Office of National Marine Sanctuaries
Office of Response and Restoration

Screening Level Risk Assessment Package

Material Service

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National Oceanic and
Atmospheric Administration

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Photo: Photograph of *Material Service*
Source: http://www.windycitydiving.net/dive-videos/wrecks

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Project Background

The past century of commerce and warfare has left a legacy of thousands of sunken vessels along the U.S. coast. Many of these wrecks pose environmental threats because of the hazardous nature of their cargoes, presence of munitions, or bunker fuel oils left onboard. As these wrecks corrode and decay, they may release oil or hazardous materials. Although a few vessels, such as USS *Arizona* in Hawaii, are well-publicized environmental threats, most wrecks, unless they pose an immediate pollution threat or impede navigation, are left alone and are largely forgotten until they begin to leak.

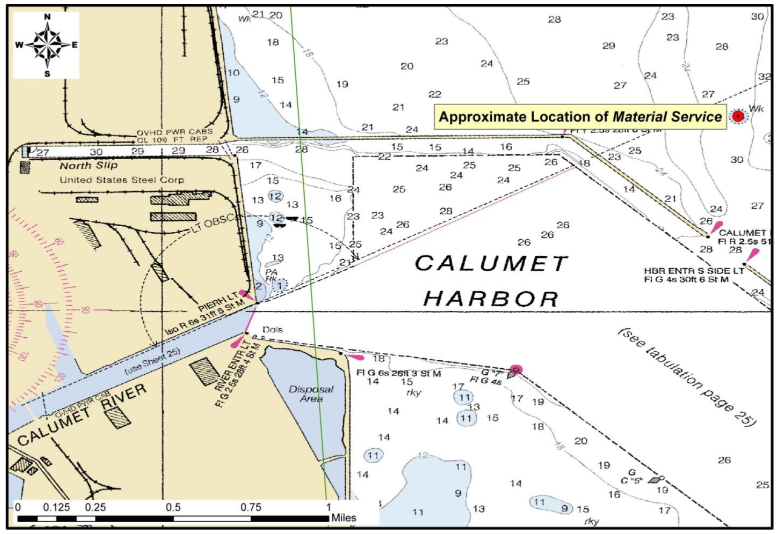
In order to narrow down the potential sites for inclusion into regional and area contingency plans, in 2010, Congress appropriated $1 million to identify the most ecologically and economically significant potentially polluting wrecks in U.S. waters. This project supports the U.S. Coast Guard and the Regional Response Teams as well as NOAA in prioritizing threats to coastal resources while at the same time assessing the historical and cultural significance of these nonrenewable cultural resources.

The potential polluting shipwrecks were identified through searching a broad variety of historical sources. NOAA then worked with Research Planning, Inc., RPS ASA, and Environmental Research Consulting to conduct the modeling forecasts, and the ecological and environmental resources at risk assessments.

Initial evaluations of shipwrecks located within American waters found that approximately 600-1,000 wrecks could pose a substantial pollution threat based on their age, type and size. This includes vessels sunk after 1891 (when vessels began being converted to use oil as fuel), vessels built of steel or other durable material (wooden vessels have likely deteriorated), cargo vessels over 1,000 gross tons (smaller vessels would have limited cargo or bunker capacity), and any tank vessel.

Additional ongoing research has revealed that 87 wrecks pose a potential pollution threat due to the violent nature in which some ships sank and the structural reduction and demolition of those that were navigational hazards. To further screen and prioritize these vessels, risk factors and scores have been applied to elements such as the amount of oil that could be on board and the potential ecological or environmental impact.

Executive Summary: *Material Service*



The freighter *Material Service*, sunk in a storm on the south shore of Lake Michigan 1936, was identified as a potential pollution threat, thus a screening-level risk assessment was conducted. The different sections of this document summarize what is known about the *Material Service*, the results of environmental impact modeling composed of different release scenarios, the ecological and socio-economic resources that would be at risk in the event of releases, the screening-level risk scoring results and overall risk assessment, and recommendations for assessment, monitoring, or remediation.

Based on this screening-level assessment, each vessel was assigned a summary score calculated using the seven risk criteria described in this report. For the Worst Case Discharge, *Material Service* scores Low with 11 points; for the Most Probable Discharge (10% of the Worse Case volume), *Material Service* also scores Low with 11 points. Given these scores, and the higher level of data certainty about the vessel, NOAA recommends that this site be noted in the Area Contingency Plans as necessary to answer future questions about the pollution risks associated with this particular vessel. Should additional information become available that would suggest a greater level of concern, then an active monitoring program could be implemented or an assessment undertaken. Outreach efforts with the technical and recreational dive community as well as commercial and recreational fishermen who frequent the area would be helpful to gain awareness of any significant changes or further deterioration of the site.

Vessel Risk Factors		Risk Score	
Pollution Potential Factors	A1: Oil Volume (total bbl)	High	
	A2: Oil Type		
	B: Wreck Clearance		
	C1: Burning of the Ship		
	C2: Oil on Water		
	D1: Nature of Casualty		
	D2: Structural Breakup		
Archaeological Assessment	Archaeological Assessment	Not Scored	
Operational Factors	Wreck Orientation	Not Scored	
	Depth		
	Confirmation of Site Condition		
	Other Hazardous Materials		
	Munitions Onboard		
	Gravesite (Civilian/Military)		
	Historical Protection Eligibility		
		WCD	MP (10%)
Ecological Resources	3A: Water Column Resources	Low	Low
	3B: Water Surface Resources	Low	Low
	3C: Shore Resources	Low	Low
Socio-Economic Resources	4A: Water Column Resources	Med	Med
	4B: Water Surface Resources	Med	Med
	4C: Shore Resources	Low	Low
Summary Risk Scores		11	11

The determination of each risk factor is explained in the document. This summary table is found on page 36.

SECTION 1: VESSEL BACKGROUND INFORMATION: REMEDIATION OF UNDERWATER LEGACY ENVIRONMENTAL THREATS (RULET)

Vessel Particulars

Official Name: *Material Service*

Official Number: 228371

Vessel Type: Freighter

Vessel Class: Self-unloading bulk freight carrier

Former Names: N/A

Year Built: 1929

Builder: Leathem, D Smith Dock Co. Sturgeon Bay, WI

Builder's Hull Number: 253

Flag: American

Owner at Loss: Leathem, Smith-Putnam Nav. CO.

Controlled by: Unknown

Chartered to: Unknown

Operated by: Unknown

Homeport: Milwaukee, WI

Length: 240 feet

Beam: 40 feet

Depth: 13 feet

Gross Tonnage: 1,077

Net Tonnage: 736

Hull Material: Steel

Hull Fastenings: Riveted

Powered by: Oil engines

Bunker Type: Marine diesel

Bunker Capacity (bbl): Unknown

Average Bunker Consumption (bbl) per 24 hours: Unknown

Liquid Cargo Capacity (bbl): Unknown

Dry Cargo Capacity: Unknown

Tank or Hold Description: Unknown

Casualty Information

Port Departed: Lockport, IL

Destination Port: Calumet Harbor, IL

Date Departed: July 28, 1936

Date Lost: July 28, 1936

Number of Days Sailing: 1

Cause of Sinking: Storm

Latitude (DD): 41.742

Longitude (DD): -87.507

Nautical Miles to Shore: 0.9

Nautical Miles to NMS: N/A

Nautical Miles to MPA: 13

Nautical Miles to Fisheries: Unknown

Approximate Water Depth (Ft): 35

Bottom Type: Lake bottom

Is There a Wreck at This Location? Yes, the wreck is a popular dive site and exists on NOAA nautical charts

Wreck Orientation: Sitting on an even keel

Vessel Armament: None

Cargo Carried when Lost: Sand

Cargo Oil Carried (bbl): 0

Cargo Oil Type: 0

Probable Fuel Oil Remaining (bbl): ≤ 3,000 (probably far less)

Fuel Type: Marine diesel

Total Oil Carried (bbl): ≤ 3,000

Dangerous Cargo or Munitions: No

Munitions Carried: None

Demolished after Sinking: Yes, divers dynamited the stern

Salvaged: Yes, partially

Cargo Lost: Yes

Reportedly Leaking: No

Historically Significant: Yes

Gravesite: Yes

Salvage Owner: Not known if any

Wreck Location

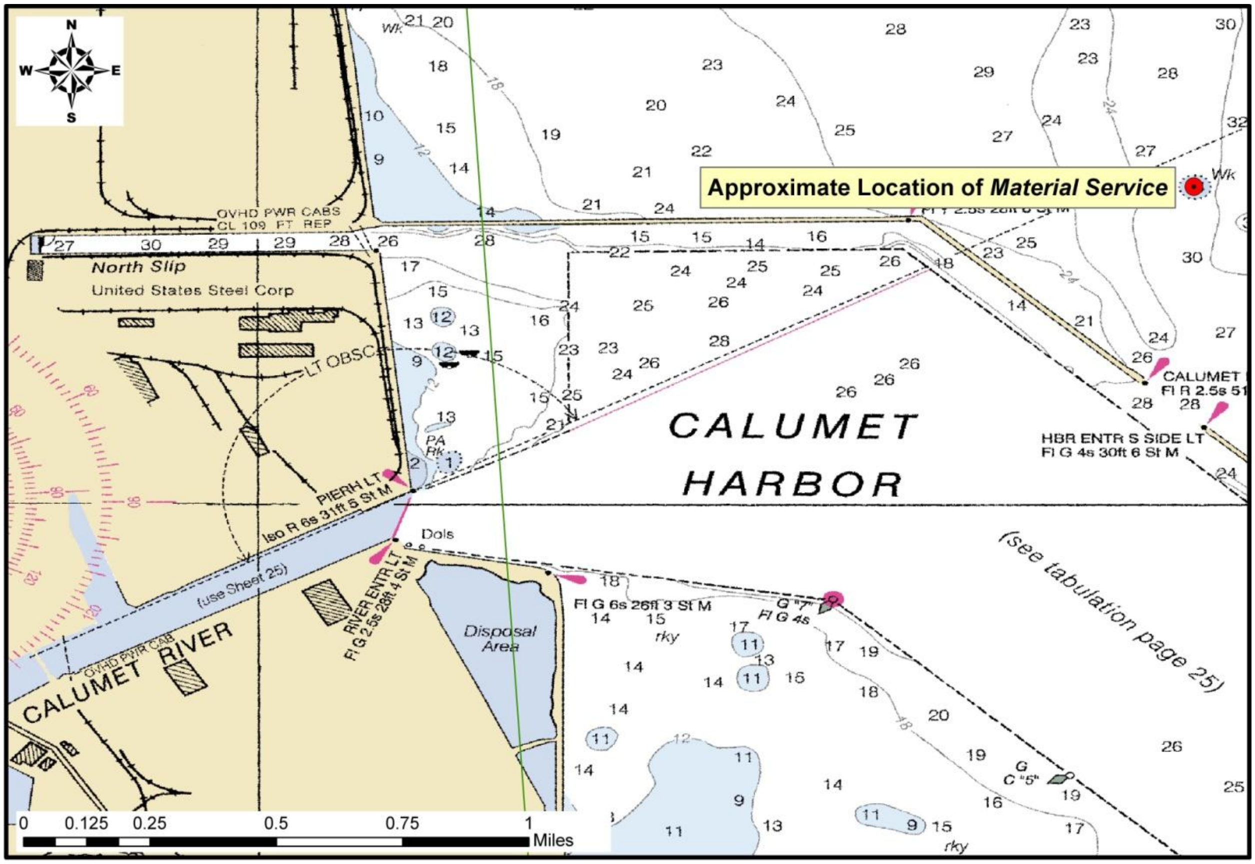


Chart Number: 14927

Casualty Narrative

"Her final voyage was on July 28, 1936, her 114th trip. She began loading sand at 12:47 pm, and completed loading at 5:15 pm. She departed from Lockport at 5:31 pm with a full cargo of 2,400 tons of sand. It was only a few hours from Lockport to the 92nd yard, and the A-Frame was kept erect. Just past midnight on the 29th the lake began to get choppy. Captain Charles D. Brown was on duty, piloting the *Material Service* towards Calumet Harbor, the entrance to the Calumet River. The lake was rough, and water had been splashing over the deck and hold covers for some time. The ship was in no apparent danger, so Captain Brown decided that there was no need to make the steel hold covers watertight with tarpaulins. These were kept handy in order to cover forty-eight 8" holes that were cut in the hold hatches to speed up the loading of sand.

