*Appendix G*
*Calvert Cliffs Acoustic Bottom Survey*

## *FOREWORD*

Natural oyster populations in Chesapeake Bay are in significant decline, but extensive restoration efforts are ongoing. Hard bottom areas of the Bay, especially shell bottom, are conducive to oyster recruitment and growth. The characteristics of the oyster life cycle, especially the reproductive characteristics, clearly emphasize the importance of hard bottom areas. Young oysters (spat) can distribute and settle widely within the Bay, and restoration efforts aim to increase the success of spat sets on hard bottom surfaces throughout the bay.

Related to the restoration efforts, the Maryland Department of Natural Resources (DNR) designated areas deemed Natural Oyster Bars (NOBs) in the mid 198os. This effort was based on the 1983 Bay Bottom Survey, included a public participation process, and is periodically refined through subsequent surveys. The area within the boundaries of a NOB is specifically established, reserved, and protected from activities and impacts considered detrimental to oyster populations or destruction of the bottom. DNR policy for natural oyster bar protection is based on the principles of protection of the bottom within the boundaries of the NOB as opposed to protection of only known live oyster concentrations.

DNR's approach to reviewing potential impacts to Maryland's NOBs requires strict impact avoidance and minimization efforts. In limited cases where no feasible alternatives exist for impacts associated with a strongly justified project serving the public good, compensatory mitigation measures are considered. The goal of any compensatory mitigation for unavoidable impacts to a NOB is to replace the area of Bay bottom within the boundaries of the NOB that would be impacted by the proposed project with an equal area of habitat that can support viable oyster populations. This latter approach applies to the proposed Calvert Cliffs Unit 3.

The construction of Calvert Cliffs Unit 3 will affect the NOB designated as 19-2 on NOB chart 19. NOB 19-2 is offshore from the existing Calvert Cliffs power plant, and uses the shoreline itself as its shoreward boundary. During the environmental review of the proposed Calvert Cliffs Unit 3, DNR evaluated the potential impacts to the eastern oyster (*Crassostrea virginica*). To gain a better understanding of the existing resources within NOB 19-2 as well as potential impacts to it, DNR, with cooperation from the Maryland Geological Survey and the Applicant, conducted an acoustic bottom survey in the areas proposed for maintenance and new dredging work for the proposed project.

The acoustic bottom survey confirmed the presence of significant areas of hard shell bottom, which represent suitable oyster habitat, in the vicinity of the proposed project. The survey results justify and confirm the appropriateness of the compensatory mitigation. The Applicant should place new hard bottom (shell, crushed concrete, or other approved material) within suitable areas of NOB 19-2, on an acre for acre basis to replace the area that will be impacted by new dredging activities associated with the proposed project. Details of the mitigation, such as depth of materials, locations within NOB 19-2, and subsequent protection of the area, should be planned and conducted in accordance with Conditions 44 and 53 and coordinated with DNR Fisheries Service.

Finally, DNR advocates the protection of the material placed as compensatory mitigation as an oyster sanctuary within NOB 19-2.

In the report that follows, titled, *Calvert Cliffs Acoustic Bottom Survey, August 21, 2008*, the results of the survey within NOB 19-2 are presented. Maps and figures showing imagery of bottom habitats are included and clearly show existing hard bottom areas. Physical sampling of sediments was also conducted to categorize the kinds of surface sediments present such as mud, sand, and shell.

# Calvert Cliffs Acoustic Bottom Survey, August 21, 2008

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## Methodology

An acoustic bottom survey of the Chesapeake Bay bottom off the Calvert Cliffs Power Plant was conducted by Maryland Geological Survey on August 21, 2008. Maryland Department of Natural Resources Research Vessel Kerhin was deployed for the survey. Data collected included side scan sonar imagery at 410 and 120 kHertz and seismic profiles at 4.0 to 24.0 kHertz. Surface grab samples were taken with a Van Veen grab sampler.

The survey objective was to map various bottom sediment types and structures present within a predetermined survey area. Survey parameters were chosen to distinguish the following bottom types: mud, sand, sand-and-shell, shell, and hard bottom. Structures mapped include dredged channels, shell bars and outcroppings, sand sheets and muddy bottom. Also detected were numerous constructed and/or abandoned structures and artifacts on the bottom.

