MINISTRY OF TOURISM
TOURISM DEVELOPMENT AUTHORITY
USAID-EEPP

OBJECTIVE 8.2.1 DOCUMENTATION
VOLUME II

ENVIRONMENTAL MONITORING UNIT MANUALS AND CHECKLISTS

(RSSTI) Red Sea Sustainable Tourism Initiative

(TDA) Tourism Development Authority

(USAID) United States Agency for International

Submitted in satisfaction of the Means of Verification 8.1.2
Tranche II
of the
Egyptian Environmental Policy Program
USAID – TDA

June 30, 2003

Acknowledgment

This program has been developed and implemented through the General Department for Environmental Affairs of the Tourism Development Authority (TDA), in collaboration with the Egyptian Environmental Affairs Agency (EEAA), and the Red Sea Sustainable Tourism Initiative (RSSTI). It was funded through the USAID - Egyptian Environmental Policy Program (EEPP), and implemented by PA Government Services (PA Consulting Group) .

Accordingly, we wish to greatfully acknowledge the participation of:

Eng. /Mohamed Magdi Qobeisi	Chief Executive Officer of TDA
Eng./ Mohamed Ali Ahmed	General Manager for Environmental Affairs, and EEPP/RSSTI General Coordinator

TDA Team:

Geologist/ Mohamed Hassanein	Manager of Environmental Dept., and Head of Environmental Monitoring Unit (EMU)
Eng. /Khaled Mostafa	Engineer at the Environmental Dept., and Inspector at EMU
Biologist/ Amr Abdel Hamid	Marine Sciences at the Environmental Dept., and Inspector at EMU
Eng./ Mohamed Rashad	Planner at the Planning Dept., and member of the EMU team
Chemist/ Aziza Abou El-Nil	TDA Chemistry and Lab Equipment Consultant

And from RSSTI (PA Consulting):

Mr. Gerald Meier
Dr. / Assem El-Gazzar

We also extend our appreciation to TDA consultants and RSSTI consultants, for their technical endeavors in preparing the EMU programs.

(3)
Tourism Facilities Monitoring

(3-1)

Environmental Monitoring Guidelines for Marinas; Jetties; and walkways

Table of Contents

1. INTRODUCTION

This document presents guidance for measuring changes in pollution loads and in water quality that may result from the construction of a marina, jetty or walkway or the implementation of management measures.

To monitor at minimum cost the success of these management measures over time, TDA will need to be creative in the ways that they take advantage of existing monitoring efforts and craft new or expanded monitoring programs. Nonpoint source (such as marinas and jetties) monitoring is generally performed by the Government, however, Universities, research institutes and nonprofit groups should be encouraged to perform nonpoint source monitoring in a range of circumstances. The landowner, however, should also perform nonpoint source water quality monitoring as part of their management plan and record keeping efforts as mandated by Law 4/94.

This guidance assumes that the reader has a good understanding of basic sample collection and sample analysis methods. Section 2 of this manual describes the different parameters to be monitored for coastal projects such as Marinas, Jetties or walkways. The level of detail in this section varies by design to give the reader more or less information on a given subject based on experience with nonpoint source monitoring efforts and also based on the on-going Environmental Information Monitoring Program (EIMP) at the EEAA.

Section 3 presents the manual to be used by TDA environmental researchers and also presents the requirements needed before the site visit and what to after survey. This manual is presented in a step-by-step approach and is given in the Arabic part of this document.

Section 4 of this document provides suggested checklists required by TDA to successfully implement an environmental monitoring program at the project level. It can also be used by the proponent to complete their record keeping reports as per the specific management plan, stated in the EIA.

This document, however, is not intended to provide recommendations regarding the operation and maintenance requirements for any given management measure, but are instead intended to provide "inspectors" with manual and procedure regarding what type of monitoring they should perform and the frequency of the monitoring. This document however provide details of the analysis required for each monitoring plan for walkways, jetties and marinas, but each monitoring plan is site specific and should be designed by the inspector, which includes the number of samples, the seasonal variation, and other conditions.

By tracking management measures and water quality simultaneously, TDA and EEAA will be in a position to evaluate the performance of those management measures and conditions of approval set under the EIA. Management measure tracking will provide the necessary information to determine whether pollution controls have been implemented, operated, and maintained adequately. Without

this information, TDA and the EEAA will not be able to fully interpret their water quality monitoring data. For example, EEAA cannot determine whether the management measures have been effective unless they know the extent to which these controls were implemented, maintained, and operated. Appropriately collected water quality information can be evaluated with trend analysis to determine whether pollutant loads have been reduced or whether water quality has improved. Valid statistical associations drawn between implementation and water quality data can be used by EEAA to indicate:

- Whether management measures have been successful in improving water quality in the coastal zone and;
- The need for additional management measures to meet water quality objectives in the coastal zone.

2. WHAT TO MONITOR

2.1. Shoreline Monitoring

Monitoring of the shoreline should commence prior to construction activity starting and should continue after it has finished. During construction control points and benchmark should be set with reference to a known coordinate system and known level. TDA can set the coordinates of this benchmark using a DGPS and later converted to the Egyptian Survey datum or w.r.t its own (TDA) coordinate system. It is always preferable to set the level of this benchmark with respect to a local low astronomical tidal level (LAT), which is the level below which water will not fall.

A baseline should also be set closer to the shoreline. There are several ways to survey the shoreline, the easiest of which is to measure the distance between the already set basin line and the existing shoreline during the survey.

Shoreline should be surveyed at least twice the length of the constructed walkway or jetty from both sides. For example, if the walkway (or jetty) length is 100 m, then 200 m from each side of the walkway should be surveyed.

Data are then plotted on an x-y map that show the different water levels, definition of the datum, previous shorelines and dates, existing shoreline and comments should show location where accretion or erosion occurs.

This activity should take place before construction starts, then after construction, then after six months from construction, then annually after that.

2.2 Monitoring of water parameters

Parameters to be measured on every six months basis:

2.2.1 Basic Parameters

Basic parameters (vertical profiles of salinity and temperature, total suspended matter (SPM), visual observations (litter, oil, tar on beaches, slicks and visual disturbance of corals, etc.)

2.2.2 Bacteriological parameters

Bacteriological parameters will be measured in the areas with high activities of tourism and outside major towns with sewage discharge. The samples will be taken in the bathing zone. The microbiological analyses to be performed are; total coli form (E. coli) and Faecal streptococci (Enterococci).

2.2.3 Eutrophication Parameters

The Eutrophication parameters (water transparency (Secchi Depth), nitrate/nitrite, ammonia, Total N and P, phosphate, silicate and chlorophyll) will be measured in the areas where possible eutrophication problems have been identified during the field mission. In homogenized water masses only a duplicate water samples shall be taken at the middle depth between the surface and the bottom. However, if stratification exists two samples shall be taken in duplicate- one at the middle depth between the surface and the halocline and another sample at the middle depth between the halocline and the bottom. Duplicate analysis shall be performed at each sample.

2.3 Monitoring of Pollutants in Biota and Sediment

Benthos, sediment and possibly shall be sampled at exactly the same locations and time. The benthos samples taken by the Van Veer Grab shall be identified to species level and quantification by counting all individuals in all samples. The sediment samples collected at the same location shall be analyzed for grain size distribution. Both types of samples shall be sampled, analyzed, stored and tagged in accordance with an internationally accepted methodology.

Due to the expensive nature of this testing, it is recommended that such campaigns take place annually or whenever a problem arises in a specific area.

2.3.1 Sediment sampling and analysis:

The parameters to be analyzed in the sediment samples are:

- Eutrophication Parameters: grain size, percent dry matter, loss on ignition, national nitrogen, and total phosphorous
- Heavy metals: Cadmium, copper, lead, mercury and zinc.
- Hydrocarbons: Total hydrocarbons by GC and PAH (Poly-aromatic Hydrocarbons)
- Pesticides: HCB (Hexachlorobenzene), HCH's, Lindane, p,p'-DDD, p,p'-DDT, aldrin and dieldrin.
- Organochlorides: Chlorinated Biphenyls (CB): CB no. 28, CB no. 52, CB no. 101, CB no. 118, CB no. 138, CB no. 153 and CB no. 180.

2.3.2 Shellfish Sampling and analysis:

The sampling and analysis of shellfish shall be conducted using the bivalve Donax trunculus. The parameters to be analyzed are:

- Heavy metals: Cadmium, copper, lead, mercury and zinc.
- Hydrocarbons: Total hydrocarbons by GC and PAH (Poly-aromatic Hydrocarbons)
- Pesticides: HCB (Hexachlorobenzene), HCH's, Lindane, p,p'-DDD, p,p'-DDT, aldrin and dieldrin.
- Organochlorides: Chlorinated Biphenyls (CB): CB no. 28, CB no. 52, CB no. 101, CB no. 118, CB no. 138, CB no. 153 and CB no. 180.
- Other parameters: shell length of the mussel (mm); percent wet and dry tissue weight; condition index of mussels, percent lipid content.

2.3.3 Sampling of coral and analysis

The corals (staghorn corals Acopora sp.) should be sampled. The corals shall not be analyzed for pesticides and organochlorines. The proposed monitoring parameters are:

- Heavy metals: Cadmium, copper, lead, mercury and zinc.

- Hydrocarbons: Total hydrocarbons by GC and PAH (Poly-aromatic Hydrocarbons)

3. Manual for TDA Environmental Researchers

The part of the document presents a step-by-step approach to TDA environmental researchers on the procedure needed before and after the site survey for monitoring. This part is given in the Arabic part of the document.

4. Environmental Monitoring Check Lists

The following criteria may be considered by the TDA in its environmental monitoring campaign. In addition, the TDA / EEAA may consider other factors relevant to a specific project or application.

4.1 Walkways

The following checklists are proposed for environmental monitoring of walkways

4.1.1 Visual Observations Found During Survey

Visual Observation for walkways (1)

Date		**Lat.**
Name of Center		**Long.**
Name of development		**Arrival Time:**
Name of researcher		**Departure Time:**

Visual Observation for walkways (2)

Category	**Type**	**Magnitude**				**Remarks**
		Light	**Moderate**	**Heavy**	**None**	
weathering	Bright/Clear					
	Drizzle					
	fog					
	Overcast-cloudy					
	Partly overcast					
	Rain					
	Shower					
Tar	Continuous new tar					
	Continuous old tar					
	Lump of new tar					
	Lump of old tar					
	No observed traces					
Accumulation	oil					
	faeces					
	seaweed					
	Algea					
	Sewage and related					
	Gross litter					
	General litter					
	Harmful litter					
Others						

4.1.2 Compliance with EIA study (only during construction)

Item	Compliant	Not Compliant
Location of construction		
Type of construction		
Method of construction		
Equipment on site		
Workers on site		
Safety and precautions on site		
Facilities for workers		
Mitigation measures to protect near-by reef		
Mitigation Measures to protect water quality		
Others		
Comments		

4.1.3 Shoreline monitoring

Location
Date of survey:
Time of survey:
BM data, x, y, z
LAT: (m) w.r.t BM level
HAT: (m) w.r.t BM level
Measurements should be made w.r.t the established baseline, for a shoreline length equals to twice the protrusion of the structure offshore from each side (please refer to figure (1).:

X distance on the baseline (m), measured every 5 m near the structure and 25 m spacing thereof.	**Y: distance between shoreline and baseline (m) – previous survey**	**Y: during this survey**
0		
5		
10		
15		
20		
25		
50		
75		
etc		
Comments: show location of erosion and/or accretion		

4.2 Jetties

The following checklists are proposed for environmental monitoring of walkways

4.2.1 Visual Observations Found During Survey

Visual Observation for Jetties (1)

Date		**Lat.**
Name of Center		**Long.**
Name of development		**Arrival Time:**
Name of researcher		**Departure Time:**

Visual Observation for Jetties (2)

Category	**Type**	**Magnitude**				**Remarks**
		Light	**Moderate**	**Heavy**	**None**	
weathering	Bright/Clear					
	Drizzle					
	fog					
	Overcast-cloudy					
	Partly overcast					
	Rain					
	Shower					
Tar	Continuous new tar					
	Continuous old tar					
	Lump of new tar					
	Lump of old tar					
	No observed traces					
Accumulation	oil					
	faeces					
	seaweed					
	Algae					
	Sewage and related					
	Gross litter					
	General litter					
	Harmful litter					
Others						

4.2.2 Compliance with EIA study (only during construction)

Item	Compliant	Not Compliant
Location of construction		
Type of construction		
Method of construction		
Equipment on site		
Workers on site		
Safety and precautions on site		
Facilities for workers		
Mitigation measures to protect near-by reef		
Mitigation Measures to protect water quality		
Others		
Comments		

4.2.3 Shoreline monitoring

Location:
Date of survey:
Time of survey:
BM data, x , y , z
LAT: (m) w.r.t BM level
HAT: (m) w.r.t BM level
Measurements should be made w.r.t the established baseline, for a shoreline length equals to twice the protrusion of the structure offshore from each side (please refer to figure (1).

X distance on the baseline (m), measured every 5 m near the structure and 25 m spacing thereof.	**Y: distance between shoreline and baseline (m) – previous survey**	**Y: during this survey**
0		
5		
10		
15		
20		
25		
50		
75		
etc		
Comments: show location of erosion and/or accretion		

4.2.4 Hydrographical Conditions

Profile Report

Date	**Depth (m)**	**Temp (C)**	**Salinity (o/$_{oo}$)**	**Oxygen (mg/l)**	**Conductivity**	**PH**
No						
Average						
Standard Deviation						
Maximum						
Minimum						

4.3 Marinas

The following checklists are proposed for environmental monitoring of walkways

4.3.1 Visual Observations Found During Survey

Visual Observation for Marinas (1)

Date		**Lat.**
Name of Center		**Long.**
Name of development		**Arrival Time:**
Name of researcher		**Departure Time:**

Visual Observation for Marinas (2)

Category	**Type**	**Magnitude**				**Remarks**
		Light	**Moderate**	**Heavy**	**None**	
weathering	Bright/Clear					
	Drizzle					
	fog					
	Overcast-cloudy					
	Partly overcast					
	Rain					
	Shower					
Tar	Continuous new tar					
	Continuous old tar					
	Lump of new tar					
	Lump of old tar					
	No observed traces					
Accumulation	oil					
	faeces					
	seaweed					
	Algae					
	Sewage and related					
	Gross litter					
	General litter					
	Harmful litter					
Others						

4.3.2 Compliance with EIA study (only during construction)

Item	Compliant	Not Compliant
Location of construction		
Type of construction		
Method of construction		
Equipment on site		
Workers on site		
Safety and precautions on site		
Facilities for workers		
Mitigation measures to protect near-by reef		
Mitigation Measures to protect water quality		
Others		
Comments		

4.3.3 Shoreline monitoring

Location:
Date of survey:
Time of survey:
BM data, x , y , z
LAT: (m) w.r.t BM level
HAT: (m) w.r.t BM level
Measurements should be made w.r.t the established baseline, for a shoreline length equals to twice the protrusion of the structure offshore from each side (please refer to figure (1).

X distance on the baseline (m), measured every 5 m near the structure and 25 m spacing thereof.	**Y: distance between shoreline and baseline (m) – previous survey**	**Y: during this survey**
0		
5		
10		
15		
20		
25		
50		
75		
etc		
Comments: show location of erosion and/or accretion		

4.3.4 Hydrographical Conditions

Profile Report

Date	Depth (m)	Temp (C)	Salinity ($o/_{oo}$)	Oxygen (mg/l)	Conductivity	PH
No						
Average						
Standard Deviation						
Maximum						
Minimum						

4.3.5 Bacteriological parameters

Station No.	Coliform Bacteria Bac/100 ml	E. Coli Bacteria Bac/ 100 ml	Faecal Streptococci Bacteria Bac/ 100 ml

4.3.6 Eutrophication Parameters

Station name: Date:

Parameter	First sample	Second Sample	Average value
Dissolved Oxygen mg/l			
DO Saturation wink %			
Chlorophyll-a g/l			
Total Suspended matter mg/l			
Transparency m			
Total Nitrogen			
Nitrate			
Nitrite M NO_2-N			
Nitrate + Nitrite NO_2-N			
Ammonia			
Phosphate PO_4-P			
Total Phosphorus			
Silicate SiO_3-Si			

(3-2)

Environmental Guidelines for the Operation of Marinas

Table of Contents

3-2-1 Introduction

Marinas are identified as facilities for mooring recreational boats, and include water and land based facilities. The primary purpose of a marina is the provision of a sheltered area for boating or shipping-related activities.
Marina activities can contribute significant pollution to the water body. Marina construction may alter the type of aquatic and upland habitat on and adjacent to the site. Fueling, maintenance operations, scraping and painting, the improper discharge of boat toilet contents, and other common activities can discharge pollutants that affect water quality.
Pollution impacts from marinas depend on the types of activities that occur at the site and the way those activities are performed. Fueling, and handling of sewage and solid waste can harm the aquatic environment if mismanaged. Persistent toxic pollutants can create significant long-term environmental problems. Other less persistent pollutants can have immediate and severe impacts, but the damage to the environment can be eliminated once the pollutant is no longer discharged.
The two groups of toxic pollutants that accumulate in the sediments near marinas are organic chemicals and heavy metals. The organic compounds most commonly associated with activities in marinas are hydrocarbons, and solvents. Hydrocarbons include persistent polynuclear (cyclic) aromatic hydrocarbons and are primarily found in oil, gasoline and exhaust from burning fuel. Components of gasoline, diesel fuel and kerosene, and solvents can be less persistent and acutely toxic.
Persistent organic chemicals eventually become harmless, but this process takes years or decades; during the interim, they can remain toxic. Heavy metals are persistent elements such as lead, mercury, copper, nickel, cadmium, zinc, chromium, and arsenic. These metals are in paint particles, metal shavings, engine oils and bilge water. Metals, such as chromated copper arsenate, are in wood preservatives commonly used in dock and pier construction. Metals generally do not break down into less harmful chemicals and tend to accumulate where they are released into the environment.
The most effective way to reduce polluted runoff is by pollution management practices and controls. This guideline describes techniques intended to help marina operators identify which pollution control practices work best for their site.

3-2-2 Guidelines for Operation

3-2-2-1 Maintenance Dredging

For most marinas situation will occur in the entrance channel and the marina basin. Furthermore to remove pollutants deposited on the bed, dredging might be required. Dredge spoil disposal can have impacts on species and seabed communities through increased turbidity and smothering. Much care has to be taken within marinas because marina silt is often found to contain hazardous elements. These elements get stirred up in the dredging process causing re-entry into the water mass. The following should be considered:

- Disposal of dredged material must be in accordance with applicable regulations and protocols;
- Perform chemical, physical, and biological analysis to determine if contaminants are present in the sediment to be dredged. These tests should be in accordance with the dumping protocols;
- Plume modelling may also be required to determine the fate of the disposed mater;
- Perform a marine survey for the proposed disposal site to avoid disrupting any special marine habitats; and
- Consider using the dredged material from the entrance channel for the nourishment of the down drift beaches

3-2-2.2 Fuel Utilities

Oil spills cause pollution and is costly to clean up. Proper containment equipment and a fuel response plan must be available. The following measures should also be considered:

- Promote the use automatic shut-off nozzles;
- Promote the use of fuel/air separators on air vents or tank stems of inboard fuel tanks to reduce the amount of fuel spilled into surface waters during fuelling of boats;
- Educate boat owners and take measures to promote the use of the correct gas: oil ratio to reduce incomplete combustion;
- Promote the use of oil-absorbing materials in the bilge areas of all boats with inboard engines. Examine these materials at least once a year and replace as necessary. Recycle them if possible, or dispose of them in accordance with petroleum disposal regulations;
- Have absorbent pads readily available at the fuel dock. Spill response equipment should also be on standby during fuelling (booms, skimmers, etc.);
- Prohibit smoking near fuelling areas;
- Provide and maintain readily accessible and clearly marked fire extinguishers near fuelling stations; and

- Train personnel on fire safety and how to put out fires.

3-2-2.3 Combating Pollution

Pollution in a marina can result from the following:

- Ship yards and workshops used for repairing and maintaining vessels;
- Wastes from vessels and ships that may include bilge water, domestic wastewater, lubricating oil or fuel oil, spillage during loading and unloading of vessels, etc.; and
- Land based sources.

The following should be considered in combating pollution:

- The sources of pollution must be identified and inspected regularly to prevent pollution from these sources;
- Collection and containment devises must be available to deal with any spill of pollutants;
- Encourage boaters to check for leaks of oil and fuel into the bilge, and to fix leaks that cause contamination of bilge water;
- Discourage the use of emulsifying soaps to clean the bilge;
- Provide oil/water separators for boaters to purchase and install in their boats and/or provide land based oil/water separators;
- Place containment berms around fixed pieces of machinery that use oil and fuel and around areas where used oil is stored;
- Properly dispose of used petroleum spill response products and maintain records o proper waste disposal;
- Establish a recycling program for petroleum-contaminated wastes; and
- Strict control on the shipyards should be enforced to prevent pollution from entering the marina basin from the yards.

3-2-2.4 Waste Collection and Pump out Facilities

The following guidelines should be considered for any waste collection and pump out facilities:

- Arrange maintenance contracts with contractors competent in the repair and servicing of pump out facilities;
- Waste collection facilities must be provided to collect all types of wastes from the ships;
- Provide well marked areas where lead acid batteries can be collected for recycling;
- Provide appropriate containers for the disposal of mercury containing devices or lamps;

- Adequate procedures should be placed for storage, transport and disposal of waste for all hazardous and dangerous materials used;
- Develop regular inspection schedules;
- Mandate the use of pump out facilities and specify penalties for failure to comply; and
- Place dye tablets in holding tanks to discourage illegal disposal.

3-2-2.5 Boat Maintenance

Engine service and repair operations generate waste which, when handled incorrectly, can cause human hazards and can endanger the environment. If the marina will include some areas for boat maintenance, the following should be considered:

- Perform boat maintenance/cleaning above the waterline in such a way that no debris falls into the water;
- Provide and clearly mark designated work areas for boat repair and maintenance. Do not permit work outside designated areas;
- Provide labelled separate disposal containers for used oil and used oil filters;
- Clean hull maintenance areas regularly to remove trash, sanding, paint chips, etc.;
- Perform abrasive blasting within spray booths or plastic tarp enclosures to prevent residue from being carried into surface waters. If tarps are used, blasting should not be done on windy days;
- Whenever possible, painting should be done indoors;
- Paints that do not contain environmentally harmful solvents should be used;
- Painting on land should be over impermeable surfaces;
- Provide proper disposal facilities to marina patrons. Covered dumpsters or other covered receptacles are preferred; and
- Provide facilities for the eventual recycling of appropriate materials.

3-2-2-6 Washing Boats

Boat owners might use a variety of boat cleaners, polishers, and detergents that can be a source of pollution and nutrients to the water. Additionally, scrubbing antifouling paints can release toxic metals into the water that may also contaminate marina bottom sediments. The following should be considered for cleaning of boats:

- Wash the boat hull above the waterline by hand. Where feasible, remove the boat from the water and perform cleaning where debris can be captured and properly disposed of;

- Detergents and cleaning compounds used for washing boats should be phosphate-free and biodegradable, and amounts used should be kept to a minimum;
- Discourage the use of detergents containing ammonia, sodium hypo chlorite, chlorinated solvents, petroleum distillates, or lye; and
- Do not allow in-the-water hull scraping or any process that occurs underwater to remove paint from the boat hull and encourage the use of sponges of soft towels.

3-2-2.7 Vessel Activities

- Exclude motorised vessels from areas that contain important shallow-water habitat;
- Provide educational materials to vessel operators on the damage that may occur from increased turbidity on underwater resources such as sea grass;
- Enforce the environmental management plan for the activities involved; and
- Establish and enforce no-wake zones to decrease turbidity.

3-2-2-8 Other

The following measures should also be considered:

- Propose measures to enhance air quality and to reduce noise.
- Propose methods to reduce visual impacts such as landscaping, materials selection and management measures.

3-2-3 Guidelines for Management and Monitoring

3-2-3-1 Land Area

Terrestrial and non-marine invertebrates, abundant in sand dunes and salt marshes, are unlikely to be affected by marina developments unless the construction involves significant modification of their habitats through land claim. It is important to identify potential weed and introduced species, and prevent infestations at the site and to control spread into localities adjacent to the marina,

The monitoring for the land area should include the following:

- Stabilization works for cuttings and embankments,
- Monitoring of the water table to predict any flooding problems,
- Monitoring of all structural elements to detect areas that require maintenance,
- Monitoring of eerosion and sedimentation control structures.

3-2-3-2Marine Area

Water quality in a low flushing marina basin can undergo a number of changes. In particular, water temperature may increase, dissolved oxygen levels may decrease, and there may be increases in certain pollutants such as copper from antifouling paints.
The following measures should be considered for the marine area in the marina and in the vicinity of the marina:

- Measures should be taken to prevent infestations by introduced species at the site and to control spread into localities adjacent to the marina;
- Use of pollutant traps and trash racks, oil separators, grease traps, drip trays, filters, controls on the build-up of debris in the vicinity of the marina;
- Measures should be included to compensate for poor flushing;
- Measures to prevent contamination of water from maintenance, repair activities or from accidental leakage or spillage of potentially harmful substances;
- Response strategies, containment and recovery facilities including location of materials used in response strategies; and Monitoring should include the following
- Surveying of the shoreline;
- Surveying of the marina basin to determine the sedimentation in the marina basin;
- Monitoring the water quality in the marina basin and along adjacent beaches; and
- Monitoring the marine habitat.

(3-3)

ENVIRONMENTAL MONITORING GUIDELINES FOR ARTIFICIAL LAGOONS

Table of Contents

3-3-1 INTRODUCTION

Artificial lagoons are often considered economically attractive landscaping features. Such lagoons and inland waterways may provide recreational opportunities or improve site aesthetics and increase the number of units overlooking the water. These lagoons may be used for swimming purposes or may be used only as landscaping features Any deterioration in the water quality inside the lagoon system will cause serious impacts on the environment. Furthermore, the function of such lagoons will vanish.

Key elements in protecting human health from potential risks associated with recreational or bathing waters are the identification of pollution sources, both continuous and intermittent, assessing their impact on the target area and undertaking remedial or management action to reduce their public health significance. Depending on the circumstances, there may be a number of actions that can be taken to reduce public health risk. Routine monitoring should be undertaken to determine if the water quality status changes over time.

These guidelines provide information on measuring changes in pollution loads and in water quality within an artificial lagoon. This guidance assumes that the reader has a good understanding of basic sample collection and sample analysis methods. Section 2 of this manual describes the different parameters to be monitored.

Section 3 of this document provides suggested checklists required by TDA to successfully implement an environmental monitoring program at the project level. It can also be used by the proponent to complete their record keeping reports as per the specific management plan, stated in the EIA.

This document, however, is not intended to provide recommendations regarding the operation and maintenance requirements for any given management measure, but is instead intended to provide "inspectors" with ideas regarding what type of monitoring they should perform. This document also does not provide details of the analysis required for each monitoring plan. Each monitoring plan should be designed by the inspector for each site and includes the number of samples, the seasonal variation, and other conditions.

By tracking management measures and water quality simultaneously, TDA and EEAA will be in a position to evaluate the performance of those management measures and conditions of approval set under the EIA. Management measure tracking will provide the necessary information to determine whether pollution controls have been implemented, operated, and maintained adequately.

Appropriately collected water quality information can be evaluated with trend analysis to determine whether pollutant loads have been reduced or whether water quality has improved. Valid statistical associations drawn between implementation and water quality data can be used by EEAA to indicate:

- Whether management measures have been successful in improving the water quality and;
- The need for additional management measures to meet water quality objectives.

3-3-2 MONITORING PARAMETERS

The following parameters should be monitored:

- Salinity
- Temperature
- Visual inspection of water in the lagoon that includes
  - Trash and debris
  - Excess algae growth
  - Noxious odour
  - Foam on surface
  - Presence of oil film on surface
- Visual inspection of lagoon structure including:
  - Deterioration in construction
  - Blocking of nozzles or drains
  - Deterioration in pumps and pipe network
  - Any leakage from lagoon

For Lagoons used by bathers the following should be monitored:

- Total coliforms.
- Faecal coliforms.

3-3-3 Environmental Monitoring Check Lists

The following criteria may be considered by the TDA in its environmental monitoring campaign. In addition, the TDA / EEAA may consider other factors relevant to a specific project or application

3-3-3-1 Visual Observations

Visual Observations (1)

Date		**Lat.**	
Name of Center		**Long.**	
Name of development		**Arrival Time:**	
Name of researcher		**Departure Time:**	

Visual Observations (2)

	Value	Comments
Air Temperature (ºC)		
Temperature of seawater (ºC)		
Wind Speed		
Wind Direction		

Visual Observations (3)

	Good Conditions	Fair	Bad Conditions	Comments
Odour of Water				
Colour of Water				
Water Transparency				
Sides of Lagoon				
Pumps				
Feeding network				

Visual Observations (4)

	Significant	Small	Not Observed	Comments
Algae Growth				
Debris				
Foam on surface				
Daily fall in water level				

3-3-3-2 Compliance with EIA Study

The following should be checked during construction

Item	Compliant	Not Compliant
Location of construction		
Type of construction		
Method of construction		
Equipment on site		
Workers on site		
Safety and precautions on site		
Facilities for workers		
Mitigation measures to protect near-by reef		
Mitigation Measures to protect water quality		
omments		

3-3-3-3 Bacteriological and Eutrophication Parameters

Date:

Station No.**	Salinity (PPM)	Temperature (ºC)	Dissolved Oxygen mg/l	pH	Total coliforms /100 ml*	Faecal coliforms /100 ml*	Comments

* For lagoons used for swimming

** Show location of stations on a plan of the lagoon

(3-4)

Environmental Guidelines for Designing of Artificial lagoons

Table of Contents

3-4-1 Introduction

Artificial lagoons are often considered economically attractive landscaping features. Such lagoons and inland waterways may provide recreational opportunities or improve site aesthetics and increase the number of units overlooking the water. These lagoons may be used for swimming purposes or may be used only as landscaping features.
Any deterioration in the water quality inside the lagoon system will cause serious impacts on the environment. Furthermore, the function of such lagoons will vanish. Thus, it is essential to properly design such lagoons as described in these guidelines to ensure that the lagoon will serve its purpose and will not have any negative impacts on the environment.
This guideline provides information on the studies required and the precautions to be considered when planning or designing artificial lagoons.