Most of the crew of 22 were asleep in their berths. Below decks, 3rd assistant engineer Joseph Change noticed an unusual amount of water in the bilges. Within five minutes this rose over two feet. The 3" and 6" pumps were put into action, but could not keep up with the influx of water. Change went to wake the chief engineer and arrange for the main pump to be utilized (this involved employing one on the ships engines). On his way the ship suddenly lurched to port. The *Material Service* was five minutes away from Calumet Harbor, when a wave washed over her decks, causing the lurch to port felt throughout the ship.

John M. Johnson, the first mate, reported that Captain Brown stated "Jack, we're going over". The ship jerked upright. Asleep in his bunk, deck hand Alfred Melby was wakened by a jolt to the shouts of "we're sinking!" Melby and six other sailors raced up the ladder leading to the deck. Clutching a life-vest, he was the last to flee. Melby was pulled under by the suction of the sinking ship, the lake "swallowing him up". He credited the life-vest with saving his life. In the pilot house, Johnson grabbed the captain's arm to help steady him, but lost his hold. In a pendulum motion, the deck swung almost vertical, starboard and port becoming up and down. Johnson and Brown were thrown into Lake Michigan. In under a minute the *Material Service* was gone.

The upright A-frame and bow light staff were visible above the surface, mute tombstones of steel that marked the graves of Captain Brown, the Chief Engineer and 14 others. Many were trapped in their berths or pulled under by suction. Change, Johnson and Melby were counted among the seven survivors. Several weeks later, on June 24, a waterlogged lifebuoy from the *Material Service* would wash ashore in Sturgeon Bay, WI, just one mile from the site of the *Material Service's* launching. A trip of over 250 miles. The sinking prompted several inquiries and a law suit for the insured value, $200,000.00. The suit was later dismissed. The disaster was eventually blamed on water entering the holds, and possibly on the erect A-Frame making the ship top heavy (the added see-sawing motion could have added to the water entry).

Captain Brown was found to be at fault. The A-Frame and light staff were removed a few days after the disaster, and the wreck temporarily buoyed. Several attempts at salvage were made over the next decade. Her $200,000.00 salvage value was a prize for anyone lucky or skilled enough to raise her. A Canadian company abandoned salvage attempts after two years of efforts. September 1944 witnessed the sale of the *Material Service* to a Detroit ship operator, William Nicholson, for $3,250.00. Considered one of the best salvers on the Great Lakes, his salvage efforts also failed, the weather constantly interfering with all attempts. The wreck was virtually ignored after that, and was abandoned." - http://www.materialservicebarge.com/

General Notes

"She was constructed in Sturgeon Bay, WI at the Smith Shipyards from late 1928 to March of 1929. She cost close to $350,000.00 (that translates to almost 14 million today!), and was on a 10 year lease to the *Material Service* Company. The motorbarge was owned by Leatham, Smith, Putnam Navigation Corp. Putnam was also Secretary/Treasurer of the *Material Service* Company.

Just over 239 feet long with a 40 foot beam and 13' 10" draft, the *Material Service* would operate profitably for several years. Her deck was almost flat, giving the low profile needed to clear the bridges, her maximum height from waterline to top, just 14' 6". She had only a rudimentary superstructure extending just three feet above the deck. The pilot house stood about a foot over this, just big enough for the pilot and one other person to stick his head in and see above the deck. It was often used as a seat for crew members while on deck. A retractable A-frame would be raised to provide the hoist needed to raise the unloading conveyor off the deck. This system was an exclusive Putnam patent. With the A-frame lowered, a man standing on deck would be the tallest object on the ship.

The *Material Service* so resembled a barge that, to look at her, you would never guess that she had crews quarters and an engine room! The unloading system was the heart of the ship and ingenious in its engineering. The erected A-Frame would hoist the far end of the 90 foot long conveyor off the deck. The conveyor's aft end was attached to a hopper at the base of the A-Frame. Cargo would be fed to the conveyor via the hopper, which in turn was fed by an inclined conveyor that hauled the cargo up from a hopper below decks. Sand and gravel was fed to this from the two tunnels that ran the length of the ship beneath the holds. Crescent shaped scrapers would drag the cargo through the tunnels, up an incline, to the hopper. The entire deck assembly - A-Frame, hopper and conveyor sat on a huge swivel that could be set to almost any angle. Cargo could be unloaded at 800 tons per hour.

The *Material Service* was self propelled, with twin screws powered by two 350 HP diesel engines. Her maximum speed was 10 1/2 MPH. Her four holds could be loaded via eight 30' X 10' subdivided hatches, and would carry 2,400 tons of cargo. She was constructed almost entirely of steel. The *Material Service* supplied gravel and sand for many Chicago buildings, most notably the Merchandise Mart. She was en route from Lockport to the *Material Service* yard at 92nd and the Calumet River when she sank." - http://www.materialservicebarge.com/

Wreck Condition/Salvage History

"Diving the *Material Service* is as simple as Lake Michigan diving gets. Located on the south shore of the lake, it can be easily found on NOAA chart #14927, just Northeast of the Calumet Harbor entrance. It is indicated as a wreck and as being marked by buoy WR10 (now gone.)... Being so large the *Material Service* is easily located with any depth sounder. It lies upright on a flat, sandy plain, the hull resting in approximately 30 feet of water. Tieing off to the can buoy is illegal, but finding a solid anchor point on the wreck is uncomplicated. The water tends to be choppy, being so close to the breakwall, but this turbulence disappears a few feet below the surface. Visibility averages seven feet, and the water is comfortable enough for a full wet suit and reef gloves…Morning dives provide the best weather and visibility...It is about a 45 minute ride to the wreck site, the Chicago skyline a constant companion… We arrive at the buoy and spot the wreck on our depth sounder, the wreck's hull creating a huge peak on the screen. We drop anchor and drag it until it is secure in the wreckage, probably one of the holds...Visibility today is just five feet. As we thought, the anchor dropped in one of the holds, and is nearly in the center of the wreck. Alex signals towards the stern, and we head that way...

To our left is the curved side of the barge. For one used to seeing railings on a ship, their absence is striking. On the right we pass the ship's holds, gaping open, the hatches long since removed. Soon we are over the area where the A-Frame was attached and pass the hopper remains. In a few moments we arrive at the stern of the ship. The damage caused by the dynamiting is all over. Exposed pipes, fractured metal and buckled plates abound. We explore this section, taking some shots through porthole style openings in the ship's side and top, then drop over the stern. Wreckage is scattered on the bottom, the remains of the aft deck and crews quarters. Surprisingly the propellers are still in place, albeit half buried in the silty bottom. After a few minutes examining this area, Alex and I head towards the bow, this time along the port side, following the convergence of the lake bottom and the ship's hull…To our left, front and back visibility fades to light green/brown, to the right passes the Algae covered, rusting hull. Nothing moves except our buddy team, the only sound our regulators and exhaust. We pass over more debris, and an occasional aluminum can. The front appears abruptly, with little contour. Perhaps a foot from the bottom, attached to the ship's nose is a large towing shackle. After a couple of more photographs here we ascend to the decks and begin our exploration of the holds. The hatch covers are long since gone, and the holds make an eerie dive. The openings are about the size of a garage door, so are easy to enter. Their bottoms are shaped like four connected v's (vvvv), to guide the cargo to the hidden tunnels.

To support the decking, I beams run down the center, between the second and third "v". They are spaced every few feet, far enough apart so a diver can pass between them. I have shot some fantastic video here, as well as unusual photographs. Little of the cargo remains, and this area is very silty…Some of the most interesting sites are what appears to be parallel railroad tracks running along the center of the ship, steel rollers between them. These are the remains of the conveyor assembly. What appears to be a cart at the track's terminus is actually the hopper. There are also some inviting openings with ladders descending below decks scattered around the ship.

These can be entered with tanks removed, but only EXPERIENCED wreck divers skilled in penetration techniques should enter. Take care diving this wreck in the early summer, as Smelt anchors and fishing line abound…." -http://www.materialservicebarge.com/

Archaeological Assessment

The archaeological assessment provides additional primary source based documentation about the sinking of vessels. It also provides condition-based archaeological assessment of the wrecks when possible. It does not provide a risk-based score or definitively assess the pollution risk or lack thereof from these vessels, but includes additional information that could not be condensed into database form.

Where the current condition of a shipwreck is not known, data from other archaeological studies of similar types of shipwrecks provide the means for brief explanations of what the shipwreck might look like and specifically, whether it is thought there is sufficient structural integrity to retain oil. This is more subjective than the Pollution Potential Tree and computer-generated resource at risk models, and as such provides an additional viewpoint to examine risk assessments and assess the threat posed by these shipwrecks. It also addresses questions of historical significance and the relevant historic preservation laws and regulations that will govern on-site assessments

In some cases where little additional historic information has been uncovered about the loss of a vessel, archaeological assessments cannot be made with any degree of certainty and were not prepared. For vessels with full archaeological assessments, NOAA archaeologists and contracted archivists have taken photographs of primary source documents from the National Archives that can be made available for future research or on-site activities.

Assessment

Because *Material Service* sank in 1936, records relating to the loss of the vessel were not part of the National Archives record groups examined by NOAA archaeologists, so we cannot provide much additional historic background or assessment other than what was included under the Casualty Narrative section in this package. This means that the best assessment and report on the sinking of the ship may be from a U.S. Coast Guard's Marine Board of Investigation Report written about this vessel if one exists or from additional reports readily accessible online.

Although it is not know if any diesel oil remains inside this ship, the stern of the wreck which contained the crews quarters and the engine room was blasted open with dynamite in the 1970s, likely destroying the vessel's fuel tanks and releasing any diesel that may have remained in the tanks. The wreck also rests upright on the bottom, which is an orientation that often leads to loss of oil from vents and piping long before loss of structural integrity of hull plates from corrosion or other physical impacts. Because NOAA archaeologists have never visited the site, it is not possible to guarantee the condition of the fuel tanks and additional condition based analysis cannot be made.

If the U.S. Coast Guard decides to assess this vessel, it should be noted that this vessel is of historic significance and will require appropriate actions be taken under the National Historic Preservation Act

(NHPA) prior to any actions that could impact the integrity of the vessel. This vessel may be eligible for listing on the National Register of Historic Places and archaeologists with the State of Illinois should be consulted to ensure compliance with archaeological standards for assessing a historic resource. The site is also considered a gravesite and appropriate actions should be undertaken to minimize disturbance to the site.

Background Information References

Vessel Image Sources: http://www.windycitydiving.net/dive-videos/wrecks

Construction Diagrams or Plans in RULET Database? No

Text References:

-http://www.materialservicebarge.com/

-http://greatlakeshistory.homestead.com/files/m.htm

-http://www.scubachicago.com/msb.html

Vessel Risk Factors

In this section, the risk factors that are associated with the vessel are defined and then applied to the *Material Service* based on the information available. These factors are reflected in the pollution potential risk assessment development by the U.S. Coast Guard Salvage Engineering Response Team (SERT) as a means to apply a salvage engineer's perspective to the historical information gathered by NOAA. This analysis reflected in Figure 1-1 is simple and straightforward and, in combination with the accompanying archaeological assessment, provides a picture of the wreck that is as complete as possible based on current knowledge and best professional judgment. This assessment ***does not*** take into consideration operational constraints such as depth or unknown location, but rather attempts to provide a replicable and objective screening of the historical date for each vessel. SERT reviewed the general historical information available for the database as a whole and provided a stepwise analysis for an initial indication of Low/Medium/High values for each vessel.

In some instances, nuances from the archaeological assessment may provide additional input that will amend the score for Section 1. Where available, additional information that may have bearing on operational considerations for any assessment or remediation activities is provided.

Each risk factor is characterized as High, Medium, or Low Risk or a category-appropriate equivalent such as No, Unknown, Yes, or Yes Partially. The risk categories correlate to the decision points reflected in Figure 1-1.

