Environment Agency

H1 Annex D2

Assessment of sanitary and other pollutants within Surface Water Discharges

We are the Environment Agency. It's our job to look after your environment and make it a better place – for you, and for future generations.

Your environment is the air you breathe, the water you drink and the ground you walk on. Working with business, Government and society as a whole, we are making your environment cleaner and healthier.

The Environment Agency. Out there, making your environment a better place.

Published by:

Environment Agency
Horizon House, Deanery Road
Bristol BS1 5AH
Tel: 0117 934 4000
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

Further copies of this report are available from our publications catalogue: http://publications.environment-agency.gov.uk or our National Customer Contact Centre: Tel: 03708 506506

Annex D2 Assessment of sanitary and other pollutants within discharges to surface waters.

This guide gives advice on assessing the discharge of sanitary and other pollutants to surface waters from the operation of installations and waste sites, point source water discharges and from stand alone water discharge activities.

An assessment of the impact of these discharges form part of the application process when applying for a bespoke permit under the Environmental Permitting Regulations.

This document replaces what previously was called Annex E.

It is part of the Environment Agency's H1 Environmental Risk Assessment Framework and should be read in conjunction with Annex D to understand who needs to use it and how it fits in to the framework.

Content

.

Summary of changes

Below is a summary of changes made to this Annex since the launch in April 2010.

Annex version	Date	Change	Template version
Issue 2.1	December 2011	References on "no deterioration" reflecting changes to our regulatory approach in response to the Water Framework Directive 2000/60/EC. Changes to section on Priority and Hazardous Substances to take account of the EQS directive 2008/105/EC. Improved methods for calculation of permit limits for discharges of Priority and Hazardous Substances. Changes to Appendix A which deals with the use of mathematical models. Responding to issues raised in the 2010 H1 Public consultation.	H1 April 2010
Issue 1.0	October 2013	Assessment of discharges containing sanitary or other pollutants to surface waters from installations and waste sites, from point source discharges to sewer and from stand alone water discharge activities.	H1 April 2011

Annex D2 – Surface water discharges

About this guidance

This guide on assessing discharges containing sanitary pollutants to surface water is part of the Environment Agency's **H1 Environmental Risk Assessment**[1] framework. It is aimed at all EPR activities with surface water discharges and includes discharges to surface water via stand alone water discharge activities.

In this context surface waters include:

- rivers,
- estuaries,
- coastal waters,
- lakes and canals.

However the following are not covered by this guidance:

- hazardous pollutants[2];
- special category effluent;
- 'other substances'[3];
- sanitary pollutants to Trac waters (estuaries and coastal waters).

You are advised not to work through this guidance without first reading **H1 Environmental Risk Assessment – Overview** to see how it fits in to the risk assessment process for permit applications and carrying out the necessary preliminary steps, and Annex D to see how surface waters assessments are now undertaken in EPR.

However, you only need to read this guidance if your activity includes substances listed for continuous discharges below.

Who does the assessment?

Following the production of the harmonised approach to the assessment of discharges to surface waters, Environment Agency expacts all applicants to use the screening methodology where appropriate. However, the screening approach has not been expanded to cover sanitary pollutants and so for this limited group of pollutants the the permitting process remains unchanged and is explained below.

For most permits, including installations and waste sites, you will need to do the assessment or engage a consultant to do it for you. In any case you should contact us first for information and advice.

For water discharge activity permits:

For permits for continuous water discharge activities to inland rivers, you may do the assessment yourself, but if you prefer you can provide us with the details of the discharge you wish to make, and we may be able to do the assessment for you. Most of the information we will need to do this can be provided on the application form, but you may need to add other relevant details. You should contact us for information and advice first.

---

[1] Environment Agency. (2010) *H1 Environmental Risk Assessment – Overview*. Environment Agency, Bristol. (Available on the Environment Agency website)

[2] Hazardous Pollutants are assessed in Annex D1

[3] There are 12 "other substances" which are listed in Part 6 of "The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010"..

As a general rule, we cannot undertake assessments of discharges to estuarine or coastal waters on your behalf, but we can offer advice as to what needs to be done. If you do not have the skills to do this yourself, then you will need to engage a consultant to advise you and to undertake the assessment.

For intermittent discharges of storm sewage we can advise what assessment work needs to be done, but where sewerage or environmental impact modelling is required, we are unable to undertake this work on your behalf.

Overview

This guide covers two kinds of discharge:

- continuous, such as treated sewage or trade effluents, or process discharges from installations or waste sites, and
- intermittent, such as combined sewage overflows and storm tank discharges.

Continuous discharges include effluent streams containing the following pollutants and determinands:

- sanitary[4],
- phosphorus,
- pH,
- temperature
- dissolved inorganic nitrogen[5] (in relation to designated sites including TraC waters and Nitrogen – limited freshwater systems).

We use two tests to decide if discharges to surface waters are acceptable. A discharge is usually acceptable if:

1. it does not cause deterioration in quality of the water body receiving the discharge, and

2. the receiving water body meets its target quality standards.

We will assess discharges using the ‘no deterioration’ test if an operator is:

- applying for a new permit for a new activity, or
- applying to increase currently permitted discharges.

We assess the effect of discharges against the uses objectives and target standards for the receiving water body. Details of the various physical and chemical standards against which we assess the impact of a discharge may be found in APPENDICES C and D. Where a discharge is direct to a designated conservation site, or could potentially impact a conservation site, the applicant will need to contact the Environment Agency to confirm the targets for the designated conservation site.

[4] Includes BOD, Ammonia, suspended solids.

[5] Dissolved inorganic nitrogen is the sum of nitrate, nitrite, and ammonia as N

Continuous discharges of trade or sewage effluent

To determine if continuous discharges are likely to be acceptable you should:

1. identify the uses objectives and target standards for the receiving water body of your discharge,
2. assess if receiving water currently meets the reported and target standards,
3. calculate allowable discharge limits,
4. decide if it is feasible to meet these limits,
5. check statutory requirements on emission limits,
6. check non-statutory requirements on emission limits, and
7. confirm final discharge and controls.

These steps are discussed below.

Identify reported and target standards

The reported standards are those recorded in the current River Basin Management Plans and these have been approved by Ministers for the water body that receives the effluent discharge and those water bodies that might be affected by the discharge further downstream. The plans are reviewed at regular intervals and you should check that you are using the most up to date information. You should also check that your proposals do not reduce the impact of any actual or planned improvements in the receiving water for the discharge since the River Basin Management Plan was published.

To identify the reported and target standards for the water body receiving your discharge and any other water bodies affected by your discharge:

- identify relevant reported and target standards for each discharged substance or determinand, and
- take the most stringent standard if more than one is available for a discharged substance or determinand.

You must contact the Environment Agency to obtain or confirm the correct reported and target standards that apply. Where a discharge is direct to a designated conservation site, or could potentially impact a conservation site, the Environment Agency will consult with Natural England on the relevant target standards. Make sure that you also check the impact of effluent temperatures and pH on receiving waters against appropriate standards. You should provide a summary of this comparison and explain whether you think your releases are acceptable.

Where your application relates to a significant increase in a discharge you should contact us in good time. Ideally you should contact us at least 12 months before a permit decision is needed for informing decisions on growth. This is because additional water quality data may need to be collected to check the reported Water Framework Directive Status for the water body.

Assess if receiving water currently meets its reported and target standards

Environment Agency can give you the current compliance against reported and target water quality standards.

Calculate the allowable discharge limit

You may be applying:

1. to improve your existing discharges to meet currently failed target environmental standards, and/or
2. for new or increased discharges that meet the requirements of 'no deterioration'.

The procedure to calculate permit limits depends on whether or not the receiving water meets the reported standards and the target standards for each identified substance or determinand.

Should you, as the applicant, wish to determine your own permit limits in support of your application then you can use the modelling tools specified in Appendix A "Calculation of River Needs Permits" (RNC).

Procedure to calculate permit limits to meet the reported or target standards:

You need to work out the allowable discharge concentration for each substance or determinand to achieve no deterioration. The parameters that are of concern are those that form the basis of the physico-chemical water quality classification scheme of the Water Framework Directive. These are ammoniacal nitrogen, phosphorus and biochemical oxygen demand (BOD). The latter is used as a way of limiting the dissolved oxygen deterioration, although it is not used as part of the formal classification process.

How to achieve "no deterioration"

No deterioration is not optional. You need to determine appropriate limits for the discharge. These limits must be environmentally protective, and technically feasible, for a cost that is proportional to the benefits. The assessment of costs and benefits can be used only in relation to the permissible within class deterioration for each element. It cannot be used to justify a change in class for a particular element. No substance or determinand in the proposed discharge must be predicted to cause deterioration beyond the current class boundary in the receiving water.

Our ideal is for no overall increased polluting load to the water body.
To meet this:

- for an existing discharge the full permitted load of the effluent should be taken, not the current performance, in order to protect against deterioration because of works over performance. The coefficient of variation (CoV) of the existing discharge quality for each determinand should be used to scale up to define a 95%ile figure for "look-up table" (LUT) parameters or 99%ile figure for permit conditions expressed as a maximum allowable concentration (MAC).
- for new discharges you need to manage all your discharges so that the overall polluting load does not increase for each element, ammonia, phosphorus or BOD.

Where this is not feasible or cost effective we may allow a within class deterioration of up to 10% in the current water quality so long as this deterioration does not, on an individual element by element basis, cause a deterioration beyond the class boundary for each one considered.

When undertaking these calculations against the current baseline status you should talk to the Environment Agency to find out if there has been an improvement since the baseline class was calculated. New discharges or increased effluent volumes and/or concentrations cannot be allowed to undermine improvements in the water body, particularly if those changes were indicating that the status class of the water body would improve when the baseline was next formally assessed.

