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Standard Guide for Cleaning of Various Oiled Shorelines and Habitats[1]

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1. Scope

1.1 This guide provides information on shoreline types and sensitive habitats that can be used as guidance for selecting appropriate cleaning techniques following an oil spill. This guide does not address protected archaeological, historical, or cultural sites.

1.2 This guide's emphasis is on typical physical and biological attributes of coastal and inland habitats that could be at risk from oil spills. It reviews and encompasses the entire spectrum of shoreline types representing a wide range of sensitivities. It is largely based on NOAA's and API's publications listed in Section 2.

1.3 This guide provides only very broad guidance on cleaning strategies for the various habitats. For more in-depth guidance, the reader is referred to Section 2, Referenced Documents.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F2205 Guide for Ecological Considerations for the Use of Chemical Dispersants in Oil Spill Response: Tropical Environments

2.2 *Other Publications:*

API Publication 4706 Environmental Considerations for Marine Oil Spill Response, 2001[3]

API and NOAA 4558 Options for Minimizing Environmental Impacts of Freshwater Spill Response, 1995[3]

NOAA Characteristic Coastal Habitats, Choosing Spill Response Alternatives, June 2010[4]

3. Significance and Use

3.1 One of the key considerations in making sound cleanup decisions for oiled shorelines is the relative sensitivity of the impacted area. Some areas are very sensitive and certain cleaning methods could cause more harm than benefit. In such cases, natural recovery will be the preferred approach. In other cases, depending on the type of oil, the amount of oil present may be so extensive that recovery will be significantly delayed or not occur at all unless active intervention is carried out.

3.2 This guide presents summary information taken from publications listed in Section 2 on the relative physical and biological sensitivities of shorelines for coastal and inland habitats. Use this guide together with the referenced publications and ASTM guides to make informed decisions prior to undertaking cleaning operations. Consult appropriate government agencies according to law.

3.3 The relative sensitivities of shorelines and resources relate to a number of factors:

3.3.1 Shoreline type (substrate, grain size, tidal elevation, etc.),

3.3.2 Biological productivity, diversity and vulnerability,

3.3.3 Exposure to wave and tidal energy, and

3.3.4 Ability to conduct cleanup without further damage.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Petroleum Institute (API), 1220 L. St., NW, Washington, DC 20005-4070, http://www.api.org.

[4] Available from the National Oceanic and Atmospheric Administration (NOAA), 14th St. and Constitution Ave., NW, Room 6217, Washington, DC 20230.

4. Description and Relative Sensitivity of Shorelines

4.1 This section summarizes the types of shorelines and habitats that may be impacted by an oil spill. The Environmental Sensitivity Index (ESI) is frequently used to characterize relative sensitivity of shorelines to oil spills. Areas exposed to high levels of physical energy and containing low biological activity would rank low (ESI=1, example: exposed rocky shores). Sheltered areas with associated high biological activity have the highest ranking (ESI=10, example: mangroves). Broad guidelines are provided on preferred strategies for cleaning these shorelines following an oil spill incident.

4.2 *Exposed Rocky Shores*—Also known as exposed wave-cut cliffs. The intertidal zone is steep (more than 30° to 45° slope) and narrow with little width. Access can be difficult and dangerous. Sediment accumulation is uncommon and usually transitory because waves remove the debris from the eroding cliffs. There is strong vertical zonation of intertidal biological communities. Species density and diversity vary greatly but can be abundant. Oil would generally be held offshore by reflection of the waves. However, pockets of stranded oil can occur. Any oil that is deposited would be rapidly removed naturally. Cleanup is usually not required.

4.3 *Exposed Man-made Structures*—These are solid structures such as seawalls, piers, and port facilities. They are common in developed areas, providing protection to residential and industrial zones. Many structures are constructed of concrete, wood, stone, or metal. They are built to protect from erosion by waves, boat wakes, and currents. They are exposed to rapid natural removal processes. Attached animals and plants are sparse to moderate. Oil would be held offshore by waves reflecting off the steep, hard surfaces in exposed settings. Cleanup may not be required. All cleanup techniques may be appropriate including surface-washing agents.