Pollution Potential Tree

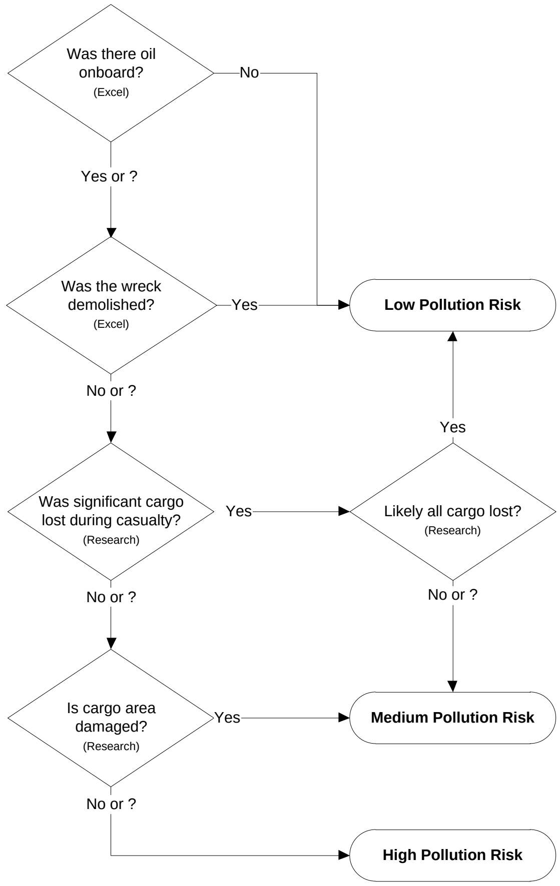


Figure 1-1: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed the above Pollution Potential Decision Tree.

Each of the risk factors also has a "data quality modifier" that reflects the completeness and reliability of the information on which the risk ranks were assigned. The quality of the information is evaluated with respect to the factors required for a reasonable preliminary risk assessment. The data quality modifier scale is:

- **High Data Quality:** All or most pertinent information on wreck available to allow for thorough risk assessment and evaluation. The data quality is high and confirmed.
- **Medium Data Quality:** Much information on wreck available, but some key factor data are missing or the data quality is questionable or not verified. Some additional research needed.
- **Low Data Quality:** Significant issues exist with missing data on wreck that precludes making preliminary risk assessment, and/or the data quality is suspect. Significant additional research needed.

In the following sections, the definition of low, medium, and high for each risk factor is provided. Also, the classification for the *Material Service* is provided, both as text and as shading of the applicable degree of risk bullet.

Pollution Potential Factors

Risk Factor A1: Total Oil Volume

The oil volume classifications correspond to the U.S. Coast Guard spill classifications:

- **Low Volume: Minor Spill** <240 bbl (10,000 gallons)
- **Medium Volume: Medium Spill** ≥240 – 2,400 bbl (100,000 gallons)
- **High Volume: Major Spill** ≥2,400 bbl (≥100,000 gallons)

The oil volume risk classifications refer to the volume of the most-likely Worst Case Discharge from the vessel and are based on the amount of oil believed or confirmed to be on the vessel.

The *Material Service* is ranked as High Volume because it is thought to have a potential for up to 3,000 bbl, based on what is probably a very conservative estimate for how much fuel oil the vessel could carry, although some of that may have been lost at the time of the casualty or after the vessel sank. Data quality is low because an exact bunker capacity for *Material Service* is not known.

The risk factor for volume also incorporates any reports or anecdotal evidence of actual leakage from the vessel or reports from divers of oil in the overheads, as opposed to potential leakage. This reflects the history of the vessel's leakage. There are no reports of leakage from the *Material Service*.

Risk Factor A2: Oil Type

The oil type(s) on board the wreck are classified only with regard to persistence, using the U.S. Coast Guard oil grouping[1]. (Toxicity is dealt with in the impact risk for the Resources at Risk classifications.) The three oil classifications are:

- **Low Risk: Group I Oils** – non-persistent oil (e.g., gasoline)
- **Medium Risk: Group II – III Oils** – medium persistent oil (e.g., diesel, No. 2 fuel, light crude, medium crude)
- **High Risk: Group IV** – high persistent oil (e.g., heavy crude oil, No. 6 fuel oil, Bunker C)

The *Material Service* is classified as Medium Risk because the bunker oil is diesel oil, a Group II oil type. Data quality is high.

Was the wreck demolished?

Risk Factor B: Wreck Clearance

This risk factor addresses whether or not the vessel was historically reported to have been demolished as a hazard to navigation or by other means such as depth charges or aerial bombs. This risk factor is based on historic records and does not take into account what a wreck site currently looks like. The risk categories are defined as:

- **Low Risk:** The wreck was reported to have been entirely destroyed after the casualty

[1] Group I Oil or Nonpersistent oil is defined as "a petroleum-based oil that, at the time of shipment, consists of hydrocarbon fractions: At least 50% of which, by volume, distill at a temperature of 340°C (645°F); and at least 95% of which, by volume, distill at a temperature of 370°C (700°F)."
Group II - Specific gravity less than 0.85 crude [API° >35.0]
Group III - Specific gravity between 0.85 and less than .95 [API° ≤35.0 and >17.5]
Group IV - Specific gravity between 0.95 to and including 1.0 [API° ≤17.5 and >10.0]

- **Medium Risk:** The wreck was reported to have been partially cleared or demolished after the casualty
- **High Risk:** The wreck was not reported to have been cleared or demolished after the casualty
- **Unknown:** It is not known whether or not the wreck was cleared or demolished at the time of or after the casualty

The *Material Service* is classified as Medium Risk because the stern was blasted with dynamite in the 1970s. Data quality is high.

Was significant cargo or bunker lost during casualty?

Risk Factor C1: Burning of the Ship

This risk factor addresses any burning that is known to have occurred at the time of the vessel casualty and may have resulted in oil products being consumed or breaks in the hull or tanks that would have increased the potential for oil to escape from the shipwreck. The risk categories are:

- **Low Risk:** Burned for multiple days
- **Medium Risk:** Burned for several hours
- **High Risk:** No burning reported at the time of the vessel casualty
- **Unknown:** It is not known whether or not the vessel burned at the time of the casualty

The *Material Service* is classified as High Risk because there was no report of fire at the time of casualty. Data quality is high.

Risk Factor C2: Reported Oil on the Water

This risk factor addresses reports of oil on the water at the time of the vessel casualty. The amount is relative and based on the number of available reports of the casualty. Seldom are the reports from trained observers so this is very subjective information. The risk categories are defined as:

- **Low Risk:** Large amounts of oil reported on the water by multiple sources
- **Medium Risk:** Moderate to little oil reported on the water during or after the sinking event
- **High Risk:** No oil reported on the water
- **Unknown:** It is not known whether or not there was oil on the water at the time of the casualty

The *Material Service* is classified as High Risk because no oil was reported to have spread across the water as the vessel went down. Data quality is low because the vessel sank at night and oil may have gone unnoticed.

Is the cargo area damaged?

Risk Factor D1: Nature of the Casualty

This risk factor addresses the means by which the vessel sank. The risk associated with each type of casualty is determined by the how violent the sinking event was and the factors that would contribute to increased initial damage or destruction of the vessel (which would lower the risk of oil, other cargo, or munitions remaining on board). The risk categories are:

- **Low Risk:** Multiple torpedo detonations, multiple mines, severe explosion

- **Medium Risk:** Single torpedo, shellfire, single mine, rupture of hull, breaking in half, grounding on rocky shoreline
- **High Risk:** Foul weather, grounding on soft bottom, collision
- **Unknown:** The cause of the loss of the vessel is not known

The *Material Service* is classified as High Risk because the vessel sank in a storm. Data quality is high.

Risk Factor D2: Structural Breakup

This risk factor takes into account how many pieces the vessel broke into during the sinking event or since sinking. This factor addresses how likely it is that multiple components of a ship were broken apart including tanks, valves, and pipes. Experience has shown that even vessels broken in three large sections can still have significant pollutants on board if the sections still have some structural integrity. The risk categories are:

- **Low Risk:** The vessel is broken into more than three pieces
- **Medium Risk:** The vessel is broken into two-three pieces
- **High Risk:** The vessel is not broken and remains as one contiguous piece
- **Unknown:** It is currently not known whether or not the vessel broke apart at the time of loss or after sinking

The *Material Service* is classified as High Risk because it is not broken apart and remains as one contiguous piece. Data quality is high.

Factors That May Impact Potential Operations

Orientation (degrees)

This factor addresses what may be known about the current orientation of the intact pieces of the wreck (with emphasis on those pieces where tanks are located) on the seafloor. For example, if the vessel turtled, not only may it have avoided demolition as a hazard to navigation, but it has a higher likelihood of retaining an oil cargo in the non-vented and more structurally robust bottom of the hull.

The *Material Service* is resting upright on the bottom. Data quality is high.

Depth

Depth information is provided where known. In many instances, depth will be an approximation based on charted depths at the last known locations.

The *Material Service* is 35 feet deep. Data quality is high.

Visual or Remote Sensing Confirmation of Site Condition

This factor takes into account what the physical status of wreck site as confirmed by remote sensing or other means such as ROV or diver observations and assesses its capability to retain a liquid cargo. This assesses whether or not the vessel was confirmed as entirely demolished as a hazard to navigation, or severely compromised by other means such as depth charges, aerial bombs, or structural collapse.

The *Material Service* is a popular dive site. Data quality is high.

Other Hazardous (Non-Oil) Cargo on Board
This factor addresses hazardous cargo other than oil that may be on board the vessel and could potentially be released, causing impacts to ecological and socio-economic resources at risk.

There are no reports of hazardous materials onboard. Data quality is high.

Munitions on Board
This factor addresses hazardous cargo other than oil that may be on board the vessel and could potentially be released or detonated causing impacts to ecological and socio-economic resources at risk.

The *Material Service* did not carry any munitions. Data quality is high.

Vessel Pollution Potential Summary

Table 1-1 summarizes the risk factor scores for the pollution potential and mitigating factors that would reduce the pollution potential for the *Material Service*. Operational factors are listed but do not have a risk score.

Table 1-1: Summary matrix for the vessel risk factors for the Material Service color-coded as red (high risk), yellow (medium risk), and green (low risk).

Vessel Risk Factors		Data Quality Score	Comments	Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Low	Maximum of 3,000 bbl, not reported to be leaking	High
	A2: Oil Type	High	Bunker oil is diesel oil, a Group II oil type	
	B: Wreck Clearance	High	Vessel partially dynamited	
	C1: Burning of the Ship	High	No fire was reported	
	C2: Oil on Water	Low	No oil was reported on the water	
	D1: Nature of Casualty	High	Storm	
	D2: Structural Breakup	High	The vessel remains in one contiguous piece	
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records of this ship exist, assessment is believed to be very accurate	Not Scored
Operational Factors	Wreck Orientation	High	Upright	Not Scored
	Depth	High	35 ft	
	Visual or Remote Sensing Confirmation of Site Condition	High	Location is a popular dive site	
	Other Hazardous Materials Onboard	High	No	
	Munitions Onboard	High	No	
	Gravesite (Civilian/Military)	High	Yes	
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA	

SECTION 2: ENVIRONMENTAL IMPACT MODELING

To help evaluate the potential transport and fates of releases from sunken wrecks, NOAA worked with RPS ASA to run a series of generalized computer model simulations of potential oil releases. The results are used to assess potential impacts to ecological and socio-economic resources, as described in Sections 3 and 4. The modeling results are useful for this screening-level risk assessment; however, it should be noted that detailed site/vessel/and seasonally specific modeling would need to be conducted prior to any intervention on a specific wreck.

Release Scenarios Used in the Modeling
The potential volume of leakage at any point in time will tend to follow a probability distribution. Most discharges are likely to be relatively small, though there could be multiple such discharges. There is a lower probability of larger discharges, though these scenarios would cause the greatest damage. A **Worst Case Discharge** (WCD) would involve the release of all of the cargo oil and bunkers present on the vessel. In the case of the *Material Service* this would be about 3,000 bbl of marine diesel fuel based on current estimates of the maximum amount of oil remaining onboard the wreck.

