Receiving environment monitoring program guideline

For use with environmentally relevant activities under the Environmental Protection Act 1994

Queensland Government

Prepared by: Water Assessment and Systems within Science Delivery, Department of Science, Information Technology, Innovation and Arts (DSITIA) on behalf of the Environmental Regulatory Practice and Support, Department of Environment and Heritage Protection.

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1	14 May 2014	Original
1.1	05 June 2014	Fixing typographical errors
2.00	9 June 2015	Correcting page numbers and updating coversheet with new template.

Contents

1 Introduction

A Receiving Environment Monitoring Program (REMP) may be included as a requirement of an environmental approval. Typically, a REMP may be required for Environmentally Relevant Activities (ERAs) under the *Environmental Protection Act 1994*, which involve an actual or potential release of contaminants to waters. The need for a REMP is usually determined when an application for an environmental authority is first assessed and is based on the nature of the activity and the potential environmental risks involved. The aim of a REMP is to monitor and assess the potential impacts of controlled or uncontrolled releases of wastewater and associated contaminants to the environment from a regulated activity. A REMP provides a basis for evaluating whether the discharge limits or other conditions imposed upon an activity have been successful in maintaining or protecting receiving environment values over time.

Data collected under a REMP has a number of potential applications and can be used to:

- test the suitability of limit and trigger values for specific water quality indicators (often referred to as parameters) and related conditions within an approval which may lead to approval amendments
- evaluate whether site operation, water management and pollution mitigation measures being adopted are effective
- support applications for future expansions to a site that may require new approvals
- support compliance activities and the identification and prevention of environmental harm.

A relevant approval holder is usually required to prepare a REMP design document as part of the conditions on their authority. The REMP design document should identify:

- the Environmental Values (EVs) that need to be enhanced or protected for receiving waters potentially affected by a release
- measurable indicators associated with these EVs (physical, chemical or biological) based on their sensitivity and relevance to the contaminants from the release or regulated activity, often based on a conceptual understanding of the hazards, sensitive receptors and potential impacts
- Water Quality Objectives (WQOs) for these indicators that are assigned to maintain or enhance identified EVs
- suitable test sites within the receiving waters that are potentially impacted by the release
- suitable control sites where a background or reference condition can be established
- how the condition of, and impacts to, EVs will be assessed at test sites using both WQOs and control site data based on appropriate and valid assessment protocols from relevant guideline documents
- quality control and assurance procedures adopted to ensure monitoring results are reliable and useful.

An authority holder may also be required to prepare REMP results reports which detail the results and outcomes of the program. These may need to be prepared on a regular basis, such as annually, depending on the approval conditions.

The aim of this guideline is to assist relevant proponents and authority holders to prepare a REMP design document, and ultimately the REMP result reports that assess and summarise the results of the program. In order to design and implement a REMP appropriately, this guideline should also be consulted in association with more specific guidance documents such as the *Technical Guideline for Wastewater Release to Queensland Waters* (EHP 2012). Refer to Attachment 1 for further information.

2 Determining the scope of a REMP

A description of scope should be included in a REMP design document. The scope is typically defined during the design phase and should consider the following:

- release characteristics (quality and quantity)
- receiving environment attributes (including location of EVs and other releases or activities)
- spatial extent (including the location of monitoring sites)
- temporal context (including timing and frequency of sampling).

The environmental approval often provides key supporting information relating to these considerations. The following sections provide more detailed guidance on how to define each of these aspects.

The key outputs of the REMP design are the indicators that need to be measured and the location and timing of sampling. Characterising the release and developing an understanding of the nature of the receiving environment greatly assist in identifying appropriate outputs. Generally, the key indicators will be those that; i) are relevant to the environmental values in the receiving water, ii) are directly or indirectly related to the contaminants and characteristics of the wastewater release/s, and iii) can be quantitatively bench marked, i.e. have associated guideline values or water quality objectives. The REMP should focus on the locations that are most likely to be impacted by the release or activity, and sample timing should be sufficient to draw conclusions within the reporting timeframes of the program.

To assist with designing the REMP and determining these key outputs, it is recommended that a conceptual model be developed first. Conceptual models can be particularly useful to show how key contaminants (or hazards) potentially impact on the receiving waters and environmental values, the environmental processes involved and ultimately the key indicators and monitoring locations that should be considered. Conceptual models can take a number of forms, including flowcharts, tables, process diagrams or pictorial diagrams and can be developed for different spatial and temporal contexts. They can depict: locations and interaction of point source and catchment inputs; key environmental values or sensitive receptors; stream flows and mixing; physical, chemical, biological and hydrological process; and possible effects or changes that can occur in the environment. For more information on conceptual models, refer to ANZECC/ARMCANZ 2000b and for further information for estuaries and coastal areas refer to http://www.ozcoasts.gov.au/conceptual_mods/index.jsp.

Figure 1, which will be referred to in subsequent sections, provides an example of a conceptual model for a sewage treatment plant that releases nutrient rich wastewater to a perennial freshwater stream. The figure is a schematic diagram showing the relative spatial locations of the activity, relevant environmental features, and a break-up of various zones.

In this example, the zones were broken up by considering hydrology, environmental values and the relative likely influence of the release. The description of the zones includes information about relative sources of contaminants and the likely environmental responses that could occur. In this case, the zone upstream of the continuous release is mainly rural with the potential for high nutrients and turbidity from this area, particularly during the wet season. Outside of an initial mixing zone, a downstream zone (Zone 1) is identified prior to the confluence with another tributary which is identified as a separate zone. The likely impacts in Zone 1 include high nutrients and low dissolved oxygen as a result of the high organic matter. However this would depend on the contaminant loads in the release and the dilution of the contaminants by the receiving water flow. The tributary flows intermittently and is another potential source of nutrients - particularly from urban stormwater run-off.

A further zone is identified downstream after the confluence with the tributary. It is likely that in this zone the elevated total and dissolved nutrients might start to contribute to an increase in algal growth, particularly during times when turbidity is low. Moving downstream, there is another zone prior to a weir where water is extracted for irrigation purposes. This is a key area for potential impacts due to the change in flow regime and the ponding of the water in the weir. Potential impacts include algae and macrophyte blooms and low dissolved oxygen leading to fish kills, particularly during drier times. Below the weir, an estuary zone is identified where freshwater is mixed with more salty estuarine water and the stream water becomes tidal.