## Analysis

The following figures, data and descriptions illustrate existing conditions on the Bay seafloor within the survey region. The location and extent of existing and potential oyster habitat within the survey area are based on surface textures observed in side scan imagery, bottom roughness as measured through seismic reflection coefficients, seismic profile imagery and surface grab samples.


**Figure 1: USGS digital orthophotoquadrangle imagery of Calvert County shoreline and Natural Oyster Bar 19-2 polygon.**

The designated acoustic bottom survey area included a proposed construction project that would impact Natural Oyster Bar 19-2, which lies offshore of the Calvert Cliffs Power Plant. While the exact footprint of the proposed project was not known to the survey personnel at the time of the field work, sufficient area offshore was covered to include the general project area.

Figure 1 presents the extent of Natural Oyster Bar 19-2 and USGS orthophotoquadrangle imagery of the shoreline. This figure gives the overall project geometry. The survey region and the proposed project are contained within NOB 19-2.

The original shoreline that existed at the time the NOB 19-2 boundary was established has been modified by construction, erosion and accretion. The current shoreline and the original western boundary of NOB 19-2 are no longer coincident. For illustrative purposes the western edge of NOB 19-2 was graphically manipulated so that the relationship between the existing shoreline and bottom features can be shown. The actual NOB 19-2 western boundary, as originally surveyed, is not depicted in this report because the polygon representing this area would obscure shoreline imagery.

