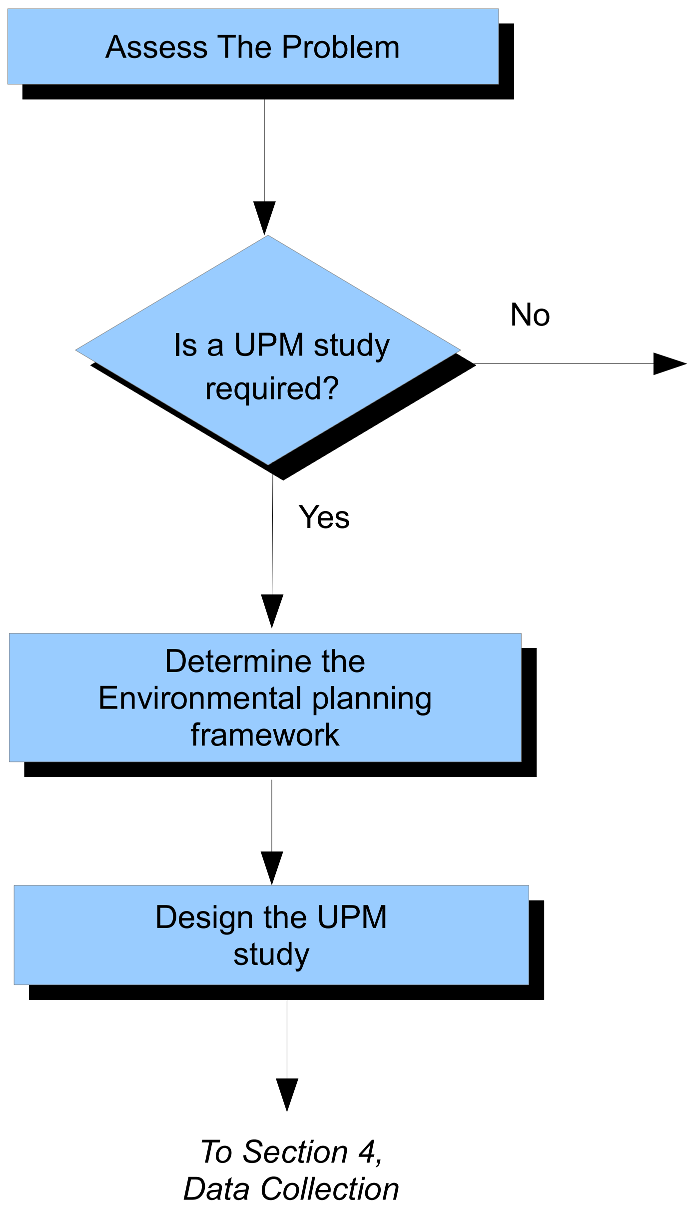
Section 3

The UPM Procedure



Section 3

Section 3 presents the steps of the UPM Procedure in detail. The structure generally follows that of the flow chart through the four planning phases.

Section 3 provides guidance in respect of scoping a UPM study, including the collation of existing data and the extraction of useful information from it. It also gives guidance on the selection of appropriate modelling techniques, based on the scale of the problem and the character of the system to be investigated.

The second stage of the study is addressed in Sections 4 and 5. In Section 4 the practical aspects of field data collection are considered. Section 5 presents information on each individual facet of modelling within the UPM framework. It provides background information on the issues associated with each type of modelling, the attributes that are required of suitable models from simple to complex, how the models should be calibrated and verified and generally made “fit for purpose”.

Section 6, the third stage, presents the generic methodology for testing the compliance of a proposed scheme with any set of environmental criteria. Subsequent subsections describe in more detail the variations necessary to demonstrate compliance with the specific forms of standard likely to be applied for the protection of aquatic life, bathing waters and amenity only waters.

The final stage, Section 7, is concerned with the non planning study issues that are necessary for successful completion of a project. There are brief sections on Discharge Consents, Engineering Design, Post Project Appraisal, Maintenance of Models and Databases and Cost Benefit Assessment. No detailed guidance is offered in respect of these aspects, but, wherever possible, reference is made to sources of more comprehensive information.

3. SECTION 3: SCOPING A UPM STUDY

Section 3 is concerned with the activities comprising the scoping of a UPM study. It covers the first four steps of the UPM Procedure (Figure 1.1) and the text is structured into the following sections.

3.1 Overview

This section of the UPM Planning Procedure can be considered to be a form of Scoping Study.

