Specify the dilution factor for effluent at the mixing zone boundary. This value should represent dilution at critical conditions if the spreadsheet is being used for developing NPDES permit limits. The dilution factor used should represent the reciprocal of the volume fraction of effluent present at the mixing zone boundary (see Permit Writer's Manual section VI-2.1).

Step 2: Specify the upstream characteristics, including temperature, pH, and alkalinity. For development of NPDES permit limits for ammonia, the 90th percentiles during the critical season are recommended. If no data are available, it is desirable to collect data describing upstream temperature, pH, and alkalinity during the critical season.

Step 3: Specify the effluent characteristics, including temperature, pH, and alkalinity. For NPDES permit limits, a reasonable worst case estimate of each may be estimated from DMR data (*e.g.* for ammonia limits use 90th percentile values from the DMR data during the critical season). If effluent data are not available then data should be collected during the critical season. In many cases, pH in ambient receiving water (at Step 2 above) may be assumed to represent the pH in the mixing zone.

User Instructions for the Output Section

The user does not need to enter or change any values or formulas in the Output Section. The spreadsheet calculates and displays the pH at the mixing zone boundary at Output Step 4. Some important factors that can influence pH are not included in this calculation. For example, photosynthesis in the receiving water may increase pH downstream from the mixing zone. In many cases where dilution is relatively large (*e.g.* greater than a dilution factor of 20) the pH in the mixing zone will be dominated by ambient conditions. This spreadsheet should be used mainly where effluent dilution is relatively low and effluent pH and alkalinity are much different than in the receiving water.

Spreadsheet RIVPLUM5.WK1

Revised February 22, 1996

This spreadsheet calculates dilution at a specified point of interest downstream from a point discharge to a river. The procedure used is described in Fischer *et al.*, 1979 (Mixing in Inland and Coastal Waters, Academic Press) and referred to in EPA/505/2-90-001 (TSD for WQ-based Toxics Control.) The calculation for dilution factors incorporates the boundary effect of shorelines using the method of superposition (Fischer *et al.*, equation 5.9.)

This spreadsheet is based on the assumption that the discharge: 1) is a single point source, which is most appropriate for single port or short diffusers, or side-bank discharges; and 2) is completely and rapidly mixed vertically, which usually only occurs in shallow rivers. If the diffuser length occupies a substantial portion of the stream width, or the discharge is not vertically mixed over the entire water column within the acute mixing zone, an alternative model should be used such PLUMES or CORMIX. RIVPLUM5.WK1 is useful for estimating dilution in shallow rivers for side-bank discharges or single-port outfalls. This spreadsheet replaces a previous version called RIVPLUM4.WK1 RIVPLUM5.WK1 was modified to include optional calculation of the effective origin of a wastewater source.

User Instructions for the Input Section

Step 1: Enter the effluent design flow (see Permit Writer's Manual section VI-3.3.2).

Step 2: Specify the receiving water characteristics, including average channel depth, velocity and width downstream from the discharge at the design flow (e.g, at 7Q10. NOTE: The product of depth*width*velocity should equal the receiving water discharge rate downstream from the discharge).

Also enter either the channel slope downstream from the discharge (*e.g.*, as measured from a USGS topographic map) or Manning's "n" coefficient for roughness. Finally, enter either 0 (if slope is entered above) or 1 (if Manning's "n" is entered above).

The slope or Manning's "n" are used to estimate shear velocity and transverse mixing coefficients. Either method may be used, depending on which data are more readily available. It is not necessary to specify both slope and Manning's "n". If comparisons are made between the two methods then care should be taken to be sure that slope and Manning's "n" values are consistent with velocity, depth, and width data since all are related by Manning's equation.
In general, it is not desirable to overestimate Manning's "n" because a lower value will generally be more protective since it will predict a lower transverse mixing coefficient. If the Manning option is used, the following values may be appropriate estimates for Manning's "n" (EPA/600/3-87-007 after Henderson, F.M., Open Channel Flow, Macmillan Co., New York, NY, 1966):

- Artificial channel, earth, smooth, no weeds: 0.020
- Artificial channel, earth, some stones and weeds: 0.025
- Natural channel, clean and straight: 0.025 - 0.030
- Natural channel, winding with pools an shoals: 0.033 - 0.040
- Natural channel, very weedy, winding and overgrown: 0.075 - 0.150

If no receiving water data are available, then data collection would be desirable. Measurements of channel cross-sections of width, depth, and velocity should be collected within the mixing zone at conditions near critical low flow (*e.g.* near 7Q10). If conditions are significantly different than 7Q10 during measurements, then data may need to be adjusted (*e.g.* using Manning's equation).

Step 3: Enter the distance between the diffuser midpoint and the nearest shoreline of the river (*e.g.*, for a side-bank discharge enter 0).

Step 4: Enter the location of the downstream point at which dilution factors will be estimated, including the distance downstream from the diffuser and the distance from the nearest shoreline. The "point of interest" is the location at which dilution factors will be estimated in the Output Section. The highest concentration of effluent downstream from the outfall will be the same distance from shore as the point of discharge. Therefore, the distance from shore for the point of interest should be the same as for the diffuser midpoint in Step 3 for a worst case. However, the dilution at any point downstream may be estimated using any combination of distances downstream and from shore for the "point of interest."

Step 5: Enter the transverse mixing coefficient constant. A value of 0.6 is recommended for most natural channels. Fischer reports that the transverse mixing coefficient can range from 0.1 to 0.2 for straight artificial channels. Curves and sidewall irregularities increase the coefficient such that in natural streams it is rarely less than 0.4. If the stream is slowly meandering and the sidewall irregularities are moderate, then the coefficient is usually in the range of 0.4 to 0.8. Therefore, a value of 0.6 is usually recommended in natural channels. Uncertainty in this constant is usually at least +/- 50 percent.

Step 6: Enter 0 to use the original equations documented in Fischer et al. (1979), or enter 1 to account for the effective origin of the wastewater source in the Fischer et al. equations. Entering 0 will give results identical to the previous version of the spreadsheet (RIVPLUM4).
The optional correction for effective origin is based on discussion in section 5.1.3 of the Fischer *et al.* text. The dilution factors for some discharges may be underestimated without correction for effective origin.

The dilution model is based on considering a rectangular channel of depth (d) into which is discharged M units of mass of effluent per unit time in the form of a vertical line source. A line source of M units into a flow of depth (d) is equivalent to a point source of strength M/d in a two-dimensional flow, for which the concentration (C) is as follows from equation 5.8 and 5.9 of Fischer *et al.* (the nomenclature is as in Fischer *et al.*; Qe=effluent flow (L^3/T); u=velocity

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(L/T); d=depth (L); Et=transverse mixing coefficient (L^2/T); x=distance downstream (L); y=distance across channel (L); W=channel width (L)):

C = k * C0 / (4*pi*x')^0.5 (eqn 1)

where

$$k = \sum_{n=-2}^{2} \{\exp[-(y'-2n-y0')^2/4x']+\exp[-(y'-2n+y0')^2/4x']\}$$

C0 = M / (u*d*W)

x' = x*Et/(u*W^2)

y' = y/W

y0' = y' at the source location y=y0

If C represents the effluent volume fraction, then the dilution factor is equal to 1/C. In order to apply this equation very close to the effluent outfall, the effective origin may be estimated as follows.

- If M is estimated as the product of effluent flow and concentration, then the effluent source concentration (Ce) is:

  Ce=M/Qe (eqn 2)

- The offset or correction (x0) for the effective origin of effluent may be estimated as follows. First, substitute eqn 2 into eqn 1 for instream C=Ce:

  M/Qe = k * C0 / (4*pi*x')^0.5 (eqn 3)

- Next, solve eqn 3 for x=x0, which is the distance downstream from the effective origin to the outfall, such that in-stream concentration equals the effluent concentration at the actual outfall location:

  x0 = (k*Qe/d)^2 / (u*4*pi*Et) (eqn 4)

- The effective distance downstream (x) in eqn 1 is then replaced by (x+x0) to account for the effective origin of the source.

User Instructions for the Output Section

The user does not need to enter or change any values or formulas in the Output Section. The plume characteristics incorporating the shoreline effect are displayed at Step 5 of the Output Section, including the approximate distance downstream to complete mix, theoretical maximum available dilution at complete mix of effluent with the receiving water, flux-average dilution at the specified downstream distance, and the calculated dilution factor at the specified point of interest downstream from the discharge.

The distance downstream to complete mixing is often overestimated because most natural channels contain sharp bends or changes that increase mixing beyond the processes included in the model. The model is most useful for predicting mixing where the channel is represented over a relatively short distance (*e.g.* to the mixing zone boundary).

Workbook PWSPREAD.XLS

Revised February 22, 1996

This Excel 5 workbook contains the following spreadsheets:

- dosag2
- idod2
- nh3fres2
- nh3salt
- phmix2
- rivplum5

The spreadsheets in PWSPREAD.XLS perform the same calculations as the Lotus 1-2-3 .WK1 files of the same names. The instructions for each of the sheets in PWSPREAD.XLS are the same as for the .WK1 files.

