EPA INFORMATION Bulletin

ENVIRONMENT PROTECTION AUTHORITY

GUIDELINES FOR THE MONITORING AND ASSESSMENT OF COASTAL POINT SOURCE DISCHARGES

Publication 677 **December 1999**

INTRODUCTION

EPA controls major sewage and industrial point source discharges to coastal environments through licences. A condition often required is performance monitoring by the licensee to demonstrate beneficial uses of the receiving environment are not compromised.

This bulletin provides guidance to licensees on how to approach the design and implementation of performance monitoring programs for coastal discharges. It provides:

- summary information on statutory obligations;
- an overview of impacts of coastal discharges on marine environments;
- a description of the types of impact studies that may be required and general principles for their design; and
- the process for EPA approval and reporting for monitoring programs.

The guidance given in this bulletin is not definitive, and proponents should consult with the EPA to determine specific requirements.

Table 1 defines a number of terms commonly used in this bulletin. An outline of the general approach and reporting process for developing monitoring proposals is provided in figure 1.

Table 1: Glossary of common terms

Term	Definition
Beneficial Use	A use of the environment, that is conducive to public benefit, welfare, safety, health or aesthetic enjoyment and which requires protection from the effects of waste discharges, emissions or deposits.
Reference Site	A benchmark sampling location that represents the characteristics of the unimpaired receiving environment.
Environmental Objectives	Minimum environmental quality standards required to protect the most sensitive beneficial use, using particular environmental indicators.
Mixing Zone	An area contiguous to a licensed waste discharge point and defined in that licence, where the receiving water quality objectives under the State *Environment Protection Policy (Waters of Victoria*) do not apply to certain indicators as specified in the licence.
Works Approval	An approval of works issued under section 19B of the *Environment Protection Act 1970*.

