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Introduction

The arrival of oil to the shore may be the last sign of an oil pollution incident. Depending on the quantity and type of spilled oil, it may be necessary to organize a clean up response to remove the oil and to prevent its reforming and impact on surrounding areas.

The cleaning of the oil-affected coasts is one of the most complex and costly operations considering the characteristics of the oil and difficulty of its removal and cleaning. Cleaning of beaches affected by oil pollution requires a good knowledge of the nature of beach, which helps the field teams to identify the appropriate methods and equipment to remove the oil stains.

Purpose of Guide

The guide has been prepared to assist decision makers, field teams and volunteers to respond quickly to coastal oil pollution and to make appropriate decisions by selecting effective methods for the clean-up operation in line with the nature of coasts and to identify the lists of equipment and the scope and reasons for its use.

The relevant authorities

The guide is designed for all federal and local authorities that have roles and responsibilities in responding to marine emergencies as a result of oil pollution.
Important types and characteristics of oil

The effective and rapid response to oil pollution and the methods and techniques used to control its spread depend on the knowledge about the physical and chemical properties of the spilled oil and the environmental and climatic factors of the site. The term “oil” is used to refer to a wide range of oil derivatives from crude oil to different grades of petroleum products subjected to different refining processes. Oils are not identical but vary greatly from one product to another. It includes light, volatile viscous and highly flammable substratum such as gasoline and other heavy non-volatile, non-viscous and less flammable such as heavy fuel oil.

The spread and subsequent disintegration of oil stains and the proportions and extent of emulsification, evaporation and biodegradation processes depend entirely on the physical and chemical properties of the spilled oil.

- **Viscosity**: The ability of oil to spill and move at a certain speed as well as the extent of its resistance to flow. Viscosity is one of the main factors that help suction of spilled oil, it is in direct and inverse relationship with heat and density.
- **Qualitative density**: The qualitative density of oil is defined as a certain volume of oil to the same volume of water (oil density compared to water density).
- **Pour point**: Temperature at which the oil becomes “plastic” and will not flow.
- **Spill point**: It is the lowest degree to pour the oil during evaporation and then cooling.

**FYI!**

- Spill point is a measure of the ability of oil for pumping process through pipes
- Low viscosity is an important index on the suitability of oil for transport through pipes and ease of pumping
- All Kinds of oil became more viscous with lower temperature
- At the pour point, the viscosity may increase enough to stop the flow

- **Specific gravity** is the gravity or density of crude oil and liquid petroleum products. API is devised jointly by the American Petroleum Institute. The measuring scale is calibrated in terms of degrees API. The oil is classified according to density to:
  - Light oil: (API) higher than 30°
  - Medium density oil: (API) between 30° - 22°
  - The types of oil with low specific weight (high API° value) are characterized by low viscosity of volatile components

- Understanding the potential fate of oil and its behavior is the best choice for response, as soon as the oil starts to spill it gets exposed to weathering factors which changes it physical and chemical properties over time.
- The dispersion and evaporation of spilled oil depends on the weather conditions and oil properties such as: viscosity, spill point and specific gravity.
Impacts of oil pollution

The nature and extent of the oil leakage in the marine environment depends on the quantity, type and location of the oil spilled in the sensitive environmental zones most of which are located in the coastal zone. It also depends on the biological structure of the affected areas, the ecological importance of the marine life and its sensitivity to oil pollution. The promptness in response to reduce the spread of oil in sensitive areas, methods of cleaning operations, its effectiveness and compatibility with the nature of the affected ecosystems are of great importance and have a direct impact on the recovery or further contamination of the affected environments.

1. Environmental impacts of oil pollution:

Oil conceals the penetration of sunlight into the water column, which adversely affects the biological processes of aquatic organisms and the flow of energy through the different levels of production in the food pyramid. It also causes the immediate loss of organisms with anaphylaxis and mortality. The following are the impacts of oil pollution on animals and habitats

- **Sea birds:** Oil destroys the characteristics of external feathers, which disrupts the structure of the thin layer of protection and isolation of the bird’s body, which leads to:
  - Low temperature of the body, which causes death in cold climate.
  - Loss of ability to float and fly and becomes an easy prey to fish
  - Disruption of some body parts as a result of swallowing oil

- **Sea Turtles:** Sea turtles do not avoid oil stains, which makes them more at risk of exposure to oil when they float to the surface causing:
  - Severe burn of the mucous membrane of the eyes and mouth and skin irritation
  - Digestive inflammation, ulceration, bleeding and poor digestion

