

Section 4

Data Collection

4. DATA COLLECTION

This section describes the range of activities involved in the planning and execution of a data collection programme to support the application of modelling tools using the UPM Procedure. The main emphasis is on inland river studies. However, issues specifically related to coastal and estuary data collection are also considered.

This section is subdivided as follows.

4.1 Introduction.

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4.1 Introduction

A site specific data collection exercise may account for a large proportion of the overall budget of a UPM study, as generally the more data that is collected the more robust the model. Therefore, it is important that the data collection exercise is managed such that the required data are captured effectively and efficiently. For example, to prevent unnecessary sitework expenditure the model requirements for the data collection exercise should exclude the range of events that are unlikely to generate the required response in the system.

An initial programme should be developed, based on the seasonal conditions for the site that will provide the best opportunity to capture the required data in the shortest possible time. This will provide the optimum start date for the data collection and will set the time-scale for any procurement procedures; the appointment of service providers; and, the installation of equipment. A methodology for data collection should be developed which may form the basis of a service provider, contract specification. It should be noted that a successful flow and quality data collection programme will require a flexible and reactive contract arrangement with service providers. This is particularly relevant to the capture of wet weather event data that, due to the variability of weather systems and the relatively short term predictability of times of arrival and quantity, requires constant monitoring of conditions and management of all parties involved in the exercise.

The majority of this section considers data collection in rivers to support UPM studies based on demonstrating compliance with the river aquatic life standards (Section 2.3). Planning

4.1.1 Introduction

Data may be collected from a number of different sources and by different parties. It is recommended that a 'data collection manager' is assigned whose role is to develop a methodology for the integration of the study requirements plus information and services from all parties involved; and, to establish a database for the quality assurance and collation of the data collected prior to subsequent use.

There are five main areas that may require input co-ordination prior to, and throughout, the duration of the data collection exercise. These are:

- consultation with 'decision makers' and modellers (the end users of the data);
- consultation with the system owner/agent (for the wastewater system and the receiving environment);
- co-ordinating the activities related to rainfall forecasting;
- co-ordinating the activities of the sitework service provider; and,
- co-ordinating the activities of the laboratory analysis provider.

This element can be time consuming and needs to be engaged in as soon as the decision to model and collect data is taken. Negotiation of access to river-side locations with riparian ownership can be protracted and if not dealt with early can delay the entire program.

4.1.2 Modelling requirements

Typically, information on the quantity and quality of continuous and intermittent discharges and receiving waters during dry weather and wet weather events are required for the calibration and verification of dynamic simulation models. For inland situations the following data may be required:

- rainfall data, for the simulation of storm events;
- river depth of flow and velocity, to enable flows to be derived;
- liquid samples, to enable the quality aspects to be investigated; and,
- continuous monitoring of selected quality parameters, such as DO, temperature and pH.

In certain rare cases sediment samples might be required, to assist in associating pollutants with sediments represented in the models, although with much more experience now it is more common to use default values. If sediment sampling is required it needs to be managed carefully and conducted using appropriate techniques to minimise the danger of the sensitive pollutants being washed out of the sample during the sampling process.

Specific data requirements for a study will depend on the nature of the site, the problems being addressed and the information inputs required by the selected modelling tools. Section 4 identifies possible requirements for sewer flow, sewage treatment and river quality modelling. Precise modelling requirements including the extent of the data required (for example, sewer network, sewage treatment works or river network), number of data sets (for example, three dry days and three storm events) and the level of data required (preferred number of data points and determinands required for analysis for each sample type) will be specific to the needs of a particular study as identified in the initial planning. The end users of the modelling results should also provide an input to the data specifications to identify required levels of risk for subsequent management decision making.

Initially, site selection for data collection should be carried out as a desk top exercise in conjunction with the modellers and site operators. A site inspection should be undertaken to balance the requirements of the model with the practical aspects of each site (for example, flow conditions, access, safety considerations and instrument security). The constraints imposed by budget and timescale will also need to be recognised. Each of these aspects should take account of the following:

- * potential flow conditions during storm events and the type of work required at each site (e.g. sampler deployment, velocity profiling, manual sampling, etc.); and,
- * hours of work: some work may be necessary during the hours of darkness and at remote locations during which the working environment may present unacceptable

hazards or access may be unacceptable to site owners/operators during unsociable hours or at night, although later technology has the ability to retain samples in a pristine condition removing the need for night working. This should be considered as it significantly reduces the health and safety risk.

