

GULF COAST INCIDENT MANAGEMENT TEAM

# ORPHAN ANCHOR PHASE II PROGRAM

Report to the Federal On-scene Commander  
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Federal On-scene Commander: \_\_\_\_\_

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**Gulf Coast Incident Management Team**

**Orphaned Anchor Program  
Phase II**

## Report to the Federal On-Scene Commander

### Executive Summary

The purpose of this report is to provide the Federal On-Scene Coordinator (FOSC) for the Deepwater Horizon (DWH) MC252 Spill of National Significance with the Orphaned Anchor Program Phase II Program description and results.

The report describes the scope of the project, the technology employed to locate any Danforth anchors which may remain in place after being used to secure shoreline protection boom, the design principals of Danforth anchors and how they were deployed, local sedimentation processes and the two Net Environmental Benefit Analyses (NEBAs) completed prior to the Phase II survey operations and prior to any recovery operations.

The Project team used the refined passive technology developed during the Phase I Pilot over a larger area in the waters of St. Bernard and Jefferson Parish. The findings of the bottom conditions and composition from the use of the passive system were verified by manual checks and measurements.

### Key Findings

- Fewer anchor targets were identified than anticipated. Those located were found in areas consistent with the original boom placement.
- Anchor targets were found buried at an average depth of 1.9 – 2.1 meters, where the risk of damage to personal and commercial vessels is extremely low.
- The anchor targets were generally located where the very soft, unconsolidated surface sediments met more consolidated and competent bottom conditions.
- Deep burial of Danforth anchors, in soft bottom conditions, is consistent with how the anchors are designed to perform.
- No free-floating polypropylene rope was identified over the course of the project.
- To date, there have been no documented reports of vessel incidents with orphan anchors.
- The degradation of the anchor material (steel and galvanized steel) poses no significant threat to human health or the environment.
- Because the anchor targets were found buried so deep, no attempts were made to recover them due to personal safety and the NEBA associated with removal of the over-burden sediment.
- Over the course of Phase I, it was evident that the technology utilized to locate the placed anchors was extremely effective. That same technology, coupled with algorithms developed to make it more effective, was applied to Phase II in an effort to find the greatest number of anchors.
- The technology employed for detection of orphan anchors in the surveyed area was successful in locating orphan anchors (46) as well as a very large number (1157) of other ferrous objects, which the State of Louisiana should consider reviewing as they may pose a hazard to navigation and risk to commercial and personal vessels (the comprehensive search data should be provided to the State of Louisiana for review and for security of information).

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## **Background and Introduction**

During the DWH Oil Spill Response in spring/summer 2010, numerous Vessels of Opportunity (VoOs) were employed by the response to place oil spill containment boom in near shore areas to prevent oiling of shorelines. Typically a length of boom was anchored at one end then deployed over the transom with additional anchors deployed along the boom length to secure it in place. Containment boom was deployed for an extended period of months in most cases. Boom was supplied from numerous sources and thus a wide variety of sizes, shapes, colors and lengths were deployed. This program resulted in approximately 3.8 million linear feet of containment boom placed along the shoreline of the Gulf of Mexico of which approximately 2.0 million linear feet were deployed in Louisiana waters. Due to the urgency and pace used to deploy the containment boom, the exact number and location of the anchors was not recorded and is not available.

Due to the extended period of use as well as the mooring load placed on the anchor system during normal and high wind and wave periods it was common practice to perform normal boom maintenance and redeploy the boom into its intended position. There are limited records of this boom maintenance activity in the response.

Once free oil from the DWH spill was no longer on the water surface and no longer posed a threat for oiling shorelines, a program to collect the boom and anchors was implemented. VoOs were dispatched to collect the boom and anchors. Although most boom anchors were collected at that time, some of the VoO operators, likely due to the size and capability of their vessels, were unable to recover all of them. Because of natural forces on the mooring system while the boom was deployed as well as the inability to recover all the anchors upon retrieval, it is a reasonable assumption that a small percentage remain in their deployed position and have been subsequently 'orphaned'.

## **Purpose and Scope of Orphan Anchor Phase II Project**

At the direction of the FOSC, the Project Team utilized the best available technology to locate and evaluate the feasibility of recovering the orphaned anchors. Additionally, the original NEBA recommended a limited reconnaissance in key areas of higher risk such as lanes of high boat traffic where records and local knowledge gave guidance on locations where booms with anchors had been deployed. The reconnaissance was intended to provide data on what representative portion of anchors were left in place and whether the anchors left behind were buried in sediment or at the sea bottom. Further the reconnaissance would also provide data on whether or not associated polypropylene rope had sunk to the sea floor or was floating near surface as a potential hazard. Following the completion of the Phase I Pilot Orphan Anchor Project which developed and verified the technology to locate orphaned anchors, the field work for the second phase of the Orphan Anchor program began April 6, 2011 and ended on May 23, 2011.

The project was intended to mitigate potential propulsion entanglement threats from suspended polypropylene anchor rope and possible collision hazards with embedded orphaned anchors (a particular concern to commercial and recreational mariners) in heavily trafficked waterways. Additionally, with consideration for safety, the Project team needed to determine whether there would be a net environmental benefit from removal of any remaining orphaned anchors. At the conclusion of this phase of the program, the Project team was to present the findings to the FOSC to help inform decisions regarding further actions.

The 73507 anchors purchased during the response and the inventory of 71779 after boom recovery operations were completed indicate about 1728 or 2.35% of the purchased anchors were unaccounted for across the entire Gulf of Mexico. This number and percentage may be orphaned in place and/or may have been lost due to poor record keeping or pilferage.

Detection of orphaned anchor and orphaned anchor related polypropylene rope in selected areas was completed through the use of multiple instruments including concurrent acoustic and magnetic surveys. Focus was centered on shallow water depth, key pre-determined high volume traffic locations that present the highest degree of hazards to navigation for both commercial and recreational traffic within the Inland Bays, Passes and Waterways of St. Bernard and Jefferson Parishes. During the acoustic and magnetic surveys (same method used for locating unexploded ordnance) for anchor detection, a Marine Sonic 600kHz side-scan sonar was employed to investigate magnetic anomalies that did not match known GIS data. Magnetic data was collected using the Geometrics G-882TVG system and one of the gradiometers surveyed at higher speeds (8-10 knots) and wider survey swaths from Research 2 (clearance vessel). All potential magnetic anomalies detected were investigated with the Marine Sonic 600 kHz transducer and second gradiometer at standard survey speeds (2.5 – 3.5kts) aboard Research 1 (discreet target hunting vessel). These oceanographic systems ran concurrently and allowed for greater mapping area at higher speeds with the customized gradiometer. All identified signatures matching the acoustic signal of possible orphaned anchors in the GIS data were mapped with Hemisphere VS101 GPS and readied for final review. Discreet target identification also included intensive area coverage with a Knutsen 3200 sub-bottom profiler. The side-scan was utilized to determine visibility of orphaned anchors and to investigate the presence of attached poly rope.

During calibration at the beginning of Phase II, a 43 pound, Danforth anchor was placed on the sea floor and within hours sank to a depth of 2.8 meters below the mud line.

The Project Coordinator working with local marine experts involved in the deployment, maintenance and recovery of boom in the survey area as well as GIS boom location data and topographical layouts, developed the search area criteria based on the best data available and a potential 'confidence of anchor location matrix'. The aerial extent of each search grid was adjusted to account for varying confidence levels in where the boom and anchors were set and possibly reset during boom maintenance. This resulted in a wider search area where lower confidence of anchor location existed and a more limited search area where confidence was higher.

The search locations selected are displayed in detail on the GIS maps contained in the Results section of this report. All areas where boom and anchors were used in St. Bernard Parish Division 4 and 5 were surveyed. At the request of the State of Louisiana, an additional limited and prioritized set of areas were surveyed in Jefferson Parish Division 1.

The detection search collected concurrent digital and magnetic data using high-resolution Marine Sonic 600kHz Side Scan Sonar (SSS), Geometrics G-88TVG Gradiometer and a Knutsen 3200 scientific echo sounder in the search grids of Saint Bernard and Jefferson Parish. It was determined using test anchors that measurable signatures (between 5nt and 150nt) were evident at 50 to 100 ft of distance. These line spacing's were determined during anchor calibration testing in Phase I and verified each morning and afternoon during Phase II (patch testing). Clearings, or high-speed passes (7-10 Knots), were made with the towed gradiometer on parallel lines at intervals of 100 feet. Utilizing this evidence, in addition to data review and discussion with Mikhail Tchernychev (software developer for the gradiometer), a search plan/grid was developed for each probable boom location. The plan included clearing passes spaced between 50 and 100 ft intervals to insure

there was never more than 50 ft of distance between the vessel and potential signatures. All anomalies fitting the parameters between 5nt and 150nt were labeled for low speed narrow swath discreet target identification using higher resolution equipment. The post-processing GIS team further investigated the data signatures acquired in the field using dipole inversion software, which provided quality assurance around data interpretation to produce a more accurate listing of signatures requiring further identification.

Using a gradiometer, discreet target identification included 25 ft passes with gradiometer in a perpendicular pass grid for the surrounding 100 ft radius centering on the target mark determined in the clearing pass. Field adjustments were made to the grids based on further analysis of anomalies during data collection. Data collected during the discreet target identification was presented to the offsite GIS post-processing team to determine specific geo-reference and signature profile for comparison with known constants derived from survey activity with test anchors in Phase I.



Typical clearing and discreet pass grids for *West South Canal* (St. Bernard Division 5) – the area search boundaries are marked in light yellow; the wide spaced lines are the high speed search (gradiometer only). The tightly spaced lines are the low speed investigations (uses gradiometer plus side scan plus sub-bottom profiling) – the red dots denote eliminated potential targets, the green dots are anchor signatures.

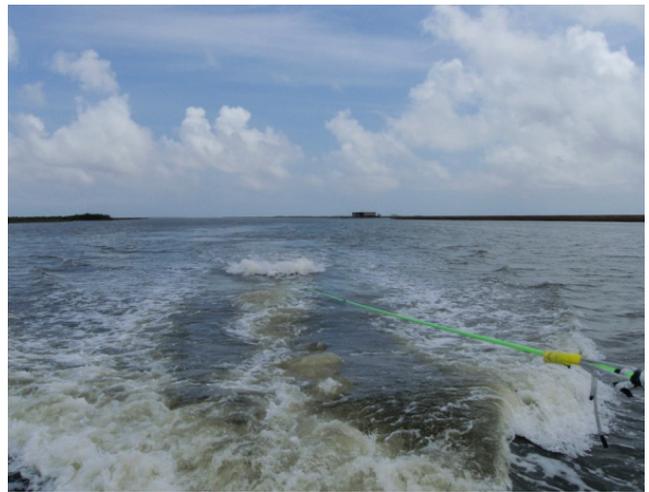
## Passive Search Technology Utilized

### Acoustic and Magnetic Search Tools

A magnetometer is an instrument used to measure the strength or direction of the magnetic field. Ferrous objects all create recordable signatures recognized by changes in the magnetic field near them. By recording the levels and reviewing the data stream it is possible to locate and estimate the size of a ferrous object. The Gradiometer's dual magnetometer configuration consists of two magnetometers mounted on a rigid frame at a known distance, which allows for a more accurate location estimate of signatures through data interpolation from the individual signature amplitudes.

The G-882TVG cesium magnetometer and transverse gradiometer (see Appendix C for detailed specifications) was utilized due to its effectiveness shown in Phase-1 of the Orphaned Anchor Project.

The G-882TVG's framework is designed and configured to be towed in deep water and to "fly" a short, controlled distance from the sea floor (5m or less). This posed an interesting challenge as to how to modify its design to override its inherent diving nature. Multiple tests were done with a variety of flotation configurations before the current design was reached that allows the gradiometer to be towed and collect data from the surface at speeds up to 8 knots. This allowed for areas to be cleared relatively quickly compared to the original configuration.



Gradiometer

Side-scan sonar is an acoustic search device used in underwater imaging. It is most commonly used to image marine substrates. The side-scan transmits a very narrow vertical fan shaped beam of acoustic energy (sound) from two transducers - one on the port and one on the starboard side of a torpedo like device commonly referred to as a towfish. The acoustic energy travels through the water and reflects off of things such as the seafloor or items on the seafloor. The acoustic energy that is reflected or is absorbed by the seafloor and

other items returns to the transducers on the towfish. The data that is received at the towfish is sent up the tow cable and through the winch, deck cable and into the CPU.

The side-scan sonar utilized for this project was a commercial grade Marine Sonics Technology system with heavy towfish in 600kHz frequency (see Appendix E for detailed specifications). The sonar towfish was deployed over the bow of the search vessel, which allowed it to work in shallow water and avoid imaging vessel prop wash. While the boat was moving the towfish was lowered to a given distance above the seafloor and the gains were adjusted to the desired settings. As the search vessel ran transects, the towfish was raised and lowered to maintain the given distance above the seafloor. The sonar and navigation data was viewed in real time and stored on a hard drive for post processing.



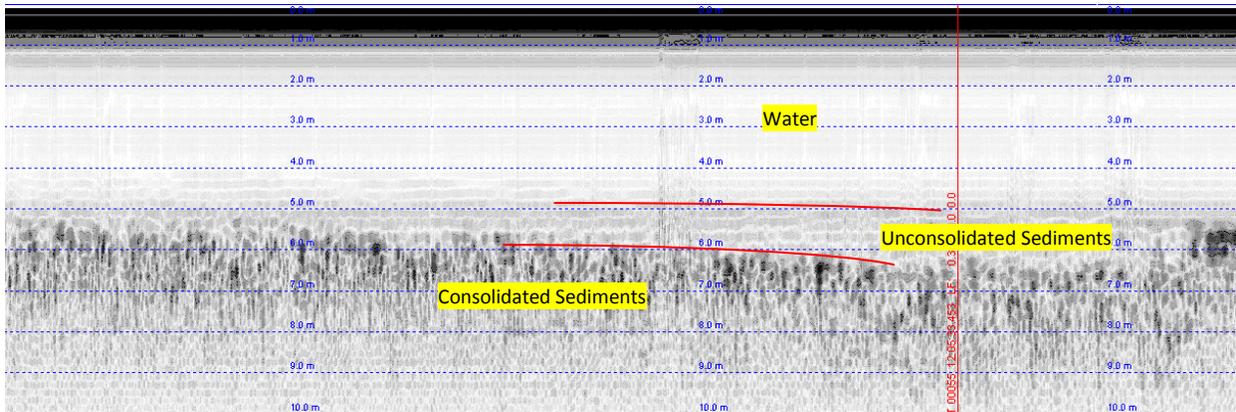
Marine Sonics Technology

Sub-bottom profiling systems identify and measure various marine sediment layers that exist below the sediment/water interface. Acoustic systems used during Phase II, like the Knudsen 3200 (see Appendix D for detailed specifications), use a technique that is similar to single beam echo sounders. A sound source emits an acoustic signal vertically downwards into the water and a receiver monitors the return signal reflected off the seafloor. Some of the acoustic signal will penetrate the seabed and be reflected when it encounters a boundary between two layers that have different acoustic impedance. The system uses this reflected energy to provide information on sediment layers beneath the sediment-water interface.

Acoustic impedance is related to the density of the material and the rate at which sound travels through the material. When there is a change in acoustic impedance, such as the water-sediment interface, part of the transmitted sound is reflected. However, some of the sound energy penetrates through the boundary and into the sediments. This energy is reflected when it encounters boundaries between deeper sediment layers having different acoustic impedance. The system uses the energy reflected by these layers to create a profile of the marine sediments.



Knudsen 3200



Sub-Bottom Profiler Data Image

### Probing To Refusal

The manual use of probing to refusal was also utilized during the search to check and verify the results of the sub-bottom profiles. Probing consists of probing with a 20 ft bamboo pole in multiple locations on each site to determine the composition of the bottom. This method worked very well as the water depths in most search areas was < 6 ft and this gave the ability to quickly and accurately measure the depth of the soft and weak surface sediments of the seabed and in some cases the interface of the soft surface sediment and harder layers at depth.



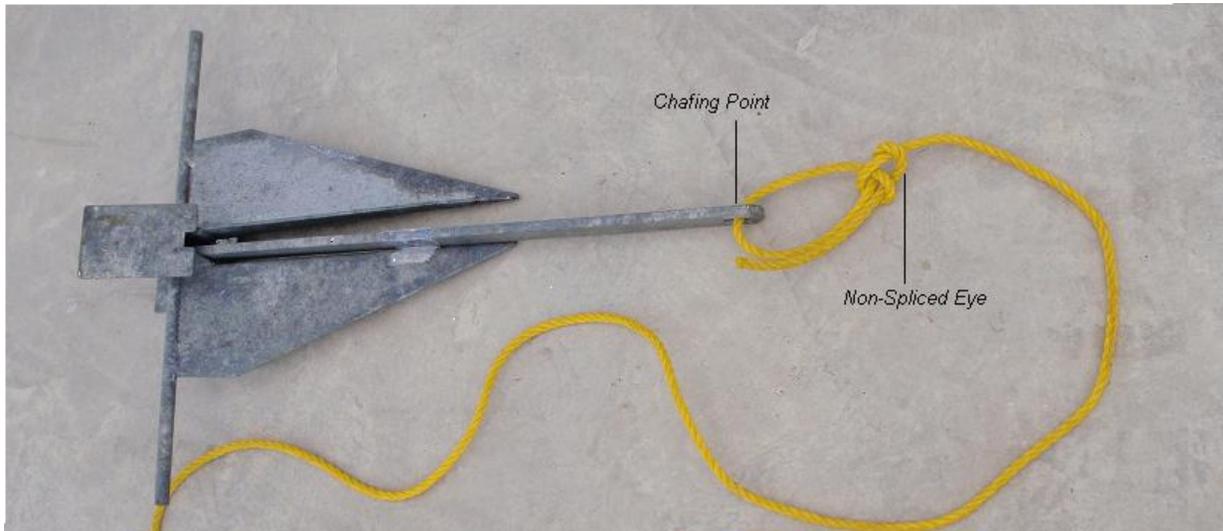
Discreet target identification also included intensive area coverage with the MarineSonics 600 kHz side-scan sonar and the Knudsen 3200 sub-bottom profiler. The side-scan was utilized to determine if an orphaned anchor or polypropylene rope were visible on the sea floor. The findings of the sub bottom profiler confirmed that the anchors detected were generally positioned at the soft surface sediment and harder layer interface on average 1.9 to 2.1 meters below the seabed. The sub-bottom profiler's data was instrumental in determining the depth of the unconsolidated sediment in the search areas, most areas showed unconsolidated sediment of > 2 meters. The method of probing to refusal was also brought in to confirm the findings of the sub-bottom profiler data.

