Water Use

Supporting Guidance (WAT-SG-11)

Modelling Coastal and Transitional Discharges

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Copyright and Legal Information

Update Summary

3Version	Description
v1.0	First issue for Water Use reference using approved content from the following documents: *Modelling_coastal_discharges.doc* *SEPA Policy No. 28*
v2.0	*Consent* renamed *Licence*, New base template applied, links to docs revised for new SEPA website, Nov 2008
v3.0	Expired CMS links reviewed and updated.

Notes

References: Linked references to other documents have been disabled in this web version of the document. See the References section for details of all referenced documents.

Printing the Document: This document is uncontrolled if printed and is only intended to be viewed online.

If you do need to print the document, the best results are achieved using Booklet printing or else double-sided, Duplex (2-on-1) A4 printing (both four pages per A4 sheet).

Always refer to the online document for accurate and up-to-date information.

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1. Key Points

This document provides Guidance on modelling discharges to coastal and transitional waters. It covers the following:

- Modelling requirements for discharges to coastal waters, transitional and sea lochs
- Background to the key factors and data requirements which need to be considered

Detailed advice and support is available from SEPA's Modelling & Data Unit

NOTE: There is currently a project underway to refine and improve this guidance. Do not rely on printed copies of this document – instead periodically check for an updated version.

2. Introduction

The impact of a discharge on any water body is dependent on discharge quality and quantity and prevailing physical and chemical conditions of the receiving waters. In contrast with a river, the physical and chemical conditions of tidal waters are highly variable both spatially and temporally. This is due to tide and wind currents, the bathymetry of the sea bed and seasonal river flow and quality.

Therefore, in order to assess the impact of a discharge to a tidal water body it is necessary to predict the duration over which the pollutants may act and thereby the area of impact and whether any other discharges (diffuse or point) might impact the same area. This assessment is normally made with some form of predictive model to enable simulation of different discharge quality parameters in combination with the different physical and chemical conditions of the receiving waters.

Models vary greatly in type and complexity but it is essential that the model chosen is appropriate to the situation in which it is being utilised. It is also important that the model is properly calibrated and validated in order to ensure that the model output is reliable and accurate.

3. Defining the Model

It is essential to define the major issues and variables under consideration at the outset in order to select an appropriate model.

- Model Duration
  The temporal extent of the discharge. It defines the duration over which the model simulates processes which may be a number of tidal cycles, days, weeks, months or even years.

- Model Domain
  The spatial extent of the model determined from a knowledge of the location and temporal effect of the discharge.

- Model Dimensionality
  Decided once the model domain and duration is known. It requires knowledge of the hydrography of the area and behaviour of the pollutants. It describes how the area is divided:

  - A one-dimensional model (1D) has a single scale e.g. length down an estuary
  - A two-dimensional model (2D) has two scales, e.g. length and depth of estuary
  - A three-dimensional model (3D) has three scales; length, width and depth
    With ever increasing computing power 3D models will become increasingly attractive as the problem is in reality three dimensional, and using a 3D model removes another simplifying assumption.

- Model Grid
  Constitutes key data such as depth, topography, river inputs, tidal elevations, flows at boundaries, etc. needed to calibrate and validate the model.

4. Model Types

The 3 basic types of model are:

- Hydrodynamic Model
- Water Quality Model
- Particle Tracking Model

4.1 Hydrodynamic Model

The hydrodynamic model predicts the surface elevations and current velocity field across the model grid. It provides the flow and dispersion data that can be used to run other models such as water quality or particle tracking. This frequently includes the dispersion of a conservative tracer, commonly calibrated against observations of salinity in marine work.

Although these models can be quite time consuming to run, once run the output files can be used to model scenarios for different outfall locations and conditions.

4.2 Water Quality Model

Water quality models simulate the chemical reactions that take place within the water body modelled. Depending on the requirements of the study the simulation can be limited to a single determinand, or a number of determinands.