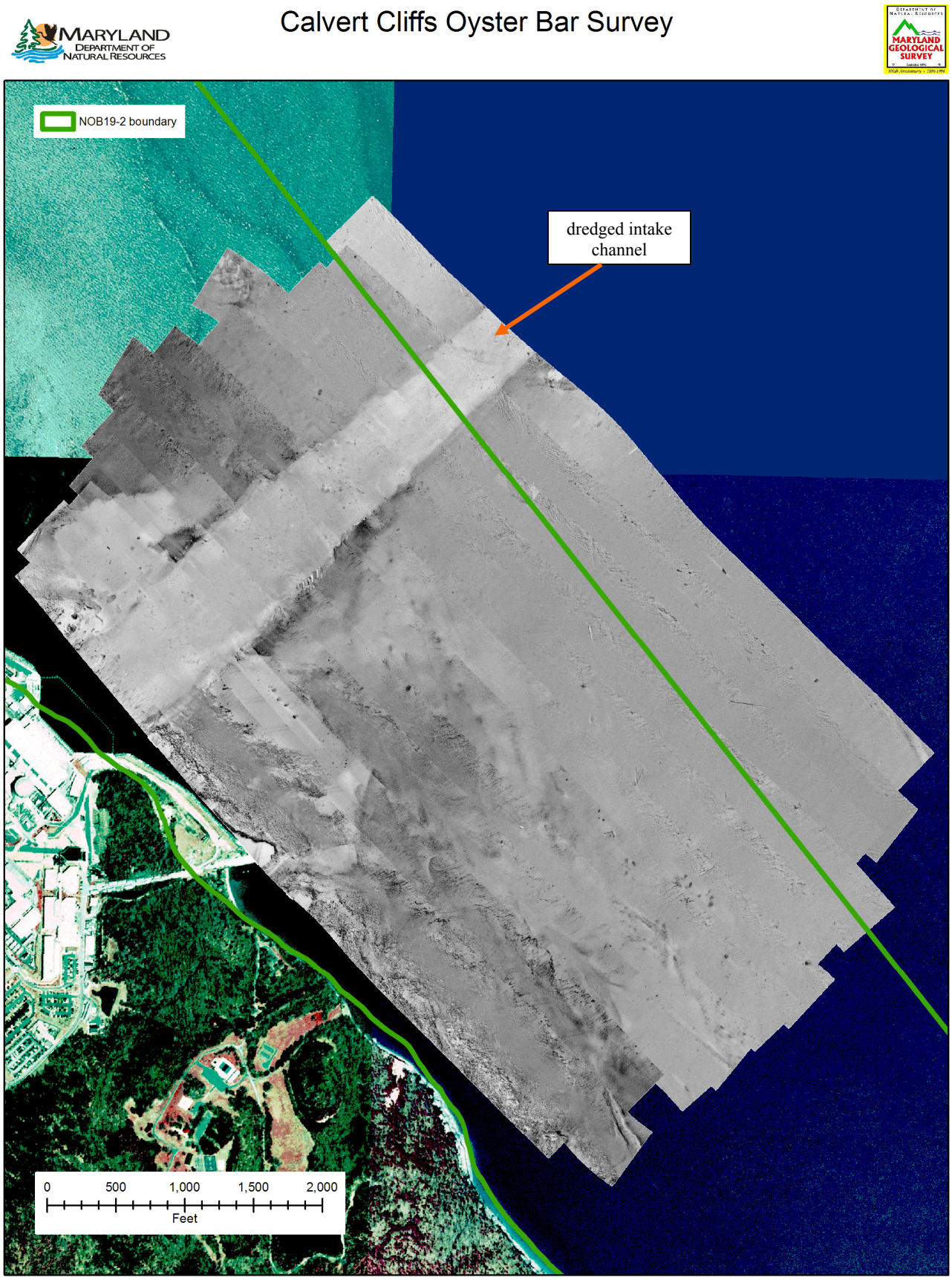


**Figure 2: Side scan sonar imagery of survey area. Various bottom features including the dredged intake channel are visible in the image.**

Figure 2 shows the survey area side scan sonar imagery and its position relative to the shoreline. The range of gray shading and textures is indicative of a variety of bottom features. The most obvious feature is the dredged intake channel which appears as the light-gray, relatively featureless swath in the upper left portion of the sonar image. The channel depth is relatively constant from west to east, approximately 11 meters (36 feet) deep in the survey area.

The darker-gray, rough areas near the shoreline are indicative of oyster bars and shell deposits on the bottom. These shell-bearing surfaces are interrupted on the northeast side by troughs containing sand and/or mud. Eastward of these troughs the sonar again shows darker-gray, mottled bottom with rough-appearing areas. This bottom type is shell-rich sand and hard clay, shell hash and shell deposits.

The dark-gray gradually lightens toward the east and becomes smoother-appearing. This is a transition area to sand and muddy sand, with little to no significant shell.

