GUIDANCE FOR NPDES PERMIT ISSUANCE

FEBRUARY 1994

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AND

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TABLE OF CONTENTS

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I. INTRODUCTION

This guidance was prepared at the request of the California State Water Resources Control Board (SWB) and the Regional Water Quality Control Boards (RWB) in anticipation of a State Superior Court Judgement invalidating the Inland Surface Water Plan (ISWP) and the Enclosed Bays and Estuaries Plan (EBEP). The primary aim is to provide guidance for issuing NPDES permits in the absence of State numeric water quality objectives for toxics.

The process for preparing NPDES permits, regardless of the availability of State promulgated numeric water quality objectives, is fundamentally the same. The difference lies in the documents upon which the permit writer relies when making judgements regarding the appropriate bases for permit requirements and the supporting documentation (i.e., statement of basis or fact sheet) necessary to defend such requirements. Where water quality standards are available, the numeric objectives therein are applied using available permitting methods. The bases for these permit requirements are not subject to challenge at the permitting stage, although the method of translating the objective to a permit requirement may be appealed. In the absence of standards containing numeric water quality objectives, the same permitting methods are used to derive permit requirements. However, the bases for such permit requirements are no longer the water quality objectives, but available federal criteria and other scientific information that may be (or have been) used to develop state-specific numeric water quality objectives. The rationale for selecting a numeric criterion as basis for the permit requirement, in addition to methods used to translate a criterion to a permit requirement, are now subject to challenge. Therefore, the rationale must be thoroughly discussed in the statement of basis, fact sheet, or findings that accompany a permit.

Consequently, this guidance focuses on the methods available for preparing NPDES permits. The proper and consistent use of these methods throughout the State will strengthen the permit process, thereby, making it easier to issue permits in the absence of adopted State numeric water quality objectives. This guidance is equally applicable whether or not the ISWP and EBEP are in effect. However, without the ISWP and EBEP, "reasonable potential" (see III.A.2 and Appendix A) is used to establish which pollutants should be limited in the permit, although both state-wide plans have implementation provisions which specify when effluent limitations should be established for a pollutant. The "standards-to-permit" process set forth in this guidance is otherwise applicable and consistent with the Clean Water Act (CWA) and implementing NPDES regulations. Other approaches may also be

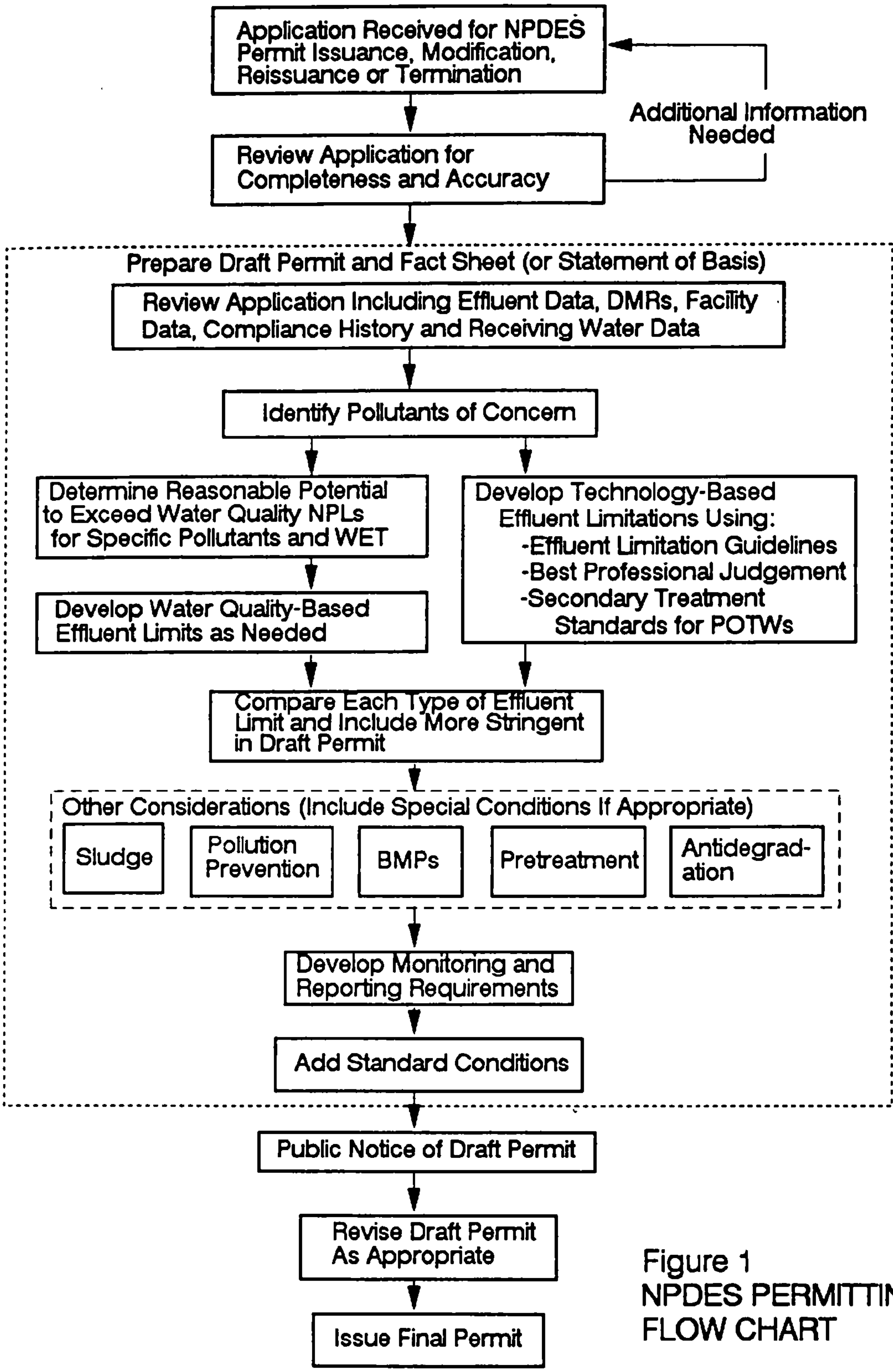

Figure 1
NPDES PERMITTING FLOW CHART

acceptable provided they are consistent with the CWA and NPDES regulations.

It should be noted that if the ISWP and EBEP are invalidated, the federal criteria promulgated for California through the National Toxics Rule (NTR) will apply. The NTR specifies numeric criteria for 40 toxic pollutants. These criteria must be used as the basis for effluent limitations. Effluent limitations for other toxic pollutants will have to be developed using other references (e.g., federal criteria and other scientific information as discussed in this guidance).

II. PERMIT APPLICATION

Persons who intend to discharge to waters of the State are required to provide the information necessary to develop appropriate provisions of a permit. The discharger should be made aware of the information needed to prepare a permit at the earliest possible date. If necessary, the State should exercise its legal authority to formally request information. The intent is to have all information provided in, or along with, the permit application that must be submitted at least 180 days prior to the expiration of an existing permit, or commencement of a discharge [see 40 CFR 122.21(c) and (d)]. Failure to submit the required application at least 180 days prior to the expiration date results in termination of the permit. Thereafter, any discharge is unauthorized. A permit may be administratively extended only if a complete and timely application is submitted.

If, for valid reasons, a discharger is unable to provide all of the necessary monitoring data prior to permit issuance, the issuance of the permit need not be delayed. The State may issue the permit with a provision that the discharger conduct the necessary monitoring under the permit. A reopener clause must also be included in the permit so that appropriate conditions can be added where monitoring data indicate that the discharge has reasonable potential to cause or contribute to the exceedance of an ambient water quality standard or objective. In general, a reopener clause may be included in a permit to address new information and regulations. The latter includes new water quality standards and effluent limitations guidelines (ELGs).

III. DRAFTING THE PERMIT

Effluent limitations are defined by NPDES regulations (see 40 CFR 122.2) as any restriction imposed by a State or EPA on quantities, discharge rates and concentrations of pollutants which are discharged from point sources into waters of the United States. Effluent limitations are either technology-based or water quality-based. In practice, technology-based requirements will define achievable treatment levels for a particular pollutant or class of pollutants (e.g., lime precipitation would be the basis for technology-based requirements for metals. These technology-based requirements are compared with water quality-based requirements for each pollutant. The more stringent requirement is included as an effluent limitation in the permit.

A. WATER QUALITY-BASED EFFLUENT LIMITATIONS

The regulatory basis for establishing water quality-based effluent limitations (WQBELs) is set forth in 40 CFR 122.44(d) of the NPDES regulations. This regulation requires that NPDES permits contain requirements in addition to, or more stringent than, promulgated effluent limitations guidelines or standards under sections 301, 304, 306, 307, 318 and 405 of the CWA necessary to achieve water quality standards established under section 303 of the CWA, including narrative criteria for water quality. Effluent limitations must be established for pollutants (either conventional, nonconventional or toxic) that are, or may be discharged at levels which cause, have the reasonable potential to cause, or contribute to an excursion above any State water quality standard, including narrative objectives for water quality [see 40 CFR 122.44(d)(1)(i)].

The requirement to impose water quality-based effluent limitations applies regardless of whether pollutant specific numeric water quality objectives have been established in State water quality standards. In such instances a narrative objective, such as the statement "all waters shall not contain toxics in toxic amounts," would be sufficient basis to develop permit limitations for toxic pollutants to protect beneficial uses designated for the receiving water body. Depending on the subsection(s) of 40 CFR 122.44 which apply to the particular discharge under consideration, effluent limitations may be pollutant specific, based on whole effluent toxicity (WET), or a combination of both.

1. BASES FOR IMPLEMENTING WATER QUALITY-BASED EFFLUENT LIMITATIONS

State water quality standards containing numeric water quality objectives are the primary basis for establishing water quality-based effluent limitations. In the absence of State numeric water quality objectives, the permit writer must rely on available information to identify the receiving water body beneficial uses and the ambient water quality, including numeric protective levels (NPLs), necessary to attain such uses. The permit writer must then rely on available methods to convert the NPLs to effluent limitations, taking into consideration factors enumerated in the regulations [see 40 CFR 122.44(d)(ii)]. Available information includes State water quality plans and/or documentation supporting the applicability of objectives to a water body, technical literature, and federal numeric ambient water quality criteria for the protection of aquatic life and human health. In California, State and federal documents that may be used as bases for developing and supporting water quality-based effluent limitations include:

- 40 CFR 122.44 - Establishing limitations, standards, and other permit conditions applicable to State NPDES programs.

- National Toxics Rule (57 FR 60848, 22 December 1992; NTR) which specifies numeric criteria for 40 toxic pollutants. In absence of ISWP and EBEP objectives, NTR numeric criteria must be used to establish effluent limitations.

- Water Quality Control Plans (Regional Basin Plans) which specify beneficial uses, and narrative and numeric objectives for Regional water bodies.

- Supporting technical documentation for the California Inland Surface Waters Plan (91-12 WQ, 1991, and subsequent amendments); the California Enclosed Bays and Estuaries Plan (91-13 WQ, 1991, and subsequent amendments); and the California Ocean Plan (SWRCB, 1990, and subsequent amendments; Ocean Plan).

- Individual federal water quality criteria documents; criteria are summarized in Quality Criteria for Water (EPA 440/5-86-001, 1986; Gold Book) and 40 CFR 131.

- Technical Support Document for Water Quality-based Toxics Control (EPA/505/2-90-001, March 1991; TSD).

NPDES regulations provide the basis for establishing the permit limitations. The NTR, State water quality plans and supporting technical documents, and federal criteria documents, specify ambient numeric objectives or criteria that are used to establish NPLs. These NPLs should be achieved in the receiving water body to protect beneficial uses identified in the Regional Basin Plans. Finally, the TSD presents the method for converting effluent and ambient data, and ambient federal criteria into effluent limitations. These documents along with other relevant information must be used to develop and justify water quality-based effluent limitations included in the permit.

2. REASONABLE POTENTIAL/SELECTION OF POLLUTANTS

When considering water quality-based effluent limitations, the permit writer should first select the pollutants for which effluent limitations must be established. The permit writer can choose to establish limitations for all pollutants covered by State water quality plans or federal criteria. However, a more reasonable and defensible approach is to selectively establish effluent limitations for those pollutants which may create or contribute to ambient water quality problems. This latter approach should reduce obstacles for issuing permits, especially in the absence of specific State numeric water quality objectives. Other approaches, such as those set forth in the ISWP and EBEP are acceptable. These plans provide that where the State is satisfied that any effluent pollutant does not occur, or is not likely to occur in a discharged effluent, the State may elect not to establish effluent limitations.

NPDES regulations at 40 CFR 122.44(d)(1)(i) require the establishment of an effluent limitation for any pollutant which is or may be discharged at a level that "will cause, have a reasonable potential to cause, or contribute to an excursion above any State water quality standard, including State narrative criteria for water quality." In determining the need for an effluent limitation, the permit writer must also consider existing controls on other point and nonpoint sources, the variability of the pollutant or pollutant parameter in the discharge, the sensitivity of the test species (for WET) and, where appropriate, the mixing of the discharge in the receiving water [see 40 CFR 122.44(d)(ii)]. Effluent limitations must be included, as appropriate, for specific pollutants and/or WET. No effluent limitation is required for any pollutant which is not present in the discharge, or will not cause, have the reasonable potential to cause, or contribute to an excursion above water quality objectives.

