SOIL QUALITY PROTECTION TECHNICAL NOTE

الدقم Duqm
هيئة المنطقة الاقتصادية الخاصة
Special Economic Zone Authority

Environment Regulatory Department

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List of Acronyms

BGL	Below Ground Level
BMP	Best Management Practices
CEMP	Construction Environmental Management Plan
DEMP	Decommissioning Environmental Management Plan
EIA	Environmental Impact Assessment
IDZ	Industrial Development Zone
MD	Ministerial Decree
MECA	Ministry of Environment and Climate Affairs
OEMP	Operational Environmental Management Plan
PPGN	Pollution Prevention Guidance Notes
QA/QC	Quality Assurance/ Quality Control
RD	Royal Decree
SEZ	Special Economic Zone
SEZAD	Special Economic Zone Authority of Duqm
SQPTN	Soil Quality Protection Technical Note

1 Introduction

1.1 Objectives

The Soil Quality Protection Technical Note (SQPTN) has been developed as part of a set of technical notes for the Environmental Requirements of the Special Economic Zone (SEZ) at Duqm. The SQPTN includes a description of the relevant national and international soil quality related standards, environmental permit requirements, methodologies for undertaking soil quality monitoring and assessments and relevant industry-specific pollution prevention guidelines.

The SQPTN is intended for future applicants whose proposed industries may adversely affect soil quality. The SQPTN is a comprehensive document that ensures compliance with the standards and provides guidance on the environmental requirements during the pre-construction, construction, operation and decommissioning phases of the Project.

Generally, the term “Soil Quality” refers to soil health and is defined as the capacity of the soil to function as a vital living ecosystem that sustains plants, animals, and humans. However, due to the nature of the Project, the overall objective is not to focus on soil as a natural resource but as a potential transport and exposure medium for contaminants. Contaminated lands may involve soils or subsurface soils that through leaching and transport, may affect groundwater, surface water and ultimately human health. Henceforward, the term “Soil Quality”, in this Technical Note, shall refer to soil contamination. The SQPTN aims to avoid soil contamination by providing monitoring and assessment methodologies, as well as Best Management Practices (BMP) and general Pollution Prevention Guidance Notes (PPGN).

The related applications which might impact the soil quality, shall be assessed and reviewed by the Special Economic Zone Authority at Duqm (SEZAD) Environmental Regulatory Department with specific requirements detailed on a case by case basis.

1.2 Project Information

The SEZ at Duqm is an integrated economic development area that covers 2,000 square kilometres. The SEZ is located in the Wilayat of Duqm on the south-east coast of Oman. The coastline of Wilayat Duqm is approximately 170 km in length, with the northern boundary lying between Nafun and Sidera, and the southern boundary being approximately 120 km south of Ras al Madrakah. Ghubbat Al Hashish and Barr Al Hikman lie to the north of the Al Wusta Region and Ras al Madrakah in the south.

The SEZ is composed of zones that include the Duqm port, the ship dry dock, the oil refinery, the regional airport, the residential, commercial and tourism area, the logistic services area, fisheries area and the industrial.

This SQP Technical Note applies to all industries in the SEZ area. Figure 1-1 specifies the boundaries of the SEZ as per RD 5/2016.

