Public Works Authority
Quality and Safety Department
Doha - Qatar

Management of Construction Dewatering

Construction Dewatering Guidelines

March 2014

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Abbreviations

ASHGHAL	Public Works Authority (ASHGHAL)
CEMP	Construction Environmental Management Plan
EIA	Environmental Impact Assessment
MoE	Ministry of Environment
MMUP	Ministry of Municipality and Urban Planning
O&M	Drainage Networks Operation and Maintenance Department of ASHGHAL
QSD	Quality, Safety and Environment Department of ASHGHAL
QCS	Qatar Construction Standards
RO	Road Opening

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Expressway Programme-
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- SALMAR Trading
- HBK
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Introduction to the Project

The Department of Quality, Safety and Environment at the Public Works Authority (ASHGHAL) appointed KEO International Consultants to carry out the Management of Construction Dewatering Guidelines Project, with the following objectives:

- The environmental protection through improving the construction dewatering process, and;
- Providing guideline to contractors and other concerned parties on the process of dewatering in the State of Qatar

In order to meet the above mentioned objectives, KEO had carried out the following tasks:

Task One: Expert literature review of all international legislation and regulations concerned with construction dewatering practices, and production of Literature Review Report. Please refer to **Appendix H** for more details.

Task Two: Field inspections of operating sites. Onsite audits for compliance against construction dewatering permit requirements, and field tests for turbidity and suspected pollution were carried out. Field inspection visits included projects specified by ASHGHAL.

Bi-weekly reports were issued to ASHGHAL to document the field inspections.

Task Three: Documentation of the current practices of construction dewatering across Qatar construction projects. This included regulatory and onsite practices. All of the previous were documented in a Review of Current Practices Report.

Task Four: Production of a Construction Dewatering Guideline Manual for Qatar.

The above tasks culminated in the development of a Guideline, providing technical and management solutions to dewatering requirements and associated issues on construction sites in Qatar. The solutions recommended as best practice, result from information gained through extension site inspections of current work sites and stakeholder consultation meetings.

The following sections now form the Best Practice Construction Dewatering Guideline for Qatar.

1 Purposes and Application

The Best Practice Construction Dewatering Guideline for Qatar provides a useful source document to help, prepare and implement dewatering management guidelines for constructions sites within Qatar.

The purpose of these Guidelines is to provide developers, contractors and government agencies involved with construction projects with:

- Information on dewatering licensing processes and requirements within Qatar;
- Information on the likely impact of construction activities on the environment by dewatering activities and how this is to be assessed;
- Information on how to avoid and minimise environmental impact by application of best practice techniques or methods in construction dewatering;
- Guidelines for undertaking risk assessment and management (environmental and Health & Safety);
- A clear statement of environmental performance objectives; and,
- Suggested best practice dewatering practices and environmental measures to meet the performance objectives based on current successful practices in Qatar.

The Guidelines provide contractors and developers with a framework within which due diligence obligations can be met and environmental damage can be avoided.

The Guidelines are not prescriptive or detailed. Application of dewatering solutions will require a certain amount of tailoring to particular site conditions and ensuring that adjustments are made should the measures listed are inappropriate to the site in this instance.

The measures proposed in the Guidelines are applicable to small, medium, and large construction projects and will depend on the level of excavation required for each project. The Guidelines should be used where appropriate to avoid and minimise impact on the receiving environment from such dewatering activities.

The Guidelines do refer to legislation, regulations or environmental policies wherever necessary. However, Developers, Contractors and their Subcontractors, when used, they must make themselves aware of their legal obligations at all times. Compliance to legislation requirements is mandatory.

It should also be noted that legislative requirements and standards are minimium standards, and methods should be employed with the intent to continually improve on these standards.

2 Formal Procedure

2.1 Current Procedure Requirements

There are four types of construction dewatering disposal options that require licensing in Qatar, as follows:

1. Discharge to the Sea via surface and groundwater network; the licensing authority should be ASHGHAL and MoE.

2. Direct discharge to the Sea; if the discharge is pumped directly to the sea, then the Ministry of Environment (MoE) should be the licensing authority.

3. (A) Discharge to Lagoon totally covered with geotextile from all sides. This method of disposal requires a license from MoE.

   (B) Discharge to Lagoon not covered. This method of disposal requires a license from MoE.

4. Discharge through Deep Well Injection. This method of disposal requires a license from MoE.

For more details, please refer to section 4 for further information on requirements for each dewatering option.

2.2 Relevant Qatari Laws and Regulations

The list of parameters required by MoE for dewatering permit is included in **Appendix A** together with Annex 4 of Law 30 of 2002 which specifies the limits for the discharged water into the marine environment (refer to **Appendix A**). The annex controls the parameters of pollutants in the water disposed to the marine environment whether via the Surface and Groundwater Network, or direct discharge to the sea.

The Qatar Construction Specifications (QCS) had also identified under section 8 – part 2.2.14 the general regulations for dewatering from excavation. **Appendix B** includes a copy of the specification for the dewatering from excavation as extracted from the QCS.

If the construction dewatering effluent is discharged to foul network, the discharging party is liable to having committed a criminal offence.

In the case of illegal discharge to Surface and Groundwater Network, the discharging party will be subjected to legal actions taken by the licencing authorities.

The contractor should refer to the Qatari Laws in its original language, Arabic. No obligations is made to any misleading translation mentioned in any approved translation for the Qatari Law.

EIA Requirements

Environmental approvals from the MoE as per Article 7 of the Law No. 30 of 2002.

Air Quality Standards

The air quality standards are controlled by the Law No. 30 of 2002 under Annex (3/First).The standards applicable to dewatering activities may include the following:

Maximum limits (of air pollutants) allowed for emissions from the movable sources; and Ambient air quality standards.

Noise Standards

The noise levels are also controlled by the Qatari Legislation under Law No. 30 of 2002 Annex (2/Fifth).

Discharge to Surface and Groundwater Network Standards

Executive Bylaws of Environment Protection Law Issued under Ordinance Law No. (30) Of 2002. Annex No. (4) Criteria and Specifications of the Hazardous Materials when disposed of in the Water Environments (taken from the MoE regulations).

2.3 Additional Studies

To assist in the development and implementation of effective dewatering systems, it is recommended that the following studies form part of the initial application process. Depending on the size of the project, these studies will assist ASHGHAL in the assessment of application in a timely manner. They will also ensure that dewatering activities are designed to account for all known site conditions, thereby reducing the chance of issues later in the project.

2.3.1 Concept Design Stage Consideration

For large infrastructure and structural projects, there is often a concept design stage where the basic features of the project are outlined to allow the project to proceed to detailed design and ultimate construction.

The concept design stage generally includes investigations of project site and its underlying conditions as this can be a major factor in the detailed design of key underground structural components, such as footings. These investigations will include environmental and geotechnical aspects, all of which can provide valuable information for the design of an effective dewatering system.

For the purposes of construction dewatering design, it is recommended that the following documents and studies are carried out during concept design and utilised where necessary:

2.3.1.1 Geotechnical, Geo-Environmental and Groundwater Investigation.

During the geotechnical, geo-environmental and groundwater investigation, the design consultant should aim to quantify the amount of water expected to be encountered during excavation and construction stages.

As levels and quantities of groundwater present in the area can be subject to various seasonal and local factors, it will be important for the design consultant to take into consideration the time of the year, surrounding structures/construction sites, known groundwater abstraction points, and any other factor which is thought to contribute to groundwater levels in the area.

The geotechnical, geo-environmental and groundwater investigation report will also identify the underlying geology of the area, and its impact on groundwater quantities and quality. The geotechnical and geo-environmental investigation report is considered an important document for the construction contractor, as it allows the design and application for the most effective dewatering system, prior to mobilisation to site.

The investigation report should be submitted to the Ministry of Environment (MoE) for their approval. Yet, the Quality, Safety and Environment Department (QSD) within ASHGHAL are involved in the approval process for ASHGHAL projects.

An additional benefit is to identify any significant contamination, or presence of significance contaminants which might require further precautions. Such discovery will warrant further investigations and management prior to dewatering permitting procedures.

2.3.1.2 Environmental Impact Assessment (EIA)

For projects requiring an EIA at the design stage, the EIA should be carefully reviewed by the design consultant/contractor. The EIA should be forwarded to MoE for their approval and for issuing the Environmental Permit.

Where available, the EIA will contain details of geotechnical surveys including groundwater, adopted from the previously mentioned report.

Although the EIA may not directly contribute to the construction dewatering design, it will document possible contamination in the area and environmental constraints, and should therefore be considered when preparing construction dewatering application papers. Existing contamination, or potential for contamination, should be carefully considered and must be taken into account when dewatered groundwater is tested for compliance.

To ensure that dewatering systems are designed to maximise environmental protection and to assist in expediting license approval processes, it is recommended that the above investigations are taken into consideration as early in the project as possible and included when applying for the discharge permit.

2.3.2 Geotechnical and Geo-Environmental Study Requirements

After the awarding of the project to the Contractor and prior to obtaining the discharge permit, The Contractor is sometimes required to carry out a geotechnical and geo-environmental investigations in order to confirm the geotechnical and environmental conditions on site and groundwater levels.

The geotechnical and geo-environmental study will identify soil types, permeability, groundwater hydrology, and the required drawdown for the construction activities. This study is required if area is suspected for contamination or if the EIA at the concept design stage has indicated the existence of contamination.

The output of the geotechnical and geo-environmental study should include the following items:

1. Time required for construction dewatering.
2. Flow rate of the dewatering discharge.
3. Required drawdown.

4. Method of construction dewatering based on all of the above findings.

To assist in the approval process, it is recommended that all of the above information is provided in the application for discharge. The ministry of Environment (MoE) is considered the authority providing the environmental approval for the geo-environmental study. Yet, the Quality, Safety and Environment Department (QSD) within ASHGHAL is involved in the approval process for their projects.

It is important to note that the requirements of the Geotechnical and Geo-environmental study are completely subject to project settings, type of contamination, and MoE's specific requirements of each project. There is no specific document regulating these requirements, as these requirements are decided on during the Scope of Works stage of the project.

2.3.3 Access to Existing Groundwater Monitoring Documents

Existing groundwater level information should be available to both ASHGHAL and MoE. This information should be used by the designers, contractors and applicants, where appropriate to assist in determine current site conditions.

All groundwater information gathered during studies as outlined above, are to be submitted to the ASHGHAL for reference and inclusion in the country database. The collection of this information is paramount to the continuous improvement of government information databases.

2.3.4 Risk Assessment of Construction Dewatering

Risk assessment in this instance can be defined as the identification and characterisation of the nature of existing and potential adverse effects to humans and the environment resulting from dewatering activities employed on site.

Risk is a function of the probability of an event occurring and the degree of damage that would result should it happen.

Details and information gathered during the concept design and associated site studies (geotechnical, groundwater & environmental) are needed to assess the risks associated with the proposed activities. The assessment allows significant risks to be identified so that they can be targeted for action.

The initial risk assessment needs to also be regularly reviewed and will become an. integral part of the Construction Environmental Management Plan. This includes a review of existing risks and the identification of new risks detected through the surveillance or the monitoring program.

To conduct the Risk Assessment the Applicant/Contractor should undertake the following key steps:

1. Information gathering
   A risk assessment requires information about site conditions.

2. Risk identification
   Hazard identification involves the identification of risks/hazards that could lead to an adverse effect on the receiving environment and/or health & safety.

3. Risk analysis
   Risk analysis considers the likelihood of the risk being realised.

4. Consequence analysis
   Consequence analysis determines the effect on the environment and health & safety should a risk be realised.

The overall risk is a function of the likelihood of the activity or event causing environmental harm or impacting on health & safety and the consequence should that risk be realised.

The risks are then ranked according to their magnitude and mitigation strategies developed.

The objective of this process is to identify and rank all potential risks that may arise from the dewatering of the construction site and then reduce risks to acceptable levels by implementing a suitable method of dewatering and/or action plan.

Risks generally associated with dewatering activities onsite include but not limited to the following:

1. Soil and slope stability and soil erosion due to dewatering activities.
2. Soil contamination. Whether contamination exists in the project area prior to commencement of construction or is caused by dewatering activities.
3. Change of groundwater properties due to dewatering practices.
4. Excessive abstraction (dewatering) of groundwater which affects nearby groundwater related activities.
5. Health and safety related issues.
6. Risks associated with impacts of dewatering activities on surrounding environment and sensitive receptors.
7. Risks associated with failure of dewatering system and/or disposal methods.

It is important to note that risks are site specific and depend on the intent of the Contractor. The Contractor is responsible for developing, implementing and managing the risk management system in terms of dewatering activities and otherwise onsite.

2.3.5 Monitoring Plan

A monitoring plan is to be included as part of the construction dewatering requirements, if not already included in the projects Construction Environmental Management Plan.

The monitoring plan will assist the licensing authority, as well as the Contrator, in keeping track of dewatering activities onsite, and identify corrective actions to be carried out.

The monitoring plan can also assist in identifying liability issues concerned with reported dewatering problems and accidents.

Outline and components of monitoring plan are provided and discussed in section 5.2.

2.3.6 Training Requirements

It is recommended that a training plan for construction dewatering is developed and submitted along with the necessary documentation for a discharge permit.

The training plan will assist the licensing authority in evaluating the level of knowledge passed on to the Contractor's staff, and is therefore an indirect indication on how well the dewatering process is being executed. The components of the submitted training plan are discussed further in section 5.3.

3 Dewatering Techniques

3.1 Construction Dewatering Methods

The design of effective construction dewatering methods should be based on a number of information sources:

- Geotechnical and groundwater site investigations undertaken at the commencement of any project;
- Information provided by any geotechnical study undertaken during the concept design stage[if applicable];
- Groundwater information sourced from relevant authorities; and,
- A site risk assessments.

The choice of dewatering method will depend primarily on the soil type and permeability and the amount of groundwater to be removed. Whilst the Contractor will be trying to find the most cost effective method of dewatering (based on the geotechnical report, and the consultant approval of the report requirements) he is obligated to implement the most effective dewatering method which minimises environmental damage, protects the health & safety of on-site personnel and meets all legislative discharge limits.

It is important to note that if contamination exists in the area all precautions need to be implemented. Contamination will be dealt with in coordination with MoE by safe disposal in designated areas as per the Environmental Law number 30 for 2002.

The figure below (Figure 3.1) demonstrates the range of common dewatering techniques, whilst accounting for soil permeability and drawdown.

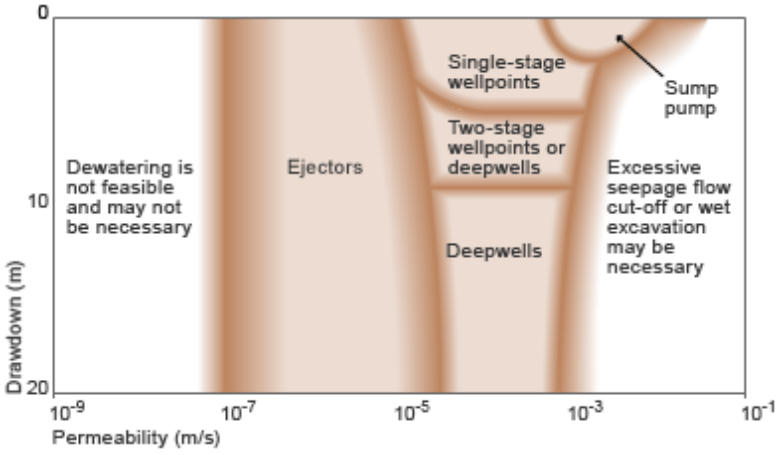

Figure 3.1 Range of Application of Pumped Well Groundwater Control Techniques

** **Source:** Preene, M. Roberts, T. Powrie, W. Dyer, M R (2000)- Groundwater Control Design & Practice (CIRIA C515), London, CIRIA.

As seen in the above figure, the choice of dewatering method depends on the required drawdown and permeability. The drawdown is determined during the design stage of structures and the groundwater investigation stage at the start of the project and the permeability is tested during the geotechnical investigation stage.

After the drawdown is determined, the Contractor must choose the method of dewatering based on the permeability of soil. The method can vary during the stages of the project depending on the required drawdown. The shaded areas near the methods' boundaries indicate that the choices can overlap, and then the Contractor can decide between the two (or more) options.

Filtering and filling materials of aggregate is required by most dewatering methods. Therefore when required, aggregates to be used shall be free draining, washed and free of debris (organic or non-organic). Preference is for a single sized aggregate (less than 10% fines).

Whilst the range of dewatering practices varies across sites depending on their size, construction depth and site conditions, the most commonly used methods of dewatering in Qatar are indicated below. Each method's use depends on the requirements and stage of project; however, it is believed that they represent the most effective solutions for dewatering construction sites in Qatar. For each method, any notable shortcomings are also discussed.

3.1.1 Sump Pits

The Sump Pit method is the simplest form of dewatering system on a construction site. Sump pits are generally utilised as a quick, least cost, solution and can be seen to be used at the start of projects as the excavation stage commences. Provided with an aggregate lining, as per O&M requirements, sump pits can be an effective means of filtering groundwater, unless the groundwater has come into contact with silt and/or limestone, which usually results in reported high turbidity.

If soil has silty characteristics; it is recommended that proper installation of geotextile and aggregates in sump pits be implemented in order to improve the quality of dewatering effluent and significantly decrease turbidity.

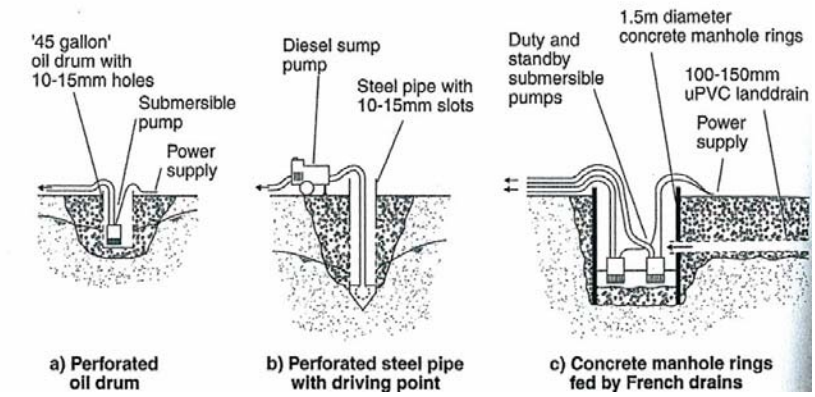

Figure 3.2 Typical Sump

**** Source:** Preene, M. Roberts, T. Powrie, W. Dyer, M R (2000)- Groundwater Control Design & Practice (CIRIA C515), London, CIRIA.

Groundwater Lowering Method	Advantages	Disadvantages
Sump pits	1. Inexpensive and simple 2. particularly effective in clean coarse soils	1. low drawdown capacity 2. May not prevent seepage leading to instability.

3.1.2 Well System

The most common practice of dewatering used in Qatar is the implementation of a Well System. Wells are systematically drilled around the construction area and submersible pumps placed into these wells. This practice appears to work effectively for many projects, especially those building projects that require excavations for deep basements.

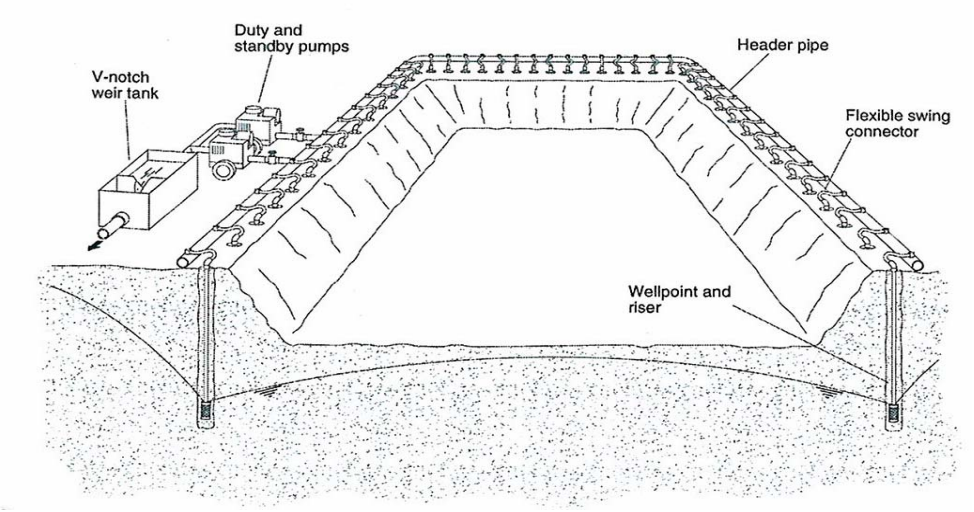

Figure 3.3 Wellpoint System Components

**** Source:** Preene, M. Roberts, T. Powrie, W. Dyer, M R (2000)- Groundwater Control Design & Practice (CIRIA C515), London, CIRIA.

Groundwater Lowering Method	Advantages	Disadvantages
Well system	1. Effective in sandy soils. 2. Provides drawdown up to 5-6 meters in sand, and 4 meters in silty soil. 3. Relatively cheap and flexible. 4. Easy installation.	1. Not effective beyond 4-6 meters of drawdown 2. Might require stages of well installation.

3.1.3 Deep Wells

Deep wells are rarely used in Qatar. Deep wells are usually equipped with filter packs & submersible pumps, and are operated using a control cabin.