3-4-2 Types of Lagoons

In general artificial lagoons can be classified as open type lagoons and closed lagoons. Open type lagoons are directly connected to the sea whereas closed type lagoons are constructed inland and are not directly connected to the sea.

3-4-2-1 Lagoons Connected to the Sea

Lagoons directly connected to the sea make use of the tidal variations to provide natural flushing for the lagoon system. Such lagoons may require a small initial cost since they will not require any lining for the bed. Due to the environmental problems associated with such lagoons, such features might be neither economically nor environmentally viable. Thus the EEAA does not recommend the construction of lagoons directly open to the sea. The approval of the SPA must also be obtained for such lagoons.
The main concerns associated with artificial lagoons open to the sea are:

- Lagoons open to the sea may have a negative impact on the neighbouring shorelines. The protection works at the inlet of the lagoons will interrupt the movement of sand along the beach and will modify the hydrodynamic conditions at the entrances. This effect will create sedimentation problems and erosion of down drift beaches.
- Open lagoons can create a source of pollution for the neighbouring beaches if the water quality in the lagoon is inadequate.
- The need for maintenance dredging poses severe negative impacts on the environment and will increase the maintenance costs for such lagoons. Maintenance dredging of open lagoons will increase the turbidity along the nearby beaches and endanger any nearby coral reefs.

These types of lagoons will not be considered any further in these guidelines and should not be proposed along the Egyptian coastlines.

3-4-2-2 Lagoons not Connected to the Sea

Artificial lagoons may be designed as closed lagoons not directly connected to the sea with a mechanical system for flushing the water body inside the lagoon. The mechanical system may be a closed recirculating system with filters used to purify the water (similar to the system used in swimming pools). In this type of design only the evaporation losses need to be compensated for and the water in the lagoon is replaced only during maintenance. Such an alternative is preferred over the open mechanical system with a sea intake and an outfall due to the problems associated with such structures as described later. For an open system with an intake or an outfall the approval of the SPA is required.
The following should be considered for closed lagoons:

- Artificial lagoons should not be placed in the setback area approved by EEAA;
- The mechanical system for artificial lagoons should be properly designed to ensure good water quality conditions in the lagoon. Water quality modelling is recommended to properly design the feeding and drainage network for such lagoons (as explained later);
- For lagoons used for swimming purposes, the hygienic quality of the water in the lagoon must be addressed to avoid spreading any diseases due to the deterioration of the water quality below the health standards;
- All components of the lagoon should be constructed with materials that will resist corrosion and will be durable; and
- The water quality in the lagoon should be monitored in order to enable early corrective actions.

3-4-3 Design Requirements for Lagoons

The requirements to properly design artificial lagoons will be provided in this section.

3-4-3-1 Water Quality

The water quality in any artificial lagoon must be adequate during all periods of the year. Thus it is essential to properly design the lagoon system to ensure the adequacy of the water quality.
It is important when proposing a layout for the lagoon to consider the following:

- Avoid convoluted and irregular shapes to avoid creating dead zones;
- The lagoon should be designed with a slope in the bed towards the area where the drains are placed;
- It is also important to consider the wind direction when choosing the location of the drains to make use of the wind in moving any suspended debris towards the drains;

- It is also important to limit the drains to a certain area and not include drains close to the nozzles to avoid any closed loops for the flow of water; and
- Keep the lagoon away from irrigation water to avoid fertilizers from reaching the water of the lagoon.

Circulation rate is related to turnover period (or flushing time), which is the time taken for a volume of water equivalent to the entire lagoon water volume to enter the lagoon. In principle, the shorter the turnover period, the more frequent the lagoon water treatment. The turn over time will depend on:

- The water depth,
- The use of the lagoon (swimming or visual only),
- The type of water used (from sea or wells),
- The atmospheric temperature, and
- The possibility of receiving any pollutants.

a) Modeling

In poorly flushed areas and in lagoons with a complex design, the use of advanced mathematical models will identify those areas where water quality standards may be violated. These models are also capable of predicting spatial and time-variant water quality conditions and provide the complete water quality picture inside a proposed marina. The distribution of the feeding nozzles and the drains should be determined by the use of these mathematical models. The minimum modeling requirements are as follows:

- Two-dimensional hydrodynamic modeling where the currents are calculated based on the sources (nozzles) and sinks (drains). The model solves the equations for conservation of mass and momentum in two dimensions. To determine the values for the discharge from each nozzle, a preliminary design for the mechanical feeding network will be required. The discharge for the drains must also be determined to specify the values for the sinks in the model.
- Two-dimensional Advection/Dispersion modelling where the flushing of the lagoon is calculated. The flushing time at critical points must be determined to ensure that no dead areas exist. If such areas exist, additional nozzles may be added to ensure that no areas that might pose problems exist. It is recommended to assume a flushing time of about four to six days as an initial value if the lagoon will not be used for swimming. For lagoons used for swimming this value should be reduced to about one day. These numbers should be confirmed from the water quality and eutrophication models described below.
- Water quality modeling should also be included where different water quality parameters are modeled (e.g. DO, BOD, etc.). These models require data on the water quality of the water used to supply water into the lagoon and the currents calculated from the hydrodynamic model. Any possible sources of pollution should also be considered (fertilizers from irrigation water, etc.). The salinity of the lagoon water should be

modeled to determine the changes that may occur in salinity due to evaporation.

- Eutrophication modeling where the growth of Algae is studied to ensure that eutrophication does not occur. This type of model is important for lagoons where sources of pollution can reach the lagoon. Any possible sources of pollution such as irrigation water that might reach he lagoon should be considered. The seasonal variation of the solar radiation, temperature and salinity are needed as forcing functions. The load of nutrients from land, if any, is a forcing function as well. The following parameters need to be determined for the water supplied to the lagoon (for the case with an intake).
    - PC, phyotplankton carbon,
    - PN, phytoplankton nitrogen,
    - PP, Phytoplankton phosphorus,
    - CH, Chlorophyll a,
    - ZC, zooplankton C,
    - DC, detritus carbon,
    - DN, detritus nitrogen,
    - DP, detritus phosphorus,
    - IN, inorganic nitrogen,
    - IP, inorganic phosphorus,
    - Total Nitrogen N, and
    - Total Phosphorus P.

b) Hygienic Quality

If the lagoons will be used for swimming purposes, the hygienic water quality should also be considered. Thus in addition to the modeling requirements provided above, the risk of growth of pathogens should not be neglected. The water quality in the lagoon must confirm with the standards set by the Ministry of Health for swimming pools and the following standards.

- Total coliforms/100ml should not exceed 10,000.
- Faecal coliforms/100ml should not exceed 2,000.
- There should be no abnormal color for the water.

3-4-3-2 Design and Maintenance

a) Pump Station

The following should be considered for the pump station:

- A standby pump must be available to be used if any of the pumps needs maintenance,
- A maintenance program should be designed for all the mechanical components of the pump station.

b) Pipe Network

The following should be considered for the pipe network:

- The screens along the drains will need regular cleaning to remove any debris trapped,
- The pipe network will require regular testing to locate any locations with leakage,
- The manholes for the drainage network will require regular cleaning, and
- The pipe network will require regular maintenance to ensure that all valves and pipes are in good condition.

c) Filters

If filters will be used for a closed system the following factors should be considered in the design of the filtration system:

- Typically, the higher the filtration rate, the lower the filtration efficiency. Higher-rate filters do not remove particles and colloids as effectively as medium-rate filters, and the filters cannot be used with coagulants.
- For sand filters the correct sand bed depth is important for efficient filtration.
- Lagoons will benefit greatly from the increased flexibility and safeguards of having more than one filter. In particular, the lagoon can remain in use with a reduced turnover on one filter while the other one is being inspected or repaired. Filtered water from one filter can be used to backwash another.
- The cleaning of a filter bed clogged with suspended solids is referred to as backwashing. It should be initiated as recommended by the filter manufacturer, when the allowable turbidity value has been exceeded or when a certain length of time without backwashing has passed.

d) Cleaning of Bed

The deposition of sediments from the atmosphere or from the feeding system and measures for the removal sediment deposited on the floor of the lagoon should be studied. For lagoons where sand is placed on the bed of the lagoon, the sand will need to be replaced periodically.

3-4-3-3 Intakes and Outfalls

For open mechanical systems taking and disposing water from and to the sea an intake and an outfall system will be required.

a) Sea Intakes

Water intakes can adversely impact aquatic organisms basically in two ways. The first is entrainment, which is the taking in of organisms with the intake water. These organisms are usually of small size (depending on the screen mesh size) and include phyto- and Zooplankton, fish eggs and larvae, and

many other forms of aquatic life. These entrained organisms may be damaged as they pass through different components of the project.
The second way in which intakes adversely impact aquatic life is through entrapment-impingement. Larger organisms that cannot pass through the screens, such as fish may be trapped ahead of these screens. If the fish is impinged on the screen for a long period it may suffocate. Delayed mortality may also occur if the fish loses its protective skin due to impingement.
The biological value of the source water should be assessed based on the following:

- Principal spawning (breeding) ground;
- Migratory pathways;
- Nursery or feeding areas; and
- Other functions critical during the life history.

A once through system utilises substantially more water from the source water body than a closed recirculating system and thus would tend to have a higher potential impact. An open once through system should not be used in an area with high biological value.
The important factors to be considered when designing the intake structure are:

- The effect of the structure and the intake pipe on the nearshore hydrodynamics and beach morphology;
- For structures having an effect on the nearshore hydrodynamics, a shoreline impact study would be necessary to determine the impact of the intake structure on the neighbouring beaches;
- The use of pipelines rather than open channels should be considered as the preferred option for beaches with high sediment transport rates; and
- The pipelines should be designed to resist corrosion by selecting suitable material that can resist the seawater. The use of glassfiber reinforced pipe systems (or similar types) can be considered since they provide non-corrosive pipes.

b) Sea Outfalls

For a marine outfall, the physical, chemical, and biological properties of the disposed water must be acceptable to prevent any severe negative impacts on the marine environment. The following should be considered when designing a marine outfall:

- According to the executive regulations of Law 4/1994, the outfall should be located at a distance not less than 500 m from the coastline. Furthermore, outfalls should not be constructed in fishing zones, swimming zones, or areas with sensitive marine habitats;
- The physical, chemical, and the biological properties of the water disposed must comply with the executive regulations provided in Law 4 of 1994;

- For structures having an effect on the nearshore hydrodynamics, a shoreline impact study would be necessary to determine the impact of the outfall structure on the neighbouring beaches. The use of pipelines in the surf zone rather than open channels should be considered for such coasts;
- The pipelines should be designed to resist corrosion by selecting suitable material that can resist the seawater.
- The outfall can be placed on a trestle with a deck elevated on piles to reduce any effect on the nearshore hydrodynamics; and
- In protected areas as the gulf of Aqaba sea outfalls are not permitted according to Law 102/1983;

(3-5)

Environmental Monitoring Guidelines for Waste Water Plants

Introduction

1- Collection, treatment, and disposal of wastewater must be implemented in a methodology/system that do not cause any hazards to the public health, or cause disturbance to the residents in tourist facilities, or cause hazards to the environment.
2- Any discharge of wastewater effluents either raw, liquid, or solid treated effluents to the sea shall be prohibited.
3- All wastewater treatment facilities must be located in non-visible areas, preferably in low areas and must be surrounded with a fence of suitable trees, and that the distance between these facilities and the main road or tourist facilities shall not be less 0.5 km.
4- The distance between non aeration treatment beds and the main road and/ or development areas must not be less than 1 km
5- To reuse the treated wastewater in irrigation, the following standards must be observed:
A- Standards for reusing treated wastewater in tree planting in areas void of residents:

-Biological Oxygen Demand (BOD5) must not exceed 30 ppm
-Suspended Solids must not exceed 30 ppm
-Deposit chlorine must not exceed 0.50 ppm

In order to reach these standards, wastewater must be treated by applying the appropriate primary and secondary treatment applications, and must be later disinfected with chlorine.

B- Standards that should be available for reusing wastewater in irrigation purposes for green areas and trees in areas where guests can be located

-Biological Oxygen Demand (BODs) must not exceed 20 ppm
-Suspended Solids must not exceed 100/100 milliliters
-Colonial bacteria must not exceed 15 ppm
-Deposit chlorine must not be less than 0.50 ppm

In order to reach these standards, wastewater must be treated by applying the appropriate primary, secondary, and tertiary treatment applications.

Wastewater Treatment System

There are two types of treatment:

1- First: This depends mainly on biochemical reduction by aerobic bacteria.
2- Second: This depends mainly on biochemical reduction by anaerobic bacteria that is we do not use aeration at all.

It is noteworthy that any wastewater treatment facility depends mainly on three main phases to carry out the treatment process as follows:

Aeration Process:

Through this process air is pushed, as required with oxygen necessary for aerobic bacteria, tat carries out the required biological processes for the reduction of biochemical organic materials. Air also helps in good mixture for water with its contents and preventing settlement

Clarification Process:

Through this process, the light material is separated on surface, and clarified water is discharged from the other side.

Filtration and chlorination Process:

Carbonic filters are used to get rid of odors. Then treated with chlorine (sodium hypo chloride)

How Wastewater Treatment Operates?

Wastewater normally consists of 200-500 ppm solid wastes and the rest is water. Chemically speaking, the solid materials are divided into an organic portion 45-80% (such as fats, lubricants, carbohydrates, starch and sugar materials, and animal and plant proteins).
And the other inorganic portion from 20 to 25% (salts, sand, stones, and metals).

The following table indicates the characteristics of the compounds comprising wastewater. Discharging this wastewater without treatment pollutes the environment by the accumulation of organic materials and millions of microorganisms that exist in wastes.

The organic materials are characterized by the biological degradation, which is measured by the amount of biological oxygen demand (BOD). This is method for locating the organic material concentration in water. Concentration of these materials can be made by chemical materials called chemical oxygen demand (COD). In the treatment process, water enters the aeration tanks, and organic oxidation is made. Organic wastes are considered nutrients for microorganisms. Air provides the proper environment for the reproduction of microorganisms that performs the process of biological oxidation of wastes through pushing air (naturally or mechanically).

As a result of this process, wastes are turned into inorganic materials that can be settled in settling beds. Water moves from the settling surface to the filtration and chlorination units and from there into the agricultural areas or to the drains. The treatment effluents can be used in producing dried sludge that can be used as fertilizers and soil conditioners.

Compound/concentration (PPM)	Weak	Medium	Strong
Total suspended solids	500	850	1200
Suspended solids	100	200	400
Volatile suspended solids	70	140	300
Biological oxygen	100	230	450
Chlorides	21	42	83
ammonium Nitrogen	5	12	21
Organic nitrogen	8	21	40
Protein ammonium	3	7	21

Symbols:

Wastewater= sanitary sewage, sewage, raw sewage, domestic sewage

- Wastewater is composed of about 00.9% of water, and 0.1 of solids by volume (solvents + suspended solids)
- Solid materials contain organic solvents and inorganic materials, containing various types of bacteria, minor and microorganisms and viruses.
- Removal and reduction of solid materials and final disposal thereof, including what is termed as human wastewater treatment.
- Our applied methodology in the treatment of human liquid wastes depends biochemical reduction of organic materials by using aerobic bacteria and the settling of solids. This is called the biological treatment process, and our applied methodology is the Activated Sludge process.

Th Activated Sludge process.

System Description:
Sewage lift stations:

There are seven lift stations that have similar in terms of internal installation of equipment as well as in terms of operation. Wastewater flows by falling and gravity from all the sites of the base station and its facilities tot he lift stations. Each lift station pumps water to the next station then to station no. 3, which receives water from all other stations and then pumps it to the treatment unit, where water is received in the flow splitter box.

A- <u>Flow Splitter Box:</u>

Consists of three parts:

<u>Bar screen:</u>

A series of vertical steel bars with an intermittent distance of 2.5 cm each. This bar screen works on screening and detaining the big solid materials and any other wastes with a bigger size than the distance in between bars.

Communitor:

This communitor works with an electric power motor, and starts operation automatically once water enters into the station inlet, to grind all the big parts and solids with the wastewater and reducing its size into 6.3 mm approximately.

V-Notch Weir and Flow Splitter:

This is a bed that is composed of two parts, where a large quantity of inlet sands and suspended solids from water settle therein. Therefore this part is considered a preliminary treatment stage.

- The inlet water into this part is divided into two equal portions that flows with falling and gravity to the 2 contact basins.
- The flow splitter box is equipped with flow meter.

B- Contact basins:

- There are two contact basins working in parallel. Each basin has a vertical cylindrical shape, including four chambers called "zones"

1-**Aeration Zone**:

- The largest zone in the basin, and occupies an area that constitutes 52% of the total volume.
- On the bottom of this zone, there are air diffusers, through which air is pumped in this area (fine air diffusers)

2 **Clarification Zone:**

- Cylindrical shape area located in the middle of the basin, and equipped with a motor that operates the bottom scrapers and sum skimmer.

3-**Digester Zone:**

Occupies an area of about 37% of the total volume of the basin, and at the bottom there are air diffusers through which air is pumped in the form of large bubbles in this part (Coarse air diffusers).

4-**Chlorine contact zone:**

- The smallest zone in the basin, which occupies about 1% of the total volume, and where chlorine is injected and mixed outside the clarifiers apart from the clarifier effluent.
- No moving parts exist in this zone

Aeration Blower System

- There are three air-generating machines located in a separate blower building.
- The three machines are connected externally with each other to give at the end two-outlet lines, each line per one contact basin. They are mutually exchangeable through a set of valves.
- These blowers provide air pressure adequate enough for the aeration process of activated sludge in the aeration tank, and also for the digested sludge in the digestion basin. In addition, it provides also the air required for various air lifting operations between zones.

C- Hypo chlorination System:

1. There are three chorine injection pumps from the mixing tanks to (?) from the chlorine injection zone in both basins.
1. Chlorine injection system is located in a separate building, as it contains pumps. Chlorine is prepared by mixing the chlorine powder with water manually by using an electric mixer, and is left to settle, and then the solution is injected and pumped.

D- Sludge Drying Beds

This separates water from solds in sludge using filtration by gravity, and drying with natural air.

E- Filtration System:

1. There are four filtration units (two per treatment basin), where both receive effluent water moving towards each basin, and filtrates water from suspended solids.
1. Outside treatment basins, water is received and entered into filtration units by gravity outflow, through batches called dosing.
1. After filtration, this water comes out of the filter moving towards the holding tank (filtered water storage tank) by gravity, then to the effluent storage tank.
1. There is automatic cleaning of the filtration media inside the filter by means of backwashing, and air scouring

Each Filtration System consists of:

1- Two tanks for the filtration media (sand + anthra coal)
2- Holding tank for backwash supply
3- Backwash holding tank for backwash return

- Air scour blower for automatic cleaning of the media by backwashing and air scouring
- Submersible pumps for backwash supply and backwash return to the splitter box.

Effluent storage and discharge system:

-Two concrete tanks open from above including two discharge pumps in each tank, working either manually or automatically.
-The tank's length is 18 m, width 9 m, and height 4 m, where water coming from the gravity filters outflows into both.
-The tank is considered a reservoir for the treated wastewater, which is required from time to time in irrigation of cultivated lands.
-Ultraviolet sunrays separate and evaporate chlorine in these stored water, and thereby the specifications of this water becomes nearly normal to be used in irrigation purposes.

Description of Contact Basin:

The main function of the treatment basins in its varied zones is to remove the non-solvent solid material by settling and the solvent organic material by biological treatment, by means of aerobic bacteria from the wastewater, in addition to digestion and stabilization of sludge, and killing of microbes and contagious organisms.

Aeration Zone:

-In this zone, the wastewater coming form the splitter box is mixed, where it has been primarily treated by settling of sands and being screened from big solids using screens. There it is mixed with activated sludge (these are the settlings that accumulated in the clarifier) coming from the clarifier.

-This water is moved from the splitter box to the aeration zones by gravity fed.

-Activated sludge flocs absorb minor particulates existing in the wastewater as well as the solvent solids.

-Air blowers provide aeration zone with air required, where the oxygen is necessary for aerobic bacteria, which conducts the biological processes required for the reduction of organic material, by means of sir diffusers fixed in the bottom of the zone (basin). Also this air helps good mixture between inlet water and activated sludge preventing it from being settled in the basin bottom.

Clarification Zone:

- A mixture of treated wastewater for the aeration basin and activated sludge is directed by means of sliding gravity into the clarifier which is known sometimes as settling zone.

- The activated sludge is settled in the bottom, while the scum and light material float on the surface, and clarified liquid or supernatant is in between both.
- The activated sludge over the bottom is pumped by air lifting to the sludge splitter box, where sludge returns again to the aeration zone.

Chlorine Contact Zone :

- Through this zone, chlorine is added and injected, where chlorine from the pumps gets in contact with treated water from the clarifier, and has no moving parts therein.

- Water flows from the clarifier tot he chlorine contact zone by means of sliding gravity.

- The chlorine works on killing and minimizing the cloriform in the treated water from the clarifier.

- The value of free chlorine deposits/residuals in this water after adding chlorine must not be less than 0.5 mg/ liter or equivalent.

Biological Treatment by activated sludge Process

Activated sludge:

- These are the settlings that accumulated in the clarifier.
- These are the suspended solids in wastewater that has settled in the bottom of the settling tank clarifier
- The activated sludge that settled in the clarifier consists of millions of aerobic bacteria, that constitute, with other microorganisms, the main factor for the success of the biological treatment process by using activated sludge process.

Some notes on activated sludge treatment:

- Liquid wastes are treated by activated sludge process by aeration and blending of these wastes after being mixed with specific rates of activated sludge in special tanks called aeration tanks, where bacteria is reproduced over the particulate's surface of this sludge.
- As a result, the mixture absorbs oxygen from compressed air and using aerobic bacteria and other microorganisms in this oxygen in stabilizing the suspended and soluble organic material, changing it into non-disintegrating material.
- The continuous blending by means of compressed air for the mixture leads to coagulation of micro suspended material, that is collection and coherence of these material into bigger flocks, that is easy to settle in the Clarifier or the final settling tank.

Aeration Tanks:

- The aeration process is performed in special tanks, on one side of which water coming from the clarifier and primary settling, comes in contact with the sludge returning from the final settling tank or clarifier.
- The mixture is detained in the aeration tank, where the compressed air of the aeration process and the blending by means of air diffusers fixed in the bottom of the basin takes place, for a period that ranges from 4 to 8 hours, during which aerobic bacteria is activated to perform its role in oxidation and stabilization of organic material.

Note: Detention Time is the period where the mixture is kept in the basin.

And depends upon:

1- Inflow into the basin
2- Size of basin

Detention Time= size/inflow

The conditions of aeration tank:

1- Availability of oxygen throughout the basin to ensure the activity of aerobic bacteria in oxidation and stabilization of organic material, changing it into stabilized material that is not easily being disintegrating or altered. (solvent oxygen more than 2 mg/liter)
2- Continuous blending by means of compressed air, resulting in coagulation of micro suspended solids to form bigger material that is easily settled in the final settling tank or clarifier.
3- Severe blending (by means of compressed air) prevents the settling of suspended solids from falling into the bottom of the basin, to prevent its potential accumulation, which contradicts the oxidation process.

The processes of aeration tank:

Coagulation:

- This is the first stage- characterized by the quick attraction between the flocs of the organic material, where oxygen is not necessarily required.
- A period from 15 to 45 minutes is required to achieve satisfactory results in this process.

Oxidation or activation:

- This is the second stage, where oxidation is performed by means of the biological forces, and providing bacteria with an amount of oxygen for its continuous activation.
- Oxidation and activation start with high speed, then is slowed a little for a period of two to five hours, then its speed is slowed gradually and continuously.

Nitrification:

Starts with the end of the first steps (coagulation), and after the oxidation starts in the basin with a short period of time. This stage is completed after a period of 8 hours often, where ammonia compounds are changed into nitrates and nitrites.

The advantages of activated sludge process:

1- Free of the problems of odors and flies
2- Requires a small space as for other types of biological treatments
3- Relative cost effective construction
4- Can be constructed near residences without causing any hazards or disruption to the citizens
5- Does not require many operators

The disadvantages of activated sludge process:

1- The resulting sludge contains a high rate of water, which highly increases its size and dries with difficulty.
2- High O & M costs
3- Requires high technical supervision
4- Results in operational difficulties on the existence of industrial wastes
5- For unknown reasons, the process results fail, which require a very long time
to restore operational results back to normal standard.

"**Troubles of Activated Sludge Treatment"**

Troubleshoots and Corrective Maintenance Procedures

Problems	Causes	Corrective Action
1- Foam formations in the aeration bed	1- Possible usage of detergent	1- Sprinkle the foam with fresh water 2- Increase the suspended particulates
	2- Very low particulates in the aeration tank	- Increase the dry sludge
	3- Too much aeration	- Decrease the aeration
	4- High temperature	- Sprinkle the foam with fresh water
	5- Increase of wastewater clearance	- Sprinkle the foam with fresh water

	6- Too much particulates in the aeration bed	- Decrease the dry sludge or eliminate it by drainage

Problems	Causes	Corrective Action
2- Sludge of aeration tank tends to be black with bad odor and the post-sludge precipitation water is turbid	1- Very low aeration in the aeration tank	- Increase aeration
	2- Too much organic load (too much organic substances)	- Decrease the organic load
3- Sludge of aeration bed does not rotate enough	1- Air pressure is not enough due to air sprayers block	Tune & clean air sprayers
	2- Not enough air	Increase air
4- solid matters in the clarifier	1- Problem with bottom drifter	Repair
	2- Blockage in the inlet of the air lift	Clean and tune air lift
	3- too much aeration in the tank	Tune the air in the tank
5- Clear water post sludge precipitation in the bed while the water in the outlet is turbid – small air bulbs in the floating sludge + sludge raise to the surface of clarifiers	Septic conditions or Anaerobic Conditions or Denitrification	1- Increase the dry sludge to the aeration bed 2- Decrease sludge duration in clarifiers by increasing drainage 3- Ensure that the minimum oxygen in the clarifiers is 1 mg/l.

Problems	Causes	Corrective Action
6- Bad sludge precipitation + no gas bubbles in the floating sludge	1- Short aeration time due to overflow from treatment plant	1- Make the following tests: - Dissolved Oxygen rate - BOD - Dry sludge rate - Plant overload - Wastewater features 2- Adjust dissolved oxygen over 2 mg/l. 3- Add chlorine to the dry sludge by 0.3 – 0.6 of the volume of the dry sludge 4- Remove as much as possible of the floating sludge from the system
	2- solid particulates in the aeration tank either too high or too low	Adjust the suspended solid particulates in the aeration tank according to the minimum and maximum limits
Low activity of bacteria of bio-treatment	Carbon dioxide increase beyond the permissible limit of the aeration bed	Add limestone so as the concentration of pH is < 8

Problems	Causes	Corrective Action
	2- Increase of carbon dioxide resulting from aerobic degradation of liquid wastes during passing into pipes.	Add chlorine to several points in the pipelines
	3- increase grease to 10% of total sediments in the aeration tank to act as buffer between oxygen and organic materials and bacteria in the sediments	Grease should be separated into special tanks before the bio-treatment plant
	4- Bacterial poisoning in the mixture of aeration tank due to decrease or increase of PH beyond the permissible limits	PH = 6-8
	5- Bacterial poisoning due to poisons like phenol	Remove such materials and eliminate them before entering the treatment plant in the sewer network

Parameter of treatment by activated sludge process:

The treatment rate of liquid wastes by this method reads the following:

1- Settle able removal % (85-90)
2- BOD reduction (80-95 %)
3- Coliform reduction (90-95 %)

Settling tanks or clarifier:

These receive the liquid wastes from aeration beds where the suspended particulates that have been oxygenated are precipitated and stabilized into such beds.

Aerobic sludge digestion

Identifying the aerobic sludge digestion:

- A biological sludge treatment used for treating the solid matters that are separated from the wastewater (sludge) composed of particulates that are separated during clarification process due to the growth of biological mass.
- Aerobic digestion is among several methods used for treating the sludge before drying and disposal (through burying or agricultural uses) – it uses the aeration to stabilize either the biological or primary sludge or both.
- Aerobic digestion decrease the volume of the solid matters in the sludge by aerobic bacteria as they degrade the volatile organic matters resulting from biological activity.
- In addition to decreasing the total volume of the sludge, the aerobic digestion makes the digested sludge less generating of bad odor when eliminated, which reduce biological risks. This operation called “Stabilization of sludge”.
- The tank, which is used as digester, is an open tank called “aerobic digester”, where the compressed air is used for sludge oxidation and mixing.
- Aerobic bacteria in the activated sludge, which is used in the biological treatment by activated sludge. This bacterium eats the organic matters in the sludge until vanished and no additional sludge is added. In this case the bacteria eat each other and this process is called auto oxidation or (Endogenous).
- In this case, the bacteria consume the protoplasm in the cell to obtain the required energy until they die and leave their tissues for oxidation to be carbon dioxide, water, and ammonia.
- 75 to 80 % of the tissues of the bacterial cells can be oxidized and the rest of 20 – 25 % consist of idle and organic matters that are not degraded biologically (by bacteria).
- Ammonia resulting from biological oxidation of bacterial cells turn into nitrates.

→ NNH3 $NO_2 + NO_3 + H_2O$

Endogenous or autoxidation:

$C_5H_7NO_3 + O_2 \longrightarrow CO_2 + H_2O + NH_3 + energy$

Factors affecting aerobic digestion:

1- Temperature:

As the aerobic digestion means an open bed, the temperature of the digested sludge depends the air temperature. The low temperature obstructs or delays the digestion process, while the high temperature (to certain limits) increases it.
Also, the loss of temperature of the digested materials must be low.

2- Oxygen requirement:

Residual oxygen must not less than 1 mg/l.

3- Energy requirement for mixing:

The digester components must be well mixed.

4- Process operation:

1- PH must be adjusted and stabilized as it could be less than 5.5 in case of nitrates formations. This could result in the growth of the so called disturbance due to the growth of the bacterial called Filamentous at low PH rate.
2- Oxygen must be adjusted so as the residual oxygen is not less than 1 ppm from time to time.
3- The solid particulates must be precipitated in the clarifier and remove the clear water to the aeration bed to enable thickening of the sludge.