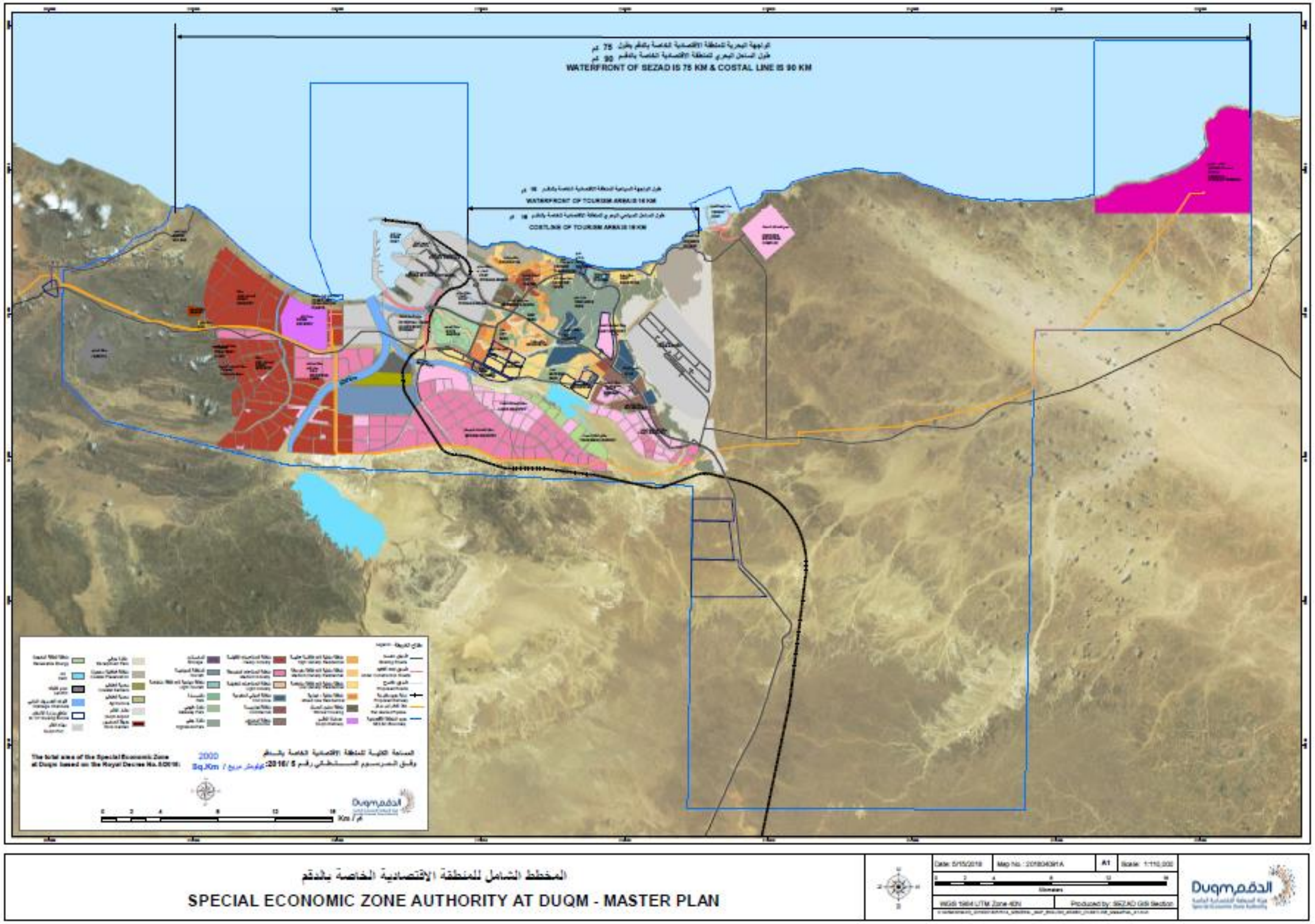

Figure 1-1: SEZD Area

2 Applicable Standards

In accordance with Royal Decree (RD 79/2013), SEZAD-Environmental Regulatory Department has the functions of the Ministry of Environment and Climate Affairs (MECA) in relation to issuing environmental permits for projects and implementing environmental regulations within the SEZ.

This Chapter details the applicable standards and legislation for soil quality management within the SEZ. At all times local requirements will override international requirements. The international standards are to be complied with, only in the absence of local standards.

Table 2-1 lists the relevant legislation and guidelines applicable to soil quality requirements.

*** It shall be noted that within SEZ, SEZAD will have the authority of concerned Ministries mentioned in the below national regulations.**

Table 2-1: Regulations relevant to soil quality

Soil Quality Regulations	
National	
RD 114/2001	Law for the Conservation of the Environment and Prevention of Pollution
MD 145/1993	Regulations for Wastewater Reuse and Discharge
MD 421/1998	Regulations For Septic Tanks, Soak away Pits, and Holding Tanks.
MD 79/2006	Specifications and requirements of sub-surface reservoirs for storage of Hydrocarbons and hazardous materials.
MD 12/2017	Amending some articles of MD 145/1993
International	
Dutch Standards (2009)	Soil and Groundwater standards (target and intervention values)

2.1 National Standards

The applicable regulations that might have an impact on soil quality are summarised below.

Each legislation has only been briefly summarised within this Chapter to provide an introduction to the legislation. The applicant is required to refer to the complete official copy of the legislation and standards in-order to identify all applicable requirements.

2.1.1 RD 114/2001: Law for the Conservation of the Environment and Prevention of Pollution

The articles of RD 114/2001 provide guidance on allowable discharge into wadis, watercourses, groundwater recharge areas, rainwater and flood drainage systems or aflaj and their channels. It also notes that it is not permitted to use or to discharge untreated wastewater in the above mentioned places. No treated wastewater should be used or discharged unless a permit to that effect is obtained according to applicable procedures and conditions.

The discharge of untreated water can have impact on the quality of soil in the area if the wastewater is not treated up to the above standards.

2.1.2 MD 145/1993: Regulations for Wastewater Reuse and Discharge

MD 145/1993 sets out standards for wastewater re-use on land (i.e. for agricultural and irrigation use) to be used as the design basis for treatment plants both temporary and permanent, and other applicable uses. Maximum permissible concentrations of various pollutants in the wastewater have also been specified in MD 145/1993. The discharge of untreated water can have impact on the quality of soil in the area if the wastewater is not treated up to the above standards.

2.1.3 MD 421/1998: Regulations for Septic Tanks, Soak away Pits, and Holding Tanks

MD 421/1998 regulates the provision of septic tanks, soakaway pits and holding tanks and provides (1) a methodology to calculate capacity of septic tanks, (2) design and measurement criteria for septic tanks and holding tanks, (3) a procedure to test for percolation and design soakaway pit.

Septic/holding tanks can have impact on the quality of soil in the area if not constructed up to the above standards and/or in the event of leakage.

2.1.4 MD 79/2006 – Regulation specifying requirements of sub-surface reservoirs for storage of Hydrocarbons and hazardous materials

The above MD sets out the specification and requirements of the underground storage of hydrocarbons and hazardous materials. Article 2 of the Decision specifies that construction of tanks for the storage of hydrocarbons or any hazardous materials will be allowed only after obtaining an environmental permit from the Ministry in accordance with the specifications and requirements provided in the

Decision.

The tank specification as well requirement of monitoring wells to monitor the impact on groundwater from the tanks are also specified in Article 2. The underground storage of hazardous and hydrocarbon materials might have an impact on soil quality if the same is not constructed and maintained properly as well as in the event of leakage from the storage area.

2.1.5 MD 12/2017 – Regulation amending MD 145/93

The decision has added the following wastewater types to MD 145/93 and the decision requires that a separate permit/discharge license is obtained for the same from the Ministry/ Authority.

- Discharge of treated waste water;

- Discharge of produced water from oil production;
- Discharge of reject water from desalination plant;
- Discharge of waste water to evaporation pond;
- Permit to discharge water (NOL)

2.2 International Standards

In the absence of standards for soil quality in Oman, reference has been made to the Netherlands Ministry of Housing, *Spatial Planning and the Environment Values Standards* also known as the *'Dutch Standards'* (Ministry of Housing, Spatial Planning and Environment Directorate General for Environmental Protection, 2009)[1].

The 'Dutch Soil Remediation Circular 2009' adapted to the new soil management policy as set out in the Soil Quality Decree, contains guidelines for the use of remediation criteria to determine the severity of pollution and whether urgent remediation is necessary. This Circular contains indicative levels of contamination as well as Intervention Values for soil.

