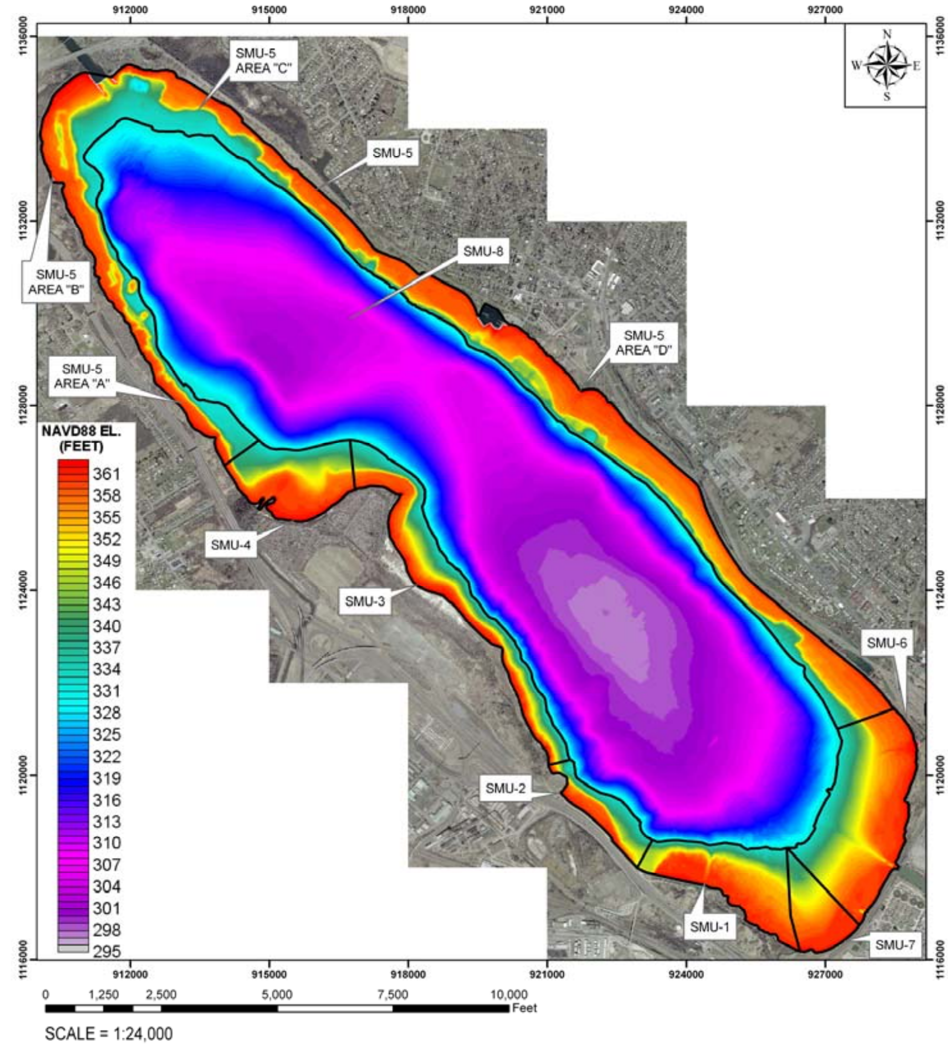
ONONDAGA LAKE
PHASE 1 PRE-DESIGN INVESTIGATION
GEOPHYSICAL SURVEY REPORT



Bathymetric Contour Map of Onondaga Lake Showing Sediment Management Units

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EXECUTIVE SUMMARY

CR Environmental, Inc. (CR) performed geophysical and bathymetric surveys of Onondaga Lake in Syracuse, New York during the fall of 2005 as part of Honeywell's Phase 1 Pre-Design Investigation (PDI) (Parsons, 2005). These surveys were completed in accordance with the approved Phase 1 PDI Work Plan and have been summarized below. These results will be utilized to further the understanding of the site and support other design related activities.

Four different types of surveys were conducted as part of the Phase 1 PDI: (1) bathymetric survey to identify the lake bottom surface; (2) side-scan sonar to characterize debris, obstructions and other surficial features of the lake bottom; (3) sub-bottom profiling to supplement the assessment subsurface stratigraphy; and (4) magnetometer data to identify debris and obstructions containing iron within or on top of the lake sediments.

Due to the extensive data set generated during this investigation, the objects or contacts described in this report have been limited to those that are at least 5 feet (ft) in size. However, the resolution of the data set will allow for a more detailed look at specific areas in the future if required. The following are highlights of the Phase 1 PDI bathymetric and geophysical results summarized by sediment management unit (SMU):

<u>SMU 1</u>

- Three intake pipes and one diffuser pipe in the central and western part of the SMU;
- A buried pipeline (Sun Oil) along the southern shoreline that extends into SMU 7;
- The highest number of side-scan sonar Contacts (predominantly of debris) of the littoral SMUs with the majority of the Contacts clustered in the northeastern corner, including two wrecks;
- Magnetic contacts indicating widespread buried material containing iron;
- A predominantly sandy silt substrate with a shoal of finer material along the shoreline;
- Limited sub-bottom sonar penetration, but evidence of thick sediment on the outer slope;

and

- Minimal observations of aquatic vegetation.

SMU 2

- Two intake pipes (72-inch and 84-inch diameter) near the Causeway structure, one buried and the other partially exposed;
- Possible buried material containing iron in 3.8 ft of water in the southwestern portion of the SMU;
- One large side-scan sonar Contact approximately 3 ft by 20 ft in size rising 0.6 ft above the sediment surface within the capping area but outside the dredge area;
- Forty to 50 ft of thinly layered sediment in the central portion of SMU 2; and
- Evidence of decaying aquatic vegetation.

SMU 3

- Widespread iron-containing material beneath the surface at the northern end of SMU 3 near the former resort;
- Seven areas of iron-containing material buried within or on the boundary of the proposed dredge area;
- Only six side-scan sonar features were observed within SMU 3; one of those may be wreckage or woody debris approximately 53 ft long, 23 ft wide and extending approximately 1 ft off the lake bottom; and
- An estimated sediment thickness of approximately 20 ft, however, sub-bottom sonar data was limited.

SMU 4

- Thirty-six indications of buried iron-containing material in the dredge area, and multiple other magnetic contacts throughout this SMU;
- Two large linear structures (pipes) containing iron visible on aerial photographs;
- A large wreck (84 ft by 34 ft) at the eastern end that rises at least 11 ft above the lake bottom; and

- Potential for as much as 60 ft of sediment thickness nearshore in the western portion of this SMU.

Four areas of SMU 5 (Area A through Area D) where dredging and/or capping may be part of the lake remedy

- The lack of objects detected in all four areas within SMU 5 using side-scan sonar, albeit shallow conditions limited the range and resolution of the instrument;
- Relatively good sub-bottom sonar penetration showing 32 to 43 ft of stratified sediment over compact parent material or bedrock (except in Area C where detected sediment thickness was 0.5 to 9 ft);
- The presence of 11 buried, iron-containing objects in Area A, several within an area that may be dredged;
- The presence of a large linear structure containing iron within Area B that extends from the shoreline;
- A trench approximately 100 ft long and 10 ft deep (max) oriented north-south in Area B; and
- Several iron-containing objects in the central portion of Area B;
- Six features of debris from side-scan sonar that rose approximately 1 to 2 ft off the bottom in Area C;
- The presence of a pipe or outfall that bisects Area D and extends into the lake 600 ft perpendicular to the shore;
- Thirty-three iron-containing objects in Area D, most of which appear to be buried; and
- Six side-scan images of debris or textural anomalies with a height above the sediment surface of 1 to 3.5 ft found near the outer boundary of Area D.

SMU 6

- Three pipeline/outfalls extending perpendicular from the shoreline - one near the mouth of Ley Creek and two at the southern end that cross into SMU 7 (Sun Oil Pipeline and Metro discharge);
- Two barge wrecks, one area of debris, one area of man-made debris; and two channel marker buoy moorings on the lake bottom are present in the area of proposed dredging;

- Widespread potentially buried iron-containing material in the shallower portions of the SMU;
- Eighty-eight side-scan sonar Contacts within SMU 6 that were predominantly debris and with an average height above the sediment of 1.3 ft to 2.1 ft; and
- Potentially as much as 54 ft of sediment at the northern end of this SMU. Data from other portions of SMU 6 are not as clear.

SMU 7

- The Sun Oil pipeline is buried along the shoreline and the Metro discharge is exposed above the lake bottom at its terminus;
- Two Contacts of debris were identified in the dredge area. An additional 41 (36 debris and 5 man-made debris) contacts were found in the rest of the SMU. These features are concentrated at the northern end with dimensions of 7.2 to 19 ft long, 2 to 18 ft wide and approximately 2 ft off the lake bottom; and
- No data on surficial sediment thickness is available on the sub-bottom record likely due to the presence of natural gases in this area.

SMU 8

- Survey transects were spaced 200 feet apart in SMU 8, necessitating a greater degree of interpolation for bathymetric and magnetic contour development. This increased spacing acted to reduce the likelihood of magnetic anomaly detection for all but the largest iron-containing objects;
- The majority of side-scan sonar contacts appear to be located at the toe of the slope leading from the littoral zone. The dominant classification was unidentified debris, and the majority are likely natural woody debris;
- Eighty-nine individual depressions were digitized in SMU 8. The majority of these occur in two clusters along the eastern sub-littoral/profundal portion of the lakebed. The depressions usually appear to be circular to oval with an average width of approximately 50 ft. Many of the depressions appear to contain a central "hub" which may be slightly mounded. Side-scan sonar data suggests depression depths range from 0.5 to 2.7 ft. A

sub-bottom sonar profile which intersected two of the depressions suggests a depression depth of about 2 ft.

- Three apparent wrecks were identified in SMU 8 at locations shown in report figures; and
- Structures which extend from littoral zone SMUs into SMU 8 include the two 16-inch intake pipes from SMU 1, and the 72” and 84” intake pipes from SMU 2.

1.0 INTRODUCTION

CR Environmental, Inc. (CR) performed geophysical surveys of Onondaga Lake in Syracuse, New York, between October 12, 2005 and November 5, 2005 as part of the Phase 1 Pre-Design Investigation work (Parsons, 2005). Standard Operating Procedures (SOPs) for the geophysical surveys were prepared by Parsons for Honeywell in August 2005 (SOP 5: Bathymetric Survey and SOP 6: Geophysical Remote Sensing Surveys) and reviewed by NYSDEC and USEPA. This report provides additional detail on the methods used to acquire and process bathymetric, side-scan sonar, sub-bottom profiler and magnetometer data. The report also includes a discussion of survey results and, in Appendix B, responses to the State of New York Department of Environmental Conservation’s (NYSDEC’s) comments on draft versions of this report. Comments from NYSDEC are dated January 22, 2007; May 25, 2007; and August 27, 2007.

The geophysical surveys were designed to allow the simultaneous acquisition of data from each sensor, while meeting the performance standards established in Parsons’ SOPs and the hydrographic survey standards promulgated by the U.S. Army Corps of Engineers (USACE, EM-1110-2-1003). Onondaga Lake has been divided into eight Sediment Management Units (SMUs) for remedial investigation (Figure 1). The geophysical survey transect spacing was established for each SMU based on existing knowledge of bottom composition and depth, and on the anticipated remediation to be performed.

Survey transects were designed using HYPACK hydrographic survey software. Background imagery including a georeferenced orthophoto and polygons representing SMU boundaries were provided by Parsons in a UTM (Zone 18, NAD83, metric) projection. These data were imported to HYPACK to guide the survey design. Survey transects were established using a 25 feet (ft) (on-center) line spacing in the littoral SMUs 1, 2, 3, 4, 6, and 7 where potential dredging, capping, and habitat efforts would benefit from higher resolution data. In SMU 5 and the deeper waters of SMU 8, 200 ft transect line spacing was established. In small portions of SMU 5 and SMU 8 where dredging and capping is part of the selected remedy, line spacing was set to 25 ft.

2.0 SURVEY VESSELS AND SURVEY COVERAGE

The geophysical survey operation was based out of the Onondaga Park Marina located on the northeastern shore of the lake in the village of Liverpool, NY. Survey activities between October 12 and 19, 2005, were conducted from CR’s 32 ft aluminum research vessel *Cyprinodon*. Survey coverage during this period included all of SMU 8 and deeper portions of most near-shore SMUs (Figure 2). Survey activities conducted during this period included the simultaneous acquisition of bathymetry, side-scan sonar, sub-bottom sonar and magnetometer data. CR’s 32 ft aluminum research vessel, *Cyprinodon*, was selected for survey operations at SMU 8 for the following reasons:

- The larger enclosed pilothouse accommodated a 4- to 5-man survey crew.
- The stern mounted A-frame and aft deck permitted longer cable lengths to be deployed for the side-scan sonar and magnetometer in the deeper portions of the lake.
- The vessel was equipped with a fast high capacity winch for quick retrieval of the side-scan sonar system.
- The vessel has a built-in 5kw generator to power all the survey electronics.

Survey activities between October 20 and November 3, 2005, were conducted from CR’s 26 ft aluminum research vessel, R/V *Lophius*. This shallow draft landing craft style vessel was used to the survey littoral SMUs. The *Lophius* has an aft pilothouse and a bow mounted A-frame that was used to deploy the side-scan sonar system in the shallower portions of the lake. Survey activities conducted between October 20 and 26, 2005, included the simultaneous acquisition of bathymetry, side-scan sonar, sub-bottom sonar, and magnetometer data. Following completion of the side-scan sonar survey on October 26, 2005, the equipment was demobilized. Survey activities conducted between October 27 and November 3, 2005, included the simultaneous acquisition of bathymetry, sub-bottom sonar, and magnetometer data for the shallower portions of all seven near-shore SMUs 1, 2, 3, 4, 5, 6, and 7. Figure 3 shows the cumulative lines surveyed by *Cyprinodon* and *Lophius* from October 12 through November 3, 2005.

On November 4, 2005, survey gear was transferred from R/V *Lophius* to CR's 22 ft fiberglass survey vessel, R/V *Seahawk.* Additional bathymetric and magnetometer data were collected for nearshore portions of the SMUs, and data along Quality Control (QC) bathymetric cross-tie transects oriented perpendicular to the primary survey transects were collected. During this same time period, *Lophius* collected box-core sediment samples.

Survey gear was transferred from *SeaHawk* to the 15 ft shallow draft aluminum jonboat R/V *Salvelinus* on November 5, 2005. The jonboat was used to survey other shallow portions of the littoral SMUs that could not be safely navigated using the larger vessels. Bathymetric data were collected from the jonboat on November 5 and 6, 2005.

Photograph 1. *CR Environmental's aluminum survey vessels R/V Cyprinodon, R/V Lophius and a jonboat at Onondaga Park Marina*

The side-scan sonar system was remobilized to R/V Lophius on November 5 and 6, 2005. Additional high resolution sonar data were collected for nearshore portions of littoral SMUs and features of interest such as shipwrecks.

Figure 4 shows complete survey trackline coverage by all CR vessels from October 12 through November 6, 2005.

3.0 NAVIGATION AND SURVEY CONTROL

Navigation for the surveys was accomplished using two Trimble AgGPS 132 12-channel Differential Global Positioning Systems (DGPS) capable of receiving the U.S. Coast Guard (USCG) Beacon corrections and the OMNISTAR subscription-based satellite differential correction service. The DGPS provided digital outputs of positions accurate to less than 1.0 meter. One of the DGPS systems was interfaced to a laptop computer running HYPACK MAX hydrographic survey software. HYPACK continually recorded vessel position and depth data in the Universal TransMercator (UTM) grid, NAD83, and provided a steering display for the vessel captain. The second DGPS was interfaced directly to the side-scan sonar acquisition system.

Vertical control for the site was brought to the lakeshore by a survey crew for the Lake team. This benchmark was located on the southern shore of the lake and used for the bathymetric survey. The control point was established at a causeway guardrail located at N 111172.736, E 922775.464 (NY State Plane, Central, NAD83, US Foot). The reported elevation of this benchmark was 372.889 feet, NAVD88. An InSitu Inc. Minitroll data logging water level recorder was installed directly beneath this vertical control benchmark. Water height above the depth sensor was recorded at 10-minute intervals throughout the survey effort. Recorded water levels were converted to elevations based on the vertical offset measured between the depth sensor and the benchmark.

A USGS Water Level Recording Station No. 04240495 is located ‘mid-lake’ at the Onondaga Park Marina on the northeastern shore of the lake. CR obtained water level data from this Station as a redundant source of water level information for comparison with data collected at the benchmark near the southern end of the lake. The USGS data were recorded using a 14- to 16-minute interval compared to the 10-minute interval set by CR at the survey benchmark.

Coincident CR records and USGS series water surface elevations were compared for data collected on October 17, 2005 and November 3, 2005. These dates were selected based on strong winds. According to the National Weather Service (NWS) data for Syracuse, between October 15 and October 17, 2005, Onondaga Lake was exposed to northwesterly winds with average speeds of 11 to 19 knots with gusts to 40 knots. After October 17, 2005, winds shifted to the west. These conditions were judged to be acceptable for the detection of seiche (i.e. internal) waves. A comparison of water levels for coincident points shows a strong agreement between water levels recorded at the two stations, with a residual difference of 0.02 ft. Early morning data for October 17, 2005, suggests the presence of a seiche with a period of approximately two hours and amplitude of approximately 0.13 ft. As would be expected, the wave was best discerned at the southern recording station. A wave of similar period, but lower amplitude (<0.05 feet), was suggested at the ‘mid-lake’ USGS station. These data suggested slightly higher water levels in the southern basin during sustained northwesterly winds.

According to the NWS data for Syracuse, the lake was exposed to a predominantly westerly wind with an average speed of approximately 11 knots with gusts up to 32 knots between November 1 and 3, 2005. Similarly, these conditions were judged to be acceptable for the detection of seiche waves. Comparison of the water level data from the two recording stations showed strong agreement between the two data sets with a residual difference of 0.01 ft. The comparison suggested the presence of a seiche with a period of one to three hours and maximum amplitude of approximately 0.11 ft. Data variability was highest at the USGS Station, likely due to its leeward position. These comparisons highlight the minimal effect of internal waves on the recorded water level data, even during the most extreme weather conditions documented during the survey period. Seiche induced error, when present, will likely be less than 0.1 ft.

4.0 GEOPHYSICAL SURVEY DATA ACQUISITION AND PROCESSING

In general, the Onondaga Lake bathymetric, side-scan sonar, sub-bottom, and magnetic data were collected simultaneously. Data acquisition and processing methods are described in detail in the sections that follow. The methods are the same as those outlined in the work plan for the Phase 1 Pre-Design Investigation. The only difference between work performed and the work plan specifications was that the line (or transect) spacing for side scan sonar acquisition in SMUs 1 through 7 was 82 feet as originally intended and planned instead of 25 feet. The 82-foot transect spacing provided complete overlapping coverage of the lake bottom. Data output from this work provides 100 percent coverage with very useful detail as summarized herein.

4.1 Bathymetric Data Acquisition

The bathymetric data acquisition system consisted of laptop computer running HYPACK hydrographic survey software, a precision single-beam echosounder, a Trimble DGPS, and a TSS DMS02 Motion Reference Sensor (MRS). The echosounder, DGPS, and MRS were interfaced to the survey computer via RS-232 serial ports.

For the survey period of October 12 to October 20, 2005, depth measurements were collected using a SyQwest, Inc. (formerly Ocean Data Equipment Corporation [ODEC], Inc.) HydroBox dual-frequency precision echosounder equipped with a dual frequency (33-kHz, 20 degree and 200-kHz, 6-degree) transducer. The dual-frequency signal accurately digitized the surface and bottom of flocculent sediment (where present) and exported these two depth values to the HYPACK data acquisition software. The echosounder was controlled from a second laptop computer which recorded the full spectrum *.odc transect files using Hydrobox software. These files included navigation and depth data. Dynamic adjustments to signal gain and range were made as necessary to ensure high quality data. The echosounder transducer was mounted to the rail of the survey vessel amidships using one of CR's high-strength adjustable booms. The DGPS antenna was attached to the top of the transducer boom, eliminating the need to correct for horizontal offsets. The transducer depth below water surface was checked and recorded at the start and end of each day.