To meet this:

- Include existing discharges in the modelling assuming that all are discharging at the current discharge loads and maximum practical loads allowed by the current permits as appropriate for the needs of the modelling. Note that the maximum should be assessed realistically. Do not, for instance, assume that all discharges will simultaneously discharge at the maximum permitted load.
- For each determinand, you may allow the receiving water to deteriorate by up to 10 per cent in the mean and 90th percentile quality (or 95th or other relevant percentile quality where appropriate).
- For rivers, calculate the downstream target water quality, as the current water quality (mean and 90th percentile/95th or other relevant percentile), plus up to 10 per cent of the current quality.
- Check that your discharge does not cause deterioration beyond the target standard. If this does happen you need to contact us.

If you think that you cannot achieve a permit limit that will allow for a 10% deterioration or less you must contact us.

Decide if it is feasible to meet these limits

You must decide if it is feasible for you to meet your discharge limits by considering:

- is it technically feasible to achieve the permit limit you have derived for no deterioration, and
- is the cost of achieving the permit limit you have derived for no deterioration is proportionate to the benefit?

If you think that the answer to either of the question is NO you must contact us. Otherwise, you should carry on with the assessment.

Check statutory requirements on emission limits

Some activities, including larger discharges of treated sewage effluent and certain types of industrial discharge, also have statutory limits on discharges. You should check that the limits you have calculated meet the statutory limits. These are specified within the Urban Wastewater Treatment Regulations and you should contact us for these limits.

Carry forward the more stringent limits to the next section.

Confirm final discharge and controls

You should summarise the outcome of the above assessment, including:

- the substances and determinands you intend to discharge
- the limit of deterioration or target standard these meet
- what controls you have in place and how they are justified (e.g. by CBA or 10% deterioration).

You will need to present your working and calculations.

Intermittent sewage effluent discharges

This guide covers the following types of intermittent discharges:

- combined sewer overflows;
- storm tank discharges.

It does not cover rainfall-related surface water discharges, nor emergency overflows from pumping stations.Further guidance is provided in EPR 7.01[5]

The extent of the assessment you will need to carry out depends on whether you are improving an existing discharge or creating a new or increasing the discharge from an existing overflow.

Existing discharges

You will need evidence to show whether these are unsatisfactory. You may already have been informed by the Environment Agency if your discharge is classed as unsatisfactory. Alternatively there is guidance in Appendix B on how to do this investigation. You should contact the Environment Agency to see if it holds any data to help confirm the satisfactory/unsatisfactory status of the overflow. If your discharge is not unsatisfactory you can apply for a Permit on the basis of the existing asset.

Criteria for unsatisfactory overflows are:

- causes significant visual or aesthetic impact due to solids, fungus;
- causes or makes a significant contribution to a deterioration in river chemical or biological class;
- causes or makes a significant contribution to a failure to comply with Bathing Water Quality Standards for identified bathing waters;
- operates in dry weather conditions;
- operates in breach of Permit conditions provided that they are still appropriate; and/or
- causes a breach of water quality standards (EQS) and other EC Directives.

In general unsatisfactory discharges will need to be improved to meet the relevant target standards. You will need to contact the Agency to confirm the appropriate standards. These may be a combination of water quality standards, emission standards, and

[5] http://www.environment-agency.gov.uk/business/topics/water/121308.aspx

sewerage design standards. The Urban Pollution Management Manual 3rd edition provides methods for assessing your proposals against the required standards.

Changes to existing discharges that are currently satisfactory should not cause any deterioration in the quality of the water body. The changes should also undo any historical deterioration that has occurred since the structure was originally designed and built.

Proposed new or increased discharges

These are generally applied for either:

- to reduce flooding;
- allow an existing emergency only overflow to operate in storms;
- to replace existing overflows as part of an overall water quality improvement scheme;
- to limit flows to full treatment at a sewage treatment works.

If the proposal is to reduce flooding or allow an existing emergency overflow to operate in storm then contact the Environment Agency as we do not usually permit these. We prefer excess surface water and infiltration to be kept out of foul or combined sewers.

If part of an overall scheme to improve intermittent discharges then any localised deterioration may be balanced against the improvements – you will need to consider any affects on amenity, or recreation.

If a new or increased overflow is required to help improve final effluent quality by limiting the flows to treatment we will expect the overflow to meet the relevant sewerage design standards. Additionally we will expect water quality standards to be met and there to be no deterioration in the quality of the water body in wet weather. To do this you will need to determine the net effect of improving the fully treated effluent during storms whilst increasing storm sewage spills.

The following table summarises these requirements:

Purpose of overflow	Meet Design Standards	Meet Water Quality Standards	Demonstrate No Deterioration	Normally Refuse
Existing overflow satisfactory		Yes		
Existing unsatisfactory	Yes	Yes		
New/upsized storm tanks	Yes	Yes	Yes	
Limit flow to treatment As part of improvement scheme	Yes	Yes	Yes	
Reduce flooding Allow pumping station emergency overflow to discharge in storm	Yes	Yes	Yes	Yes
Action	See below	Contact EA And see below	See below	Contact EA

Design standards

Definitions

For design purposes the following definitions apply:

P = Population served

G = Water consumption per head per day

I = Infiltration (maximum)

E = Trade Effluent flow to sewer as applicable

Flow to full treatment

The flow passed forward to full treatment is controlled by the setting of the final overflow on the sewerage. This setting known as the flow to full treatment (FFT) and should exceed the maximum flow rate arriving at the works in dry weather conditions. It should also be sufficient to allow any storm storage within the sewer system and at the sewage treatment works to be emptied within a reasonable time after rainfall. It should be designed so that storm storage can be emptied soon enough to be available for subsequent events. You will need more storage to meet water quality standards if the

FFT is set too low. This is because additional storage will be needed to retain closely spaced rainfall events. This will be more costly overall.

Normally flows up to 3DWF (defined below) arriving at the sewage treatment works should be passed to full treatment. This should allow storm tanks at the sewage works to be emptied as soon as practicable which is a Permit requirement.

3DWF is defined as 3PG +1 +3E

The factors in this formula should be based on the operator's design horizon and should be validated against any available measured flow data.

Storm tanks

These standards apply to flows in excess of the FFT arriving at sewage treatment works discharging to inland waters and estuaries.

These design standards are normally considered as minimum standards. Higher or lower standards may be appropriate depending on receiving water quality standards and any no deterioration requirements.

Storm tanks:

- Should only be filled whenever incoming flows exceed FFT
- Should be properly designed to settle suspended solids
- Should have a storage capacity of either 68 litres/head of population served or 2 hours storage for the maximum flow received.
- Should not discharge a significant quantity of solid matter having a size greater than 6mm in any one dimension. This requires some form of solids separation having a performance equivalent to a 6 mm 2 dimensional aperture screen - see UPM Manual 3rd edition for details.
- Their contents should be passed to full treatment as soon as practicable after it has stopped filling. This usually requires an automated system to return stored flows whenever the flow arriving at the sewage works is less than the FFT.

Combined Sewer Overflows (CSOs)

To protect amenity values in the vicinity of the discharge it should not contain a significant quantity of solid matter having a size greater than 6mm in more than one dimension. This requires some form of solids separation device that has a performance equivalent to a 6 mm 2 dimensional aperture screen, see UPM Manual 3rd edition for details. The Agency may accept a reduced level of protection in situations where the amenity value in the vicinity of the discharge is low.

Discharges of storm sewage from combined sewer overflows should only comprise of flows over and above the design pass forward flow (PFF). The normal minimum requirement for the pass forward flow is given by Formula A which is defined as follows:

Formula A (litres/day) = (PG+I+E) + 1360 P + 2E

Alternatively, the operator may use sewer modelling to demonstrate that the frequency and volume of spill from the proposed overflow will not cause significant deterioration.

Additional requirements for CSO discharges to Bathing Waters:

Where a discharge impacts on anEU designated bathing water the overflow should be designed so as not to spill more than 3 times per bathing season on average. The bathing season is May to September inclusive. As a minimum the most recent 10 year rainfall record representative of the rain falling on the catchment should be used for this analysis. Guidance on this can be found in the UPM Manual 3rd edition and from the Environment Agency.

Where more than one overflow impacts on the same part of the bathing water the total spills from those overflows should not exceed 3 per bathing season on average. Guidance on how to aggregate discharges is available in from the Environment Agency.

For the purpose of this guidance a single spill is defined as any discharge or series of discharges occurring within 12 hours. If the discharge/s lasts between 12 and 36 hours it counts as 2 spills. Any discharge/s extending beyond 36 hours count as an extra spill for each additional 24 hour period.

Individual spills counted in this way are then discounted if the volume discharged to the bathing water, as totalled from all overflows, is less than a particular significance threshold. You will need to contact the Agency to confirm the threshold which may be site specific. Discharges greater than 50 m^3 will usually be significant.

For discharges to EU designated bathing waters it may be possible to design improvements to meet the microbial standards of the EU bathing water directive as an alternative to the spill frequency standard described above. You should contact the Agency to confirm whether this is an option and if so what the appropriate standards are.

Additional CSO requirements for discharges to Shellfish Waters:

Where a discharge impacts on an EU designated Shellfish Water the overflow should be designed so as to spill no more than 10 times per year on average. As a minimum the most recent 10 year rainfall record representative of the rain falling on the catchment should be used for this analysis. Guidance on this can be found in the UPM Manual 3rd edition. Further guidance on this approach is also contained in the Agency document: Consenting Discharges to achieve the requirements of the Shellfish Waters Directive (microbial quality) 169_01.

For discharges to EU designated shellfish waters it may be possible to design improvements to meet the microbial standards of the EU Shellfish Waters Directive as an alternative to the spill frequency standard described above. You should contact the Agency to confirm whether this is an option and if so what the appropriate standards are.

The counting of spills and discounting of minor discharge volumes is as described above for bathing waters.

Water quality standards

You may need to check whether existing discharges comply with the relevant water quality standards or you may need to design schemes to meet the appropriate water quality standards.

These include standards arising from EU Directives as well as 99 percentile standards and fundamental intermittent standards which are used for design purposes.

You should contact the Environment Agency to confirm the standards relevant to the receiving water.

The Environment Agency may also have flow and quality data to generate boundary conditions for use in modelling.

