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Developing Cleanup Endpoints for Inland Oil Spills

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ABSTRACT 300273:

Achieving consensus on cleanup endpoints for inland oil spills can be difficult. They tend to be more stringent than those applied to spills in the marine environment and often require more intensive cleanup methods with the risk of increased ecological impacts. There are limited data on which to evaluate net environmental benefit considerations, weighing the consequences between ecological versus human-use priorities. Inland habitats often lack some of the dynamic physical processes (such as waves and tidal fluctuations) that can speed the rate of natural removal of oil residues. The direct human uses of inland habitats, such as for drinking water, recreation, industrial use, and irrigation, require a higher degree of treatment than may be required in the marine environment to avoid human health and socio-economic impacts. Spills in close proximity to where people live, work, or recreate also often require treatment to a higher level. Inland spills can affect smaller water bodies where there are slower rates of dilution and degradation. There may be large-scale differences in water levels during the response, causing oil to be stranded well above normal levels where it can pose hazards to wildlife as well as humans using these areas. Many states perform risk assessments and develop endpoints for sediment quality and/or surface and groundwater guidelines that must be met as part of the remediation phase after the emergency response is completed. Case studies are used to illustrate these issues. Guidelines are provided for developing appropriate cleanup endpoints for inland oil spills and selection of appropriate treatment methods to reach them.

INTRODUCTION:

Freshwater habitats provide unique resources and uses in very different ways than coastal and marine habitats. Manual and mechanical cleanup is normally a primary response tool for freshwater environments affected by oil spills. Response countermeasures such as dispersants and other chemical or non-traditional technologies often are not applicable to fresh water environments or present concerns that significantly limit their use compared to coastal or marine environments. Oil released in inland waters is subject to the natural hydrologic flow as well as any man-made changes, of which there are many, to the hydrologic system. For example, the banks can be armored, stream flow is directed through culvert systems, or dams of all sizes and uses turn riverine systems into lakes. Another confounding issue is flooding where waterways leave their banks and/or change courses. The potential for groundwater contamination is often a primary public health concern. The differences between spills in inland versus coastal environments is embodied in the National Contingency Plan (40 CFR 300.5), where a major discharge means a discharge of more than 10,000 gallons of oil to the inland waters as opposed to more than 100,000 gallons of oil to coastal waters.

When affected by an oil spill, responders and agency representatives struggle with how to develop appropriate cleanup endpoints for these spills. The goal of any spill response, be it coastal or inland, should be to select the treatment methods and endpoints that will result in the most rapid recovery of the environment (Michel and Benggio, 1999). For inland spill response, there are often two perspectives that have to be resolved: 1) Remove all of the spilled oil from the environment versus; 2) Remove as much oil as possible without damaging or slowing the overall habitat/resource recovery. Cleanup endpoints for spills in coastal and marine settings seldom have endpoints as rigorous as “No oil observed” though these can be used for amenity beaches (NOAA, 2013). Most of the time, cleanup endpoints in coastal and marine settings are based on acknowledgement that any residual oil will weather or degrade over time, sped by natural removal processes in areas exposed to waves and currents. Thus endpoints such as “no longer rubs off on contact” or “no longer generates sheens that affect sensitive resources” are agreed to. The U.S. authority to respond to oil discharges is granted under the Clean Water Act (CWA), and it is triggered by any oil discharge that ”may be harmful” to include those that: (a) Violate applicable water quality standards; or (b) Cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines. This authority is often translated into the cleanup endpoint of “no sheen.” Once the Federal response has ended, the site is frequently turned over to the state, which may use endpoints based on their regulations that often use water and sediment quality thresholds for contaminant levels. Removing oil to the extent that soil, sediment, and water meet state regulatory limits could require additional cleanup efforts.

There are studies that show aggressive removal of oil from sensitive habitats such as marshes and mangroves can slow the overall recovery (Hoff, 2010; Michel and Rutherford, 2013). The response community and agency representatives are more accustomed to evaluating the relative environmental risks for coastal and marine spills, using the concept of net environmental benefit to select cleanup endpoints for different habitats and degrees of use.