Workbook FARFIELD.XLS

Revised February 22, 1996

[NOTE: This workbook requires the Analysis ToolPak Add-In, which must be configured using the "Tools/Add-Ins" menu in Excel 5.]

This Excel 5 workbook calculates far-field mixing of a plume using the method of N.H. Brooks (1959, "Diffusion of Sewage Effluent in an Ocean Current," in "Waste Disposal in the Marine Environment", edited by E.A. Pearson, pp, 246-267, Pergamon Press, New York, NY.) This workbook is useful for estimating dilution beyond the range of near-field models such as UDKHDEN or PLUMES/UM using Brook's 4/3-power law, linear diffusivity, and constant diffusivity algorithms.

Brooks' model is applied in this workbook using the algorithm of EPA's PLUMES model (1993, "Dilution Models for Effluent Discharges," U.S. Environmental Protection Agency, EPA/600/R-93/139, Washington, DC.) with the addition of a linear diffusivity algorithm as described by R.A. Grace (1978, "Marine Outfall Systems: Planning, Design, and Construction," Prentice-Hall Inc., Englewood Cliffs, NJ.)

FARFIELD.XLS contains the following four spreadsheets:

- PLUMES algorithm
- Brooks' four-thirds power law
- Brooks' linear diffusivity
- Brooks' constant diffusivity

The "PLUMES algorithm" spreadsheet uses the same method as EPA's PLUMES model ("Dilution Models for Effluent Discharges," U.S. Environmental Protection Agency, EPA/600/R-94/086) to implement Brooks' far-field models. The PLUMES algorithm is documented in equations 66-73 of EPA/600/R-94/086. The major difference between the "PLUMES algorithm" and the other spreadsheets is in the treatment of the parameter "alpha" in the following equation:

epsilon(0) = alpha * b ^n

where epsilon(0) is the lateral diffusion coefficient (L^2/T), b is the width of the plume (L), and n is an exponent used to estimate the initial value of epsilon. The PLUMES algorithm assumes that the initial value of epsilon(0) at the start of far-field modeling is based on n=4/3 for both the 4/3 power law and constant diffusivity models. Therefore, the PLUMES algorithm assumes that "alpha" has units of L^(2/3)/T and n=4/3 regardless of which Brooks' model is used.

The "PLUMES algorithm" spreadsheet also includes Brooks' linear diffusivity model and uses n=4/3 for the initial calculation of epsilon(0). The linear diffusivity model used in the spreadsheet is as presented by equation 7-65 of Grace (1978).

The "Brooks' four-thirds power law", "Brooks' linear diffusivity", and "Brooks constant diffusivity" spreadsheets differ from the "PLUMES algorithm" spreadsheet by assuming different units for "alpha" and different values of n depending on the model being used. "Alpha" has units of L^(2/3)/T for the 4/3 power law (n=4/3), L/T for the linear diffusivity model (n=1), and L^2/T for the constant diffusivity model (n=0). Brooks' equations as documented in equations 7-64, 7-65, and 7-66 of Grace (1978) were used to estimate dilution along the plume trajectory.

User Instructions for the Input Section

Step 1: Specify the plume and diffuser characteristics at the start of far-field mixing. The computations at the end of a near-field mixing model such as UDKHDEN or PLUMES/UM is usually used to define the conditions at the start of far-field mixing. The necessary parameters are the flux-average dilution factor at the end of near-field model computations, the estimated initial width at the start of far-field mixing (*e.g.* equation 70 as described in the PLUMES manual (EPA/600/R-94/086), and the horizontal distance that the plume travels during the near-field mixing phase.

Step 2: Specify the horizontal distance from the outfall to the mixing zone boundary along the trajectory of the plume (*e.g.* as defined in WAC 173-201A-100).

Step 3: Specify the parameter "alpha" as described above. The units for "alpha" depend on which spreadsheet is used, as discussed above.

Step 4: Specify the horizontal current speed along the far-field plume trajectory.

Step 5 (optional): Specify the initial pollutant concentration and the first-order decay rate. The initial concentration for far-field mixing should be the final concentration at the end of near-field mixing.

User Instructions for the Output Section

The user does not need to enter or change any values or formulas in the Output Section. The spreadsheets calculate dilution along the trajectory of the plume and at the specified mixing zone boundary. Optional calculation of pollutant concentrations assuming first-order decay rates is also provided.

9.2 GUIDELINES FOR USING TSDCALC 9.XLW

TSDCALC9.XLW is a workbook composed of several spreadsheets. Several are duplicates of those given above. It is used for reference and for developing permit limits. The individual spreadsheets contained in TSDCALC9 are CRITERIA.XLS, AMMONIA.XLS, REASPOT.XLS, LIMIT.XLS, PERFORMLIM.XLS, and HUMAN-H.XLS. The spreadsheets CRITERIA.XLS and AMMONIA.XLS contain or calculate water quality criteria. The spreadsheets REASPOT.XLS, and LIMIT.XLS determine reasonable potential (to violate the aquatic life water quality standards) and calculate effluent limits. The spreadsheet PERFORMLIM.XLS calculates performance-based effluent limitations and accounts for autocorrelation if known. The spreadsheet HUMAN-H.XLS determines reasonable potential and calculates effluent limits for human health pollutants. The process and formulas for determining reasonable potential and effluent limits in these spreadsheets are taken directly from the *Technical Support Document for Water Quality-based Toxics Control*, (EPA 505/2-90-001). The adjustment for autocorrelation is from EPA (1996a), and EPA (1996b)

CRITERIA.XLS

This spreadsheet is split for convenience of the permit writer. The pollutants of concern can be copied from the lower view and pasted in the upper view. The upper view can then be printed with only the pollutants of concern. Documentation text is found in rows 186-193.

Input - Cell B199 is a fill-in cell for receiving water TSS concentration, if known. TSS is used for calculating the partitioning translator for copper and zinc. If no TSS values are placed in this cell, the statewide 95th percentile ratio or the conversion factor is used as the default translator.

Input - Cell B200 is a fill-in cell, which characterizes the TSS data. Place an A in this cell if the TSS data is derived from several seasons. Place an S in this cell if the TSS data is only from the critical period.

Input - Cell B201 is a fill-in cell for hardness of the receiving water. Hardness is used to calculate several of the metal criteria. The hardness value should be the lowest value from the critical period if the data set is less than 20, or the 10th percentile value if the data set is 20 or greater. Column A contains the pollutant name, the CAS number, and where it is found on the table of effluent characteristics in the NPDES permit application.

Column B is labeled "Priority Pollutant?" A Y in this column means the chemical is a priority pollutant (toxic pollutant).

Column C is labeled Carcinogen? A Y in this column means the chemical is a carcinogen.

Columns D through G are the aquatic life water quality criteria for fresh and marine waters.

Columns H and I are the human health criteria for fresh and salt water. These columns are more correctly stated as Criteria for consumption of water and organisms (typically fresh water) and Criteria for the consumption of organisms only (typically salt water).

Column J gives the source of the criteria and any additional comments. A notation of NTR-HH means the human health criteria are from the National Toxics Rule and therefore part of our regulatory requirements. A notation of Gold Book means the criterion is a federal EPA criterion. These values should be treated as guidance. The "Gold Book" has been modified extensively by federal regulations such as the National Toxics Rule and others.

Columns K through N are translators for the metal criteria, which are used for determining reasonable potential. The translators for cadmium, copper, lead, and zinc are based on data presented by Pelletier (1996).

AMMONIA.XLS

This spreadsheet calculates the freshwater ammonia criteria. The **inputs** for this spreadsheet are temperature and pH of the receiving water at the time of critical condition. If the ammonia criteria are being calculated for non-salmonid waters the acute TCAP must be changed to 25 and the chronic TCAP to 20.

REASPOT.XLS

This spreadsheet determines if there is a reasonable potential for violation of the aquatic life water quality standards based on the input values. There is an example for reasonable potential determination for metals in the PWM in Chapter VI.

Input - Column A - enter the pollutant parameter.

Input - Column B and C – These are the metal criteria translator values taken from Criteria.XLS. If there is no value placed here the default value is the metal conversion factor.

Input - Column D is the ambient background concentration. For metals use the dissolved concentration. If you only have ambient total recoverable data, use the translator to convert the total recoverable data to dissolved.

Input - Columns E and F - enter the appropriate acute and chronic water quality criteria for the parameter.

Columns G and H are the calculated expected concentrations at the edge of the acute and chronic mixing zones. They are calculated from expected effluent concentration, ambient concentration, dilution factors and, for metals, the translator.

Column I compares the expected acute and chronic criteria with the concentration at the edge of the appropriate dilution zone. It returns a yes if the expected concentration is higher than the criteria or a no if not. Yes indicates a reasonable potential to violate the water quality criteria.

Column J is the upper percentile estimate of the effluent concentration. The recommended value to enter is 0.95.

Column K is a calculated value

Input -Column L - Enter in the highest measured effluent concentration

Input -Column M - Enter the coefficient of variation of the effluent parameter (standard deviation/mean). The default value is 0.6. If you have more than 10 effluent values this value should be calculated instead of using the default.