Reasonable potential is determined using a sequential (i.e., tiered) process (see Appendix A and TSD, Chapter 3). In the first step, the steady-state mass balance equation is used to project the maximum resultant in-stream concentration for a pollutant after complete mixing under critical flow conditions. If the projected in-stream concentration is greater than the applicable NPL (i.e., the objective, criteria, or standard necessary to attain the designated beneficial uses), then effluent limitations must be established for that pollutant. If the projected in-stream concentration is less than the applicable NPL, the permit writer must then exercise judgement as to whether reasonable potential exists.

In the second step, historical effluent data for the pollutant of concern and appropriate statistics derived from those data are used to statistically estimate the maximum effluent concentration. In practice, these statistics are used to calculate an uncertainty multiplier that adjusts the maximum observed effluent concentration to a probability-based maximum concentration (see TSD, Chapter 3.3.2, p. 52). This higher concentration is then used in the mass balance equation to project the maximum resultant in-stream concentration for the pollutant after complete mixing (see Appendix

A). Reasonable potential is established if the projected in-stream concentration exceeds the NPL. If reasonable potential is established for a pollutant, water quality-based effluent limitations must be included in the permit. Where reasonable potential is not demonstrated, water quality-based effluent limitations need not be included in the permit.

When effluent data are not available or are insufficient, reasonable potential determinations may still be made and effluent limitations included in the permit. In such instances, reasonable potential determinations should consider the type of discharger, existing knowledge regarding the use, generation, or presence of a pollutant at the facility or contributing facility (in the case of POTWs), and risks posed by the discharge. Permits should also require additional monitoring and a reopener clause in cases where insufficient or no information are available upon which to adequately evaluate reasonable potential (see TSD, Chapter 3.2, pp. 50-51).

The tiered methodology used to evaluate reasonable potential with and without facility-specific effluent and receiving water quality data is outlined in Appendix A.

For ocean discharges, sufficient dilution is necessary to assure compliance with numeric objectives for toxic pollutants set forth in the Ocean Plan. Under the Ocean Plan, factors to consider that influence the initial dilution achievable for ocean outfalls include: observed waste flow characteristics, observed receiving water density structure, and the assumption that no currents, of sufficient strength to influence the initial dilution process, flow across the discharge structure. These factors are input parameters for standard dilution models used to calculate the minimum initial dilution (i.e., lowest average initial dilution within any single month of the year) for ocean outfalls. The calculated minimum initial dilution and maximum effluent pollutant concentrations (either statistically unadjusted or adjusted for uncertainty) may then be used to determine whether any pollutant which is or may be discharged will cause, has the reasonable potential to cause, or contributes to excursions above Ocean Plan objectives. This process is outlined in Appendix C.

Due to the complex circulation patterns observed in enclosed bays and estuaries, tracer or dye studies conducted during conditions that approach critical flows are recommended to determine the areal extent of mixing in a water body, the boundary where the effluent has completely mixed with the ambient water, and the dilution that results from the mixing (see Appendix C and TSD, Chapter 4).

3. ESTABLISHING WATER QUALITY-BASED EFFLUENT LIMITATIONS

After the appropriate water quality NPL is determined (see

III.A.1) and reasonable potential is established for a pollutant (see III.A.2), the NPL must be converted to a permit limitation using the usual permitting methods and appropriate receiving water conditions. Where mixing zones are allowed, appropriate dilution factors may be used to calculate the effluent limitation. However, if mixing zones are not explicitly allowed by State water quality standards, the NPL is applied directly as an end-of-pipe effluent limitation.

In converting NPLs to effluent limitations, averaging times and the use of mass and/or concentration limits should be reconciled. NPDES regulations require that all numeric effluent limitations be expressed, unless impracticable, as both daily maximum and monthly average values (for all discharges other than POTWs), or as weekly average and monthly average values (for POTWs) [see 40 CFR 122.45(d)]. For data tracking purposes, it is important that daily limits be expressed as "daily maximum," rather than "daily average." The regulations further require that pollutants must have mass-based limits except where such limits are impractical or inappropriate, as set forth at 40 CFR 122.45(f). Where effluent dilution is less than 100:1, both mass and concentration effluent limits should be specified (see TSD, pp. 110-111). This section of the permit guidance outlines the final step in the "standards-to-permit" process, where 1-hour average (acute) and 4-day average (chronic) NPLs (e.g., federal criteria) are converted to daily maximum and monthly average effluent limitations. This methodology first calculates waste load allocations (WLAs) for those pollutants where reasonable potential has been established. Maximum daily limitations (MDL) and average monthly limitations (AML) required to meet the most limiting WLA are then calculated using statistical procedures outlined in Appendix B (also, see TSD, Chapter 5).

As used herein, WLA is the maximum allowable effluent pollutant concentration or load that will comply with the applicable NPL. The WLA is calculated using the steady-state mass balance equation [$Q_dC_d + Q_sC_s = Q_rC_r$, where Q is flow; C is pollutant concentration; and subscripts refer to upstream (s), discharge (d), and downstream after complete mixing (r)]. Thus, where mixing zones are not allowed, the WLA becomes the appropriate NPL applied at the end-of-pipe. The WLA is not premised upon the existence of a total maximum daily load (TMDL); however, where a TMDL exists, the WLA is that portion of the allowable load assigned to a particular discharge on the basis of procedures specified in the State water quality standards.

WLA calculations are always made assuming critical conditions [i.e., 1-day low flow with a 10 year recurrence interval (1Q10) for calculating acute WLAs; consecutive 7-day low flow with a 10 year recurrence interval (7Q10) for calculating chronic WLAs; and the harmonic mean flow for calculating human health WLAs]. Where data are available, background concentrations should also reflect critical flow conditions.

In this guidance, the steady-state mass balance equation is used to determine WLAs. This approach, coupled with conservative assumptions, should be protective of water body beneficial uses. The permit should also require both effluent and ambient monitoring as an on-going assessment of the impact of the discharge on the receiving water. Where circumstances dictate, alternative models (e.g., dynamic) that estimate dilution or fate of effluent pollutants are available (see TSD, Chapter 4). The use of dynamic models may be a more rigorous method for calculating WLAs. However, they require large amounts of quality data. If these data are not available, then dynamic model calculate inaccurate projections. Under such conditions, the steady-state mass balance equation is recommended.

Where reasonable potential analyses project an excursion above an applicable NPL, WLAs for that pollutant are determined at each effect level (i.e., acute, chronic and human health) (see Appendix B).

Once a WLA is determined for each effect level, the long term average (LTA) discharge conditions required to meet these WLAs at a specified confidence level (i.e., 99%) are calculated using statistics derived from appropriate effluent data. The LTA is a discharge performance level that should be achieved to ensure that effect level WLAs will not be exceeded at least 99% of the time (see Appendix B).

Finally, using the lowest (most limiting) effect level LTA, a maximum daily limitation (MDL) and an average monthly limitation (AML) are calculated using statistics derived from appropriate effluent data.

This methodology is detailed in Appendix B, and summarized in the TSD (see Chapter 5).

4. INTERIM PERMIT LIMITATIONS

The CWA at section 301(b)(1)(C) requires that water quality standards be met by July 1, 1977. Consequently, subsequent changes to State water quality standards must be met at the date of permit issuance unless authorization (i.e, a compliance schedule) is included in either State-wide water quality plans or basin plans. A permit cannot contain a compliance schedule unless this condition is met. Without this condition, the permit writer may use an appropriate enforcement mechanism to address the noncompliance or anticipated noncompliance (e.g., the issuance of an administrative order concurrent with the permit).

Where compliance schedules are authorized, interim effluent limitations should be included in the permit or administrative order, as appropriate, unless, for valid reasons, data are insufficient. Interim permit limitations may be developed as follows:

- Where the permittee is in compliance with existing effluent limitations, these values may be specified as interim limitations in the reissued permit. Otherwise, they are the least stringent limitations that can appear in subsequent permits.

- Where effluent data are available, daily maximum and monthly average interim limitations based on facility performance should be implemented in the reissued permit. The appropriate statistical methodology should be used to calculate performance-based effluent limitations (see TSD, Chapter 5, Table 5.2, p.103, and Appendix E). However, performance-based interim limitations can not be less stringent than limitations specified in the previous permit, unless antibacksliding requirements are met. If effluent concentrations exceeded previous permit limitations, the permittee would not have been in compliance with the previous permit. Hence, before the permit is reissued, the noncompliance under the previous permit must be addressed through appropriate enforcement action. If the permittee made good faith effort to comply (e.g., installed and properly operated appropriate treatment), previous effluent limitations may be relaxed, provided that applicable NPLs are met in the receiving water body (see Great Lakes Initiative, 57 FR 20803, 16 April 1993).

Where data are lacking and reasonable potential cannot be evaluated, effluent monitoring may be required as a condition of the reissued permit. In this situation, since reasonable potential has not been established, final effluent limitations need not be specified in the permit at the time of issuance. A permit reopener clause [see 40 CFR 122.44(c)] allowing for the implementation of water quality-based effluent limitations, if effluent monitoring data establishes that the discharge shows reasonable potential to exceed the NPL, should be included in the permit (see TSD, Chapter 3, p. 51).

B. TECHNOLOGY-BASED EFFLUENT LIMITATIONS FOR INDUSTRIAL SOURCES

As noted previously, the CWA requires compliance with the more stringent of technology-based or water quality-based requirements. Consequently, the permit writer should evaluate both requirements when developing effluent limitations.

For industrial sources, section 301(b)(2) of the CWA requires by March 31, 1989, the application of Best Available Treatment Economically Achievable (BAT) for toxic and nonconventional pollutants, and Best Conventional Pollutant Control Technology (BCT) for conventional pollutants. BAT and BCT replace Best Practical Control Technology (BPT) which was to have been achieved by July 1, 1977. Toxic pollutants (see 40 CFR 401.15) include 126 pollutants (primarily metals and organics) of particular concern. Conventional pollutants are defined at 40 CFR 401.16 and include pH, BOD_5, oil and grease, suspended solids, and fecal coliform. All other pollutants (e.g., nutrients and WET) are classified as nonconventional pollutants. Since the deadline has passed for compliance with BAT/BCT effluent limitations, all newly issued permits must require immediate compliance with appropriate BAT/BCT limitations.

Section 306 of the CWA requires compliance with New Source Performance Standards (NSPS) for industrial facilities classified as new sources (see 40 CFR 122.2). NSPS are another category of technology-based effluent limits which may be more stringent than BCT/BAT to reflect the greater opportunities for incorporating pollution control technologies into new facilities.

1. EFFLUENT LIMITATIONS GUIDELINES

As provided by section 304(b) of the CWA, EPA has promulgated effluent limitations guidelines for 51 categories of industrial dischargers. These guidelines are based on analyses conducted by EPA of the technological and financial capacity of these industries to control pollutants in their discharges.

2. EFFLUENT LIMITATIONS BASED ON BEST PROFESSIONAL JUDGEMENT

Effluent limitations guidelines have not been promulgated by EPA for all categories of industries. In addition, promulgated guidelines may not address all sources of wastewater from a particular facility. In such cases, the permit writer must develop appropriate technology-based limits based on best professional judgment (BPJ), as authorized by section 402(a)(1) of the CWA and NPDES regulations at 40 CFR 122.43-44 and 125.3.

When developing BPJ limits, the same factors must be considered by the permit writer as are considered by EPA in the formal promulgation of effluent limitations guidelines. These factors are set forth in section 304(b)(2)(B) of the CWA and include: the age of equipment and facilities involved; the process employed; the engineering aspects of the application of various types of control techniques; process changes; the cost of achieving such effluent reduction; non-water quality environmental impacts (including energy requirements); and other such factors as are deemed appropriate. Various BPJ permitting methods are available to assist in the development of permit limitations (see Training Manual for NPDES Permit Writers (EPA 833-B-93-003, March 1993, Chapter 4).

Additional technology-based limitations based on BPJ may be included in NPDES permits in the form of best management practices [BMPs; see 40 CFR 122.44(k) and 125.100-102]. BMPs generally refer to operating or maintenance procedures designed to reduce pollutants in discharges (see Best Management Practices Guidance Document, June 1981).

C. TECHNOLOGY-BASED EFFLUENT LIMITATIONS FOR POTWs

Publicly-owned treatment works (POTWs) are also required to comply with technology-based effluent limitations which are referred to as "secondary treatment." These effluent limitations are set forth at 40 CFR 133 and include limits for BOD_5, suspended solids and pH. The regulations also provide that under certain circumstances (e.g., waste treatment ponds), permits for POTWs may be written with less stringent "equivalent to secondary" effluent limitations or alternate State requirements.

IV. SPECIAL CONSIDERATIONS

A. WATER QUALITY-BASED EFFLUENT LIMITATIONS FOR METALS

1. EXPRESSION OF AQUATIC LIFE CRITERIA FOR METALS

After reviewing the available information on metals toxicity, EPA recently recommended implementing for metals the dissolved measurement as the basis to set and measure compliance with water quality standards; however, EPA also recognizes that the total recoverable measurement may be used by States to satisfy appropriate risk management decisions [see Policy Guidance for Aquatic Life Metals Criteria, EPA Office of Water, 1 October 1993 (Metals Policy)]. In the absence of adopted State water quality objectives for metals, federal metals criteria or other rigorously developed criteria should be used to develop NPLs.

Federal metals criteria were developed using total recoverable measurements. If a State chooses to use the dissolved measurement for determining NPLs and effluent limitations, the appropriate correction factor must be used to convert from total recoverable to dissolved. EPA's "Guidance document on dissolved criteria, expression of Aquatic Life Criteria, October 1993" (see Metals Policy attachment) presents correction factors for converting metals criteria from total recoverable to dissolved. These correction factors are the simple ratios of the two metals measurements and were derived from laboratory data used to establish federal metals criteria.