- **Coral reefs:** Coral reefs provide a rich and highly productive diversified ecosystem. They are extremely sensitive habitats and its recovery from oil pollution requires long periods of time. The oil naturally dispersed or by chemical dispersants can be exposed to suffocation and damage.
Impacts of oil pollution

- **Mangroves**: Mangrove forests provide an adequate habitat for many marine species. They are important breeding areas for fish. Its complex root structures capture and stabilize soil, thereby reducing beach erosion and acting as a natural barrier limiting the strength of waves and storms. Being located in the coastal areas, they are heavily exposed to oil pollution, which leads to the erosion of its roots and closure of oxygen resources and eventually its death.

- **Fish**: mature fish usually avoid oil polluted areas, however fish in early stages of life are more likely to be affected by the presence of oil in water which affects their vitality and excites hydrocarbons in their tissue.

- **Mammals and marine reptiles**: whales and dolphins may be at risk from floating oil when they get to the sea surface to breathe, oil can cause damage to the nasal tissue and eyes.

2. **Socio-economic impacts of oil pollution**
   - Damage to coastal and environmental tourism activities
   - Disruption of fishing activity and safety of seafood
   - Disruption of the movement of maritime vessels and commercial exchanges and the accompanying administrative complications and economic losses
   - High cost of pollution control, clean-up of affected areas and rehabilitation of coastal ecosystems

3. **Historical and cultural impacts of oil pollution**
   - Effects the sites of historical and cultural value
   - Damages the aesthetic view of coastal areas
   - Loss of marine and migratory birdwatching areas
Assessment of volume and spread of oil

(1) Assessment of pollution’s volume and spread

In preparation to start the cleaning process, it is very important for a specialized technical team to conduct a survey of contaminated areas and a rapid, accurate and systematic assessment of:

- Estimating the size and spread of oil spots in the coastal area
- Collecting oil samples
- Geographical identification of pollution area
- Preliminary assessment of pollution impacts
- Collect following climate data to consider during the cleaning process:
  - Wind Speed and direction
  - Strength of waves
  - Ocean currents
  - Tide
  - Temperature

(2) Oil Pollution Response Strategy

Data and information generated from surveys are necessary in the process of developing a response and decision-making strategy and determining the methods and techniques of cleaning operations.

- Selection of cleaning process techniques
- Mobilization of resources and equipment
- Establishment of field task forces
- Process identification
- Processing and organizing of intervention areas
- Prepare a timetable for the implementation of operations
(3) Selection of methods and techniques

Each pollution incident is a unique case and different from the other. There is no single method suitable for all cases. There are a number of methods available for coastal cleaning operations that can be adopted depending on the state of pollution and how it develops. They vary based on following:

- Pollution characteristics (nature of oil, its spread and concentration through place and time, its physical and chemical properties)
- Characteristics and geomorphology of the pollution site
- Easiness and difficulty of access to the pollution site
- Uses and sensitivity of the site
- Potential environmental impact of clean-up operations

**FYI!**

Mainly the environmental sensitivity and socio-economic uses of the polluted site determine the quality and most appropriate method of cleaning process

The type and characteristics of beach determine the most appropriate cleaning methods to be used

The decision to “do nothing” and merely follow the evolution of pollution is a preferred option in some cases where the cleaning methods have more serious environmental impacts than oil pollution
(4) Logistic and field organization of the site

At the work site, apart from the contaminated area to be cleaned, there are several other areas to be identified and restricted from entry. The movement of vehicle and pedestrians should be organized by placing signs and traffic signals. Those areas are:

- Contaminated area
- Storage area (waste storage)
- Disinfection area: the area must be equipped with the necessary equipment to ensure that the personnel and equipment can be cleaned and disinfected after each cleaning process before leaving the work site. The hygiene tools and protective equipment should be collected in order to facilitate the management of site
- Rest area: should contain at least changing rooms, toilets, first aid kit and canteen
- A dedicated storage area for tools and machines

(5) Daily action plan

The team leader presents the daily work program and the most important procedures followed:

- Detailed description of the type and characteristics of pollution
- Review of operational objectives
- Site privacy
- Clarification of the technologies to be adopted and its methods of use
- Clarifying the administrative categorization and coordination among individuals
- Briefing employees on safety rules
- Explain the procedures followed in case of accidents
- Distribute teams and tasks
- Integrating volunteers from organizations and civil society into specialized task forces
- Provide quick training courses for volunteers

Team leader presents daily program
Reference (Dubai Police)
General guidelines

Before proceeding with cleaning operations

Wear protective clothing and equipment (oil, chemical spray, metal dust) from the essentials and priorities before starting cleaning operations to avoid any risks to people.