Although not found to be present in Qatar at present, deep wells have unlimited drawdown, they require a minimum spacing of 10 meters, and have far greater efficiency.

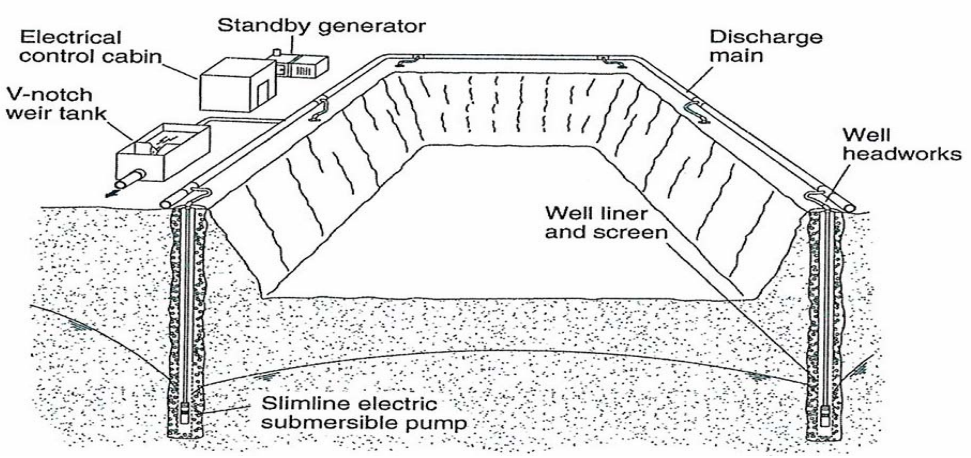

Figure 3.4 Deepwell System Components

**** Source:** Preene, M. Roberts, T. Powrie, W. Dyer, M R (2000)- Groundwater Control Design & Practice (CIRIA C515), London, CIRIA.

Groundwater Lowering Method	Advantages	Disadvantages
Deep wells	1. No limit on drawdown 2. Fewer wells required than the well system	1. Expensive to install

3.1.4 Ditches/ French Drains

Ditches and French drains (commonly known as trenches in construction projects in Qatar) are also used on Qatar's construction sites. The ditches are formed in a pre-planned manner, allowing groundwater flow to surface in the deeper level trenches. Perforated pipes are then placed in the trenches, and groundwater extracted through these pipelines to be filtered. These trenches were particularly common in infrastructure network projects.

Graded aggregates and geotextile layer to be used when laying out the pipelines.

Figure 3.5 Ditch and French Drain

**** Source:** Preene, M. Roberts, T. Powrie, W. Dyer, M R (2000)- Groundwater Control Design & Practice (CIRIA C515), London, CIRIA.

Groundwater Lowering Method	Advantages	Disadvantages
Ditches/ French drains	1. Relatively inexpensive 2. Controls shallow groundwater and over-bleed. 3. Effective in controlling groundwater after casting of foundations.	1. Possible obstruction of traffic 2. Groundwater will only be controlled at shallow depth. 3. unlikely to be effective in fine-grained soil

3.1.5 Cut-Off Excavation Barriers

Cut Off barriers are designed to limit and/or control groundwater entering the construction site from a neighbouring property. An assessment of groundwater infiltration is required to determine to what extent barriers are required and how they are constructed.

Commonly used excavation barriers in Qatar include structural concrete walls and secant piles. Both techniques are applicable to most types of soil and provide slope stability for deep excavated areas.

3.2 Dewatering Effluent Treatment

3.2.1 Settlement Tank

The settlement tank is the most common and most effective methods of treatment in Qatar. The settlement tank is primarily used to maximise the distance that the effluent has to travel prior to reaching the discharge point, and therefore increasing the settlement efficiency.

All projects in Qatar which apply for a discharge permit are obligated to provide a settlement tank.

When choosing the settlement tank, the choice should be based on the following factors:

1. The type of soil to be dewatered.
2. Flow rate quantity and frequency.
3. Possible peak factors flows.
4. Retention time required for solids to settle. This will also be based on the soil type.

Settlement Tank Types

The common types of weir tanks used are Regular tank and V-notch tanks (30°, 60°, and 90°). The V-notch tanks serve to accelerate the passing of the effluent through the tank.

For safety purposes, it is recommended that tanks be suitably covered with a top cover or specific lid, to ensure unauthorised access is not permitted.

It is important to note that sometimes these tanks are used onsite as a discharge tanks. Therefore, it is important that tanks are used as settlement tanks and be marked clearly as such.

Tank Size

In order to make a decision on the tank size, the volume of tank are to be estimated as per the below equations.

The volumes calculated depend primarily on the retention time of water in the tank, and the flow rate of discharge.

Tank volume:

$V = Q\ t$

Where:

V: Volume (m^3)

Q: Expected flow rate (m^3/hour)

t: retention period (hour)

The tank's depth is calculated as follows:

$d = V/A$

Where:

d: depth, m

V: volume, m^3

A: surface area, m^2

Figure 3.6 Typical Settlement Tank Used in Qatar

It is important to note that these equations are to be used as a guide only, but do provide a basis for calculating the minimum tank size required based on the flow rate provided by the Contractor.

For fine grained type of soils, it is preferred to have secondary methods of treatment as per section 3.2.2.

3.2.2 Other Treatment

Silt and Fine Grained Soils

For the removal of silt and fine grained suspended particles, the following inexpensive methods can be effectively applied:

Dewatering Tank: a dewatering tank can remove sediment (sand, silt, and visible oil). The dewatering tank is equipped with a fabric filter. The flow passes through the filter before being discharged at the bottom end of the tank. The tank can be used in addition to the weir tank or any other treatment method. It is portable, inexpensive and many types of filter clothes can be used.

Yet, the dewatering tanks should be subjected to periodic cleaning based on the visual inspection or reduced flow, through lifting the sand and silt from the tank.

1. **Gravity Bag Filter:** (Also known as dewatering bag) is made of geotextile fabric that can filter out silt and fine grained soil particles. This filter is easy to install, inexpensive, and becomes more effective as sediment builds up inside the bag. The type of bag should be selected based on the flow rates of discharge and permeability of soil.

   This method is to be used as a secondary treatment for groundwater. It requires continuous monitoring to avoid hose failure, particularly if sediment builds up in a manner that interferes with the acquisition of a reasonable flow rate discharge.

   The Gravity Bag Filter does not require cleaning, as it is a disposable filter. The filter is to be disposed of in accordance with the waste management guidelines of the project. The filter is to be replaced when it starts passing solids, or blocks the passing of water at a rate that is adequate.

Figure 3.7 Gravity Bag Filter

Slurry Water

"The drilling [slurry] muds containing substantial quantities of organic liquids and water-soluble salts are treated to render them environmentally acceptable for disposal" (C M Wilwerding 1989)

Slurry water occurrence is common during dewatering processes in Qatar. While there is filtration equipment and water treatment technology available to treat slurry water, these are best used in countries with a different climate to that of Qatar's.

The best option for treating slurry by filtration is using a Centrifugal Filter. However, as previously mentioned, this is not a preferable to be used in Qatar as slurry can be dried easily in a more environmentally friendly manner.

It is also important to note that even when treatment equipment is used, the resulting silt will have to be disposed at a licensed landfill, along with having to dispose of the equipment at its end of service life.

If the silt contains hazardous material, then a license should be issued from MoE as per the procedures detailed in Annex (7.2) of the Qatari Law of Environment (Copy of the procedures together with the form of application is provided in **Appendix (C)**). And if the silt has no hazardous materials then the license shall be issued from the concerned Municipality.

To eliminate the issues with incompatible equipment and hot climates, it is recommended that treatment methods be designed to manage the slurry either onsite by drying the first instance before transfer to landfill, or by transfer to the landfill directly.

The conventional drying process comprises laying out of slurry mud on an air permeable drying bed lined with suitable material.

The drying process must commit to the following environmental considerations:

1. Amount of slurry generated must not exceed the capacity of the spreading system.
2. Drying process must not impose nuisance or emit odour.
3. Drying process must not impose health and safety risks.

The choice of drying process, whether by using a centrifuge machine or a drying lagoon is subject to project settings and expected amount of slurry to be generated.

The slurry handling process is to be submitted with the dewatering permit application if generation of slurry is expected to occur.

Contamination of Groundwater

In the event of discovering the contamination of the receiving environment such as groundwater by dewatering effluent, the contractor is obligated to report the discovery to the licensing authority (ASHGHAL, MoE) and the effluent is to be dealt with as per the construction Environmental Management Plan (CEMP), or as per the common agreement between O&M, QSD and MoE. Samples of groundwater should be taken and tested. Reasonable suspicion can be established by one of the following methods:

1. Possible history of contamination in the area; such as prior land use (eg. petrol station), or the area is known to have septic tank issues.

2. EIA: if there is an EIA prepared for the project, it should be reviewed and approved by MoE in order to eliminate the possibility of contamination. If the EIA indicates the presence of contamination, the Contractor is obligated to report the findings to MoE for their feedback, and test for the type of contamination detected in the EIA.

3. The Contractor is obligated to use a water quality assessment (such as the example in figure 3.8) to establish the possibility of contamination in the area.

Water Quality Assessment	
The following questions provide n initial assessment of the quality of the water to be discharged from the dewatering operation.	
Common Sense Test	1. Review the project records. Is there any reason to suspect that the water may be polluted by something other than sediment? **No** **Yes** 2. Is the water located in an area of known contamination? **No** **Yes**
Sight Test	Does the water have an abnormal visual feature, such as: (circle) **Oily Sheen** **Floating Foam** **Murky Appearance** **Unusual Colour** **Other**
Smell Test	Does the water have an odour? **No** **Yes** Possible odours include gasoline, petroleum, ammonia, sewage, etc.
If you answered YES to any of the above questions, explain: If you answered YES to any of the questions in the assessment or suspect that the water contains pollutants other than sediments, contact the Project Consultant for assistance with additional testing and management options.	

Figure 3.8 Water Quality Assessments

**** Adapted from Source:** The office of Environmental Engineering, California Department of Transportation (Caltrans), Field Guide to Construction Site Dewatering, USA, 2001.

In the event of discovering groundwater contamination, the Contractor is obligated to report the discovery to the licensing authority (MoE / ASHGHAL) and the effluent is to be dealt with as per the Construction Environmental Management Plan (CEMP), or as per a common agreement between O&M, QSD, and MoE.

4 Disposal Options

Qatar construction sites use four (4) common means of disposal, namely:

1. Discharge to sea via the Surface and Groundwater Network;
2. Direct Discharge to the sea;
3. (A) Discharge to lagoon totally covered by geotextile from all sides;

   (B) Discharge to lagoon not covered, and;
4. Discharge by injection to deep groundwater aquifer (Deep well injection).

The following section discusses the options available in Qatar in terms of dewatering effluent disposal, and describes the best option depending on the circumstances of the project.

4.1 Discharge to Sea via Surface and Groundwater Network

Disposal of dewatering effluent to the Surface and Groundwater Network is the most common practice in Qatar. The Surface and Groundwater Network eventually leads to outfalls that discharge to Sea.

The disposal to the network directly via pipelines, or via tankers, depends on the availability of Surface and Groundwater Network in the project area.

The Surface and Groundwater Network is an acceptable option for disposal given that Contractor are also reusing the effluent on site whenever possible (refer to section 4.6 for recycle and reuse onsite).

If a Contractor chooses to discharge to the Surface and Groundwater Network, obtaining a license from QSD and the Operation and Maintenance Department (O&M) within ASHGHAL is required to allow the discharge of groundwater to the Surface and Groundwater Network. A license from the Ministry of Environment is also required through the submission of an Environmental Permit Application.

Measurements of flow rates must be undertaken in order to monitor the discharge flow and ensure that it is within the limits provided to the licensing authority (refer **Appendix A** for discharge limits).

The Contractor must provide the licensing authority with the maximum expected flow rate (i.e the peak flow) and the expected average flow rate, in order to avoid back flooding when flows exceed the capacity of the manhole assigned to the Contractor. Therefore, the contractor should install a flow meter at the construction site in order to measure the quantities of groundwater flow.

The Contractor should also notify the licensing authority if peak flows are expected to be reached frequently during the winter season, particularly when heavy rain is forecast, so as to avoid penalties if the manhole back floods.

If a Contractor is operating from an area which is not served by a Surface and Groundwater Network, and determines that the most cost effective solution is to use tankers to transport

dewatering effluent to the nearest assigned manhole, the Contractor is then obligated to provide a brief statement demonstrating the traffic impacts caused by their tankers.

If the resultant traffic impact proves to be significant, the Contractor is either to consider other options of disposal, or retain dewatering effluent onsite and then transport the effluent when traffic is less congested, therefore minimising traffic impacts.

In the event that tankers are used to transport dewatering effluent, in order to monitor discharge to Surface and Groundwater Network the Contractor must record all particulars associated with its removal, such as:

- Installing a flow meter at the construction site in order to measure the quantities of groundwater flow.
- Record of tankers coming to and leaving the site (eg. registration plate no., capacity, records of water quality)
- Volumes of effluent transported.

The recording of tanker movements is in addition to the installation of a meter on the weir/sediment tank.

Yet, when applying for the discharge permit the following documents are required:

1. Official letter from the company addressed to: The Manager of Drainage Networks O&M Dept- Asset Affairs- ASHGHAL. (Includes start and end date of dewatering works & method of statement for dewatering).
2. Application form for pumping groundwater to be filled and stamped.
3. Copy of building permit.
4. Copy of the site map.
5. Copy of ID card of the applicant's engineer.
6. Copy of the registration company.
7. Copy of Road Opening (RO) Permit.
8. Copy of Traffic Department Approval, as part of the RO Permit
9. Testing of samples, and conformation of compliant results prior to obtaining the two-month permit. The Contractor must note that the sample testing is to be carried out after obtaining the five-day temporary permit, and is to be submitted after the previous requirements are submitted and a temporary permit is granted.

Once the application is submitted, the project is given a reference number which includes a serial number, type of discharge (e.g groundwater) and the date of application.

The reference number is then assigned to an O&M engineer who will advise on the applicable disposal option and shall assign a manhole for the application. Drawing and comments are then returned to the applicant for information and/or action.

The applicant is issued a temporary permit for five days. The purpose of the temporary permit is to allow the applicant to obtain approvals from the concerned authorities, and install the equipment in order to take water samples.

During the temporary dewatering permit; only discharge is allowed for collecting samples and to proceed with other department requirements. All samples are taken by laboratory representative from the list of laboratories approved by ASHGHAL and MoE; it's prohibited for samples to be taken by the Contractor. The collected samples should be tested for Total Suspended Solids (TSS, turbidity and the short list of parameters included in **Appendix A**. Test results should be uploaded online to QSD by the laboratory. Yet, it should be highlighted here that any testing activities are not only limited to the parameters provided on the short list developed by QSD; it should also cover the list of parameters required by MoE for dewatering permit. Approval is then granted if the test results meet the requirements of discharge. The Quality Limits are attached in **Appendix A**.

If the installation requires a road crossing, a RO permit is required. If not, a RO is not required. The applicant must obtain a license from the concerned authorities for installation of all tanks and hoses.

Following the issuance of the permit, regular inspections by the O&M staff are carried out. The Contractor is then required to undertake weekly laboratory tests for TSS and turbidity of effluent samples, and bi-monthly tests prior to renewing the permit. Permit renewal request should be submitted in 7 days advance before expiry day of the previous permit. The bi-monthly tests are for TSS, turbidity and the short list of parameters included in **Appendix A** together with the parameters listed under Annex (4) of the law of Environment number 30/2002.

A copy of the Permitting Application and pro-forms are attached in **Appendix D.**

Refer to **Appendix E** for a flowchart of the permitting procedure for the discharge to sea via Surface and Groundwater network.

4.2 Direct Discharge to Sea

MoE is the licensing authority for discharging dewatering effluent direct to the Sea.

If a Contractor found that the applicable option for dewatering is the direct discharge to sea, a secondary method of treatment must be installed to allow the dewatering effluent to settle before reaching the discharge outfall point. The discharge to the outfall point is achieved through the use of pipelines or transportation via tankers. Based on the number of tankers, the transportation may be subjected to a traffic impact assessment study based on the requirements of MoE.

The Contractor may therefore be subject to a number of pertinent laws and regulations:

When issuing direct sea discharge permits, MoE have the following concerns that need to be addressed as per Annex 4 of the Qatari Law of Environment and the list of parameters required by MoE for dewatering permit (included in **Appendix A)**, which includes the test of the following parameters:

1. Bacterial counts
2. Turbidity and TSS levels
3. Presence of Petroleum compounds.
4. Presence of heavy metals.
5. Others, as per MoE requirements.

Refer to **Appendix E** for a flowchart of the permitting procedure for the direct discharge to sea. A copy of the environmental permit application form is included in **Appendix F**.

For more information, contact MoE on:

Telephone +974 4420 7777

Fax + 974 4420 7000

Email Responsibility@moe.gov.qa

4.3 Discharge to Lagoons:

A. Discharge to Lagoon totally covered with geotextile from all sides

Lagoons are licensed by MoE.

It is recommended that a lagoon totally covered with geotextile from all sides, formed in a depressive area, is used in locations where it is logistically impossible or cost and socially prohibitive to deliver effluent to the Surface and Groundwater Network using other means.

If Contractor chooses to discharge the dewatering effluent to a lagoon, license is given by MoE. The dewatering to lagoons is mainly based on the requirements by MoE which is given for case by case. The use of this option is depending on the water quality. Yet, the general requirements of MoE can be summarised in the following information:

1. Dewatering effluent quantity.
2. Detailed Engineering drawings for the lagoon showing the geotextile lining of the lagoon.
3. Duration of dewatering discharge
4. Dewatering effluent quality. Dewatering effluent quality is tested initially against the list of parameters required by MoE for dewatering permit (included in **Appendix A)**. And then tested weekly. Monthly testing is also required for selected parameters.
5. Coordinates of lagoon, inclusive of dewatering discharge points.
6. Location map
7. Others, as per MoE requirements.

Refer to **Appendix E** for a flowchart of the permitting procedure for the discharge through the use of lagoons. A copy of the environmental permit application form is included in **Appendix F**.

For more information, contact MoE on:

Telephone +974 4420 7777

Fax + 974 4420 7000

Email Responsibility@moe.gov.qa

B. Discharge to Lagoon not covered

The discharge to a logon which is not covered is depending on the discharged water quality. Similar to the above option, the licensing authority for this option is the Ministry of Environment. The list of parameters required by MoE for dewatering permit is included in **Appendix A**. The general requirements of MoE are similar to the above option.

Refer to **Appendix E** for a flowchart of the permitting procedure for the discharge through the use of lagoons. A copy of the environmental permit application form is included in **Appendix F**.

For more information, contact MoE on:

Telephone +974 4420 7777

Fax + 974 4420 7000

Email Responsibility@moe.gov.qa

4.4 Discharge by injection to deep groundwater aquifer (Deep well injection)

Disposal by injection to groundwater aquifer is a common method in Qatar to dispose of treated effluent of sewage treatment plants. Yet, the use of deep well injection for the discharge of dewatering effluent to groundwater aquifer is also done in few big projects.

However and prior to the discharge to the deep well, a careful assessment of geological conditions must be conducted in order to determine the suitable depth and location of porous aquifer reservoirs and identifying the safe rate of injection to the deep aquifer. Generally, the depth of the deep well should not be less than 400 – 600 m deep, which is the expected depth of Umm Er Radhumma (UER) aquifer.

In all cases, MoE require the contractor to conduct an Environmental Assessment for the impact from the project as soon as drilling of the deep well and the analysis of the samples is achieved. This should be done by a qualified consultant with previous experience in similar projects.

The general requirements of MoE for the use of the deep well injection can be summarised in the following information:

1. Duration of dewatering discharge.
2. Dewatering effluent quality. Dewatering effluent quality is tested initially against the parameters specified in the standards for the water use for irrigation purpose of the Qatari Law of Environment. And then periodically testing each week based on MoE requirements.
3. The parameters required for the physical, chemical, biological, microbiological analysis includes but not limited to: EC, Tempreture, DO, pH, Turbidity, FRC, TPH, O&G, Sulphide, Metals, BOD, COD, TOC, surfactants, VOC, BETX, TDS, TSS, PAHs, TAlk, Nitrate, Nitrite, Ammonia, TKN, Phosphorus, Chloride, Sodium, Sulfite, Total Phenol, Carbonate, E-Coli, Facel Coliform, Bacteria and SAR.
4. A0 design map for the whole project including the location of the injection well and network of shallow trenches connecting the wells.

5. Comparison study between the use of the shallow networking and the perforated pipelines.
6. Drilling of monitoring wells to suitable depth to monitor the impact on the shallow aquifer.
7. Providing the injection wells with emergency valves to stop injection in case of contamination.

Refer to **Appendix E** for a flowchart of the permitting procedure for the discharge through the use of deep well injection. A copy of the environmental permit application form is included in **Appendix F**.

As mentioned above, the injection of dewatering effluent to groundwater aquifer is licensed by MoE and is completely subject to their approval, therefore for further information, please contact MoE on:

Telephone +974 4420 7777

Fax + 974 4420 7000

Email Responsibility@moe.gov.qa

5 Integrated Management of Construction Dewatering

Construction dewatering practices are better managed if they are integrated with existing construction management systems, such as a CEMP, monitoring plan and training programmes. The dewatering practice will then form part of the regular construction inspection/monitoring program.