Criteria of good digestion:

1- BOD must be low in the clear water post precipitation (1.6 – 1.9 mg/l).
2- Reducing the percentage of the volatile solid particulates by 40 – 50 % comparing to the activated sludge feeding the digester.
3- Residual dissolved oxygen must not less than 1 mg/l.
4- Temperature must not less than 15 degree in winter and 25 degree in summer.
5- Duration time of the digested sludge must not less than 15 days, taking into consideration the temperature and other characteristics of the sludge.
6- Sludge concentration in the digester is about 70 %.

Sludge stabilization:

The sludge must be stabilized in order to:

1- Removing the pathogenic bacteria.
2- Eliminating odor.
3- Preventing rotten.
4- Reducing solid particulates volume.

This can be done through several ways:

1- Aerobic and anaerobic digestion
2- Chemical oxidation of the volatile organic matters.
3- Adding chemicals to the sludge to prevent growth of pathogenic bacteria.
4- Using high temperature to sterilize the sludge.

Stabilization:

Transferring the complex organic compounds into simple non-transformable substances.

EX: A → B → C → C → C …**Sludge drying beds:**

- Sludge drying beds is an ideal method for dewatering digested sludge.
- After drying the sludge. It is removed from the beds to be buried or used as soil conditioner.

Advantages of dry beds:

1- Low cost method.
2- Does not need high quality of efficiency or follow ups.
3- Contains high percentage of solid matters in the dry sludge.

Air sand drying beds:

- This is the used method in low and medium population.
- It consists of open beds.
- It consists of three parallel beds, the bed length is 23 meters and the width is 7 meters. A base and concrete walls of 1/3 meter surround it deep to prevent filtered water leakage through the bed to the ground water.
- The bed base is sloped and equipped with side drainages.
- The dry bed consists of sand layer followed by gravel layer over the sub- drainage, which consists of punched pipes to collect and dispose separated substances from the sludge and turn it back to the lifting plant through the slope and gravity then to the wastewater treatment plant.
- The sludge leaves the digester and goes to drying beds through steel pipes that are divided into three branches one for each bed that can be controlled by a group of valves.
- The sludge is spread on the surface of the drying bed at 20 – 30 cm thick and is dried by natural evaporation and gravity filtration besides the sub drainage system for the filtered water.

- Then the sludge is lifted from the drying beds after being dried to the extent, which enables burning tit. This sludge has cracked surface and black or dark brown color.
- The moisture content of this sludge is 60 % after 10 – 15 days of suitable weather conditions.
- The sludge is removed from the beds manually by shovel or loader.
- In case of cold weather, the conditions of the dried sludge are better than other weather conditions and 20 % or more increases the solid particulates content in the sludge.

Quality Control of wastewater treatment process

Test	Parameters				Remarks
	Inlet	Aeration	Clarification	Outlet	
DO		More than 2 mg/l	More than 1 mg/l	More than .5 mg/l	Less criteria result in reducing the required bacterial activity
BOD	Less than 200 mg/l			Less than 30 mg/l	Parameter for organic material in the inlet and outlet water to determine the effectiveness of the treatment system
% of precipitation		30 – 50 %	0 –5 %		Good parameter to load the aeration bed by activated sludge
SS	More than 100 mg/l	3000 - 5000		Less than 30 mg/l	Gives an idea about the efficiency of the treatment system
pH	About 7	About 7	About 7	About 7	Determines whether acidic or alkaline
Free chlorine (residual)				More than .5 mg/l	To eliminate residual harmful bacteria
Coliform bacteria				Less than 200/100 mg	Reduce pathogenic bacteria

Recommended limits for wastewater components when used for land irrigation

Item	Value		
	No hazard at all	Possible hazard	Sever hazard
Salinity	Less than 750 micron	750 - 3000	More than 3000
PH	Normal limits	6.5 – 8.4	--------
Sodium S. A. R	Less than 3	3 - 9	More than 10
Chlorides mg/l	Less than 142	142 – 355	More than 355
Ammonia	Less than 5	5 – 30	More than 30
Ion Bicarbonates	Less than 90	90 - 520	More than 520

Note: Sodium Absorption Ratio (S.A.R) = Na / √ Ca + Mg/ 2

Permissible limits:

Less than 10 = good, no hazard
Up to 18 = medium, result in problems in the heavy soils
More than 18 = result in problem

Therefore, adding some salts to the distilled water will check the strong corrosive ability of water. These additives include sodium chloride and calcium carbonates etc. The latter is one of the most anti-corrosive materials used in product water. In this case, treatment is conducted by mixing product water with quantities of saline water (well water) or by preparing calcium carbonates by passing carbon dioxide through live lime.

What happens to brine blow down?

The common denominator in all desalination processes is the production of brine, also known as “reject”, or “blow down”. Brine contains excess salts left over from feed water in the course of producing fresh water. It also contains chemicals added in the desalination process besides any percentage of water sediments or internal reactions within the process. . However, it often covers a large percentage of water. Therefore, in order to properly dispose of this residual water (in an environment-friendly way), brine should be re-discharged to the sea should the desalination plant be situated close to the sea. This minimizes potential for any possible problems. The main source of pollution in the concentrated flow is the salt that causes no problem to the sea. At the same time, it should be taken into consideration that a potential problem may arise from additional contents such as chemical and water temperature and that no land or water surface should be polluted with salts and chemicals contained in the brine blow down. Figure 6-7 shows some standards and specifications for certain materials and elements before disposal into marine environment, as established by the Egyptian Ministry of Environmental Affairs. It should be noted that such standards (that

are at present under review) have some weaknesses; for example total dissolved substances) TDD) are no more than 2,000 ppm, which is difficult or impossible to achieve, while the feed water itself id close or more than 2,000 ppm.

A visible problem arises when a desalination plant is erected in the hinterland far away from the major water body. Disposal covers diluting brine, injecting it into saline- water- bearing rocks, evaporating or piping it to disposal point. All these means add up to the cost of desalination process. Brine disposal means should subject of consideration in ant economic feasibility study, as the cost of brine disposal can negatively affect desalination economics.

Comparative analysis of basic features of commercial seawater desalination technologies (Table 3)

Technology	Features
Multi-stage flash evaporation (MSF)	1. Feed water components (salinity) do not affect energy consumption per m3. 2. Product water of very low salinity, i.e. 5-25 ppm. 3. Mature technology, process stable and operation and maintenance expertise very high. 4. Large- capacity units up to 100,000 m3 /day may be built. (At present, up to 60,000 m3 /day). 5. Evaporation away from heat convection surface. 6. Simple technology.
Multi-effect evaporation (ME)	1. Feed water components (salinity) do not affect energy consumption per m3. 2. Product water of very low salinity, i.e. 5-25 ppm. 3. Mature technology, process stable and operation and maintenance expertise very high. 4. Low-level maximum temperature leads to: I. Lower sedimentation and corrosion rate. II. Higher availability and reliability and III. Use of cheap materials.
Vapor compression (VC)	1. Needs only electric power (MVC). 2. Product water of very low salinity, i.e. 5-25 ppm. 3. Needs no cooling water and therefore can be built away fro a major water source. 4. Most simple and efficient technology. 5. Low-level maximum temperature leads to: I. Lower sedimentation and corrosion rate. Higher availability and reliability and II. Use of cheap materials.
Reverse osmosis (RO)	

Table 3-1

Desalination technologies and quantities produced for various activities and sectors in Egypt

Activity/sector	Technology used	Total (M3/day)	Purpose
1- Tourism	Reverse osmosis	30,000	Supply tourist village with fresh water.
2- Oil & petrochemicals	Reverse osmosis, electro dialysis, thermal plants, and ionic exchanger.	30,000	Supply personnel with fresh water Some other landscaping / agro/ industrial activities
Urban communities	Reverse osmosis	23,000	Supply personnel with fresh water.
4- Electricity	Multi-stage flash distillation, ionic exchanger, reverse osmosis	11,000	Supply steam boilers with pure water and supply personnel with fresh water.
5-Industry	Pre-treatment, ionic exchanger, reverse osmosis, vapor compression	2,000-5,000	Pharmaceutical, fertilizer, weaving, boilers industries and production processes.
6- Health and hospitals	Reverse osmosis	2,500	Highly pure water for kidney dialysis units

Tests conducted on product water sample from a desalination plant

Copy from p.66

Tourism Development Authority requirements for Potable Water

1. all tourist facilities related to potable water treatment shall be located as far as possible beyond the range of tourists' sight.
2. In the case of using reverse osmosis or condensation water desalination processes, residual brine solution shall be preferably disposed through beach wells or evaporation ponds far away from the beach. Brine solution may be discharged into the sea, provided that disposal drains shall be buried under seabed sands and solutions shall be disposed from vertical extensions at least 100 away from the coral reef area into water no less than 15-m deep.
3. Desalinated water shall be obtained preferably from subterranean sources or from beach wells. Seawater may be used, provided that intake pipes (excluding inlet) shall be buried under seabed sands, in a coral-reef-free area.

In the case of feeding tourist facilities from a prive source, such water shall satisfy the following requirements:

I- Chemical parameters

- PH : 7.0 – 8.50
- Color (tone): no more than
- Taste: no more than
- Odor: inoffensive
- Turbidity (JTU): not more than 5.0
- TDS: not more than 500 ppm
- Total hardness: not more than 100 ppm
- Calcium: not more than 75 ppm
- Magnesium: not more than 50 ppm
- Chloride: not more than 200 ppm
- Sulphate: not more than 200 ppm
- Iron : not more than 0.10 ppm
- Manganese: not more than 0.05 ppm
- Copper: not more than 0.05 ppm
- Zinc: not more than 5.0 ppm
- Phenol: not more than o.oo1 ppm

II- Biological parameters

⇒ **Chlorinated and treated water**

1. 90 percent of samples (100 ml) taken over one year should not contain any colonic bacteria.
2. No sample should contain E.Coli.

3. No sample should contain more tha 10 colonic bacteria.
4. No colonic bacteria should be present in two consecutive samples.

⇒ **Non-treated subterranean water**

- The probable number of colonic bacteria in any sample should not exceed 5/100 ml.

Construction Stage Requirements

1. Storage areas and site staff offices and accommodation shall be decided subject to Tourist Development Authority's approval, provided that these site should be provided with appropriate non-polluting sanitation facilities.
2. Various construction debris and site staff waste shall be disposed of to the designated areas, thus causing no environmental pollution.
3. Investor shall be liable for compliance by his staff working on the site of his tourist facilities with environmental protection requirements referred to above.

Operation Stage Requirements

1. Every investor shall be liable for compliance by his staff working on and visitors to his tourist facilities with environmental protection requirements referred to above
2. Every investor shall be responsible for keeping clean his tourist facilities together with the surrounding grounds, including the beach. He shall be providing measures necessary to manage waste resulting from various tourist activities in accordance with requirements referred to above.
3. It is forbidden to kill, damage or collect coral reefs, snails or fish in the project area.
4. It is forbidden to anchor boats into coral reefs.
5. It is forbidden to dump garbage or any other waste into the sea.

Treatment Plant Analysis

Parameters	Units	R.W Inlet		Sedimentation Water		Filtration Water		Notes
		St. limit	Sample	St. limit	Sample	St. limit	Sample	
pH	-							
Total Dissolved Solids(TDS)	mg/lit							
Free Chlorine	mg/lit							
Turbidity	NTU							
Dissolved Oxygen(DO)	mg/lit							
Biochemical Oxygen (BOD-5)	mg/lit							
E-Coli	No./ lit							

(3-6)

Environmental Monitoring Guidelines for Water Treatment plants

INTRODUCTION

Desalination /desalting is the common name for removing salinity from seawater. Under this common name, there come all desalination methods, including separating fresh water from salt water through evaporation then condensation. This process is called distillation.

Technologies used in desalination

The following are of desalination methods, which are generally divided into the:

a- Thermal method (distillation) such as
- Multi Stage Flash (MSF)
- Multi Effect Desalination (ME or MED)
- Vapor Compression (VC)

b- Membrane Method such as:
- Reverse Osmosis (RO)
- Electro dialysis (Reverse) (ED or EDR)

NOTE

How Is Industrial Waste treated?

Liquid waste treatment methods are generally divided into three types:

⇒ Natural (gravitation) treatment, such as screening, sedimentation and filtration methods, which naturally takes precedence over other methods,

⇒ Chemical treatment, i.e. by adding chemicals during sedimentation, absorption and purification operations and

⇒ Biological treatment, i.e. biologically removing organic material, by transforming them into gaseous or solid materials, which can eliminate through sedimentation or filtration.

Industrial waste components may differ depending on several factors including the following:

- ☒ Type of industry;
- ☒ Processing stages where water is used water discharge rate,
- ☒ Chemicals used in manufacturing stages, and
- ☒ Technical and human standard of manpower employed in industry.

Usually certain industrial waste is more concentrated than wastewater, in terms of organic, suspended and dissolved substances. Industrial waste also contains toxic materials, which

are allowed to be discharged to sanitary drainage networks only under specific conditions.

The treatment process depends on several factors including:

- Liquid waste discharge rate,
- Properties of waste and how far they comply with laws,
- Chemical requirements, environmental compliance, energy requirements and future costs,
- Operation and maintenance requirements including manpower, etc.

In petroleum companies, for example, the Law on Environment recommends that the quantity of petroleum materials suspended in waste water should not be more than 10 ppp. Therefore, we use basins to separate oil and petroleum materials suspended in water (which are collected from all disposal units of the company). In these separation basins several screens are used to retain large-scale lumps in the course of the water flow in the separation basins. Oil skimmers are used to skim the oil layer floating on top of the water to be treated. This layer will be disposed later on. After the water has passed through the oil separation basins it will be stored in larger basins for sedimentation of suspended granules before disposal into the company outlet. The following table shows the standards specified by the Egyptian Ministry of Environment for liquid industrial waste allowed to be disposed to sanitary drainage networks.

Desalinations Methods :

1- Vapor compression desalination

Vapor compression desalination method is used for relatively small and medium size water production units (up to 5000 m3/day). This technology was used in Europe since 1910 and in Japan since 1920. In this technology the temperature of compressed vapor is used in the final stages as a source of heat instead of using outside vapor (from boilers).

Figure 4.22 shows a model single-stage (effect) desalination unit, where sea water (supply) reaches point1 to the steam room after being heated in a heat exchanger (preheater), making use of the product water (PW) heat and sometimes of the heat of the brine blow down. Suppose vapor production was started (using an external preheater), the vapor produced from the unit at point2 will be compressed until it reaches higher temperature at point3, so that the hot vapor will be the ource of heat necessary to evaporate another part of feed water. The compressed hot vapor moves around the salt water pipes at point4, so the vapor around the pipes will condensate. The condensed heat will be used to boil salt water inside the pipes and to produce another quantity of vapor, which will in turn compressed, thus the cycle will

turn on. The condensed water leaves the unit as a product water running past the preheated and loses part of it is heat to the supply salt water entering into the unit. To maintain salinity ratio within the space of salt water, a quantity of this water will be blown down (as it runs past the preheater it will give it some heat.) figure (4.23 and 4.24) shows other models of commercial unit using vapor compression technology.

How vapor is compressed?

There are two methods for vapor compression:
Mechanical vapor compression (MVC) and Thermal vapor compression (TVC).

a. Mechanical vapor compression

Under this method an electric-powered mechanical compressor is used to compress vapor. The electric power of the compressor engine is the only source of energy to drive the unit. Figure 4.22 to 4.24 show this type of units. The compressor can be also used for rarefication inside the steam (evaporation) room and for suction of gases from the unit.

b. Thermal vapor compression

Under this method external driving steam flow is used (at a relatively high pressure) through an ejector to cause rarefication inside the room and to suck vapor produced from the room through a suction pipe and to compress and blow it out through a nozzle together with the external steam. Figure 4.25 shows a model ejector by suction of vapor produced together with gases it causes the rarefication.
Figures 4.26 and 4.27 show two models of real mechanical and thermal vapor compression units, while figure 4.28 shows a model of a thermal vapor compression unit operating at a capacity of 2500m^3/m.

2.Desalination by Reverse Osmosis

What does reverse osmosis means?

Membranes play an important role in salt separation. This process has its applications in the body of human, animal, and plant. Most processes of food element absorption in living cells****in human, animal, and plant body benefit from the osmosis process. There is an interesting example of this process that the reader can make and see its results. He can make a cavity inside a potato, wherein he can put a quantity of dry edible salt. He will note that the cavity was filled with salt water. This means that the fresh water has moved through the potato membrane to the salt (i.e. from the place with lower salinity concentration to one with higher salinity concentration). This is the osmosis process. The reverse osmosis process is the reverse transition of fresh water from a solution with higher salinity concentration to one with lower salinity concentration a solution if both solutions are separated by a semi-permeable membrane that allows the

passage of one element exclusive of the other, i.e. it allows for example water but not salt to permeate and vice versa.

When did reverse osmosis process first emerge?

Although the reverse osmosis process was quite known to many more tha 100 years ago, the membrane water treatment technology is quite modern. The fist announcement of the use of reverse osmosis process was a patent in the same name for water softening by using Ferro cyanide membrane on porous porcelain fixtures. In 1952, cellulose acetate membranes were produced in the University of Florida to desalinate water by reverse osmosis. The poor rate of fresh water production was attributed to the thickness of the membrane then used. (That was about the time when electro-dialysis technology emerged.) During 1950s, membranes were developed to increase water passage rate and salt suction rate. During the 1960s some types of membranes such as spiral-wound or tubular membranes were produced, followed in the 1970 s by polyamide hollow –fine-fiber membranes. In the meantime, production of cellulose acetate membranes has stabilized. Up to the 1970s, membranes had been developed for use in desalting low-salinity water, while since the end of the 1970s they were developed for desalting high-salinity water.

How fresh water is is separated by reverse osmosis?

If we put some saline water on one side of a semi-permeable membrane and fresh water on the other side, naturally fresh water (with lower concentration) will permeate through to the saline water (with higher concentration), in order to cause osmotic equilibrium. This is called osmosis process. Thus fresh water will continue to permeate in this direction and the saline water column will rise higher as a result of the increase of the quantity of water in the solution as fresh water continues to flow (Figure 5-1). As the water column rises, pressure on the saline solution side rises and resistance to the permeability of fresh water so heightens that it totally prevents permeability of fresh water. At this level of pressure known as osmotic pressure, equilibrium occurs. Scientists later found out that this process could be reversed. In other words, if we apply to the saline solution higher pressure, frsh water will move from the saline solution (with higher concentration) in the opposite direction and will parmeate through to the side of fresh water (with lower concentration). This is caller reverse osmosis process, whereby fresh water is extracted from saline solution through semi-permeable membranes. This process requires no heating or change in form, but requires the saline solution be placed under a pressure higher than osmotic pressure. So that reverse osmosis process can be completed, (figure 5.1)

The value of osmotic pressure depends on several factors including salinity (concentration) ratio of saline water, quality of total dissolved solids (TDS) and temperature. Osmotic pressure for sodium chloride (edible salt), which represents 60 percent of saline water, ranges between 1-1.1pound/square inch (about 0.07bar) for each 100ppm TDS (or 1bar for

each 1430 ppm), (figure5.2). For example, well water with a salinity of 5000 ppm; osmotic pressure will be about 320psi(about 22 bar). However, it should be noted that the real pressure necessary for reverse osmosis process normally far exceeds these figures, due to the fact that the necessary pressures are added to the following:

1. Loss of necessary pressure for the flow of feed water through the membrane, pipe and valve assembly,
2. Increase in water salinity in the course of passage through membranes (from one to the other), as a result of extraction of fresh water,
3. Static pressure required to lift water to product water tanks, or discharge brine tanks and
4. Potential partial blockage of membranes over time as a result of sedimentation suspended matter, salts, organic components, etc.

In application, saline feed water is injected into a closed pressure vessel, where saline water is compressed and pushed through a number of membranes. When part of the fresh water passes through a membrane, the brine salinity gross higher. Hence the more saline part of the fees water is disposed. Failing such disposal, the steady increase in the feed water salinity will cause many problems such as increasing sedimentation, raising pressure across membranes (as osmotic pressure raises with the increase of salinity). The amount of water so disposed ranges from 20-70 percent of feed water, depending on the amount of salts in feed water. This solution is called reject. In the meantime the fresh water permeating through the membranes is called the permeate or product water,(figure 5.3).

Such technologies need thorough preliminary treatment processes of feed water (to remove suspended matter such as clay, sand, etc.), to remove, exterminate and separate aquatic micro organisms (fungi, bacteria and algae), in order to protect the desalination unit against blockage and damage of membranes. Product water also need final treatment to adjust its properties so as to suit required properties by use (potable water, steam boiler water or for industrial, food and medical uses). Accordingly, a desalination plant comprises three basic systems: preliminary treatment, fresh water separation (through membranes) and final treatment, (Figure 5.4).

Membranes: composition and functioning

Membranes are composed of a natural or synthetic semi-permeable material that allows water to pass excluding salts. Reverse osmosis membranes process are composed of special material (such as cellulose acetate or polyamide. They can be U- shaped hollow fine fibers or spiral-wound sheets. Membranes function on the basis of what is called ‘the theory of flow by selective absorption (capillary property). This means that the membrane is so constituted as to allow the absorption of water only(and rejection of salts). The ability of membrane to separate salts depends on diameter of pores through which the absorbed water passes. Pore diameter range from 1 to 15 Angstrom (i.e 1-15 $x10^{-9}$m.), which is much lower than micro filters, which screens microorganisms by filtration. Figures 5-6 and 5-7 show models of these membranes.

Compare reverse osmosis membranes

Membranes, the core component of reverse osmosis process, are composed of thin material about 0.04- 0.1 micron, fixed with porous materials bringing their thickness to about 0.01 mm. (Figure 5-8). They differ in terms of permeability to fresh water and expulsion of salts. Membranes can screen 90-99 per cent of non-organic materials and about 100 percent of organic materials (such as bacteria and viruses) and other (such as silica). Fresh water flows from the cavities of the molecular structure of the membrane material by diffusionpartial. Material like cellulose acetate and polyamide as bases for commercial membranes. Figure 5-1 shows difference between both materials in membranes.

What is the difference between reverse osmosis process and micro-filtration process?

Both reverse osmosis and micro-filtration processes are alike in that they separate water from its components. While micro-filtration process separates suspended substance only, ultra-filtration nano -filtration and reverse osmosis processes can separate dissolved substances. For this reason, reverse osmosis process is sometimes called hyper -filtration. Figure 5-1 shows difference between both materials in membranes. Figure 5-2 shows difference between filtration and reverse osmosis processes, while Figure 5-1shows properties of different filtration membranes, in comparison with reverse osmosis process

Table 1 Comparisons
Between membrane materials

Cellulose acetate	Polyamide
High rate of fresh water flow to space unit.	Low rate of water flow to space unit.
Used in hollow fine fibers and spiral-wound membranes, etc..	Used in hollow fine fibers and spiral-wound membranes, etc..
Have shorter life span than polyamide.	Have longer life span than cellulose acetate.
Excessive chlorine –resistant up to lowest ppm.	Chlorine- sensitive
Stable up to PH3.5 _ 6.5	Stable up to PH3-11.
Bacteria-sensitive.	Bacteria –resistant.
Potential- collapse – sensitive with temperature rise and instability of hydrogen number.	Potential- collapse – resistant with temperature rise and instability of hydrogen number.
Relatively cheaper	Relatively more expensive

Table 2 difference between
Micro-filtration and reverse osmosis process

Micro-filtration	Reverse osmosis
Osmotic pressure very low.	Osmotic pressure high depending on water salinity.
Salinity does not rise with filtration.	Salinity rises ad fresh water is separated in process.
Separates elements depending on size.	There are factors that cause saltd separation process.
Flow perpendicular to filter for element separation.	Saline solution flows parallel with membrane.
Filtration (even micro-filtration) needs low pressure (down to 5 bar).	Filtration needs high pressure to complete process (more than 10 times of micro-filtration.
Can remove only dissolved solids of medium molecular weight.	Can remove solids of small molecular weight.

Table 3
Properties of Reverse osmosis
Membranes compared to other types

Process	Membrane pore size	Pressure applied (psi)	Separable substances	Materials used in making membranes	Membrane shape
Micro-filtration (MF)	(50-200)°A	10-30	Residues,	Polysalfone, fluourocarbonates & glass carbon.	Tubular
Ultra-filtration (UF)	(10-100) °A	20-75	Proteins, high-molecular-weight-organic substances.	Cellulose / acrylic polysalfone / ceramics	Asymmetrical HFF membranes
Nano – filtration (NF)	(7-100) °A	50-150	Ca^{++}/Mg^{++} Diequivelant ions	Aromatic polyamides, polyvinyl alcholic derivatives	Flat sheet composites.
Reverse osmosis (RO)	(1-15) °A	150-300 LP 350-600 St.Br 800-1200 SW	All foregoing together with mono equivalent Ions	Cellulose acetate, CA, Aliph. Polyamides, aromatic polyamides, polysalfone, polyfuran	Asymmetrical flat, Flat composites, asymmetrical HFF

Also called membrane softening, as it is used at present as a substitute for chemical softening under 1000mg/ liter.
Water, while high - pressures membranes are used desalinate the saline sea water.

Final treatment is intended to maintain prosperities of water and prepare it to the required use specification. This treatment can cover removal of gases, and adjusting alkalinity by modifying pH.

Table 4 – Advantages and
Disadvantages of reverse osmosis technology

Advantages	Disadvantages
1- Operates at low temperature, thus reducing corrosion and sedimentation.	1- Electric consumption rate: 4 (well water)/ 8 (sea water) kwh/ m3.
2- Water produced by seawater desalination has a salinity of 300- 500, suitable to drinking water.	2- Preliminary price per unit: $800 –2,400 (m3 /day.
3- Elasticity of unit capacities from a few liters to tens of thousands cubic meter/ day.	3- Water production price: & 0.75 –1.25/ m3 (depending on salinity and unit capacity.
4- Needs only electric power.	4- Percentage of global water production: 36 per cent for units larger than 100 m3/day. 35 per cent for units larger than 5,000 m3/day.

Therefore, adding some salts to the distilled water will check the strong corrosive ability of water. These additives include sodium chloride and calcium carbonates etc. The latter is one of the most anti-corrosive materials used in product water. In this case,

Monitoring a desalinating plant effluent

Two key parameters are used to monitor a desalinating plant effluent, these parameters are temperature and salinity, however, and they should be measured on a monthly basis both at 5m and 10 from the effluent terminal. The temperature can be measured simply by the thermometer while the salinity can be measured by the salinometer. A data sheet like that can be obtained:

Temperature and salinity at the effluent terminal during the year…

	Temperature		**Salinity**	
Jan.	**5m nearshore**	**10m nearshore**	**5m nearshore**	**10m nearshore**
Feb				
Mar.				
Apr.				
May				
Jun.				
Jul				
Aug.				
Sep.				
Oct.				
Nov.				
Dec.				

(3-7)

Environmental Monitoring Guidelines for Electric Power Generating Stations

Table of Content

1. Description of Activity

The Tourism Development Authority (TDA), of the Egyptian Ministry of Tourism, seeks to develop environmental monitoring guidelines for electric power generating stations as found along the Red Sea development area. The objective of this guideline is to provide both the TDA and its investors with a set of indicators, measurements or observational techniques and monitoring schedule to help insure the safe and environmentally responsible operation of activities related to electric power generating stations.

This environmental monitoring guideline is developed using standard practices and internationally accepted norms. It is designed to be used by TDA and Investor personnel. The guidelines shall emphasize simple effective indicators for identifying potential environmental problems associated with electric power generating stations. A monitoring matrix is developed to be used as the basis for conducting monitoring activities. A rapid assessment of likely environmental impacts associated with electric power generating stations shall be modified to reflect the realities encountered along the Red Sea development area recognizing the unique climatic, physical, and biological features of the area. This guideline will cover the two discrete life cycle elements, namely construction phase and operation phase (including maintenance).

This document includes: -

1. The identification of potential environmental interactions associated with electric power generating stations. These interactions are used as a basis for the identification of potential negative environmental consequences resulting from activities associated with electric power generating stations. Additionally, potential environmental problem areas from fuel storage and handling, noise, excessive exhaust emissions, lubricant management and disposal.

2. The identification of indicators and the development of monitoring protocols to evaluate these indicators. Using the consequences identified to identify and enumerate a series of indicators, which can be used to assess the effects of these activities. This information will be used by TDA in the development of their environmental monitoring program.

1.1 General Description, Operation and Typical Setting

The diesel engine is the most efficient prime mover commonly available today. Diesel engines generate electricity more economically than any other device in their size range. But the diesel is one of the largest contributors to environmental pollution problems worldwide.

Monitoring definition: it is a combination of observations and measurements for the performance of a plan, programmer or measure, and its compliance with environmental policy and legislation. Other definition is, the provision of the necessary information about progress of implementation of a project, plan, etc. in order to ensure that project management and cooperation partners are able to follow the implementation of the projects and if necessary adjust activities, inputs and budgets, in order to obtain the objectives laid down for the project.

It is obvious that electricity plays a crucial role in the operation of hotels and resorts. In a great portion of the red sea area utility grid is not available, so hotels and resorts generate their electricity demand by their own electric power generation stations.

In these document small-scale electric power stations, reciprocating engines will be only considered. Large and medium electric power stations (steam turbine, gas turbine and combined cycle based electric power stations) are out of scope of this document.

1.2 General Design Features

The proposed monitoring system shall emphasize the use of low technology monitoring techniques. Preferred chemical analytical techniques are those, which can be obtained from simple and direct reading devices. If a chemical analysis is required, the technique chosen shall be sufficient to produce reliable data without over specification of technique or necessary level or precision.

A baseline data form describing the operational facility is developed. This includes number of generators, rated output, operational requirements, and any pertinent manufacturer's performance standards (e.g. noise ratings, emission ratings etc.), employees, required certifications, maintenance cycles and other facility data to be used as the facility baseline.

1.3 Interactions with Other System

The proposed monitoring system should be integrated with other environmental systems. In addition, it will be used to complete plant environmental resister, stated by environmental law # 4, 1994. Also, it could be used as an input tool for an energy management system.

