Section 1

Introduction

1. INTRODUCTION

1.1 Definition of Urban Pollution Management

Urban Pollution Management (UPM) is defined as **the management of wastewater discharges from sewer and sewage treatment systems under wet weather conditions such that the requirements of the receiving water are met in a cost effective way**. This statement encompasses several key aspects that are worthy of further consideration:

"sewer and sewage treatment works": meaning that UPM is an holistic approach to the management of discharges from the urban wastewater system, addressing all components of the drainage system including combined sewer overflows (CSOs) and surface water outfalls (SWOs) as well as storm tanks and treated effluents from the sewage treatment works (STWs).

"wet weather conditions": UPM is concerned with the performance of the urban wastewater system during and in the recovery period from rainfall. It does **not** explicitly address the performance of urban wastewater systems under dry weather conditions. On the contrary, it assumes that the system performance under dry weather conditions is satisfactory.

"requirements of the receiving water": meaning that the whole of the UPM concept and application procedure is driven by the need to protect the legitimate uses of the environment, although the role of emission standards is recognised where necessary and appropriate.

"cost effective way": suggesting that the procedure leads to the identification of least cost solutions commensurate with meeting the needs of the environment.

1.2 Purpose and benefits of the UPM Manual

Wet weather impacts arising from urban catchments are widely recognised as a major cause of unsatisfactory receiving water quality. The manner and causes of these impacts are complex phenomena that require integrated planning strategies for effective management. The historical piecemeal approach to the management of the different elements of the urban wastewater system has been shown to be ineffective by virtue of the scale of wet weather problems now endemic throughout the majority of countries with developed infrastructure. Integrated strategies have two key characteristics. First, they provide a high degree of confidence that all forms of surface receiving waters (rivers, lakes, canals, estuaries and coastal waters) are adequately protected. Second, and equally important, they are strategies that are cost effective and avoid over provision of hydraulic or treatment capacity and/or storage.

It was in recognition of the need for such a strategy that the UK water industry undertook a major programme of research during the late 1980's and early 1990's. This programme, known as the Urban Pollution Management Research Programme, developed many new tools together with an overall application procedure. It is this Procedure, together with supporting information, that is documented in the UPM Manual. The Second Edition of the Manual built upon the first edition, that was published in 1994, by including the benefits and experience together with the fruits of further research and development.

This Review enables the substantial technological improvements in wastewater modelling and the experience of the implementation of sewer network improvements over the last 15 years to be taken into account to both improve and ensure that the guidance is able to be updated.

- **More cost effective solutions**

  Use of the UPM Procedure has been shown in many built examples to result in substantial overall cost savings both for individual schemes and for extensive planning programmes. The methodology provides a better understanding of the true causes and extent of pollution problems allowing more focused and cost effective solutions to be implemented.

- **Achievement of environmental targets**

  Cost effective schemes are only of value if they achieve the desired performance. Achievement of environmental (and, where applicable, emission) standards is fundamental to the UPM Procedure which allows increased confidence that the targets will be attained. Experience to date has shown this confidence to be justified.

- **More consistent plans**

  The use of a well documented and widely accepted procedure based on sound science and planning principles results in greater consistency in proposed schemes. Experience has demonstrated the benefits of a collaborative approach between the operator and regulator in order to achieve agreement on discharge consents.

- **Improved understanding**

  Users of the technology have noted that, in addition to the quantifiable benefits of enhanced cost effectiveness and increased confidence in the proposed schemes. The improved understanding of their systems resulting from the data collation and modelling aspects of the study is in itself a major benefit in their future activities.

1.3 Status of the UPM Procedure

The Procedure is accepted as best current practice by the industry and regulators for the management of urban wet weather discharges and is therefore commended to all relevant parties.

The environmental standards have been reviewed (Review of urban pollution management standards against WFD requirements) and have been ratified by the regulators for use in the United Kingdom. The Procedure is put forward as a logical, objective and scientifically defensible methodology for managing the complex problems associated with urban wastewater discharges under wet weather conditions to achieve a sustainable water environment.

