Technical Guidance Document for Wastewater and Marine Water Quality Monitoring

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هيئة البيئة - أبوظبي
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List of Abbreviations

°C	degrees Celsius
µmhos/cm	micromhos per centimeter (units of conductivity)
BFD	block flow diagram
EAD	Environment Agency–Abu Dhabi
EMP	Environmental Management Plan
ER	Environmental Report
g/kg	grams per kilogram
g/m^3	grams per cubic meter
ISO	International Organization for Standardization
ISWQM	in situ (field) water quality monitoring
kg BOD/m^3 d	kilograms of biological oxygen demand per cubic meter per day
kg/d	kilograms per day
L/m^3 min	liters per cubic meter per minute
m	meter
m^3	cubic meters
m^3/d	cubic meters per day
m^3/hr	cubic meters per hour
m^3/m^2 d	cubic meters per square meter per day
m^3/s	cubic meters per second
MDL	method detection limit
mg/L	milligrams per liter
MMDR	Marine Monitoring Data Record (Form)
NNOR	Non-normal Operations Record (Form)
NTU	Nephelometric Turbidity Units
OMDR	Outlet Monitoring Data Record (Form)
QA/QC	quality assurance/quality control
SLER	Standard Limit Exceedance Record (Form)
UAE	United Arab Emirates
WQMSR	Water Quality Monitoring Summary Report

Definition of Terms

Block Flow Diagram—A visual representation of flow streams and process units of a treatment or process scheme that includes blocks connected by arrows.

Chain of Custody—A legal term that refers to the ability to guarantee the identity and integrity of the sample (or data) from collection through reporting of the test results. Chain of custody is a process used to maintain and document the chronological history of the sample (or data). Chain-of-custody documents should include the name or initials of the person collecting the sample (or data), each person or entity subsequently responsible for the chain of custody, dates the items (sample or data) were collected or transferred, the collection location, a brief description of the item, and a sample identification number.

Construction—The time period corresponding to any event, process, or activity that occurs during the construction phase (e.g., building of site, buildings, processing units) of the proposed project. This phase terminates when the project goes into full operation or use.

Cumulative Impact—The impact that results from the incremental impact of an action added to the impact(s) of other actions. A cumulative impact includes impacts associated with past and ongoing on-site and nearby activities.

Decommissioning—The time period corresponding to any event, process, or activity that occurs during the Decommissioning phase (destruction or dismantling) of the proposed project. The Decommissioning phase follows the Operation phase.

Design Capacity—The average daily flow or load that a process treatment unit or other facility is designed to accommodate.

Entity—An individual, establishment, company, association, society, partnership, corporation, municipality, institution, government organization, agency, or group.

Environmental Component—An attribute or constituent of the environment that may be impacted by the proposed project. These environmental components include air quality; marine water; waste management; geology, seismicity, soil, and groundwater; marine ecology; terrestrial ecology; noise; traffic; and socio-economics.

Environmental Impact—A positive or negative impact that occurs to an environmental component as a result of the proposed project. This impact can be directly or indirectly caused by the different phases of the project (Construction, Operation, and Decommissioning).

Environmental Management Plans—A collective term that includes Construction Environmental Management (EAD, 2010a), Operation Environmental Management (EAD, 2010b), and Decommissioning Environmental Management (EAD, 2010c) Plans.

Environmental Reports—Collective term that includes Environmental Impact Assessment (EAD, 2010d), Preliminary Environmental Review (EAD, 2010e), Strategic Environmental Assessment (EAD, 2010f) and Terms of Reference (EAD, 2010g) Technical Guidance Documents.

Major Incident—A non-normal operation or occurrence that is likely to impact the condition and/or health of at least one environmental component.

Method Detection Limit—The minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

Minor Incident—A non-normal operation or occurrence that is not likely to impact the condition and/or health of at least one environmental component.

Mixing Zone—Refers to an area or volume of a surface water that is contiguous to a point source discharge where dilution of the discharge takes place. The extent and boundary of the mixing zone area is determined by the return of the waterbody to ambient conditions.

Operation—The time period corresponding to any event, process, or activity that occurs during the Operation phase (fully functioning) of the proposed project. The Operation phase follows the Construction phase, and then terminates when the project enters the Decommissioning phase.

Pollutant—A foreign substance that alters the biological, physical, and/or chemical condition of environmental media (e.g., water, air) and causes instability, disorder, harm, and/or discomfort to humans and/or an ecosystem.

Pre-treatment—Any device, system, or equipment that can physically, biologically, or chemically change the nature or composition of wastewater before discharge into a sewerage system or marine waters.

Project Site—The physical area within which all phases (i.e., Construction, Operation, and Decommissioning), processes, and activities of the proposed project will take place. The boundary of the project site is defined by the titled property boundary. The project site is equivalent to the project area.

Proponent—The developer, permit applicant, company, or agency associated with the proposed project.

Recycled Water—The treated liquid effluent produced by a wastewater treatment system that is suitable for reuse.

Reuse—Treated wastewater that is reused for another purpose (e.g., irrigation).

Residual Impact—A potential environmental impact that is associated with the proposed project, but is not addressed as part of the recommended mitigation measures (i.e., is not mitigated as part of the proposed project).

Selected Impact—Refers to the impact associated with the Construction, Operation, and/or Decommissioning phases of the proposed project that the proponent has selected to mitigate.

Sewerage System—A system consisting, wholly or mainly, of sewerage pipes, pumping stations, tankers, and other plant and equipment used to transport wastewater from the premises to a wastewater treatment system.

Treatment System—A system consisting, wholly or mainly of pipes, pumping stations, tankers, and other plant and equipment that changes the biological, physical, and/or chemical condition of wastewater.

Water Balance—A graphical representation of the water use and distribution at the proposed project site or facility.