Potential risks

- Exposure to volatile chemical spray and dust
- Exposure to bad weather
- Exposure to slippage due to viscosity of oil
- Exposure to audio pollution

Conditions for selection of personal protective equipment

The use of personal safety equipment depends on the following:

- Physical and chemical properties of oil (viscosity, density, toxicity)
- The prevailing weather in the pollution area (temperature, strong winds, rain, waves)
- Method for cleaning operations
**General strategy for coastal clean-up**

### Stages of beach cleaning

<table>
<thead>
<tr>
<th>1st Stage</th>
<th>2nd Stage</th>
<th>3rd Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reduce as much as possible the amount of oil that could devastate coastal areas</strong></td>
<td><strong>Removal of suspended oil and oil-contaminated coastal Sediments</strong></td>
<td><strong>Final cleaning process for minor contamination and residual of oil stains</strong></td>
</tr>
</tbody>
</table>

- Surrounding and collection of floating oil near the coast with floating barriers
- Disposal of solid and natural waste on the coast before the arrival of oil
- Reduce the spread of oil stains
- Mobilization of material and human resources
- Setting up the operations site and providing the requirements of teams and volunteers
- Stop the oil spill from the source (ship, oil facility ...)
- Allocate specific areas for waste disposal

- Surround the oil spots with floating barriers to prevent its spread and divert it away from environmentally sensitive areas
- Minimize oil through suction operations
- Take all measures to prevent pollution from reaching high-sensitivity areas
- Clean the beach from pollution in the most appropriate and efficient way
- Collection and separation of all types of waste at source
- Initial treatment of affected marine, wild habitat and land areas

- Conduct a comprehensive survey of the contaminated area and monitor the remaining oil stains
- Ensure that oil spots do not move to other places
- Remove the remaining oil stains
- Ensure that all cleaning objectives are achieved
- Prepare daily reports and final report on cleaning operations
- Photographic documentation of beach status before and after pollution
- Transfer waste to places of disposal
Coastal oil spill cleanup methods and techniques

Beach cleaning techniques

1. Manual cleaning
2. Mechanical cleaning
3. Pumping of floating oil
4. Washing by low pressure water
5. Washing with waves
6. Washing by high pressure
7. Use of sorbents
8. Beach cleaning/sand sifting
9. Beach cleaning/gravel cleaning
(1) Manual cleaning

**Description**

The process of manual cleaning is a selective process suitable for all types of beaches, especially for sensitive areas. The manual cleaning is one of the basic methods of cleaning and targets various types of oil pollution. In this system, the oil contaminated sediments and waste are removed, stored and disposed of by hand or using manual tools.

**Conditions for selecting technique**

- Pollution of all types, especially dispersed (diffused)
- Difficulty in deploying the mechanical equipment to polluted areas
- Preservation of clean sand as much as possible
- All types of beaches, especially sandy beaches
- Manual cleaning requires a large number of labor

**Manual cleaning equipment and safety**

- Cleaning equipment
- Skimmers, bulldozers, brushes, thorns
- Bags for collecting oil stains
- Waste containers
- Front-end loader for waste disposal

**Personal protective equipment**

- Work and chemical resistant gloves
- Safety boots
- Buffer masks
- Filtration mask
- Ear muffs
General guidelines

The team is divided into four groups according to the following functions:

- Combining / abrasion / collection
- Placing in bags and containers
- Waste disposal
- Collection and transport oiled wildlife to areas for cleaning and treatment
- Using holed shovels for highly viscous or emulsified oil types to discharge excess water
- The oil of high viscosity mixed with sand and water will be pumped into trenches to collect it
- Waste can be disposed of manually or using a front-end loader if the assembly area is accessible
- Don’t over-fill bins, plastic bags
- Maintain as much as possible keeping clean sediment in its places

Manual cleaning
Reference (http://news.freejdubai.com)

Collecting waste in bags
Reference (Dubai Police)
(2) Mechanical cleaning

During this process, high-viscosity oils will be absorbed, collected and removed in easily accessible places where large amounts of pollution are witnessed, especially sandy beaches. Cleaning operations require high skill to reduce the amount of uncontaminated water and sediments collected during the process. Heavy equipment used for cleaning may also lead to mix oil with clean soil.

