OIL SPILL SURVEILLANCE & TRACKING

INTRODUCTION

Before spill response tactics are selected and equipment deployed, spill management personnel must first have a clear picture of the geographic extent and movement of the spilled oil. The location, thickness, and movement of the oil must be regularly and accurately defined.

This section contains two tactics to assist spill managers in surveying and tracking spilled oil.

- ***Plume Delineation*** describes the tactics and equipment used to determine the size, shape, and trajectory of an oil spill on land.
- ***Discharge Tracking On Water*** describes the tactics and equipment used to track the movement of an oil slick on the water's surface.

PLUME DELINEATION, LAND

OBJECTIVE & STRATEGY

PD

The objective of the Plume Delineation tactic is to determine the extent and trajectory of an oil spill plume both on the surface and subsurface. This tactic may be used on land and on solid ice.

The general strategy used in performing Plume Delineation is to:

1. Identify the approximate location of the spill.
2. Assess the site characteristics and determine equipment and personnel needs.
3. Deploy equipment and personnel to the location.
4. Commence delineation operation.
5. Repeat as necessary to determine oil movement and trajectory.

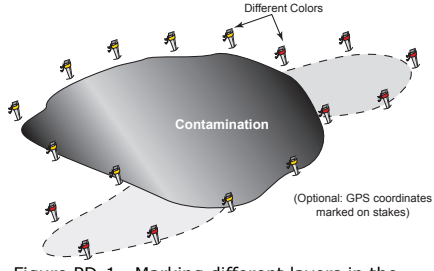


Figure PD-1. Marking different layers in the plume.

TACTIC DESCRIPTION

When oil spills on land or solid ice it behaves in predictable ways; it will begin to spread laterally and it will sink through soil or snow. Given sufficient quantity and time, the plume will migrate down until it reaches an impermeable layer or a water table. The oil plume will migrate over time, driven by topography, wind, and water movement. The rate and direction of oil plume movement is dependent on the characteristics of the oil, air temperature, soil temperature, water table hydrology, and the permeability of the soil.

The extent and movement of the sub-surface oil plume can be

very different from the surface plume. Oil spilled on porous gravel may show little surface contamination, yet sink to a flowing water table and spread over a large area. Oil spilled on a wetland will usually remain on the surface, floating on the water-saturated soil. Oil spilled on solid ice may find its way through cracks, reach the water below, and migrate away from the surface site. Oil deposited on a mixed sand and gravel shoreline may sink down to a fine sand layer, migrate down slope, and resurface on an incoming tide. Oil spilled during the winter may be covered by subsequent snowfall or wind blown drifting snow.

The purpose of the Plume Delineation tactic is to use simple methods to quickly assess the spatial extent of surface and subsurface oil to aid in response planning during the emergent phase of the spill response. Repeating the delineation will establish the direction and rate of any movement of the plume, establishing a trajectory. A more detailed quantification of the spill plume for the cleanup and remediation phases of the response may be required and those techniques are not covered in this manual.

Operating Environments

Plume Delineation can be used in the following operating environments:

- Solid Ice,
- Marsh,
- Tundra,
- Shoreline, and
- Other Land.

Deployment Configurations

THE SPILL PLUME IS VISIBLE AND ACCESSIBLE

The tactic is deployed by mapping the edges of the plume. If the plume has distinctly different levels, layers, or concentrations, then each facet of the plume is mapped separately. The edges of the plume are marked and labeled with surveyor's stakes, wooden laths, or something similar (Figure PD-1). Different color paint or flagging tape may be used to indicate different layers or concentrations in the plume. Simultaneously, a record is made of the location of

each stake with a handheld GPS. This may be done by setting waypoints in the GPS, using the same label as marked on the stakes. The same GPS may be used to record a track of the plume edge. A hand drawn map is sketched in the field to assist in developing final maps with the aid of computer software. The Situation Unit in the Planning Section may have map software. Repeating the delineation procedure after a period of time has passed will aid in the assessment of the direction and rate of movement of the spill.