5.1 Groundwater Recycle & Reuse Onsite

It is recommended, where environmentally safe and cost effective, that dewatering effluent is reused or recycled onsite.

The reuse options onsite will depend on a number of factors, including the type of project. The contractor should propose the treatment in case the water is polluted by organic and inorganic chemicals or subjected to biological contamination. The treatment should focus but not limited to low DO, presence of Bacteria, elevated levels of TSS or turbidity and presence of oil.

It is therefore recommended that the CEMP be used to identify all opportunities of reuse onsite. Yet, the options for the reuse of the groundwater should be discussed with MoE and shall be subjected to the approval by MoE.

Options could include but not be limited to:

1. Control of dust onsite. (Subject to the level of safety and quality of dewatering effluent).
2. Reuse of dewatering effluent.
3. Concrete curing.
4. Excavation activities requiring water.
5. Washing of machinery and site equipment.
6. Watering of onsite landscaping, when the turbidity is very low to avoid compromising the integrity of the soil.
7. If the dewatering effluent quality is within limits of soil compaction parameters requirements (refer to QCS), it can be used for soil compaction purposes.

Contractor to conduct a feasibility study to evaluate whether it's feasible to erect an RO system for dewatering effluent treatment, in order to use the dewatering effluent instead of fresh potable water.

The feasibility study is to compare both options in terms of financial viability.

5.2 Construction Environmental Management Plan (CEMP)

The CEMP is prepared to minimise the impacts of the project and its activities on the receiving environment. The CEMP is prepared prior to mobilising to site.

The Contractor should uses the geotechnical investigations and previous EIA (if applicable) as guidelines when preparing the CEMP.

When dewatering activities are included within the project site, the preparation of the CEMP should include the following:

- Identification of opportunities to reuse the dewatering effluent onsite in order to reduce the amount of disposed effluent.
- Dewatering techniques being employed on site
- Disposal methods employed on-site and relevant monitoring plan to ensure compliance with discharge limits.
- Copy of discharge limits.
- Roles and responsibilities of the Environmental Advisor on site.

Roles and responsibilities have to be clearly defined when designing a dewatering system. These roles and responsibilities are to be submitted as an essential element to satisfy the CEMP requirements when applying for the dewatering effluent discharge permit.

Refer to **Appendix G** for an example of inspection sheet for the dewatering process.

5.3 Monitoring Plan

The environmental monitoring plan is used to monitor the anticipated impacts of the project o the surrounding and receiving environments. It is imperative that, should dewatering activities exist on site, there is integration all testing and monitoring requirements.

Integration of monitoring plans may be between systems within individual sites or between several sites, depending on management systems or owners

1. **Environmental monitoring plan:** The environmental monitoring plan is to outline the steps required for monitoring of construction dewatering practices. The integration of dewatering practices into the monitoring plan will pave the way to introduce a dewatering monitoring plan.

   The findings of the dewatering monitoring reports are to be summarised and included in the environmental monitoring reports.

2. **The dewatering practices monitoring plan:** Introduction of a dewatering practices monitoring plan, sampling points, variables, frequencies and reporting. This plan should be cyclic which stands to be audited as part of the master environmental monitoring plan. Corrective actions from audits are to be implemented to ensure improved performance.

5.4 Training Plan

The integration of construction dewatering training into the training plan of the Contractor is essential to introduce all staff to construction dewatering related information.

It is recommended that information on dewatering equipment and related emergencies are included in the training provided to staff entering or working on the site.

The training for all staff does not have to be comprehensive; however, it should include basic items such as:

1. Brief explanation of the construction dewatering purpose
2. Introduction to the dewatering equipment. Inclusion of photos in the training presentation.
3. Health and safety related concerns, education on related emergencies, and contact information of person in charge of dewatering to be provided in the presentation.

Training for dewatering staff, however, should be the responsibility of the Project Consultant and as per each Project needs and requirements. The training should be comprehensive and should include all components dewatering staff need to be familiar with.

5.5 Odour Control

The odour levels have been given a threshold value as indicated in the Qatari Construction Specifications (QCS). Therefore, it is highly recommended to measure the level of odour parameters, a devise should be installed within the construction site to measure odour parameters (eg: H_2S).

The QCS has identified two types of odour control equipment; control equipment carbon type and control equipment scrubber type. **Appendix (I)** includes a copy of the odour control equipment for carbon and scrubber types.

6 Health & Safety Considerations

Health and safety issues are the most important part of any construction project. It is recommended that health and safety measures in relation to dewatering practices are enforced strictly, in order to prevent and/or minimise on-site accidents.

In addition to the conventional health and safety measures implemented in construction sites, the following considerations are to be incorporated to contribute to the health and safety practices relating to construction dewatering:

6.1 Site Investigation

During the initial site investigations, the Contractor has to identify potential health and safety risks in the project area. Examples of risks are: potential contamination posing health and safety concern to labour workers and site staff, slope stability issues due to dewatering practices... etc.

Identified risks have to be considered and mitigated against during design and execution of dewatering.

This exercise can be undertaken during the Risk Assessment process as described earlier in this Guideline.

6.2 Design Considerations

The design of dewatering stage is the most convenient stage to plan properly in order to prevent foreseeable health and safety issues arising during operational dewatering.

All designs must take into account the health & safety considerations associated with dewatering, which include but are not limited to:

1. Preparation of layout plan for dewatering equipment.
2. Ensure access to dewatering equipment, without compromising the safety of staff.
3. Ensure that all dewatering equipment –especially equipment placed offsite- is marked clearly with name of project and Contractor, and contact person details.
4. Provide protective covers for assigned manholes which do not hinder the discharged flow.
5. The mandatory use of PPE. All staff entering a project's safe zone have to be wearing appropriate safety gear. This also applies to staff managing dewatering equipment offsite.
6. The Contractor is to exercise duty of care when designing, installing and operating the dewatering equipment and process.

6.3 Housekeeping Considerations

It is recommended that during the regular inspection of projects, the licensing authority is to observe the status of housekeeping of dewatering equipment. Inadequate housekeeping can expose staff and visitors to injury.

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LIST OF APPENDICES

Appendix A

Short List of Parameters as provided by Ashghal – MoE list of Parameters required for Dewatering Permits- Environmental Laws and Regulations- Annex 4, Law 30 of 2002

Project Name:
Contractor Name:
Dewatering Discharge Permit Situation: (1) Experimental, (2) In Operation (Permit No.:), (3) For renewals

TO: Director of Quality, Safety and Environment Department, Environmental Section
Public Works Authority
FROM: ( ) LABORATORY
Project Name: ( )

Analysis Results Report of Dewatered Water Quality

Date of Sampling: **Date of Analysis:**

Parameter	Symbol	Unit	Sample (1)	Sample (2)	Sample (3)	Discharge Limit	Comments
Location: describe sample location							
Discharge Rate (m3/sec): To Be Filled by Contractor							
p H						6 - 9	
Alkalinity as Ca CO3	Alk.	mg/l					
Turbidity		NTU				50	
Total Dissolved Solids	TDS	mg/l				1500	
Total Suspended Solids	TSS	mg/l				50	
Chemical Oxygen Demand	COD	mg/l				100	
Sulfide	S^{2-}	mg/l					
Oil & Grease	O&G	mg/l				15	
Odour		ppm					

CC:Director of Maintenance & Operation Department
Network Maintenance & Operation Section

Chemist In Charge Signature:
Laboratory Stamp:

Analysis Required by MoE for the Dewatering Permit

1. TDS (mg/l)
2. Turbidity (NTU)
3. Dissolved Oxygen (mg/l)
4. Sulphide (mg/l)
5. Oil & Grease (mg/l)
6. TSS (mg/l)
7. pH (mg/l)
8. Odor
9. Alkalinity (mg $CACO_3$/L)
10. Metals (Cr, Pb, Ni, Zn, Cd, As, Se, Cu) mg/l and (Hg) ug/l
11. BOD5 (mg/l)
12. COD (mg/l)
13. TPH (Gasoline Range Hydrocarbons, Diesel Range Hydrocarbons, Heavy Fractions) (mg/kg)
14. Total Coliform Bacteria (MPN/100 ml)
15. Escherichia Coli (MPN/100 ml)

The Test Results should show:

1. Material tested
2. Date of Sampling
3. Date of delivery of sample to the lab
4. Reporting Date
5. Lab where analysis was achieved
6. QA/QC Procedures of the used lab

Note

*Analysis sheet from the lab should be signed and stamped

*MoE has the right to add or delete parameters to and from this list

Annex No. (4)

Criteria and Specifications of the Hazardous Materials when Disposed of in the Water Environments

1) **Criteria and Specifications of Some Materials when Disposed of in the Water Environments**

2) **Liquid, Illiquid, Polluting and Unsolvable Materials Prohibited to be Disposed of in Water Environments:**

1) Criteria and Specifications of Some Materials when Disposed of in the Water Environments

Considering the provision of the Article (89) of the executive bylaws of the Environment Protection Law, no disposal of wastes is allowed except in the distance not less than four marine miles from the coastline if the waste water is treated and in the distance not less than twelve marine miles if the disposal is for the wastes not treated.

Also disposal is not allowed in the places of fishing or places of bathing or natural quarantines, protecting the economic or beauty value of the area.

Description	Symbol	Max Limit	Unit
1- Physical Experiments			
Total dissolvent	TDS	1500	Mg/L
Total suspended solids	TSS	50	Mg/L
Hydrogen base	PH	6-9	
Floating bodies		Nil	
Temperature Degree	T	Not more than three degrees above the relevant average	$(\Delta T)^{oC}$
Turbidity	NTU	50	Mg/L
Colour		Free from colour materials	
2- Inorganic Materials			
Ammonium	NH_4^+	3	Mg/L
Sediment Chloride	Cl_2	0.05	Mg/L
Cyanide	**CN**	0.1	Mg/L
Fluorides	F	1	Mg/L
Phosphor in the form of Phosphate	**PO_4^{-3}**	2	Mg/L
Sulphur	S^{-2}	0.1	Mg/L
Required Vital Oxygen	BOD_5	50	Mg/L
Required Chemical Oxygen	COD	100	Mg/L
Urea		2	Mg/L
Total Nitrogen	TKN	100	Mg/L

3- Rare Factors			
Aluminium	AL	3	Mg/L
Arsenic	As	0.5	Mg/L

Barium	Ba	2	Mg/L
Boron	B^{-}	1.5	Mg/L
Cadmium	Cd	0.05	Mg/L
Total Chrome	Cr	0.2	Mg/L
Cobalt	Co	2	Mg/L
Copper	Cu	0.5	Mg/L
Iron	Fe	1	Mg/L
Lead	Pb	0.1	Mg/L
Manganese	Mn	0.2	Mg/L
Mercury	Hg	0.001	Mg/L
Nickel	Ni	0.5	Mg/L
Zinc	Zn	2	Mg/L
Silver	Ag	0.005	Mg/L
Selenium	Se	0.02	Mg/L

4- Organic Materials			
Oil and grease	O & G	15	Mg/L
Total phenols		0.5	Mg/L

Halogen Hydrocarbons and Different Kinds of Pesticides		0.1	Mg/L
Dioxine / Viran		$1.34x10^{-7}$	Ug/L
Tri Halomethane	THM	100	Ug/L
5- Biological Experiments			
Possible No. of Colon Group in 100 M^3	MPN	100	MPN/100ml
No of infantal eggs		Nil	
No of infantal worms		Nil	
No of fecal colon bacillus		100	MPN/100ml

Annex No. (4/2)

Liquid, Illiquid, Polluting and Unsolvable Materials Prohibited to be Disposed of in Water Environments:

Liquid, Illiquid, Polluting and Unsolvable Materials Prohibited to be Disposed of in Water Environments:

The unsolvable materials are those materials which are found in the environment for a long period, depending basically on the quantities disposed of in the water environments. Some of them are solved after a long period ranging from months to years depending on the components of these materials and concentration in the environment.

Inorganic Materials:

For Example:

Mercury and its components
Lead and its components
Cadmium and its components

Cobalt, Fantium, Nickel, Selenium, Zinc and its Components

Organic Materials

For Example:

Organophosphorus Pesticides
Dimethoate
Malathion

Organochlorine Pesticides
Aldrin
Dieldrino
DDT

Chloridane

Endrine

Unsolvable and Remaining the Residues for Many Years

Polychlorinated Biphenyls

(PCBs)

Aroclor 1254

2,3,5,6 Tetrachlorobiphenyl

2.3.6 Trichlorobiphenyl

Unsolvable completely and counted as high toxic in its very low concentrations:

Polynuclear Aromatic Hydrocarbons (PAH)

Benzo (a) Pyrene Naphthalene

Solvable, small quantity is solved within years.

Solid Materials

For Example: Plastic, Fishing Net, Coir, Containers.

Appendix B

Copy of the Qatar Construction Specifications (QCS) section 8 – part 2.2.14 for the dewatering from excavation

Dewatering Requirements as extracted from the QCS 2010- section 8 – part 2.2.14 (Dewatering from Excavation)

1. The Contractor shall submit methods statements including drawings and data showing the intended plan for dewatering operations. Details of locations and capacities of dewatering wells, well points, pumps, sumps, collection and discharge lines, standby units, water disposal methods, monitoring and settlement shall be included. The methods statement shall be submitted to the Engineer for approval not less than 30 days before the start of dewatering operations. The Engineer reserves the right to reject the proposal if he is not satisfied with measures.

2. The Contractor shall satisfy himself on the scope of dewatering necessary for the construction of the Works and shall make the necessary investigations to obtain the required data and information.

3. Where necessary, the Contractor shall divert natural and artificial waterways encountered at the Site until the Works are completed.

4. The Contractor shall perform dewatering as necessary to ensure that:

    - The Works are installed on dry areas and excavations, including without limitation the construction of all structures and underground piping.

    - Dewatering is carried out only to a depth sufficient for the required excavation.

    - During construction, no groundwater shall come into contact with any concrete surface or reinforcement

    - Structures shall be capable of withstanding any hydrostatic pressure to which it may be subjected during construction and until completed.

5. The Contractor's dewatering operations shall be conducted so as not to endanger the foundations or stability of the Works or any adjacent structures. Damage caused by the Contractor's operations shall be made good by the Contractor at no additional cost to the Employer.

6. Water removed from excavations shall be pumped directly to the sea or, if approved, to the surface water drainage system via an efficient system of discharge lines. No water may be discharged to the sewerage system, to the Works, or to open spaces. No water shall be conveyed or discharged in such a way as to cause nuisance or damage to traffic or to public or private property or services.

7. Where discharging to the sea is not possible, and no surface water drainage system is available permission may be granted to discharge into the sewerage system provided measures are adopted not to pass any salt and debris into the system.

8. Unless otherwise approved by the Engineer, wellpoint dewatering systems shall be provided on both sides of trenches.

9. The static water level shall be drawn down a minimum of 300 mm below the bottom of the excavation so as to maintain the undisturbed state of the foundation soils and allow the placement of any fill or backfill to the required density. The dewatering system shall be installed and operated so that the groundwater level outside the excavation is not reduced to the extent that would damage or endanger adjacent structures or property.

10. The Contractor shall, where extensive dewatering is required, be fully qualified to perform the dewatering operations or shall furnish the services of an experienced, qualified, and equipped

11. When directed by the Engineer, the Contractor shall establish a specified number of groundwater level monitoring stations at each site which shall be observed during the work. These shall be located as directed by the Engineer and consist of acceptable open tube piezometers. When directed by the Engineer, the Contractor shall provide settlement gauges to the approval of the Engineer and monitor settlement of new and existing facilities.

12. Dewatering shall not result in the flow of water along the pipe zone material. Full consideration should be given to the use of cut-off walls to reduce the potential for groundwater flow along pipe trenches. The Contractor shall submit for the Engineer's approval, details of his proposed method of working and temporary works installations to achieve this.

13. If the use of drainage conduits, channels or subdrains is approved by the Engineer and are to be left in place below the level and within the width limits of permanent Works they shall be structural capable of providing support. Ballast filled subdrains to be left in place under concrete shall be covered with a geotextile membrane. Subdrains left in place shall be filled with Grade 20 SRC concrete or an approved cementitious grout.

14. The release of groundwater to its natural static level shall be performed so as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted fill or backfill and prevent floatation or movement of structures, pipelines and sewers.

15. No dewatering system shall be removed until infiltration testing is completed nor without the approval of the Engineer. Monitoring and settlement measurement systems shall be maintained in operation until removal is approved by the Engineer. With the approval of the Engineer, wellpoints and like items may be abandoned in place.

16. Partially completed permanent works shall not be allowed to become flooded and the Contractor shall allow for additional standby pumps and equipment required to ensure this. A pump operator shall be on site 24 hours per day to supervise pumping equipment.

17. In the event of partially completed trenches becoming flooded, the Contractor shall re-excavate to formation level and re-lay the pipes.

Appendix C

Copy of the procedures for the transportation and disposal of hazardous waste & the form of application as per MoE regulations

Supreme Council for the Environment & Natural Reserves
Technical Affairs Dept.

(Annex No. 7-2)

Form of Application for a Licence to Transport and Dispose of the Hazardous Wastes (Form No. 1)

Note to Applicants

1. The application should be completed in block letters and submitted along with relevant supplemental information to the General Secretariat.

2. All who proposes to transport and/or dispose of the industrial waste inside the State should fill up the Form No. (1) – Licence Application and the Form No. (2), 48 hours prior to the transportation, in order to obtain the final approval.

3. All the producers, transporters and receivers of wastes should follow the directions and instructions set forth by the Council in this regard. If the Application is accepted the Council will co-ordinate with the concerned departments in this regard. In case of any additional terms which the Council sees necessary it will be explained in the box allotted for the same in the Form.
4. The Applicant should read the Form carefully and fill up all the information required therein. In case of any inquiry while filling up the Application please call directly the Council. The Council assumes no responsibility for delays arising from the submission of incomplete information.

Information about the proposed waste transportation										
From	Name and Address of the Waste Producer :						Identification Number of the Producer :			
Application No.										
Date: (dd/mm/yy)										
To the Concerned Department										
Process										
Type of Application	□ Normal □ Urgent Reason:									
Expected Date: (dd/mm/yy)										
Tick(√) the appropriate box	Toxic	Inert	Flamable	Corrosive	Odorous	Acid	Highly Reactive	Infectious	Flash Point	Boiling Point

Description of the Waste Please enclose the following: ▪ Lab analysis for the wastes ▪ Safety and security certificate.	Type of Waste (Solid / Liquid / Paste / Gas)									
	Intl Number for the waste (if any)									
	Intl Number for materials (if any)									
	Origin:									
	Qty (Ltr. Kg. Ton ….etc)									
	Explain the present status of the waste (container, barrels, etc..)									
	Additional Information about the wastes.									
Special Handling Instructions	Please specify (personal safety equipment, eyes, hands and ears protection equipment, etc……)									

Validation of the Application		
Applicants Details	Name:	Stamp
	Signature :	Date (dd/mm/yy)
	Telephone:	Fax:
For Official Use Only		
From	Supreme Council for the Environment and Natural Reserves	
To Concerned Dept.		Tel.
		Fax:
CC: Civil Defence	Note: Copy only for hazardous wastes transportation only.	Tel
		Fax:
Decision	Request Accepted ◯	Request Rejected ◯
With the following conditions:	If the Application is accepted, the transporter should follow the following guidelines and terms for source or producer of the wastes.	

	a- Producer	
	b- Transporter	
	c- Receiving facility	
	Please put circle in the suitable place: Other conditions upon delivery:	
	Return Form (1) and (2) to the Council	
	Other terms at the time of delivery.	
Recommended by:	Name	Designation
	Signature	
Approved	General Secretariat	
	Date: (dd/mm/yy)	

- The transporter should keep the copy of the original application and the original certificate should keep while transporting the wastes.

Appendix D

Discharge Permit Forms

Public Works Authority

Assets Affairs

Drainage O&M Networks Department

Application For Ground Water Pumping

T0 : **Managers of Drainage O&M - DA and Quality , Safety & Environment Departments - PWA**

FROM : **Contractor**

Project		**Previous Permit No.**		**Temporary / Trial Permit No.**	
Location				**O&M / Application Ref.No.**	
Quantity		**l/s**	**Duration**		**days / weeks**

From : / / 20

Project Coordinator Signature & Stamp	**Consultant's Approval Signature & Stamp**	**S&G Networks Availability For Drainage O&M use only**			
		Pro.Dis. MH. NO.			**Remarks**
		PS NO.			
		OUT FALL	**YES**	**NO**	
		Signature			
Date:	**Date:**	**Date:**			

General Conditions :

A) The Contractor undertakes to obey environmental law No.30,Year 2002, and its execution articles, specially article No. 4, regarding water quality specification and discharge limits to aquatic environment and any others specific condition.

B) The contractor should design and implement discharge limits mitigation measures according to each site site specific condition, geotechnical and soil mechanics report.
It could be one or more of the following:

1) Filters/sand traps to comply with water specification required .
2) Geotechnical sheets to prevent suction of silt and mud from suction wells.
3) Odor mitigation measures specifications used in case of odor problem.
4) Weekly sampling and analyzing, TSS, TDS, p H, Turbidity, odour,any other parameters required.
5) All laboratory analysis and checks (weather initial, weekly or random) will be at contractors cost.
6) The contractor shall keep record of all laboratory analysis and make its ready for randum inspection by PWA

C) The contractor shall respect and continue to respect the conditions & specifications mentioned above ,any violation will entitle Drainage O&M Dep. to cancel this permit and take legal actions.