For inland spills, it is difficult to reach agreement that it is appropriate to leave some oil for natural removal, so that less damage is done to sensitive habitats. Trustees and stakeholders are often unfamiliar with cleanup methods and how those methods can cause significant damage due to trampling, road building, vegetation removal, excavation, etc. Trustees and stakeholders are also often unaware that the environment can attenuate some oil. Studies need to be conducted and shared on how much oil can be naturally attenuated and in what period of time in the more closed environmental systems found in freshwater settings. At some point the damage done by removing additional oil will do more damage to the environment than leaving the oil in place.

Consequently, cleanup endpoints are needed to:

- Define the conditions beyond which further active treatment is likely to provide no net environmental benefit and may delay, rather than accelerate, recovery of impacted habitats and natural resources;
- Define the target conditions that must be achieved before active treatment may cease. As such, these criteria signal the transition from active response-related cleanup to maintenance and monitoring, or final sign-off;
- Provide Operations with clear targets for when treatment activities are done;
- Provide Shoreline Cleanup Assessment Technique (SCAT) Teams with criteria with which to inform their recommendations of the most appropriate treatment options and evaluate results of treatment activities; and
- Provide those responsible for the follow-up remediation with guidelines that are consistent with those provided to emergency responders.

There are generally four types of cleanup endpoints (Sergy and Owens, 2007, 2008; NOAA 2013): 1) Quantitative endpoints that build on the terminology of the SCAT process and use metrics related to the percent oil distribution, the oil thicknesses, the oil type, etc. (e.g., no more than 10% Stain); 2) Qualitative endpoints that describe the presence and character of oil (e.g., does not rub off on contact); 3) Analytical criteria for sediment and water quality (e.g., less than x parts per million [ppm] total petroleum hydrocarbons); and 4) Interpretive impact endpoints (e.g., removal to the point when further treatment will result in excessive habitat disruption). At this point, no further treatment (NFT) is recommended due to a net environmental benefit consideration. This last endpoint is applied mostly to sensitive habitats when meeting one of the first three endpoints would cause greater harm than leaving the oil to attenuate naturally. This type of recommendation is best made by the SCAT team in the field.

The goals of this paper are to identify the key drivers for oil spill cleanup during inland spills, use four recent case studies to demonstrate how these drivers affected those responses, and provide guidance for developing appropriate cleanup methods and endpoints for future inland oil spill responses.

KEY DRIVERS OF CLEANUP ENDPOINTS FOR INLAND SPILL RESPONSE:

The cleanup methods and endpoints used during inland spill responses are controlled by the key drivers summarized in Table 1.

Table 1. Key drivers for inland spill response.

Key Driver	Cleanup Endpoints Issues
Water is a precious resource	Requires meeting water quality standards appropriate for water use for drinking, subsistence fishing or trapping, cooling for major industries such as power plants, and/or irrigation, with less tolerance for even low levels of sheening. Livestock and game using the water for life cycle purposes or drinking and/or eating. Reduce risks of groundwater contamination.
Public outcry, often by a community with little oil spill experience	Intense demands by a disturbed public can drive politicians to request a more aggressive cleanup than science alone dictates.

Key Driver	Cleanup Endpoints Issues
Human uses of impacted water body and riparian zone, with pressure for aggressive removal and quick re-opening of closed areas	Requires meeting water quality standards for recreational use such as swimming, fishing, and boating in water bodies where oil persistence is an issue. Remobilization of oil in riparian zones can pose chronic exposures to people, affecting passive uses such as walks along riparian zones, public places and parks along the waterway. Prolonged closure zones in areas of chronic oiling can have socioeconomic effects, such as loss of business, refusal to consume agricultural and livestock products, and loss of tourism.
Proximity to human habitation	Need high degree of removal to reduce exposure hazards for people who live nearby.
Longer persistence of spilled oil in freshwater than in oceans	Leads to more intensive removal efforts in areas with lower rates of natural removal processes in sheltered habitats without exposure to physical removal processes such as waves and currents. Spills on land penetrate more deeply and can contaminate groundwater, often requiring more intrusive remediation techniques.
Size of impacted water body and scope of oiling	Even small spills can affect the entire pond, stream, or wetland. Spills can cover relatively large areas per volume of oil. Can affect an entire local population of plants, phytoplankton, insects and other crucial habitat components as well as directly affecting the animals dependent on those habitats.
Increased sensitivity of environment to cleanup methods	Inland habitats can be more susceptible to damage from foot traffic, construction of access corridors, topographic changes from sediment removal, habitat damage from vegetation removal, and increased erosion. Animals at greater risk to oiling, particularly those with small home ranges. Sediment/vegetation removal can increase risks of bank erosion. Habitats may already have sustained previous degradation due to industrial activity.
Logistical challenges for Operations in gaining access	Spread of oil into areas with difficult access requires construction of access corridors and staging areas for oiled material handling or leaving the oil to naturally attenuate.
State cleanup guidelines and Federal response authorities	States often have sediment quality standards that must be met, often after the emergency response is over. EPA tends to issue cleanup orders using their regulatory authority, which comes from the Clean Water Act and is contingent on sheens or threats of sheen on navigable water.
Presence of cultural and historic resources	Sites are often naturalized and difficult to recognize in the field. Historic and cultural resources may be delicate and not easily cleaned, while at the same time be the focus of high regard with significant public involvement in restoration.
Presence or use by wildlife resources and important plant habitat	Inland sites especially when adjacent to water bodies and water ways are often important to a variety of wildlife species and birds. They may be critical areas used by migratory birds or other protected species. Additionally, shorelines of inland waterways and waterbodies may be habitat for important protected plant species.