Having selected the most appropriate sites, an inspection with the sitework provider should be carried out to determine equipment security requirements and the preferred instrument position to ensure good data capture.

Specific considerations for the range of data collection sites (sewer network, sewage treatment works, river networks and marine environments) are discussed below. Installation of equipment, routine site visits and event sampling activities must be sanctioned by the landowners, asset owner/agents, safety representatives, police and any other interested parties.

4.1.3 Rainfall forecasting

A weather forecasting service should be engaged to provide access to information on a continuous (24 hour) basis, with a minimum five day forecast period. A five day forecast will allow forward planning of data collection activities and adequate warning of potentially suitable storm events. Subsequent forecasts will allow a refinement of data collection timing or amendment of proposed activities.

It is important to maintain regular contact with the weather forecasting service so that any change in the predicted weather patterns can be accommodated in the site work programme to prevent any unnecessary activity and expenditure, and ensure efficient capture of appropriate event data.

4.1.4 Sitework service provider

A sitework provider should be responsible for the supply, installation and deployment of equipment when required. A sitework team may also be required to provide additional data, such as channel dimensions, velocity profiles, levels, grab samples, and to conduct time of travel/dilution studies.

For event data collection, it will be necessary for the sitework team to be available for call out at a pre-determined short notice period (i.e. minimum time required to travel to site and deploy samplers) on a 24 hour, 7 days a week basis, so that any potential storm event, that develops at short notice, may be considered for sampling.

The sitework team should be fully equipped and trained for the proposed tasks and working environment, taking into account that some of the work may be necessary during the hours of darkness and close to deep water and/or in confined spaces, or where specific working procedures/controls apply. Where possible, alternatives to any potentially hazardous locations should be selected at the planning stage of the data collection exercise.

4.1.5 Laboratory analysis service

UK capacity for liquid sample analysis for BOD is now limited. It is vital that the Laboratory service provider is engaged with at the advanced planning stage to ensure that the capacity is available to undertake the high volumes of individual samples that will be delivered after specific events.

An analytical laboratory should be engaged to carry out analysis of the aqueous and sludge/sediment samples collected. The required analytical suites, levels of detection and any non-standard analytical procedures should be confirmed with the laboratory prior to

commencing any sampling exercises. The laboratory should hold NAMAS or equivalent quality certification to ensure reliability of the results. The data collection manager should evaluate the capability of the laboratory according to the following criteria:

- the provision of a 24 hour service, 7 days a week, including the collection/receipt of samples;
- the capacity of the laboratory to receive and analyse the total number of samples generated by the sampling exercise for a particular event;
- the minimum interval between the receipt of subsequent sets of samples; and,
- the provision of the results in an acceptable format at a specified timescale.

It may be necessary to utilise additional laboratory services (for example, through a sub-contract by the primary laboratory) for analysis of some parameters or to provide additional capacity. Any additional laboratory services used should be subjected to the same specification and quality assurance controls. Transport, division of samples and reporting should be the responsibility of the 'primary' laboratory to ensure a consistency of service and reporting through adequate sample custody documentation and labelling.

The provision of test samples prior to the commencement of the sampling programme should be considered to allow the laboratory to establish the levels of dilution for BOD analysis for different sources of samples; for example, crude sewage, sludge samples and river samples. A system of sample identification should be established to ensure the source of the sample cannot be mistaken and the correct analysis is carried out when different sample types are submitted for different parameter suites.

A procedure for notification of proposed sampling exercises, including confirmation of the success of a particular sampling exercise, should be established with specific arrangements for out of hours work. The sample preservation, transport and analytical procedures should be confirmed following each sampling exercise.

Sample transport should be arranged to deliver the samples to the laboratory as quickly as possible following sample retrieval. Refrigerated transport and preservatives should be considered to retard sample deterioration, where appropriate. Chain of custody documentation should be considered where third party courier services are used or if specific levels of service are specified in the contract.

4.2 Equipment

4.2.1 Introduction

The following types of equipment are typically required to provide both *in situ* measurements and discrete samples, for both continuous and event based data collection programmes:

- depth, depth and velocity (flow) monitors;
- automatic samplers;
- water quality monitors; and
- raingauges.

The actual equipment required will, as with their deployment, depend on a combination of the site characteristics, the model requirements and the purpose of the study. Specific requirements for coastal/estuary applications are considered in Section 5.6.