Input - Column N - Enter the number of data values in the set from which the value entered in Column L was taken.

Column P is the calculated value used as a multiplier. Column L is multiplied by this value to estimate the 95th percentile value of a small data set lognormally distributed. This value is equivalent to the multiplier in Table 3.2 95/95 in the TSD. If the permit writer has 20 or more data points for a parameter in the effluent, the 95th percentile effluent value can be calculated more accurately by transforming the data by log or lognormal, finding the 95th percentile value and then converting the value back by taking antilog or natural antilog. This value is placed in Column L and the number of samples is varied by trial and error until the multiplier in Column P equals 1.0. For example, with a CV of 0.6 column P would have to be 58 for the multiplier to equal 1.

LIMITS.XLS

This spreadsheet calculates effluent limits for aquatic life pollutants by use of formulas given in the Technical Support Document Box 5-2. Limits are required for any parameters that show a reasonable potential in the preceding spreadsheet. If the parameter has an extensive database, the values should be lognormal transformed (see comment in G2 of PERFORMLIM) and then the spreadsheet PERFORMLIM.XLS used to calculate effluent limits.

Input - Column A - enter the parameter

Input - Columns B and C - enter the acute and chronic dilution factors

Input - Columns F, G, and H can be copied from REASPOT.XLS

Column I is the calculated Average Monthly effluent limit

Column J is the calculated Daily Maximum effluent limit

Columns L and M are the calculated wasteload allocations for acute and chronic criteria

Columns N and O are the acute and chronic long term averages necessary to meet the wasteload allocations. The smaller of these two (the limiting LTA) is automatically placed in column R.

Column P is the expected coefficient of variation for the LTA. Use the effluent CV if available or use the default CV of 0.6.

Column Q is the probability the LTA will meet the WLA (expectation that the water quality standards will be met). A value of 0.99 (recommended by EPA) means an expected probability of exceedance of 0.01 or 1%.

Column S is the effluent CV. Use the calculated value if available or a default of 0.6 if an actual value can't be calculated.

Columns T and U are the expected probability of error for the effluent limits. The recommended values are 0.95 for the AML and 0.99 for the MDL (See the PWM pg. VI-28 for a discussion).

Input - Column V - The number of samples which will be required per month for compliance sampling. If sampling will be less than 1 per month use a value of 1 in this column.

PERFORMLIM.XLS

This spreadsheet calculates performance-based effluent limits. It will account for autocorrelation if the autocorrelation factor is known. The permit manager should assume effluent data is non-normally distributed and use EXCEL™ to transform the data using a lognormal transformation. A note in cell G2 explains the procedure for lognormal data transformation. Rows 5 through 8 are **input** cells. The lognormal transformed mean and variance are placed in cell H5 and H6. The number of samples per month that will be required for compliance monitoring is placed in cell H7. The autocorrelation factor is placed in cell H8 if it is known. Cells H9 through H13 are calculated intermediate values. Cells H15 and H16 are the calculated effluent limits.

HUMAN-H.XLS

This spreadsheet calculates reasonable potential and the effluent limits for human health pollutants. Reasonable potential for human health criteria is based on the 50th percentile effluent value. This spreadsheet deals with the effluent values in two ways. In a situation where the permit writer has 10 or more data points for the effluent concentration, the 50th percentile should be calculated by using the statistical calculation in EXCEL or some other software. Place this calculated 50th percentile value in column N. Any number in this column is always used for calculations if present so it must be 0 unless a calculated percentile value is placed here. In a situation with less than 10 data points, the 50th percentile effluent concentration is estimated within the spreadsheet by placing the highest observed effluent concentration in column I. The estimated coefficient of variation is placed in column J and the expected number of compliance monitoring samples is placed in column L. The 50th percentile value is calculated and then is used to calculate the expected concentration at the edge of the mixing zone. The dilution factor is placed in the last column (o). Carcinogens and non-carcinogens have different design criteria for effluent and receiving water flow so the dilution factors may be different for different human health pollutants. The spreadsheet calculates the expected concentration at the edge of the mixing zone, notes whether an effluent limit is required and, if so, calculates the limits using five and one percent error probabilities for average monthly and daily maximum, respectively.

Input -Column A – Enter the pollutant parameter name

Input – Column B – Enter the ambient concentration as the geometric mean of the receiving water values.

Input – Column C – Enter the human health criteria value.
Column D – This column calculates the expected concentration at the edge of the chronic mixing zone.

Column E – This column returns a yes or no as a determination of reasonable potential.
Input - Column F – The number of samples expected to be required in the permit for compliance monitoring.

Columns G and H – the calculated monthly average and daily maximum limits. Note that the monthly average limit equals the WLA adjusted for the background concentration.

Column I – The expected effluent percentile at 95% confidence. The recommended value is 0.5 in this column.

Column J – Internal calculation used to calculate multiplier (Col. O).

Input - Column K – The maximum effluent concentration measured.

Input - Column L – The coefficient of variation. The default value is 0.6 but this should calculated from the effluent data if there are 10 or more data points. The coefficient of variation is the standard deviation ÷ the mean.

Column M – An internal calculation used to calculate the multiplier (Col. O).

Column N – The number of data points in the data set from which value in Column K was taken.

Column O – The calculated value which is used to multiply the value in Column K to estimate the 50th percentile at the 95th percent confidence level. The formula for this multiplier is taken from the EPA TSD.

Input - Column P – The calculated 50th percentile effluent concentration. With 10 or more effluent data points the 50th percentile value should be calculated and placed in this column. A number in this column will take precedence over an estimated value. If the 50th percentile value isn't calculated this column should be 0.
Input - Column Q – The chronic mixing zone dilution factor.

10. AN ALTERNATE METHOD FOR ESTIMATING UPPER QUANTILES

This method estimates a selected upper percentile value from a distribution assumed to be lognormally distributed. The most statistically valid estimate of an upper percentile value is a maximum likelihood estimator which is proportional to the population geometric mean. If one assumes the population of effluent concentrations to fit a lognormal distribution, this relationship is given by:

$C_p = C_{mean} * \exp (Z_p * \sigma - 0.5 * \sigma^2)$

Where: Z_p = normal distribution factor at pth percentile
$\sigma^2 = \ln(CV^2 + 1)$

To calculate the maximum likelihood estimator of the 95th percentile, the specific relationship becomes:

$C_{95} = C_{mean} * \exp (1.645 * \sigma - 0.5 * \sigma^2)$

if CV is assumed = 0.6,
$\sigma^2 = .307$

The ratio of the estimated 95th percentile value to the mean (C_{95}/C_{mean}) = 2.13

A single effluent value or the geometric mean of a group of values is multiplied by the ratio to yield the estimate of the 95th percentile value.

The following table shows the ratio of the upper percentile to the mean for the 90th, 95th, and 99th percentiles

Ratio of Upper Percentiles to Geometric Mean

Percentile	Z	C_p/C_{mean}
90	1.283	1.74
95	1.645	2.13
99	2.386	3.11

In use with limited data sets assumed to be lognormally distributed, the geometric mean is multipled by the value in the right column above to estimate the percentile given in left column. This estimation technique results in lower estimates of upper percentile values than the technique discussed in the TSD in Section 3.2.2. for n less than 6. At some number of values it becomes more accurate simply to calculate the desired percentile value. Most spreadsheets have this capability. The number of values at which this occurs can't be predicted because it depends on the characteristics of the population being sampled. Using the TSD upper quantile estimation technique on page 56 and calculating where the largest value is greater than the 90th percentile (at 95% Confidence), the value of n is 30. In other estimation techniques for lognormal distributions, Gilbert (1987) predicts a large sample as $n = 20$.

11. GUIDANCE ON THE APPROPRIATE SIZE MIXING ZONE FOR A UNIQUE OUTFALL CONFIGURATION

In this situation a 170-foot diffuser runs parallel to the bank of a large river, rather than projecting across the river (see Figure 1). The 26 equally spaced eight-inch ports discharge away from the bank toward the deeper water. Thus, the plumes are carried downstream by the current "one over the other" (serially), rather than adjacent to each other (in parallel). The depth of water is 18 feet.

The regulations pertaining to sizing of mixing zones are in the Water Quality Standards for Surface Waters ..., WAC 173-201A-100. The freshwater rules apply (while this river is influenced by the tide, the flow simply slows but does not reverse). The regulation states that the chronic mixing zone shall:

"(i) Not extend in a downstream direction for a distance from the discharge port(s) greater than three hundred feet plus the depth of water over the discharge port(s), or extend upstream for a distance of over one hundred feet;

(ii) Not utilize greater than twenty-five percent of the flow;

(iii) Not occupy greater than twenty-five percent of the width of the water body."

This language does not address a serial discharge situation; (*i.e.*, it is not clear from which discharge port(s) the 300-foot measurement begins).