Key Driver	Cleanup Endpoints Issues
Frequent water-level changes, and sometimes changes in directional flow, which can be very large seasonally	Causes failure in containment strategies. Can lead to a push for aggressive removal of bulk oil before predicted flood or seiche events. Pushes oil into more sensitive floodplains where removal is more difficult and where human use is more likely to be impacted. Spreads oil over larger areas and to downstream reaches quickly.

RECENT INLAND OIL SPILL CASE STUDIES AND LESSONS LEARNED:

Enbridge/Kalamazoo River Spill, Michigan

Spill Summary: On July 26, 2010, Enbridge, Inc. noticed a pressure drop in their pipeline after they tried to restart the line following a scheduled shut down. The line was shut down and the valves were shut upstream and downstream of the pressure drop (approximately 3 miles of 30-inch line). The approximately 70,000-barrel spill affected 40 miles of the Kalamazoo River, which experienced flooding before and after the spill. Over several days the river level fell, stranding oil in some upland, backwater, and wetland areas. The habitats affected included riparian strips, agricultural fields, city parks, and residential lawns and gardens.

The Unified Command (UC), consisting of the U.S. Environmental Protection Agency (EPA), five state and county agencies, and the Responsible Party (RP), determined that the endpoint to be achieved was no free product or sheening impacting waters of the U.S. The EPA issued a CWA 311(c) Order to the RP to ensure that the source was secured and oil did not continue to enter or threaten the waters. The Order included a short window to achieve this. The UC, with recommendations from the Science Team and the Operations Section Chief, determined the menu of cleanup methods/tools that would be utilized. These methods/tools were in turn provided to the SCAT teams, who made recommendations on their use in each segment.

Key Drivers: 1) Prevent oil from passing Morrow Lake. On the downstream side of the Morrow dam, a large polychlorinated biphenyl (PCB)-contaminated sediment site was to be avoided so that PCBs, which are oleophilic, would not mix with the oil complicating and worsening the event. 2) An order was issued requiring removal of oil within 60 days of issuance of the Order. 3) Weather was a driver as rain events would strand oil anew and winter could potential limit cleanup activities. 4) The state had just gone through a reorganization that affected the environmental agencies so that they were not able to fully take over oversight of the RP. 5) Some of the oil sank, contaminating long stretches of the river bottom.

Final Results: 1) A five-step sign-off process was instituted and completed. Of the approximately 160 segments, 60 required continued treatment for sheening. The initial SCAT determinations were redone later to deal with renewed emphasis on oil removal in the sheening locations and submersed oil. 2) Because many areas continued to experience sheening, increasingly aggressive techniques were used until the sheening was eliminated. The deadlines in the order were extended. In the years after the initial response was conducted, the area was reassessed multiple times and more aggressive cleanup methods were employed to eliminate persistent sheening in areas where the submersed oil accumulated.