It starts at one or more of the following points:

- a potential environmental problem related to urban wet weather wastewater discharges to a specific set of receiving waters has been identified;
- a potential environmental problem in receiving waters has been identified, but its origin is not clear; and,
- significant changes are proposed to a sewerage network, including growth, and checks are required to ensure that the proposed changes do not lead to environmental deterioration in the receiving waters.

It ends with a Scope Statement that:

- sets out the specific reason(s) for the UPM study, and the associated detailed outcomes to be achieved;
- sets out the background and existing understanding of the question(s) that are to be investigated, in terms of existing datasets, models, and previous studies;
- defines the specific receiving water quality standards that apply to the study;
- identifies the models and application procedures appropriate to the outcomes of the study;
- identifies to what extent existing data meet the needs of the proposed modelling study and what data need to be collected specifically for the purposes of the investigation; and,
- defines a study programme and resource plan.

The steps involved in arriving at the Scope Statement are:

- assessment of the problem through detailed consideration of the existing data and discussions between the interested parties;
- confirmation that a UPM study is required;
- identification of the environmental planning framework for the proposed study;
- definition of an appropriate investigation methodology based on the nature of the problem, the environmental framework and whatever practical constraints exist; and,
- definition of a programme and resource plan, based on the requirements identified in the preceding steps.

3.2 Review of existing information

The key objective of this stage is to review the extent to which current water quality is already clearly understood and to make an initial assessment of the likely relative importance of different discharges in relation to receiving water impact. Depending on the reason for the study, this may include situations where there is no current adverse environmental impact, but where one may be reasonably expected to occur in the future; for example, as a result of significant growth in a sewerage catchment.

It involves the initial assembly and inspection of all existing data relating to the environmental quality and ecology of the catchment and to the performance of the urban wastewater system. Likely sources of information and data will include:

- routine spot receiving water quality sampling data collected as part of surveillance, compliance or operational monitoring programmes;
- routine river flow data collected as part of surveillance, compliance or operational monitoring programmes;
- catchment management plans compiled by the environmental regulator;
- conditions within permits for discharges to controlled waters;
- theoretical and actual data on the settings of overflows on the sewerage network;
- STW performance data collected by the operator;
- drainage area plans/study reports compiled by the urban wastewater system operator; and,
- data from any other past studies of relevance undertaken within the catchment.

This information should be examined with a view to understanding the performance of the urban wastewater system, other potential pertinent factors and the related environmental impact.

The output from this stage should be:

- the best possible understanding of the definition and nature of the observed current or expected future impact,
- a source apportionment evaluation, identifying the likely influences and range of conditions to be considered when evaluating the potential causes of that impact.

This will then allow a firm decision to be made on whether or not to proceed with a UPM study.

Further guidance on existing data assessment is provided in the following subsections.

3.2.1 Receiving water quality

At this stage, available water quality data and associated targets should be collated and reviewed in consultation with the regulator, for the following reasons:

- to identify the extent of available receiving water quality information.
- to confirm whether the existing the data is sufficient to allow an initial assessment against the relevant water quality targets to be made.
- if sufficient, to confirm the extent to which the receiving water quality targets are already achieved.
- if insufficient, to identify the additional data required.
- to identify whether sufficient receiving water quality (and flow) information exists to enable an appropriate impact model to be constructed, including the associated boundary conditions.
- if insufficient, to identify the additional data required.

3.3 Source apportionment assessment

To identify the potential causes of changes in water quality, an overview of chemical and biological water quality within the river catchment should be carried out. Information should ideally be sufficiently detailed in space and time to allow the effects of each set of inputs to be identified.

Data analysis should aim to allow the effects of the natural environment, including tributaries and diffuse inputs to be identified, along with inputs from the built environment, including CSOs, storm tank inputs, inputs from surface water sewers and direct industrial inputs. The objective of the analysis should be to demonstrate a proper understanding of cause and effect in terms of inputs and impacts. Where this is not initially possible, several possible courses of action exist, including reappraisal of the existing information, collection of additional field data and refinement of the supporting calculations and models.

3.3.1 Intermittent discharges

The degree to which intermittent discharges affect the quality of the receiving water must be properly understood in relation to their interaction with other continuous discharges. The identification of unsatisfactory intermittent discharges within the study catchment is a prerequisite to developing this understanding and is thus a key component of the preliminary analysis.

Some possible criteria for evaluating the performance of intermittent discharges, based on their perceived impact and mode of operation, are described in Section 2.2 of Part II. These criteria, although somewhat subjective in nature, have a logical basis and are in common use in many parts of the United Kingdom.

The preliminary assessment should help identify:-

- Where intermittent discharges do not meet basic performance criteria (e.g. formula A or equivalent; discharging in non-storm conditions)
- Where there are aesthetic performance deficiencies
- Where there are existing water quality deficiencies.

