SHORELINE ASSESSMENT AND ENVIRONMENTAL IMPACTS FROM THE *M/T WESTCHESTER* OIL SPILL IN THE MISSISSIPPI RIVER

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INCIDENT SUMMARY

On 28 November 2000, the *M/T Westchester,* an inbound tanker on the Mississippi River, lost main engines due to a crankcase explosion. With the loss of steerage, the ship's captain deployed the port anchor followed by the starboard anchor in an attempt to maintain control. The vessel struck an unidentified navigational hazard, causing a release of 13,200 barrels (554,400 gallons) of Nigerian crude oil. The vessel anchored at River Mile (RM) 38 (miles up river of Head of Passes). A dive survey identified six fractures over a 40-foot section in the hull of the *M/T Westchester* at the forward portion of the #1 starboard cargo tank. The fractures ranged from 2-6 inches wide and 2-6 feet long and ran lengthwise along the bottom of the hull.

Many of the key bayous and cuts (crevasses) were boomed by exclusion booms to keep the oil out or deflection booms to direct the oil out of the river and into sheltered areas for recovery. A very large amount of oil was deflected by booms into an abandoned slip (Fig. 1) and recovered using drum skimmers. A large volume of oil was trapped at the entrance to Empire Lock and recovered. Winds for the first morning were light and the oil moved slowly downriver. Later, northeasterly winds pushed much of the oil along the west bank for a distance of about 20 miles. Winds were out of the north and east for most of the response, keeping the oil against the west bank and minimizing oiling of habitats and animals along the eastern bank.

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are needed to see this picture.

FIGURE 1. Deflection boom diverting oil slicks into a slip for recovery during the first day after the spill. Note that the thick, emulsified oil is not sheening.

Figure 2 shows the overflight conducted on 1 December, when the surface oil reached the maximum extent downriver. Most of the oil observed below Venice was described as light and consisted of silver and dull-sliver sheens. However, sheens were observed in many of the marsh tidal creeks and bayous such as Grand Pass. Sheens were also observed in marshes and open water west of the river below Venice, having passed through the many cuts in the river levee. No oil was observed to enter the open Gulf of Mexico.

By 7 December, most of the free-floating oil had been recovered. Shoreline cleanup continued until 22 December 2000, when the response took a short Christmas break. On 20 February 2001, 84 days after the initial spill, the last cleanup segment was signed off as meeting the cleanup endpoints.