Lessons Learned: Issuing the CWA311(c) Order helped to focus the attention of the RP on the response. However it caused SCAT to come to a somewhat false end, as 60 locations still needed some form of Operations and Maintenance activities to continue collection of remobilized oil. The team was forced to be more rigorous in their recommendations as oil resurfaced. The use of a photo book to identify habitats was useful, but not complete, scientific, nor transferrable. Building on the idea of photo books (also used at the Silvertip Spill), Habitat Fact Sheets were created, following a scheme developed by the Department of the Interior, to provide information on sensitivity, oil spill impacts, and appropriate response methods for various habitat/vegetation types.

Silvertip Pipeline Spill, Montana

Spill Summary: A 12-inch crude oil pipeline within the ExxonMobil Silvertip Pipeline System was breached on July 1, 2011 during flood conditions in the Yellowstone River releasing an estimated 750 to 1,000 barrels of crude oil into the river. The pipeline was shut down within 7 minutes of the low-pressure alarm. However, the 14-mile section of pipeline between adjacent pump stations likely filled with river water, displacing a significant amount of oil that floated to the surface. The habitats affected included riparian strips, agricultural fields, city parks, and residential lawns and gardens. There were many naturally occurring debris piles that provide habitat and trapped oil in seemingly random patterns.

Public perception drove much of this cleanup. The river name conjured up the name of the National Park, which was not affected. This spill came relatively shortly after the *Deepwater Horizon* so the media and public were still familiar with the issues. The UC was limited in reaching consensus on response actions, as the Governor of Montana did not want the state to participate in the UC with the RP due to perception issues. This is a common thread in the inland zone where the regulatory agencies must ensure that there is no perception that the government and the spiller are too closely aligned. The process for developing endpoints was challenging, due to the state not fully participating in the UC. Consequently, a Science Team was created whose role was to answer questions that the SCAT team had and to make recommendations on cleanup techniques. The group was comprised of technical experts from government, academia, industry, and local non-governmental organizations. In coastal spills, this group is referred to as a Technical Advisory Group. The Science Team required significant education as many of the participants had little or no oil spill experience. The divide between “remove all oil” and those who would consider the net environmental benefit was very clear in this group. Consensus was difficult to reach, and much discussion and education was needed. The initial SCAT process focused on location types (land side of the levee, water side of the levee, islands, etc.) and was simplified to one menu that the Command approved. SCAT teams then chose appropriate recommendations from that one menu of approved techniques. The cleanup endpoints were:

- Oiled banks and structures shall be free of pooled, mobile or recoverable oil that is capable of being refloated when inundated.
- Floating oil-coated debris shall be removed.
- Oiling stain or sporadic coat may remain if it does not rub off on contact (residual oil not easily removed does not pose a significant contact hazard to wildlife because it does not wipe off on feathers or fur, and is not a source of persistent/chronic sheen).
- Depending on negotiations with individual landowners, additional treatment requirements may supplement UC requirements; these cases will be coordinated by RP representatives.

- Un-oiled debris, sediment, and vegetation will be left in place.

Key Drivers: 1) Very high water flow that changed over time. 2) High media coverage.

Final Results: A five step sign-off process was instituted and completed. When SCAT surveys got ahead of Operations, surveys had to be redone when the oiling conditions changed.

Lessons Learned: There was not a lot of control over public perception especially when it came out that the RP had not been fully forthcoming about products carried by the pipeline and with a Governor that is a soil scientist with some knowledge of the science lingo. What did exist, was the opportunity for education between the two polar points of view. Without more studies about the ability, or lack thereof, of habitat recovery from some percentage of oil, discussions seemed to be more philosophical than scientific. There is a real need for studies to determine how much oil can be left on what size waterway to have a viable decision-making process.

Bay Springs Pipeline Spill, Mississippi

Spill Summary: On February 5, 2013, Plains All American Pipeline initially reported a release of 45 gallons of crude oil from an eight-inch line near Bay Springs, MS into Piney Branch, impacting 0.75 miles of waterway. Mississippi Department of Environmental Quality (MDEQ) responded and requested EPA assistance. MDEQ and EPA estimated a release of approximately 100 barrels of crude oil from the pipeline. The released product migrated overland from the discharge point into an intermittent stream and to Piney Branch, a tributary of Tallahoma Creek. Response crews implemented containment and recovery strategies in this creek that meandered through a wetland dominated by bottomland hardwood cypress. Initially, recovery consisted of using booms to contain the oil and skimmers and pumps for collecting it on the water. The release impacted approximately 2 miles of waterway.