1.4 Principal Environmental Concerns

The environmental impacts of electric power generation stations are highly dependant on design, mode of operation and site conditions. The following are possible environmental concerns related to electric power generation activity:-

1. Air quality;
2. Liquid waste and sewage;
3. Soils and geology;
4. Visual pollution;
5. Noise and vibration;
6. Traffic;
7. Historic and cultural legacy;
8. Socio-economic;
9. Solid wastes; and
10. Public health and safety.

1.5 Key Environmental Effects and Interactions

The following sub-section presents a brief description for these environmental concerns.

1.5.1 Air quality

The emission of dust from construction activities is dramatically variable. It is highly depend on the type of activity, ground state and nature and wind speed and direction. However, the following air pollutants emissions will result during construction activities: -

- Emissions of dust during construction activities; and
- Emissions from the exhaust of vehicles serving the construction activities of generation station.

The potential for dust to be emitted during the construction phase is strongly dependent of the type of construction activities taking place, hot and dry weather during the construction period, the wind speed and wind carry emitted particles towards potentially sensitive receptors.

The types of construction activities that could generate dust are: -

1. On-site earth moving activities, this includes excavation and removing superficial deposits of sands;
2. Site stripping;
3. Construction vehicle movements;
4. Blow-off and spillage from vehicles during import of construction materials and any export of surplus material from the site

In addition to dust from contraction activities, indirect transport of particles, due vehicles accessing the site and involved in the removal of soil, may lead to increased dust emissions. This is dependent on several factors including: -

- Number of vehicles accessing the site;
- Cleanliness of on-site roads and/or routes;
- Cleanliness of vehicles; and
- Weather conditions.

On the other hand, during the operation of generation station the following air pollutants emissions will result:-

- Stack emissions;
- Fugitive emissions from fuel storage tanks; and
- Emissions from the exhaust of vehicles serving the operation of generation station, mainly fuel tracks.

1.5.2 Liquid waste and sewage

During the operation of the electric power station three water systems, which will be supplied by either local supplier or utility, exist these are: -

- Cooling water system;
- Fire fighting water system, mainly this will be supplied from fire fighting water storage tank; and
- Potable water system.

The cooling water is supplied from water treatment plant and the purposes of the treatment are to prevent: -

1. Furring of heat exchanger surface due to mineral content of water;
2. Corrosion of metals due to dissolved oxygen and carbon dioxide;
3. Cavitations due to boiling point and pump impeller pressure drop; and
4. Freezing if coolant is exposed to frost.

During construction period, a temporary drainage system should be installed to collect and store the site drainage. Also, temporary storage tanks or containers for fuels and other liquid necessary for construction activities should be installed.

Sanitary wastewater (sewage and washing water) generated by site workers should be taken into consideration. This wastewater should be disposed by:

- Tank sanitary system to dispose wastewater off-sit; or
- Use nearest local sewer system.

1.5.3 Soils and geology

Construction activities, which affect the soil, are: -

- Site preparation;
- Top soil removal;
- Excavation for foundations;
- Install temporary drainage system;
- Excavation of trenches, water pipes, fuel pipes, power cables, etc.

Regarding ground contamination, during the construction period, there are a number of contamination sources, these are:-

- Fuel tank;
- Lubricating oil;
- Other fluids (coolant, … etc); and
- Sanitary effluents and detergents.

During operation the following contaminating substance has to be on the site:-

- Fuel oil (Solar or Mazout);
- Lubricating oil; and
- Other fluids (coolant, etc).

These substances must be stored in special storage tanks.

1.5.4 Visual pollution

During construction period, the powerhouse and its ability to accommodate future expansion or changes should be considered. Visual relationship between the site and its setting during construction and operation should be noticed.

The electric power station should be a matched structure with the surrounding environment to avoid visual impact.

1.5.5 Noise and vibration

Noise and vibration during construction and operation activities on the main site should be assessed. The main major sources for noise and vibrations are: -

1. Vehicles serving the construction activities of generation station;
2. Fuel trucks (during construction and operation); and
3. Engine running (during construction and operation).

Regarding the noise created from the operation of the generation station, mainly the noise comes from the vibrations created by the generating set and associated connected equipment. In addition, another source of noise is airborne noise, which comes from the generating set in particular at the high end of the frequency range.

1.5.6 Traffic

The impact of generated traffic during the construction and operation of the electric power station is the difference between baseline traffic flows and the traffic flow during the construction or operation of the power plant. Source of traffic are:-

- Vehicles serving the construction activities of generation station; and
- Fuel trucks (during construction and operation)

1.5.7 Historic and cultural legacy

Construction activities may have impact on historic and cultural legacy. So, enough information should be available to justify the impact of these activities. However, once the electric generation plant under operation there will not be any impact.

1.5.8 Socio-economic

The following are the possible socio-economic effects of the electric generation station, which have to be investigated: -

- Employment;
- Spin-off benefits to the local economy; and
- Demand for local services.

Obviously, electric power generation station creates new jobs. It should be mentioned that during the construction period, encouragement of employment from the local labor force whenever the skills are available and competitive.

1.5.9 Solid wastes

The main sources of solid waste, which will be accumulated during construction and operation, are: -

- Construction Soil; and
    - General wastes and residues from construction activities and the use of machinery, for instance, packaging damaged building materials, etc

- Operation
    - Sludge from fuel and lubrication oil separators;
    - Coolant waste.
    - Packaging waste from operational consumable supplies;
    - Commercial waste from the canteen and staff facilities.

1.5.10 Public health and safety

The most important environmental aspects concerning public health is air pollution and noise.

As the electric power generation station will be within the utility area. Therefore, there will be no significant risk to the surrounding environment.

Grounding

The generating set and all associated equipment, control and switchgear panels must be earthed before the set is put into operation. Grounding decreases hazard to human life. Other benefits of grounding are out of scope of this document.

However, grounding system for the gen-set and for fuel tank should be installed for the purpose of workers safety. Also, Fire alarm and fighting system should be installed to avoid any personnel risk.

Fire protection

Diesel fuel can be stored safely above ground in suitable containers. Whilst the flash point is high it is inflammable and suitable fire fighting equipment should be provided.

Provision of fire fighting system should be made in the initial design of the plant room. The storage area should be adjacent to an access door, if possible.

Foam or CO2 should be used for fuel and lubrication oil fire. Also, sand can be used for minor and isolated fires. Under no circumstances should water be used to control a fire in the plant room.

1.6 Hazardous Materials used in Operation

Engine fuel and lubrication oil are considered as hazardous material. Therefore, care should be taken in handling, storage and using these materials.

Water treatment: the engine cooling system is subject to rust and cavitations attacks. To minimize the severity of this condition an anti-corrosive agent can be added to totally clean and limpid coolant water. An antifreeze solution is also required to prevent freezing of the coolant in cold weather. However, the cooling system of a diesel engine is closed cycle. So there is no risk from the cooling water of the engine.

1.6.1 Inventory and Usage

Number of fuel trucks incoming to site and amount of lubrication oil containers purchased should be recorded on daily bases. Also, for fuel usage and lubrication oil usage has to be known. Fuel tank could be scaled; width and length of the tank are known, to calculate how much fuel used every day, week or month. For lubrication oil, it is replaced or added according to time schedule, normally based on number of operating hours.

1.6.2 Storage

Dependent upon the specific site layout, the fuel can be supplied to the engine either from: -

- An intermediate daily tank service tank located within the plant room or generator enclosure, which is automatically refilled from a bulk storage tank; or
- Directly from the bulk storage tank.

It should be noted that fuel tank should be installed in a bund to suit 110% of the contents of the fuel tank.

Lubrication oil containers must be stored away from any heat source.

1.6.3 Disposals

Used lubrication oil should be handled and stored by authorized person. It should be collected in one or many containers and then transported out side the site to a place where it is recycled or treated. It is forbidden to set out into desert or seawater.

2. Indicators and Measures of Effects

2.1 Description of Indicators of Environmental Effects

Mainly two environmental aspects will be measured and monitored as they considered being most effect and simple to measure. These are: -

- Air pollutants,
- Noise

Other environmental effect will be considered in other environmental systems, as wastewater treatment plant, and solid waste managements.

2.1.1 Construction

Air polluants:-

A quantities assessment of construction dust impacts is only applied when significant quantities of earth moving over extended periods or if the material to be moved is suspected to be contaminated.

At wind speed above 3 m/sec, dust particles may be carried by the wind to another location. Particles greater than 100 μ m are most probable to settle within about 100 m of the initial source. Fine dust particles, less than 10 μ m are most likely to slow down by atmospheric turbulence and to be transported further off-site. In strong wind conditions some of these particles could be transported to a distance of about 500 m. Of course rainfall does effect dust particles emission and distance to be settled.

Regarding other air pollutants emissions form the engine exhaust smoke, NO_x, SO_x, suspended particles and CO are to be monitored. This could be through measurements of pollutants concentration at the exhaust pipe or ambient air. The second option is very expensive to measure.

Noise

Noise due to construction and operation will be monitored through noise measurements in different location.

2.1.2 Operation

Ditto as construction phase.

2.2 Observations and Measurement Techniques

The proposed system will be designed to be simple and easy to upgrade and integrated with other monitoring systems. However, there are some measurements as well as observations should be taken periodically during both construction and operation phases.

2.2.1 Construction

Dust

During construction phase care should be directed to dust creation from construction activities. It is very expensive to measure dust as air quality parameter; therefore, this will be evaluated based on TDA personal experiences.

Air quality

Air pollutants can be measured as a concentration in the diesel engine exhaust (by engine gas analyzer) or ground level (air quality). Measuring the pollutants concentration is much cheaper than measuring the ground level air pollutants. In addition, some observations or the exhaust color can lead to discover that there is a problem; this will be explained in the next subsection.

Noise

Simple noise meter can be used to measure noise level at different location.

Fuel spillage

Fuel tank and piping should be observed regularly to find out if there is any leakage. Maintenance staff will handle fixing this problem.

2.2.2 Operation

Ditto as construction phase, but dust creation will be very minor and has very minor effect.

2.3 Interpretation of Results

It is very important to know the Egyptian environmental pollutants limits, according to law #4, 1994, to be able to interpret the observation and measurements.

Air pollution

Emission standards and World Bank guidelines require the developer to ensure that the emission levels during construction and operation do not exceed set maximum limits for pollutants concentration.

Table 1 shows maximum atmospheric emission according to law #4, 1994 and World Bank guidelines. (Exhaust pipe shall be 2.5 times the surrounding buildings height). Table 2 presents ambient air quality guideline.

Table 1 maximum atmospheric emission (mg/Nm3)

Pollutants	Egyptian standards	WB guideline	World bank guideline for engine driven power plants (less than 50MW)
Nitrogen dioxide	300	320	2300 (NO x)
Suspended particulate	500		
Sulfur dioxide			
Existing	4000		
New	2500	2000	2000
Carbon monoxide			
Existing	4000		
New	2500		

Table 2: Ambient Air Quality Guideline

Pollutants	Average Period	Egyptian Standards	WB guideline
Nitrogen Dioxide	1 hr 24 hr 1 year	400 150 --	No limit 150 100
Sulphur Dioxide	1 hr 24 hr 1 year	350 150 60	No limit 150 80
Carbon Monoxide	1 hr 8 hr	30,000 10,000	- -
Thoracic Particulate (PM10)	24 hr 1 year	70 -	150 50
Total suspended particles	24 hr 1 year	230 90	230 80

Liquid waste and sewage

Table 3 shows liquid effluent guidelines. Table 4 shows draining into local sewer network limits (law #48 for 1982). It should be noted that these parameters should be evaluated within the wastewater treatment plant-monitoring programmed.

Table 3: Liquid effluent guidelines (mg/liter)

Parameter	**Max limit (mg/liter)**
Temperature	Not more than 10 degrees over existing level
Ph	6-9
Color	Free of colored agents
Biochemical Oxygen demand	60
Chemical Oxygen Demand	100
Total Dissolved Solids	2000
Oil & grease	15
Chromium	1
Copper	1.5
Iron	1.5

Table 4 draining into local sewer network limits (law #48 for 1982)

Parameter	**Max limit (mg/liter)**
Temperature	Not more than 40C
Ph	6-10
Biochemical Oxygen demand	400 PPM
Chemical Oxygen Demand	700 PPM
Oil & grease	100 PPM

Noise

Table 5 shows the Egyptian ambient limits for different activities.

Table 5: Egyptian ambient limits for different activities

Receptor	Egyptian Standards (dB)		
	Day time[1]	Evening time[2]	Night time[3]
Industrial areas (heavy industry)	60-70	55-65	50-60
Commercial, administrative and downtown areas	55-65	50-60	45-55

[1] From 7 am to 6 pm
[2] From 6 pm to 10 pm
[3] From 10 pm to 7 am

Residential areas including some workshops or commercial business or public rods	50-60	45-55	40-50
Residential areas in the city	45-55	40-50	35-45
Residential suburbs having low traffic	40-50	35-45	30-40
Rural residential areas (hospitals & gardens)	35-45	30-40	25-35

2.3.1 Construction

Air polluants

1. Dust

Dust during the construction should be observed on regular bases to minimize its effect on other resorts and/or hotels as well as site workers.

2. Engine air pollutants

The primary pollutants from diesel engines are oxides of nitrogen (NOx), total organic compounds (hydrocarbons), carbon monoxide (CO), and particulates, which include visible emissions (smoke). Air pollutants can be evaluated in the concentration of pollutants in the engine exhaust or ground level. The measurement of the concentration of pollutants in the engine chimney is much easier and lower cost than the ground level measurements. The first needs engine gas analyzer and the second needs ambient air analyzer. The followings are the different air pollutants coming out from the engine chimney and their causes.

A.Nitrogen oxide

Nitrogen oxide formation is directly related to high pressures and temperatures during the combustion process and to the nitrogen content, if any, of the fuel.

B.Smoke & Particulate Matter

Liquid particulates appear as white smoke in the exhaust during an engine cold start, idling, or low load operation. They consist primarily of raw fuel with some partially burned hydrocarbons and lubricating oil. White smoke emissions are generally associated with older gasoline engines and are rarely seen in the exhaust from diesel or gas-fueled units. They cease when the engine reaches its normal operating temperature and can be minimized during low demand situations by proper idle adjustment.

Blue smoke is emitted when lubricating oil leaks. Proper maintenance is the most effective method of preventing these emissions. The primary constituent

of black smoke is agglomerated carbon particles (soot). These form in a two-step process in regions of the combustion mixture that are oxygen deficient. First the hydrocarbons decompose into acetylene and hydrogen in the high temperature regions of the cylinder. Then, when the local gas temperature drops as the piston moves down and the gases expand, the acetylene condenses and releases its hydrogen atoms. As a result, pure carbon particles are created. This mechanism of formation is associated with the low air/fuel ratio conditions that commonly exist at the core of the injected fuel spray, in the center of large individual fuel droplets, and in fuel layers along the walls. Designing the fuel injector to provide for an even distribution of fine fuel droplets such that they do not impinge on the cylinder walls can reduce the formation of particles from this source.

Once formed, the carbon will combine with oxygen to form CO and CO2 if it is still at an elevated temperature. Since the temperature of the exhaust system is too low for this oxidation to occur, soot exiting the combustion chamber before it has had the opportunity to oxidize completely will be discharged as visible particles.

C.Sulfur Oxides

Sulfur oxide emissions are a function of the sulfur content in the fuel, only, rather than of any combustion variables. In fact, during the combustion process essentially all the sulfur in the fuel is oxidized to SO2. The oxidation of SO2 gives sulfur trioxide (SO3), which reacts with water to give sulfuric acid (H2SO4), a contributor to acid precipitation. Sulfuric acid reacts with basic substances to give sulfates, which are fine particulates that contribute to PM-10 and visibility reduction. The reduction of SOx emissions would also minimize corrosion of the engine parts.

D.Carbon Dioxide

Concern about the increasing release of greenhouse gases such as CO2 has grown out of research that documents the buildup of gases in the atmosphere and estimates the implications of continued accumulations. Carbon dioxide is largely transparent to incoming solar radiation, but can absorb infrared radiation reemitted by the Earth.

3.Noise reduction methods:

Reduction of structure borne noise can be achieved by use of anti vibration mounts and flexible connections. Reduction of airborne noise can be achieved by the use of splitter attenuators, exhaust gas mufflers, acoustic wall and ceiling linings, acoustic inlet and outlet louvers, enclosure and drop over canopies.

In addition, the use of slow speed fans within a plant room or internally mounted heat exchanger with an external mounted low noise cooling tower would be advantages whilst locating them outside the plant room in acoustic housings.

Enclosures can be supplied for installing over a generating set within a plant room to isolate the rest of the building from noise.

Fuel leakage

To protect soil from pollutants, fuel leakage shall be observed regularly. It is very easy to fix and stop this leakage.

2.3.2 Operations

Ditto as construction.

3. Implementation of Monitoring Requirements

The form is designed to be easily transferred to a computer database system in the future using discrete variables and consistent data labels. The parameter for facility location shall be presented using Latitude, Longitude obtained from GPS and stored in decimal format (i.e. degrees with minutes and seconds appended in their decimal form).

3.1 Assignment or Responsibility

Monitoring of small-scale electric power generation plant has three main benefits for both TDA and the investor, they are: -

1. Help in establishing a comprehensive database of generation facilities in TDA concision area;
2. Prevent and or expect any environmental problem; and
3. Monitor the performance of the diesel engine gen-set, which can help in building preventive maintenance programme. Of course this will increase the availability and reliability for the generation plant, which will lead to minimum downtime for the gen-set.

The following sub sections summarize the responsibility of both TDA and the facility personal in applying the proposed monitoring programme.

3.1.1 TDA

TDA will be responsible for field monitoring and keeping records. Coordinator should be nominated by TDA to coordinate between TDA team and different facilities to be monitored. Measuring equipment needed to conduct field measurements shall be purchased by TDA. TDA shall issue a monthly report about its monitoring activities. This report shall include site location, name of

the facility, generation station power, type of fuel, major environmental aspects, etc. Also, it must include a brief description of any environmental events, for instance, exceeding one or more environmental limits of any environmental aspect.

3.1.2 Facility

Full cooperation is anticipated from facility owner and or management. Facility management should facilitate the field measurements and keeping its records available to TDA team. Any required technical assistance from facility personal should be available to TDA team, when required. Facility management must keep regular records as listed in table 11.

3.2 Specialized Expertise

Monitoring small-scale electric power generation facilities does not need a highly specialized expert. One-day training seminar is quite enough to train the responsible personals about different diesel gen-set components and possible environmental aspects which should be looked at.

3.2.1 Personal and Training required

TDA team should be trained to conduct monitoring for gen-set. Training must include a brief description of small-scale electric power generation plant components and different environmental aspect to look at. Training will be in-house and in field.

3.2.2 Specialized Equipment

A general specification for measuring equipment needed to complete monitoring matrix is presented in Appendix 1. Appendix 2 shows a technical catalogue of an engine gas analyzer.

3.3 Recommended Implementation Schedule

The following is the tentative time schedule for implementation of the monitoring programme:-

Task	Completion Date
Approve monitoring report	15 April 2003
Prepare and issue measuring instruments	15 April 2003
TDA training on implementing monitoring programme	9-10 May 2003
Receive measuring instruments offers	20 May 2003
Clarifications	1 June 2003

Bid evaluation	5 June 2003
Purchase order issuing	15 June 2003
Delivery of measuring equipment	15 July 2003
Training on measuring equipment	20 July 2003
Full implementation of monitoring programme	1 August 2003

4. Electric Generation station

This section presents schematic diagram of the electric generation facility, nameplate technical data sheet and input and output data log sheet for the generation station.

4.1 General schematic diagram

The following diagrams show general schematic diagrams for fuel system and general gen-set layout. The main purpose of these diagrams is to present for non-technical persons or persons who are not familiar with power generation the different system components.

4.1.1 Fuel system

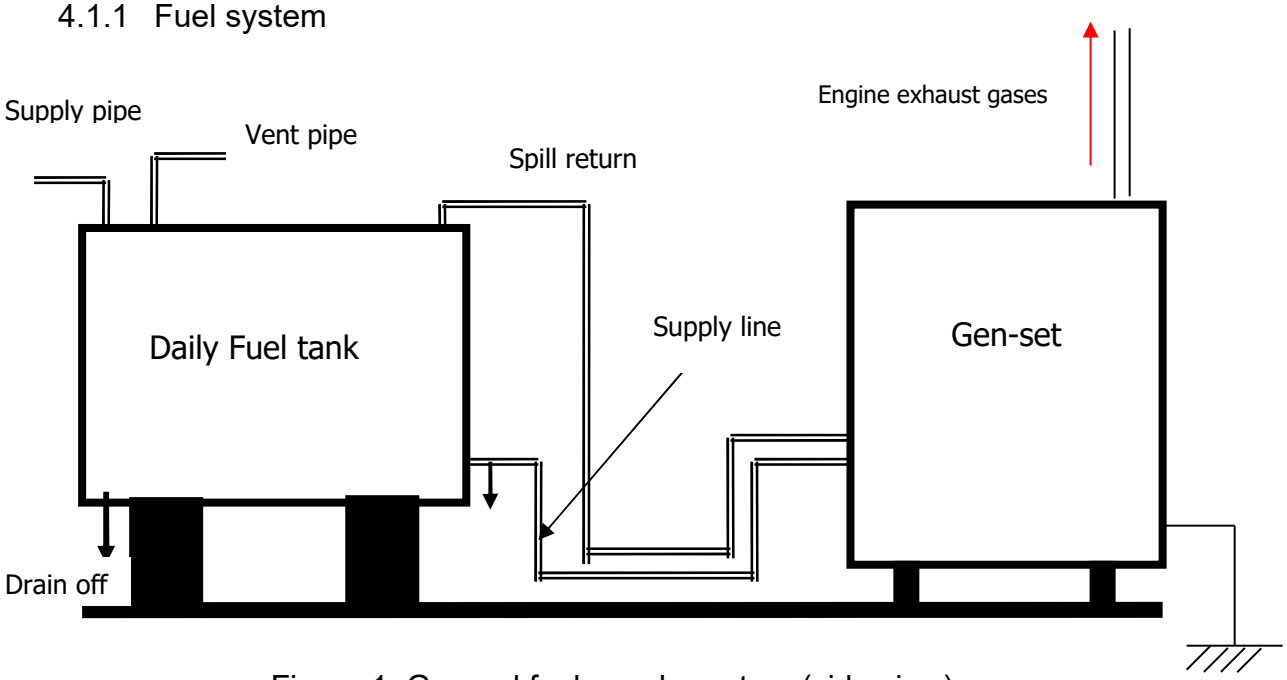


Figure 1: General fuel supply system (side view)

4.1.2 Gen-set layout

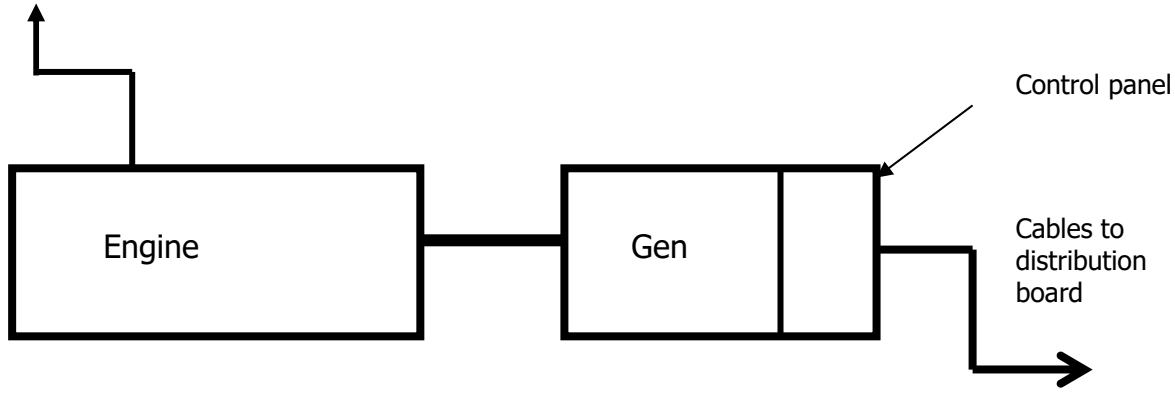


Figure 2: Gen-set general layout

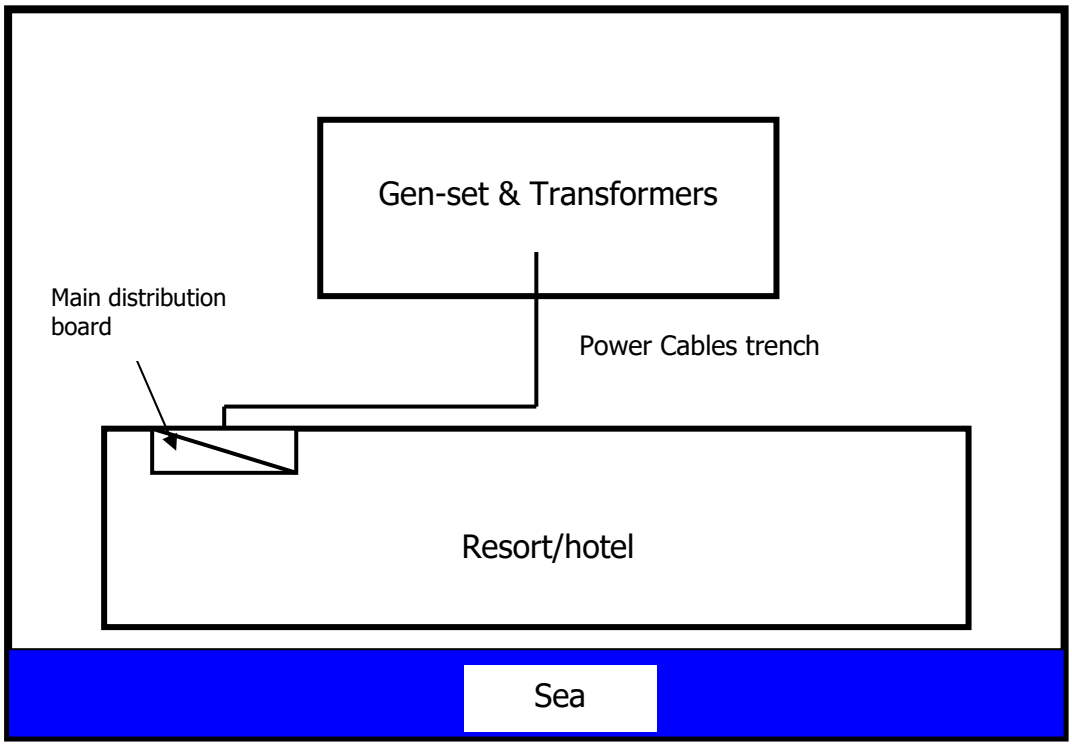


Figure 3: General Layout of the Resort/hotel

4.2 Engine cooling water

The primary purpose of any water treatment programmer is to protect the surfaces of all water passages from corrosion and any scaling or sludge deposits which will slow down the transfer of heat to or from the water. If the system is exposed to low ambient temperatures antifreeze protection is needed. In addition, capitation erosion protection is required for engine cooling systems. From the maintenance and operation point of view, it is essential to monitor the water condition carefully and continuously. Depend on the engine manufacturer recommendations, cooling water must meet the following specifications:-

Calcium (Ca)	Less than 1 ppm
Magnesium (Mg)	Less than 1 ppm
Total hardness (CaCo3)	Less than 1 ppm
Chloride	Less than 25 ppm
Sulfate	Less than 25 ppm

4.3 Gen-set technical data

Table 6: Gen-set data sheet

	Item	Description	Remarks
1	Fuel type		Solar
2	Engine make		1500, 1000, 750 RPM
3	Speed		
4	Prime/stand by		
5	Electrical output		KW or kVA
6	Fuel consumption @ 100% load		Liter/kWh (if available)
7	Lubrication oil capacity		liter
8	Exhaust flow rate		M3/hr
9	Exhaust temperature		C
10	Supply voltage & frequency		380 V, 11 kV, 50, 60 Hz
11	Engine make		
12	Set model		
13	Year of manufacturer		

4.3 Generation station log sheet

Table 7 presents essential data for diesel engine operation monitoring. It is very important that the surveyor should take maintenance schedule for gen-set. This will include oil change schedule, overhaul and routine maintenance. Table 8 shows oil and spare parts schedule.

Table 7: Diesel gen-set operational data

	Month	Operating hr	Fuel consumption (liter)[4]	Max power* (kW)	Energy consumption* (kWh)	Remarks (mention major maintenance, oil change, .. etc)
1	January					
2	February					
3	March					
4	April					
5	May					
6	June					
7	July					
8	August					
9	September					
10	October					
11	November					

* If available

[4] Daily fuel consumption can be calculated by (L*H*W)/*1000 = --- liter

Table 8: Diesel gen-set maintenance schedule

No of op. hrs	Lub. Oil	Spare parts	Overhaul	Remarks

5. Matrix of Effects, Indicators, Techniques, & Responsibilities

Table 9 summaries the effects, indicators techniques as well as the responsibilities of implementing the proposed monitoring programme. It is very important that the success of implementing this programme is highly dependent on the transparence and full cooperation between TDA and investor.