A data collection specification should identify the data requirements and the acceptable level of data return. There is a wide range of commercially available equipment employed by specialist subcontractors that are fit for purpose, although specific sampling/data requirements

and the requirement to use intrinsically safe equipment in confined spaces or restricted areas may exclude the use of certain types.

The following guidance documents provide information on the use of the equipment:

- [WRc Guide to Flow Surveys](#)
- [WaPUG River Data Collection Guide](#)

Several standard contract and technical specifications exist and an example can be located here:

WaPUG UPM Data Collection Technical Specification

Depth only, depth and velocity monitors, raingauges and water quality monitors (DO/temperature/pH) will be deployed throughout the survey period, for continuous data collection. Automatic samplers may only need to be deployed for the duration of each storm or dry weather period although this will be subject to the sampling methodology developed for each data collection programme as samplers may be deployed for longer periods where remote triggering is employed. Since the launch of the UPM procedure the specialist data collection market has seen considerable technical and organisational developments and advances – for example the use of telemetry alongside radar rainfall to time triggering of events is now common and very successful. Recently, the arrival of reliable battery operated samplers with refrigeration has also led to a step change in the robustness of the data collection process and a reduction in cost. It is now possible to hold samples in the field and maintain the viability of the sample whilst the suitability of the sampled event in terms of rainfall, spill duration and magnitude, etc. is assessed. This has been demonstrated to reduce the laboratory costs. Raingauges may be placed throughout the catchment, as per the requirements of a sewer flow survey ([WRc, 1987](#)).

Considerable advances have already been made in data collection, and with the advent of the Water Framework Directive significant research budget is being expended to increase the accuracy, reliability and range of on-line measurements. Attempts to monitor Ammonia on line have met with mixed success but it is likely that within the next 5 to 10 years it will be possible to use on-line devices to undertake much of the data collection.

4.2.2 Depth and velocity monitors - sewers

Depth and velocity monitors can be used to measure sewage effluent flow. The specification for depth and velocity flow measurement instruments should be as set out in "[Model Contract Document for Short Term Sewer Flow Surveys](#)" ([WRc, 1993](#)). Pressure transducer or ultrasonic depth measurement techniques are appropriate, subject to suitable locations for installation and the range of depths anticipated.

Ultrasonic doppler shift or electromagnetic current instruments are alternative methods of velocity measurement. The principle of operation of ultrasonic sensors relies on the emission and receipt of a signal reflected from sediment particles or air bubbles in the flow. In clear flows the detection of the returned signal is unreliable and consequently the data are unreliable.

4.2.3 Depth and velocity monitors - rivers

Where continuous velocity monitoring is required it is necessary to select a velocity ([WaPUG River Data Collection Guide](#))

4.2.4 Automatic samplers

Automatic samplers are used to take a time series of liquid samples for subsequent laboratory analysis. A minimum specification should be for independent power supply, pre-programmable for start time, sample intervals of between 5 minutes and 2 hours, capable of taking a minimum of 24, discrete, 500 ml samples and incorporating a purging cycle during the collection of each sample.

These minimum specifications are well within the capability of all the commonly used samplers and some offer additional capabilities such as; one litre sample bottles, variable interval sampling frequency and integration with external sensors. The majority of samplers are constructed to a similar design with each sampler unit consisting of two main modules. The sampling module contains all of the electric components, pump, etc. A container module houses the sample bottles. A liquid sample is drawn up the inlet hose and deposited directly into a sample bottle via a distributor arm controlled by a pre-programmed micro-processor. The sample container modules are designed to allow the addition of ice packs to maintain a low temperature to retard any deterioration of the samples.

There are now a number of manufacturers who supply automatic samplers with battery operated refrigeration units built in and with very reliable two way telemetry devices built in. Thus use of this equipment has been shown to deliver significant reductions in the labour elements of UPM data collection exercises.

4.2.5 Water quality monitors

Portable water quality monitoring probes are required to measure parameters in-situ, particularly at river data collection sites. Dissolved oxygen, temperature and pH are the parameters commonly recorded. A number of instruments are available with varying specifications. However, a minimum specification should be a capability to record data at a minimum 15 minute intervals and be independently powered for at least 48 hours operation.

Usually it is necessary to deploy this type of instrument immediately prior to event sampling, following workshop calibration, because many of the current devices cannot guarantee the stability of the dissolved oxygen calibration for extended periods. However, recent developments claim an improved performance for water quality monitors along with a basic remote communication facility. Other problems include algal growth that can mask the sensors, particularly during the summer months, and vandalism of equipment.