2. TRANSLATING DISSOLVED CRITERIA INTO TOTAL RECOVERABLE PERMIT LIMITATIONS

NPLs for metals should be expressed as dissolved, provided that the State has accepted the use of dissolved in lieu of total recoverable. However, NPDES regulations require that limitations for metals in permits be expressed as total recoverable, except under those conditions set forth at 40 CFR 122.45(c). These include circumstances where technology-based effluent limitations specify dissolved, or where the analytical method employed only measures dissolved. Thus, where NPLs for metals are expressed as dissolved metals, it may be necessary to develop translators to convert dissolved NPLs to total recoverable effluent limitations. The translator is based on the relationship between the two metal measurements in the receiving water body. Consequently, these translators should be developed using site-specific ambient data.

When developing total recoverable effluent limitations for metals, the permit writer should assume that the relationship between total recoverable and dissolved is 1:1 (i.e., translator = 1). *If the applicant requests the opportunity to develop* site-specific translators, the NPDES permit should include conditions specifying required outcomes and a schedule for completion of the translator study. During the translator study, the permit writer may apply interim metals limits.

National data are available for developing translators; however, this approach should be used only for establishing interim effluent limitations. Final effluent limitations should be based on translators that reflect partition coefficients developed using site-specific ambient water chemistry. Where ambient data are insufficient, a monitoring program must be undertaken by the permittee to acquire data necessary to develop the translator (see Guidance Document on Dynamic Modeling and Translators, August 1993; and Technical Guidance Manual for Performing Waste Load Allocations, Book II: Streams and Rivers, Chapter 3 - Toxic Substances, EPA-440/4-84-022, June 1984).

3. INCLUDING TRANSLATOR REQUIREMENTS IN NPDES PERMITS

A period of up to 2 years is recommended for a translator study. Minimum data requirements necessary for the study are outlined in the Metals Policy. A study plan should be completed within the first 3 months of permit issuance, followed by 12 months of monitoring and data collection. Up to 3 months can be allowed for data analysis and submission of a report that includes recommendations for site-specific translators and where appropriate, a request for permit modification. The final report should also describe: 1) whether compliance with translated metals limits can be achieved; and if not 2) what is required to achieve compliance; and 3) where applicable, how changes resulting from the study would satisfy State antidegradation requirements. Where appropriate, a permit modification should be issued within 6 months following the modification request.

The permit must clearly specify the form of metals limitations (i.e., total, total recoverable, or disolved).

B. WHOLE EFFLUENT TOXICITY TESTING IN NPDES PERMITS

1. BASIS FOR WHOLE EFFLUENT TOXICITY

The whole effluent approach to water quality-based toxics control for the protection of aquatic life involves the use of acute and chronic toxicity tests to measure the toxicity of effluents or ambient water. The Whole Effluent Toxicity (WET) approach is important because specific NPLs for all pollutants have not been developed, and complex mixtures of effluent pollutants may have toxic effects that specific NPLs do not address. The WET approach allows the permit writer to require achievement of the narrative standard, "no toxics in toxic amounts" [see CWA section 101(a)(3)], that is applicable to all waters of the United States (see 40 CFR 122.2). The CWA clearly authorizes the use of toxicity testing and WET limitations in NPDES permits (see TSD, Appendix B-1).

When determining the need for a WET permit limit, the permit writer must consider those conditions specified under 40 CFR Part 122.44(d)(1)(ii). WET permit limits are required when a discharge exceeds, has the reasonable potential to exceed, or contributes to excursions above narrative and/or numeric WET criteria [see 40 CFR Part 122.44(d)(1)(iv) and (v)]. However, when a permittee has identified the toxicant(s) causing toxicity and numeric limitations have been established for the pollutant(s), numeric limitations for WET need not be placed in the permit. Although, continued monitoring for toxicity will still be required. Reasonable potential determinations are made as discussed in III.A.2.

2. TOXICITY REQUIREMENTS

In the absence of specific numeric water quality objectives for acute and chronic toxicity, the narrative criterion "no toxics in toxic amounts" applies. Achievement of the narrative criterion, as applied herein, means that ambient waters shall not demonstrate for acute toxicity: 1) less than 90% survival, 50% of the time, based on any monthly median, or 2) less than 70% survival, 10% of the time, based on any monthly median. For chronic toxicity, ambient waters shall not demonstrate a test result of greater than 1 TUc.

The chronic toxicity limitation is to be expressed as 1 TUc as a daily average. Any one test that shows greater than 1 TUc would be considered a violation. Immediately upon exceedance of the limitation the permittee shall conduct a Toxicity Reduction Evaluation (TRE) and where appropriate, a Toxicity Identification Evaluation (TIE) to identify the cause(s) of toxicity. The permit shall also require the submission of a TRE workplan to the State within 60 days of permit (re)issuance.

At the discretion of the permit writer the limitation can be expressed as 1 TUc as a monthly median. This discretion is dependent on consideration of the permittees ability and willingness to conduct multiple testing during a month. The expression 1 TUc as a monthly median addresses the dischargers concern of one sample being a violation. This expression allows the permittee the option to conduct additional tests within a month, and have those additional tests be used to determine compliance.

Effluent limitations shall be calculated to achieve these NPLs using the methods discussed in III.A.3. Where mixing zones are allowed, it may be used for calculating limitations for chronic toxicity in effluent dominated waters. The chronic toxicity NPL of 1 TUc may be met at the end of the mixing zone to allow for dissipation of the effects, due to volatization, or chemical or physical changes. (The behavior of chlorine and ammonia best illustrate the applicability of mixing zones to effluent dominated waters). The dilution will have to be determined empirically by the discharger through a monitoring program designed to determine the dissipation that occurs in the receiving waterbody. The dilution credit would then be applied to the 1 TUc NPL to determine the effluent limitations.

Published EPA TRE and Toxicity Identification Evaluation (TIE is component of the TRE) guidance manuals include:

- Generalized Methodology for Conducting Industrial Toxicity Reduction Evaluations (TREs) (EPA/600/2-88/070, 1989);

- Toxicity Reduction Evaluation Protocol for Municipal Wastewater Treatment Plants (EPA/600/2-88/062, 1989);

- Methods for Aquatic Toxicity Identification Evaluations: Phase I Toxicity Characterization Procedures (EPA/600/6-91/003, 1991);

- Toxicity Identification Evaluation: Characterization of Chronically Toxic Effluents, Phase I (EPA/600/6-91/005, 1991);

- Methods for Aquatic Toxicity Identification Evaluations: Phase II Toxicity Identification Procedures (EPA/600/R-92/080, 1992); and

- Methods for Aquatic Toxicity Identification Evaluations: Phase III Toxicity Confirmation Procedures (EPA/R-92/081, 1992).

3. TYPES OF TOXICITY TESTING

The two types of toxicity tests are acute and chronic. An acute toxicity test is defined as a static-renewal, static non-renewal or flow-through test of 96-hours or less in duration with lethality as the measured endpoint. Acute toxicity can be reported as a lethal concentration (LC), or a no observable adverse effect concentration (NOAEC). NOAEC is the highest effluent concentration at which survival is not significantly different from the control. LC is the toxicant concentration that would cause mortality to a certain percentage of the test organisms (e.g. LC 10).

Traditionally, chronic toxicity tests are full life-cycle or shortened tests of about 30 days. However, the duration of most chronic toxicity tests has been shortened to 7 days by focusing on the most sensitive life-cycle stages (e.g., juveniles instead of adult fish). The measured endpoint can be reduced fertilization, reproduction, growth and/or mortality. Chronic toxicity endpoints can be recorded as the no observed effect concentration (NOEC), the lowest observed effect concentration (LOEC), or the effect concentration (EC). The NOEC is the highest concentration of toxicant, in terms of percent effluent, to which the test organisms are exposed that causes no observable adverse effect. The LOEC is the lowest concentration of toxicant to which the test organisms are exposed that causes an observed effect. The EC is the toxicant concentration that would cause an adverse effect on a certain percentage of the test organisms (e.g., EC10 or EC50).

WET permit limits should be expressed as toxic units (TU). Chronic toxicity is expressed as TUc = 100/NOEC.

EPA has published WET guidance and recommended toxicity test protocols in four manuals:

- Technical Support Document for Water Quality-based Toxics Control (EPA/505/2-90/001, 1991);

- Methods for Measuring Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms (EPA/600/4-90/027, 1991);

- Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms (EPA/600/4-91/002, 1992); and

- Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms (EPA/600/4-91/003, 1992).

GLOSSARY

GLOSSARY

Antidegradation refers to policies which are part of each State's water quality standards which are designed to protect water quality and provide a method for assessing activities that may impact the integrity of a water body.

Average monthly limitation (AML) is the highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during that month divided by the number of daily discharges measured during that month.

Best management practices (BMPs) are schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include but are not limited to treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal or drainage from raw material storage.

Best professional judgment (BPJ) is the highest technical opinion developed by a permit writer after consideration of all reasonably available and pertinent data or information which forms the basis for the terms and conditions of a permit.

Daily Discharge is the discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the 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 discharges over the day. For pollutants with limitations expressed in other units (e.g., concentration), daily discharge is calculated as the average measurement of the pollutant over the day.

Effluent limitation is any restriction imposed by a permitting authority on quantities, discharge rates, and concentrations of pollutants which are discharged from point sources into waters of the United States.

Effluent limitation guideline (ELG) is a regulation published by the Administrator of EPA under section 304(b) of the Clean Water Act to adopt or revise an effluent limitation.

Harmonic mean flow (HMF) is the number of daily flow measurements of a stream divided by the sum of the reciprocals of the flows. This is the design flow which is used for estimating human health impacts of a discharge.

Load allocations (LAs) are the portion of a receiving water's total daily maximum load that are attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources.

Long term average (LTA) is performance level that should be achieved in a discharge to ensure that the WLA will not be exceeded at least 99% of the time.

Maximum daily limitation (MDL) is the highest allowable daily discharge of a pollutant.

Numeric protective level (NPL) is a numeric water quality value determined to be appropriate for a given receiving water body based on a review of the beneficial uses of the water body and the water quality necessary for protection of such uses.

1Q10 is the lowest 1-day flow of a receiving water to be expected over a 1 year period. This flow is used for estimating acute effects of a discharge.

7Q10 is the lowest 7-day flow of a receiving water to be expected over a 10 year period. This flow is used for estimating chronic effects of a discharge.

Toxicity reduction evaluation (TRE) is a site-specific study conducted in a step-wise 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.

Total maximum daily load (TMDL) is the sum of the individual waste load allocations and load allocations. A margin of safety is included with the two types of allocations so that any additional loading, regardless of source, would not produce a violation of water quality standards.

Waste load allocation (WLA) is the maximum allowable effluent pollutant concentration or load which is allocated to existing or future point sources of pollution which, considering the total maximum daily load to the receiving water, will ensure compliance with the NPL.

APPENDIX A

APPENDIX A

ESTABLISHING REASONABLE POTENTIAL

I. BASIS FOR ESTABLISHING REASONABLE POTENTIAL

NPDES regulations at 40 CFR 122.44(d) require the permit writer to establish effluent limitations for pollutants which show reasonable potential to cause, or contribute to an excursion above State water quality standards, including State narrative objectives for water quality.

As required under 40 CFR 122.44(d)(ii), the permit writer must consider a number of factors in establishing reasonable potential including existing pollution controls, pollutant variability in the effluent, sensitivity of toxicity test species, and dilution in the receiving water. The following discussions outline the tiered methodology followed when conducting a reasonable potential evaluation. Regulations supporting reasonable potential determinations are discussed in the TSD (see Chapter 3).

Justification for imposing water quality-based effluent limitations based on reasonable potential is required in the statement of basis, or fact sheet [see 40 CFR 122.44(d)(vi)(C)].

II. ESTABLISHING REASONABLE POTENTIAL WITH FACILITY-SPECIFIC DATA

Where facility-specific effluent data are available, reasonable potential is evaluated in a sequential (i.e., tiered) process. The first-tier analysis may be performed by using a simple steady-state mass balance equation. The mass balance equation relates the mass of pollutants upstream of a point source discharge, to the mass of pollutants downstream after mixing of the discharge in the receiving water is complete. The general mass balance equation for the recommended steady-state model (see <u>Training Manual for NPDES Permit Writers</u>, EPA 833-B-93-003, March 1993, pp. 6-10) is:

$$QdCd + QsCs = QrCr \quad \text{, where}$$

Qd = waste discharge flow in million gallons per day (MGD), or cubic feet per second (cfs)

Cd = waste discharge pollutant concentration in milligrams per liter (mg/L)

Qs = background in-stream flow in MGD or cfs above point of discharge during critical flow conditions

Cs = background in-stream pollutant concentration in mg/L

Qr = resultant in-stream flow after discharge in MGD or cfs (i.e., Qs + Qd)

Cr = resultant in-stream pollutant concentration in mg/L in the stream reach (after complete mixing)

For reasonable potential determinations, this equation is rearranged to solve for the resultant in-stream concentration (Cr) at the edge of the mixing zone:

$$Cr = \frac{(Qd)(Cd) + (Qs)(Cs)}{Qr}$$

Using the mass balance equation, Cr should be calculated using conservative (i.e., critical) assumptions for background in-stream receiving water flow (Qs), background in-stream receiving water pollutant concentration (Cs), waste discharge flow (Qd) and waste discharge pollutant concentration (Cd). Critical waste discharge conditions should be represented by the highest observed pollutant concentration and waste discharge flow. Critical background in-stream receiving water flows are: 1) the 1Q10 flow (1-day low flow over a 10-year recurrence interval) for calculating acute effects; 2) the 7Q10 flow (consecutive 7-day low flow over a 10-year recurrence interval) for calculating chronic effects; and 3) the harmonic mean flow for calculating human health effects. Where possible, background in-stream pollutant concentrations should correlate with critical background in-stream flows, as critical pollutant concentrations occur during low flows. If site-specific ambient pollutant concentration data are lacking, then other appropriate ambient data, accessible through STORET, may be used. Ambient low flow data, developed by the U.S. Geological Survey, are also available through STORET.