### Danforth Anchor Overview



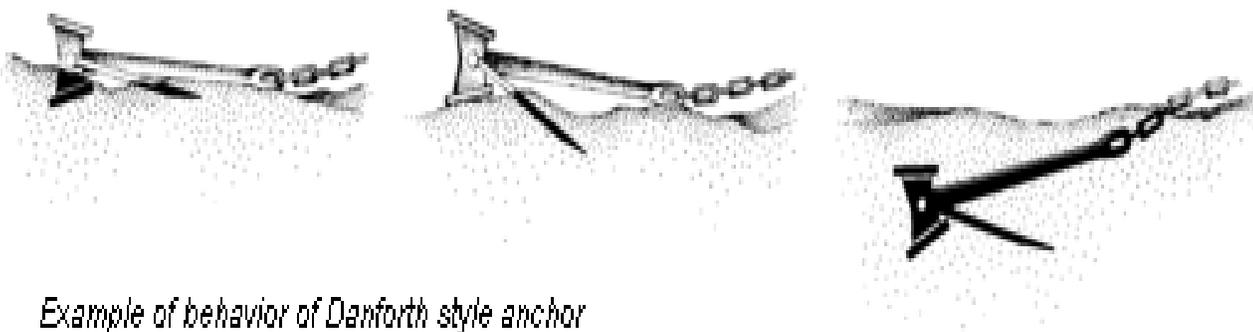
Example of proper anchor tackle

The anchoring method used for the booming of the waters searched was intended to be the standard Danforth-style anchor weighing 25-43 lbs. The anchor is coupled with a shackle attached to 10+ ft of 3/8" chain, which is attached to a length of polypropylene rope that is spliced and fitted with a metal thimble to avoid chafing and line separation where contact is made. The spacing of anchors along the boom length varied and was not recorded. The spacing varied due to different boom manufacturers' design and anchor points, boom size, the exposure of the boom to natural wind and wave loading and the availability of anchors when deployed. Information obtained from response personnel involved in the boom deployment and maintenance activity indicated a typical spacing of 200 to 400 ft. Due to supply issues and the urgency to deploy boom in the area, some anchors were set using only polypropylene rope tied directly to the anchor (see image below). The absence of chain or thimble between the rope and the anchor stock expose the rope to potential chafing which could lead to separation when the mooring line is under load during high wind and waves periods or during anchor retrieval. The lack of splicing eyes into the ends of rope also creates the risk of knot separation as polypropylene rope is extremely slick and can allow knots to release if constant tension is not applied.



Example of how a large number anchors were set in St. Bernard

The Danforth style anchor uses a stock at the crown attached to two large flat triangular flukes. The stock is hinged so the flukes can orient toward the bottom. Tripping palms at the crown act to tip the flukes into the seabed. The flukes are designed to bury themselves deeper as more pulling pressure is applied to its stock. This type of anchor achieves strength through depth of burial, and has a 30+ degree angle of the flukes to the stock of the anchor that forces it to dig in further as additional tension is applied. When set, the stock of the Danforth style anchor lays parallel with the seabed (A 40 lb anchor has an estimated holding strength of 2000 lbs but can vary depending upon sediment strength). The Danforth anchor holds well in seabed with a variety of sedimentary consistencies. It is also important to note that if a Danforth anchor is left in place, the stock of the anchor is free to drop into a horizontal position parallel to the seabed due to the force of gravity and will not be left sticking up.



*Example of behavior of Danforth style anchor*



Boom secured with 40 pound Danforth Anchors

### **Sedimentation**

Jesse E. McNinch, an Adjunct Professor of Marine Science at the Virginia Institute of Marine Science, observes and models small-scale sedimentary processes (e.g. scour, burial) around artifacts such as anchors. The following publication yields insights into what will happen to buried anchors during tropical storms and normal weather periods. The dynamic nature of the deposition and scouring is such that buried debris may be uncovered during tropical storms; however, as described in the study results below, it will likely move deeper and will be covered again with the soft fluidized sediments.

### **McNinch - Potential Fate of Material Left on the Seabed of Chandeleur Sound**

Anecdotal reports from workers probing the seabed, coupled with chirp sub-bottom profiles (Figure X), indicate a thick layer (0.3-1m) of fluidized mud overlying more consolidated, cohesive clay substrates across the study site. This seabed characterization is consistent with conditions described on the west side of the Mississippi river delta in similar water depths (Elgar and Raubenheimer, 2008) where the density of the overlying fluid mud was reported to be  $1.3\text{g/cm}^3$  (Kineke, 2007 referenced in Elgar and Raubenheimer, 2008). Sediments comprising Chandeleur Sound, part of the subsiding St. Bernard deltaic plain (Suter et al, 1988), include clay, silt and sand (Kahn and Roberts, 1982). Sand layers likely result from winnowing during storm conditions and possible transport from the fringing barrier islands when the Chandeleur Islands are over-washed and breached (Keen, 2002).

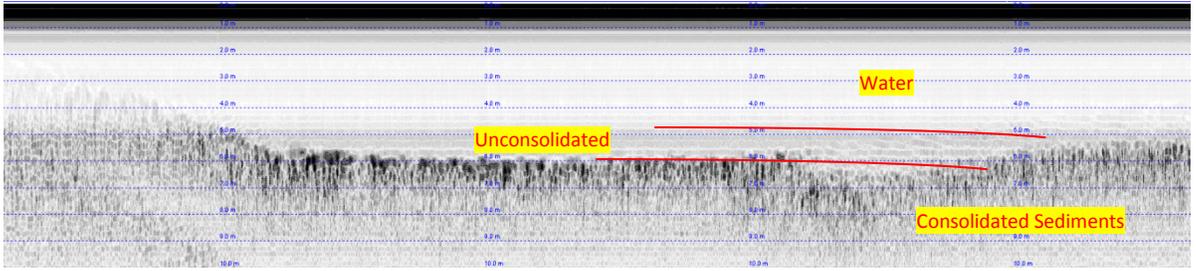


Figure X: Chirp sub-bottom profile showing fluidized mud layer at seabed surface and underlying acoustic reflection surfaces that are likely more cohesive, clay-rich substrates.

The limited fetch and shallow water depths of Chandeleur Sound constrain wave heights. Observations by Keen (2002) at the north end of Chandeleur Sound reveal significant wave heights of less than 0.3m and wave periods of less than 3s during non-storm conditions. Winter cold fronts may generate substantial wind conditions but the strongest winds associated with the frontal passage phase are typically directed from the west and north (Keen, 2002), which minimizes the fetch distance at the study site. Strong winds from tropical cyclones, however, may be directed from the south and southeast, which would maximize wave conditions at the study site. Smith (2007) used STWAVE, a numerical wave model, to simulate wave conditions in Chandeleur Sound during Hurricane Katrina. Significant wave heights exceeded 1m over the study site and were directed from the southeast with periods in excess of 8s at the peak of the hurricane (Figure Y). Observations by Goni et al (2007) from a wide region of the Mississippi delta revealed substantial reworking of the seabed during Hurricane Katrina, typically seen as erosion of the surface sediment (incised 8cm) followed by deposition of suspended silts and clays.

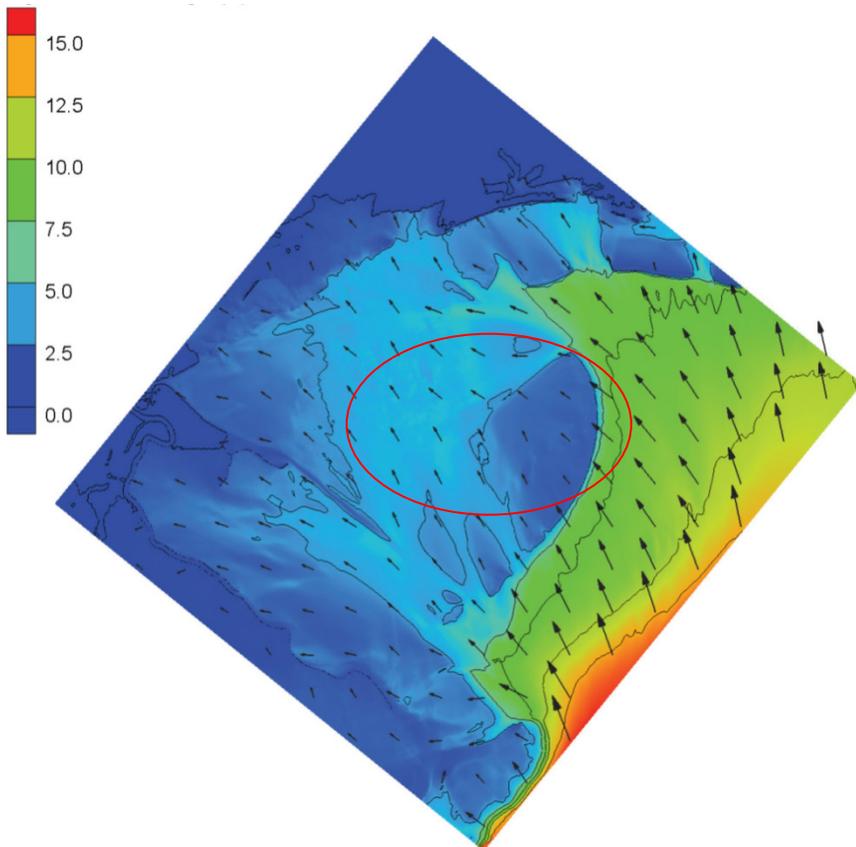


Figure Y: Maximum significant wave height (ft) and direction during Hurricane Katrina (28-30 August, 2005) modeled from STWAVE simulations (Smith, 2007). The study site region is shown inside red oval.

The layer of fluidized mud observed at the study site is very likely re-suspended and mixed throughout the water column during tropical cyclone events like Hurricane Katrina. Although the fluidized mud layer typically dissipates surface wave energy (Elgar and Raubenheimer, 2008) during extreme storm conditions, the surface sediment layer will be removed and some erosion of the underlying, more-cohesive substrate may occur. McNinch et al (2006) examined the fate of artifacts (e.g. cannons) in shallow settings and found that material associated with the shipwreck settled 3-4m over 300yrs but remained largely in-place (horizontal position) and intact. The settling process was driven by episodic events of scour when the artifacts became exposed on the seabed during large wave conditions that eroded the surrounding seabed. Once exposed and protruding above the surrounding seabed, scour processes initiated and the artifacts settled deeper into its scour hole until no longer projecting above the seabed. This episodic process of erosion – scour – settling (Figure Z) may continue until the material reaches a depth below wave base such that wave orbital velocities are too slow to transport sediment or the object settles to a substrate that is erosion resistant and cannot be scoured sufficiently to lower the object below the surrounding seabed surface (McNinch et al., 2006).

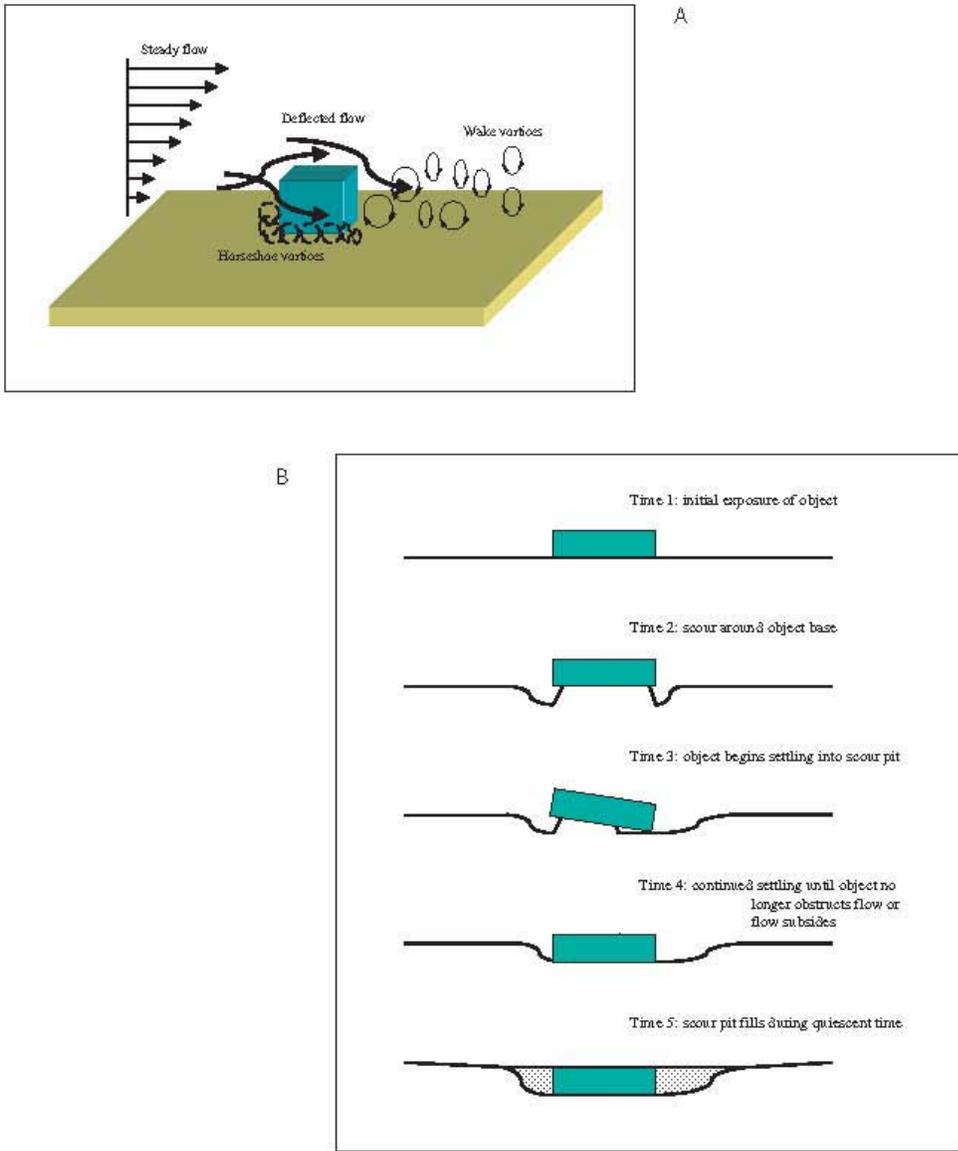


Figure Z: Schematic diagram of scour and settling processes when an object rests on an unconsolidated substrate and is exposed to flows that are near or above critical threshold velocities for sediment transport.

It is likely that the material at the study site will settle to lower substrate depths during extreme storm events when wave conditions mobilize the surface fluid mud layer and then become buried again when the fine-grained sediment settle from the water column during quiescent conditions. Should the material encounter an erosion-resistant substrate (e.g. a cohesive clay layer) the objects will likely remain proud above the seabed (i.e. not scour and settle) during extreme storms and then get re-buried by subsequent deposition of silt and clay.

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### Net Environmental Benefit Analyses (NEBAs)

As part of the Phase II project two NEBAs were completed – a pre-survey NEBA (March 18<sup>th</sup>, 2011) and a pre-recovery NEBA (June 9<sup>th</sup>, 2011).

#### Phase II Pre-survey Net Environmental Benefit Analysis (NEBA)

A risk based pre-survey NEBA was performed to examine the environmental, health and safety impacts of three alternative actions: 1) leave the anchors in place, (toxicity of iron and pathways, toxicity of zinc and pathways, navigation hazard) 2) locate and identify the anchors using remote sensing techniques, (acoustics on mammals, risk to personnel of marine operations, disturb habitat) and 3) locate, salvage and remove the anchors from the sea bottom (snag a pipeline, damage an oil line, damage an abandoned well, damage a communication cable, unexploded ordinance, disturb marine archeology, disturb habitat, and risk to personnel of marine operations).

The NEBA team was lead by a recognized expert in the application of risk based NEBA and the team was selected for their expertise and for their cognitive abilities. Input was sought from appropriate State agencies.

In summary, leaving the anchors in place posed the lowest overall environmental and human health risk. However when specific geographic areas were evaluated in detail certain risks such as hazard to navigation, commercial fishing and recreation were higher. Therefore, although the overall risk of leaving anchors in place is low, this Phase II program was undertaken to survey locations in higher risk areas such as lanes of high boat traffic that cross know areas of booms. Locating and identifying anchors also presented a relatively low level of environmental and human health risk. However medium risk existed for marine personnel in conducting the operations. This Phase II performed modest reconnaissance in prioritized targeted areas, which minimized

risk. As this report confirms, the anchors pose no hazard to recreational boaters or commercial fishermen. Finally it was determined that salvage and removal of the anchors from the sea bottom posed the greatest risk. Although there was a low probability of occurrence, the consequential risk of these categories was substantial if an accident were to occur. Salvage and removal of the anchors showed the highest risk and the most dangerous consequences of the three alternatives.

This NEBA (see Appendix A) was delivered to the FOSC on March 18, 2011, well in advance of the finalization of the Phase II plan.

### **Phase II Pre Recovery Net Environmental Benefit Analysis (NEBA)**

A risk based pre recovery NEBA was performed to provide the Federal On-Scene Coordinator (FOSC) with a NEBA associated with removing orphan anchors from the waters of the State of Louisiana, which were deployed during the response to the Deepwater Horizon MC252 Spill of National Significance. This NEBA also considered the personal and public safety implications of removing the anchors, which is not normally done as part of the NEBA. The question for this NEBA was which response option provides for the greatest net environmental benefit when considering that recovery operations will have some adverse environmental impacts. It was noted that the State of Louisiana stated their expectation that the anchors used during the response be removed.

The conclusion was that the response option that would derive the greatest net environmental benefit is that of allowing the anchors to remain in place to degrade via natural processes. The analysis utilized effect values from +2 to -2 and a weight scale from 1 to 5. Thus the maximum scoring range is between +10 to -10 for each response option. Natural processes scored a -0.46 and had the least negative score of the response options studied. The "least invasive methods" category ranked as the second best option with a score of -4.70. Ranking third and as the most adverse response option consider was the "most invasive methods" category, which scored -7.63.