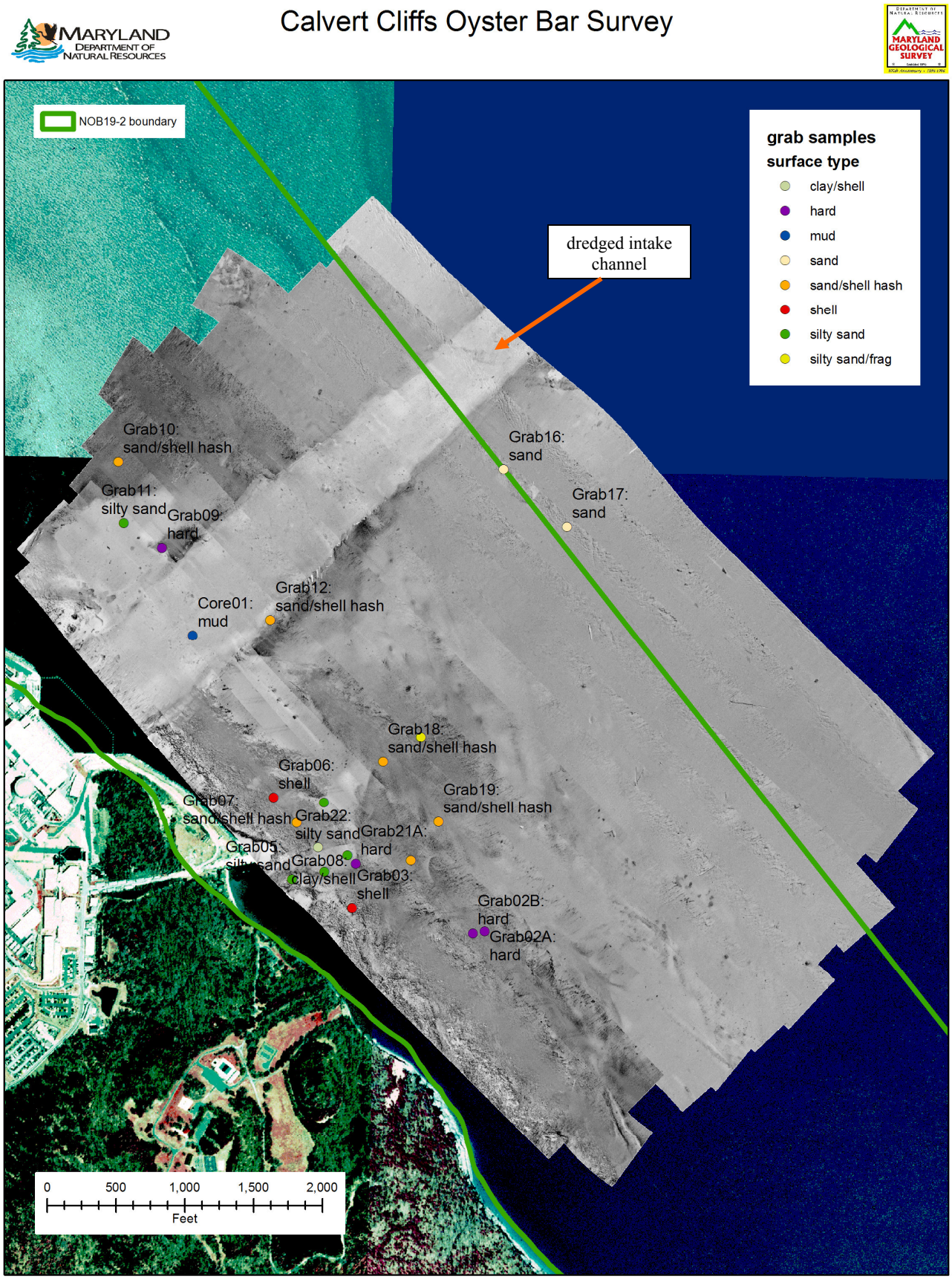


**Figure 3: Surface grab sample locations.**

Surface grab samples and one gravity core were taken to assist in the interpretation of the acoustic survey. While there are several techniques available to verify the interpretation of remote acoustic bottom data, sampling is the most reliable. By comparing the quantitative values of acoustic data with the qualitative description of physical samples, the confidence of mapping interpretations is greatly increased.

Figure 3 maps the location and general description of samples. Table 1 is a more complete list of sample descriptions. Notably, one sample, Grab06, contained 2 live oysters. Several samples contained live crustaceans and mussels, indicative of viable oyster habitat. Two samples, Grab16 and Grab17, were taken in 30 feet of water. These two samples consist of sand with presence of hydrogen sulfide odor. Hydrogen sulfide indicates anoxic conditions at this depth and time of year, making oyster survival unlikely in this portion of the survey area. It should be noted that the anoxic samples were taken at the extreme eastern edge of NOB 19-2, and far from the eastern edge of the project area.

The bottom of the dredged intake channel is predominantly mud, and seismic profiles indicate the mud may contain anoxic gases such as methane and hydrogen sulfide, making the channel an unlikely environment for oysters. From this experience, it would not be unreasonable to expect that future dredged channels would develop similar conditions unfavorable to benthic shellfish communities, particularly if deeper than 25 feet.