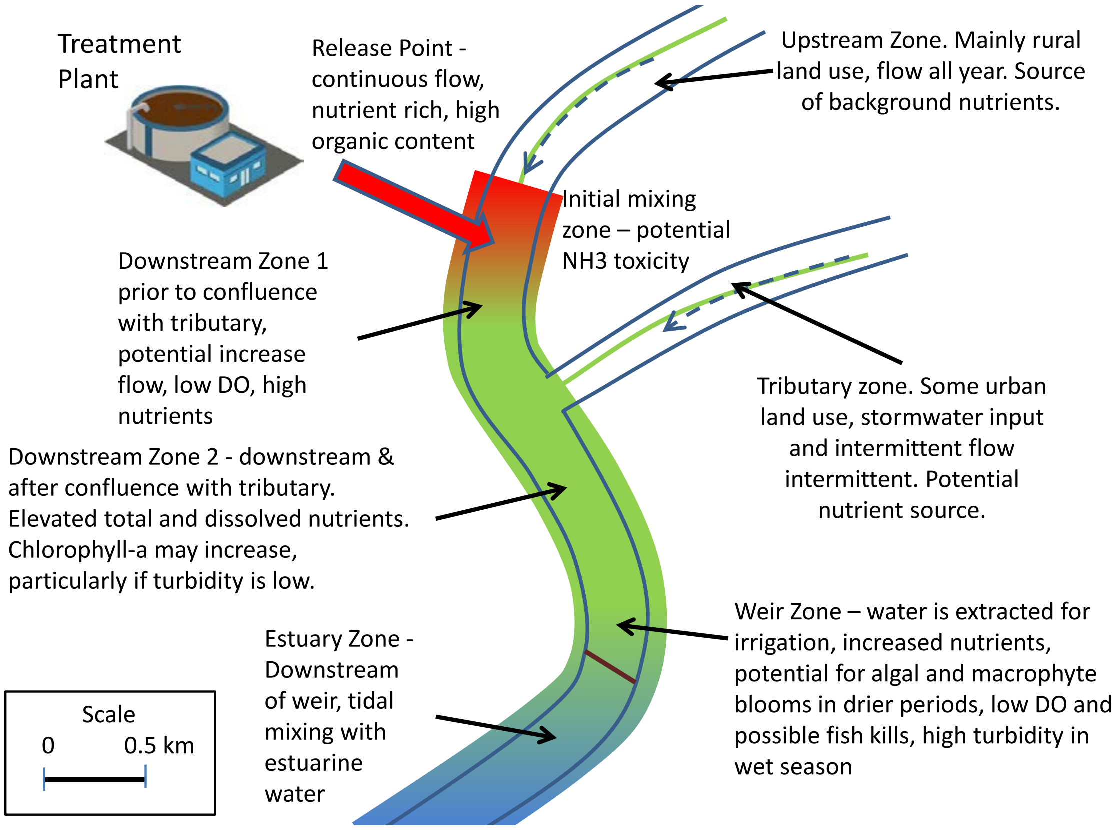

Figure 1. Conceptual model: example of a sewage treatment plant involving release of nutrient rich wastewater to a perennial freshwater stream.

2.1 Release characterisation

The characterisation of a release is needed to help identify the contaminants of concern - i.e. those contaminants that might impact on the receiving environment. This is achieved using the procedure described in the *Technical Guideline for Wastewater Release to Queensland Waters* (EHP 2012). Release characterisation should also include consideration of other aspects of the release, such as magnitude and timing. Under the guideline, contaminants pose a potential risk to the receiving environment where expected concentrations in the receiving environment are greater than Water Quality Objectives (WQOs). A risk assessment of the activity and potential releases should have been undertaken as part of the original application process for the activity. Nonetheless, it is worth revisiting, and if necessary, revising this assessment for the specific purpose of designing the REMP. Revisiting the risk assessment is also important if the context for the release has changed. The guideline provides examples of potential issues of concern and water quality contaminants for major activity types.

Other factors affecting the potential impacts associated with the release include the specific location of the proposed discharge. This is important because it determines which receiving waters will potentially be affected. In addition, information on the timing and frequency of a release provides information about the circumstances under which the release will occur. For example, some discharges may only occur in the wet season or during flood or ebb tide conditions. Releases may also be continuous or event based. It is also important to consider the influence of the release structure, such as the use of diffusers that can provide a higher level of mixing, thus reducing the potential for high toxicity at the point of release. The influence and performance of any treatment measures should also be considered as part of characterising the release.

Although ‘end-of-pipe’ monitoring is not technically receiving environment monitoring, it is essential that this information is collected to help interpret the results of the REMP. The end-of-pipe monitoring necessary may be more than what is required under the environmental approval. Typically, end-of-pipe monitoring is required at a higher frequency than environment monitoring and does not generally include response indicators such as chlorophyll-a concentration. Flow monitoring of a release is essential. If contaminants monitored in the receiving environment are not also monitored end-of-pipe, the data may have limited value. End-of-pipe monitoring should ideally coincide with environment sampling. For the sewage treatment release example in Figure 1, typical end-of-pipe indicators are listed in Table 1. These are grouped into categories of broader hazard types.

For each of the water quality indicators, it is useful to understand the likely concentrations and ranges that will occur. This will help assess the relative risk of each hazard and the need for receiving environment monitoring of related indicators.

Table 1. Typical end-of-pipe indicators for a sewage treatment plant release.

Hazard category	Typical end-of-pipe indicators for sewage treatment plant releases
Nutrients	Total nutrients (nitrogen, phosphorous), dissolved nutrient (including ammonia, oxidised nitrogen, and filterable reactive phosphorous) concentrations Discharge volumes (e.g. ML/day)
Organic Matter	Biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), and dissolved oxygen concentrations Discharge volumes (e.g.ML/day)
Pathogens	Enterococci concentrations Discharge volumes (e.g. ML/day)
Chlorine	Chlorine (free), total chlorine, disinfection by-products (such as THM) concentrations Discharge volumes (ML/day)
Flow	Discharge flow (e.g. cumecs, ML/day)

2.2 Receiving environment attributes

An understanding of the receiving environment is required to identify all relevant indicators that will need to be monitored and the factors that may affect these indicators. This understanding will also help to ensure the spatial extent and the timing and frequency of monitoring is appropriate to the receiving environment (see below). Section 3 provides more detailed guidance on how to understand the receiving environment and the selection of indicators.

Receiving environment and catchment information often reviewed as part of a REMP design includes:

- the type and locations of relevant EVs (e.g. stock, drinking water off-takes or supplies, and irrigated crops and soil types) and known water uses
- catchment hydrology and stream flow information
- the location and nature of potential sources of pollution in the catchment
- the local water quality or other issues that may affect the monitoring program
- the location of any water storages or impoundments (e.g. weirs and dams)
- ecosystem health and water quality information (e.g. the location of any sensitive or important habitat or refugia and the water type for the receiving waters).

Figure 1 provides an example of one way that receiving environment information could be presented. Information may also be presented in maps and tables. Appendix 2 presents some examples of how an assessment of environmental values and water quality objectives can be presented within a REMP Design Document. Based on this and an assessment of the potential hazards and risks of the activity, monitoring indicators and locations can be identified and prioritised.

For the sewage treatment example in Figure 1, typical receiving environment indicators and a potential justification for their use are presented in Table 2. The need for each indicator should be assessed on a case-by-case basis.

Table 2. Typical receiving environment indicators for a sewage treatment plant release.

Hazard category	Typical environmental indicators	Justification
Nutrients	Total nutrients (nitrogen, phosphorous), dissolved nutrients (including ammonia oxidised nitrogen, and filterable reactive phosphorous), chlorophyll-a, suspended solids (or turbidity) and dissolved oxygen concentrations, macrophyte monitoring, and stream flow	Relevant receiving environment monitoring includes nutrient concentrations plus response indicators such as chlorophyll-a concentrations. Secondary response indicators include suspended solids or turbidity. This is because primary production (i.e. algal growth) is both affected by and affects suspended matter and light attenuation. Dissolved oxygen concentrations can also be affected by both primary production and biological breakdown of ammonia. Biological monitoring, such as for macrophytes, may also be warranted where there is a potential for eutrophication.
Organic Matter	Dissolved oxygen, ammonia, suspended sediments(or turbidity) and chlorophyll-a concentrations	Dissolved oxygen is a key indicator and will show an oxygen 'sag' if readily biodegradable high organic matter is present. Chlorophyll-a, ammonia and suspended sediments (or turbidity) concentrations should also be measured for the reasons explained above. Note that BOD, COD, TOC indicators are generally at very low levels in typical receiving environment outside of mixing zones and are therefore not usually measured in receiving waters.
Pathogens	Enterococci concentrations - (high risk only)	Where pathogens are potentially present in wastewater releases, enterococci is recommended where recreational waters are possibly affected. Monitoring of the receiving environment may not be required unless there are recreational areas within close proximity to the release or where the release is not disinfected and a high risk is identified.
Chlorine	Total chlorine concentrations - (high risk only)	Where chlorine is used for disinfection, monitoring in the receiving environment would generally only be required if a high risk is identified but would probably focus initially on total chlorine.
Stream Flow Change	Stream flow (cumecs, daily), suspended solids concentrations/turbidity, biological monitoring (e.g. macro-invertebrates, fish).	Changes in stream flow can cause erosion, change mixing and residence times and change stream flow. This can potentially impact on fish and other biological species.