D) Drainage O&M Dep. has the right to cancel the issued permit for any reason without any claims.

For Contractor use only

We certify that We accept to obey and follow all the above mentioned general conditions & specifications.

Name :

Signature :

Date:

Stamp

Quality , Safety & Environment Department Approval ☐ Approved ☐ Not Approved

TO : Manager of Drainage O&M Department - AA

I would like to inform you that we have no objection to issue the permit as the above condition.

Approval Ref. No.:

Manager of Quality , Safety & Environment Department

N.B. Original approved application must be returned to Drainage O&M Dep. to issue the permanent permit.

قطـر تستحـق الأفضـل
Qatar Deserves The Best

Public Works Authority
Assets affairs
Draiange Networks O&M Department

Permit For Ground Water Pumping

Permit No. _____

To : M/s. Abd Al Hamed Mohamed S & Co.

From : Manager Draiange Networks O&M Department

As per the approval ref . No. _____ (copy attached)

You are hereby authorised to discharge surface/ground water, subject to the following conditions:-

Discharge point _____

Quantity _____ **l/s**

Duration _____ **days**

Start date _____ **Expiry date** _____

This permit is subject to the general conditions and specifications mentioned in application form.

Head of Unit _____ **Head of Division** _____

Ahmed Mohamed Sharif
Manager Drainage Networks O&M Department

cc: **Manager of Quality , Safety & Environment Department**
Area Engineer
File

N.B. **Renewal request to be submitted 7 days before expiry of previous permit**

أوافق على تنفيذ جميع الشروط الواردة بطلب الخدمة والشروط اعلاه.
We accept the permit on the application & above mentioned conditions .

Name: _____ Mob. No. _____

Signature _____ Date _____

قطـر تستحـق الأفضـل
Qatar Deserves The Best

Public Works Authority
Assest Affairs
Draiange Networks O&M Department

Temporary Permit For Ground Water Pumping
تصريح مؤقت لضخ مياه جوفية

Temporary Permit No. /2014

To : M/s. HBK Contracting Co.

From : Manager Draiange Networks O&M Department

As per the application ref . No.

You are hereby authorized to discharge surface/ground water, subject to the following conditions:-

Discharge point

Quantity l/s

Duration (Only 5 days) - This permit only for taking sample

Start date **Expiry date**

The contractor shall take a sample of the water to an approved laboratory and submit the result report to Quality , Safety & Environment Department -PWA attched with application for approval.

This permit only for taking sample and over pumping is not allowed .

Head of Unit **Head Of Division**

Ahmed Mohamed Sharif
Manager Drainage Networks O&M Department

cc: **Manager of Quality , Safety & Environment Department**

Area Engineer **MS Attached**

File

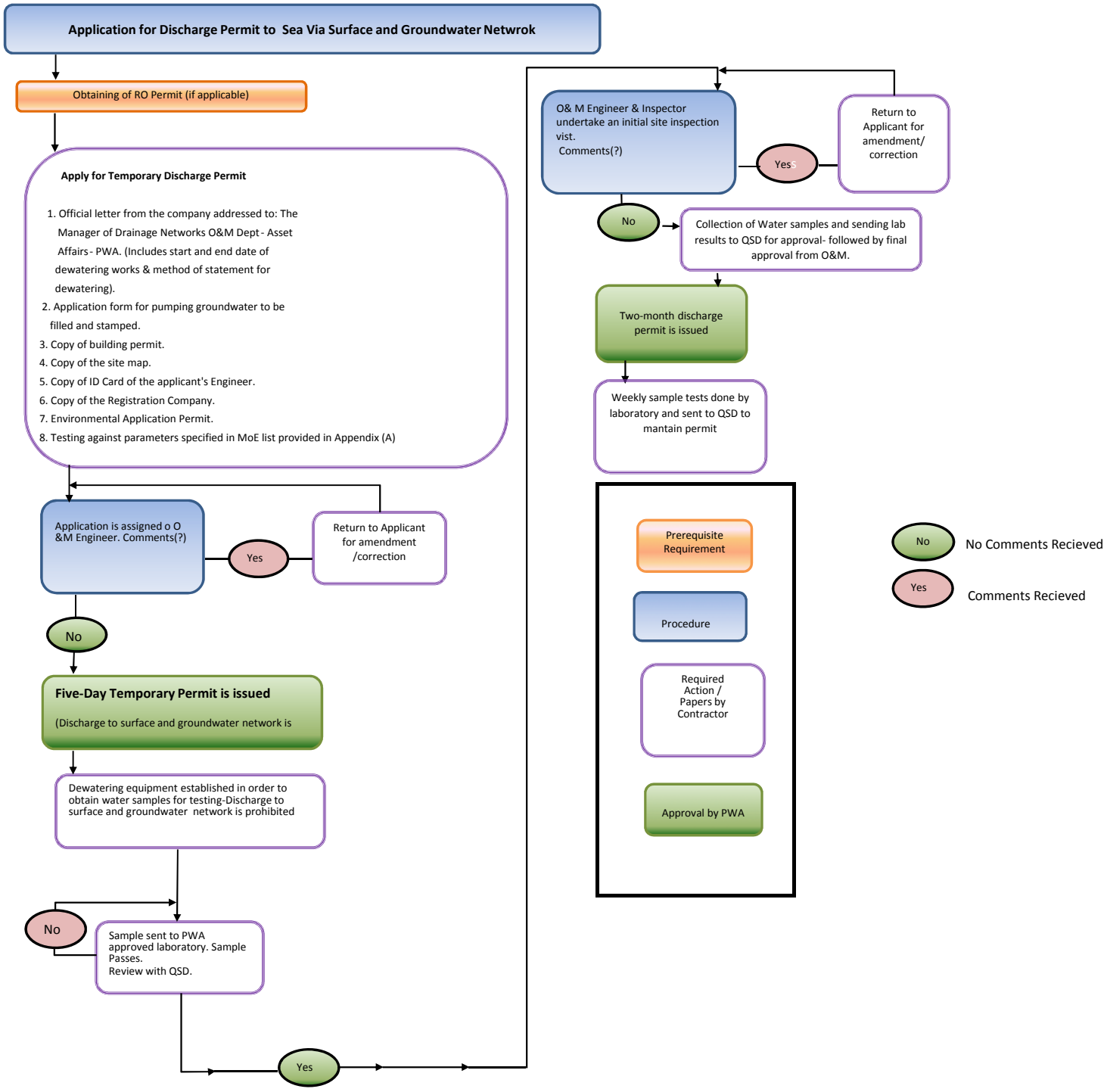
أوافق على تنفيذ جميع الشروط الواردة بطلب الخدمة والشروط اعلاه.
We accept the permit on the application & above mentioned conditions .

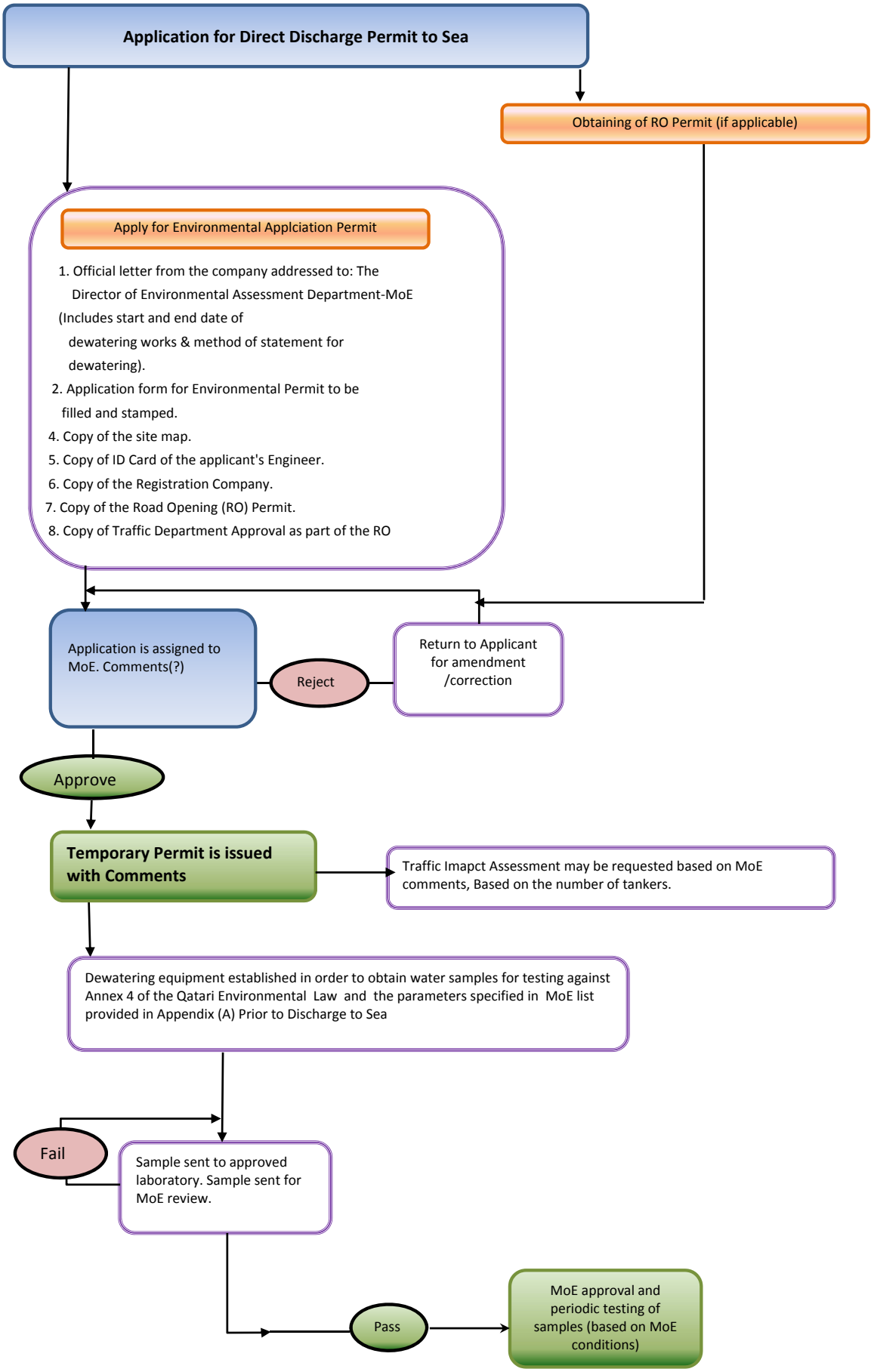
Name: Mob. No.

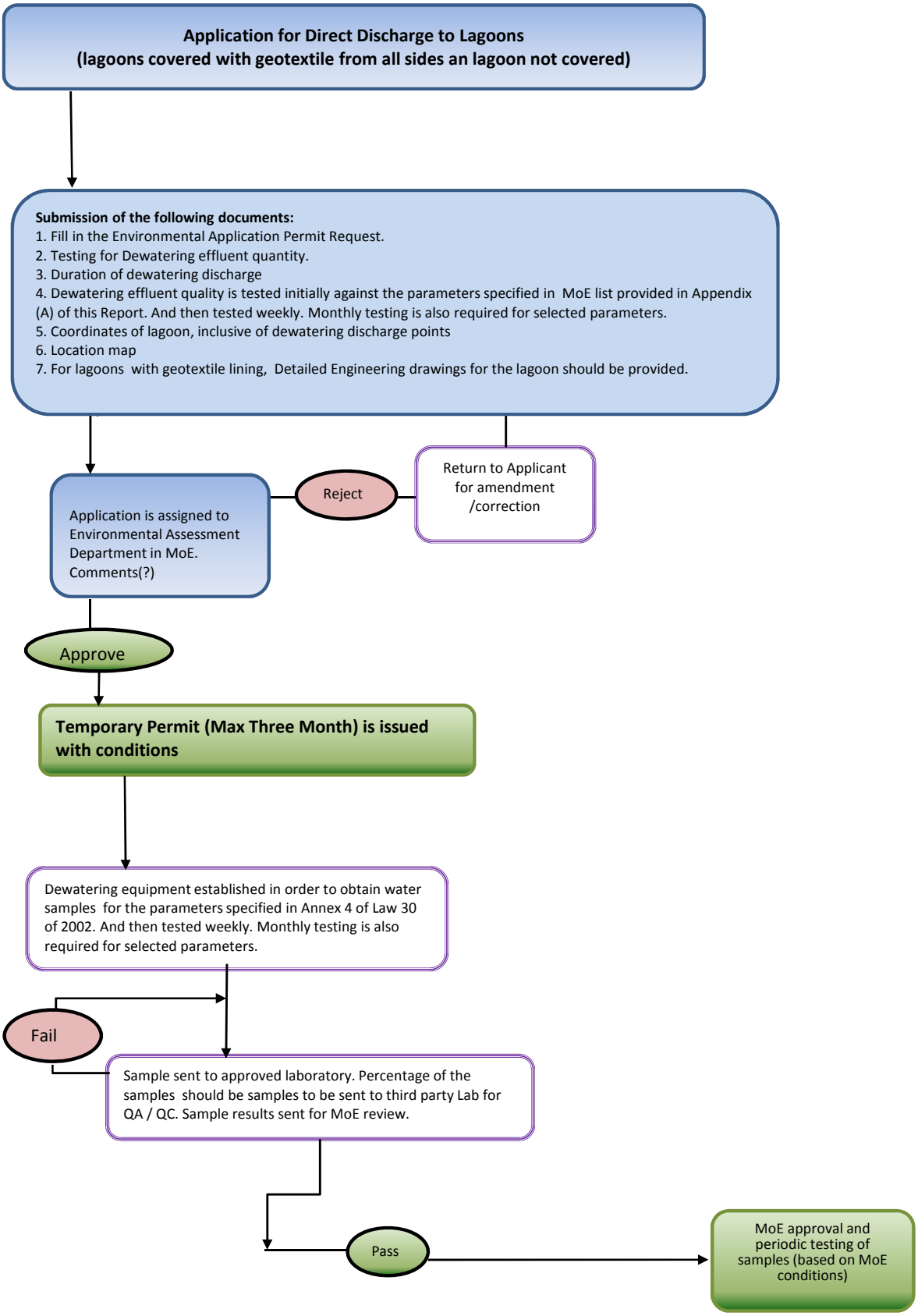
Signature Date

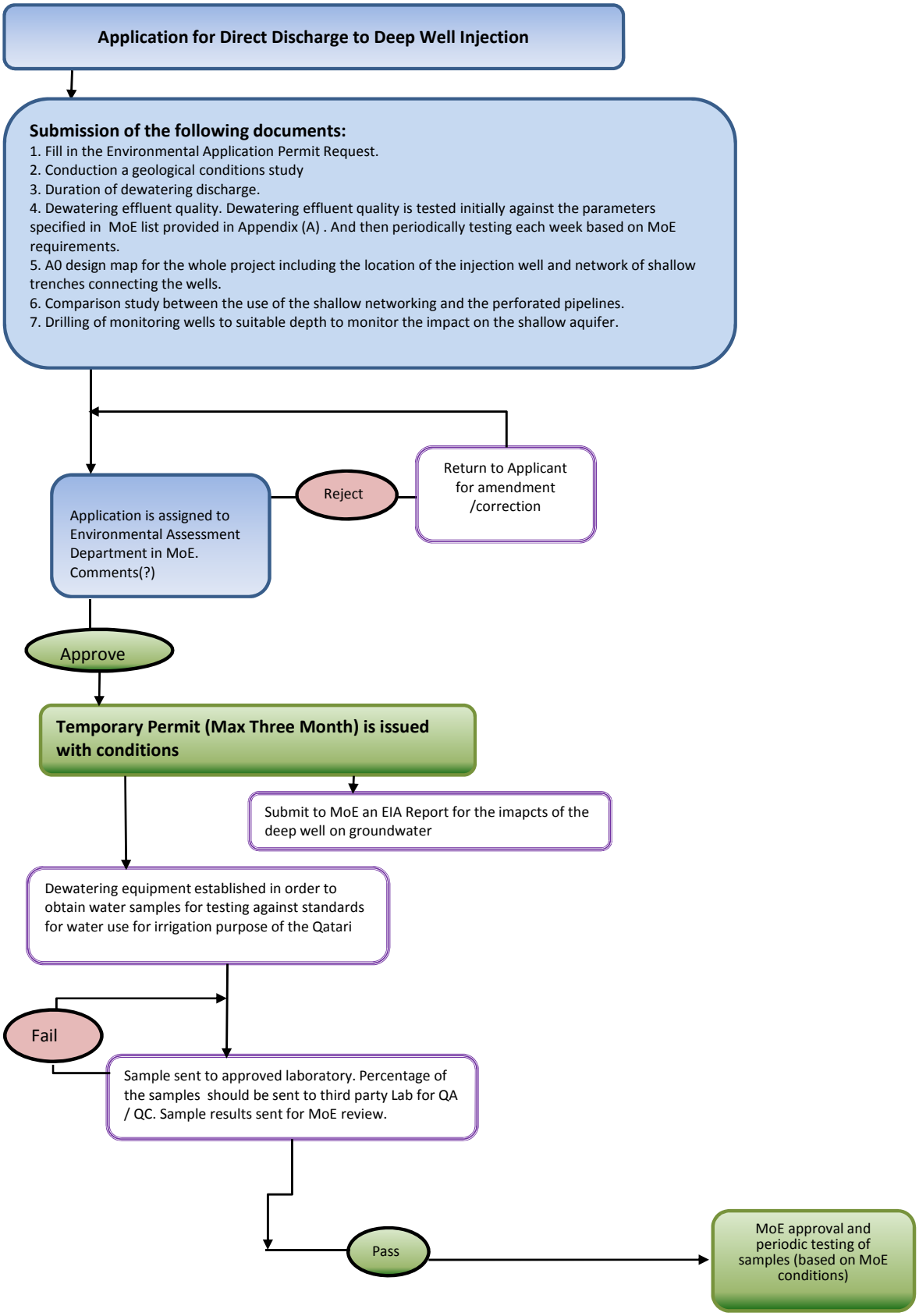
Appendix E

Application for Permit- Procedure Flowchart for each Dewatering Option


Application for Discharge Permit to Sea Via Surface and Groundwater Netwrok
Obtaining of RO Permit (if applicable)
Apply for Temporary Discharge Permit
1. Official letter from the company addressed to: The Manager of Drainage Networks O&M Dept - Asset Affairs - PWA. (Includes start and end date of dewatering works & method of statement for dewatering).
2. Application form for pumping groundwater to be filled and stamped.
3. Copy of building permit.
4. Copy of the site map.
5. Copy of ID Card of the applicant's Engineer.
6. Copy of the Registration Company.
7. Environmental Application Permit.
8. Testing against parameters specified in MoE list provided in Appendix (A)
Application is assigned o O &M Engineer. Comments(?)
Yes
Return to Applicant for amendment /correction
No
Five-Day Temporary Permit is issued
(Discharge to surface and groundwater network is
Dewatering equipment established in order to obtain water samples for testing-Discharge to surface and groundwater network is prohibited
No
Sample sent to PWA approved laboratory. Sample Passes.
Review with QSD.
Yes
O& M Engineer & Inspector undertake an initial site inspection vist.
Comments(?)
Yes
Return to Applicant for amendment/ correction
No
Collection of Water samples and sending lab results to QSD for approval- followed by final approval from O&M.
Two-month discharge permit is issued
Weekly sample tests done by laboratory and sent to QSD to mantain permit
Prerequisite Requirement
Procedure
Required Action / Papers by Contractor
Approval by PWA
No
No Comments Recieved
Yes
Comments Recieved


Application for Direct Discharge Permit to Sea
Obtaining of RO Permit (if applicable)
Apply for Environmental Applciation Permit
1. Official letter from the company addressed to: The Director of Environmental Assessment Department-MoE (Includes start and end date of dewatering works & method of statement for dewatering).
2. Application form for Environmental Permit to be filled and stamped.
4. Copy of the site map.
5. Copy of ID Card of the applicant's Engineer.
6. Copy of the Registration Company.
7. Copy of the Road Opening (RO) Permit.
8. Copy of Traffic Department Approval as part of the RO
Application is assigned to MoE. Comments(?)
Reject
Return to Applicant for amendment /correction
Approve
Temporary Permit is issued with Comments
Traffic Imapct Assessment may be requested based on MoE comments, Based on the number of tankers.
Dewatering equipment established in order to obtain water samples for testing against Annex 4 of the Qatari Environmental Law and the parameters specified in MoE list provided in Appendix (A) Prior to Discharge to Sea
Fail
Sample sent to approved laboratory. Sample sent for MoE review.
Pass
MoE approval and periodic testing of samples (based on MoE conditions)


Application for Direct Discharge to Lagoons
(lagoons covered with geotextile from all sides an lagoon not covered)
Submission of the following documents:
1. Fill in the Environmental Application Permit Request.
2. Testing for Dewatering effluent quantity.
3. Duration of dewatering discharge
4. Dewatering effluent quality is tested initially against the parameters specified in MoE list provided in Appendix (A) of this Report. And then tested weekly. Monthly testing is also required for selected parameters.
5. Coordinates of lagoon, inclusive of dewatering discharge points
6. Location map
7. For lagoons with geotextile lining, Detailed Engineering drawings for the lagoon should be provided.
Application is assigned to Environmental Assessment Department in MoE. Comments(?)
Reject
Return to Applicant for amendment /correction
Approve
Temporary Permit (Max Three Month) is issued with conditions
Dewatering equipment established in order to obtain water samples for the parameters specified in Annex 4 of Law 30 of 2002. And then tested weekly. Monthly testing is also required for selected parameters.
Fail
Sample sent to approved laboratory. Percentage of the samples should be samples to be sent to third party Lab for QA / QC. Sample results sent for MoE review.
Pass
MoE approval and periodic testing of samples (based on MoE conditions)


Application for Direct Discharge to Deep Well Injection
Submission of the following documents:
1. Fill in the Environmental Application Permit Request.
2. Conduction a geological conditions study
3. Duration of dewatering discharge.
4. Dewatering effluent quality. Dewatering effluent quality is tested initially against the parameters specified in MoE list provided in Appendix (A) . And then periodically testing each week based on MoE requirements.
5. A0 design map for the whole project including the location of the injection well and network of shallow trenches connecting the wells.
6. Comparison study between the use of the shallow networking and the perforated pipelines.
7. Drilling of monitoring wells to suitable depth to monitor the impact on the shallow aquifer.
Application is assigned to Environmental Assessment Department in MoE. Comments(?)
Reject
Return to Applicant for amendment /correction
Approve
Temporary Permit (Max Three Month) is issued with conditions
Submit to MoE an EIA Report for the imapcts of the deep well on groundwater
Dewatering equipment established in order to obtain water samples for testing against standards for water use for irrigation purpose of the Qatari
Fail
Sample sent to approved laboratory. Percentage of the samples should be sent to third party Lab for QA / QC. Sample results sent for MoE review.
Pass
MoE approval and periodic testing of samples (based on MoE conditions)

Appendix F

Environmental Permit Application- MoE

وزارة البيئة
Ministry of Environment

استمارة طلب الحصول على التصريح البيئي
(Application form for Environmental Permit)

رقم الطلب:

١ ـ معلومات عامة General Information

١ ـ ١ اسم المشروع Project Name

.....