Table 9: Monitoring Matrix

Anticipated Environmental Effect	**Life Cycle Phase (Construction /Operation)**	**Indicator**	**Measure of Effect**	**Measurement or Observation Technique**	**Responsible Entity**	**Sample Period**	**Record Keeping Requirement**
Creation of Dust	Construction	Visual signs of huge amount of dust and/or complains for surrounding resorts/hotels	Observe the construction activities and ask mangers of surrounding resorts/hotels	Schedule dust-creation construction activities to reduce the intensity of the dust creation	TDA/investor	During Soil moving activities: daily Building activities: weekly Then: monthly	TDA maintains records for events and remedies taken
Noise	Construction/ Operation	Hearing high level of noise	Measurements of noise level	Compare the measurements with the Egyptian standards or other if not available	TDA	Construction During Soil moving activities: daily Then: monthly Operation phase: monthly	TDA maintain measurements record

Anticipated Environmental Effect	Life Cycle Phase (Construction /Operation)	Indicator	Measure of Effect	Measurement or Observation Technique	Responsible Entity	Sample Period	Record Keeping Requirement
Contamination of soil with fuel or petroleum products	Operation/ Construction	Visual signs of spills and leaks	Observe the location and intensity of spills associated with generator fuel tank and supplying systems	Trained observer notes current conditions compared to typical unpolluted systems and compares observations with previous inspections	TDA and Investor	Investor - Daily TDA – Weekly	Investor maintains record of observations TDA Records weekly observations and verifies investor records
Air pollution	Construction/ Operation	Visual smoke	Measure air emission concentration	Compare these measurements with the Egyptian standards	TDA	Monthly	TDA maintain records of measurements and events of exceeding limits
Solid waste	Construction/ Operation	Visual inspection	Observe how plant staff manage oil containers, used spare parts, … etc	Make sure that it comply with other environmental systems	TDA/investor	Monthly	TDA/investor maintain prouder of solid waste managements

Environmental Monitoring Guidelines for Electric Power Generating Stations

Monitoring Forms

Monitoring notes

The following are some important notes that must be taken into consideration in conducting field survey: -

1. Lubrication oil:- engine lub oil is made up and replaced according to the operating hours. Surveyor should know how the operator manages used lub oil. It must be handled through oi/fuel supplier or company.
2. Fuel leakages: - Care should be directed to fuel storage tank, daily tank and main tank. Also fuel-piping system to the gen-set should be visually inspected. Any leakage or spillage must be reported and action must be taken by the operator to stop any leakages or spillage.
3. Cooling water: - Cooling water is expensive water. Many inhibitors are added to have a better heat transfer to the cooling water. It is not common to replace cooling water; however, make up may be occurred.
4. Grounding system: - surveyor must inspect visually the ground system. Which simply consists of driven rod in the earth and it is connected to gen-set body. Main distribution switchboard also must be grounded.
5. Solid waste: - solid wastes are plastic, carton and wooden containers for lub oil, spare parts and other materials necessary for operation of gen-set. It should be handled in accordance with solid waste management system of the hotel.
6. Fire fighting system: - it should be installed in gen-set room. A brief description of this system should be noted.

Monitoring Reporting Form TDA

Facility Name		Facility Coordinates (decimal degrees)	
Date of Inspection		Latitude	Longitude
Inspector			
Life Cycle Phase (construction/operation)			
Inspection Parameter	**Finding**	**Limits (mg/m3)**	**Notes**
Dust			
Noise			
Air pollutants			
Nox		300	
Sox		4000	
CO		4000	
Fuel spillage		NA	
Grounding system		NA	
Lub oil handling		NA	
Fire fighting system		NA	
Solid waste		NA	

General Observations
Noted Deficiencies
Follow-up Recommendation and time schedule

Facility Monitoring Reporting Form

Facility Name		Facility Coordinates (decimal degrees)	
Date of Inspection		Latitude	Longitude
Inspector			
Life Cycle Phase (construction/operation)			
Inspection Parameter	**Finding**	**Limit**	**Notes**
Dust complains		NA	
Noise complains		NA	
Fuel spillage		NA	
Soils waste		NA	
Fire fighting system		NA	
Solid waste		NA	
Lub oil		NA	

General Observations
Problems Identified
Corrective Action Taken

Sample format for Excel sheet monitoring results

Site: ----------
Location: ----------
Contact person: ----------
Tel/Fax, E mail: - ----------

#	Date & time	Air pollutants				Dust	Noise	Solid waste	Fuel Spillage	Remarks
		NOx	SOx	CO	Other					

(3-8)

Environmental Monitoring Guidelines for Waste Disposal Sites

Table of Contents

3.8.3 Implementation of Monitoring Requirements

3.8.3.1 Assignment or Responsibility

a)TDA

b) Private Sector

3.8.3.2 Specialized Expertise

a) Personal and Training required

b) Specialized Equipment

3.8.3.3 Recommended Implementation Schedule

Matrix of Effects, Indicators, Techniques, and Responsibilities (Appendix A)

Monitoring Forms (Appendix B)

3.8.1 Description of Activity

3.8.1.1 General Description, Operation and Typical Setting

The problem of solid waste disposal has been aggravating everywhere in the Red Sea. Its negative manifestations on public health, environment and national economy are being quite apparent and acute. The currently operating waste disposal sites are very poorly managed and the need for controlled solid waste disposal sites is increasing in the region.

Controlled disposal site should be properly selected to minimize its negative impacts on the environment. For example, wetlands and areas of flooding potential are unsuitable for this use. The groundwater level should be deep enough from waste liquid (leach ate). Moreover, disposal sites should not be in the neighborhood of drinking water wells, urban areas, airports, or sensitive protected areas.

In the Red Sea region, controlled disposal sites are not required to be state-of –the –art for engineered sanitary landfills, but represent the minimum standards for waste disposal sites in an arid environment.

The operation procedures inside a controlled disposal site starts with dumping incoming waste at the disposal pit (filling area). Dumped waste shall exclude any medical waste, liquid waste or recyclables like plastic bottles, aluminum cans and glass bottles. Only hotel waste (include landscape waste), construction waste and sludge shall be accepted in the disposal site and must be dumped separately. Any mixture of the three waste types shall not be accepted at the disposal site.

The filling fundamental concept is that incoming waste is deposited in a specific area in the filling area, spread, and compacted and covered at the end of reach working day with a thin layer of soil.

3.8.1.2 General Design Features

The proposed general design features of controlled disposal sites in the Red Sea include:

Disposal Pit (Filling Area). This is an excavated area designated for filling operations. The excavation depth considers the groundwater depth. The bottom of the pit must be designed to minimize percolation of liquid from the waste "leachate" down toward groundwater. A soil liner should be constructed from low permeability soils compacted to a thickness of at least 30cm. The soil liner should be then covered with at least with another 30 cm of drainage material to ensure its integrity during operation.

Fence. Two types of fencing shall be used at the disposal site. Movable fencing should be placed directly downwind from the filling part in use and this can be adjusted daily. Permanent fencing should be at least placed along the downwind perimeter of the whole filling area and perpendicular to the prevailing wind direction, but it would be better to have permanent fencing all around the filling area.

Access Road. The access road must provide direct access to the disposal area and be designed to bear the weight of heavy trucks. A well-graded and constructed access road makes it easier for trucks to reach the disposal area and thus minimizes the chances of random dumping. Also a well-compacted access road will minimize the impact on air quality due to dust generation from truck movement.

Site Security. The entrance to the disposal site should be secured with a fence and gate to prevent uncontrolled dumping. Fencing should be placed strategically to prevent uncontrolled access by trucks and/or scavengers. It is also advisable that personnel be assigned to police the site regularly during off-hours.

Employee facilities. There should be facilities for employees working at the site including bathroom, drinking water, first aid and shelter.

Storm water drainage. The perimeter of the disposal area must be designed to divert precipitation and surface water from running onto the disposal area. All such water must be diverted away from the disposal area.

Visual buffer. When a controlled disposal area is sited within visual distance of public roads and buildings, a visual barrier should be constructed to hide the active disposal area.

Finally, it is important to mention that both leachate control and landfill gas are not included in the given design features for the following reasons:

1. These design features will add significant cost.
2. Leachate amount will probably be very little because of the high evaporation rate in the Red Sea region.
3. Landfill gas will be produced but the cost again is the barrier.

3.8.1.3 Principal Environmental Concerns

Improper solid waste disposal causes many negative environmental impacts. The following represent the principal environmental concerns during construction and operation of solid waste disposal sites:

- Air Quality
- Groundwater level
- Proximity to urban areas and airports

- Proximity to drinking water wells
- Ground Stability
- Floods
- Proximity to sensitive area (e.g. protected areas)
- Proximity to occupied facilities (e.g. resort/hotel, school, hospitals, etc.)
- Public Health

3.8.1.4 Internal system interactions

In the disposal site, the collection trucks unload the collected waste in an area called the "receiving area". At this area waste separation starts to sort out the recyclables and the remaining waste will be taken to the filling area or the disposal pit where waste compaction takes place to reduce the waste volume. This step is followed by the placement of daily soil cover and ensures complete coverage of waste.

It is important to have a monthly complete record for the number of loads coming to the site every day. This could help to determine an estimate of the waste generation rate and its consistency throughout the year.

3.8.1.5 Interactions with external systems

Solid waste disposal interact with other external systems like collection and transportation. External systems directly affect the required number of workers and the operation schedule inside the disposal area. For example, efficient collection system definitely increases the amount of collected waste which ultimately goes to the disposal site and the number of required workers will increase. With the same concept, efficient waste transportation helps the contactor to have an accurate operation schedule. This means, that proper management of disposal sites must be coupled with both efficient waste collection and transportation.

Moreover, at source waste separation that most of the Red Sea resorts perform is a step ahead for decreasing amount of waste going to the disposal site and decreasing efforts needed at the disposal site for separating recyclables.

3.8.1.6 Key Environmental Effects and Interactions

The main environmental effects resulting from both construction and operation of solid waste disposal sites are:

- Air pollution
- Groundwater contamination
- Land pollution
- Health

These effects will be described in details in 2.1.1 and 2.1.2.

3.8.1.7 Hazardous Materials used in Operation

There are no expected hazardous materials to be used during operating the disposal site.

3.8.2 Indicators **and Measures of Effects**

*3.8.*2.1 **Description of Indicators of Environmental Effects**

a) **Construction**

During the solid waste disposal site construction phase the following parameters could be affected as follows:

- ***Air Quality***

Generally, dust generation due to excavation work and truck movement shall impact the air quality in the area. This is a short-term impact, as this impact will stop after construction. The air quality in the area shall be also impacted if poorly maintained equipments are used.

- ***Groundwater***

The groundwater shall be contaminated if there is any fuel spillage either from working equipments or from fuel storage tanks kept in the site. This impact is also applied to any other liquid chemicals stored in the site during construction.

- ***Land***

Construction activities, which are mainly excavating the disposal pit and constructing the access road, will have a negative effect on land by changing the natural landscape. Because this is an irreversible impact and to avoid this kind of impacts, it is preferred to select naturally low area with considering the flood hazards.

- ***Marine Life***

The marine life could be negatively impacted if excavation and construction waste is dumped close to the beach or not handled properly. For example, empty cement bags can be carried by wind to the sea. This is a very long-term impact as any damage to the marine life and especially the coral reefs would take hundreds of years to grow up again.

- ***Terrestrial life***

Loss in terrestrial life could happen in the disposal site due to excavation work. Site selection should take in consideration both terrestrial fauna and flora. A barren site of any terrestrial life shall eliminate this impact.

- ***Heath***

During the construction phase, negative heath impacts could occur on workers due to dust generation from excavating the disposal pit.

- ***Workforce***

Local workers are needed during the construction phase. This is considered to have a short-term positive impact on the population living in the surrounding areas.

b) Operation

During the solid waste disposal site operation phase the following parameters could be affected as follows:

- ***Air Quality***

The air quality will be negatively impacted during the disposal site operation due to filling operation and vehicle movements along the access road. Both will generate dust and this will impact the air quality as long as the disposal site is in use. Burning waste shall also affect the air quality adversely.

- ***Groundwater***

The negative impacts on the groundwater will likely to happen if the compacted soil layer liner was not installed properly and therefore, leachate percolation will contaminate the groundwater. Negative impacts from fuel spillage either from equipments or from fuel storage tanks will also affect the groundwater. Bringing any type of unacceptable waste especially liquid waste to the disposal area shall also have negative impacts on the groundwater.

- ***Land***

The main negative impacts on land will be during the construction phase. During operation, land could be negatively affected by wind-blown trash. Both continuous fence maintenance and placement of daily soil cover could minimize this impact.

- ***Marine Life***

The marine life could be directly impacted if the fence is broken or has holes in it. This could allow wind-blown trash to get spread allover the surrounding area and if carried to the sea serious losses in the marine life will happen. This is a long-term relatively irreversible negative impact.

- ***Terrestrial life***

The terrestrial life in the surrounding area will be negatively impacted by any wind-blown trash. Wind blown plastic bags captured by desert plants are an example that could cause serious loss in these plants. The plastic bags acts as barrier for air and sunlight to reach these plants.

- ***Heath***

The workers heath could be negatively impacted due to their direct contact with waste and dust generation from the filling operations. Beside the workers, the presence of facility shall have positive impacts on the public heath in the region if the disposal site runs properly.

- ***Workforce***

Local workers are needed during the operation phase. This is considered to have a long-term positive impact on the population living in the surrounding areas.

3.8.2.2 Observations and Measurement Techniques

a) Construction

- ***Air Quality***

The monitor shall note the dust height from the ground surface during the construction of the access road and excavating the disposal pit.

- ***Ground water***

The monitor shall inspect compacted soil layer and ensure its cover to the whole disposal pit where waste will be placed. He shall also note any fuel leak in the site.

- ***Land***

The monitor shall note the presence of any excavation or construction waste at the beach area. Any wind-blown trash shall be also recorded.

- ***Marine Life***

The monitor shall note the presence of any excavation or construction waste at the beach area. Any wind-blown trash shall be also recorded.

- ***Terrestrial life***

The monitor shall note the presence of wind-blown trash in the area surrounding the construction site.

- ***Heath***

During the construction phase, all workers at or close to excavation area shall wear masks to protect them from breathing dust suspended in the air.

- ***Workforce***

The monitor shall note the number of local workers involved in the construction of the disposal site.

b) Operation

- ***Air Quality***

The monitor shall note any fire or smoke coming out from the dumped waste. Dust height from the filling operation shall be also recorded.

- ***Groundwater***

The monitor shall inspect all incoming loads to the disposal area to ensure absence of any liquid waste, which shall not be collected by the contractor. There should be also no fuel leak on the ground.

- ***Land***

The monitor shall inspect the fence and note the presence of wind-blown trash in the area surrounding the disposal site. Any dumped waste seen along the access road sides must be recorded.

- ***Marine Life***

In cooperation with resorts the monitors shall be informed during their regular visits of any wind-blown trash occurring at their beaches. The fence height must be checked for capturing all trash.

- ***Terrestrial life***

The monitor shall note the presence of wind-blown trash in the area surrounding the construction site. The fence height must be checked for capturing all trash.

- ***Heath***

During the operation phase, all workers at or close to excavation area shall wear masks to protect them from breathing dust suspended in the air. Fire and smoke shall be recorded if seen at the site

- ***Workforce***

The monitor shall note the number of local workers involved in the operation of the disposal site.

*3.8.*2.3 Interpretation of Results

a) Construction

- ***Air Quality***

Dust control measures could include paving of the access road, use of water trucks to spray water, minimizing excavations in windy days.

- ***Ground water***

In case the monitoring record contains any comments regarding any fuel leakage, the monitor shall inform the contractor immediately to take corrective

actions like stop using the equipment making this leak or fix any fuel tanks in the site.

- ***Land***

The monitoring record shall mention any construction or excavation waste at the surrounding area or along the access road. The contactor must remove all this kind of waste and designate an area in the disposal pit for dumping the construction waste. The excavation waste can be used as a daily soil cover.

- ***Marine Life***

Any construction, excavation waste recorded at or close to the beach area must be removed immediately by the contractor.

- ***Terrestrial life***

Any construction, excavation waste recorded at or close to the disposal site must be removed immediately by the contractor.

- ***Heath***

The contactor shall be asked to stop the excavation works, if his workers are not wearing masks to protect them from breathing airborne dust. He shall not start working unless he provides masks.

- ***Workforce***

The contractor shall be encouraged to use local workers during construction as they cost him less than bringing workers from far areas. This could be stated in the agreement between the TDA and the contractor to use a certain percentage of his workers from local people.

b) Operations

- ***Air Quality***

Burning waste must be forbidden. There should be always a water truck in the site. Water spraying can be used to minimize the dust in the air. In windy days, the contractor can be asked to decrease his excavation activities in

- ***Ground water***

The proper placement of the bottom liner shall minimize the negative impacts of leachate on the groundwater. If the monitor record shows any waste dumped in area without lining, the contractor must remove this waste immediately to the lined filling area. The same applies to any fuel leakage seen or liquid waste seen on the ground.

- ***Land***

The monitoring record shall mention any wind-blown trash at the surrounding area or along the access road. The contactor must take corrective actions like sending crews to cleanup the surrounding area and all the contaminated areas.

The contractor shall also increase the fence height to be more efficient in capturing wind-blown trash.

- Marine Life

The monitoring record shall mention any wind-blown trash at beach areas close to the site. The contactor must take corrective actions like sending crews to cleanup the beach. The contractor shall also increase the fence height to be more efficient in capturing wind-blown trash.

- ***Terrestrial life***

The monitoring record shall mention any wind-blown trash at the surrounding area. The contactor must take corrective actions like sending crews to cleanup the surrounding area. The contractor shall also increase the fence height to be more efficient in capturing wind-blown trash.

- ***Heath***

The contactor shall be asked to stop the filling operations, if his workers are not wearing masks and gloves to protect them from direct contact with waste. He shall not start working unless he provides mask and gloves for his workers.

- ***Workforce***

The contractor shall be encouraged to use local workers during operation as they cost him less than bringing workers from far areas. This could be stated in the agreement between the TDA and the contractor to use a certain percentage of his workers from local people.

3.8.3. **Implementation of Monitoring Requirements**

*3.8.*2.1 Assignment or Responsibility

Waste disposal site will be most probably located in the TDA lands. For this reason, the TDA will be responsible for monitoring their lands. The private sector (resorts/hotels) as it represents the main source of waste in the region and the solid waste problem could affect their investments is also responsible for monitoring the solid waste contractor performance. Therefore, it is very important to keep continuous exchange of monitoring results between both parties. The success of the monitoring program will be directly affected by this cooperation.

a) TDA

The TDA shall be responsible for sending well-trained monitors for evaluating the disposal site contractor compliance with the environmental conditions. The TDA monitoring plan shall include the following:

- *Access Road*

The access road gives a first impression about the level of compliance of operating contractor in handling waste at the disposal site. In other words, the

access road must be clean of any litter. The presence of waste will be due to either unloading waste outside the disposal site or wind blown trash. In both cases the surrounding area will be contaminated. The TDA monitors shall inspect the access road on a daily basis.

- *Fence*

No holes or breaks in the fence shall be observable. Also, the fence height shall not allow any wind-carried litter to spread out in the area surrounding the disposal site. The TDA monitors shall inspect the fence and ensure litter-picking crews are working in the surrounding area.

- *Presence of unacceptable waste*

Acceptable waste is only allowed to be taken to the disposal area and include both hotel and construction waste. Other waste types, like medical waste, liquid waste, and hazardous waste shall not be even collected by the contactor. The TDA monitor shall be responsible for recording any type of unacceptable waste in the site.

- *Waste separation*

The contactor shall assign an area inside the disposal site for waste separation if not previously sorted at the source. Nothing should be left in this area at the end of every working day. Recyclables are either placed in a different area or send for selling. The TDA monitor shall inspect that recyclable are not dumped in the filling area.

- *Waste Compaction*

In-place waste compaction will decrease the waste volume and in turn will add more lifetimes to the selected disposal site. This process shall be performed at the end of every working day. The TDA monitors shall check that the waste compaction equipment is working properly.

- *Placement of daily soil cover*

The daily soil cover will suppress fires, control vectors, and hide the waste from birds and scavenging. Therefore, the placement of daily soil cover will decrease the environmental impacts resulting from direct exposure of waste. The TDA monitors shall note any waste exposure without soil cover.

- *Scavenging*

All type of scavenging carried out by the Ababda inside the disposal site must be forbidden. Any on-site sorting shall be confined to a dedicated area of the disposal site. The negative environmental impacts will arise from the direct contact with waste. The TDA monitor shall ensure that all waste separation workers are wearing gloves. He also shall note any waste scavenging by Ababda.

- *Litter Control*

The disposal site crew shall be responsible for picking up litter inside the disposal site as well as wind blown litter caused by the disposal site and along all access roads and the surrounding area. On a continuous basis, the disposal site crew shall inspect the entire perimeter and collect all litter outside the disposal site.

- *Fire*

Burning of waste to decrease the waste volume shall be forbidden in the disposal site. Any fire and smoke will definitely affect the air quality in the area. Moreover, this will affect the labor health working in the site. The TDA monitors shall note any waste burning in the site.

- *Dust*

There will be dust generation in the disposal site due to waste filling operations. The TDA monitors shall note the dust height and the presence of water truck in the site used for water spraying when the dust levels increase.

b) Private Sector

The private sector (resorts/hotels) shall be responsible for monitoring the following:

- Access Road
- Fence
- Litter
- Fire
- Dust

The results of these monitored items shall be available for the TDA monitors.

- Specialized Expertise

- Personal and Training required

The training of all monitors should concentrate on teaching them how to evaluate the contractor compliance with the minimum technical requirements contained in the agreement between the TDA and the disposal site contractor. To achieve this, monitors needs to be trained on the following:

- Study and become fully knowledgeable of the agreement specifications for solid waste disposal site construction and operation.
- Aware of all laws regulating waste collection, transportation and final disposal.
- Aware of the Red Sea solid waste characteristics (waste generation & waste composition).
- Fully aware with operation of controlled solid waste disposal site.
- Observe and report violations of disposal site rules and regulations.

- Complete monitoring forms.

    - Specialized Equipment

Controlled disposal sites require daily management. Three pieces of equipment are essential: front-end loader, bulldozer, and dump truck.

- Front-end loader. The loader is used for material handling: loading the dump truck, placing cover material, etc. Smaller scale sites may only need the loader periodically for material handling. Larger scale sites will probably require a loader on site at all times.

- Bulldozer. The bulldozer is used to manage the filling process, compact waste, spread cover material, maintain on-site roads, perform general grading work, etc. A bulldozer needs to be on-site at all times.

- Dump truck. The dump truck is used for moving materials. It may be needed only periodically.

Additional pieces of equipment that may be needed during operations include: water truck, scraper, and/or road grader. Depending on the site of operation, more than one piece of a certain type of equipment may be needed. It may be feasible to share equipment among several sites or lease equipment for temporary use.

- Recommended Implementation Schedule

The following table represents the proposed schedule for the TDA and the private sector to monitor the performance of the disposal site contractor.

Monitored Item	Sample Period (TDA)	Sample Period (Resorts/Hotels)
Access Road	Weekly	Daily
Fence	Monthly	Monthly
Presence of Unacceptable waste	Daily	TDA only
Waste Separation	Weekly	TDA only
Waste compaction	Daily	TDA only
Placement of daily soil cover	Daily	TDA only
Wind-blown litter	Weekly	Daily
Dust	Weekly	Daily
Fire	Daily	Daily
Scavenging	Weekly	TDA only

Appendix A

Monitoring Matrix

Anticipated Environmental Effect	Life Cycle Phase (Construction/ Operation)	Indicator	Measure of Effect	Measurement or Observation Technique	Responsible Entity	Sample Period	Record Keeping Requirement
Air Pollution	Construction & Operation	Presence of airborne dust in the area	Dust Height from the ground surface.	Trained observer notes current conditions and compared to typical unpolluted systems and compares observations with previous inspections.	TDA and Investor	TDA – Weekly Investor – 2 times a week	Investor maintains record of observations and the TDA observations verifies investor records
Groundwater contamination	Construction & Operation	Presence of fuel spillage during construction and presence of liquid waste during operation	No attempt to stop fuel spillage on the ground and continue receiving liquid waste.	Analysis of Water samples from monitoring well close to the site.	TDA	TDA –Weekly	TDA maintains record of observations and compare it after controlling the effect
Land pollution	Construction & Operation	Presence of wind-blown trash	Wind-blown trash with no apparent attempt to stop it.	Trained observer notes current conditions and compared to typical unpolluted systems and compares observations with previous inspections.	TDA and Investor	TDA – Weekly Investor - Daily	Investor maintains record of observations and the TDA observations verifies investor records
Loss in Terrestrial and Marine life	Construction & Operation	Presence of construction waste and wind-blown trash close to the beach	Pilling up of waste close to the beach.	Trained observer notes the current conditions and compare it with unpolluted areas.	TDA and Investor	TDA – Weekly Investor - Daily	Investor maintains record of observations and the TDA observations verifies investor records

Heath	Construction & Operation	-Workers not wearing masks and gloves. - Ababda scavenging waste	No attempt to stop scavenging and providing workers with masks and gloves	Trained observer notes the current conditions.	TDA and Investor	TDA – Monthly Investor - Weekly	Investor maintains record of observations and the TDA observations verifies investor records

Appendix B

Monitoring Reporting Form TDA

Facility Name	Name of disposal site (e.g. Shagraa Disposal site)	Facility Coordinates (decimal degrees)	
Date of Inspection		Latitude	Longitude
Inspector			

Life Cycle Phase (construction/operation)	
Inspection Parameter	Finding
Parameter 1 Access Road	
Parameter 2 Fence	
Parameter 3 Presence of unacceptable waste	
Parameter 4 Waste separation	
Parameter 5 Waste compaction	
Parameter 6 Daily soil cover	
Parameter 7 Fire	
Parameter 8 Litter	
Parameter 9 Dust	
Parameter 10 Scavenging	

General Observations
Noted Deficiencies
Follow-up Recommendation

Facility Monitoring Reporting Form

Facility Name	Name of disposal site (e.g. Shagraa Disposal site	Facility Coordinates (decimal degrees)	
Date of Inspection		Latitude	Longitude
Inspector			

Life Cycle Phase (construction/operation)	
Inspection Parameter	Finding
Parameter 1 Access Road	
Parameter 2 Fence	
Parameter 3 Fire	
Parameter 4 Litter	
Parameter 5 Dust	
Parameter 6 Scavenging	
Parameter 7	
Parameter 8	
Parameter 9	

General Observations
Problems Identified
Corrective Action Taken

(3-9)

Environmental Monitoring Guidelines for Fuel Stations

TABLE OF CONTENTS

1 Description of Activity

1.1 General Description

The Tourism Development Authority (TDA), of the Egyptian Ministry of Tourism, seeks to develop environmental monitoring guidelines for fuel stations as found along the Red Sea Development area. The objective of these guidelines is to provide both the TDA and its investors with a set of indicators, measurement or observational techniques and monitoring schedule to help insure the safe and environmentally responsible operation of activities related to fuel stations

The most common activities performed at fuel stations are:

1. Fuel supply (e.g. gasoline, LPG, CNG)
2. Replacement of automotive fluids (e.g. motor oil, radiator coolant, transmission fluid, brake fluid)
3. Replacement of non-repairable equipment (e.g. brake shoes/pads, shocks, batteries, belts, mufflers, electrical components, water pumps)
4. Repair of fixable equipment (e.g. brake drums, alternators, fuel pumps, carburetors, power train components)
5. Automotive service for body and tires (e.g. cleaning, tire change)
6. Food Mart services (e.g. automotive equipment, food and beverages)

A typical fuel service station would consist of different zones for fueling service (including the dispensers, underground storage tanks USTs, and aboveground storage tanks ASTs), auto-repair zone (oil pits, storage facility and employees lockers room), and tire repair and food mart sections.

1.1.1 TYPICAL SETTINGS

1.1.1.1 Dispensing Operations and Storage Vessels

Flammable and combustible liquids, LPG and CNG are not to be dispensed in buildings and the dispensers for such products shall not be located in buildings.

Fueling stations located at bulk plants shall be separated from areas where bulk operations are conducted by a fence or similar barrier.

LPG and CNG tanks shall be located at least 20 feet from AST’s containing flammable and combustible liquids.

Installation of Dispensing Devices

1. Dispensers should be protected from physical damage by mounting on a concrete island 6 inches in height or by other approved means.
2. Dispensers should be secured to the island in an approved manner. Dispensers should not be secured by conduit or piping.
3. Emergency fuel shutdown devices should be provided for all dispensers and be located at least 20 feet, but not more than 100 feet from dispensers and be distinctly labeled **EMERGENCY FUEL SHUTDOWN**.
4. An electrical disconnect switch should be provided for all dispensers.

Dispensers should be located:

1. At least 10 feet from buildings.
2. At least 10 feet from buildings having combustible exterior walls or buildings having exterior walls not part of a one-hour fire-resistive assembly,

   Exception: Canopies constructed in accordance with the Building Code.
3. At least 20 feet from sources of ignition,
4. Be located such that the nozzle, when fully extended, will not reach within 5 feet of building openings
5. Be located such that the vehicles being fueled will be entirely on the premises of the fuel dispensing station.

Supervision of Dispensing Operations

The dispensing of fuel should be supervised by a qualified attendant at all times. The attendant's primary function is to supervise and control dispensing of fuel. Attendants should prevent dispensing into unapproved containers, control ignition sources, mitigate spills and use fire extinguishers.

A means of communicating with the fire department should be provided or made available or in reach of the attendant. During hours of operation, stations should provide a fire alarm transmitting device as well as a telephone not requiring the use of a coin to report an emergency.

Filling a Container

There have been several fires at service stations when customers placed metal containers on plastic bed liners in pickup trucks while filling the containers with gasoline. Filling a container is a special situation that requires extra precautions:

- Use only approved plastic or metal container.
- Shut off the vehicle's engine.
- Place the container **on the ground** a safe distance from the vehicle, other customers, and traffic. Don't fill a container in or on a car or truck.

- Keep the nozzle in contact with the container during filling.
- Control the nozzle valve manually; do not latch it open. If the nozzle is fitted with a fume-recycling device, the filler-spout seal must be compressed to activate the dispenser.
- Do not smoke.
- Avoid breathing gasoline fumes.

Flowing gasoline generates a static electric charge that builds up on the gasoline in the receiving container. If the charge isn't given an opportunity to dissipate, it could jump from the container to the metal spout of the dispenser nozzle as a static spark. If a spark occurs near the open mouth of the container where the concentration of gasoline vapor and air is in the flammable range, it could ignite the gasoline.

Putting the container on the ground and keeping the nozzle in contact with the container help dissipate the static charge. The charge will dissipate more slowly from a container being filled on an insulating surface - carpet in the trunk of a car and on the bed of a utility vehicle or the plastic bed liner of a pickup truck. Placing the container on the ground has the secondary benefit that an accidental spill won't contaminate the vehicle.
Fill the container only about 95% full. This leaves room for gasoline to expand if it warms up in storage. Without an air space, expansion will force liquid gasoline out of the container or distort the container.