2.3 The spatial extent of the REMP

The spatial extent of the REMP is typically restricted to the local waterways adjacent to the activity and is generally specified in the environmental approval requiring the REMP to be undertaken. Nonetheless, the spatial extent and location of monitoring sites should be assessed on a case-by-case basis considering the potential risk to downstream environmental values. Risks are likely to increase with large scale activities and where local downstream values include sensitive receptors such as high ecological values, permanent or semi-permanent pools in temporary systems, drinking water supplies, and recreational waters.

The spatial extent of REMPs can nominally be divided into near-field, mid-field and far-field. For near-field assessment, a REMP is used to assess the extent of any mixing zone for toxicants in the discharge and potentially the performance of a diffuser. This may be required when toxicant concentrations permitted in the release are high compared to toxicant guideline trigger values identified for receiving waters. A far-field REMP is a larger scale program, which typically focusses on whole streams, waterways or bays. A far-field REMP is undertaken where the emphasis is on broad scale issues, often related to nutrient, sediment or salinity impacts (including cumulative impacts). Generally, there is more than one point source activity, and potentially more than one organisation in the catchment is required to contribute to the implementation of a far-field monitoring program.

The mid-field REMP is more common and focusses on the changes in water quality after the initial mixing zone to some defined spatial context where the release is most likely to dominate water quality. Monitoring points in such a REMP are generally selected as either (i) test sites, or (ii) un-impacted sites, also referred to as ‘control’ or ‘reference’ sites. The spatial extent of a mid-field REMP is typically in the order of several kilometres from the activity. Indicators such as oxygen concentrations, suspended solids, and dissolved/total nutrients often need to be assessed over the mid-field as they can change rapidly over this spatial scale. In freshwater, mid-field environmental monitoring can also include salinity, sulphate and flow.

An example of a mid-field REMP is provided in Figure 2 for the sewage treatment release example presented in Figure 1. This includes two control sites and 3 downstream test sites for measuring water quality. In this example, one of the test sites is below the weir in the estuary. Depending on the scale and specific risks involved, this may not be required. In some cases, an alternative test monitoring site may be considered above the weir after the confluence with the tributary. Stream flow monitoring sites are not presented but would generally be located at the weir adjacent to monitoring point X4 and ideally upstream of the release point—at or above monitoring point X1.

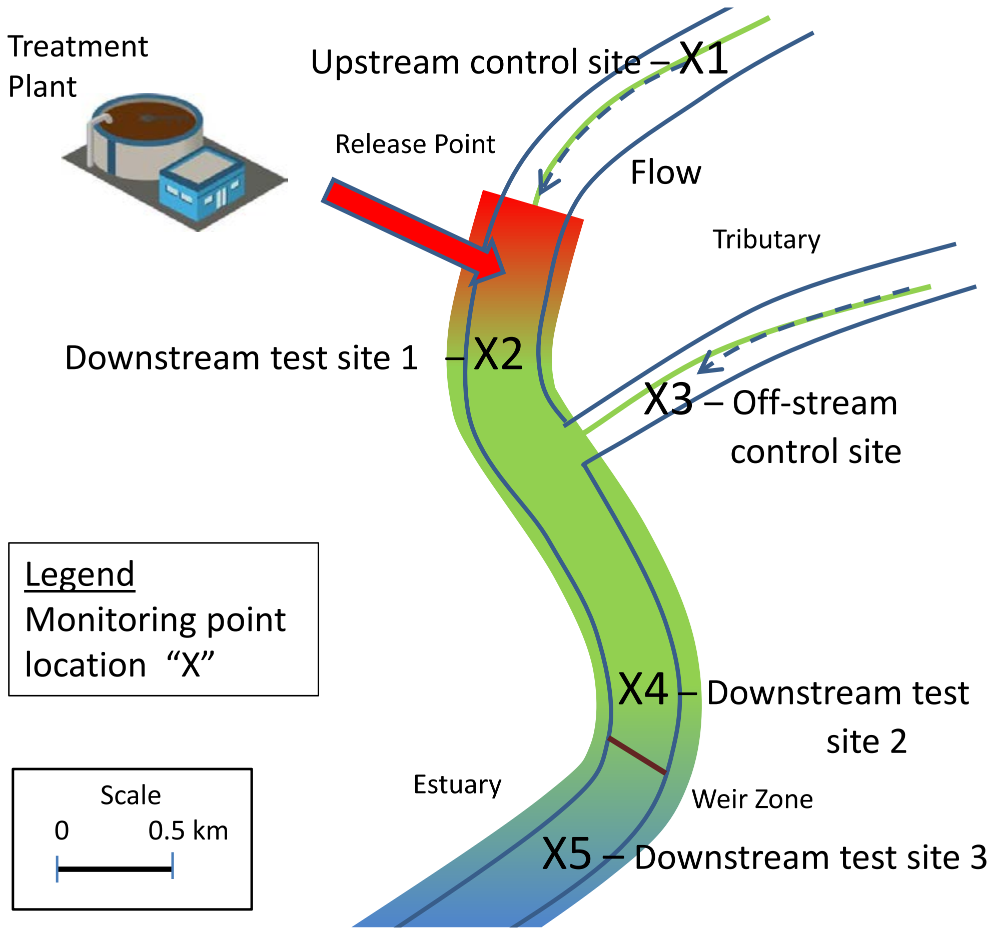

Figure 2. An example of a mid-field REMP, showing proposed locations for monitoring, for a sewage treatment plant release to a perennial freshwater stream.

2.4 The temporal basis of sampling

Sampling frequency should be sufficient to generate enough data for valid condition assessment purposes within the REMP reporting period (generally 1 year). This includes a consideration of statistical robustness, such that valid statistics (medians and percentiles) can be derived from the data set; (a) to compare test and control site water quality; and (b) for test site comparison with WQOs for each parameter. The *Queensland Water Quality Guidelines* (DERM, 2009a) include further information about recommended sampling frequencies.

The timing (temporal basis) of the sampling to be undertaken for a REMP will be dependent on the nature of the release (e.g. continuous, intermittent, event-based) and the nature of the receiving water (e.g. tidal estuaries, perennial or temporary freshwaters). Monitoring of release(s) from the activity is required within the same time period that REMP sampling is undertaken.

For event-based releases in temporary streams, monitoring of water quality should focus predominantly on the times when releases are more likely to occur. In the case of continuous releases, water quality monitoring will typically need to occur periodically throughout the year with due consideration given to the influence of seasonal variation.

For example, more intensive sampling may be needed during dry weather periods when impacts from point source releases may be greater, thereby capturing potential worst-case scenarios. Otherwise, sampling may be undertaken on a routine basis (for example monthly).

In determining the most appropriate timing for sampling, any environmental variability that may influence the data generated within a REMP should be considered. For example, the data needs to be representative, and not biased toward periods irrelevant to the assessment (e.g. extreme wet weather periods or perhaps periods of no flow). The timing of sampling will also be dependent upon consideration of the environmental media being sampled (e.g. surface water, sediment, and biota). For example, biological monitoring may focus on periods following natural flows or release, or periods when only remnant semi-permanent or permanent waterholes remain.