**Table 1: Calvert Cliffs Oyster Bar Grab and Core Sample Descriptions [1]**

| Sample | Depth (meters) | Description |
|---|---|---|
| Grab01 | 6.4 | Firm silty sand w/old shell fragments throughout |
| Grab02A | 5.3 | No sample recovered |
| Grab02B | 5.3 | 1 oyster shell fragment |
| Grab03 | 2.1 | Oyster shell fragments; 2-inch mussels attached to shell fragments; red "hair-like" algae growing on mussels |
| Grab04 | 3.5 | Fine silty sand (color = 5Y4/1 over N2); firm; $H_2S$ smell; very small shell fragments throughout |
| Grab05 | 2.1 | Fine silty sand (color = 5Y4/1 over N2); firm; $H_2S$ smell; very small shell fragments throughout |
| Grab06 | 3.2 | 6-7 inch rock; 2 live 3-4 inch oysters; several sand crabs; lots of shell hash/small pebbles; silty sand veneer throughout |
| Grab07 | 3.3 | Very fine sand w/mixed shell hash throughout; few oyster shell fragments throughout |
| Grab08 | 3.6 | Silty clay w/old oyster shells; barnacles on shells; several sand crabs |
| Grab09 | 5.8 | 2 old oyster shell fragments (halves); small worms living on shells |
| Grab10 | 6.9 | Shell hash/fragments; very fine muddy sand veneer throughout |
| Grab11 | 5.1 | Very fine silty sand; slightly firm; no shell fragments; slight $H_2S$ smell |
| Grab12 | 8.5 | Shell hash/fragments; very fine muddy sand veneer throughout |
| Grab16 | 9.6 | Fine to medium sand; anoxic; N2 color throughout; no noticeable oxidized surface layer; $H_2S$ smell throughout |
| Grab17 | 9.4 | Fine to medium sand; anoxic; N2 color throughout; no noticeable oxidized surface layer; $H_2S$ smell throughout |
| Grab18 | 5.6 | Oyster/mussel shell hash; slightly silty sand veneer throughout |
| Grab19 | 5.5 | Oyster/mussel shell hash; slightly silty sand veneer throughout |
| Grab20 | 5.4 | Oyster/mussel shell hash; slightly silty sand veneer throughout |
| Grab21A | 4.4 | No sample recovered |
| Grab21B | 4.5 | Very fine silty sand (5Y4/1 over N2); moderately firm; slight $H_2S$ smell at depth |
| Grab22 | 4.8 | Very fine silty sand (5Y4/1 over N2); moderately firm; slight $H_2S$ smell at depth |
| Core01 | 10.4 | Mud |