The likeliest scenario of oil release from most sunken wrecks, including the *Material Service*, is a small, episodic release that may be precipitated by disturbance of the vessel in storms. Each of these episodic releases may cause impacts and require a response. **Episodic** releases are modeled using 1% of the WCD. Another scenario is a very low chronic release, i.e., a relatively regular release of small amounts of oil that causes continuous oiling and impacts over the course of a long period of time. This type of release would likely be precipitated by corrosion of piping that allows oil to flow or bubble out at a slow, steady rate. **Chronic** releases are modeled using 0.1% of the WCD.

The **Most Probable** scenario is premised on the release of all the oil from one tank. In the absence of information on the number and condition of the cargo or fuel tanks for all the wrecks being assessed, this scenario is modeled using 10% of the WCD. The **Large** scenario is loss of 50% of the WCD. The five major types of releases are summarized in Table 2-1. The actual type of release that occurs will depend on the condition of the vessel, time factors, and disturbances to the wreck. Note that episodic and chronic release scenarios represent a small release that is repeated many times, potentially repeating the same magnitude and type of impact(s) with each release. The actual impacts would depend on the environmental factors such as real-time and forecast winds and currents during each release and the types/quantities of ecological and socio-economic resources present.

The model results here are based on running the RPS ASA Spill Impact Model Application Package (SIMAP) two hundred times for each of the five spill volumes shown in Table 2-1. The model randomly selects the date of the release, and corresponding environmental, wind, and ocean current information from a long-term wind and current database.

When a spill occurs, the trajectory, fate, and effects of the oil will depend on environmental variables, such as the wind and current directions over the course of the oil release, as well as seasonal effects. The magnitude and nature of potential impacts to resources will also generally have a strong seasonal component (e.g., timing of bird migrations, turtle nesting periods, fishing seasons, and tourism seasons).

Table 2-1: Potential oil release scenario types for the *Material Service*.

Scenario Type	Release per Episode	Time Period	Release Rate	Relative Likelihood	Response Tier
Chronic (0.1% of WCD)	3 bbl	Fairly regular intervals or constant	100 bbl over several days	More likely	Tier 1
Episodic (1% of WCD)	30 bbl	Irregular intervals	Over several hours or days	Most Probable	Tier 1-2
Most Probable (10% of WCD)	300 bbl	One-time release	Over several hours or days	Most Probable	Tier 2
Large (50% of WCD)	1,500 bbl	One-time release	Over several hours or days	Less likely	Tier 2-3
Worst Case	3,000 bbl	One-time release	Over several hours or days	Least likely	Tier 3

The modeling results represent 200 simulations for each spill volume with variations in spill trajectory based on winds and currents. The spectrum of the simulations gives a perspective on the variations in likely impact scenarios. Some resources will be impacted in nearly all cases; some resources may not be impacted unless the spill trajectory happens to go in that direction based on winds and currents at the time of the release and in its aftermath.

For the large and WCD scenarios, the duration of the release was assumed to be 12 hours, envisioning a storm scenario where the wreck is damaged or broken up, and the model simulations were run for a period of 30 days. The releases were assumed to be from a depth between 2-3 meters above the sea floor, using the information known about the wreck location and depth.

As discussed in the NOAA 2013 Risk Assessment for Potentially Polluting Wrecks in U.S. Waters, NOAA identified 87 high and medium priority wrecks for screening-level risk assessment. Within the available funds, it was not feasible to conduct computer model simulations of all 87 high and medium priority wrecks. Therefore, efforts were made to create “clusters” of vessels in reasonable proximity and with similar oil types. In general, the wreck with the largest potential amount of oil onboard was selected for modeling of oil release volumes, and the results were used as surrogates for the other vessels in the cluster. In particular, the regression curves created for the modeled wreck were used to determine the impacts to water column, water surface, and shoreline resources. The *Material Service*, with up to 3,000 bbl of marine diesel onboard, was clustered with the *Prins Willem V*, which was modeled at 3,000 bbl of light fuel oil. Figure 2-1 shows the location of both vessels.

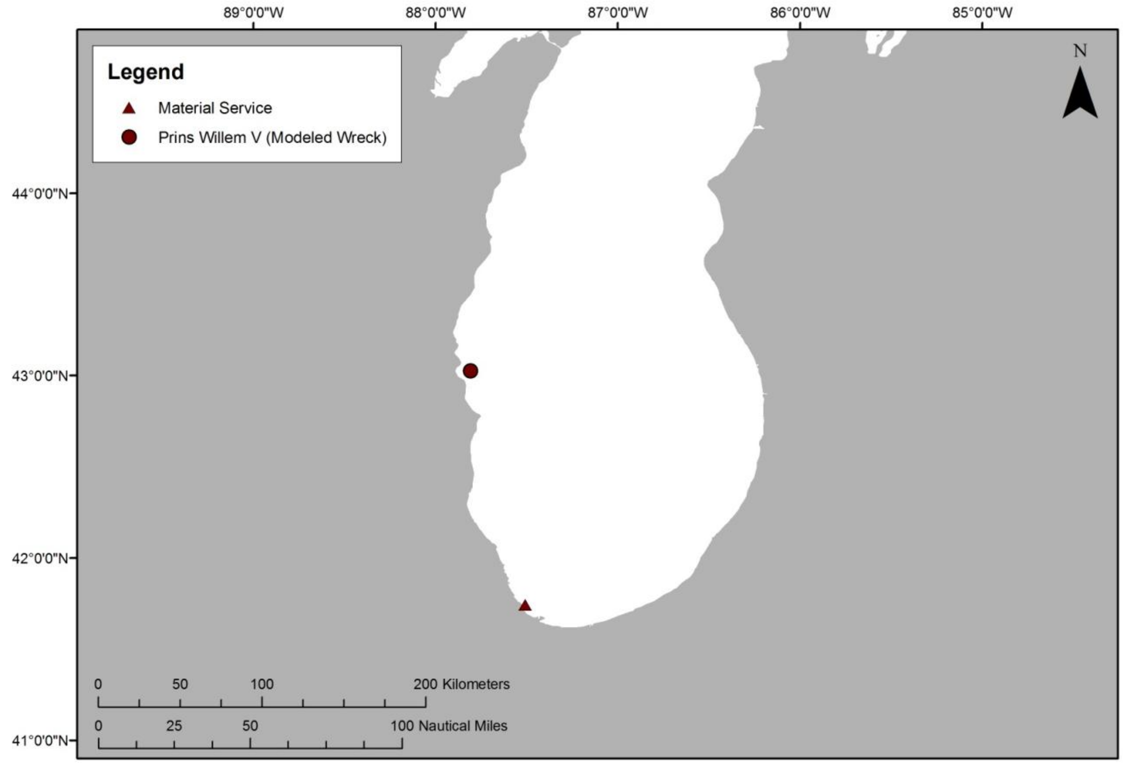


Figure 2-1: Location of the *Material Service* (red triangle), the wreck discussed in this package, and the *Prins Willem V* (red circle) which was the wreck that was actually modeled in the computer modeling simulations. The results for the *Prins Willem V* are used to estimate the impacts of releases from the *Material Service*, as discussed in the text.

It is important to acknowledge that these scenarios are only for this screening-level assessment. Detailed site/vessel/and seasonally specific modeling would need to be conducted prior to any intervention on a specific wreck.

Oil Type for Release

The *Material Service* contained a maximum of 3,000 bbl of marine diesel as the fuel (a Group II oil). Thus, the spill model for the *Prins Willem V*, which was run using light fuel oil, was used for this scoping assessment of the *Material Service*.

Oil Thickness Thresholds

The model results are reported for different oil thickness thresholds, based on the amount of oil on the water surface or shoreline and the resources potentially at risk. Table 2-2 shows the terminology and thicknesses used in this report, for both oil thickness on water and the shoreline. For oil on the water surface, a thickness of 0.01 g/m^2, which would appear as a barely visible sheen, was used as the threshold for socio-economic impacts because often fishing is prohibited in areas with any visible oil, to prevent contamination of fishing gear and catch. A thickness of 10 g/m^2 was used as the threshold for ecological impacts, primarily due to impacts to birds, because that amount of oil has been observed to be enough to mortally impact birds and other wildlife. In reality, it is very unlikely that oil would be evenly distributed on the water surface. Spilled oil is always distributed patchily on the water surface in bands or tarballs with clean water in between. So, Table 2-2a shows the number of tarballs per acre on the water surface for these oil thickness thresholds, assuming that each tarball was a sphere that was 1 inch in diameter. For oil stranded onshore, a thickness of 1 g/m^2 was used as the threshold for socio-economic impacts because that amount of oil would conservatively trigger the need for shoreline cleanup on amenity beaches. A thickness of 100 g/m^2 was used as the threshold for ecological impacts based on a synthesis of the literature showing that shoreline life has been affected by this degree of oiling.[2] Because oil often strands onshore as tarballs, Table 2-2a shows the number of tarballs per m^2 on the shoreline for these oil thickness thresholds, assuming that each tarball was a sphere that was 1 inch in diameter.

Table 2-2a: Oil thickness thresholds used in calculating area of water impacted. Refer to Sections 3 and 4 for explanations of the thresholds for ecological and socio-economic resource impacts.

Oil Description	Sheen Appearance	Approximate Sheen Thickness		No. of 1 inch Tarballs	Threshold/Risk Factor
Oil Sheen	Barely Visible	0.00001 mm	0.01 g/m^2	~5-6 tarballs per acre	Socio-economic Impacts to Water Surface/Risk Factor 4B-1 and 2
Heavy Oil Sheen	Dark Colors	0.01 mm	10 g/m^2	~5,000-6,000 tarballs per acre	Ecological Impacts to Water Surface/ Risk Factor 3B-1 and 2

Table 2-2b: Oil thickness thresholds used in calculating miles of shoreline impacted. Refer to Sections 3 and 4 for explanations of the thresholds for ecological and socio-economic resource impacts.

Oil Description	Oil Appearance	Approximate Sheen Thickness		No. of 1 inch Tarballs	Threshold/Risk Factor
Oil Sheen/Tarballs	Dull Colors	0.001 mm	1 g/m^2	~0.12-0.14 tarballs/m^2	Socio-economic Impacts to Shoreline Users/Risk Factor 4C-1 and 2
Oil Slick/Tarballs	Brown to Black	0.1 mm	100 g/m^2	~12-14 tarballs/m^2	Ecological Impacts to Shoreline Habitats/Risk Factor 3C-1 and 2

Potential Impacts to the Water Column

Impacts to the water column from an oil release from the *Material Service* will be determined by the volume of leakage. Because oil from sunken vessels will be released at low pressures, the droplet sizes will be large enough for the oil to float to the surface. Therefore, impacts to water column resources will result from the natural dispersion of the floating oil slicks on the surface, which is limited to about the top 33 feet. The metric used for ranking impacts to the water column is the area of water surface in mi^2 that has been contaminated by 1 part per billion (ppb) oil to a depth of 33 feet. At 1 ppb, there are likely to be impacts to sensitive organisms in the water column and potential tainting of seafood, so this concentration is used as a screening threshold for both the ecological and socio-economic risk factors for water column resource impacts. To assist planners in understanding the scale of potential impacts for different leakage volumes, a regression curve was generated for the water column volume oiled using the five volume

[2] French, D., M. Reed, K. Jayko, S. Feng, H. Rines, S. Pavignano, T. Isaji, S. Puckett, A. Keller, F. W. French III, D. Gifford, J. McCue, G. Brown, E. MacDonald, J. Quirk, S. Natzke, R. Bishop, M. Welsh, M. Phillips and B.S. Ingram, 1996. The CERCLA type A natural resource damage assessment model for coastal and marine environments (NRDAM/CME), Technical Documentation, Vol. I - V, Office of Environmental Policy and Compliance, U.S. Dept. Interior, Washington, DC.

scenarios, which is shown in Figure 2-2, which is the regression curve for the *Prins Willem V*. Using this figure, the water column impacts can be estimated for any spill volume. On Figure 2-2, arrows are used to indicate the where the WCD for the *Material Service* plots on the curve and how the area of the water column impact is determined.