The accuracy of the HydroBox is approximately 0.5% of the water depth with a resolution of 0.1 ft. System accuracy was checked at the start and end of each survey day by comparing echosounder water depth measurements to known water depths. Known water depths were obtained using the "bar check" method, in which a metal plate was lowered beneath the echosounder's transducer to several known distances (e.g., 5.0, 10.0, 15.0 and 20.0 ft) below the water surface. Based on these comparisons, the echosounder was calibrated for shallow water conditions. "Bar-check" calibrations were consistently accurate to within 0.1 ft throughout the survey.

Because shallow water profile characteristics did not accurately represent the stratified water profile characteristics at the lake, additional calibrations were conducted *in situ* twice per day by collecting water column profiles of sound velocity. Sound velocity in water can be determined based on measurements of temperature and salinity. Measurements of water column temperature and salinity were performed using either a Seabird SEACAT-19 CTD water quality profiler or an InSitu, Inc. Troll 9000 water column profiler. A sound velocity profile was calculated using the Chen equation (C-T. Chen and F. J. Millero, 1977). Profile data were entered into HYPACK and were used to adjust raw soundings.

The bathymetric data acquisition system was calibrated for system latency (i.e., the short delay between DGPS position solution and digital recording on the acquisition computer) by collecting data along a cross-slope transect in reciprocal directions. Data for the two survey transects were compared using HYPACK and a time correction factor of 0.25 seconds was calculated. This correction factor accounts for the slight delay between DGPS position solution calculation and digital recording on the survey computer.

On October 20, 2005, the survey crew noted that the HydroBox with the dual frequency transducer was irregularly digitizing the lake bottom in depths generally less than 5 ft. After consultation with Parsons, the HydroBox was demobilized and was replaced with a SyQwest Bathy500-MF precision echosounder equipped with a 200-kHz 8-degree transducer. The Bathy500-MF has the same accuracy and precision as the HydroBox, but collects data using a single frequency. This system was used to collect depth soundings for the remainder of the survey.

Redundant backups of bathymetric data were recorded to compact disk and a 40GB removable hard drive at the end of each survey day.

4.2 Bathymetric Data Processing

Bathymetric data were processed using the HYPACK Single-Beam Processor Module. Individual transect data were visually inspected in profile format, and components of processing included removal of outlying soundings associated with water column interference (e.g., fish, vegetation, or mid-water column debris), conversion of soundings to NAVD88 elevations based on recorded water level data, correction of soundings for variations in sound velocity, and adjustment of sounding locations based on latency corrections.

After performing these data adjustments, the processed bathymetric data were combined into a single comma-delimited ASCII text file including fields for Northing, Easting, and Elevation. Data were converted to the desired New York State Plane grid (Central - 3102) (NAD83, US Foot) using ACE Corpscon Version 6.0. The Corpscon data output consisted of a comma-delimited ASCII text file with fields for Northing, Easting, and Elevation. This file was converted to SHP format.

CR carefully digitized the apparent shoreline on a high resolution orthophoto provided by Parsons. A total of 1,147 points were manually digitized. Based on the average lake elevation over the last 30 years, which was noted in the RI report, these points were assigned an elevation of 362.82 feet (NAVD88), the reported average lake level over the last 30 years. These digitized points were merged with the bathymetric data in order to allow interpolation of bottom elevations between the assumed shoreline and the nearest soundings. This combined data set was imported to Golden Software, Inc. Surfer V.8.1 Surface Modeling Software. A grid of the lake bottom elevations was created using triangulation interpolation methods and a 10 ft node interval. A contour map depicting bottom elevations using a 1 ft contour interval was created from this grid and the map was exported in SHP and DXF formats. A second map was created using conventional hydrographic spectrum shading and this map was exported as a georeferenced TIF image file. It is noteworthy that minor contouring anomalies were generated in portions of SMUs 5 and 8 due to the wide line spacing (200 ft) relative to the specified grid density of 10 ft.

4.3 Side-Scan Sonar Data Acquisition

Side-scan sonar data were collected between October 12 and October 26, 2005. Additional side-scan sonar data were collected for specific areas of interest such as shipwrecks on November 5 and 6, 2005. Data were collected along every third of the parallel bathymetric survey transects in littoral SMUs and along all survey transects in SMU 8 and portions of SMU 5 (i.e., 82 ft transect spacing for littoral SMUs and 200 ft spacing for SMU 8 and portions of SMU 5. Side-scan sonar data were acquired using an Edgetech 272 TD towfish interfaced to a topside processor via an Analog Control Interface (ACI) circuit. The ACI allowed adjustment of both port and starboard signal gains as judged necessary by the sonar operator. Control of the ACI and sonar signal settings was accomplished using Chesapeake Technology, Inc. SonarWizMAP acquisition software.

Sonar data was collected using a 100-kHz or 500-kHz signal and 82 to 164 foot range scales, resulting in approximately 200 percent overlap for littoral SMUs and approximately 82 percent overlap for SMU 8 and portions of SMU 5. This data was augmented by high resolution swaths collected along the majority of the shoreline and over features of specific interest (e.g., wreckage, depressions). The side-scan towfish was towed as near to the bottom as possible given abundant debris. Survey activities in shallow nearshore areas were conducted by deploying the towfish from the bow of *Lophius* with the towfish approximately 1 ft beneath the water surface. This allowed acquisition of data in very shoal conditions, with the shoalest area corresponding to a water depth of approximately 1.5 ft, depending on bottom and shoreline morphology. Section 5.2 of this report presents several examples of sonar data collected in nearshore areas. For example, Figure 27 depicts a thoroughly insonified (i.e. detected by the side-scan sonar system) lakebed at an elevation of 362 ft in SMU 7. During earlier portions of the survey conducted in the deeper waters of SMU 8, the water column was thermally stratified. This thermocline caused refraction of the sonar signal which was observed to adversely affect the sonar data. The effects of refraction were minimized by manipulation of the towfish height above bottom. The length of towfish cable let out relative to the DGPS antenna (i.e., layback) was recorded for each line to aid position correction during processing.

All data was archived to CD and removable hard drive(s) at the end of each survey day. Draft sonar mosaics were produced regularly in the field and at CR's office to ensure adequate survey coverage and to allow identification of noteworthy features.

4.4 Side-Scan Sonar Processing

Sonar data were processed redundantly using two Chesapeake Technology, Inc. software packages, SonarWeb and SonarWizMAP. SonarWeb was used to create the sonar mosaics, HTML navigable data files and GIS formatted navigation shapefiles. The navigation files are best queried and analyzed in ESRI ArcMAP 9.0 (or later). SonarWizMAP was used to digitize and classify objects depicted on the sonar records. These digitized objects (Contacts) were exported in HTML navigable format, as well as several GIS and CAD formats.

Processing of raw side-scan sonar data in SonarWeb consisted of corrections for towfish layback (i.e., the distance between the towfish and the DGPS antenna), adjustments of data for signal attenuation, and georeferencing of sonar imagery (i.e., projection of the sonar data into real-space coordinates). First, water column portions of the acoustic returns were removed through inspection and processing of each survey transect. The raw data were then corrected by calculating and applying accurate layback and catenary coefficients to each of the data files. Layback and catenary (i.e., factor corresponding to the approximate degree of cable curvature) corrections were calculated from the recorded "cable out" using a simple trigonometric function and the height of the towfish above the lakebed. The accuracies of the calculated corrections were evaluated by comparing the reported locations of features shown on sonar data for reciprocal survey transects, and by comparing reported feature locations with actual positions documented by the bathymetric data. Data were then adjusted for variations of the sonar beam angle of incidence relative to the lakebed (Beam Angle Corrections - BAC) and signal attenuation with distance (Time Varied Gain Corrections - TVG). Georeferenced mosaics and transect data were created and delivered using variations of the BAC and TVG corrections, including a dataset produced without BAC or TVG adjustments, a data set produced using only BAC correction, and a data set produced using only TVG adjustments. This redundant processing was conducted to take advantage of characteristics of each type of adjustment without the risk of obscuring the raw data. The resolution of georeferenced imagery was set to 0.98-ft per pixel. This roughly matches the mid-range of the 100 kHz sonar resolution while taking advantage of the higher 500 kHz resolution. Note that sonar waterfall imagery resolution was not constrained by this pixel size determination.

Side-scan sonar data processed in SonarWeb were delivered in several forms including: georeferenced JPG files, high-resolution annotated "waterfall" imagery (uncorrected raw data) of each survey lane, and GIS shapefiles (polygons) of transect navigation data, with the width of the polygons corresponding to sonar range settings. Also, a set of HTML files for the project was created, allowing Web-browser (i.e., Internet Explorer or Netscape) access to all survey data and imagery. Georeferenced sonar data were incorporated in a GIS database for comparison with other data. Because of the degree of overlap between navigation polygons, the navigation shapefiles are best queried and analyzed in ESRI ArcMAP 9.0 (or later). It is also important to note that while the mosaics produced for this report included all projected sonar files, users of ArcMAP can create customized mosaics of areas of specific interest by selectively adding data for individual transects and adjusting image transparency and contrast. In some instances, selective removal of the extensively overlapped sonar data may result in a "clearer" image.

Processing of raw side-scan sonar data in SonarWizMAP consisted of many of the same elements described above, including water column removal, layback corrections, and TVG adjustment. Processed data were inspected for Contacts (bottom features) on a line-by-line basis. Observed Contacts were digitized. Based on consultation with Parsons, only objects greater than 5 ft long in any dimension were digitized, but smaller contacts could be digitized in the future from this data. The digitizing process generated a high-resolution "waterfall" imagery of each object, as well as approximate dimensions, height above bottom, and position. Because the sonar data had a great degree of overlap, many Contacts were depicted on more than one survey transect and were digitized more than once. CR reviewed sonar data and imagery for these replicates and selected the most representative digitized Contact for inclusion in a sonar database. Replicate images of some Contacts, including wrecks and obviously man-made structures, were retained because it is helpful to evaluate records collected from as many angles as possible when characterizing such features.

Digitized Contacts were exported from SonarWizMAP as an HTML-navigable database which included sonar imagery, Contact dimensions, positions, and a general classification of the object's nature. Side-scan sonar contacts are presented in reverse bronze scale, with lighter portions of the image representing strong signal returns, and dark or black portions of the image representing sonar "shadows". The water column is shown as a dark or black band above the first return. CR Environmental digitized contacts that were greater than 5 ft in any dimension. Digitized contacts were limited to 5 ft to bound the extent of targets identified in the large study area and limit the initial database size. Based on subjective evaluation of sonar imagery, contacts were assigned to one of several classes. These classes include:

- "Depressions" (if anomalous relative to surrounding data);
- "Mounds" (if anomalous relative to surrounding data);
- "Wreck";

- "Debris (man made)" – Contact has a complexity and signal return which suggests man-made origin;
- "Furrows" – Linear depressions created by objects pulled along the lakebed (e.g., anchor);

- "Debris" – Default classification for Contacts. Class likely includes natural and man-made objects;
- "Structure" – Contact appears to be related to a civil or engineered feature;
- "Textural Anomaly" – Substrate appears unnaturally coarse or fine relative to the surrounding lakebed; and
- "Vegetation" – Patches of irregular reflectors commonly associated with aquatic vegetation in shallow water.

Note that in most cases, interpretation of side-scan sonar data is a subjective task. CR has offered these classifications to aid the focus of a sonar layperson interested in a small subset of the data (e.g., depressions or wrecks). It is possible that many Contacts assigned the default classification "debris" may be of man-made origin, and that some Contacts classified as man-made debris may be natural woody objects. The Contact database was also delivered in SHP and DBF formats to allow for GIS mapping efforts.

4.5 Sub-Bottom Sonar Data Acquisition

During the bathymetric survey, sub-bottom sonar data were collected simultaneously along the same set of survey transects. Data were collected using a SyQwest 10-kHz Stratabox sub-bottom profiling system. This system consists of a large transducer mounted to a vertical boom on the amidships rail, an on-board signal processor and amplifier, and a data acquisition computer. Data were recorded in .ODC format using proprietary StrataBox software running on a dedicated laptop computer. The StrataBox software and the integrity of logged data files have been third-party verified by several leading geophysical software companies, including CodaOctopus, Inc., Chesapeake Technology, Inc., and Triton Imaging, Inc. The computer was interfaced to the

DGPS through a serial port. Offsets between the transducer and the DGPS antenna were recorded to allow position correction during data processing. Data were archived to CD and portable hard drive(s) at the end of each survey day.

4.6 Sub-Bottom Sonar Data Processing

Sub-bottom profile data were processed using Chesapeake Technology's SonarWeb software. Appropriate adjustments to TVG were made during processing. Sub-bottom profiles were exported in JPG format with accompanying HTML-navigable indices and GIS shapefiles (polygons) of transect navigation data with the width of the polygons corresponding to sonar range settings. As with side scan sonar data, because of the degree of overlap between navigation polygons, the navigation shapefiles are best queried and analyzed in ESRI ArcMAP 9.0 (or later). Several sample profiles were selected for each SMU and inclusion in this report. The deepest reflector on each of these profiles was digitized and appears as a red polyline.

4.7 Magnetic Data Acquisition

During the geophysical survey, magnetic data were collected simultaneously with the bathymetric and sub-bottom data along the same set of survey transects. Magnetic data were acquired using a Geometrics, Inc. G-881 High resolution marine Cesium magnetometer system. The magnetic data acquisition system consisted of the magnetic sensor mounted on a towfish, an onboard power supply and serial interface, and a data acquisition computer. The data stream from the magnetic sensor was routed to the HYPACK navigation computer via serial port. HYPACK recorded magnetic readings in gammas (1.0 gamma = 1 nanoTesla) as a separate field within the same raw data file containing bathymetric soundings. The position of the magnetometer towfish was calculated in real-time using a HYPACK mobile device driver which considered "cable out" relative to the DGPS antenna, the cable catenary curve, and the effects of vessel course corrections.

The magnetometer towfish was kept as close to the lakebed as practical during survey activities in greater than approximately 15 ft depths. In shallow portions of the lake, the towfish was suspended from a surface float to prevent collision with the bottom or impact with debris. The sensor was consistently deployed at a great enough distance from the survey vessel to preclude the potential for magnetic interference from the hull.

4.8 Magnetic Data Processing

Magnetometer data were processed using HYPACK's Single-Beam Processor Module and the HYPACK GRatio program. The processing effort was designed to generate three magnetic data products:

- The positions and approximate magnitudes of anomalies observed during close inspection of data for individual transects;
- A database consisting of total magnetic field intensity measurements for the entire lake; and
- A database consisting of relative magnetic gradient data which minimizes temporal and geological interferences.

Each magnetic survey transect was first inspected in profile format for characteristic signals which indicate the presence of ferrous anomalies. Observed anomalous signals were digitized to an ASCII database including fields for position, approximate magnitude (in gammas), and shape. Signal shape classifications included dipolar (DP), Monopolar (MP) and Monopolar negative (MP-). The final database contained 1,256 digitized anomalies. Note that due to the highly sensitive nature of the cesium vapor sensor and the closer proximity of survey transects, it is likely that many of these anomalies are magnetic signatures of the same ferrous object detected on multiple parallel transects.

After inspecting each data file and digitizing anomalies, magnetic measurements were merged into a single ASCII comma-delimited database containing all total field (TF) magnetic intensity measurements for the entire lake. The database contained fields for Northing, Easting, and magnitude. This combined data set was imported to Golden Software, Inc. Surfer V.8.1 Surface

Modeling Software. A grid of magnetic intensity was created using triangulation interpolation methods and a 15 ft node interval. A contour map was created from this grid depicting TF magnetism using a 10-gamma contour interval and the map was exported in SHP and DXF formats. A second map was created using spectrum shading and this map was exported as a georeferenced TIF image file.

The final magnetic data processing procedure employed is sometimes referred to as the "Pole-Reduction" technique. This method effectively eliminates background magnetic interference associated with geologic structures and temporal/diurnal magnetic variations by transforming total field measurements into gradient values. Data were transformed by subtracting sequential TF values and replacing the original values with the difference called the magnetic gradient value (or "Gratio", HYPACK survey software). An example of the calculation in HYPACK of these magnetic gradient values (Gratios) from total field intensity measurements is provided below (e.g., 54,390.91 gammas – 54,391.97 gammas = -1.06 gammas, the Gratio).

Gratio	Time	Easting	Northing	Gamma
-1.02	09:35:47	402564.75	4769392.43	54389.88
-1.03	09:35:47	402564.50	4769392.46	54390.91
-1.06	09:35:48	402564.25	4769392.48	54391.97
-1.16	09:35:48	402564.00	4769392.51	54393.13
-1.18	09:35:48	402563.75	4769392.53	54394.31
-1.25	09:35:48	402563.49	4769392.56	54395.56
-1.26	09:35:48	402563.24	4769392.58	54396.82
-1.39	09:35:48	402562.98	4769392.61	54398.21

All TF magnetic data were transformed into this pole-reduced (PR) form and merged into a single ASCII comma-delimited database including fields for Northing, Easting, and "Gratio" (in gammas). This combined data set was imported to Golden Software, Inc. Surfer V.8.1 Surface Modeling Software. A grid of "relative" magnetic intensity was created using triangulation interpolation methods and a 15 ft node interval. A contour map was created from this grid depicting PR magnetism using a 5-gamma contour interval and the map was exported in SHP and DXF formats. A second map was created using spectrum shading and was exported as a georeferenced TIF image file.

5.0 GEOPHYSICAL SURVEY RESULTS

5.1 Bathymetry Results

Figure 5 is a 1 ft contour interval bathymetric map of Onondaga Lake generated from the 2005 data set. The lake has two main basins. The larger southern basin (minimum elevation 298 ft NAVD88) is slightly deeper than the northern basin (minimum elevation 302 ft NAVD88). The mean and minimum elevations of the lakebed are 324.7 ft and 297.1 ft, respectively. Volume and surface area calculations for the lake were conducted using Surfer V. 8.1 by comparing the bathymetric grid surface to the assigned shoreline elevation of 362.82 feet. The volume of the lake is approximately 112,740 acre-feet. The planar area of the lake surface is approximately 2,952.5 acres. The surface area of the lakebed is slightly greater than the surface area due to irregular morphology, and was calculated as approximately 2,955.8 acres.

Figures 6 through 15 are bathymetric contour maps of SMUs 1 through 7, respectively. These figures include vertically exaggerated “3-dimensional” artificially illuminated surface maps of each SMU to facilitate recognition of bathymetric features. SMU 5 was divided into four areas of interest (Areas “A”, “B”, “C” and “D”) based on anticipated remediation strategies (see Figures 10 through 13).

5.2 Side-Scan Sonar Results

Side-scan sonar data have historically been depicted as a range of gray shades that correspond to the strength of the returning signal. Shading is used to infer bottom type and topography. A superior inverted bronze colorized shading scale is recommended to optimize data analysis and target recognition. This scale is recommended because most people using the data can perceive a wider range of color shades than gray shades, and are most sensitive to the color scales' longer wavelengths. A key to the inverted bronze scale is provided below. Note that sonar mosaics were delivered digitally in a grey scale. The colorization process was conducted using ArcMAP 9.0 GIS software.

Key to Side-scan Sonar Image Shading

Sonar shadow------------ Weak Signal Return------------------------Strong Signal Return

Side-scan sonar results are presented as a mosaic of gray or color shaded information. In general, weak signal returns correspond to smooth lakebed substrates (e.g., fine sediments with little micro-topography), soft materials that absorb the signal, or lakebed sloping away from the signal source (towfish). These features appear medium to dark brown in the inverted brown scale and lighter gray in the conventional scale. Strong signal returns correspond to rough lakebed substrates (e.g., gravel, cobble), highly reflective materials, or to a lakebed sloping towards the signal source. These features appear as lighter shades of brown and orange in the inverted brown scale and dark gray to black in the conventional scale. Features that rise above the seabed (e.g., wreckage) reflect more of the sonar energy than the surrounding substrate resulting in strong signal returns due to decreased angle of incidence. These features often prevent insonification of the area opposite the signal source, resulting in a sonar "shadow" (dark brown to black in the inverted brown scale and white in the conventional scale). The length of these shadows can be used to calculate the approximate height of the elevated features.