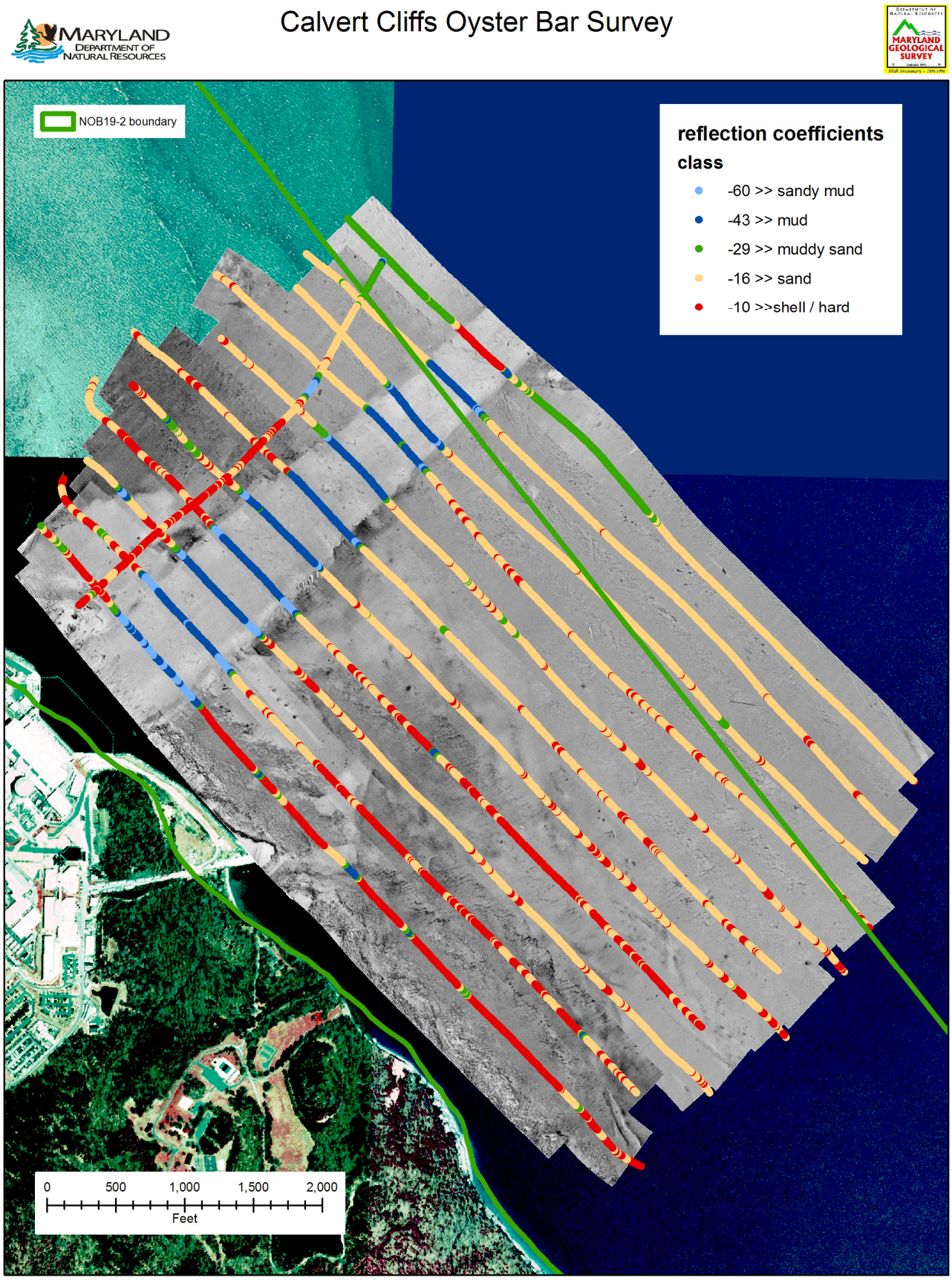


**Figure 4: Reflection coefficients from seismic data. This is a gross indicator of surface roughness/hardness.**

Figure 4 shows reflection coefficients from the seismic data collected during the survey. Normally this survey would have included an acoustic seabed classification system. However, Maryland Geological Survey's system was being upgraded at the time of the survey, so reflection coefficient data was substituted. These data are cruder and are not refined to the extent that a seabed classification system produces. However, the reflection coefficients contain useful information, and the pattern displayed by these data correlates well with the grayscale and roughness seen in the sonar imagery, and also track well with grab samples.