1.4 Scope of the UPM Procedure

The UPM Procedure is a very powerful tool when applied in the manner described in this Manual and within its intended boundaries. However, the Procedure is not all embracing and it is important to recognise its limits if wasted effort and inappropriate solutions are to be avoided.

- **Wet weather conditions**

  UPM is concerned with the performance of urban wastewater systems, primarily, under wet weather conditions. There is an implicit assumption that the performance of the system under dry weather conditions is satisfactory. The nature of some environmental standards, for example percentile forms of standard, may necessitate a certain degree of consideration of the intervening dry weather periods.

- **Urban, industrial and rural discharges**

  UPM is only explicitly concerned with the management of urban wastewater discharges. These may occur via CSOs, SWOs and/or STWs. Depending on the

specific modelling tools used, any or all of these discharges can be considered individually and their interactivity can be examined. Where industrial inputs occur into public sewer systems, appropriate allowance must be made for these. Independent industrial discharges and rural inputs to the receiving waters are not directly considered in the methodology, but their effect on the background conditions of the receiving waters must be allowed for in an appropriate way.

- **Groundwater**

  The UPM Procedure applies to all forms of surface receiving waters. No consideration is given to groundwaters either in terms of their interaction with surface waters or through direct pollution of sub-surface waters by urban wastewater discharges.

- **Physical limits**

  The generic UPM Procedure is applicable to all scales of urban wastewater systems from the relatively small and simple to the very large and complex. In all cases, the principles of the procedure remain the same, but the tools used to implement it may change markedly. The use of simple and cheap modelling techniques will be adequate and acceptable for small scale, simple problems where the additional cost of over design is relatively small,. Applications involving the use of detailed quality simulation models of all components of the drainage system will be appropriate for larger schemes in complex catchments where the marginal cost consequences of over or under design are substantial.

  The UPM Procedure, as described in this Manual, is designed for use at an urban catchment scale; meaning that it is applicable to the sewer system(s) draining to a single STW. The interaction of all discharges within such a catchment and their combined effect on the receiving water can be investigated using the Procedure. For example, by application to a series of urban catchments down the length of a major river, with the output conditions of one study providing the input conditions to the next.

  There are now many examples for catchments including major conurbations that utilise the tools and procedure at a more strategic level of detail to allow the interactions between contiguous urban catchments to be investigated.

- **Conceptual design**

  The detailed UPM Procedure commences at the point where a firm decision has been taken to investigate a problem in a particular urban catchment. UPM has little role in deciding the relative priority of investigating the problem in Catchment A as opposed to Catchment B.

  The UPM Procedure ends at the point of developing a conceptual, or outline, design tailored to meet specified environmental requirements. The product of a UPM study is a detailed emission specification for all significant discharges in the urban wastewater system together with an outline form of engineering solution. This may, for example, be expressed in terms of volumes of storage required at a general location or an increase in transport capacity for a selected sewer length. The continuation and spill flow regimes and the required amenity emission standard will also typically be specified at CSOs and other major sewerage discharge points. Required changes in STW performance may also be identified and even, in rare cases, changes to the receiving water configuration could be suggested. However, the UPM Procedure and Manual do not address detailed engineering design issues. For further information refer to the CIWEM Urban Drainage Group Guidance/WaPUG Modelling Guides.

1.5 The UPM Procedure

The UPM Procedure is illustrated in Figure 1.1. There are four major phases in the Procedure starting with initial planning, moving through data collection and model building to testing the compliance of proposed solutions, before concluding with post planning study issues such as consents and engineering design (although these issues are not considered in detail within the Manual). The steps involved in each of these phases are summarised in the figure.