<table>
<thead>
<tr>
<th>Process description</th>
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<tbody>
<tr>
<td>Mechanical cleaning is used to clean areas where high levels of pollution are observed. The process involves the use of heavy equipment to remove oil and sediments in easily accessible locations.</td>
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<table>
<thead>
<tr>
<th>Technique selection requirements</th>
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<tr>
<td>High level of pollution</td>
</tr>
<tr>
<td>Pollutants from low to high viscous oil</td>
</tr>
<tr>
<td>Easy access of heavy equipment to the place of contamination</td>
</tr>
<tr>
<td>Flat sandy beaches capable of bearing heavy equipment</td>
</tr>
<tr>
<td>Ensure the safety of heavy equipments</td>
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<table>
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<td>Hydraulic excavator</td>
</tr>
<tr>
<td>Grader machine/ tractor</td>
</tr>
<tr>
<td>Tractor or loader with front blade</td>
</tr>
<tr>
<td>Rear-end loader</td>
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<tr>
<td>Sifting machine for cleaning beaches</td>
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Hydraulic excavator
Backhoe Loader
General guidelines

- Mechanical technology for the collection of contaminants is highly profitable through its accelerated oil removal operations. In this process, the equipment can recover volumes of up to 400-800 cubic meters of mixture of oil and contaminated sand.
- Tractors are used to rub off contaminated materials.
- Soil moving equipment with a front blade will be placed in a tilted position.
- Low viscous liquid oil will be rubbed off to the collection points or trenches on the coast and then pumped them out.
- Gathering and distributing oil of high viscosity in long tilted lines on the beach and then removing them at a later stage.
- Mechanical technology is used only in cases of severe pollution and not used in cases of mild or minor pollution.
- Driver of the machine must have experience in dealing with oil pollution.
- Do not pass machines through pollution area to avoid the mixing of clean deposits with oil.
- Provide two employees for each machine to guide the driver.
- Dig trenches to find out the depth of oil in the soil.
- Level the sand after cleaning using a leveling machine.
(3) Pumping of floating oil

After surrounding the accumulated oil on water brink or collected in the pre-drilled trenches with floating barriers, it will be pumped through skimmers to tanks or dump trucks.

### Types of skimmers

- **Oleophilic skimmers**: It depends on the adhesion of oil to the moving surface and its separation from the water. They are highly efficient, especially with the oil types of medium viscosity, as it can restore a big proportion of oil from the water.
- **Suction skimmers**: The suction device is simply designed to recover the oil by pumps or air suction systems directly placed on the floating oil with with a mesh screen to inhibit the ingress of debris.
- **A weir skimmer**: Selectively recovers oil by the force of gravity into a central reservoir where it pumped to storage with as little water as possible.

### Technique selection requirements

- Large amounts of low or medium viscosity oil
- Accessibility to earthmoving Equipment and vacuum track to the polluted site
- Sand and gravel beaches and ports
- Suitable weather and absence of strong currents and waves

### Cleaning equipment

- Light containment booms
- Beach-sealing booms
- Backhoe loader (trenches / berms)
- Skimmer & skimmer head
- Pump & vacuum truck
- Personal protective equipment
Types of skimmers

**Oleophilic drum skimmer** is designed to recover oil spilled in the coasts and ports with a low rate of uncontaminated water. It has the capacity of 19.6 cubic meters per hour and highly effective with low and medium viscosity oils.

**A weir Skimmer selectively** recovers oil over the top central weir sited just below the upper surface of the slick is suitable for many types of oil as it will not use the non-contaminated water. The oil will stick to the rotary disks to the collection place in order to pump it to the storage area.

**Portable vacuum system** is highly profitable and used in hard-to-reach places, especially stone barriers, sandy and gravel beaches. Its storage capacity is very less.

**Small oleophilic disc skimmer** is connected to a vacuum pump for automatic oil suction through a number of small holes. It is normally used in quiet waters with minimum solid waste.