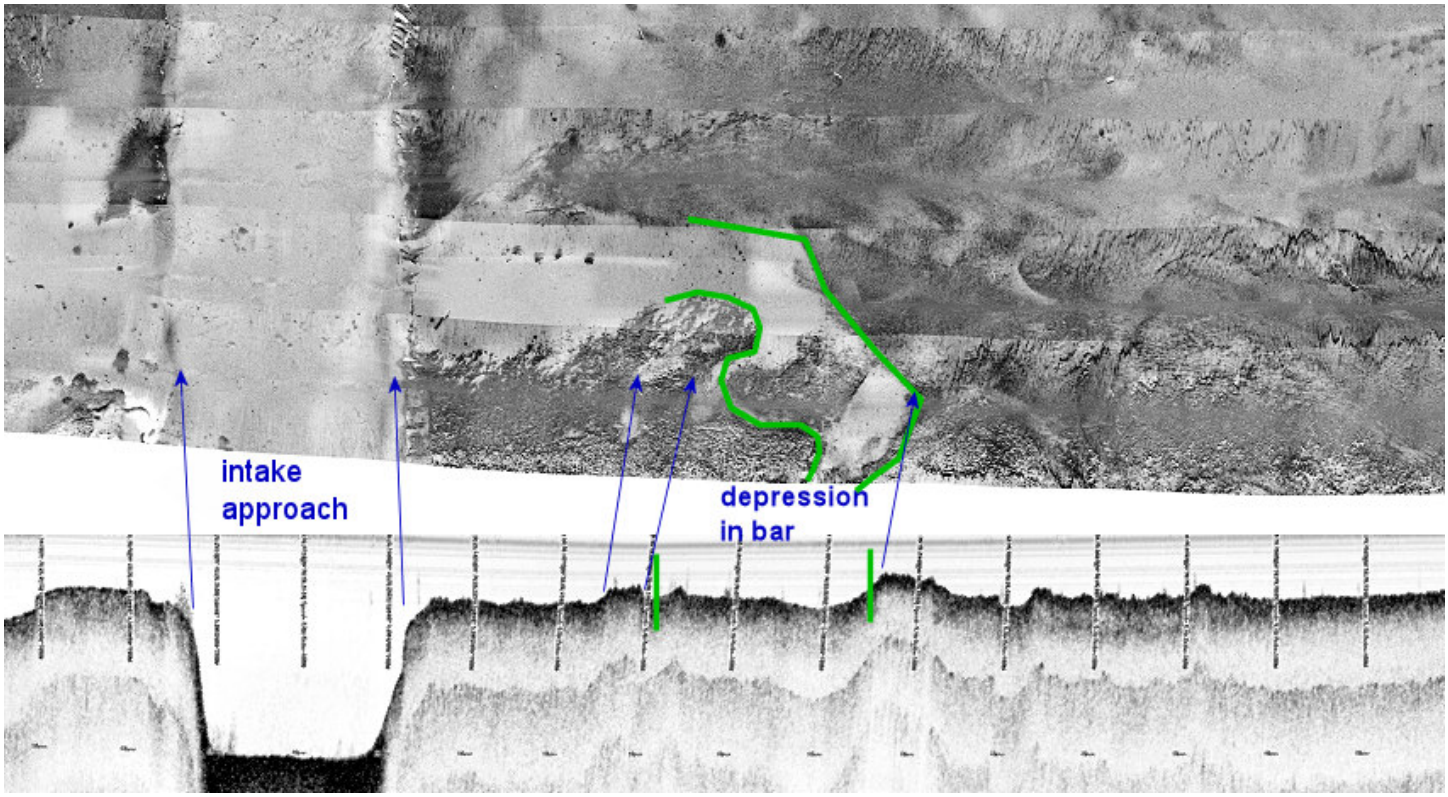


**Figure 5: Side scan sonar imagery of survey area. Various bottom features including the dredged intake channel are visible in the image.**

Figure 5 compares a seismic profile along a side scan sonar track line. The 10-meter (33-foot) deep intake channel is clearly evident.

The shell-free depression in the shelly bottom is outlined in green. The origin of this depression is not clear. However, dark, sinuous shell beds can be seen encroaching on the depression.

Possible buried shell deposits can also be seen on the right side of the seismic profile. The high points, or mounds, protruding from the bottom are exposed shell.