The UPM Manual 3rd edition describes methods for demonstrating compliance and designing improvements.

The proposed method, models, and data, should be agreed with the Agency before work commences. All models should be confirmed as fit for purpose by independent review and audit.

Demonstrate 'No Deterioration'

The Environment Agency's objective when permitting new or increased discharges is for no deterioration in the wet weather quality of the receiving water. In general for rivers and estuaries this means no deterioration in the quality of the water at any percentile, including the 99th percentile and higher, and no increase in the number of exceedences of the `fundamental intermittent standards` set out in the UPM Manual 3rd edition.

Relocating or rationalising and reducing storm discharges may cause localised deteriorations which may be outweighed by improvements elsewhere. You should consult with the Environment Agency to see whether this is likely to be acceptable.

Creating a new or increased storm overflow at the inlet to a sewage treatment works will only be considered where the impact of the additional storm discharge is outweighed by the improvement in the wet weather quality of the fully treated effluent. This can be demonstrated using modelling to carry out a full impact assessment. Alternatively a simplified approach involving only sewerage modelling is described below:

The simplified approach is set out below, other approaches are acceptable:

- Predict a time series of the existing final effluent load by running the existing system model for a time series of rainfall events.
- Predict a time series of the combined load from the storm tank and the improved final effluent by running the rainfall time series on the proposed system model.
- Compare the two load time series at various percentiles, including ones greater than the 99th percentile, to make sure there is no deterioration in the discharge load at any percentile.

What you should do next

If you are happy that you have completed your assessment of surface water discharges correctly, you should:

- complete any other risk assessments for your activity, as set out in Step 2 of **H1 Environmental Risk Assessment – Overview**
- if you have assessed all the risks from your activity, continue with Step 3 of **H1 Environmental Risk Assessment – Overview**.

You should also document your assessment of releases to surface waters.

Appendix A Calculation of River Needs Permits

Introduction

This appendix is about calculating a particular kind of numerical limit that is placed in permits for discharges to rivers. These permit limits are standards that need to be achieved by the discharge in order to meet specified numerical values for water quality standards[6] in the river. We call these types of permit limits – River Needs Permits.

Such limits will be required where the discharge load is appreciable in the context of the standard that must be achieved in the river[7], in terms of the dilution provided by the river.

Some types of limits in permits are not set to meet particular numerical standards for water quality in the receiving water. These types of limits may take be limits imposed on particular types of discharge or industry, for a variety of reasons and risks linked to legislation. This appendix does not apply to these types of limits, though, in terms of topics such as the correct assessment of compliance, there are common features.

This appendix is also a guide for the Environment Agency's software for calculating such permit limits. This software is called RQP (River Quality Planning). It is available from the Environment Agency on a CD or memory stick.

This appendix is based on the Environment Agency's guidance to its staff. The full version of the guidance can be obtained from the Agency.

In particular, this appendix covers the permit limits that are needed to achieve the water quality standards defined for Directives issued by the European Commission.

Some of the standards which define the High, Good, Moderate and Poor classes for the Water Framework Directive are given, by way of illustration, in Table 1.1 to 1.3 for two of the common determinands. You will probably need the advice of the Agency on the particular standards, and which determinands, apply for you.

Table 1.1: Standards for ammonia

Total Ammonia (mg/l) (annual 90-percentile)				
Type of river	High	Good	Moderate	Poor
Upland and low alkalinity	0.2	0.3	0.75	1.1
Lowland and high alkalinity	0.3	0.6	1.1	2.5

[6] Such standards may also include requirements to meet "standards" based on limiting deterioration.

[7] The term "river" is used throughout thought the principles apply to all discharges whose permit limits are dictated by dilution

Table 1.2: Typology for nutrient conditions for rivers		
Altitude	Annual average alkalinity (as mg/l calcium carbonate)	
	Less than 50	More than 50
Under 80 metres	Type 1	Type 3
Over 80 metres	Type 2	Type 4

Table 1.3: Standards for phosphorus in rivers				
Soluble Reactive Phosphorus (µg/l) (annual average)				
Type (Table 1.2)	High	Good	Moderate	Poor
1	30	50	150	500
2	20	40	150	500
3 and 4	50	120	250	1000

The standards for phosphorus in rivers are currently under review. An announcement on the outcome of the review is expected shortly.

The next part of this appendix deals with the basic calculations. Most users will seldom need to step beyond these.

Our broader guidance (see para 5 on page 10) covers the calculation of the permit limits needed to meet river standards for un-ionised Ammonia. It also includes intermittent discharges, seasonal limits, catchment models like SIMCAT, and other details.

The Basis of the calculations

The mixing of a discharge with a river is described by the Mass Balance Equation [1]:

$$T = \frac{FC + fc}{F + f}$$

where:

- F is the river flow upstream of the discharge
- C is the concentration of pollutant in the river upstream of the discharge
- f is the flow of the discharge
- c is the concentration of pollutant in the discharge
- T is the concentration of pollutant downstream of the discharge.

The most commonly used quality standards for rivers are the annual 90-percentiles for the Biochemical Oxygen Demand (BOD) and Total Ammonia and the annual mean standard for Phosphate.

The 90-percentiles are standards that will be achieved with the required degree of reliability so long as the concentration specified as the 90-percentile limit is exceeded for no more than 10% of the time.

Similarly, the discharge limits for BOD and Total Ammonia that come out of the calculations will always be expressed as annual means or annual percentiles. There is no avoiding this in a correct calculation.

For BOD and Total Ammonia the discharge limits are set as annual 95-percentiles in the permits for sewage treatment works operated by the water companies. For phosphate they are usually set as an annual mean.

At the time of writing, the values of the annual 95-percentile limits we calculate for all other determinands in the permit are actually placed in the permit as if they were absolute or maximum values. (This may change in future).

But in these we seek to interpret the absolute limits as the original annual 95-percentiles when, for example, we look at the question of the performance of a discharge in meeting its permit and protecting the river.

It is a mathematical fact that a single application of Equation [1] cannot be used to calculate the permit limits needed to meet river targets[8]. We must use methods that produce the statistical distribution of T by combining the statistical distributions of F,C, f and c.

We do this by Monte-Carlo Simulation. In this, a value for each of the variables F, C, f and c is plucked randomly from the full range of possible values.

A value for T is calculated from each set of plucked values of F, C, f and c using the Mass Balance Equation. The sequence of selection and mass balance is repeated until enough values of T have been calculated to define its full statistical distribution. Each value of T (or each value of F,C, f or c) is called a shot. Routine calculations are set up to use 1000 shots for T.

It is usually sufficient to assume that F, C, f and c follow the log-normal distribution, but any other distributions can be used.

You will be aware that the values of F, C, f and c are not random in practice but may be related to one another. For example, after rain, the values of the river flow, F, and the discharge flow, f, will rise together. We say that F and f are correlated.

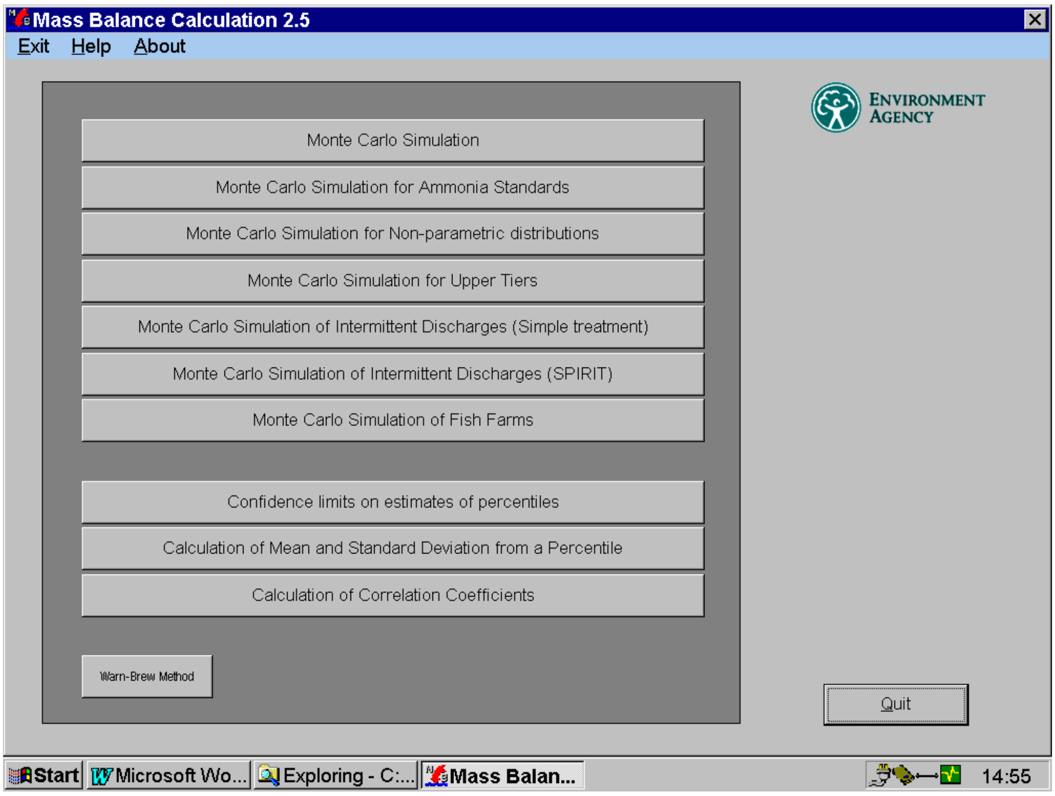
You can introduce all the statistical correlations between F, C, f and c by entering values for correlation coefficients. RQP contains a default correlation coefficient of 0.6 between river and discharge flow. The default values are zero for all the other correlations.

In most cases you will not need to change these defaults. We discuss later when you might want to.