**Fixed weir skimmer** recovers the spilled oil with high-selectivity through the top of a submersible barrier located directly below the surface of the oil spot. It will use gravity to pump the oil into a storage tank.
Coastal oil spill cleanup methods and techniques

Cleaning Scenarios

### Scenario No.1

1. Enclose the spilled oil and contain it using floating barriers
2. Pump the oil to dump trucks using a skimmer match the location and oil properties
3. Survey the surrounding area to make sure there is no leakage of oil stains from floating barriers
4. Suction of scattered spots

One of the conditions for the effective use of floating barriers is appropriate climatic conditions and the absence of strong currents and waves

**Reference:** (response.restoration.noaa.gov)

### Scenario No.2

1. At the case of high tide, dig a trench along the shore line in the interdital zone during low tide time
2. Build a sand wall at the top of the trench using sand extracted from the trench
3. Put plastic linings in the trench and on the sand wall to prevent corrosion and avoid mixing of clean sand with oil
4. Pump the assembled oil in trench to the dump trucks

Clean the trenches and remove the plastic linings after cleaning operations

**Reference:** (response.restoration.noaa.gov)

**Surrounding the oil using floating barriers before suction**

**Digging trench along the beach to collect oil**
General guidelines

- Choose the most effective skimmer based on the type of oil to be recovered and its physical and chemical properties
- The decision to choose oil recovery at sea or near shore is based on prevailing climatic conditions such as the state of the sea, wind power, water currents and sensitive sites
- Monitor the performance of the skimmer continuously to ensure optimum efficiency
- Good logistic preparation for various operations (pumping, storage and disposal of oil) to ensure the cleaning process is carried out efficiently and quickly

Oil suction process by a weir skimmer

A weir skimmer selectively recovers over the top of the central weir located just below the upper surface of the slick by the force of gravity into the central reservoir where it is pumped to storage.


- Oil viscosity is a key factor that limits the efficiency of recovery devices
- Stop the use of scrapers and related resources as the process becomes less efficient.
- The abrasive equipment must be cleaned and fully maintained after each cleaning process
- The oil suction process requires two to three people to work in each recovery or storage unit
- Record all equipment and quantities of recovered oil in the daily activity log
- In addition to suction, the manual or mechanical cleaning is important to collect oil stains scattered from the suction and storage operations.
(4) Washing by low pressure

The contaminated areas of the beach with different components (sand, gravel, stones ...) are absorbed using large quantities of low pressure water to separate the oil suspended or buried in the sand. Then the contaminated materials will be rinsed or washed to prevent oil penetration and discharge into the collection areas. The rinsing is executed by using to the lower areas encircled by floating barriers that enable the recovery of oil. The abrasives, pumps or discharging trucks can be used to recover the collected oil.

- Low or medium viscosity oil types
- Oil spill within sediments and rocks
- Sensitive areas such as mangroves
- Off-road areas that are not accessible
- Cleaning of remaining accumulations and liquid waste from oil that are difficult to recover using other technologies

- High speed transfer pump for flooding
- Beach-sealing booms, sorbent materials, skimmers, light containment booms
- Flooding (hoses)
- Dump trucks
- Personal protective equipment
Coastal Oil Spill Clean Up Guide

General guidelines

- Form a worker’s team to recover liquid waste contaminated with oil after immersion in water
- Immerse the contaminated area using a flexible perforated pipe or hose laid longitudinally above the shore line
- Pulling seawater into the site of the contaminated area through pumps to release the buried oil
- Use floating barriers (booms) to isolate the contaminated area and prevent leakage of liquid waste
- Ensure good control on water pressure while flooding contaminated habitats (marshes and mangroves) to avoid physical damage to plants and associated marine habitats

Oil between rocks and dust needs to be flooded by water to separate and remove it from rocks
Reference (photos.orr.noaa.gov)

Immersion with holed hose
Reference (response.restoration.noaa.gov)

Adapt the pressure of hoses in consistent with the nature of substrates, if it is rocky or sandy or gravel
Spray angle should be small especially on sediment and in sensitive areas in order to limit erosion and deep burying of oil as far as possible
Use skimmers and pumps whenever possible to speed up the cleaning process
Assemble oil after immersion and rinsing with booms
Reference (photos.orr.noaa.gov)

Washing mangroves by low pressure
Reference (photos.orr.noaa.gov)
(5) Washing with waves

Cleaning the beaches with waves is a form of washing through low pressure. However, it depends on the natural energy of the waves and to ensure large amounts of water for the separation contaminant. The amount of water used in this method is much more than can be given by pumps.

The contaminated coastal material to be treated will be transported to the inter-tidal zone during the low tide time. The tidal currents will move the beach substrate and redistribute it along the coast, allowing oil to be separated to the top of the shore where it can be recovered manually. The process will be repeated several times, if the first washing is not sufficient to remove the contamination to the required level.