The more complex the model, the more complex the data required to set-up, calibrate and validate the results. Therefore, it is important that the tool used is demonstrated to be suitable for the problem to be solved.

A common error is to implement a model that is more sophisticated than required and then encounter problems with calibration and validation.

4.3 Particle Tracking Model

Particle tracking models simulate the behaviour of compounds or organisms in the water column by representing them as a number of particles. These are advected and dispersed throughout the water body using a flow field obtained from a hydrodynamic model or from surveys. The model simulates the behaviour of these particles over time including processes such as bacterial die-off, or variable buoyancy.

Such models are frequently used in conjunction with the “random walk” theory of dispersion, where random numbers are used to describe the dispersive nature of the environment.

These models run much faster than most water quality or hydrodynamic models, as they read the flow field from data files rather than computing them. The model tracks and records the movement of particles through time.

Another advantage of these models is that runs can be made for different environmental conditions and percentile plots of compliance may be created. Particle tracking is commonly used for bacterial modelling.

5. Model Set up

5.1 Data Requirements

Data is required to set up the model and to validate and calibrate the model against observations. The set up data is required to define the bathymetry within the model, and to provide boundary and initial conditions.

Boundary Conditions are needed to describe the inputs to the models, which may be riverine or point source discharge data, plus tidal flow and elevations at the seaward boundary of the model.

Initial Conditions data is required to set parameters, particularly water quality, at the start of the model run. This could be water depth or the number of plankton per square metre.

5.2 Model Calibration

Calibration is the process by which the model is adjusted to reproduce the characteristics of the study area for a given set of conditions. The model output is compared against observed measurements and model parameters and coefficients are adjusted to improve agreement.

Calibration data for hydrodynamic models may consist of water levels, current speeds and directions, drogue tracks, salinity measurements and dye tracking data. To achieve calibration of the tidal cycle the model is often compared to tidal heights or flows that have been harmonically analysed to remove the wind effect from observations. However, if the model is to be used to simulate wind effects it is equally important that the model is compared against the observed data.

Other important considerations for hydrodynamic model calibration are:

- Location and number of data points to give good coverage of the model area, particularly at specific points of interest (e.g. outfalls, end-receptors)
- Accuracy of calibration data, including boundary conditions, initial conditions and meteorological conditions
- Distribution of data with respect to model dimensionality - vertical and lateral variability fully described, if appropriate
- Required level of agreement between model output and observations from field surveys, sampling etc. In other words, is the model fit for purpose?
- Degree of adjustment needed to demonstrate agreement

Typically, the model resolution, the bathymetry and sea bed roughness coefficient are adjusted to improve agreement to the desired level. Good agreement between predicted and observed salinities and dye-tracking results is necessary to demonstrate that the model accurately reproduces the dispersive characteristics of the study area. This is essential to achieve accurate water quality simulations.

Calibration data for water quality models consists of concentrations of the variables of interest at points throughout the model area over the period of interest. Seasonal variations may be important for some parameters such as nutrients and chlorophyll. The considerations listed above for hydrodynamic calibration are important for water quality calibration. In addition it is important that all inputs to the model area from e.g. outfalls or rivers are accurately specified.

The reaction rates and coefficients in equations describing chemical kinetics in the water column are adjusted to improve agreement between water quality predictions and observations to the desired level. In general, the level of is less for water quality than for hydrodynamics because of greater environmental variability of water quality parameters.

5.3 Model Validation

This demonstrates model accuracy by comparison of model output with a separate, independent dataset. The model should provide good agreement without further adjustment. It is common practice to calibrate a hydrodynamic model against a spring tide dataset then validate against a neap tide dataset. Calibration and validation periods for a water quality model should reflect the timescales of the parameters in question, tidal and possibly seasonal variability.

5.4 Sensitivity Testing

Once a model has been set-up, calibrated and validated it is important to test the sensitivity of the model output to the key input parameters, i.e. the boundary and initial conditions. A model report should always include a section on sensitivity testing, demonstrating the variation in model output in relation to variation in the input data. Some models have automatic sensitivity testing routines; others require the operator to make a number of runs, while manually varying the input parameters. It is important to check and understand model sensitivity to both boundary and initial conditions.