In the example of a sewage treatment plant release to a perennial freshwater stream in Figure 1, key considerations include that the release is continuous and that the stream is flowing all year round. Depending on the scale of the activity, budget and resources, surface water quality monitoring should be undertaken on a monthly basis. In locations where wet weather periods are long and dominate the system, routine monitoring may be restricted to dry weather periods only. An increased likelihood of impact would justify intensification in monitoring and assessment. For example given the specific issues in the weir in dry weather (in the example), more intensive or different types of monitoring may be undertaken at this time. This could include more spatially intensive physical or chemical water quality monitoring, or biological assessment.

3 The REMP design document

The following section is intended to provide generic guidance for the development of a REMP design document. This generic guidance should be considered together with the minimum requirements indicated within the conditions of the authority. In brief, the REMP design document should describe the aim of the REMP with clear objectives against which the progress of the REMP can be assessed. The REMP design document should also detail the spatial extent of any monitoring required and the minimum requirements in terms of the indicators to be monitored for each of the environmental media.

The REMP design document should generally include a description of; (i) aims and objectives, (ii) the activity, (iii) the receiving waters, (iv) program design, and (v) reporting. Each of these aspects is described in more detail below.

3.1 Aims and objectives

The aims and objectives of the REMP should be consistent with the conditions of the approval (where specified) and should provide additional detail regarding receiving waters, contaminants and indicators, environmental media considered and spatial and temporal scales for the assessment. Where the aims and objectives are not specified in the approval, they should be clearly stated in the REMP design document. For example, the aim of the REMP is often ‘to quantify the potential impact of a controlled or uncontrolled release of wastewater and associated contaminants from the licensed activity on the receiving environment’.

3.2 Description of the activity

Relevant aspects of the authorised activity should be provided in the REMP design document, including the source and location of any wastewater release points. The document must briefly describe the pertinent history of the authorised activity at the site, including major changes in production, water management, treatment and disposal.

The results of the risk assessment of the activity and potential releases should also be summarised, highlighting the key contaminants and issues of potential concern for these receiving waters.

3.3 Description of the receiving waters

The description of the receiving waters should be supported by a range of material as described below.

Suitably scaled maps should be included showing the site location, plan of the development and relevant boundaries, stream names, wastewater release points, monitoring points, and the location of downstream EVs or sensitive receptors (e.g. high ecological value aquatic ecosystems, semi-permanent or permanent waterholes in ephemeral or intermittent systems, drinking water supplies, water uses or users, etc.). Queensland Wetland Mapping (WetlandInfo) may be useful for mapping wetlands and Category A, B or C Environmentally Sensitive Areas should be included in any maps. It is important that the maps show the location of wetland areas and other sensitive receptors in relation to receiving waters. All maps should be appropriately labelled and include a scale bar. If this information is requested by the administering department, it should also be provided electronically in ESRI GIS format.

Environmental values (EVs) should be identified, with existing uses for the receiving waters clearly described and mapped. Where Schedule 1 of Environmental Protection (Water) Policy (EPP (Water)) has identified specific EVs for the receiving waterways, these should be used. Where there are no scheduled EVs, default environmental values are indicated in the EPP (Water). EVs and existing uses can be subsequently refined, based on site specific assessments and relevant supporting information (e.g. referenced reports, scientific literature and database searches). Sufficient detail should be provided regarding the spatial location and nature of each EV. For example, in a case where agricultural land use for irrigation is identified as an EV, it is important to articulate/ show the location of irrigation off-takes in relation to the release, the types of cropping, and in specific cases, the soil type. This information is important for designing the monitoring program (e.g. for selecting sampling sites) and also for identifying the appropriate WQOs for each EV.

Water quality objectives (WQOs) should also be identified to protect the identified EV's. To ensure that all EVs are protected, WQOs generally represent the most stringent of the guideline values identified for all of the EVs in each location.

Information for deriving WQOs can be obtained from the following documents or websites and should be referenced in the REMP Design Document:

- *Environmental Protection (Water) Policy 2009 Schedule 1*
- *Queensland Water Quality Guidelines* (QWQG) Version 3 (DERM 2009a)
- The National Water Quality Management Strategy (NWQMS) Guidelines, including:
    - Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ 2000a)
    - Australian Drinking Water Guidelines (NHMRC and NRMMC 2011)
    - Guidelines for Managing Risks in Recreational Water (NHMRC 2008)
    - other relevant national guidelines.

If there is any inconsistency between the documents above then refer to Section 7 of the EPP (Water) for guidance. Where guideline documents have been updated, the value/s from the most recent document should be used.

For aquatic ecosystem protection, the appropriateness of each WQO or water quality guideline (WQG) will depend on the type of water and the management intent (or level of protection) for the receiving waters. The rules for defining water types are provided in Section 2.4 (Defining water types for guidelines) of the QWQG (DERM 2009a). In estuarine waters, where it may be unclear whether the fresh or marine WQG would apply, it is again necessary to select the most stringent of these as default guideline values.

The management intent for waters is defined in Section 14 of the EPP (Water). The management intent (or level of protection) for *specific catchments* are indicated in Schedule 1 of the EPP (Water) documents and associated mapping in relevant Schedule 1 plans. If WQOs are not available in Schedule 1 of the EPP (Water), management intent can be determined on the basis of an assessment of the aquatic ecosystem condition in accordance with Section 2.2.2 (Guideline for aquatic ecosystems for different levels of protection) of the QWQGs (DERM 2009a).

Three ecosystem conditions are defined within QWQG—High Ecological Value (HEV), Slightly to Moderately Disturbed (SMD) and Highly Disturbed (HD). In areas that have no scheduled EVs or WQOs, the default level of protection or management intent is that of a SMD aquatic ecosystem, and would be equivalent to 'Moderately Disturbed' in the most recent draft of the EPP (Water)[1] where four levels of protection are prescribed.

In some cases, local background concentrations of specific contaminants can be significantly higher than WQOs for EVs identified within the REMP area. This may occur as a consequence of either natural or anthropogenic influences. In such cases, an assessment against WQOs alone will have limited value. For this reason, it is essential that both the test site data and control site data are assessed appropriately against the WQOs. Generally, control site data collected in a REMP cannot be used to derive local WQGs as referred to in Section 4.4.3 or Appendix D of the QWQGs (DERM 2009a) as the sites are unlikely to meet the criteria for 'reference sites'. Nonetheless, the data quality and quantity requirements and methodologies described can still be applied to derive background conditions (for example, 20th, 50th and 80th percentile values) from control sites.

Land uses and other point source releases should be described. Point source releases upstream and downstream of the activity within the REMP area that may; (i) influence existing water quality and/or hydrology, and/or (ii) contribute to potential cumulative impacts, should be described.

Available historical or other relevant data sources should be included in the REMP Design Document, including a review of available data collected in previous monitoring studies conducted within the spatial extent or specified waterway(s) of the REMP. This previous monitoring data can be used to inform the monitoring program design, and assist in characterising and describing the baseline condition of the receiving waters. Where historical data is used to support statements regarding water quality or condition assessment, it should be presented in a format that allows for an assessment of its suitability (i.e. inclusion of meta-data and appropriate summary statistics). Data from other sources should be appropriately referenced.

3.4 Monitoring program design

The REMP design report must describe in detail each monitoring component of the REMP that will achieve the stated aims and objectives. For general guidance on monitoring program design, refer to water quality guideline documents (ANZECC & ARMCANZ 2000a and DERM 2009a), as well as monitoring and sampling manuals (DERM 2009b and ANZECC & ARMCANZ 2000b).