1.1.1.2 General Safety Precautions

Gasoline is dangerous. First, and foremost, it is highly flammable - it is easy to ignite and it burns explosively. Second, exposure to gasoline liquid or vapor can cause adverse health effects. All companies are required to develop and make available safety information on their products called Material Safety Data Sheet - MSDS. The MSDS provides detailed information on the hazards associated with gasoline and the appropriate responses.

MSDS for gasoline contains the following human health warnings:
DANGER!

- Harmful or fatal if swallowed — can enter lungs and cause damage.
- Vapor harmful.
- Long-term exposure to vapor has caused cancer in laboratory animals.
- May cause eye and skin irritation.
- Extremely flammable.
- Keep out of reach of children.

First Aid

Eye Contact Flush eyes immediately with fresh water for at least 15 minutes while holding the eyelids open. Remove contact lenses, if worn. No additional first aid should be necessary. However, if irritation persists, see a doctor.
Skin Contact Wash skin thoroughly with soap and water. Remove and wash contaminated clothing. See a doctor if irritation is severe.
Inhalation If respiratory irritation or nervous systems effects (headache, dizziness) occur, move the person to fresh air. If any of these effects continue, see a doctor.
Ingestion If swallowed, give water or milk to drink and telephone for medical advice. DO NOT make the person vomit unless directed to do so by medical personnel. If medical advice cannot be obtained, then take the person to the nearest medical emergency treatment center or hospital.
Emergency Information Call local Poison Control Center.

1.1.1.3 Sources of Ignition

Electrical equipment shall be in accordance with the Electrical Code. Smoking and open flames are prohibited in dispensing areas and engines of vehicles being fueled shall be stopped.

1.1.1.4 Signs

Signs prohibiting smoking, dispensing into unapproved containers, dispensing by persons under 16 years of age and requiring vehicle engines to be stopped during fueling shall be conspicuously posted within sight of each dispenser.

In addition to posted instructions and telephone numbers for owner or operators and a sign reading:
In Case of Spill or Release,

1. Use Emergency Shutoff!
2. Report the Accident!
3. Fire Dept. Tel. #
4. Facility Address.

1.1.1.5 Fire Protection

Portable fire extinguishers shall be provided in accordance to the standards set by the National Defense Department.

Clearance from Combustibles
Weeds, grass, trash, brush and other combustible materials shall be kept at least 10 feet from fuel storage and handling equipment.

1.1.1.6 Maintenance

Fueling dispensing systems shall be maintained in proper operating condition.

1.1.1.7 Age Requirement

Flammable and combustible liquids shall be dispensed only by persons 16 years of age or older.

1.1.2 LIQUEFIED PETROLEUM GAS (LPG) VEHICLE FUEL DISPENSING STATIONS

Liquefied Petroleum Gas LPG is predominantly propane with iso-butane and n-butane. It has one major advantage over CNG, the tanks do not have to be high pressure, and the fuel is stored as a liquid. The fuel offers most of the environmental benefits of CNG, including high octane.

Approximately 20-25% more fuel is required, unless the engine is optimized (CR 12:1) for LPG, in which case there is no decrease in power or increase in fuel consumption. There have been several studies that have compared the relative advantages of CNG and LPG, and often LPG has been found to be a more suitable transportation fuel.

1.1.2.1 Dispensing Operations

In addition to the previously mentioned typical setting for fuel dispensers, the following are the concerns regarding LPG dispensing stations:

A. The point of transfer should be at least 25 feet from buildings with combustible exterior walls or noncombustible walls that are not part of a one-hour fire-resistive assembly, public streets, sidewalks and railroads;
B. LPG dispensers should be at least 10 feet from driveways and building exterior walls that are part of a one-hour fire-resistive assembly.
C. LPG dispensers should not be located on the same island as a gasoline dispenser.
D. LPG storage and dispensing equipment should be located outdoors.

Installation of Dispensing Equipment

1. Dispensing equipment should be installed in accordance with the manufacturer's specifications.
2. Manual shutoff and excess flow valves should be installed in the liquid lines.

   Exception: An emergency shutoff valve may be installed in lieu of an excess flow valve if approved.
3. Hoses and piping for LPG dispensing should be provided with hydrostatic relief valves, hose length should not exceed

18 feet and hose should be protected from mechanical damage.

4. Vehicle impact protection should be provided for LPG storage containers, pumps and dispensers.
5. Private self-service LPG dispensing systems, including key, code and card lock dispensing systems, should not be open to the public and should be limited to filling permanently mounted containers on LPG powered vehicles.

1.1.2.2 Equipment

A drawing showing all piping, regulators, storage vessels, compressor and equipment should be provided in the EIA to the CAA for approval.

1.1.2.3 Emergency Shutdown Equipment

LPG dispensing stations should provide an emergency shutoff switch between 25 and 75 feet of dispensers and facility owners should ensure safe operation of the system and training of the users.

1.1.2.4 Approvals

The containers, equipment and appurtenances to LPG systems should be listed in the EIA, and approved by the Competent Administrative Authority CAA.

1.1.2.5 Attendants

During all times, qualified attendants should conduct motor vehicle LPG fueling operations.

1.1.3 COMPRESSED NATURAL GAS (CNG) VEHICLE FUEL DISPENSING STATIONS

Compressed Natural Gas CNG is usually around 70-90% methane with 10-20% ethane, 2-8% propane's, and decreasing quantities of the higher HCs up to butane. The fuel has a high octane and usually only trace quantities of unsaturated. The emissions from CNG have lower concentrations of the hydrocarbons responsible for photochemical smog, reduced CO, SO_x, and NO_x, and the lean misfire limit is extended. There are no technical disadvantages, providing the installation is performed correctly. The major disadvantages of compressed gas are the reduced range and the freezing around the pressure regulator. As natural gas pipelines do not go everywhere, most conversions are dual-fuel with gasoline. The ignition timing and tachometry are significantly different, but good conversions will provide about 85% of the gasoline power over

the full operating range, with easy switching between the two fuels. Concerns about the safety of CNG have proved to be unfounded.

1.1.3.1 Dispensing Operations

1. Compression, storage and dispensing equipment should be located aboveground.
2. The aggregate capacity for storage at any one installation is 183,000 cubic feet.
3. Storage and dispensing equipment should be installed as follows:
    a. Not beneath power lines,
    b. 10 feet or more from the nearest building or property line that can be built upon, sidewalks, or sources of ignition,
    c. 25 feet or more from the nearest railroad track or 50 feet from any railroad track or transit line where the main power of propulsion is from electricity.
    d. 50 feet or more from a vertical plane below overhead trolley bus lines.
4. Self-service CNG dispensing systems, including key, code and card lock systems should be limited to filling of permanently mounted containers on CNG-powered vehicles.
5. Self-service CNG dispensing systems shall have an emergency shutoff switch located between 25 and 75 feet from dispensers and the owner shall ensure the safe operation of the system and the training of the users.

1.1.3.2 Equipment

A drawing showing all piping, regulators, storage vessels, compressor and equipment should be provided in the EIA to the CAA for approval.

Pressure Regulators

Pressure regulators should be designed, installed and protected according to the Mechanical Code.

Valves

Gas piping to equipment should be provided with a remote, readily accessible manual shutoff valve.

1.1.3.3 Emergency Shutdown Equipment

An emergency shutdown device should be located between 25 and 75 feet from dispensers and should also be provided in the compressor area.

1.1.3.4 Discharge of CNG from Motor Vehicle Storage Containers

The discharge of CNG from motor vehicle fuel cylinders should be accomplished through a use-closed transfer system or an approved method of atmospheric venting.

- For use-closed transfer systems, a documented procedure explaining the sequence of events for discharging the cylinder should be provided to the CAA for review and approval including the action the operator will take in the event of a release during discharging activities.
- For atmospheric venting, a drawing showing locations of vessel support, piping, the method of grounding and bonding, and other equipment shall be provided to the chief.

The following instruction should be adhered to:

1. A method of rigidly supporting the vessel during venting of CNG should be provided.
2. The structure or appurtenance used for stabilizing the cylinder should be separated from equipment, features and exposures as follows: Buildings, vehicles, CNG compressors, dispensers and storage vessels: 25 feet; Property lines and public ways: 15 feet.
3. The structure used for supporting the cylinder being vented should be grounded.
4. The vent tube should terminate at least 10 feet above grade.

1.1.3.5 Approvals

Storage vessels and equipment for compression, dispensing, pressure relief, pressure regulating and piping should be listed in the EIA to be approved by the CAA. Hoses, hose connections, dispensers, gas-detection systems and electrical equipment used for CNG should also be listed and labeled.

1.1.3.6 Attendants

Qualified attendants that have been trained in the proper handling of CNG should conduct motor vehicle fueling operations.

1.1.4 OIL CHANGING PITS

The services provided in the Oil Changing Pits include the following:

- Replace the vehicle's oil with up to 5 liters of motor oil
- Replace the oil filter
- Inspect the brake fluid level
- Inspect the air filtration system
- Lubricate the chassis

- Check & fill transmission / transaxle fluid
- Check & fill battery water
- Check & fill power steering fluid
- Check & fill windshield washer fluid
- Check & fill differential fluid
- Air filtration replacement
- Headlight replacement

The following are the concerns that should be adhered to all the times:

- Floor openings between upper and lower levels used for oil changes should be guarded by a cover, a guardrail, or equivalent on all open sides (except at entrance to stairway or ladder way) to prevent employees from falling through the 37 inch wide, 9 foot deep hole. While the cover is not in place, the floor opening should be constantly attended by someone or should be protected by guardrails.
- While operating the raised platform, on the lower level from which employees work on cars, there should always be an employee on the upper level.
- A yellow grate cover should be pulled up when short compact cars are being serviced to cover the remainder of the opening.
- Toe boards should be installed around the edges at permanent floor openings where persons may pass below the opening. The toe guard should be 2-1/2 inch tall.
- Triangular signs posted at all entrances and openings of the shop read: **CAUTION-FLOOR OPENING**.
- Ordinarily there should be a waist high rope at every bay door that is only removed when a car is pulled in over one of the open pits.
- During general safety orientation, the employees should be shown training tapes that warns of not to be on the lower level while vehicles are moving in and out. Employer's safety manual addressing the safety of employees working in the pit area should be made available.
- All employees should wear oil resistant shoes that help reduce, although not eliminate, the possibility of slip and fall accidents around the open areas.
- The service area where the pits are located is restricted to employees only and warning signs are in place;
- Service pit openings are illuminated, painted with “OSHA yellow” safety paint.

1.1.5 WORKSHOP, CLEAN UP SERVICE AREA & FOOD MART

The services provided in these sections include the following:

- Inflate the tires to proper pressure

- Tire Rotation / Balancing & Alignment
- Vacuum the interior floors
- Clean the exterior windows
- Radiator Coolant Service
- Mart services

The areas should be clearly marked and well maintained at all times. The operations should be attended by well-trained employees and safety precautions adhered at all times. Signs in the cleaning area should be posted indicating that the area is only for working personal.

1.1.6 JET A1 FUEL STATIONS

Jet A1 fuel is meant for aeroplanes and small jets. It is usually stored in AST. These tanks are connected to pipelines that are routed to the airfield where aircraft are refuelled by direct connection. An alternative is for aircraft to be filled by road tanker that collect fuel from the tanks at a loading gantry.

The Jet A 1 tanks are epoxy lined and are inspected every 3 to 5 years.

UST are used as control tanks (emergency buffer) in connection with quality checks on jet fuel. In addition, UST could be also used for spillages buffering in connection with vehicles.

General Design Features

All gasoline/service stations, with or without associated convenience food marts, should conform to the following design standards.

1.1.7 BUILDING SECURITY AND SITE LAYOUT

1. All trash enclosures should be within a clear line of sight and be visible from the cashier station, day or night.
2. All public phones should be outgoing only, should be visible from the cashier area and should be located indoors. There should be no outdoor locations for public phones.
3. There should be motion detector lighting in non-viewable areas.
4. There should be alarm systems on all outside doors and enunciators on interior doors/entrances.
5. There should be adequate lighting that does not create shadows.
6. There should be clear lines of sight from inside and outside the store.

1.1.8 LANDSCAPING

A twenty (20) foot, landscape strip should be required for all property lines adjacent to or across a public right-of-way from residential uses.

1.1.9 ACCESS AND TRAFFIC

Access to gasoline/service stations located on corner lots may be limited to *"right-in, right-out only"* if warranted by site conditions or traffic patterns based on the results of a traffic study. Site conditions or traffic patterns that may warrant right-in, right-out traffic movements include, but are not limited to:

1. Traffic volumes on adjacent rights-of-way that make left-hand turning movements a safety hazard; or
2. Left-hand turning movements from the station that interfere with the left-hand turning movements on adjacent public rights-of-ways.

1.1.9.1 Parking

Where appropriate, consideration should be given to provide parking to the following:

- Employees
- Vehicles being serviced
- Convenience store customers (non-petrol purchasers)
- Fast food/restaurant customers
- Storage at car wash, air hose etc.

All parking (or storage) should be clearly marked and located such that there is no obstruction to the sale of motor vehicle fuels, or conflicts between patrons and the facilities mentioned above.
Car wash structures should be placed so as to provide storage for several cars proceeding to the wash. Car wash maneuvers should not conflict with driveway maneuvers.

The parking requirements for the various site activities should be added together to determine the maximum space needed. If the parking requirements are calculated on an hourly basis for the various site activities it may be possible to demonstrate that the peak times do not coincide, thereby reducing total space required.

1.1.9.2 Bulk tank filling

The operation of bulk tank filling should take place from within the service station site and without obstruction to driveways and adjacent footpaths. Tanker access to bulk filling positions should be sited so that tankers can enter and exit the site in a forward direction.

To mitigate the potential for on-site conflicts between pedestrians or motorists and bulk filling tankers, the on-site route should be designed to avoid the necessity for reverse maneuvers.

It is acknowledged that some tankers may experience difficulty using a 9-meter driveway. However, the benefits of obtaining an orderly entry and exit maneuver by light vehicle users offsets the infrequent use by bulk tankers.

1.1.9.3 Entry and Exit

To achieve easy entry and exit from the station, turns with an inside radius of less than 4.5 meters should not be used. For a 4.5-meter radius turn, a path width of 4.5 meters should be provided to ensure that there is sufficient width for a vehicle to traverse between the pumps and any kerb, nib wall or landscaping etc. For turns of 7.5 meter inside radii (and greater) a minimum path width of 3.5 meters should be provided. When the station is to provide for any large vehicles such as buses, trucks and tankers, the minimum inside turning radii required is 7.5 meters with a path width of 4.5 meters.

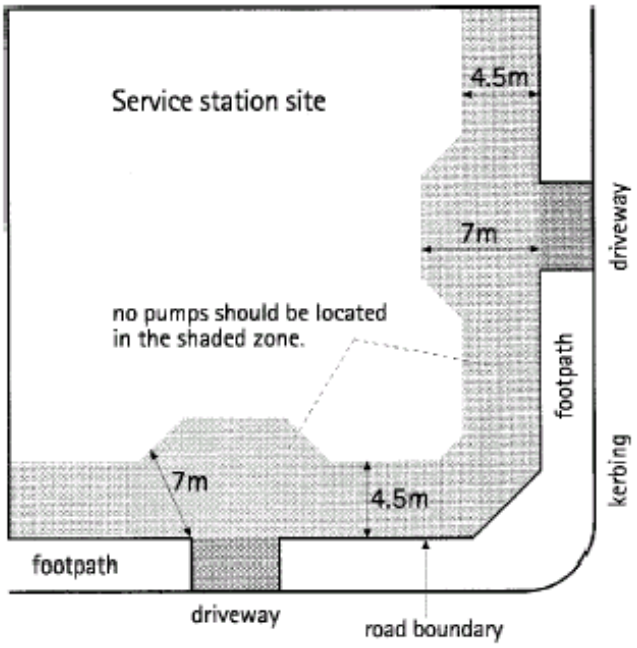


Fig. 1: Entry and Exit Maneuvers Radii

1.1.9.4 Driveway angle and width

1.1.9.4.1 Driveway angle

For pedestrian safety and operational reasons, e.g. visibility, the angle between the driveway and the frontage road (kerb) should be in the range of 70 degrees to 90 degrees. Driveways at an angle less than 70 degrees are more acceptable where access is made from a divided road or one-way roadway, with full consideration given to pedestrian movements and vehicle entry speeds.
Driveways located on urban arterial roads and rural roads may require the consideration of widening kerbside lane width. They may also require the provision of acceleration and deceleration lanes where driveway maneuvers will significantly affect roadway capacity and operating speeds.

1.1.9.4.2 5.4.2 Driveway width

Large driveway widths may allow vehicle entry and exit maneuvers to be undertaken with more ease but increase a pedestrian's exposure to conflict. The design vehicle, driveway type, e.g. one-way, two-way, and traffic generation are some of the factors affecting driveway width. The width should be restrictive enough to discourage parallel exiting maneuvers, which can result in visibility restrictions and conflicts.

The radius (or splay) at the roadway edge will be site specific and determined from the swept paths of the appropriate design vehicle. On any road, all vehicles should be able to undertake their turning maneuvers without crossing the road centerline, and preferably without encroaching into adjacent lanes on a multi-lane roadway, with the exception of the occasional bulk filling tanker. It may be preferable that bulk filling tankers do not use any driveway intended for one-way use. This is because use by tankers may require widening to a maximum of 9 meters, under which circumstances the driveway is likely to be used as a two-way driveway by other vehicles.

The recommended dimensions should be measured at the road boundary (the legal boundary between the service station site and the road reserve:

- One-way road should have a movement minimum width of 3.5 meters and a maximum width of 5.0 meters.
- Two-way road should have a movement minimum width of 6.0 meters and a maximum width of 9.0 meters.

Where a bulk filling tanker requires access via a one-way driveway, a greater maximum width may be required (to a maximum of 9 meters).

1.1.9.5 Advertising Signs

The presence of some advertising signs at service stations may compromise road safety in the following ways:

- By directly distracting or confusing motorists

- By presenting a physical obstruction to vehicles moving on or off the carriageway
- By obstructing visibility (advertising or traffic signs).

To achieve advertising, which is safe and effective from a road safety point of view, adequate distance and visibility should be taken into consideration, in addition to consulting the CAA.

1.1.10 FLOORS

Porous concrete floors or floors where a high surface buildup is desired need heavy-bodied epoxy coating which penetrates into the pores of the concrete for excellent adhesion and "lies on top" to form a solid surface plate, recognized as a contaminant barrier.

The epoxy coating provides floors with heavy-duty protection from wear. It prevents dusting of concrete, makes floors wear longer, protects floors from penetration of oil, grease, and foreign matter, mechanically hardens the concrete by filling the pores and binding the particles, and provides a hard, yet elastic, durable, damage-resistant surface.

1.1.11 UST - UNDERGROUND STORAGE TANKS

The UST system includes the tank, piping, and ancillary equipment, such as flexible connectors, fittings, and pumps. The USTs are composite tanks, constructed of galvanized steel with a Glass-reinforced polyester (GRP) coating. UST for storage of hydrocarbons and oxygenated solvents are intended for burial horizontally and should be protected against corrosion by a 3 mm GRP coating.

Pipelines used to convey petroleum products should utilize the use of flexible piping for underground use at service stations and consumer installations and should be of non-corrosive plastic materials. Flexible piping and appropriate fittings reduce the number of joints in pipe work and thus the potential for leaks.

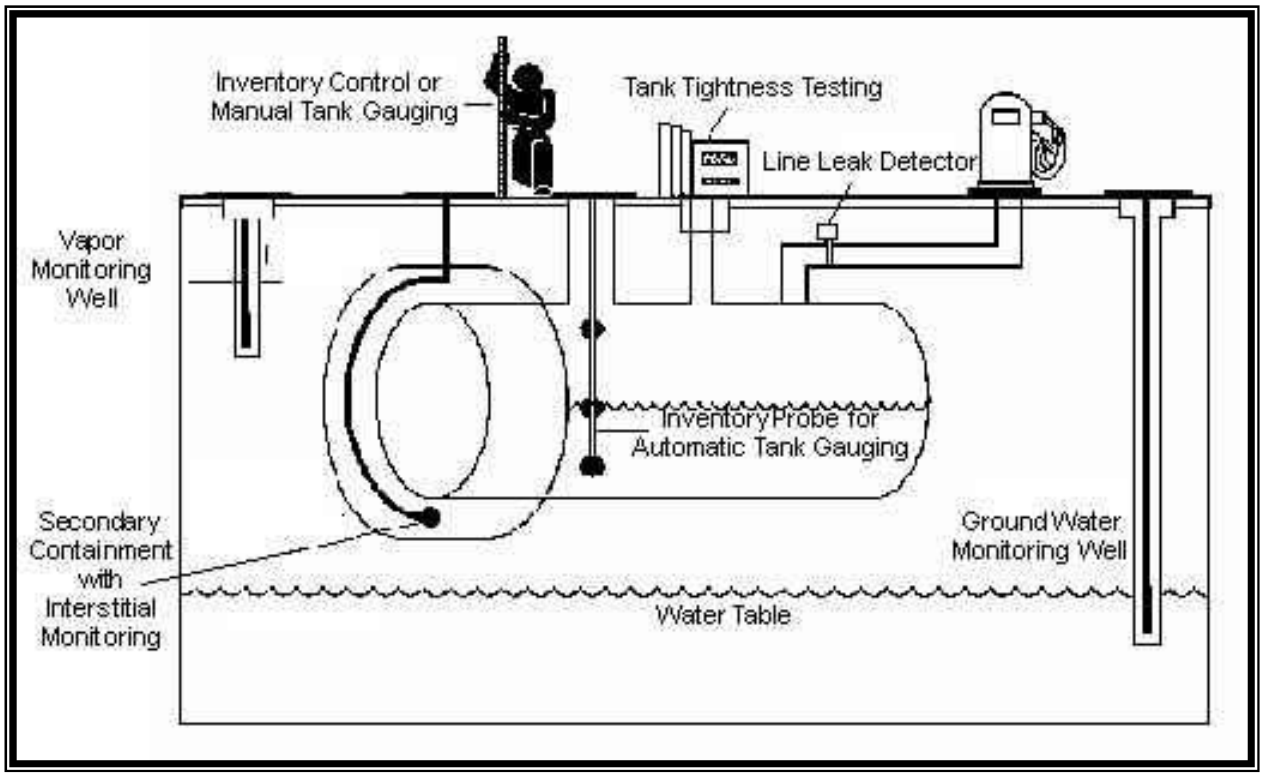
Additional assurance is provided for installations in sensitive environments, where double-skinned tanks are used, or the area in which the tanks are to be installed is lined with an impermeable layer of plastic sheeting or, for example, clay.

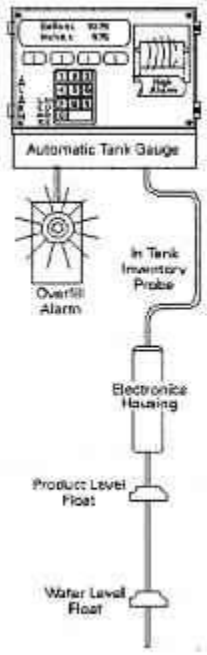
Thus, the contractor to install USTs should abide to the following:

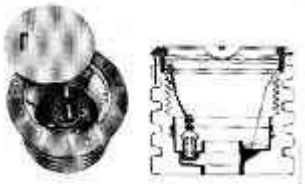
1. UST should be of double skin construction.
2. UST should be contained in order to prevent leaks from reaching the underground. Secondary containment is a barrier between the portion of an UST system that contains product and the outside environment. Examples of secondary containment include an outer tank or piping wall, an excavation liner, and a bladder inside an

UST. The area between the inner and outer barriers -called the interstitial space- is monitored manually or automatically for evidence of a leak. The bund hole is sometimes filled with sand which could be washed in case of spills. The corrosion is of concern in this case.

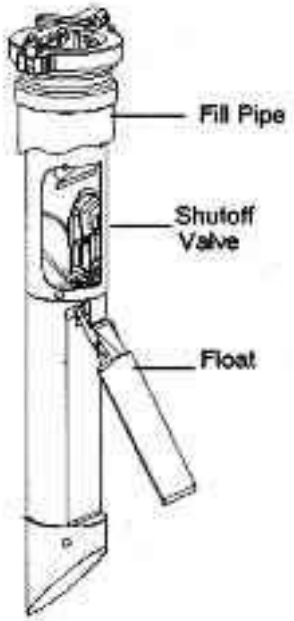
3. UST components should be protected from corrosion. The material of the tank should be nonmetallic, non-corrodible material, such as USTs made of (or clad or jacketed with) fiberglass reinforced plastic (FRP) or other no corrodible materials.
4. UST components made from metal, however, that routinely contain product and are in direct contact with the ground need corrosion protection provided by cathodic protection or (in some cases) lining the interior of the tank with dielectric coating (a coating that does not conduct electricity).
5. UST should be equipped to be gauged either automatically or manually. An automatic tank gauging (ATG) system consists of a probe permanently installed in a tank and wired to a monitor to provide information on product level and temperature. ATG systems automatically calculate the changes in product volume that can indicate a leaking tank.
6. UST should be fitted with a leak detection system.
7. UST should be fitted with overfill prevention devices.
8. All new or replacement tank venting systems should be capable of vapor balancing. Vapor monitoring measures product vapors in the soil at the UST site to check for a leak. A site assessment must determine the number and placement of monitoring wells that make sure a release is detected. NOTE: vapor monitors will not work well with substances that do not easily vaporize (i.e. diesel fuel).
9. Striker plates for all tanks to reduce potentials for tank damage due to repeated hitting with gauging stick.
10. Monitoring wells should be installed in the pea gravel surrounding the tank and fitted with a hydrocarbon sensing system. The wells should be one meter below the tanks and these are inspected on a regular basis for the presence of hydrocarbons. Groundwater monitoring looks for the presence of liquid product floating on the groundwater at the UST site. A site assessment must determine the number and placement of monitoring wells that make sure a release is detected. (This method cannot be used at sites where groundwater is more than 20 feet below the surface.)
11. Integrity testing of secondary containment systems
12. All pipelines and new tanks for the storage of petrol should be tested on site prior to operation.
13. The emergency electrical switch should be readily visible and identifiable to the public and within easy reach being not more than 1.8 meters from the ground.







Spill Buckets



Automatic Tank Gauge Automatic Shut of Device

Fig. 2: UST System Dispensers

Fuel dispensing nozzles should be equipped with “hold-open latches” (automatic shutoffs) except where prohibited by local fire departments.

Dispenser hoses should be equipped with dry-breakaway connections to minimize product losses due to customer drive-offs.

Under dispenser containment sumps (or pans) to capture drips and small spills, in combination with sump monitoring devices to provide early warning of dispenser area leaks.

It is reasonable to expect some queuing for service at petrol pumps. However, if the arrival rate of customers exceeds the service rate then queue lengths and delays may become excessive, or alternatively customers may purchase fuel elsewhere. Because traffic generation and expected queuing characteristics are site specific, it is not the intention of this document to propose ideal queuing disciplines or service layouts.

It is desirable that queuing vehicles do not block any driveway because this may cause a conflict between entering vehicles and traffic on the frontage road, or obstruct pedestrian flows on footpaths. To facilitate this requirement no pump should be located within 7 meters of any point on a driveway. This allows one vehicle to queue behind another that is being served. The pump layout must not enable vehicles to be served from outside the site, i.e. the road reserve. This may be achieved by:

- Locating pumps 4.5 meters or greater from the boundary
- Installing landscaping or low nib walls.

Consideration must be given to any future road widening which could alter road boundaries.

1.1.12 DRAIN SYSTEM

Surface water drainage patterns should be designed to minimize the flow of storm water over refueling areas, product and vapor recovery spill containment boxes, and air/water supply areas. The site should be graded and paved to prevent run-on of storm water in addition to installation of a roof over the area in question. Collection drains should be constructed around the forecourt to contain runoff and that all runoff should be directed to oil-water separators so that the hydrocarbon pollutants can be collected, for recycling, or for disposal to hazardous waste dumps. Drains within the facility boundary should be labeled, by paint/stencil (or equivalent), to indicate whether they flow to an oil/water separator, directly to the sewer, or to a storm drain.

1.1.13 CONTAINMENT DEVICES

In case of spill or overfill, contain, absorb, and clean up equipment should be made available and in reach to act accordingly. Enough absorbent material should be kept at the facility to contain a spill or overfill of petroleum products until emergency response personnel can respond to the incident. The suggested supplies include, but are not limited to, the following:

- Containment devices, such as containment booms, dikes, and pillows.
- Absorbent material, such as kitty litter, chopped corncob, sand, and sawdust. (Be sure of proper disposal of used absorbent materials.)
- Mats or other material capable of keeping spill or overfill out of nearby storm drains.
- Spark-free flashlight.
- Spark-free shovel.
- Buckets.
- Reels of “caution tape,” traffic cones, and warning signs.
- Personal protective gear.

Table 1: Design Summary Table

	Gasoline	LPG	CNG
Tanks & Point of transfer		At least 20 ft from AST Point of transfer should be 25 ft from Buildings.	At least 20 ft from AST Point of transfer should be 25 ft from Buildings. Vent tube should be 10 ft above ground.
Dispensers	Mounted on concrete islands 6 inches from ground. Located at least 10 ft from Buildings and 20 ft from ignition sources	Mounted on concrete islands 6 inches from ground. Not to be located on the same island of Gasoline Located at least 10 ft from Buildings and 20 ft from ignition sources.	Mounted on concrete islands 6 inches from ground. Not to be located on the same island of Gasoline Located at least 10 ft from Buildings and 20 ft from ignition sources, 25-50 ft from railroad, and 50 ft from vertical plane of trolley bus.
Nozzles and Hoses	When fully extended 5 ft from Buildings	Hose should not be more than 18 ft.	Hose should not be more than 18 ft.
Emergency Shutoff	Between 20 – 100 ft and not more than 180 cm above ground.	Between 25 – 75 ft and not more than 180 cm above ground.	Between 25 – 75 ft and not more than 180 cm above ground.

1.2 Interactions with Other System

The fuel station system as mentioned in Section 1.1 is comprised of various systems, and accordingly interacts with external systems among which are the following:

1. Sewer Treatment System
2. Solid Waste Collection and Disposal System
3. Transportation and Traffic System

Proper management of the fuel station guarantees good handling of the external systems and harmony within the various internal systems.