Current developments in on-line lab based systems are likely to provide the next breakthrough in data quality.

4.2.6 Raingauges

Standard tipping bucket raingauges with 0.2 mm tipper, should be deployed throughout the catchment as per "[Model Contract Document for Short Term Sewer Flow Surveys](#)", (WRc, 1993).

4.2.7 Remote triggering

The use of telemetry and remote control options allow a greater choice of events that may be selected for sampling by including events that may otherwise have been discounted for logistical reasons.

4.3 Guidance on site applications for data collection programmes

4.3.1 Data collection in sewer networks

A procedure and specification for the collection of flow data in foul and storm water sewer systems is identified in 'A Guide to short term flow surveys of sewer systems' ([WRc, 1987](#)).

The suitability of water quality sampling sites within a sewer system is determined by considering the site location, the physical dimensions of the manhole and the nature of the effluent flows. An alternative site should be considered if 24 hour access to a site may be restricted (if the site is located on a traffic sensitive route or within private property) or if the manhole is physically too small to accommodate the equipment. Where selection of an alternative site is not possible (for example, when monitoring a CSO), it may be necessary to undertake minor civil engineering works or modify the sampler deployment methodology.

The installation of weather proof/vandal proof GRP kiosks on a temporary basis has been successful on a wide range of studies and allows the study to utilise none intrinsically safe sampling equipment for sewer networks. Intrinsically safe equipment is now only recommended for use at sites where no other alternative exists as this type of equipment has had its performance and reliability compromised by the need to limit its power to comply with the ATEX Regulations.

Installation of the equipment should take into consideration the variation in depth of flow between dry weather and storm flow conditions with the fixing of sensors and intake hoses, positioned so as to take representative samples. Caution should be exercised where there is evidence of surcharging as the equipment may become submerged and the reliability of the sampling compromised.

Significant attention must be given to the timing of the sampling procedure and the frequency of sampling as there is a high risk of missing the spill events when sampling in CSO's. In many cases it is advisable to sample on the "wet" side of the CSO (ie in the sewer system) as it is reasonable to assume that the sewage is well mixed and uniform such that there is little difference in the quality of the retained and spilled flows. If sampling inside the CSO, it is vital that some reliable form of spill detection is installed to indicate when spills are being discharged to the receiving waters.

4.3.2 Data collection in sewage treatment works

Access to flow at the preferred stage of the process is frequently not possible due to the layout of the works. Alternative sites should be selected in conjunction with the modeller and works operator. Working procedures should take into consideration the additional hazards presented by deep tanks and automatic machinery. Where possible, site selection should avoid such hazards. Grab samples of effluent or sludges may be required. These may be taken either manually or with automatic samplers. Arrangements may be necessary with the works operator to ensure representative samples can be taken if de-sludging of tanks is a manual process. Equipment security is generally not a problem within the works and the samplers can be located either free standing or within equipment kiosks adjacent to flow channels.

Flow measurement at works as a temporary exercise is fraught with difficulty. Most of the structures inside works are designed to control flow levels and velocities and as such are not suitable for flow measurement techniques.

4.3.3 Data collection in rivers

Flow and quality data may be required at strategic locations on the river system including in-situ measurements of dissolved oxygen, temperature and pH. The suitability of the river channel, hydraulic conditions during low and high flow, access and equipment security are the major considerations when selecting data collection sites. Care should be taken to ensure the equipment is installed securely, referenced to a fixed point and is positioned to take representative readings and samples during all flow conditions. It should be noted that seasonal variations in weed growth and sediment deposition may also vary the channel profile and flow conditions over a longer time scale. Additional work may be required at river sites to ensure reliable discharge data are available for the variable conditions. Cross-section profiles should be established to provide accurate measurements, with reference benchmarking to both the depth sensor and a fixed point to allow for quality assurance checks.

Dilution gauging surveys should be carried out to establish the time of travel during various flow conditions and may be used to measure shallow flows accurately where the nature of the river bed prevents accurate measurement by other means, or where storm flows prevent velocity profiling. Time of travel/dilution gauging surveys are carried out by the addition of a selected tracer to the flow (subject to approval by the local environmental regulator), with the measurement of tracer dilution downstream of the mixing reach. This measurement continues throughout the period the tracer passes through the downstream site thereby allowing the discharge to be calculated.

The [WaPUG River Data Collection Guide 1998](#) provides more detail and recommendations on in river data collection elements.