Purpose of This Technical Guidance Document

The purpose of this document is to provide guidance for the following:

- The development and detailing of wastewater and marine water quality monitoring in the relevant sections of Environmental Reports (ERs) and Environmental Management Plans (EMPs).
- The content, data, and format for the Wastewater and Marine Water Quality Monitoring Reports associated with the wastewater and marine water quality monitoring programs outlined in ERs and EMPs and approved by the Environment Agency–Abu Dhabi (EAD).

EAD, which is the Competent Authority in the environmental field, will review and evaluate the ERs, EMPs, and Wastewater and Marine Water Quality Monitoring Reports.

Section I. Background

Definitions of Wastewater and Marine Water

"Wastewater," in the context of this Technical Guidance Document, is defined as the water-borne wastes generated during all phases (Construction, Operation, and Decommissioning) of the proposed project that are

- Discharged into a sewerage system or marine waters, with or without treatment prior to discharge.
- Treated or recycled water that is reused for another purpose (e.g., used for irrigation).

Wastewater includes *trade effluent*, defined by Regulation and Supervision Bureau (2010) as, "any wastewater discharged to a sewerage system that is produced in the course of any industrial, commercial, agricultural, medical, scientific, or trade activity, but does not include domestic wastewater." However, "wastewater" in this Technical Guidance Document is broader in definition because it consists of the following: facility waste waters and storm water; treated or non-treated wastewaters discharged directly into sewerage systems or marine waters; and recycled water that is treated and reused. Monitoring or assessment of wastewater quality occurs prior to discharge or reuse to ensure that pollutant levels within the wastewater and/or receiving marine waters comply with and do not exceed water quality standards.

"Marine water," in the context of this Technical Guidance Document, is defined as the body or bodies of marine water that receive pollutants generated by the proposed project. "Pollutants," in this context, include physical and chemical contaminants that are: (1) contained within treated or non-treated wastewater; (2) created by project dredging and reclamation; and (3) from non-point sources. Monitoring of marine water quality occurs at specified locations within the receiving marine water body to ensure that pollutant(s) do not alter the biological, physical, and/or chemical conditions of the marine waters beyond acceptable levels, at specified distances from the pollutant(s) source. The proponent should refer to *Technical Guidance Document for the Permitting of Marine Dredging Operations in Abu Dhabi* (EAD, 2011) for further guidance regarding marine water quality monitoring associated with dredging and reclamation activities.

Objective of Wastewater and Marine Water Quality Monitoring

The objectives of wastewater and marine water quality monitoring are to

- Minimize the impact of the proposed project on the environment.
- Ensure that mitigation associated with all phases (i.e., Construction, Operation, and Decommissioning) of the proposed project meets or exceeds the water quality standards outlined within the ER, EMP, and/or associated permit (see Water Quality Standards in Section II of this Technical Guidance Document for more information).

- Ensure that unmitigated impacts of the proposed project do not adversely influence wastewater and/or marine waters beyond an acceptable level.
- Ensure compliance with the following laws and regulations:
  - United Arab Emirates (UAE) Federal Law No. 24 of 1999 Protection and Development of the Environment.
  - *Trade Effluent Control Regulations 2010* (Regulation and Supervision Bureau, 2010).

To meet these goals, the wastewater and marine water quality monitoring programs associated with the proposed project must be comprehensive and well planned, and the ER or EMP should provide a detailed description of the programs that will be adopted by the proponent of the project. This information should be documented clearly and concisely in the relevant sections of the ER or EMP. In addition, Wastewater and Marine Water Quality Monitoring Reports must be submitted to EAD in accordance with the reporting schedule and terms outlined in the ER, EMP, and/or associated permit, and then approved by EAD.

Preparation and Submission of Wastewater and Marine Water Quality Monitoring

The proponent of the proposed project is responsible for preparing and submitting the Wastewater and Marine Water Quality Monitoring section(s) within the ER or EMP, in accordance with the content requirements outlined in Section II of this Technical Guidance Document. The full ER or EMP, including the Wastewater and Marine Water Quality Monitoring sections, should be produced by an EAD–approved and –registered environmental consultant operating within Abu Dhabi Emirate. A current list of registered consultants can be obtained from EAD's Customer Service or from EAD's Web site at http://www.ead.ae. The proponent should refer to the *Technical Guidance Document for Submission of Environmental Permit Applications and Environmental Studies* (EAD, 2010h) for guidance regarding the required number of copies and format of ERs and EMPs.

The proponent of the proposed project is also responsible for preparing and submitting the Wastewater and Marine Water Quality Monitoring Reports for EAD's review, if required. The Monitoring Reports should be prepared by an EAD–approved and –registered environmental consultant operating within Abu Dhabi Emirate and should adhere to the layout and content requirements outlined in Section III of this Technical Guidance Document.

Review of Wastewater and Marine Water Quality Monitoring

EAD will review the Wastewater and Marine Water Quality Monitoring sections of the submitted ER, EMP, and Wastewater and Marine Water Quality Monitoring Reports to verify that each is complete and meets all of the stipulated requirements. The proponent should refer to *Technical Guidance Document for Submission of Environmental Permit Applications and Environmental Studies* (EAD, 2010h) for guidance regarding the time frame for the review of ERs and EMPs.

Section II. Content of Wastewater and Marine Water Quality Monitoring in ERs and EMPs

Wastewater and marine water quality monitoring should be described in detail in Sections 5.x.4 of the ER and Sections 7 and 8 of the EMP. Environmental components within the ER that may require monitoring of wastewater and marine water quality include, but are not limited to, Marine Water (Section 5.2.4) and Waste Management (Section 5.3.4), and a detailed monitoring plan should be provided for each (**Table 1**). In addition, in Section 5.x.4 for each environmental component within the ER, the specific wastewater and marine water quality monitoring programs associated with selected (Section 5.x.4.1), cumulative (Section 5.x.4.2), and residual (Section 5.x.4.3) impacts should be addressed. Subsections within the EMP that may require wastewater and marine water quality monitoring include, but are not limited to, the Erosion and Sediment Control and Stormwater Control Plan (Section 7.2) and the Water Quality and Marine Ecology Management Plan (Section 7.5).