.....

طبيعة المشروع Project Type

(بنية أساسية ـ صناعي ـ زراعي ـ أخرى) (Infrastructure - Industrial - Agricultural - Others)

.....

١ ـ ٢ اسم مالك المشروع Name of Project Proponent

(شخص ـ شركة) (Individual- Company)

.....

١ ـ ٣ اسم الشخص المسؤول Name of Person in - Charge

.....

العنوان Address .....

رقم التليفون: Tel. No. ..... رقم الفاكس Fax No. .....

١ ـ ٤ الجهة المانحة للترخيص Licensing Authority

.....

.....

.....

٢ - بيانات المشروع Project Data

مكان وموقع المشروع (برجاء إرفاق خريطة مفصلة ومعتمدة من الجهة الإدارية المختصة وبمقياس رسم مناسب موضحاً بها حدود الموقع وموقفه بالنسبة للكتلة السكنية والأنشطة المجاورة وطرق المواصلات والمناطق الأثرية والحمية والسياحية إن وجدت ، وبيان بنسبة ملوثات الهواء والضوضاء الناتجة عن المشروع في المنطقة).

Project Location (Please attach an approved, and detailed map of appropriate scale, showing project boundaries and location with respect to residential areas, nearby activites, roads, archaeological/reserve/tourist sites [if any], and data on air pollutants and noise expected to be generated from the project).

٢ - ١ موقع المشروع Project Location

.....

.....

☐ مدينة City ☐ قرية Village ☐ منطقة صناعية معتمدة Approved Industrial Zone

☐ أخرى (Other places, Specify) .....

☐ داخل التخطيط Within Planning Area ☐ خارج التخطيط Outside Planning Area

☐ منطقة سكنية Residential Area ☐ منطقة تجارية Commercial Area

☐ مبنى مستقل Independent Building .....

المساحة الكلية للمشروع (م٢) (Total Project Area, m^2) .....

المساحة الكلية لمباني المشروع (م٢) (Total Construction Area, m^2) .....

٢ - ٢ طبيعة المشروع Project Type

☐ جديد New ☐ قائم Existing ☐ توسعات Expansion

☐ استبدال موقع Site Relocation ☐ تجديد Renovation

طبيعة التوسعات أو التجديدات Type of Expansion or Renovation .....

.....

إذا كانت طبيعة المشروع توسعات أو تجديدات فهل تم تقديم دراسة تقييم أثر بيئي للمشروع الأساسي؟

If the Project type is expansion/renovation, was there an EIA for the original Project?

☐ نعم Yes ☐ لا No

تاريخ الحصول على موافقة وزارة البيئة السابقة Date of the Previous Permit from MOE

.....

.....

.....

٢ ـ ٣ الطاقة الإنتاجية Production Capacity ☐

أو or

السعة التخزينية Storage Capacity ☐

مع ذكر الوحدات المستخدمة Provide Units Used .....

٢ ـ ٤ المنتج النهائي Final Product .....

.....

٢ ـ ٥ المنتج الثانوي By- Product .....

.....

٢ ـ ٦ وصف عام للمنطقة المحيطة بالمشروع متضمنة المناطق الأثرية والتاريخية والمحميات والمناطق السياحية والترفيهية.

A general decription of the area around the Project including a description of archaeological, historical, protected, tourist and recreational areas

.....

.....

٢ ـ ٧ البنية الأساسية المتوفرة وغير المتوفرة Available/Unavailable Infrastructure

- مصادرالمياه water supply ☐ متوفرة available ☐ غير متوفرة not available
- شبكة الكهرباء electric power grid ☐ متوفرة available ☐ غير متوفرة not available
- شبكة صرف صحي sewer system network ☐ متوفرة available ☐ غير متوفرة not available
- شبكة طرق road network ☐ متوفرة available ☐ غير متوفرة not available
- مصدر للوقود fuel source ☐ متوفرة available ☐ غير متوفرة not available

٢ ـ ٨ أسباب اختيار الموقع Reasons for selecting project Site/Location

.....

.....

٣ - مراحل المشروع وتواريخ بدايتها المتوقعة Project Phases & Expected Starting Dates

- الإنشاء Construction .....

- التشغيل Operation .....

٤ ـ وصف موجز للمشروع أثناء مراحل الإنشاء Brief Description of the Project's Construction Stages

.....

.....

.....

.....

٤ ـ ١ مصادر المياه Water Sources ..... استخداماتها Purpose of Use .....

معدل الاستهلاك Consumption Rate .....

٤ ـ ٢ نوع الوقود Fuel Type ..... مصدر الوقود Fuel Source .....

معدل الاستهلاك Consumption Rate .....

مع ذكر الوحدات المستخدمة Provide Units Used .....

٤ ـ ٣ العمالة المتوقعة وأماكن إقامتهم Expected Number of Workers and their Accomodation Site

.....

.....

٥ ـ المخلفات الناتجة عن الإنشاء وطرق التخلص منها Construction Wastes and Methods of Disposal

٥ ـ ١ مخلفات صلبة Solid Wastes ..... نوعيها Type .....

كميتها Quantity (with units) ..... طرق التخلص Method of Disposal .....

.....

٥ ـ ٢ مخلفات سائلة Liquid Waste ..... نوعيتها Type .....

كميتها Quantity (with units) ..... طرق التخلص Method of Disposal .....

.....

٥ ـ ٣ انبعاثات غازية Gaseous Emissions

(دخان ـ رائحة ـ مواد عالقة ـ أخرى) (Smoke- Smell - Particulate Matter - Others)

.....

مع ذكر الوحدات المستخدمة Provide Units Used

.....

٥ ـ ٤ ضوضاء Noise .....

مع ذكر الوحدات المستخدمة Provide Units Used .....

٦ ـ وصف تفصيلي لمرحلة التشغيل (ترفق أشكال أو رسومات توضيحية)

Detailed Description of the Operation Phase (Attach Illustrative Drawings/Diagrams)

٦ ـ ١ المكونات الرئيسية للمشروع Main Project Components

.....

.....

.....

٦ ـ ٢ وصف العمليات الصناعية (مدعماً بالكتالوجات وخرائط التشغيل.. الخ)

Description of Industrial Processes (Supported by Catalogues Manuals, Diagrams, etc).

.....

.....

.....

.....

٦ ـ ٣ الطاقة الكهربائية المستخدمة Electrical Power Used

مصدرها Source .....

٦ ـ ٤ المواد الخام Raw Material

المادة Material	النوع (غاز ـ سائل ـ صلب) Type (Solid-Liquid-Gas)	الكمية (م٣/يوم أو كجم/ يوم) Quantity (m^3/day or kg/day)	المصدر Source

٦ ـ ٥ البدائل المأخوذة في الاعتبار للمواد الخام المستخدمة Alternatives Considered for the Raw Material Used

.....

.....

.....

٦ ـ ٦ أسباب اختيار التكنولوجيا المستخدمة Reasons for Selecting the Used Technology

.....

.....

.....

٦ ـ ٧ العمالة المتوقعة وأماكن إقامتهم Expected Number of Workers and their Accomodation Site

.....

.....

٦ ـ ٨ نوع ومصادر الوقود Type and Source of fuel .....

معدلات الاستهلاك Rate of Consumption .....

مع ذكر الوحدات المستخدمة Provide Units Used .....

(شبكة كهرباء عمومية Electricity Grid/ مولدات Generators /خلايا شمسية Solar cells).

٦ ـ ٩ مصادر المياه Water Sources .....

معدلات الاستهلاك Consumption Rate .....

مع ذكر الوحدات المستخدمة Provide Units Used .....

(شبكة عمومية Public Network/ مياه جوفية Groundwater/ مياه سطحية Surface Water).

٧ ـ النفايات والمخلفات الناتجة عن التشغيل ومعالجتها وطرق التخلص منها

(توضح المعايير المتوقعة للانبعاثات الغازية ومياه الصرف بعد المعالجة)

Waste generated from the operation phase, treatment and methods of disposal

(Indicate Expected Concentration of Liquid Wastes, Gaseous emissions and solid wastes)

٧ ـ ١ المخلفات السائلة Liquid Wastes

أ - الصرف الصحي Sanitary .....

.....

معدل الصرف: ( ) م٣/ يوم أو كجم/ يوم Discharge Rate m^3/day or kg/day

وسائل التحكم Control Methods .....

.....

طرق التخلص Disposal Methods

(شبكة عمومية ـ خزانات ـ ... الخ) (Sewer System- Tanks- etc.)

.....

الصرف الصناعي Industrial Discharge .....

.....

.....

معدل الصرف ( ) م٣/ يوم أو كجم/ يوم Discharge Rate m^3/day or kg/day

وسائل التحكم Control Methods .....

.....

التحليل المتوقع للصرف الصناعي Expected Analysis of Industrial Discharge

.....

.....

طرق التخلص من الصرف Disposal Method of Discharge

(يختار أحد البدائل التالية) (select one of the following)

* على شبكة البلدية مباشرة Directly to municipal system ( )

* توجد وحدة معالجة للصرف الصناعي خاصة بالنشاط، ثم يصرف على الشبكة ( )

(يرفق كتالوج بوحدة المعالجة المستخدمة ومعايير الصرف الناتج عن وحدة المعالجة).

There is a treatment unit of industrial wastewater and after treatment, wastewater is discharged to public network (Attach a scheme of the treatment unit to be used and the discharge concentration from the treatment unit)

* يجمع في مخزن بدون معالجة Stored without treatment ( )

٧ ـ ٢ المخلفات الغازية (ملوثات الهواء) Gaseous Emissions (Air Pollutants)

ـ الملوثات من المصادر الثابتة Pollutants from Stationary Sources .....

.....

ـ الملوثات من المصادر المتحركة Pollutants form Mobile Sources .....

.....

ـ الملوثات من مصادر حرق الوقود Pollutants from fuel Combustion

.....

.....

٧ ـ ٣ المخلفات الصلبة Solid Wastes

طرق النقل والتداول والتخزين Methods of Transport, Handling and Storage

.....

.....

.....

التخلص من المخلفات Waste Disposal

(مدفن آمن ـ متعهد ـ أخرى) (Landfill- Contractor- Others)

.....

.....

٧ ـ ٤ النفايات والمواد الخطرة Hazardous Wastes & Materials

طرق النقل والتداول والتخزين Methods of Transport, Handling and Storage

.....

.....

.....

التخلص من المخلفات Waste Disposal

(مدفن آمن ـ متعهد ـ أخرى) (Landfill- Contractor- Others)

.....

.....

٨ ـ تحليل مبدئي للآثار البيئية أثناء مرحلة التشغيل والتخفيف من الآثار البيئية لها

Initial Assessment of Environmental Impacts During Operation and Mitigation of Impacts

٨ ـ ١ تأثير المشروع على نوعية الهواء

Project Impact on Air Quality

.....

٨ ـ ٢ تأثير المشروع على جودة ووفرة المياه

Project Impact on Water Availability and Quality

.....

٨ ـ ٣ تأثير المشروع على جودة وخصوبة التربة

Project Impact on Soil Quality and Fertility

.....

٨ ـ ٤ التلوث البصري Visual Pollution

.....

٨ ـ ٥ الضوضاء Noise

.....

٨ ـ ٦ أي تأثيرات أخرى محتملة أو هامة ناجمة عن هذا النشاط

Any other major or potential impacts resulting from this project / activity

.....

٨ ـ ٧ وصف لأي وسائل أخرى لتخفيف الآثار السلبية للمشروع لم يتم ذكرها سابقاً

Description of any other measures, which were not mentioned earlier, to mitigate project's negative impacts

.....

٨ ـ ٨ الاحتياطات المتخذة بشأن صحة بيئة العمل وأمان العاملين وتسهيلات مكافحة الحريق .

Measures taken regarding quality of the working environment and workers' safety and fire fighting facilities / systems

.....

٩ ـ التخزين Storage

٩ ـ ١ وسائل تخزين المواد الخام وكفاءتها

Methods and Efficiency of Raw Materials Storage

.....

٩ ـ ٢ وسائل تخزين المنتجات الأساسية وكفاءتها

Methods and Efficiency of Main Products Storage

.....

٩ ـ ٣ وسائل تخزين المنتجات الثانوية وكفاءتها

Methods and Efficiency of by-products Storage

.....

١٠ ـ النقل Transportaion

١٠ ـ ١ طرق نقل المواد الخام وكفاءتها

Methods and Efficiency of Raw Materials Trasnport

.....

.....

١٠ ـ ٢ طرق نقل المنتجات الأساسية وكفاءتها

Methods and Efficiency of Main Products Transport

.....

.....

١٠ ـ ٣ طرق نقل المنتجات الثانوية وكفاءتها

Methods and Efficiency by-products Transport

.....

.....

١١ ـ تكاليف حماية البيئة بالنسبة لرأس المال

Cost of Environmental Protection Relative to Capital Investment

١١ ـ ١ التكلفة الخاصة للتحكم في التلوث (ريال قطري)

Cost of Pollution Control (Qatari Riyals)

.....

.....

١١ ـ ٢ رأس المال (ريال قطري)

Capital Cost (Qatari Riyals)

.....

.....

• ترفق دراسة تقييم الأثر البيئي بالنسبة للمشروعات المدرجة في الملحق رقم (١) المرفق في اللائحة التنفيذية

Attach Environmental Impact Assessment Study of Projects Listed in Annex (1) of The Executive By-Law.

أقرار
Declaration

أقر أنا الموقع أدناه بأن البيانات المدونة بهذه الاستمارة صحيحة ودقيقة طبقاً للمعلومات المتوفرة لديّ، وأنه في حالة أي تعديل لاحق سيتم إخطار وزارة البيئة على الفور.

وهذا إقرار مني بذلك..

I, hereby, declare that all the information and data provided in this application are correct and accurate as per the information available and in case of any modifications, the MoE would be immediately informed.

And this is my declaration.

المقر ..... Name

رقم البطاقة الشخصية ..... Identification Card Number

صفته ..... Position

التاريخ ..... Date

بيانات تملأ بمعرفة الجهة الإدارية المختصة أو المانحة للترخيص
Form Filled with the Knowledge of the Competent Governing or Licensing Authority

اعتماد الجهة الإدارية أو المانحة للترخيص

Signature of the Competent Government or Licensing Authority

الاسم ..... Name

الوظيفة ..... Occupation

التوقيع ..... Signature

الجهة أو الإدارة المانحة للترخيص

Competent or Licensing Authority

خاتم الجهة

Official Stamp

المتطلبات الإدارية لطلبات
التصريح البيئي المقدمة لوزارة البيئة

١ ـ أن يكون الطلب مرفق بكتاب صادر من صاحب العلاقة (الشخص الطبيعي أو المعنوي المالك للمشروع أو المفوض بإدارته) وموجه إلى مدير إدارة الشؤون الفنية بوزارة البيئة.

٢ ـ أن يكون الطلب مرفقاً بكتاب إحالة صادر من الجهة الإدارية المرخصة للمنشأة/ المشروع/ النشاط (وزارة الطاقة والصناعة، وزارة الاقتصاد والتجارة، وزارة البلدية والتخطيط العمراني، مدينة مسيعيد الصناعية، مدينة رأس لفان الصناعية ...الخ). الطلبات الخاصة بالمنشآت الصناعية ولجميع الحالات يتوجب تقديمها من خلال وزارة الطاقة والصناعة/ إدارة التنمية الصناعية.

٣ ـ أن تكون المعلومات المتضمنة في الطلب مطبوعة باللغة العربية، وتحديداً ما يتعلق بالبيانات الإدارية، وتقبل مرفقات الطلب الفنية حصراً باللغة الإنجليزية.

٤ ـ في حالة المشاريع الإنشائية يستوجب إرفاق الخرائط المناسبة بالإضافة إلى توصيف عام لآليات التنفيذ (General Method Statement).

٥ ـ التأكد من أن جميع البيانات المتوفرة قد تم تضمينها في الطلب أو إرفاقها به، وبخلافه فيكتب في الحقل المعني عبارة (لا يوجد أو لا ينطبق).

٦ ـ كتاب تخويل من صاحب العلاقة إلى الشخص المخول بمتابعة الطلب، ويستثنى من ذلك الجهات الحكومية، في حالة تقديم ما يثبت أن الشخص يعمل موظفاً لدى تلك الجهة بصفة مندوب أو ما يماثله.

٧ ـ صورة عن إثبات حجز الاسم التجاري للمشاريع الصناعية/ التجارية/ المهنية في حالة كون الطلب المقدم لمشروع جديد (لأول مرة).

٨ ـ صورة من البطاقة الشخصية لمالك المشروع (الشخص الطبيعي)، أو المخول بالتوقيع على استمارة الطلب. ويستثنى من ذلك الجهات الحكومية، حيث يكتفي بالكتاب الموضح في (١) أعلاه.

٩ ـ في حالة إرفاق مستندات مع الطلب، فيجب إرفاق نسخة الكترونية عنها (CD or Disk)، إن أمكن.

١٠ ـ كافة المرفقات يجب أن تكون على ورقة بحجم (A4) أو (A3).

١١ ـ في حالة كون الطلب المقدم لتوسعة أو تعديل مشروع قائم، فيجب تقديم الآتي بالإضافة إلى ما ورد أعلاه باستثناء الفقرة (٦):

أ ـ صورة من شهادة قيد في سجل صناعي، وزارة الطاقة والصناعة (إن وجد).

ب ـ صورة من الرخصة التجارية، وزارة البلدية والتخطيط العمراني (إن وجد).

ت ـ صورة من السجل التجاري، وزارة الاقتصاد والتجارة (إن وجد).

ث ـ صورة من التصريح البيئي السابق.

ج ـ صورة من الشهادة الصادرة عن الإدارة العامة للدفاع المدني (إن وجد).

Appendix G

Dewatering Process Inspection Sheet

Dewatering Procedure Inspection Sheet

Site Information

Site Name — Date
Site Number
Location
Contractor — Present

Dewatering Contractor
Consultant — Laboratory
Owner
Other

Type of Construction Site
Stage

Permit

Valid Permit — Y N — Ref Number
Quantity — Duration
M.H

Comments

Field Inspections

Dewatering technique

Pre-disposal treatment	Y	N		Disposal Option
Compliance with permit	Y	N		
Record keeping	Y	N		

Other Comments

Problems/issues:

Lab Tests

Turbidity Levels			Problem	Y	N

Other

Labor training		Y	N	
Housekeeping	Good	Fair	Poor	

Water Quality Assessment				
The following questions provide an initial assessment of the quality of the water to be discharged from the dewatering operation				
Common Sense Test	1 2	Review the project records. Is there any reason to suspect that the water may be polluted by something other than sediment? Is the water located in an area of known contamination?		
Sight Test	Does the water have an abnormal visual feature, such as (circle): Oily Sheen Floating Foam Murky Appearance Unusual Color Other			
Smell Test	Does the water have an odor? Possible odors include gasoline, petroleum, ammonia, sewage, etc.			
If you answered YES to any of the above questions, explain:				

Appendix H

Literature Review Report

Management of Construction Dewatering –

Literature Review Report

Table of Contents

Abbreviations

EA	Environment Agency
EIA	Environmental Impact Assessment
EHS	Environment and Heritage Services
SEPA	Scottish Environment Protection Agency
STP	Sewage Treatment Plant

1. Introduction

The Department of Quality, Safety and Environment at the Public Works Authority (Ashghal) has appointed KEO International Consultants to carry out the study for Environmental Protection by Improved Construction Dewatering - Stage 1, in April 2012.