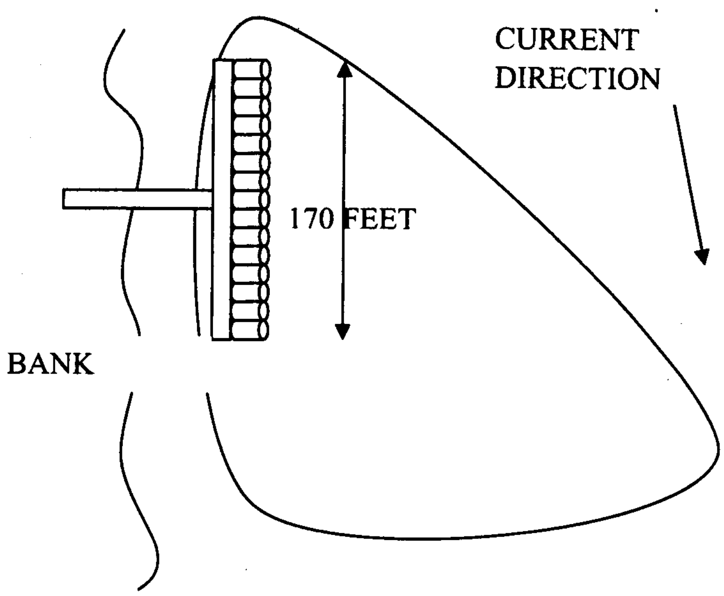
The reasonable solution is: If an outfall is configured such that the centerline of the diffuser lies parallel to the direction of current flow, then the distance to the downstream chronic mixing zone boundary is to be determined by beginning the measurement from the most upstream port in the diffuser. The distance from the downstream port to the chronic mixing zone boundary will be:

300 ft. + depth of water – length of diffuser. (1)

An acute boundary is 10 percent of the distance allowed for the chronic mixing zone. In this situation it will be 10 percent of the distance determined in equation (1). The width of these mixing zones will be addressed by subpart (iii) of the regulations mentioned above. This solution ensures that length of diffuser is not a factor in size of mixing zone and discourages the use of diffusers much longer than 170 feet in this type of configuration.

The mixing zone will be 148 feet from the downstream port. The acute boundary will be 14.8 feet from the downstream port. Width of the mixing zone will be very large since this outfall is to a large river.

Figure 1. Unique Outfall Orientation



12. WATER EFFECT RATIO

This section is based upon the EPA document, *Interim Guidance on Determination and Use of Water-Effect Ratios for Metals,* EPA-823-B-94-001. The reader should review the EPA document for a full understanding of the requirements for determining a water effect ratio (WER). This section documents Ecology's decisions on WER's where the process is different than that described by EPA or where the EPA document has optional conditions for the permitting authority to decide. Some of the EPA requirements (must do's) are listed in this section for emphasis. This section only covers Method 1 (see below).

The executive summary from the EPA document is reproduced below for background information. Ecology believes WER studies must be conducted as rigorous scientific investigations because they are modifications of the State's water quality criteria.

Executive Summary

A variety of-physical and chemical characteristics of both the water and the metal can influence the toxicity of a metal to aquatic organisms in a surface water. When a site-specific aquatic life criterion is derived for a metal, an adjustment procedure based on the toxicological determination of a water-effect ratio (WER) may be used to account for a difference between the toxicity of the metal in laboratory dilution water and its toxicity in the water at the site. If there is a difference in toxicity and it is not taken into account, the aquatic life criterion for the body of water will be more or less protective than intended by EPA's Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. After a WER is determined for a site, a site-specific aquatic life criterion can be calculated by multiplying an appropriate national, state, or recalculated criterion by the WER. Most WERs are expected to be equal to or greater than 1.0, but some might be less than 1.0. Because most aquatic life criteria consist of two numbers, i.e., a Criterion Maximum Concentration (CMC) and a Criterion Continuous Concentration (CCC), either a cmcWER or a cccWER or both might be needed for a site. The cmcWER and the cccWER cannot be assumed to be equal, but it is not always necessary to determine both.

In order to determine a WER, side-by-side toxicity tests are performed to measure the toxicity of the metal in two dilution waters. One of the waters has to be water that would be acceptable for use in laboratory toxicity tests conducted for the derivation of national water quality criteria for aquatic life. In most situations, the second dilution water will be a simulated downstream water that is prepared by mixing upstream water and effluent in an appropriate ratio; in other situations, the second dilution water will be a sample-of the actual site water to which the site-specific criterion is to apply. The WER is calculated by dividing the endpoint obtained in the site water by the endpoint obtained in the laboratory dilution water. A WER should be determined using a toxicity test whose endpoint is close to, but not lower than, the CMC and/or CCC that is-to be adjusted.

WERs are determined individually for each metal at each site; WERs cannot be extrapolated from one metal to another, one effluent to another, or one site water to another.

Because determining a WER requires substantial resources, the desirability of obtaining a WER should be carefully evaluated:

1. Determine whether use of "clean techniques" for collecting, handling, storing, preparing, and analyzing samples will eliminate the reason for considering determination of a WER, because existing data concerning concentrations of metals in effluents and surface waters might be erroneously high.

2. Evaluate the potential for reducing the discharge of the metal.

3. Investigate possible constraints on the permit limits, such as antibacksliding and antidegradation requirements and human health and wildlife criteria.

4. Consider use of the Recalculation Procedure.

5. Evaluate the cost-effectiveness of determining a WER.

Two methods are used to determine WERs. Method 1, which is used to determine chronic (cccWERs) that apply near plumes and to determine all acute (cmcWERs), uses data concerning three or more distinctly separate sampling events... For each sampling event, a WER is determined using a selected toxicity test; for at least one of the sampling events, a confirmatory WER is determined using a different test.

Method 2, which is used to determine a cccWER for a large body of water outside the vicinities of plumes, requires substantial site-specific planning and more resources than Method 1. WERs are determined using samples of actual site water obtained at various times, locations, and depths to identify the range of WERs in the body of water. The WERs are used to determine how many site-specific CCCs should be derived for the body of water and what the one or more CCCs should be.

12.1 Conditions for Determining a WER (EPA pg 9)

a. The Permittee **must** have examined other options for reducing the concentration of metals in the effluent such as pollution prevention and treatment. This must be reported in the form of an engineering report as specified in Chapter 173-240 WAC. This report must precede or be submitted with the WER study plan discussed below. If any technology-based option meets the cost test for reasonableness, that option must be implemented before Ecology will agree to a WER study.

b. Before beginning a WER study the Permittee **must** have conducted a sampling and analysis study of the receiving water and effluent using clean sampling and analytical techniques (EPA 821-R-95034, EPA 821-R-95-001, EPA 821-R-95-002. Ecology has found that reducing contamination in metals sampling and analysis often causes a subsequent finding of no reasonable potential because of lower concentrations. The results of the clean sampling and analysis study may be submitted with the WER study request although Ecology strongly recommends that the clean sampling study be submitted for approval prior to conducting the study. The clean sampling study must be conducted at a minimum during low flow and high flow. The study plan should discuss the existing data and the period of the year in which critical condition is likely to occur.

   Clean sampling and analytical techniques must also be used during the WER study. The concentrations of metals in each of the WER dilutions and in receiving water analyses must be measured as total recoverable and dissolved.

c. Ecology highly recommends that the Permittee conduct dynamic modeling of the discharge to confirm the determination of reasonable potential before conducting a WER study.

d. The discharge in question must be conducting routine WET tests on the effluent.

e. The discharge in question must be meeting existing technology-based requirements.

f. All toxicity tests will be conducted by laboratories certified by Ecology and following EPA or Ecology approved protocols and Ecology WET test guidance (Ecology Publication WQ-R-95-80). All toxicity tests will be subject to a quality assurance review by Ecology before they will be accepted (see Ecology Publication WQ-R-95-80).

g. Any WER study must be submitted to, and approved by Ecology before the study begins. Ecology recommends that a range-finding study be conducted as a component of the full study. All quality assurance measures would apply to the range-finding study.

h. A WER may be for acute criteria (LC50 site water/LC50 control water) or for a chronic criteria (NOEC site water/NOEC control water).

i. All data will be submitted in the final report, including the bench sheets for the toxicity tests.

12.2 Conditions for Using a WER (EPA pg10)

a. The WER shall be reevaluated during year 5 of the wastewater discharge permit or sooner if significant changes occur in the receiving water or in the effluent. The reevaluation may be reduced in scope from the original determination but will include toxicity testing and receiving water analysis at the critical condition.

b. WET testing will be required in the permit.

c. A receiving water bioassessment may be required in complex discharge situations.

d. Regardless of the magnitude of the WER determined in a WER study, Ecology will only authorize the highest WER that allows a permittee to fall below the "reasonable potential" threshold.

12.3. Sample-Specific WER approach (EPA pg 13-15)

The implementation process for this approach is not fully developed in the EPA guidance document and is not applicable to discharge situations.

12.4 Determining WERs for areas in or near plumes (Method 1). (EPA pg 17)

The WER in fresh water should be determined using:

a. upstream water and

b. simulated downstream water at the acute dilution factor and

c. Simulated downstream at the complete mix ratio when the dilution factor for complete mix is 20 or less. When the dilution factor is greater than 20 for complete mix, use simulated downstream water at the chronic dilution factor.