Table 1. Organization and Corresponding Section Number for the Environmental Components Addressed Within Environmental Reports

Section Number	Environmental Component
5.1	Air Quality
5.2	Marine Water
5.3	Waste Management
5.4	Geology, Seismicity, Soil, and Groundwater
5.5	Marine Ecology
5.6	Terrestrial Ecology
5.7	Noise
5.8	Traffic
5.9	Socio-economics
5.10	Other Environmental Component(s)

The following text describes the information that should be included in the Wastewater and Marine Water Quality Monitoring sections of ERs and EMPs. Some of this information may already be detailed in preceding or other sections of the ER or EMP, and therefore, does not need to be repeated. In addition, it may be possible to group the monitoring programs for selected, cumulative, and residual impacts into a single monitoring program. If at least one of these two conditions exists, then the location(s) of the water quality monitoring information should be referenced in the appropriate Wastewater and Marine Water Quality Monitoring sections of the ER or EMP.

Background Information

The Wastewater and Marine Water Quality Monitoring sections or other relevant sections of the ER or EMP should provide background information regarding the wastewater generated by all phases of the proposed project. The following information should be included in the appropriate sections:

- All processes that are expected to generate wastewater that will be discharged into a sewerage system or marine waters and/or that will be treated for reuse should be described.
- When relevant, stormwater should be identified as a source of wastewater. This description should include whether the stormwater is discharged into a sewerage system or directly into marine waters.
- Any dredging or reclamation activities that may impact marine waters should be detailed.
- The water balance of the proposed project should be described. A water balance identifies all successive water uses (e.g., sanitary, boiler, cooling, on-site water treatment) and associated flow direction and flow rates (e.g., cubic meters per hour [m^3/hr]). The descriptions should also include a diagram identifying the flow path of water through all uses from source to wastewater outlets. Each outlet should be labeled with an identifier (e.g., O-001, O-002) for reference and association with data and additional descriptions. An example of a water balance diagram is presented in **Figure 1**.
- The structures discharging wastewater into the marine waters and/or sewerage system should be described. The structure associated with each wastewater outlet should be identified with the outlet identifier, as previously described. For discharge of wastewater into marine waters, information on the pipe dimensions, the material(s), and the distance of discharge from the shoreline should also be provided. Some examples of discharge structures include pipe (surface, subsurface), weir, outfall, and diffuser.
- Any pre-treatment or treatment that wastewater, including stormwater, will undergo prior to discharge or reuse should be described. Details regarding the treatment systems and processes, as well as the biological, chemical, and physical properties that will be altered by the treatments should be provided. The ER or EMP should also include a block flow diagram (BFD) and information on the design capacity for each treatment system that is present and used at the proposed project. Relevant design capacity information should be detailed, and

depending on design, could include hydraulic retention time, surface loading rate, organic loading, and nitrification. An example of a BFD is provided in **Figure 2**.

- If treated wastewater will be reused, identification and description of the fate or final use of the treated wastewater should be detailed in the ER or EMP. Specific information that should be detailed includes the entity that will use the treated wastewater, the intended uses of the treated wastewater, and an estimate of the average annual or monthly volume of treated wastewater that will be reused.

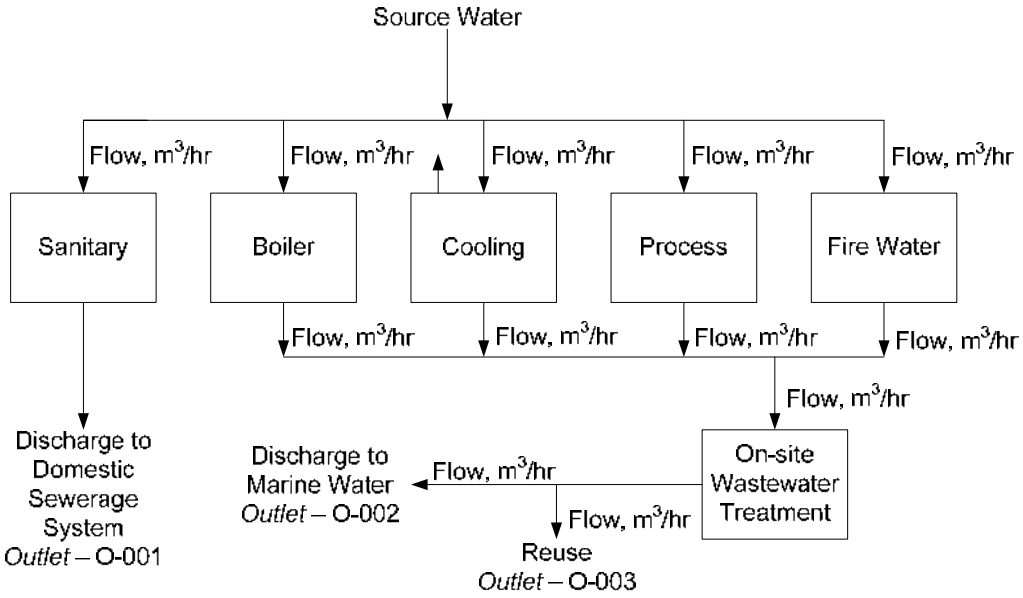

Figure 1. An example of a facility water balance diagram, indicating the source, successive uses, flow rates, and output of water in a proposed project facility.