The preliminary study should also seek to identify if any observed impacts are as a result of normal or abnormal operation of the sewerage network.

The UPM Manual does not cover the evaluation of aesthetic deficiencies further. Further information can be found in FWR Core Reports FR0465 and FR0466.

3.3.2 Discharges from STWs

The performance of STWs under wet weather conditions and specific performance data requirements are discussed in detail in Section 4.4.

Such guidance should be reviewed in the light of any information on the actual performance during wet weather and the degree to which this affects receiving water quality.

Where available, data relating to the performance of STWs under wet weather conditions, including the performance of storm tanks, should be assessed as a contribution to the wet weather impact. Full use should be made of any continuous flow and spot sample data on spill flows from storm tanks and from the treated effluent stream.

In addition, as fully treated final effluent can also be important in considering the impact of discharges on environmental quality, they should be included in any evaluation.

3.3.3 Surface water outfalls

Run-off from separately sewered areas may vary widely in quality depending on the nature and usage of the area. As such, surface water run-off may be either a significant additional cause of deterioration in receiving water quality, or may constitute a source of relatively clean run-off that dilutes the impact of more polluted inputs. Hence, all significant surface water inputs should be quantified in terms of flow and load.

Data on any standards set for storm water run-off may be obtained from the regulator, for example, emission standards for flows and/or the pollutant loads discharged through a SWO annually or for a particular return period event. (Default and Sensitivity Values for use in Simplified Modelling Studies).

3.3.4 Industrial discharges

Wastewaters from industrial sources may be either treated at site and discharged directly to the receiving water or can be discharged to the public sewer system (following pre-treatment as required) for treatment at the sewage treatment works.

In general, industrial discharges are unlikely to be strongly influenced by wet weather events, although the possibility of polluted run-off from contaminated areas within industrial premises should be recognised.

Any UPM study must make allowance for any trade effluent discharges to sewer in the base flow loads and for the possible influence of such inputs on the composition of intermittent discharges. Information may be obtained by reviewing current discharge consents and any available compliance data. Where possible, data should be obtained on all industrial discharges in the catchment, the nature of their consents and whether discharges are to sewage treatment works or directly to receiving waters.

Trade effluent figures, for both actual and consented discharges (obtained from traders in the catchment for both current and planned discharges), should be examined to identify major differences between measured and consented flows and loads.

The significance of these discharges should be evaluated in relation to data on other sources of environmental impact.

3.4 Confirmation that a UPM study is required

The output from the preceding stage is the best possible understanding of the nature and causes of the problem based on the available information. At this stage, it is therefore advisable to review the decision to proceed with a UPM study, based on one or more of the following:

- an environmental problem has been confirmed to exist; i.e. that receiving waters are known to be failing to achieve their EQO;
- whilst a receiving water is currently satisfactory, proposed changes are likely to significantly deteriorate the receiving water quality;
- an environmental problem is suspected, but confirmation is required that it exists, along with identification of the likely causes;
- the problem is associated with wet weather related discharges from the urban wastewater system; and,
- the nature and size/capacity of the solution cannot be determined by straightforward means.

If all of these criteria are met then it is probably appropriate to proceed with planning the UPM study. If several are not met, then it is likely that an alternative form of investigative study is required.

3.5 Determine environmental planning framework

The use objectives of all affected receiving waters and the environmental standards with which the environmental regulator requires compliance are identified at this stage.

The importance of this step cannot be over emphasised. All of the data collection, modelling and compliance testing activities that follow in the UPM study are governed by the criteria identified at this stage. It is vital that a clear and unambiguous understanding of the compliance requirements are agreed by all interested parties. Otherwise, there is a high risk that substantial, unproductive or abortive work will follow in the later stages of the study.

As discussed in Section 2, protection of receiving waters can be achieved in several ways under the overall umbrella of an EQO/EQS approach based on different types of environmental standards; for example, applicable emission standards; minimum performance standards, (Section 2.1). The regulator may wish to use a combination of these approaches to protect receiving waters depending on the importance and vulnerability of the receiving water concerned.

The standards comprise the environmental planning framework that can be used as the basis for assessing both current performance and the suitability of upgrading proposals. The planning framework must be agreed by the discharger and regulator if the output from the UPM study is to be fully accepted.

To provide clarity on all of the relevant information and standards agreed between the discharger and regulator, it is recommended that this is appropriately documented, including maps of the system under investigation.

3.6 Selection of modelling approaches

For most components, there are a number of different tools that can be used. To a considerable extent, the form of tools appropriate to the study will be determined by the form of the standards with which compliance has to be demonstrated. Clearly, the selected tool has to be capable of generating outputs in a form compatible with the specified standards.