KEO is required to carry out the following tasks:

Task One: Expert literature review of all international legislation and regulations concerned with construction dewatering practices, and production of Literature Review Report.

Task Two: Conduct field inspections. Carry out onsite audits for compliance against construction dewatering permit requirements, and field tests for turbidity and suspected pollution. Field inspection visits to include projects specified by Ashghal.

Bi-weekly reports will be issued to Ashghal to document the field inspections.

Task Three: Documentation of the current practices of construction dewatering across Qatar construction projects. This will include regulatory and onsite practices. All of the previous will be documented in a Review of Current Practices Report.

Task Four: Production of a Construction Dewatering Manual for Qatar.

This Manual will document the literature review of international legislation, regulations, and guidelines. Citation in the report is minimal to allow discussion of literature's applicability in Qatar.

This report by no means provides recommendations for implementation, it is rather a review of practices which can potentially be implemented in Qatar.

Following the comprehensive field inspections and current practice studies, KEO will be able to identify existing problems associated with dewatering practices in Qatar. The Literature Review report will then be used as a tool to address these problems based on relevant international guidelines.

In this report groundwater abstraction refers to the permanent use of groundwater, where groundwater dewatering refers to the temporary lowering of the groundwater table to facilitate construction.

1.1 Scope of the Review

For the purpose of this review; international legislation, regulations, and guidelines from the United States, United Kingdom, Scotland, Australia and Canada were reviewed. No regional guidelines were found during the research phase.

Relevant and accepted international documents were reviewed for their technical, environmental management, and procedural solutions to dewatering practices.

The objective of the review was to identify guidelines which can be reasonably and practically applied in Qatar. The report only provides bullet point discussions of practices which can be considered for implementation in Qatar. The citation in the report is minimal to meet the Ashghal requirement of less than 10 page report as stated in the project briefing document.

This discussion is limited to methods employed by the industry to achieve environmentally sustainable practices.

All literature reviewed will be supplied in a separate Appendix.

To ensure that the objectives established by this report were addressed only, local regulations are not discussed. All relevant and applicable local regulations will be discussed in the Review of Current Practices Report, to be issued in June 2012.

2. Regulations and Standards by Country

1.2 United States

Guidelines from Maine, New York, California, New Hampshire, Massachusetts and the US Army Corps of Engineers were reviewed for applicability across Qatar. A summary of each is provided below.

2.1.1. Maine

The scope of the review of Maine documentation included Maine Erosion & Sediment Control issued by the Maine Department of Environment Protection.

Applicability in Qatar:

The Maine documentation addresses a number of sedimentation control issues and uses many locally based solutions, based on topography and locally available materials. The primary practices that are considered applicable to Qatar are as follows:

- A licensed transporter could be an applicable method in transporting effluent, especially if the dewatering effluent has been contaminated.
- Discharge channels are applicable if proper ditch lining is used, however, its applicability in Qatar is restricted by the hot climate most of the year, and the fact that the channels are only applicable in rural areas with limited chances of exposure to the risk of damage by third parties.
- Adoption of sediment removal practices can be integrated into the Qatari dewatering practices through change of regulations. Sediment removal varies in technique. While sheet flow will not be applicable for Qatar, other sediment removal structures and excavated ponds can be applied. Given that proper alteration to suit the Qatari weather and environment conditions is followed. Alterations include but not limited to: proper lining, using manufactured structures which are heat-resistant... etc.
- Maintenance and reviewing the dewatering facilities should be done in a cyclic manner that allows modifications and improvement. Flow concentration should be monitored to determine if further treatment is required.

2.1.2. New York

The Dewatering Permit Guidelines of New York City state that most of the groundwater dewatering effluent in New York is disposed of via sewer networks.

Approval is required if the discharge exceeds 10,000 per day to sewer lines in order for Department of Environmental Protection to be aware of the impact on the sewage treatment plant.

No further detailing of dewatering techniques were available as part of the regulatory outline.

Applicability in Qatar:

Discharge to the sewer networks is likely to strain the sewage treatment plants and result in failure in the treatment process.

2.1.3. California

The Field Guide to Construction Site Dewatering is a comprehensive guide for dewatering operations. This Field Guide provides many and varied applications which could be applicable to Qatar.

Applicability in Qatar:

The following points are practices which can be implemented in Qatar from the Field Guide to Construction Site Dewatering.

- Catagorising discharges into Stormwater and Non-Stormwater in dewatering permit applications can be applicable to Qatar, given that the Contractor will be able to separate between the two discharges onsite. This will also allow onsite water recycling opportunities. It, however, will have to be closely monitored by the licensing authority, and should be subject to liability if non-qualifying non-stormwater is discharged without a permit. Different methods of handling and discharge could be required for the different streams (e.g groundwater could go to sewer networks, and stormwater to stormwater drainage networks).

- The applicability of dewatering management options are subject to many conditions in Qatar. Therefore, while the management of dewatering discharge can be evolved to include potential effluent

receivers such as STPs, the regulations and consequent liability have to developed in parallel to the management options.

Potential receivers such as STPs, if considered, have to be reviewed against specific requirements prior to commencement of disposal of the dewatering effluent. Failure to do so could result in poor or catastrophic environmental consequences.

- Dewatering effluent disposal options which might be applicable to Qatar

  a. Retain the water on site.
  b. Discharge to the sanitary sewer with permission from the local agency.
  c. Discharge to an adjacent land or facility with permission of the owner.
  d. Transport and dispose of offsite using a Transportation, Storage & Disposal (TSD) contractor.
  e. Discharge water to a storm drainage system or a water body. Should be subject to quality requirements and may require further treatment.

- Qatari dewatering effluent will require sedimentation and settlement solutions. This can be explored further during the site visits and review of Qatari current practices.

  a. Sediment options to be considered for use in Qatar
  b. Weir Tank
  c. Sediment/Desilting Basin
  d. Sediment Trap
  e. Cartridge Filter
  f. Dewatering Tank
  g. Gravity Bag Filter
  h. Sand Media Particulate Filter
  i. Pressurized Bag Filter

2.1.4. New Hampshire & Massachusetts

The Dewatering General Permits for the Commonwealth of Massachusetts and the State of New Hampshire are combined and published in the General Permits for Dewatering Activity Discharge.

Applicability in Qatar:

The General Permits' guidelines specify a set of standard procedures for application and comprehensively set the requirements for reporting and

monitoring the dewatering discharge. The guidelines skim through the limits set for few pollutants and include the acceptable methods for runoff, erosion, and sediment controls.

For applicability in Qatar, the General Permits' guidelines would provide a good example for setting a comprehensive set of procedures and requirements that can be smoothly adapted and integrated into the Qatari practices.

2.1.5. US Army Corps of Engineers

In 2004, the US Army Corps of Engineers issued a Unified Facilities Criteria for Dewatering and Groundwater Control.

This manual, unlike country regulations, is a technical governmental manual. The manual includes specific instructions and calculations on how to investigate, operate and manage dewatering and groundwater control.

The manual provides comprehensive and mathematical technical guidance for dewatering. However it does not include procedures for transportation or disposal of the dewatering effluent, nor does it specify dewatering pollutant limits.

For the purpose of literature review for dewatering practices, the table below is extracted from the manual, summarising the techniques used by the US Army Corps of Engineers.

Method	Application
Sumps and ditches	Collect water entering an excavation or structure
Conventional wellpoint system	Dewaters soils that can be drained by gravity flow
Vacuum wellpoint system	Dewater or stabilize soil with low permeability. (Some silts, sandy silts)
Jet-educator wellpoint	Dewater soils that can be drained by gravity flow. Usually for deep excavations where small flows are required.
Deep-well system	Dewaters soils that can be drained by gravity flow. Usually for large deep excavations where large flows are required.
Vertical sand drains	Usually used to conduct water from an upper stratum to a lower more pervious stratum.

Method	Application
Electro-osmosis	Dewater soils that cannot be drained by gravity. (Some silts, clayey silts, clayey silty sands).
Cutoffs	Stop or minimize seepage into an excavation when installed down to an impervious stratum

Applicability in Qatar:

The US Army Corps of Engineers' manual lists common techniques for dewatering, many of which can be applied in Qatar.

These methods can be introduced as part of the best practice manual and to be used as guidance to future projects' dewatering techniques. Methods should be selected based on site-specific assessment.

1.3 United Kingdom

The discharge of water from excavations is designated as 'trade effluent', and therefore requires a permit. However, the UK regulations allow discharge of dewatering effluent without a permit under certain temporary conditions.

When a permit is required, the owner is to contact the Environment Agency.

The dewatering practices are broadly covered and governed by the Pollution Prevention Guidelines under Site Drainage.

The Pollution Prevention Guidelines is a brief document stating practices to be implemented in order to prevent pollution for onsite activities. No specific technical or management guidance is provided in the Pollution Prevention Guidelines.

1.4 Scotland

Scotland's legal framework is independent from the UK, and therefore it has independent guidelines and regulatory bodies.

The dewatering practices are governed by Scotland Environment Protection Agency's (SEPA) Regulatory Method (WAT-RM-11), Licensing Groundwater Abstractions including Dewatering, Annex 1: Dewatering Operations – Estimating the Groundwater Component.

SEPA also, states that the abstraction of rainwater from an excavation is not a controlled activity, therefore authorisation is not required.

Applicability in Qatar:

SEPA regulates for groundwater abstraction. Dewatering operations are included in the Regulatory Method as Annex 1, however, the dewatering is only concerned with removing rainwater from construction site.

Therefore, these regulations are inapplicable in terms of dewatering practices in Qatar.

1.5 Australia

For the purpose of this document; the Cairns Regional Council - Dewatering Guidelines and Government of Western Australia, Water and Rivers Commission, Water Quality Protection Note - Dewatering of Soil, were reviewed as the only relevant governmental published guidelines on dewatering practices.

It is worth mentioning that overriding legislation is the State and Federal Government Environmental Protection legislation.

Applicability in Qatar:

The Australian guidelines require that the recommendations are to be used in conjunction with an environmental site assessment. The environmental site assessment would comprise baseline assessment along with assessment of other sensitive receptors.

The environmental site assessment can be applied in Qatar given that it does not shift the focus of the permit from the main point, which is the disposal of dewatering effluent that complies with the regulations and does not cause deterioration to the environment.

Due to the relative similarities between the environment and geological makeup in Australia and Qatar, compared to other countries which have dewatering guidelines and regulations, Australia's guidelines could prove to be more useful in terms of the adoption of accepted methods of treatment and disposal, especially in terms of turbidity water treatment.

1.6 Canada

Under the City of Calgary Drainage Bylaw 37M2005, no person shall discharge, release, or cause to be placed any substance other than storm drainage into the storm drainage system unless they are authorized to do so, in writing by The City.

The previously mentioned bylaw and the City of Calgary Permit Information were reviewed as part of the study.

Applicability in Qatar:

The Calgary Canadian guidelines are mainly concerned with administrating types of permits and their requirements. Administrative requirements that can be integrated into the Qatari best practice from the Canadian guidelines would mainly consist of document requirements and records.

Moreover, no dewatering drainage into networks is allowed without a permit issued by the City of Calgary. Discharge exceeding certain limit set by the City of Calgary requires special review of infrastructure capacity prior to commencing the disposal process.

Implementation of infrastructure capacity review requirements when the discharge rate is higher than a certain limit can be integrated into the Qatari permit requirements to protect the network capacity and efficiency.

The Canadian guidelines also include further general advice on further treatment if pollutants happen to exceed the quality standards for the receiver water body, or target network capacity.

3. Conclusion

As part of this Literature Review report, KEO has reviewed international legislation, regulations and guidelines and discussed applicable aspects which can be implemented in Qatar.

Guideline practices discussed in terms of relevance to Qatar vary between technical and management methods. Technical methods include dewatering technique and treatment and disposal options. Management methods include procedural systems which can be implemented in Qatar, and proposed future assessments to be incorporated into current practices.

The Report's objective has been met by exploring the international regulations concerned with dewatering of construction sites. KEO will now use this document, in conjunction with the Review of Current Practices report (to be issued in June), to develop a best practice procedure for the Construction Dewatering Manual for Qatar.

4. Bibliography

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2. The City of Calgary- *Application Information for Drainage & Dewatering Permits*, Canada, 2012.
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4. Department of Environmental Protection- New York, *Dewatering Permit Guidelines*, US, 2004.
5. Environment Agency, *Regulatory Position Statement*, UK, 2011.
6. Environmental Alliance; Environment Agency, SEPA, Environment & Heritage Service, *Pollution Prevention Guidelines*, UK.
7. Government of Western Australia, Water and Rivers Commission, *Water Quality Protection Note- Dewatering of Soil*, Australia, 2003.
8. Maine Department of Environmental Protection *Maine Erosion & Sediment Control, Section G-3*, US, 2003.
9. National Pollutant Discharge Elimination System (NPDES) *General Permits for Dewatering Activity Discharge*, US, 2008.
10. The office of Environmental Engineering, California Department of Transportation (Caltrans), *Field Guide to Construction Site Dewatering*, USA, 2001.
11. SEPA, Scottish Environment Protection Agency, *Regulatory Method (WAT-RM-11), Licensing Groundwater Abstractions including Dewatering*, 2010.
12. US Army Corps of Engineers, Unified *Facilities Criteria (UFC), Dewatering and Groundwater Control,* US, 2004.

Appendix I

Copy of the odour control equipment for carbon and scrubber types

9. ODOUR CONTROL EQUIPMENT-CARBON TYPE

9.1 GENERAL

9.1.1 Scope

1 This Part includes the requirements for the design, manufacture, construction, installation testing and commissioning of force ventilated and passive odour control equipment.

2 Related Sections and Parts are as follows:

This Section
Part 1, General
Section 1, General
Section 8, Sewerage
Section 21, Electrical Works

9.1.2 References

1 The standards referred to in this part are:

ASTM D2862 ----------Test Method for Particle Size Distribution of Granular Activated Carbon
ASTM D3467 ----------Test Method for Carbon Tetrachloride Activity of Activated Carbon

BS 848, ----------Fans for general purposes
BS 970 (ISO 683) -----Wrought steels for mechanical and allied engineering purposes
BS 3532----------Method of specifying unsaturated polyester resin systems
BS 3749----------E glass fibre woven roving fabrics for the reinforcement of polyester and epoxy resin systems
BS 5000 (IEC 34, 72)Rotating electrical machines of particular types or for particular applications
BS 3496 (ISO 1888) --E glass fibre chopped strand mat for the reinforcement of polyester and epoxy resin systems
BS 5345 (IEC 79)------Code of practice for selection, installation and maintenance of electrical apparatus for use in potentially explosive atmosphere
BS 7671----------Requirements for electrical installations
BS 6105 (ISO 3506) --Corrosion resistant stainless steel fasteners
BS 2782 (ISO 174, 181, 307, 8618) Methods of testing plastics
BS 6339 (ISO 6580) --Dimensions of circular flanges for general purpose industrial fans
BS EN 779, Particular air filters for general ventilation

9.1.3 System Description

1 Performance Requirements

Concentration of hydrogen sulphide	:	as specified in Project Specification
Other Contaminants:		
Mercaptons	:	trace only
Amines (mono/di/tri)	:	10 ppm
Ammonia	:	50 ppm
Sulphide Concentration in Solution	:	50 mg/l
Removal of hydrogen sulphide gas and ammonia	:	99.8 %
Removal of amines	:	95 %
Removal of mercapatans	:	No requirement

2 The ventilation for force ventilated systems will operate either continuously or on a timer.

3 Air shall be supplied into the wet well to dilute the air/gas mixture via a fly screened inlet.

4 The deodorisation equipment shall operate continuously.

5 The sizing and design criteria for the system are given in the particular Project Specification.

6 The odour system shall be designed for indoor or door out installation as shown on the Contract drawings and as specified.

9.1.4 Submittals

1 In addition to the requirements of Part 1 of this Section, the Contractor shall provide information and data as described in the following paragraphs.

2 Design data providing the following information:

(a) calculations to justify the sizing and life of the carbon bed(s) at the concentrations given
(b) calculations to justify the sizing of the fan(s) if forced ventilated odour control equipment is used
(c) user certificates

3 Shop Drawings providing the following information:

(a) product data
  (i) fibreglass resin manufacturer's technical data on composition and characteristics of resin for fibreglass items including hydrostatic and burn tests
  (ii) manufacturer's technical data on other equipment used
  (iii) carbon specification including test reports
(b) dimensional layout of stack and all equipment used
(c) fan test data as BS 848.

4 Samples:

(a) vessel and duct GRP, pre-filter mesh, activated carbon.

5 Operation and maintenance and instruction manuals including:

(a) odour reduction site test report(s) as specified in Part 9.3.2
(b) the documentation in 3 and 4 above.

9.1.5 Warranty

1 The Contractor shall obtain from the Odour Control System manufacturer a warranty that his system meets the specified odour level reduction criteria, and life for the carbon bed. This does not in any way alter the Contractor's guarantee under the Contract.

9.2 PRODUCTS

9.2.1 General

1 All units shall be designed to operate continuously in temperatures up to 55 °C with 100 % condensing humidity and to reduce odours to an unobjectionable and unobtrusive level, and shall consist of one of the following types, as specified.

(a) passive deodoriser. This system will be used for totally enclosed areas without forced ventilation where positive displacement occurs. The passive deodoriser system shall operate as a free-standing unit suitable for outside use in the conditions prevailing at site and shall contain pre-filter cells, activated carbon filter cells or loose activated carbon and all necessary appurtenances. Access to the filters shall be quick and easy without the requirements of special tools for replacement of carbon, cells and pre-filters. The design of the entire unit shall be such as to ensure a minimum of maintenance time
(b) forced ventilation deodoriser system. The deodoriser shall contain pre-filter cells, activated carbon filter cells, or loose activated carbon, fan unit, a vent stack and all necessary appurtenances. Access to the filters shall be quick and easy without the requirements of special tools for replacing carbon, cells and pre-filters. The design of

the entire unit shall be such as to ensure a minimum of maintenance and operating timing.

2 Activated Carbon Support System. This shall be one of two types

(a) removable carbon cell type filters. Carbon filters shall be of the rechargeable cell type with stainless steel or moulded GRP frames and perforated faces riveted together. The filter cells shall be arranged to give a counter current multiple pass system with the lowest filter taking the heavy load. When the lowest filter is spent it shall be removed and higher filters moved down to replace the one beneath and a new filter fitted in the highest position. Two additional complete sets of carbon filters shall be provided as a minimum

(b) bulk carbon system. The odour control unit forms a receptable for the granular activated carbon which is placed in, either manually or using a proprietary mechanical vacuum device.

9.2.2 Materials

1 Deodoriser Unit and Ducting: These shall be of chemical and ultraviolet light resistant GRP using water resistant 'E' glass chopped strand mat or woven glass fabric to BS 3496 and BS 3749. All surfaces and exposed edges shall be gel coat/flow coat covered using resin to BS 3532. Alternatively the deodoriser unit and ducting may be manufactured in uPVC or polypropylene/selmar and wrapped externally with G.R.P, generally as above. All fittings shall be stainless steel and sealing strips shall be neoprene. The units shall have smooth semi-gloss finish in white and shall be fully weatherproof.

2 Moisture Eliminator. These shall be incorporated in each duct. They shall be manufactured from corrosion resistant materials and shall incorporate drain facilities and access panels for cleaning. They shall incorporate a baffle arrangement with air cooling.

3 Prefilters. Prefilters shall be of washable urethane or polypropylene knitted wool to BS EN 779 designed as a particle and moisture barrier. The unit shall have an access plate for easy removal of prefilters. They shall be fabricated such that:

(a) maximum efficiency is not less than 95%, based on test dust No. 2
(b) maximum air velocity is 2.5 m/s at the design airflow
(c) the clean filter resistance does not exceed 90 Pa
(d) filters do not sag, flutter or be obstructed by contact with other filters or duct surfaces
(e) the size shall be not less than 600 mm x 600 mm x 45 mm thick
(f) corrosion resistant drain valves are provided
(g) there are no void areas or short-circuiting

4 Activated carbon. This shall be as follows:

(a) removable cell type units. Carbon granules shall be coconut based and impregnated with potassium iodide, size 5-10 BS mesh. The cells shall be adequately filled and sealed to prevent short circuiting. Cells shall be rechargeable.