One or two crews walk around the perimeter of the spill, placing stakes in the ground every 50 to 100 feet while recording the stake locations with a handheld GPS. Setting waypoints on the GPS is a convenient way to record the stake locations. Once the stakes are set, a track of the spill edge can be recorded with the GPS. Many GPS have a function to calculate the area of a track that forms an enclosure. Digital photographs of the site, taken from several perspectives after the color-coded stakes are in place, are also very useful.

For large spills, an ATV or snow vehicle can be used to assist in moving around the spill, if vehicle use is approved and will not damage the environment. Very large spills may require a helicopter.

An initial hand-drawn sketch is best drawn on a topographic map, as-built survey, aerial photograph, or other depiction of the site. Contingency plans usually have line drawings and maps of facilities. The sketch should have as much detail and labeling as possible. Make sure to note the time, date, and person making the drawing. The sketch can be used to produce more precise maps when combined with GPS data (Figure PD-2).

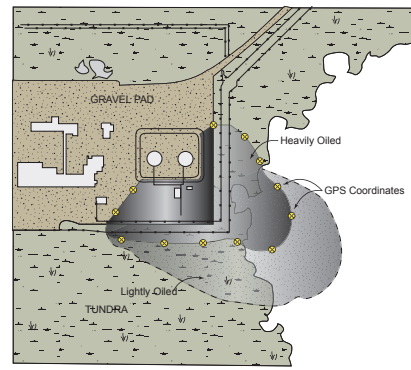


Figure PD-2. Plan view of plume delineation map.

THE SPILL PLUME IS NOT VISIBLE

If the perimeter of the spill cannot be seen, because it is below ground or under snow or ice, then a different approach is required. First assess the probable location of the spill and the surrounding terrain to determine the likely migration path of the plume. In this case a grid may be used to delineate the plume (Figure PD-3). The grid is first laid out from a starting point where the spill is known or suspected to have occurred. From this origin, the grid is set in all directions. The grid is established with stakes set a consistent distance apart. If the spill is thought to be less than an acre in size, the grid should be set on a 25 foot spacing. If the spill is over one acre, the grid spacing can be increased accordingly.

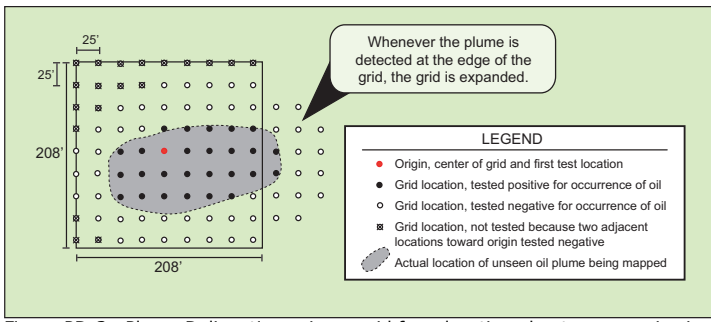


Figure PD-3. Plume Delineation using a grid for a location about one acre in size.

Once the grid is established, a method to test for the occurrence of oil must be established. The method usually involves digging or drilling a hole to the water table or some pre-determined depth to assess for the presence of oil. Other remote sensing technology, such as infrared cameras or Photo Ionization Detection (PID), can be used. The test method is first applied at the origin/center of the grid and then to adjacent grid locations in a systematic fashion. If oil is not detected at the origin, re-assess the most likely location of the spill and re-set the grid if necessary. If oil is detected, the adjacent untested grid locations are tested too. When an adjacent location tests negative for oil, its adjacent locations are also tested. When two successive locations test negative for oil, subsequent locations in the direction away from

the oil are not tested. If a location on the edge of the grid tests positive for oil, then the grid must be expanded. This tactic may have to be modified depending on the terrain and situation.

Once the tests are completed, the stakes marking the grid locations should be color coded to indicate if they were tested and if so, the results of the test. A hand sketch and digital photographs, as described above, should also be completed for the site.