Beyond this, the use of more complex modelling tools becomes appropriate as:

- the problem increases in complexity; and,
- the cost of the likely solution increases.

A complicated problem, for example where there are a large number of discharges and there is considerable interaction between them, will require more detailed models to reliably predict the impact on the receiving water. Equally, detailed models to explore cost-saving design refinements will be more appropriate in situations where high construction costs are likely.

Both these factors - technical complexity and cost - need to be reflected in the final choice of data and tools. The methodology used must satisfy two criteria:

1. It must be **technically acceptable** - i.e., it must adequately address the technical complexity of the problem; and,
2. It must be **cost-effective** - i.e., the total costs should be as low as possible, consistent with meeting the first criterion.

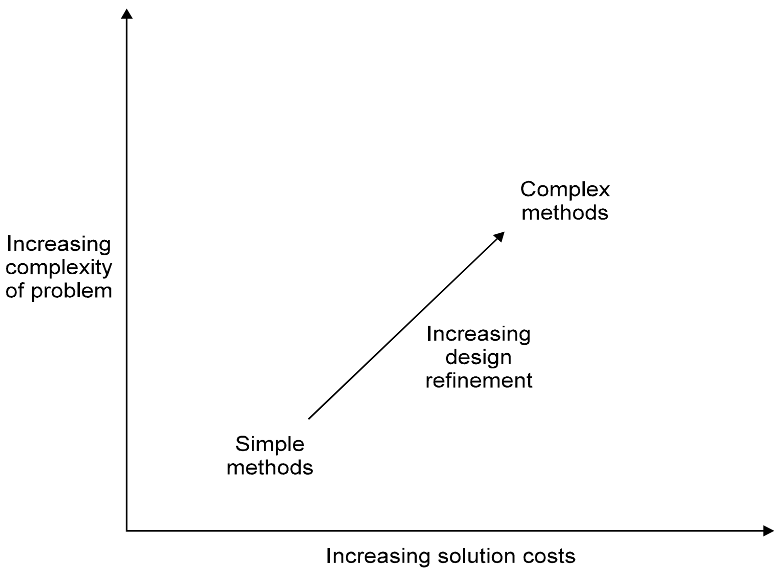


Figure 3.1 Modelling tools in relation to system complexity and solution costs

The following sub-sections provide more specific guidance on the selection of modelling tools based on the nature of the urban wastewater system to be modelled. However, if the modelling technique suggested by the scale and nature of the system is not capable of providing outputs in the form required to assess compliance with the agreed standards, an alternative method must be employed that does.

3.6.1 Rainfall inputs

The use of storm events selected from a long rainfall time series is recommended for all UPM applications irrespective of size or complexity. The specific storms selected from within the time series will be dictated by the standards with which compliance is to be demonstrated rather than the scale and/or complexity of the system to be investigated. Hence, no choice is required at this stage in respect of rainfall inputs.

3.6.2 Sewer modelling

Given development in sewer flow modelling and the associated capabilities of people to build and run those models, they should, generally, be adopted for a UPM study following appropriate checks on the quality of the construction and verification.

Even where a sewer system is small or uncomplicated, then it may be preferable to build an unverified sewer model, rather than construct a simple tank model of the sewer system.

Within the model, it is important to represent the run-off from the whole urban catchment; that is both the combined and separate storm water systems. This allows increases in river flow and quality due to local surface run-off to be included in any dilution or in-river process calculations for intermittent discharges. Usually it will be adequate to take a very simple modelling approach for the separate surface water catchments.

Sewer quality modelling is generally carried out within the main sewer modelling tool. The main choice is between using:

- Default parameters for representing BOD and ammonia concentrations in the sewer flow: or,
- Detailed simulation of sewer quality.

The latter should be considered where:

- the sewer system is large, complex and flat such that the detailed knowledge about the sewer sediments (i.e. quantities, characteristics and behaviour) is needed;
- there is a significant interaction with the STW, i.e. the STW quality is known to deteriorate considerably during storms and that this is a major factor in affecting river quality (see further discussion in the next section); or,
- there are significant trade inputs to the sewer system that could contribute to downstream overflows.

3.6.3 Sewage treatment quality modelling

The effluent from the STW serving an urban catchment will create a background loading in the receiving water which will affect the ability to assimilate intermittent discharges. The quality of the effluent may also deteriorate during wet weather thereby exacerbating the problem.

To estimate these effluent loadings, the main choice is between using:

- effluent flow and quality distributions, based on historical or projected data (at times of wet weather); or,
- a detailed STW quality model.