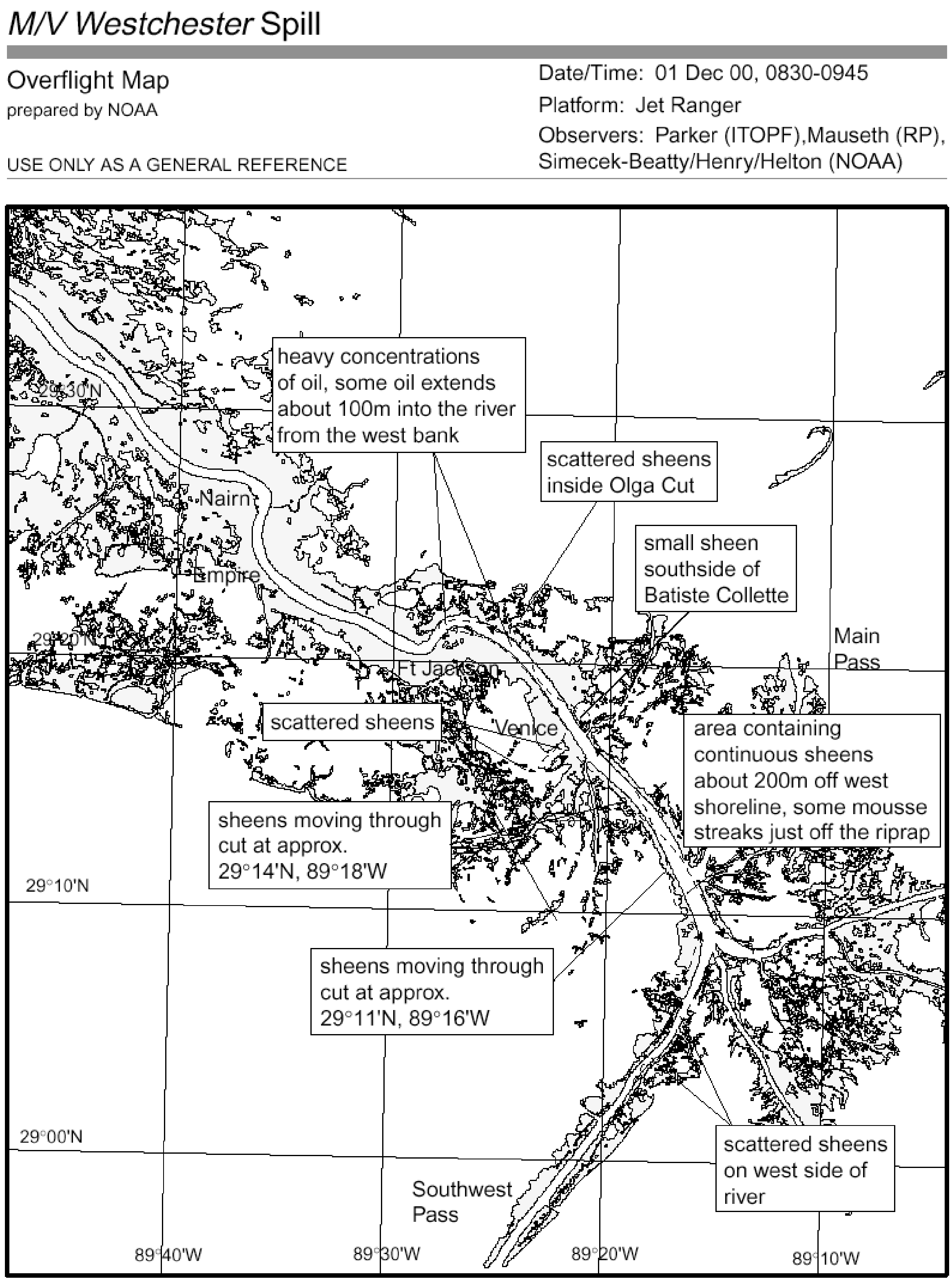

Figure 2. Overflight map for 1 December 2000. Note extent of oil below Venice.

PROPERTIES OF THE SPILLED OIL

The Nigerian crude oil released from the *M/T Westchester* had the following properties:

API - 36.4	Specific gravity - 0.8428
Pour point - 45°F	Viscosity of fresh oil - 8.3 centiStokes at 20°C

The oil had a high paraffin content and a low asphaltene content. When spilled, the oil did not spread as thin film or sheen as is typical for a light crude oil (see Fig. 1). On cool mornings, the temperature was below the pour point of the oil, causing the oil to have the consistency of margarine. Figure 3 shows cleanup workers using squeegees to push the oil into piles for recovery. The oil readily formed an emulsion; three samples collected within the first few days contained 32, 43, and 63 percent water by weight. The spilled oil was not in the ADIOS database, but distillation data were obtained and used to run the ADIOS2 model.

Figure 3. Cleanup of the viscous oil early in the morning when it was below the pour point.

Figure 4 shows the distribution of polynuclear aromatic hydrocarbons (PAHs) in the source oil. Total PAHs are about 1 percent of the oil by weight. Note that the naphthalenes account for about 75 percent of the PAHs. The naphthalene component is important because these compounds are the most water-soluble and contribute significantly to the acute toxicity of the oil to aquatic resources.

The fate of the spilled oil is estimated below:

Volume spilled: 13,200 barrels
Lost via evaporation (30 percent): 3,900 barrels
Recovered as free oil (average of 50 percent water in recovered liquids): 6,500 barrels
Recovered as oiled sediment: 1000 barrels
Recovered during removal of oiled debris: 400 barrels
Remaining in the environment: 1,400 barrels

The very high on-water recovery rate (50%) was attributed to the rapid deployment of boom at key locations, the steady N/NE winds that held the oil against the river bank, the emulsification of the oil that kept it from spreading, and the deployment of more than twenty skimming systems. There was no evidence that a significant fraction of the spilled oil sank. Samples of oil from different shorelines and cleanup operations had specific gravities of 0.93-0.97, but still lighter than even fresh water. The oil quickly formed thick tarballs, ranging in size from 0.5 to 15 centimeters (cm). Shoreline assessment teams reported seeing viscous oil patties that had stranded in backwater areas and sloughs during low water and did not re-float when the river level rose. However, when disturbed, the oil did re-float, indicating that it had stuck to the substrate but still remained buoyant. The cold conditions (below the pour point) also contributed to this behavior.