The Federal On-Scene Coordinator (FOSC), with support of the state, issued a Clean Water Act 311(c) Order to the RP to ensure that the source was secured quickly and materials did not continue to enter or threaten the waters. The Order did not include a time frame for completing the cleanup or endpoints to be achieved. The FOSC, in coordination with the state, established a cleanup endpoint of “no recoverable product” for the site. The area impacted by the oil included multiple habitat types including manmade structures, hardwood bottomlands, and wetlands. Because of this variety, the UC provided further direction, requiring the cleanup be halted when additional efforts would cause more harm to the habitat than allowing natural attenuation of the oil. The UC, with support of the removal contractors and SCAT teams, determined the cleanup methods/tools that would be utilized to achieve these endpoints.

SCAT teams, comprised of personnel from EPA, state, RP, and often a cleanup contractor/ foreman recommended specific cleanup methods from this list for each segment or group of segments surveyed. A combination of GIS/GPS technology and simple field markings (pin flags and taping) was employed to identify locations requiring removal actions in each segment.

SCAT re-inspected each segment following treatment and provided important information to the UC on the effectiveness of the tools selected for removal and the conditions of the environment as a result of their application. Upon recommendations from the SCAT teams, the UC revised its cleanup endpoint in specific locations as they took into account the potential damage to sensitive habitats from the cleanup process. Direct communications between the SCAT team leader and the Operations Section Chief ensured that problems areas could be swiftly addressed when identified.

Key Drivers: 1) Environment – Protecting navigable waters, shorelines and natural resources associated with them. 2) Land Owners – Ensuring impacted property owners were informed and involved. 3) Weather – Heavy storms were forecasted to bring potentially flooding rains.

Final Results: The use of the CWA 311c Order, with its requirement to prevent the release or threat of release of oil into the waterway, was effective in focusing efforts to end continued oiling of the waterway. The early and continued use of SCAT provided valuable feedback to the UC on the progress of the cleanup and the appropriateness of the tools and the cleanup endpoints selected for the site. SCAT information allowed the UC to modify the endpoint of no recoverable oil when it became clear that continued cleanup operations would do more environmental damage than leaving the oil in place. The interaction of the SCAT team leader and the Operations Chief enhanced the efficiency of the cleanup operation by ensuring that problem areas could be addressed swiftly when identified.

Lessons Learned: Issuing the 311(c) CWA Order helped to focus the necessary resources on the response. Cleanup endpoints may need to be modified for habitat specific needs within a site. The close working relationship between SCAT teams and Operations enhanced the removal process.

Red Butte Creek Oil Spill, Salt Lake City, Utah

Spill Summary: On June 11, 2010, a 10-inch crude oil pipeline owned by Chevron released approximately 1,000 barrels of oil into Red Butte Creek, in Salt Lake City, Utah, an urban stream that is heavily controlled by dams and reservoirs. The stream flows through natural channels, urban parks, and buried culverts before emptying into Jordan River, a tributary of the Great Salt Lake. Three miles of Red Butte Creek were significantly oiled and required treatment.

The FOSC worked with city, county, academic, state, and federal stakeholders in a large group setting to determine what the cleanup drivers were and to discuss net environmental benefit. The City of Salt Lake had recently completed a riparian corridor survey of Red Butte Creek and other nearby drainages. Most state and local agencies in UC were familiar with the survey, which created an informed group of representatives. Based on the survey findings, UC determined that the priority was the macroinvertebrate community in the sediment and the large trees and vegetation along the shoreline. These receptors were less sensitive to trace amounts of oil than they were to erosion and sedimentation. The focus on macro-invertebrates and large trees led the group to select a low-impact response method that would minimize bank erosion. The UC agreed it was critical to protect the riparian corridor and vegetated canopy even though it meant leaving some staining on rocks and culverts, and some residual sheening.