If there is no significant interaction between the sewer system and the STW, then using an effluent flow and quality based on frequency distribution data will be adequate. This will allow acceptable estimates of background STW loading on a river to be assessed.

In this context, ‘interaction’ between the sewer system and the 'STW' means either:

- there is a river quality problem downstream of the STW due to a complex interaction of intermittent discharges, storm tank and STW effluents impacting upon the river quality; or,
- the STW effluent quality deteriorates significantly during wet weather and causes a river problem, regardless of the intermittent discharges (this problem will only get worse after any new intermittent discharge storage is introduced).

For large urban catchments with significant interaction, it is recommended that use of a detailed STW quality model is considered. It should be noted that this also implies the need for detailed sewer flow and quality models.

3.6.4 River impact modelling

The nature of river impact modelling undertaken in a UPM study will be influenced by the following factors:

- the form of the standards against which the compliance of a proposed scheme must be checked;
- the assimilative capacity of the river, that is a function of many factors including slope and width/depth ratio; and,
- the size of the scheme, for which catchment population can be considered to be an indicator.

In identifying the appropriate form of river impact modelling to adopt it is necessary to take account of all of these factors in a logical way. In the majority of cases the initial criteria to consider are the standards that have been identified.

If only a minimum performance criterion has been specified, expressed in terms of, say, a spill frequency or minimum retained flow (Section 2.1), no river impact modelling of any type will be required irrespective of the nature of the receiving water or size of the scheme. However, minimum performance standards alone are unlikely to be specified for large schemes affecting sensitive watercourses.

Compliance with in-river standards expressed in terms of BOD and/or total ammonia concentrations can be assessed by a simple mass balance approach for all sizes of schemes and types of receiving water.

However, if DO or un-ionised ammonia standards are applicable (e.g. the Fundamental Intermittent standards and/or in-river percentile standards), some form of impact modelling will be required. In these circumstances the appropriate degree of complexity and accuracy of the choice of modelling will depend on the sensitivity of the river and the size of the scheme in question. (CIWEM UDG River Modelling Guide).

3.6.5 Estuary impact modelling

The appropriate form of estuary impact modelling will be dictated by the following factors:

- the standards with which the proposed scheme must be demonstrated to be compliant (may be standards for the protection of aquatic life, bathing waters and/or amenity use standards);
- the physical characteristics of the estuary (this will dictate whether one, two or even three dimensional modelling is required); and,
- the size of the scheme, or likely significance of the discharge(s), on the estuarial water quality.

All of these factors can vary extremely widely for estuaries. Hence, it is not possible to give generalised guidance for the initial selection of models. Choices have to be made on a case by case basis, based on consideration of the above factors.

3.6.6 Marine impact modelling

The type of marine impact modelling required will depend on the type of marine standards set.

If spill frequency standards alone have been specified (Section 2.4.3), then this will only require sewer flow modelling. For this purpose, no marine impact modelling is necessary.

Where marine standards are defined either in terms of concentration / duration / frequency, or as percentiles, then consideration should be given to full marine impact modelling.

3.7 Programme and resource plan

3.7.1 Identify data requirements

Once modelling needs have been identified, existing data should be re-examined in relation to specified modelling requirements. It is possible that existing models (for example, of the sewer system) may be available for use within the source apportionment study, although the suitability for UPM application should be carefully assessed. A review of modelling needs against existing data should be carried out for all modelling components of the study as this will define the additional data collection requirements, if any.

There may be a need to implement a short-term intensive data collection programme designed to allow, for example, for effective calibration and verification of the sewer, sewage treatment and receiving water impact models. A detailed specification for the data collection programme must be produced as this is a costly activity. The specification must cover all the issues associated with practical data collection including triggering/call out arrangements, sample collection, transportation, analysis and data management. These, and other related issues, are discussed in more detail in Section 4.

3.7.2 Develop study programme

All external constraints applicable to the study need to be identified in developing the programme for a UPM study. For example, if there is a fixed date by which the study must be completed, or the solution constructed. The time of year may influence the data collection elements, as it may only be feasible to collect certain types of data at specific times in the year.

The quantity and quality of the existing available data may also be a factor. If substantial amounts of good quality relevant data are available, it may be appropriate to build models initially using only these data to help focus and minimise specific data collection needs. Alternatively a dearth of relevant data may rule this approach out and dictate that data are collected at an early stage in the study.

Based on present experience, it is recommended that major UPM studies are programmed as a single stage approach. In this approach, the study is undertaken with a commitment to collect new or additional data from the outset. The models are constructed, calibrated and verified in a single pass on the basis of the specifically collected data and are then used to address the study objectives.