Once the projected maximum in-stream pollutant concentration (Cr) is calculated, this value can be compared to the appropriate numeric protective level (NPL). Where Cr is greater than the NPL, reasonable potential is established for that pollutant at the specified effect level (i.e., acute, chronic or human health). When reasonable potential is demonstrated, water quality-based effluent limitations must then be developed for those individual pollutants and/or WET.

If the projected maximum resultant in-stream pollutant concentration (Cr) is less than the NPL, the permit writer must then exercise judgement to determine whether reasonable potential exists. This judgement depends on how large the difference is between Cr and the applicable NPL, the uncertainty of maximum effluent concentrations, type of discharger, and the sensitivity of the receiving water. To assist in making this judgement, a second-tier assessment may be performed that statistically addresses the uncertainty of maximum effluent concentrations for individual pollutants. The second-tier analysis is a six step process (see TSD, Box 3-2, p. 53) and is conducted for an effluent pollutant data set as follows:

1. Determine the total number of samples in the data set (k) and the highest observed effluent concentration.

2. Calculate the coefficient of variation (CV), where the CV is the standard deviation over the mean (σ/μ) (see TSD, Appendix E). For sample sizes less than 10 ($k < 10$) a default CV of 0.6 can be used (see TSD, Box 3-2, p. 53).

3. Choose uncertainty multiplier from Table 3-1 or 3-2 (see TSD, p. 54) using k and the CV. The 99% confidence level and 99% probability basis is recommended.

4. Calculate the adjusted maximum effluent concentration by multiplying the uncertainty multiplier times the highest observed effluent concentration (Cd).

5. Re-calculate the maximum resultant in-stream pollutant concentration (Cr) using the adjusted maximum effluent concentration (Cd) and the mass balance equation.

6. *Compare Cr with the applicable NPL. Reasonable potential* is established when Cr exceeds the NPL.

When reasonable potential is established by either first- and/or second-tier analyses, a water quality-based effluent limitation must be included in the permit for that particular pollutant.

III. ESTABLISHING REASONABLE POTENTIAL WITHOUT FACILITY-SPECIFIC EFFLUENT DATA

Where facility-specific effluent data are lacking, the permit writer may still conduct a reasonable potential evaluation. Establishing reasonable potential under such circumstances requires a systematic consideration of all applicable factors in 40 CFR 122.44(d)(1)(ii) (see TSD, pp. 50-51 and Box 3-1, p. 49) including:

- Existing ambient water quality data;
- Available dilution in the receiving water;
- Type of receiving water and designated uses;
- Industry/POTW type and nature of the discharges;
- Compliance history and historical toxic impacts; and

- Information from permit application or DMRs.

If a review of ambient monitoring data shows in-stream exceedances or near exceedances of a NPL and that pollutant is present in the discharge, reasonable potential is clearly established and effluent limitations for that pollutant should be included in the permit. The in-stream exceedance of a NPL indicates that the receiving water body cannot assimilate any additional load of that pollutant. Consequently, compliance with the NPL must be met at the end-of-pipe (i.e., no dilution).

When effluent data are lacking the permit writer may choose to require periodic monitoring for pollutants that may be present in a discharge, or periodic effluent scans for all 126 priority pollutants. The type of monitoring should be determined by the nature of the discharge and receiving water, and the amount of available dilution (see TSD, pp. 57-59, Figure 3-2). Under these conditions, the permit should be issued with a reopener clause allowing for modification of the permit to include effluent limitations where monitoring data show reasonable potential for in-stream excursions above ambient NPLs.

IV. FINDING NO REASONABLE POTENTIAL

Where existing effluent monitoring data show no reasonable potential for excursions above ambient NPLs, the permit need not contain water quality-based effluent limitations. However, the permit writer may include monitoring requirements in the permit to continue to re-affirm initial reasonable potential determinations and to monitor for effluent changes (see TSD, pp. 59, 64).

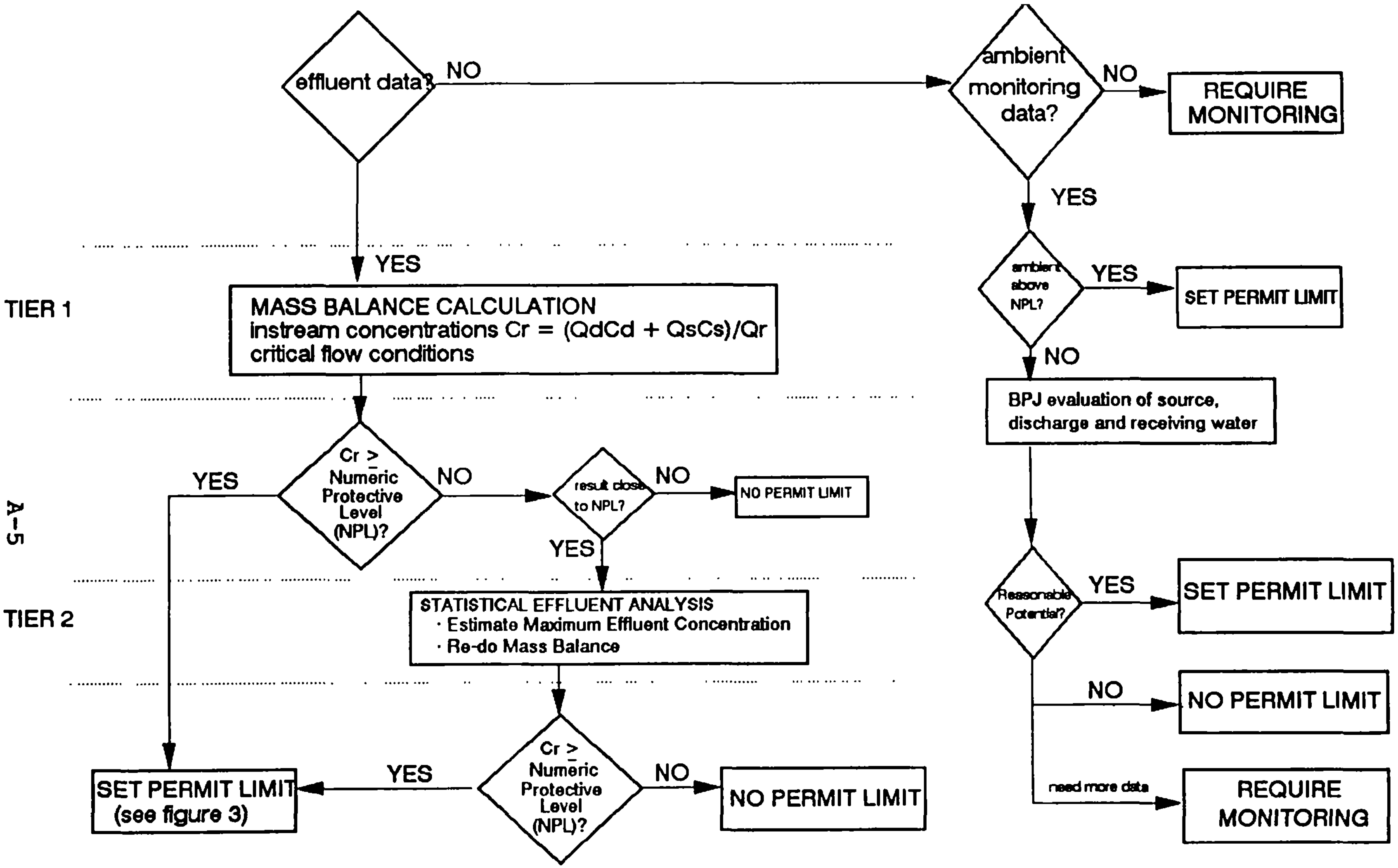

Figure 2
REASONABLE POTENTIAL
FLOW CHART FOR PERMITTING

APPENDIX B

APPENDIX B

DETERMINING WATER QUALITY-BASED EFFLUENT LIMITATIONS

Water quality-based effluent limitations (WQBELs) are based on maintaining effluent quality at a level that will comply with appropriate NPLs, even during critical conditions in the receiving water. These effluent limitations are based on the allowable effluent loading concentration, or waste load allocation (WLA) (i.e., Cd). Pollutant WLAs can be adjusted for uncertainty using statistics calculated from historical effluent data; these adjusted WLAs define the desired levels of performance, or targeted long-term average discharge conditions (LTAs) for specific NPL effect levels (i.e., acute, chronic, or human health). Permit limits are calculated using statistics derived from historical effluent data and the most limiting target LTA for a specific NPL.

The coefficient of variation (CV) is the critical statistic calculated for each pollutant using historical effluent data. Where historical data are insufficient (i.e., $k < 10$), the CV may be estimated by 0.6 (see TSD, Appendix E, p. E-3). Statistical derivation procedures for the average monthly limit (AML) should assume that at least four samples (n) will be taken per month (see TSD, pp. 107, 110).

The WLA required to protect against both acute and chronic effects under critical conditions may be calculated using either steady-state or dynamic models. In many cases, a WLA for a pollutant of concern is not apportioned under a total maximum daily load (TMDL) for the receiving water. In such cases, the allowable effluent loading concentration (Cd) based on steady-state assumptions may be substituted for the more rigorously determined WLA. The steady-state model is the mass balance formula, QdCd + QsCs = QrCr, used in reasonable potential evaluations. However, the equation is rearranged to solve for the effluent concentration (Cd), or WLA, necessary to achieve the appropriate NPL, which for compliance purposes is set equal to Cr:

$$Cd = \frac{[Cr\ (Qd + Qs)] - [(Cs)(Qs)]}{Qd}$$, where

Qd = waste discharge flow in million gallons per day (MGD), or cubic feet per second (cfs)

Cd = waste discharge pollutant concentration in milligrams per liter (mg/L)

Qs = background in-stream flow in MGD or cfs above point of discharge

Cs = background in-stream pollutant concentration in mg/L

Qr = resultant in-stream flow after discharge in MGD or cfs (i.e., Qs + Qd)

Cr = Numeric Protective Level (NPL) = resultant in-stream pollutant concentration in mg/L in the stream reach (after complete mixing)

In most cases, this steady-state model should be used to calculate the WLA (i.e., allowable effluent concentration) that will meet acute and chronic water quality criteria for the protection of aquatic life at 1Q10 and 7Q10 design flows, respectively, and chronic water quality criteria for the protection of human health at the harmonic mean flow (see TSD, p. 68). Ambient low flow data from the U.S. Geological Survey are available on STORET.

Background pollutant concentrations (Cs) used in the mass balance equation should reflect critical flow conditions. However, if site-specific pollutant data are not available, other appropriate data (e.g., STORET data) should be used to calculate Cs. In such cases, the permit should require both effluent and ambient monitoring.

When calculating the WLA, it should be noted that if State water quality standards and plans do not explicitly allow the application of mixing zones, the appropriate NPL must be met at the end-of-pipe (i.e., NPL = Cr = Cd = WLA). Where mixing zones are allowed, there should be no acute effects within the mixing zone; chronic NPLs must be met at the edge of the mixing zone (see TSD, p. 58).

If adequate receiving water flow and effluent concentration data are available to estimate frequency distributions, dynamic modeling techniques can be used to calculate allowable effluent loadings that will more precisely maintain water quality standards (see TSD, p. 97). However, the steady-state mass balance equation, when coupled with the recommended conservative assumptions, should be adequately protective of receiving water beneficial uses.

Most WLAs calculated using federal water quality criteria for the protection of aquatic life have both acute and chronic requirements, whereas WLAs determined using federal water quality criteria for the protection of human health have only chronic requirements. For permit implementation, acute and chronic WLAs need to be converted to maximum daily limits (MDLs) and average monthly limits (AMLs). The following methodology (see TSD, Box 5-2, p. 100; Figure 5-4, p. 101; and Tables 5-1, 5-2 and 5-3, pp. 102-103, 106) is designed to derive permit limits for specific pollutants and WET to achieve calculated WLAs at the 99% confidence level for MDLs and the 95% confidence level for AMLs.

1. Using the mass balance equation to solve for the allowable effluent concentration (Cd), or WLA, for a pollutant of concern:

   a. Set Cr equal to applicable acute, chronic, and human health NPLs.

   b. Background receiving water (Qs) and discharge (Qd) flows, and background pollutant concentration (Cs) should represent critical conditions.

   c. Solve for Cd, or acute (WLAa), chronic (WLAc) and human health (WLAh) waste load allocations, respectively.

2. To calculate the coefficient of variation (CV):

   a. Use effluent data set of 'k' observations to calculate the mean (μ) and standard deviation (σ) (see TSD, Appendix E).

   b. Calculate the coefficient of variation (CV), where CV = σ/μ.

   c. Where the effluent data set is small (k < 10), the conservative value of 0.6 is recommended to estimate the CV (see TSD, Appendix E, p. E-3).