(b) bulk carbon filters. The activated carbon shall be virgin granular, derived from bituminous coal, vapour-phase type, chemically impregnated with sodium hydroxide, and suitable for control of sewage odours. Sufficient activated carbon shall be provided to fill the adsorber to the full bed depth as designed by the odour control system manufacturer. The carbon shall have the following performance specifications:

Carbon Substrate	
CC1 4 Number	percentage by weight (ASTM D3467), 60
Iodine number, minimum	1000
Mean particle diameter	3.7 mm
Percent ash maximum	8 percent
Impregnated Carbon	
Apparent density(1) minimum	0.55 g/cu cm
Hardness number, minimum	95
Moisture, maximum(2)	15 percent
Maximum head loss (Pa) at 0.254 m/s linear	

velocity (through a dense packed bed)(3)	1450 Pa/bed of 900 mm
H_2S breakthrough capacity, minimum(4)	25 g H_2S removed/100 g of carbon

notes:

(1) as determined by ASTM D2862 on a dry basis. The delivered apparent density shall range from 0.55 to 0.64 g/cu cm
(2) calculated on a total product basis
(3) dense packing as defined by procedure for apparent density determination where a glass 100 ml graduated cylinder is filled through a funnel with 24 mm inside diameter stem at a uniform rate not exceeding 1 ml/s. Pressure drop is measured across a 900 mm deep carbon bed, at least 125 mm in diameter
(4) the determination of H_2S breakthrough capacity shall be made by passing a moist (85 % R.H.) air stream containing 1 % H_2S at a rate of 1450 m^3/min through a 20 mm diameter by 230 mm deep bed of uniformly packed activated carbon and monitored to 50 mg/l breakthrough. Results are expressed in g H_2S removed per g of carbon
(5) the carbon supplied shall be of a type chemically regenerable in-situ by the use of up to 48 % sodium hydroxide for a minimum number of five times, or regenerated by water if appropriate.

5 Fittings and fasteners. Fittings shall be stainless steel BS 970 Grade 316S31, fasteners BS 970 Grade 304S15 and BS 6105.

9.2.3 Fabrication

1 Carbon adsorbers shall be fabricated such that the vessel walls are not used to transfer any vertical loads to the foundations or vertically support any portion of the carbon support system. The carbon support system shall be removable for vessels of 1 m diameter or less and shall be constructed of materials resistant to corrosion or deterioration under the service conditions specified.

2 Vessels in solid bed filters shall incorporate a removable hatch at the bottom for removal of carbon. All vessels shall have either a removable top or manway access.

3 Vessels shall be constructed in accordance with BS 4994 category III or equivalent.

9.2.4 Accessories

1 Each carbon adsorber vessel shall include the following accessories:

(a) manometer: This shall be provided to continuously monitor the pressure drop across each carbon bed
(b) sample probes: each vessel shall have three 40 mm diameter sample probes per bed which shall extend into the bed a minimum of 300 mm. The sample probes shall be adequate to provide suitable extraction of carbon samples from the carbon bed. The sample probes shall extend outside the vessel wall and shall be isolated with a uPVC ball valve
(c) grounding rod: a stainless steel rod shall be provided to adequately ground each carbon bed
(d) H_2S monitor: one portable hydrogen sulphide monitor shall be provided for each adsorber vessel to detect hydrogen sulphide concentration via a colour coded detector card. The housing shall be a weatherproof enclosure which also allows easy replacement of detector cards
(e) PVC-u drainage valves and 20 mm diameter pipework routed back to the wet well to drain off any condensate from the prefilters
(f) PVC-u drain valve and 20 mm diameter pipework routed back to wet well to drain off any condensate/regeneration liquid from the deodoriser unit
(g) air tight covers with gaskets to facilitate easy removal of carbon cells or loose carbon
(h) three PVC-u air sample probes which extend outside vessel walls and are fitted with PVC-u isolating valves

(i) gaskets: 3 mm thick full face constructed of neoprene or equal
(j) lifting and holding down lugs

2 An inlet shall be fitted to the wet well to allow fresh air to be drawn in. This shall be of GRP or PVC-u construction with an insect screen.

9.2.5 Centrifugal Fan

1 The fan shall be centrifugal, belt-driven type constructed from corrosion resistant fibreglass reinforced plastic or stainless steel with vibration free mountings. The fan shall be capable of the performance specifications as shown below:

(a) unit capacity : as designated
(b) static pressure : 3000 Pa, or as required
(c) operating temperature : 0 - 70 °C
(d) Motor : high efficiency, 415 V, 3 phase, 50 Hz IP 55;1500 rpm, power as required, rated for zone 2 use with methane gas (BS 5345), to BS 5000.

2 Exhaust fans shall be suitable for continuous 24-hour operation and shall be non-overloading. Each fan shall operate such that no point on the fan curve requires more than the rated motor power.

3 The fan housing, flanges and backward curved impellers shall be constructed of flame retardant GRP laminate or stainless steel, capable of resisting continuous fume temperatures of 70 °C. The manufacturer shall state the type of resin used and confirm that it shall perform satisfactorily under the operating conditions. All interior surfaces exposed to the corrosive air stream shall be resin rich.

4 Wheel and shaft assemblies shall be statically and dynamically balanced to a maximum of 0.5 μm displacement prior to assembly and every fan test run prior to shipment.

5 Fans shall comply with BS 848 and be provided with the following standard features:

(a) drive assembly: belts shall be oil, heat and static resistant type, sized for continuous duty. Shafts shall be constructed of heavy duty steel turned, ground and polished, keyed at both ends
(c) bearings: heavy duty, self-aligning, pillow block bearings, with grease fittings
(d) shaft seal: a fibreglass and neoprene shaft seal shall be placed where the shaft leaves the housing along with a viton shaft slinger between the seal and wheel on belt drive units
(e) bases: heavy gauge hot rolled steel, epoxy coated.
(f) the fan shall be provided with the following accessories:
  (i) flanged and drilled inlet and outlet to BS 6339
  (ii) drain
  (iii) access door
  (iv) vibration isolation system
  (v) belt and shaft guard as Part 1
  (vi) earthing as QGEWC requirements and BS 7671
(g) flexible connectors:
  (i) flexible connectors shall be installed on the fan inlet and outlet to dampen axial, lateral, and vibrational duct movement
  (ii) the flexible connector shall be resistant to the corrosive gases being processed and shall be able to withstand ± 3750 Pa. The flexible connector shall be minimum 30 mm long.

6 Dampers:

(a) suitable sized dampers shall be provided as follows:
  (i) balancing damper between the fan outlet and the carbon adsorber inlet
  (ii) isolation dampers at each carbon adsorber outlet.
(b) the dampers shall be provided in accordance with the following specifications:
  (i) the dampers shall be flanged and drilled to withstand 3000 Pa
  (ii) flange mount channel frame shall be vinylester with reinforced bearing pad

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(iii) the blade thickness shall be as required by the damper manufacturer
(iv) the bearings shall be moulded plastic material
(v) fibreglass axles shall extend full length of blade and 150 mm beyond frame
(vi) the unit shall be equipped with a full circumference blade seal to limit leakage to less than 1 m^3/m^2 min at 3000 Pa

9.2.6 Electrical Control Panel

1 A prewired, preassembled electrical control panel shall be provided for the odour control system as specified in the Project Specification. The control panel shall contain pushbuttons, indicating lights, fan motor starters, alarms, and other controls for a complete automatic system. The panel shall be wired suitable for connection to 415 V a.c., 3 phase, 50 Hz source. The panel shall comply with Part 1 of this Section and Section 21.

9.2.7 Factory Inspection and Testing

1 The Contractor shall secure from the equipment manufacturers certification that the following factory tests have been carried out, and submit to the Engineer prior to shipment. Fibreglass vessels shall be tested as follows:

(a) hydrostatically tested prior to shipment, with water to the top of the vessel for a minimum of 24 h
(b) the water must be contained with no visible signs of leaks or excessive wall deflection
(c) a minimum of two burn tests of cutouts, from areas where access doors or piping cutouts are required, to verify glass resin ratio.

2 Activated carbon shall be tested as Part 9.2.2.4

3 Fans shall be tested as required by BS 848, Part 1 and 2.

9.2.8 Spare Parts and Tools

1 The Contractor shall provide from the equipment manufacturer's all the spare parts and tools required during the commissioning and maintenance periods as specified in Part 1, including those below. In addition, sufficient activated carbon shall be provided for the complete operation of the odour removal system for two years of operation.

2 The following tools and shall be provided in addition to any others required:

(a) sampling tool
(b) plastic container for shipping carbon samples.

3 The following spare parts shall be furnished as a minimum requirement, in addition to any additional spare parts required for two years of operation.

Item	Quantity	
Complete Centrifugal Fan	(1)	
Sets of V-belts	(2)	
Sets of bearings	(2)	
Shaft seals	(2)	(if fitted)
Carbon	(1)	Supplies guaranteed for two years operation
Prefilter set	(2)	

9.3 INSTALLATION AND COMMISSIONING

9.3.1 General

1 If required by the Project Specification, the Contractor shall furnish from the odour control system supplies the services on site of a factory trained service technician or engineer. He shall inspect the equipment installation, advise and assist with commissioning and train the

Employer's operations and maintenance personnel.

2 The odour control system shall be installed in accordance with manufacturer's written instructions, by suitably qualified and experienced personnel.

9.3.2 Site Inspection and Testing

1 Vessel Test. The above water test shall be repeated on site after installation.

2 Fans shall be tested as required by BS 848 Part 1 and shall be installed in accordance with BS 848 Part 5.

3 Odour Vessels Test: The Contractor shall test as follows:

(a) the odour control system to certify that it meets requirements after completion of the installation
(b) all odour testing conducted by the Contractor in the presence of the Engineer
(c) the odour control system test shall be conducted after all the air systems are tested and balanced. Separate H_2S tests shall be conducted on each odour control system
(d) the H_2S tests shall be repeated at the end of the maintenance period with the equipment in full operation during the time of year determined by the Employer to have greatest odour problems, using the actual gas levels generated by the pumping stations
(e) the hydrogen sulphide test shall comprise as follows:
  (i) hydrogen sulphide (H_2S) concentrations shall be measured using a calibrated portable H_2S analyser
  (ii) if instructed by the Engineer, bottled H_2S gas shall be used to determine if the specified H_2S performance requirements are met
  (iii) each test: three sets of samples shall be taken over an 8 h period:
    - each test shall consist of an inlet and outlet H_2S test
    - the supplier shall be responsible for supplying the H_2S for the bottled H_2S testing
    - the three H_2S levels to be tested shall be selected by the Engineer.
(f) if the odour control system fails to meet the performance criteria, it shall be the Contractor's responsibility to make all the modifications necessary to improve performance at no cost to the Employer. The Contractor shall pay for all additional testing required to verify that performance criteria are being met
(g) final acceptance of the system will only be possible after successful completion of this testing
(h) documentation for all the testing shall be submitted to the Engineer.

END OF PART

10. ODOUR CONTROL EQUIPMENT-SCRUBBER TYPE

10.1 GENERAL

10.1.1 Scope

1 This Part specifies the requirements for the design, manufacture, construction, installation testing and commissioning of odour scrubber systems and related auxiliary equipment.

2 Related Sections and Parts are as follows:

This Section
Part 1, General
Section 8, Sewerage
Section 10, Instrumentation Control and Automation
Section 21, Electrical Works

10.1.2 References

1 The following standards and other documents are referred to in this Part:

BS 848, ----------Fans for general purposes
BS 970 (ISO 683) -----Wrought steels for mechanical and allied engineering purposes
BS 1646 (ISO 3511) --Symbolic representation for process measurement control functions and instrumentation
BS 2782 (ISO 181, 174, 307, 8618) Methods of testing plastics
BS 3496 (ISO 1888) E glass fibre chopped strand mat for the reinforcement of polyester and epoxy resin systems
BS 3532----------Method of specifying unsaturated polyester resin systems
BS 3749----------E glass fibre woven roving fabrics for the reinforcement of polyester and epoxy resin systems
BS 4504----------Circular flanges for pipes valves and fittings
BS 4994----------Design and construction of tanks and vessels in reinforced plastics
BS 5000 (IEC 34,72) Rotating electrical machines of particular types or for particular applications
BS 5345 (IEC 79)------Code of practice for selection, installation and maintenance of electrical apparatus for use in potentially explosive atmosphere
BS 5512 (ISO 281)----Methods of calculating dynamic load ratings and rating life of rolling bearings
BS 6105 (ISO 3506) --Corrosion resistant stainless steel fasteners
BS 6339 (ISO 6580) --Dimensions of circular flanges for general purpose industrial fans
BS 7671----------Requirements for electrical installations

10.1.3 System Description

1 Performance requirements:

concentration of hydrogen sulphide (unless specified otherwise) : 500 ppm
other contaminants:

Mercapatans	:	trace only
Amines (mono (di/tri)	:	10ppm
Ammonia	:	50ppm
Sulphide concentration in solution	:	50 mgl
Number of air changes per hour in ventilated volume	:	4 minimum. More if Contractor deems necessary.
Removal of hydrosulphide gas and ammonia	:	99.8%
Removal of amines	:	95%
Removal of mercapatans	:	No requirement

The above criteria are for domestic sewage of a quality normally encountered in Qatar. Highly septic sewage or sewage from industrial sources will need special analysis and the possible addition of a sulphuric acid stage or a separate sodium hydroxide stage.

2 The scrubber shall be the counterflow, packed bed tower type.

3 Sodium hydroxide 20 % w/w (NaOH) and sodium hypochlorite 12 % w/w (NaOCl) are to be used as the scrubbing reagents for removing hydrogen sulphide from the odour source. For some installations with ammonia levels above 30 ppm or other industrial chemicals, addition of a sulphuric acid 20 % w/w (H_2SO_4) stage will be necessary. Operation of the scrubber shall be automatically controlled (with manual override capability) as follows. A single speed fan activated by a manual start/stop push-button switch, draws odorous air through the packed beds of the scrubber. The selected recirculation pump (a standby is to be provided), also activated by a manual start/stop pushbutton switch, circulates scrubber liquors through the packed beds. Sulphuric acid (if used), Sodium hydroxide and sodium hypochlorite are added to the scrubber liquor via metering pumps. Sulphuric acid must be added separately in another stage. These pumps are controlled through set points on analysers for pH for H_2SO_4 and NaOH and Redox (oxidation reduction potential) for NaOCl. Chemical is added until the highest set point on the analyser is reached. The recirculation pumps shall be interlocked with the metering pumps so that in automatic mode, recirculation pump failure will cause shut down of metering pumps. Pressure switches shall initiate change over to the standby Flow switches (rotameters) shall initiate change over to standby on low flow fan.

4 The final control involved in the scrubber is water makeup to replace both “bleed” scrubber liquor and evaporative losses. This is to be achieved with a capacitance type liquid level element and a solenoid valve on the supply line fed from the water softener.

5 Scrubber liquid is bled off continuously so that the potable water added is sufficient to maintain the salts in solution.

6 The odour scrubber system shall be designed for indoor or outdoor installation as shown on the drawings and specified.

7 The chemical storage and feed system shall be designed for outdoor installation.

8 A duplex ion exchange water softener shall be fitted on the potable water supply line, with booster pumps if necessary.

10.1.4 Submittals

1 In addition to the requirements of Part 1 of this Section, the Contractor shall provide data and information as described in the following paragraphs.

2 Design Data providing the following information:

(a) calculations to justify the sizing of the fans, packed bed, pumps and chemical storage tanks
(b) calculations as required by BS 4994 category III pertaining to the construction of the scrubber and chemical storage tanks
(c) structural calculations for foundations and guy wires or any other external means of support, taking into account wind loadings
(d) user certificates.

3 Shop Drawings providing the following information:

(a) product data
  (i) fibreglass resin and plastic liner manufacturer"s technical data on composition. Characteristics of resin and liner including hydrostatic and burn test
  (ii) manufacturer"s technical data on other equipment used
(b) dimensional layout of stack and all equipment used
(c) fan test data as BS 848 Parts 1 and 2.

4 Instrumentation:

(a) complete layout and wiring diagrams of unit control panels.
(b) complete process and instrumentation diagrams drawn in accordance with BS 1646

5 Samples

(a) vessel and duct GRP and liner, packed media.

6 Operation and maintenance and instruction manuals including:

(a) odour reduction field test report(s) as specified in Part 10.3
(b) the documentation in Clauses 2, 3 and 4 above in Part 10.1.4.

10.1.5 Warranty

1 In addition to the guarantee requirements of Part 1 of this Section, the Contractor shall ensure that the odour control scrubber equipment manufacturer be responsible for the proper performance and warranty of the odour control system. The system shall be designed and guaranteed to meet the odour removal requirement as outlined in this specification.

2 Warranties and guarantees by the suppliers of various components in lieu of single-source responsibility by the scrubber manufacturer will not be accepted. The Contractor shall ensure that the scrubber manufacturer is solely responsible for the warranty.

3 The scrubber manufacturer must state in his proposal the guaranteed removal efficiency of the scrubber, based on the gas inlet concentration.

10.2 PRODUCTS

10.2.1 General

1 Those items of the scrubbers and fans specified to be constructed of fibre glass reinforced polyester resin shall have approximately 25 % glass reinforcement with a 75 % resin content and conform to the following:

(a) the polyester resin shall be ortho and isophtalic polyester vinylester resin to BS 3532
(b) reinforcing material shall be a commercial grade of glass fibre water resistant type „E" chopped strand mat or woven glass fabric to BS 3496 and BS 3749
(c) surface finish shall be a gelcoat flow coat isophtalic resin to BS 3532. All drilled, cut or otherwise exposed edges shall be sealed with polyester resin
(d) all materials, fabrication procedures, manufacturing tolerances, workmanship, tests, and product quality shall conform to BS 4994
(e) the scrubbing towers and chemical storage tanks shall include conductive resin strips behind weld lines, and nozzle fitting joints, to enable a full spark test to be carried out, both in the factory and subsequently on site
(f) Each scrubbing tower and chemical storage tank shall have a corrosion resistant welded thermoplastic liner of either PVC-u or polypropylene. If PVC-u is used it shall be annealed after fabrication and welding.

10.2.2 Scrubbers

1 The scrubber shall be single or dual stage vertical, counter-current design, packed tower type.

2 The scrubber shall contain in the main packed bed a minimum depth of 3 m of nominal 50 mm size filamentous toroidal helix shaped or spherical type packing, having a free volume of 95 %, with 28 m^2 of surface area per m^3 of packing. Packing is to be randomly dumped into the scrubber; structured type packing is not acceptable. Material of construction is to be polypropylene. Pressure drop per metre of packing shall not exceed 15 mm water column.

3 The scrubber shall include an entrainment separator/demister, internal spray piping or liquid distribution as recommended by the specialist scrubber packing manufacturer, packing, packing supports, lifting and hold down lugs.

4 All liquid handling nozzles, external to the vessel, shall be flanged to NP16. Gas handling nozzles shall be of the dimensions as outlined in BS 6339. Couplings shall be fully flanged, NP16. Minimum projection of nozzles shall be 150 mm.

5 Scrubber nozzles and appurtenances shall include:

(a) make-up water inlet
(b) hydrochloric acid supply connection
(c) overflow
(d) sump drain
(e) scrubber liquor recirculation inlet (to spray header)
(f) scrubber liquor recirculation outlet (to pump suction)
(g) pH probe mounting
(h) Redox probe mounting
(i) level sensor mounting connections with stilling well
(j) a minimum of three manholes with neoprene gaskets (for servicing spray nozzles, packed bed, and scrubber sump)
(k) four GRP tie down lugs or base flange
(l) mounting brackets for scrubber recirculation piping
(m) stainless steel guy wires as necessary
(n) gas sampling points on inlet and outlet to the scrubber. If necessary, both shall be piped using 12 mm piping to a convenient point for use of a hand held hydrogen sulphide monitor.

6 The scrubber tower shall be capable of operating at the design flow rate with a maximum static pressure loss of 75 mm water column. The packing depth, recirculation rate, and recirculation solution shall be designed to meet the required efficiency.

7 The scrubber housing and internal structural members shall be fabricated of GRP, and shall be not less than 5 mm thickness. External reinforcing ribs, if required for pressure or vacuum conditions or wind load, shall be suitably designed and installed not more than 1 m apart. Colour shall be white.

8 An internal moisture entrainment separator section shall be furnished with each unit which is to consist of 300 mm deep packed bed. The demister shall be capable of removing not less than 99 % of the entrained moisture of the air exiting the scrubber, consisting of droplets 10 μm and larger.

9 Packing support plates for the main bed shall be manufactured from polypropylene having 40 mm by 40 mm square openings and being 40 mm deep. Packing support plates for the entrainment separator section shall be manufactured from polypropylene, having a minimum 84 percent open area , or same as above. Any internal supports required shall be of the same material as the shell. Support plates are not required for chevron blades.

10 The scrubbing liquid distribution system shall be the spray type of manufacturer"s standard design, sized for the flowrates required and taking into varying air delivery rates of +10 %. No liquid distributors shall be permitted. Spray headers shall be placed at the manufacturer"s recommended distance above the packing. Material of construction shall be chlorinated polyvinyl chloride (PVC-C), NP16. Spray nozzles shall be spiral design, full cone type, constructed of PVC

11 The scrubber shall be designed with a minimum of 600 mm of shell height between the gas inlet and bottom to act as an integral sump. The sump shall hold a minimum of two minutes supply of scrubbing liquid. The sump shall be furnished with a level sensor as specified herein.

12 No internal wetted metal bolts, or components are permitted. All external bolts and fasteners including anchor bolts and flanged bolts shall be BS 970 316 stainless steel. Stainless steel anchor bolts guy wires and clips shall be provided by the manufacturer.

13 The scrubber shall be supplied with integral mounting lugs and pipe supports for the (PVC-C) scrubber liquor recirculation piping. Mountings shall be designed with consideration for pipe inlet and outlet connections. Pipe supports shall be non-metallic channels and straps.