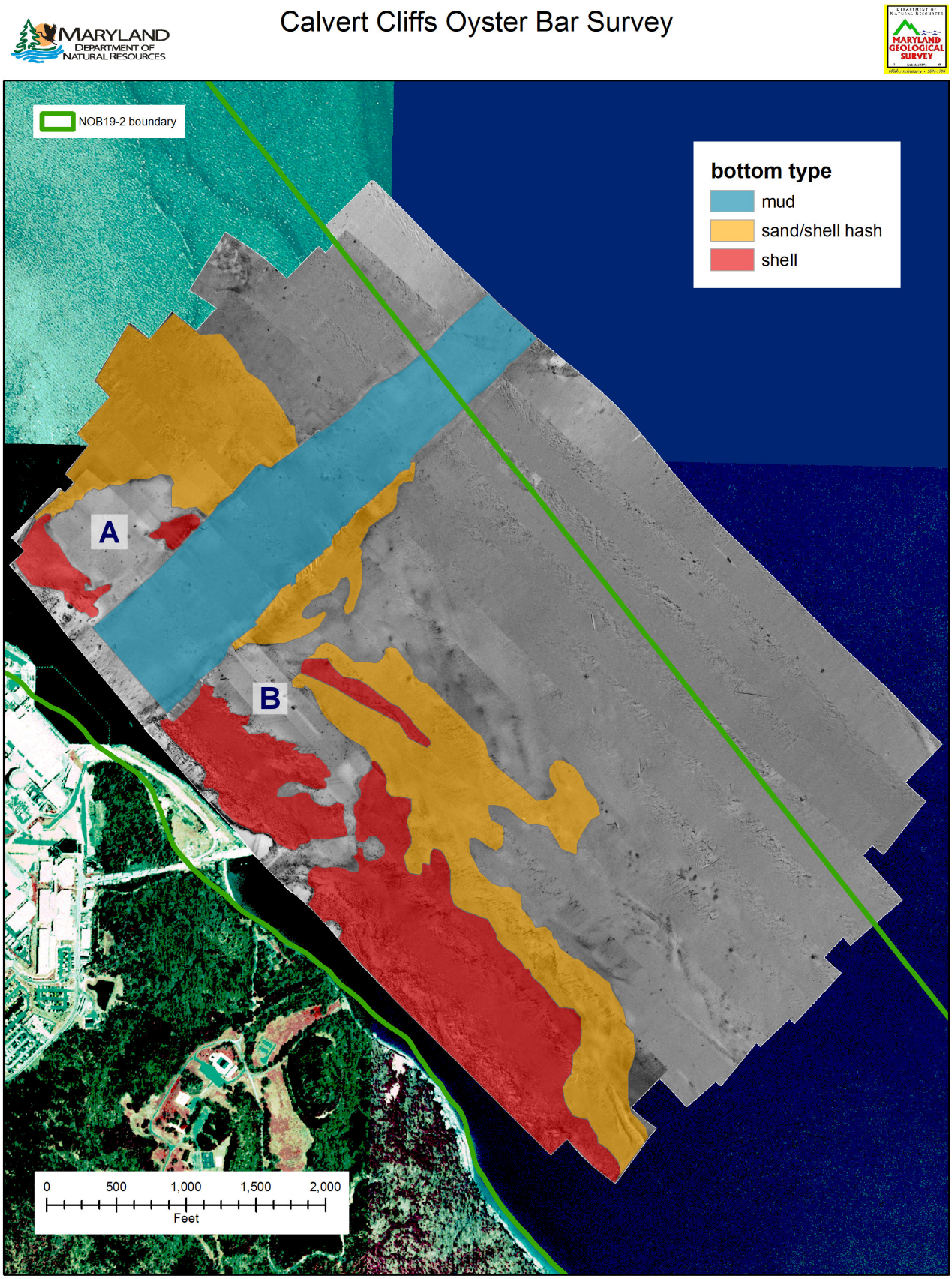


**Figure 6: Bottom-type polygons. Polygons determined by side scan sonar imagery and seismic reflection coefficients.**

Figure 6 presents an interpretation of bottom types based on acoustic survey data. Employing side scan imagery, seismic profiling and reflection coefficient data, polygons containing 3 major bottom types were constructed. The types are:

1) Mud;
2) Sand with significant shell and shell hash;
3) Shell / hard bottom.

Areas which do not fall under these 3 classes consist of sandy bottom, from medium to fine sand, and in places, muddy. Because these areas do not appear to have significant shell material or are typically unfavorable shellfish habitat, they were not indicated on the map. The predominantly muddy intake channel is also unfavorable for reef habitat.

The red polygons near the shore represent significant reefs and shell deposits. These areas contain the highest quality oyster habitat in the study area. At least two market-sized live oysters were sampled in this bottom class. Water depth, currents and the presence of existing shell material are most favorable for oyster development within the red areas. Hard bottom is either shell on hard sand or hard clay. Both hard sand and clay will support shell deposits, unlike mud.

There are two notable, shell-free patches associated with the red polygons, marked “A” and “B” in Figure 5. These appear to be depressions in the shelly bottom, covered with sand, mud and hard-clay. Samples from these areas have a slight hydrogen sulfide odor indicating anoxic conditions at the time of sampling. It is unclear whether these areas were dredged at some point, or if they were scoured by prop wash or other man-induced activity. Patch B provides a sinuous path from the dock area on the shoreline, through the shell bottom to the intake channel to the north and to deeper water to the east. The field survey does not reveal the western extent of Patch A and whether it extends to the shore.

East of the red polygons are several orange polygons which delineate sandy bottom with significant shell content. Side scan sonar imagery suggests patches of shell on the surface within these areas, which may support living shellfish communities. Seismic data indicates this type of bottom once supported significant shellfish populations, and could provide habitat in the future. The presence of shell and shell hash at the surface is proof of bottom hard enough to support reef materials, and abundant calcium is available for shell formation. Additionally, seismic imagery reveals the presence of shell material just below the surface, an indication that old reefs have been covered by sand and shell hash. This buried material has the potential for being exhumed and reused to restore lost habitat. The shelly sand bottom within the orange polygons is interpreted as having once supported shellfish communities and is capable of restoration.

## Conclusion

Results of this survey indicate the viable oyster habitat off the Power Plant, within NOB 19-2, extends at least from the 5 foot contour to approximately the 20-foot contour, a distance of about 1300 feet eastward of the 5 foot contour. The field survey did not extend all the way to shore in some places due to boat draft and equipment limitations, so habitat may extend closer to shore.

## Notes

[1] Numbers appearing in Table 1 such as 5Y4/1 and N2 refer to sediment color values. These numbers are derived from the Munsell Rock Color Chart, and are intended to present semi-quantitative, reproducible descriptions of sediment color. Color is often an indication of oxic/anoxic conditions. 5Y4/1 is in the olive-gray range and N2 is in the grayish-black range. Black sediments with a hydrogen sulfide odor are anoxic.