Soil Intervention Values are the maximum tolerable concentrations above which remediation is required. This occurs if one or more compounds in concentrations equal to or higher than the Intervention Value is found in more than 25 m^3 of soil.

Values for soil/sediment are expressed as the concentration in a standard soil (10% organic matter and 25% clay). Intervention Values vary according to the clay and organic matter content of the soil and therefore it is recommended that site specific values be considered when applying the Dutch Standards internationally. In other words, the intervention values provided are converted to values that apply to the actual soil being assessed on the basis of the measured organic matter and clay. The converted values can then be compared with the measured concentrations in the soil.

❖ *Soil Type Correction Formula for Metals*

The following soil type correction formula can be used for the conversion for metals:

(IW) b = (IW) sb x [{A + (B x % clay) + (C x % organic matter)} / {A + (Bx25) + (C x 10)}]

In which:

- (IW) b = intervention value for the soil being assessed
- (IW) sb = intervention value for standard soil
- % clay = measured percentage clay in the soil being assessed. A clay content of 2% is assumed for soil with a measured clay content below 2%.

[1] 'Dutch Soil Remediation Circular 2009' (Rijkswaterstaat, 2009)

- % organic matter = percentage organic matter measured in the soil being assessed. An organic matter content of 2% is measured for soil with a measured organic matter content below 2%.

3 Environmental Permitting Requirements

3.1 Environmental Regulatory Procedure

The environmental permitting requirements within SEZ are governed by SEZAD Environmental Regulatory Department. A summary of the permitting procedure is outlined below:

1. In accordance with SEZAD Decision 326/2015, the SEZAD Environmental Regulatory Department have developed a list of projects within the SEZ that require an Environmental Impact Assessment (EIA).
2. MECA regulation promulgated under MD 48/2017, issued in May 2017, has categorised the projects into three types and has listed the projects, which require EIA study. MD 48/2017 shall also be taken into consideration during the permitting requirement.
3. For projects requiring an EIA study, the development shall undergo the following:
    - Scoping study, identifying the topics and methodology, that need to be included in the EIA. Reviewing of scoping report takes up to 15 days.
    - On approval of scoping study, an EIA study is conducted and submitted to SEZAD. The reviewing of an EIA report shall take 40 days as per SD 326/2015.
4. On approval of the EIA report, a permit application is submitted to SEZAD with required documents.
5. For projects, which do not require an EIA study, the development can directly go for permitting, with the required documents.
6. For projects not listed in SD 326/2015 and/or which falls in Category C of MD 48/2017, a screening exercise is conducted by SEZAD Environmental Regulatory Department, depending on the project application, and a screening opinion,[2] is provided.

3.2 Environmental Impact Assessment (EIA)

The EIA study shall be developed by a MECA registered environmental consultant[3]. SEZAD have the authorization to reject environmental reports which are conducted by companies who are not registered with MECA to undertake these studies.

Detailed EIA is a procedure undertaken for those projects with major/significant impacts to the environment. For an industrial project, the EIA generally would assist in determining site suitability

[2] SEZAD reserves the right to request EIA study for projects that are not listed in the regulations. This shall be decided during the screening stage of the project and depending on type of project and likely impacts

[3] A list of the MECA registered environmental consultants can be obtained from MECA.

as well as the necessary environmental control and mitigation measures.

The objectives of the EIA are summarised as follows:

- To examine and select the best from the project options available;
- To identify, predict and assess significant residual environmental impacts;
- To recommend and incorporate into the project plan, appropriate abatement and mitigating measures; and
- To identify the environmental costs and benefits of the project to the community.

For details on Environmental Impact Assessment, Refer SEZAD Environmental Impact Assessment Guideline.

3.2.1 Construction Environmental Management Plan (CEMP) / Operational Environmental Management Plan (OEMP) / Decommissioning Environmental Management Plan (DEMP)

A CEMP/OEMP/DEMP is a practical plan of management measures which are designed to minimise environmental impacts from the construction and operation phase of a project. The document will need to outline the below requirements (at a minimum):

- Site specific activities of the development.
- Address the associated environmental and heritage issues.
- Provide planned management strategies to avoid and minimise impacts.
- A CEMP/OEMP/DEMP will also provide a management plan for how wastes generated by the activities will be contained and cleaned-up appropriately.

Refer SEZAD Environmental Impact Assessment Guideline for details on CEMP/OEMP.

4 Monitoring and Assessment Methodologies

To identify the presence of contamination, this Chapter addresses soil quality monitoring and assessment methodologies for all the Project phases.

4.1 Monitoring Methodology

Monitoring methodologies are discussed for all the Project phases to develop the baseline soil conditions and to ensure adequate soil quality.

The suggested monitoring methodologies are considered common for all proposed industries in the SEZ, except for the parameters to be analysed during the operation phase, as they are industry-specific.

Where soil monitoring reveals contamination in excess of the required standards, a Soil Management Program shall be required to establish a soil monitoring proposal with remediation options, disposal locations, and periodic progress reports. However, it is beyond the scope of this Technical Note to define specific requirements for this management program.

4.1.1 Baseline Monitoring - Before Construction

All companies in SEZ shall conduct a Zero Soil Survey (soil and groundwater) and an End Survey, for the beginning and end of a tenant's lease period, respectively.

- The zero survey report has to give a very clear description of the soil quality at the beginning of the tenancy period and shall serve as the reference quality when the plot is leased back.
- If the End survey indicates new or increased contamination of soil (ground or groundwater) the tenant shall be liable to propose and carry out a mutual agreed plan to remediate the contamination to the level of the zero survey.
- Contractors or tenants who carry out soil surveys must comply with Oman law and regulations.