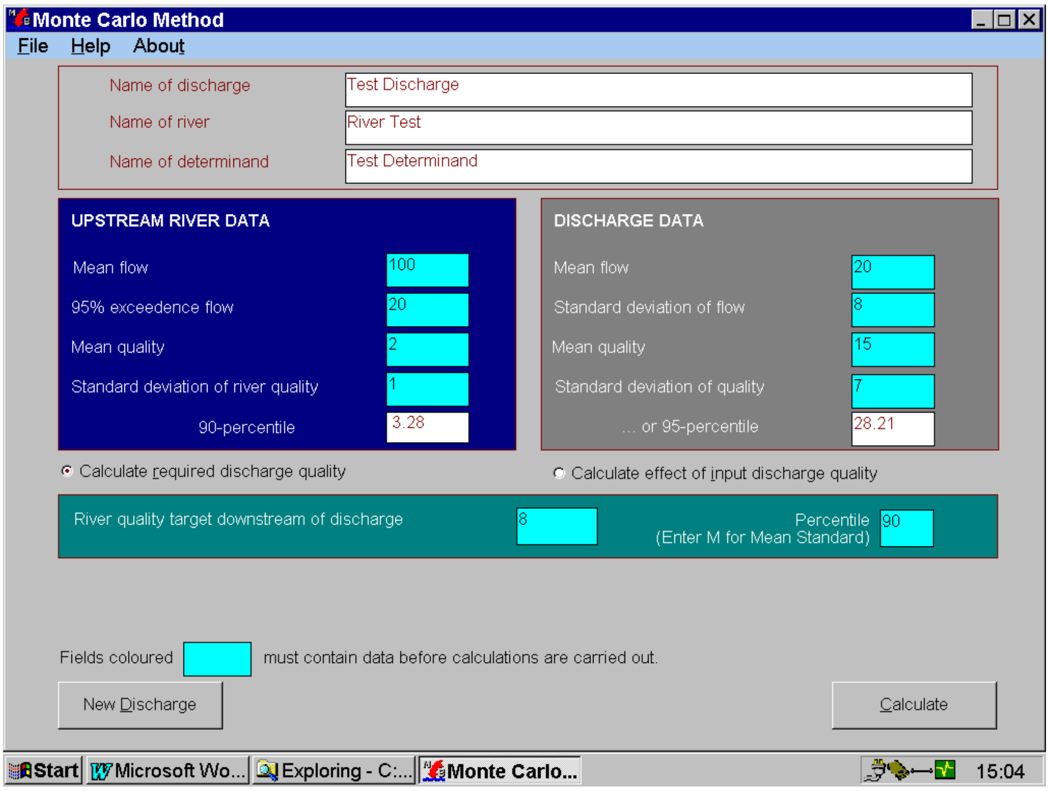
[8] Other methods produce permit limits that are not those needed to meet the river quality standard. Usually they are too strict.

DOING THE CALCULATIONS

When you start RQP you get the following screen. It lists the various types of calculations you can do.



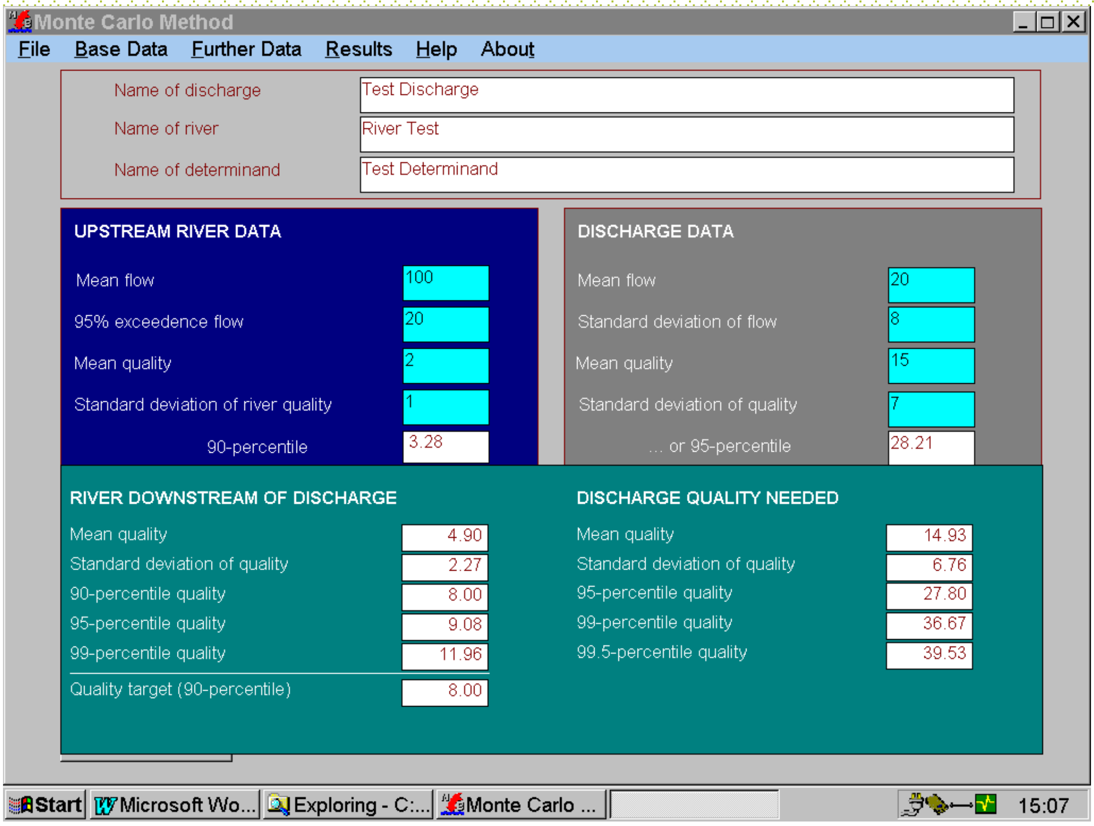
Click MONTE CARLO SIMULATION to start. You need to enter a value in each blue box.



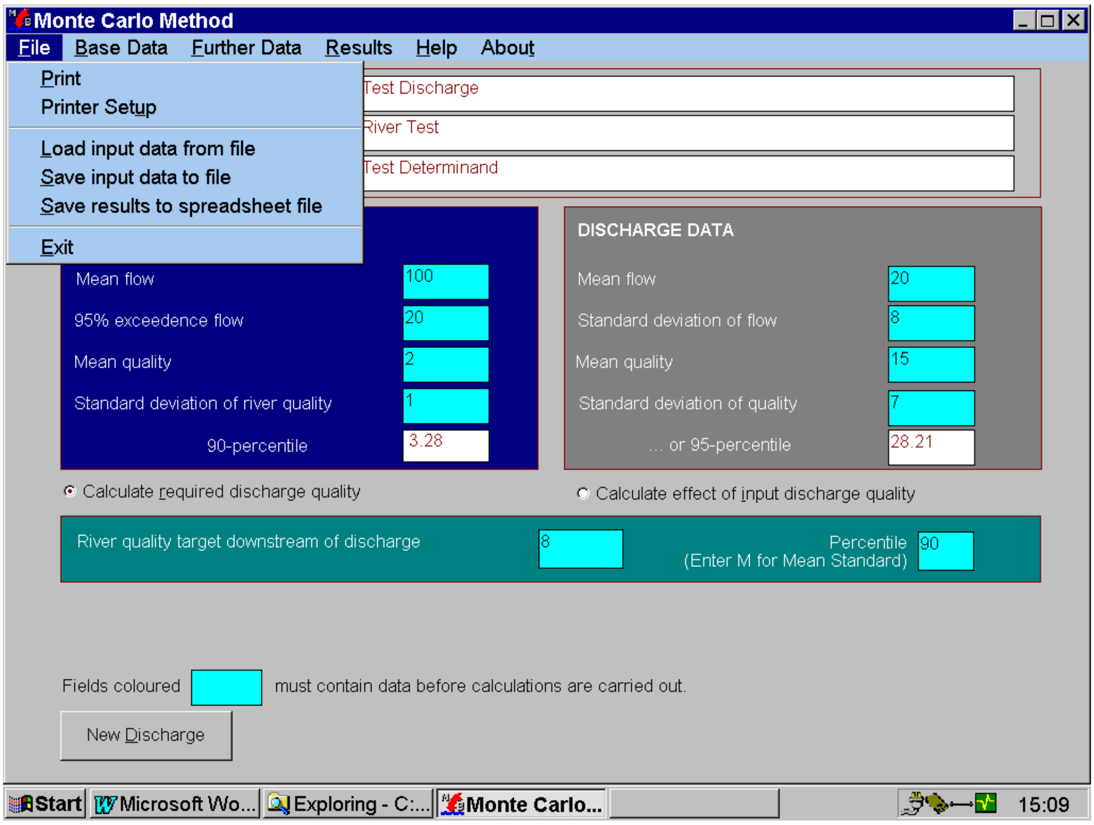
The calculation is then done and the results displayed on the screen. The method may be used "forwards" (to calculate the river quality downstream of some particular discharge quality). Click Calculate effect of input discharge quality for this.

It can also be use "backwards" (to calculate the discharge quality needed to achieve a target quality in the river). Click CALCULATE REQUIRED DISCHARGE QUALITY for this.

An example of the output for the forward calculation is shown below. A 95-percentile discharge quality of 27.8 produces an annual mean in the river of 4.9.