4.4 *Exposed Wave-Cut Platforms and Sheltered Bedrock Habitats*—These habitats are characterized by gently sloping bedrock shelves, called platforms, of highly variable width. A steep scarp or low bluff may back the shoreline. They often co-occur with gravel beaches. The platform surface is irregular and cracks, crevices, and tidal pools are common. Small accumulations of gravel can be found in the tidal pools and crevices in the platform. Areas of sandy veneer can occur on the platform in less exposed settings. These habitats can support large populations of encrusting animals and plants, including barnacles, snails, mussels, and macroalgae. Birds and seals use platforms for feeding and resting during low tide. Oil does not adhere to the wet surface, but could penetrate crevices or sediment veneers. Cleanup may not be necessary. Pockets of stranded oil may occur. If the area is accessible, it may be feasible to manually remove heavy oil accumulations and oiled debris.

4.5 *Sand Habitats*—Sand habitats are generally flat to moderately sloping and relatively hard-packed. Sand habitats include sand bars and banks along rivers. In developed areas, sand habitats can be man-made for the purpose of recreation. In exposed coastal areas, they are commonly backed by dunes or seawalls. There can be heavy accumulations of stranded marine vegetation or other debris. Sand habitats can undergo rapid erosion/deposition cycles as currents and storms relocate the sand. Sand habitats have low to medium sensitivity. In developed areas, sand habitats used as recreational beaches are considered sensitive for economic reasons. Biological populations are typically of low density except if the habitat is in a protected area and contains muddy sediments. Birds use sand habitats for resting, feeding, and nesting. Turtles use these habitats to lay their eggs. Oil penetration can be as much as 15 cm in fine- to medium-grain sand and up to 30 cm in coarse-grain sand. Cleanup should concentrate on manually removing persistent oil and oily debris. On recreational beaches, extensive cleanup is required. Replacement with clean sand having the appropriate composition, grain-size, and color may be necessary if large amounts of sand are removed during cleanup.

4.6 *Tundra Cliffs*—These shorelines are found in extremely cold regions near permafrost areas. They are generally comprised of vegetation overlying peat and permafrost. The cliff height ranges from less than 1 metre to as much as 10 metres. The vegetation on the tundra is a living plant community that is sensitive to disturbance. The main users of this shoreline are migratory birds during the summer season and they are most at risk by oiling. Oil can be removed from beach deposits by sorbents or by manual and mechanical methods as long as there is no damage to the peat substrate. Access may be limited due to fragility of tundra vegetation.

4.7 *Mixed Sand and Gravel Habitats*—These moderately sloping habitats contain significant (over 25 % each) amounts of both sand and gravel. The high-tide berm area is usually composed of sand and fine gravel and the lower part is coarser with cobbles to boulders. In glaciated areas, large boulders may occur. Mixed sand and gravel habitats occur along lakes and as bars along rivers and streams. There can be large-scale changes in the sediment distribution patterns depending upon season, because of the transport of sand offshore during storms. Desiccation and sediment mobility on exposed areas result in low densities of attached animals and plants. The presence of algae, mussels, and barnacles indicate coastal habitats that are relatively sheltered. In freshwater areas, worms and insects such as mayflies, caddisflies, and midges may burrow in mixed sand and gravel habitats. This habitat may include fish spawning areas, birds, and mammals. Oil penetration and sediment deposition can result in subsurface oil layers at depths of over a metre. If the sand fraction exceeds 40 %, oil behavior will be much as it is for a sand habitat. Heavy accumulations of oil should be removed using low-pressure flushing. All oiled debris should be removed; sediment removal should be limited as much as possible as erosion is a concern. In coastal areas, relocation of oiled sediment from high-tide zones to upper intertidal zones can be effective in areas regularly exposed to wave activity.