The Project Data DVD included as Attachment "A" contains the HTML navigable database of digitized side-scan sonar "Contacts" (features of interest). The resolution of images in this database is superior to that of the georeference mosaics. Figure 16 depicts the overall distribution of digitized sonar Contacts. Figures 17A though 17E are sample imagery and descriptions of these Contacts. Figures 18 through 27 show Contacts and colorized mosaics for each SMU, and the four areas of interest in SMU 5 (“A” through “D”) are presented on Figures 22 through 25.

As shown on Figure 16, the majority of sonar Contacts were identified within approximately 1,500 ft of shore, with the greatest concentration observed near the outer edges of SMU 1 and SMU 7. Most Contacts appear to be located on the mid to lower portions of slopes. The sonar data allowed definitive identification of the locations and orientations of outfalls and other structures (e.g., see Figures 17D and 17E), vessel wreckage (e.g., see Figures 17A and 17B), and widespread irregularly shaped debris. Side-scan data also allowed construction of high resolution images depicting numerous large ring-shaped depressions (Figure 17C). In addition to digitized Contacts, sonar data identified abundant smaller debris of potential interest. Figure 28 shows a portion of the mosaic in SMU 8 (“raw” sonar imagery, without BAC correction). This image depicts an approximately 900 ft long linear trail of debris. Two circular depressions are located at the western terminus of this debris field. Note that while segments of this debris trail were included in the database of digitized Contacts and a GIS polygon was constructed to encompass the trail, inspection of the mosaic provides a clearer representation of the size and orientation of the field. Similarly, Figures 29A and 29B show a small field of Contacts in the northern portion of SMU 8. While at least two of the larger objects within this field (i.e., larger than 5 ft in any dimension) were digitized and included in the database, the data suggests the presence of as many as 18 individual smaller objects. This debris field was also encompassed within a GIS polygon delivered with the sonar database (and included on the DVD in Attachment A). Many of the reflections from these smaller objects appear in parallel multiple sets. This type of reflection sometimes indicates the presence of fluid filled containers, with the parallel reflections caused by “ringing” of the signal within the container. It is equally possible that these Contacts are hardwood logs or similarly shaped objects. These data highlight the prudence of follow-up investigations for some sonar Contacts, if they are located in an area of interest, using direct means of observation such as drop video.

In several portions of SMU 8, particularly in the northern basin, the sonar data identified dense networks of furrows which generally followed the long axis of the lake. Figure 30 is a sample of this type of bottom feature. Furrows of this nature are commonly associated with bottom trawl fishing gear. Such a fishery or similar bottom disturbance caused by fishery research has not been reported to CR. However, if the type of bottom disturbance and the approximate dates of the disturbance were identified, the presence of these furrows would provide insight into the stability of the profundal benthic substrates over time.

The northern portion of SMU 8 contains numerous bottom features which appear to be composed of piles of coarse debris (e.g., cobble, brick, rock) interspersed with similarly sized depressions. Figure 31A depicts the extent of these features, and Figure 31B presents a detailed sonar "waterfall" image of a group of mounds. As shown on Figures 31A and 31B, many of these features appear to occur in evenly spaced "chains". Similar features are commonly observed on sonar records collected at dredged material disposal areas, and are the result of serial release of material from barges. Given the close proximity of these features to the northern canal entrance, it is possible that the features may be dredge spoils associated with construction or maintenance of the canal. It is noteworthy that the irregular terrain associated with these mounds and depressions is responsible for significant contouring artifacts on the bathymetric map in this portion of the lake (see Figure 5 and digital bathymetric data).

5.3 Sub-Bottom Sonar Results

The spatial extent of areas of successful sub-bottom penetration was heterogeneous and limited. It is possible that wide expanses of the lakebed contain entrained natural gases (e.g., mixtures of sulfides and methanes) associated with microbial degradation of organic detritus. This phenomenon was also documented by NYSDEC (Proposed Plan, November 29, 2004), and is quite common in relatively quiescent freshwater lakes.

Interpretation of seismic reflection data in very shallow water is frequently complicated by the presence of strong multiple reflectors which are present on profiles at intervals slightly greater than 2x the depth below the transducer. Confounding this approach is the fact that sedimentary patterns often approximate parent strata morphology. A second significant source of interference in sub-bottom data is introduced by artifacts termed “multipath” reflections. These artifacts are generated when the sonar signal follows an indirect path from the transducer to the sediment surface, resulting in anomalous “ghost” reflections which may appear in the sub-surface or water column portion of the sonar record. A final major source of interference in sub-bottom sonar data is introduced by reflections associated with the side-lobes of the signal striking portions of the lakebed across-track or along-track, especially if steep slopes are nearby. The processing effort considered the potential presence of each of these artifact types in order to minimize the likelihood of misinterpretation of sub-bottom reflectors.

Appendices A-1 through A-8 present sub-bottom profiles (cross-sections) for each SMU, as identified in SOP 6. Locus maps indicating the precise location of each sample profile are presented on the first page of each Appendix. These locus maps utilize the side-scan sonar mosaic, shaded bathymetric transparency and color orthophotos to provide spatial reference. The sonar file name is referenced on both the locus and individual profiles to allow digital inspection using Stratabox playback software or the HTML-navigable database of sub-bottom sonar imagery.

Sample sub-bottom profiles for SMU 1 are provided in Appendix A-1. Horizontal grid lines (blue) on these profiles represent 20-ft depth intervals. Bottom elevations coincident with selected profiles ranged from approximately 341 to 350 ft (about 12 to19 ft deep). Penetration in SMU 1 appeared to be greatest along the mid to lower portion of the slope. Penetration in SMU 1 ranged from 0 ft for sediments potentially entrained with gases to greater than 27 ft below the sediment surface (see Profile 1). Sub-bottom substrates in each of the profiles appear to be stratified at regular intervals. Note that Profile 3 suggested the presence of 25 ft of stratified materials and also recorded a strong parabolic reflector at the location of a nearby outfall.

Sample sub-bottom profiles for SMU 2 are provided in Appendix A-2. Horizontal grid lines (blue) on these profiles represent 20-ft depth intervals. Bottom elevations coincident with selected profiles ranged from approximately 339 ft (Profile 2) to 359 ft (Profile 3) or about 3 to 23 ft deep below the water surface. Interpretation of these profiles was confounded by the presence of multiple reflectors. Data for each of these profiles suggested the presence of layered substrates extending from 37 to 50 ft beneath the sediment surface.

Sample sub-bottom profiles for SMU 3 are presented in Appendix A-3. Horizontal grid lines (blue) on these profiles represent 20 ft depth intervals. Bottom elevations coincident with selected profiles ranged from approximately 341 ft to 351 ft (about 12 to 21 ft deep below the water surface). Data for the sample profiles suggested the presence of 7 to 23 ft of sediment.

Sample sub-bottom profiles for SMU 4 are provided in Appendix A-4. Horizontal grid lines (blue) on these profiles represent 20-ft depth intervals. Bottom elevations coincident with selected profiles ranged from approximately 345 ft to 359 ft (about 3 to 18 ft deep below the water surface). All three of the selected profiles were collected from a small embayment near the western portion of the SMU. Penetration in this area of SMU 4 was excellent, and suggested the presence of 35 to 60 ft of stratified substrates. Penetration for the remainder of SMU 4 appeared to be minimal.

Sample sub-bottom profiles for SMU 5, Area “A,” are provided in Appendix A-5A. Horizontal grid lines (blue) on these profiles represent 20-ft depth intervals. Bottom elevations coincident with selected profiles ranged from approximately 358 ft to 360 ft (about 2 to 4 ft deep). Despite these shallow depths, sub-bottom penetration and resolution in SMU 5 Area “A” was amongst the most successful of any littoral SMU. The sample records show 29 to 42 ft of layered material. Profile 2 consistently showed an undulating strong reflector beneath the layered material for its entire 1,065 ft length. It seems likely that some physical, chemical, or biological mechanism is preventing the accumulation of entrained natural gases (and possibly sediment compaction) in this area. Sediments in this area may have been reworked during construction of the Thruway Bridge. An alternate hypothesis for the superior sonar data in this area is that it may have abnormally high groundwater discharge, although such a hypothesis is not supported by data for this area.

Sample sub-bottom profiles for SMU 5, Area “B” are provided in Appendix A-5B. Horizontal grid lines (blue) on these profiles represent 20-ft depth intervals. Selected transects were located on a relatively flat shoal shoreward of an elongated underwater ridge which may be a relict structure associated with the historic resort. Bottom elevations coincident with selected profiles ranged from approximately 356 ft to 358 ft (about 4 to 6 ft deep). Sub-bottom sonar data suggests that as much as 32 ft of stratified sediments are located in Area “B.”

Sample sub-bottom profiles for SMU 5, Area “C” are provided in Appendix A-5C. Horizontal grid lines (blue) on these profiles represent 20 ft depth intervals. Bottom elevations coincident with selected profiles ranged from approximately 356 ft to 347 ft (about 6 to 15 ft deep). Sub-bottom sonar data suggests the presence of a highly reflective strata approximately 5 to 9 ft below the sediment surface.

Sample sub-bottom profiles for SMU 5, Area “D” are provided in Appendix A-5D. Horizontal grid lines (blue) on these profiles represent 20 ft depth intervals. Selected transects were located approximately 80 ft to the east of a large pipe or outfall which is clearly depicted on both bathymetric and side-scan sonar data. Bottom elevations coincident with selected profiles ranged from approximately 358 ft to 359 ft (about 3 to 4 ft deep). Sub-bottom sonar data suggests that as much as 34 ft of stratified sediments are located in Area “D.” However, this interpretation of the sonar data is tenuous due to shallow depths and associated interference.

Sample sub-bottom profiles for SMU 6 are provided in Appendix A-6. Horizontal grid lines (blue) on these profiles represent 20 ft depth intervals. Bottom elevations coincident with selected profiles ranged from approximately 358 ft to 359 ft (about 3 to 4 ft deep). Sonar penetration in SMU 6 was limited to the northern portion of the SMU near the outlet of Ley Creek. Sample profiles from this area suggest the presence of 31 to 54 ft of layered sediment. However, this interpretation of sonar data is tenuous due to shallow depths and associated interference.

Sample sub-bottom profiles for SMU 7 are provided in Appendix A-7. The sub-bottom sonar system did not penetrate sediments in any portion of SMU 7. Sample profiles were included for this SMU to illustrate the typical appearance of multiple reflections. It is likely that penetration in SMU 7 was negated due to the presence of natural gases in surficial sediments.

Sample sub-bottom profiles for SMU 8 are provided in Appendix A-8. Horizontal grid lines (blue) on these profiles represent 20 ft depth intervals. Penetration of sediments in SMU 8 was infrequent. Sample profiles were selected from a portion of SMU 8 previously identified as "Fluid Venting Locations; Possible Gas Venting, Springs, or Waste Material Areas; and Fluid Venting Areas" (see PDI Phase I SAP, Figure 2). Profile 1 was located at an elevation of 305 to 306 ft (approximately 58 ft deep). The side-scan sonar data at this location indicated the presence of a broad circular depression (see sonar Contacts 0378 and 0380 on the DVD, Attachment 1). Sub-bottom sonar data along Profile 1 suggests the presence of as much as 37 ft of sediment. The profile also intersects one of the circular depressions. A faint parabolic reflector is visible directly beneath the depression and may indicate an accumulation of natural gas. Note also that the edges of the depression are slightly raised relative to the adjacent lakebed, suggesting that the depression may have initially formed as a mound which collapsed after release of entrained gases. Profiles 2 and 3 depict additional circular depressions. The dimensions of the depressions are relatively consistent with depths of 2 to 3 ft and widths of 60 to 80 ft. The northwestern depression depicted on Profile 3 (left) shows water column interference directly above the feature. The southeastern depression (right) is located above a faint parabolic reflector, similar to the observation noted for Profile 1. While Profile 3 suggests the presence of up to 50 ft of sediment, this characterization is uncertain due to the survey transect's orientation relative to the northern slope. It is possible that the highlighted sub-bottom strata (red) on Profile 3 is actually a sonar side-lobe reflection from the nearby sloped lakebed.

5.4 Magnetic Data Results

As discussed in Section 4.8, magnetic data were redundantly processed to yield three data sets including: an ASCII database of Total Magnetic Field (TF) measurements, an ASCII database of

Pole-Reduced (PR) magnetic ratio values, and a database of manually digitized anomalies, including anomaly magnitudes and signal shapes. The base maps and databases discussed below have been delivered as high resolution TIFs, SHP formatted contour maps, and in SHP and XLS database formats.

Figure 32 presents contours created from TF magnetic measurements using a 5-gamma (g) interval. A magnetic field gradient is clearly visible from the northwestern to southwestern portions of the lake. The magnitude of this gradient was great enough to outweigh temporal field variations over the course of the survey. This gradient may reflect depth to bedrock or sedimentary properties. Large anomalies, including outfalls, pipelines, and wrecks are easily identifiable on Figure 32.

Figure 33 presents contours created from PR magnetic measurements using a 5-gamma (g) interval. The PR processing method successfully minimized geological and temporal variations of background magnetic fields, allowing closer inspection of magnetic anomalies associated with man-made structures and debris. Figures 34 and 35 present TF and PR magnetic maps for the southern basin to illustrate differences between the two processing approaches. These figures demonstrate the ability of the PR method to facilitate identification of low magnitude anomalies which were masked by background field intensity.

While the two databases presented on Figures 32 through 35 allow broad-scale analyses of magnetic data, it is important to note that the depicted anomalies are based on interpolation of data between transects spaced 25 to 200 ft apart. As with all contour maps produced using interpolation methods (e.g., bathymetry), the contouring process may introduce small data artifacts and obscure fine-scale data features of potential interest due to grid dimensions. For these reasons, CR has produced maps of magnetic anomalies from the manually digitized database. The maps include side-scan sonar and bathymetric base maps using GIS transparency settings, allowing review of ferrous anomalies relative to surficial sonar Contacts and basin morphometry. Anomalies on these maps have been color coded by magnitude.

Figure 36 presents magnetic anomalies digitized in SMU 1. Low-magnitude anomalies were widespread throughout all of SMU 1's littoral zone and two outfalls are clearly depicted extending from the shore to deeper water. These outfalls are also identified on side-scan sonar and bathymetric data records. Most of the near-shore magnetic anomalies recorded in SMU 1 did not appear to be associated with side-scan sonar Contacts, suggesting that the ferrous or fired debris associated with the anomaly may be buried beneath the sediment surface. Conversely, many of the side-scan sonar Contacts digitized for SMU 1, particularly those located in the northeastern portion of the SMU, were not associated with magnetic anomalies. This suggests that these sonar Contacts are non-ferrous (e.g., woody debris).

Figure 37 presents magnetic anomalies digitized in SMU 2. Low-magnitude anomalies were sparsely distributed in SMU 2. Moderate to high magnitude anomalies (~1,000 g) were recorded at the northern extent of SMU 2. Co-located side-scan data suggests a lens of coarse material extending into the lake. One ferrous pipeline was depicted in SMU 2 extending from the shore to deeper water beyond the limit of the SMU. This feature was recorded by both side-scan sonar and the single beam echosounder, confirming a surficial expression. Historical data for SMU 2 identifies this feature as a possible "drain or intake".

Figure 38 presents magnetic anomalies digitized in SMU 3. Low to high magnitude anomalies were sparse in SMU 3, with the exception of the northernmost portion of the SMU. Several large anomalies (i.e., greater than 1,000 gammas) were recorded near the land feature identified on the U.S.G.S. 24k Quadrangle as Lakeview Point. Historical data shows polygons representing the footprint of the "old resort" in this area. None of the remaining anomalies in SMU 3 were previously identified in the historical data. Some of the magnetic anomalies recorded in SMU 3 appear to be co-located with side-scan sonar Contacts, suggesting surficial expression of ferrous material. Many of the anomalies, particularly those on the northern shore on Lakeview Point, did not match digitized side-scan sonar Contacts. This suggests that the ferrous or fired material responsible for the magnetic anomaly is buried beneath the sediment surface.

Figure 39 presents magnetic anomalies digitized in SMU 4. Magnetic anomalies were concentrated in the shoal portion of the SMU. The highest concentration of anomalies was distributed near the mouth of Ninemile Creek. A wreck was identified in the eastern portion of the SMU. The maximum recorded anomaly magnitude at the wreck was 1,235 gammas. This wreck was also identified by side-scan sonar (see Contact 0501). An approximately 250 ft long linear distribution of anomalies was recorded in the southeastern portion of the SMU and may represent a pipeline or cable. The historical data did not identify structures in this area. The majority of anomalies in SMU 4 did not correspond to digitized side-scan sonar Contacts, suggesting that these anomalies are either buried beneath the sediment surface or that the object(s) associated with the anomalies were smaller than the 5 ft minimum threshold for sonar Contact consideration.

Figure 40 presents magnetic anomalies digitized in SMU 5, Area "A." Very few anomalies were recorded in this area. None of the anomalies appeared to be associated with a side-scan sonar Contact. This suggests that these anomalies are either buried beneath the sediment surface or that the object(s) associated with the anomalies were smaller than the 5 ft minimum threshold for sonar Contact consideration.

Figure 41 presents magnetic anomalies digitized in SMU 5, Area "B." Magnetic anomalies were irregularly distributed throughout the southerly portion of Area "B", with a shoreward tendency. Magnetic anomalies did not appear to be associated with side-scan sonar Contacts, suggesting that these anomalies are either buried beneath the sediment surface or that the object(s) associated with the anomalies were smaller than the 5 ft minimum threshold for sonar Contact consideration. A linear arrangement of anomalies was recorded perpendicular to the southern shore of Area "B". The structure associated with these anomalies shows on digital orthophotos and appears to be a relict dock or pier.

Figure 42 presents magnetic anomalies digitized in and near SMU 5, Area "C." Magnetic anomalies were not recorded within the boundary of this area. This suggests that the side-scan sonar Contacts recorded for Area "C" were not ferrous or fired. Smaller anomalies were recorded slightly outside of the Area “C” boundary, and other anomalies within the boundary were suggested by contoured PR magnetic data (see Figure 33).

Figure 43 presents magnetic anomalies digitized in and near SMU 5, Area “D.” The most noteworthy group of anomalies in this area is a linear arrangement of high magnitude anomalies oriented perpendicular to the shoreline in the central portion of the area. The feature terminates approximately 630 ft from shore and is coincident with a GIS polyline identified as a pipeline or outfall. This same feature is depicted on side-scan sonar data (Figure 25), bathymetric data (Figure 13), and on the digital orthophoto. The remainder of the magnetic anomalies in Area 5 “D” possessed relatively low magnitude and were not associated with digitized side-scan sonar Contacts. This suggests that these anomalies are either buried beneath the sediment surface or that the object(s) associated with the anomalies were smaller than the 5 ft minimum threshold for sonar Contact consideration.

Figure 44 presents magnetic anomalies digitized in and near SMU 6. Magnetic anomalies were densely distributed throughout SMU 6, especially in near-shore areas. Two linear arrangements of high magnitude anomalies were identified extending perpendicular to the shoreline. Each of these features is approximately coincident with “pipelines or outfalls” identified in the historical data. A third linear arrangement of anomalies extends from the southern corner of SMU 6 to the southwest into SMU 7. This feature is identified as the “Sun Oil Line” in the historical data. This feature does not appear on the side-scan sonar data and is likely buried beneath the sediment surface. A cluster of high magnitude anomalies is located in the central portion of the SMU approximately 600 ft off shore. This cluster is coincident with a wreck identified by side-scan sonar (see Contact 0255). Many other low to high magnitude anomalies in SMU 6 appear to be co-located with the reported positions of the “old resort” in the historical data.