- Pollution of sediment and gravel with buried oil
- This method is used after initial cleaning of by other techniques
- Medium power waves
- Used on the open coasts whether dandy or covered with gravel

- Hydraulic excavator
- Rear-end loader
- Sorbents / Floating barriers
- Manual collection equipment

Reference (photos.orr.noaa.gov)
(6) Washing by high pressure

This technique is used in the final stage of cleaning when the recovery of large amounts of oil is completed but the cleaning operations seem not to be sufficient. The use of this technique is often in port wharfs and breakwaters. Cold and hot water can be used depending on the type and characteristics of the oil.

**Process description**

- Completion of early stages of clean up by removing large quantities of oil
- Substrates, roofs, stones, breakwaters and harbor docks
- Recreational and coastal tourism areas
- Efficiency of cleaning and removal of pollution residues from surfaces
- Avoid using salt water to maintain equipment

**Technique selection requirements**

- Hot water pressure washer
- Direct source of fresh water or seawater supply
- Oil recovery equipment: Light containment boom, sorbents, skimmers, pump
- Shore-sealing boom
- Personal protective equipment

**Cleaning equipment**

- Cleaning of breakwater by high pressure
  Reference (photos.orr.noaa.gov)
- Cleaning of breakwater
  Reference (oceanservice.noaa.gov)
General guidelines

- Assess the need for high pressure cleaning, taking into account the degree of contamination and ecological sensitivity of the site to avoid destruction of marine life and plants living on hard surfaces and rocks.

- High pressure cleaning is recommended using operating temperatures ranging from 70° to 90° C.

- As much as possible, avoid high-pressure cleaning using seawater to avoid surface decomposition and damage to pumping equipment.

- Recover effluents using sorbents or booms and skimmers, protect the surrounding area using geotextiles.

- Containment oil with shore-sealing boom in case of leakage into the sea.
(7) Use of sorbents

The sorbents are oil-absorbing chemicals placed on the oil surface for its absorption and are used by various forms of ramparts, including fenders, cushions, winders, traps and granules or particles stored in nets.

The sorbent technique allows the recovery of oil in the event of other methods are not being suitable; as it is one of the complementary techniques to cleaning. It is very useful for cleaning operations as it absorbs the oil and rejects water during the process.

### Process description

Absorbing oil using sorbent barrier
Reference (photos.orr.noaa.gov)

### Technique selection requirements

- Pollution of all kinds
- Pollution at sea or on coast
- Collection of leaked oil during washing operations
- Stable weather factors and normal sea currents

### Cleaning equipment

- Sorbents
- Air diffusers to deploy large amounts of absorbent materials
- Boxes - drums for disposal (storage of oil-saturated sorbents)
- Means of transport for the disposal of oil-saturated sorbents
- Personal protective equipment: protective clothing, raincoats and oilskin jacket, protective helmets, safety goggles and masks
Types of sorbents

Oil sorbents are made using organic products such as bark, peat, sawdust, paper-pulp, cork, chicken feathers, straw, wool and inorganic products such as pumice glass as well as manufactured materials such as polypropylene and other polymers. Manufactured materials are usually the most effective in recovering oil, but organic and inorganic materials effectiveness is limited to adsorption and are more attractive because of their natural availability and low cost.

<table>
<thead>
<tr>
<th>Types</th>
<th>Material</th>
<th>Benefits</th>
<th>Disadvantages</th>
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</thead>
<tbody>
<tr>
<td>Bulk</td>
<td>Organic (paper-pulp, straw)</td>
<td>• Available in nature and obtainable as waste</td>
<td>• Hard to control can be spread by wind</td>
</tr>
<tr>
<td></td>
<td>Inorganic</td>
<td>• Low-cost</td>
<td>• Hard to recover</td>
</tr>
<tr>
<td></td>
<td>Manufactured (polypropylene)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enclosed</td>
<td>All bulk materials that can be wrapped in nets</td>
<td>• Easier to use</td>
<td>• Structure strength is limited to that of net</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Easier to restore</td>
<td>• Limited capacity to retain oil</td>
</tr>
<tr>
<td>Continuous</td>
<td>Mainly made from polypropylene (synthetic)</td>
<td>• Long-term storage</td>
<td>• Limited efficiency on high viscosity oil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Easy to use and restore</td>
<td>• difficulty of decomposition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• High ability of recovering oil</td>
<td></td>
</tr>
<tr>
<td>Fiber</td>
<td>Mainly made from polypropylene (synthetic)</td>
<td>• Effective on weathered and more viscous oils</td>
<td>• Less effective on light and medium oil</td>
</tr>
</tbody>
</table>