6. Initial dilution

Effluent discharged to tidal waters is typically buoyant as a consequence of the difference in density between the effluent and surrounding saline waters. Without adequate initial dilution effluent upwelling can create surface slicks causing significant aesthetic impact at the very least. Initial dilution is the process whereby the discharge from a submerged outfall is entrained by surrounding waters as a result of turbulent mixing and discharge buoyancy relative to ambient water density.

The main factors controlling the initial dilution afforded by an outfall are:

- Water depth
- Ambient current
- Effluent density
- Outfall diffuser design (number of ports, port diameter, discharge rate etc.)

It is normally calculated using a stand-alone model or set of equations and then factored into the inputs of a more detailed model.

SEPA's requirements for initial dilution, set as 95%iles, are:

- x 100 for primary treated sewage effluent;
- x 50 for secondary treated sewage effluent (>100 p.e.);
- x 50 for industrial effluents dependent on treatment etc (case specific).

Further information on initial dilution is contained in *section 11*.

- *Initial Dilution and Mixing Zone*
  Provides general information and details SEPA's requirement for initial dilution
- *SEPA Standards for Models*
  Sets out minimum mathematical modelling requirements for presentation to SEPA
- *Approved Initial Dilution Models*
  Details some models that can be used to calculate initial dilution

7. Estuarine Modelling

Estuaries may receive a number of major discharges in close proximity requiring that any model takes account of combined inputs. Thus, estuarine modelling studies benefit from detailed knowledge of all contributing sources.

Estuaries are characterised by a longitudinal variation in salinity from coastal seawater at the seaward boundary to zero at the upstream fresh water boundary. Conditions within an estuary are dynamic and complex through the combination of tidal forcing, winds and variation in freshwater inputs. Longitudinal and lateral variations in salinity, and hence water density, can have a significant effect on estuarine hydrodynamics, mixing and subsequent water quality. Selection of an appropriate numerical model with the capability to reproduce these features (if present) is essential.

Conditions within estuaries can vary from well-mixed to partially-mixed to stratified, depending largely on tidal range, but also on depth and fresh water input. In a well-mixed estuary, longitudinal variability is most significant and it is often acceptable to assume lateral and vertical variations are small and thus a 1D time varying model (dynamic) is the most appropriate choice. For hydrodynamics this will simulate tidally forced variations in water level and current velocity along the length of the estuary. The model output corresponds to cross-sectionally averaged conditions at any point along the length of the estuary.

If estuary width is significant, but there is good vertical mixing, then a 2D depth-averaged model may be appropriate. These models predict lateral variations in conditions. If, however, vertical stratification is significant due to temperature/density differences, but lateral variations are small, a 2D width-averaged model is most appropriate. Finally, if both width and depth variation are important within the areas of interest a 3D dynamic model is required.

Estuaries can be prone to dissolved oxygen (DO) depletion and are a major source of nutrient inputs to coastal waters, from both natural and anthropogenic sources. Therefore the water quality model chosen must be capable of simulating complex processes and relationships.

8. Coastal Waters

Coastal waters, in contrast with estuaries, are generally less bounded, with reduced significance of freshwater inputs. However, lateral variability can seldom be ignored and the significance of wind effects is greater. It is often reasonable to build a model to simulate only one specific discharge.

Although the model domain might include other sources, it may be reasonable to demonstrate that the effects of the discharges under consideration will not overlap. The model domain is often much larger for a coastal model and the water quality models may be more sophisticated wherever eutrophication is an issue.

Spatial variability generally requires at least a two dimensional model. When depth variation can be demonstrated to be negligible, a 2D depth averaged model is appropriate. The location of the seaward boundary is often critical both for the provision of reasonable data and in determining the area of impact for the model. In areas where both lateral and vertical structure are significant, 3D models are necessary. This may be caused by water depth, low tidal energy, seasonal density patterns - possibly increased freshwater influence in winter or increased surface warming in summer.