The cleanup endpoint was to capture all recoverable oil and leave minimal sheen-generating oil in place. Locations where sheen-generating oil was left in place were on steep banks and around tree root balls. The treatment method was to flood and drain the impacted reach twice by manipulating the dams and reservoir. Following each intentional flooding, the channel banks were flushed manually by workers on foot using backpack sprayers and floating pumps. UC agencies and resource trustees monitored the operations periodically. Although not formal, this was a "SCAT" process and included the RP, U.S. Fish and Wildlife Service, Utah Department of Environmental Quality, and EPA/U.S. Coast Guard. On the second pass with handheld pumps, the SCAT team accompanied cleanup workers determined when the endpoint had been met. This is an example of the fourth type of endpoint as stated previously. The general priorities for resource protection had been established by UC, and the SCAT teams, which were essentially made up of UC representatives, made the judgment of when further cleanup would do more harm than good.

It is worth noting that this spill occurred while the BP *Deepwater Horizon* and Kalamazoo River spill responses were ongoing. This reduced the attention paid to the spill. However it was one of the largest to occur in Region 8 in some time and, due to proximity of permanent, full-time residences, had greater potential to impact public health.

Key Drivers: 1) Protect macroinvertebrates and riparian habitat. 2) Ensure health of large trees along stream banks. 3) No direct human use of impacted water.

Final Result: Cleanup endpoints were met. State and local resource agencies have continued to monitor the impacted area, but no further cleanup actions have been taken.

Lessons Learned: Because the endpoint was a judgment call on when further cleanup action would harm the key resources, it was critical to have the SCAT team travel with Operations on their final pass. This greatly improved efficiency, because it eliminated multiple mobilizations and allowed the resource managers to make nuanced determinations based on their expertise. The endpoint could not have been easily communicated in a way that cleanup contractors could implement in the field. The UC's understanding of the local ecosystem due to the recent riparian study facilitated consensus on a cleanup endpoint that stopped short of no visible oil. It is unusual for inland resource trustees to have a whole ecosystem consensus going into a spill. It is more typical for the consensus to be created during the spill response. The resource trustees required education on the impacts of oil in the environment, but they already agreed on the critical features of the ecosystem itself. Since this good fortune is not typical, the SCAT program on an inland spill must start the process early of educating resource trustees on the impacts of oil and asking them to reach consensus on critical ecosystem components to protect.

DEVELOPING CLEANUP ENDPOINTS FOR INLAND SPILLS:

Shoreline assessment, development of cleanup endpoints, and response options for inland waters, shorelines, and lands follow a similar process to standard coastal methods. Differences are primarily related to: 1) Types of vegetation, shoreline/habitat; 2) Types of fresh water bodies and their associated physical characteristics when compared to coastal water bodies; 3) Differences in oil fate and behavior in various inland fresh water environments due to the ranges of energy to which they are subjected; 4) Differences in the variety of cleanup drivers, inland habitat use, and acceptable cleanup endpoints when compared to coastal environments; 5) Existence of potential for contamination of groundwater resources through soil/sediment surface contamination and introduction via percolation or other mechanisms; 6) Differences in access and effects of highly aggressive versus less aggressive cleanup techniques; and 7) Differences in usage of spill response products and countermeasures for inland and freshwater response.

Discussed below are considerations in developing cleanup endpoints for inland oil spills. Table 2 provides guidelines for cleanup methods and endpoints based on these considerations for inland habitats.

Table 2. Guidelines for selecting cleanup methods and endpoints for different inland habitats.

Basis for Treatment	Applicable Habitats	Treatment Methods	Example Primary[1] Cleanup Endpoints	Guidelines for NFT[2] Determination
Protection of Public Health and Safety	- High public use areas - Residential areas - Groundwater supplies	- Whatever needed to remove threats: excavate, cut, flush, remove/replace	- No visible oil - No detectable oil (sight or smell)	- When oil residues are no longer a threat to human health and safety - Falls below threshold odor or exposure limits
Protection of Sensitive Resources and Habitats	Wetlands, bird-nesting areas, T&E species habitat, wildlife refuges, national parks, other protected areas	- Gross oil removal using vacuum, skimming, manual removal using walking boards in soft substrates - Passive recovery of sheens	- No free-floating black oil or mousse on the water surface - No accessible oiled debris - No oil in sediments that are used for nesting, hibernating grubbing for food	- Usually determined by resource manager or land manager experts - Case studies that show habitat damage from aggressive treatment - Particular sensitivity of a species or habitat - Inability to replace habitat
Removing Aesthetic Impacts in High-use Areas	- Hard substrates such as bedrock, gravel, seawalls, riprap - Beaches - Vegetation - Debris	- Wipe, high-pressure, high-temperature flush, cut, remove/ replace	- No visible oil - No more than 20% Stain or Coat	- Less aggressive removal during seasonal low-use periods could allow natural processes to work - Consider how long before the oil weathers - Public information campaign concerning remaining staining required
Removing Contact Hazard (both humans and wildlife)	- Hard substrates such as seawalls, riprap, bedrock - Vegetation - Debris - Soil	- Wipe, flush, cut, sorbent barriers, remove/replace	- No longer rubs off on contact - No oil that rubs off on sorbents	- Consider how long before the oil will weather to a non-sticky Stain or Coat - Avoid excessive vegetation removal -Falls below known limits for hazards - Public information campaign concerning remaining staining required