Figure 45 presents magnetic anomalies digitized in and near SMU 7. The most pronounced magnetic feature was the linear arrangement of anomalies extending from SMU 6 into the northern portion of SMU 7. This feature is classified in the historical data as a “pipe or outfall.” A feature described as the “Sun Oil Line” is associated with a second linear arrangement of anomalies approximately 490 ft from shore. A cluster of moderate to high magnitude anomalies located at the southeastern portion of SMU 7 appears to be co-located with the "old resort." Several of the magnetic anomalies in SMU 7 appear to be co-located with side-scan sonar Contacts. The majority of sonar Contacts identified for the northern portion of SMU 7 did not appear to be coincident with magnetic anomalies, suggesting non-ferrous composition.

Figure 46 presents magnetic anomalies digitized in SMU 8 (and for the entire lake). While fewer magnetic anomalies were recorded in SMU 8, the line spacing for SMU 8 was 8x greater than for the littoral SMUs, reducing the likelihood of object detection. Nonetheless, this transect spacing appears to have been sufficient for identification of large anomalies, such as the southern basin wreck identified as sonar Contact 0355.

6.0 DISCUSSION OF GEOPHYSICAL RESULTS BY SEDIMENT MANAGEMENT UNIT

The following Section provides a discussion of survey findings for each Sediment Management Unit (SMU) based on the lake bottom remedy specified in NYSDEC's 2005 Record of Decision. Table 1 summarizes bathymetric conditions for each SMU. Table 2 provides the density and dimensions of digitized side-scan sonar Contacts (i.e., features > 5 ft in any dimension) within each SMU. Prior to the SMU-specific discussion, the use and limitations of the various remote sensing technologies employed are highlighted to provide the reader with context for interpretation of the geophysical data.

6.1 Use and Limitations of Survey Technologies

Each of the four remote sensing technologies (i.e. single-beam bathymetry, side-scan sonar, sub-bottom sonar, and magnetometer) has detection capabilities and limitations. Understanding these systems' capabilities and limitations is essential to understanding how they affect data interpretation, and conclusions that may be drawn from the data. Co-located evidence of bottom features or anomalies using different technologies provides added detail and certainty. Generally surficial debris < 1 ft in any dimension is difficult to distinguish. In addition, small buried ferrous objects between magnetometer survey transect lines, and buried non-ferrous objects between sub-bottom survey lines cannot be detected.

6.1.1 Single-Beam Bathymetry

The single-beam echosounders used to map the lake are excellent tools for measuring water depth directly beneath the boat-mounted transducer, especially in shallow water. After applying adjustments for variations in water column sound velocity, recording latency, and water level fluctuations, these sonar depth measurements provide an accurate record of bottom elevations along survey tracklines. The closer the bathymetric survey line spacing, the less interpolation is needed to construct continuous elevation contours from single-beam data. All littoral SMUs at Onondaga Lake were surveyed with 82 foot line spacings to provide accurate estimates for dredge volumes. The water depth precision of the echosounders used for this survey is 0.1 ft. The manufacturer's published accuracy specification for both echosounders is 0.1 percent of the indicated depth (e.g., +/- 0.02 ft at 20 ft depths, +/- 0.06 ft at 60 ft depths). Given the mean lake depth of about 38 ft, a hypothetical mean accuracy of 0.04 ft would be expected. As previously discussed, other environmental variables influence the actual field accuracy of the sounding system. Among these variables are water column stratification, internal waves, differential mounding of water on the leeward side of the lake, and vessel motion. A reasonable, though unquantified, estimate of the affect of these variables on accuracy would be approximately 0.2 to 0.3 ft. In an attempt to quantify system accuracy and biases, coincident data points from survey transect data and "cross-tie" transect data were compared and summarized. This comparison was conducted using unsorted data (i.e., no thinning or binning to remove outliers). The comparison included over 1,400 co-located data points and suggests a mean difference between points of 0.14 ft, lower than the ACOE suggested allowable accuracy and mean bias values for "Soft Bottom Dredge Support Surveys".

The echosounder's ability to detect small scale features or objects directly beneath the transducer is largely a function of the transducer's beam-width and the water depth. For instance, the 'footprint' (insonified area) of the single beam 8 degree transducer used for this survey, was less than 2 sq ft at 10 ft depths, and increased to approximately 10 sq ft at 25 ft depths. Adjacent objects smaller than the beam footprint could not be differentiated and would be recorded as a single depth anomaly.

Because of the interpolation between survey lines required with single-beam bathymetry and the variation in beam footprint with depth, it is not the ideal instrument for identifying small scale morphological features or debris. Therefore, as on this project, it is often coupled with side-scan sonar technology which provides complete coverage of the bottom.

6.1.2 Side-Scan Sonar

The towed side-scan sonar system provides complete coverage of the bottom in varying swath widths depending on the instrument's frequency and water column characteristics. These swaths of data are pieced together to create mosaics providing a shaded image of the bottom based on the amplitude of the return signal and showing habitat features and substrate roughness and hardness. Side-scan sonar is an ideal instrument for identifying surficial obstructions and debris at the sediment surface. The forms and materials that make up obstructions and debris at the sediment mudline (the sediment-water interface) can be detected with side-scan sonar. Mosaics can be imported into HYPACK survey software allowing precision navigation to features of interest. Groundtruthing with grab sampling or video is important for substrate and image confirmation. The high frequency signal of the side-scan system does not substantially penetrate surficial sediments.

Side-scan sonar data can be used to estimate the approximate dimensions of detected objects on the lakebed, including object height above the mudline. These height measurements are made by measuring the length of sonar "shadows" behind objects, considering the height of the towfish and the corrected range to the object.

The ability of the side-scan system to detect bottom features is related to several characteristics of the sonar system and the method of deployment. Integral system characteristics which influence image resolution include signal frequency, horizontal and vertical beam angles, signal (ping) duration, swath range selection, and operator adjustments of signal gain controls. The resolution and quality of sonar imagery is also influenced by towfish depth, vessel survey speed, the degree of overlap between survey transects, and water column characteristics. Based on the operations procedure detailed in Section 4.3 and SOP 6, the approximate resolution of the side-scan sonar data collected for this project ranges from approximately 5 cm to 50 cm (about 2 to 20 inches), depending on the transect-specific settings. Data collected in littoral SMUs 1 through 7 were afforded at least a 200-percent overlap of the bottom coverage at a slow towing speed, reducing the possibility that significant features would be missed.

The positions reported for Contacts identified using side-scan sonar are subject to two uncertainties. The first uncertainty is associated with post-processing correction for the towfish layback (i.e., the distance between the DGPS antenna and the towfish). This correction has been applied to all data with demonstrable success. However, minor variations in vessel speed and towfish altitude can introduce some position uncertainty. This uncertainty is greatest for data in deep portions of SMU 8 where substantial lengths of tow cable were laid out to achieve the desired towfish altitude in the water column. This layback uncertainty is likely minimal (e.g. < 6 to 9 ft) in littoral SMUs for which short lengths of cable were deployed and the layback was infrequently manipulated. The second Contact position uncertainty is integral to all side-scan sonar systems. The side-scan sonograph is a two-dimensional record of the strength of the return sonar signal. As previously described in Section 4.4, raw sonar data is “slant-range” corrected by removing the water column portion of the sonograph. However, the two-dimensional nature of the data and the slant-range correction methods necessitate a geometric assumption of a flat lakebed (horizontal bottom). For instance, consider a sonar transect which runs parallel to the shoreline near the toe of a steep slope. Assume that the port channel is facing shoreward up the slope and that the sonar range is set to 82 feet. Because the sonar is recording the positions of bottom features using a range-calculation based on signal travel time, the reported “across-track” dimensions and position of a Contact observed mid-slope may be different than the actual dimension and/or position. Similarly, two objects at equal distance from the towfish (e.g., one object mid-slope at 50-foot range, another at the toe of the slope at 50-foot range) will overlap on the data record even though the true across-ground distance between the two may be substantial. This effect can introduce unwanted artifacts into the data. Sonar data acquired "up-slope" also results in decreased bottom grazing angles, shortened shadows associated with objects, and a decrease in the calculated object height. Additionally, more acoustic energy can be received on the up-slope channel, complicating classification of substrate reflectance relative to flat bottom areas. The inverse of these uncertainties associated with the "flat-bottom" assumptions occurs with the down-slope oriented sonar channel.

In order to estimate the likely magnitude of position errors on data collected in the deepest water (see Figure 2 in the report for vessel track lines), several adjacent data files, which intersected the central "ridge" between basins, were inspected. Estimated laybacks for the selected lines ranged from 75 feet to 105 feet. The difference between object positions' depicted on these files were measured. Position errors ranged from 4 feet to 25 feet (average 12.5 feet). The maximum position error was associated with a change in vessel heading.

6.1.3 Sub-Bottom Sonar

Sub-bottom sonar systems can be used to estimate the depth of various sediment strata or depth to bedrock, and can detect larger objects at or near the sediment surface. .The system used for this survey has been shown to penetrate and image up to 120 ft of sediment under ideal conditions. As alluded to in Section 5.3, sediment composition and geotechnical properties play a major role in determining sonar penetration. The acoustical impedance and sound absorption coefficient of sediments varies with grain size, pore space and several other characteristics, each of which influences penetration.

The major factor limiting sub-bottom sonar penetration in most organic-rich sediments such as Onondaga Lake is the common occurrence of natural gases. Gas accumulations may occur near the sediment surface or at depth. These gases are most commonly mixtures of sulfides and methane, and are produced by natural biodegradation of organic detritus. The great difference between the acoustic impedances of gas and sediment cause the majority of the sub-bottom sonar signal to be reflected back into the water column, effectively precluding sonar penetration. Such gaseous interference appeared to be prevalent in Onondaga Lake resulting in intermittent sonar penetration and ability to estimate sediment depth or detect large objects near the mudline.

6.1.4 Magnetometer

A magnetometer was used to identify ferrous containing objects both above and below the sediment surface, and to determine if features identified by side-scan sonar (above the sediment surface) contained iron. The magnetometer employed for the Onondaga Lake survey, a Geometrics Model 881, detects ferrous materials using a Cesium vapor and optical pumping technique which allows discrimination of magnetic variations as low as 1 gamma. The magnitude of a magnetic anomaly detected depends on the ferrous mass of an object and its distance from the magnetometer. A list of common objects and the typical maximum magnetic anomaly that would be detected is provided below for reference:

OBJECT	NEAR DISTANCE	FAR DISTANCE
Ship (1000 tons)	300 to 700 gammas @100 ft	1 gamma @ 800 ft
Automobile (1 ton)	40 gammas @ 30 ft	2 gammas @ 40 ft
Pipeline (12 inch diameter)	50 to 200 gammas @ 25 ft	12 to 50 gammas @ 50 ft
Fenceline	15 gammas @ 10 ft	1 to 2 gammas @ 25 ft
File (10 inches long)	50 to 100 gammas @ 5 ft	5 to 10 gammas @ 10 ft

(From G-881 Operating Manual 25831-OM, 2001)

In addition to ferrous mass and distance, the orientation, composition and shape of a ferrous object influence the magnitude of the detected anomaly. For instance, a 12-inch pipeline will have a similar magnetic effect as 1 ton of iron at a range of about 50 ft. The position of the sensor relative to the object's magnetic field and the orientation of the object on the lakebed will influence the "shape" of the anomaly. For instance, consider an iron pipe lying flat on the lakebed. If the magnetometer intersects only one lobe of the pipe's magnetic field, the magnetic signature will likely be monopolar (i.e., in profile view, a positive or negative parabola), with the duration, response magnitude and tangent of the curve reflecting the size and proximity of the object. If the sensor intersects both lobes of the field, the response curve will appear dipolar (i.e., sinusoidal), with the actual position of the object corresponding to the midpoint between positive and negative responses. However, if the same pipe were embedded vertically in the sediment, even if the sensor is towed directly above the pipe, it is likely that the "shape" of the response in profile will be monopolar.

6.2 SMU 1

SMU 1 along the southeastern nearshore area of Onondaga Lake is approximately 87.2 acres (Figure 5). The proposed remedial methods include dredging an average of 10 ft followed by capping throughout the entire SMU. The minimum and mean mudline elevations recorded in SMU 1 were 330.3 ft and 352.9 ft, respectively (see Figure 6). These elevations correspond to maximum and mean water depths of 32.6 ft and 9.9 ft, respectively. The volume of water within SMU 1 is approximately 875 acre ft or about 0.8 percent of the total lake volume (Table 1).

Magnetic data identified three 16-inch diameter intake pipes extending from shore in the western portion of SMU 1 (Figure 34). The westernmost of the two 16-inch intake pipes appears to terminate 1,230 ft from shore. The easternmost of the two 16-inch intake pipes appears to terminate 1,145 ft from shore. The pipe identified as a "potential" third 16-inch intake appears to terminate 890 ft from shore, approximately coincident with the outer boundary of SMU 1. The magnitude of magnetic anomalies associated with this potential third pipe was somewhat lower than the previous two, suggesting deeper burial or lower ferrous content. Side-scan sonar data clearly identifies the surficial expression of the terminus of each of the three pipes. A fourth large diffuser extends 790 ft from shore in the central portion of SMU 1. This structure was clearly identified by all four of the remote sensing techniques (i.e., side-scan sonar, sub-bottom sonar, single-beam bathymetry and magnetometer). Side-scan data show that this feature is exposed at the sediment surface along its entire length (Figures 17E and 18). Magnetic data for SMU 1 also indicate the presence of a pipeline which bisects the shoal southeastern corner of

SMU 1 and extends into SMU 7 (Figures 32 through 36). This pipeline was not identified by side-scan data, suggesting burial beneath the mudline.

As previously discussed in Section 5.4, low magnitude magnetic anomalies were widespread throughout SMU 1. The majority of these anomalies do not appear to be associated with digitized side-scan sonar Contacts larger than 5 ft in size, suggesting burial beneath the sediment surface. A total of 50 individual magnetic anomalies were digitized in SMU 1 (excluding those associated with the structures described above), with magnitudes ranging from 4 to 715 gammas (average = 135g, SD = 176.7). Twenty-six of these were dipolar anomalies, with an average magnitude of 116g.

Both man-made debris and unidentified surface debris were documented at a higher density in SMU 1 than in any of the other littoral SMUs (Table 2). The majority of side-scan sonar Contacts appear to be clustered in the northeastern corner of SMU 1 at elevations below 351 (Figure 18). The average height of debris above the bottom was approximately 1.5 ft, although several contacts were substantially higher. Of these, two distinct Contacts were classified as likely wreckage, with heights ranging from 1.6 to 9.7 ft above the bottom.

A comparison of the side-scan mosaic, with available surficial geotechnical data, suggests that the dominant sediment texture for the Solvay waste within SMU 1 is sandy silt. A tongue of silty sand appears to extend from the shore in the central portion of the SMU. The side-scan data suggest that this extensive shoal along the shoreline, approximately coincident with the 356 ft contour, has a slightly lower reflective nature than the lakebed reflectance observed at similar elevations in adjacent SMUs. Whether this difference reflects a sediment textural property or the presence/absence of Solvay waste cannot be determined based solely on geophysical data. Sediment sampling would be required to confirm this hypothesis.

The side-scan sonar data did not suggest the presence of widespread aquatic vegetation in SMU 1, and vegetation was only rarely observed at the water surface in any SMU during the October to November survey period. It is possible that during this period vegetation had decayed and draped the sediment surface.

The sub-bottom sonar data suggests the presence of as much as 27 ft of layered substrates on the slope at the outer edge of the SMU 1 shoal (see Appendix A-1). The nature of the material beneath these surficial substrates cannot be ascertained from sub-bottom sonar records. Sonar penetration was limited throughout much of the remainder of SMU 1, suggesting either the presence of entrained gases near the sediment surface or sediment acoustical properties that would prevent sonar penetration (i.e. compacted parent material or bedrock).

Of note for the proposed dredging of SMU 1 is the accurate location of the following:

- Three intake pipes and one diffuser pipe, the largest and most centrally located is exposed along its entire length;
- A buried pipeline in the southeastern corner of the SMU which extends into SMU 7;
- The highest number of side-scan sonar Contacts (predominantly of debris) of the littoral SMUs with the majority of the Contacts clustered in the northeastern corner, including two wrecks with heights above the lakebed of about 2 to 10 ft;
- Magnetic anomalies indicating widespread buried ferrous material;
- A predominantly sandy silt substrate with a shoal of finer material along the shoreline;
- Limited sub-bottom sonar penetration, but evidence of sediment thickness of about 27 ft on the outer slope; and
- Minimal observations of aquatic vegetation during the late fall survey.

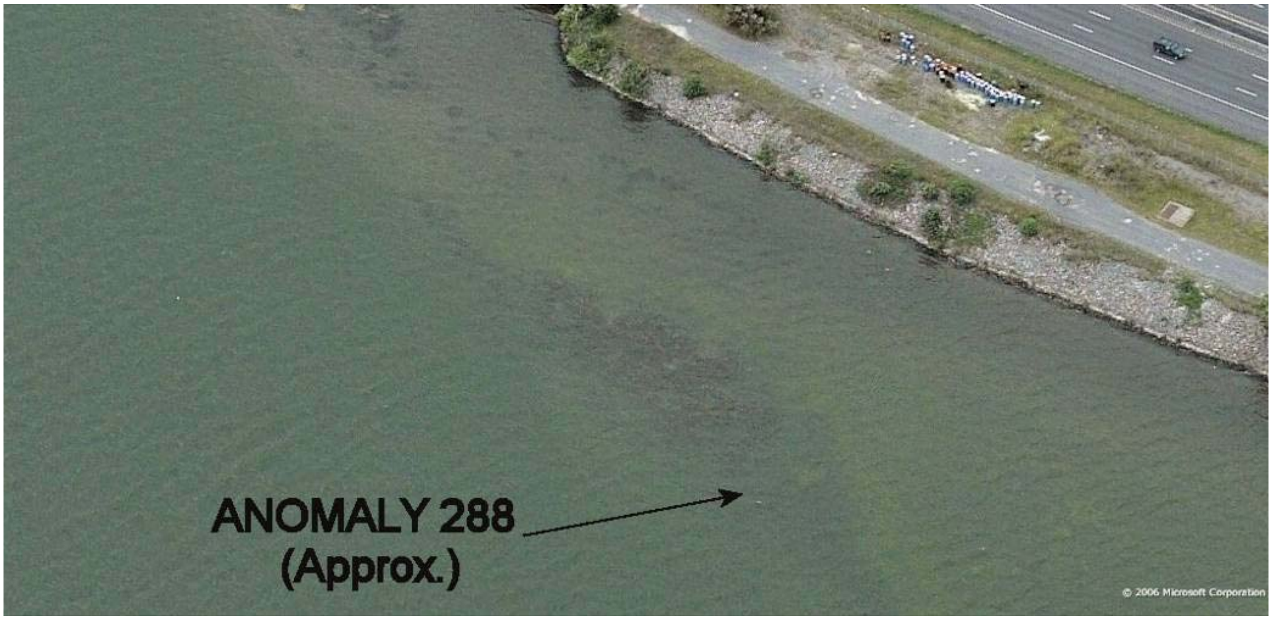
6.3 SMU 2

SMU 2 is approximately 35.4 acres in the southwestern nearshore area of Onondaga Lake (Figure 5). The proposed remedial methods for SMU 2 include dredging of 5.5 acres to an average water depth of 8 ft, capping the dredged area, and capping an additional 16 acres. The minimum and mean mudline elevations recorded in SMU 2 were 329.9 ft and 347.1 ft, respectively (Figure 7). These elevations correspond to maximum and mean water depths of 32.9 ft and 15.7 ft, respectively. The volume of water within SMU 2 is approximately 568.5 acre ft or about 0.5 percent of the total lake volume (Table 1).