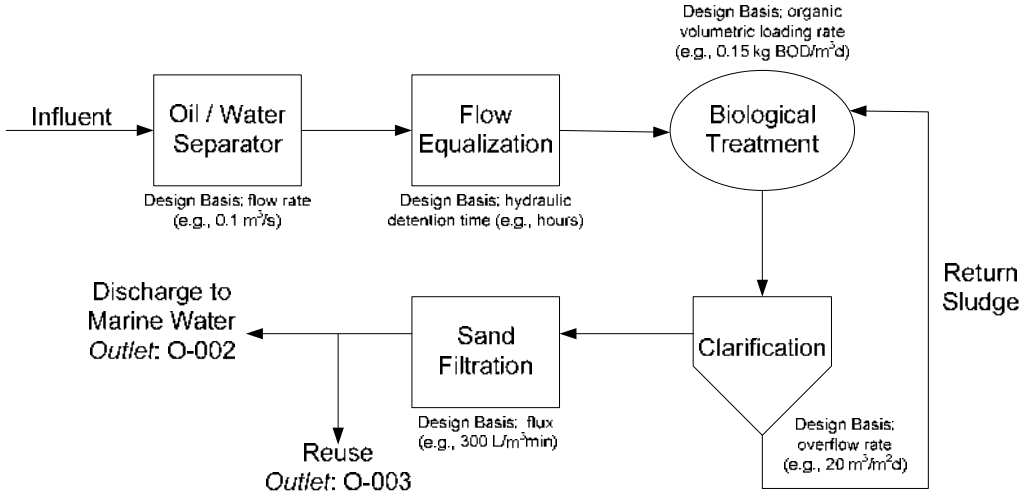

Figure 2. An example of a wastewater treatment plant block flow diagram indicating the source, successive uses, flow rates, and output of water in a proposed project.

Note: L/m^3 min = liters per cubic meter per minute, kg BOD/m^3 d = kilograms of **biological oxygen demand** per cubic meter per day, m^3/s = cubic meters per second, m^3/m^2 d = cubic meter per square meter per day.

Water Quality Standards

The Wastewater and Marine Water Quality Monitoring sections of the ER or EMP should provide background information on probable wastewater and marine water pollutants and the water quality standards that will be adopted for the proposed project. The following information should be detailed in the ER or EMP:

- The probable pollutants in wastewater, including stormwater, discharged into a sewerage system and/or marine waters or wastewater treated prior to reuse should be described.
- The probable pollutants created with dredging and reclamation activity should be described. This information should provide a detailed account of the locations and probable amounts of materials that will be dredged and reclaimed.
- The pollutants that will be monitored in wastewater discharged into sewerage or marine systems, marine water (monitored at sampling locations in the marine waters receiving wastewater and/or dredged material pollutants), and treated wastewater that will be reused should be described.
- The water quality standards to be adopted by the monitoring programs for wastewater, marine water, and treated wastewater that will be reused should be described. UAE standards must be applied, when available. In the absence of such standards, international standards should be adopted. In all instances, the proposed UAE or international standards must be appropriate for the water type and end use (wastewater discharged into a sewerage system, wastewater discharged into marine waters, pollutants within marine waters, or wastewater treated for reuse). In addition, all proposed standards must be justified by the proponent and subsequently approved by EAD. See Annex B for EAD's water quality standards for wastewater discharged into marine waters and for receiving marine waters, as outlined in *Standards and Limits for Pollution to Air and Marine Environments, Occupational Exposure Pesticides, and Chemical Use* (EAD, 2010i).

The pollutants that will be monitored and their associated water quality standards should be presented in a tabular form for each monitored wastewater and/or marine water.

Monitoring Program

The Wastewater and Marine Water Quality Monitoring sections of the ER or EMP should provide relevant information and detailed descriptions of the wastewater and marine water quality monitoring programs that will be adopted by the proposed project. Information should be provided in text, maps, and/or tabular format. Information should also include: a sampling regime; in situ measurements; sample collection, handling, and analysis; monitoring in the event of standard limit exceedances or occurrences of an incident; Wastewater and Marine Water Quality Monitoring Report preparation and submission; and corrective actions for non-compliance. This information is described in the following paragraphs.

Sampling Regime

There should be detailed descriptions of the sampling regimes that will be implemented as part of the wastewater and marine water quality monitoring programs. Specific information that should be provided includes descriptions of sampling locations, sample collection frequency, and the types of samples, which are discussed in the following paragraphs.

Sampling Locations

The total number of and locations for sample collections should be indicated. For pre-treated and non-treated wastewater discharged into a sewerage system or marine waters, a sample should be collected at each outlet and associated with an outlet identifier number (e.g., O-001, O-002). For the receiving marine waters, sampling locations should be determined by ambient conditions and mixing zone analyses and should also be labeled with numeric identifiers (e.g., M-001, M-002). Both the mixing zone and the waters adjacent to the mixing zone should be adequately sampled horizontally and vertically to assess the extent of impact. In cases in which the impact of discharge or dredging on marine systems is expected to be significant and/or alternate methods of determination are not appropriate, the coverage of the mixing zone should be determined by a hydrodynamic model. Examples of suitable models for mixing zone analyses are presented in **Table 2**. If discharged wastewater is expected to have minimal impact on marine systems, delineation of the mixing zone can be determined by using an alternate method. The model or method used to determine the mixing zone

should be clearly described and justified in the ER or EMP. In addition, for each sample location, information on sampling depths and criteria used to determine the depths should also be provided.

For both wastewater and marine water quality monitoring, maps should be provided that indicate the proposed sample locations, associated outlet or marine sample location identifiers, the extent of the modeled or measured mixing zone, and/or locations of dredging and reclamation activity. An example of a map for marine water quality monitoring is presented in **Figure A-1** in Annex A of this Technical Guidance Document.

Sample Collection Frequency

The sample collection frequency (e.g., daily, monthly, quarterly, annually) that will be adopted for the monitoring programs should be provided and justified within the ER or EMP. Sample collection frequency should be described for the wastewater discharged into sewerage systems and marine waters, the wastewater treated for reuse, and/or the receiving marine waters. Sampling frequency may differ by water type.

Types of Samples

The types of samples that will be collected (e.g., grab or composite) for the monitoring programs should be detailed. Descriptions of the sample type should be provided for the wastewater discharged into sewerage systems and marine waters, the wastewater treated for reuse, and/or the receiving marine waters.