This NEBA (see Appendix B) was delivered to the FOSC on June 9, 2011.

### **Results**

An industry leader was utilized to successfully and safely carry out an Acoustic and Magnetic Search for Orphaned Anchor Detection using the best available technology and possible subsequent recovery in key pre-determined high volume traffic locations (with input from area experts) within the Inland Bays, Passes and Waterways of Saint Bernard and Jefferson Parish, Louisiana as part of the Orphan Anchor Phase II Project.

The Phase II investigation was successful in providing answers to the questions raised in the pre survey NEBA:

1. Can orphan anchors be located using passive survey methods,
2. How many anchors were orphaned,
3. Were they buried or on the sea floor, and
4. Were polypropylene ropes connected to orphan anchors a floating hazard?

In summary, the Phase II investigation showed that there were fewer than expected anchors left behind, that those found were buried in sediment and not a hazard to boats or fishing, and that polypropylene rope was

not a floating hazard. The NEBA addressing the possibility of recovering the orphaned anchors and indicates that less environmental harm will be done by leaving the anchors in place.

The findings of the side-scan and sub-bottom profilers confirmed that the 46 anchor signatures detected in St. Bernard Parish Division 4 and Division 5 had settled deep into the unconsolidated sediment layers. No anchor signatures were identified within the limited search area in Jefferson Parish likely due to the different seabed sediment conditions (harder bottom making for easier removal). The sub-bottom profiler's data was instrumental in determining the depth of the unconsolidated sediment in the search areas. Most areas showed unconsolidated sediment of greater than 2 meters. The method of probing to refusal was also utilized to confirm the findings of the sub-bottom profiler data. Most areas probed showed a layer of unconsolidated sediment of greater than 2 meters above point of refusal in St. Bernard Parish. The bottom profile in Jefferson Parish is a sandy bottom characterized by consolidated sediment showing almost zero meters of penetration when probing to refusal. Due to this bottom condition and the use of proper anchor tackle, no anchor signatures were identified in the limited search area within Jefferson Parish.

#### **Detailed St. Bernard Division 4 Findings and Examples**

St. Bernard's Division 4 was divided into nineteen search locations that were chosen by working with local marine experts involved in the deployment, maintenance and recovery of boom in the Division as well consulting GIS boom location data and topographical layouts covering all boom and anchor locations. The aerial extent of each search grid was adjusted to account for varying confidence levels in where the boom and anchors were set and possibly reset during boom maintenance.

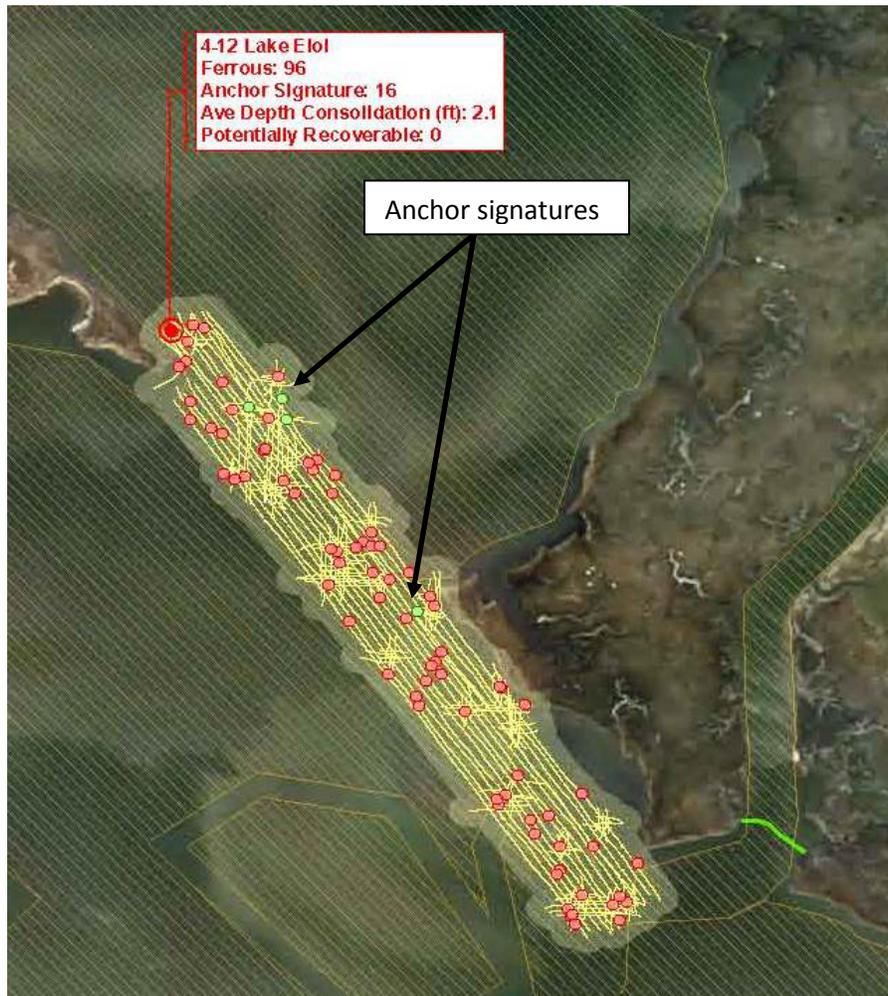
Clearance passes were conducted over all search locations first. These passes recorded all 506 ferrous targets and eliminated those that clearly fell outside the amplitude of an anchor signature (15-150 nt). This eliminated 284 of the ferrous objects from further consideration.

The 222 remaining targets that fell in within the anchor signature range were each looked at individually using the low speed target identification process, which eliminated 195 of these targets. The remaining 27 anchor signatures were checked for depth of burial and examined with side-scan to make sure no part of the anchor tackle was exposed.

Bayou Loutre depicted below provides a good example of a location with a large number of ferrous material but no anchors.



The only example in St. Bernard Division 4 that could be interpreted as an example of stranded boom was found at the mouth of Lake Eloi. Note the highlighted green dots along the likely boom line.



The Results for **St. Bernard Division 4** are shown in the following figure and summarized in the table below.



Orphan Anchor Phase II Search Results: St. Bernard Parish Division 4											
Location #	General Location	Start	End	Cleared Date	Boom ft	Ttl Ferrous Targets	Potential Anchors	Eliminated During ID	Depth (m) of Consolidation	Anchor Signature	Notes
Div 4-1	Treasure Pass	29.818991° -89.416033°	29.817656° -89.412465°	5/1/2011	1216	8	2	1	2.2	1	Too shallow < 2' water (>2.2m. uncon. Sediment. no-refusal) submerged
Div 4-2	Treasure Pass	29.818933° -89.402760°	29.819007° -89.399276°	5/1/2011	1089	11	4	3	2.0	1	Too shallow < 2' water (>2.0m. uncon. sediment. no-refusal) submerged
Div 4-3	Treasure Pass	29.820075° -89.384967°	29.820827° -89.379404°	5/1/2011	1791	34	7	7	2.0	0	All potentials outside magnetic signatures
Div 4-4	Christmas Camp Lake	29.818424° -89.346631°	29.816391° -89.345667°	4/21/2011	792	3	2	1	2.1	1	Less than 2' water (>2.1m. uncon. sediment. no-refusal) submerged
Div 4-5	Treasure Bay	29.809892° -89.358546°	29.798685° -89.356370°	4/29/2011	4153	102	27	25	2.1	2	Submerged (>2.1m. unconsolidatd sediment. no-refusal)
Div 4-6	Treasure Bay	29.798685° -89.356370°	29.797817° -89.354879°	4/30/2011	562	21	15	14	2.0	1	Submerged (> 2m. unconsolidatd sediment. no-refusal)
Div 4-7	Bayou Loutre	29.798323° -89.367243°	29.797480° -89.367477°	4/30/2011	312	17	11	11	2.2	0	All potentials outside magnetic signatures
Div 4-8	Bayou Loutre	29.798323° -89.367243°	29.797806° -89.364772°	4/30/2011	805	12	4	4	2.3	0	Potential (> 2m. unconsolidated sediment. no-refusal) submerged
Div 4-9	Morgan Harbor	29.797250° -89.347900°	29.794056° -89.344936°	4/30/2011	1546	11	6	6	1.9	0	All potentials outside magnetic signatures
Div 4-10	Lake Eloi	29.801139° -89.466458°	29.801532° -89.463127°	4/30/2011	1061	9	5	3	2.0	2	Less than 2' water (>2.0m. Uncon. Sediment. no-refusal)
Div 4-11	Lake Eloi	29.796879° -89.472965°	29.793834° -89.472126°	4/30/2011	1142	19	7	5	2.2	2	Less than 2' water (>2.2m. Uncon. Sediment. no-refusal) submerged
Div 4-12	Lake Eloi	29.794184° -89.446358°	29.781313° -89.436439°	4/30/2011	5606	96	38	22	2.1	16	Less than 2' water (>2.1m. Uncon. Sediment. no-refusal) submerged
Div 4-13	Lake Eloi	29.781288° -89.426838°	29.781320° -89.423658°	4/29/2011	1004	28	5	4	2.4	1	(>2.4m Uncon. Sediment. no-refusal) Submerged
Div 4-14	Bay Eloi	29.786890° -89.400446°	29.787575° -89.400515°	4/28/2011	239	7	3	3	2.0	0	Outside mag. Signatures (>2.0m-no-refusal)
Div 4-15	Bay Eloi	29.783900° -89.371959°	29.783101° -89.371211°	4/23/2011	384	15	15	15	2.1	0	Metal garbage lined the narrow shoreline. Hazards were marked with pilings. (>2.1 m-nr)
Div 4-16	Deadman Island	29.741132° -89.360989°	29.743013° -89.355535°		5598						
Div 4-17	Point Lidia	29.772937° -89.321154°	29.761745° -89.315875°	4/29/2011	4352	113	71	71		x	Area marked by oil industry pipeline & debris. Weathered out
Div 4-18	Point Lidia	29.761621° -89.296227°	29.763519° -89.285174°		3537						
Div 4-19	Bay Eloi	29.757784° -89.440869°	29.758691° -89.441955°		466						
					35655	506	222	195	2.1	27	

### Detailed St. Bernard Division 5 Findings and Examples

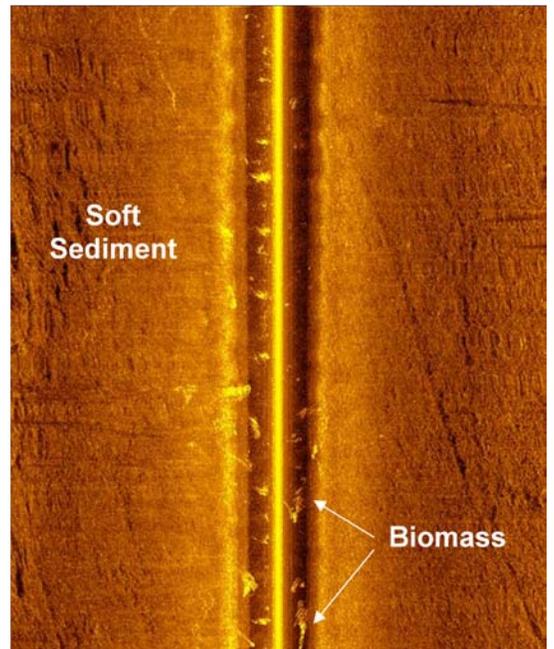
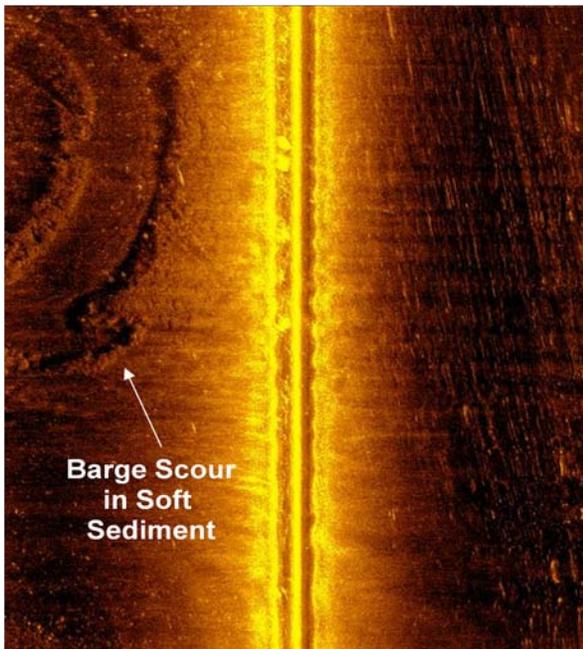
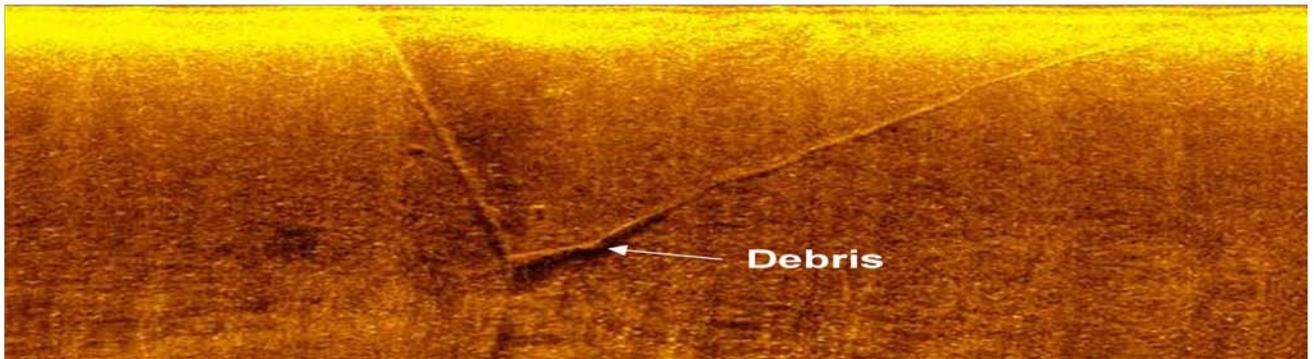
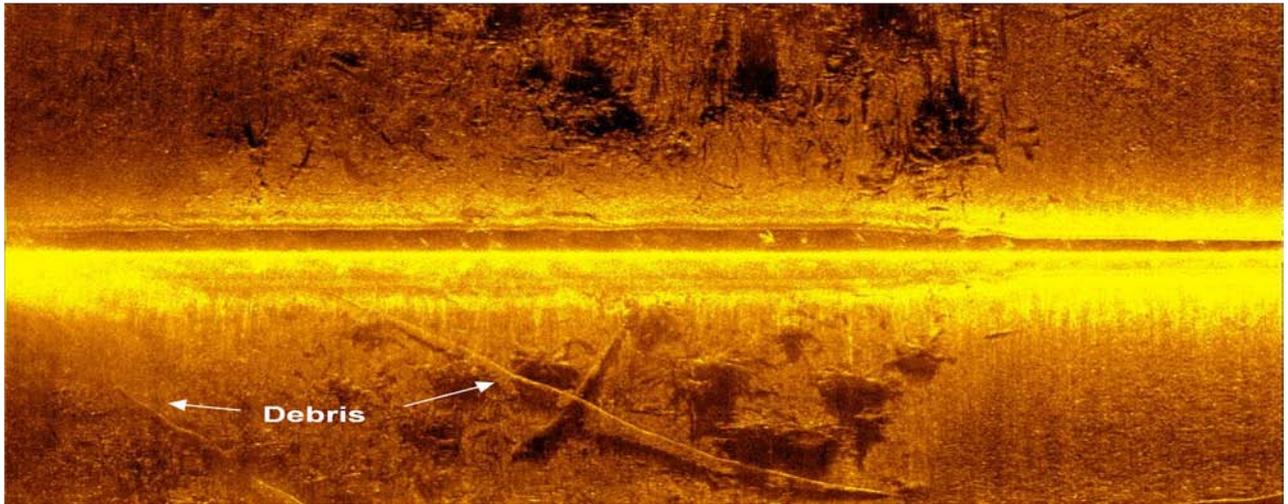
St. Bernard's Division 5 was divided into 25 search locations. The process for setting out the search patterns was exactly the same as what was done for Division 4. Further, the clearing searches and the target ID searches were done with the same equipment, using the same procedures, to detect ferrous material and eliminate those items that were not anchors.

In this case, 386 of the 593 ferrous objects were eliminated during the clearing passes. A further 188 were eliminated during the target identification operations. The remaining 19 anchor signatures locations were checked for depth of burial and examined with side scan to make sure no part of the anchor tackle was exposed.

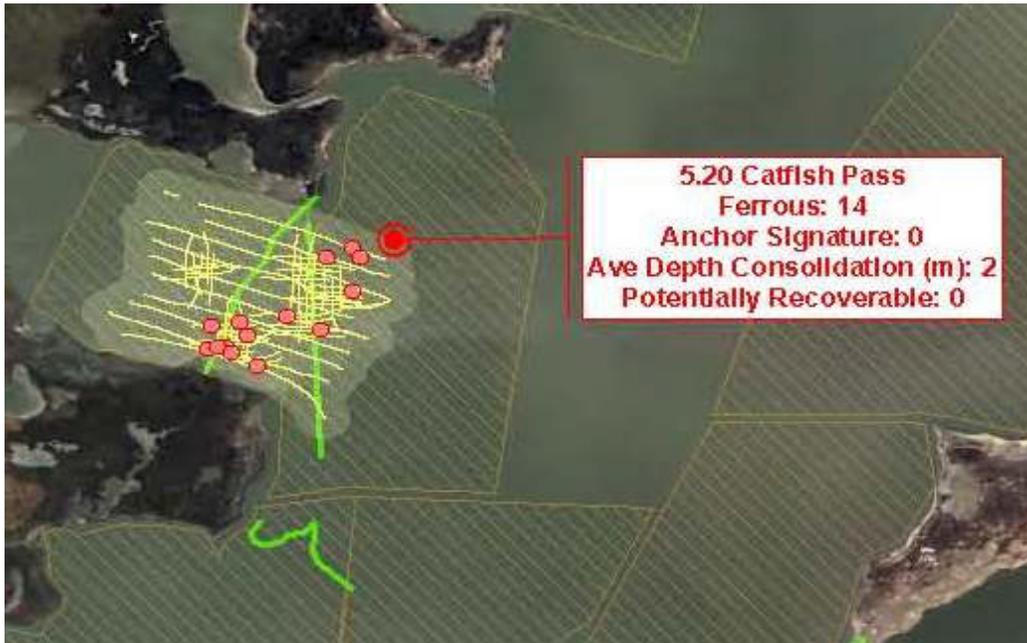
Comfort Island is an example of a large number of ferrous targets with no discernable anchor signatures.