3. To determine long-term averaged discharge conditions (LTAs):

   a. Use the following equations to calculate acute and chronic long-term average discharge conditions (LTAa and LTAc) that will satisfy the acute and chronic waste load allocation (WLAa and WLAc). The CV calculated above is used to estimate both acute and chronic WLA multipliers (see TSD, Table 5-1, p. 102).

$$LTAa = WLAa \cdot e^{[0.5\,\sigma^2 - z\,\sigma]}$$

$$LTAc = WLAc \cdot e^{[0.5\,\sigma_4{}^2 - z\,\sigma_4]}$$, where

$e^{[0.5\,\sigma^2 - z\,\sigma]}$ = acute WLA multiplier
$e^{[0.5\,\sigma_4{}^2 - z\,\sigma_4]}$ = chronic WLA multiplier
z = 2.326 for the 99th percentile occurrence probability for the LTA is recommended

   b. Set the long-term average discharge condition for human health (LTAh) equal to the waste load allocation for human health (WLAh).

$$LTAh = WLAh$$

4. Determine the lowest (most limiting) long-term average discharge condition (LTA).

$$LTA = \text{minimum (LTAa, LTAc, or LTAh)}$$

5. Calculate the maximum daily permit limit (MDL) and average monthly permit limit (AML) using the lowest (most limiting) long-term average discharge condition.

   a. Use the following equations to calculate the MDL and AML when the most limiting long-term average discharge condition is either acute (LTAa) or chronic (LTAc). The CV calculated above is used to estimate both acute and chronic LTA multipliers (see TSD, Table 5-2, p. 103).

      $$MDL = LTA \cdot e^{[z\sigma - 0.5\sigma^2]}$$, where

      $e^{[z\sigma - 0.5\sigma^2]}$ = MDL LTA multiplier
      z = 2.326 for the 99th percentile occurrence probability for the MDL is recommended

      $$AML = LTA \cdot e^{[z\sigma_n - 0.5\sigma_n^2]}$$, where

      $e^{[z\sigma_n - 0.5\sigma_n^2]}$ = AML LTA multiplier
      z = 1.645 for the 95th percentile occurrence probability for the AML is recommended
      n = number of samples/month

   b. Use the following equations to calculate the MDL and AML when the most limiting long-term average discharge condition is human health (LTAh).

      $$AML = LTAh$$

      $$MDL = AML \cdot [MDL/AML]$$, where

      [MDL/AML] is taken from the TSD (Table 5-3, p. 106), using the CV calculated above and the number of samples/month (n).

Following these procedures, the maximum daily limit (MDL) and average monthly limit (AML) may be then incorporated into the permit as justifiable water quality-based effluent limitations.

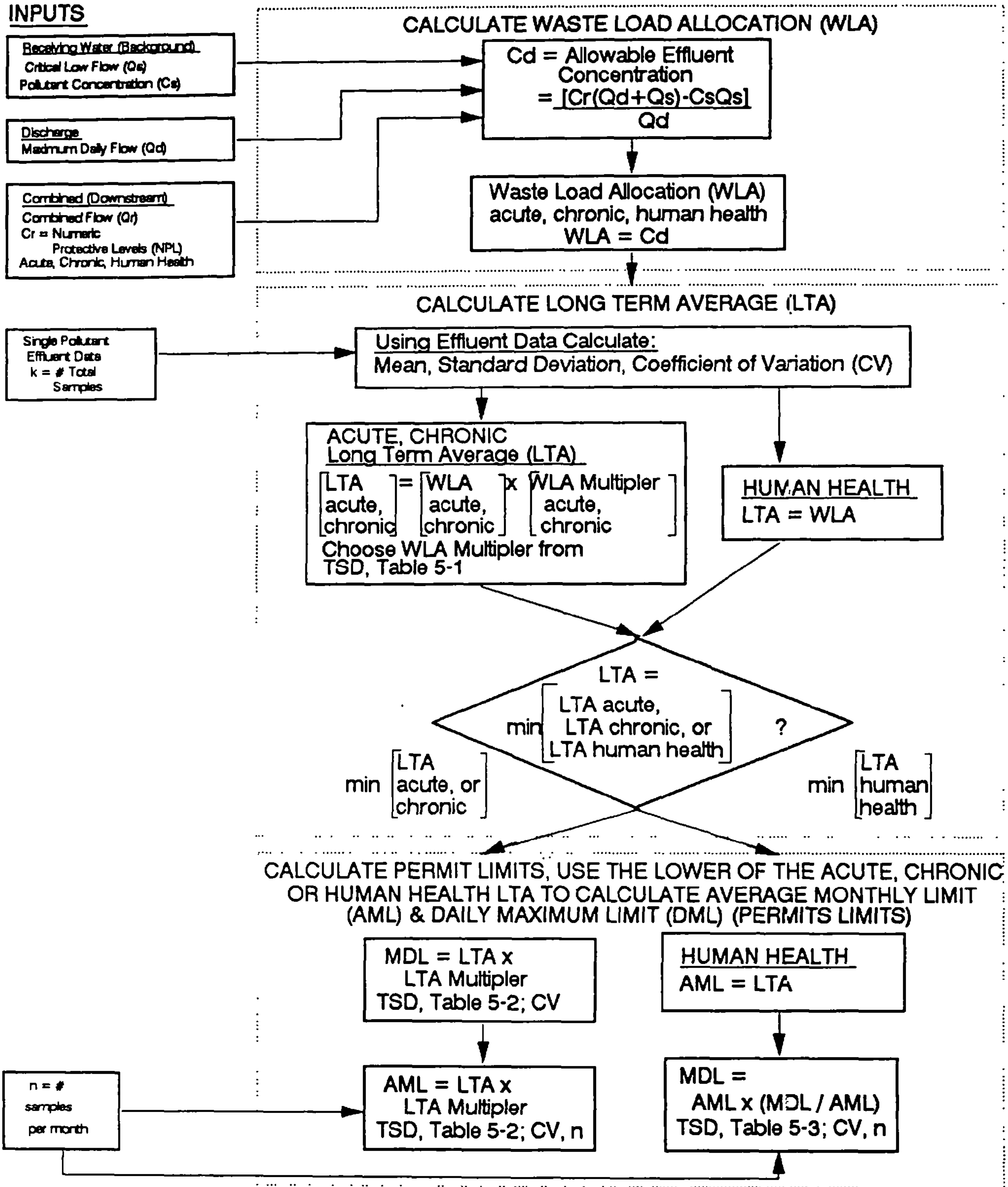

Figure 3 Calculating Average Monthly Limits (AML) & Maximum Daily Limits (MDL) Using Steady-State Assumptions

APPENDIX C

APPENDIX C

DETERMINING DILUTION FOR OCEANS AND ESTUARIES

I. CALCULATING MINIMUM INITIAL DILUTIONS FOR OCEAN DISCHARGES

For ocean outfalls, dilution, transport and dispersion of discharged effluent are important variables to consider when evaluating potential environmental impacts on marine communities. Non-saline (lower-density) effluent discharged through a submerged ocean outfall generally rises rapidly toward the surface in a buoyant plume, entraining significant amounts of ambient saline water. As the plume rises and entrains ambient water, its density increases and its momentum and buoyancy decrease accordingly. If a sufficient ambient vertical density gradient is present (e.g., pycnocline or thermocline), the plume will spread horizontally at the level of neutral buoyancy (i.e., plume density equals ambient water density). If a sufficient density gradient is not present, the diluted effluent will reach the water surface and flow horizontally. The dilution achieved at the completion of this process is called the "initial dilution" and occurs within minutes of discharge. With proper location and design, ocean outfalls can achieve initial dilution values of about 100:1.

Sufficient initial dilution is necessary to assure compliance with State water quality standards. Factors influencing the initial dilution achievable for a particular outfall include:

- Effluent density and historic flow rate;
- Discharge depth;
- Diffuser characteristics (i.e., port sizes, spacing and orientation);
- Receiving water density profiles; and
- Ambient current speed and direction [i.e., zero (0) under Ocean Plan.

These factors are input parameters for several standard dilution models that calculate the initial dilutions expected under different oceanographic and diffuser conditions. Older plume models are summarized in Revised Section 301(h) Technical Support Document (EPA 430/9-82-011); this document also references other methods and mathematical models that may be adapted for estimating initial dilution. More recently, PLUMES, a plume model interface and manager available from EPA, offers users two initial dilution models, RSB and UM. PLUMES is explained in the user guide, Dilution Models for Effluent Discharges (EPA/600/R-93/139, July 1993), and includes a user-friendly tutorial providing examples of

RSB and UM. The PLUMES models are intended for use with plumes discharged to marine and freshwater bodies. Buoyant and dense plumes, single sources, and many diffuser outfall configurations may be modeled.

While effluent density and flows, discharge depth, and diffuser characteristics are readily available for model input, site-specific receiving water density profile data may be lacking. Since initial dilution calculations can be strongly dependent on ambient density profiles relative to effluent density, a substantial amount of data from the discharge site and/or nearby sites having similar environmental conditions should be evaluated before selecting a worst-case ambient density profile for calculating a minimum initial dilution.

Where site- or nearby site-specific density profiles are lacking, two options are available to the permit writer:

- Ambient monitoring may be required during critical periods to determine the worst-case density profile upon which to model the minimum initial dilution;

- Existing worst-case density profiles measured for several ocean outfalls in California are available from EPA and may be used to develop an interim minimum initial dilution and interim numeric effluent limitations, while ambient monitoring is conducted to determine the worst-case site-specific density profile upon which to model the minimum initial dilution.

Once the appropriate minimum initial dilution has been calculated, the permit writer may either conduct a reasonable potential evaluation to determine those pollutants requiring water quality-based effluent limitations, or may choose to develop effluent limitations for all toxic pollutants limited under the Ocean Plan.

Water quality-based effluent limitations for Table B pollutants (except radioactivity) are calculated using appropriate background seawater concentrations (Cs) and the following equation (see Ocean Plan, p. 10):

$$Ce = Co + Dm\,(Co - Cs)$$, where

Ce = effluent concentration limit

Co = concentration to be met at the completion of initial dilution

Cs = background seawater concentration (see Ocean Plan, p. 10)

Dm = minimum probable initial dilution expressed as parts seawater per part wastewater

Table B marine aquatic life objectives are limited as instantaneous maximum, daily maximum, and 6-month median concentrations, while Table B human health objectives are limited as 30-day average concentrations.

II. CALCULATING MINIMUM INITIAL DILUTIONS FOR ESTUARINE DISCHARGES

In estuaries and coastal bays, determining the nature and extent of a discharge plume is complicated by conditions such as differences in tides, riverine input, wind intensity and direction, and thermal and saline stratification. For example, tidal frequency and amplitude vary significantly in different coastal regions of the United States. Furthermore, tidal influences at any specific location have daily and monthly cycles. As a result, discharge dilutions cannot be reliably estimated using ratios of conservative discharge and receiving water flows. It is recommended that dilutions for these water bodies be determined empirically, by employing dye or tracer studies under critical conditions.

In estuaries without stratification, the critical dilution condition includes a combination of low-water slack at spring tide for the estuary and design low flow for riverine inflow. In estuaries with stratification, a site-specific analysis to determine a period of minimum stratification and a period of maximum stratification, both at low-water slack, should be made to evaluate which one results in the lowest dilution. In general, minimum stratification is associated with low river inflows and large tidal ranges (spring tide), whereas maximum stratification is associated with high river inflows and low tidal ranges (neap tide).

After either stratified or unstratified estuaries are evaluated at critical design conditions, an off-design condition should be checked. The off-design condition (e.g., higher flow or lower stratification) recommended for both cases is the period of maximum velocity during a tidal cycle. This off-design condition results in greater dilution than the design condition, but it causes the maximal extension of the plume. Extension of the plume into critical resource areas may cause more water quality problems that the high-concentration, low-dilution situation.

Recommendations for a critical design for coastal bays are the same as for stratified estuaries. The period of maximum stratification must be compared with the period of minimum stratification in order to select the worst case. The off-design condition of maximum tidal velocity should also be evaluated to predict the worst-case extent of the plume.

APPENDIX D

APPENDIX D

CASE EXAMPLES

I. INTRODUCTION

This appendix presents examples of the development of water quality-based discharge limits to illustrate the integration of the guidance detailed in sections III.A.2 and III.A.3, and Appendices A and B (also, see TSD, Chapter 7). There are three examples: an industrial discharge with ample dilution, a publicly owned treatment works (POTW) with moderate dilution, and the combination of an industrial facility and a POTW discharge to the same reach. For each example, reasonable potential is determined for pollutants of concern, and acute (1-day average), chronic (4-day average), and human health NPLs are translated into daily maximum and monthly average permit limits.

II. CASE 1: INDUSTRIAL DISCHARGE

The first example is the Jaybird Corporation, a metal finishing firm. The NPDES permit for the facility is about to expire, and the corporation has submitted an application for a new permit. The example shows the steps that a permit writer would take to determine if a water quality-based effluent limit is necessary and then to establish such a limit. The example also illustrates when best available technology (BAT) limits are applied instead of water quality-based limits, the use of human health NPLs, and the variations in the limits derived by different waste load allocation (WLA) methods.

A. GENERAL SITE DESCRIPTION AND INFORMATION

The Jaybird Corporation facility discharges into the Locapunct River. The river is approximately 60 miles long and its banks are occupied by small towns separated by woodland and farmland. The river is classified by the State in the water quality standards as having designated uses of a fish habitat, primary contact recreation, and a drinking water supply. For these uses, the State has adopted the federal water quality criteria into the water quality standards to protect aquatic life and human health. The State standards also include a narrative objective of "no toxics in toxic amounts" for other toxic materials.

Water quality monitoring indicates some infrequent excursions above water quality objectives for copper and nickel. These pollutants have been found in measurable quantities in the effluents of several facilities.