Basis for Treatment	Applicable Habitats	Treatment Methods	Example Primary[1] Cleanup Endpoints	Guidelines for NFT[2] Determination
Mitigating Persistent Sheens	- Rivers, streams, other flowing water bodies - Lakes, ponds, other standing water bodies - Seasonally flooded wetlands	- Actively remove the major sources of sheens (excavate, dredge, flush, cut, remove/ replace) - Passively contain/recover sheens with booms and sorbents	- No longer generates sheens that affect sensitive resources - No longer releases black oil or mousse during flushing operations - No longer generates black oil or mousse during high-water events	In low-use areas: - Consider seasonal use and processes (e.g., flooding) that speed natural removal In high-use areas: - Education on considerations between aggressive removal and chronic sheens - Site specific studies to assess receptor risk
Mitigating Intermittent Sheens (triggered by rainfall, temperature changes, etc.)	- Rivers, streams, other flowing water bodies - Lakes, ponds, other standing water bodies - Seasonally flooded wetlands	- Actively remove the major sources of sheens (excavate, dredge, flush, cut, remove/ replace) - Passively contain/recover sheens with booms and sorbents	- No longer generates sheens that affect sensitive resources	In low-use areas: - Education on considerations between aggressive removal and chronic sheens In high-use areas: - Education on considerations between aggressive removal and chronic sheens - Site specific studies to assess receptor risk
Mitigating Sediment/Soil Contamination	- Upland soils - River/lake bed sediments - Wetland sediments	- Actively remove gross contamination (excavate, dredge, remove/replace) - Passively contain/ recover remobilized oil with booms and sorbents - In-situ techniques such as aeration, tilling, phytoremediation, adding nutrients	- No visual oil greater than Stain or Coat - Does not release black oil when disturbed - Agriculture or pasture for human use may need a ppm endpoint	- High risk of erosion or excessive sedimentation - Unacceptable changes in surface topography - Avoid excessive change in sediment/soil quality, e.g., organic matter content, grain size - Potential permanent change to the habitat type e.g., wetland to open water

[1] Secondary Cleanup Endpoints should include "Or, as low as reasonably practicable considering net environmental benefit"
[2] No Further Treatment

<u>Phases of Response</u>: Because of the potential longer persistence of oil in inland habitats, there may be a need for cleanup endpoints for different phases of the response, such as: 1) Used to determine that the "active phase" of the response is complete; and 2) Used to determine when a "maintenance and monitoring phase" is complete and the entire response can be terminated for a specific area. This is a common approach used for coastal oil spill response, particularly in sensitive habitats such as wetlands.

Type of Use Considerations: Delineate cleanup endpoints in terms of type of use, such as:

- High-use public areas (e.g., waterfront parks, water access points, amenity beaches)
- Residential areas
- Low-use public and private areas
- Agency management areas where land managers participate in determining cleanup methods and endpoints that address ecological sensitivity and protection
- Industrial areas (often have other sources of contamination and habitat degradation and issues of how to differentiate between the source oil and "background" contamination)
- Agricultural areas subject to oiling during floods (where tilling and nutrients could be used to speed biodegradation of oil residues, depending on water quality constraints)