The following side scan images recorded during the survey show of some of the debris found **Comfort Island**.



**Cat Fish Pass** is an example of where boom was set in an area of oyster leases that showed little debris and no anchors.



**Dry Bread Island** was only citable example of where boom may have been stranded. The spacing between anchors at the upper left is approximately 350 feet.





## Orphan Anchor Phase II Search Results: St. Bernard Parish Division 5

Map Location #	General Location	Start	End	Cleared Date	Boom ft	Ferrous Targets	Potential Anchors	Eliminated During ID	Depth (m) to Consolidation	Anchor Signature	Notes
5-1	Comfort Island	29°49'46.00N 89°15'55.00W	29°49'46.00N 89°14'35.00W	40640	14852	244	78	43	2.1	NA	100's of targets of all strengths. No visible anchors. Too shallow in
5-2	Dry Bread Island	29°50'56.00N 89°18'29.00W	29°50'17.00N 89°17'46.00W	40641	10928	31	19	11	2.2	8	Too shallow and submerged
5-3	Drum Bay Island	29°55'16.50N 89°15'55.00W	29°55'16.50N 89°15'35.00W	40646	5037	27	11	10	2	1	Too shallow. < 2' water.
5-4	Treasure Pass	29°49'34.00N 89°25'20.00W	29°49'37.00N 89°25'15.00W	40644	1152	0	0	0	x	0	Off Priority Listing(Cptn Casey)
5-5	Sample Island Pass	29°52'31.00N 89°15'39.00W	29°52'36.00N 89°15'25.00W	40646	1580	22	16	15	2.2	1	submerged
5-6	West South Canal	29°49'24.00"N 89°19'13.37"W	29°49'39.00"N 89°19'23.00"W	36995	1640	58	11	9	2	2	submerged
5-7	North end of Canal	29°50'22.35"N 89°19'28.19"W	29°50'27.77"N 89°19'22.32"W	40647	1444	7	4	4	2	0	4: cleared < 2' water
5-8	Pipeline Pass	29°50'14.72"N 89°23'42.62"W	29°50'20.74"N 89°23'32.27"W	40644	2815	0	0	0	x	0	Off Priority Listing(Cptn Casey)
5-9	Scow Pass	29° 52.388"N 89° 16.482"W	29° 52.405"N 89° 16.160"W	40642	732	27	12	11	2.1	1	SS images show entanglement.
5-10	Keelboat Pass West	29° 53.037"N 89° 15.309"W	29° 53.005"N 89° 15.258"W	40642	75	2	0	0	x	0	Zero contacts
5-11	Keelboat Pass East	29° 53.007"N 89° 14.572"W	29° 53.054"N 89° 14.489"W	40642	808	1	0	0	x	0	Zero contacts
5-12	White Log Lake North	29° 51.254"N 89° 19.337"W	29° 51.304"N 89° 19.138"W	40642	1154	14	4	3	2	1	ruled out. < 2' water
5-13	White Log Lake South	29° 50.918"N 89° 19.706"W	29° 51.024"N 89° 19.434"W	40644	979	17	5	4	2	1	All potential anchors ruled out
5-14	Skiff Lake North	29° 52.065"N 89° 18.663"W	29° 52.130"N 89° 18.486"W	40644	1282	11	2	2	2.1	2	Outside Signature
5-15	Skiff Lake South	29° 51.858"N 89° 18.533"W	29° 51.860"N 89° 18.381"W	40644	1018	7	3	3	2	0	< 2' water.
5-16	Bayou De Soto	29° 53.397"N 89° 21.606"W	29° 53.373"N 89° 21.538"W	40647	329	3	2	2	1.8	0	> 3' of unconsolidated
5-17	Bayou Julia West	29° 52.783"N 89° 21.391"W	29° 52.652"N 89° 21.153"W	40647	581	10	2	2	2.2	0	> 3' of unconsolidated
5-18	Bayou Julia East	29° 52.640"N 89° 20.507"W	29° 52.707"N 89° 20.390"W	40644	589	22	10	10	2.3	0	All outside Mag. Signatures
5-19	Bayou Julia South	29° 52.235"N 89° 19.913"W	29° 52.254"N 89° 19.772"W	40647	778	10	2	2	1.8	0	Target in 12' water. 3+ feet of unconsolidated sediment
5-20	Catfish Pass	29° 53.713"N 89° 20.709"W	29° 53.621"N 89° 20.499"W	40644	2212	14	7	7	2	0	Shallow & outside signature
5-21	Deadman Bayou	29° 55.423"N 89° 17.154"W	29° 55.438"N 89° 17.100"W	40646	367	27	4	3	2	1	Data shows submerged
5-22	Work Order #22	x	x	40644	213	0	0	0	x		Off Priority Listing(Cptn Casey)
5-23	Work Order #23	C. Casey	C. Casey	40646	613	13	4	4	2.2	0	outside signature
5-24	Work Order #24	C. Casey	C. Casey	40646	3096	17	8	7	2.2	1	Cleared
5-25	Work Order #25	C. Casey	C. Casey	40646	1117	9	3	3	2	0	Outside scope of magnetics
					55391	593	207	155	2	19	

## Jefferson Parish Division 1 – A Consolidated Bottom Environment Clear of Anchor Signatures

A limited search was conducted in Jefferson Division 1 to test a consolidated sandy bottom environment. The same process was used to set out search patterns and 10 search grids were selected. The clearing searches identified 58 ferrous objects for further investigation. All 58 of those objects were eliminated during the target ID searches. The bottom profile in Jefferson Parish is a sandy bottom characterized by consolidated sediment showing almost zero meters of penetration when probing to refusal. No anchor signatures were identified in the area, likely due to this bottom condition and the use of proper anchor tackle.



Jefferson Parish Division 1 Trials												
Map Location	General Location	Start	End	END LAT	End LON	Assignment Description	Cantilever Measurement feet	Offset Ratio	Total Boom Feet	High Speed Survey Blue	Low Speed Survey Blue	Survey Notes
Div 2-1	Grand Isle Jetty	29.200125°,-90.039392°	29.193262°,-90.039034°		29.193262°,-90.039034°	High traffic	2446	1.5	3669	x	x	
Div 2-2	Grand Isle Channel west	29.192515°,-90.044953°	29.182935°,-90.046385°		29.182935°,-90.046385°	High traffic	3502	1.5	5253	x	x	
Div 2-3	Back Bay	29.204297°,-90.056100°	29.201246°,-90.054873°		29.201246°,-90.054873°	High traffic	1182	1.5	1773	x	x	1
Div 2-4	Caminada Bay Southwest	29.212957°,-90.095618°	29.207491°,-90.095528°		29.207491°,-90.095528°	High traffic	1947	1.5	2921	x	x	
Div 2-5	Bay Lizette South	29.248914°,-90.095914°	29.253077°,-90.103248°		29.253077°,-90.103248°	High traffic	2778	1.5	4167	x	x	
Div 2-14	Grand Isle Pass East	29° 15' 49.67"N, 89° 56' 53.84"W	29° 15' 36.69"N, 89° 56' 32.97"W	29:15:36.69 N	089:56:32.97 W	High traffic	2270	1.5	3405	x	x	40' depth - too deep to survey
Div 2-15	Grand Isle Pass East	29° 16' 15.88"N, 89° 56' 37.47"W	29° 15' 58.55"N, 89° 56' 36.73"W	29:15:58.55 N	089:56:36.73 W	High traffic	1717	1.5	2576	x	x	40' depth - too deep to survey
Div 2-16	Grand Terre Pass	29° 17' 34.64"N, 89° 54' 13.90"W	29° 16' 53.44"N, 89° 54' 18.87"W	29:16:53.44 N	089:54:18.87 W	High traffic	4181	1.5	6272	x	x	40' depth - too deep to survey
Div 2-23	Queen Bess Island	29° 18' 6.25"N, 89° 57' 49.57"W	29° 18' 6.25"N, 89° 57' 49.57"W			High traffic/Rookery Boom circled island	8742	1.5	13113	x	x	
Div 2-24	Grand Isle Channel	29° 12' 55.04"N, 90° 2' 51.86"W	29° 13' 6.70"N, 90° 2' 41.98"W	29:13:06.70 N	090:02:41.98 W	High traffic	1468	1.5	2202	x	x	
							30233	Total Boom Ft	45350	100%	100%	58 58 0

As required by the Archeological Resources and Protection Act of 1979, and the National Historic Preservation Act of 1966, as amended, the raw and processed data from the survey will be transferred to the State of Louisiana for security of information purposes. As well the State may take the opportunity to assess the thousands of ferrous objects found that were not anchors for potential hazards to navigation and risk to commercial and private fishing. A copy of this data will be maintained on the GIS database server bp1txddb081-c as required by the legal hold order.

## **Key Findings**

- Fewer anchor targets were identified than anticipated. Those located were found in areas consistent with the original boom placement.
- Anchor targets were found buried at an average depth of 1.9 – 2.1 meters, where the risk of damage to personal and commercial vessels is extremely low.
- The anchor targets were generally located where the very soft, unconsolidated surface sediments met more consolidated and competent bottom conditions.
- Deep burial of Danforth anchors, in soft bottom conditions, is consistent with how the anchors are designed to perform.
- No free-floating polypropylene rope was identified over the course of the project.
- To date, there have been no documented reports of vessel incidents with orphan anchors.
- The degradation of the anchor material (steel and galvanized steel) poses no significant threat to human health or the environment.
- Because the anchor targets were found buried so deep, no attempts were made to recover them due to personal safety and the NEBA associated with removal of the over-burden sediment.
- Over the course of Phase I, it was evident that the technology utilized to locate the placed anchors was extremely effective. That same technology, coupled with algorithms developed to make it more effective, was applied to Phase II in an effort to find the greatest number of anchors.
- The technology employed for detection of orphan anchors in the surveyed area was successful in locating orphan anchors (46) as well as a very large number (1157) of other ferrous objects, which the State of Louisiana should consider reviewing as they may pose a hazard to navigation and risk to commercial and personal vessels (the comprehensive search data should be provided to the State of Louisiana for review and for security of information).

## **Conclusions**

The Orphan Anchor Survey Phase II investigation clearly answered the questions raised in the NEBA by showing that there were far fewer anchors left behind than expected and that those found were buried in sediment. No evidence of floating polypropylene rope was found in any of the locations surveyed.

The Orphan Anchor Survey verified that orphan anchors in St. Bernard are deeply buried in soft deltaic sediments. These anchors are unlikely to be re-exposed, dislodged and moved shoreward. Anchors are small, compact, heavy objects that have a small cross sectional area – they are heavy for their size. If the same amount of steel were to be reformed into another shape, for example a barrel or box shape, it would weigh the same but have a much larger cross sectional area, which would make it subject to being moved by wave action. Because waves disturb the bottom by suspending sediments in the water column, an anchor is likely to migrate further downward vertically in the sediments in which it is buried than to be transported horizontally.

**Appendix A – Pre-Survey Net Environmental Benefit Analysis (NEBA)****18 March, 2011****Prepared for Capt. Hanzalik, FOSC and Tom Zimmer, BP IC****by****L. Bruce, A. Maki, B. Wood, M. Taylor, T. M. Garrett, J. Burns, J. Hokanson****Executive Summary**

The purpose of this report is to provide the Federal On-Scene Coordinator (FOSC) for the Deepwater Horizon MC252 Spill of National Significance with a risk-based Net Environmental Benefits Analysis (NEBA) associated with removing remaining anchors used to secure oil booms. Three alternative actions were considered: 1) Leave the anchors in place, 2) locate and identify the anchors using remote sensing techniques, and 3) locate, salvage and remove the anchors from the sea bottom.

Alternative 1: Results from the Phase I Orphaned Anchor Identification Program indicate that there were fewer anchors left in place than previously envisioned. Empirical data from that investigation also show that five of the six anchors placed in the study area were completely buried beneath the sediment within ten days of their placement on the water bottom. Leaving the anchors in place posed the lowest overall environmental and human health risk. However when specific geographic areas were evaluated in detail, certain risks such as potential hazard to navigation, commercial fishing and recreational use were higher. Therefore, although the overall risk of leaving anchors in place is low, consideration should be given to reconnaissance location surveys in higher risk areas. These surveys could be performed on a priority basis.

Alternative 2: Locating and identifying anchors also presented a relatively low level of environmental and human health risk. However medium risk existed for marine personnel in conducting the operations. The overall level of risk would depend upon the level of effort and extent of operations. Modest reconnaissance style operations in prioritized targeted areas would pose minimal risks. A limited reconnaissance effort may provide additional data to evaluate whether or not further efforts may be warranted.

Alternative 3: Salvage and removal of the anchors from the sea bottom posed the greatest risk of the three alternatives. Although the composite risk for any given category did not exceed “medium” because of the low probability of occurrence, the consequential risk of some of these categories was substantial if an incident were to occur. This alternative shows the highest risk and most dangerous consequences of the three.

**Net Environmental Benefits Analysis**

**Statement of the Problem** – During the DWH Oil Spill Response period in summer 2010, numerous Vessels of Opportunity (VOOs) were employed by BP to place oil spill boom in nearshore areas to prevent oiling of sensitive shorelines. Typically a length of boom was anchored at one end then deployed over the transom and a second anchor was deployed at the end of the boom length. Boom was supplied from numerous sources and thus a wide variety of boom sizes, shapes, colors and lengths were deployed. This program resulted in approximately 3.8 million linear feet of containment boom placed along Gulf of Mexico shores of which approximately 2.0 million linear feet were employed in Louisiana waters. Accordingly, an undetermined number of anchors held this boom in place.



Figure 1 Photograph of deployed boom that would require anchors to hold in place.

Once free oil was removed from the water surface and no longer posed a threat for oiling shorelines, a program to collect the boom was implemented. The VoOs were dispatched to collect the boom. Although most boom anchors were collected at that time, some of the VoO operators, likely due to the size and capability of their vessels, were unable to recover some of the anchors. Inventories have been conducted to try to determine how many anchors were left on the sea bottom, where the “orphaned” anchors may be located, and whether or not they pose any risks to ecological resources, human health and vessel navigation.

Efforts from the Orphaned Anchor Identification and Recovery Pilot Program Phase 1 yielded the following information. During operations to recover the boom, every anchor that could be found and recovered was removed with the boom. There were two circumstances in which some anchors were not recovered:

1. anchors that were no longer attached to the boom, a circumstance that made it impossible at the time to know the location of the anchor, and
2. anchors that were attached to the boom but buried so deeply in the sediment as to make recovery unreasonable or impossible

The pilot program also demonstrated that with the appropriate combination of equipment, anchors resting on the surface of the sediment can be detected but with significant limitations:

- the technology demonstrated to be effective at identifying anchors is only usable in water depth of four feet or more,
- there is infrastructure in the coastal waters and a large volume of ferrous material that interfere with the successful identification of orphaned anchors even when using the most effective technology, and

- three percent or less of the objects detected by even the most effective technology were proven to be anchors.

The removal of the test anchors proved to be a difficult task. Only four of the six test anchors were successfully retrieved using conventional retrieval tools. Five of the six anchors were completely buried beneath the sediment within ten days of their placement on the water bottom.

NEBA Methodology – During the Exxon Valdez Oil Spill (EVOS) in 1989 a decision making process was developed to assist in identifying relative risks of clean-up alternatives including the no-action alternative. The process identified the ecological and human health risks associated with an action and then provided a basis to develop a comparison of risks with other alternatives. Using this comprehensive identification of the ecological and human health risks approach allowed for a science-based identification and ultimate selection of the least harmful clean-up alternatives. This study evaluates the risks of certain alternative actions and places them in a matrix for comparison. Recommendations based on the relative risks are summarized in conclusion.

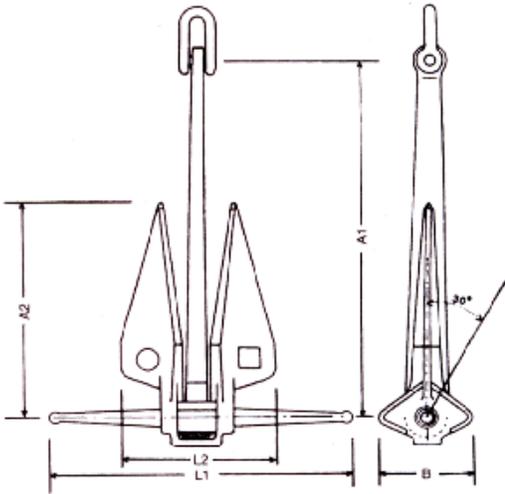
NEBA for Boom Anchor Removal -This study was designed to assess the relative risks comparing the alternatives of boom anchor removal vs. the option of leaving these anchors in place by conducting a Net Environmental Benefits Analysis (NEBA). Specifically the questions addressed by this NEBA are:

1. What, if any, are the risks to human health, the environment, and public safety if the remaining anchors are left in place?
2. What, if any, are the risks to human health, the environment, and public safety in employing various means in locating and identifying the remaining anchors?
3. What, if any, are the risks to human health, the environment, and public safety in removal operations for the remaining anchors?

### **Alternatives Analysis:**

#### **(1). Leaving the Remaining Anchors in Place**

The risk factors posed by leaving the anchors in place are the ecological and human health risks associated with the slow rust and decay of the anchors and the physical risk of hazard to navigation as well as commercial fishing and recreational activities. Most of the anchors used are standard galvanized Danforth anchors composed of zinc galvanized iron.



Danforth schematic. Note 30 degree angle on shank.