Table 2. Mixing Zone Models and Internet References

Model	Internet Reference
CORMIX	http://www.mixzon.com
PLUMES	http://www.epa.gov/ceampubl/swater/vplume/index.html
VisJet	http://www.aoe-water.hku.hk/visjet/visjet.htm
DESCAR	http://www.canarina.com/outfall.htm

The goal of wastewater and marine monitoring is to ensure that water quality standards are not exceeded due to effluent discharges and dredging/reclamation activities. Given the diversity of effluent types and the dynamic nature of tidal and coastal regions, no one sampling regime can be recommended for an adequate assessment at all locations. Site-specific factors should be used to determine the spatial extent of the sampling program. Detailed guidance on the development of an appropriate sampling regime (i.e., sample location and frequency) is provided in the following documents:

- International Organization for Standardization (ISO) 5667-1, *Water Quality—Sampling—Part 1: Guidance on the Design of Sampling Programs and Sampling Techniques (ISO, 2006)*
- ISO 5667-9, *Water Quality—Sampling—Part 9: Guidance on Sampling from Marine Waters* (ISO, 1992)
- *Handbook for Sampling and Sample Preservation of Water and Wastewater* (U.S. EPA, 1982).

In Situ Measurements

The wastewater and marine water quality monitoring programs outlined in the ER or EMP should include detailed descriptions of any in situ (field) water quality monitoring (ISWQM) measurements that will be conducted at the sampling locations. These measurements could be conducted on wastewater at discharge outlets and/or at the sampling locations in the marine waters. ISWQM measurements are typically collected for parameters that have short holding times (i.e., less than

15 minutes), and thus are not practical for laboratory analysis. Parameters that are commonly included in ISWQM are pH, temperature, conductivity, dissolved oxygen, turbidity, free chlorine, and salinity.

The field equipment used for in situ wastewater and marine water quality monitoring should only be used for their intended purposes. In addition, the calibration and maintenance of the field monitoring equipment should follow the manufacturers' instructions. Flow measurement devices should be maintained and operated in a way to ensure accurate, reproducible results. Recommended good practices for flow rate measurement are outlined in The Environment Agency's guides, *Minimum Requirements for the Self-monitoring of Effluent Flow Version 3.2* (The Environment Agency, 2008), and *Performance Standards and Test Procedures for Continuous Water Monitoring Equipment Part 1—Performance Standards and Test Procedures for Automatic Water Sampling Equipment Version 2.1* (The Environment Agency, 2009a).

ISWQM measurements should be collected at the time of sampling and should be recorded in an ISWQM data record form or in similar documentation. If an outlet is not discharging during a sampling event, then the date and time of the visit and "no flow" should be recorded for this outlet. A sample ISWQM Data Record Form is presented **Table A-1** in Annex A of this Technical Guidance Document and is available on EAD's Web site. The following information should be recorded for all ISWQM measurements and presented on the ISWQM Data Record Form or on an equivalent document:

- Name, address, and telephone number of the facility
- Date and time of monitoring
- Permit number
- Monitoring station or outlet identifier(s)
- Sample depth (marine monitoring stations only)
- Name of the person who collected the in situ measurements
- Flow rate (outlets only)
- Results of the monitored parameters
- Weather conditions during monitoring
- Any relevant notes
- Make and model of the field meter, the calibration date, the parameters measured, and the name of the person who conducted the calibration
- Flow measurement device or method, the calibration date, and the name of the person who conducted the calibration.

ISWQM Data Record Forms or equivalent documents should be submitted in the appendix of the Wastewater and Marine Water Quality Monitoring Reports for the corresponding reporting period (described in Section III of this Technical Guidance Document). An EAD–approved and –registered environmental consultant operating within Abu Dhabi Emirate or employees of the proposed project can collect the in situ measurements and complete the form. In both cases, EAD must approve the sampling and in situ measurement protocol detailed within the ER or EMP, and the person or company collecting the in situ measurements should strictly adhere to this protocol.

Sample Collection, Handling, and Analysis

The Wastewater and Marine Water Quality Monitoring sections of the ER or EMP should include detailed descriptions of the processes and protocols for sample collection, handling, and analysis.

Sample Collection and Handling

The sample collection and handling procedures that will be implemented for wastewater and marine water quality monitoring should be described. Sample collection should be conducted in a manner that is representative of the discharge or monitoring location and depth. In addition, the samples should be

handled in a manner that is standardized and ensures the highest level of analysis precision and accuracy. The following documents provide guidance and examples of good practices for the collection and handling of representative wastewater and marine water quality samples:

- ISO 5667-1, *Water Quality—Sampling, Part 1: Guidance on the Design of Sampling Programs and Sampling Techniques* (ISO, 2006)
- ISO 5667-2, *Water Quality—Sampling, Part 2: Guidance on Sampling Techniques* (ISO, 1991)
- ISO 5667-3, *Water Quality—Sampling, Part 3: Guidance on the Preservation and Handling of Samples* (ISO, 2003)
- *Standard Methods for the Examination of Water and Wastewater* (APHA, 1998).

An EAD–approved and –registered environmental consultant operating within Abu Dhabi Emirate or employees of the proposed project can collect the wastewater and marine water quality samples. In both cases, EAD must approve the sample collection protocol detailed within the ER or EMP. In addition, the person or company collecting the in situ measurements must strictly adhere to this protocol. A chain-of-custody document should also accompany the samples from the time of collection to delivery at the laboratory for analysis. The chain of custody should include the following information:

- Name of the facility
- Name of the person who collected the samples, along with full contact information (i.e., name, affiliation, address, phone number, fax number, e-mail address, and Web site)
- Sample type (e.g., composite or grab)
- Container type and number
- Name of laboratory that conducted the analyses
- Unique Laboratory ID that correlates to the Sample ID
- Required analyses
- Preservative
- Method of delivery
- Laboratory delivery date and time
- The name of the person who relinquished the sample and the date and time
- The name of the person who received the sample and the date and time
- Any special instructions.