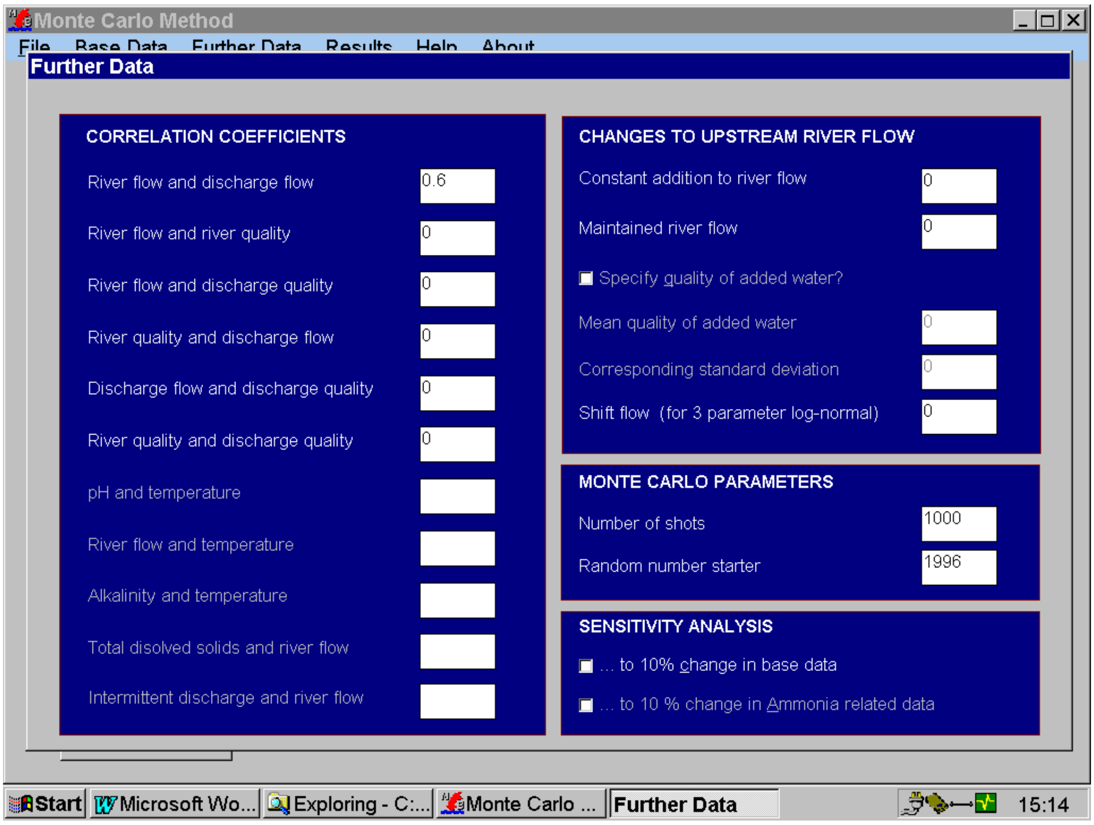


The results can be printed by clicking Print on the File menu. You can transfer them to your own reports using Save results to spreadsheet file.



Monte Carlo Simulation can test the effects of assumptions by clicking Further Data.

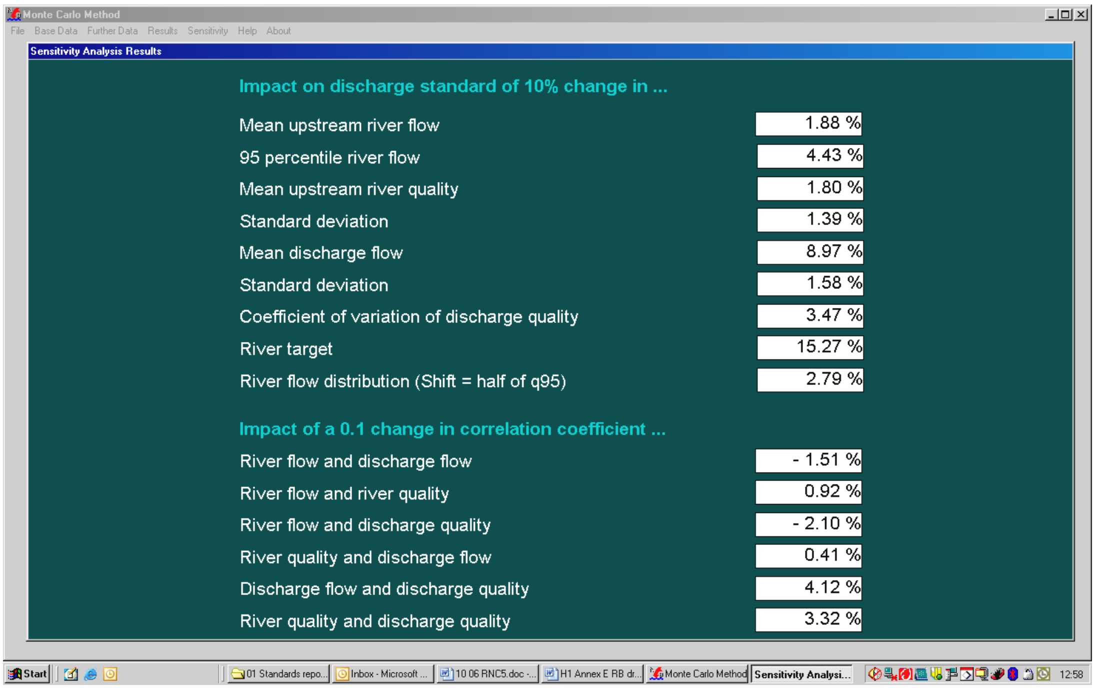
This produces the screen shown below.



This can be used as a check on the sensitivity to the assumption that the river flow is log-normal. Change the shift flow to say, half the 95-percentile, to check this. (Note that, as shown on the first screen produced by RQO, that there are options to use any distributions for F, f, C and c).

Also, you can see that this screen can be used to calculate the effect on river quality of abstractions that reduce the flow in rivers upstream of discharges. It can also evaluate options that might improve river quality by adding to river flow upstream of a discharge.

There is also a “sensitivity analysis” that produces a report on the effects of lots of changes in the data.



DATA

You will have seen above that you need data that characterise the statistical distributions of F, C, f and c. In most cases, the data can be presumed to be log-normal. This means that two summary statistics will define the complete distribution. Any two statistics may be used, so RQP uses those readily available. These are:

■ River flow:	mean and 5-percentile
■ Upstream river quality:	mean and standard deviation
■ Discharge flow:	mean and standard deviation
■ Discharge quality:	mean and standard deviation

Target River Quality

The river target is usually an annual 90-percentile or an annual mean although other percentiles could turn up for various pollutants. Water quality standards that are expressed as things like absolute limits, or Maximum Allowed Concentrations, are taken to be annual 95-percentiles[9].

General Background

Most users just obtain or compute the summary statistics and get on with the calculations. This would make use of the built-in assumptions about distributions and correlation.

In most cases this produces good results. The results, and the decisions on permit limits which are based on them, are not significantly affected by the built-in assumptions.

You might like to use packages like EXCEL to inspect the raw data in the form of graphs. This will show up peculiarities, like outliers, which might have produced summary statistics which were misleading.

You might want to use things like EXCEL to display the data as histograms, and to test which distributions provide the best fit to the data. This will show the cases where it might be risky, or too cautious, to assume a particular distribution. This advice is can be important for the less common pollutants.

You will probably be aware of the statistical errors associated with estimates of means and percentiles of river and discharge quality. These are nearly always more important than doubts about distributions and correlation.

You can calculate confidence limits on the estimates of percentiles by clicking on CONFIDENCE LIMITS ON ESTIMATES OF PERCENTILES on the RQP screen. There are other devices bundled up with RQP that allow you to calculate confidence limits for the annual mean, though it is simple to include such method in the process by which you calculated your annual means.

Where you have to do calculations despite gaps in knowledge you should make neutral, not pessimistic, assumptions (for example by sticking to the default options that are already set up in RQP). But you should check the sensitivity of your results to the uncertainties in data. Often you will find that these tests do not affect the results of the calculation too much, nor the decision on the permit limit. Cases where this is not the case are discussed below (see ‘Results which are sensitive to data’ on page 34)..

The main reason for avoiding pessimistic assumptions is that they lead to permit limits that are too strict solely. This outcome is unfortunate if the reasons are based on failure to resource the effort needed to collect data. It is sometimes too tempting to make pessimistic assumptions for several aspects of the data, for each of the four variables, and the river quality target. Such a combination is statistically unlikely in the Real World, and will result in proposals for permit limits which are much stricter than those actually needed to meet the river target.

---

[9] This is because such absolute limits, coupled with the usual sampling rate, are not absolute limits, but mathematically closer to 95-percentiles than 99.999-percentiles.

A key pointing all this is that the derivation of the annual 90-percentile standard embodies both the impact of the pollutant and the acceptability (or risk) of the impact. It covers the risk of damage and has taken account of variation in water quality in the context of this risk.

If you are unhappy to assume the log-normal distribution you can try others. Experience suggests that you will not need to do this very often. The button on the first screen and labelled "MONTE CARLO SIMULATION FOR NON-PARAMETRIC DISTRIBUTIONS" allows you to use any distribution for river flow provided you spend a half-hour sorting out the data for this. It also allows any distribution for river quality, discharge flow or discharge quality.

Some discharges enter a stream close to its confluence with another watercourse. Here, the calculation may need to take account of the river quality targets of both rivers. This is mentioned below (see page 37 'Discharges to Tributaries').

Sometimes you will deal with a set of discharges to a river and decisions on one discharge have a big effect on what should be done at the others. You should be able to deal with this in a systematic series of calculations starting at the upstream discharges and working downstream. You may need to allow for natural purification as the river flows downstream. For the most complex catchments it might save time if you use a Catchment Model like SIMCAT.

River Flow

For most discharges, estimates of upstream river flow will be available from past calculations. You may need to ask the Environment Agency for information on river flow.

Usually, two summary statistics are required to characterise the river flow distribution. The mean and the 5-percentile flow are easiest to use. With the assumption of log-normality, these statistics define the full Flow Duration Curve.

The statistics should be estimates for the past few years. Flows should have been adjusted for the net effect of current (or projected) discharges and abstractions.

In river quality planning, the low flow, like the 5-percentile low flow, is required, with the mean, solely to characterise the total distribution of flows[10]. Results are sensitive to gross errors in the flow data but are not so dramatically affected by error in the low flow value itself.

This means that the flow data need not be as accurate as required for, say, deciding an abstraction license. Where gauged data are lacking, estimates based on a knowledge of catchment area and type will usually be sufficient.

Small streams should not be given a zero low flow just because they are of trivial importance to water resources. If a better estimate of the low flow is, say, 1 or 2% of the mean then this value should be specified even though this might be viewed as zero as a water resource.