DEPLOYMENT CONSIDERATIONS AND LIMITATIONS

SAFETY

- PPE is required of all personnel in the Hot Zone; consult the incident-specific Site Safety Plan for requirements.
- Worker exposure to contaminants should be minimized.
- The buddy system should always be used in the Hot Zone.
- If heavy equipment is used, a spotter should be present.

DEPLOYMENT

- If wildlife or historic properties are encountered, see Wildlife Checklist or Historic Properties Checklist in Section A Part III.

REFERENCES TO OTHER TACTICS

Other tactics that may be involved in Plume Delineation include:

- PPE Personal Protective Equipment
- SEC Site Entry Criteria
- Dp Personnel Decontamination

EQUIPMENT AND PERSONNEL RESOURCES

Resources for delineating a plume include hand-held GPS, a digital camera, a diagram or map, marking pens/pencils, log book, paint or flagging tape, stakes, and a hammer to drive stakes. If the oil is not visible, test holes will have to be dug with an auger, rock drill, excavator, or other equipment suitable to the situation.

PD

Equipment	Function	Quantity	Notes
Hand held GPS	Determine locations	1 or more	Personnel should be familiar with operation for the model and the Situation Unit should be capable of downloading data from the GPS. Extra batteries and antennae.
Digital camera	Capture images of the stakes, once color coded	1	Extra batteries and media.
Surveyor stakes or equivalent	Marking the edge of the plume or locations in a grid	100 for a one acre spill, more if the spill is larger	Make sure the stakes are long enough to be seen above snow, grass and terrain
Paint or flagging tape	Color coding stakes	4 different colors	Bright colors work best
Log book and maps or diagrams	Taking notes, drawing sketches, and recording data	As necessary	
Hand tools	Driving stakes, digging holes, clearing brush	Situation specific	
Digging system (hand tools, auger, rock drill, excavator, or other)	Digging holes to determine the presence of oil	Situation specific	Only needed if subsurface oil is to be detected
Vessel/Vehicles	**Function**	**Quantity**	**Notes**
ATV or Snow Vehicle with or without a trailer	Access the site and move around the perimeter of the spill	1 to 2 optional	Vehicles should only be used if they will not cause damage to the environment
Personnel	**Function**	**Quantity**	**Notes**
Field Team Leader	Supervises operations under the Direction of the Operations Section Chief	1 or more	Should be trained in plume delineation
Skilled Technicians	Work under the direction of Field Team Leader	1 to 2	Depending on situation/activities
General Technicians	Work under the direction of Skilled Technician	0 to 3	Depending on size of spill
Operators	Operate heavy equipment or drilling equipment	0 to 3	Depends on equipment utilized

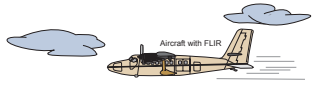
DISCHARGE TRACKING ON WATER

OBJECTIVE & STRATEGY

DT

The objective of the Discharge Tracking On Water tactic is to determine the extent and trajectory of an oil spill slick on the surface of the water.

The general strategy used in performing Discharge Tracking On Water is to:



1. Identify the approximate location of the spill.
2. Assess the site characteristics and determine equipment and personnel needs.
3. Deploy equipment and personnel to the location.
4. Commence tracking operation.
5. Repeat as necessary to determine oil movement and trajectory.

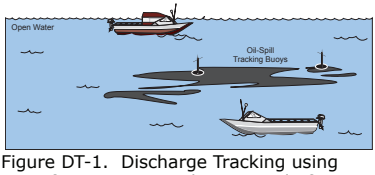


Figure DT-1. Discharge Tracking using aircraft, marine vessel viewing platforms, and tracking buoys.

TACTIC DESCRIPTION

One of the first steps in a response to an oil spill on the water is to assess the location, character and spatial extent of the oil slick. When oil spills on water it behaves in predictable ways; it will begin to spread laterally and it will begin to change character through a process called weathering. The oil slick will move and change shape and size over time, driven by wind, sea state, currents, and tides. Weathering is caused by evaporation, dissolution, dispersion, and emulsification. The rate of weathering is dependent on the characteristics of the oil, wind, sea state, air temperature, water temperature, and exposure to sunlight.