9. Sea Lochs

The Scottish sea-loch or Voe is a fjordic system which can be thought of as a cross between an estuary and coastal water. Many systems are wide (>1 km) and can be very long (up to 60 km). The vertical structure of these systems is often complicated, especially if the system has a shallow sill or sills. This leads to a defined density structure which can remain stable for long periods of time until overturning occurs causing complete mixing in a short space of time.

When considering models for lochs it is very important to identify the parameters critical to the system and ignore those which are inconsequential to avoid overcomplicating the model. For instance, if the important factor is the residence time of a pollutant, lateral variation may not be important and 2D model simulating length and depth may be acceptable. Alternatively, in a shallow system a 2D model with no vertical variation may be acceptable.

10. Examples of Modelling Requirements

The following examples show typical modelling solutions:

Longsea outfall for 20,000 p.e. discharging into a tidally dynamic coastal bay

A 2D hydrodynamic model would be required which would drive a 2 or 3D Particle Tracking Model for bacterial assessment. The hydrodynamic model would also be used to support a Water Quality model if there were concerns regarding the impact on Environmental Quality Standards for Dangerous Substances.

Septic tank discharge for a small community of 300 p.e.

Preferred outfall location could be identified using simple survey, published tidal data work to show the trajectory of the effluent and an initial dilution assessment to demonstrate compliance as set out in *section 11.3*.

100,000 p.e. equivalent into a deep urban estuary (e.g. Clyde).

This would require either a 3D or 2DV Hydrodynamic model coupled with a 3D WQ model. In many such cases SEPA may have a suitable hydrodynamic model already constructed.

11. Initial Dilution, Mixing Zones, Standards

This section applies to discharges from coastal and estuarine outfalls. It is based on the details in the deleted *SEPA Policy Document No. 28* and covers:

- *Overview*
- *Initial Dilution and Mixing Zone*
- *SEPA Standards for Models*
- *Approved Initial Dilution Models*
- *Glossary of Terms Used*

Note: Details in this Appendix do not apply to marine fish farm installations.

11.1 Overview

Scottish water authorities and private industry depend heavily on the use of the marine environment for the disposal of effluents. Most coastal towns and many large commercial plants discharge their wastewater directly to the sea through a sea outfall. As the effluent discharges, it usually forms a buoyant plume which rises to the surface. Sea water becomes entrained and mixing occurs, diluting the plume as it rises to form a surface "boil". The degree to which this occurs varies considerably as the tidal cycle alters both the depth of the outfall below the surface and the ambient velocity of the water past the end of the outfall. The dilution which the plume receives as it rises from the point of discharge is known as the **initial dilution**.

Subsequent, or secondary, mixing with the receiving water occurs away from the boil and is generally slower, the rate depending on hydrographic conditions. If the initial effluent is buoyant then this secondary mixing will normally be restricted to the upper layers of the sea until the relative densities are such that mixing can take place throughout the water column.

SEPA may identify an area of sea surface surrounding a surface boil and define it as a **mixing zone**. This zone comprises an early part of the secondary mixing process and is prescribed to ensure that no environmental damage will be encountered outwith its boundaries. An individual mixing zone is only defined with respect to an established environmental quality standard (EQS) for a particular polluting substance. The mixing zone is the area of sea surface within which the EQS will be exceeded.

This Appendix sets out a common set of SEPA criteria for quantifying these dilution processes, while recognising that there may be different degrees of complexity and site specificity involved, depending on the nature and composition of the discharge, and the dynamics and sensitivity of the receiving water.

The objective of defining mixing zones is to allow a rational and sound scientific basis for the derivation of marine discharge licence conditions which can be related to readily enforceable end of pipe effluent concentrations and design criteria.

