POINT SOURCE DISCHARGES TO STREAMS: PROTOCOL FOR IN-STREAM MONITORING AND ASSESSMENT

Publication 596 **February 1998**

1. INTRODUCTION

The level of environmental protection desired by Victorians for their streams and waterways is established by State environment protection policies (SEPPs). SEPPs specify the environmental quality objectives that must be attained and maintained to achieve this level of protection. Any proposal to discharge waste into the environment must be consistent with the requirements of all relevant SEPPs and must ensure that environmental objectives are not exceeded, unless a mixing zone (EPA 1981) has been granted.

Monitoring of licensed discharges to streams has traditionally only required primarily chemical analysis of the discharge, prior to it entering the stream. A major problem with this "end-of-pipe" approach is that it does not indicate what impact the discharge is having on the ecosystem within the receiving waters. Often licence requirements are met at the end-of-pipe, but impacts on stream environments are still evident.

Given that the purpose of monitoring discharges is to assess and minimise impacts of the discharges on receiving waters, there is a clear need to extend assessment and monitoring beyond the end-of-pipe. Ultimately, the best assessment of the health of an aquatic ecosystem is an examination of the organisms that live within it, in conjunction with potential explanatory water quality indicators.

The *SEPP (Waters of Victoria)* (Government of Victoria 1988) sets water quality objectives for all general surface waters in the State, and provides a Statewide policy framework for several catchment-specific policies. Water quality objectives typically include physico-chemical indicators such as dissolved oxygen, salinity, turbidity and toxicants. Where numerical nutrient objectives are not provided in a SEPP, guideline concentrations from *Preliminary Nutrient Guidelines for Victorian Inland Streams* (EPA 1995a) will be used.

It is expected that ecological objectives will be established for all Victorian streams by the end of 1999 and will be progressively included in SEPPs. Ecological objectives using aquatic macroinvertebrates (which include worms, molluscs, crustaceans and insects) have been included in the *Draft State Environment Protection Policy (Waters of Victoria) Schedule F7* (EPA 1995b). They are also being developed for the review of the Western Port and catchment SEPP (Government of Victoria 1979).

Currently there are no ecological objectives for other forms of biota, with the exception of five fish species in the *Draft State Environment Protection Policy (Waters of Victoria) Schedule F7* (EPA 1995b). EPA is developing a protocol for the use of diatoms, particularly in the assessment of nutrient status of waters. Although numerical diatom objectives are yet to be set for Victorian waters, there are readily available methods for the use of diatoms in the assessment of nutrient status of water bodies (for example, Reid *et al.* 1995).

In addition to physico-chemical and biological monitoring and assessment programs, mixing zone compliance, toxicity testing of complex effluents, and investigations for potential pathogens may also be needed, depending on the characteristics of the licensed discharge.

This protocol is designed to assist industry in assessing attainment of EPA licence conditions or SEPP objectives in the design and implementation of in-stream assessment programs for point source discharges to streams. This includes selection of:

- aquatic organisms
- water quality indicators
- number and location of sampling sites
- the number and timing of sampling events.

Information is also provided on analysis, interpretation and reporting requirements. The approach described here has been developed by EPA through many years of experience in the design and implementation of in-stream monitoring and assessment programs. All sampling programs which have been designed to meet EPA licence conditions or assess SEPP objectives will need to be submitted to EPA for approval.

2. DESIGNING AN IN-STREAM MONITORING PROGRAM

2.1 Primary aim and goals

The major aim of an in-stream monitoring program is to monitor and assess impacts of a discharge on the ecosystem of the receiving stream. This includes the physical, chemical and biological environment. Four major goals must be met to achieve the primary aim.

1. Determine an acceptable number and location of sites for sampling.
2. Select the appropriate indicators, methods, and times for sampling.
3. Analyse and interpret results.
4. Report results and conclusions.

2.2 How to meet these goals

2.2.1 Acceptable number and location of sites

- An in-stream monitoring program designed to assess the impact of a discharge must include sampling at control sites (not affected by the discharge) and sampling at sites which are affected by the discharge.
- For proposed new discharges, sampling at all sites must be undertaken before and after the commencement of the discharge. This allows the most accurate assessment of the potential impact on the stream environment.
- In situations where discharges have been occurring prior to the initiation of an in-stream monitoring program, there may not be data available to assess prior conditions. In these situations, control and impact sites need to be carefully chosen to avoid possible confounding environmental influences.
- Generally, a minimum of two, and up to four, control sites which are not affected by the discharge are needed, to provide an indication of the conditions and extent of variation at unaffected sites.
- The effluent must be sampled at a site immediately prior to it discharging to the stream.
- Downstream of the discharge, the number and location of sites must be sufficient to determine the extent of the impact. The expected number of sites would range from a minimum of three sites to a maximum of six sites.
- All sites sampled must be as similar as possible to allow direct and meaningful comparison. This includes similarity in stream depth, current velocity, bed substrate, aquatic vegetation and riparian conditions. If a site comparable to the monitoring sites does not exist upstream of the discharge, a suitable site(s) in a similar but unimpacted waterway may be used as a control site.

2.2.2 Selection of indicators, methods and times

- Physico-chemical indicator selection must consider the nature of the effluent. Physico-chemical analyses can include nutrients, metals, suspended solids, biological oxygen demand, chemical oxygen demand, petroleum hydrocarbons and other toxicants. *In situ* measurements of electrical conductivity, diurnal dissolved oxygen and pH must always be taken. Stream flow and effluent discharge volumes will also be required.
- All physico-chemical water samples and *in-situ* measurements will be obtained, preserved and analysed using EPA approved methods outlined in *A Guide to the Sampling and Analysis of Water and Wastewater* (EPA 1995c). Method detection limits must be at concentrations less than the objectives established in the relevant SEPPs, and must be analysed by a laboratory accredited for the selected analyses by the National Association of Testing Authorities.