The Jaybird Corporation is a metal finishing facility that specializes in copper plating of lead shells for a nearby military installation. As a metal finisher, the Jaybird Corporation is relatively small with a discharge of 0.034 cfs (0.022 MGD). The effluent at the Jaybird Corporation is treated by precipitation and settles before discharge through a multiport diffuser. The corporation is subject to BAT and best practicable technology (BPT) effluent limits for the metal finishing industry.

B. EFFLUENT CHARACTERIZATION FOR SPECIFIC CHEMICALS

The permit writer has adopted a procedure in which pollutant concentrations in each facility are evaluated for the potential to cause, have the reasonable potential to cause, or contribute to an excursion of the water quality standards. The permit writer used the effluent characterization process for specific chemicals described in section III.A.2 and Appendix A. In general, the procedures are designed to determine which pollutants are of concern and which require effluent limits.

STEP 1: Identify Pollutants of Concern

Data were obtained from a number of sources to identify and quantify the pollutants of concern in the Jaybird Corporation effluent:

- Effluent chemical concentrations were taken from the Permit Application Form 2C, Discharge Monitoring Reports (DMRs), EPA's Permit Compliance System (PCS), and permit files.
- EPA's STORET data base was used to obtain U.S. Geological Survey flow data and ambient monitoring data for the river.
- BAT limits for the metal finishing industry were obtained from 40 CM 433 Subpart A.

The permit writer noticed in review of these data that the information in Form 2C replicated the information in the DMRs, and therefore decided to use the DMR data as the primary basis for characterizing the effluent. These data for toxicants in the DMRs are shown in Table D-1. For those parameters currently not covered by the permit, Form 2C data indicated that pollutant concentrations were below detection limits. The permit writer requested information from the facility showing the detection levels used; these levels were consistent with the detection levels listed in the NPDES regulations at 40 CFR 136.

The effluent from the Jaybird Corporation is regulated by the

Metal Finishing Point Source Category effluent guidelines at 40 CFR 433 Subpart A. These guidelines regulate the following toxic pollutants: cadmium, chromium, copper, cyanide, lead, nickel, silver, zinc, and total toxic organics.

Although these parameters were regulated at the Jaybird Corporation, the only toxic pollutants evident in the discharge were lead, copper, and nickel. The facility's treatment system reduced concentrations of other pollutants to below detection.

STEP 2: Determine the Acute, Chronic, and Human Health NPLs for Pollutants of Concern

The State has adopted numeric acute (1-day average) and chronic (4-day average) aquatic life objectives, and human health objectives. The water quality standards present the acute and chronic objectives as equations based on ambient hardness concentrations. The standards require that the 85th percentile lowest hardness be used. This value is 100 mg/l as $CaCO_3$ for the Locapunct River.

Table D-1. Effluent Data for the Jaybird Corporation

n	Copper ug/l	Lead ug/l	Nickel ug/l	Toxicity TUc
1	1,317	187	223	5
2	1,092	230	261	10
3	1,073	258	464	5
4	1,059	423	341	20
5	1,072	227	369	
6	1,677	275	1,058	
7	2,664	364	199	
8	1,058	170	259	
9	3,439	259	437	
10	6,596	264	773	
11	1,211	267	300	
12	1,082	175	356	
Mean	1,945	258	420	10
SD	1,650	74	252	7.1
CV	0.8	0.3	0.6	0.7
Max	6,596	423	1,058	20
Min	1,058	170	199	5
N	12	12	12	4

Source: DMR data for chemicals; 308 request for whole effluent toxicity.
Notes: Metals reported as total recoverable metals; toxicity reported in chronic toxic units (100/NOEC). The permittee did not use a geometric dilution series for the toxicity tests. The results are the highest toxic units for any of the test organisms used.

The acute and chronic aquatic life objectives for metals in the standards are expressed as the acid soluble form of the metal. The State has adopted a ratio to express the acid soluble form of metals as the total recoverable form for the purposes of developing NPDES permit limits. This ratio is based on historical data that the State has collected for rivers in the basin where the Locapunct lies. The values of the ratio are 0.35 for lead, 0.70 for copper, and 0.85 for nickel. The standards consider the objectives for human health protection to be in the total recoverable form of the metal.

Based on the hardness and acid soluble-to-total recoverable ratios, the applicable State water quality objectives are the following:

Pollutant	Chronic (ug/l)	Acute (ug/l)	Human Health (ug/l)
Lead	9.1	235	50
Copper	17.1	25.7	NA
Nickel	188	1,647	13.4

STEP 3: Determine Dilution for Aquatic Life and Human Health Impacts

The State water quality standards require that compliance with water quality NPLs be achieved at the edge of the mixing zone. The standards specify the minimum dilution at which the NPLs apply. These are the 7Q10 flow for chronic, the 1Q10 flow for acute, and the harmonic mean flow for human health NPLs. The U.S. Geological Survey operates a gaging station on the river; the flow statistics were calculated using the data from this station:

- 7Q10 flow = 13.0 cfs
- 1Q10 flow = 10.1 cfs
- Harmonic mean flow = 38.0 cfs

The facility provided a study of the outfall that showed that the multiport diffuser quickly achieved complete mixing across the width of the river. Dilution at the edge of the mixing zone could, therefore, be characterized by the mass balance equation:

$$Cr = (CdQd + CsQs)/(Qd + Qs)$$, where

Cr = the receiving water concentration

Cd = the maximum effluent concentration

Qd = the effluent flow

Cs = the receiving water background concentration

Qs = the appropriate receiving water flow

Qr = Qd+Qs

STEP 4: Determine Reasonable Potential for Excursions

To determine if the facility discharge was expected to cause or have the reasonable potential to cause acute, chronic, or human health objective to be exceeded in the receiving water, the maximum receiving water concentration of each pollutant was first compared to the appropriate receiving water objective. If the objectives were exceeded, then this was considered evidence that a water quality based limitation must be developed.

Maximum expected concentrations were calculated using the average effluent flow, maximum effluent concentrations, background receiving water concentrations, and the relevant receiving water flow: the 1Q10 for acute, the 7Q10 for chronic, or the harmonic mean for human health objectives. The background receiving water concentrations for total recoverable metals were obtained from STORET data:

Lead	1.6 ug/l
Copper	4.8 ug/l
Nickel	13.2 ug/l

The maximum effluent concentration was estimated using the statistical approach outlined in section III.A.2 and Appendix A. There were 12 concentrations of each metal reported in the DMRs. For lead, these concentrations had a maximum value of 423 ug/l, an arithmetic mean of 258 ug/l, an arithmetic standard deviation of 74, and an arithmetic coefficient of variation of 74/258, or 0.3. This coefficient of variation (CV) and the number of observations determined which uncertainty multiplier was selected from TSD, Table 3-1. In this case, the multiplier value for 12 observations and a CV of 0.3 was interpolated from the values for 12 observations and CVs of 0.2 and 0.4. The 99th percentile multiplier was estimated to be 1.7. Similar calculations were conducted for copper (multiplier of 2.8) and nickel (multiplier of 3.7).

The receiving water concentration for lead for comparison with the chronic objective was calculated using data from Table D-1:

$$Cr = \left[\frac{(1.7 \text{ x } 423 \text{ ug/l x } 0.034 \text{ cfs}) + (1.6 \text{ ug/l x } 13 \text{ cfs})}{(0.034 \text{ cfs} + 13 \text{ cfs})}\right]$$

$$= 3.5 \text{ ug/l} \quad \text{, where}$$

13 cfs = the background receiving water flow at 7Q10

0.034 cfs = the mean effluent flow

423 ug/l = the maximum effluent concentration

1.7 = the statistical effluent multiplier to estimate the 99th percentile concentration

1.6 ug/l = the background receiving water concentration

The value of the calculated receiving water concentration, 3.5 ug/l, was less than the chronic water quality objective of 9.1 ug/l for lead, and therefore there is no reasonable potential for the chronic objective to be exceeded.

Using the effluent data presented in Table D-1, the receiving water concentration is compared to the acute objective as:

$$Cr = \left[\frac{(1.7 \times 423\ ug/l \times 0.034\ cfs)+(1.6\ ug/l \times 10.1\ cfs)}{(0.034\ cfs + 10.1\ cfs)}\right]$$

$$= 4.0\ ug/l$$

where 10.1 cfs is the receiving water 1Q10 flow and the other values are identical to those for the chronic comparison. The resulting concentration of 4.0 ug/l was less than the acute objective of 234 ug/l for lead. There is no reasonable potential for the acute objective to be exceeded.

The receiving water concentration for comparison to the human health objective was calculated as:

$$Cr = \left[\frac{(1.7 \times 423\ ug/l \times 0.034\ cfs) + (1.6\ ug/l \times 38\ cfs)}{(0.034\ cfs + 38\ cfs)}\right]$$

$$= 2.2\ ug/l$$

where 38 cfs is the harmonic mean flow and other values are the same as above. This value was less than the human heath objective of 50 ug/l for lead, so there is no reasonable potential for the human health objective to be exceeded.

Similar calculations were done for copper and nickel:

	Objective (ug/l)	Receiving Water Concentration (ug/l)
<u>Copper</u>		
Chronic	17.1	22.0
Acute	25.7	26.9

	Objective (ug/l)	Receiving Water Concentration (ug/l)
Nickel		
Chronic	188	15.9
Acute	1,647	16.6
Human Health	13.4	14.1

The effluent characterization showed the reasonable potential for excursions above the chronic objective for copper and above the human health objective for nickel. Therefore, permit limits are necessary for these two pollutants.

C. EFFLUENT CHARACTERIZATION FOR WHOLE EFFLUENT TOXICITY

Whole effluent toxicity also was evaluated since there was a potential for excursions above the narrative water quality objective due to the combination of effluent toxicants with other toxicants in the receiving water and in the effluent but below the detection level. The procedures used below follow those outlined in section III.A.2 and Appendix B, and presented schematically in the TSD (see Chapter 3, Box 3-2).

STEP 1: Dilution Determination

The initial dilution determination was used to establish the types of toxicity tests that are conducted to characterize the effluent. The dilution at the low-flow characteristics for the facility is the following:

At the 7Q10, dilution = (0.034 cfs + 13 cfs)/0.034 cfs
= 383

At the 1Q10, dilution = (0.034 cfs + 10.1 cfs)/0.034 cfs
= 298

STEP 2: Conduct Toxicity Testing

EPA recommends that a discharger having a dilution between 100:1 and 1,000:1 be required to conduct either chronic or acute toxicity testing. The permit writer decided to require chronic testing but required the permittee to report the test results at the 48-hour endpoint so that acute toxicity could be measured. One year before the permit was due to expire, the permit writer requested, under the authority of CWA section 308, that the permittee test his effluent for toxicity to provide effluent information in order to write the next NPDES permit. In this case, the permit writer specified that the discharger submit quarterly chronic toxicity data for 1 year using the EPA toxicity tests for <u>Selenastrum</u>, <u>Ceriodaphnia</u>, and <u>Pimephales</u>. The permit writer also specified that upstream ambient water be used as the diluent in the tests so as to allow the tests to measure additive effects from ambient toxics. In response to the section 308 request, the discharger submitted the whole effluent toxicity data shown in Table D-1.

STEP 3: Determine Reasonable Potential for Excursions

The State interprets its narrative objective for whole effluent toxicity to require that the TSD recommendations of 0.3 TUa, and 1.0 TUc be used as numeric values for acute and chronic toxicity, respectively. In accordance with the State standards, the acute objective applies under the 1Q10 flow and the chronic objective applies under the 7Q10 flow.

The determination of exceedance of the acute or the chronic objective was simplified by the way in which the tests were conducted. Since the upstream ambient water was used as a diluent, the test results already include an assessment of contributions from background toxicity. Therefore, the upstream receiving water concentration was set to zero.

The maximum effluent concentration was again estimated by using the statistical approach in section III.A.2 and Appendix A. As shown in Table D-1, there were four observations of whole effluent toxicity. Based on the guidance in Appendix A (also, see TSD, Box 3-2), these are insufficient to determine the CV accurately; therefore, the default CV of 0.6 was used. The effluent multiplier of 4.7 was obtained from TSD, Table 3-1 using the number of observations, the CV, and the 99-percent probability basis.

The receiving water concentration for chronic toxicity for comparison with the chronic objective was calculated using data from Table D-1:

$$Cr = \left[\frac{(4.7 \text{ x } 20 \text{ TUc x } 0.034 \text{ cfs}) + (0 \text{ TUc x } 13 \text{ cfs})}{(0.034 \text{ cfs} + 13 \text{ cfs})}\right]$$

$$= 0.25 \text{ TUc}$$, where

13 cfs = the background receiving water flow at 7Q10

0.034 cfs = the mean effluent flow

4.7 = the statistical effluent multiplier

20 TUc = the maximum effluent concentration

The value of the calculated receiving water concentration, 0.25 TUc, was less than the chronic objective of 1.0 TUc, and therefore there is no reasonable potential for the chronic objective to be exceeded.

To calculate the receiving water concentration for acute toxicity, the permit writer first converted the chronic toxicity data into equivalent acute toxicity units by applying the acute-to-chronic ratio (ACR) of 5 obtained from the monitoring data. The receiving water concentration for acute toxicity was then calculated:

$$Cr = \left[\frac{(4.7 \times 20\ TUc\ /\ 5\ ACR \times 0.034\ cfs) + (0\ TUc \times 10.1\ cfs)}{(0.034\ cfs + 10.1\ cfs)}\right]$$

$$= 0.06\ TUa$$

where 10.1 cfs is the receiving water flow at 1Q10, 5 i.. the acute to chronic ratio, and the other values are the same as above. The calculated value of 0.06 TUa is below the objective of 0.3 TUa; therefore, there is no reasonable potential for the acute objective to be exceeded. Since there was no reasonable potential for exceedances above either acute or chronic objectives, permit limits were not developed for whole effluent toxicity.