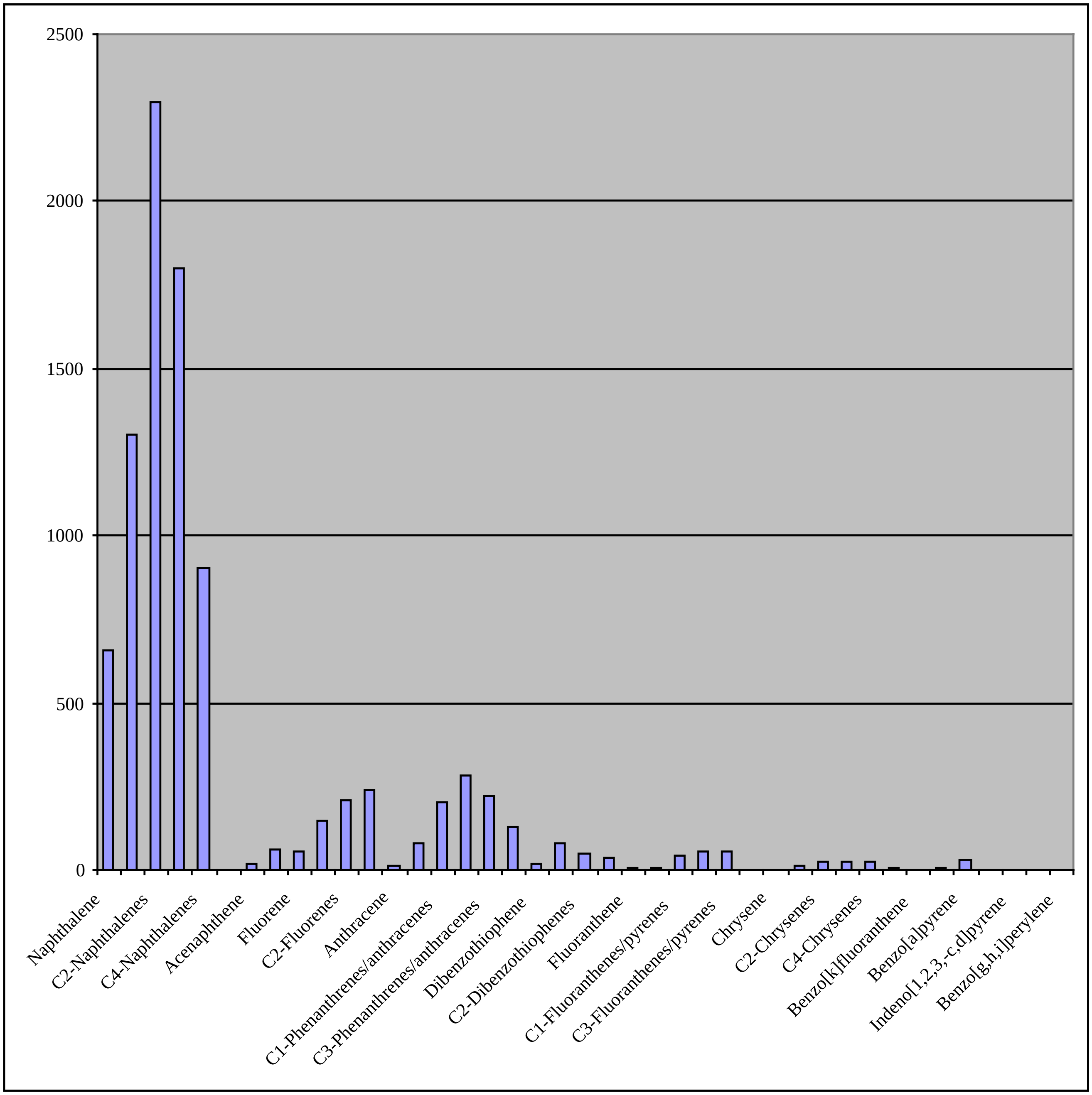

Figure 4. Distribution of PAHs in the source oil. Concentrations for the “y” axis are in mg/Kg.

SHORELINE HABITATS AFFECTED BY THE SPILL

A shoreline cleanup assessment team (SCAT) conducted initial and followup surveys to document the extent and degree of shoreline oiling, make cleanup recommendations, and sign off shoreline segments as meeting cleanup endpoints. Standard methods and terminology were used to describe and quantify the degree of shoreline oiling. These data were recorded on forms and sketch maps, following the procedures in the NOAA Shoreline Assessment Manual (Michel et al., 1998) The initial shoreline surveys were conducted by foot or by boat and completed on 2 December.