[10] It is sometimes suggested that the 5-percentile low flow is used as the sole measure of dilution in the calculation of the permit limit. Such methods are wrong.

If you intend to use non-parametric distributions for river flow you will need to obtain an estimate of the full Flow Duration Curve (as a graph or a table of values). You can then take as many points from this curve as you need to characterise its shape. The points should be equidistant in respect of the probability that they occur.

Upstream River Quality

If you check the sensitivity of your results to the data you will find often that the data on the upstream river quality are the most important source of uncertainty.

It is sobering to calculate the statistical uncertainty in estimates of percentiles. Take Ammonia for example. An estimate of a 90-percentile based on 30 samples can easily have a 90% confidence interval which extends from -50% to +100% of the value estimated.

This uncertainty is caused mainly by the Laws of Chance in sampling – statistical sampling error. There may also be additional errors from sampling that is not representative and in chemical analysis.

The mean and standard deviation are required for river quality just upstream of the point of discharge. To avoid the effects of unusual years, and to minimise the effects of statistical sampling error on small sets of data, it is usually best to use results obtained, say, over 3-4 complete years.

Unless, of course, there has been a step change in river quality during this time. This might result from some improvement in the quality of the upstream river. In these cases it may be better to place the upstream river in the middle of its presumed class.

Where the nearest upstream monitoring point is some distance upstream of the discharge, it can be important to allow for the effects of natural purification from the monitoring point to the point in the river just upstream of the discharge.

To calculate this effect you may need to find two sampling points on the river (or a neighbouring river) between which there are no significant inputs of pollution or dilution. You then need the mean quality at both these points. You might use these data to work out a rate constant which you can then apply to work out the effect of natural purification on other stretches of river or on other rivers.

Where no upstream quality data are available, or when there are only a few samples, we can use data from neighbouring or similar rivers.

Alternatively, it is usually better to assume, at least for the BOD, that the upstream river lies in the middle or in the best quarter of its (presumed) Class. Faced with the sampling errors noted above in para 2, we may feel safer with estimates of upstream quality which are based on the presumed Class.

In the absence of any data on Ammonia which can be assumed to apply for the upstream river, we might use values which are near zero (or as recorded for clean streams).

We would not normally require a discharge to have tight standards just because pollution upstream of the discharge provides poor quality river water for dilution. We would expect that the upstream pollution would be improved so that the stretch of river achieves its target. If we need to consider the downstream discharge in advance of this happening, we might assume the upstream river lies in the middle of its target class, or easily complies with the water quality standard.

Also, we might use a Catchment Model to look at permit limits in one go for all the discharges in the catchment, along with other sources of pollution and damage.

Discharge Flow. You need the annual mean daily flow and the standard deviation. For discharges which are gauged you should avoid data for part-years because of the seasonal variation.

For quickness, we often estimate for sewage works the mean daily flow as 1.25 times the stated Dry Weather Flow. The standard deviation is seldom a critical factor, and can often be taken as one third of the mean. Both of these factors will be larger for works which are overloaded.

It is wrong to assume the standard deviation is zero, just because you have no information.

When a works is to be extended, you will have to use estimates of the future flow. Here, it is usually adequate to base the estimates on the expected Dry Weather Flow of the new works, or by scaling the current flows.

In water quality planning it is usual to express the discharge load in terms of its flow and concentration and how these are correlated from day to day. Within the Monte Carlo Simulation this gives the appropriate statistical distribution of discharge load. It may be that for some types of discharge that the discharge flow is trivial compared with the river flow and that the "load" is dominated by the variation in concentration. In such a case it need not matter if the discharge flow is entered as a constant of 1.0 and the "load" entered as "concentration".

Seasonal Discharges

Some discharges do not operate all the time but only occasionally, or only at certain seasons, or on particular days of the week. These discharges should be handled using the Non-Parametric form of Monte Carlo Simulation that is listed on the first screen of RQP. In such a distribution the correct proportion of values will be entered as zero. Details are in the full version of the Environment Agency's procedures.

Discharge Quality

In the calculation of the permit limit (the backwards calculation), you may be surprised that the calculation asks you for the discharge quality. After all, you want to calculate the discharge quality needed to meet the river target.

The values you enter for the backwards calculations are used only as a starting point. It is important only that the ratio of mean to standard deviation is sensible. Outside this constraint, the actual values of the mean and standard deviation entered do not affect the results of the calculation of what is needed to achieve the water quality standard..

You can start with the mean and standard deviation for the current discharge quality. If the calculated permit limit turns out to be a lot tighter (or laxer) than the current quality you should repeat the calculation. This time start with the mean and standard deviation for a discharge quality which is typical of the type of works which will be needed to achieve the calculated permit limit. (We do this because the extent to which discharge quality varies about the mean does depend on the type of treatment).

Seasonal Permit Limits

For some continuous discharges you may want to have water quality standards on the discharge which differ according to the time of year. The method for calculating these is in the full version of the Environment Agency's procedures. Generally the calculations show that such limits hold few benefits to dischargers, compared with all-year limits.

Precision Required of Data

Generally, the sensitivity of your results to data is far smaller than the statistical errors associated with sampling programmes. Exceptions are discussed in below.

Two general points are made here:

- it is quicker to repeat a calculation to gauge whether the permit limit is sensitive to the data, than to seek out and process input data to a prejudged impression of the required accuracy;

- any sensitivity to data reflects real uncertainty about the decisions needed to achieve the river target. It is not a consequence of the method of calculation.

DOING THE CALCULATIONS

It is straightforward to enter your data and calculate the permit limit. It is advisable to do more than one calculation. They take so little extra time.

It is helpful to check the downstream river quality produced by common discharge standards like 20 mg/l of BOD and 5 mg/l of Total Ammonia.

Important tests are:

- the change in the permit limit caused by a small change in the river target or the upstream river quality
- the change in the downstream river quality caused by a variation of the discharge quality and flow.

When the data are poor and the calculations give a strict permit limit, you should also check the effect of:

- a change in the ratio of standard deviation to mean in the discharge quality
- a more optimistic assumptions about the quality of the upstream river.

Similarly, you may want to check the effect of correlation, especially that between river flow and:

- discharge flow; or,
- discharge quality (especially for Ammonia).

If your decision on the permit limit for an important discharge is sensitive to correlation then it is prudent to calculate the actual correlation coefficients that apply to your discharge. To do this you need to go back to the raw data you used to calculate the summary statistics. You then need to pair these by date and, for cases where you assume a log-normal distribution, do a linear regression on the logarithms of the paired data. The coefficient provided by this, commonly called r, is the one required by as the correlation coefficient in the Monte Carlo calculation.

Finally you may want to satisfy yourself that the calculated permit limit is insensitive to the assumption that river flows are log-normal. We mentioned this above on page 25 after the Monte Carlo screen.

It is useful to calculate the river quality produced downstream of the current discharge (the forwards calculation). This shows the effect of the discharge relative to other sources of pollution and helps flag cases where the upstream quality is already close to the water quality standard we want to achieve downstream.

You may be able to compare this estimate of river quality with an estimate based on actual measurements of river quality downstream of the discharge. This may assure you that the calculations are correct, but you should be prepared for differences if only because of the effect of statistical sampling error in the data for river (and discharge) quality (see page 30 para 2).

The calculated river quality may be a better estimate of the true summary statistics for river quality downstream of the discharge than that obtained from the analysis of samples of the river water itself. This may happen because of the precision added by using the samples of discharge quality to estimate river quality.

In some cases there may be significant differences between the results of the your calculation and the measured quality in the river. This may indicate errors in the data used in the calculation, or the action of sources and sinks of pollution (and the effects like incomplete mixing). These factors may need to be taken into account in plans to meet river targets.

It may also indicate more subtle effects like those caused by the fact that we take most samples between the hours of 10.00 and 15.00. Because of the time taken for a volume of river water to travel, day-time river monitoring may tend, for example, to record in the river the effects of the effluent load discharged at night. This called the effect of Sample Window.

INTERPRETING THE RESULTS

The following paragraphs describe some of the types of results that require special care in interpretation.

Failure to Achieve the River Target

The quality which you entered for the river upstream of the discharge can sometimes be worse than the river target required downstream. The permit limit will then have to be similar, or better, than the quality of the upstream river. In some cases it may be impossible to meet the river target even if the discharge quality had a concentration of zero.

The interpretation of this result is that the river target cannot be met unless river quality is improved upstream of the discharge. However, this type of result can be produced if you:

- use a river target which is too strict
- neglect to allow for improvements to upstream sources of pollution; or,
- ignore natural purification.

In these cases the results point out where a sensible permit limit can be set only if you consider the combined effect, say, of several discharges

Results which are Sensitive to Data

This condition will occur in many calculations for example when the upstream quality is close to the river target, there is only a small capacity for the river to take more pollution and still remain within the target. This capacity may increase several fold if the data for the calculation are changed slightly.

You should look at the data for the quality of the river upstream of the discharge and check whether this is close to the target required downstream of the discharge.

The calculated permit limit can also be sensitive to data in cases where the discharge is so small that it has a trivial effect on river quality. What may happen is that the calculated permit limit, which may be a huge value, will change markedly following a slight change to the river target or upstream river quality.

Often the practical effect of this will be limited by the use of off-the-shelf minimum standards for permit limits. But the interpretation is that the permit limit can be set without regard to the target in the receiving stream. You can check this, as noted above, by calculating the river quality downstream of various values of the discharge quality.

Occasionally you may find that you have set up a calculation which combines an upstream river quality which is worse than the target with enormous dilution of the discharge flow by the river. Here the calculated permit limit can be very sensitive to data although the downstream river quality will be almost unaffected by the discharge.

In practice the permit limit can be set without regard to the river target. Again you can check this point by calculating the effect on water quality of the current discharge load.

Discharges with Little Dilution

When the 5-percentile river flow is zero or some small proportion of the discharge flow, the calculated permit limit will come out close to the concentration entered for the river target. This reflects the fact that where there is no dilution from the river, the distribution of discharge quality must be the equivalent of that required for the river target.