The monitoring components considered will typically include water quality, sediment quality, biological or flow monitoring (alone or in combination). Guidance on the selection of these monitoring components is provided below.

3.4.1 Monitoring program components

Water quality monitoring is typically the primary form of monitoring undertaken as part of a REMP and is needed to assess the potential contribution of any release of contaminants to changes in receiving water quality. Monitoring usually includes a combination of; (i) *in situ* measurements obtained using field instruments to monitor indicators such as dissolved oxygen and pH, and (ii) field sampling using manual grab sampling or auto-sampling with subsequent laboratory analysis.

Passive sampling devices are also being used more commonly for specific contaminants because they allow time integrated sampling of water quality. For more general information on the types of sampling available for surface waters refer to Section 4.3.2 of *the Australian Guidelines for Water Quality Monitoring and Reporting* (ANZECC & ARMCANZ 2000b). Appendix C2 of the *Monitoring and Sampling Manual* (DERM 2009b) provides useful information about passive sampling devices.

[1] Refer to Section 6 (2) of the EPP (Water) for further information on levels or protection for aquatic ecosystems

Sediment contaminant monitoring should only be necessary when the risk of accumulation of contaminants in the sediment has been identified by the risk-assessment and/or where water quality results indicate regular and sustained exceedances of WQOs at test sites downstream of the activity. However in order to subsequently demonstrate the suitability of release conditions, sediment contaminant monitoring should initially be included within a REMP. Baseline conditions can be established by comparing data to sediment quality guidelines (*Interim sediment quality guideline* (ISQG**)** ANZECC & ARMCANZ 2000a[2]) and also to control site sediment quality data.

Sediment sampling can only occur at sites where suitable substrates exist (i.e. silty or muddy substrates, not sand). Comparisons of data collected from control site monitoring with data from sediment contaminant monitoring test sites should include consideration of additional factors such as particle size distribution. It may be necessary to present results in terms of both 'total' and 'fine (< 63 µm' size) fractions to aid with the interpretation of sediment data. Guidance for monitoring design for sediment quality assessment is provided in the *Handbook for Sediment Quality Assessment* (Simpson et al. 2005).

Biological monitoring in freshwater, estuarine and marine systems should be 'fit-for-purpose' depending on the organisms present and the sensitivity of the habitat (e.g. a sensitive habitat might include critical habitat for endangered species). When choosing the biological monitoring parameters, careful consideration needs to be given to the potential impacts of the activity and the organisms that may be sensitive to those impacts. However the organisms that are sensitive to the impacts from an activity may not necessarily be threatened, endangered or vulnerable species. Biological monitoring should be considered when:

- the goal is to establish a clear link between the contaminants (or flow) to be released and potential impacts on the biological organisms and/or ecosystems
- suitable guidelines or benchmarks and methods exist to allow for reliable and quantitative assessment. For example, monitoring seagrass might be necessary where potential turbidity or suspended solids increases are likely to occur and impact on them.
    - Guidance on biological monitoring techniques and design for fresh, estuarine and marine waters is provided in the *Monitoring and Sampling Manual 2009* - Version 2 (DERM 2009b).
    - Guidance on biological monitoring in temporary streams can be found in Smith et al. (2004) *Review of Methods for Water Quality Assessment of Temporary Stream and Lake Systems.* Specific guidance on monitoring coral reefs and seagrass can be found in Hill and Wilkinson (2004), *Methods for Ecological Monitoring of Coral Reefs,* and Short et al. (2006), *Manual for Monitoring Seagrass Habitat.*

Flow monitoring is very important when dealing with point source releases to freshwater streams, whether they are perennial or temporary. This is because flow will heavily influence water quality and biological indicators. Collection of this information will permit an analysis of the relationship between individual water quality parameters and flow conditions, help characterise the receiving environment and inform the derivation of WQOs (e.g. salinity WQOs can be derived for high and base flow conditions). Understanding stream flow is also essential for predicting mixing and dilution of releases with receiving waters. Flow monitoring includes stream level (height in metres) and discharge (volume in cubic metres per second) measurements. Flow monitoring information from established government gauging stations may be accessed through the Department of Natural Resources and Mines' Water Monitoring Portal, or by establishing gauging stations to measure flow characteristics. Stream flow or discharge, stream height or level, cross-sectional area, and stream velocity etc. are all useful information.

3.4.2 Monitoring component information

For each of the monitoring components in section 3.4.1, the monitoring program design should include (where applicable) the information discussed below.

Sampling sites selected for the REMP should be described, including a justification of the suitability of specific sites as control and test sites. The sampling sites should include any receiving environment sites specified within the approval (or a subset of these), and the additional sites required to monitor downstream receptors or satisfy the spatial extent of the REMP (as specified in the approval or determined by a risk-assessment).

[2] Note that the sediment quality guidelines are currently under revision.

Monitoring sites should not be located directly adjacent to point source releases to avoid being within mixing zones, unless it is a planned near-field study. Monitoring sites should also not be at the confluence of streams to avoid the mixing effects of the different streams. For flowing non-tidal streams, most test sites are located downstream of the activity. Monitoring site selection typically includes at least one upstream (or off-stream) location per stream or release location as the control site. For tidal areas, such as estuaries, test sites are generally located both upstream and downstream of the activity due to the potential influence of tidal mixing. For bays or open waters, test sites can be spread in any direction from the activity or release, although factors such as dominant wind or tide and bathymetry may be important for site selection. Control sites for estuarine or marine waters should be located at sites that cannot be affected by the release or activity but are of a similar nature or water type to the test sites.

REMP monitoring sites should be mapped and clearly tabulated as shown in Attachment 3 and coordinates and spatial data provided electronically to the administering authority in ESRI GIS format if requested. Any points where wastewater is released and monitored (as outlined in approval conditions) should be added to the map and tabulated for context. Note that the data obtained from release monitoring required under the approval should be incorporated into the REMP for interpretative purposes.

Indicators should be selected based on the characterisation of both the releases and the receiving environment. The indicators that will be sampled as part of each monitoring component should be identified. Water quality monitoring components should include indicators as specified within the approval and any additional indicators, such as temperature, dissolved oxygen, major ions, and hardness that may be measured for interpretative purposes.

Indicators should be measured in appropriate forms (e.g. units, speciation, dissolved (filtered) or total (unfiltered), etc.) to allow for direct comparison to relevant WQOs for specific EVs. Sampling frequency and other important information should be tabulated as shown in the example in Attachment 3.

Sampling methods should be described (e.g. *in situ* instruments, grab sampling, auto-sampling), as should analytical methods and statistical approaches that will be used to measure each indicator. The guidance documents employed to develop valid sampling protocols should also be detailed. Suitable guidance documents may be specified in the conditions of the approval. These documents generally include:

- *Monitoring and Sampling Manual 2009* - Version 2 (DERM 2009b)
- *Handbook for Sediment Quality Assessment* (Simpson et al. 2005)
- *Australian Guidelines for Water Quality Monitoring and Reporting* (ANZECC & ARMCANZ 2000b)
- *National Assessment Guidelines for Dredging 2009* (DEWHA 2009)
- Relevant Australian Standards such as AS5667.1 *Guidance on Sampling of Bottom Sediments*.

Suitable sample containers, and storage and holding times for each indicator to be sampled and subsequently analysed are recommended in guidance documents. The suitability of some sampling methods may be limited for certain indicators because of site specific factors. For example, auto-samplers may not be suitable for all indicators if these samples cannot be collected in suitable time-frames (for example as a consequence of flooding or site access constraints). Any modifications to standard methodologies should be described.