Photos of Danforth anchors. Shank rises maximum of thirty degrees from horizontal when deployed. This encourages the flukes to dig in and hold rather than slide along the bottom. The anchors are designed to lay flat in storage or if free from chain or rode to avoid creating a hazard.

### Ecological and Human health risk of zinc and iron

#### Zinc

Zinc is naturally present in seawater and is considered an essential dietary mineral necessary for human health. Zinc is present in surface waters largely from naturally occurring deposits in the earth's crust but it is also present as a result of industrial wastewater discharges from galvanic industries, battery production etc. The average zinc concentration in seawater is 0.6 – 5 parts per billion. Rivers generally contain between 5 and 10 parts per billion. Algae contain as much as 20-700 parts per million, sea fish and shells contain 3-25 parts per million, oysters contain 100-900 parts per million and lobsters contain 7-50 parts per million. The World Health Organization states that there is no health based limit required for zinc in drinking water. However, there is an aesthetic limit for zinc in drinking water of 5 parts per million because of taste. Thus elemental zinc is generally not considered a hazard to human health or the environment.

Ecotoxicological tests indicate that a predicted no effect concentration is 150 to 200 parts per billion. This is considered to be the concentration at which no environmental effects occur. The human body contains approximately 2-3 grams of zinc; and the mineral zinc has dietary value as a trace element. Its functions

involve mainly enzymatic processes and DNA replication. The human hormone insulin contains zinc. The minimum daily intake is 2-3 grams, at which level it prevents deficiencies.

The low toxicity of zinc to humans and aquatic life and the fact that it is an essential trace mineral for humans, all indicate the risks from exposure to the small amount of zinc that may be slowly released from rusting anchors in the nearshore environment are extremely low. At this stage of the NEBA, there are no significant ecological or human health risks from potential exposure to zinc resulting from leaving the anchors in place.

#### Iron:

Iron is one of the most abundant metals on earth and is considered essential to most life forms including humans. Iron is generally considered not soluble in water, particularly seawater, because when iron contacts water the normal product is rust particles. However, in very low concentrations, iron may occur in freshwater in two forms: either the soluble ferrous iron or the insoluble ferric iron. Freshwater containing ferrous iron is clear because the iron is dissolved. When exposed to air or atmosphere (oxygen), the water turns cloudy and a reddish brown substance begins to form. This sediment is the oxidized (rust) or ferric form of iron that dissolves in water only at very low concentrations.

Rivers contain 0.5 to 1 part per million iron naturally. Oxygen in the water limits the concentration. Some groundwater with low oxygen levels may contain approximately 100 parts per million. Seawater contains 1 to 3 parts per billion iron naturally. The amount varies by area and depth because of available oxygen in seawater and because iron is an essential nutrient for life that is quickly taken up by plankton and other sea life when it is available. Most algae naturally contain between 20 and 200 parts per million iron and some brown algae may contain up to 4,000 parts per million. Iron is part of their life chemistry. Iron occurs naturally in many seafoods such as tuna, halibut, shrimp and oysters, and in terrestrial foods such as chicken, pork and beef.

In humans, iron is a central component of hemoglobin in the blood. One pint of blood contains approximately 250 milligrams of iron which binds oxygen and transports it from the lungs to other body parts. It then transports CO<sub>2</sub> back to the lungs. People with low iron levels in their blood are called anemic and they may be treated with iron supplements. Iron is considered a vitamin supplement for children under 6 years old and is vital to some brain and memory functions. Like all chemicals, iron can be toxic if ingested in extreme overdose or in some chemical forms not common in nature.

Iron is not classified as a priority pollutant because of its low toxicity to sea life in water and sediments. Thus at this stage of the NEBA analysis we conclude that the human health and ecological risks from rusting anchors on the sea bottom are considered insignificant.

#### Physical risks of Hazard to Navigation

Mr. Tim Boriski and Mr. David Ledet with US Coast Guard Eighth District in New Orleans were interviewed to help define and evaluate hazards to navigation. The following information was provided: *A Hazard to navigation* is an obstruction, usually sunken, that presents sufficient danger to navigation so as to require

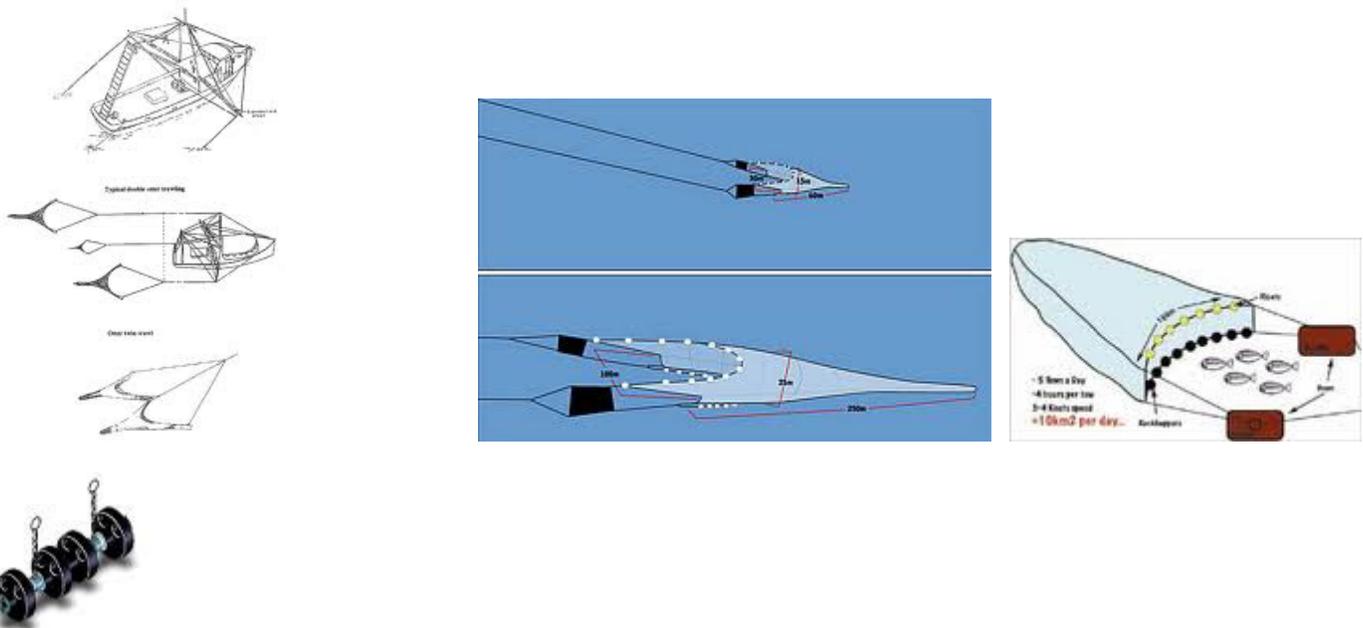
expeditious, affirmative action such as marking, removal, or redefinition of a designated waterway to provide for navigational safety (33CFR part 245.5).

Additionally, in determining whether an obstruction is a hazard to navigation for the purposes of marking, the District Commander considers, but is not limited to, the following factors: (a) Location of the obstruction in relation to the navigable channel and other navigational traffic patterns; (b) Navigational difficulty in the vicinity of the obstruction; (c) Depth of water over the obstruction, fluctuation of the water level, and other hydrologic characteristics in the area; (d) Draft, type, and density of vessel traffic or other marine activity in the vicinity of the obstruction; (e) Physical characteristics of the obstruction; (f) Possible movement of the obstruction; (g) Location of the obstruction in relation to other obstructions or aids to navigation; (h) Prevailing and historical weather conditions; (i) Length of time that the obstruction has been in existence; (j) History of vessel incidents involving the obstruction; and (k) Whether the obstruction is defined as a hazard to navigation under other statutes or regulations. (33CFR part 64.31). Also under 33CFR part 64, the owner of a wreck or obstruction is responsible/liable for marking and removing said wreck or obstruction.

In light of these definitions, unless the precise location of an orphaned anchor is specified, and it is in a shallow navigation way, a hazard to navigation determination cannot be made.

Physical Risk to Commercial Fishing

Louisiana Department of Wildlife and Fisheries data indicate that there are approximately 40,000 commercial shrimp trips and 32,000 oyster trips per year in state waters. Some commercial shrimpers may use “butterfly nets” where the boat is primarily stationary letting the current bring the shrimp. Some use “otter nets” where the boat deploys nets to trawl actively at or near bottom. Some otter nets may use “rollers” or “rockhoppers” at the bottom of the net that allow the nets to roll or jump some obstacles on the sea bottom as shown below.



Illustrations of shrimp boat with nets deployed and of rollers and rockhoppers at bottom of nets.

Of the shrimp trips, approximately 29,000 per annum use “skimmer” nets in shallow water along the shoreline or banks. Skimmer nets are usually deployed from small boats and the net consists of a top bar holding the net and two vertical bars on either end to extend the net downward. There is no bottom bar on the net because lead lines are used to weight the bottom. Occasionally the furthest vertical bar from the boat is shorter than the near bar to allow for slope of the bottom toward the bank.

Oysters are harvested with an oyster dredge consisting of open top box with beveled teeth on one open side and a heavy duty bag or net attached to gather the oysters. Of necessity, shrimp and oyster trawls or dredges proceed at slow speeds.

#### Physical Risk to Recreational Fishing and other Recreation

In Louisiana recreational boaters and fishermen seldom use nets as described above. When they do there are restrictions regarding net size (16 foot), size of catch (100 pound daily limit) and use of catch (cannot be sold).

Both recreational boating and recreational hook and line fishing are popular and important to the State of Louisiana. In 2008 the Louisiana Department of Wildlife and Fisheries sold 483,591 marine recreational fishing licenses. These shallow water activities, both private and charter, are conducted in waters as shallow as two feet and done from boats ranging from eight to thirty feet in length. Speeds of these vessels range from trawling to transit speeds in excess of 40 knots. If a recreational or charter vessel, while being operated in compliance with commonly accepted practice and regulations, were to become entangled with an anchor kit (anchor, chain or polypropylene rope) a potential outcome could be an injury or disabling of a vessel in a remote area.

Because the Phase I study indicated that five out of six anchors in the study area were buried beneath the sea bottom within 10 days of placement the NEBA team has assigned the overall level of potential hazard by the anchors to commercial fishing and recreation as medium, with a probability of low. However, efforts to check for or locate anchors in areas that could be of greater hazard, such lanes of boat traffic that are in known Response boom deployment areas, should be considered on a priority basis.

The risk ratings for navigational hazards from leaving anchors in place are given by category in the final risk matrix (Table 1) below.

#### NEBA Conclusions from Leaving Anchors in Place

The overall composite risk of leaving the anchors in place is medium to low. However, the potential hazard level and risk may vary considerably by location and activity. The consequential risk of a recreational boater hitting an anchor is higher than that of commercial fishing. Although the overall risk is medium to low, consideration should be given for a reconnaissance effort to locate and identify anchors in areas of greater potential hazard such as lanes of boat traffic that are in known Response boom deployment areas. A reconnaissance effort may provide an indication of whether or not further efforts may be warranted.

### **(2.) Locating and Identifying Anchors**

Acoustic and magnetic methods have been tested for locating and identifying anchors. The acoustic method uses a bow mounted high-frequency side scan. The magnetic method uses a marine magnetic gradiometer.

The side scan sonar is an active detection system that emits an acoustic pulse into the water column. The acoustic pulse travels outward and is reflected by objects in the water column, the seabed, and objects on the seabed. The pulses emitted by the side scan sonar are at frequencies of 600 kilohertz and 1.2 gigahertz. The high frequencies of the side scan sonar result in very rapid attenuation of the signal. The side scan sonar is bow mounted above the water-line. The rapid attenuation of the side scan sonar signal combined with the operational restriction of terminating the side scan sonar use when marine mammals are present result in a low risk of acoustic interference with marine mammals and a low probability of occurrence. Because the side scan sonar is positioned above the waterline, and because very shallow water areas are avoided, the risk of habitat disturbance by the side scan sonar system and the probability of habitat disturbance are considered low.

The marine magnetic gradiometer is a passive system that measures the ambient magnetic field. Magnetic fields generated by objects and the distortion of the earth's natural magnetic field by ferrous objects are sensed by the gradiometer and used to determine the location of ferrous objects.

Because the gradiometer is a passive instrument that is towed just below the water surface, the risk of habitat disturbance and probability of occurrence are considered very low.

An accurate determination of the height of the gradiometer above the seabed is required to process the marine gradiometer data. Therefore the marine magnetic gradiometer is equipped with an acoustic 200 kilohertz single-beam echo sounder. Because of the high frequency, rapid attenuation and low output of the echo sounder, the probability of occurrence and risk of acoustic interference with marine mammals are low.

The weight, size and deployment method of the gradiometer pose a medium risk to personnel over the long run. Although precautions have been taken regarding personnel, and an electric winch is used to lift the gradiometer out of the water, the gradiometer is fairly large and heavy in air, and must be deployed and retrieved at the start and end of a survey. The probability of an incident occurring is low due to procedures in place for deployment and recovery of the gradiometer.

The risk ratings for locating and identifying anchors are given by category in the final risk matrix below (Table 1).

#### NEBA Conclusions to locating and identifying anchors

Locating and identifying anchors indicate a relatively low level of environmental and human health risk. However a medium risk exists for marine personnel conducting the location operations. The overall level of risk would depend upon the level of effort and extent of operations. Modest reconnaissance style operations in prioritized targeted areas would pose minimal risk. A limited reconnaissance effort may provide additional data to evaluate whether or not further efforts would be warranted.

### **(3). Location, Salvage and Removal of Anchors from the Sea Bottom**

Salvage and Removal - The consequence risks and probability of an incident occurring are illustrated in the risk matrix. These are simply graded as High (H), Medium (M) or Low (L). The risks and probabilities are based on

professional judgment of the NEBA team members and based on the premise of utilizing a competent contractor with marine equipment and cranes audited by an approved and competent BP auditor.

The orphaned anchors will have been previously located, marked and verified by a BP furnished competent survey contractor. At each location where orphaned anchor salvage is required, a hazard survey will have been performed by the BP furnished competent survey contractor. The hazard survey will identify the following: pipelines, flowlines, wells, communications cables, electric cables, unexploded ordinance, items and objects of historical/archaeological importance, oyster beds, etc.

For each of the four hazards: Snag a pipeline, snag an oil line, damage an abandoned well or encounter unexploded ordinance, the consequential risks are high. This indicates that if this hazard was to occur, the consequential risks associated with that encounter are high and would likely result in oil spills of some magnitude or a potential explosion in the case of unexploded ordinance. However if the proper survey procedures are followed as detailed above, the probability of encountering any one of these hazards would be very low i.e. the marine survey would have pin-pointed the exact location of pipelines, supply lines and wells so that the anchor retrieval process would stay clear of those areas. This then results in the composite risk rating of Medium for these four potential hazards.

Similarly the consequential risks associated with encountering a communications cable are judged to be a bit lower than an oil line and are classed as medium since no oil spill would result, however there could be a disruption of communications served by the cable. But again assuming a detailed marine survey was conducted, the location of all cables will be known and the probability of encounter would be low thus resulting in a medium composite risk rating.

The consequential risks to the benthic marine habitat are considered low since there would likely be some localized disruption of the marine sediments in the immediate area of the of the retrieval efforts but the probabilities of any meaningful risks to localized biota are considered to be low thus resulting in a medium composite risk rating.

Similarly the risks to marine operations personnel are considered medium due to the potential injury types that could occur during the retrieval operations (slips, trips, falls) or overboard risks. But again the probability of these risks is considered to be low since operations will be conducted by experienced, trained personnel. This results in the medium composite risk rating. The risk ratings for salvage and removal of anchors are given by category in the final risk matrix below (Table1).

#### Analysis for Submerged Cultural Resources During Salvage Operations

HDR/SEARCH, Inc. cross-referenced Louisiana archaeological databases and numerous shipwreck databases with the derived boom locations in a GIS environment. Terrestrial archaeological databases included the Louisiana Archaeological Site File and newly discovered sites post MC252 (surveyed by HDR, Inc.). The offshore databases included NOAA's Automated Wreck and Obstruction Information System (AWOIS); NOAA's ENC Direct to GIS for the Gulf of Mexico Region, which is a service providing nautical chart information for download; the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) Historic Shipwrecks database; the U.S. Coast Guard shipwreck database; the U.S. Navy shipwreck database; the Global Maritime Wrecks Database (GMWD); and two private databases created by Garrison and Coastal

Environments, Inc. (CEI). HDR/SEARCH, Inc. generated 150-meter buffers around all potential site locations and determined which mapped boom locations intersected these buffers. Only four known Louisiana sites are within 150 m of originally placed booms. Only one offshore site is within 150 m of an originally placed boom.

With such a small number of recorded resources the probability of encountering submerged cultural resources at the derived boom locations is low and the risk of impacting those resources if boom anchor removal operations move forward is also low.

NEBA Conclusions from salvage and removal of anchors from the sea bottom

As shown in the final risk matrix below, salvage and removal of the anchors from the sea bottom poses the greatest risk of the three alternatives. Although the composite risk for any given category did not exceed “medium” because of the low probability of occurrence, the consequential risk of some of these categories was substantial if an incident were to occur. The highest risk and most dangerous consequences lie with the salvage and removal alternative. It is not recommended unless located and identified anchors are in a very high risk geographic area.

Table 1. Risk Matrix for the three action alternatives:

Action	Consequential Risk Low/Medium/High	Probability Low/Medium/High	Composite Risk Rating L = Green; M = Yellow; H = Red
<b>(1.) Leave Remaining Anchors</b>			
Toxicity of Fe and pathways	L	L	Low
Toxicity of Zn and pathways	L	L	Low
Navigation hazard/ Commercial Fishing/ Recreational Use	M	L	Medium
<b>(2.) Locating and Identifying Anchors</b>			
Acoustic on Mammals	L	L	Low
Risk to personnel of Marine Operations	M	L	Medium
Disturb Habitat	L	L	Low
<b>(3.) Salvage and Removal of Anchors from sea bottom</b>			
Snag a pipeline (cause leak)	H	L	Medium
Snag oil line from well to TB	H	L	Medium
Damage abandoned oil well	H	L	Medium
Damage communication Cable	M	L	Medium
Unexploded Ordinance	H	L	Medium
Disturb Marine Archeology	L	L	Low
Disturb Habitat	L	L	Medium
Risk to personnel of Marine operations	M	L	Medium

**Conclusions:**

Three alternative actions were considered: 1) Leave the anchors in place, 2) locate and identify the anchors using remote sensing techniques, and 3) locate, salvage and remove the anchors from the sea bottom.