14 The scrubber shall be equipped with a differential pressure gauge on the inlet and outlet ductwork which shall be installed so that abnormalities that may occur in the scrubber can be visually detected. The scrubber shall have pressure taps located below the main packed bed and above the entrainment separator, and the gauge shall be mounted on a scrubber shell. The differential pressure gauge shall include instrument traps, and valve manifolds to permit testing and zero setting of the gauge. Plastic tubing equipment with PVC condensate traps shall connect the high and low pressure taps. The gauge shall have a 100 mm round face.

15 Redox and pH probes for analysing the contents shall be located in the scrubber sumps. The probes and analysers shall provide the chemical feed control as described herein. The probes shall meet the following specifications:

(a)	range :	pH probe	:	0-14 pH : Redox probe; 0-1000 mV
(b)	stability :			± 01.% per 24 hours, non-cumulative
(c)	wetted materials sensor			Liquid crystal polymer body
(d)	accuracy/ sensitivity			± 0.1 pH unit : Redox probe : ± 1 mV
(e)	temp. limits			65^0C
(f)	pressure rating			0-350 kPa
(g)	interconnect cable			manufacturer"s standard

(h) each probe shall be supplied with a two wire transmitter and analyser

(i) the analyser shall be microprocessor based with a 4 digit display, with dual programmable high/low set points, contacts. Alarm conditions shall be indicated on the instrument by front panel LED"s with auxiliary alarm contacts. Automatic or manual temperature compensation shall be selectable, with the option to display the process temperature. A data logging system for high/low signals shall be incorporated. Set-up, alarm and control functions shall be accessible on the front panel

(j) each probe shall be provided with a protector or well as recommended by the manufacturer

(k) the manufacturer shall supply all necessary hardware and wiring for installation of probe and analyser.

16 The sump liquid level sensor shall be a capacitance type liquid level probe with a Teflon coated probe element and integrally mounted cast iron or epoxy coated enclosure. The probe shall be a dual-point sensor, for high and low liquid levels. On low liquid level, an electrically operated solenoid valve shall open and allow scrubber make-up water to flow into sump. The valve shall close when high set point is reached. Low-low level shall simultaneously sound an alarm in the control panel and shut off the recirculation pumps. Probe shall be inserted in type 316 stainless steel stilling wells mounted externally of the scrubber.

17 All instrumentation mounted inside the scrubber tower or tanks shall be intrinsically safe.

10.2.3 Fans

1 Duty/standby fans shall be provided for each scrubber unit. Each fan shall have a single speed motor with the capacity and power to deliver the required volume of air against the total pressure losses in the air intake, duct collection systems, packed bed, mist eliminator and ductwork to the fan and exiting out of the stack.

2 The fan shall be centrifugal, belt-driven type constructed from corrosion resistant fibre glass reinforced plastic or stainless steel, with vibration free mountings. The fan shall be capable of the performance specifications as shown below:

(a) unit capacity : as required

(b) static pressure : 3000 Pa, or as required
(c) operating temperature : 0 -70 ^{0}C
(d) Motor : high efficiency, 415 V, 3 phase, 50 Hz IP 55; 1500 rpm power as required, rated for zone 2 use with methane gas (BS 5345), to BS 5000, 1500 rpm.

3 Exhaust fans shall be suitable for continuous 24-hour operation and shall be non-overloading. Each fan shall operate such that no point on the fan curve requires more than the rated motor power.

4 The fan housing, flanges and backward curved impellers shall be constructed of flame retardant GRP laminate or stainless steel, capable of resisting continuous fume temperature of 70 ^{0}C. The manufacturer shall state the type of resin used and confirm that it will perform satisfactorily under the operating conditions. All interior surfaces exposed to the corrosive air stream shall be resin rich.

5 Wheel and shaft assemblies shall be statically and dynamically balanced to a maximum of 0.5 μm displacement prior to assembly and every fan test run prior to shipment.

6 Fans shall comply with BS 848 and be provided with the following standard features:

(a) drive assembly: belts shall be oil, heat and static resistant type, sized for continuous duty. Shafts shall be constructed of heavy duty steel turned, ground and polished, keyed at both ends
(b) bearings: heavy duty, self-aligning, pillow block bearings, with grease fittings
(c) shaft seal: a fibreglass and neoprene shaft seal shall be placed where the shaft leaves the housing, along with a viton shaft slinger between the seal and wheel on belt drive units
(d) bases: heavy gauge hot rolled steel, epoxy coated
(e) the fan shall be provided with the following accessories:
  (i) flanged and drilled inlet and outlet to BS 6339
  (ii) drain
  (iii) access door
  (iv) vibration isolation system
  (v) belt and shaft guard as Part 1
  (vi) earthing as QGEWC requirements and BS 7671
(f) flexible connectors:
  (i) flexible connectors shall be installed on the fan inlet and outlet to dampen axial, lateral, and vibrational duct movement. Flexible connectors shall be installed at each fan inlet and outlet
  (ii) the flexible connector shall be resistant to the corrosive gases being processed and shall be able to withstand ± 3750 Pa. The flexible connector shall be minimum 30 mm long.

7 Dampers:

(a) suitable sized dampers shall be provided as follows:
  (i) balancing damper between the fan outlet and the scrubber inlet
  (ii) isolation dampers at each fan inlet and outlet
(b) the dampers shall be provided in accordance with the following specifications:
  (i) the damper shall be flanged and drilled to withstand 3000 Pa
  (iii) the blade thickness shall be as required by the damper manufacturer
  (iv) the bearings shall be moulded plastic material
  (v) fibreglass axles shall extend full length of blade and 150 mm beyond frame
  (vi) the unit shall be equipped with a full circumference blade seal to limit leakage to less than 1 m^3 /m^2 min at 3000 Pa.

10.2.4 Recirculation Pumps

1 Pumps shall be of the direct coupled, single stage, end suction, horizontal, back pullout corrosion resistant, centrifugal type.

2 Impellers with integral shaft sleeves shall be balanced semi-open fibre glass reinforced resin polyester or PVC-C.

3 The pump casing shall be a resin injected hot press moulded fibre glass reinforced polyester or PVC-C. The casing shall be free standing supported by heavy duty non-metallic feet. Suction and discharge nozzles shall be NP16 flanges.

4 The shaft shall be constructed of 316 stainless steel of sufficient diameter to assure rigid support of the impeller to prevent excessive vibration.

5 The bearing housing shall be constructed of cast iron, machined with precision pins of tongue-and-groove construction to ensure permanent alignment.

6 Bearings shall be of the anti-friction, oil lubricated, ball type and enclosed in a cast iron, oil-tight bearing frame. Bearings shall have a minimum L-10 rating of 20,000 hours under full load continuous 24-hour duty. Bearings shall be oil lubricated. The pump shall be equipped with constant level oiler.

7 The shaft seal shall be mechanical, EPDM/carbon/ceramic. Seal water shall be provided if necessary.

8 Pumps and motors shall be bolted to a common GRP baseplate. Pumps shall be grouted in place with epoxy grout.

9 Pumps shall be directly coupled to the motor with a suitable spacer type coupling and guard.

10 Duty/standby change over shall be by means of a low flow switch mounted in the liquor feed.

11 Motor:

(a) each pump shall be provided with a horizontal squirrel cage induction, totally enclosed fan cooled motor, of sufficient power such that no point on the pump curve requires more than the rated power of the motor furnished

(b) each motor shall be suitable for 415 V, 3 phase, 50 Hz continuous 24-hour operation and shall conform to the requirements of Part 1 of this Section and Section 21.

10.2.5 Chemical Feed Pumps

1 The pumps shall be of the hydraulically balanced double diaphragm type, wherein a measuring piston reciprocates within a cylinder and causes hydraulic oil to deflect a flat diaphragm. The diaphragm shall be supported throughout the entire pumping stroke. The hydraulic oil system shall include a means to automatically relieve excess hydraulic pressure, makeup oil and bleed-off vapours. Mechanically operated devices are not acceptable. The chemical metering head shall include a diaphragm cavity moulded into the head material, or have other intrinsic design features to prevent diaphragm damage during restricted inlet conditions. The pump shall have a flow-through liquid path from bottom to top. The diaphragm shall be capable of sealing under full head bolt torque limits without stressing the diaphragm. Pump heads shall be polyproylene and diaphragms PTFE.

2 The metered liquid shall enter the metering head at the bottom and exit at the top through alumina-ceramic disk or ball type check valves. These may be gravity seating or spring loaded to meet service conditions. Valve assemblies shall be replaceable without threading. Valve seats, shall be of Viton, gaskets shall be PTFE.

3 The pump mechanism shall have flooded lubrication using a common oil with the hydraulic system. It shall not contain auxiliary lubricator mechanisms. The pump mechanism shall be sealed from direct contact with the outside atmosphere and shall be suitable for operation in ambient conditions of 55 °C without the use of heating or cooling devices. Manual capacity adjustments between 0 and 100 % shall be accomplished while the pump is idle, or operating, by simply changing the piston stroke length. A minimum of 400 adjustment increments shall be available. Stroke adjustments shall provide positive, repeatable settings within ± 0.25 % over the entire pumping range. Pump delivery shall be repeatable within ± 1 % accuracy over a 10 to 1 range.

4 Pump bearings shall be heavy duty ball or tapered roller bearings with a BS 5512 L-10 rated life of 20 000 hours under normal operation.

5 Each pump shall have an integral pressure relief valve to prevent damage to the pump or piping in the event of a downstream pipe blockage.

6 Pumps shall be capable of operating continuously with liquids at 40° C.

7 Each pump specified herein shall be driven by a squirrel cage induction motor suitable for operation on a 240 V, single phase, 50 Hz power supply, and meeting the requirements for electrical motors as specified in Part 1 of this Section and Section 21. Motors shall be direct coupled to the pumps, with flexible couplings.

8 Each pump discharge shall include a back pressure valve designed to create a constant back pressure without chatter or cycling. Parts in contact with the pumped liquid shall be suitable for use with H_2SO4, NaOH and NaOCl as specified herein. A PTFE diaphragm shall seal the spring and bonnet from the product. The diaphragm shall seal on a replaceable seat and shall ensure tight shutoff at zero flow.

10.2.6 Chemical Storage Tanks

1 The storage tanks shall be of lined laminated construction, designed and fabricated in accordance with BS 4994 category III, and shall provide safe, sound, and leak-proof storage at atmospheric pressure for the specified liquids. Lamination thickness specified in the standards shall be considered minimum thicknesses.

2 Tanks shall be constructed of a welded PVDF, PVC-u or polypropylene liner and contact-moulded translucent reinforced plastic resin. As a minimum, tank construction shall consist of a 50 μm resin-rich exterior mat, a middle layer mat to develop the necessary strength, and a 250 to 300 μm resin-rich nexus veil interior and a minimum 3 mm thick plastic liner.

3 Tanks, anchors, and supports shall be designed for exterior installation that shall withstand a horizontal wind load of up to 160 km/h without movement or damage. Tanks shall also be designed for a concentrated dead load at the top of the tank of 500 kg. Tanks shall include hold-down anchors. Anchors shall be designed to hold the tank against an uplift pressure of 2 m of water column. Tanks shall be designed for pneumatic tanker loading.

4 Factory-applied insulation shall be provided for all storage tanks. Insulation shall be 50 mm thick and shall provide a maximum coefficient of thermal conductivity (K Value) of 0.4 kg.cal/h/m^2/°C. Insulation shall be protected by an additional fibreglass laminate built up to a minimum thickness of 0.4 mm. This protective laminate shall include expansion joints spaced to preclude damage due to thermal expansion. A lip shall be provided at each joint to prevent moisture from entering. The exterior laminate shall also include a pigmented protective gel coat in a colour to be selected by the Engineer. Loose insulation shall be packed into the gusset around the pipe neck at each tank nozzle, and shall be taped to provide a weatherproof seal.

5 A permanently attached encapsulated paper or stainless steel tag shall be affixed to the outside laminate covering the insulation. This label shall contain the following information:

(a) manufacturer
(b) corrosion-resistant liner
(c) type of liner reinforcement
(d) chemical to be stored
    (i) concentration
    (ii) maximum specific gravity
    (iii) maximum temperature
(e) exterior resin
(f) tank capacity
(g) date of manufacture.

6 The tanks shall include the fittings and appurtenances shown on the drawings and described herein:

(a) hinged, top-mounted access manway (800 mm diameter) with non-slip walkway and 316 stainless steel ladder cage, and handrailing
(b) conical gusseted, flanged connections for fill, inlet, outlet, drain, vent and overflow. All shall be minimum 75 mm diameter. The overflow shall be piped into the tank bund to prevent splashing. Connections shall be located as shown on the Drawings. Flange face and bolting shall be in accordance with NP 16
(c) low level probes shall be fitted in each tank to stop the dosing pumps in the event of low level being detected. Suitable gasketed covers shall be provided for these probes
(d) screened vent. The vent shall be sized for release of air during tanker offloading
(e) anchor and lifting lugs
(f) A visual cat and mouse type liquid level gauge shall be provided on each tank, or alternatively a hand operated pneumatic bubbler.

7 Tanks shall be segregated in bunds. Bunds shall have individual capacities equal to 1.1 times the tank full volume. Alternatively tanks of a proprietary design with integral bunds may be provided.

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10.2.7 Rotameters

1 General. Rotameters shall be provided as shown on the drawings and specified herein. Rotameters shall include a plastic housing or frame. Rotameters shall include a flow indicator suitable for indoor installations. All wetted parts and fittings shall be 316 stainless steel, except O-rings. Meters shall have a minimum rangeability of 10:1.

2 Make-up Water. Rotameters shall include a dial flow indicator, 316L or plastic, suitable for high pressure, high temperature flow indication. The metering float shall be magnetically coupled to an indicator housed in a fully gasketed, reinforced fibreglass case. Accuracy shall be plus or minus 5 % of full scale. A stainless steel control valve shall be provided for precise regulation of liquid flow rate.

3 Seal Water (if used) and recirculation pump rotameters shall be armoured purge meter type with magnetically coupled indicator used for low flow, high pressure, and high temperature. Accuracy shall be plus or minus 10 % of measuring flow rate. Rotameter shall include a 12 mm stainless steel needle valve.

10.2.8 WYE Strainer

1 Wye strainer shall be installed on the potable water, recirculation and dosing pump feeds,. Strainers shall have a PVC body with type 304 or 316 stainless or PVC strainers with 0.8 mm perforations.

10.2.9 Sump Overflow Trap

1 A trap shall be provided on the scrubber sump overflow line to prevent air inflow through the scrubber.

10.2.10 Acid Supply Connection

1 The scrubber shall be equipped with a nozzle for addition of a dilute acid solution to the sump. A 50 mm PVC ball valve and 50 by 100 mm funnel shall be installed for this.

10.2.11 Pressure And Vacuum Gauges

1 General. Pressure gauges shall be of the stem-mounting type.

2 Construction. Gauges shall be of the bourdon tube or bellows type with 270 ° clockwise pointer travel. Dials shall be white with black numerals. Dial size shall be 100 mm. Panel mounted gauges shall have round bezels for flush mounting and rear connection, others shall have a stem-mounting bottom connection. Connections for all gauges shall be male 12 mm

threaded with square wrench flats. Wetted parts shall be compatible with the process fluid. Cases shall be impact resistant plastic. Accuracy shall be ±0.5 % of span.

3 Chemical Seal. The gauge shall be furnished with a diaphragm seal. The diaphragm seal shall have a 316 stainless steel (minimum) top and bottom housing and a 316 stainless steel diaphragm welded to the top housing. When the process fluid is not compatible with 316 stainless steel, the manufacturer shall provide a diaphragm seal compatible with the process fluid. The process connection shall be a 20 mm threaded connection with a flushing connection. The fill fluid shall be silicone.

10.2.12 Pressure Switches

1 Pressure switches shall be operated by a brass bourdon tube actuating a switch. Switches shall be single pole double throw, rated at 4 A, 240 V a.c., 50 Hz, and have deadband adjustable up to 100 % of switch range. The adjustable operating range shall be 1 mPa, with calibrated dials and two pointers indicating set and reset points. Enclosures shall be IP 65.

2 Pressure switches shall be fitted in the dosing and potable water booster pump lines to effect changeover from duty to standby pumps.

3 A pressure drop transmitter shall be fitted in the ducting to effect changeover from duty to standby fans.

10.2.13 Drench Showers

1 One or more drench showers shall be provided by the chemical storage tanks, as specified.

2 Showers shall be operated by a walk-on platform with stainless steel operating linkages and a stainless steel stay open valve which locks open.

3 The shower deluge shall be provided by gravity from a tank mounted above the shower with an in-line or tank mounted thermostatically operated heater, fitted with 30 mA RCD protection.

4 The shower shall incorporate an emergency eye/face wash fountain with a flexible hose

5 The shower shall be complete with a light and emergency shower/eye wash signs.

10.2.14 Water Softener

1 These shall be dual cylinder water softeners, rated for continuous output with an integral meter initiated water power regeneration. The softener shall use a fine bead resin bed in conjunction with a brine solution. The softener shall be rated for 28 days use without the salt storage being replenished.

2 A water storage break tank shall be provided to feed the softeners via duty/standby water booster pumps.

10.2.15 Control Panel

1 A prewired, preassembled electrical control panel shall be provided for the odour control system, as specified in the particular Project Specification

2 The panel shall be supplied complete with all equipment and accessories, including the following:

(a) motor control switches and indicating lights for the fans, recirculating pumps chemical metering pumps, pH and Redox analyser/controllers

(b) interlocks between recirculating pumps, chemical metering pumps, and sump level control. Interlocks between pH and Redox analyser/controllers, chemical metering pumps, and the make-up water solenoid valve and level controls

(c) selector switches for manual or automatic operation

(d) an annunciator with volt-free contacts for remote signalling, as required in the Project Specification.

3 Additionally the panel construction and components shall meet the requirements of Part 1 of this Section, Section 21 and shall be suitable for connection to 415V 3 phase 50Hz.

10.2.16 Factory Inspection and Testing

1 The Contractor shall secure from the equipment manufacturers certification that the following factory tests have been carried out, and submit to the Engineer prior to shipment.

2 Fibreglass vessels shall be tested as follows:

(a) hydrostatically tested prior to shipment, with water to the top of the vessel for a minimum of 24 hours

(b) the water must be contained with no leaks or excessive wall deflection.

3 Fans shall be tested as required by BS 848, Parts 1 and 2

4 One pump of each size supplied shall be factory tested. Where multiple units are provided, only one of each size and type shall be tested. Dosing pumps shall be tested in accordance with BS 5316 Part 2, recirculation pumps to BS 5316 Part 1.

10.2.17 Spare Parts and Tools

1 The Contractor shall provide from the equipment manufacturers all the spare parts and tools required during the commissioning and maintenance periods as specified in Part 1, including those below:

2 In addition, sufficient chemicals shall be provided for the complete operation of the odour removal system for 2 years of operation.

3 The following spare parts shall be furnished as a minimum requirement, in addition to any additional spare parts required for two years of operation.

Item	Quantity
Fan	
Complete Centrifugal Fan	(1)
Sets of V- belts	(2)
Sets of bearing	(2)
Shaft seals	(2) (if fitted)
Scrubber	
main packing	(100 %) (for 1 bed)
spray nozzles	(1) (set)
moisture separator packing	(5%) (of total)
Dosing pumps	
diaphragms	(8)
Disk check valves and sets	(8)
Pump gaskets and „O „ rings	(8) (complete sets)
Pumps and motors	(2)
Recirculation Pumps	
Impeller	(2)
Seals	(8)
Pump and motor	(1)

10.3 INSTALLATION AND COMMISSIONING

10.3.1 Installation

1 The Contractor shall ensure the supplier of the odour control system furnishes the services on site of a factory trained service technician or engineer. He shall inspect the equipment installation, advise and assist with commissioning, and train the Employer"s operations and maintenance personnel.

2 The odour control system shall be installed in accordance with manufacturer"s written instructions, by suitably qualified and experienced personnel.

10.3.2 Site Inspection and Testing

1 Vessel and tank tests. The above water tests shall be repeated on site after installation.

2 Fans shall be tested as required by BS 848 Part 1 and shall be installed in accordance with BS 848 Part 5.

3 Odour System Test: The Contractor shall test as follows:

(a) the odour control system to certify that it meets requirements after completion of the installation

(b) all odour shall be testing conducted by the Contractor in the presence of the Engineer

(c) the odour control system test shall be conducted after all the air systems are tested and balanced. Separate H_2S tests shall be conducted on each odour control system

(d) the H_2S tests shall be repeated at the end of the maintenance period with the plant in full operation during the time of year determined by the Employer to have greatest odour problems, using the actual gas levels generated by the pumping stations

(e) the hydrogen sulphide test shall comprise as follows:

(i) hydrogen sulphide (H_2S) concentrations shall be measured using a calibrated portable H_2S analyser

(ii) if instructed by the Engineer, bottled H_2S gas shall be used to determine if the specified H_2S performance requirements are met

(iii) each test: three sets of samples shall be taken over an 8 h period:

- each test shall consist of an inlet and outlet H_2S test
- the supplier shall be responsible for supplying the H_2S for the bottled H_2S testing
- the three H_2S levels to be tested shall be selected by the Engineer.

(f) if the odour control system fails to meet the performance criteria, it shall be the Contractor"s responsibility to make all the modifications necessary to improve performance at no cost to the Employer. The Contractor shall pay for all additional testing required to verify that performance criteria are being met

(g) final acceptance of the system will only be possible after successful completion of this testing

(h) documentation for all the testing shall be submitted to the Engineer.

END OF PART