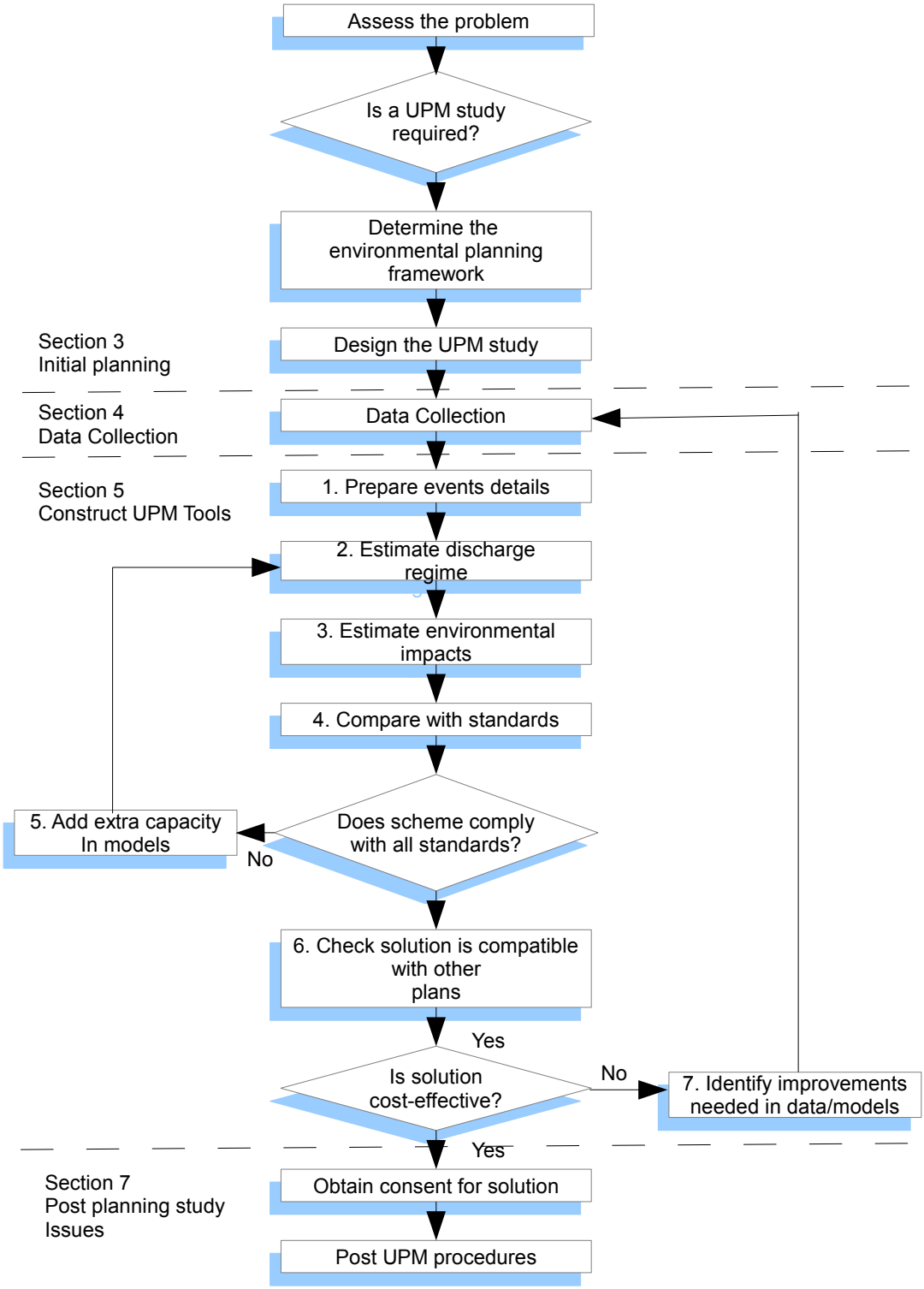

Figure 1.1 The Urban Pollution Management Planning Procedure

Section 3 - Initial Planning

The Procedure commences at the point when it has been decided that a problem exists in a particular catchment that requires upgrading. The objective is to design a planning study appropriate to the characteristics of the urban wastewater system, the applicable environmental standards and nature of the problem.

The first step is to gain the best possible understanding of the current performance of the urban wastewater system on the basis of the existing information. This defines the nature of the problem to be addressed and allows the need for a UPM study to be confirmed.