Based on the above, a thorough site assessment and remediation prior to construction is the best approach to understand and reduce the potential for ongoing contaminant liability. Therefore, the Project applicant shall establish the existing soil conditions on the site, either through up-to-date environmental information, or by carrying out a thorough baseline soil investigation prior to the start of construction.

The soil investigations shall determine the geological profile and the presence of any contamination. These investigations shall comprise of the following:

- Drilling boreholes – including rock coring;
- Machine excavated trial pits;
- Collection of soil samples from boreholes and trial pits; and,
- Laboratory testing of soil samples to determine physical and chemical parameters.

4.1.1.1 Sampling Locations

Soil sampling locations shall be selected within the site boundaries to represent all soil types within the site. A non-targeted sampling approach, using the grid sampling methodology, is recommended as it provides a more complete coverage of the area than the random methods.

4.1.1.2 Number of Sampling Points

The number of sampling points is dependent of the size of the Project area, as presented in Table 4.1, and on the variability of the surficial geology and landscape. Samples shall be collected from all major soil types to allow adequate characterization of site variability.

Table 4-1: Number of Sampling Points

Site Area (m^2)	Number of Drilling/Trial Pits points
< 10,000	At least 5 points
10,000-50,000	From 5 to 15 points
50,000-250,000	From 15 to 60 points

4.1.1.3 Collection of Samples

Two (2) approaches can be used for collecting soil samples.

1- The first approach, is collecting soil samples from trial pits which have the advantage of providing better observations of the subsurface and larger soil samples. Trial pits shall be excavated to a maximum depth of 5m and shall have rectangular dimensions (3 x 1.5m). A minimum of (2) soil samples shall be collected at different depths.

2- The second approach, is collecting soil samples from the boreholes using a coring device to cause minimal disturbance. It is recommended to collect at least two (2) samples from each borehole to identify the soil quality at different depths.

One (1) soil sample shall represent the topsoil layer (i.e. 0.5m bgl) and the second soil sample shall represent the soil quality just above the groundwater level (i.e. at the soil-groundwater interface). Where there are apparent changes in soil lithology or presence of visible contamination in the soils, it may be necessary to alter the default soil sampling depths to reflect site conditions.

The soil samples shall be collected in dedicated bags/containers (material of container depends on the parameter to be analysed), labelled clearly (with the sampling location codes and the depths at which the samples were taken) and stored in cool boxes at a temperature of approximately 4˚C until delivered to the laboratory.

A submission sheet and chain of custody (CoC) form must accompany all samples submitted to the laboratory to ensure sample traceability.

4.1.1.4 Analysis of Parameters

Soil parameters shall be selected based on the existing potential sources of contamination. In the absence of national soil standards, the parameters listed in the Dutch Standards shall be analysed to determine the presence of contamination. These include, but are not limited to, the following:

- Electrical conductivity (EC), pH, turbidity, dissolved oxygen (DO), and temperature
- Metals and Heavy metals
- Inorganic substances

- Aromatic compounds
- Polycyclic aromatic hydrocarbons
- Chlorinated hydrocarbons
- Pesticides

Analysis shall be conducted by laboratories permitted or certified for this purpose and Quality Assurance/Quality Control (QA/QC) plans shall be prepared and implemented. QA/QC documentation shall be included in monitoring reports. Blind soil sample shall be collected to confirm the quality and the results of the samples. One (1) blind sample shall be collected from each 10 collected soil samples.

4.1.2 Monitoring during Construction

The purpose for undertaking soil quality monitoring during construction phase is to detect any exceedance in soil contaminants as a result of the construction activities. The soil monitoring methodology with sample location and frequency shall be as detailed and included in the EIA report.

4.1.2.1 Sampling Locations

During construction it is advised to use a targeted sampling approach. This approach is used to select the sample locations on areas of greatest potential for contamination, such as areas adjacent to fuel storage tanks. Professional judgement shall also be used to determine sample locations based on initial observations of soils, such as surface staining of the ground or a strong odour from the soils.

4.1.2.2 Number of Sampling Points

The number of sampling points is dependent of the size of the area of interest, as presented in Table 4.1 previously, and on the variability of the surficial geology and landscape.

4.1.2.3 Monitoring Methodology

Soil samples must be collected in such a manner that ensures changes in contaminant concentration with depth are delineated. When sampling for volatile and semi-volatile substances, discrete samples must be collected to avoid changes in contaminant concentration during sampling.

If the release of substance is superficial and above ground, it is sufficient to collect soil samples from test pits/trial pits. Where there is potential for release of substance from infrastructure below ground (e.g. storage tanks and pipelines), it is suggested to have the boreholes drilled 2m below the finishing level of infrastructure. Otherwise, it can be collected from the geotechnical or structural boreholes. For locations associated with a spill or potential release of particular contaminants that may be degraded easily under aerobic conditions but slowly in subsurface conditions, boreholes shall be used for collection of soil samples to screen against the potential contamination at deeper depths, including subsurface.

4.1.2.4 Analysis of Parameters

Soil parameters shall be selected based on the potential sources of contamination, i.e. Hydrocarbons are tested for when activities related to the use of fuel or hazardous materials are taking place. To identify the presence of contamination, soil samples shall be analysed against the parameters listed in the Dutch Standards.

4.1.2.5 Frequency of Monitoring

The frequency of soil quality monitoring during construction shall be as specified in the EIA report unless otherwise decided by SEZAD-Environmental Regulatory Department. Any change in frequency shall be provided to the industry in the EIA approvals, permits or other such official communication by SEZAD Environmental Regulatory Department.

As a minimum, soil shall be monitored immediately after a major environmental incident/spill has been identified to determine the extent of contamination. Additional samples shall be conducted after any spill remediation activities have taken place to determine that all contamination has been removed.

4.1.3 Monitoring during Operation

Where the risk of soil contamination is minimal because of the kind of industry operation taking place at a specific location or because engineered controls are in place to protect soil, part of the plant areas may be exempted from operational soil monitoring. The level of risk shall be clearly established prior to exempting any facility area. If monitoring is required during operation, the following monitoring methodology shall be followed. The details on the same shall also be included in the EIA report.