If this is unacceptable, we will either have to live with failure to meet the river target or insist that the discharge goes elsewhere.

Some decisions of this type depend on whether a small watercourse is important enough to be treated as a river and so be classified under the Water Framework Directive.

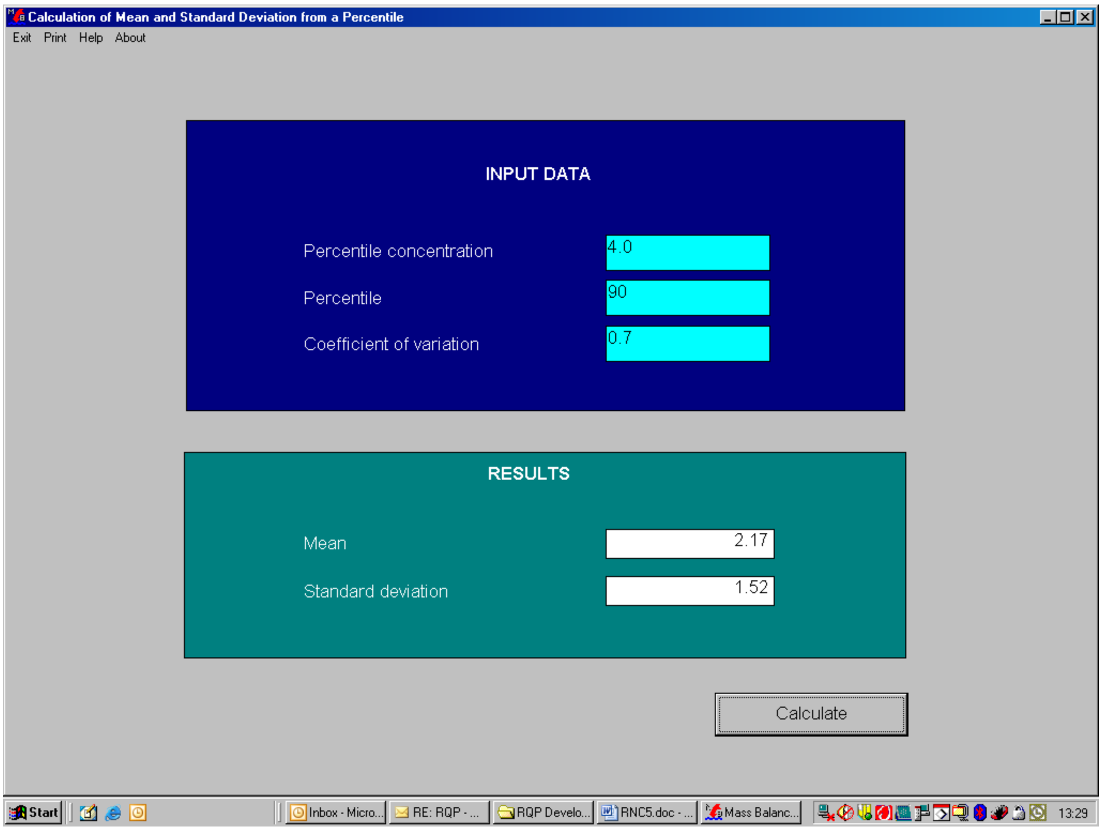
Supporting Calculations

Standard Deviation from Mean and Percentile

You can do these calculations using RQP by clicking on "CALCULATION OF MEAN AND STANDARD DEVIATION FROM A PERCENTILE" on the initial RQP screen (see page 22 'Doing the calculations').

You enter in the blue boxes the percentile concentration, the percentile point (for example 90 for the 90-percentile), and your estimate of the coefficient of variation (the ratio of the standard deviation to the mean). The calculated mean and standard deviation appears in the white boxes.

As shown below in the copy of the screen, values of 4, 90 and 0.7 for the input data, give a mean of 2.17 and a standard deviation of 1.52.



Your estimate of the coefficient of variation should be based data on river quality though it is usually safe to use the following:

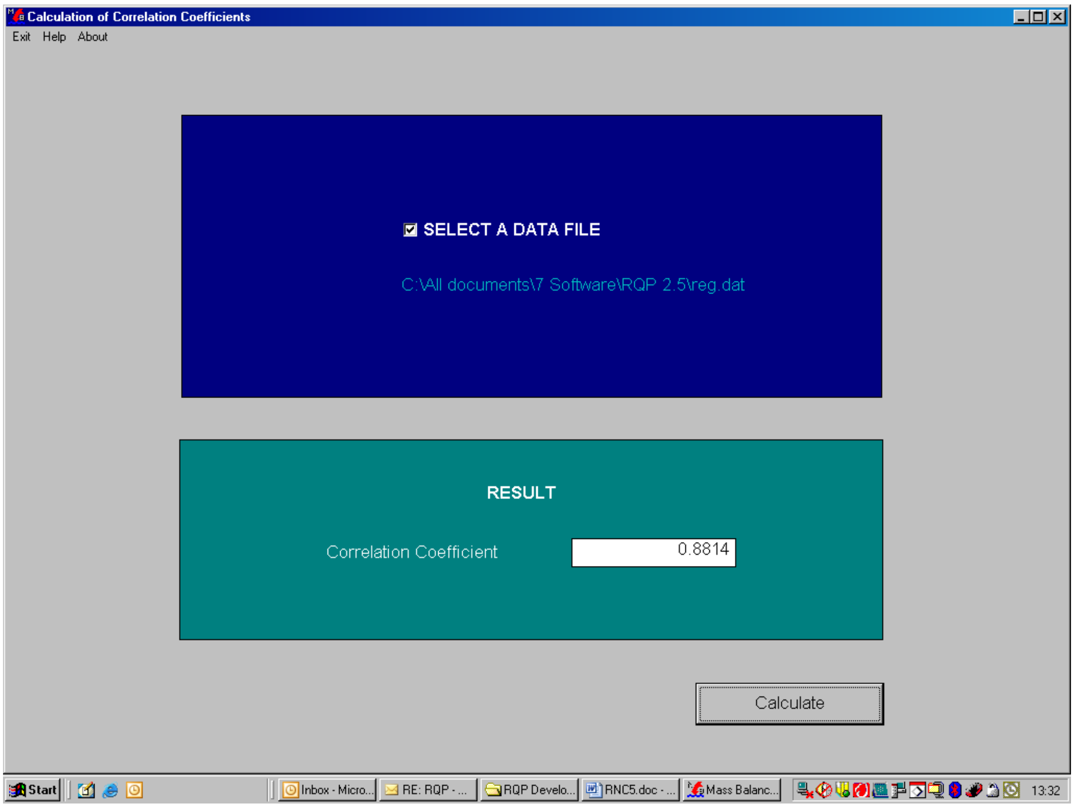
BOD	0.6
Phosphate	0.8
Ammonia	1
Metals	2

Calculation of Correlation Coefficients

One of the programmes on the RQP screen allows you to calculate correlation coefficients. To use it click on "CALCULATION OF CORRELATION COEFFICIENTS".

You might want to do this if you have found a calculation in which the decision on the permit limit is sensitive to the value of one or more of the correlation coefficients.

You will be asked you for the name of a data-file. An example, called REG.DAT, is provided as part of RQP. You double-click on the file name and then click calculate".



The data-file consists of pairs of values of the variables for which you want to calculate the correlation coefficient. REG.DAT has the 12 rows of data shown below. In the first row, for example, the values 2 and 4, could be corresponding values of discharge flow and river flow - values measured at the same time.

2	4
3	6
2	5
4	8
1	9
3	5
2	8
10	20
3	5
2	2
1	2
0.1	0.7

The programme takes logs of these data and displays the correlation coefficient between the logged variables.

Discharges to Tributaries

Some discharges enter a river close to the confluence with another watercourse. Here, you may need to take account of the target quality in both each rivers.

It may be important to allow for natural purification in the river which first receives the discharge and check what is needed to meet the target in the second river. Alternatively, you can use SIMCAT for this type of calculation.

APPENDIX B

Appendix B Evidence to show storm overflow discharges are unsatisfactory

Criteria	You need to provide evidence that a discharge qualifies for inclusion against one or more of these criteria: i. causes significant visual or aesthetic impact due to solids, fungus ii. causes or makes a significant contribution to a deterioration in river chemical or biological class; iii. causes or makes a significant contribution to a failure to comply with Bathing Water Quality Standards for identified bathing waters; iv. operates in dry weather conditions; v. operates in breach of Permit conditions provided that they are still appropriate; vi. causes a breach of water quality standards (EQS) and other EC Directives; and/or vii. causes unacceptable pollution of groundwater.

Type of information to be considered

Environment Agency records	Our records include: ▪ Public complaints ▪ pollution incidents (use NIRS and NIRS2) ▪ any history of dry weather flow operation ▪ any impact on water quality class or objectives (using for example the reasons for failure or bathing waters stewardship databases).
Modelling – by us or a water company	*Riverine or marine water quality impact modelling* Assess impact on water quality class or objectives. This will be of assistance to check compliance with the appropriate water quality standards. For example those associated with freshwater fish, bathing or shellfish waters directives. *Sewerage modelling* Spill frequency, volume and duration information will assist with impact assessment. Spill frequency modelling can be used to identify those overflows that significantly contribute to bathing waters and shellfish waters standards failures. Survey data collected to build models may help identify problems with sewerage infrastructure, for example low weir setting giving rise to operation during dry weather

Water company records	Confirm what is already installed at the discharge structure. For example, screening if available, pass forward flow, facilities in case of emergency. Event duration monitoring records if available Please note it is not expected that evidence would be provided under all the categories above, but the evidence must be robust and demonstrate the discharge is unsatisfactory against the relevant qualifying criteria. **Example** Where a discharge qualifies as unsatisfactory due to significant visual or aesthetic impact then in you would expect to have evidence in the form of: ▪ photographic evidence of sewage debris or sewage fungus; ▪ a history of public complaint; ▪ from aesthetic surveys. You would also expect field staff to have visited the site. *Using judgement* Water quality planning, regulatory specialist and field staff should use their judgement to determine whether there is sufficient evidence to justify the inclusion of a discharge for improvement works. Identified discharges may be subject to review to determine whether there is sufficient evidence to identify them as unsatisfactory.