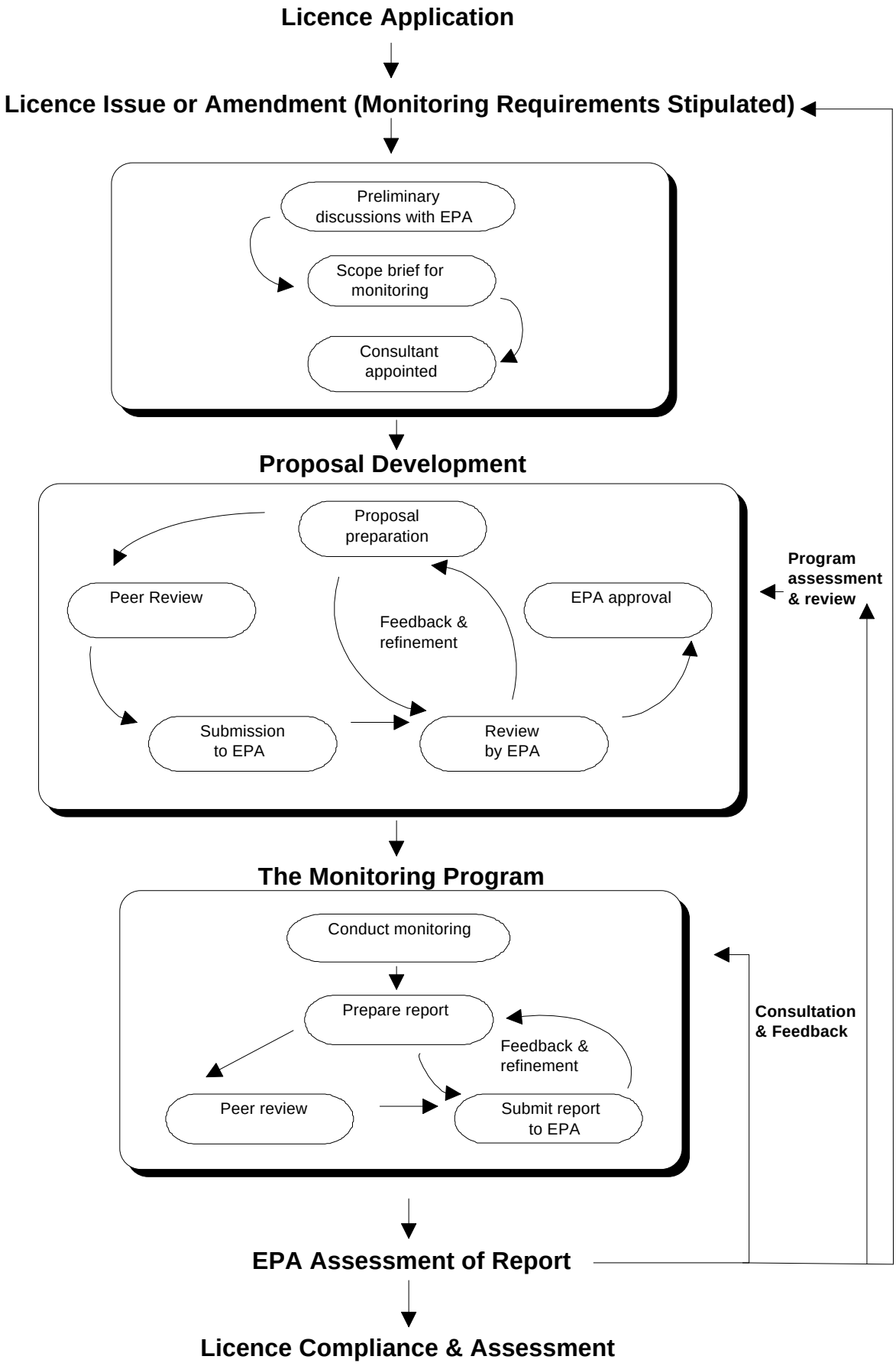

Figure 1: Process for the development of a monitoring program for the assessment of coastal point source discharges

REGULATORY FRAMEWORK

Waters of Victoria

The *State Environment Protection Policy Waters of Victoria* (*WoV*) is a statutory expression of the community's expectations, values and priorities for using and protecting all surface waters in Victoria. WoV stipulates a clear set of publicly agreed environmental quality objectives that will achieve the desired level of protection of beneficial uses. As such WoV provides the context for environmental decision-making and bench-marking of management actions.

Schedules to *WoV* address specific issues in regional water bodies and catchments. Schedules have been issued for several marine and estuarine systems including Port Phillip Bay, Western Port and Gippsland Lakes.

WoV, and its schedules, include provisions for the management of point source discharges, including coastal outfalls.

Conditions of works approvals and licence discharges

All works approvals and coastal discharge licences granted by EPA must be consistent with the provisions of the *Environment Protection Act* 1970, *WoV*, the Industrial Waste Management Policy (*Waste Minimisation*) and any other applicable statutory policies.

Mixing zones designated in EPA licences recognise that waste discharges may adversely affect local ecosystem functioning and allow for some impact in the receiving environment close to the outfall site. Mixing zones are defined by water quality and/or ecological objectives and must be kept as small as practicable and progressively reduced in size via the application of best practice management. *WoV* water quality objectives do not apply within a mixing zone, although the beneficial uses specified must not be adversely affected.

As part of the licence conditions EPA may require a licensee to submit for approval a proposal to assess environmental impacts and monitor compliance with policy objectives and licence conditions.

Such monitoring studies aim to evaluate the adverse effects of a discharge on the receiving environment. The results of these studies are used to inform management and the community as to whether the discharge is having an adverse environmental impact, and if so, the urgency, extent and nature of improvement needed to achieve environmental objectives.

TYPES OF IMPACTS ON COASTAL ECOSYSTEMS AND THEIR ASSESSMENT

The scope of individual monitoring programs varies with the environmental risk posed by the discharge, the nature of the receiving environment, and the extent of the mixing zone.

There are five classes of monitoring studies:

- physico-chemical;
- pathogen;
- ecological;
- bioaccumulation; and
- toxicity.