In all cases it should be demonstrated that analytical methods are sufficiently sensitive for the purposes of assessment against WQOs. It is generally unacceptable for limits of reporting (LORs) to be greater than the WQOs that the data are being compared with, particularly when appropriate sensitivity is analytically feasible. LORs should subsequently be presented for each parameter to allow for assessment of their suitability - these can be distinguished using ‘< LOR value’ in all results tables. The validity of field instrumentation or laboratory analysis with respect to reference methods (e.g. United States Environmental Protection Agency (USEPA) and American Public Health Association (APHA)) should be tabulated together with the LORs in the design document.

The sample size (n) for the REMP should be nominated and justified, with due consideration for the sampling frequency and timing (see below). The sample size is the number of samples needed to be representative and to quantify the variation at each site (or time) so as to enable differences between sites (or times) to be determined with statistical confidence. For water quality, Appendix D of the QWQGs (DERM 2009a) provides some advice on the appropriate sample size for comparison between test sites and aquatic ecosystem guideline values. This section of the QWQG (DERM 2009a) discusses the minimum number of samples required to avoid errors based on data from reference sites. However, the appropriate sample size for each REMP will need to be determined on a case by case, site specific basis. Sampling of water quality to establish a baseline condition as part of the application process (for example in an Environmental Impact Statement (EIS)) may be helpful in determining an appropriate sample size. For example, sampling in these early phases can be used to conduct a power analysis to determine optimum sample size.

The sampling frequency and timing should be described and justified for each component of the monitoring program and it should be demonstrated how these will be sufficient to achieve the aims and objectives of the REMP.

For the **water quality** component, the design document should describe how the planned sampling frequency will be sufficient to facilitate the comparison of control site data with test site data, and the comparison of test site data against the values described in guidelines.

If conditions are changing relatively quickly, and this change is significant to the interpretation of what is occurring (e.g. as water quality changes when a waterhole dries), then the sampling frequency during that stage should be increased.

The intended timing of sampling with respect to tide or stream flow and release of wastewater should also be identified. Most freshwater systems in Queensland are ephemeral and often have highly variable flow regimes. For these systems, the timing and frequency of sampling requires special consideration. Sampling of temporary freshwater streams is generally restricted to periods of stream flow[3], although samples can be taken from semi-permanent or permanent waterholes during nil flow periods for specific purposes (See Section 2.5 of QWQGs (DERM 2009a)). It is important to note that data collected during high flow, base flow or nil flow periods should not be pooled when using the data to derive trigger values given the significant differences in water quality that often occur. Sampling of estuarine water is typically undertaken during run out (ebb) tide. Monitoring of toxicant mixing zones often focuses on anticipated worst-case scenarios (i.e. neap tides or low flows).

For the **biological monitoring** component, the timing of sampling in response to wet and dry cycles should be considered to allow for larval growth and recruitment of, for example, aquatic macro-invertebrates in temporary systems. Macro-invertebrates should not be sampled within 4-6 weeks of a high flow event. Also, as the minimum wetted time for individual semi-permanent water holes can affect the populations present, prevailing conditions should be considered in order to accept or reject them as an ecosystem that requires monitoring. Where decisions are made to exclude monitoring sites on the basis of antecedent conditions, the criteria to be used in decision making should be explicitly stated in the REMP Design Document. Water quality sampling should always be undertaken in conjunction with biological monitoring to assist with the interpretation of macro-invertebrate results in freshwater systems.

Quality Assurance/Quality Control (QA/QC) procedures should be described for all aspects of the monitoring program, including field sampling, transport, laboratory analysis and data handling. Examples of relevant procedures for field sampling can include sample replication to describe reproducibility and the use of field and laboratory blanks to validate the data collected. The maintenance and/or calibration procedures undertaken to ensure the validity of the data collected should also be described and calibration and results data need to be recorded and kept for all field instruments used. Continuous measurements using *in situ* probes frequently result in meter 'drift' and frequent quality checking and calibration is required to ensure results are reliable. The document should also describe the actions that will be taken if QA/QC procedures are breached (e.g. a series of samples prove to be contaminated or not preserved appropriately or a calibration is in error). Finally, any processes that will be used to identify erroneous data (such as comparisons with inter-laboratory and duplicate, or blanks results) and rectify errors should be described in the REMP design document.

Data analysis methodologies should be described, including how the data collected will be summarised for assessment and reporting purposes. It is also important to describe how the meta-data (site description; number of samples; the timing of sampling for each parameter at each site) will be incorporated into the REMP report in order to assess the appropriateness of methods used to summarise the data. Assessment protocols for different types of indicators (i.e. physico-chemical stressors, toxicants in water, toxicants in sediment, biota) should be described in accordance with the relevant guidelines.

Water quality test site results should be compared with both WQOs and control site water quality. As a minimum, a condition assessment should be conducted over an annual cycle to allow sufficient time to gather data for statistical analysis over various flows (base flow and high flow) and to take into account seasonal periods. Any additional data analysis conducted beyond the test or control site and WQO comparisons should be explained in detail, including methodology. Any raw data used in the analysis should also be included in the reporting. Suitable reporting statistics (e.g. 20th, 50th, 80th, 95th percentiles) for describing water quality will depend on the assessment protocol for each parameter. Refer to Appendix D of the QWQGs (DERM 2009a) for guidance on approaches for assessing compliance with water quality guidelines for different stressor types.

[3] Stream flow is split into two categories in the QWQGs—high flow and base flow (DERM 2009a).

Sediment quality assessment should be consistent with sections 3.5.5 and 7.4.4.4 and of the *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC & ARMCANZ 2000a), as well as subsequent revisions to the guidelines (Simpson et. al. 2010). In brief, there should at least be a comparison of test site medians with sediment guideline trigger values. Alternatively, there should be a comparison of test site median values with control site median or 80th percentile values. Where test site data indicates an elevation of test parameters above the levels indicated at control sites, then any factors controlling bioavailability should be considered. It is important when comparing test and control site data that samples with a similar grain-size distribution are used. If this is not possible then a specific grain-size fraction will need to be used for comparison.

Biological or ecological data analysis methodologies are discretionary, with no specific data analyses recommended for use in biological monitoring. However, in some regions where scheduled WQOs are available for biological indicators in high ecological value systems, the document should show that the existing (baseline) indicators for habitat, biota and riparian areas are maintained. For scheduled WQOs in moderately disturbed systems (at a minimum); (a) the median value of biological indicators (e.g. macro-invertebrates) at test sites should be compared with scheduled WQOs; (b) the ratio of observed versus expected native fish species should be calculated; and (c) the number of exotic fish species relative to the current number of exotic species in the main channel should be calculated.

Flow data analysis methodologies for flow assessment purposes are also discretionary. Integrated quantity and quality hydraulic models (IQQM) are commonly used in flow assessment by the Queensland Government for water resource planning. Reference to flow objectives in the water resource plan for the region where the REMP is located is recommended when making comparisons with test site data. Note that there is a scheduled WQO for some high ecological regions of Queensland where existing flow must be maintained. Where water releases result in an alteration to the flow regime in the receiving system, in some cases it may be necessary to compare the existing flow regime with the regime that includes proposed releases. This may be achieved by comparing a range of flow statistics calculated from modelled flow scenarios, or by evaluating whether the Environmental Flow Objectives have been met under the *Water Act 2000* for the relevant Water Resource Plan (WRP).

4 The REMP result report

In some cases, a REMP result report may be required as a condition of an approval. The REMP result report format and the timing of reporting should be consistent with the environmental approval and with any other requirements of the administering authority. Reporting may be required on an annual basis or when requested by the administering authority. A report may not be needed where data is routinely submitted and reported to the Wastewater Tracking and Electronic Reporting Systems (WaTERS).