11.2 Initial Dilution and Mixing Zones

11.2.1 Initial Dilution

As mentioned in section 6 above, SEPA will expect new or modified sewage discharges with greater than 100 population equivalent to be designed and constructed to provide:

- Minimum initial dilution of 100 times (95 percentile) for primary treated effluents
- Minimum initial dilution of 50 times (95 percentile) for secondary treated effluent, including septic tank effluent.

These criteria are based on the estimated requirements to reduce to acceptable levels both the visibility of density slicks and the occurrence of smell nuisance.

- Minimum initial dilution of 50 times (95 percentile) is also expected for significant new or modified industrial discharges, although these will be judged on a case by case basis.

A mean rate of flow of effluent will be used when deriving the estimates of initial dilution.

These expectations will be applied uniformly in coastal waters, but SEPA accepts that discharges made at certain estuarine locations may not be able to achieve these minimum criteria. Exceptions may also be considered where the discharger can demonstrate to SEPA‘s satisfaction that the costs associated with complying with these standards are excessive in relation to the environmental benefit.

Careful design of the type and position of the outfall diffuser can maximise the initial dilution that is achieved and hence minimise the environmental impact of the discharge. In order to do this, some form of numerical modelling is required. In addition, modelling can assist in determining the shape and dilution potential of the mixing zone. All modelling work must conform to SEPA‘s generic modelling requirements listed in *SEPA Standards for Models.*

Dischargers will be expected to use one of the models listed in *Approved Initial Dilution Models* to ensure compatibility with SEPA‘s ability to audit the calculations. This list will be updated as necessary and dischargers may use other models if agreed in advance with SEPA.

Particular checks should be made that the effluent plume reaches the sea surface after initial dilution for all possible combinations of effluent density and receiving water stratification. If it is found that the effluent cannot always be guaranteed to reach the surface then this extra complication with all its implications for water quality must be considered. In these cases, appropriate standards may have to be met at the point that the plume is stopped by a density barrier after only limited initial dilution.

SEPA accepts that, in specific cases, a phased approach may be appropriate for the implementation of outfall design requirements. Any phasing arrangement will be included in the licence conditions.

11.2.2 Mixing Zones

The potential dilution, shape and orientation of any mixing zone under various hydrographic conditions cannot be usefully defined without some technical monitoring of the specific receiving water. Field studies may have to include some temperature and salinity measurements to assess the likelihood of stratification. The identification of a suitable outfall location and derivation of appropriate licence conditions, based on design requirements, will require an assessment of the total dilution, subject to the conditions 1-10 listed below.

The mixing zone should meet all of the following criteria that are relevant:

1. It is expected that the mixing zone around the effluent surface boil would normally be set at a maximum distance of 100m in any direction (that the plume may travel) from the centre of the boil, or from the nearest individual diffuser boil where there is a multiport arrangement. The dilution this allows must be calculated for each site.
2. The concentration of dispersing effluent must be such that no established relevant UK or SEPA chemical Environmental Quality Standard is breached outwith the mixing zone. This must take account of the individual standards which may be expressed as annual mean values, or percentile exceedance values, or maximum allowable concentrations.
3. Where an effluent requires control through toxicity-based criteria then the concentration of dispersing effluent must be such that there is no residual toxicity outwith the defined mixing zone i.e. the residual concentration of the toxic substance shall comply with the Predicted No Effect Concentration (PNEC) lethal or sub-lethal, acute or chronic, determined from an appropriate SEPA approved toxicity test (see Definitions).
4. After initial dilution there should no point within the mixing zone where the residual concentration of effluent exceeds the 3 hour acute No Observed Effects Concentration (NOEC) for any SEPA approved lethal or sub-lethal test. Twenty-four hour acute tests may be substituted where such test data cannot be obtained.
5. Two or more mixing zones from different neighbouring outfalls must not merge or take up all the diluting capacity of any receiving water body. It is recommended that the edges of the mixing zones be at least 100m apart. If, for any reason, this criterion cannot be met, then the toxicity of the mixed effluents must be considered.