The licence will identify which of these studies are relevant, and need to be addressed by the licensee.

The remainder of this section summarises the rationale and general design principles underpinning these five categories of monitoring. Although these descriptions provide general guidance, the monitoring program will need to be designed to address objectives that relate to the specific discharge and receiving waters. This ensures that the program cost-effectively addresses environmental risks posed by the licensed discharge.

The licensee should engage experts suitably qualified in the design of monitoring programs to prepare a proposal and liaise with EPA on technical aspects of the monitoring program. The proposal needs to be sufficiently flexible to incorporate changes during the life of the project to incorporate greater understanding of the nature and extent of any impacts, as well as changes in technology and policy development.

a) Physico-chemical studies

Physical factors such as water depth, current speed, bottom topography, tidal and prevailing weather conditions act in concert to influence the dilution, dispersion and accumulation of effluent in the receiving environment. Hydrodynamic and hydrographic studies that take account of these factors may need to be undertaken in the vicinity of the discharge to establish the physical mixing of the effluent in the water column (dilution), transport of the effluent in the water column (dispersal) and its ultimate fate in the receiving environment. This data is used to define the size and nature of the mixing zone. Where a new coastal discharge is being considered these studies form an important prerequisite for siting the discharge to mitigate impacts on the receiving environment. They are also an important precursor to the choice of sampling sites for biological monitoring programs; they identify areas with the highest probability of being exposed to the effluent and consequently where sampling should focus.

Common parameters in these programs include concentrations of nutrients, such as nitrogen and phosphorus, levels of toxicants, such as heavy metals and organic chemicals, and physical factors such as dissolved oxygen, salinity and pH. The values of these indicators must comply with the levels set in the licence for the effluent, mixing zone and receiving environment. For waters outside mixing zones indicators must comply with the relevant State environment protection policy.

All physical and chemical testing must comply with EPA Publication 441, *A Guide to the Sampling and Analysis of Water and Wastewater*.

b) Pathogens

Studies on pathogens and the dispersion of effluent plumes provide information on risks to human health, particularly when the effluent is discharged close to primary contact areas such as swimming beaches and shellfish harvesting areas.

Investigations of the impacts and risks of pathogens to human health have commonly measured the abundance of the bacterium, *Escherichia coli* which indicates the presence of faecal material. Other pathogens such as enterococci and enteroviruses may also be examined.

The concentrations of selected pathogens should be measured at varying distances from the outfall site in order to gauge potential risks. Sites chosen should include those where human contact is possible (eg swimming and surf beaches), where shellfish are harvested for consumption and/or at sites of ecological significance.

c) Ecological studies

The broad objective of ecological studies is to assess the responses of biological populations and assemblages in the receiving environment to the effluent discharge.

There are two broad categories of indices that can be used: changes in benthic populations and communities such as species abundance, composition, diversity and function; and metabolic and physiological responses of individual organisms to effluent discharge, such as reproduction, tissue nutrient content, photosynthetic capacity and respiration.

Commonly used indices include:

- changes in the abundance of species and composition of sediment in fauna;
- changes in the abundance of animals and plants associated with rocky reefs; and
- physiological responses of micro or macroalgae to effluent exposure.

The choice of ecological indicators and the survey design depends upon the chemical composition of the effluent, the physical nature of the receiving environment and the habitats and biota surrounding the discharge. The assessment of effluent characteristics and the results from physico-chemical studies should form a basis for determining the types of biological parameters and the location of sites chosen.

The impacts of effluent discharges are inferred by statistically significant differences in the parameter of interest, both spatially and over time. The design of the monitoring program should allow confidence that biologically meaningful differences are likely to be distinguished from background variability.

Spatially, differences can be measured either along a gradient, or between the discharge site and one, or preferably more, reference (controls) sites. The spatial distribution and variability of biological assemblages has an important bearing of the number on sites and replication needed to discriminate any changes that can be attributed to the discharge from natural background patchiness of biological populations. The choice and number of sites should be explicitly matched to the spatial scales over which the abundance of indicator

organisms vary, and the distance over which the impact is likely to occur.