APPENDIX C

Appendix C Criteria for identifying the types of river, lake, transitional or coastal water to which the environmental standards in Appendix D apply

Table 1: Criteria for identifying the types of river to which the dissolved oxygen (a) biochemical oxygen demand(b) and ammonia(c) standards for rivers apply

Site Altitude	Alkalinity (as mg/l Ca CO3)				
	Less than 10	10 to 50	50 to 100	100 to 200	Over 200
Under 80 metres	Type 1	Type 2	Type 3	Type 5	Type 7
Over 80 metres			Type 4	Type 6	

Notes to Table 1 –

(a) The environmental standards for dissolved oxygen are specified in Table 1 in Appendix D of this Annex.

(b) The environmental standards for biochemical oxygen demand are specified in Table 2 in Appendix D of this Annex.

(c) The environmental standards for ammonia are specified in Table 3 in Appendix D of this Annex.

Table 2: Criteria for identifying types of river to which the reactive phosphorus standards for rivers apply(a)

Altitude	Annual mean alkalinity (as mg/l Ca CO3)	
	<50	>50
Under 80 metres	Type 1n	Type 3n
Over 80 metres	Type 2n	Type 4n

Note to Table 2 – (a) The environmental standards for reactive phosphorus are specified in Table 5 in Appendix D of this Annex.

Table 3: Criteria for identifying types of lake to which the dissolved oxygen standards for rivers apply(a)

Type	Description
Salmonid	Freshwater lakes which would naturally support populations of salmonid fish
Cyprinid	Freshwater lakes which would not naturally support populations of salmonid fish

Notes to Table 3 – The environmental standards for dissolved oxygen in freshwater lakes are specified in Table 7 in Appendix D of this Annex.

Table 4: Geological characteristics used to identify geological categories to which the lake total phosphorus standards apply			
Geological category	Annual mean alkalinity Micro-equivalents per litre	Annual mean conductivity Micro Siemens per centimetre	Solid geology of the catchment of the [lake] (% of catchment)
Low alkalinity	<200	≤70	
			>90% siliceous
Modern alkalinity	200-1000	>70-250	>50% siliceous and ≤90% siliceous
High alkalinity	>1000	>250-1000	≥50% calcareous
Marl		>250-1000	>65% limestone

Table 5: Depth characteristics used to identify depth categories to which the lake phosphorus standards apply	
Depth category	Mean depth (metres)
Very shallow	<3
Shallow	3-15
Deep	>15

Table 6: Criteria for identifying types of transitional and coastal water to which the dissolved inorganic nitrogen standards for transitional and coastal waters apply	
Type	Annual mean concentration of suspended particulate matter (mg/l)
Very turbid	>300
Medium turbidity	<100-300
Intermediate	10-100
Clear	<10

APPENDIX D

Appendix D General Physico-chemical standards

The following tables define environmental standards for water quality in rivers and in lakes.

Table 1: Standards for dissolved oxygen in rivers				
Dissolved Oxygen (per cent saturation)				
(10 – percentile)				
1	2	3	4	5
Type	High	Good	Moderate	Poor
1,2,4 and 6 Salmonid	80	75	64	50
3,5 and 7	70	60	54	45

Table 2: Biochemical oxygen demand (BOD) standards for rivers (i)				
Biological Oxygen Demand (mg/l)				
(90 – percentile)				
Type	High	Good	Moderate	Poor
1,2,4,6 and Salmonid	3	4	6	7.5
3,5 and 7	4	5	6.5	9

Note to Table 2 – (i) Biochemical oxygen demand shall not be used in clarifying the status of water bodies.

Table 3: Ammonia standards for rivers				
Total ammonia as nitrogen (mg/l)				
(90 – percentile)				
Type	High	Good	Moderate	Poor
1,2,4 and 6	0.2	0.3	0.75	1.1
3,5 and 7	0.3	0.6	1.1	2.5

Table 4: Standards for acid conditions in rivers	
pH – all river types in England and Wales	
High	Good
pH 6 as 5 percentile	pH 5.2 as a 10 percentile
pH 9 as a 95 percentile	

Table 5: Phosphorus standards for rivers				
Reactive phosphorus standards	Concentration as µg/l as annual means			
Type	High	Good	Moderate	Poor
1n	30	50	150	500
2n	20	40	150	500
3n & 4n	50	120	250	1000

Table 6: Temperature standards for rivers								
Column 1	Column 2		Column 3		Column 4		Column 5	
	High		Good		Moderate		Poor	
River temp type	Non-cyprinid	Cyprinid	Non-cyprinid	Cyprinid	Non-cyprinid	Cyprinid	Non-cyprinid	Cyprinid
River temp (°c) as an annual 98-percentile standard	20	25	23	28	28	30	30	32
Increase or decrease in temp (°c) in relation to the ambient river temp, as an annual 98-percentile standard	2	2	3	3	-	-	-	-

Note to Table 6 – The standards specified for temperature in Row 4; Columns 2 and 3 of Table 6 must not be used for the purpose of classifying the status of bodies of surface water except where the water receives consented thermal discharges.

Table 7: Dissolved oxygen standards for freshwater lakes		
Status	Mean in July – August (mg/l)	
	Salmonid	Cyprinid
High	9	8
Good	7	6
Moderate	4	4
Poor	1	1

Note to Table 7 – The mean for mixed lakes is throughout the whole water column and the mean for stratified lakes is for readings taken in hypolimnion.

Table 8: Acid condition standards for all freshwater lakes	
High	Good
Acid Neutralising Capacity (micro equivalents per litre) as annual mean values	
>40	>20

Table 9: Salinity standards for freshwater lakes with no natural saline influence	
Status	Proposed boundary
	Annual mean (micro Siemens per centimetre)
Good	1000

Table 10: Standards for Total phosphorus standards for freshwater and brackish lakes			
Annual mean total phosphorus concentration (µg/l)			
Column 1	Column 2	Column 3	Column 4
High	Good	Moderate	Poor
(R ÷ H) or 5, whichever is the larger value	(R ÷ G) or 8, whichever is the larger value	[(R ÷ G) ÷ 0.5] or 16, whichever is the larger value	[(R ÷ G) ÷ 0.25] or 32, whichever is the larger value

Table 11: Type–specific total phosphorus standards for freshwater and brackish lakes where the standards specified in Table 10 do not apply				
Type	Annual mean concentration of total phosphorus (µg/l)			
Column 1	Column 2	Column 3	Column 4	Column 5
Geological and depth category	High	Good	Moderate	Poor
High alkalinity; shallow - Region 1	16	23	46	92
High alkalinity; shallow - Region 2	25	35	70	140
High alkalinity; very shallow - Region 1	23	31	62	124
High alkalinity; very shallow - Region 2	35	49	98	196
Moderate alkalinity; deep	8	12	24	48
Moderate alkalinity; shallow	11	16	32	64

Moderate alkalinity; very shallow	15	22	44	88
Low alkalinity; deep	5	8	16	32
Low alkalinity; shallow	7	10	20	40
Low alkalinity; very shallow	9	14	28	56
Marl; shallow	9	20	40	80
Marl; very shallow	10	24	48	96

Table 12: Dissolved oxygen standards for transitional and coastal waters with salinities normalised to 35.	
Column 1	Column 2
Boundaries	Dissolved oxygen concentration (mg/l) as 5-percentile values with a compliance period of at least 1 year
High	5.7
Good	4.0
Moderate	2.4
Poor	1.6

Table 13: Dissolved oxygen standards for transitional and coastal waters with salinities (i) < 35	
Column 1	Column 2
Boundaries	Dissolved oxygen concentration (mg/l) as 5-percentile values with a compliance period of at least 1 year
High	= 7-(0.037 x (salinity))
Good	= 5-(0.028 x (salinity))
Moderate	= 3-(0.017 x (salinity))

Table 14: Dissolved inorganic nitrogen standards for coastal waters salinity 30 – 34.5		
Mean dissolved inorganic nitrogen concentration (micromoles per litre) during the period 1 November to 28 February		
Column 1	Column 2	Column 3
Type	High	Good
Clear	12[i]	18[i]
		99-percentile standard for the period 1 November to 28 February
Intermediate turbidity	18[i]	70[i]
Medium turbidity	18[i]	180[i]

Very turbid	18[i]	270[i]

Notes to Table 14 – [i]The standard refers to the concentration of dissolved inorganic nitrogen at a mean salinity of 32 for the period 1st November to 28th February. If the standard in column 3 is exceeded then status is moderate.

Table 15: Dissolved inorganic nitrogen standards for transitional waters (salinity 25), or parts thereof		
Mean dissolved inorganic nitrogen concentration (micromoles per litre) during the period 1st November to 28th February		
Column 1	Column 2	Column 3
Type	High	Good
Clear	20[i]	30[i]
		99-percentile standard for the period 1st November to 28th February
Intermediate turbidity	30	70
Medium turbidity	30	180
Very turbid	30	270

Notes to Table 15 – [i]The standard refers to the concentration of dissolved inorganic nitrogen at a mean salinity of 25 for the period 1st November to 28th February of 32. If the standard in column 3 is exceeded then status is moderate.

Temperature Standards for TraC Waters

There are no WFD temperature standards defined for TraC waters. However, there are assessment criteria for predicting the mixing zone for thermal discharges in TraC waters. You must contact the Environment Agency to confirm the correct assessment criteria to use.

Would you like to find out more about us, or about your environment?

Then call us on

03708 506 506 (Mon-Fri 8-6)

Calls to 03 numbers cost the same as calls to standard geographic numbers (i.e. numbers beginning with 01 or 02).

email

enquiries@environment-agency.gov.uk

or visit our website

www.environment-agency.gov.uk

incident hotline 0800 80 70 60 (24hrs)
floodline 0845 988 1188