In cases where a REMP result report needs to be prepared, the following information should be considered to ensure the consistency of REMP reporting across activities.

The REMP result report should be consistent with the minimum criteria as defined in the authorisation and be consistent with the REMP resign report. The following structure is recommended where applicable:

The title page should include the activity name, activity operators, location, tenure numbers (where applicable), approval number, date of report, report version, and authorship.

The introduction should briefly re-state the aims and objectives of the REMP, and pertinent details about the activity including any non-compliance issues.

REMP updates should be provided, with references made to the most recent REMP design document and any modifications in the program should be described. Relevant implementation or operational issues should be included for the reporting period. The authorisations under which releases were made within the reporting period should also be listed. This may include both Environmental Authorities and Transitional Environmental Programs, and a summary of the releases from the site during this period (i.e. dates, release rate, total volume, compliance monitoring of the releases).

The results for each component of the monitoring program should be described. All results should be presented in a format consistent with the requirement to assess test site data against WQOs and control site data for each indicator. Appropriate formats may include tables or graphs (time series or box and whisker plots). The results should be assessed and discussed by:

- assessing the quantity and quality of the wastewater release for the period of the assessment
- presenting interpretative data on factors such as rainfall, stream flow or other releases of waste water that may influence results
- reviewing or updating available control site data collected as part of the REMP, with justification provided for the inclusion of data from any new sites for the derivation of local reference condition values or guidelines
- comparing control and potentially impacted site data for each indicator within the reporting period, with WQOs identified to protect or enhance EVs (the potential influence of the wastewater release on results for this period and whether it is significant and whether the assimilative capacity for the system has been exceeded should be discussed)
- undertaking a longer term assessment using historical monitoring data and describing any apparent temporal or spatial trends in the data sets and potential influences of the wastewater release.

The interpretation of findings should include:

- recommendations for further investigation
- changes or improvements that can be made to the monitoring program
- potential changes to management and/or conditioning of the authorised activity to minimise impacts.

References cited in the REMP report should be included in a reference section. Where a cited supporting document is crucial to the validation of any findings in the REMP and not readily accessible, it should be included as an Appendix.

Appendices should contain sufficient supporting information to support the validity of results presented within the report. For example, the appendices can include the provision of raw data reports from accredited laboratories. Meta-data and quality assurance/quality control (QA/QC) summaries, relating to either the field protocols or laboratory procedure results that allow for the sufficiency and validity of the data generated to be assessed, can also be included in the appendices. Data that is not accompanied by adequate meta-data and QA/QC information may not be acceptable.

Raw REMP data may be required if it is considered necessary to validate results reported within the REMP. For this purpose, all raw data records should be provided (if requested) in a suitable electronic format (i.e. Excel files), unless the data is provided to the administering authority via the Wastewater Tracking and Electronic Reporting System (WaTERS) or other approved government system. A template is available for submission of REMP data to WaTERS.

References

ANZECC & ARMCANZ. 2000a. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Canberra: Australian and New Zealand Environment & Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand.

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EHP. 2012. Technical Guideline Licencing – Wastewater Release to Queensland Waters. Brisbane: Department of Environment and Heritage Protection, Queensland Government.

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Hart B, Bailey P, Edwards R, et al. 1991. A review of the salt sensitivity of the Australian freshwater biota, Hydrobiologia, 210, pp105-144.

Hill J and Wilkinson C. 2004. Methods for Ecological Monitoring of Coral Reefs: A Resource for Managers. Townsville: Australian Institute of Marine Science.

NHMRC. 2008. Guidelines for Managing Risks in Recreational Water. Canberra: National Health and Medical Research Council, Commonwealth of Australia.

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Simpson S, Batley G and Chariton A. 2010. Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines. Lucas Heights: CSIRO Land and Water Science.

Smith R, Jeffree R, John J & Clayton P. 2004. Review of methods for water quality assessment of temporary stream and lake systems. Kenmore: Australian Centre for Mining Environmental Research.

Simpson S, Batley G, Chariton A, et al. 2005. Handbook for Sediment Quality Assessment. Bangor: CSIRO.

Attachment 1

Links to other documents

Topic	Relevant document/ section
General guidance for assessing risk from wastewater release to Queensland waters	Technical Guideline for Wastewater Release to Queensland Waters (EHP 2012)
Water quality guidelines	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ 2000a); Queensland Water Quality Guidelines (DERM 2009a) Australian Drinking Water Guidelines (NHMRC & NRMMC 2011) Guidelines for Managing Risks in Recreational Water (NHMRC 2008)
Environmental Value definition	Environmental Protection Act 1994 (Section 9)
Guidance of selecting water quality objectives to protect or enhance EVs	Environmental Protection (Water) Policy 2009 (Section 10)
General sampling design	Monitoring and Sampling Manual (DERM 2009b) Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC & ARMCANZ 2000b)
Information to guide sediment quality investigations	Handbook for Sediment Quality Assessment (Simpson et. al. 2005)
Sediment guidelines	Section 3.5 of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ 2000a)
Framework for determining management and monitoring requirements for ocean disposal of dredged material	National Assessment Guidelines for Dredging (DEWHA 2009)

Attachment 2

Sample tables and data templates for REMP design and reporting

Environmental Values (Example only)

Environmental Value		Sandy Creek	Rocky Creek
Aquatic ecosystems	HEV		
	SMD	X	X
	HD		
Primary industries	Irrigation – (include crop & soil types)		X
	Farm water supply		
	Stock watering (include animal type)	X	X
Recreation and aesthetics	Primary recreation		
	Secondary recreation		X
	Visual recreation		
Drinking water	Suitable raw water supply		X
Industrial uses	Mining		
Cultural and spiritual values	Indigenous		
	Symbolic		
	Lifestyles		

Water quality objectives (Example only)

Parameter1	Units	Ecosystem (SMD)	Stock watering (beef cattle) & general use	Irrigation (cropping) LTV	Raw water supply	Most stringent
pH	pH	6.5-8.0 (lowland) QWQG	6-9 ANZECC	NA	6.5-8.5 ANZECC	6.5-8.0 (lowland) QWQG
EC	µS/cm	720 (Fitzroy N) QWQG	5970 ANZECC	3700 ANZECC	NA	720 (Fitzroy N) QWQG
Turbidity	NTU	50 (lowland) QWQG	NA	NA	NA	50 (lowland) QWQG
Dissolved Oxygen	% sat	85-110 (lowland) QWQG	NA	NA	>80 ANZECC	85-110 (lowland) QWQG
Ammonia	µg/L	20 (lowland) as N? QWQG	NA	NA	10 ANZECC	20 (lowland) QWQG
Total Suspended Solids	mg/L	10 (lowland) QWQG	NA	NA	50 ANZECC	10 (lowland) QWQG
Sulfate	mg/L	NA	1000 ANZECC	NA	400 ANZECC	400 ANZECC
Fluoride	µg/L	NA	2000 ANZECC	1000 ANZECC	NA	1000 ANZECC
Aluminium	µg/L	55 dissolved ANZECC	5000 total ANZECC	5000 total ANZECC	200 total ANZECC	55 dissolved ANZECC
Arsenic	µg/L	13 ANZECC	500 ANZECC	100 ANZECC	50 ANZECC	13 ANZECC
Manganese		1900 ANZECC	NA	200 ANZECC	100 ANZECC	100 ANZECC

QWQG – Queensland Water Quality Guidelines (DERM 2009a)
ANZECC - ANZECC & ARMCANZ (2000) Australian and New Zealand guidelines for fresh and marine water quality

Monitoring point and stream description table (Example)