4.1.3.1 Sampling Locations

Operational soil monitoring shall be designed to identify the most likely locations for release of substances. Soil samples shall be collected at the following locations:

- Known soil contaminated points;
- Known releases of contaminants of potential concern to soil during operation; and,
- Potential soil contamination, including but not limited to the following:
    - Areas for storage of product, raw material, treatment chemical, catalyst or waste;
    - Near process areas;
    - Chemical loading and unloading facilities;
    - Storage areas such as warehouses for new and out of service equipment (including but not limited to transformers, vehicles and compressors);
    - Machinery servicing and maintenance areas;
    - Washing areas for equipment (including but not limited to containers, tanks, filters and vehicles);
    - Near underground sumps, tanks and pipelines;
    - Any off-site areas that may have been impacted by activities that have occurred onsite, whether planned (e.g., wastewater irrigation) or unplanned (e.g., spills);

- Near unlined drainage ditches;
- Low-lying areas that may be affected by surface run-off;
- Above-ground chemical pipe racks;
- Near oil production and disposal wells;
- Any other areas where contamination may occur.

4.1.3.2 Number of Sampling Points

The number of sampling points is dependent of the size of the area of interest, as presented Table 4.1 previously, and on the variability of the surficial geology and landscape.

4.1.3.3 Monitoring Methodology

The monitoring methodology during operation shall be similar to that followed during construction phase, described in Section 4.1.2.3.

4.1.3.4 Analysis of Parameters

Industry-specific substances are raw materials, releases or by-products of a plant operation. The applicant must review past and current operations to develop a list of industry-specific substances.

Industry-specific substances include but are not limited to the following:

- Strong acid digestible trace elements such as barium, cadmium, chromium (total and hexavalent), cobalt, copper, lead, mercury, molybdenum, nickel, selenium, vanadium, and zinc;
- Inorganics such as arsenic, boron (hot water extractable), cyanide, and sulphur;
- Salts such as sodium chloride;
- Hydrocarbons such as benzene, ethylbenzene, toluene, and xylenes (BTEX), polycyclic aromatics, fractions F1, F2, F3 and F4 of petroleum hydrocarbons;
- Process chemicals such as methanol, ethanol, sulfolane, glycols, and amines;
- Halogenated organics such as brominated or chlorinated sterilants, dioxins and furans, chlorobenzenes, chlorophenols, polychlorinated biphenyls, perchloroethylene and vinyl chloride;
- Any toxic organic precursors, intermediates, products, by-products, additives, or catalysts.

Analysis shall be conducted by laboratories permitted or certified for this purpose and QA/QC plans shall be prepared and implemented. QA/QC documentation shall be included in monitoring reports. Blind soil sample shall be collected to confirm the quality and the results of the samples. One (1) blind sample shall be collected from each 10 collected soil samples.

4.1.3.5 Frequency of Monitoring

The frequency of monitoring during operation is influenced by the sensitivity value of the sensitive receivers and whether or not the concentrations reach critical levels for some of the parameters measured. As a minimum, soils should be monitored immediately after a major environmental spill has been identified to determine the extent of any contamination. Additional monitoring of soils shall be conducted immediately after any spill remediation activities have been conducted to determine that all contamination has been removed.

The frequency of soil quality monitoring during operation shall be as detailed in the EIA report and the same shall be followed unless otherwise decided by SEZAD-Environmental Regulatory Department. Any change in frequency shall be provided to the industry in the EIA approvals, permits or other such official communication by SEZAD Environmental Regulatory Department.

4.1.4 Monitoring during Decommissioning

Normally, the methodology for monitoring soil quality during construction is similar to the methodology adopted during decommissioning, as the equipment and procedures employed are alike. It is however acknowledged that some industries can be polluting during their operation phase and can potentially contaminate the groundwater from the subsurface structures. In such case, it is advised that the proponent refer to SEZAD-Environmental Regulatory Department for a monitoring methodology during decommissioning.

Once the decommissioning phase has been completed it is recommended that a soil monitoring program shall be conducted to identify the need for remedial activities. The post-decommissioning soil monitoring program shall follow the same methodology as the baseline monitoring before construction (see Section 4.1.1.). If the monitoring results show the need for remediation, then a Soil Management Program shall be established.

4.2 Assessment Methodology

The purpose of assessing soil quality is to protect groundwater quality and human health. The assessment is conducted by evaluating physico-chemical contamination indicators.

This section discusses the soil assessment methodology that shall be followed by each Project applicant for all Project phases. The methodology is considered common for all proposed industries.

4.2.1 Identification of Exceedance

Prior to assessing an impact on soil quality, the results of the soil monitoring laboratory analysis shall be compared against the Dutch standards to detect the presence of contamination.

The Dutch standards determine the need for remediation and its urgency. The applicant is required to refer to the complete official copy of this Circular to thoroughly understand the methodology.

4.2.2 Impact Assessment

If the site is found to be contaminated due to project activities, the significance of the impact shall be determined by comparing the value and sensitivity of the soil against the magnitude of impact of the resultant effect. The assessment follows a three-step process:

- Evaluating the value of the soil and sensitivity of the receptors (human or ecological);

- Assessing the magnitude of the impact of the proposed industry on the soil quality, be it adverse or beneficial; and
- Determining the significance of effect resulting from impact (of a certain magnitude) on the resource (of particular value)

Refer SEZAD EIA guideline for generic classifications for environmental value, magnitude of impact and significance of effect.

5 General Pollution Prevention Guidance Notes (PPGN)

This chapter gives an overview of the general PPGN during the Project phases. International Best Management Practices for the proposed industries in the SEZ area are also provided within this chapter to reduce the risk of soil contamination from industry-specific polluting activities.