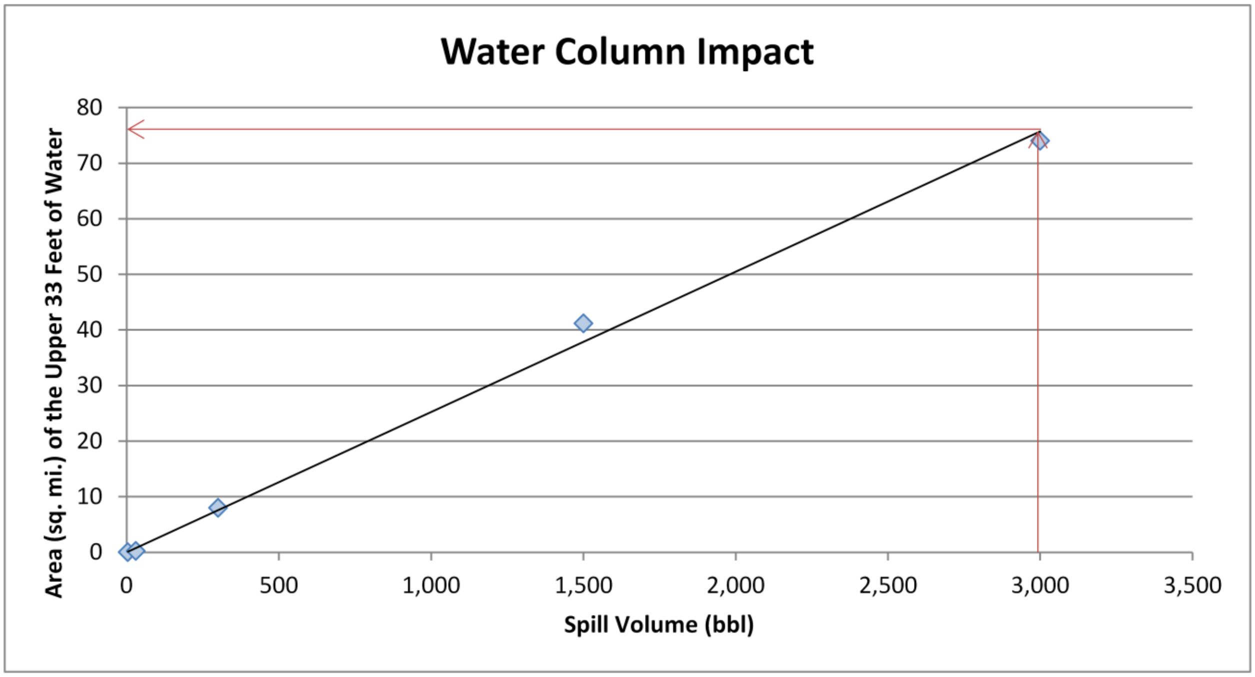


Figure 2-2: Regression curve for estimating the area of water column at or above 1 ppb aromatics impacted as a function of spill volume for the *Material Service*. This regression curve was generated for the *Prins Willem V*, which has the same oil type and similar volume of potential releases as the *Material Service*. The arrows indicate where the WCD for the *Material Service* falls on the curve and how the area of water column impact can be determined for any spill volume.

Potential Water Surface Slick

The slick size from an oil release is a function of the quantity released. The estimated water surface coverage by a fresh slick (the total water surface area "swept" by oil over time) for the various scenarios is shown in Table 2-3, as the mean result of the 200 model runs for the *Prins Willem V* then using the regression curve shown in Figure 2-3 to calculate the values for the different release scenarios for the *Material Service*. Note that this is an estimate of total water surface affected over a 30-day period. The slick will not be continuous but rather be broken and patchy. Surface expression is likely to be in the form of sheens and streamers. The location, size, shape, and spread of the oil slick(s) from an oil release from the *Material Service* will depend on environmental conditions, including winds and currents, at the time of release and in its aftermath. Refer to the risk assessment package for the *Prins Willem V* for maps (Figs. 2-2 and 2-3) showing the areas potentially affected by slicks using the Most Probable volume and the socio-economic and ecological thresholds.

Table 2-3: Estimated slick area swept on water for oil release scenarios from the *Material Service*, based on the model results for the *Prins Willem V*.

Scenario Type	Oil Volume (bbl)	Estimated Slick Area Swept Mean of All Models	
		0.01 g/m²	**10 g/m²**
Chronic	3	48 mi²	10 mi²
Episodic	30	170 mi²	41 mi²
Most Probable	300	620 mi²	170 mi²
Large	1,500	1,500 mi²	460 mi²
Worst Case Discharge	3,000	2,200 mi²	720 mi²

The actual area affected by a release will be determined by the volume of leakage, whether it is from one or more tanks at a time. To assist planners in understanding the scale of potential impacts for different leakage volumes, a regression curve was generated for the water surface area oiled using the five volume scenarios for the *Prins Willem V*, which is shown in Figure 2-3 and referenced in Table 2-3. Using this figure, the area of water surface with a barely visible sheen can be estimated for any spill volume from the *Material Service*.

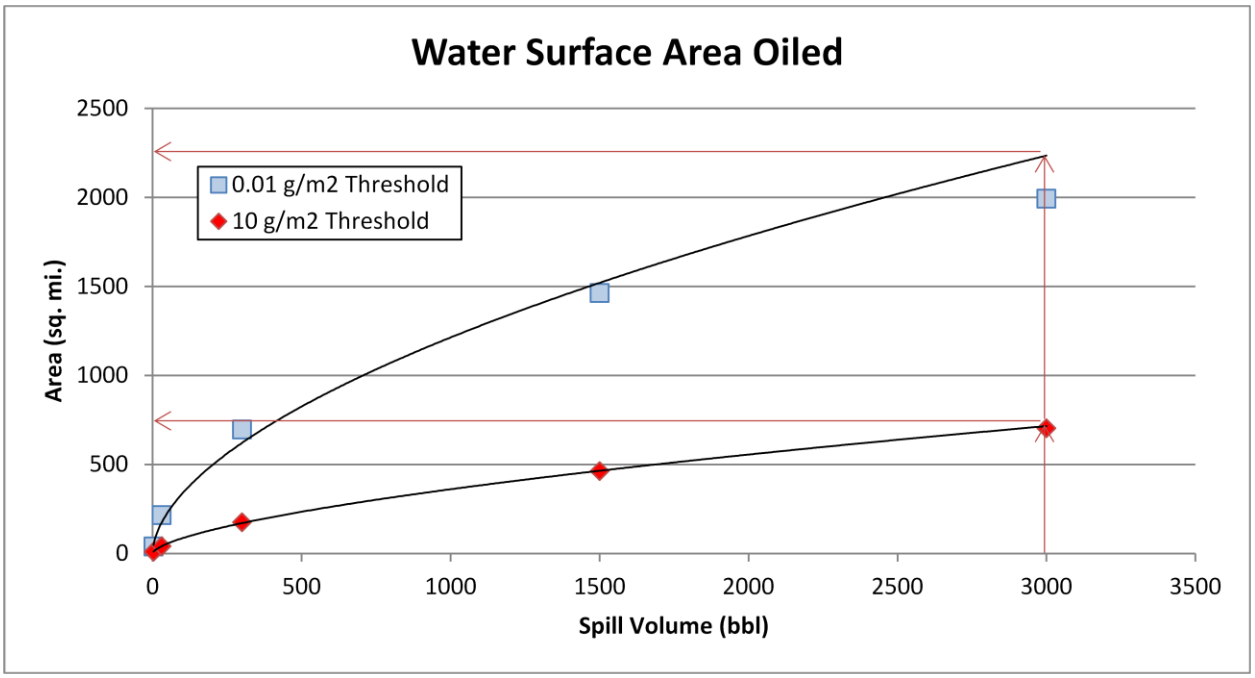


Figure 2-3: Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *Material Service*, showing both the ecological threshold of 10 g/m² and socio-economic threshold of 0.01 g/m², based on the model results for the *Prins Willem V*. The arrows indicate where the WCD for the *Material Service* falls on the curve and how the area of water surface impact can be determined for any spill volume.

Potential Shoreline Impacts

Based on these modeling results, shorelines on both sides of Lake Michigan are at risk. (Refer to Figure 2-6 in the *Prins Willem V* package to see the probability of oil stranding on the shoreline at concentrations that exceed the threshold of 1 g/m^2, for the Most Probable release). However, the specific areas that would be oiled will depend on the currents and winds at the time of the oil release(s), as well as on the amount of oil released. Estimated miles of shoreline oiling above the socio-economic threshold of 1 g/m^2 and the ecological threshold of 100 g/m^2 by scenario type are shown in Table 2-4.

Table 2-4: Estimated shoreline oiling from leakage from the *Material Service*, based on the modeling results for the *Prins Willem V*.

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2	Estimated Miles of Shoreline Oiling Above 100 g/m^2
Chronic	3	0	0
Episodic	30	2	0
Most Probable	300	5	1
Large	1,500	7	3
Worst Case Discharge	3,000	8	6

The actual shore length affected by a release will be determined by the volume of leakage and environmental conditions during an actual release. To assist planners in scaling the potential impact for different leakage volumes, a regression curve was generated for the total shoreline length oiled using the five volume scenarios for the *Prins Willem V*, as detailed in Table 2-4 and shown in Figure 2-4. Using this figure, the shore length oiled can be estimated for any spill volume from the *Material Service*.

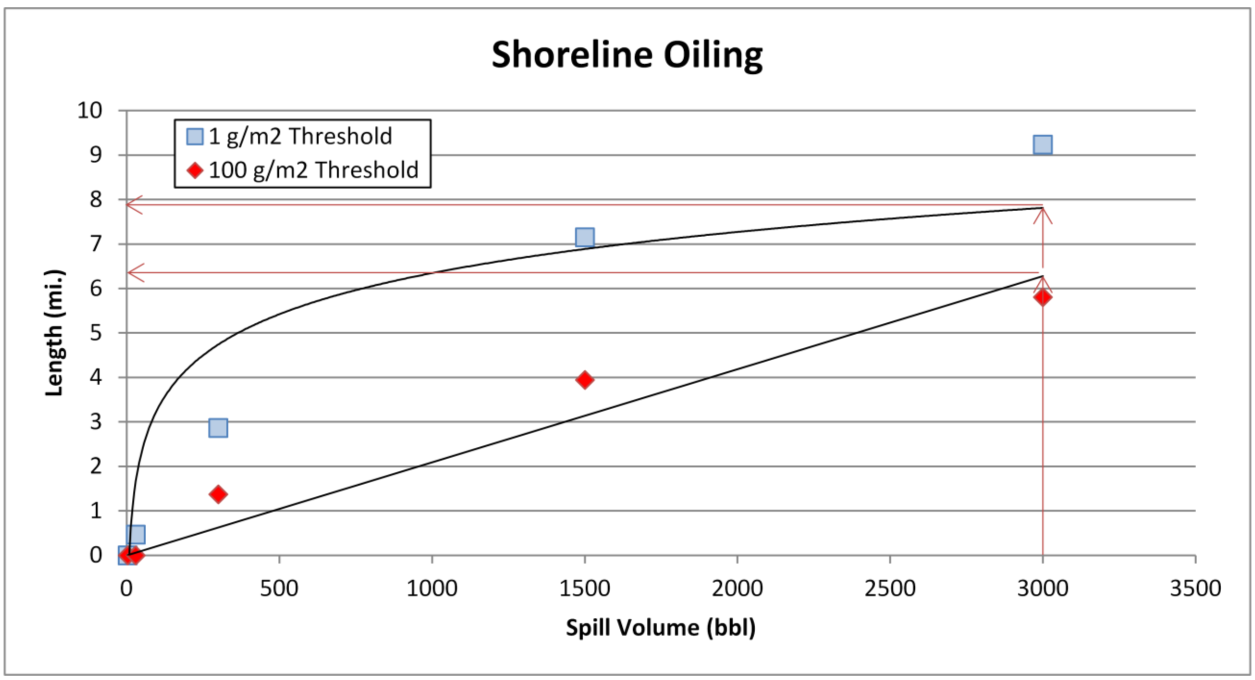


Figure 2-4: Regression curve for estimating the amount of shoreline oiling at different thresholds as a function of spill volume for the *Material Service*, based on the model results for the *Prins Willem V*. The arrows indicate where the WCD for the *Material Service* falls on the curve and how the length of shoreline impact can be determined for any spill volume.