- All physico-chemical water samples and *in-situ* measurements need to be undertaken monthly (when discharging). Stream and effluent discharge volume must be measured daily. In the months when biological sampling will occur, it must coincide with physico-chemical sampling.

- Habitat descriptors for each site need to be collected from maps and from field observation and measurement. These are required to aid interpretation of results and enable use of predictive models. These variables include:
  - ♦ latitude and longitude
  - ♦ stream width and depth
  - ♦ substrate composition
  - ♦ riparian vegetation
  - ♦ catchment area
  - ♦ altitude.

  A full list of required habitat variables and collection methods is presented in *Rapid Bioassessment of Victorian Streams* (EPA 1998).

- Biological indicators need to be selected based on individual features of the discharge and characteristics of the stream, as well as existing or potential threats to the aquatic ecosystem. Biological assessment using macro-invertebrates is recommended for a general assessment of ecological health. Rapid techniques are available and there is a published EPA protocol for their use – *Rapid Bioassessment of Victorian Streams* (EPA 1998). Ecological objectives have been established for the Yarra River catchment and are currently being developed for the rest of Victoria.

- Diatoms can also be used as biological indicators, and a protocol for their use will be available late in 1998. Diatoms are particularly suited to assessing nutrient effects as their species distributions react directly to nutrient concentrations. In comparison, macro-invertebrates are particularly good for assessing toxic effects and oxygen stress. The best approach is to use both diatoms and macroinvertebrates.

- Other forms of biota may also be monitored to suit the situation. For example, concerns regarding the influence of nutrient discharges on aquatic macrophytes (water plants) may necessitate this group being monitored. Similarly, when a particular species or group of species is threatened, individual monitoring programs will need to be designed to address the issue.

- Biological sampling must be undertaken by aquatic ecologists experienced in sampling the community-type being used for the biological assessment. Processing of samples must be undertaken by appropriately qualified aquatic ecologists.

- Biological sampling must be undertaken at least twice each year, in spring/early summer and in autumn. For seasonal or intermittent streams and discharges, timing of sampling will need to be considered on an individual basis.

- For new or proposed discharges, biological and physico-chemical sampling should be undertaken for at least two years prior to discharge commencing.

2.2.3 Data analysis and interpretation

- Data analysis and interpretation must be undertaken by a qualified aquatic ecologist.

- The purpose is to compare the stream invertebrate community structure and water quality between control and impacted sites.

- Analysis must include consideration of habitat variations between sites and seasonal variation, including flows.

- Interpretation of the data is assisted by numerical analyses, including classification and ordination, and also by indices including SIGNAL (Stream Invertebrate Grade Number Average Level) and by predictive models, for example, AUSRIVAS (AUStralian RIVer Assessment System, Simpson *et al*. 1997).

- Interpretation must assess results against ecological and water quality objectives.

2.2.4 Reporting

- Reports must be concise and informative, include data summaries, and provide a clear statement of major findings which are drawn from and supported by the data.

- For pre-existing discharges, all data is to be reported after two years of data collection, for review by EPA. For new discharges, all data will be reported after two years of discharge operation. At these stages the monitoring program will be reviewed.

- The entire set of raw data must be presented, in a clear and interpretable form, in an appendix to the report. All data must also be provided to EPA in an approved electronic format.

3. OUTCOMES

- The judgement as to whether the data indicate a detrimental change in environmental quality between the control and impact sites will rest with the Authority.
- Any demonstrable in-stream difference between control and impact sites beyond natural variability will be considered sufficient evidence of an impact, warranting improvements in the quality of the discharge or further investigations, potentially including toxicity studies.
- Where there is no demonstrable in-stream difference between control and impact sites, the monitoring program may be substantially reduced.

4. SUMMARY

- This protocol is designed to assist industry in assessing attainment of licence conditions and SEPP requirements.
- The protocol provides an approach and methodology for undertaking monitoring and assessment of the impact of point source discharges on stream ecosystems.
- The protocol is only a part of an overall approach, and may need to be combined with toxicity, mixing zone or pathogen studies.

5. REFERENCES

EPA (1981). *Mixing Zones*. EPA Publication WQ-10.

EPA (1995a). *Preliminary Nutrient Guidelines for Victorian Inland Streams*. EPA Publication 478.

EPA (1995b). *Draft State Environment Protection Policy (Waters of Victoria) Schedule F7. Waters of the Yarra Catchment and Draft Policy Impact Assessment*. EPA Publication **471**.

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

EPA (1998). *Rapid Bioassessment of Victorian Streams: The Approach and Methods of the Environment Protection Authority*. EPA Publication 604.

Government of Victoria (1979). *State Environment Protection Policy No. W-28 (The Waters of Westernport Bay and Catchment)*.

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

Reid, M., Tibby, J., Penny, D. and Gell, P. (1995). The use of diatoms to assess past and present water quality. *Australian Journal of Ecology* 20:57-64.

Simpson, J., Norris, R., Barmuta, L. and Blackman, P. (1997). Australian River Assessment System. National River Health Program Predictive Model Manual (1st draft) From the web site http://ausrivas.canberra.edu.au/ausrivas/

FURTHER INFORMATION

EPA Information Centre
477 Collins Street, Melbourne 3000
Tel: (03) 9628 5622 Fax: (03) 9628 5391

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