The next step is to reach agreement between all interested parties on the applicable environmental standards. This step is crucial because it sets the “goalposts” for the investigation that is to follow.

The form of the investigation can be planned, which is the final step, when the environmental targets are known. Judgements have to be made at this stage about the relative importance of different discharges and the water quality interactions in different components of the urban wastewater system. Two approaches are possible. The first seeks to identify the simplest form of investigation that can be sure to produce a “safe” solution. Subsequent iterations of the planning process in which the models are refined lead to the identification of the most cost effective solution. The second approach seeks to identify the form of investigation most appropriate to the needs of the project at the outset and the study is completed in a single pass.

Section 4 - Data Collection

Section 5 - Construct UPM Tools

The data and models to be used in the investigation are assembled and the models are made “fit for purpose” by appropriate processes of calibration and verification. The level of effort involved can vary enormously depending on the form of study identified to be appropriate. At one extreme, it may be little more than the identification of existing key data. At the other, major intensive field data collection and model validation activities may be required.

Section 6 - Assessing Performance

The models developed are used to establish the performance of the existing urban wastewater system relative to the required standards. Proposed upgrading solutions can then be readily incorporated into the models and the degree of improvement identified. Iterations, in that extra capacity is progressively added to the urban wastewater system, allow a solution that is compliant with the standards to be identified.

The penultimate step requires that the compatibility of the proposed solution is checked against other planned work affecting the catchment.

Finally, consideration is given to if it is likely to be cost effective to refine the solution by employing more complex modelling tools. The cost of building more detailed simulation models is compared to the potential savings in the solution cost and a decision is taken whether or not to revisit the outline scheme.

Section 7 - Post Scheme Monitoring

The planning study finishes with the identification of a conceptual design. However, there are numerous issues following this stage that have to be addressed by the planner before the proposed solution can be built. The most important of these are identified in this Section in a fit for purpose and optimisation review.

- **Partnership approach**

  In theory, a UPM study can be undertaken by a single party. However, by definition, a UPM study is usually wide-ranging in terms of the area it covers and the issues it touches upon. Generally, an operator and a regulator together with environment users will all have an interest in the outcome of the project. There is a very strong requirement to identify the environmental planning framework clearly during the Initial Planning phase of the project. Hence, all parties should be involved in this consultation process and a "partnership approach" to planning and executing a UPM study should be adopted.

  Experience to date since the UPM Procedure has been available reinforces this message. The output from a large scale UPM study can be very considerable in terms of its volume and complexity. It is unreasonable to expect the authority responsible for granting permission for the discharges to accept the output at face value. An auditing process is likely to be lengthy and may well occur at a stage when the timetable to completion is tight. There will be no "surprises" at the end and the granting of a formal licence for the discharge should be trouble free if a partnership approach has been adopted throughout the life of the study

- **Prioritisation of catchments**

  The UPM approach is applicable to all areas experiencing wet weather problems related to urban wastewater discharges. For many operators this can mean that a large number of urban drainage catchments are the subject of potential UPM studies and decisions have to be made to prioritise the order in which they are tackled.

  There can be many bases on which to decide the relative priority for solving problems in different urban drainage catchments and hence for determining the order in that UPM studies should be carried out. Frequently, the severity of the problems being experienced in the receiving water will be a major factor. In many instances, operators may be prepared to allow the regulator's priorities to dictate the order for undertaking UPM studies. However, it must be appreciated that the environmental regulator's perceptions of problems will be orientated to individual bodies of receiving water, not to the urban drainage catchments on which UPM studies are based. It may be more beneficial to concentrate on urban catchments with a larger number of less severe problems, rather than focus on individual problems of a high priority that may be dispersed over several urban catchments.

  Another basis for selecting an area may be that works are required for other reasons. There is then a strong case for identifying a solution that solves all of the problems within the catchment (even if not all aspects of it are implemented immediately). An integrated approach to upgrading all aspects of urban wastewater system performance has long been advocated and the potential benefits are well recognised.