Absorbent containment barriers of polypropylene
Reference (photos.orr.noaa.gov)
General guidelines

- Restore all sorbents used in oil collection operations, whether contaminated with oil or not
- Contaminated pollutant should be disposed of in a special plant dealing with hazardous waste
- Avoid as much as possible the use of absorbent materials in the absence of hazardous waste treatment plants
- If the absorbent material is not restored from the water surface, it becomes as much a pollutants as the oil itself
- When it is near the coast, an effective floating containment absorbent barrier can be used to capture leakage from shore washing operations
- Recovery and disposal of sorbents should be accelerated to avoid its fermentation and damage to the environment
(8) Beach cleaning / sand sifting

Process description

This technique is used in the final stage of the coastal cleaning process by manual and mechanical screening machines. The surface layer is removed by mechanical drilling inside the sediment and then pushed on a conveyor belt, in order to start the separation process between the clean sand and the oil tar. Depending on the size of the mesh, the contaminated material is passed to the storage box on the vehicle. Clean sand is allowed to fall again on the beach.

Technique selection requirements

- To use during the initial treatment of pollution and often during the final stage of cleaning operations
- Often used in sandy beaches with homogeneous, small-sized sand
- Easy access to machines and tractors
- Residues of contamination from cleaning operations in the form of a tar or oil-contaminated sands
- Specialized and experienced labor
Coastal oil spill cleanup methods and techniques

General guidelines

- Repeatedly plough or harrow the lightly oiled sediment before starting the mechanical screening process
- Remove all large-sized waste to avoid obstructing screening machines
- Manual screening requires a large number of workers, and used especially in beaches and recreational areas
- Provide the necessary labor to remove the remaining small oil tar manually
- Reduce the speed of tractor while passing filter machine
- Monitor each performance of screening process at the end
- Pathways of coastal screening machines are parallel to the shoreline with starting and ending points
- Avoid as much as possible the passage of screening machines on sand dunes and plants scattered on the beach

Cleaning equipment

- Self-propelled small beach cleaning machines
- Large size beach cleaning machines
- Pollution loading machines / tractor
- Sand sieve, mason’s sieve, Nets with small mesh size
- Personal protective equipment (safety shoes, gloves, glasses)

Reference (photos.orr.noaa.gov)

Reference (www.uaeclean.com)

Reference (www.uaeclean.com)

Reference (www.uaeclean.com)
(9) Beach / gravel cleaning

Gravel cleaning is one of the techniques used in the final stages of beach cleaning operations, in which oil-contaminated gravel is collected and placed in three-sided cages covered with terrestrial textile tapes to prevent leakage of liquid drizzle. Liquid waste is disposed of through the base using high pressure washing and collected using sorbents. Rotary drums are also used for the same purpose, in which the oiled gravel and stones with oil will be loaded into a mixing device adding non-toxic materials or sand to help the process. After rapid mixing for 5 to 15 minutes depending on the degree of pollution, the mixer will be filled with water while maintaining a slow circulation that enables the oil to be separated from the gravel and disposed of in designated tanks.

- Recent oil pollution
- Used for manual cleaning of gravel and oiled stones
- Used in all locations at the site of contamination or elsewhere
- Availability of specialized labor

- Use wire mesh or perforated cart
- Washing machines
- Absorbent materials / non-toxic washing materials
- Shovels, hand carts for collecting gravel and contaminated stones
- Waste recovery system
- Concrete mixer
- Personal protective equipment
Coastal oil spill cleanup methods and techniques

General guidelines

Washing stones using holed cages
- Form teams according to the task of collecting, washing, suction, recovery and disposal of oil
- Collect oiled gravel and small stones using thorns, shovels and hand carts and put them in cages
- Separate gravel from small stones
- Wash the gravel using washing machines
- Place stones and gravel in plastic mesh bags to prevent them from falling out of the cage
- Use hot water in the first stage and non-toxic materials in a second stage if necessary to get rid of oil
- Disposal of oil waste using sorbents

Washing stones using concrete mixer
- Form teams according to the task of collecting, washing, suction, recovery and disposal of oil
- Collect oiled gravel and small stones using thorns, shovels and hand carts and put them in the concrete mixer
- Fill the concrete mixer with water to a level of one third of its capacity
- Run the mixer swiftly for 5 to 15 minutes
- Add non-toxic materials or sand if the cleaning process with water could not complete disposal of oil
- At the end of cleaning process, the mixer should be filled with water and the contaminated waste should be disposed of and stored in tanks
Annex: Types of beaches