Magnetic data identified a large linear magnetic anomaly in the southern portion of the SMU within the proposed dredge and capping area (Figures 34 and 37). The historical database identified a “former 72-inch intake line” and an 84-inch intake line approximately coincident with the shoreward expression of this magnetic anomaly. Closer evaluation of contoured and digitized magnetic anomalies suggests an approximately 40-ft separation of these intake lines at the shore, with a gradual increase in separation to approximately 150 ft at the terminus of the pipes. The northern 72-inch intake anomaly extends approximately 1,240 ft into the lake perpendicular to the shoreline. This pipe is clearly visible in bathymetric data (Figure 7). The southern 84-inch intake anomaly extends approximately 1,200 ft into the lake perpendicular to the shoreline. Side-scan sonar data shows surficial expression of the 72-inch pipe from a point 370 ft from shore to its terminus (see Figure 19 and Contact 263). The pipe and its sonar “shadow” are separated, suggesting that much of the outer portion of the 72-inch pipe may be suspended above the sediment surface by regularly spaced support structures. However, neither the side-scan data or bathymetric data identified a surficial expression of the 84-inch pipe within the boundary of SMU 2, suggesting burial. The side-scan data did identify a structure at the terminus of the 84-inch pipe in SMU 8.

Excluding these two intakes, magnetic anomalies were relatively sparse in SMU 2. However, the magnitudes of four anomalies were relatively high, ranging from 530g to 1906g. None of these large anomalies were located within an area designated for dredging or capping. However, they do appear to be associated with side-scan sonar features located near the northern boundary of SMU 2 (e.g., sonar Contact 0333, which has a shape and size suggestive of a pickup truck).

A single 87g dipolar anomaly was located at the northern boundary of the southern SMU 2 dredge area (Anomaly No. 288). This anomaly is located 205 ft from shore at a lakebed elevation of approximately 359 ft (i.e., 3.8 ft deep). This anomaly was not coincident with a digitized side-scan sonar Contact and close inspection of the sonar mosaic at this location does not suggest the presence of surficial debris. When sonar data for this location is compared to high resolution aerial photography available from Microsoft, Inc. (www.local.live.com, Photograph 2 below), it is clear that some features on the sonar record indicate the presence of decaying aquatic vegetation which may be obscuring the side-scan record of the Contact.



Photograph 2. *Aerial photograph of SMU 2 at Magnetic Anomaly No. 288*

Apart from the two intake pipes discussed above, relatively few side-scan sonar Contacts were digitized (Table 2). None of the seven sonar Contacts fell within proposed dredge areas (Figure 19). A single Contact (No. 245) fell within a proposed capping area. This linear object measures approximately 3 ft wide by 20 ft long and rises approximately 0.6 ft above the sediment surface.

Sub-bottom sonar data for SMU 2 suggests that as much as 40 to 50 ft of sediment with fine layering is present in the central portion of the SMU. This is best illustrated by Profiles No. 1 and No. 4 (Appendix A-2). Strong multiple returns were present in much of the sub-bottom data for this SMU suggesting the presence of entrained gases that interfere with sub-bottom sonar penetration and add uncertainty to this characterization.

Of note for the proposed dredging and capping operation at SMU 2 is the location of:

- Two intake pipes at the southeastern end of SMU 2 in the proposed dredge and capping areas, one buried and the other partially exposed;

- Possible buried ferrous material (Anomaly No. 288) in 3.8 ft of water at the northern boundary of the southern SMU 2 dredge area, 205 ft from shore;
- One nonferrous sonar Contact (No. 245), a linear object 3 ft by 20 ft and rising 0.6 ft above the sediment surface, within a proposed capping area;
- Forty to 50 ft of thinly layered sediment in the central portion of SMU 2, uncertainty regarding sediment depth throughout the majority of the SMU; and
- Evidence of decaying aquatic vegetation.

6.4 SMU 3

SMU 3 occupies approximately 115.3 acres of the western nearshore area of Onondaga Lake (Figure 5). The proposed remedial methods for SMU 3 include dredging of 11 acres to an average water depth of 4.5 ft, capping the dredged area, and capping of an additional 29 acres. The minimum and mean mudline elevations recorded in SMU 3 were 328.2 ft and 348.1 ft, respectively (Figure 8). These elevations correspond to maximum and mean water depths of 34.6 ft and 14.7 ft, respectively. The volume of water within SMU 3 is approximately 1,722 acre-ft, approximately 1.5 percent of the total lake volume (Table 1).

Ninety-six magnetic anomalies were digitized from magnetic transect data (Figure 38). The average and maximum magnitudes of these anomalies were approximately 519g and 11,240g, respectively. Seven of these anomalies were located within or on the boundary of proposed dredge areas, with magnitudes ranging from 7g to 77g (average = 25.4g). None of these anomalies was associated with a side-scan sonar Contact. The large cluster of magnetic anomalies located to the south of the peninsula at the northern portion of the SMU, are adjacent to an area identified in the historical records as a portion of the former resort. Side-scan sonar data identified several Contacts in this area approximately coincident with magnetic anomalies (see Contacts 450, 454, 456 on project DVD).

Side-scan sonar Contacts digitized in SMU 3 were few (Table 2, Figure 20). A single sonar Contact (No. 0422) was located within the boundary of the proposed northern dredge area.

Although this Contact was classified as debris, the nature of the object(s) is uncertain. There are no co-located magnetic anomalies. The Contact is composed of at least five discreet features which rise approximately 3 ft above the sediment surface. These features may represent rooted aquatic vegetation. No other sonar Contacts were digitized within the proposed dredge boundaries of SMU 3. A single feature classified as wreckage was identified in SMU 3 (sonar Contact No. 0403, project DVD). This object is not associated with magnetic anomalies and this classification is based solely upon the configuration and size of the feature. It is equally likely that this Contact is woody debris.

Sub-bottom sonar penetration was heterogeneous and sparse in SMU 3. Sample profiles suggest the presence of approximately 20 ft of sediment (Appendix A-3). Layering of sub-bottom strata appears less well defined in SMU 3 compared to SMU 1 and SMU 2 (Appendix A-1 and A-2).

Relevant to the planning of the dredge and capping efforts in SMU 3 are:

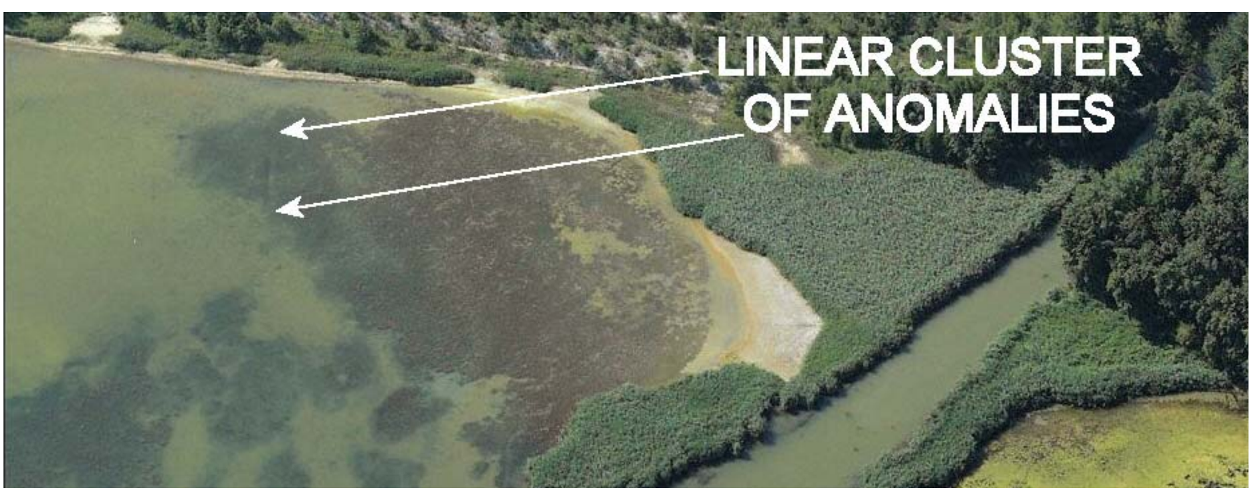
- The presence of widespread buried ferrous containing material of higher density at the northern end of SMU 3 near the former resort and seven areas of buried iron-containing material within or on the boundary of the proposed dredge area;
- One side-scan sonar feature (Contact 0422) that may be aquatic vegetation on the boundary of the proposed northern dredge area. Only five other side-scan sonar features were observed within SMU 3, and one may be nonferrous wreckage or woody debris 53 ft long, 23 ft wide and about 1 ft off the lake bottom; and
- An estimated sediment thickness of about 20 ft, however, data was limited.

6.5 SMU 4

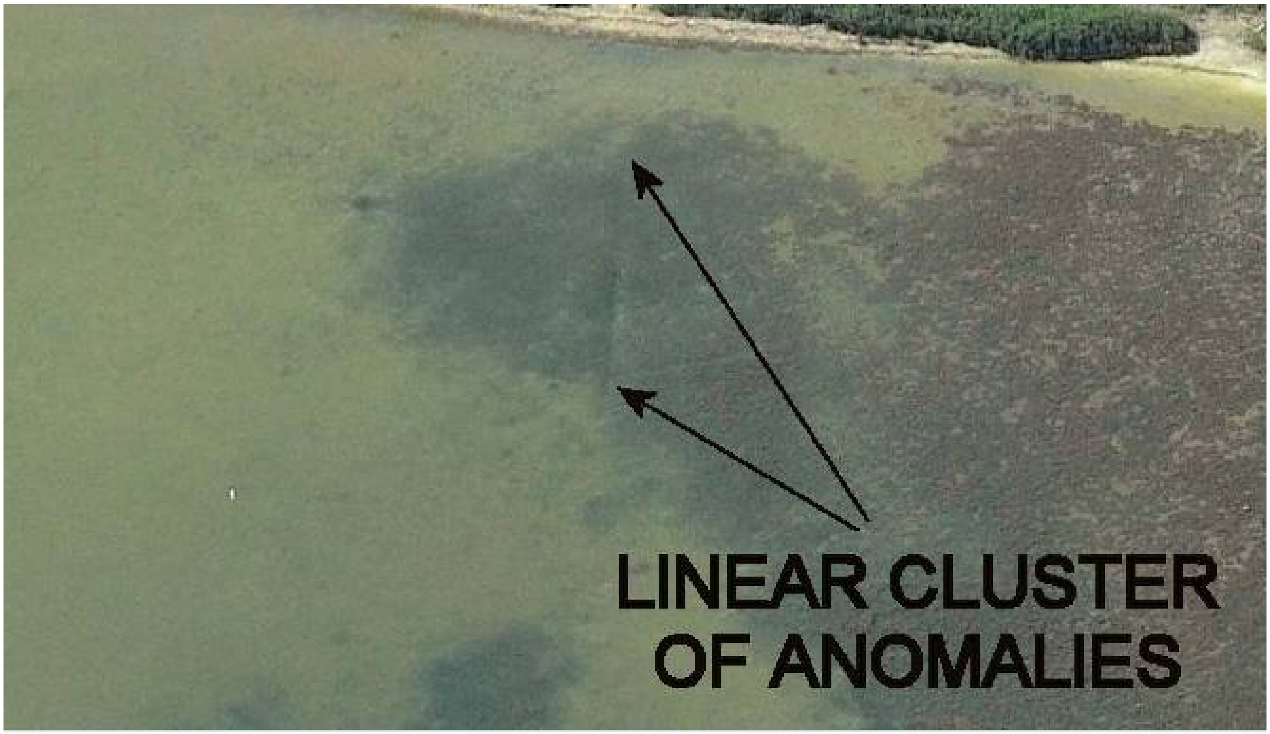
SMU 4 occupies approximately 78.5 acres along the central western shore of Onondaga Lake (Figure 5). The proposed remedial methods include dredging of 22 acres to an average water depth of 4.5 ft within the dredge area, and capping of the entire SMU. The minimum and mean mudline elevations recorded in SMU 4 were 331.3 ft and 350.9 ft, respectively (Figure 9). These elevations correspond to maximum and mean water depths of 31.5 ft and 12 ft, respectively. The volume of water within SMU 4 is approximately 956 acre-ft or about 0.85 percent of the total lake volume (Table 1). The majority of the proposed dredge area for SMU 4 contains water less than 3 ft deep, and the range and resolution of side-scan sonar data in the majority of this area was limited by these shallow conditions.

Eighty-eight magnetic anomalies were digitized from magnetic transect data (Figure 39). The average and maximum magnitudes of these anomalies were approximately 516g and 11,545g, respectively. Thirty-six of these anomalies were located within or on the boundary of the proposed dredge area, with magnitudes ranging from 8g to 11,545g (average = 1,133g). None of the anomalies within the dredge area were associated with a side-scan sonar Contact. The majority of the anomalies were located in shallow portions of the SMU at elevations less than 355 ft (i.e. in less than 7 ft of water).

An approximately linear cluster of large anomalies is located approximately 100 yards to the east of the Nine Mile Creek inlet, and extends approximately 370 ft into SMU 4 from the shoreline (Figure 39). This cluster is located at an elevation of 360 to 361 ft in waters 1 to 2 ft deep. Side-scan sonar coverage and resolution of this area was limited by the shallow depths. However, some indication of the nature of this cluster can be gained from inspection of high resolution aerial photography (Microsoft, Inc. (www.local.live.com, Photographs 3 and 4, below).



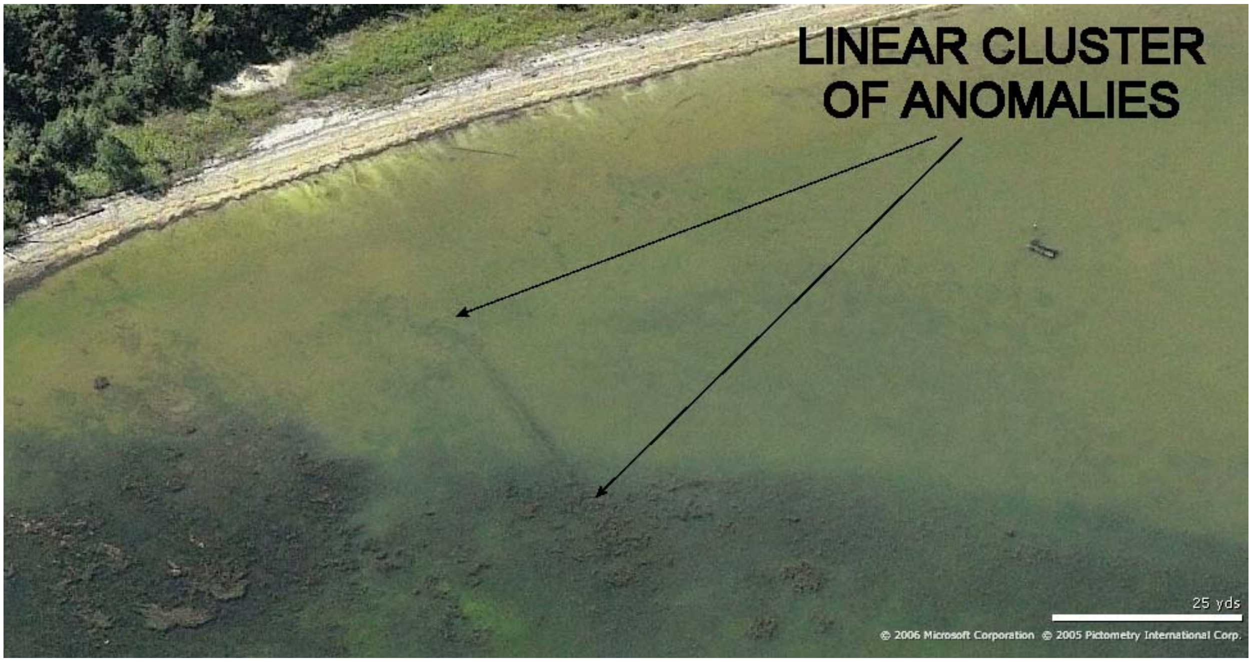
Photograph 3. *Aerial photograph (looking south) at SMU 4 identifies a linear bottom feature approximately co-located with a linear arrangement of magnetic anomalies.*



Photograph 4. *Close-up of an aerial photograph (looking south) which identifies the same linear bottom feature approximately co-located with a linear arrangement of magnetic anomalies.*

These images suggest that there is a surficial expression of the object associated with these large magnetic anomalies. The historical database does not identify nearby structures which would aid in characterization of this structure.

A nearly identical linear cluster of magnetic anomalies was identified approximately 970 ft from the eastern SMU boundary (Figure 39). The elevation of this cluster is nearly identical to the previously described group, with an equally adverse limitation on side-scan image quality. Inspection of this general area using the same open-source of aerial photography clearly identifies a large linear structure (www.local.live.com, Photograph 5, below).



Photograph 5. *Close-up of an aerial photograph (looking south) which identifies a linear bottom feature approximately co-located with a linear arrangement of magnetic anomalies.*

As mentioned previously, the range and resolution of side-scan sonar in the majority of SMU 4 was limited by water depths of less than 3 ft deep. Six side-scan sonar Contacts were digitized within SMU 4 (Table 2). A large wreck (Contact 0501) was documented 300 ft west of the eastern boundary of SMU 4, 530 feet from shore (Figure 21). The wreck is clearly visible from the surface, and the center of the wreck is located at an elevation of 349 ft. The wreck was also detected by several magnetometer passes and is represented by four magnetic anomalies. The wreckage rises at least 11 ft above the sediment surface. The dimensions and construction of the wreckage are consistent with a barge. Note that this characterization should be substantiated by a qualified marine archaeologist or a dive team.

The best sub-bottom sonar penetration within SMU 4 was observed at the nearshore western portion of the SMU (Appendix A-4). Much of the rest of the SMU was characterized by negligible penetration. Although the shallow conditions in the western nearshore area add substantial uncertainty to data interpretation, it appears that as much as 60 ft of stratified materials may be present in this portion of the SMU.

Noteworthy for the planning of remedial activities in this SMU are:

- Thirty-six indications of buried ferrous material in the dredge area, and fifty-two other magnetic anomalies indicating ferrous containing material within the rest of SMU 4;
- Two large linear ferrous structures visible on aerial photographs;
- A large wreck (84 ft x 34 ft) at the eastern end of the SMU that rises at least 11 ft above the sediment surface; and
- Potential for as much as 60 ft of sediment nearshore in the western portion of SMU 4.

6.6 SMU 5

SMU 5 covers 507.7 acres of the northern and eastern nearshore area of Onondaga Lake (Figure 5). The minimum and mean mudline elevations for SMU 5 are 326.7 and 350.1 ft, respectively. These elevations correspond to maximum and mean water depths of 36.1 ft and 12.8 ft, respectively. The volume of water within SMU 5 is approximately 6,574 acre-ft or about 5.8 percent of the total lake volume (Table 2). A comparison of the side-scan mosaic with available surficial geotechnical data suggests that the dominant sediment texture within SMU 5 is silty sand.

Remediation has not been proposed for the majority of SMU 5 (450 acres). The remaining 57.7 acres of SMU 5 has been divided into four potential dredge/capping areas identified as “Area A” through “Area D” in a clockwise direction from the boundary between SMU 4 and SMU 5 (Figure 5). The Isolation Capping polygon IDs for these four areas are: SMU 5 Area “A” = Station S95; SMU 5 Area “B” = Station S111; SMU 5 Area “C” = Stations S108 and S109; SMU 5 Area “D” = Station S66. These areas are referred to as SMU 5A through SMU 5D in the discussion that follows. The final subsection of the SMU 5 discussion focuses on results obtained outside of these proposed dredge/capping areas.

6.6.1 SMU 5, Area A

SMU 5A covers 7.6 acres of the northwestern nearshore area of Onondaga Lake (Figure 5).