6. Normally no mixing zone would be expected to impinge on the MLWS shoreline, although SEPA recognises that this may be varied in narrow estuarine locations.
7. A mixing zone should generally not plug an estuary, sea loch or small bay. It is expected that a mixing zone in such a situation should take up no more than a half of the narrowest dimension.
8. SEPA has a statutory obligation, under the *Conservation (Natural Habitats etc) Regulations,* not to issue a licence for any discharge which has been shown, by an appropriate assessment, to be likely to have an adverse effect on the designated conservation interests of a Special Area of Conservation (SAC, under the European Habitats Directive) or a Special Protection Area (SPA, under the European Wild Birds Directive). Where a mixing zone may impinge on any SAC or SPA, SEPA has a duty to ensure, before issuing a licence, that the integrity of the site will not be adversely affected. The integrity of a site is defined in the *Habitats Directive 92/43/EEC* (CELEX: 31992L0043) as the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or levels of populations of the species for which it was classified. SEPA will ensure that no mixing zone will jeopardise the integrity of any designated sites, and will apply the same approach to other sites with statutory conservation designation (e.g. SSSIs). Consideration will also be given to other areas which have a recognised, but non-statutory, conservation interest (egg Marine Consultation Areas).
9. The mixing zone should not give rise to any significant visible slicks or other aesthetic problems.
10. Where solids are present in the effluent, and where these solids are expected to accumulate on the sea bed, a similar approach to that used for the liquid dispersal will be utilised. In this case the 100m mixing zone is retained but the toxicity criteria must recognise the extended exposure times possible for the resident benthic organisms.

The sea bed sediment must meet standstill clauses for appropriate EC dangerous substances outside the mixing zone. Build up of other potentially toxic substances must also be avoided but no formally accepted quantitative standards currently exist.

SEPA will expect that no solids will be permitted to accumulate on the sea bed within the identified mixing zone in quantities which would give rise to acute toxicity. However, the science of sediment toxicity is in a developmental stage with no widely agreed protocols for toxicity testing. SEPA will discuss individual cases with each discharger.

Where adverse benthic effects can be demonstrated to arise only from non-persistent organic sources then the levels of acceptable change will be as described in the *Comprehensive Studies Task Team Report (1997)*. The predictive BenOss model, referred to in the report, may be used where the organic load is expected to be significant.

It is recognised that calculating the dilution and potential effects resulting from defining a mixing zone in this way requires a degree of accompanying survey work and technical data that may not be available or reasonably obtainable. The decision on whether to relax any of these guidelines has to be site-specific and based on a sound assessment of risk. Previous SEPA experience has shown that some effluents exhibit either greater or lesser toxicity than an existing knowledge of their chemical constituents would suggest. A preliminary toxicity screening of any significant complex effluent should be undertaken before assuming toxicity does not need to be considered.

11.3 SEPA Standards for Models

These guidelines form the basis of a common core of generic standards required by mathematical modelling presented to SEPA. It is important that all work presented to SEPA is based upon sound science using the best available information and that the models used are shown to be “fit for purpose“. The sophistication and cost of any project will be expected to reflect the complexity and scope of the scenario to be modelled.

The following eleven points list the key areas which any modelling studies for any media should cover. The points are equally applicable to a simple study of the environmental impact of a septic tank discharge or to the design and location of a large power station smoke stack, except that the scope and depth of the study will vary.

1. Statement of objective -to explain clearly the situation being modelled and the objectives of the modelling study, including details of the output required from the model.
2. Justification of the model -to demonstrate that the model used is suitable for this study, this should include examples of previous applications in similar circumstances.
3. Technical description of model -history of the model, development history, published articles, details of the conversion of the model into a software package. Details of the experience and training of the model users.
4. Data -any model is only as good as the source data, the data required for the model must be clearly defined.
5. Data collection -the data collection and measurement techniques should be quoted, including expected errors and relevant quality assurance. The raw data should be available to SEPA if required, as should details of the instrumentation and their calibrations.
6. Calibration -it is important that the model is calibrated against a full data set which is representative of the range of conditions to be modelled. The model coefficients to be calibrated and the procedures used to optimise the calibration must be stated clearly.
7. Validation -data sets independent of those used for calibration must be employed for validation tests. Every effort should be made to validate the model across the range of conditions for which it will be run. Validation tests and analysis of model errors must be undertaken for the key variables required from the modelling study.
8. Sensitivity analysis -this analysis must be presented to demonstrate the effect on the key output parameters resulting from variation of input data and controlling assumptions.
9. Quality assurance -to demonstrate that the model has been subject to an evaluation procedure establishing its suitability for the relevant tasks.
10. Auditability -to ensure that there is a clear account of the modelling exercise for inspection by SEPA.