5.1 Pollution Prevention Guidelines during Construction

This section provides general PPGN for protecting soil quality from potential construction polluting activities. Specific details shall be included in the CEMP, which shall be developed and implemented by the construction contractor.

If not managed properly, construction activities can lead to adverse impacts on soil quality through unwanted sources of pollution that may compromise the baseline conditions and lead to soil contamination.

The construction activities that have the potential to impact soil quality include, but are not limited to, the following:

- Site clearance activities; these include the demolition activities and vegetation clearance (if any).
- Disturbance of previously contaminated soils
- Earthworks and grading activities, including cut and fill
- Chemicals management (storage, handling and disposal of chemicals, leakages, spills)
- Hazardous waste management (waste oil, solvent, waste chemicals, chemical containers, batteries, filters, fluorescent bulbs, etc.)
- Water and wastewater management (discharge from concrete batch plants, vehicle wash down water, dewatering etc.)
- Soil erosion during construction activities.

The PPGN shall include, but are not limited to, the following guidelines:

- All materials to be used during construction shall be identified and their hazard potential evaluated.
- All waste effluents, including the type(s), quantities, and source(s) shall be identified.
- Discharge of pollutants from spills and leaks shall be minimised and a Chemical Spill and Leak Prevention Procedure shall be implemented.
- Collection tanks shall be lined by reinforced concrete to prevent seepage of pollutants into the soil.
- Hazardous waste storage requirements shall be equipped with appropriate valves and temporary stored in an impermeable surface with secondary containment to avoid spilling or dripping of hazardous materials onto the soil.
- Oil water separators shall be installed and maintained as appropriate at construction refuelling facilities, workshops,

parking areas, wash down, fuel storage and containment areas.

- The main construction site shall be preferably connected to local sewer systems. However, in areas where sewer systems are not available, the provision of septic tanks shall be necessary, or alternatively constructing dedicated wastewater treatment plants at the construction site.
- Contaminated material shall be stockpiled on an impermeable surface, in a bunded area and covered to prevent contaminated runoff.
- The contaminated material shall be disposed of
- If the land is previously contaminated, dewatered water shall be properly disposed and not discharged directly over land.
- Concrete or cement mixing shall be sited on an impermeable designated area.

It should be noted that PPGN for the decommissioning phase shall require a Decommissioning Environmental Management Plan (DEMP) which shall include the same management plans as the construction phase. Therefore, Section 5.1 can be considered applicable to the decommissioning phase.

5.2 Pollution Prevention Guidelines during Operation

This section provides general PPGN for protecting soil quality from industrial operations that can lead to soil contamination. Specific details shall be included in the OEMP, which shall be developed and implemented by the operator appointed environmental consultant.

Since each industry uses different raw materials and processes, the pollutants generated will vary in content and quantity. Therefore, additional industry-specific BMPS are included in Section 5.3.

General operational PPGN are listed below:

5.2.1 Handling of Waste and Chemicals

- Chemicals in bulk storage shall be properly labelled and have material safety data sheets available in the work area.
- Storage tanks of diesel or waste solvents shall be fitted with overfill protection device and shall have a secondary containment system to avoid and leaks or spills.
- The secondary containment system shall have a total volume exceeding 110% of the volume of the tank. Containment systems shall provide an impervious barrier to prevent spills from discharging outside the containment system.
- Storage tanks shall be properly maintained and regularly inspected.
- All fixed tanks shall be provided with a suitable overflow system that discharges to an area within the bund wall or to a collection or holding point.
- Leak detection systems shall be installed.
- Oil water separators and grease traps shall be installed and maintained as appropriate at refuelling facilities, workshops,

parking areas, wash down, fuel storage and containment areas.

5.2.2 Storm water Management

- All uncontaminated surface storm water shall be diverted from chemical storage areas.
- Sludge from storm water catchments or collection and treatment systems may contain elevated levels of pollutants and shall not be disposed directly on the soil. Disposal shall be compliance with local regulatory requirements.
- All washing operations shall take place at a location where wastewater effluent is disposed in a careful and acceptable manner.
- The “first flush system” to contain spills and leaks shall not be used.

5.2.3 Incident Management

- Procedures or Emergency Response Plans shall be put in place to deal with spill emergencies.
- Staff shall be trained in incident management.
- All major spill incidents shall immediately be reported to SEZAD.

5.3 Industry-Specific Best Management Practices

5.3.1 Petrochemical Industry

In petrochemical industries large amounts of hydrocarbon-containing effluents are generated and could critically impact the soil quality if not properly managed.

To avoid soil pollution caused by the discharge of liquid effluents, raw material and hazardous waste the following BMPs are recommended, as a minimum:

- All materials to be used during operation shall be identified and their hazard potential evaluated.
- Pollution prevention techniques for dust emissions from stockpiles of raw materials, clinker, coal, and waste shall be implemented to help minimize contamination of soil.
- All hazardous materials shall be stored, treated and disposed in appropriate facilities.
- Emergency Spill Response procedures shall be implemented.
- Soil shall be analysed mainly for metals and heavy metals, at a minimum, arsenic, cadmium, chromium, mercury, lead and vanadium.
- Storage areas and drainage shall be maintained to prevent accidental spillage of hazardous material.
- Solid materials, fuels and waste piles shall be covered or confined to prevent pollution of surface water and ultimately soil.

- Contamination of storm water shall be controlled by implementing spill prevention techniques.
- Industrial process wastewater shall be treated before disposal using primary treatment methods.

5.3.2 Limestone/Cement Industry

Cement and limestone production processes involve quarrying and mining, grinding, and homogenizing of raw materials. This industry can affect soil quality, in many ways namely:

- The constant fall of cement dust on the soil;
- The infiltration of the runoff from the surface and material storage/ waste disposal areas into the soil;
- The direct disposal of untreated wastewater onto the soil which is characterised by high pH, dissolved solids (potassium and sulphate) and suspended solids.
- Disposal of solid waste which includes spoil rocks from clinker production, kiln dust, waste from plant maintenance (e.g. used oil and scrap metal), and alkali or chloride / fluoride containing dust build-up from the kiln.