Temporally, studies should ideally be based on comparisons between pre- and post-discharge periods. Surveys should be undertaken more than once at impact and reference sites prior to the operation commencing discharge to the receiving environment. The frequency of sampling—both pre- and post-operation—should also take into account any seasonal changes in species composition. This establishes the baseline conditions and natural variability of the receiving environment. Comparing this benchmark of pre-existing conditions to data collected subsequent to the discharge commencing can provide a powerful test of whether there are significant biological changes that can be attributed to the outfall.

d) Bioaccumulation studies

Bioaccumulation studies investigate accumulation of toxicants in benthic organisms, such as plants and filter feeders (eg shellfish) that are exposed to effluents, and in motile predatory animals that consume benthic organisms exposed to the effluent.

Bioaccumulation studies should firstly identify toxicants of concern and those organisms that are likely to accumulate these toxicants. The selection should be based on species that are either locally abundant, easily cultured and transplanted and/or consumed by humans.

Periodic surveys should assess concentrations of toxicants in the biota to confirm there is no ecologically significant accumulation of toxicants and that concentrations are below health thresholds for human consumption. Some toxicants may also cause the tainting of fish tissue and studies may be required to test for those compounds known to contribute to fish tainting.

e) Toxicity tests

Toxicology is the science that seeks to understand and predict the effects of chemicals on biota. Toxicity tests achieve this by exposing biota to a range of chemical or effluent concentrations under controlled (usually laboratory) conditions.

Toxicity tests may be used to evaluate the physiological and biochemical responses of organisms to a source of pollution, and identify the constituent(s) of the effluent that may be causing any deleterious effects. This information is useful for evaluating treatment options so that toxic constituent(s) can be removed from the effluent to reduce any adverse effects on the receiving environment.

Waste discharges must not be acutely toxic to aquatic species. Acute toxicity tests usually use lethality as the endpoint. A discharge is considered to be acutely toxic if it kills 50 percent or more of an exposed population of test organisms in a relatively short period of time (eg 96 hours). However, lethality is a relatively insensitive endpoint, and toxicological testing that measures sub-lethal and/or chronic effects may be required to ensure earlier and more sensitive assessment of the impact of effluent.

Toxicity tests must be standard certified and/or published tests with detailed protocols. Tests should provide an appropriate measure of the impact of the effluent and use biota that are representative of other organisms in the receiving environment. Tests must be approved by EPA who will specify the frequency of monitoring. Additional tests should be undertaken when significant changes in effluent composition occur.

PROPOSAL DEVELOPMENT

The design for the monitoring program must be submitted to EPA for approval prior to implementation. EPA should be consulted early in the process of proposal development to ensure both the appropriateness of the approach to ensure accurate characterisation of environmental risks associated with the outfall (figure 1).

Preparing the proposal

The proposal should summarise the findings of previous studies and include pre-existing and current data on effluent characteristics and impacts associated with the discharge.

Details of monitoring proposals will depend on the approach applied and the nature of the impact on the receiving environment. However, the following types of information, with supporting rationale, should be included in all proposals.

a) *Program objectives*: it is essential that the objectives of each monitoring program are specified clearly as statistically testable hypotheses and agreed to with EPA.

b) *Site location*: a scale map showing the location of outfall and sampling sites, and any effluent dispersion information.

c) *Project team*: an outline of the expertise of the personnel designing and conducting the monitoring.

d) *Variables*: a description of, and rationale for, indicators selected.

e) *Sampling methods*: these should be consistent with currently recognised methods.

f) *Sampling design:* the sampling strategy undertaken to meet objectives. It should include specification of the number of sites, frequency and timing of sampling surveys, replication levels for samples, and any other stratification of sampling that will improve the ability to discriminate any impacts. The statistical power of the sampling design to detect a specified and justifiable effect size should be given.

g) *Data analysis and interpretation*: planned analysis methods, and an outline of the approach to interpretation and evaluation of data in the context of stated objectives.