4.8 *Gravel Habitats*—These habitats are composed of substrate ranging in size from pebbles to boulders. They can be very steep, with multiple wave-built berms forming the upper beach. Density of animals and plants in the upper intertidal zone is low on exposed habitats, but can be high on sheltered gravel habitats and on the lower intertidal zone. Gravel habitats occur along lakes and as bars along rivers and streams. In freshwater areas, biological communities are of low density. Adult insects and larvae (mayflies, stoneflies, caddisflies, and midges) live among the gravel. Flatworms, leeches, and crustaceans also occur. Fish spawning areas may occur in this habitat. Stranded oil is likely to penetrate deeply into gravel habitats because of the high permeability/pore space. Heavy accumulations of pooled oil should be removed quickly. All oiled debris should be removed. Substrate removal should be limited as much as possible due to the slow rate of natural replenishment in freshwater areas.

4.9 *Vegetated Shoreline Habitats*—These habitats occur in non-wetland banks of rivers and lakes. The slopes of these habitats may be gentle or steep. Characteristic vegetation include grasses, bushes, and trees. Leaf litter and woody debris can be trapped among the vegetation. Lawns and gardens may occur along a river or lake in developed areas. Sediments range from clay to gravel. Seasonal flooding may occur along the banks with high-energy removal conditions. Many species of animals use vegetated banks as important habitats. Oil can penetrate sediments and contact root systems. On gentle banks, oil may contaminate large areas of vegetation. Various cleanup methods may be appropriate such as vacuuming, sorbent use, low-pressure flushing, removal of oily debris, use of surface-washing agents, burning, and cutting of oiled vegetation.

4.10 *Freshwater Mud Habitats*—Mud habitats occur along river floodplains and lake bottoms that are exposed during seasonal low water levels. These habitats are typically found in low-energy areas and often associated with wetlands. This habitat is often a natural collection area for debris and spilled oil. Sediments are predominantly silt and clay but may be mixed with sand and gravel. The sediments are typically water saturated. Vegetation cover varies. Invertebrate communities may be abundant in the sediment. As a result, mud habitats are important feeding grounds for birds and as nursery areas for fish. Oil will generally not penetrate the sediment except through animal burrows and decaying root and stem holes. These habitats are very sensitive (ESI = 9) to oil and response operations. Access may be limited due to shallow water, vegetation, and soft substrate. Care must be taken during clean up to minimize erosion and prevent mixing the oil deeper into the sediments.

4.11 *Riprap*—Riprap is composed of cobble- to boulder-sized blocks of granite, limestone, concrete, or other materials which are intentionally added for the protection of shorelines. Examples are breakwaters and jetties around inlets and marinas. Riprap is common in highly developed waterfront areas. Attached biological communities vary from rich to sparse. Birds use riprap as roosting sites. Persistent oil can penetrate deeply between the riprap and can readily adhere to rough surfaces. High pressure ambient water flushing and use of surface-washing agents may be effective for removal if the oil is fresh and liquid, but the oil must be recovered. Special care must be taken in cleaning riprap as personnel injuries have been often reported for this particular shoreline type.

4.12 *Exposed Tidal Flats*—These are broad intertidal areas composed primarily of sand and mud and minor amounts of gravel. Tidal currents and waves are strong enough to mobilize the sediment. Flats are usually associated with another shoreline type such as wetlands on the landward side, though they can also occur as separate shoals. They are commonly associated with estuaries and tidal inlets. Seagrass beds may occur on the lower edges of tidal flats. Large numbers of sediment-dwelling invertebrates may be present. Tidal flats are heavily used by birds for roosting and foraging, and are rearing areas for fish and shellfish. Oil does not usually adhere to the surface of exposed tidal flats but will move across and accumulate at the high-tide line. Currents and waves are very effective in natural removal of the oil. Heavy machinery or other aggressive techniques are not recommended for cleanup.