Potential remediation was included for Area A (or SMU 5A) as presented in the November 2004 Feasibility Study Report based on area around previous sample location S95. The minimum and mean mudline elevations recorded in SMU 5A were 331.2 ft and 351.2 ft, respectively (Figure 10). These elevations correspond to maximum and mean water depths of 31.6 ft and 11.6 ft, respectively. The volume of water within SMU 5A is approximately 92.4 acre-ft or about 0.08 percent of the total lake volume (Table 1). The proposed dredge area for SMU 5A is above elevation 356, with the vast majority above elevation 359 (i.e., less than 3 ft deep). The range and resolution of side-scan sonar data in the majority of this area was limited by these shallow conditions. Given this limitation, it is noteworthy that no side-scan sonar Contacts were observed for this area (Figure 22, Table 3).

Eleven magnetic anomalies were digitized from magnetic transect data within the boundary of SMU 5A (Figure 40). The magnitude of these anomalies ranged from 9g to 1,123g, with a mean of 245g. Although, the majority of these anomalies were located at depths less than 4 ft deep, review of aerial photography for this area did not suggest a surficial expression of the materials associated with these anomalies. It is likely that these objects are buried beneath the sediment surface.

Sub-bottom sonar penetration in this area was very successful relative to other littoral regions of the lake. As shown in Appendix A-5A, stratified sediments were documented to a depth below the mudline of at least 42 ft. A highly reflective stratum was identified below these strata which precluded sonar penetration. This reflector may indicate the depth to rock or compacted parent material.

Pertinent to the proposed dredging and capping operation at SMU 5A are:

- The presence of 11 buried ferrous objects, several within the area to be dredged;
- The lack of objects detected using side-scan sonar, albeit shallow conditions limited the range and resolution of the instrument; and
- Relatively good sub-bottom sonar penetration showing 42 ft of stratified sediment over compact parent material or bedrock.

6.6.2 SMU 5, Area B

SMU 5B at the northwestern end of Onondaga Lake is approximately 20.1 acres. Potential remediation was included for Area B (or SMU 5B) as presented in the November 2004 Feasibility Study Report based on area around previous sample location S111. The minimum and mean mudline elevations recorded in SMU 5B were 346 ft and 357.4 ft, respectively (see Figure 11). These elevations correspond to maximum and mean water depths of 16.8 ft and 5.4 ft, respectively.

The volume of water within SMU 5B is approximately 112.1 acre-ft or about 0.1 percent of the total lake volume (Table 1). The proposed dredge area for SMU 5B is above elevation 358 (i.e. in less than 4 ft of water).

The range and resolution of side-scan sonar data in the northwestern portion of SMU 5B was severely limited. Side-scan sonar data was not obtainable from the shore to a distance of 150 to 200 ft (Figure 23).

Bathymetric data identify two distinct morphological features of interest is SMU 5B. Due to the shallow conditions of this area, these two features can also be observed in orthophotographs and aerial photography. The first bathymetric anomaly is located adjacent to the southern shore of SMU 5B and extends perpendicular to the shore for approximately 355 ft (www.local.live.com, Photograph 6, below). The relief of this structure is generally less than 1 ft. The structure is approximately 40 ft wide at the shore, with a 60 ft wide terminus.

This feature was not identified in the historical database. The parallel linear structure and evenly spaced cross members are clearly shown in Photograph 7, below (from www.local.live.com). This image also suggests the presence of surrounding debris. Both the side-scan sonar data and magnetic data identified the feature (Figures 23 and 41). All three remote sensing methods

Photograph 6. – *View to the north of a feature in southern SMU 5B.*

Photograph 7. – *View to the east of the feature in southern SMU 5B, showing its linear nature, cross members and surrounding debris.*

suggest a broad, well-defined terminal structure with nearby pilings. Side-scan sonar data suggests vertical sheet piling, at least at the terminus (Figure 47). Nine magnetic anomalies were associated with the structure (Figure 41). The magnitude of these magnetic anomalies ranged from 9g to 595g (average 237g).

The second morphometric irregularity was identified by bathymetric and side-scan sonar data (Table 2, Figure 23). This feature appears to be an approximately north-south oriented narrow trench. The elevation at the upper edge of the trench is 357 ft NAVD88. The deepest portion of the trench is at an elevation of 347 ft (Figure 11). The trench may have been created by maintenance dredging many years ago and is approximately 1,060 ft long and 50 to 150 ft wide.
A cluster of magnetic anomalies was observed in the central portion of the SMU 5B proposed dredge area. The magnitude of these anomalies ranged from 5g to 1958g (average 132g). This cluster is adjacent to the southeastern limit of the trench and is immediately south of an area identified by the historical database as a portion of the old resort (Figure 41).

Sub-bottom data for SMU 5B suggests the presence of as much as 32 ft of sediment. The upper 10 to 15 ft may have different textural properties than the deeper sediment layers (Appendix A-5B).

Results for SMU 5B relevant to the proposed dredge and capping activities include:

- The presence of a large linear structure with ferrous material in dredge and capping areas of southern SMU 5B that extends from the shoreline;
- An maximum 100 ft long by 10 ft deep, north-south oriented trench in the area to be capped;
- Several ferrous containing objects in the central portion of the SMU 5B proposed dredge area; and
- The presence of up to 32 ft of sediment.

6.6.3 SMU 5, Area C

SMU 5C is 8.4 acres at the northeastern end of Onondaga Lake (Figure 5). Potential remediation was included for Area C (or SMU 5C) as presented in the November 2004 Feasibility Study Report based on area around previous sample location S108. The minimum and mean mudline elevations recorded in SMU 5C were 332.4 ft and 339.9 ft, respectively (Figure 12). These elevations correspond to maximum and mean water depths of 30.5 ft and 23 ft, respectively. The volume of water within SMU 5C is approximately 200.3 acre-ft or about 0.18 percent of the total lake volume (Table 1).

Magnetic anomalies were not observed within the boundary of SMU 5C (Figure 42), and only six side-scan sonar Contacts were digitized in this area (Figure 24, Table 2). These Contacts were characterized as debris and man-made debris, and generally rose 1 to 2 ft above the sediment surface.

Sub-bottom sonar penetration was minimal throughout most of SMU 5C. Select sub-bottom profiles penetrated 5 to 9 ft of sediment. The strata below this surficial sediment was highly reflective and well defined suggesting more compacted material or bedrock (see Appendix A-5C).

Of note for the proposed dredging and capping operation at SMU 5C is the location of:

- Six features of nonferrous debris that rose about 1 to 2 ft off the bottom;
- A relatively smaller sediment thickness (5 to 9 ft) than detected in other littoral SMUs.

6.6.4 SMU 5, Area D

SMU 5D is 21.7 acres on the east-central nearshore area of Onondaga Lake (Figure 5, Table 1). Potential remediation was included for Area D (or SMU 5D) as presented in the November 2004 Feasibility Study Report based on area around previous sample location S66. The minimum and mean mudline elevations recorded in SMU 5D were 329.1 ft and 353.8 ft, respectively (Figure

13). These elevations correspond to maximum and mean water depths of 33.8 ft and 9 ft, respectively. The volume of water within SMU 5D is approximately 199.2 acre-ft or about 0.18 percent of the total lake volume (Table 1).

A structure was identified by magnetic, bathymetric, and side-scan sonar data which nearly bisects SMU 5D, extending into the lake 600 ft perpendicular to the shoreline (Figures 13, 25 and 43). This feature is also clearly visible on both orthophotography and aerial photography. The historical database identifies this structure as a “Type-7” pipe or outfall. Side-scan sonar Contact imagery of this pipe suggests a width of 2.5 to 3.5 ft (Contacts 0530, 0533, and 0535 on the project DVD). Side-scan sonar and bathymetric data suggest that at least a portion of the pipeline is elevated 1 to 2 ft above the sediment surface (see Contact 0535 gap between pipeline and shadow).

Excluding anomalies associated with this pipe, 33 magnetic anomalies were digitized in SMU 5D. The magnitude of these anomalies ranged from 10g to 354g (average 51g). Only one of these anomalies was associated with a side-scan sonar Contact (No. 0531) located on the top edge of the littoral zone slope at elevation 356. This sonar Contact was tentatively identified as a patch of aquatic vegetation.

Other than the pipe, six side-scan sonar Contacts were digitized in SMU 5D (see Figure 25, Table 2). The estimated height of these features above the sediment surface ranged from 0.8 ft to 3.5 ft (average 1.84 ft).

Sub-bottom data for SMU 5D suggests the presence of as much as 43 ft of sediment of which the upper 15 to 20 ft of sediment may have different textural properties compared to deeper layers (Appendix A-5D).

Pertinent to the proposed dredge and capping operation at SMU 5D is:

- The presence of a ‘Type-7” pipe or outfall that bisects SMU 5D and extends into the lake 600 ft perpendicular to the shore;

- Thirty three ferrous objects, most of which appear to be buried and a single anomaly tentatively characterized as aquatic vegetation;
- Six side-scan images of debris or textural anomalies with a height above the sediment surface of 1 to 3.5 ft and found near the outer boundary of SMU 5D; and
- As much as 43 ft of sediment, with strata of a different textural property below 15 to 20 ft.

6.6.5 SMU 5 OUTSIDE DREDGING/CAPPING AREAS

The portion of SMU 5 outside of dredging and capping areas constitutes 450 acres of the lake's littoral zone, and the majority of SMU 5. The minimum and mean elevations are 326.7 and 350.1 ft, respectively. These elevations correspond to maximum and mean depths of 36.1 ft and 12.8 ft, respectively. The volume of water within this portion of SMU 5 is approximately 5,970 acre-ft or about 5.3 percent of the total lake volume (Table 2).

A comparison of the side-scan mosaic, with available surficial geotechnical data, suggests that the dominant sediment texture within this portion of SMU 5 is silty sand.

Although numerous sonar Contacts and magnetic anomalies were digitized in SMU 5, the discussion has been limited to only a few features of potential interest due to the lack of remedial activities proposed for this portion of the SMU. Sonar Contact No. 0601 appears to be wreckage or a large condensed debris field located between two areas described by the historical database as portions of the old resort. The feature is approximately 1,420 ft north of the boundary of SMU 5A.

A World War II era aircraft was anecdotally reported to have crashed into the lake. Of the sonar digitized Contacts, No's 0565 and 0567 most closely resemble aircraft wreckage, both in structure and approximate dimensions (Figure 48).

Finally, a feature previously described as a wreck along the northeastern shore in SMU 5 (see Figure 2 of Phase I PDI Work Plan) was characterized as debris in this survey. Sonar Contact (No. 637) was approximately co-located with this feature, but its configuration was insufficiently distinct to justify classification as wreckage.

6.7 SMU 6

SMU 6 at the southern end of Onondaga Lake is approximately 161.3 acres (Figure 5, Table 1). The remedial methods proposed include dredging of approximately 33 acres to a water depth of 6.5 ft, capping the dredged area, and capping an additional 123 acres. The minimum and mean mudline elevations recorded in SMU 6 were 329.9 ft and 351.5 ft, respectively (see Figure 14). These elevations correspond to maximum and mean water depths of 32.9 ft and 11.3 ft, respectively. The volume of water within SMU 6 is approximately 1,854 acre-ft or about 1.6 percent of the total lake volume (Table 1).

Magnetic anomalies were widespread throughout SMU 6, and the density of these anomalies increased with decreasing depth (Figure 44). Three clusters of magnetic anomalies were identified which corresponded to wreckage clearly identifiable in orthophotography, aerial photography, and the side-scan sonar data (Contacts 0255, 0308 and 0343 on the project DVD). It is likely, based on layouts and sizes, that these wrecks are barges. Many of the other anomalies did not appear to be coincident with side-scan sonar Contacts and, therefore, are likely to be buried ferrous material.

Three linear arrangements of magnetic anomalies were identified in SMU 6 which corresponded to pipeline and intake features in the historical database (Figures 34 and 44).

The northernmost of these magnetic anomalies is located slightly to the north of the mouth of Ley Creek and extends approximately 790 ft from the shoreline of SMU 6. It is identified in the historical database as a “Type 7” pipe or outfall. The pipe/outfall was also detected during the bathymetric survey (Figure 14) and by side-scan sonar (Figure 26, Contacts 0345 and 0346). It appears to be composed of a lattice-like arrangement of structures about 27 ft wide, likely with coarser substrate (possibly shield rock) within the central region (Figure 49). Side-scan sonar data suggests that this feature rises approximately 9 ft above the sediment surface, and aerial photographs suggest that some portions rise to the water surface.

The second linear arrangement of anomalies extends from the southern shoreline of SMU 6 into SMU 7, and was also described by the historical database as a “Type 7” pipeline or outfall. This linear feature was not identified by side-scan sonar or bathymetric data in SMU 6, but it is likely the discharge pipe from the Metro plant. Its terminus was expressed at the surface in SMU 7 at elevation 339. Side-scan sonar data collected within SMU 7 suggests that the feature is 2 to 4 ft wide.

The third and southernmost linear arrangement of anomalies was immediately south of the feature described above. This feature originates in SMU 6, and bisects the shoals of SMU 7 and SMU 1 (Figure 34). In the historical database, this linear feature is described as a potential Sun Oil pipeline. Side-scan sonar data suggests that the pipeline is about 3 ft wide (Contact 0007 on the project DVD).

Eighty-eight side-scan sonar Contacts were digitized and their dimensions summarized (Table 2). The dominant Contact classifications within SMU 6 were debris and man-made debris with an average height above the sediment of 1.3 ft and 2.1 ft, respectively. Of these 88 Contacts, only six were located within proposed dredge areas. These six Contacts included two barge wrecks, one debris Contact, one man-made debris Contact, and two Contacts classified as structures. These structures (Contacts No. 150 and No. 169) and Contact 0201 slightly outside of the dredge area were approximately co-located with lights and buoys at the entrance to the canal. These features are clearly visible on aerial photographs and on NOAA’s nautical chart for the lake (Chart No. 14786_48).

Sub-bottom sonar penetration in SMU 6 was limited to a small area at the northern limit of the SMU (Appendix A-6). Although these profiles were collected in very shallow water, estimated penetration was as great as 54 ft. The presence of strong multiple returns on the profiles suggests the presence of entrained gases and makes interpretation of sub-bottom data uncertain.

Of note for the proposed dredging and capping operation at SMU 6 is the location of:

- Three pipeline/outfalls which extended perpendicular from the shoreline of SMU 6. One near the mouth of Ley Creek and two at the southern end of the SMU. The two more southerly crossed into SMU 7;
- In the area of proposed dredging are two barge wrecks; one area of debris, one area of man-made debris; and two structures tentatively identified as channel marker buoys;
- Widespread potentially buried ferrous material in the shallower portions of the SMU;
- Eighty-eight side-scan sonar Contacts within SMU 6 that were predominantly debris and man-made debris with an average height above the sediment of 1.3 ft and 2.1 ft, respectively; and
- There is the potential for as much as 54 ft of sediment at the northern limit of SMU 6. Data from other portions of the SMU are not as clear.

6.8 SMU 7

SMU 7 at the southern end of Onondaga Lake is approximately 41.9 acres (Figure 5, Table 1). The remedial methods proposed for SMU 7 include dredging of approximately 13 acres to a water depth of 5.75 ft, capping the dredged area, and capping the remaining 38 acres. The minimum and mean mudline elevations recorded in SMU 7 were 332.1 ft and 354.2 ft, respectively (Figure 15). These elevations correspond to maximum and mean water depths of 30.7 ft and 8.6 ft, respectively. The volume of water within SMU 7 is approximately 365.6 acre-ft or about 0.3 percent of the total lake volume (Table 1).

Magnetic anomalies in SMU 7 were concentrated near the shoreline (Figure 45). Many of these nearshore anomalies are associated with the Sun Oil pipeline that passes through SMU 6, SMU 7, and SMU 1. In addition, as described for SMU 6, a feature classified by the historical database as a “Type 7” pipeline or outfall originates along the southern shore of SMU 6 and extends into SMU 7 (Figure 34). The terminus of this feature is expressed at the surface in SMU 7 at elevation 339 approximately 1,700 ft from shore (see sonar Contact 0037 on the project DVD). This is likely the Metro discharge pipe and the side-scan sonar data collected within SMU 7 suggests it is 2 to 4 ft wide.

Excluding sonar Contacts associated with these two pipelines, 43 sonar Contacts were digitized within SMU 7 (see Table 2). The majority of these Contacts were classified as debris (unidentified). Only two of these Contacts were located within the proposed dredge area.

The sub-bottom sonar system did not penetrate sediments in any portion of SMU 7. It is likely that penetration in SMU 7 was negated due to the presence of natural gases in surficial sediments.

Of note for the planning of remedial activities in SMU 7 are:

- Two pipelines cross SMU 7. The Sun Oil pipeline is buried and the "Type 7" pipe/outfall (Metro discharge) is exposed at its terminus;
- Two Contacts of debris were in the dredge area. An additional 41 (36 debris and 5 man-made debris) were found in the rest of the SMU, much of which will be capped. These features concentrated at the northern end of SMU 7, are 7.2 to 19 ft long, 2 to 18 ft wide and on average about 2 ft off the lake bottom.
- No data on surficial sediment thickness is available on the sub-bottom record likely due to the presence of natural gases which prevents sonar penetration.

6.9 SMU 8

SMU 8 consists of the entire sub-littoral and profundal zones of the lake (Figure 5). The area of SMU 8 is approximately 1,913.1 acres. The proposed remedial method for this area includes monitored natural recovery and potentially some thin layer capping. The minimum and mean mudline elevations recorded in SMU 8 were 297.1 ft and 310.8 ft, respectively (Figure 5). These elevations correspond to maximum and mean water depths of 65.7 ft and 52.1 ft, respectively.

The volume of water within SMU 8 is approximately 99,878 acre-ft or about 88.5 percent of the total lake volume (Table 1).

As described in previous Sections, the survey methods for SMU 8 varied from those of the littoral SMUs. Survey transects were spaced 200 ft apart, necessitating a greater degree of interpolation for bathymetric and magnetic contour development. This increased spacing acted to reduce the likelihood of magnetic anomaly detection for all but the largest ferrous objects. In addition, a lesser degree of side-scan sonar swath overlap was achieved in this SMU due to the increased transect spacing.

The majority of side-scan sonar Contacts appear to be located at the toe of the slope leading from the littoral zone (Figure 16). The dominant Contact classification was unidentified debris (Table 2). It is likely that the majority of these Contacts are natural woody detritus.

Eighty-nine individual depressions were digitized in SMU 8. The majority of these occur in two clusters along the eastern sub-littoral/profundal portion of the lakebed. The depressions usually appear to be circular to oval with an average width of approximately 50 ft. Many of the depressions appear to contain a central “hub” which may be slightly mounded. Because most of the depressions were located in areas of reduced bathymetric transect spacing, assessment of their depth is less certain. Side-scan sonar data suggests depression depths range from 0.5 to 2.7 ft. A sub-bottom sonar profile which intersected two of the depressions suggests a depression depth of about 2 ft (Appendix A-8).

A third small cluster of depressions was identified in the northern portion of the northern lake basin (Figure 31B). Many of these northern depressions appear to be less regularly shaped than their southern counterparts.

Three apparent wrecks were identified in SMU 8. One apparent wreck was approximately 1,400 ft from the eastern shore of the southern basin (Contact No. 0429). This wreck was not identified by the historical database and was not detected by the magnetometer.

A second apparent wreck was identified in the southern basin by side-scan sonar, bathymetry, and magnetics (Figure 50). This wreck is approximately 58 ft long, 18 ft wide and stands about 12 ft above the sediment surface.

A third apparent wreck was identified in SMU 8 approximately 210 ft beyond the boundary of SMU 1. The wreck is approximately co-located with the terminus of the 16-inch intake pipe which extends from the shoreline of SMU 1 into SMU 8. The configuration of this wreck is consistent with that of a barge (Figure 51, Contact 0267). It is approximately 110 ft long, 25 ft wide and stands approximately 10 ft above the sediment surface.