4.4 Further considerations for data collection in estuary and coastal studies

4.4.1 General

The general management principles described previously apply equally to data collection to support modelling in estuary and coastal applications. Requirements for wastewater system and sewage treatment plant/effluent monitoring will be identical. Analytical requirements will be based on chemical or bacterial parameters depending on the focus of the study.

A number of special considerations relate to data collection activities in estuary and coastal waters. Many of these considerations arise because of the scale and greater depths of these receiving waters compared to most freshwater situations. Full salinity in coastal waters, salinity gradients in estuaries, wave action and tidal currents will introduce further complications. Sampling locations in both estuary and coastal waters will often be in open waters and will require the use of boats, that introduces additional logistical and management issues.

General requirements for data collection to support estuary and coastal modelling are considered in Section 5.6 and 5.7. This section discusses specific data collection methods and data management issues to support these modelling activities. It should be pointed out that data collection for model calibration and validation in estuaries and coastal waters potentially involves intensive field surveys that can incur a considerable cost burden to a modelling study. Field surveys are typically undertaken over a tidal cycle (13 hours) at times of mean neap and mean spring tides. Event sampling introduces a further level of complexity and cost implications and is not frequently undertaken in estuaries and coastal waters. Often the receiving water models are calibrated and validated during dry weather and event conditions are then simulated.

Certain fundamental data requirements exist for model calibration and validation to assess compliance of wet weather discharges with water quality standards within an estuary or coastal water. Data collection methods to meet these requirements are considered below.

CIWEM's Urban Drainage Group, formerly WaPUG, is currently developing a Guidance document/draft specification for data collection exercises in Estuarine and Coastal Waters. This is due for publication in draft form in Autumn 2012.

4.4.2 Bathymetry

Typically, the use of hydrodynamic models in estuaries and coastal waters requires the description of bathymetry as depth and position over cross-sections of the estuary or within specified grids for a coastal dispersion model. Admiralty charts may be consulted to provide much of this information, although situations will arise where updated chart data are not available. Data may also be available from specific studies undertaken within the area of interest. A bathymetric survey may be required if these sources of data cannot provide information of sufficient resolution for model calibration/verification. Specialist survey contractors can be employed to undertake surveys operating from a suitably equipped small vessel fitted with an accurate navigation system, ultrasonic depth profilers and satellite global positioning systems. Water levels must also be measured continuously over the sampling period.

4.4.3 Loads to estuaries and coastal waters

Flow data and concentrations of contaminants of interest for all inputs to an estuary are essential. Where data are not available from discharges, specific surveys may be required.

Concentration measurements taken from the discharges are generally required throughout mean and neap tides for the determinands of interest for calibrating water quality models. Flow should also be measured at all inputs. Ideally, data should be collected for each determinand both for the inputs and within the area of interest. Significant inputs should be monitored for three days preceding each survey, to provide the model with initialisation data (by obtaining data prior to the survey measured concentrations in the estuary can be related to contaminant loads). An estimate of the pollutant loads over the preceding few days is required to calibrate a water quality model. An understanding of the oxygen demand of effluents is needed, as some effluents may have the capacity to remove oxygen at different rates, if investigating the effects of wet weather intermittent discharges on DO. It is recommended that continuous effluent inputs should be sampled two to three times a day and at sites within the model area on an hourly basis over the tidal period. Daily freshwater flows for five days preceding the selected spring or neap tide may also be required.

4.4.4 Water quality measurements

In situ measurements of temperature, salinity and dissolved oxygen should be made continuously at strategic points within the estuary or area of coastal water. Continuous water quality monitors are available for monitoring a combination of depth, temperature, dissolved oxygen, salinity, pH for periods of several weeks. Measurements can be made with the monitor positioned in open water, moored to a buoy, attached to a dock, dropped over the side of a vessel or towed underwater. Discrete samples will need to be taken for other determinands such as bacteria and ammonia. One of the sampling sites should be located close to the model boundary to set up the boundary condition.

If studies are undertaken for coastal and estuarine waters the shore based flows (water-courses, CSO's, treatment works etc.) discharging to these waters are often sampled. If this is the case and bacteria are to be sampled, the data collection should be organised such that

the samples are preserved in line with the current Environment Agency Guidelines for sampling bathing water. HMSO [The Bathing water regulations 2008, Part 3 Monitoring](#).