4.13 *Sheltered Rocky Shores and Clay Scarps*—Rocky shorelines consist of bedrock of variable slope, ranging from vertical to wide rocky ledges, which are sheltered from most wave and tidal energy. Species density and diversity vary greatly. Clay scarps frequently occur along bays and man-made waterways. Clay scarps provide important nursery grounds for fish and feeding areas for birds. Clay substrate may have numerous holes from animal burrows and root cavities. These habitats should be assigned high priority when establishing protection zones. Oil will generally not adhere to wet surfaces such as algae-covered rock and clay sediment, so it will end up on dry, rough rock surfaces, particularly at the high-tide line. If oil is to be removed, use only low-pressure and ambient temperature flushing of the rocky surfaces at high tide so that oil can be recovered before it can impact biologically rich areas in the lower tidal zones.

4.14 *Peat Shorelines*—Peat shorelines are formed from eroding tundra cliffs that are adjacent to intertidal zones. These shorelines are found in Alaska and in Arctic regions. Erosion of peat shorelines occurs from wave action, ice scour, and melting of frozen peat. Eroded peat can accumulate as thick mats in the intertidal zone. Peat shorelines typically occur as mats deposited on a sand or gravel beach. Another thin and temporary layer of sand may overlie the peat. Peat shorelines contain slurry-type materials having the appearance of coffee grounds. The slurry is found at the foot of eroding peat scarps and in depositional areas. The slurry moves along the shore with the currents. Natural recovery may be the least damaging response option. Mechanical removal of oil may result in physical damage and mixing the oil into the peat.

4.15 *Inundated Lowland Tundra*—This habitat occurs where areas of the Arctic shoreline have subsided and are flooded by the sea. This habitat also includes low-lying areas not in the intertidal zone that can be inundated during spring tide or storm surges. Inundated lowland tundra areas are complex and may be comprised of tundra, vegetated flats and river banks, peat mats, brackish lagoons, streams, and ice. It is an important feeding area for migratory birds. Lowland tundra is highly sensitive to oil spills. Extensive damage to the tundra is likely to occur during cleanup. Access and movement on land or nearshore may be difficult. Natural recovery may be the least damaging response option. Some cleanup may be warranted if large amounts of oil persist and cause chronic re-oiling of adjacent habitats.

4.16 *Sheltered Tidal Flats*—These are very low-energy habitats, which support large populations of animals and plants. The flats are important foraging areas for birds and nursery areas for marine organisms. Sediment-dwelling invertebrates are typically abundant. Sheltered tidal flats are composed primarily of mud, silt, and clay with minor amounts of sand and shell. Tidal flats are sheltered from major wave activity. Marshes and seagrass beds may be associated with tidal flats. The soft sediments cannot support even light foot traffic. Oil does not usually adhere to the surface but rather moves across the flat and accumulates at the high tide line. If burrows or other crevices in muddy sediments are present, oil can fill these and impact sub-surface species. This is a high-priority protection area since cleanup options are limited.

4.17 *Salt, Brackish, and Freshwater Wetland Habitats*—Freshwater wetlands include marshes, bogs, bottomland hardwood forests, fens, playas, prarie potholes, and swamps. Wetlands are highly variable with respect to substrate, seasonal occurrence, hydrology, vegetation, and biota. Vegetation occurs at the water's edge or underwater. Channels and drainages with flowing water may be present. Marshes are wetlands comprised of dense, emergent, herbaceous vegetation, such as Spartina grasses. Depending on location and inter-annual variations in rainfall and runoff, the vegetation can include species that are tolerant to a wide range of salinities, including freshwater conditions. In addition to providing protected feeding grounds, marsh vegetation helps to maintain the stability of the shoreline and prevent erosion. Sediments are composed of organic muds except where sand is abundant on the outer exposed areas. Marshes are low-energy areas relatively sheltered from waves and strong tidal currents. Flora and fauna are abundant. Wetlands provide important habitat for numerous aquatic and terrestrial species including migratory birds. Endangered or protected species may occur in wetland areas. Oil will readily adhere to the vegetation but heavy oiling will generally be restricted to the outer fringe of thick vegetation. Light oil can penetrate the top few centimetres of sediment but under some circumstances, oil can enter burrows and cracks down to one metre. Wetlands are high-priority protection areas because cleaning options are limited due to the sensitivity of the areas. Under light oiling, the best practice is to let the area recover naturally. Cleanup of heavily pooled oil such as by vacuum, use of surface-washing agents, sorbents, burning, or low-pressure flushing, should be undertaken only when it is clearly needed for the recovery of the habitat. Any such undertaking should be very carefully planned to minimize permanent damage to the vegetation.