SECTION 3: ECOLOGICAL RESOURCES AT RISK

Ecological resources at risk from a catastrophic release of oil from the *Material Service* (Table 3-1) include numerous guilds of birds, particularly those sensitive to surface oiling while rafting or plunge diving to feed and are present in nearshore waters. Large numbers of birds use the lakeshore as migratory habitat and beaches are important habitat for migratory shorebirds. Several species of recreational and commercially caught fish are present in nearshore Lake Michigan.

Table 3-1: Ecological resources at risk from a release of oil from the *Material Service*.
(*FT = Federal threatened; FE = Federal endangered; ST = State threatened, SE = State endangered).

Species Group	Species Subgroup and Geography	Seasonal Presence
Diving Ducks, Waterfowl and Seabirds	Nearshore areas are important foraging locations for migratory and overwintering ring-billed and herring gulls, Caspian (SE), common (SE) and Forster's (SE) terns, diving ducks (scaup, scoters, mergansers), common loon, horned and pied-billed grebes, and Canada geese • Important locations: Sheboygan Reef, Ozaukee Bight, Harrington Beach Lakeshore • Greater scaup, common goldeneye, bufflehead, red-breasted merganser are highly abundant; long tailed duck, white-winged scoter, black scoter, surf scoter are common • Rare gull species have been seen here on occasion (wintering glaucous, Iceland, Thayer's, lesser black-backed, greater black-backed, ivory gulls)	Shorebirds present Apr-Oct Waterfowl/diving ducks present Aug-May
Shorebirds	Critical migratory and foraging habitat for piping plover (FE) exists along shorelines in the area of impact and plovers historically nested in the region Populations of other shorebirds can be found along the lakeshore in highest numbers in spring and fall, including sanderling, dunlin, common snipe, and spotted, least, semipalmated, pectoral sandpipers	Piping plover present spring/fall Shorebirds present spring-fall
Raptors and Passerines	Migratory raptors (bald eagle, osprey, peregrine falcon (SE), red-shouldered hawk (ST), northern goshawk) and passerines use these areas • 1,000s of migrating raptors use Ozaukee Bight in fall; lower numbers in spring	Raptors present Aug -May
Mammals	Raccoon, mink, river otter and beaver occur in nearshore habitats	Year round
Fish	Lake Michigan is home to almost 100 species of fish. The lakeshore and adjacent rivers support important recreational fisheries Coastal rivers support higher diversity of species, such as shiners, catfish, sunfish, perches, including longear sunfish (ST) and greater redhorse (ST) Coastal wetlands comprise very little of shoreline but are extremely important juvenile and forage fish habitat Many fish spawn seasonally in nearshore or upstream areas • Mouths of rivers are spawning/aggregation hotspots for rainbow trout, yellow perch, rainbow smelt, muskellunge, walleye, gizzard shad, rock bass, northern pike, carp, spottail shiner, smallmouth bass, alewife, coho salmon, lake whitefish, brook trout, lake trout, Chinook salmon, brown trout • Lake whitefish are abundant near shorelines in the fall and spawn in shallow rock or sand bottomed lake waters less than 25 feet deep • Lake trout spawn on nearshore shoals throughout the area of impact • Brook trout spawn over hard substrate along the lakeshore • Rainbow trout spawn in the mouths of rivers	*Spring spawning* Lake sturgeon, walleye, rainbow trout, yellow perch, rainbow smelt, muskellunge, gizzard shad, rock bass *Summer spawning* Spottail shiner, smallmouth bass, carp, alewife *Fall spawning* Lake whitefish, lake trout, coho and Chinook salmon, brown trout, lake trout

The Environmental Sensitivity Index (ESI) atlases for the potentially impacted coastal areas from a leak from the *Material Service* are generally available at each U.S. Coast Guard Sector. They can also be downloaded at: http://response.restoration.noaa.gov/esi. These maps show detailed spatial information on the distribution of sensitive shoreline habitats, biological resources, and human-use resources. The tables on the back of the maps provide more detailed life-history information for each species and location. The ESI atlases should be consulted to assess the potential environmental resources at risk for specific spill scenarios. In addition, the Geographic Response Plans within the Area Contingency Plans prepared by the Area Committee for each U.S. Coast Guard Sector have detailed information on the nearshore and shoreline ecological resources at risk and should be consulted.

Ecological Risk Factors

Risk Factor 3: Impacts to Ecological Resources at Risk (EcoRAR)

Ecological resources include plants and animals (e.g., fish, birds, invertebrates, and mammals), as well as the habitats in which they live. All impact factors are based on a Worst Case and the Most Probable Discharge oil release from the wreck. Risk factors for ecological resources at risk (EcoRAR) are divided into three categories:

- Impacts to the water column and resources in the water column;
- Impacts to the water surface and resources on the water surface; and
- Impacts to the shoreline and resources on the shoreline.

The impacts from an oil release from the wreck would depend greatly on the direction in which the oil slick moves, which would, in turn, depend on wind direction and currents at the time of and after the oil release. Impacts are characterized in the risk analysis based on the likelihood of any measurable impact, as well as the degree of impact that would be expected if there is an impact. The measure of the degree of impact is based on the median case for which there is at least some impact. The median case is the "middle case" – half of the cases with significant impacts have less impact than this case, and half have more.

For each of the three ecological resources at risk categories, risk is defined as:

- The **probability of oiling** over a certain threshold (i.e., the likelihood that there will be an impact to ecological resources over a certain minimal amount); and
- The **degree of oiling** (the magnitude or amount of that impact).

As a reminder, the ecological impact thresholds are: 1 ppb aromatics for water column impacts; 10 g/m^2 for water surface impacts; and 100 g/m^2 for shoreline impacts.

In the following sections, the definition of low, medium, and high for each ecological risk factor is provided. Also, the classification for the *Material Service* is provided, both as text and as shading of the applicable degree of risk bullet, for the WCD release of 3,000 bbl and a border around the Most Probable Discharge of 300 bbl. Please note: The probability of oiling cannot be determined using the regression curves; probability can only be determined from the 200 model runs. Thus, the modeling results and regression curves for the *Prins Willem V* are used to estimate the values used in the risk scoring for the **degree of oiling only**.

Risk Factor 3A: Water Column Impacts to EcoRAR

Water column impacts occur beneath the water surface. The ecological resources at risk for water column impacts are fish, marine mammals, and invertebrates (e.g., shellfish, and small organisms that are food for larger organisms in the food chain). These organisms can be affected by toxic components in the oil. The threshold for water column impact to ecological resources at risk is a dissolved aromatic hydrocarbons concentration of 1 ppb (i.e., 1 part total dissolved aromatics per one billion parts water). Dissolved aromatic hydrocarbons are the most toxic part of the oil. At this concentration and above, one would expect impacts to organisms in the water column.

Risk Factor 3A-1: Water Column Probability of Oiling of EcoRAR (not scored)

This risk factor reflects the probability that at least 0.2 mi^2 of the upper 33 feet of the water column would be contaminated with a high enough concentration of oil to cause ecological impacts. The three risk scores for water column oiling probability are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

Risk Factor 3A-2: Water Column Degree of Oiling of EcoRAR

The degree of oiling of the water column reflects the total volume of water that would be contaminated by oil at a concentration high enough to cause impacts. The three categories of impact are:

- **Low Impact:** impact on less than 0.2 mi^2 of the upper 33 feet of the water column at the threshold level
- **Medium Impact**: impact on 0.2 to 200 mi^2 of the upper 33 feet of the water column at the threshold level
- **High Impact:** impact on more than 200 mi^2 of the upper 33 feet of the water column at the threshold level

The *Material Service* is classified as Medium Risk for degree of oiling for water column ecological resources for the WCD of 3,000 bbl because the mean volume of water contaminated in the model runs was 76 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 300 bbl, the *Material Service* is classified as Medium Risk for degree of oiling because the mean volume of water contaminated was 8 mi^2 of the upper 33 feet of the water column.

Risk Factor 3B: Water Surface Impacts to EcoRAR

Ecological resources at risk at the water surface include surface feeding and diving sea birds, sea turtles, and marine mammals. These organisms can be affected by the toxicity of the oil as well as from coating with oil. The threshold for water surface oiling impact to ecological resources at risk is 10 g/m^2 (10 grams of floating oil per square meter of water surface). At this concentration and above, one would expect impacts to birds and other animals that spend time on the water surface.

Risk Factor 3B-1: Water Surface Probability of Oiling of EcoRAR (not scored)

This risk factor reflects the probability that at least 1,000 mi^2 of the water surface would be affected by enough oil to cause impacts to ecological resources. The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

Risk Factor 3B-2: Water Surface Degree of Oiling of EcoRAR

The degree of oiling of the water surface reflects the total amount of oil that would affect the water surface in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** less than 1,000 mi^2 of water surface impact at the threshold level
- **Medium Impact:** 1,000 to 10,000 mi^2 of water surface impact at the threshold level
- **High Impact:** more than 10,000 mi^2 of water surface impact at the threshold level

The *Material Service* is classified as Low Risk for degree of oiling for water surface ecological resources for the WCD because the mean area of water contaminated in the model runs was 720 mi^2. It is also classified as Low Risk for degree of oiling for the Most Probable Discharge because the mean area of water contaminated was 170 mi^2.

Risk Factor 3C: Shoreline Impacts to EcoRAR

The impacts to different types of shorelines vary based on their type and the organisms that live on them. For the modeled wrecks, shorelines were weighted by their degree of sensitivity to oiling. Wetlands are the most sensitive (weighted as "3" in the impact modeling), rocky and gravel shores are moderately sensitive (weighted as "2"), and sand beaches (weighted as "1") are the least sensitive to ecological impacts of oil. In this risk analysis for the *Material Service*, shorelines have NOT been weighted by their degree of sensitivity to oiling because these data are available only for modeled vessels. Therefore, the impacts are evaluated only on the total number of shoreline miles oiled as determined from the regression curve.

Risk Factor 3C-1: Shoreline Probability of Oiling of EcoRAR (not scored)

This risk factor reflects the probability that the shoreline would be coated by enough oil to cause impacts to shoreline organisms. The threshold for shoreline oiling impacts to ecological resources at risk is 100 g/m^2 (i.e., 100 grams of oil per square meter of shoreline). The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

Risk Factor 3C-2: Shoreline Degree of Oiling of EcoRAR

The degree of oiling of the shoreline reflects the length of shorelines oiled by at least 100 g/m^2 in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** less than 10 miles of shoreline impacted at the threshold level
- **Medium Impact:** 10 - 100 miles of shoreline impacted at the threshold level
- **High Impact:** more than 100 miles of shoreline impacted at the threshold level

The *Material Service* is classified as Low Risk for degree of oiling for shoreline ecological resources for the WCD because the mean length of shoreline contaminated in the model runs was 6 miles. It is classified as Low Risk for degree of oiling for the Most Probable Discharge because the mean length of shoreline contaminated in the model runs was 1 mile.