Alternative 1: Results from the Phase I Orphaned Anchor Identification Program indicate that there were fewer anchors left in place than previously envisioned. Empirical data from that investigation also show that five of the six anchors placed in the study area were completely buried beneath the sediment within ten days of their placement on the water bottom. Leaving the anchors in place posed the lowest overall environmental and human health risk. However when specific geographic areas were evaluated in detail certain risks such as hazard to navigation, commercial fishing and recreation were higher. Therefore, although the overall risk of leaving anchors in place is low, consideration should be given to reconnaissance location surveys in higher risk areas such as lanes of high boat traffic that cross known areas of booms. These surveys could be performed on a priority basis.

Alternative 2: Locating and identifying anchors also presented a relatively low level of environmental and human health risk. However medium risk existed for marine personnel in conducting the operations. The overall level of risk would depend upon the level of effort and extent of operations. Modest reconnaissance style operations in prioritized targeted areas would pose minimal risks. A limited reconnaissance effort may provide additional data to evaluate whether or not further efforts may be warranted.

Alternative 3: Salvage and removal of the anchors from the sea bottom posed the greatest risk of the three alternatives. Although the composite risk for any given category did not exceed "medium" because of the low probability of occurrence, the consequential risk of some of these categories was substantial if an incident were to occur. This alternative shows the highest risk and most dangerous consequences of the three.

**Appendix B – Pre Recovery Net Environmental Benefit Analysis (NEBA)****Net Environmental Benefit Analysis for LA Orphan Anchors**

Team members: USCG: CDR Dan Norton, LTJG Tyler Stutin  
NOAA: Frank Csulak, Toni Debosier, Karla Reece, David Dale  
USFWS: Janice Engle  
State of LA: Phil Bowman, Mike Algero  
Historic Preservation: Larry Murphy  
BP: John Nepywoda, Lyle Bruce, Brian Wood

**Purpose:**

The purpose of this report is to provide the Federal On-Scene Coordinator (FOSC) with a Net Environmental Benefit Analysis (NEBA) associated with removing orphan anchors from the waters of the state of LA which were deployed during the response to the Deepwater Horizon MC252 Spill of National Significance. The question for this NEBA is which response option provides for the greatest net environmental benefit when considering that recovery operations will have some adverse environmental impacts. It is noted that the State of Louisiana stated their expectation that the anchors used during the response be removed.

**Geographic area of concern:**

The areas of concern in general for this analysis include selected tidal waters in Louisiana where oil boom was placed during the oil spill response, and specifically those waters of St. Bernard, Jefferson, Terrebonne, Lafourche and Plaquemines Parishes. The specific inland bays, passes, and waterways were selected due to their shallow water and higher vessel traffic volume which presented the highest risk for hazards to navigation, and are identified in the Orphan Anchor Phase II Program Report to the Federal On Scene Coordinator. The Mississippi River delta plain with its associated wetlands and barrier shorelines are characterized as the product of the continuous accumulation of sediments deposited by the river and its distributaries. Regular shifts in the river's course have resulted in four ancestral and two active delta lobes, which accumulated as overlapping, stacked sequences of unconsolidated sands and mud. As each delta lobe was abandoned by the river, its main source of sediment, the deltas experienced erosion and degradation due to compaction of loose sediment, rise in relative sea level, and catastrophic storms. Marine coastal processes eroded and reworked the seaward margins of the deltas forming sandy headlands and barrier beaches. As erosion and degradation continued, segmented low-relief barrier islands formed and eventually were separated from the mainland by shallow bays and lagoons. The Louisiana coastal region is transited by recreational and commercial vessels including shrimp boats, fishing vessels, duck hunters, and more.

**Anchor Characterization:**

Much background work on characterizing the anchor issues and with identifying possible anchor locations has been completed under two previous studies developed for the FOSC. The following characterization and ecological and human health risk information is provided from the NEBA for Boom Anchor Removal dated March 18, 2011. The potential risks posed by leaving the anchors in place are the ecological and human health risks associated with the slow rust and decay of the anchors and the physical risk of hazard to navigation as well as commercial fishing and recreational activities. Most of the anchors used are standard galvanized Danforth anchors composed of zinc galvanized mild steel (which consists of iron and carbon).



Photos of Danforth anchors. Shank rises maximum of thirty degrees from horizontal when deployed. This encourages the flukes to dig in and hold rather than slide along the bottom. The anchors are designed to lay flat in storage or if free from chain or rode to avoid creating a hazard.

### Ecological and Human health risk of zinc and iron

#### 1. Zinc

Zinc is naturally present in seawater and is considered an essential dietary mineral necessary for human health. Zinc is present in surface waters largely from naturally occurring deposits in the earth's crust but it is also present as a result of industrial wastewater discharges from galvanic industries, battery production etc. The average zinc concentration in seawater is 0.6 – 5 parts per billion. Rivers generally contain between 5 and 10 parts per billion. Algae contain as much as 20-700 parts per million, sea fish and shells contain 3-25 parts per million, oysters contain 100-900 parts per million and lobsters contain 7-50 parts per million. The World Health Organization states that there is no health based limit required for zinc in drinking water. However, there is an aesthetic limit for zinc in drinking water of 5 parts per million because of taste. Thus elemental zinc is generally not considered a hazard to human health or the environment. Ecotoxicological tests indicate that a predicted no effect concentration is 150 to 200 parts per billion. This is considered to be the concentration at which no environmental effects occur. The human body contains approximately 2-3 grams of zinc; and the mineral zinc has dietary value as a trace element. Its functions involve mainly enzymatic processes and DNA replication. The human hormone insulin contains zinc. The minimum daily intake is 2-3 milligrams, at which level it prevents deficiencies. The low toxicity of zinc to humans and aquatic life and the fact that it is an essential trace mineral for humans, all indicate the risks from exposure to the small amount of zinc that may be slowly released from rusting anchors in the nearshore environment are extremely low. At this stage of the NEBA, there are no significant ecological or human health risks from potential exposure to zinc resulting from leaving the anchors in place.

#### 2. Iron:

Iron is one of the most abundant metals on earth and is considered essential to most life forms including humans. Iron is generally considered not soluble in water, particularly seawater, because when iron contacts water the normal product is rust particles. However, in very low concentrations, iron may occur in freshwater in two forms: either the soluble ferrous iron or the insoluble ferric iron. Freshwater containing ferrous iron is clear because the iron is dissolved. When exposed to air or atmosphere (oxygen), the water turns cloudy and a reddish brown substance begins to form. This sediment is the oxidized (rust) or ferric form of iron that dissolves in water only at very low concentrations. Rivers contain 0.5 to 1 part per million of iron naturally. Oxygen in the water limits the concentration. Some groundwater with low oxygen levels may contain approximately 100 parts per million. Seawater contains 1 to 3 parts per billion iron naturally. The amount varies by area and depth because of available oxygen in seawater and because iron is an essential nutrient for life that is quickly taken up by plankton and other sea life when it is available. Most algae naturally contain between 20 and 200 parts per million iron and some brown algae may contain up to 4,000 parts per million. Iron is part of their life chemistry. Iron occurs naturally in many seafoods such as tuna, halibut, shrimp and oysters, and in terrestrial foods such as chicken, pork and beef. In humans, iron is a central component of hemoglobin in the blood. One pint of blood contains approximately 250 milligrams of

iron which binds oxygen and transports it from the lungs to other body parts. It then transports CO<sub>2</sub> back to the lungs. People with low iron levels in their blood are called anemic and they may be treated with iron supplements. Iron is considered a vitamin supplement for children under 6 years old and is vital to some brain and memory functions. Like all chemicals, iron can be toxic if ingested in extreme overdose or in some chemical forms not common in nature. Iron is not classified as a priority pollutant because of its low toxicity to sea life in water and sediments.

### **Species and Habitat Overview:**

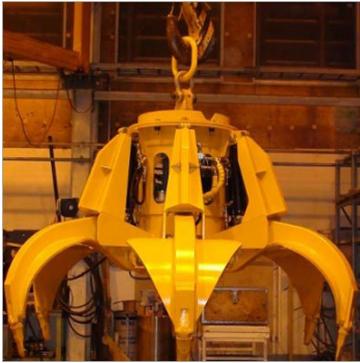
Endangered and threatened species or critical habitat under the jurisdiction of NMFS that may occur in or near the action area are sea turtles and Gulf sturgeon. Protected marine mammal species (dolphins and whales) may also occur in or near the action area. Vessel and in-water operations, including orphan anchor location and retrieval, may affect these animals either directly or indirectly through sound, physical contact, habitat alteration, and/or harassment. General habitat types occurring in the project areas include unvegetated and vegetated bottoms, oysters, and the water column. These habitat types have been identified and described as Essential Fish Habitat for federally managed species under the Magnuson-Stevens Fishery Conservation and Management Act. Unvegetated bottoms consist of sand, silt and mud and vegetated bottoms may support algae or rooted submerged aquatic vegetation such as *Ruppia* sp. and *Halodule* sp.

### **Response Options:**

1. Natural processes - Leave known orphan anchors in place to degrade via natural processes.
2. Least Invasive Methods – Includes: Shallow water Dive team recovery, Orange peel grapple.
3. Most Invasive Methods – Includes: Water based dredge, Propeller wash deflector device, Cofferdam. All three methods are deemed to be essentially equivalent in terms of expected impact to the marine environment for the purpose of this analysis.

### **Response Descriptions:**

1. Natural processes - Anchor degradation via natural process. No mechanical or manual recovery is performed.
2. Least Invasive Method Examples - Dive team recovery would utilize small boats and poles for finding anchors located in shallow water & sediments. Recovery of anchors in shallow waters once located would be via divers digging up the anchor when located no more than one foot (1') in depth within the substrate. Orange peel grapple, Orange Peel Grapple picture and specification shown below. Requires crane and the orange peel grapple. Crane to have a 50-ton lifting capacity minimum and be capable of reaching past the side of the barge a minimum of 40-ft with the Grapple. Crane shall be capable of working the specified orange peel grapple in a maximum of 30-ft of water. Crane certification papers and load test information within the last 12-months to be furnished to BP. Orange Peel Grapple has a 0.75 yard capacity, is mechanical, and is operated with 2 wire ropes. Designed to allow mud and silt to escape while capturing orphaned anchors. Grapple to have an opening large enough to capture the anchor. Some modification may be required. This method is less invasive due to its ability to make a single grab or very limited number of grabs through the sediment to retrieve an anchor.



3. Most Invasive Method Example - Water based grab dredge. A [grab](#) dredger picks up seabed material with a clam shell grab, which hangs from an onboard crane or a [crane ship](#), or is carried by a hydraulic arm, or is mounted like on a [dragline](#). This technique is often used in excavation of [bay mud](#). Most of these dredges are crane barges with spuds. This method is considered more invasive due to the repeated grabs that are required to remove the overlying sediments and expose the object for recovery. The creation of a large depression in the sediment is necessary to ensure the depression walls remain stable in order to facilitate anchor recover.



#### **Analysis Issues:**

To evaluate the options above, answers were sought for these questions:

- a. Are there human health concerns in leaving the anchors in place?
- b. If no further action is taken, what are the potential effects of the anchors to the environment?
- c. Are there commercial or recreation vessel concerns?
- d. Are there hazard to navigation concerns?
- e. What does a Net Environmental Benefit Analysis (NEBA) justify?

#### **Analysis Assumptions and Ranking Factors:**

See appendix (c).

#### **Analysis Results:**

See matrix.

Based on this review, the following are the responses to the questions posed above:

- a. Are there human health concerns in leaving the anchors in place?

There are no expected human health concerns due to the chemical composition or degradation of the zinc galvanized mild steel Danforth anchors.

- b. If no further action is taken, what are the potential effects of the anchors to the environment?

If left in place the zinc galvanized mild steel Danforth anchors are expected to remain buried in the soft, muddy sediments and slowly oxidize. An anchor test conducted found that within ten days, the test anchors settled to a depth of 1.9 to 2.1 meters at the test site. The anchor test may not be representative of sediment conditions across the entire area of concern and, for example, anchors may have minimal penetration into sand sediments. The chemical composition and degradation of the metal anchors would be the primary concern, however the loading rate would be very small, and the area of impact would be small as well. The anchors are expected to present minimal environmental threat to the marine environment including wildlife due to the natural concentrations of zinc and iron present in the marine environment. Zinc based protection products are also widely used in marine applications and the addition of zinc to the environment from orphan anchors is considered insignificant compared to the loadings from other sources.

- c. Are there commercial or recreation vessel concerns?

Due to the negative buoyancy of the anchors compared to the density of Louisiana's high concentration of muddy sediments, the anchors are expected to settle within the sediment and present very minimal physical risk to commercial or recreational fishing activities. An anchor test conducted found that within ten days, the test anchors settled to a depth of 1.9 to 2.1 meters at the test site. The anchor test may not be representative of sediment conditions across the entire area of concern. Anchors may have minimal penetration into sand sediments, or be moved or exposed during weather events, but would still be expected to present minimal risk to commercial and recreational vessels due to its location on or within the substrate.

- d. Are there hazard to navigation concerns?

Due to the negative buoyancy of the anchors compared to the density of Louisiana's high concentration of muddy sediments, the anchors have been found to settle within the sediment and present a very minimal hazard to navigation. An anchor test conducted found that within ten days, the test anchors settled to a depth of 1.9 to 2.1 meters at the test site. The anchor test may not be representative of sediment conditions across the entire area of concern. Anchors may have minimal penetration into sand sediments, or be moved or exposed during weather events, but would still be expected to present minimal risk to commercial and recreational vessels due to its location on or within the substrate.

- e. What does the Net Environmental Benefit Analysis (NEBA) justify?

See matrix and conclusion below.

**Conclusion:** Based on the NEBA results, the conclusion is that the response option that would derive the greatest net environmental benefit is that of allowing the anchors to remain in place to degrade via natural processes. The analysis utilized effect values from +2 to -2 and a weight scale from 1 to 5. Thus the maximum scoring range is between +10 to -10 for each response option. Natural processes scored a -0.41 and had the least negative score of the response options studied. The "least invasive methods" category ranked as the second best option with a score of -4.25. Ranking third and as the most adverse response option consider was the "most invasive methods" category which scored -6.91.

**Recommendation:** Based upon this analysis, the NEBA team recommends to the FOSC that the response option of Natural Processes be pursued as the response endpoint for the Louisiana Orphan Anchors.

**List of Appendixes:**

**Appendix (a) Bird Nesting Map - St. Bernard**

**Appendix (b) Bird Nesting Map - Jefferson**

**Appendix (c) Analysis Assumptions and Ranking Factors**

**Appendix (d) NEBA Matrix**

**List of References:**

Net Environmental Benefits Analysis for Boom Anchor Removal, 18 March, 2011, Prepared for Capt. Hanzalik, FOSC and Tom Zimmer, BP IC by L. Bruce, A. Maki, B. Wood, M. Taylor, T. M. Garrett, J. Burns, J. Hokanson

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OSAT 2 (<http://www.restorethegulf.gov/release/2011/03/01/osat-2-fate-and-effects-oil-beaches>) Contains analytical, ecological, and environmental fate data.

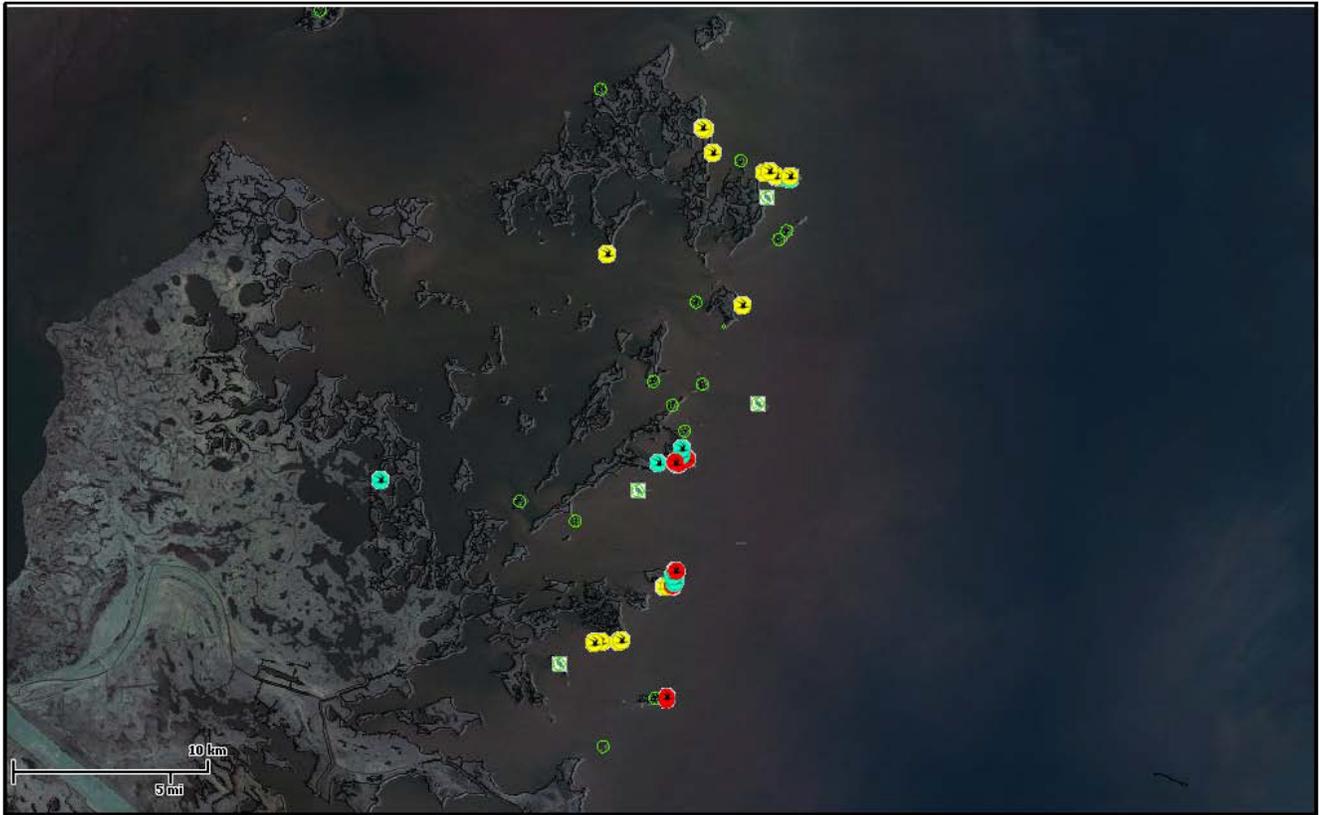
Pfister, C.,B.A. Harrington, and M. Lavine. 1992. The impact of human disturbance on shorebirds at a migration staging area. Biol. Conserv. 60: 115-126.