Sandy beaches

Mixed beaches (sand and gravel)

Rocky beaches

Mud beaches
Annex: Types of beaches

Rock structures and barriers

Salt flats

Cliff
## Annex(2): Coastal oil spill clean up

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<tr>
<th>Oil Combating Techniques</th>
<th>Technique Selection requirements</th>
<th>Cleaning equipment</th>
<th>Advantages and benefits</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| **Manual Cleaning**      | Suitable for all types of coasts and beaches, especially sandy beaches and Low-level pollution cases scattered over large areas | • Requires a large number of labor  
• Personal safety and protection equipment, cleaning tools and storage equipment | • Selective and high recovery of oil from all types of coasts  
• Maintains coastal properties at high rates | Slow oil restoring processes and difficulty of managing the large number of Labor, which requires good preparation and coordination between teams |
| **Mechanical cleaning**  | Easy access of heavy equipment to contaminated areas with high oil viscous | Hydraulic excavator, tractor, loader, sand sifting machines | • Fast recovery  
• Fast recovery of High oil viscosity  
• Minimum number of labor | • Loss of a large proportion of sand and gravel  
• Damage environmentally sensitive areas |
| **Pumping of floating oil** | Recovery of light viscosity oil spread in form of pools with access from the shoreline | • Skimmer and pumps  
• Oil collection equipment  
• Temporary oil storage equipment | • Fast recovery  
• High efficiency especially with viscous types of oil  
• Minimum number of labor | • Bad weather conditions that limit the efficiency of oil recovery through suction  
• Solid waste from shipwrecks and plastics that disrupt the operation |
| **Washing by low pressure** | Beaches and sensitive habitats contaminated with low or medium viscosity oil | • Pumps, water hoses and holed pipes Skimmer  
• Sorbents  
• Booms | • Recovery of buried oil without removal of sediment  
• Removal of suspended oil in sensitive areas with minimal damages | • Re-deployment of oil within sediments if oil is not contained  
• The possibility of spreading oil and damage to plants and marine life |
## Continuance Annex(2): Coastal oil spill clean up

| Washing with waves | Light to moderately contaminated shoreline sediment (sandy beaches) on exposed shoreline | • Hydraulic excavator  
• Rear-end loader  
• Sorbents/ floating barriers  
• Manual collection equipment | • Use the natural wave energy to clean the coast  
• Maintaining sand and gravel | • Extinguish the oil removed from the sand to other areas  
• Cause temporary imbalance of substrate size and coastal erosion in the medium and long term |
|---|---|---|---|---|
| Washing by high pressure | Light contamination of hard structure (seawalls, rocks) | • Pressure washing machines that uses hot water  
• Oil recovery equipment booms, sorbents | • High efficiency for removal of light contamination  
• Doesn’t require specialized workers or expertise | High pressure could cause damage to marine life |
| Use of sorbents | All types of pollution on coastal areas, at sea or on beaches in a stable climatic environment | • Sorbents  
• Air diffuser to deploy large amount of absorbent materials  
• Beach-sealing booms | • High efficiency on different areas specially closed ports  
• It can be used as a main technique for recovering oil or as a support technique in the final stage | Difficulty in storing and transporting polluted contaminated barriers  
Excessive use of absorbent materials may cause adverse effect on marine habitat |
| Beach cleaning / sand sifting | Recovery of tarballs and small nodules of oiled sand on sand beaches | • Self-propelled small and large cleaning machines  
• Large mesh, excavators, and hand sieves | • Recovery of big amount of clean sand  
• Recovers the aesthetic view of coastal areas | Slow technique and requires large number of labors.  
Destruction of sand dunes and plants |
| Beach/ gravel cleaning | Beaches covered with gravel and are lightly contaminated | • Concrete mixer  
• Wire mesh or perforated cart | • Preserves the aesthetic view of coastal areas  
• Recovery of beach gravel negate the need to remove sediment from the site | Slow technique  
Requires large number of labor  
Possibility of re-polluting the beach with oil-contaminated liquids |
### Annex(2): Coastal oil spill clean up methods

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<tr>
<th>Coastal properties</th>
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<th>Pumping of floating oil</th>
<th>Washing by low pressure</th>
<th>Washing by high pressure</th>
<th>Use of absorbent materials</th>
<th>Beach cleaning / gravel sifting</th>
<th>Beach Cleaning/ gravel cleaning</th>
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