Considering the modeled risk scores and the ecological resources at risk, the ecological risk from potential releases of the WCD of 3,000 bbl of light fuel oil from the *Material Service* is summarized as listed below and indicated in the far-right column in Table 3-2:

- Water column resources – Low, because of the limited potential for impacts to nearshore fish spawning habitat
- Water surface resources – Low, because of limited concentrations of migratory, wintering, and nesting birds in the relatively small surface area affected. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens and streamers
- Shoreline resources – Low, because of the lower likelihood of significant amounts of light fuel oil to strand onshore and most of the potentially impacted shorelines are man-made structures and sand/gravel beaches where a light fuel oil would not be as persistent as heavier oils

Table 3-2: Ecological risk factor scores for the **Worst Case Discharge of 3,000 bbl** of light fuel oil from the *Material Service*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	Medium	High	N/A: Only available for modeled vessels	Low
3A-2: Water Column Degree EcoRAR Oiling	Low	**Medium**	High	The mean volume of water contaminated above 1 ppb was 76 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	Low	Medium	High	N/A: Only available for modeled vessels	Low
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	Medium	High	The mean area of water contaminated above 10 g/m^2 was 720 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	High	N/A: Only available for modeled vessels	Low
3C-2: Shoreline Degree EcoRAR Oiling	**Low**	Medium	High	The length of shoreline contaminated by at least 100 g/m^2 was 6 mi	

For the Most Probable Discharge of 300 bbl of light fuel oil, the ecological risk from potential releases from the *Material Service* is summarized as listed below and indicated in the far-right column in Table 3-3:

- Water column resources – Low, because of the likely smaller volume of potential water column impacts
- Water surface resources – Low, because of limited concentrations of migratory, wintering, and nesting birds in the relatively small surface area affected. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens and streamers
- Shoreline resources – Low, because so few miles of shoreline are at risk

Table 3-3: Ecological risk factor scores for the **Most Probable Discharge of 300 bbl** of light fuel oil from the *Material Service*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	Medium	High	N/A: Only available for modeled vessels	Low
3A-2: Water Column Degree EcoRAR Oiling	**Low**	Medium	High	The mean volume of water contaminated above 1 ppb was 8 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	Low	Medium	High	N/A: Only available for modeled vessels	Low
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	Medium	High	The mean area of water contaminated above 10 g/m^2 was 170 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	High	N/A: Only available for modeled vessels	Low
3C-2: Shoreline Degree EcoRAR Oiling	**Low**	Medium	High	The length of shoreline contaminated by at least 100 g/m^2 was 1 mi	

SECTION 4: SOCIO-ECONOMIC RESOURCES AT RISK

In addition to natural resource impacts, spills from sunken wrecks have the potential to cause significant social and economic impacts. Socio-economic resources potentially at risk from oiling are listed in Table 4-1 and shown in Figures 4-1 and 4-2. The potential economic impacts include disruption of coastal economic activities such as commercial and recreational fishing, boating, vacationing, commercial shipping, and other activities that may become claims following a spill.

Socio-economic resources in the areas potentially affected by a release from the *Material Service* include recreational beaches along the coasts of western Michigan and eastern Wisconsin that are very highly utilized. Many areas along the entire potential spill zone contain popular seaside resorts and support recreational activities such as boating, diving, sightseeing, sailing, fishing, and wildlife viewing.

A release could impact shipping lanes, which accommodate ports in Wisconsin, Indiana, and Illinois, and into inland ports in the inland Mississippi River system. There are over 51,000 port vessel calls to the three major ports in Lake Michigan annually. Commercial fishing is somewhat economically important to the region. A release could impact fishing fleets where regional commercial landings for 2009 exceeded $7.2 million.

In addition to the ESI atlases, the Geographic Response Plans within the Area Contingency Plans prepared by the Area Committee for each U.S. Coast Guard Sector have detailed information on important socio-economic resources at risk.

Spill response costs for a release of oil from the Material Service would be dependent on volume of oil released and specific areas impacted. The specific shoreline impacts and spread of the oil would determine the response required and the costs for that response.

Table 4-1: Socio-economic resources at risk from a release of oil from the *Material Service*.

Resource Type	Resource Name	Economic Activities
Shore Communities	Benton Harbor, MI Chicago, IL Evanston, IL Grand Haven, MI Hagar Shores, MI Highland Park, IL Kenosha, WI Lake Bluff, IL Lake Forest, IL Ludington, MI Milwaukee, WI Muskegon, MI Norton Shores, MI Pentwater, MI Port Washington, WI Racine, WI Saugatuck, MI Sheboygan, WI South Haven, MI	Potentially affected lake-front communities in Wisconsin, Illinois, and Michigan provide recreational activities (e.g., swimming, boating, recreational fishing, wildlife viewing, nature study, sports, dining, camping, and amusement parks) with substantial income for local communities and state tax income. Many of these recreational activities are limited to or concentrated into the late spring through the early fall months.

Resource Type	Resource Name	Economic Activities
	Stony Lake, MI Waukegan, IL	
State Parks	Charles Mears State Park, MI Duck Lake State Park, MI Fischer Creek State Recreation Area, WI Grand Haven State Park, MI Grand Mere State Park, MI Harrington Beach State Park, WI Holland State Park, MI Kohler-Andrae State Park, WI Lakeshore State Park, WI Ludington State Park, MI Muskegon State Park, MI PJ Hoffmaster State Park, MI Saugatuck Dunes State Park, MI Silver Lake State Park, MI Van Buren State Park, MI	Coastal state parks are significant recreational resources for the public (e.g., swimming, boating, recreational fishing, wildlife viewing, nature study, sports, dining, camping, and amusement parks). They provide income to the states. State parks in Wisconsin, Illinois, and Michigan are potentially impacted. There are also many municipal parks. Many of these recreational activities are limited to or concentrated into the late spring into early fall months.
Commercial Fishing	A number of fishing fleets use Lake Michigan for commercial fishing purposes.	
	Michigan	Total Landings (2009): $4.6M
	Wisconsin	Total Landings (2009): $2.6M
Ports	There are a number of significant commercial ports in the Pacific Northwest that could potentially be impacted by spillage and spill response activities.	
	Milwaukee, WI	3,476 port calls annually
	Chicago, IL	41,213 port calls annually
	Indiana-Burns Harbor	6,546 port calls annually
Power Plants	Palisades Nuclear Generating Station, MI Donald C. Cook Nuclear Generating Station, MI Ludington Power Plant, MI Port Washington Generating Station, WI Edgewater Generating Station, WI Valley Power Plant, WI Oak Creek Power Plant, WI Waukegan Power Station, IL Fisk Generating Station, IL Crawford Generating Station, IL	Industrial water intakes for several power generating plants are located on Lake Michigan.

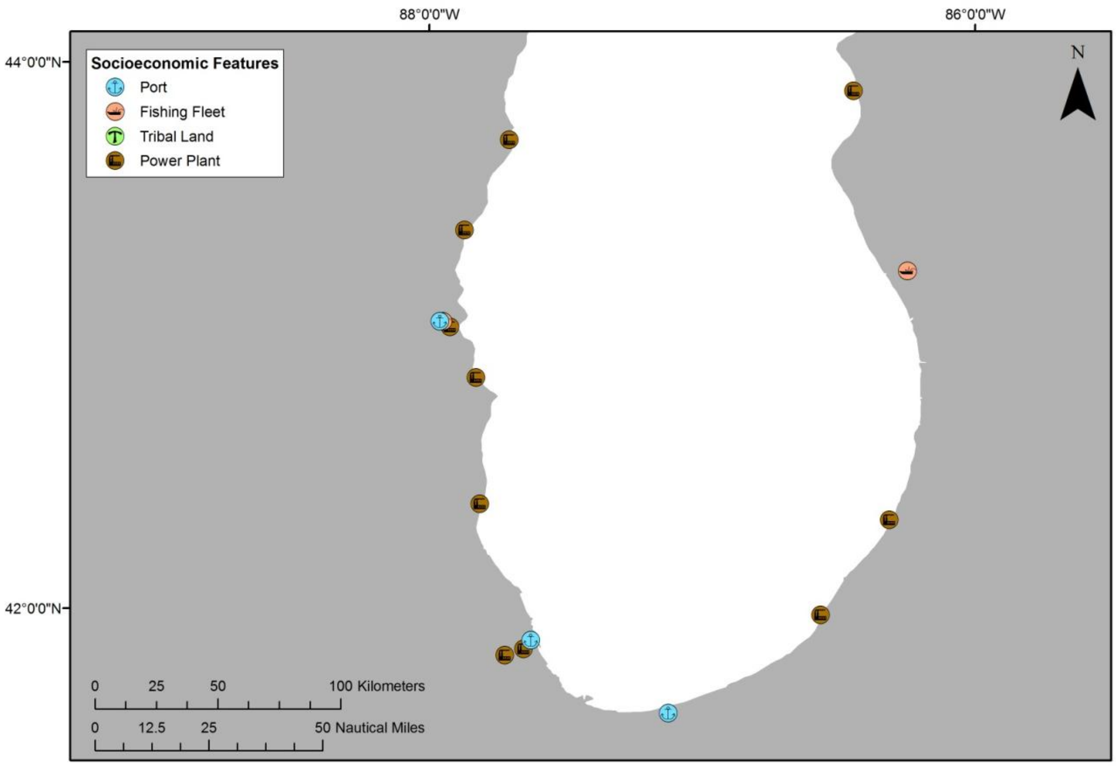


Figure 4-1: Tribal lands, ports, and commercial fishing fleets at risk from a release from the *Material Service*. (Note that there are no tribal lands at risk.)

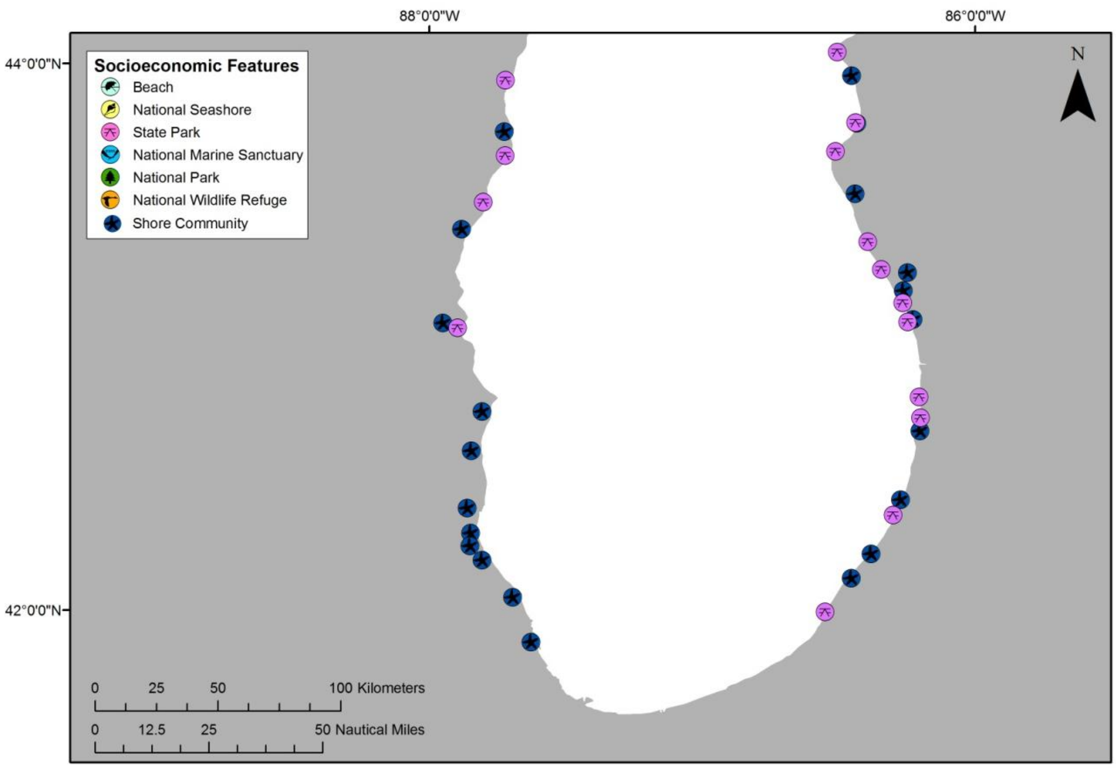


Figure 4-2: Beaches, coastal state parks, Federal protected areas, and shore communities at risk from a release from the *Material Service*.

Socio-Economic Risk Factors

Risk Factor 4: Impacts to Socio-economic Resources at Risk (SRAR)

Socio-economic resources at risk (SRAR) include potentially impacted resources that have some economic value, including commercial and recreational fishing, tourist beaches, private property, etc. All impact factors are evaluated for both the Worst Case and the Most Probable Discharge oil release from the wreck. Risk factors for socio-economic resources at risk are divided into three categories:

- **Water Column:** Impacts to the water column and to socio-economic resources in the water column (i.e., fish and invertebrates that have economic value);
- **Water Surface:** Impacts to the water surface and resources on the water surface (i.e., boating and commercial fishing); and
- **Shoreline:** Impacts to the shoreline and resources on the shoreline (i.e., beaches, real property).

The impacts from an oil release from the wreck would depend greatly on the direction in which the oil slick moves, which would, in turn, depend on wind direction and currents at the time of and after the oil release. Impacts are characterized in the risk analysis based on the likelihood of any measurable impact, as well as the degree of impact that would be expected if there were one. The measure of the degree of impact is based on the median case for which there is at least some impact. The median case is the "middle case" – half of the cases with significant impacts have less impact than this case, and half have more.