  Another approach to prioritising investigations is by the analysis of environmental and financial costs against the benefits accrued. Much progress has been made in recent years in terms of attributing economic values to environmental improvements, (FWR, 1996) allowing objective comparisons to be made between competing schemes. Multi attribute techniques have been developed to assist in this form of analysis. The available information in terms of scheme costs is likely to be relatively uncertain prior to undertaking a detailed UPM study, but it is probable that sufficient knowledge exists to allow reasonable judgements to be made about which schemes are likely to offer the

best environmental return. It is recommended that the initial assumptions should be revisited at the conclusion of the UPM study to ensure that the judgement was justified (Section 7.5).

- **Interaction between UPM study areas**
  The UPM Procedure is designed to be applied to a single urban drainage catchment area However, there will be interaction between drainage areas within a river basin or perhaps on adjacent coastal areas. How such interactions are handled needs to be agreed with the environmental regulator responsible. However, the principle should apply that one area should not be required to make up for the shortcomings of another. Hence, in such situations the assumption should normally be that boundary conditions (river flow entering the study area, marine waters at the edges of the study area, etc.) are at the mid point in the range allowed by the regulator. Where data suggest that this is not currently being achieved, the assumptions used for modelling purposes should be agreed at the outset by all the relevant parties.

- **Timescales for undertaking UPM studies**
  It is advisable to plan and execute UPM studies well in advance of the need to implement a solution becoming acute. The time taken to undertake complex UPM studies can be considerable. Where field data collection is required to allow effective model validation, a UPM study can be expected to take a year or more to complete. The deadlines to achieve compliance with EU Directives and other capital investment planning requirements are examples of the types of external pressure that can come to bear and that reinforce the need for early planning of UPM studies.

- **Audit trail**
  Working procedures that allow (and indeed require) the creation of an audit trail are to be commended in any form of modelling study. UPM studies frequently involve the construction of many component models and many iterations in the use of these models. Therefore, it is essential that a logical record of how the solution was arrived at is available upon completion of the study. A well documented record should be maintained of the following factors:

    - sources of data;
    - assumptions made during model building, calibration and verification;
    - changes made to the models to reflect proposed upgrading scenarios;
    - input and boundary conditions for specific model runs; and,
    - model outputs.

  Typically the investment that is made in collecting the data to validate the models and in building and using the models is considerable. Proper documentation and maintenance of the databases, models and outputs ensures that full value is gained from this investment.

  This topic is considered in more detail in Section 7.4.

- **Relationship with other planning studies**
  UPM studies are concerned solely with managing the impact of urban wastewater systems on the environment. As such, UPM studies cannot be undertaken in isolation from other forms of planning activities. Other plans may affect the data on which the UPM study is based. For example, the regional development plans may show that the population residing within the catchment served by the urban wastewater system is scheduled to increase significantly over the lifespan of the planned scheme. Clearly, it would be imprudent to design the scheme without taking the population increase into account. The potential effect of such plans needs to be checked early on in a UPM study. In other circumstances the proposed UPM solution needs to be checked against other

plans at a later stage. An example of this is to check that a UPM conceptual solution to construct a tank at a specific location does not clash with plans to build houses or a road at the same location. The UPM conceptual solution should also be checked at this stage against any planned works to alleviate flooding or structural dereliction in the urban wastewater system.

- **Post project appraisal**

  The integrated approach that is central to UPM and much of the technology that allows it to be implemented is relatively new. Hence, there is a strong case for monitoring the performance of schemes that have been planned using this technology to confirm that the anticipated performance is achieved and that the perceived environmental benefits are realised. Ideally, post project appraisal should be aimed at both testing compliance with the agreed regulatory permit and assessing achievement of the EQS in the receiving water.

  Routine water quality monitoring goes some way to providing these answers, especially with the trend towards the inclusion of telemetered links in permits. However, for major schemes it is recommended that more intensive data collection programmes should be considered specifically with the above aims.