11. Reporting -clear description of the model including the underlying principles and implicit or explicit assumptions. Also a clear summary of the numerical output, the likely errors, bias, sensitivity and their implications for the objectives of the study and the conclusions.

11.4 Approved Initial Dilution Models

- **ELSID**
  The ELSID software is freely available from the Environment Agency of England and Wales. The program can calculate dilutions for discharges into still waters, calculate dilutions for discharges into tidal waters and perform Monte-Carlo simulations of initial dilution to calculate 95 percentile compliance. Particularly for small discharges, it is recommended that the Cederwall equation is used and this is provided as part of ELSID.

- **PLUMES**
  PLUMES is a model from the United States Environment Protection Agency which includes two initial dilution models and a model interface manager for preparing common input and running the model. PLUMES models are intended for use with plumes discharged to marine and fresh water.

- **CORMIX**
  CORMIX is a length scale model intended for the analysis and prediction of wastefield characteristics and dilutions of submerged multiport discharges. It attempts to cover cases of positively or negatively buoyant discharges issuing into stratified or non-stratified flowing water. If sufficient hydrographic data are available CORMIX can also be used to calculate potential dilution within a defined mixing zone.

Which model is chosen for a particular outfall will be dependent on the situation and should be discussed with the appropriate SEPA staff. In general terms ELSID should be chosen where the water is not too shallow and the rising plumes from multiport diffusers do not merge. In more complex situations CORMIX or PLUMES should be used. All of these models are available free, subject to certain use conditions. Use of the above models does not exclude any discharger, or their consultants, using other calculations in addition to these for their own purposes.

11.5 Glossary of Terms Used

To help interpret the information in the Annexes, refer to the following definitions:

Term	Definition
Acute toxicity	Toxicity arising from exposure of an organism for a period which is short relative to the life span of that organism. This would be in the order of minutes for bacteria and usually up to 4 days for fish. The duration of an acute toxicity test is generally 4 days or less and mortality is the response most often measured.
Chronic toxicity	Toxicity arising from exposure of an organism for a period which is a significant proportion of the life span of that organism, such as 10% or more. A chronic toxicity test is used to study the effects of continuous long-term exposure to a chemical or other potentially toxic material.
No Observed Effect Concentration (NOEC)	The highest concentration of a material in a toxicity test that has no statistically significant adverse effect on the exposed population of test organisms as compared with the controls.
Predicted No Effect Concentration (PNEC)	The environmental concentration of a chemical or substance which is regarded as a level below which the balance of probability is such that an unacceptable effect will not occur.

References

NOTE: Linked references to other documents have been disabled in this web version of the document.

See the Water >Guidance pages of the SEPA website for Guidance and other documentation (*www.sepa.org.uk/water/water_regulation/guidance.aspx*).

All references to external documents are listed on this page along with an indicative URL to help locate the document. The full path is not provided as SEPA can not guarantee its future location.

External References

Comprehensive Studies Task Team Report, second edition (1997)
Report for the purposes of Article 6 & 8.5 of *Urban Waste Water Treatment Directive 91/271/EEC* (CELEX: 31991L0271)

Conservation (Natural Habitats etc) Regulations 1994, SI 2716 (www.netregs.org.uk)

Habitats Directive 92/43/EEC (CELEX: 31992L0043)

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