USFWS Current Nesting Sites, May 31, 2011

Gulf Coast Incident Management Team Shoreline Treatment Recommendations (STRs)

NIH website: <http://ods.od.nih.gov/factsheets/iron/>

NIH website: <http://ods.od.nih.gov/factsheets/Zinc-HealthProfessional/#h2>



### Current Nesting Sites

for Area: St. Bernard Nesting Bird Use 10June11

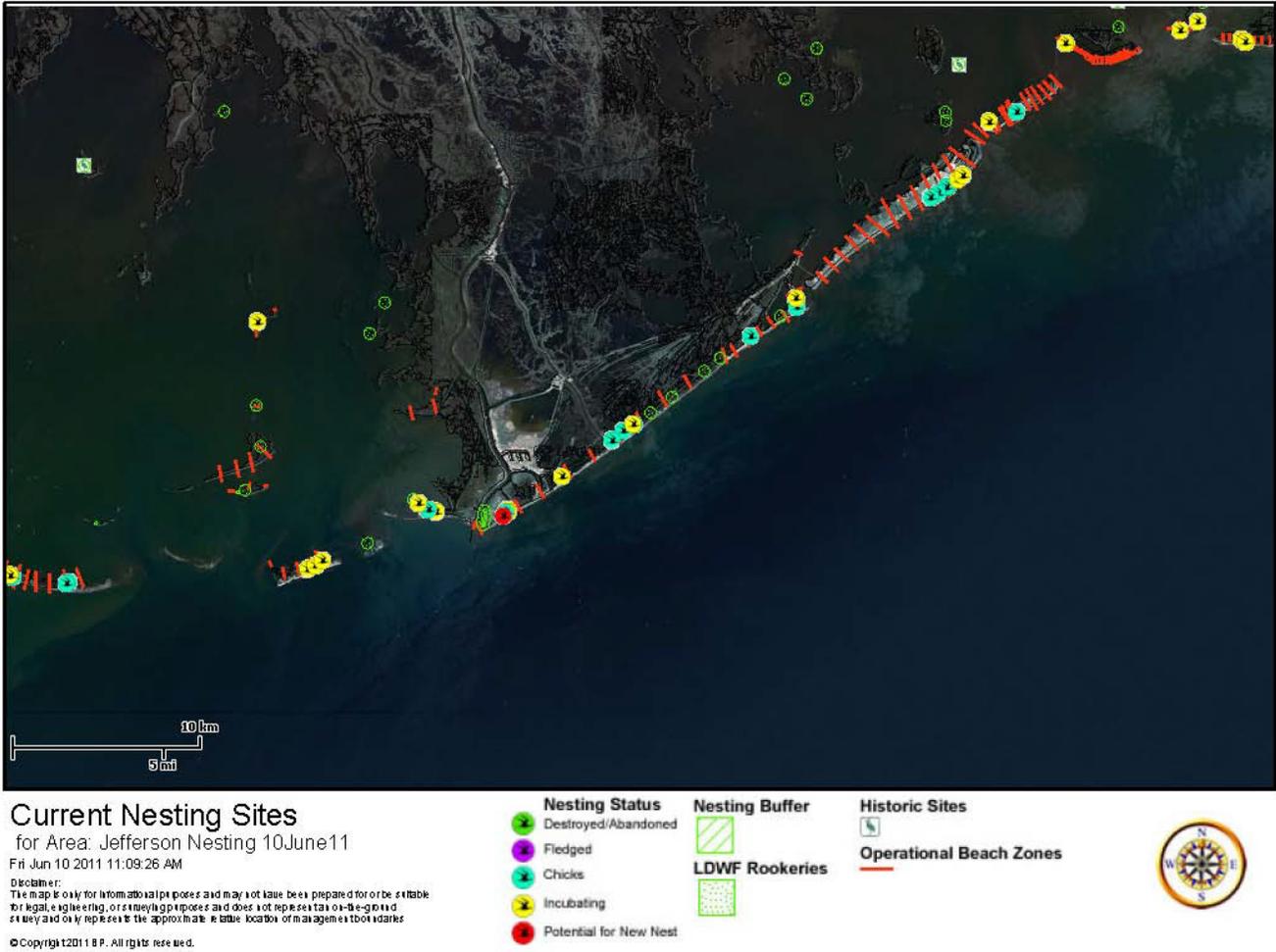
Fri Jun 10 2011 10:52:30 AM

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 The map is only for informational purposes and may not have been prepared for or be suitable for legal engineering, or it may represent and does not represent as-of-the-ground status and only represents the approximate relative location of management tool markers.

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<p><b>Nesting Status</b></p> <ul style="list-style-type: none"> <li> Destroyed/Abandoned</li> <li> Fledged</li> <li> Chicks</li> <li> Incubating</li> <li> Potential for New Nest</li> </ul>	<p><b>Nesting Buffer</b></p> <ul style="list-style-type: none"> <li> Nesting Buffer</li> <li><b>LDWF Rookeries</b></li> <li> LDWF Rookeries</li> </ul>	<p><b>Historic Sites</b></p> <ul style="list-style-type: none"> <li> Historic Sites</li> <li> Operational Beach Zones</li> </ul>
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**Appendix (c): Analysis Assumptions and Ranking Factors**

**Analysis Assumptions:**

1. Best Management Practices will be implemented to the maximum extent practicable.
2. Any anchors present may or may not contain attached polypropylene line.
3. Any anchors present are expected to settle within soft, muddy sediments but may be partially or fully exposed on sand sediments.
4. That the State of Louisiana considers the orphan anchors to be waste if left in place.

**Weights:**

Higher weight values were assigned to those factors for which the federal government has regulatory obligations.

**Ranking Factors:**

**Disturbance**

- Gulf Sturgeon** – Least disturbance will occur from no activities, while large equipment would create the greatest disturbance.
- Sea Turtles** - Least disturbance will occur from no activities, while large equipment would create the greatest disturbance.
- Essential Fish Habitat Vegetated** - Allowing natural processes to degrade the anchors over time below the sediment surface are anticipated to have no identifiable or measurable adverse effects on

the quality and quantity of essential fish habitats. Any methods utilized, either least invasive or most invasive, to recover the anchors would result in turbidity and sediment removal in the immediate project area. Depending upon the utilization and effectiveness of water quality and turbidity control measures suspended sediments may adversely affect submerged aquatic vegetation and oysters beyond the immediate project area. Over time, unvegetated bottoms are expected to recover more quickly than vegetated bottoms or areas supporting oysters. Factoring longer recovery time, as well as potential permanent loss of these habitat types in the immediate project area, is cause for greater concern in these habitat types. No identifiable or measurable adverse impacts to essential fish habitats are anticipated to occur from exposure to zinc or iron if the anchors are allowed to degrade over time below the sediment surface.

**-Essential Fish Habitat Non-Vegetated** – See Essential Fish Habitat Vegetated description.

**-Migratory Birds** - Leaving the anchors in place (natural processes) would result in no disturbance effect to migratory birds because retrieval actions would not occur (causing disturbance) and known anchors are buried in sediments of the sea floor. Larger boats and crews operating over greater periods of time would more likely create disturbance to migratory birds nesting in the vicinity of actions (please refer to migratory bird nesting maps).

**-Marine Mammals** - Least disturbance will occur from no activities, while large equipment would create the greatest disturbance.

**-Other Wildlife** - Least disturbance will occur from no activities, while large equipment would create the greatest disturbance.

**-Physical habitat** - Least disturbance will occur from no activities, while large equipment would create the greatest disturbance.

**-Historic Property** – Concerns identified from Section 106 participation. Least disturbance will occur from no activities, while large equipment would create the greatest disturbance.

### Exposure to Zinc and Iron

**-Gulf Sturgeon** – The chemical composition and degradation of the metal anchors are expected to be insignificant due to the natural concentrations of zinc and iron present in the marine environment and the expected small loading rate and area of impact.

**-Sea Turtles** - The chemical composition and degradation of the metal anchors are expected to be insignificant due to the natural concentrations of zinc and iron present in the marine environment and the expected small loading rate and area of impact.

**-Essential Fish Habitat Vegetated** - Allowing natural processes to degrade the anchors over time below the sediment surface are anticipated to have no identifiable or measurable adverse affects on the quality and quantity of essential fish habitats. Any methods utilized, either least invasive or most invasive, to recover the anchors would result in turbidity and sediment removal in the immediate project area. Depending upon the utilization and effectiveness of water quality and turbidity control measures suspended sediments may adversely affect submerged aquatic vegetation and oysters beyond the immediate project area. Over time, unvegetated bottoms are expected to recover more quickly than vegetated bottoms or areas supporting oysters. Factoring longer recovery time, as well as potential permanent loss of these habitat types in the immediate project area, is cause for greater concern in these habitat types. No identifiable or measurable adverse impacts to essential fish habitats are anticipated to occur from exposure to zinc or iron if the anchors are allowed to degrade over time below the sediment surface.

**-Essential Fish Habitat Non-Vegetated** - See Essential Fish Habitat Vegetated description.

**-Migratory Birds** - Because the anchors are submerged, there would be no exposure of migratory birds to zinc or iron.

**-Marine Mammals** - The chemical composition and degradation of the metal anchors are expected to be insignificant due to the natural concentrations of zinc and iron present in the marine environment and the expected small loading rate and area of impact.

**-Other Wildlife** - The chemical composition and degradation of the metal anchors are expected to be insignificant due to the natural concentrations of zinc and iron present in the marine environment and the expected small loading rate and area of impact.

**-Physical habitat** - The chemical composition and degradation of the metal anchors are expected to be insignificant due to the natural concentrations of zinc and iron present in the marine environment and the expected small loading rate and area of impact.

**-Historic Property** – The chemical composition and degradation of the metal anchors are expected to be insignificant due to the natural concentrations of zinc and iron present in the marine environment and the expected small loading rate and area of impact.

**Waste Generation** – Expected waste to be generated during the response process. May include the product being removed, incidental material collected due to recovery efficiencies (sand, seaweed, etc.), disposable or soiled responder protective equipment, consumables & packaging material, etc.

**Human Health** – Expected impacts to human health from the available response options. Normally due to the presence or reduction of potentially hazardous materials related to each response option.

**Safety: Industrial** – Safety considerations for the response personnel conducting the specific response option. Unless mitigated, highly hazardous response options are unlikely to be considered due to the potential for personnel injury.

**Safety: Public** - Safety considerations for the general public which may access the area under consideration and thus be exposed to specific hazards.

Orphan Anchor NEBA

SCORING VALUES:		+2 Most beneficial +1 Beneficial 0 No Effect -1 Adverse -2 Most Adverse		Response Options					
Factors Affected	Stressor	Resource Name	weight	Natural Processes	Least invasive methods	Most invasive methods	weighted scores		
Trust Resources	Disturbance	Gulf Sturgeon	5	0	-1	-2	0	-5	-10
		Sea Turtles	5	0	-1	-2	0	-5	-10
		Essential Fish Habitat - unvegetated	3	0	-1	-1	0	-3	-3
		Essential Fish Habitat - vegetated & oysters	4	0	-2	-2	0	-8	-8
		Marine Mammals	5	0	-1	-2	0	-5	-10
		Migratory birds	5	0	-1	-2	0	-5	-10
		Other wildlife	4	0	-1	-2	0	-4	-8
		Physical Habitat	4	0	-1	-2	0	-4	-8
	Historic Property	5	-1	-2	-2	-5	-10	-10	
	Exposure to Zinc and Iron	Gulf Sturgeon	3	0	0	0	0	0	0
		Sea Turtles	3	0	0	0	0	0	0
		Essential Fish Habitat - unvegetated	3	0	0	0	0	0	0
		Essential Fish Habitat - vegetated & oysters	3	0	0	0	0	0	0
		Marine Mammals	3	0	0	0	0	0	0
		Migratory birds	3	0	0	0	0	0	0
		Other wildlife	2	0	0	0	0	0	0
		Physical Habitat	1	0	0	0	0	0	0
Historic Property	1	0	0	0	0	0	0		
Trust Resources (AVG)			5	-0.278	-2.722	-4.278	-1.3889	-13.611	-21.39
Waste Generation			1	0	-0.5	-1.5	0	-0.5	-1.5
Human Health			5	0	0	0	0	0	0
<b>TOTAL SCORE (AVG)</b>				<b>-0.463</b>	<b>-4.704</b>	<b>-7.630</b>			
Safety - Industrial			5	0	-2	-2	0	-10	-10
Safety - Public			5	-2	0	0	-10	0	0
<b>SAFETY TOTAL</b>				<b>-5</b>	<b>-5</b>	<b>-5</b>			

Completed June 09, 2011

**Appendix C – GV-882TVG CESIUM MAGNETOMETER & TRANSVERSE GRADIOMETER SPECIFICATIONS**

## G-882TVG CESIUM MAGNETOMETER & TRANSVERSE GRADIOMETER

- Marine Search Applications for UXO, pipelines, lost objects with Multi-Sensor Array Capability
- High Sensitivity – 0.004 nT/sq-rt-Hz RMS with dual CM-221 Larmor Counters
- Very Low Heading Error –  $\pm 0.25$ nT over 360° equatorial and polar spins
- Versatility – CM-221 counter includes 8 channel 12 bit A to D converters for real time internal diagnostics, digital data stream concatenation, and short, long or telemetry over coax options
- Reliability and Ruggedness – Cesium magnetometers never need be returned to factory for calibration or tuning. Designed for tough environmental conditions and high “G” loads
- Gradiometer arrays offering simultaneous operation of up to 8 separate sensors using the designed-in multi-sensor data concatenation of the CM-221 internal counter
- Geometrics offers complete turnkey systems including tow cables, gradiometer wing, digital data acquisition systems with real time anomaly detection, GPS navigation and post acquisition data processing software and training.



The Geometrics Model G-882TVG Transverse Gradiometer system mates the well-proven high-performance cesium sensor with dual high sensitivity and high speed CM-221 Larmor Counters. This advanced integrated magnetometer system provides unmatched versatility in performance, with a wide sensor separation for maximum target detection efficiency and survey cost effectiveness.

The system comprises a transverse wing and two G-882 Cesium Vapor magnetometer fish with stabilizer weights and fins. Tow cables may be up to 150m in length with standard power supply or up to 700m with a high capacity voltage sense supply. Depth sensors provide gradiometer attitude and depth information to the operator depth and an echo-sounder altimeter provides height above sea floor for proper system flight control.

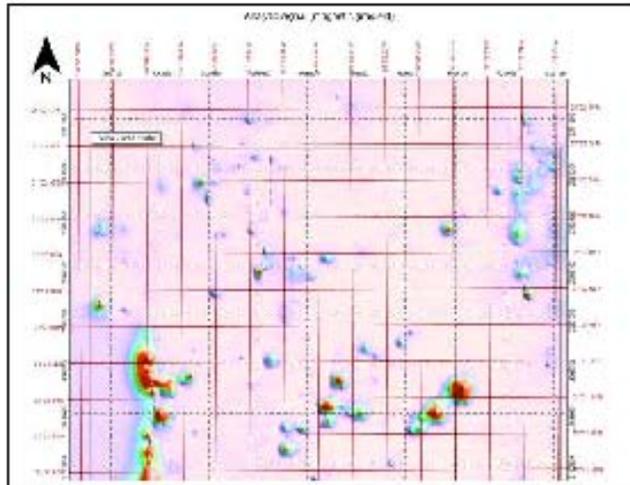
Dual sensors are synchronized to 1ms sampling and data is transmitted via RS-232 for recording by any standard PC computer using our industry standard MagLogLite software. High sample and data transmission rates (up to 40 samples per second) are standard.

The G-882G provides sensitivities of 0.004 nT/ $\sqrt{\text{Hz}}$  RMS or approximately 0.01 nT P-P at 10 Hz, selectable via software command for detection of the smallest anomalies. MagLog software computes the transverse difference for display and analysis in real time, using the customer supplied GPS for interpolation and target positioning.

The system's high performance is excellent for the detection and delineation of cables, pipelines, environmental, archaeological or military UXO and EOD targets.