Sensitivity to Damage from Cleanup Activities: Sensitive habitats where aggressive cleanup could cause damage include wetlands, soft substrates, areas prone to erosion, habitats with threatened/endangered plants, habitats that rely on debris, and cultural/historic sites. Sensitive resources include bird-nesting areas where response actions can cause physical disturbance, threatened/endangered animals and plants where response can affect sustainability of a population, meandering rivers and streams where altered land elevations will have significant impacts, and specialized environments such as bogs and fens where soil cannot easily be replaced. There are many studies of how aggressive cleanup can cause additional damage to sensitive coastal habitats; however, there are few such studies for sensitive inland habitats. Cleanup endpoints for sensitive habitats should always include, in addition to the primary endpoint(s), a secondary endpoint such as "or, as low as reasonably practicable considering net environmental benefit." This endpoint allows SCAT teams to use their judgment in the field to recommend termination of treatment even though the site does not meet the primary endpoints.

Stakeholder Involvement and Education Throughout the Process: Inland spills can affect communities with little to no prior experience with oil spill response and effects. Good communications, site visits, educational materials, and use of trusted local leaders and scientists are essential to getting buy-in by local politicians and communities. Taking stakeholders on site visits of the cleanup efforts can help them understand the impact of cleanup methods and facilitate consensus by making it about a specific, concrete problem.

Use of Operational Endpoints: Cleanup endpoints should be based on the effectiveness of approved treatment methods. For example, if only deluge or low-pressure flushing is allowed on a vegetated bank, the endpoint would be "flush until no black oil is released." If sorbents are used for passive recovery of oil in a water body, the endpoint would be "when sorbents no longer recover oil after a rainfall event" (defined based on local conditions). If wiping of vegetation or debris is the allowed treatment method, the endpoint would be "no oil that rubs off on sorbents." This consideration is based on the concept of As Low As Reasonably Practicable (ALARP), considering the allowable treatment methods. Field guides can be generated to inform Operations in application of these endpoints.

Use of SCAT Terminology for Cleanup Endpoints: The SCAT process has become an integral part of inland spill response (see case studies). SCAT terminology should be the basis for quantitative cleanup endpoints, such as "no more than 10% coat on man-made structures or vegetation," or "no more than >10% stain on sand."

Acknowledge the Value and Role of Natural Removal Processes: Natural processes, such as rainfall/flooding events and microbial degradation, can be effective within acceptable time periods for some sites.

Minimize Use of Endpoints based on Water and Sediment Quality Criteria (defined as less than x ppm of contaminant and requires chemical analysis): Such criteria are most appropriate for high public use areas. However, oil spills generate contamination that can be highly variable and difficult to sample representatively (thus the preferred use of visual endpoints).

No Further Treatment due to Net Environmental Benefit: This consideration should be used when the approved treatment method crosses the boundary to causing more harm than good.

SUMMARY:

Recent spill \ demonstrate the need to improve the development and implementation of appropriate cleanup endpoints for inland spills. Recommendations and lessons learned include:

- There has to be a stakeholder education component led by the Planning Unit that is established early and comprehensively to educate stakeholders on the impacts of oil and cleanup methods. This means materials and people with such skills and knowledge must be ready to deploy within days of a significant event.
- More studies and photo-documentation are needed of the impacts of aggressive treatment and the outcomes of sites where natural removal processes were allowed to be part of the response. This kind of information could be used to support the education component for both stakeholders and responders.
- In the absence of consensus over less stringent endpoints, EPA typically uses "no sheen." While this is effective at removing oil from the environment, in some cases it will extend the time it takes an ecosystem to recover.
- Spill-specific photo books and the new EPA Habitat Fact Sheets are effective ways to communicate appropriate endpoints to Operations and provide a more systematic and scientific approach to guide responses.
- Have SCAT presence in the field that is very responsive to questions from Operations (case studies show multiple successes with SCAT accompanying Operations).
- Develop SCAT job-aids and manuals tailored to inland spill response and that provide assessment and response guidance to address contamination or potential contamination of drinking and groundwater sources.
- As with all oil spill cleanups, the process is a flexible and iterative process that requires: 1) Selection of useful "target" endpoints; 2) Application of techniques that may achieve that endpoint while limiting additional impact; and 3) Constant monitoring to confirm endpoint success, and modification of the target endpoint or techniques applied as needed to reflect current conditions and unacceptable impacts resulting from treatment.
- The further development of the tools and practices discussed in this paper will aid responders in developing cleanup endpoints for their next inland oil spill.

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