To avoid soil pollution, the following BMPs are recommended, as a minimum:

- All materials to be used during operation shall be identified and their hazard potential evaluated.
- Pollution prevention techniques for dust emissions from stockpiles of raw materials, clinker, coal, and waste shall be implemented to help minimize contamination of soil.
- The liquid effluent shall be treated using primary treatment techniques (e.g. oil water separators, screening, pH adjustment, filtration, sedimentation, etc.) before discharge if it exceeds the relevant Omani standards.
- Storm water flowing through pet–coke, coal, and waste material stockpiles shall be prevented by diking, covering or enclosing stockpiles.
- Infiltration of storm water that has been in contact with raw material stockpiles shall be controlled by paving or lining the base of the stockpiles, installing run-off controls around them and collecting the storm water in a lined basin to allow particulate matter to settle before separation, control, and recycling or discharge.
- Slurry tank wash or spills shall not be discharged onto the ground.
- Soil shall be analysed, at a minimum, for pH, nitrogen, phosphorous and potassium content.
- Recover collected cement kiln dust and reuse in cement production process. Materials that cannot be reused in the production process due to its composition can be alternatively used as lightweight construction aggregates, blocks and for soil stabilisation.

5.3.3 Silica Sand/Glass Industry

For glass manufacturing, amounts of liquid effluents discharged are marginal in comparison with other industrial sectors and are limited to particular processes. Discharges may be affected by glass solids, soluble glass-making materials (i.e. sodium sulphate), organic compounds (caused by lubricant oil used in the cutting process), and treatment chemicals (i.e. dissolved salts and water treatment chemicals) for the cooling-water system.

To avoid soil pollution, the following BMPs are recommended, as a minimum:

- All materials to be used during operation shall be identified and their hazard potential evaluated.
- The liquid effluent shall be treated (oil water separators, screening, pH adjustment, filtration, sedimentation, etc.) before discharge if it exceeds the relevant Omani standards.
- Where possible, raw material or toxic product products shall be replaced with other materials that produce less waste.
- Refractory waste shall be recycled for use in other industries.

5.3.4 Fishery Industry

The processes used in the fish industry include harvesting of the fish, storing, receiving, eviscerating, pre-cooking, cleaning, preserving and packaging. Due to the different processes, this industry generates large volumes of polluted wastewater due to the high water consumption. The wastewater generated is characterised with high organic content, salt content, total suspended solids, fats, nitrogen, phosphorous, ammonia and traces of detergents and disinfectants from the cleaning activities. If this wastewater is disposed directly onto the soil it can degrade the soil quality and potentially contaminate groundwater.

To avoid soil pollution, the following BMPs are recommended, as a minimum:

- All materials to be used during operation shall be identified and their hazard potential evaluated.
- Where chemicals are used, chemical handling and storage procedures, and spill control measures shall be developed to minimise accidental release to the environment.
- The liquid effluent shall be treated using primary treatment techniques (e.g. oil water separators, screening, pH adjustment, filtration, sedimentation, etc.) before discharge if it exceeds the relevant Omani standards.
- Establish procedures for dry cleaning/ removal of offal during processing (e.g. filter conveyor, dry vacuum, vacuum suction, offal hopper).
- Solid waste shall be contained in dry form and if composting is applied, it should be managed properly to avoid health and hygiene implications.

5.3.5 Automotive Industry

The automotive manufacturing industry may result in accidental spills or intentional dumping of chemicals and untreated wastewater onto soils. Many possible contaminants include petroleum products, PAHs, solvents like trichloroethylene (TCE), used tires and rubber products, metals (used engine oil may contain chromium, lead, molybdenum, or nickel from engine wear), and used batteries (which may release lead or mercury).

To avoid soil pollution, the following BMPs are recommended, as a minimum:

- All materials to be used during operation shall be identified and their hazard potential evaluated.
- Leaks shall be eliminated and regular inspection and maintenance shall be undertaken.
- Used tires and rubber shall be recycled or re-threaded.
- Used oils shall be stored in containers with secondary containment and leaks shall be regularly checked.
- Used batteries shall be stored upright in sturdy, acid resistant, leak-proof containers.

5.3.6 Power Generation Industry

Power generation facilities can either be large utility plants or industrial combustion plants, providing power (e.g. in the form of electricity or mechanical power), steam, or heat to industrial production processes. The main factors affected soil quality are the effluents from a thermal power plants (e.g. blowdown, ash handling wastewater, material storage runoff, etc.), the solid waste generated due to the high percentage of ash in the fuel (e.g. fly ash, bottom ash, boiler slag, etc.), and the hazardous materials stored and used in the combustion facilities (e.g. liquid fuel, chemicals, etc.).

To avoid soil pollution, the following BMPs are recommended, as a minimum:

- All materials to be used during operation shall be identified and their hazard potential evaluated.
- Pollution prevention techniques for dust emissions shall be implemented to help minimize contamination of soil.
- All hazardous materials shall be stored, contained treated and disposed in appropriate facilities.
- Emergency Spill Response procedures shall be implemented.
- Storage areas and drainage shall be maintained to prevent accidental spillage of hazardous material.
- Solid materials, fuels and waste piles shall be covered or confined to prevent pollution of surface water and ultimately soil.
- Industrial process wastewater shall be treated before disposal using primary treatment methods.
- Collect and recycle dry bottom ash and fly ash from power plants if containing high levels of economically valuable metals.