The shoreline assessment data were used to estimate the areal extent of oiling for the different shoreline habitats. Using digital shoreline data, the length of river shoreline by habitat type and degree of oiling was calculated for each shoreline segment. The SCAT data were used to estimate the width of the oil for each sub-segment and the degree of oil exposure. Table 1 shows the total area of shoreline oiled by habitat, calculated from the SCAT data. Heavy oil is defined as a band of oil at least 1 meter wide and greater than 50 percent distribution. Because of the viscosity of the oil, the oiling band was usually described as cover (>0.1 cm to <1 cm) or pooled (>1 cm). Moderate oil is defined as any oil deposits that are between 10 and 50 percent distribution. Light oil is oil distribution that is less than 10 percent. Each oiled shoreline type, extent of oiling, and cleanup methods and endpoints are discussed below.

Table 1. Total shoreline oiling (in acres) by habitat type and degree of oil exposure.

Shoreline Habitat	All	Heavy	Medium	Light
Riprap	11.14	7.07	2.47	1.60
Fresh marsh	0.86	0.83	0.03	
Freshwater edge of slough	0.52	0.52		
Sand flats	7.23	7.23		
Mud flats (batture lands)	15.40		15.40	
Total	35.15	15.65	17.90	1.60

Riprap

Habitat and oil descriptions. Most of the oiled shoreline along the west bank of the river was composed of riprap revetments. These are shoreline protection structures formed from cobble- to boulder-sized pieces of rock. In some areas, there are two lines of riprap: a low line along the river, and a larger, higher line of riprap against the levee. The oil coated the riprap blocks and penetrated deeply into the crevices. In many areas, oil pooled inside the crevices.

Cleanup strategy and results. High-volume flushing with ambient-temperature water was initially successful in removing much of the oil penetrated into the riprap. The only limitation was water depth. Some locations were too shallow for the barge to access. In shallow locations, primarily the northern cleanup zones, small hand-held systems were used, with less effectiveness. The cold winter weather (often near freezing at night) severely reduced the effectiveness of the wash pump systems. At such low temperatures, the oil remained a semisolid and could not be mobilized.

Cleanup endpoints. No pooled oil visible in crevasses. No more than 30 percent coat (black oil that can be scrapped off with a fingernail) on visible rock surface. No black/brown oil is mobilized during cleaning or natural flushing (no oil remaining that is a threat of being a secondary source).

Sand Flats

Habitat and oil description. This habitat type consists of fine grained-sand flats that are exposed during low water (either low tide or low river levels). In the spill impact area, sand flats occurred mainly along the river side of the “island” from RM 18 to 19.5. Fringing reeds and willow trees commonly bordered the flats on the landward side. Stranded oil was observed from within the roots of willow trees and other riverine vegetation to the low tide line. Oil on the sand flat occurred as a band of emulsified oil 1-3 cm thick and up to 15 m wide. There was no penetration of oil into the water-saturated sediments. However, there were some areas of oil burial by a thin layer of sediment.

Cleanup strategy and results. Manual recovery of free oil and oiled sand was conducted, using squeegees to push the oil into piles for manual recovery with shovels or sumps for vacuum removal. Oiled vegetation was removed to access free oil. Heavily oiled vegetation and debris were removed. Pom-pom snare was used to wipe oil off willow trees bordering the sand flats. The flats were trafficable, and large numbers of workers were involved in the cleanup. By 22 December, the sand flat was signed off as meeting cleanup endpoints.

Cleanup endpoints. Remove all black/brown oil. No more than 5 percent stain on sand.

Mud Flats

Habitat and oil descriptions. Mud flats are partially vegetated, muddy areas that are located between the outer and inner lines of riprap, mostly in the batture areas. Vegetation, ranging from herbaceous grasses to small trees, occurred around the edges of the flats. These habitats were oiled in two ways: 1) by floating oil that passed through the outer line of riprap when floating oil was on the river. This oiling occurred as isolated patches of thick oil (often greater than 3 cm thick; and 2) during cleanup operations when large-volume flushing was conducted on the outer line of riprap. This oiling occurred as oil sheens throughout the time that cleanup was conducted in these areas.