The WER in salt water should be determined using:

a. Water from the area of discharge but away from the influence of the discharge

b. Simulated effluent/receiving water at the chronic dilution ratio.

12.5 Design flows for WER(s)

The WER's should be measured three times at the time of critical condition and once at a time of non-critical condition. The critical condition is defined in Washington's Water Quality Standards as when the physical, chemical, and biological characteristics of the receiving water environment interact with the effluent to produce the greatest potential adverse impact on aquatic biota and existing or characteristic water uses. The two periods most likely to be the time of critical condition for metals in freshwater whose criteria are hardness dependant are at the time of lowest water hardness (usually wintertime) or at the time of lowest dilution (typically summer low flow).

The Permittee should discuss the time of critical condition (with calculations) in the study plan submittal. If the critical condition is determined to be during low flow the study plan should have a schedule of sampling at or near the critical low flow (typically the time of 7Q10 but no more than 2 times the 7Q10) and at a seasonal high flow. The minimum number of sampling periods is three at time of critical condition (EPA type 1) at a minimum of 5 days apart and one at non-critical condition (EPA type 2).

12.6 Which toxicity tests

For freshwater the species are: Primary - Ceriodapnia sp. or Daphnia magna; Secondary – salmonid (Rainbow Trout or Brook Trout). These species have approved tests for both acute and chronic. Other species or species surrogates may be required if there is a listing for the waterbody under the ESA.

For saltwater the potential species are: Primary – mysid (*Holmesimysis costata* EPA/600/R-95/136, August 1995 or *Mysidopsis bahia* EPA/600/4-91/003); Secondary - topsmelt (*Atherinops affinis* EPA/600/R-95/136) or silverside minnow (*Menidia beryllina* EPA/600/4-91/003). These species have both acute and chronic tests.

12.7 Should an acute WER or a chronic WER or both be determined?

Enough information must be collected to allow Ecology to determine the influence of background and effluent quality on the toxic effect of pollutants. For freshwater, collecting information on the effect of the upstream water, the effluent and receiving water at the simulated acute ratio (if a mixing zone is allowed) and at simulated full mix (or chronic dilution depending on the circumstance) will allow that determination. Additional ratios may be tested at the proponent's option. In many cases the acute criteria and dilution factor are the critical variables in determining reasonable potential. If this is the case, the Permittee may consider a phased project by conducting the acute WER first (since the acute WLA is usually limiting) and then conduct the chronic WER if necessary.

12.8 Deriving a Final WER (FWER)

With the minimum requirements specified above, then the EPA guidance for the calculation of a final WER depends on the range of individual WER's.

" If the range of the Type 1 WERs is not greater than a factor of 5 the FWER is the lower of (a) the geometric mean (lower 70^{th} percent confidence level) of all the Type 1 WERs and (b) the lowest hWER.

If the range of the Type 1 WERs is greater than a factor of 5 the FWER is the lowest of (a) the lowest Type 1 WER, (b) the lowest hWER, and (c) the geometric mean (lower 70^{th} percent confidence level) of all the Type 1 and Type 2 WERs.

A hWER is a method of deriving a protective WER for a flow other than that for which an experimental WER was determined. Typically, the WER's for high flows are used to calculate WER's using low flow design flow.

$$hWER = \frac{(HCME)(eFLOWdf) + (uCONCdf)(uFLOWdf)}{(CCC)(eFLOWdf + uFLOWdf)}$$ = highest WER that could be used to derive a site-specific criterion for the downstream water at design flow so that there would be adequate protection at the flow for which the HCME was determined. EPA presents this formula as a method for deriving a low flow (design flow) WER from experimental wer's derived at high flow. This equation doesn't account for the effluent concentration (HCME) being measured as total recoverable (metals limits are as total recoverable) and also assumes complete mix. Using the chronic dilution factor and assuming the effluent concentration is given as dissolved gives the following formula for the chronic hWER:

$$hWER = \frac{(HCME / df_c) + (uCONC * (df_c - 1))}{CCC}$$

Accounting for effluent concentration as total recoverable gives:

$$hWER = \frac{(((HCME * translator) / df_c) + (uCONC * (df_c - 1)))}{CCC}$$

In the EPA guidance the following equation is given for the HCME.

$$HCME = \frac{[(CCC)(WER)(eFLOW + uFLOW)] - [(uCONC)(uFLOW)]}{eFLOW}$$ = highest concentration of

metal that could be in the effluent without causing the concentration of metal in the downstream water at complete mix to exceed the site-specific criterion that would be derived for that water using the experimentally determined WER. Converting the formula to use dilution factor gives:

$$HCME = ((CCC * WER * df) - (uCONC * (df - 1)))$$

CCC = water quality criteria to be adjusted

eFLOW = the flow of the effluent that was the basis of preparation of the simulated downstream water. This should be the flow of the effluent that existed when the samples were taken.

eCONC = effluent concentration

uFLOW = the flow of the upstream water that was the basis of the preparation of the simulated downstream water. This should be the flow of the upstream water that existed when the samples were taken.

uCONC = the concentration of metal in the sample of upstream water used in the preparation of the simulated downstream waster measured as dissolved.

hWER = highest WER that could be used to derive a site-specific criterion for the downstream water at design flow so that there would be adequate protection at the flow for which the HCME was determined.

HCME= highest concentration of metal that could be in the effluent without causing the concentration of metal in the downstream water at complete mix to exceed the site-specific criterion that would be derived for that water using the experimentally determined WER.

df_c = chronic dilution factor

df_a = acute dilution factor

The hardness of the laboratory dilution water must be between 50 and 150 mg/l.

12.9 Example

This example is similar to that used previously in Chapter VI for demonstrating reasonable potential for metals. That example should be reviewed if there are questions on determining reasonable potential, deriving effluent concentrations, determining effluent concentrations or determining receiving water background concentrations.

METAL PLATING PLANT

- Effluent discharge rate (90th percentile)(eFLOW) = 0.034 CFS
- River low flow (uFLOW) = 13.0 CFS, high flow = 152 CFS
- River background copper concentration (u CONC) low flow = 2.8 μ/l dissolved, high flow = 2.0 μ/l dissolved.
- Effluent copper concentration = 60 μg/l (total recoverable)
- Translator = 0.95
- Dilution factors: Acute low flow = 10.6 (2.5% flow), chronic low flow = 110 (calculated by model), full mix low flow = 383, acute high flow = 113 (2.5% flow), chronic high flow = 180, full mix high flow = 4472
- Receiving water hardness (lowest 10 percentile for season) = 75.3 mg/l low flow, 20 mg/l high flow
- Effluent hardness = 100 mg/l

1. Evaluate the critical condition by calculating the hardness, the resulting metal criteria, and the copper concentration at the acute mixing zone boundary, chronic mixing zone boundary and full mix for high flow/low hardness and low flow/high hardness. Assume the 60 μg/l effluent concentration as total recoverable results in a dissolved concentration of 57 μg/l (60 x 0.95) for determining instream concentrations. The reasonable potential spreadsheet (REASPOT.XLS) may be used to evaluate critical condition.

HIGH FLOW								
ACUTE			CHRONIC			FULL MIX		
hardness	criteria	conc.	hardness	criteria	conc.	hardness	criteria	conc.
20.7	3.86	2.49	20.4	2.92	2.31	20	2.87	2.01
LOW FLOW								
ACUTE			CHRONIC			FULL MIX		
hardness	criteria	conc.	hardness	criteria	conc.	hardness	criteria	conc.
77.6	13.4	7.9	75.5	8.93	3.3	75.4	8.92	2.9

If the data shown here is placed in the reasonable potential spreadsheet (REASPOT.XLS) and there is assumed to be only one effluent value for copper, the reasonable potential determination and the amount of exceedance of the criteria are: high flow acute =yes (1.33); high flow chronic = yes (1.35); low flow acute = yes (2.68); low flow chronic = no. The expected copper concentration at the acute dilution zone boundary at low flow is 2.7 times the criteria while the copper concentration at the chronic boundary is below the criteria. Low flow acute appears to be the critical period and boundary.

Note that sample size only has to increase to 7 in the reasonable potential analysis to show no reasonable potential, assuming the highest value stays the same. This demonstrates why the effluent and receiving water should be fully characterized with clean sampling and analysis before a WER study is authorized.

2.) The following WER's were determined during high flow and low flow.

EXPERIMENTAL WER'S:

PRIMARY LOW FLOW		
UPSTREAM	ACUTE BOUNDARY	CHRONIC BOUNDARY
5.0	4.0	2.0
6.0	4.3	17.8
6.2	4.6	6.4
SECONDARY LOW FLOW		
7.3	5.0	8.0
PRIMARY HIGH FLOW		
4.0	5.5	4.5

HCME's and hWER's

HCME'S	
2175	2007
hWER's	
16.7	17.6

Acute and chronic WER's are calculated separately.

3.) The final WER in this example, since the range of WER's is greater than 5, is the lowest of a) the lowest WER, b) the lowest hWER, or c) the 70th percent confidence level of the geometric mean of the WER's.