D. DETERMINE WASTE LOAD ALLOCATION

The waste load allocation (WLA) was used to determine the level of effluent concentration that would comply with water quality standards in the receiving waters. A WLA will only be determined for those parameters that have a reasonable potential to cause exceedances of water quality standards. Therefore, WLAs were determined for copper and nickel. Since there was no reasonable potential for excursions above the acute or chronic objectives for nickel, only the WLA for human health was calculated.

To determine WLAs, the numeric objectives in the water quality standards and background concentrations were used to calculate effluent concentrations that would result in compliance with those standards. The calculation of WLAs used receiving water flows that were appropriate to each standard: chronic WLAs were calculated using the 7Q10 flow, acute WLAs were calculated using the 1Q10 flow, and human health WLAs were calculated using the harmonic mean flow. Since the effluent was mixed rapidly by the multiport diffuser, the mass balance equation was used:

$$WLA = [NPL \times (Qd + Qs) - QsCs]/Qd$$, where

Qd = the effluent flow

Qs = the receiving water flow

Cs = the background receiving water concentration

NPL = the Numeric Protective Level

The chronic and acute WLAs for copper were calculated at the 7Q10 and 1Q10 flows, respectively:

$$WLAc = [17.1 \text{ ug/l} \times (0.034 \text{ cfs} + 13 \text{ cfs}) - 13 \text{ cfs} \times 4.8 \text{ ug/l}] / 0.034 \text{ cfs}$$
$$= 4{,}720 \text{ ug/l}$$

$$WLAa = [25.7 \text{ ug/l} \times (0.034 \text{ cfs} + 10.1 \text{ cfs}) - 10.1 \text{ cfs} \times 4.8 \text{ ug/l}] / 0.034 \text{ cfs}$$
$$= 6{,}234 \text{ ug/l}$$

The human health WLA for nickel was calculated at the harmonic mean flow:

$$WLAh = [13.4 \text{ ug/l} \times (0.034 \text{ cfs} + 38 \text{ cfs}) - 38 \text{ cfs} \times 13.2 \text{ ug/l} / 0.034 \text{ cfs}$$
$$= 237 \text{ ug/l}$$

E. DEVELOP PERMIT LIMITS

Permit limits were developed using the steady-state mass balance model as described in section III.A.3 and Appendix B (also, see TSD, Chapter 5). Values for constants were obtained from Tables 5-1, 5-2, and 5-3 in the TSD.

STEP 1: Calculate LTA

The chronic long-term average (LTA) for copper was calculated using the following formula:

$$LTAc = WLAc \cdot e^{[0.5 \sigma_4^2 - z \sigma_4]}$$
$$= 4{,}720 \text{ ug/l} \times 0.440$$
$$= 2{,}077 \text{ ug/l}$$

where values of $e^{[0.5 \sigma_4^2 - z \sigma_4]}$ are presented in Table 5-1 (see TSD, Chapter 5). The CV of 0.8, and the z value for the 99th occurrence probability were used.

The acute LTA for copper was calculated, again using the 99th percentile occurrence probability values from Table 5-1 as the multiplier:

$$LTAa = WLAa \cdot e^{[0.5 \sigma^2 - z \sigma]}$$
$$= 6{,}234 \text{ ug/l} \times 0.249$$
$$= 1{,}552 \text{ ug/l}$$

The human health LTA for nickel is considered to be the same as the WLA because the 70-year averaging period is used for human health evaluations (see TSD, Chapter 5.4.4). The LTA is calculated as:

$$LTAh = WLAh$$
$$= 237 \text{ ug/l}$$

STEP 2: Determine the Most Limiting LTA

The limiting LTA for each pollutant is the minimum of the chronic, acute and human health LTAs. The limiting LTA value is used in the next step to calculate maximum daily limits and average monthly limits. The limiting LTA for copper was found to be the acute LTA (1,552 ug/l) and the limiting LTA for nickel was found to be the human health LTA (237 ug/l).

STEP 3: Calculate Maximum Daily and Average Monthly Limits

The maximum daily limit (MDL) for copper was calculated using the expression:

$$MDL = LTA \cdot e^{[z\sigma - 0.5\sigma^2]}$$
$$= 1{,}552 \text{ ug/l} \times 4.01$$
$$= 6{,}224 \text{ ug/l}$$

where the appropriate value for $e^{[z\sigma - 0.5\sigma^2]}$ was taken from Table 5-2 using the row with the CV for copper (0.8) and the column for the 99th percentile probability basis.

The average monthly limit (AML) for copper was calculated using the expression:

$$AML = LTA \cdot e^{[z\sigma_n - 0.5\sigma_n^2]}$$
$$= 1{,}552 \text{ ug/l} \times 1.75$$
$$= 2{,}716 \text{ ug/l}$$

where the value for $e^{[z\sigma_n - 0.5\sigma_n^2]}$ was taken from Table 5-2 and, for this case, the number of samples per month was four. The z value for the 95th percentile probability basis was used.

The effluent limits for nickel were determined by using the recommendations in Appendix B and the TSD (see Chapter 5.4.4). The AML was considered to be identical to the WLAh whereas the MDL was calculated from the AML by using the appropriate multiplier factor in Table 5-3. With a CV of 0.6, four samples per month for sampling, and a 99th percentile used for the MDL, the factor is 1.64:

$$MDL = AML \times 1.64$$
$$= 237 \text{ ug/l} \times 1.64$$
$$= 389 \text{ ug/l}$$

F. DETERMINING AND EXPRESSING THE CONTROLLING EFFLUENT LIMITS

The NPDES regulations specify that effluent limits require treatment characteristic of the appropriate treatment technology and also achieve water quality standards. If water quality-based limits are more stringent than BAT limits, then the water quality-based limits become the basis for the effluent limits. Conversely, if the treatment technology (BAT) limits are more stringent, then they become the basis for the limits.

A comparison between the water quality-based and technology-based effluent limits are shown below. For nickel, water quality-based limits are more stringent, whereas for copper, BAT limits are the more stringent.

		Copper	Nickel
Water Quality	MDL	6,224	389
	AML	2,716	237
BAT	MDL	3,380	3,980
	AML	2,070	2,380
Limit to use	MDL	3,380	389
	AML	2,070	237

In accordance with NPDES regulations, the effluent limits are expressed in the permit as mass (pounds per day) by multiplying the concentrations above by the effluent flow of 0.034 cfs and the conversion factor of 5.394:

	Copper (lb/d)	Nickel (lb/d)
MDL	0.62	0.071
AML	0.38	0.043

III. CASE 2: POTW DISCHARGE

The second example is of a fictitious POTW that discharges to the same reach as the Jaybird Corporation. The NPDES permit for this facility also is up for reissuance. The example highlights the use of background receiving water concentrations, and demonstrates the differences between industrial and POTW permit limits. In developing permit limits for the POTW in this example, potential impacts from the Jaybird Corporation discharge were considered in the use of background receiving water concentrations. The interrelationships between the two facilities are discussed explicitly in Case 3.

A. GENERAL SITE DESCRIPTION AND INFORMATION

The Locapunct River receives discharges from a POTW serving Auburn, a small city of about 10,000 people. The POTW treats a mixture of household and industrial waste with an activated sludge process. The mean effluent flow from the POTW is 1.23 cfs. The POTW has no pretreatment program, but the municipality is aware of the small industries that are indirect dischargers because of research conducted by a local university. Generally, the plant is well operated.

B. EFFLUENT CHARACTERIZATION FOR SPECIFIC CHEMICALS

The approach for determining which pollutants cause, have the reasonable potential to cause, or contribute to excursions above water quality standards applies to POTWs as well as industries. The permit writer used the procedures described for the Jaybird Corporation in the evaluation of the Auburn POTW.

STEP 1: Identify Pollutants of Concern

At the time of the last permit issuance, there was evidence of a number of toxic pollutants in the POTW's effluent, including copper, chlorine, and ammonia. These pollutants had monitoring requirements in the previous permit. Because there were metals in the effluent and, due to the industries discharging into the POTW sewer system, the permit writer requested the POTW to conduct a complete priority pollutant scan of the effluent. The data received following the section 308 letter request indicated that the concentrations of all priority pollutants except copper were below detection limits. The POTW's primary toxic pollutants of concern were copper, chlorine, and ammonia (see Table D-2).

STEP 2: Determine Acute, Chronic and Human Health NPLs for Pollutants of Concern

As described in the example of the industrial discharge, the water quality standards include numeric objectives for copper. The State also has adopted a numeric objective for ammonia that is a function of the river 85th percentile pH and temperature; these values are 8.25 and 25°C, respectively. Finally, the State interprets its narrative objective of "no toxics in toxic amounts" to require use of the federal water quality criteria in the absence of a numeric State objective. As a result, the permit writer uses federal criteria for chlorine. The applicable water quality NPLs for the river are as follows:

	Chronic (ug/l)	Acute (ug/l)
Copper	17.1	25.7
Chlorine	11	19
Ammonia	540	4,000

Table D-2. Effluent Data for the Auburn POTW

n	Copper ug/l	Chlorine ug/l	Ammonia ug/l	Toxicity TUc
1	268	185	11,009	2
2	115	301	13,025	1
3	228	881	12,201	1
4	59	372	24,548	2
5	53	245	9,700	
6	213	244	15,645	
7	68	123	21,358	
8	200	343	3,976	
9	262	153	22,307	
10	519	448	7,427	
11	53	1,022	11,834	
12	474	347	8,430	
13	115	130	4,382	
14	259	128	9,330	
15	404	271	6,137	
16	57	451	6,448	
17	101	701	37,772	
18	187	582	14,307	
19	103	178	16,848	
20	76	436	28,205	
21	198	347	12,119	
22	265	475	11,778	
23	60	153	3,109	
24	112	268	4,474	
Mean	185	366	13,182	1.5
SD	133	235	8,491	0.6
CV	0.7	0.6	0.6	0.4
Max	519	1,022	37,772	2
Min	52.6	123	3,109	1

Source: DMR data for chemicals; 308 request for whole effluent toxicity.
Notes: Metals as total recoverable, toxicity in toxic units (100/NOEC). The results are the highest toxic units for any of the test organisms used.

STEP 3: Determine Dilution for Aquatic Life and Human Health Impacts

The State water quality standards require that compliance with water quality NPLs be achieved at the edge of the mixing zone. The standards specify the minimum dilution at which the NPLs apply. These are the 7Q10 flow for chronic NPLs, the 1Q10 flow for the acute NPLs, and the harmonic mean flow for human health NPLs. The U.S. Geological Survey operates a gaging station on the river. The flow statistics were calculated using the data from this station:

- 7Q10 flow = 13.0 cfs
- 1Q10 flow = 10.1 cfs
- Harmonic mean flow = 38.0 cfs

The POTW is located at a bend of the river where mixing is rapid. Therefore, the permit writer used the steady-state mass balance equation to calculate the receiving water concentrations. This is the same equation used for the industrial example.

STEP 4: Determine Reasonable Potential for Excursions

The determination of possible exceedances of acute or chronic NPLs were based on a calculation of the maximum receiving water concentration of each pollutant, followed by a comparison to the appropriate receiving water NPL. The calculation of the maximum receiving water concentrations were made using the statistical estimate of the 99th percentile concentration of each pollutant in the effluent, the same flow used in the industrial example, and background receiving water concentrations of:

Copper	4.8	ug/l
Chlorine	0	ug/l
Ammonia	120	ug/l

Maximum effluent concentrations were estimated using the statistical approach outlined in section III.A.2 and Appendix A. There were 24 concentrations for each chemical reported in the DMRs. For copper, these concentrations had a maximum value of 519 ug/l, an arithmetic mean of 185 ug/l, an arithmetic standard deviation of 133, and an arithmetic coefficient of variation of 133/185, or 0.7. The multiplier was calculated to be 2.4 based on the CV of 0.7, 24 observations, and a 99-percent confidence level (see TSD, Table 3-1). Similar calculations were conducted for chlorine (multiplier of 2.2) and ammonia (multiplier of 2.2).

The receiving water concentrations for each pollutant were calculated. An example calculation for the comparison of copper to the chronic objective is as follows:

$$Cr = \frac{[(2.4 \times 519\ ug/l \times 1.23\ cfs) + (4.8\ ug/l \times 13\ cfs)]}{(1.23\ cfs + 13\ cfs)}$$

$$= 112\ ug/l \quad , \text{where}$$

519 ug/l = the maximum measured effluent concentration

2.4 = the statistical multiplier

1.23 cfs = the average effluent flow

4.8 ug/l = the upstream receiving water concentration

13 cfs = the 7Q10 flow

The maximum receiving water concentrations for comparison to applicable standards for all pollutants were calculated to be:

	NPL (ug/l)	Receiving Water Concentration (ug/l)
Copper		
Chronic	17.1	112
Acute	25.7	140
Chlorine		
Chronic	11	194
Acute	19	244
Ammonia		
Chronic	540	7,292
Acute	4,000	9,128

The effluent characterization showed the reasonable potential for excursions above the chronic and acute NPLs for copper, chlorine, and ammonia. Therefore, permit limits were developed for these pollutants.