MP Code	MP Description	Stream Name	Basin & Stream Code	Water Type	AMTD (km)	LAT (GDA'94)	LNG (GDA'94)
MP1	1000 m downstream of RP1	Sandy Creek	143-0068	Lower catchment	134	-21.5555	147.6666

Monitoring frequency and methods (Example)

Indicator categories	Sampling/analysis methods	MP Code	Frequency
In situ measurements (pH, EC, turbidity, temperature and DO)	Hand held YSI meter/field test	MP1, MP2, MP3	Daily
Metals (dissolved and total)	Grab sampling/laboratory analysis	MP1, MP2, MP3	Monthly
Flow	Gauging station	MP4	Continuous (minimum hourly)

List of indicators, method, levels of reporting (Example)

Indicator code	Indicator unit	Method	Level of Reporting
Flow - instantaneous	m3/s		
pH	Unit		
Aluminium (dissolved)	µg/L		
Aluminium (total)	µg/L		
Ammonia as N	mg/L		
Arsenic (dissolved)	µg/L		
Arsenic (total)	µg/L		
Boron (dissolved)	µg/L		
Boron (total)	µg/L		
Cadmium (dissolved)	µg/L		

Cadmium (total)	µg/L		
Chromium (dissolved)	µg/L		
Chromium (total)	µg/L		
Cobalt (dissolved)	µg/L		
Cobalt (total)	µg/L		
Copper (dissolved)	µg/L		
Copper (total)	µg/L		
Electrical Conductivity	µS/cm		
Fluoride (Total)	µg/L		
Iron (dissolved)	µg/L		
Iron (total)	µg/L		
Lead (dissolved)	µg/L		
Lead (total)	µg/L		
Manganese (dissolved)	µg/L		
Manganese (total)	µg/L		
Mercury (dissolved)	µg/L		
Mercury (total)	µg/L		
Molybdenum (dissolved)	µg/L		
Molybdenum (total)	µg/L		
Nickel (dissolved)	µg/L		
Nickel (total)	µg/L		
Nitrate as N	mg/L		
Nitrogen - Oxidised (NOx as N)	mg/L		
Nitrite as N	mg/L		
Oil and Grease	mg/L		
Selenium (dissolved)	µg/L		
Selenium (total)	µg/L		
Silver (dissolved)	µg/L		
Silver (total)	µg/L		

Sulphate (SO42-)	mg/L		
Suspended Solids	mg/L		
Total Petroleum hydrocarbons (C10-C14)	mg/L		
Total Petroleum hydrocarbons (C10-C36) (sum)	mg/L		
Total Petroleum hydrocarbons (C15-C28)	mg/L		
Total Petroleum hydrocarbons (C29-C36)	mg/L		
Total Petroleum hydrocarbons (C6-C9)	mg/L		
Total Recoverable Hydrocarbons (>C10-C16)	mg/L		
Total Recoverable Hydrocarbons (>C10-C40) (sum)	mg/L		
Total Recoverable Hydrocarbons (>C16-C34)	mg/L		
Total Recoverable Hydrocarbons (>C34-C40)	mg/L		
Total Recoverable Hydrocarbons (C6-C10)	mg/L		
Turbidity	NTU		
Uranium (dissolved)	µg/L		
Uranium (total)	µg/L		
Vanadium (dissolved)	µg/L		
Vanadium (total)	µg/L		
Zinc (dissolved)	µg/L		
Zinc (total)	µg/L		

Results metadata tables (Examples)

Collecting organisation name	Principal contact	Indicator/indicator group
ABC Services, Brisbane	John Smith	Nutrients
XTZ Consulting, Mackay	Paul Jones	*In situ* samples

Lab description	Principal contact	Indicator/indicator group
Queensland Health Scientific Services, Brisbane	John Smith	Nutrients

Collect mtd description	Indicator/indicator group
Method described in the DERM Monitoring and Sampling Manual, 2009 Version 2, ISBN 978-0-9806986-1-9	Metals

Instrument description	Indicator/indicator group
YSI 6920 V2	pH, DO, EC (*in situ*)

Raw data sheet table (Example)

Date	Time	Depth (m)	MP Code	Indicator	Collecting organisation	Laboratory	Result value	Comments
1/1/2001	20:30:50	0.2	MP1	pH	ABC Services	QHSS	7.0	

Attachment 3

Glossary and abbreviations

Glossary of terms

Term	Definition
Assimilative Capacity	The assimilative capacity of a receiving water is said to be exceeded for a particular contaminant if the water quality measure does not comply with the relevant WQO. The assimilative capacity reference-based parameters can be assessed by comparing the median of the results taken from the monitoring point location (typically for a minimum of 12 months) to the relevant WQO for that indicator. For toxicants, the assessment is generally based on a comparison of the 95th percentile to the relevant toxicant trigger value.
Control Site	Control sites can be described as monitoring sites that are identical in all respects to the site being assessed (sometimes called the test site) except for the disturbance" (Section 3.1.4.1; ANZECC & ARMCANZ 2000a). Control sites are usually upstream, off stream or in another location to the proposed activity or wastewater release such that they are not be impacted by the activity or wastewater release. Control sites could also include those sites where water quality was assessed prior to an activity commencing and can include those that fulfil the "reference site criteria" as outlined in the Queensland Water Quality Guidelines (DERM 2009a).
Temporary Stream	Streams can be defined based on their surface hydrologic flow duration and are called either perennial or temporary. Under normal circumstances, perennial streams flow throughout the year, whereas temporary streams have no surface flow for some portion of the year. Temporary streams can be further classified as either intermittent or ephemeral depending on the degree of channel formation, predictability for flow and dependence on rainfall.
Test Site	Test sites are sites that may be potentially impacted by the activity or wastewater release. For non-tidal flowing streams, they are usually located downstream of activity or wastewater release.
Guideline Trigger Value	In the context of this document refers to: For water: "physical and chemical water quality guidelines for ecosystem management (See Sections 1.1; p1-3 and 2.1.4.; p 2-10 (ANZECC & ARMCANZ 2000a). For sediment: a value that "if exceeded, prompt further action as defined by the decision tree. The first-level screening compares the trigger value with the measured value for the total contaminant concentration in the sediment. If the trigger value is exceeded, then this triggers either management/remedial action or further investigation to consider the fraction of the contaminant that is bioavailable or can be transformed and mobilised in a bioavailable form." See Section 3.5.2; p3.5-4 and Table 3.5.2.; p3.5-4 (ANZECC & ARMCANZ 2000a)
Water Quality Objective	Numerical concentration or load limits or narrative statements that have been established to enhance or protect environmental values of a water. Water quality objectives are based on water quality guidelines, but may be modified by consideration of the economic and social impacts of protecting the environmental values of water (EHP 2013).
Water Quality Guideline	Quantitative measures of indicators that protect an environmental value. These measures can be concentrations, loads or alternatively a biological measure (EHP 2013).

Abbreviations

Abbreviation	Definition
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Australian and Resource Management Council of Australia and New Zealand
DERM	Former Department of Environment and Resource Management
DEWHA	Department of the Environment, Water, Heritage and the Arts
EA	Environmental Authority
EHP	Environment and Heritage Department
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPP	Environmental Protection Policy
EV	Environmental Value
NHMRC	National Health and Medical Research Council
NRMMC	National Resource Management Ministerial Council
NWQMS	National Water Quality Management Strategy
QWQG	Queensland Water Quality Guidelines
REMP	Receiving Environment Monitoring Program
TEP	Transitional Environmental Program
WaTERS	Wastewater Tracking and Electronic Reporting System
WQG	Water Quality Guideline
WQO	Water Quality Objective