Structures which extend into SMU 8 include the two 16-inch intake pipes which extend from SMU 1, and the former 72-inch and 84-inch intake pipes, which extend from SMU 2 into SMU 8. All of these structures have been previously described, and their locations are best represented on Figure 34.

7.0 CONCLUSIONS

The bathymetric and other geophysical survey results described in this report have identified bathymetric contours and potential wreckage, debris, pipelines, outfalls, and other structures. The data also identify features of potential interest related to sediment characteristics, including potential gas venting areas and sediment depositional patterns. Results vary widely for the various sediment management units within the lake as described in this report. The results from this survey provide a quality data set that will allow for the advancement of the design for the Onondaga Lake remedy.

8.0 REFERENCES

C-T. Chen and F. J. Millero. 1977. *Speed of Sound in Seawater at High Pressures*. J. Acoustic Soc. Am., 32(10), page 1357.

Parsons, 2005. *Onondaga Lake Pre-Design Investigation: Phase I Work Plan.* Onondaga County, NY. Prepared for Honeywell. September 2005. Includes the following appendices relevant to the geophysical survey work (bound separately and dated September 2005 unless noted otherwise): Appendix A - Sampling and Analysis Plan, Appendix B - Quality Assurance Project Plan, Appendix C - Project Safety Plan, and Standard Operating Procedures (November 2005).

U.S. Army Corps of Engineers. Jan. 1 2002. *Engineering and Design - Hydrographic Surveying.* Publication Number: EM 1110-2-1003. Change No. 1, 01 April 2004.

TABLES

TABLE 1

Summary of Bathymetric Conditions for Each Sediment Management Unit

Onondaga Lake, Syracuse, NY

SMU ID	AREA (ACRES)	MINIMUM MUDLINE ELEVATION (FT)	MEAN MUDLINE ELEVATION (FT)	MAXIMUM WATER DEPTH (FT)	MEAN WATER DEPTH (FT)	WATER VOLUME (ACRE-FEET)
1	87.2	330.3	352.9	32.6	9.9	874.6
2	35.4	329.9	347.1	32.9	15.7	568.5
3	115.3	328.2	348.1	34.6	14.7	1,721.9
4	78.5	331.3	350.9	31.5	12.0	956.1
5 (ENTIRE SMU)	507.7	326.7	350.1	36.1	12.8	6,574.4
AREA 5A	7.6	331.2	351.2	31.6	11.6	92.4
AREA 5B	20.1	346.0	357.4	16.8	5.4	112.1
AREA 5C	8.4	332.4	339.9	30.5	23.0	200.3
AREA 5D	21.7	329.1	353.8	33.8	9.0	199.2
6	161.3	329.9	351.5	32.9	11.3	1,854.2
7	41.9	332.1	354.2	30.7	8.6	365.6
8	1,913.1	297.1	310.8	65.7	52.1	99,878.3

Note: Elevation in NAVD 88. Mean and maximum depth values were calculated based on an assumed shoreline water level elevation of 362.82 ft, NAVD88.

TABLE 2

Summary of Digitized Side-Scan Sonar Contact Distribution and Dimensions
Onondaga Lake, Syracuse, NY

(Reference Figures 18 through 29)

			DIMENSIONS (FEET)								
		NUMBER OF	HEIGHT[2]			LENGTH			WIDTH		
AREA	CONTACT TYPE	CONTACTS	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN
SMU 1	Debris	85	0.0	11.9	1.3	4.8	51.0	16.6	0.0	139.8	7.8
	Debris (Man-made)	25	0.0	5.5	1.8	6.9	176.1	33.4	0.9	19.2	8.3
	Structures*	14	0.0	7.1	2.0	35.7	322.3	155.3	0.5	122.1	21.3
	Wreckage*	2	1.6	9.7	5.7	47.9	48.5	48.2	13.1	16.2	14.7
	Mounds	1		1.6			57.7			17.6	
	Textural Anomaly	1		3.0			50.8			15.7	
SMU 2	Debris	4	0.6	8.6	4.6	8.6	54.2	24.0	3.1	5.9	4.1
	Debris (Man-made)	3	2.2	5.5	3.7	11.5	77.0	34.1	4.5	28.9	14.7
	Structures*	3	1.6	11.1	6.5	132.3	178.6	148.1	1.9	19.5	7.8
SMU 3	Debris	9	0.0	6.1	1.6	8.5	117.7	31.2	1.2	16.9	8.1
	Debris (Man-made)	5	0.7	5.1	2.7	38.7	79.8	59.1	6.8	50.5	23.7
	Depressions	1		0.0			60.4			19.0	
	Textural Anomaly	1		6.3			40.1			33.6	
	Wreckage*	1		0.8			53.2			23.3	
SMU 4	Debris	4	0.0	2.5	1.0	25.8	100.4	72.0	2.1	13.4	6.3
	Debris (Man-made)	1		0.3			26.3			12.3	
	Wreckage*	1		11.1			84.5			34.5	
SMU 5[1]	Debris	63	0.0	13.8	2.7	5.8	103.4	18.2	0.0	148.7	12.8
	Debris (Man-made)	24	0.6	16.5	4.3	7.4	85.1	30.2	1.4	27.9	10.4
	Depressions	8	0.0	-9.6	-2.3	31.2	121.2	64.7	0.0	77.3	35.3
	Textural Anomaly	8	0.0	3.7	0.9	14.1	157.2	67.0	9.2	52.3	21.3
	Mounds	2	1.3	4.7	3.0	39.8	51.3	45.6	16.0	24.5	20.2
	Wreckage*	1		7.3			97.7			31.0	
SMU 5, AREA A (S95)	NO DIGITIZED CONTACTS										
SMU 5, AREA B (S111)	Debris	2	0.5	2.2	1.3	6.5	22.2	14.4	0.0	1.4	0.7
	Textural Anomaly	1		2.8			111.1			33.9	
SMU 5, AREA C (S108)	Debris	3	0.0	1.4	0.8	11.4	22.2	15.4	4.2	5.2	4.5
	Debris (Man-made)	3	0.7	2.1	1.5	9.6	37.4	20.8	3.3	11.5	7.9
SMU 5, AREA D (S66)	Debris	3	0.8	3.5	1.9	1.5	19.9	9.5	1.9	8.0	5.6
	Structures*	3	0.0	1.7	0.9	83.0	342.3	199.2	2.5	3.7	3.0
	Textural Anomaly	2	1.5	2.4	1.9	46.4	54.1	50.3	23.4	49.1	36.2
	Debris (Man-made)	1		1.6			8.1			3.2	
SMU 6	Debris	58	0.0	5.5	1.3	6.9	67.6	20.2	1.4	47.8	8.3
	Debris (Man-made)	21	0.0	4.7	2.1	8.2	118.2	29.5	3.5	20.4	9.3
	Structures*	4	2.4	4.7	3.3	11.2	96.2	37.7	3.7	29.8	13.0
	Wreckage*	4	1.5	8.6	3.9	84.6	111.3	95.1	25.9	40.5	33.2
	Textural Anomaly	1		0.0			23.1			28.0	
SMU 7	Debris	38	0.4	5.7	1.7	7.2	53.7	19.2	1.5	18.0	6.7
	Debris (Man-made)	5	1.1	2.8	1.8	4.9	46.3	22.0	2.5	8.0	4.3
	Structures*	4	0.0	1.7	0.8	78.0	322.5	172.3	1.7	12.1	5.2
SMU-8	Debris	188	0.0	20.5	1.6	1.5	168.8	20.5	1.1	87.0	7.4
	Depressions	89	0.0	-2.7	-0.5	17.8	158.8	51.6	18.4	83.8	38.6
	Debris (Man-made)	14	0.4	15.1	4.3	3.5	55.4	16.8	1.7	61.7	9.7
	Wreckage*	14	1.8	12.5	6.9	19.4	111.2	72.6	12.4	27.7	18.8
	Mounds	13	0.0	2.8	0.4	14.2	43.4	29.8	14.8	37.2	26.4
	Structures*	5	0.6	18.4	4.5	88.6	194.5	133.8	0.8	12.0	6.1
	Textural Anomaly	2	0.0	0.6	0.3	6.5	17.2	11.8	9.5	14.6	12.0
	Furrows	1		0.0			119.5			1.4	

[1] Portion of SMU 5 outside of Areas "A, B, C, and D". Area A is associated with the polygon around previous sample S95. Area B is associated with the polygon around previous sample S111. Area C is associated with the polygon around previous sample S108. Area D is associated with the polygon around previous sample S66.

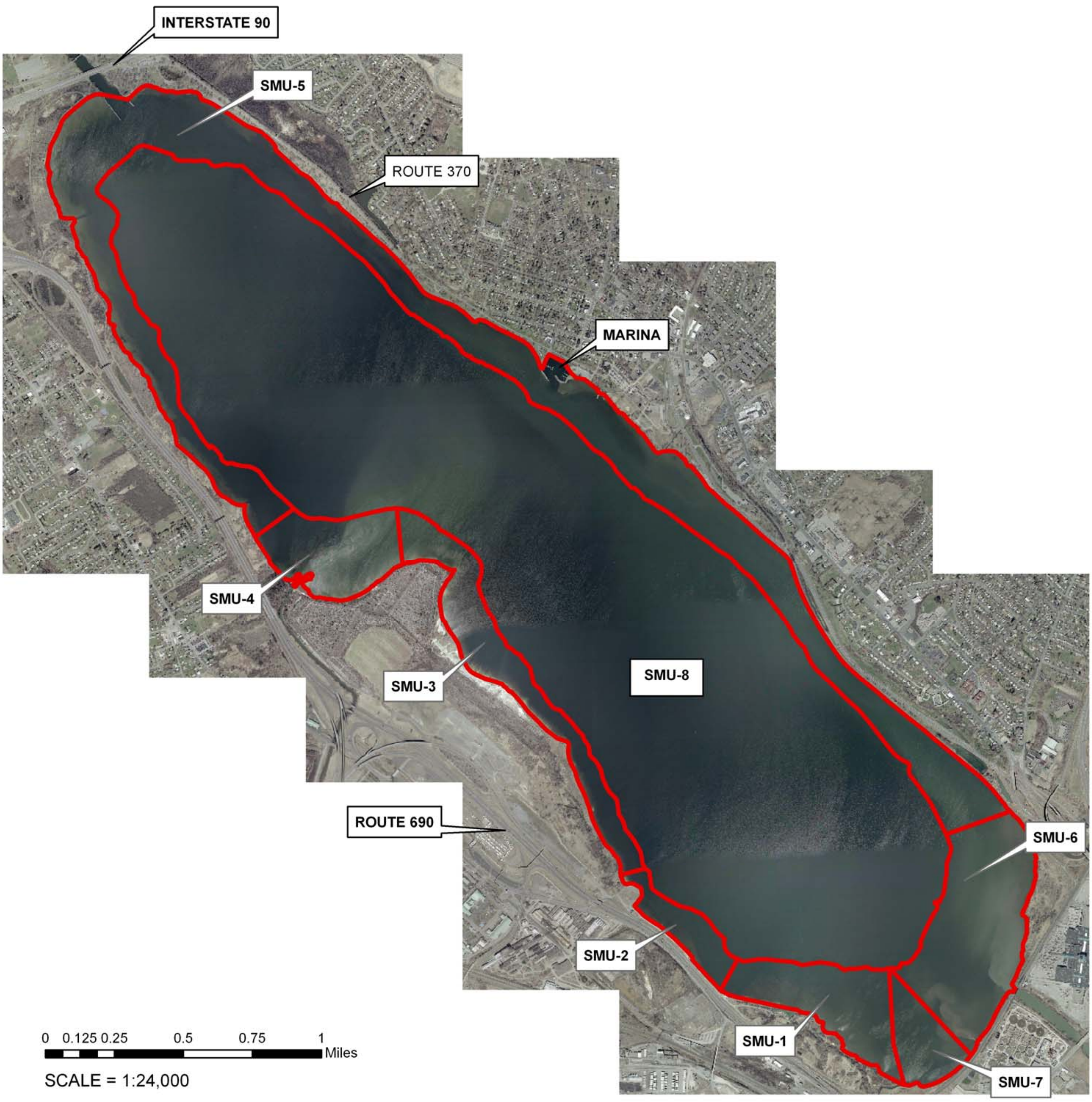
[2] Height is the distance in feet that the Contact lies above the sediment surface

*** As described in the report text, some Contacts in the "Structures" and "Wreckage" classes were digitized more than once on overlapping side-scan sonar files in order to provide additional details regarding orientation and composition. Thus, the values presented above reflect the number and dimensions of fewer contacts than described in the text.**

FIGURES

FIGURE 1

SITE MAP WITH
SEDIMENT MANAGEMENT UNITS (SMU'S)
ONONDAGA LAKE
SYRACUSE, NEW YORK



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Ecological and Oceanographic Consultants

FIGURE 2

SURVEY TRACKLINES OCCUPIED BETWEEN OCTOBER 12 AND 19, 2005 FROM R/V CYPRINODON

FIGURE 3

SURVEY TRACKLINES OCCUPIED BETWEEN OCTOBER 12 AND NOVEMBER 3, 2005 FROM R/V CYPRINODON AND R/V LOPHIUS

FIGURE 4

COMPLETE SURVEY TRACKLINE COVERAGE
OCTOBER 12 AND NOVEMBER 6, 2005

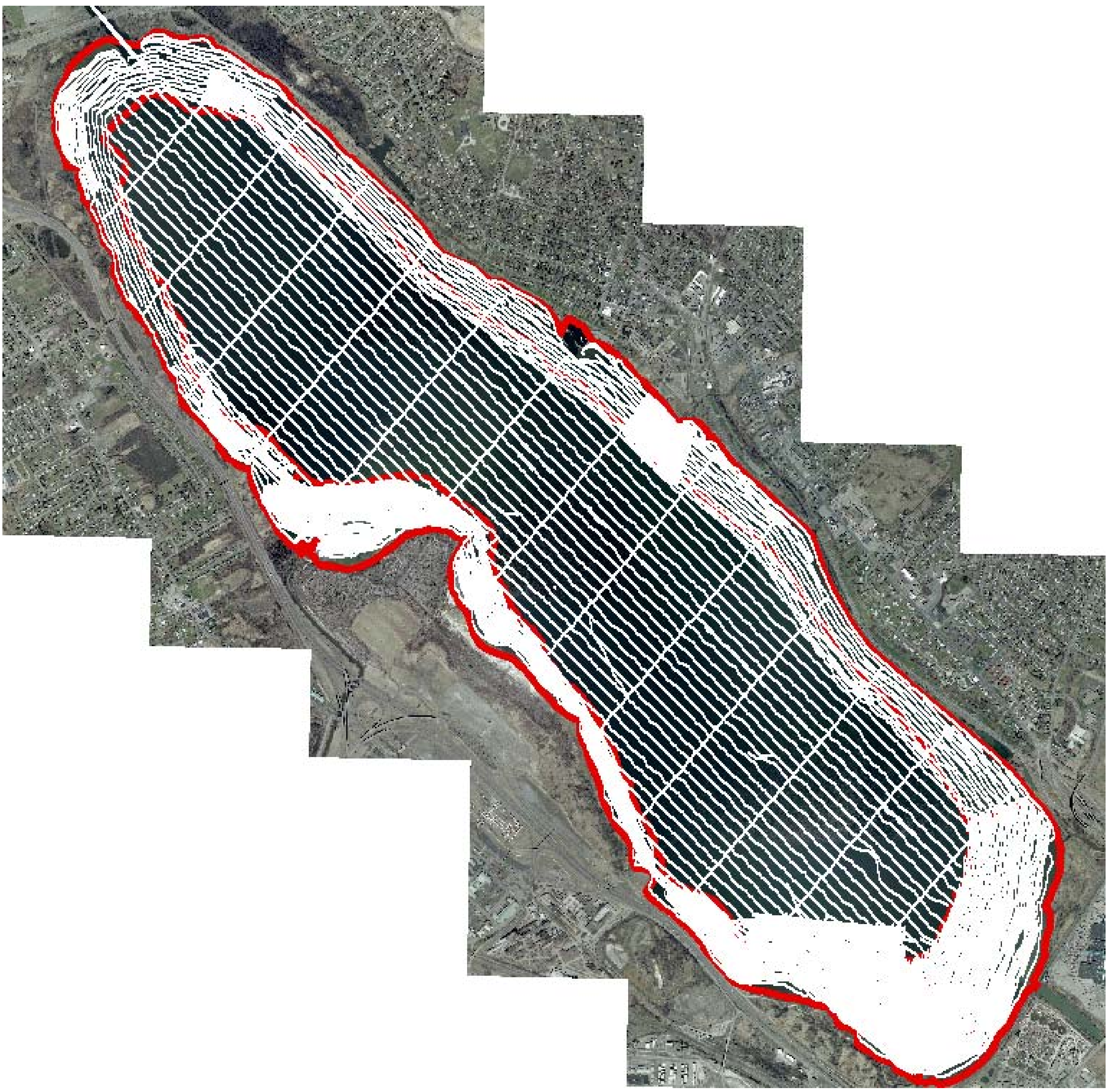
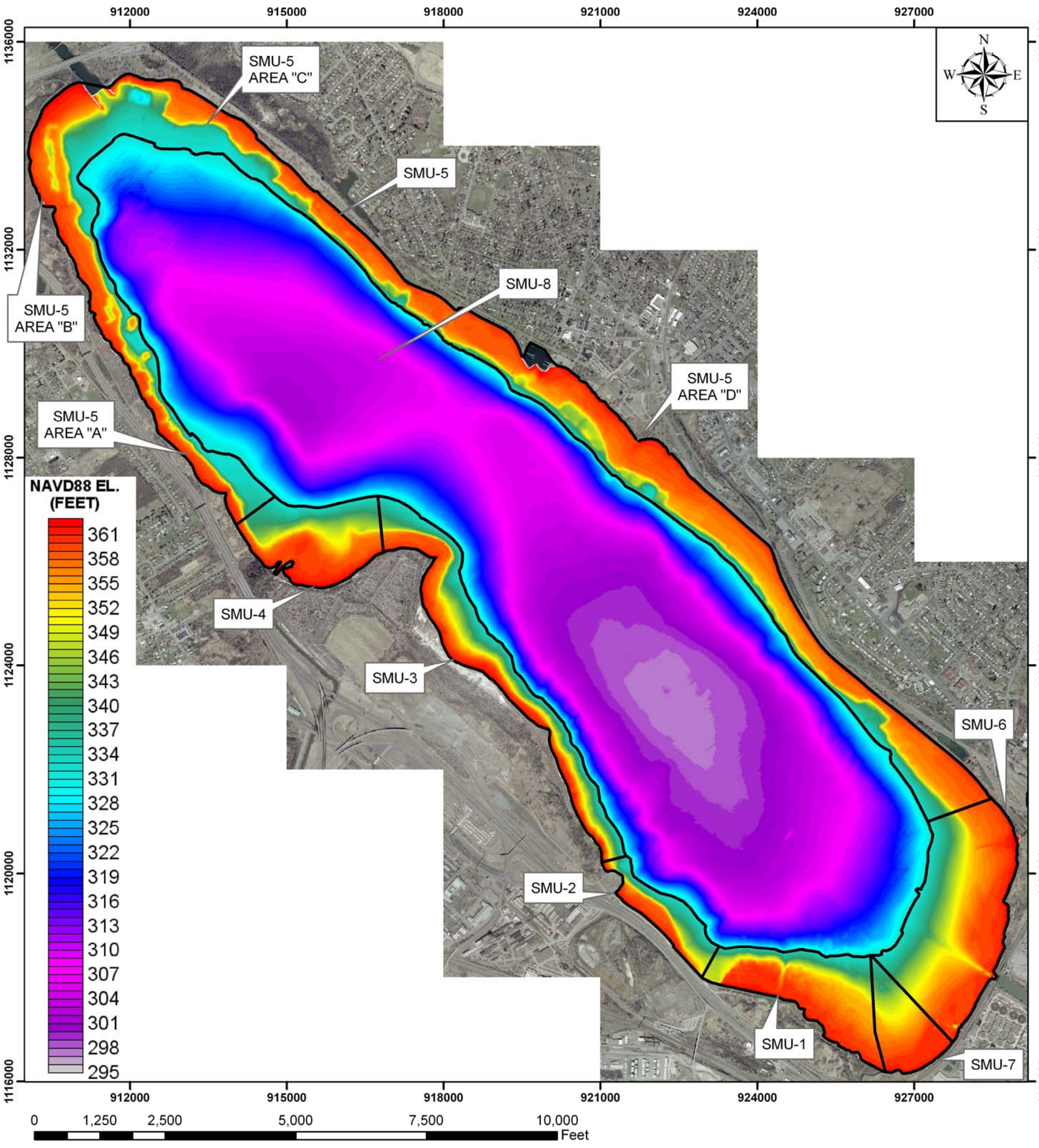


FIGURE 5
ONONDAGA LAKE BATHYMETRY & SMU LOCUS MAP
1.0 FOOT CONTOUR INTERVAL
NAVD88 ELEVATIONS



SCALE = 1:24,000

NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Soundings were collected using a 200 kHz precision fathometer.
3. Contours were calculated based on interpolation between data collected along survey transects spaced 25 to 200 feet apart.
4. Grid: NY State Plane (Central), NAD83, US Foot.
5. Not for Navigation.