C. EFFLUENT CHARACTERIZATION FOR WHOLE EFFLUENT TOXICITY

STEP 1: Dilution Determination

The initial dilution determination was used to establish the types of toxicity tests that must be conducted to characterize the effluent. The dilution at the low flow characteristics for the facility is the following:

At the 7Q10, dilution = (1.23 cfs + 13 cfs)/1.23 cfs
= 11.6

At the 1Q10, dilution = (1.23 cfs + 10.1 cfs)/1.23 cfs
= 9.2

STEP 2: Conduct Toxicity Testing

EPA recommends that a discharger having a dilution less than 100 be required to conduct chronic toxicity testing. The permit writer requested through a section 308 letter that the POTW provide quarterly chronic toxicity data for the year prior to permit reissuance. Tests using Selenastrum, Ceriodaphnia, and Pimephales were required. The permit writer also required the permittee to report the test results at the 48-hour endpoint so that acute toxicity also could be measured. Table D-2 summarizes the results of the whole effluent toxicity testing.

STEP 3: Determine Reasonable Potential for Excursions

As explained in the industrial example, the State interprets its narrative objective for whole effluent toxicity to require that the TSD recommendations of 0.3 TUa and 1.0 TUc be used as numeric objective for acute and chronic toxicity, respectively. In accordance with the State standards, the acute objective applies under the 1Q10 flow and the chronic objective applies under the 7Q10 flow.

The reasonable potential determination of exceedance of the acute or the chronic objective was conducted in the same way as described in the industrial example. Upstream ambient water was used as a diluent to assess contributions directly from background toxicity; therefore, the upstream receiving water concentration was set to zero. The maximum effluent concentration was again estimated by using the statistical approach in section III.A.2 and Appendix A. For the same reasons as were expressed in the industrial example, a multiplier of 4.7 was used.

The receiving water concentration for chronic toxicity for comparison with the chronic objective was calculated using data from Table D-2:

$$Cr = \left[\frac{(4.7 \times 2\ TUc \times 1.23\ cfs) + (0\ TUc \times 13\ cfs)}{(1.23\ cfs + 13\ cfs)}\right]$$

$$= 0.8\ TUc$$, where

13 cfs = the background receiving water flow at 7Q10

1.23 cfs = the mean effluent flow

4.7 = the statistical effluent multiplier

4 TUc = the maximum effluent concentration

The value of the calculated receiving water concentration, 0.8 TUc, is less than the chronic water quality objective of 1.0 TUc, and, therefore, there is no reasonable potential for the chronic objective to be exceeded.

To calculate the receiving water concentration for acute toxicity, the permit writer first converted the chronic toxicity data into equivalent acute toxicity units by applying the ACR of 2 obtained from the monitoring data. The receiving water concentration for acute toxicity was then calculated:

$$Cr = \left[\frac{(4.7 \times 2\ TUc\ /\ 2\ ACR \times 1.23\ cfs) + (0\ TUc \times 10.1\ cfs)}{(1.23\ cfs + 10.1\ cfs)}\right]$$

$$= 0.5\ TUa$$

where 10.1 cfs is the receiving water flow at 1Q10, 2 is the acute to chronic ratio, and other values are the same as above. The calculated value of 0.5 TUa is greater than the objective of 0.3 TUa. Therefore, there is reasonable potential for the acute objective to be exceeded and permit limits were developed for whole effluent toxicity.

D. DETERMINE WASTE LOAD ALLOCATIONS

WLAs for chemicals and whole effluent toxicity were determined using information on the available dilution at the edge of the mixing zone. The calculation of WLAs using the steady-state model was described previously in Case 1 (also, see Appendix B). Using this equation, the WLAs for the POTW are:

	Toxicity (TU)	Copper (ug/l)	Chlorine (ug/l)	Ammonia (ug/l)
WLAa	2.8	197	175	35,860
WLAc	11.6	147	127	4,979

E. DEVELOP PERMIT LIMITS

The permit limit development process described in Appendix B was applied to all pollutants. This process is identical to that explained previously in Case 1 except that: 1) the WLA for acute toxicity needs to be expressed in equivalent chronic toxic units by multiplying by the ACR of 2; and 2) daily sampling of chlorine is required in the permit.

The calculated LTA and permit limits are:

	Toxicity (TUa)	Copper (ug/l)	Chlorine (ug/l)	Ammonia (ug/l)
LTAa	1.8	55.4	56.2	11,511
LTAc	6.1	70.7	66.9	2,625
MDL	5.6	197	175	8,162
AML	2.8	91	87	4,067

F. DETERMINING AND EXPRESSING THE CONTROLLING EFFLUENT LIMITS

The treatment technology for POTWs is secondary treatment and is characterized by effluent limits for biochemical oxygen demand, total suspended solids, and pH. There are no BAT limits for toxics for POTWs, so there was no need to compare these water quality-based limits with other limits to determine which were more stringent.

The permit writer decided to use acute toxicity tests rather than chronic tests to measure compliance with the toxicity effluent limits. The appropriate effluent limits in terms of TUa were calculated by dividing the above calculation for TUc by the ACR of 2 that was obtained from effluent monitoring.

In accordance with NPDES regulations, the effluent limits for chemicals were expressed in the permit as mass (pounds per day) by multiplying the concentrations above by the effluent flow of 1.23 cfs and the conversion factor of 5.394. Because there is no equivalent mass based unit for toxicity, toxicity mass limits are impractical under the regulation.

	Toxicity (TUa)	Copper (lb/d)	Chlorine (lb/d)	Ammonia (lb/d)
MDL	2.8	1.31	1.16	54.2
AML	1.4	0.64	0.58	27.07

IV. CASE 3: MULTIPLE DISCHARGES INTO THE SAME REACH

Permit development for water quality-based toxics control has been illustrated for two single dischargers. This process increases in complexity in cases of multiple dischargers into a reach. The development of permit limits for multiple dischargers is based on the degradation in water quality resulting from the combined discharges, the development of total maximum daily loads (TMDLs) for the river reach before generating WLAs, and the allocation of discharges to each discharger. The following example describes the permit development process when two dischargers release effluent into the same reach of a river. The dischargers are the Jaybird manufacturing plant described in Case 1 and the

Auburn POTW described in Case 2. These facilities discharge into the Locapunct River, whose flow characteristics were described previously.

A. EFFLUENT CHARACTERIZATION

The major differences in the effluent characterization for one facility and for multiple facilities is to identify those pollutants that are common to more than one facility, and to determine whether the combined discharges cause or are likely to cause water quality standards excursions.

STEP 1: Identify Pollutants of Concern

Based on the data in Form 2C, the DMRs from the Jaybird Corporation and the data in the DMRs and section 308 request from the Auburn POTW, the permit writer found two contaminants common to both discharges: copper and whole effluent toxicity. Lead and nickel were found to be a problem at the Jaybird Corporation, but since there were no complicating discharges from the POTW, it was dealt with as a pollutant only at the metal finishing facility. Similarly, chlorine and ammonia were discharged solely by the POTW, so it was not necessary to provide effluent limits for the metal finishing facility for these chemicals.

STEP 2: Determine the Acute and Chronic NPLs for Pollutants of Concern

The numerical standards adopted by the State already have been presented. The relevant values for copper and whole effluent toxicity are:

	Chronic	Acute
Copper	17.1 ug/l	25.7 ug/l
Toxicity	1.0 TUc	0.3 TUa

STEP 3: Determine Dilution for Aquatic Life and Human Health Impacts

Since this example is concerned with potential excursions above standards resulting from the collective discharge of two dischargers, the calculation of dilution includes the combined effluent flow from both facilities. The combined dilution can be characterized by the complete mixing equation:

$$Cr = (Cd_1 Qd_1 + Cd_2 Qd_2 + CsQs) / (Qd_1 + Qd_2 + Qs)$$, where

Qd_1 and Qd_2 = the flows of the two facilities

Cd_1 and Cd_2 = the effluent concentrations of the two facilities

Cs = the upstream receiving water concentration

Qs = the receiving water flow

STEP 4: Determine Reasonable Potential for Excursions

To determine if acute or chronic objectives were exceeded as a result of the combined discharges into the river, the receiving water concentration of each pollutant was calculated and compared to the appropriate objective. The receiving water concentration calculation was based on the maximum value of the effluent concentrations (obtained from effluent data and multiplied by the appropriate statistical factor), average effluent flows, background receiving water concentrations, and appropriate river flows. All this information has been presented previously in the separate examples. The following results were obtained:

	Objectives (ug/l)	Receiving Water Concentration (ug/l)
Copper		
Chronic	17.1	156
Acute	25.7	194
Toxicity		
Chronic	1.0	0.57
Acute	0.3	0.45

These calculations demonstrated exceedances of the copper chronic and acute objectives and the toxicity acute objective. Permit limits were required.

B. TMDLs AND WLAs

WLAs were calculated to develop permit limits. WLAs for each discharger and chemical were based on calculated TMDLs, the total load to the Locapunct River that would not result in water quality standards exceedances. TMDLs are comprised of a load allocation for nonpoint sources, WLAs for point sources, and, if required by the State, a reserve capacity. TMDLs are further described in the TSD (see Chapter 4).

STEP 1: Calculate TMDL

The first step in developing individual WLAs for the two dischargers was to develop TMDLs for each pollutant of concern.

TMDLs were developed in the same way as an individual WLA with the total load of a pollutant from the two dischargers being considered as a single discharge.

The calculation of TMDLs used the following formula:

$$TMDL = NPL \times (Qt + Qs) \quad \text{, where}$$

NPL = the numeric protective level

Qt = the combined flow of both effluent

Qs = the appropriate receiving water flow

The acute objective copper TMDL was calculated by using the data presented in the previous two examples as:

TMDL = 25.7 ug/l x (0.034 cfs + 1.23 cfs + 10.1 cfs)

= 292 ug-cfs/l , where

25.7 ug/l = the acute criterion

0.034 cfs and 1.23 cfs = the average effluent flows

10.1 cfs = the 1Q10

Similar calculations were made for chronic copper and acute toxicity. A TMDL was not calculated for chronic toxicity because chronic toxicity does not demonstrate additivity (see TSD, Chapter 1). The results are summarized below.

	Total Maximum Daily Loads	
	Chronic	Acute
Copper (ug-cfs/l)	244	292
Toxicity (TUa-cfs/l)	NA	3.4

STEP 2: Develop WLAs

The State had adopted an approach into the water quality plan that described how WLAs were to be calculated. The approach required that existing upstream concentrations be used to determine the load allocation part of the TMDL and that 10 percent of the TMDL had to be reserved and unavailable for allocation. The remainder of the TMDL could be apportioned to point sources in the WLA.

The permit writer decided to allocate the waste loads based on the proportion of the existing load of each parameter that was attributed to each of the existing discharges. Based on the information shown in Tables D-1 and D-2 and the average effluent flows, the pollutant loads from each facility are shown below.

Parameter	Auburn POTW Load	Auburn POTW Proportion	Jaybird Corporation Load	Jaybird Corporation Proportion
Copper (ug-cfs/l)	227.6	0.77	66.1	0.23
Toxicity (TUa-cfs/l)	1.23	0.90	0.14	0.10

Individual WLAs were then determined using the following equation:

$$WLA = (TMDL - LA - 10\%\ TMDL) \times proportion / Qd$$

where the chronic TMDL was used to determine the chronic WLA, and the acute TMDL was used to determine the acute WLA for each facility. The WLAs for each pollutant and for each facility are presented as follows:

Parameter	Acute WLA POTW	Acute WLA Jaybird	Chronic WLA POTW	Chronic WLA Jaybird
Copper (ug/l)	134	1,450	98.4	1,063
Toxicity (TUa)	2.2	9.0	NA	NA

C. PERMIT LIMIT DEVELOPMENT

Once the WLAs had been determined, permit limit development proceeded as in the previous examples. LTAs were calculated from the WLAs, and the limiting LTA was selected for calculating permit limits. For the metal finisher, where BAT limits were more restrictive than the water quality-based limits, the BAT limits applied. For the POTW, permit limits for toxic materials were required only to prevent exceedances of water quality standards. This process is summarized below.

STEP 1: Calculate LTAs

The LTA was calculated for each discharger and pollutant as described in section III.A.3 and Appendix B; the LTAs are shown below.

Parameter	Acute LTA POTW	Acute LTA Jaybird	Chronic LTA POTW	Chronic LTA Jaybird
Copper (ug/l)	37.7	361	47.3	468
Toxicity (TUa)	0.71	2.9	NA	NA

STEP 2: Determine the Most Limiting LTA

The minimum LTA was used to calculate MDLs and AMLs. The acute LTA was the lower LTA for both pollutants.

STEP 3: Calculate the Maximum Daily and Average Monthly Limits

The MDL and AML were calculated as described in section III.A.3 and Appendix B.

Parameter	Average Monthly Limit POTW	Average Monthly Limit Jaybird	Maximum Daily Limit POTW	Maximum Daily Limit Jaybird
Copper (ug/l)	62	632	134	1,448
Toxicity (TUa)	1.1	4.5	2.2	9.0

STEP 4: Express the Limits

The final step is to compare the water quality-based limits to the BAT limits to ensure that the more restrictive of the two are used, and to express the copper limits in terms of mass. The copper water quality-based requirements for Jaybird Corporation are more limiting than BAT requirements (see Case 1). Therefore, water quality based limits are required by the permit. In addition, the limits are lower than those calculated when only one of the facilities were considered. The final permit limits are listed below.

Parameter	Average Monthly Limit POTW	Average Monthly Limit Jaybird	Maximum Daily Limit POTW	Maximum Daily Limit Jaybird
Copper (ug/l)	0.41	0.12	0.89	0.27
Toxicity (TUa)	1.1	4.5	2.2	9.0