Sample Analysis

Details should be provided regarding the protocol, methods, analysis laboratory, and quality assurance and quality control (QA/QC) measures that will be adopted for sample analysis associated with the wastewater and marine water quality monitoring programs. Sample analysis should follow a standard protocol and be performed using methods that are accurate, repeatable, and considered to be good international practice. The following documents outline good practices, QA/QC protocols, and approved standard methods of analysis used for water quality monitoring:

- The U.S. *Code of Federal Regulations*, Title 40—Protection of Environment, Chapter 1, U.S. Environmental Protection Agency, Sub-chapter D, Water Programs Part 136—*Guidance for Establishing Test Procedures for the Analysis of Pollutants*
- *Methods for the Examination of Waters and Associated Materials* (The Environment Agency, 2009b)
- *Standard Methods for the Examination of Water and Wastewater (20th edition)* (APHA, 1998).

The laboratory conducting the sample analyses for the wastewater and marine water quality monitoring programs should be an EAD–registered laboratory. This laboratory should follow

standardized, internationally accepted procedures and methods; use internationally accepted analysis equipment; and provide a report for each set of analyses. This report should contain critical information that ensures the quality of the data used in reporting. The following information should be presented in these reports:

- Name and contact information of the laboratory
- Laboratory accreditation
- Sample Laboratory ID that correlates to a Sample ID (if different)
- Sample collection date and time
- Analysis date and time
- Laboratory method used
- Detection limit and identifier (e.g., method detection limit [MDL])
- Name of the person who performed the analyses
- Analytical results and the units of measure.

The Wastewater and Marine Water Quality Monitoring sections of the ER or EMP should also describe the QA/QC measures used when performing laboratory analyses, as well as the protocol for handling samples below detection. The test method used for analysis must have a detection limit less than the lowest EAD limit for the specific parameter. In addition, the laboratory and/or proponent should adopt and describe a standardized approach for reporting analysis results that are below the detection limit of the method and/or instrument. A common practice is to use the median point between zero and the MDL.

Monitoring Sample Record Forms

The record keeping or documentation protocol that will be used for the wastewater and marine water quality monitoring programs should be described. Outlet Monitoring Data Record (OMDR) and Marine Monitoring Data Record (MMDR) Forms, or equivalent documentation, should be maintained for each monitoring station. Examples of the OMDR and MMDR Forms are presented as **Tables A-2** and **A-3**, respectively, in Annex A of this Technical Guidance Document. Electronic spreadsheet versions of these forms are available on EAD's Web site.

Data from the ISWQM and the laboratory reports are used to complete the OMDR and MMDR Forms. For each sampling event, the concentration of each parameter and associated flow rate, if applicable, are used to calculate the mass loading. The minimum, maximum, and average concentrations and mass loading for each parameter are determined for the duration of the reporting period. If the laboratory reports a "non-detect" or a value less than the detection limit (e.g., <0.005 milligrams per liter [mg/L] or MDL), it is suggested that half of the reported detection limit (or the midpoint between zero and the MDL) be used in the calculations. The OMDR and MMDR Forms for each monitoring station should be completed and submitted in the appendix of the Wastewater and Marine Water Quality Monitoring Report for the corresponding reporting period (see Section III of this Technical Guidance Document).

Monitoring in the Event of Standard Limit Exceedance or Occurrence of an Incident

The Wastewater and Marine Water Quality Monitoring sections of the ER or EMP should include detailed descriptions of the processes and protocols that will be used in the event of standard limit exceedance or occurrence of an incident.

Standard Limit Exceedance

If there is an exceedance of a water quality standard, then additional monitoring is necessary to determine the duration, extent, and potential causes of the exceedance. The wastewater and marine water quality monitoring programs within the ER or EMP should clearly describe the monitoring program that will be enacted following the detection of a standard limit exceedance. Monitoring

frequency should be increased to an appropriate level and samples should be collected in the standard limit exceedance waters (wastewater, treated wastewater, and/or marine waters) until non-exceedance or ambient levels are recorded for at least three consecutive sampling events. The increased monitoring frequency proposed within the ER or EMP should be consistent with the frequency necessary to determine the source of exceedance and remedy the situation as quickly as possible. For standard limit exceedances in treated or non-treated wastewater, samples should be composites of sequential samples collected hourly for an appropriate time period. The selected time period should capture the fluctuations associated with the facility operation cycle (e.g., if the facility operates on an 8-hour cycle, then the composite sample should consist of samples collected each hour for 8 hours). For standard limit exceedances in marine waters, samples should be collected at the locations where the standards were exceeded and at adjacent locations to document the spread and extent of the exceedance. Each standard limit exceedance and monitoring event following the exceedance should be documented in a Standard Limit Exceedance Record (SLER) Form or in equivalent documentation. In addition, the sources of the exceedance and actions taken to correct the problem should be identified. **Table A-4** in Annex A of this Technical Guidance Document provides an example of an SLER Form that could be used to record standard exceedances. An electronic spreadsheet version of this form is available on EAD's Web site. All SLER Forms or equivalent documents should be submitted in the appendix of the Wastewater and Marine Water Quality Monitoring Reports for the corresponding reporting period (described in Section III of this Technical Guidance Document).

If exceedance problems are ongoing and/or not properly corrected, then EAD may require the proponent of the proposed project to create an Environmental Action Plan (EAD, 2010j).

Occurrence of Incident

If an incident could potentially impact wastewater or marine water quality, then additional water quality monitoring may be necessary. As per the instructions for EMPs, the proponent must notify EAD as soon as possible when an incident occurs. The proponent should also document this incident and its potential impact on wastewater or marine water quality, providing as much detail as possible. **Table A-5** in Annex A of this Technical Guidance Document provides an example of a standard Non-normal Operations Record (NNOR) Form that could be used to document incidents. An electronic spreadsheet version of this form is available from EAD's Web site. All NNOR Forms or equivalent documents should be submitted in the appendix of the Wastewater and Marine Water Quality Monitoring Reports for the corresponding reporting period (described in Section III of this Technical Guidance Document).