The purpose of the Discharge Tracking On Water tactic is to use simple methods to quickly assess the spatial extent of surface oil to aid response planning during the emergent phase of the spill response (Figure DT-1). Repeat observations will establish the direction and rate of movement of the slick, establishing a trajectory. The process of predicting the movement and weathering of oil using vector analysis or computer modeling is not covered in this manual.

The best and most direct method of tracking oil slicks is by direct observation. Oil spill observations should be done by a trained observer using an aircraft or marine vessel as a viewing platform. No other method can accurately document the location, shape, size, thickness, coverage, state of weathering, and trajectory of an oil slick. Aircraft, either fixed-wing or rotary-wing, are the most common viewing platforms. Fixed-wing aircraft usually travel farther and faster than rotary-wing aircraft and allow for a rapid assessment over a larger area. Rotary-aircraft can fly slower and lower, allowing the observer a better view of the slick. After site characterization has taken place, marine vessels can be used to make direct observations, but the observer does not have the advantage of perspective available from an aircraft. However, an observer aboard a marine vessel can actually sample the oil and better assess its consistency and thickness and is less likely to misidentify other naturally-occurring slicks as oil. It is useful to have correlated aerial and marine observations taken at the same time and place.

Aerial and marine observations should be made by a team of observers comprised of representatives of each organization in the Unified Command (RP, FOSC, SOSC). The observation team should strive for consensus agreement on the area, type, and thickness of the oil observed to negate later disagreements about what was observed.

If the oil slick cannot be directly observed, due to non-availability of aircraft or vessels, visibility, darkness, or remoteness, then indirect methods, such as infrared technology or tracking buoys, may be used. These indirect methods are useful to keep track of the slick until direct observations can be made.

Operating Environments

Discharge Tracking On Water can be used in the following operating environments:

- Open Water,
- Protected Water,
- Calm Water,
- Fast Water, and
- Broken Ice.

Deployment Configurations

THE SPILL SLICK IS VISIBLE

If the oil spill is visible and accessible, it should be assessed and mapped by a trained observer. If the slick has distinctly different thicknesses, as evidenced by different colors, then each thickness of the slick is mapped separately. Repeating the observation procedure after a period of time has passed will aid in the assessment of the direction and rate of movement of the spill. The accuracy of the technique is largely dependent on the experience and training of the observer. NOAA has developed an Open-Water Oil Identification Job Aid for Aerial Observation which includes: checklists, example photographs and sketches, and coverage charts. Other oil observation standards have been developed by the American Society for Testing and Materials (ASTM) International.

If the oil slick is reasonably continuous, a track of the edge of the slick can be recorded with the GPS. Many GPS have a function to calculate the area of a track that forms an enclosure. Digital photographs of the slick, taken from several perspectives, are also very useful.

An initial hand-drawn sketch is best drawn on a nautical chart, topographic map, aerial photograph, shoreline map or other depiction of the area. The sketch should have as much detail and labeling as possible. Make sure to note the time, date, and person making the drawing. Logs, GPS data, maps, and photographs of oil slick observations should be given to the Situation Unit in the Planning Section as soon as possible.

THE SPILL SLICK IS NOT VISIBLE

If the oil slick cannot be seen, because of fog, darkness, or lack of an observation platform, then a different approach is required. Two alternative methods are observation with the aid of infrared technology and tracking buoys.

Infrared technology involves using an infrared camera to detect the difference in temperature between the oil slick and the surrounding water. As the slick spreads and cools to the ambient temperature, infrared technology becomes less effective. Infrared cameras are available as handheld and fixed/mounted devices. Infrared sensors can be an effective remote sensing system when mounted on an aircraft, vessel, or helicopter. Using infrared technology requires training specific to the system in use and works best when calibrated by comparison with visual observations. Use the same procedures described above to map the slick when using infrared technology.