**Software**

Geometrics supplies MagMap2000 and MagPick with each system for analysis and interpretation of total field and gradient data. Analytical signal is computed from the transverse gradient, longitudinal time gradient and computed vertical gradient to give a time-variation free data set for contouring and plotting of anomaly targets. Simultaneous dual inversion routines in MagPick produce a located target worksheet with models including object latitude-longitude position and depth of burial. Download <http://geom.geometrics.com/pub/mag/Software/Posters.zip> for more information



**MODEL G-882TVG MARINE CESIUM GRADIOMETER SPECIFICATIONS**

<b>OPERATING PRINCIPLE:</b>	Self-oscillating split-beam cesium vapor (non-radioactive)
<b>OPERATING RANGE:</b>	20,000 to 100,000 nT
<b>OPERATING ZONES:</b>	The earth's field vector should be at an angle greater than 10° from the sensor's equator and greater than 10° from the sensor's long axis. Automatic hemisphere switching.
<b>SENSITIVITY WITH CM-221 COUNTER:</b>	<0.004 nT/sq-rt-Hz RMS. Typically 0.01 nT P-P at a 0.1 second (10 Hz) sample rate (90% of all readings falling within the P-P envelope)
<b>SAMPLE RATE:</b>	Up to 40Hz in 100ms increments
<b>HEADING ERROR:</b>	<0.25 nT over entire 360° equatorial and polar spins
<b>ABSOLUTE ACCURACY:</b>	<3 nT throughout range
<b>OUTPUT:</b>	Cycle of Larmor frequency = 3.498572 Hz/nT, RS-232 data at 115K baud, concatenated data streams from 2 to 8 sensors depending on sample rate
<b>MECHANICAL:</b>	Total weight including 70kg (155 lbs) including two fish, wing and tow cable. Sensor separation is 1.5m for maximum gradient
<b>CABLES:</b>	Vectran Reinforced multi-conductor tow cable. Breaking strength 3,800 lbs, 0.48 in OD, 500 ft standard maximum. Up to 2100 ft with variable voltage supply. 200 ft (60m) weighs 17 lbs (7.7 kg).
<b>OPERATING TEMPERATURE:</b>	-30°F to +122°F (-35°C to +50°C)
<b>STORAGE TEMPERATURE:</b>	-48°F to +158°F (-45°C to +70°C)
<b>ALTITUDE:</b>	Up to 30,000 ft (9,000 m)
<b>DEPTH RATING:</b>	Depth rated to 4,000 psi (2,700m)
<b>POWER:</b>	115/220 VAC, 60 watts at turn-on and 40 watts thereafter
<b>ACCESSORIES:</b>	
Standard:	Power/RS-232 multiconductor cable (electronics to power/data junction box with 9 pin RS-232 connector and power lugs), lengths to be specified, operation manual and reusable shipping and storage containers
Optional:	
Logging Software	MagLog (Logs GPS and Mag, shows trackplot, mag profile, other data )
Processing software	MagMap2000, MagPick

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

05/09



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**Appendix D – KNUDSEN 3200 SUB BOTTOM PROFILER**

ISO9001 CERTIFIED

Proudly Made  
In CANADA**CHIRP RACK SERIES**

Knudsen CHIRP Systems are the next benchmark in scientific sub-bottom profiling echosounders. The CHIRP Rack system, a blackbox system which interfaces to your computer via a USB connection, incorporates the latest in digital signal processing technology and includes Knudsen SounderSuite Windows application software and chirp and correlation processing algorithms to enhance sub-bottom capability. The unit, housed in a 3U rackmount case, is ideal for quick installation to a standard equipment rack on your survey platform.

Available in a 2 or 4 channel configuration, the versatile system is particularly well suited to multiple survey roles and includes a wide range of standard bathymetry and sidescan frequencies for both shallow and deeper depths.

**Technical Specifications:** *(subject to change without notice):***Available Channels**

- Chirp 3200: 1 channel
- Chirp 3202: 2 channels
- Chirp 3204: up to 4 channels

**Frequency**

- All channels: 3.5kHz - 210kHz

**Output Power**

- Up to 2kW on Channels 1 and 2
- Up to 1kW on Channels 3 and 4

**Input Power**

- 85 - 265 VAC (DC Optional)

**Pulse Length**

- Up to 64ms

**Gain**

- Manual, automatic (AGC), and time varied (TVG)
- 96db range of programmable analog gain

**Ranges**

- 5, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000

**Phasing**

- Manual and automatic (up to 50% overlaps)

**Units**

- Meters, Feet, or Fathoms

**Resolution**

- 1cm (0-99.99), 1dm (100-999.9), 1m (>1000)
- 1/100ft (0-99.99), 1/10ft (100-999.9), 1ft (>1000)
- 1/100m (0-99.99), 1/10m (100-999.9), 1m (>1000)

**Sound Velocity**

- 1300 - 1800 m/s Resolution 1m/s
- 4265 - 5906 ft/s Resolution 1ft/s
- 710 - 984 fms Resolution 1 fms

**Draft**

- 0-100m Resolution 1cm
- 0-328ft Resolution 0.01ft
- 0-549fms Resolution 0.01fms

**Interface**

- USB 2.0 Full Speed (12Mbps)

**Output Data**

- Full resolution envelope data in KEB binary format and XTF (for sidescan only)
- Industry standard SEG-Y in 16-bit fixed point in user selected raw, filtered, or envelope detected form
- User configurable ASCII digital depth strings

**Dimensions**

- 533mm (21") x 463mm (19") x 133mm (5.25")

**Weight**

- Chirp 3200: 11kg (24lbs)
- Chirp 3202: 12kg (26lbs)
- Chirp 3204: 14kg (30lbs)

**Installation**

- 3U Rackmount case

**Operating Temperature**

- 0 - 50 °C

**Additional Features**

- Frequency agility on all channels
- Chirp and correlation processing
- Transmit signal generation control
- Advanced digital filter control
- Built-in drivers for all popular GPS
- Built-in test signal generator
- Compatible with industry standard dataloggers and processing software (Hypack, QINSy, SmartWiz)
- Heave compensated echogram

**Options**

- Sidescan option
- Network option for multiple PC operation
- Remote Display Indicators
- EchoSim Sonar Signal Simulator

**SounderSuite Software (included)**

- Windows Vista, XP and 2000 compatible
- Easy to use Graphical User Interface (GUI)
- Postsurvey Display and Printing Software
- Large Digitized Depth Display
- Print to standard Windows printers and most thermal printers

**Appendix E – MARINE SONIC SIDE SCAN SONAR**



CENTUTION™ Splash Proof



**Marine Sonic Technology, Ltd.**  
 5508 George Washington Memorial Highway  
 P.O. Box 730  
 White Marsh, VA 23183



AUV and ROV System

Phone: 800-447-4804 Fax: 804 – 693-6785  
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Sea Scan® PC Side Scan Sonar System Information/Specifications Sheet

GENERAL

Sea Scan® PC is a high-resolution side scan sonar system designed to locate large and small objects underwater as well as display bottom information used for biological research and survey operations. The system provides a near photographic sonic image, regardless of underwater visibility, and employs a state of the art personal computer (PC) for all control, display, analysis and storage functions. This sheet provides operating information and system specifications for all systems manufactured by Marine Sonic Technology, Ltd. (MSTL).

MSTL manufactures the Sea Scan® PC as a Towed System, AUV/ROV System, Submerged System, and as a combination Sea Scan® PC system and Geometrics Magnetometer known as the MagScan®. In addition, MSTL is a leader in custom side scan sonar applications, working with customers to meet their unique and demanding custom installations.

The towed system is MSTL’s basic and most popular system. It is available in several different models with each providing near picture quality images, ease of operation, a powerful software package, dependability and affordability. MSTL also offers the Sea Scan® PC system components miniaturized for AUV/ROV applications. The system’s electronics card is available as an ISA or PC104 card and the single and dual frequency transducers have been streamlined and miniaturized for AUV/ROV applications.

Two additional and unique side scan sonar systems produced by MSTL are the Submerged System (non-towed) and the MagScan® System (towed). The Submerged System was designed and developed to meet the requirements for a side scan sonar system, which could be operated underwater. A diver inside a wet underwater vehicle can easily operate the system.



FIELDWORKS Portable System



Submerged System

The second unique system is the MagScan<sup>®</sup>, which is manufactured in conjunction with Geometrics<sup>®</sup>, Inc. This system combines, in one towfish, the Sea Scan<sup>®</sup> PC system and the Geometrics<sup>®</sup> G-880 magnetometer. This unique combination allows for collection and display of real time sonar images and magnetometer data on the same screen.

Sea Scan<sup>®</sup> PC systems are used worldwide by law enforcement agencies including the U.S. Customs Service, state and city police departments, sheriffs departments, fire departments, dive teams and naval military forces. Additional Sea Scan<sup>®</sup> PC systems are employed by treasure hunters, oil companies, diving and salvage companies, survey companies, and major universities for archaeological and biological research.

MSTL has designed and manufactured custom configurations to meet unique customer needs. Some special configurations completed are:

- U.S. Customs Service for detecting illegal drug shipments.
- Woods Hole Oceanographic Institution for use in autonomous underwater vehicle (AUV) research.
- Submerged system for wet underwater manned operations.
- A dual frequency (150-600 kHz) deep system for use aboard the U.S. Navy's research submarine NR-1.
- Several 600 kHz modular transducer sets rated to Full Ocean depth.

Sea Scan<sup>®</sup> PC is a registered trademark and U.S. Patents 5,142,502 and 5,142,503 cover all equipment.

## **SYSTEM DESCRIPTIONS**

### **TOWED SYSTEMS**

A complete Sea Scan<sup>®</sup> PC towed system consists of a personal computer, LCD flat panel display, keyboard, mouse, two specially designed towcables and a single frequency towfish. In addition, an operator's manual, small tool kit, asset of towcable line weights, five (5) hours of factory training and a one year limited warranty are part of the system. All components are shipped in rugged, foam lined, shipping containers. The system is covered by a one year limited warranty. A complete towed system with the shipping containers weighs, on average, 100 kg (220 lbs.).

The Sea Scan<sup>®</sup> PC towed system is available in three different configurations:

- A Desktop Sea Scan<sup>®</sup> PC system includes a rack mount case computer with Windows Me and an Intel<sup>™</sup> based Pentium<sup>™</sup> III processor or equivalent CPU. Additional features: 256 MB RAM, 60 GB hard drive, 3.5" floppy drive, internal R/RW CD drive, wireless mouse and keyboard, associated power cords and a 15" LCD flat panel monitor.
- A Portable Sea Scan<sup>®</sup> PC system includes a portable PC (SBS 904 or Fieldworks 8000) containing a CELERON/Intel<sup>™</sup> Pentium<sup>™</sup> processor with 32/64 MB RAM, a 30/6 GB hard

drive, 3.5"/CD Rom internal drive, mouse, keyboard, associated power cords and a color active display. Neither system is considered either "Splash-proof" or "Water-proof".

- The "CENTURION"<sup>®</sup> Splash Proof Sea Scan<sup>®</sup> PC system, designed and manufactured by MSTL, includes a small rugged case containing a 233 MHz CPU, 128 MB RAM, a 20 GB hard drive, increased connectivity and network/USB compatible. The system comes with a keyboard and waterproof mouse, an external GARMIN "eTrex" Legend GPS plus a second JRC D/GPS system and external R/RW CD-ROM drive. The "CENTURION"<sup>®</sup> features a 10.4" daylight readable screen for easier target recognition and detection. All external connections are splash proof. The unit has been designed for open boat operations in a rain and seawater spray environment. The system normal operates from a 12 VDC battery source. Computer dimensions are 13" x 11" x 6" and weight is 12 pounds.

**Towfish**

Each of the Sea Scan<sup>®</sup> PC systems contain one single frequency towfish available in the following frequencies: 150, 300, 600, 900, or 1200 kHz. The towfish is certified to an operating depth of 300-meters (984-ft.).

- The fish is constructed of solid polyvinyl chloride (PVC) and other non-corrosive materials.

**TOWFISH SPECIFICATIONS**

kHz	150	300	600	900	1200
Length (m/in)	1.1/42	1.1/42	1.1/42	1.1/42	1.1/42
Diameter (cm/in)	10.2/4	10.2/4	10.2/4	10.2/4	10.2/4
Weight in air (kg/lbs.)	16.8/37	15.9/35	15/33	15/33	15/33
Pulse Length (µsec/cycles)	33/5	20/6	10/6	6.7/6	5/6
Typical Range Resolution – (cm/in)	58/23(300)	29/11.4(150)	9.7/3.8(50)	7.8/3(40)	3.9/1.5(20)
Axial Resolution – aperture size (cm/in)	61/24	61/24	30.5/12	22.9/9	15.2/6
Typical Maximum Range (meters)	400-500	200-300	100	40	20

**Towcables**

- A 100 and 30-meter cable are standard with the towed system. Optional lengths are available up to 800 meters depending on the transducer frequency operating with the cable.
- The cable is constructed using three custom coaxial cables and a 545-kg (1250 lbs.) braided Kevlar<sup>™</sup> strength member covered by either a polyurethane or polyethylene outer jacket to a nominal cable diameter of approximately 0.36" or less.
- 100-meters of cable weighs 9.1 kg (20 lbs.) in air, 4.1 kg (9 lbs.) in water.
- The minimum safe bending radius is 13 cm (5 in.)

**Towable Line Weights**

- A set of towable line weights is a part of each towed system that enables the towfish to achieve greater operating depths. The weights are easily attached to the towcable through the use of two large electrical ties. The weights work best when placed on the cable 8 to 10 feet in front of the towfish

**Maintenance**

- The Sea Scan<sup>®</sup> PC system is virtually maintenance free. After use in saltwater the towfish, cable, and wet end connectors should be flushed with fresh water to reduce salt buildup. During cable/towfish hookup the wet end connectors should be sprayed with WD 40 to lubricate the "O" ring seal and clean out any water or dirt that may be in the connector. During cable and towfish storage, the dust shields should be installed to reduce dirt infusion and possible connector damage. Periodically the towcable should be checked for signs of wear and abrasion. A PC technician can perform computer repairs locally. Required repairs to either the Sea Scan<sup>®</sup> PC system or transducer electronics card must be performed at the factory. The towfish contains no serviceable parts that require either maintenance or adjustments in the field.

**AUV/ROV SYSTEMS**

MSTL's AUV/ROV systems have been designed and built to the exacting standards of today's AUV/ROV market. The AUV/ROV system components use the same proven technology found in the towed systems but have been redesigned to make them smaller and more energy efficient. A normal AUV/ROV system will consist of the system electronics card, transducer electronics card, a pair of transducers, and connecting cables. To satisfy the uniqueness of each AUV/ROV system, MSTL can tailor a system that ranges from just the basic side scan sonar components to a complete turn-key system that includes the PC, power supply, mounting brackets, connectors, cables, and pressurized containers.

**System Electronics**

- The Sea Scan<sup>®</sup> PC system electronics card (installed in the PC) is available in two configurations: Full size, full length, ISA card and a compact PC-104 card for embedded installations.
- System Electronics ISA Card: Size 340mm x 100mm x 19mm (13.4" x 3.9" x 0.75"), Weight: 361 gms (12.7 oz), Power consumption is 6-10 watts (Consumption is dependent on scanning speed and selected range scale).
- System Electronics PC-104 Card: Size 97mm x 92mm x 17mm (3.8" x 3.6" x 0.66"), Weight: 142 gms (5 oz), Power consumption is 4.8 watts maximum (Consumption can be lower depending on scanning speed and selected range).

**Transducer Electronics Card**

- The Sea Scan® PC transducer electronics card is available in the following frequencies: 150, 300, 600, 900 and 1200 kHz. The card can be mounted inside the AUV/ROV pressurized container or sealed as a wet version for mounting outside the vehicle. Dual frequency cards are available in any combination of frequencies desired by the customer. Standard depth rating, when the card is encased and mounted outside the AUV/ROV, is 300-meters. Greater depth ratings are available.
- Transducer Electronics Card: Size 188mm x 58mm x 23mm (7.4” x 2.3” x 0.9”), Weight 227 gms (8 oz) (unpotted card). Two cards are needed for a dual frequency system.

**Transducer Modules**

- Transducer modules are available in a variety of shapes, sizes and in the following frequencies: 150, 300, 600, 900 or 1200 kHz. MSTL can make custom shaped modules to meet specific applications. Standard modules are available with a 300-meter depth rating. Deep modules, with a depth rating of either 6000-meters or Full Ocean Depth, are available.

**AUV/ROV TRANSDUCER SPECIFICATIONS**

kHz	DF*	150	300	600	900	1200
Length (in/mm)	28/711	28/711	28/711	17.5/444	TBD	TBD
Width (in/mm)	4/102	3/76	2.25/57	1.5/38	TBD	TBD
Height (in/mm)	3/76	2/51	2/51	1.5/38	TBD	TBD
Weight (oz/gms)	16lbs/7.3kg	TBD	TBD	34.5/980	TBD	TBD

\*Dual Frequency: 150/600 kHz, 300-meter depth rating.

**SUBMERGED SYSTEM**

MSTL manufactures a unique side scan sonar system for manned sonar operations from a wet underwater vehicle. Housed in a small pressure aluminum case, the unit is easily mounted inside with the transducers fix mounted to the hull. System features and specifications are listed below.

**Features**

- Sea Scan® PC hardware and software are housed in a pressure tested (tested to Mil Std) aluminum case.
- Windows™ ME operating environment.
- All components have successfully passed “Out Gassing” testing.
- Single or Dual Frequency configured, hull mounted transducers.

- Industrial 233 MHz Processor, 20 GB hard drive, external R/W CD ROM drive, 10.4" Color flat screen display.
- Navigation Data via Mil-1553 interface card or NEMA 0183 data stream.
- Keyboard for setup/file transfer.
- Unique underwater tilt mouse for system operations.

### **MagScan SYSTEM**

This is the first commercially available combined side scan sonar and cesium magnetometer system; a new and powerful tool featuring simultaneous and extremely high resolution display of both data sets using a single towfish. This system provides real time confirmation of acoustic and magnetic effects for targets of all sizes in a user-friendly Windows™ interface.

#### **Features**

- High-resolution 600 or 900 kHz sonar images in conjunction with high quality marine magnetics. Sensitivity better than 0.002 nT at 1 Hz, 0.02 nT sensitivity at 10 Hz (samples per second).
- Single tow cable, 100-meter standard with an optional length 200-meter cable.
- Magnetometer cycle rates selectable from 100 Hz to 0.01 Hz.
- Sea Scan® PC side scan sonar specifications are the same as listed for the towed systems.

### **STANDARD Sea Scan® PC SYSTEM COMPONENTS**

**Operational Toolkit** - Each system comes with a toolkit containing system applicable spare fuses, cable hardware, spanner wrench and other miscellaneous tools.

**Operator's Training** - Five (5) hours of factory training, for up to four individuals, is included in the price of each system. This training is designed to provide the basic information necessary to safely setup and operate the system. Areas covered in the classroom training include; fundamentals of sonar operations, operations and features of the system software, system setup and testing, side scan water operations, and system troubleshooting procedures. This training is conducted at the factory in White Marsh, Virginia. Travel and living expenses associated with this training are the responsibility of the customer.

Operation of the Sea Scan® PC system is easily learned by anyone who has a basic familiarity with computers and Windows™ operation. A training mode is also included in the operational software that provides the customer with the ability to practice all controls and functions, in the office or at home, prior to going to sea. Interpretation of the data collected is relatively easy since the image quality is near photographic. As operators gain experience with the system, minor details, shadows, etc. will become more apparent and meaningful.