For acute:

The lowest WER is 4.0.
The lowest hWER is 16.7

The 70th percent lower confidence level of the geometric mean (Type 1 and Type 2, excluding upstream) is 4.5 (see EPA page 71).

The final acute WER would be 4.0, however a WER of 2.7 causes a finding of no reasonable potential so a WER of 3 is authorized.

For chronic:

The lowest WER is 2.0.

The lowest hWER is 4.5

The 70th percent lower confidence level of the geometric mean (Type 1 and Type 2, excluding upstream) is 3.8.

The final chronic WER is 2.0.

12.10 Glossary for WER

Acute-chronic ratio - an appropriate measure of the acute toxicity of a material divided by an appropriate measure of the chronic toxicity of the same material under the same conditions.

Appropriate regulatory authority - Usually the State water pollution control agency, even for States under the National Toxics Rule; if, however, a State were to waive its section 401 authority, the Water management Division of the EPA Regional Office would become the appropriate regulatory authority.

Clean techniques - a set of procedures designed to prevent contamination of samples so that concentrations of trace metals can be measured accurately and precisely.

Critical species - a species that is commercially or recreationally important at the site, a species that exists at the site and is listed as threatened or endangered under Section 4 of the Endangered Species Act, or a species for which there is evidence that the loss of the species from the site is likely to cause an unacceptable impact on a commercially or recreationally important species, a threatened or endangered species, the abundance of a variety of other species, or the structure or function of the community.

Design flow - the flow used for steady-state wasteload allocation modeling.

Dissolved metal - defined here as "metal that passes through either a 0.45-µm or 0.40-µm membrane filter".

Endpoint - the concentration of test material that is expected to cause a specified amount of adverse effect.

Final Water-Effect Ratio - the WER that is used in the calculation of a site-specific aquatic life criterion.

Flow-through test - a test in which test solutions flow into the test chambers either intermittently (every few minutes) or continuously and the excess flows out.

Labile metal - metal that is in water and will readily convert from one form to another when in a nonequilibrium condition.

Particulate metal - metal that is measured by the total recoverable method but not by the dissolved method

Primary test - the toxicity test used in the determination of a Final Water-Effect Ratio (FWER); the specification of the test includes the test species, the life stage of the-species, the duration of the test, and the adverse effect on which the endpoint is based.

Refractory metal - metal that is in water and will not readily convert from one form to another when in a non-equilibrium condition, i.e., metal that is in water and is not labile.

Renewal test - a test in which either the test solution in a test chamber is renewed at least once during the test or the test organisms are transferred into a new test solution of the same composition at least once during the test.

Secondary test - a toxicity test that is usually conducted along with the primary test to test the assumptions that, within experimental variation, (a) similar WERs will be obtained using tests that have similar sensitivities to the test material, and (b) tests that are less sensitive to the test material will usually give WERs that are closer to 1.

Simulated downstream water - a site water prepared by mixing effluent and upstream water in a known ratio.

Site-specific aquatic life criterion - a water quality criterion for aquatic life that has been derived to be specifically appropriate to the water quality characteristics and/or species composition at a particular location.

Site water - upstream water, actual downstream water, or simulated downstream water in which a toxicity test is conducted side-by-side with the same toxicity test in a laboratory dilution water to determine a WER.

Static test - a test in which the solution and organisms that are in a test chamber at the beginning of the test remain in the chamber until the end of the test.

Total recoverable metal - metal that is in aqueous solution after the sample is appropriately acidified and digested and insoluble material is separated.

Water-effect ratio - an appropriate measure of the toxicity of a material obtained in a site water divided by the same measure of the toxicity of the same material obtained simultaneously in a laboratory dilution water.

13. DERIVING THE 7Q10 HIGH FLOW (HF) AND THE DESIGN SPILL

13.1. Guidelines for Deriving the 7QHF

Use the record of observed flow data. For the Columbia River use the record from water year 1974 to the present. 1974 is the year when the last major storage reservoir was built in the Columbia River Basin. If data is not available for the location of interest, make reasonable calculations based on an approved 7Q10hf for up-river or down-river locations or dams. Flow data must include total river flow.

The period of record may be extended by including modeled or transformed data prior to 1974 that represents the current condition of the basin with all dams in place. If this is done, compare results of using data from the observed period of record with the results of using the data from the extended period of record. This serves as a check to see if the proposed method for extending the period of record gives comparable results.

To the extent possible, take into account any trends or anticipated changes of flows in the future.

Use daily average flows to calculate the 7Q10hf and then determine the highest 7-consecutive-day average peak flow for each year.

Calculate frequency/return interval using standard hydrology methods (see USGS bulletin 17B, *Guidelines for Determining Flood Flow Frequency*, or any hydrology textbook)

Information submitted to Ecology must include documentation of the methods of calculating 7Q10hf, including assumptions about data, current trends, anticipated changes, quality assurance, methods of measurement, methods of transforming historic data and comparisons of 7Q10hf values for other dams.

13.2 Determining Design Spill for Gas Abatement

To determine the design spill for gas abatement use the hourly spill data for high flow months of a high flow year (1997 for example) and extrapolate to the 7Q10hf. The high flow months for the Columbia River are May and June.

APPENDIX 13

1. SUPPORTING STATISTICAL STUDY FOR PERFORMANCE-BASED REDUCTION OF MONITORING (from EPA, April 96)

Effect of Sample Size on Probability of Violation

EPA has done a statistical analysis on the effect of sampling frequency on compliance assessment. The basic premise underlying a performance-based reduction approach is that maintaining a low average discharge relative to the permit limit results in a low probability of the occurrence of a violation for a wide range of sampling frequencies.

The probability of the occurrence of a violation of a monthly average permit limit was calculated. Tables 13-1,13-2 and 13-3 display the percentage of time that a monthly average permit violation will be reported given sample size and a long-term average to permit ratio. This probability is dependent on the true long-term average of the discharge, the permit limit, and the monthly sampling frequency. The variables of long-term average and permit limit are both reflected in the tables by expressing these as a ratio. Tables 13-1, 13-2, and 13-3 assume a normal distribution of monthly averages and show the effect of altering the assumed coefficient of variation, using 20%, 60%, and 80%, respectively.

Obviously, the best estimate of the true monthly average discharge is obtained by daily sampling. One can assess the true violation rate of a discharge by looking at the probability calculated assuming sampling was done daily (30 times per month). In order to maintain compliance with a permit limit, the long term average level of the discharge must be controlled at a level less than the permit limit. Reducing the sample size, while increasing the probability that a violation will be reported, does not change the underlying probability of reporting a violation associated with a baseline estimate of the monthly average calculated with 30 samples. With a constant performance, the probabilities of reporting a permit violation increase as the sample size is reduced from daily sampling because the variance of the average is inversely proportional to the sample size.

Looking at the true violation rate of a facility sampling daily and operating at 75% of their permit limit, these tables show that the probability of a violation in a given month is 1% or less. If the long-term average discharge is 65% of the permit limit, the true percentage of violation is less than 1%. As sample size decreases for a given discharge/limit ratio, the expected percentage

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of time that the average of the samples collected during the month will exceed the permit limit increases. For example, Table 13-3 demonstrates that at a ratio of 65%, the expected violation rate is effectively zero. If a subsample of 8 samples per month is taken instead of 30, the facility has a 3% chance of reporting a violation. If only one sample per month is taken, the chances of reporting a violation increase to 25%. The facility performance (true monthly average discharge) has not changed, thus "missed" monthly average violations are not an issue. The probabilities calculated for very low sampling frequencies reflects the risk assumed by the discharge operator that monthly average violations will be reported when in fact the process average is under permit limit. If facility performance degrades during the permit term and sampling has been reduced, it can be seen that the facility will have probability of reporting violations at a higher rate, even if the long-term average is still below the permit limit. An example will illustrate this point. Table 13-3 shows that if a facility was judged to be at 75% of their permit limit and reduced sampling from 16 to 12 times per month, the probability of violation would change from approximately 5% to 7%. If the long-term average performance degraded to 90% of the permit limit, the 12 monthly samples would yield expected monthly average permit violations 32% of the time instead of 29% of the time if 16 samples were collected.

Table 13-3 shows probabilities calculated using a more conservative assumption of 80% coefficient of variation. The results show that facilities with a long term average of less than or equal to 75% have essentially no chance of violating a monthly average limit, hence facilities with this performance would be good candidates for performance-based monitoring reductions. The reductions in Table XIII-1A1 were designed to maintain approximately the same level of reported violations as that experienced with their current (baseline) sampling.

Table 13-1. Probability of Reporting Monthly Average Permit Violations at 20% Effluent Variability (CV = 0.20; Normal Distribution).

Monthly Sample Size

[1]LTA/Permit	30	28	24	20	16	12	8	4	2	1
100%	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**
95%	7%	8%	10%	12%	15%	18%	23%	30%	35%	40%
90%	0%	0%	0%	1%	1%	3%	6%	13%	22%	29%
85%	0%	0%	0%	0%	0%	0%	1%	4%	11%	19%
80%	0%	0%	0%	0%	0%	0%	0%	1%	4%	11%
75%	0%	0%	0%	0%	0%	0%	0%	0%	1%	5%
70%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%
65%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
55%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
40%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

[1] Ratio of calculated average of at least 2 years of effluent data to monthly average permit limit.