1.3 Internal System Interactions

The fuel station system include the following activities each in its own subsystem:

1. Fuel supply and management
2. Automotive service management system: replacement of automotive fluids, replacement of non-repairable equipment, repair of fixable equipment, stock management, and service for body and tires (e.g. cleaning, tire change)
3. Food Mart Management System
4. Safety and Training Management System

The homogeneity and harmony within the service station internal system interactions and communication, result in safe operation, efficient work accomplishment and customer satisfaction.

1.3.1 FUEL SUPPLY AND MANAGEMENT

Monitoring of the UST fuel level -*tank gauging*- is a key element for proper management. Ordering of new supply should always be associated with proper measurement and proper operation practices in order to avoid over spillage of the product and also to avoid pumping of water with the product while monitoring the water level during the gauging operations. The recommended practice is to order the supply of product when the remaining amount in the tank is about 20% of the UST volume.

1.3.2 AUTOMOTIVE SERVICE MANAGEMENT SYSTEM

Management of the various services is associated with stock and supply control. The stock area should be properly vented and clean. Ventilation should be enough to prevent the accumulation of flammable vapors. Avoid over stocking and thus operation should be on the terms of *First In First Out*.

1.3.3 FOOD MART MANAGEMENT SYSTEM

Mart management requires orientation to solid waste production sources. Continuous inspection of the electrical appliances and abiding the electricity code of practice in hazardous areas.

1.3.4 SAFETY AND TRAINING MANAGEMENT SYSTEM

Continuous training session and round about orientations to newly employed personnel is the key to proper and safe operation and management practices. Availability of MSDS and documentation about products and equipment is important. This section will be discussed in more details later in the document.

1.4 Interactions with External Systems

1.4.1 SEWER TREATMENT SYSTEM

The run off storm water may always flush product into the storm-drains around the service station. The effluent water would carry products from the areas of fuel dispensing, automotive service and mart section. The contaminants could very possible be gasoline, oil, solid particulate and suspended matter. The service station should install light liquid separators, interceptors and silt traps to avoid the flushing of the products into the sewers and to keep the drains clean all the time.

Oil Skimming

The relationship between oil and water in a mixture is governed by two physical properties:

Specific Gravity: Most hydrocarbons have a lower specific gravity than water. Without agitation, oil separates from the water and floats to the surface. These oils are known as LNAPL's, Light Non-Aqueous Phase Liquid. Oils (and other compounds) that sink in water have a higher specific gravity and are known as DNAPL's, Dense Non-Aqueous Phase Liquid.

Surface Tension and Affinity: Normally, oil bonds more tightly to itself and other materials than to water. This affinity, and differences in surface tension between oil and water, cause oils to adhere to a skimming medium.

Although designs vary, all oil skimmers rely on specific gravity, surface tension and a moving medium to remove floating oil from a fluid's surface.

Floating or sinking oil and grease cling to skimming media more readily than water, and water has little affinity for the media. This allows skimming media in the shape of a belt, disk, drum, etc. to pass through a fluid surface to pick up oil and grease with very little water. This oily material is subsequently removed from the media with wiper blades or pinch rollers.

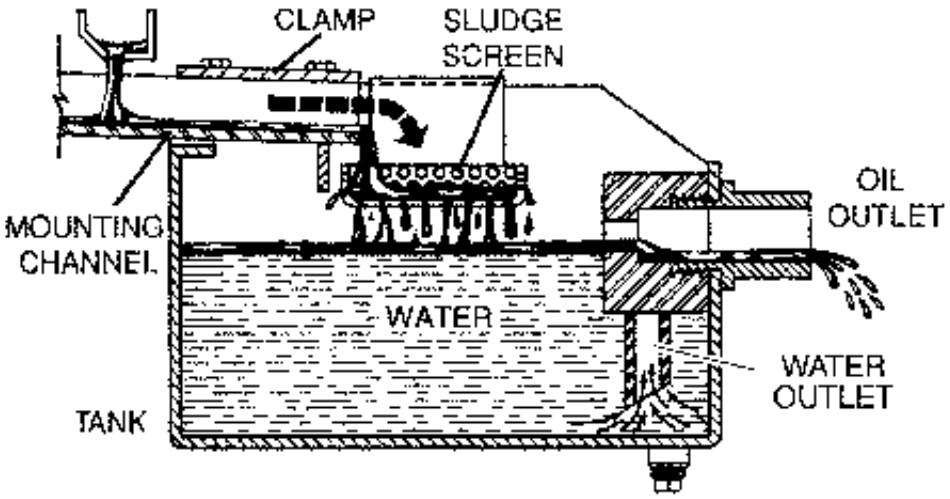


Fig.3: Oil Skimming

1.4.2 SOLID WASTE COLLECTION AND DISPOSAL SYSTEM

The contractor to collect the solid waste generated should present documentation regarding the disposal system and ensure safe handling and disposal of all waste from the service station.

1.4.3 TRANSPORTATION AND TRAFFIC SYSTEM

An understanding of fundamental traffic engineering principles is necessary to ensure safe road design. Some of the more important principles are:

- Reducing the number of conflict points
- Separating the points of conflict
- Controlling vehicle speeds
- Defining vehicle paths

By implementing traffic management techniques such as one-way driveways, solid islands and solid medians, the number of conflict points can be reduced. The conflict points associated with a service station driveway should be separated from the conflict points of an adjacent intersection. This will separate the motorist's decision points and better define vehicle paths at, and adjacent to, intersections.

1.5 Principle Environmental Concerns

Formulated gasoline is a complex mixture of hydrocarbons. It has a boiling range of approximately 30-220^{o}C, a vapor pressure of 400-775 mm Hg at 20^{o}C, and has very low water solubility (less than 1%). The odor recognition limit is approximately 0.8 ppm (API, 1994). The odor threshold of gasoline is altered by the presence of MTBE (Methyl Tertiary Butyl Ether), which also imparts a more recognizable odor to the gasoline. MTBE is used as a component in gasoline where its primary purpose is as an octane enhancer. MTBE can be present in gasoline to about 15% by volume.

Petrol and diesel are normally held at service stations in underground storage tanks
(USTs). The main concern of environmental pollution from service stations is leaking from USTs and the migrating of the product to the underground water and eventually to the aquifer in the area polluting the soil and water. The result of leak is loss of product and jeopardizing of the environment.

1.6 Key Environmental Effects and Interactions

The major environmental impacts of fuel stations operation are on the following categories:

Physical Environment

- Soil
- Ground Water Quality
- Air Quality

Biological Environment

- Terrestrial component

Social Environment

- Socioeconomic Activity
- Aesthetic value

1.6.1 SOIL

Soil or land contamination may result through direct spill of the product or leak from the USTs and the piping system of the fuel station. The dispensing activity and the floor integrity are the major players in land contamination. Cracks in the concrete floor of the station would mean propagation of the HC into the soil.

Underground water wells in the vicinity of the activity would be affected if the spill mitigation measures were not followed.

MTBE and other oxygenates generally have high vapor pressures, and they tend to volatilize. Oxygenates have relatively low Henry's Law Constant (K_H) values, and so they partition strongly into soil moisture. Vapor-phase migration will be much faster in dry soil and much slower in moist soil. Oxygenates have little tendency to volatilize from groundwater, and so the soil vapor in the vicinity of a dissolved-phase plume may only contain low, or even non-detectable, oxygenate concentrations. Volatilization will be particularly low if there is significant groundwater recharge: in that case, fresh water will accumulate on top of the dissolved-phase plume as it migrates down gradient. The dissolved oxygenate molecules will then have to diffuse upward through the fresh water wedge before they can volatilize, and this process can take decades.

Oxygenates, like other fuel components, can migrate in the vapor phase to receptors in overlying buildings. At present, the potential risks posed by this pathway are not clear. Many oxygenates (particularly MTBE) have little tendency to sorb to soil, and they are resistant to biodegradation. These factors would increase the potential for vapor-phase migration. On the other hand, vapor-phase oxygenates partition strongly into soil moisture, as noted above. Any precipitation (or other forms of recharge) migrating downward would readily "capture" vapor-phase oxygenates, thereby reducing (or even eliminating) the potential for vapor-phase migration.

MTBE and other oxygenates generally have low organic carbon partition coefficient (Koc) values. Thus, in dry soils, oxygenates are less likely to occur in soil samples because they are less likely to be adsorbed to naturally occurring organic carbon. On the other hand, oxygenates also tend to have relatively high solubilities, and so they are more likely to be dissolved in soil moisture. In moist or water-saturated soils, such as those collected within the saturated zone, oxygenates may be readily detectable.

The corrective strategies that remove contaminants from soils include vacuum extraction, soil washing, and soil excavation.

1.6.2 UNDERGROUND WATER

MTBE's and other ether oxygenates' solubility in water is very much higher than that of the hydrocarbon components of gasoline, i.e. the potential to dissolve into ground water is higher than that of the hydrocarbon components, such as Benzene, Toluene, Ethyl benzene and Xylene (BTEX Hydrocarbons). Oxygenates generally have low Koc values and low K_H values; ether oxygenates also have low biodegradation rates. Dissolved-phase ether oxygenates therefore tend to remain in groundwater, instead of sorbing to soil, volatilizing to soil vapor,

or biodegrading. MTBE has a specific gravity of 0.740, which is even less than the BTEX compounds. Therefore, as it is less dense than water, it cannot sink. Dissolved constituents, which are less dense than water can reach deeper groundwater in response to natural or induced hydraulic gradient and diffuse recharges. All dissolved constituents can form narrow plumes if the groundwater flow direction remains constants over time.

1.6.2.1 Ecological Toxicity

The available evidence suggests that MTBE in surface waters has limited acute and chronic toxicity for aquatic organisms.

1.6.2.2 Taste and Odor

At high concentrations, MTBE is considered to have a strong, turpentine-like odor; however, human sensitivity to this odor varies. Individual taste and odor threshold values ranging from 2.5 µg/l to 740 µg/l have been reported (Oxygenated Fuel Association - OFA). Several recent studies concluded that MTBE concentrations in the 20 to 40 µg/l range would likely avert unpleasant taste and odor effects, but also noted that some people may detect the chemical below this range.

1.6.2.3 Monitoring and Remediation

Groundwater monitoring looks for the presence of liquid product floating on the groundwater at the UST site. A site assessment must determine the number and placement of monitoring wells that make sure a release is detected. This method cannot be used at sites where groundwater is more than 20 feet below the surface.

The presence of MTBE and other ether oxygenates in groundwater does not prevent the application of conventional active remedial methods such as air stripping, carbon adsorption using granular activated carbon, and soil vapor extraction.

1.6.3 AIR

The strategies used to remove contaminants from soil and groundwater can sometimes result in the transfer of contaminants into the air. For example, air stripping towers, which are commonly used to remove volatile organic compounds (VOCs) from water, transfer a high percentage of the contaminant from the liquid phase to the vapor phase where they may be released to the atmosphere. Likewise, two widely used technologies of soil remediation, soil excavation and vacuum extraction, involve bringing soil and/or vapors to the surface of the ground where vapors may move freely into the atmosphere.

The release of contaminants into the atmosphere is undesirable for two reasons:

1. Exposure to VOCs could pose public health risks if released in sufficient quantities for long periods of time. Benzene, which commonly makes up to 2 to 4 percent of gasoline, is a known carcinogen.
2. VOCs are ozone precursors, thus making them more undesirable.

Vapor monitoring is a measure at the UST site to check for a leak, and it is used to measure product vapors in the soil. A site assessment must determine the number and placement of monitoring wells that make sure a release is detected. NOTE: vapor monitors will not work well with substances that do not easily vaporize (such as diesel fuel). Combustible Gas Meter are used to measure vapors

1.6.4 TERRESTRIAL

Apart from the contextual environmental concerns surrounding retail fuel stations – such as impacts on the existing urban fabric and social dynamics of the neighborhood, traffic build-up and impacts on the existing services infrastructure, visual impacts, noise and air pollution, and the constraints imposed on any alternative future land use per site – the immediate and perhaps most significant concerns relate to potential contamination of the soil and of ground and surface water with hazardous hydrocarbons. Secondary impacts that may arise from such contamination include the risk to public health and safety, and damage to flora and fauna in the vicinity.

In most fuel stations, oil resulting from automotive service operations is collected to be blended and reprocessed as another grade of lube oil in some oil reprocessing facility. Some Stations, however, do not operated in the same manner and collect the oil in oil waste pits which are a fatal attraction to migratory birds. Birds, bats and other wildlife mistake these oily pits for wetlands. Birds landing on waste pits can get covered with oil which causes them to drown. Many bird deaths go undetected because the carcasses sink to the bottom of the pits. Oil destroys the feathers' ability to insulate the birds resulting in death from heat or cold stress. Even a light sheen on the water surface can be deadly. Oil on the feathers of female birds can be transferred to their eggs back at the nest, killing the embryo. Some birds become victims of pits when they feed on insects trapped in oil covering the surface of the water. Animals scavenging on dead birds at these pits often succumb to the toxic effects of oil.

Photo 1

Photo 2

Photos 1,2,3: Oil and Terrestrial Environment

1.6.5 SOCIOECONOMIC

The presence of fuel stations is usually associated with socioeconomic benefits. Use of local workers during the construction phase and needed workforce during operation. In addition, raise in economic levels might be expected. Also, the activity will cause exporting of new facilities, equipment and techniques to the project area positively influencing the cultural environment.

1.6.6 AESTHETIC VALUE

The aesthetic value would be disturbed during the construction and operation as the virginity of the area exist no more. Thus, during the design phase, the aesthetic value must be taken into consideration such that the administrative buildings and the site is in harmony with the surrounding environment.

1.7 Hazardous Materials used in Operation

1.7.1 INVENTORY AND USAGE

The liquid products used in the fuel stations are:

1. Cleaning Fluids
2. Lube Oils
3. Gear Oils
4. Gasoline

In addition to other products in the Mart section including air and oil filters, vehicle accessories and food and beverages.

1.7.2 STORAGE

The cleaning fluids -lube oils and gear oils-come in containers of various sizes, typically 1 liter. The gasoline is stored in USTs.

1.7.3 DISPOSALS

The used oils are to be collected in drums and shipped to oil reclaiming plants to be reprocessed to lower grade oils.

2 Indicators and Measures of Effects

2.1 Description of Indicators of Environmental Effects

2.1.1 CONSTRUCTION

During the construction phase, the activities that could impact the environment are identified as:

1. Land occupation
2. Site preparation
3. Site access and transport of material,
4. Handling of materials and storage
5. Soil excavation and construction work
6. Waste disposal.
7. Workforce
8. Proper design and construction

2.1.1.1 Land Occupation

Trenching and laying of pipes and USTs has an adverse effect because the trenches are usually left open for some time and accidents could happen. Also, the development of the area will result in loss of habitat for fauna and flora.

2.1.1.2 Site preparation

Dust will be generated affecting the air quality. If ground water table exists near to the ground level, water might need to be pumped out and could flow back to the sea causing ground water contamination.

2.1.1.3 Material Transportation

The transportation of material will have an adverse effect on air and it will cause noise pollution as well, due to truck movement, however it could be eliminated if proper well-maintained equipment is used. This activity might affect biological environment due to expected disturbance on site.

2.1.1.4 Materials Handling and Storage

The construction materials and fuel for machinery can have a slight adverse effect on the environment if stored improperly. Proper storage means that the storage location must be chosen carefully so that the material can be stacked safely and avoid interactions with the weather conditions in the area.

2.1.1.5 Soil Excavation and Construction Activities

Excavation works for the installation of pipelines is not likely to affect the geology of the site because pipes are to be embedded 1 to 5 meters depth maximum. The impact on land is limited to USTs and trenches. However, air quality will be

adversely affected during the construction due to the generated dust. Excavation equipment and machinery will generate localized and short-term noise pollution. Also water contamination could be expected during construction in case of spillage of raw materials to the seashore, however, well performed and experienced work could mitigate these effects remarkably. An adverse effect on biological environment could be estimated due to the excavation work, which will cause damages to flora and fauna. There is a positive effect on the socioeconomic environment due to presenting of new building techniques and operations, which might not be known in the area. However, other minor adverse effect on public might be estimated due to construction hazards on public life, a proper construction safety rules could minimize that effect, if followed.

2.1.1.6 Waste Disposal

The topsoil will be removed during the construction. If the solid waste remained after construction, it will have a minor negative impact on the land. From an aesthetic point of view a minor adverse effect occurs. Wastes must be dumped in a proper and approved dumpsite in the area.

2.1.1.7 Workforce

Although upper management of construction will come from Cairo or any other big city, there will be some local recruitment from labor in the surrounding area of the resort. The socio-economic benefits will be positively affected. In addition, there will be a raise in the economic levels. Also, this activity will cause exporting of new facilities, equipment and techniques to the project area positively influencing the cultural environment.

2.1.1.8 Proper Design and Construction

A proper design will preserve better system and positive impact on over all environments. Also, proper and trained construction management will ensure positive impacts due to understanding of work quality principles. The good design and proper construction will maintain minimum adverse effects on land, water, air and noise. On the other side, it will maximize the positive effects on public, economic and cultural. Aesthetics will be maintained properly as well.

2.1.2 OPERATION

The activities that could impact the environment during the operation of the utilities are:

1. Land occupation
2. Operation and maintenance
3. Supply of materials and utilities
4. Transport and access to site
5. Waste disposal
6. Workforce and training

2.1.2.1 Land Occupation

Once the station is installed, the land occupation will be that for the pumping station, USTs, small patches of land for the manholes and valve chambers for the networks, the dispensing facilities, and the Mart section. Aesthetic could be adversely affected if improper architectural design is adopted.

2.1.2.2 Operation and Maintenance

During operation, surface water drainage patterns should be regularly cleaned and checked to prevent clogging. The flow of storm water over refueling areas could impact the underground water. Strong odors while dispensing of gasoline could be emitted. Spills and cracks are the main cause of pollution to soil and underground water. Continuous maintenance and UST testing could determine and mitigate the spill prior to occurrence. Cultural will be positively affected due to educating the local workers of modern technologies in system operation and maintenance.

2.1.2.3 Supply of Materials and Resources

Supply of the required spare parts needed for proper operation is very important. And supply of gasoline stock is a vital operation. Extreme caution during the activity would result in preventing spills or fire hazards.

2.1.2.4 Waste Disposal

If the generated liquid or solid wastes out of operations were not handled properly, it will cause an adverse impact on human and quality of life and also from an aesthetic point of view. Liquid wastes should be contained so as not to be mixed with the sewer system.

2.1.2.5 Workforce

The required workforce for operation and maintenance of the networks will be recruited and mostly locally which would positively affect the economic and cultural of the social environment.

2.2 Observations and Measurement Techniques

Site investigation is crucial when assessing the risk a soil and/or groundwater contamination incident may pose towards the environment and human health. Therefore, considerable efforts should be made to conduct proper site investigation and assessment, especially if there is a reason to believe the contamination might be serious and/or at a critical location such as an active aquifer or in the middle of an urban community. The assessment is to be carried during the life time of the project, during construction and operation phases.

2.2.1 CONSTRUCTION

2.2.1.1 Soil

Soil samples are collected for two primary reasons during MTBE site assessments: hydro geologic characterization and source-zone chemical characterization. Soil cores are collected to define the shallow subsurface geology and hydro geologic properties of the soil (e.g., grain size, porosity, permeability, bulk density). In fine-grained strata, soil cores are often the only way to identify the presence of features like desiccation cracks or root holes that can dramatically increase the secondary permeability of the soil. At complex, heterogeneous sites, continuous soil cores are needed to define the subsurface geology. At other sites, spot-coring may be all that is necessary to confirm the conceptual geologic model of the site. Soil coring is typically needed to confirm the results of surface geophysical surveys and to calibrate the reading from a cone penetrometer-testing (CPT) rig.

2.2.1.2 Underground Water

During the construction phase, underground water quality should be monitored and registered. Monitoring wells are to be installed. Single interval monitoring wells are most common. Single interval monitoring wells are typically constructed of 1/2 to 1-inch diameter PVC. Well screens are made of either slotted PVC or stainless drive points containing ports wrapped with stainless steel mesh. Riser pipes are made of PVC or, in the case of stainless steel drive points, 1/2 inch-diameter polyethylene or Teflon tubing. The wells are typically installed by advancing a displacement tip on the end of the DP rods. The PVC pipe or tubing can be advanced with the DP rods, or inserted after the DP rods have been pushed to the desired depth. When the DP rods are pulled out, sand collapses around the well screens and riser pipe. With larger DP rod systems, a pre-packed sand pack can be attached to the well screens. Also, cement or bentonite seals can be injected into the annular space as the DP rods are withdrawn. Water samples are collected using peristaltic pumps, small-diameter bailers, checks valve tubing pumps, and airlift pumps. Small-diameter bladder pumps are now available for sampling 1-inch-diameter monitoring wells. Hydraulic heads are measured with standard electric tapes or depth indicators. A number of manufacturers also make electronic pressure transducers that will fit inside of small-diameter monitoring wells. The wells should not form pathways for the vertical migration of contaminants.

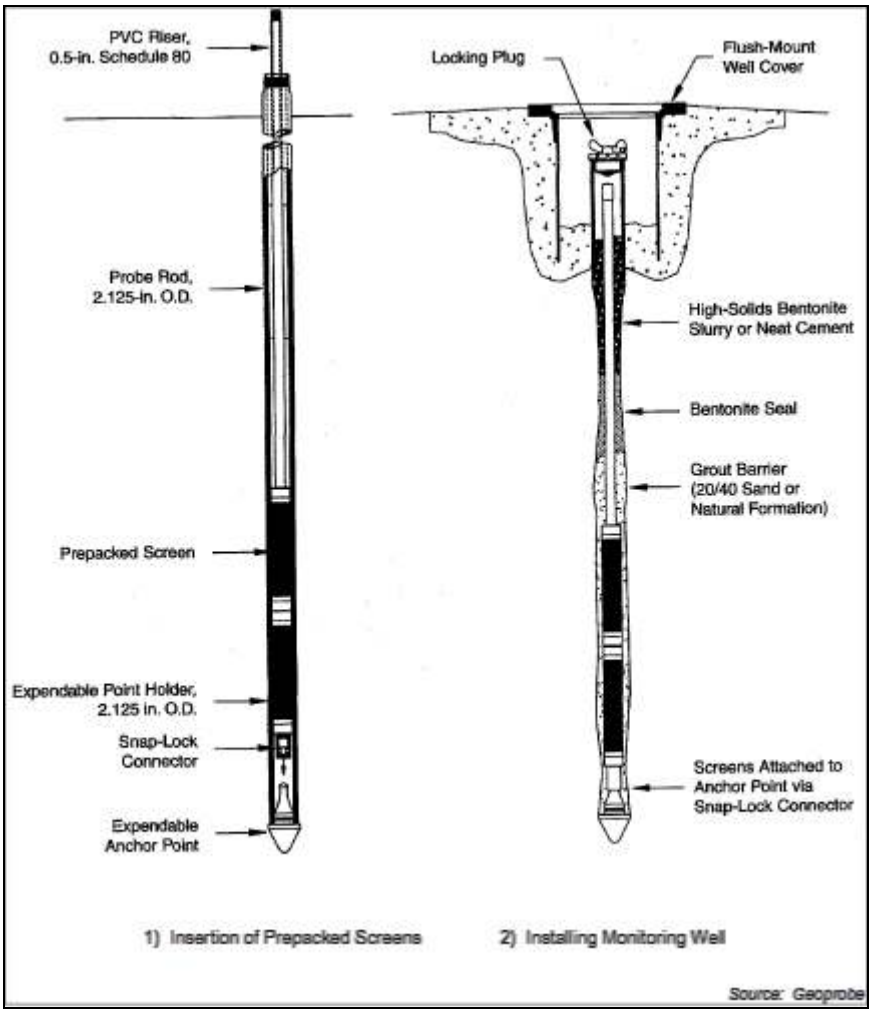


Fig. 4: Single-Interval Monitoring Well Installed With Direct-Push Equipment

2.2.1.3 Air

During construction, the air borne impact is only due to dust.

2.2.2 OPERATION

2.2.2.1 Soil

There are two primary types of soil sampling tools. The first is referred to as “non-sealed” samplers or sample barrels. These tools include barrel samplers, split barrel samplers (e.g., Standard Penetration (SPT) samplers) and thin-walled tube samplers (e.g., Shelby tubes; Figure 5). The tools are open at the end, allowing the soil to enter the sample barrel as it is driven into the ground. Open barrel samplers should only be used when they are advanced through hollow-stem augers or a drive casing (in the case of a dual-tube DP system) that prevents slough from cross-contaminating the soil sample.

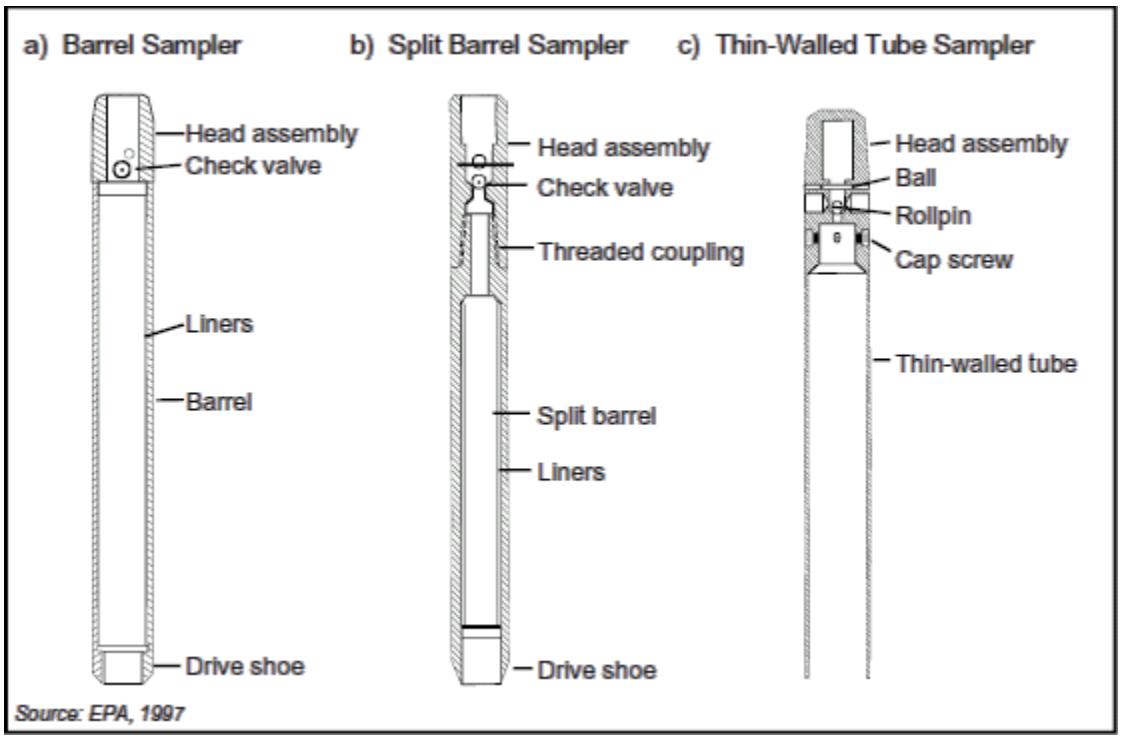


Fig 5: Examples of Non-Sealed Soil Samplers and Sample Barrels

The second type of soil sampling tool is a sealed barrel or “piston sampler.” Piston samplers are the most commonly used types of soil sampling tools used during environmental assessments. Piston samplers are sealed with a watertight piston as they are pushed to the desired sampling depth. The piston is then released. Continued pushing of the tool allows the soil sample to enter the sample barrel (Figure 6). When the sample barrel is full, withdrawing the sampling rods retrieves the sample. Subsequent samples are collected in the same way. The primary advantage of piston samplers is that they are sealed until they reach the desired sampling depth. This allows the tool to be pushed through heavily contaminated soil or water without cross-contaminating the soil sample collected at a deeper depth. Piston soil samplers are commonly used with single rod Direct Push (DP) systems.