When a major incident occurs and EAD is notified, EAD staff will visit the project site and determine any requirements for additional monitoring efforts. The objective of additional monitoring would be to characterize the impact of the incident on water quality and the length of time before conditions return to non-exceedance or ambient condition levels. Typically, minor incidents would not require additional monitoring.

The Wastewater and Marine Water Quality Monitoring sections of the ER or EMP should state a commitment to follow these procedures. These sections should also list potential minor and major incidents that could occur at the project site and impact wastewater and/or marine water quality. The names and contact information of the persons responsible for managing and notifying EAD of incidents should also be provided.

Wastewater and Marine Water Quality Monitoring Report Preparation and Submission

The objectives, content, and format of Wastewater and Marine Water Quality Monitoring Reports are outlined in Section III of this Technical Guidance Document. These sections of the ER or EMP should include the names of the persons responsible for managing the preparation and submission of Monitoring Reports. An EAD–approved and –registered environmental consultant or laboratory should prepare and submit the Monitoring Reports to EAD.

If required, Wastewater and Marine Water Quality Monitoring Reports should be submitted to EAD on a regular basis. For most proposed projects, Monitoring Reports are submitted quarterly. The Wastewater and Marine Water Quality Monitoring sections of the ER or EMP should state a commitment to this reporting frequency. Alternate reporting frequencies are possible, but must be justified by the proponent and approved by EAD. Upon review, EAD may request a different reporting frequency.

Corrective Actions for Non-Compliance

The Wastewater and Marine Water Quality Monitoring sections of the ER or EMP should also describe the corrective actions that will be implemented if monitoring data indicate that mitigation measures are not meeting water quality standards and/or residual impacts are adversely affecting wastewater or marine water quality beyond an acceptable level. Within these descriptions, there should be specific details about any process and/or equipment modifications that will occur. The time frame for making these corrective actions should also be included in these descriptions.

Section III. Monitoring Report Format and Content

The objective of Wastewater and Marine Watery Quality Monitoring Reports are to routinely document and summarize the results from the wastewater and marine water quality monitoring programs. The proponent of the proposed project should prepare these Monitoring Reports in accordance with the schedule outlined in the ER or EMP and approved by EAD. These Monitoring Reports should be submitted to EAD according to the guidelines outlined in *Technical Guidance Document for Submission of Environmental Permit Applications and Environmental Studies* (EAD, 2010h).

Each Wastewater and Marine Watery Quality Monitoring Report prepared by the proponent should follow the suggested layout and contain a cover page, objectives, sample collections and measurements, monitoring results, incidents, and appendix, which are described below.

1. Cover Page

The cover page of the Monitoring Report should include the name of the project and/or facility, the complete contact information of the proponent preparing and submitting the Monitoring Report, the reporting period, and the date of preparation.

2. Objectives

The Objectives section of the Monitoring Report should state the objectives of the report and the reporting period, corresponding to the range of dates within which all sample collections and/or in situ measurements were conducted. If any of the following items are being monitored, then they should be included in this section of the Monitoring Report:

- Wastewater discharged into the sewerage system
- Wastewater discharged into marine waters
- Wastewater treated for reuse
- Marine waters.

3. Sample Collections and Measurements

The Sample Collections and Measurements Section of the Monitoring Report should discuss the number and type of wastewater and/or marine water samples that were collected and the in situ measurements that were conducted. If any sampling locations (i.e., outlets or marine water sample locations) were not sampled during the reporting period, then these locations should be listed and a justification for the absence of sample collection at each should be provided.

4. Monitoring Results

The Monitoring Results section of this report should discuss the results from the monitoring of wastewater and/or marine waters. The results for each monitoring location (outlet and marine water) should be summarized in a Water Quality Monitoring Summary Report (WQMSR) or an equivalent form. An example of the WQMSR Form is shown as **Table A-6** in Annex A of this Technical Guidance Document. An electronic spreadsheet version of this form is available on the EAD's Web site. The following information should be included in the WQMSR:

- Facility name and address
- Reporting period
- Individual responsible for completing report
- Permit number
- Monitoring station or sampling location
- Laboratory performing analyses
- Minimum, maximum, and average concentrations of a parameter
- Minimum, maximum, and average mass loadings of a parameter
- Number of sampling events
- Standard limit (e.g., UAE or EAD limit)
- Number of exceedances
- Laboratory method detection limit
- Any notes
- Explanation of exceedances
- Occurrence of exceedances during previous reporting periods (indicate each relevant reporting period and the corresponding number of exceedances)
- Planned actions to prevent or reduce future exceedances.

The OMDR and MMDR Forms or equivalent forms that detail the results and sampling information presented in the summary should be included in the appendix of the Monitoring Report.

5. Standard Limit Exceedance

The Standard Limit Exceedance section of the Monitoring Report should provide detailed descriptions of standard limit exceedances events in monitored wastewaters and/or marine waters that occurred during the reporting period. SLER Forms or equivalent documentation reporting the details of exceedance events should be included in the appendix of the Monitoring Report.

6. Incidents

The Incidents section of the Monitoring Report should describe the occurrence of any minor or major incident that occurred during the reporting period and could impact wastewater and/or marine water quality. The NNOR Form or equivalent documentation reporting the details of the incident should be included in the appendix of the Monitoring Report. If a major incident occurred and additional monitoring was required, then the corresponding report forms should also be included in the appendix of the Monitoring Report.

7. Appendix

The appendix should contain all the water quality monitoring forms that were generated during the reporting period and referenced within the Monitoring Report.

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Annex A

Figure A-1. Example of a map indicating sampling locations for marine water quality measurements.