Table 13-2. Probability of Reporting Monthly Average Permit Violations at 60% Effluent Variability (CV = 0.60; Normal Distribution)

Monthly Sample Size

[1]LTA/Permit	30	28	24	20	16	12	8	4	2	1
100%	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**
95%	32%	32%	33%	35%	36%	38%	40%	43%	45%	47%
90%	16%	16%	18%	20%	23%	26%	30%	36%	40%	43%
85%	5%	6%	7%	9%	12%	15%	20%	28%	34%	38%
80%	1%	1%	2%	3%	5%	7%	12%	20%	28%	34%
75%	0%	0%	0%	1%	1%	3%	6%	13%	22%	29%
70%	0%	0%	0%	0%	0%	1%	2%	8%	16%	24%
65%	0%	0%	0%	0%	0%	0%	1%	4%	10%	18%
60%	0%	0%	0%	0%	0%	0%	0%	1%	6%	13%
55%	0%	0%	0%	0%	0%	0%	0%	0%	3%	9%
50%	0%	0%	0%	0%	0%	0%	0%	0%	1%	5%
40%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

[1] Ratio of calculated average of at least 2 years of effluent data to monthly average permit limit.

Table 13-3. Probability of Reporting Monthly Average Permit Violations at 80% Effluent Variability (CV = 0.80; Normal Distribution)

Monthly Sample Size

[1]LTA/Permit	30	28	24	20	16	12	8	4	2	1
100%	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**
95%	36%	36%	37%	38%	40%	41%	43%	45%	46%	47%
90%	22%	23%	25%	27%	29%	32%	35%	39%	42%	44%
85%	11%	12%	14%	16%	19%	22%	27%	33%	38%	41%
80%	4%	5%	6%	8%	11%	14%	19%	27%	33%	38%
75%	1%	1%	2%	3%	5%	7%	12%	20%	28%	34%
70%	0%	0%	0%	1%	2%	3%	6%	14%	22%	30%
65%	0%	0%	0%	0%	0%	1%	3%	9%	17%	25%
60%	0%	0%	0%	0%	0%	0%	1%	5%	12%	20%
55%	0%	0%	0%	0%	0%	0%	0%	2%	7%	15%
50%	0%	0%	0%	0%	0%	0%	0%	1%	4%	11%
40%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%
30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

[1] Ratio of calculated average of at least 2 years of effluent data to monthly average permit limit.

Detailed Protocol for Calculating Probability of Reporting Permit Violations

Calculation of probabilities for Tables 13-1 to 13-3

Probability distributions may be used to model effluent data and assess the probability of permit violations. The models provide a logical and consistent methodological framework for using observed performance data to assess permit limitations in an objective manner. The goal of the limitations is to establish performance levels that enforce good treatment and ensure that water quality objectives are met. In deriving limitations, sufficient allowance for variation in treatment performance is provided such that a well-operated treatment system should be capable of compliance with the limitations at all times. In using probability models as the basis for limits, it is necessary to select a percentile value such that, within the context of the model, any meaningful limit will have a non-zero probability of being exceeded.

The results shown in the tables here are derived from probability distribution functions that may be used to model effluent data. That is, the processes are assumed to operate over time in a manner that is consistent with past performance. No intervention to change the process or exert more or less control over the discharge is assumed.

Calculation of the probability that a reported permit violation will occur depends upon: the number of individual samples taken during the month, the long-term discharge level, the variance of the discharge concentrations, the probability distribution of the individual samples during the month, and the permit limit. There are two probability distributions commonly used to model effluent data: the lognormal distribution and the normal distribution. The lognormal distribution usually provides a good fit to data sets comprised of individual effluent measurements because such data typically have two critical lognormal characteristics: they are positive valued and positively skewed. Positive skewness means that the data are characterized by a tendency for a preponderance of measurements in the lower range of possible values with relatively fewer measurements stretched out over a wider range of possible upper values. The lognormal also has the property that the logarithms (natural or base 10) of the data are normally distributed. The normal distribution has the well-known "bell shape" and is mathematically straightforward so that working with the logarithms of effluent data is relatively uncomplicated.

The asymptotic distribution of sample averages is normally distributed. That is, the average of a sample of individual measurements will have a distribution that is approximately normally distributed regardless of the distribution of the individual measurements. The quality of the approximation depends on several factors including the number of individual measurements being averaged and the form of the underlying distribution. Although individual effluent measurements are rarely normally distributed, it is reasonable in many situations to approximate the distribution of the averages of effluent measurements with a normal distribution and thus the normal approximation is used in many cases as a model for monthly average effluent limitations. The results in Tables 13-1 through 13-3 are based on the assumption of a normal distribution for the averages of effluent measurements. Extensive discussion on the statistical modelling of effluent data and methodology for setting effluent limitations are contained in EPA's 1991 Technical Support Document for Water Quality-based Toxics Control (TSD).

The results of calculating probability of a reported violation of a monthly average permit limit are shown in Tables 13-1 through 13-3 under different conditions. The purpose of these tables is to provide some insight into the effects of changing monitoring requirements. The probability of exceeding the monthly limit when the long-term average of the discharge is at the desired value can be thought of as the Type I error rate (alpha-level) of the monitoring program. When the long-term average exceeds the desired limit, the probability of exceeding the monthly limit is now the monitoring program's ability to detect violation increases if the long-term average increases over the desired level. It should be understood that if permit limits are held constant and performance measures such as long term average discharge and variability of treatment do not change, then reducing the number of monitoring measurements used to calculate the monthly average causes the probability of a violation to increase for all values of the long term average less than the monthly average permit limit. This has a two-fold effect: 1) the chances of reporting a violation even when the long term average is less than the desired level (the Type I error rate) go up 2) the sensitivity (ability to detect violations) of the program increases. The Tables also show that if the average discharge level is held well below the monthly average limit, the chances of a violation are small. The thee tables reflect three different levels of variation in the underlying daily data as measured by the coefficient of variation. The coefficient of variation (CV) is the ratio of the standard deviation of the distribution to the mean and is often expressed as a percentage. The CV is a convenient measure for summarizing the relative variability in a data set. The results in Tables 13-1, 13-2, and 13-3 use CVs of 20%, 60% and 80% respectively. A coefficient of variation of 60% was used in the TSD to describe a typical level of variation for lognormally distributed effluent data. CVs of 80% and 20% were used to show the effects of higher and lower levels of variability.

The probability distribution of the average of N daily measurements taken during a month, M_N, is given by the following normal probability density function:

$$g(M_N)=\frac{1}{\sqrt{\frac{2\pi}{N}}\sigma}e^{-\frac{N(M_N-\mu)^2}{2\sigma^2}}$$

where μ is the mean or long term average, and σ is the standard deviation of the daily discharges. If μ_1 is the maximum monthly average allowed by the permit, then the probability that the monthly average exceeds the permit maximum is given by $P(M_N>\mu_1)$. Using simple algebra this probability can be rewritten as:

$$P(M_N>\mu_1)=P\left(\frac{M_N-\mu}{\frac{\sigma}{\sqrt{N}}}>\frac{\mu_1-\mu}{\frac{\sigma}{\sqrt{N}}}\right)=1-\phi\left(\frac{\mu_1-\mu}{\frac{\sigma}{\sqrt{N}}}\right),$$

where $\Phi(.)$ is the standard normal cumulative probability function (the Microsoft®Excel built-in function NORMDIST).

Since

$$\frac{\mu_1 - \mu}{\frac{\sigma}{\sqrt{N}}} = \frac{\sqrt{N}}{C}\left(\frac{1}{\left(\frac{\mu}{\mu_1}\right)} - 1\right),$$

where C is the coefficient of variation, then the probability of a monthly average exceeding the maximum allowable can be calculated using C, N, and the ratio of the long-term average to the maximum allowable monthly average using NORMDIST. This is how the values in Tables 13-1, 13-2, and 13-3 were calculated.

Alternate approaches to probability calculations:

The probabilities in Tables 13-1 to 13-3 were calculated with the assumption that the distribution of the sample means is normal. Individual sample values are generally best fit to a lognormal distribution. As discussed in the TSD, the mean of small samples from a lognormal distribution is in most cases approximately lognormal. Probabilities can be calculated assuming a lognormal distribution by two different methods, a Monte Carlo technique and the Microsoft Excel built-in function LOGNORMDIST. The resulting probabilities will be very close to those in the normal distribution table for the sample sizes and discharge levels under consideration for monitoring reductions, although the probabilities calculated from these two distributions may not be comparable for all sample sizes and all discharge levels.

The statistical evaluations used in this analysis are intended for use only to illustrate the effect and benefits of this strategy, alternative statistical techniques and approaches may be utilized in other situations.

2. DETERMINING THE NUMBER OF SAMPLES REQUIRED FOR COMPLIANCE MONITORING

This section provides some statistical tools for selection of a monitoring frequency when effluent data is available.