Tracking buoys are another alternative to visual tracking of oil slicks on the water (Figure DT-2). Tracking buoys are floating radio devices that broadcast a signal, which can be used to remotely locate the buoy. Some buoys contain a GPS device that allows a very precise location. Some tracking buoy systems transmit to portable radio receivers and other systems transmit to satellites. If the tracking buoy remains within the slick, then relocating the oil spill is greatly simplified. Unfortunately, experience has shown that tracking buoys often do not remain within an oil slick. Tracking buoys do not indicate the thickness, area, coverage, or consistency of the oil slick.

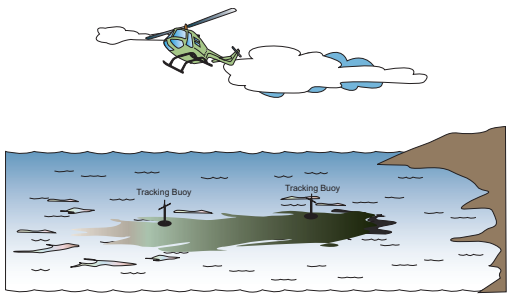


Figure DT-2. Discharge Tracking using tracking buoys.

DEPLOYMENT CONSIDERATIONS AND LIMITATIONS

SAFETY

- PPE is required of all personnel in aircraft and marine vessels, see the incident Site Safety Plan and check with the aircraft operator for PPE and PFD requirements.
- Flight following procedures should be observed for all observation aircraft.
- Vessels, including skiffs, must have a minimum of two crew aboard.
- If possible, vessels in transit to/from an operation or staging area should transit in pairs.
- A communications schedule should be established and followed, between vessels in transit and the Operations Section or Radio Dispatcher.

DEPLOYMENT

- Consider wildlife impacts.
- The time on digital cameras used for aerial surveys should be set to coincide with the GPS or a photograph of the GPS time can be taking allowing the time tags on the photographs to be adjusted later.
- All GPS used for surveys should be set to the same datum, i.e. NAD 27, NAD 83, or WGS.
- It is best to have multiple observers from different organizations on aerial surveillance flights. The surveillance team should strive for "consensus of observations", resulting in a single report (map, GPS tract, etc.) being given to the Situation Unit or Documentation Unit.

REFERENCES TO OTHER TACTICS

Other tactics that may be involved in Discharge Tracking On Water include:

ISw In-Situ Burning On Water

DS Dispersant Application

EQUIPMENT AND PERSONNEL RESOURCES

DT

Resources for Oil Spill Tracking On Water include a GPS, a digital camera, a diagram or map of the area, marking pens/ pencils, log book, and an aircraft or vessel to be used as an observation platform. If the oil is not visible, tracking buoys or an infrared sensor will be needed.

Equipment	Function	Quantity	Notes
GPS	Determine locations	1 or more	Personnel should be familiar with operation for the model and the Situation Unit should be capable of downloading data from the GPS. Should have extra battery and antenna.
Digital camera	Capture images of oil slick	1	Extra batteries and media
Log book and maps or diagrams	Taking notes, drawing sketches, and recording data	As necessary	Folding knee board or clip board
Infrared camera or video system	Detection of oil in low visibility	Situation specific	Requires trained operator and should be calibrated on the specific spill
Tracking buoy system (transmitting buoys and receivers)	Detection of oil in low visibility	Situation specific	Does not indicate thickness, area, coverage, or consistency
Vessel/Vehicles	**Function**	**Quantity**	**Notes**
Aircraft, helicopter, or marine vessel with crew	Observation or buoy deployment platform	1 to 2 optional	Situation dependent
Personnel	**Function**	**Quantity**	**Notes**
Observer(s)	Observe and assess the nature of the slick and record data	1 or more	Should be trained in oil observation and any equipment that is being used
Skilled Technicians	Work under the direction of Lead Observer	0 to 2	Operates infrared cameras or tracking buoy system as dictated by the situation

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