Table A-1. Example of a Blank in situ Water Quality Monitoring Data Record Form

IN SITU WATER QUALITY MONITORING (IWQM) DATA RECORD

Facility:		Individual Completing This Sheet:	
Permit No.:			

Calibration Record				
Field Meter Model	Parameters Measured	Calibration Date	Calibrated By	Notes

Flow Measurement—Outlets Only			
Monitoring Station	Flow Measurement Method	Calibration Date	Calibrated By

Monitoring Station	Date and Time	Flow Rate (Outlets)	Depth (Marine)	pH	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µmhos/cm)	Turbidity (NTU)	Salinity	Weather Conditions	Individual Conducting Monitoring

NOTES:

Note: °C = degrees Celsius, mg/L = milligrams per liter, NTU = Nephelometric Turbidity Units, µmhos/cm = micromhos per centimeter.

Table A-2. Example of a Blank Outlet Monitoring Data Record

OUTLET MONITORING DATA RECORD (OMDR)

Facility:	
Individual Completing This Sheet:	
Outlet No.	
Permit No.:	
Laboratory Performing Analyses:	

				Pollutant:			Pollutant:			Pollutant:			Pollutant:		
Sample Date and Time	Sample ID	Sample Type (Grab/Composite)	Flow Rate (m^3/d)	Concentration (mg/L)[a, b]	Mass Loading (kg/d)[c]	Analysis Date	Concentration (mg/L)[a, b]	Mass Loading (kg/d)[c]	Analysis Date	Concentration (mg/L)[a, b]	Mass Loading (kg/d)[c]	Analysis Date	Concentration (mg/L)[a, b]	Mass Loading (kg/d)[c]	Analysis Date
					0			0			0			0	
					0			0			0			0	
					0			0			0			0	
					0			0			0			0	
					0			0			0			0	
					0			0			0			0	
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					0			0			0			0	
					0			0			0			0	
					0			0			0			0	
					0			0			0			0	
		Minimum	0	0	0	Minimum	0	0	Minimum	0	0	Minimum	0	0	
		Maximum	0	0	0	Maximum	0	0	Maximum	0	0	Maximum	0	0	
		Average			0	Average		0	Average		0	Average		0	

Note: g/kg = grams per kilogram, g/m^3 = grams per cubic meter, kg/d = kilograms per day, m^3/d = cubic meters per day, MDL = method detection limit, mg/L = milligrams per liter.

[a] Non-detects should be reported as MDL/2.

[b] g/m^3 = mg/L

[c] Mass loading, kg/d = (concentration, g/m^3)*(flow rate, m^3/d)/(10^3 g/kg)

Table A-3. Example of a Blank Marine Monitoring Data Record

MARINE MONITORING DATA RECORD (MMDR)			
Facility:		Individual Completing This Sheet:	
Monitoring Station:			
Permit No.:			
Laboratory Performing Analyses:			

				Pollutant:		Pollutant:		Pollutant:		Pollutant:	
Sample Date and Time	Sample ID	Sample Type (Grab/Composite)	Sample Depth (m)	Concentration (mg/L)[a, b]	Analysis Date	Concentration (mg/L)[a, b]	Analysis Date	Concentration (mg/L)[a, b]	Analysis Date	Concentration (mg/L)[a, b]	Analysis Date
		Minimum			Minimum		Minimum		Minimum		
		Maximum			Maximum		Maximum		Maximum		
		Average			Average		Average		Average		

Note: m = meter, MDL = method detection limit, mg/L = milligrams per liter.

[a] Non-detects should be reported as MDL/2.

[b] g/m^3 = mg/L

Table A-4. Example of a Standard Limit Exceedance Form to Document a Standard Limit Exceedance Event and Increased Water Quality Monitoring Following the Event

Standard Limit Exceedance Record (SLER)			
Facility:		**Individual Completing This Sheet:**	
Permit No.:			
Laboratory Performing Analyses:			

Standard Exceedance Event Description						
Monitoring Station or Location	**Parameter**	**Sample ID**	**Sample Collection Date and Time**	**Value**	**Units**	**Standard Limit**

Water Quality Data—Post-Exceedance monitoring						
Monitoring Station or Location	**Parameter**	**Sample ID**	**Sample Collection Date and Time**	**Value**	**Units**	**Notes**

Cause of Exceedance
Please describe the cause of the event:

Corrective Action
Please describe your Corrective Action Plan and/or corrective actions taken:

Table A-5. Example of a Non-normal Operation Record Form to Document the Occurrence of an Incident That Could Impact Wastewater or Marine Water Quality

Non-normal Operation Record (NNOR)			
Facility:		**Individual Completing This Sheet:**	
Monitoring Station:			
Permit No.:			
Laboratory Performing Analyses:			

Event Description						
Outlet(s) Emitting Discharge	**Start Date and Time of Event**	**Finish Date and Time of Event**	**Date and Time Event Reported**	**Estimated Volume of Discharge (m^3)**	**Impacted Receiving Water(s)**	**Observable Impacts**

Water Quality Data						
Parameter	**Monitoring Station or Location**	**Date and Time**	**Value**	**Units**	**Sample ID**	**Notes**

Cause of Event
Please describe the cause of the event:

Corrective Action
Please describe your Corrective Action Plan:

Note: m^3 = cubic meter.

Table A-6. Example of a Blank Water Quality Monitoring Summary Report

WATER QUALITY MONITORING SUMMARY REPORT (WQMSR)

Facility:		**Reporting Period:**	
Individual Responsible for Completing Report:		**Permit No.:**	
Monitoring Station:		**Laboratory Performing Analyses:**	

Parameter	Concentration				Mass Loading (Outlets Only)				Number of Sampling Events	EAD Limits	Number of Exceedances	Previous Exceedances (Reporting Period[s] and Corresponding Number of Exceedances)	Laboratory MDL	Notes
	Minimum	Maximum	Average	Units	Minimum	Maximum	Average	Units						

Note: MDL = method detection limit.

Provide and explanation of all exceedances:
Provide planned actions to prevent or reduce future exceedances:

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