4.18 *Mangroves*—Mangroves rank as one of the most sensitive marine environments in the world, supporting a great diversity and abundance of animal and plant species. Mangroves are salt-tolerant trees and shrubs that grow within the tidal range on low-energy tropical and subtropical marine and estuarine shores of the world. Mangroves are important as protectors of shorelines from erosion and serve as habitat for both aquatic and terrestrial species. Mangroves produce leaves, twigs, and fruits that contribute to detrital food webs on which many marine species depend. The width of a mangrove forest can range from one tree to many kilometres. The substrate can be sand, mud, leaf litter, or peat. Outer fringing forests can be exposed to relatively high wave activity and currents, but forests located in bays and estuaries are well-sheltered. Debris in the storm swash line is very common and oil will tend to concentrate on the accumulated debris. In most areas, mangrove forests rank as the highest priority protection areas. If oil does enter the forest, it readily adheres to prop roots, tree trunks, and pneumatophores. Oil adherence can be fatal to the trees over time, as oil interferes with the normal gas and water exchange on which the trees depend. Adding dispersant to oil prior to its entering the forest could save the threatened trees but could also negatively affect the biological communities (Guide F2205). Some success has been reported in small-scale studies with cleaning oiled trees with surface-washing agents but the practicality of this approach in a dense forest with limited access is questionable. In most cases, cleanup activities after oiling are not recommended except where access to the oil from terrestrial areas is possible with minimum physical damage.

4.19 *Coral Reefs*—Coral reefs are structures created and maintained by populations of hard corals and coralline algae. The reefs are mostly sub-tidal but some portions can be exposed during very low tide. Reefs support highly diverse biological communities and are key attractions in popular tourist areas. Coral reefs vary widely in sensitivity to spilled oil. The three primary exposure routes are: direct contact with floating oil, exposure to dissolved and dispersed oil in the water column, and contamination of the substrate by oil deposited on the seafloor. Reefs are a high priority prevention area but their prevalence and wide geographical distribution could make this unfeasible for a large spill. In many cases, the oil will float over the reefs with minimal impact. Dispersant use directly over shallow reefs can have significant effects and is not recommended, but use of dispersants away from reef areas can reduce impacts on highly sensitive intertidal environments such as corals (Guide F2205). Outside of the immediate vicinity of reefs, burning can also protect sensitive environments, but burn residues, if any, could sink to the sea floor with potential effects.

4.20 *Seagrasses*—Seagrasses are highly productive habitats that occur on intertidal flats and in shallow coastal waters worldwide from arctic to tropical climates. Seagrasses serve as a food source for species such as green turtles, manatees, and waterfowl, and as nursery areas for shellfish and finfish. Floating oil will pass over sub-tidal seagrasses with little or no contamination. Oil can contact seagrasses if it is heavier than seawater or attaches to suspended sediment and sinks. In this event, oil can become trapped in the beds and affect the leaves. Dispersant use on oil in offshore areas can reduce impacts on sensitive communities but dispersion directly over seagrass beds is not recommended unless the alternative is oiling of a higher priority habitat such as a mangrove forest (Guide F2205). Burning oil outside the immediate vicinity of seagrasses is a viable alternative. Cutting oiled grasses well above the rootline is another viable response option.

4.21 *Kelp*—Kelp are very large brown algae that grow on hard sub-tidal substrates in temperate regions. They have a "holdfast" that attaches to the substrate, a stem-like stipe, and