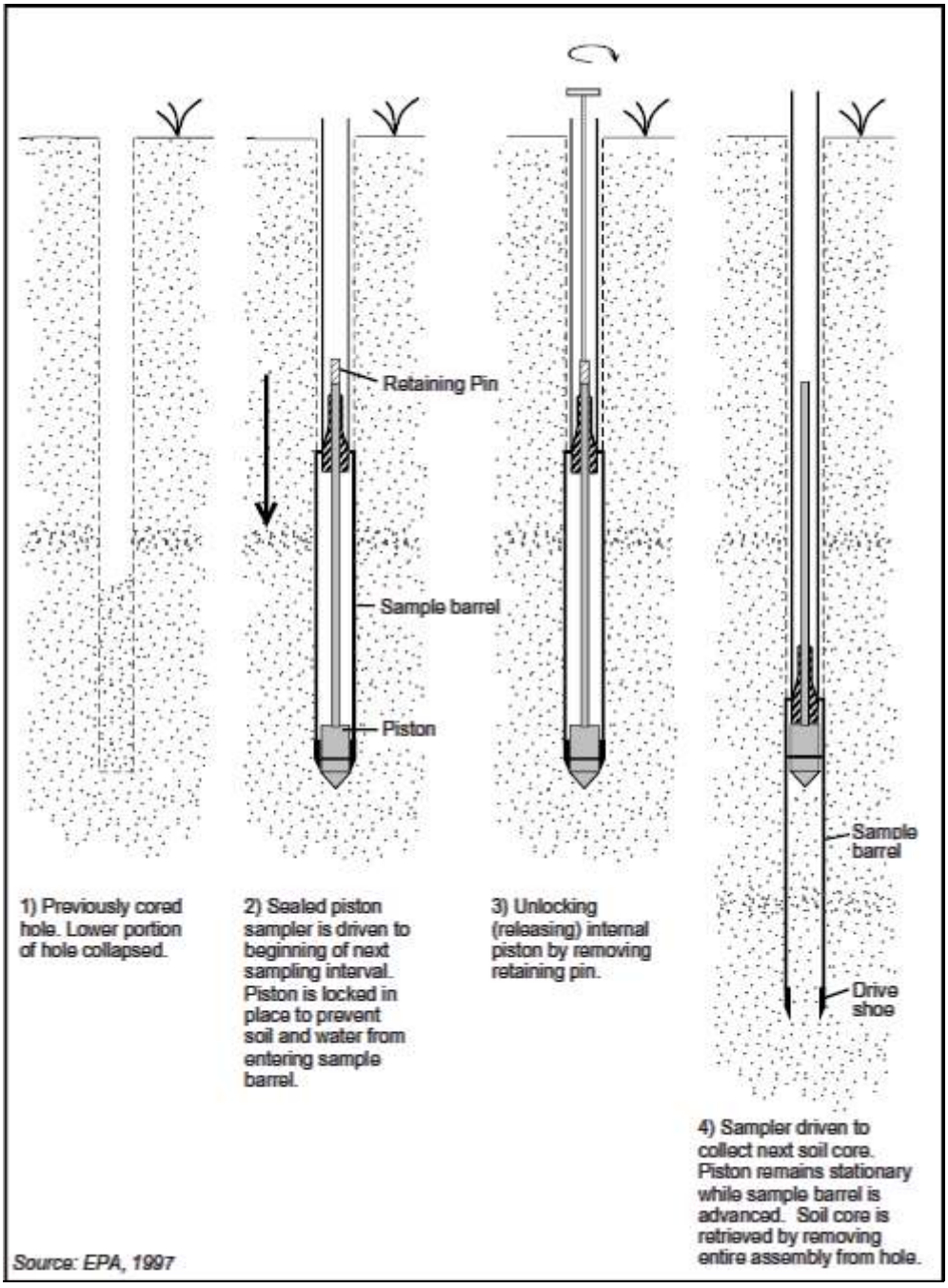


Fig. 6: Example of a Piston Soil Sampler

Collecting vertical profiles of gaseous concentrations of MTBE and other petroleum hydrocarbons can provide valuable information about the release mechanism (e.g., vapor releases). Because of the affinity of MTBE for water, however, soil gas surveys can rarely be used to identify the location of dissolved plumes of MTBE. A wide variety of soil gas sampling tools exist, some of which are depicted in Figure 7. Some use an expendable tip to seal the rods as they are advanced to the target depth. Others use a retractable tip. Still others use an

expendable or retractable tip equipped with flexible tubing through which the sample is extracted. Soil gas samples are typically extracted using a vacuum pump and are collected in stainless steel canisters, bags, or syringes. Soil gas samples should be analyzed as soon as possible (ideally on site) to prevent diffusive losses or biodegradation of the samples.

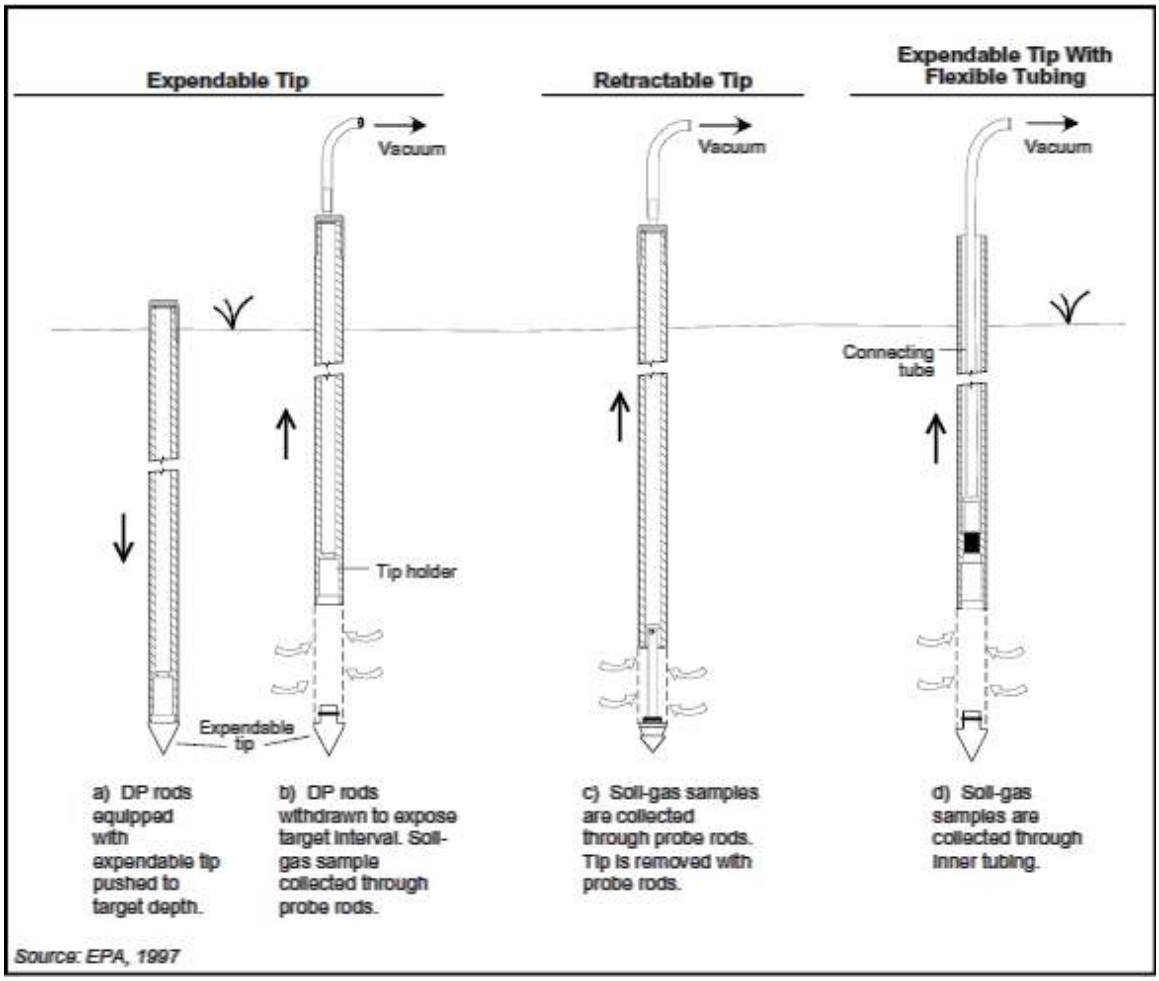


Fig 7: Examples of Soil Gas Sampling Tools

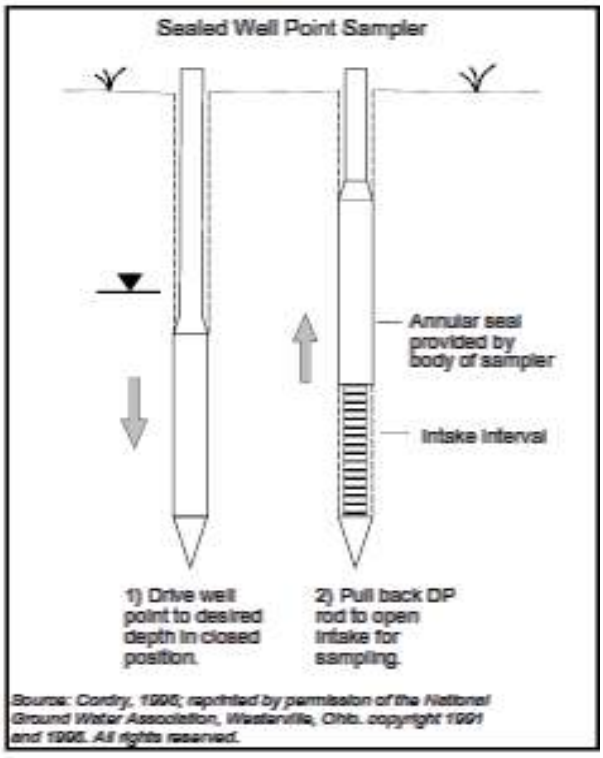
2.2.2.2 Underground Water

Collection of groundwater samples constitutes one of the primary activities of MTBE field investigations, especially when definition of the dissolved plume is necessary. MTBE has tendency to partition into water (due to the chemical's low Henry's constant), thus lose of significant mass of MTBE with most DP groundwater sampling methods is not applicable.

Three types of DP groundwater sampling tools are commonly used to collect one-time samples of groundwater, yielding “snapshots” of groundwater quality at a particular location. The first type is the conventional well point made of wire-wrapped steel well screens and steel riser pipe. Well points are widely available for shallow water supplies in rural areas. Well points can be left in place as permanent monitoring wells to allow collection of additional groundwater samples overtime. Well points are best used in sand and gravel aquifers, since silt and clay formations can plug the exposed well screens as the well points are advanced. Also, well points are susceptible to cross-contamination when the points are pushed through high-concentration portions of a dissolved plume to less contaminated groundwater underlying the plume. This potential bias should be negligible for MTBE assessments, however, because very little MTBE would be sorbed on soil inadvertently pushed to the deeper depths.

Sealed screen underground water sampling tools are the most commonly used DP sampling tools (Figure 8). Sealed screen samplers are commonly used with truck-mounted DP rigs, where the samplers are advanced on the end of steel DP rods. Once advanced to the target depth, the tool is withdrawn a specified distance (ranging from 0.5 to 5 feet), exposing a well screen. Groundwater flows into a reservoir inside of the tool, and can be retrieved by withdrawing the tool, or extracting the water sample with a small sampling pump. Sealed screen samplers are often used to collect depth-discrete groundwater samples in conjunction with conventional drilling methods. These methods are typically used to delineate MTBE plumes that occur at depths greater than can be reached with smaller truck mounted DP rigs. To collect a groundwater sample, the sealed screen sampler is lowered down through the inside of the rotary drill rods, and pushed a few feet into the undisturbed aquifer (Figure 9). The sampling tool is pulled back, exposing the wells screens, and water samples are collected as described above.

Fig. 8: Example of a Sealed Screen Groundwater Sampling Tool



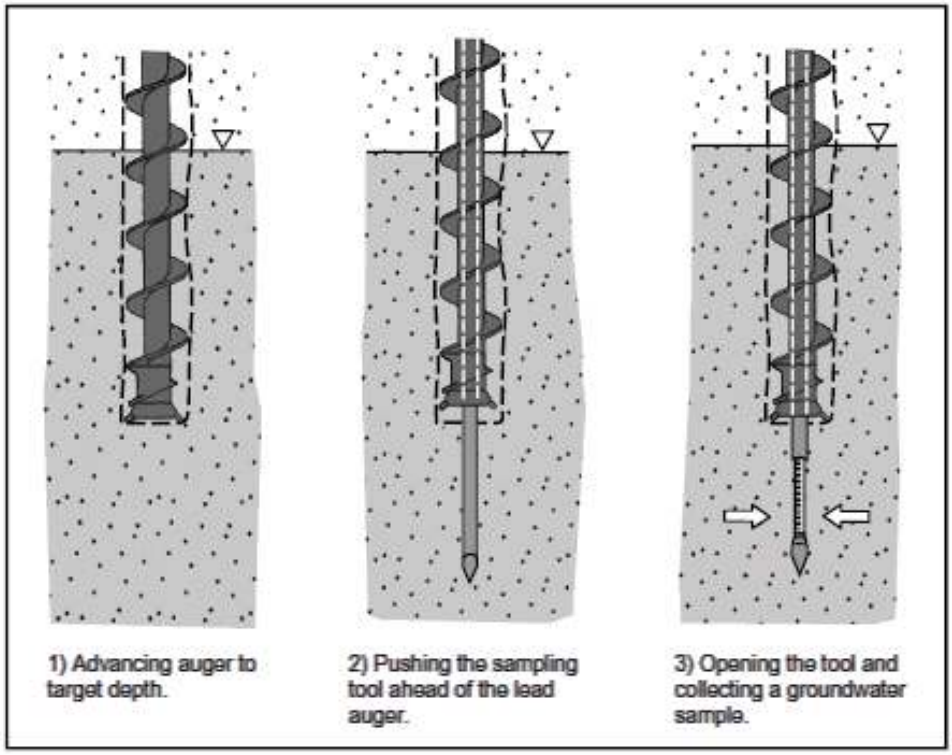


Fig. 9: Collecting a Groundwater Sample Ahead of a Hollow Stem Auger Using a Sealed Screen Direct-Push Tool

Another type of groundwater sampling tool, referred to as a groundwater profiler, is used to collect multiple depth-discrete groundwater samples in a single push. With an underground water profiler, groundwater samples are collected through ports located at the bottom of the DP rods (Figure 10). Samples are extracted through Teflon tubing that runs inside of the DP rods from the intake ports to the ground surface. Samples are collected in vials mounted upstream of the peristaltic pump, in order to avoid negative biases caused by sorption of organic molecules to the peristaltic tubing. After a sample has been collected, the flow of water is reversed, and de-ionized water is pumped slowly down through the Teflon tubing and out of the sampling ports. This flushes the old sample out of the tubing and keeps the ports from plugging. When the next sampling depth is reached, the flow direction is again reversed, pumping groundwater to the surface. Care should be taken to avoid collection of the first water that is pumped out of the system, since this will consist primarily of de-ionized water contained within the tubing (the arrival of aquifer water is easily determined by monitoring the electrical conductivity of the effluent). Groundwater profilers are especially useful for delineating stratified contaminant plumes in coarse-grained aquifers.

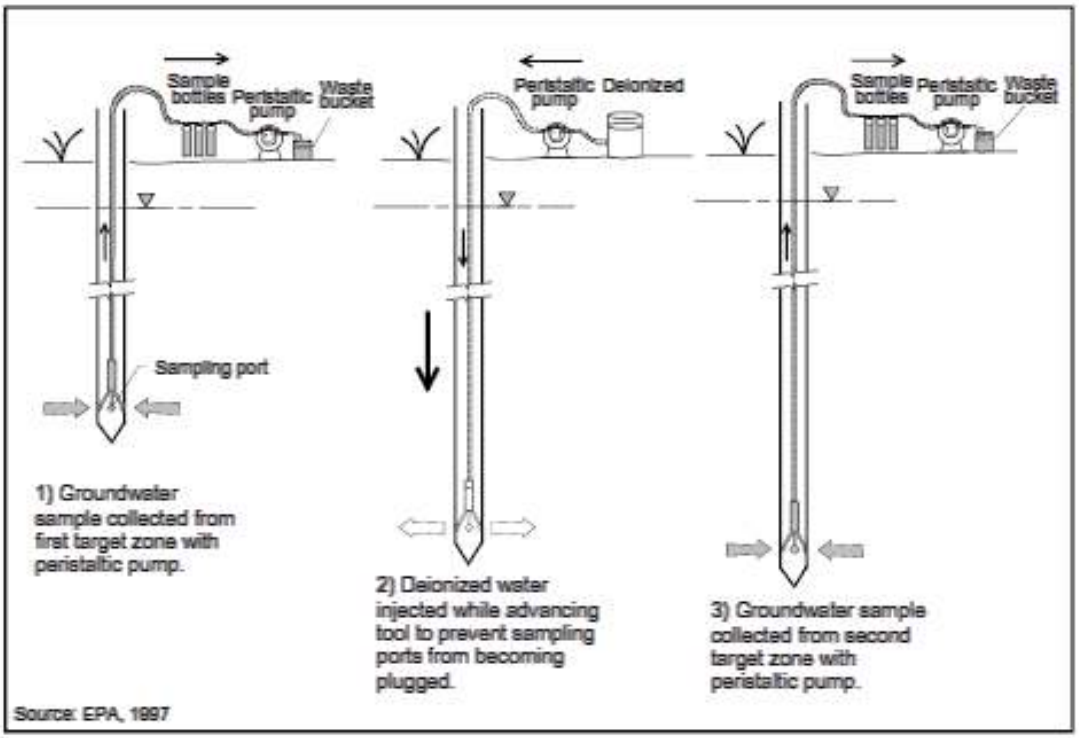


Fig. 10: Example of a Groundwater Profiler

Another groundwater sampling tool, the Simul Probe, facilitates the collection of soil and soil gas or groundwater from the same depth interval. The Simul Probe tool has seen widespread use in MTBE assessments, and is typically used in conjunction with powerful DP or conventional drilling rigs, as described above.

2.2.2.3 Air

The highest exposure to air-borne MTBE experienced by the public is during vehicle fuelling. However, exposures are generally less than 35 mg/m³ and are only at such levels for very short periods. Very small quantities may also be discharged unburned from vehicle exhausts: levels of approximately 0.05g/km have been reported.

Higher exposures for longer periods may be experienced by workers during the production, storage and distribution of MTBE itself, and also of gasoline containing MTBE. Typical occupational exposures are 4 to 45 mg/m³ during MTBE handling, and 0.3 to 20 mg/m³ during gasoline handling. These can be compared with the occupational exposure limit for MTBE of 92 mg/m³ in the UK (8 hours). In most other European countries the limit is higher: up to 180 mg/m^3.

Although MTBE's distinctive smell makes the vapors easy to detect, there is no indication that they persist long enough in the air at a level which would,

according to latest scientific information, cause harm to the environment or to human health.

2.3 Interpretation of Results

2.3.1 CONSTRUCTION

The data collected during the construction phase would represent the baseline data of the existing environment prior to any activity.

2.3.2 OPERATION

Data from periodic monitoring should be interpreted and summarized using potentiometric contour maps and isoconcentration contour maps. Sites that warrant a standard or limited level of assessment would usually require a similar monitoring period and data summary

3 Implementation of Monitoring Requirements

3.1 Assignment or Responsibility

3.1.1 TDA

A regulatory agency in association with EGPC for inspection and enforcement procedures should be established. There appears to be a lack of adequate enforcement against owners/operators who are not complying with leak detection requirements or who fail to follow-up on suspected releases. Other suggestions for improvement of the regulatory enforcement process, include:

- Consolidate regulations to reduce overlap and improve clarity (e.g., clearly define “reportable quantity”).
- Expand training for regulatory inspectors and ensure the uniformity of the training.
- Increase administrative and legal support for enforcement activities.
- Provide sufficient funding and human resources for these regulatory improvements, particularly at the local level.

Leak Reporting and Remediation

Although monitoring of stock levels alerts the station owner to possible leaks, the authorities are often not made aware of such an event and there are no systems in place to ensure that this happens. Consequently, the problem may be rectified at the station and the tank or pipeline replaced, but the environmental damage on site is not necessarily remediate adequately.

Owner/Operator Certification and Training

There is no requirement, nor any authority, to certify the owners, operators, inspectors, or contractors. However, certification and licensing program for

contractors should be adopted and involves the installation, removal, and upgrade of USTs.

Tanker Driver Certification and Training
Consistent certification requirements for all tanker drivers in association with the Department of Transportation [DOT] and in accordance to its requirements. In addition, proper training from EGPC and the Civil Defense. Third-party oversight during product delivery, particularly for newly trained drivers is recommended.

Customer Education
There currently is very little emphasis placed on public outreach with regards to leak prevention at service stations. Booklets that address emissions during fueling could be made available to educate the customers on the fuelling activity and environmental hazards. Work with the local NGO to attempt to educate the general public about their role and responsibility in the proper handling and use of gasoline and actions in case of major road spill. The usage of portable fuel containers and properly disposing unused gasoline to prevent spills in remote locations is of concern and interest to the general public. LPG and CNG introduction and efficiency of using such fuelling technique in cars and trucks.

3.1.2 PRIVATE SECTOR

Inconsistent Product Monitoring
The monitoring practices at a great number of stations are inadequate and records are not updated consistently. Product losses and possible leaks can only be recognized if stock levels are recorded methodically and if authorities or independent consultants on a regular basis audit the records. Thus, the station owner should adopt an EMS and keep a logbook of all the incident records and in-situ auditing reports. Checklists and forms presented in Appendix B are recommended for usage and should be kept for at least two to three years.

3.2 Specialized Expertise

3.2.1 PERSONAL AND TRAINING REQUIRED

Operator Certification and Training
Operators should be training on the following:

- UST installation
- UST upgrading - interior lining and corrosion protection
- UST leak detection standards and systems
- UST compliance inspections
- UST removal technical and regulatory aspects
- Spill response and reporting
- Site maintenance and cleanup
- Inventory control

- Overfill prevention
- Operating and understanding leak prevention and alarm systems
- Requirements for third-party oversight and QA/QC documentation

As earlier mentioned, all employees should be trained upon hiring and annually thereafter on proper methods for handling and disposing of waste, and understand storm water discharge prohibitions and wastewater discharge requirements. Use a training log or similar method to document training.

Tanker Driver Certification and Training
Tanker driver training programs and materials should be used to potentially reduce overfills and surface spillage. Rigorous training programs for all tanker drivers, including sections on: importance of drivers' roles in avoiding and reducing spills; spill response and reporting; tank gauging; purpose and function of overfill protection devices and spill boxes; vapor recovery systems; and, health and safety.

3.2.2 SPECIALIZED EQUIPMENT

The monitoring equipment to be found in the fuel stations would be mainly Water Refining Paste to determine the presence of water in the Gasoline UST, or use of probe to measure the HC content in monitoring wells

3.3 Recommended Implementation Schedule

Underground water and soil assessment should be conducted on monthly basis. In-situ auditing and reporting should be documented and made available to the CAA to check accordingly. In newly constructed sites, bimonthly monitoring and auditing is recommended, while the UST integrity should be tested every three years. While in vigorous areas or near protected areas, tighter schedule would be the best alternative.

4 References

1. **American Petroleum Institute - API**. API Soil and Groundwater Research Bulletin.
2. **American Petroleum Institute - API**. Strategies for Characterizing Subsurface Releases of Gasoline Containing MTBE.
3. **CONCAWE Health Management Group**. The Health Hazards and Exposures Associated with Gasoline Containing MTBE.
4. **Environmental Containment Encyclopedia.** Jet Fuel.
5. **Italian National Centre of Research**. A Risk Based Approach for the Design of Motorway Service Stations.
6. **MUFC Guidebook.** Motor Vehicle Fuel Dispensing.
7. **Scottish Environmental Protection Agency**. Construction and Operation of Fuelling Stations.
8. **The European Fuel Oxygenates Association - EFOA**. MTBE Resource Guide.
9. **Urban Green File**. Managing Environmental Impacts of Retail Fuel Stations.
10. **U.S. Department of Energy.** Guidebook for Handling, Storing & Dispensing Fuel Ethanol.
11. **U.S. Department of Energy.** Federal Environmental Monitoring Handbook.
12. **U.S. Environmental Protection Agency - EPA**. Clean Alternative Fuels: LNG.
13. **U.S. Environmental Protection Agency - EPA**. Estimating Air Emissions from Petroleum UST Cleanups.
14. **U.S. Environmental Protection Agency - EPA**. Oil Pollution Prevention and Response.
15. **U.S. Fish and Wildlife Service**. Environmental Contaminants.

5 Appendix A: Monitoring Matrix

Anticipated Environmental Effect	Life Cycle Phase	Indicator	Measure of Effect	Measurement or Observation Technique	Responsible Entity	Sample Period	Record Keeping Requirement
Solid waste contaminating the land	Construction	Debris during the construction phase	Amount of debris and construction waste	Observer notes the amount of debris during the construction phase	TDA and Investor	Investor – Biweekly TDA – Monthly	Investor maintains contracts with contractor to sustain the environment and clean the area TDA records observations
Underground water contamination during UST installation and during monitoring wells digging	Construction	Liquid waste in the trenches for UST	Intensity of liquid waste	Prior to filling the UST chambers with sand, liquid waste should be visible and is not to be mixed with the leak from tanks. The monitoring wells are good indicators.	TDA and Investor	Investor – according to the number of UST. TDA – Once during the construction phase	Investor conduct analysis from the monitoring wells and maintains the records for observations. TDA verifies investor records.

Contamination of sewers and underground	Operation	Clogging of storm water drains. No presence of silt trap	Amount of clog in the drain system around the station	Trained observer notes that the storm water drain system is clogged and not clean. Observer notes no presence of silt trap or interceptors in site.	TDA and Investor	Investor – Weekly TDA - Monthly	Investor maintains records of housekeeping and observations. TDA records monthly observations and verifies investor records
Anticipated Environmental Effect	Life Cycle Phase	Indicator	Measure of Effect	Measurement or Observation Technique	Responsible Entity	Sample Period	Record Keeping Requirement
Contamination of soil and underground water	Operation	Cracks on the floors of the station	Amount of cracks and distance to the dispensers	Trained observer notes the presence of cracks on the floor of the site and the presence of spills in the dispensing vicinity	TDA and Investor	Investor – Weekly TDA – Monthly	Investor maintains floor integrity records and observations. TDA records monthly observations and verifies investor records
Contamination of soil and air	Operation	Leaks from the venture nozzles	Size and intensity of leaks	Trained observer notes the clogging of the venture nozzle and notes the spills and the leaking from it. Observer notes	TDA and Investor	Investor – Weekly TDA – Monthly	Investor maintains records for venture nozzles check and cleanup.

				the distances between the dispensing operation and the buildings and insures its accordance to the design table in section 1.2. Observer also notes the odors during the fueling operations			TDA records monthly observations and verifies investor records
Contamination of land and health hazard	Operation	Oil spills in the oil changing pits. No presence of toeboards and safety precautions in the area	Amount of spills in the pit, and availability of safety precautions manuals and stickers	Trained observer notes the housekeeping in the oil changing pit area and checks the availability of safety manuals and stickers in the area	TDA and Investor	Investor – Daily TDA – Monthly	Investor maintains records for shipping of used oil (if applicable) and housekeeping records. TDA records monthly observations and verifies investor records
Anticipated Environmental Effect	Life Cycle Phase	Indicator	Measure of Effect	Measurement or Observation Technique	Responsible Entity	Sample Period	Record Keeping Requirement

Fuel spills contribute to land and groundwater pollution	Operation	Petroleum stains or obvious signs of spills in fueling area	Size and intensity of spill	Trained observer notes current conditions compared to typical unpolluted systems and compares observations with previous inspections	TDA and Investor	Investor – Weekly TDA – Monthly	Investor maintains record of observations. TDA records monthly observations and verifies investor records
Fuel spills during UST filling operations contribute to land and groundwater pollution	Operation	Petroleum stains or liquid petroleum in the spill buckets	Size and intensity of spill	Trained observer notes the presence of solid matter in the spill buckets and checks the integrity of the system	TDA and Investor	Investor – Weekly TDA – Monthly	Investor maintains record of observations during UST filling. TDA records monthly observations and verifies investor records
Petroleum contamination from tank or distribution line leak	Operation	Obvious leaks or significant stains in surrounding soil	Observe soil in vicinity of tanks or distribution lines for stains or liquid.	Trained observer notes surface conditions of surrounding area for signs of petroleum contamination. Observer notes odors or the presence of leaks or contaminated	TDA and Investor	Investor – Weekly TDA – Monthly	Investor maintains record of observations. TDA records monthly observations and verifies investor records

				debris			
Anticipated Environmental Effect	Life Cycle Phase	Indicator	Measure of Effect	Measurement or Observation Technique	Responsible Entity	Sample Period	Record Keeping Requirement
Solid waste from stock and mart sections	Operations	Accumulation of unused containers in the waste collection area and the inventory area	Observe the inventory and the waste collection system	Trained observer notes the accumulation of stock in the inventory. Observer notes waste segregation if present	TDA and Investor	Investor – Weekly TDA – Monthly	Investor maintains record of inventory control TDA records monthly observations and verifies investor records
Contamination to the sewer system	Operation	Grease and oil products wash off during automotive cleanup services	Observe the cleanup operations	Trained observer notes surface conditions of surrounding area for signs of grease or oil contamination	TDA and Investor	Investor – Weekly TDA – Monthly	Investor maintains record of observations. TDA records monthly observations and verifies investor records

6 Appendix B: Checklists

Monitoring Reporting Form TDA

Facility Name		Facility Coordinates (decimal degrees)	
Date of Inspection		Latitude	Longitude
Inspector			
Life Cycle Phase (Construction/Operation)			
Inspection Parameter	Finding		
Storm water Drains			
Floor Integrity			
Dispensing Nozzles			
Dispensing Islands			
Safety Stickers			
Emergency Signs			
Spill Buckets			
Interstitial Monitoring			
UST Alarm System			
Inventory			
Automotive Washing Service			
Solid Waste			
General Observations			
Noted Deficiencies			
Follow-up Recommendation			

Facility Monitoring Reporting Form

Facility Name		Facility Coordinates (decimal degrees)	
Date of Inspection		Latitude	Longitude
Inspector			
Life Cycle Phase (Construction/Operation)			
Inspection Parameter	Finding		
Storm water Drains			
Floor Integrity			
Dispensing Nozzles			
Dispensing Islands			
Safety Stickers			
Emergency Signs			
Spill Buckets			
Interstitial Monitoring			
UST Alarm System			
Inventory			
Automotive Washing Service			
Solid Waste			
General Observations			
Problems Identified			
Corrective Action Taken			

FUEL DISPENSING SYSTEM MONTHLY VISUAL INSPECTION CHECKLIST

FILL AREA	DATE	RESULTS	REMARKS
Fill Containment Liquid Accumulation Removal			
Fill Pipe Drop Tube in Place			
Fill Caps & Gaskets in Place			
Fill Caps Locked			
Fuel Overflow Relief Valve in Place			
Liquid Accumulation Removal			
Fill Covers Color Coded			
Other Comments:			

FUEL DISPENSING SYSTEM MONTHLY VISUAL INSPECTION CHECKLIST

DISPENSER	DATE	RESULTS	REMARKS
Dispenser Liner Integrity			
Liquid Accumulation Removal			
Liquid Sensor Connection			
Shear Valve in Place			
Fuel Filter Integrity			
Pipe Fitting Leaks			
Corrosion Protection Anode Connection			
Vapor Pumps Operation			
Pressure Vent Valve in Place			
Other Comments:			

FUEL DISPENSING SYSTEM MONTHLY VISUAL INSPECTION CHECKLIST

SUBMERSIBLE PUMP/PIPING	DATE	RESULTS	REMARKS
Secondary Containment Integrity			
Containment Cover			
Liquid Sensor in Place			
Corrosion Protection Anode Wire in Place			
Submersible Pumps Condition			
Pump & Piping free from Soil			
Amount of Fuel in Containment			
Hydrocarbon Odors Moderate or Strong			

MONITORING WELLS	DATE	RESULTS	REMARKS
Monitoring Well Caps in Place with Lock			
Monitoring Well Grouting Integrity			
Liquid Accumulation Removal			
Monitoring Wells Covers Color Coded			