In situ measurements offshore should be taken using the same depth criterion throughout the sampling area. This should be either at one metre below the surface or at mid-depth to avoid any surface effects. Replicate samples and 'blank samples' should be considered to check sampling and analytical techniques. Notes should be taken of weather conditions and events that could affect the water movement and water quality (large ship movements, weir openings, large concentrations of birds, sewage tankers discharging to STW etc.). In stratified estuaries, measurements should be taken at one metre depth intervals.

Data required for water quality models in coastal waters may include dye dispersion data or bacterial spore dispersion data.

Survey techniques using these tracers are discussed in 'Design Guide for Marine Treatment Schemes' ([WRc, 1990](#)). A licence must be obtained from the environmental regulator if tracers are to be added to estuaries or coastal waters.

4.4.5 Currents

Currents may be measured using the following measurement techniques:

- drogue tracking;
- current metering; and,
- remote sensing of surface currents.

Drogue tracking

The simplest and most commonly applied technique for tracking drogues is to use sub-surface drogues with surface markers (e.g. a small buoy). The drogue may be adjusted to track water movement at different levels. Drogues of this type must be carefully designed to ensure that wind effects on the surface float and marker are small in relation to the drag on the sub-surface drogue. Following release, drogues are often followed for a tidal cycle during which wind speed and direction are recorded.

Current metering

A number of methods can be utilised in current meters to sense flow velocity in estuaries and coastal waters including propeller/impeller systems, rotor systems, acoustic methods and electromagnetic systems. The most appropriate type of instrument in any situation will depend on a number of factors ([WRc, 1990](#)) including:

- purpose of measurements;
- suitable deployment methods;
- length of measurement period;
- appropriate sampling scheme;
- data processing requirements and facilities;
- deployment position (geographic location, depth below the surface);
- probable flow characteristics; and,
- level of accuracy required.

It should be noted that current meter data are point specific, whereas drogues provide better spatial information. Further details on the use of current meters are discussed elsewhere ([WRc, 1990](#)).

Remote sensing of surface currents

These systems make use of shore-installed radar to provide information about near surface currents by analysing Doppler shift in radar signal backscattered by surface waves. One such application is OSCAR (Ocean Surface Current Radar). Such systems are advantageous in that large areas can be covered very effectively. The disadvantages are that results are affected by wind and measurements are for near surface currents only (a disadvantage where models require depth-averaged velocities).

4.4.6 Tidal measurements

A number of instruments are available for measuring tidal levels. These can be split into four categories.

- Electrical pressure sensors - including those that measure absolute pressure (including atmospheric pressure) and those that measure the pressure differential between the head of water and atmospheric pressure.
- 'Bubbler type' sensors - air from a constant supply is introduced into a small subsea reservoir where it escapes through a small hole and the variation in pressure at this reservoir due to the variation in water level is recorded.
- 'Stilling well type' sensors - a float is suspended within a tube open to the atmosphere and the sea. The vertical movement of the float is transferred to a recorder.
- Tide boards - a graduated board read by an observer (or sonic tide board that can be read automatically).

Additional supporting data, such as measurements of atmospheric pressure, water density and wind records, are required before accurate analysis of tidal measurements can be carried out. Tidal readings should always be related to a datum and accurate timing of measurements should be carried out. Calibration and checks on instrument performance should be carried out on a regular basis. Ideally, tidal measurements should be made continuously (or as a minimum as a 2-minute average every ten minutes) through the survey period.

4.4.7 Wind speed and direction

Measurements of wind speed and direction should be made both prior to and during the survey period. Detailed information may be obtained from the Meteorological Office or local port authority.

4.4.8 Marine survey management

The basic survey management issues identified for riverine studies (such as application of quality assurance and control procedures; testing and calibration of equipment; mobilisation of survey teams; training of personnel; safety issues, etc.) are equally applicable to studies in estuaries and coastal waters. A significant amount of planning time is needed to design and execute an estuary or marine survey and this should not be underestimated.

The use of boats imposes a higher level of logistical and safety challenges. However, the use of an experienced survey team can overcome many of the potential problems. An additional service boat is often necessary to collect samples from the main sampling vessel; for example, discrete samples collected for microbiological analyses will require processing within a specified time period (in some situations within six hours of collection).

Close liaison should be maintained with the environmental regulator throughout the planning of the survey and during the data collection exercise. It is also important to notify the local port authority of potential survey times. For example, the authority will wish to notify mariners that

surveys are in progress if shipping lanes are to be crossed. Access to ports and marinas for taking land based samples or for dropping off samples must be obtained through the port authority and land owners.