It is recommended that the permit writer use formula 3 with a confidence level of 90% and a relative error (d_r) around the mean of no larger than 20% (0.20) to derive a baseline monitoring frequency. Table 1 is compiled from formula 3 for several combinations of confidence level, relative error and coefficients of variation. The rest of this section provides background material.

An effluent limit is a control parameter to assure that the long term average (LTA) of a wastewater control device or practice is being maintained. The LTA may be derived from the performance of a wastewater treatment device or from a wasteload allocation necessary to meet water quality standards. We assume the number of samples required to demonstrate compliance is the same as that necessary to determine a mean of a sample from a population.

For a sampled population which is normally distributed, in which the samples are not correlated over time or space, and in which the number of elements in the sampled population (N) is large relative to the standard deviation (σ), the number of samples (n) required to estimate a population mean is:

$$n = (Z_{1-\alpha/2}\,\sigma/d)^2$$

where

$Z_{1-\alpha/2}$ is the standard normal deviate that cuts off $(100\alpha/2)\%$ of the tails of a standard normal distribution and

σ= standard deviation of the sampled population and

d = error around the mean.

This formula is for a two tailed test where the sample mean may be higher or lower than the true mean. In our situation we are only concerned with the situation in which the sample mean is higher than the true mean. Therefore, a one-tailed test is appropriate.

$$n = (Z_{1-\alpha}\,\sigma/d)^2 \qquad (1$$

(from Gilbert 1987)

To estimate a population mean with a error (d) of 20 (plus or minus 10) with a 10% probability of type I error (α)when the standard deviation (σ) of the population is 50 requires

$n = (Z_{0.10}\,50/20)^2 = (1.2816*50/20)^2 = 10.2 \approx 10$ samples.

This assumes the data are independently, normally distributed and not correlated over time or space.

Effluent data is typically lognormally distributed (Schaeffer, et al. 1980) but parametric statistics ($\overline{X}$ and s^2) are the best estimators of the population parameters if the coefficient of variation (η) is less than 1.2 (Gilbert 1987). A typical coefficient of variation (η) for conventional pollutants from domestic wastewater treatment plants is 0.6. Other pollutants and industrial treatment processes typically have a higher CV of 1 to 1.5.

An adjustment for autocorrelation can be made to the formulas for sample numbers if necessary. This adjustment increases the number of samples required.

If the standard deviation is uncertain (because of limited previous sampling) then the *t* distribution should be used in the place of the standard normal distribution

$$n = \left(t_{1-\alpha,n-1}\sigma / d\right)^2 \qquad (2$$

and the process of determining n becomes iterative.

Start with equation 1 above and use a Z value to approximate n,

$$n_1 = (1.2816*50/20)^2$$
$$n_1 \cong 10$$

then go to a t table to find $t_{0.90,\,9}$ which is 1.383. Placing this value into equation 2 gives 12.

$$n = (1.383*50 \div 20)^2 = 11.95 \cong 12$$

Placing the t value for $t_{.90,\,11}$ which is 1.363 into equation 2 gives 11.6 which is approximately 12 which then is the answer.

The margin of error can be expressed as relative error (d_r) of the mean instead of a absolute value and the coefficient of variation ($\eta = \sigma/\mu$) can be used as the measure of variability. The formula then becomes

$$n = \left(Z_{1-\alpha}\eta / d_r\right)^2 \qquad (3$$

(from Gilbert 1987)

and a table can be produced of some common values (Table 1).

Table 1. Sample sizes required for Estimating the True Mean μ

Confidence level $(1-\alpha)$	Relative Error d_r	Coefficient of Variation (η) 0.60	1.00
.80 ($Z_{0.80}$ = .846)	.10	26	72
	.20	6	18
	.30	3	8
	.50	1	3
.85 ($Z_{0.85}$ =1.062)	.10	41	113
	.20	10	28
	.30	5	13
	.50	2	5
.90 (**$Z_{0.90}$ = 1.282**)	.10	59	164
	.20	15	41
	.30	7	18
	.50	2	7
.95 ($Z_{0.95}$ = 1.645)	.10	97	271
	.20	24	68
	.30	11	30
	.50	4	11
.99 ($Z_{0.99}$ =2.326)	.10	195	541
	.20	49	135
	.30	22	60
	.50	8	22

The permit writer may adjust sample sizes from Table 1 according to factors discussed in section 1.3.1 of Chapter XIII.

Formula 3 can be adjusted for uncertainty of the standard deviation by use of the t distribution and an iterative process as in formula 2. The number of samples required for a given confidence level, relative error and cv will be slightly higher using the t distribution, however, not significant for the extra effort.

Zar (1996) presents an alternative method for determining n, the number of samples to determine the mean with specified type I (α) and type II (β) error probabilities, as;

$$n = \frac{s^2}{\delta^2}(t_{\alpha(1),\upsilon} + t_{\beta(1),\upsilon})^2 \qquad (4$$

where

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s^2 is the sample variance estimated with ν degrees of freedom

β is the probability of type II error

δ is the size of the error around the mean (d from above)

α, and t are defined as above.

In this equation the number of data required to calculate a confidence interval of a specified width depends upon: 1) the width desired - narrow widths require more samples 2) the variability in the population - larger variability requires larger sample size 3) the confidence level (type I error) and 4) the assurance that the confidence interval will be no larger than that specified (type II error).

This formula is also iterative.

To determine the number of samples required to estimate the mean of a sample with a 90% probability that the 95% confidence interval will be no wider than 3 mg/l (the effluent limit is 30 mg/l), then $\delta = 3$ mg/l, $\beta = 0.10$, $1-\alpha = 0.95$, and $\alpha = 0.05$. Assume an estimate of the population variance from previous sampling : $s^2 = 18.0388$ with $\nu = 24$. If we start with a guess of 8 samples per month then

$$t_{0.05(1),7} = 1.895 \text{ and } t_{0.10,(1),7} = 1.415$$

Using equation 4,

$$n = \frac{s^2}{\delta^2}(t_{\alpha(1),\upsilon} + t_{\beta(1),\upsilon})^2$$

$$n = (18.0388/9)(1.895+1.415)^2$$

$$n = 22$$

for n = 22, $t_{0.05(1),21} = 1.721$ and $t_{0.10,(1),21} = 1.323$

$$n = (18.0388/9)(1.721+1.323)^2$$

$$n = 19$$

for n = 19, $t_{0.05(1),18} = 1.734$ and $t_{0.10(1),18} = 1.330$

$$n = (18.0388/9)(1.734+1.330)^2$$

$$n = 19$$

This formula gives a higher n because of the additional constraint of the type II error.

AN INDUSTRIAL EXAMPLE

A permit manager proposes to use the following data to derive performance-based effluent limits for a discharge from a metal facility. The data are metal concentrations in mg/l from a settling basin. The permit writer wants to know the number of samples to determine the monthly average such that the type I error (false judgement of noncompliance) will be 5% with a 10% interval around the mean.

Mean	0.627260274
Standard Error	0.010826197
Median	0.59
Mode	0.5
Standard Deviation	0.206834198
Sample Variance	0.042780385
Kurtosis	5.752860027
Skewness	1.644693358
CV	0.33
Range	1.7
Minimum	0.29
Maximum	1.99
Sum	228.95
Count	365
Confidence Level(95.0%)	0.02128972

99th percentile = 0.2135155

A. Using formula 1 to determine the number of samples per month to determine a monthly average , with d = 0.06 (10% of the mean), and α =0.05. The data standard deviation s is used as an estimator of σ.

$n = (Z_{1-\alpha/2}\,\sigma/d)^2$

$n = (1.645 * 0.2068 / 0.06)^2 = 32$ samples/month

B. Using formula 2, d = 0.06 or 10% of the mean, α =0.05 and, the data standard deviation, s, as an estimator of σ.

$$n = \left(t_{1-\alpha/2,\, n-1} \sigma / d \right)^2$$

The Z value is used as an initial estimator for t.
n = ($Z_{.95}$* 0.2068 / 0.06)^2 = (1.645 * 0.2068 / 0.06)^2 = 32
n = ($t_{.95,31}$ * 0.2068 / 0.06)^2 = (1.696 * 0.2068 / 0.06)^2 = 34
n = ($t_{.95,33}$ * 0.2068 / 0.06)^2 = (1.693 * 0.2068 / 0.06)^2 = 34 samples/month.

C. Using formula 3 with the coefficient of variation (η) = 0.33, relative error (d_r) = 0.10 and α = 0.05.

$$n = \left(Z_{1-\alpha} \eta / d_r \right)^2$$

n = (1.645 * 0.33 / 0.10)^2 = 29 samples/month

Using t values in this formula will increase n slightly to 31.

D. Using formula 4 to determine n with β = 0.1 (probability noncompliance is occurring but not detected).

$$n = \frac{s^2}{\delta^2} (t_{\alpha(1),\upsilon} + t_{\beta(1),\upsilon})^2$$

$$n = \frac{0.0428}{(0.0627)^2} (1.645 + 1.282)^2$$

$$n = 93$$

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