Cleanup strategy and results. Cleanup methods included low-pressure flushing, manual oil removal, and passive recovery by sorbents. Some oiled vegetation was cut. Sorbents were placed along the river edge of the flats to recover remobilized oil once flushing was no longer effective. The biggest problem was re-oiling of these areas by oil remobilized during cleanup of the adjacent riprap.

Cleanup endpoint. No more black/brown oil released (no visible free oil).

Sloughs

Habitat and oil descriptions. Sloughs are natural waterbodies that have limited access, vegetated banks, and very soft substrates. They are an important habitat for wildlife adjacent to the river. The large slough located behind an island (at river mile 19) was an area of particular importance to wildlife, and it was given high priority for cleanup. Free oil was pooled in the sloughs and covered much of the fringing vegetation.

Cleanup strategy and results. Cleanup workers using low-pressure flushing to push free oil toward skimmers and vacuum trucks. Cleanup workers, operating from boats and standing on the shoreline, flushed the oiled vegetation with water. In some areas, oiled vegetation was cut and removed.

Cleanup endpoints. Soil, sand, and mud areas should contain less than 5 percent stain. Remove all free oil. No oiled vegetation.

Freshwater Marsh

Habitat and oil descriptions. Freshwater marsh and other herbaceous vegetation occurred as grasses on the landward side of the sand flats and as pockets of freshwater marshes in the slough. Oiling occurred usually as a narrow band along the outer fringe.

Cleanup strategy and results. Cleanup methods included low-pressure flushing, wiping of oil from the vegetation, and passive recovery by sorbents. Some oiled vegetation was cut.

Cleanup endpoint. No more black/brown oil released (no visible free oil).

WILDLIFE IMPACTS

A total of nineteen oiled birds were turned into the rehabilitation center. Of these, five were brought in dead and fourteen were brought in live. Of the fourteen live, oiled birds, nine died and one was euthanized. Four birds were treated and successfully released. In addition, three oiled turtles were captured, cleaned, and released, and two dead nutria were collected.

During the spill, the Trustees conducted field surveys to document the number of birds by species present in the area affected by the spill and identify oiled birds that needed capture and rehabilitation. On 30 November, there were 284 birds along the west bank and 1,387 along the east bank between RM 12 and 25. On 1 December, observers reported 546 birds along the west bank and 620 birds along the east bank for this same general area. Birds were obviously moving around, depending on habitat preferences and the degree of disturbance by oil and response activities. It appears that birds were avoiding the west bank area, either because they detected and moved away from the oil or were disturbed by the response activities concentrated along the west bank.

WATER COLUMN SAMPLING

Water samples were collected over a five-day period, starting on 30 November and ending on 4 December 2000. Two types of water samples were collected:

- Grab samples that were collected by placing a 3.8 liter glass bottle under the water surface at about 30 cm depth, removing the cap at that depth and allowing the bottle to fill, then sealing the cap and bringing the bottle to the surface.
- Filtered samples were collected using a high-volume filtering system to filter up to 8 liters of water on station. Both the filtered water and the filter are collected and preserved.

A total of 20 samples were analyzed for total PAHs (including the alkylated homologs). Background dissolved PAH concentrations in the Mississippi River were ranged from 27-70 ug/Kg, or parts per billion (ppb). Dissolved concentrations measured in samples taken immediately adjacent to areas of intense shoreline flushing reached 2,200-72,000 ppb. Outside of these areas, dissolved PAHs in the mainstem of the river adjacent to oiled shorelines were in the range of 200-300 ppb for the first few days after the initial release. Within 1mile downstream of the area of heaviest shoreline oiling, dissolved PAHs dropped to background levels. There were no reported fishkills.

SUMMARY

The rapid and highly effective response for this spill was aided by favorable wind conditions and resulted in minimal amounts of environmental impact, considering the large volume of oil released and the sensitive habitats of the lower delta. Shoreline cleanup was hampered by abnormally cold weather conditions, with temperatures often below the pour point of the spilled oil. Such conditions kept the spilled oil immobilized as a viscous, semi-solid in thick concentrations on the shoreline. The SCAT process worked well to support operations in evaluating cleanup methods and developing cleanup endpoints.

REFERENCES CITED

Michel, J., B. Benggio, and I. Byron, 1998. Shoreline Assessment Manual. Hazardous Materials Response Division, National Oceanic and Atmospheric Administration, 54 pp + app.