In preparing the proposal, previous investigations from other outfalls should be used for guidance, citations provided and copies of any information from these studies that are important for the evaluation should be attached to the proposal.

There are a number of texts providing detailed information on sampling strategies appropriate for the detection of the impacts of nutrients and toxicants on biological communities. These should be consulted when preparing the proposal.

Approval process

In considering a monitoring proposal, EPA may require that proposals undergo external independent review by one or more recognised experts. EPA will recommend qualified reviewers, and the cost of the review will be borne by the licensee.

EPA will consider these reviews as well as assessments by its own specialist staff to determine the adequacy of the proposed monitoring. EPA may make further suggestions to improve the overall efficacy of the monitoring design.

Once the monitoring design has been finalised the licensee will be given written advice to proceed with implementing the monitoring program.

REPORTING AND REVIEW ON THE MONITORING PROGRAM

Preparing the Report

After completion of each milestone of the monitoring program a report should be prepared for submission to EPA. These reports should:

- be concise and informative and focus on program objectives;
- describe the receiving environment and sampling approach and methodology;
- include descriptive summaries and graphical presentations of data, and results of statistical analyses;
- provide clear statements of findings, which are drawn from, and supported by, the data and made in the context of existing scientific literature;
- contain the entire set of raw data either in tab delimited format or any agreed electronic format;
- provide recommendations for future monitoring and detail any proposed changes to existing effluent management arrangements.

Assessment

The report will be evaluated in the context of achieving licence compliance, and assessing the impact of the discharge on beneficial uses both within and outside the mixing zone. It will also be assessed in terms of minimising impacts outside mixing zones, and providing a scientifically meaningful understanding of the impacts associated with coastal waste discharges.

External peer review may be required of the final report, at cost to the licensee.

EPA will assess all recommendations made with regard to future monitoring and proposed changes to effluent management. EPA will also specify requirements for further monitoring and/or direct alternative programs via licence amendment.

RELEVANT EPA PUBLICATIONS

EPA (Victoria) 1981, *Mixing Zones*, EPA Information Bulletin WQ-10.

EPA (Victoria) 1988, *State Environment Protection Policy Waters of Victoria.*

EPA (Victoria) 1994, *Coastal Wastewater Discharges in Victoria*, EPA Publication 399.

EPA (Victoria) 1995, *A Guide to the Sampling and Analysis of Water and Wastewater*, EPA Publication 441.

Keough, M.J. and Mapstone, B.D. 1995, *Protocols for Designing Marine Ecological Monitoring Programs Associated With BEK Mills*, National Pulp Mills Research Program, Technical Report No. 11.

Keough, M.J. and Maptsone, B.D. 1997, Designing Environmental Monitoring for Pulp Mills in Australia, *Water Science and Technology*, 35 (2-3): 397–404.

Quinn, G.P. and Keough, M.J. 1991, *Biological Monitoring in Port Phillip Bay and its Relationship to Inputs of Nutrients and Toxicants*, EPA Publication 365, EPA (Victoria).

FURTHER INFORMATION

EPA Information Centre

40 City Road, Southbank 3006
Tel: (03) 9695 2722 Fax: (03) 9695 2780

EPA Regional Offices

Gippsland

7 Church Street, Traralgon 3844
Tel: (03) 5176 1744 Fax: (03) 5174 7851

North-East

24 Ely Street, Wangaratta 3677
Tel: (03) 5721 7277 Fax: (03) 5721 2121

North-West

43 Williamson Street, Bendigo 3550
Tel: (03) 5442 4393 Fax: (03) 5443 6555

South Metro

45 Princes Highway, Dandenong 3175
Tel: (03) 9794 0677 Fax: (03) 9794 5188

South-West

Cnr Lt Malop & Fenwick Streets, Geelong 3220
Tel: (03) 5226 4825 Fax: (03) 5226 4632

EPA internet site

www.epa.vic.gov.au

State Government
of Victoria