5.3.7 Desalination Industry

The reject brine from the seawater desalination plants is generally discharged to sea. But in some special cases, particularly small capacity plants, it is discharged to lined disposal ponds or alternative approved locations. There is a possibility for soil contaminations with chemical constituents from various sources (i.e. reject brine, pre-treatment waste and cleaning waste of desalination plants). The major constituents of reject brine are inorganic salts. The brine also contains small quantities of anti-scale additives, corrosion products, and other reaction products. High salt contents in reject effluent with elevated levels of sodium, chloride, and boron can reduce plants and soil productivity and increase the risk of soil salinization.

To avoid soil pollution, the following BMPs are recommended, as a minimum:

- Lined disposal pits or ponds shall be used for disposal of reject brine.
- Reject brine chemical composition and concentrate disposal shall follow national or international regulations and policies.
- Pollution reduction programs including recycling and reusing water and developing alternative technology, shall be applied by industries.
- Solar ponds shall be used in large desalination plants for the production of heat and electricity.
- Evaporation mechanism shall be enhanced by increasing the size of the evaporation pond, spraying of brine, creating turbulence in the pond and creating airflow over the pond.
- Reject brine from desalination plants can be used as a growth medium for spirulina, fish, and shrimp culture i.e. arthospira platensis and tilapia, which are of high commercial value.
- Minerals can be extracted from the reject brine and salt concentrate can be chemically converted to chemicals such as sodium carbonate (Na_2CO_3), sodium bicarbonate ($NaHCO_3$) and ammonium chloride (NH_4Cl) using a series of batch gas bubbler.

5.3.8 Infrastructure (Port, Harbour and Terminals, Airport, Gas Distribution Network)

Infrastructure project may include airport, ports, harbour and terminals, gas distribution network, etc. The soil pollution source from infrastructure project varies depending on the type of project as well as operational activities.

5.3.8.1 Port Harbour and Terminals

The impact on soil is also likely from dangerous goods handling in the ports.

To avoid soil pollution from ports and terminals, the following BMPs are recommended:

- Wastewater from bulk tank cleaning should be collected through appropriate on-site or off-site treatment prior to discharge;
- Ports should provide ship operators with details on the pertaining ballast water management requirements, including

the availability, location, and capacities of reception facilities, as well as with information on local areas and situations where ballast water uptake should be avoided.

- Sewage from ships should be collected and treated on-site or off-site;
- A collection and disposal system should be developed for ship-generated garbage for ships alongside and at anchor, consistent with the International Maritime Organization (IMO) Comprehensive Manual on Port Reception Facilities.
- Closable skips should be provided at the berths, and towed or self-propelled barges fitted with skips should be used to collect garbage from ships at anchor;
- Oil and chemical-handling facilities in ports should be located with consideration of natural drainage systems and the presence of environmentally-sensitive areas/receptors (e.g., mangroves, corals, aquaculture projects, and beaches, etc.).
- Siting of these facilities should include provisions for physical separation/distance to avoid and minimize adverse impacts.
- Hazardous materials storage and handling facilities should be constructed away from traffic zones and should include protective mechanisms (e.g., reinforced posts, concrete barriers, etc.) to protect storage areas from vehicle accidents.
- Covered and ventilated temporary storage areas should be designed to facilitate collection of potentially hazardous leaks and spills, including the use of sloped surfaces to direct spill flows, and the use of catch basins with valve systems to allow spills and releases to enter a dead-end sump from which spilled materials can be pumped/recovered. Where hydraulic equipment is used over or adjacent to water or other sensitive receptors, biodegradable45 hydraulic oils should be used.
- Ports should include secondary containment for above ground liquid storage tanks and tanker truck loading and unloading areas.
- Fuelling areas should be equipped with containment basins in areas with a high risk of accidental releases of oil or hazardous materials (e.g., fuelling or fuel transfer locations). Fuel dispensing equipment should be equipped with “breakaway” hose connections that provide emergency shutdown of flow should the fuelling connection be broken by movement. Fuelling equipment should be inspected prior to fuelling activities to ensure all components are in satisfactory condition.

5.3.8.2 Airports

Airport operations include the storage and handling of fuels (e.g. jet fuel, diesel, and gasoline) primarily associated with aircraft fuelling activities as well as with ground support vehicles. Fuels may be stored in aboveground or underground storage tanks and conveyed to dispensing locations. Further effluents from airport include storm water runoff from paved surfaces and sanitary wastewater from public and employee services and from airplanes.

Recommended strategies for the prevention and control of soil pollution associated with fuel storage and effluent management in airports include

- Diverting and treating storm water drainage from potentially contaminated area through use of an oil / water separator prior to discharge;
- Collection systems for aircraft and airport facility sanitary sewage should be provided;
- Wastewater effluents shall be treated and managed according to the Omani regulation before re-use/discharge;
- Water containing fire extinguishing agents and non-combusted flammable materials should be treated prior to discharge;
- Solid waste recycling program shall be implemented which involve placing labelled waste containers in passenger terminals for metals, glass, paper, and plastics;
- Food establishments should segregate compostable and other food waste for recycling as agricultural fertilizer and animal feed;
- Fire training shall take place on impermeable surfaces surrounded by a retaining dyke to prevent foam and powder or other environmentally hazardous fire extinguishing agents or polluted fire water from entering the storm water system;
- Emergency Spill Response procedures shall be implemented.

5.3.9 Mining

Mining activity generate large volumes of waste during various stages of the mining cycle. Solid wastes may include mining waste, workshop scrap, household and non-process-related industrial waste, as wells as waste oils, chemicals, and other potentially hazardous wastes.

Waste materials should be handled, stored, and transported so as to avoid leaks, spills or other types of accidental releases into soils, or groundwater.

Recommended strategies for the prevention and control of soil pollution

- Ensuring that contractors handling, treating, and disposing of hazardous waste are licensed by the relevant regulatory agencies and following good international industry practice for the waste being handled
- Ensuring compliance with applicable local and international regulations
- Secondary containment systems should be constructed with materials appropriate for the wastes being contained and adequate to prevent loss to the environment

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