For each of the three socio-economic resources at risk categories, risk is classified with regard to:

- The **probability of oiling** over a certain threshold (i.e., the likelihood that there will be exposure to socio-economic resources over a certain minimal amount known to cause impacts); and
- The **degree of oiling** (the magnitude or amount of that exposure over the threshold known to cause impacts).

As a reminder, the socio-economic impact thresholds are: 1 ppb aromatics for water column impacts; 0.01 g/m^2 for water surface impacts; and 1 g/m^2 for shoreline impacts.

In the following sections, the definition of low, medium, and high for each socio-economic risk factor is provided. Also, in the text classification for the *Material Service*, shading indicates the degree of risk for a WCD release of 3,000 bbl and a border indicates degree of risk for the Most Probable Discharge of 300 bbl. Please note: The probability of oiling cannot be determined using the regression curves; probability can only be determined from the 200 model runs. Thus, the modeling results and regression curves for the *Prins Willem V* are used to estimate the values used in the risk scoring for the **degree of oiling only**.

Risk Factor 4A-1: Water Column: Probability of Oiling of SRAR (not scored)

This risk factor reflects the probability that at least 0.2 mi2 of the upper 33 feet of the water column would be contaminated with a high enough concentration of oil to cause socio-economic impacts. The threshold for water column impact to socio-economic resources at risk is an oil concentration of 1 ppb (i.e., 1 part oil per one billion parts water). At this concentration and above, one would expect impacts and potential tainting to socio-economic resources (e.g., fish and shellfish) in the water column; this concentration is used as a screening threshold for both the ecological and socio-economic risk factors.

The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

Risk Factor 4A-2: Water Column Degree of Oiling of SRAR

The degree of oiling of the water column reflects the total amount of oil that would affect the water column in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** impact on less than 0.2 mi^2 of the upper 33 feet of the water column at the threshold level
- **Medium Impact:** impact on 0.2 to 200 mi^2 of the upper 33 feet of the water column at the threshold level
- **High Impact:** impact on more than 200 mi^2 of the upper 33 feet of the water column at the threshold level

The *Material Service* is classified as Medium Risk for degree of oiling for water column socio-economic resources for the WCD of 3,000 bbl because the mean volume of water contaminated in the model runs was 76 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 300 bbl, the *Material Service* is classified as Medium Risk for degree of oiling because the mean volume of water contaminated 8 mi^2 of the upper 33 feet of the water column.

Risk Factor 4B-1: Water Surface Probability of Oiling of SRAR (not scored)

This risk factor reflects the probability that at least 1,000 mi^2 of the water surface would be affected by enough oil to cause impacts to socio-economic resources. The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

The threshold level for water surface impacts to socio-economic resources at risk is 0.01 g/m^2 (i.e., 0.01 grams of floating oil per square meter of water surface). At this concentration and above, one would expect impacts to socio-economic resources on the water surface.

Risk Factor 4B-2: Water Surface Degree of Oiling of SRAR

The degree of oiling of the water surface reflects the total amount of oil that would affect the water surface in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** less than 1,000 mi^2 of water surface impact at the threshold level
- **Medium Impact:** 1,000 to 10,000 mi^2 of water surface impact at the threshold level
- **High Impact:** more than 10,000 mi^2 of water surface impact at the threshold level

The *Material Service* is classified as Medium Risk for degree of oiling for water surface socio-economic resources for the WCD of 3,000 bbl because the mean area of water contaminated in the model runs was

2,200 mi^2. The *Material Service* is classified as Low Risk for degree of oiling because the mean area for water surface socio-economic resources for the Most Probable Discharge of water contaminated was 620 mi^2.

Risk Factor 4C: Shoreline Impacts to SRAR

The impacts to different types of shorelines vary based on economic value. For the modeled wrecks, shorelines have been weighted by their degree of sensitivity to oiling. Sand beaches are the most economically valued shorelines (weighted as "3" in the impact analysis), rocky and gravel shores are moderately valued (weighted as "2"), and wetlands are the least economically valued shorelines (weighted as "1"). In this risk analysis for the *Material Service*, shorelines have NOT been weighted by their degree of sensitivity to oiling because these data are available only for modeled vessels. Therefore, the impacts are evaluated only on the total number of shoreline miles oiled as determined from the regression curve.

Risk Factor 4C-1: Shoreline Probability of Oiling of SRAR (not scored)

This risk factor reflects the probability that the shoreline would be coated by enough oil to cause impacts to shoreline users. The threshold for impacts to shoreline SRAR is 1 g/m^2 (i.e., 1 gram of oil per square meter of shoreline). The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

Risk Factor 4C-2: Shoreline Degree of Oiling of SRAR

The degree of oiling of the shoreline reflects the total amount of oil that would affect the shoreline in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** less than 10 miles of shoreline impacted at threshold level
- **Medium Impact:** 10 - 100 miles of shoreline impacted at threshold level
- **High Impact:** more than 100 miles of shoreline impacted at threshold level

The *Material Service* is classified as Low Risk for degree of oiling for shoreline socio-economic resources for the WCD because the mean length of shoreline contaminated in the model runs was 8 miles. The *Material Service* is classified as Low Risk for degree of oiling for shoreline socio-economic resources for the Most Probable Discharge because the mean length of shoreline contaminated was 5 miles.

Considering the modeled risk scores and the socio-economic resources at risk, the socio-economic risk from potential releases of the WCD of 3,000 bbl of light fuel oil from the *Material Service* is summarized as listed below and indicated in the far-right column in Table 4-2:

- Water column resources – Medium, because although a relatively large area of water column would be impacted in areas with water intakes for power plants the oil would break up quickly
- Water surface resources – Medium, because although a large area of water surface would be impacted offshore in areas with shipping lanes where there are few alternatives for routing, the oil would break up quickly. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – Low, because a small length of shoreline would be impacted in areas with high-value and sensitive resources

Table 4-2: Socio-economic risk factor ranks for the **Worst Case Discharge of 3,000 bbl** of light fuel oil from the *Material Service*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	High	N/A: Only available for modeled vessels	Med
4A-2: Water Column Degree SRAR Oiling	Low	Medium	High	The mean volume of water contaminated above 1 ppb was 76 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	High	N/A: Only available for modeled vessels	Med
4B-2: Water Surface Degree SRAR Oiling	Low	Medium	High	The mean area of water contaminated above 0.01 g/m^2 was 2,200 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	High	N/A: Only available for modeled vessels	Low
4C-2: Shoreline Degree SRAR Oiling	Low	Medium	High	The length of shoreline contaminated by at least 1 g/m^2 was 8 mi	

For the Most Probable Discharge of 300 bbl, the socio-economic risk from potential releases of light fuel oil from the *Material Service* is summarized as listed below and indicated in the far-right column in Table 4-3:

- Water column resources – Medium, because although a relatively large area of water column would be impacted in areas with water intakes for power plants the oil would break up quickly
- Water surface resources – Medium, because although a large area of water surface would be impacted offshore in areas with shipping lanes where there are few alternatives for routing, the oil would break up quickly. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – Low, because a small length of shoreline would be impacted in areas with high-value and sensitive resources

Table 4-3: Socio-economic risk factor ranks for the **Most Probable Discharge of 300 bbl** of light fuel oil from the *Material Service*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	High	N/A: Only available for modeled vessels	Med
4A-2: Water Column Degree SRAR Oiling	Low	Medium	High	The mean volume of water contaminated above 1 ppb was 8 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	High	N/A: Only available for modeled vessels	Med
4B-2: Water Surface Degree SRAR Oiling	Low	Medium	High	The mean area of water contaminated above 0.01 g/m^2 was 620 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	High	N/A: Only available for modeled vessels	Low
4C-2: Shoreline Degree SRAR Oiling	Low	Medium	High	The length of shoreline contaminated by at least 1 g/m^2 was 5 mi	

SECTION 5: OVERALL RISK ASSESSMENT AND RECOMMENDATIONS FOR ASSESSMENT, MONITORING, OR REMEDIATION

The overall risk assessment for the *Material Service* is comprised of a compilation of several components that reflect the best available knowledge about this particular site. Those components are reflected in the previous sections of this document and are:

- Vessel casualty information and how site formation processes have worked on this vessel
- Ecological resources at risk
- Socio-economic resources at risk
- Other complicating factors (war graves, other hazardous cargo, etc.)

Table 5-1 summarizes the screening-level risk assessment scores for the different risk factors, as discussed in the previous sections. As noted in Sections 3 and 4, each of the ecological and socio-economic risk factors each has two components, probability and degree. Of those two, degree is given more weight in deciding the combined score for an individual factor, e.g., a high probability and medium degree score would result in a medium overall for that factor. Please note: The probability of oiling cannot be determined using the regression curves; probability can only be determined from the 200 model runs. Thus, the modeling results and regression curves for the *Prins Willem V* were used to estimate the values used in the risk scoring for the **degree of oiling only**.

In order to make the scoring more uniform and replicable between wrecks, a value was assigned to each of the 7 criteria. This assessment has a total of 7 criteria (based on table 5-1) with 3 possible scores for each criteria (L, M, H). Each was assigned a point value of L=1, M=2, H=3. The total possible score is 21 points, and the minimum score is 7. The resulting category summaries are:

Low Priority	7-11
Medium Priority	12-14
High Priority	15-21

For the Worst Case Discharge, *Material Service* scores Low with 11 points; for the Most Probable Discharge, *Material Service* also scores Low with 11 points. Under the National Contingency Plan, the U.S. Coast Guard and the Regional Response Team have the primary authority and responsibility to plan, prepare for, and respond to oil spills in U.S. waters. Based on the technical review of available information, NOAA proposes the following recommendations for the *Material Service*. The final determination of what type of action, if any, rests with the U.S. Coast Guard.

Material Service	**Possible NOAA Recommendations**
	Wreck should be considered for further assessment to determine the vessel condition, amount of oil onboard, and feasibility of oil removal action
	Location is unknown; Use surveys of opportunity to attempt to locate this vessel and gather more information on the vessel condition
	Conduct active monitoring to look for releases or changes in rates of releases
✓	Be noted in the Area Contingency Plans so that if a mystery spill is reported in the general area, this vessel could be investigated as a source
✓	Conduct outreach efforts with the technical and recreational dive community as well as commercial and recreational fishermen who frequent the area, to gain awareness of changes in the site

Table 5-1: Summary of risk factors for the *Material Service*.

Vessel Risk Factors		Data Quality Score	Comments		Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Low	Maximum of 3000 bbl, not reported to be leaking		**High**
	A2: Oil Type	High	Bunker oil is diesel oil, a Group II oil type		
	B: Wreck Clearance	High	Vessel partially dynamited		
	C1: Burning of the Ship	High	No fire was reported		
	C2: Oil on Water	Low	No oil was reported on the water		
	D1: Nature of Casualty	High	Storm		
	D2: Structural Breakup	High	The vessel remains in one contiguous piece		
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records of this ship exist, assessment is believed to be very accurate		**Not Scored**
Operational Factors	Wreck Orientation	High	Upright		**Not Scored**
	Depth	High	35 ft		
	Visual or Remote Sensing Confirmation of Site Condition	High	Location is a popular dive site		
	Other Hazardous Materials Onboard	High	No		
	Munitions Onboard	High	No		
	Gravesite (Civilian/Military)	High	Yes		
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA		
				WCD	**Most Probable**
Ecological Resources	3A: Water Column Resources	High	Greatest potential impacts are to nearshore fish spawning habitat	**Low**	**Low**
	3B: Water Surface Resources	High	Area of potential impact relatively small	**Low**	**Low**
	3C: Shore Resources	High	Limited shoreline impact by non-persistent light oil	**Low**	**Low**
Socio-Economic Resources	4A: Water Column Resources	High	Although a relatively large area of water column would be impacted in areas with water intakes for power plants the oil would break up quickly	**Med**	**Med**
	4B: Water Surface Resources	High	Although a large area of water surface would be impacted in offshore shipping lanes where there are few alternatives for routing, the oil would break up quickly	**Med**	**Med**
	4C: Shore Resources	High	Small length of shoreline would be impacted in areas with high-value and sensitive resources	**Low**	**Low**
Summary Risk Scores				**11**	**11**