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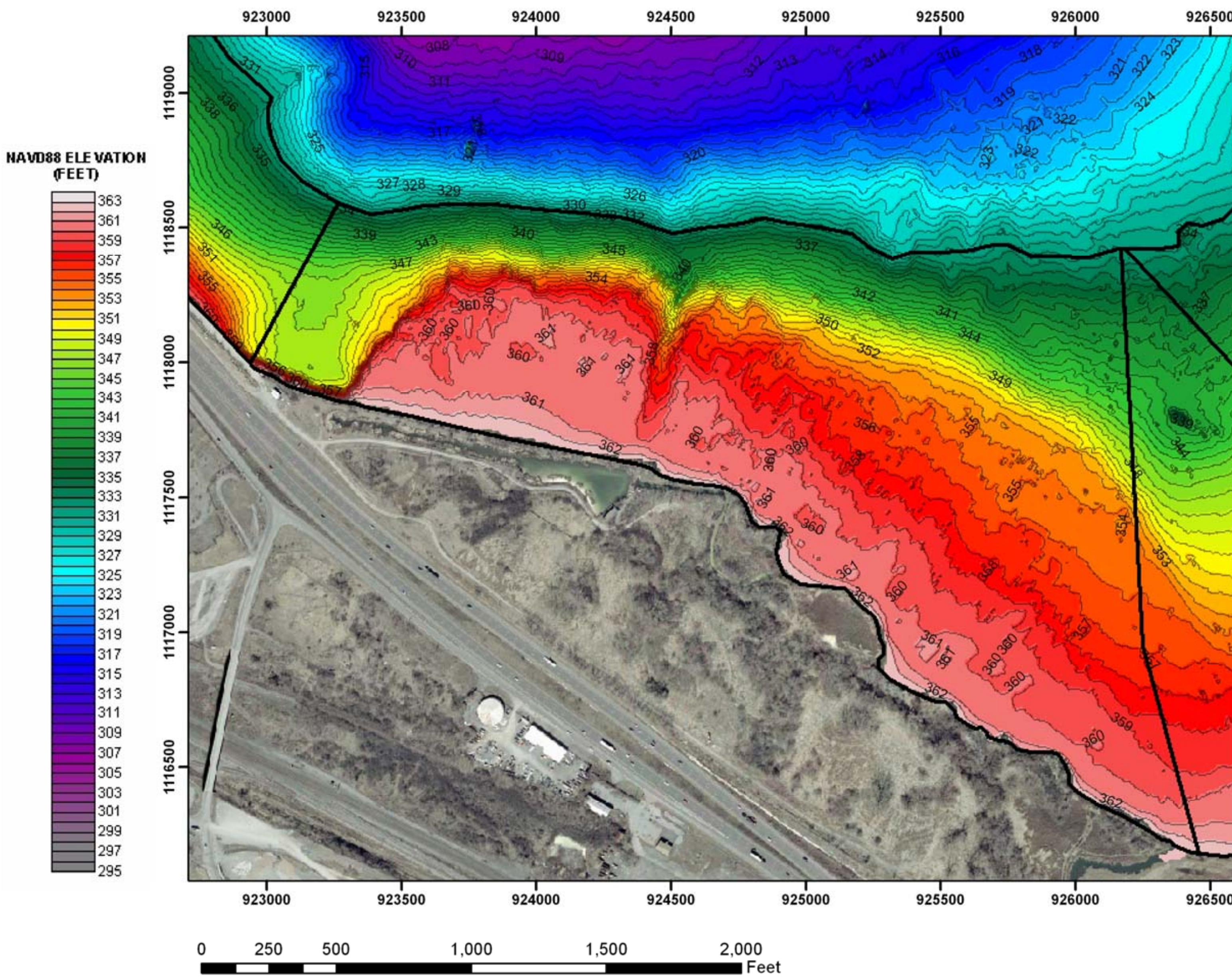
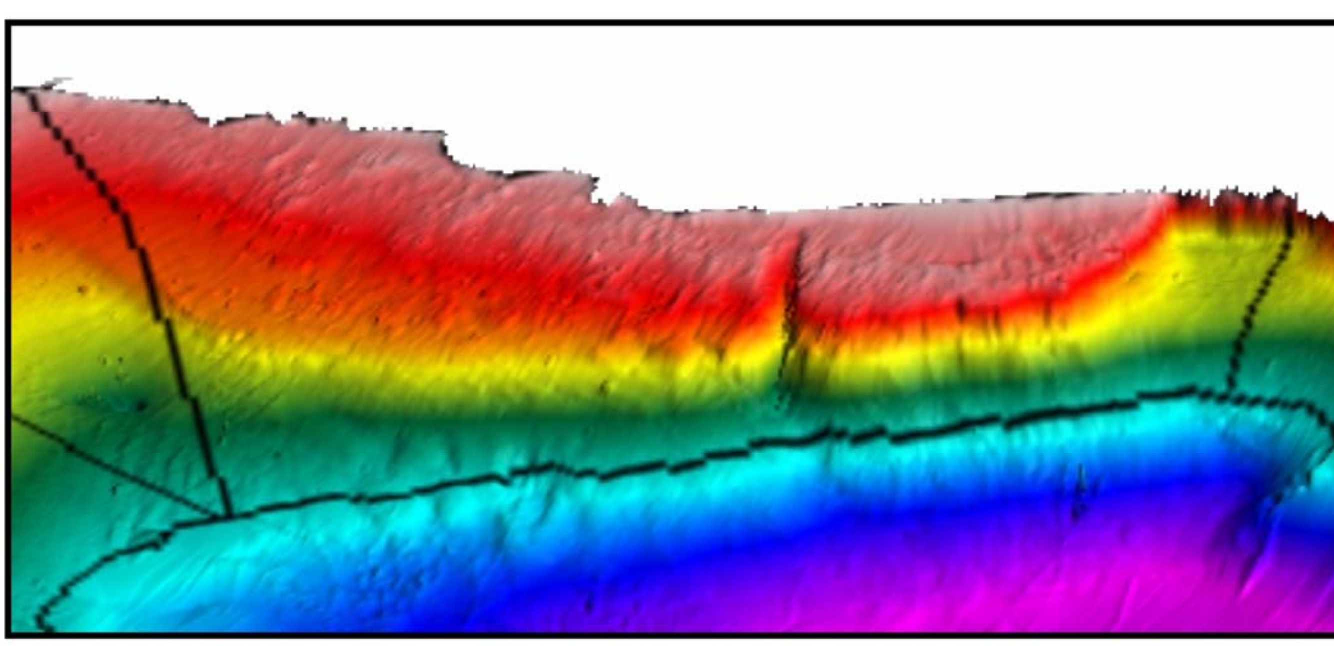
FIGURE 6

BATHYMETRIC CONTOUR MAP AND ARTIFICIALLY ILLUMINATED SURFACE MAP OF SMU 1, ONONDAGA LAKE
1.0 FOOT CONTOUR INTERVAL



SHOREWARD LOOKING 3-DIMENSIONAL SURFACE MAP



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Soundings were collected using a 200 kHz precision fathometer.
3. Contours were calculated based on interpolation between data collected along survey transects spaced 25 to 200 feet apart.
4. Grid: NY State Plane (Central), NAD83, US Foot.
5. Not for Navigation.

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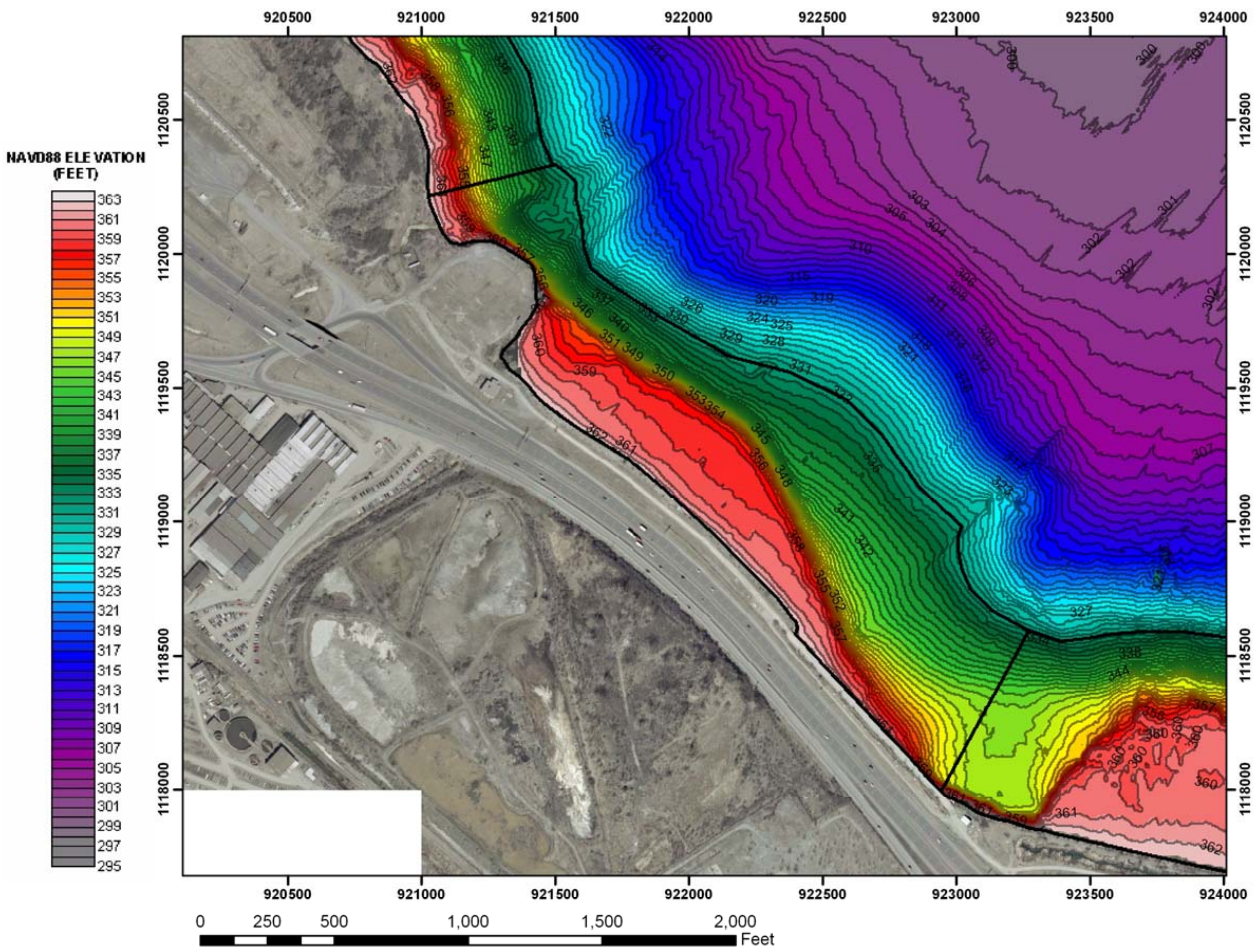
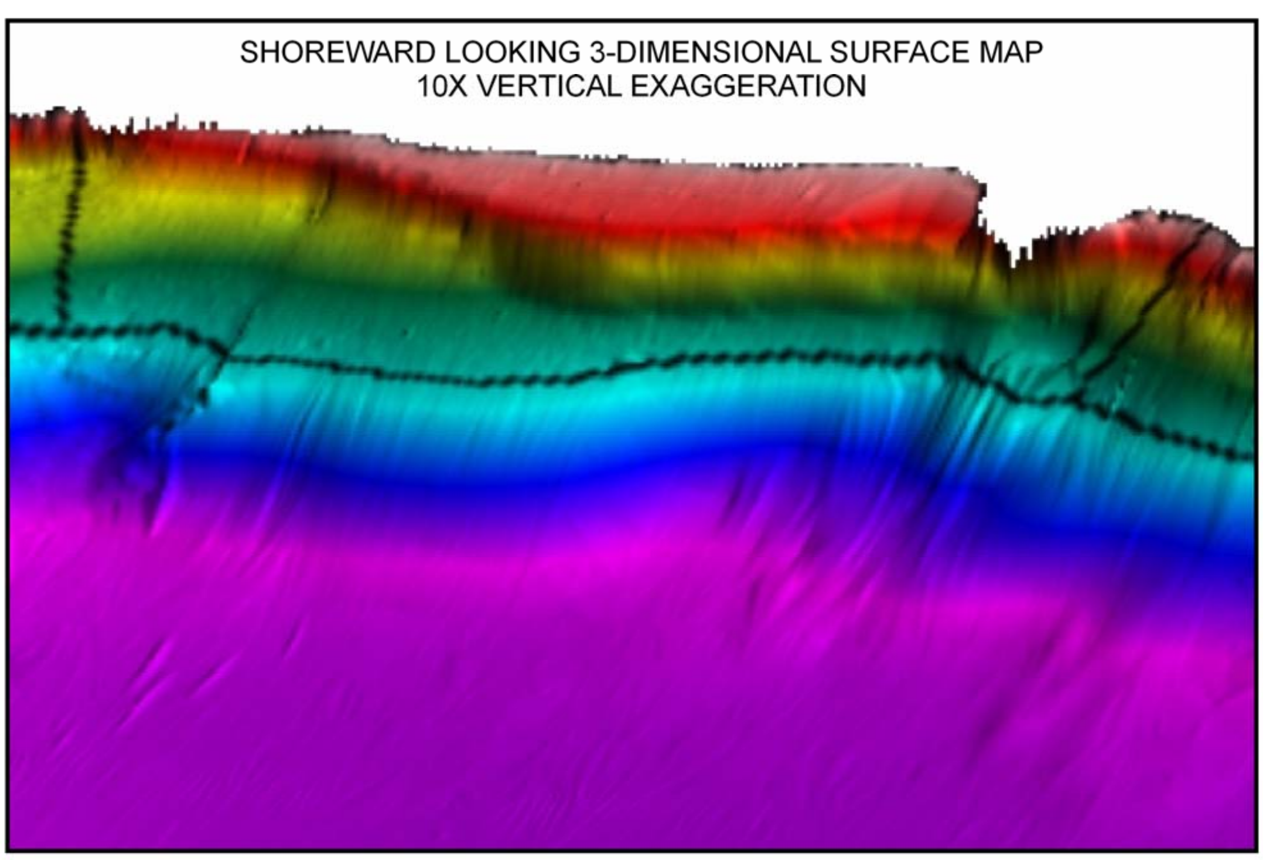
FIGURE 7

BATHYMETRIC CONTOUR MAP AND ARTIFICIALLY ILLUMINATED SURFACE MAP OF SMU 2, ONONDAGA LAKE
1.0 FOOT CONTOUR INTERVAL





NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Soundings were collected using a 200 kHz precision fathometer.
3. Contours were calculated based on interpolation between data collected along survey transects spaced 25 to 200 feet apart.
4. Grid: NY State Plane (Central), NAD83, US Foot.
5. Not for Navigation.

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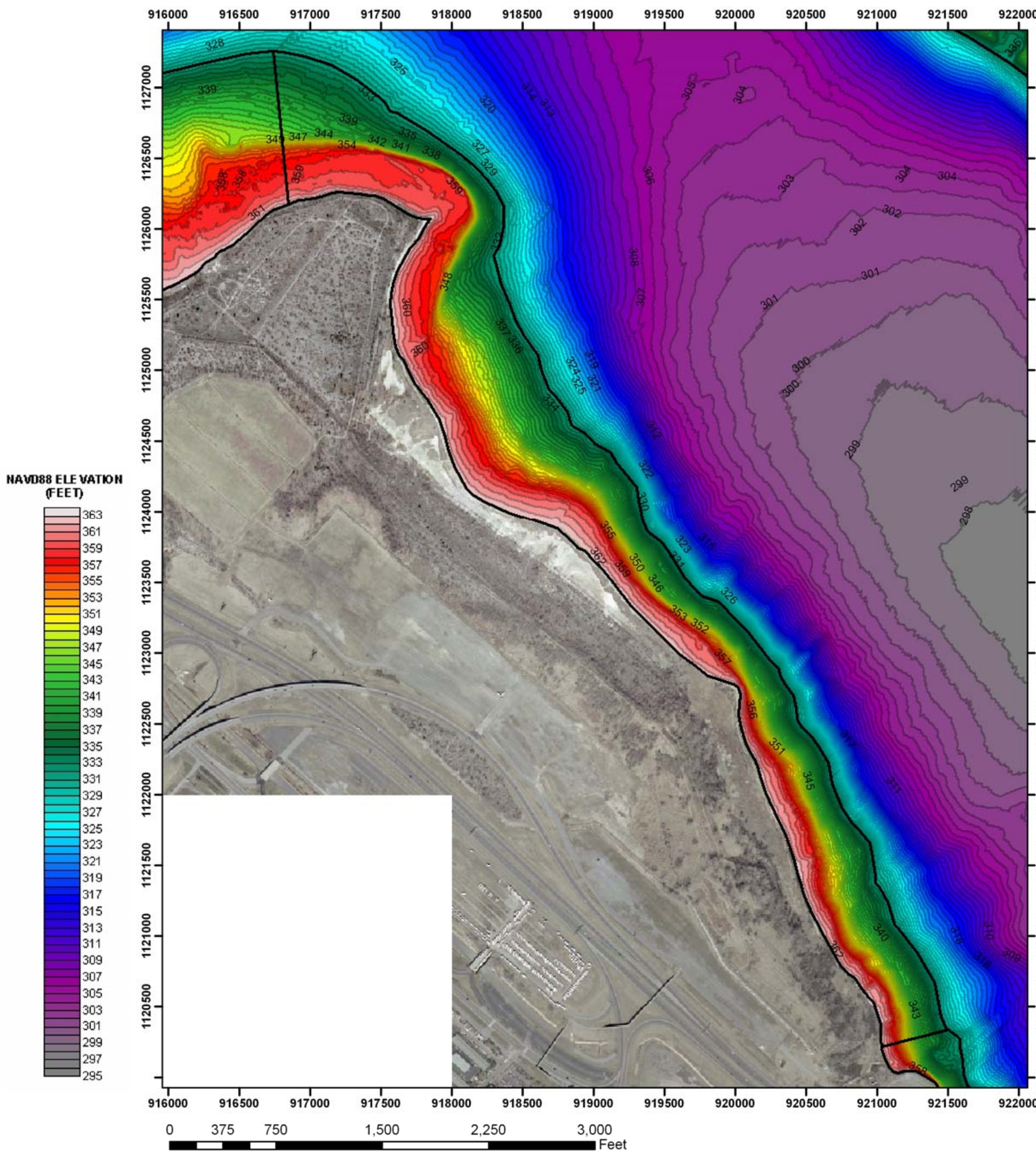
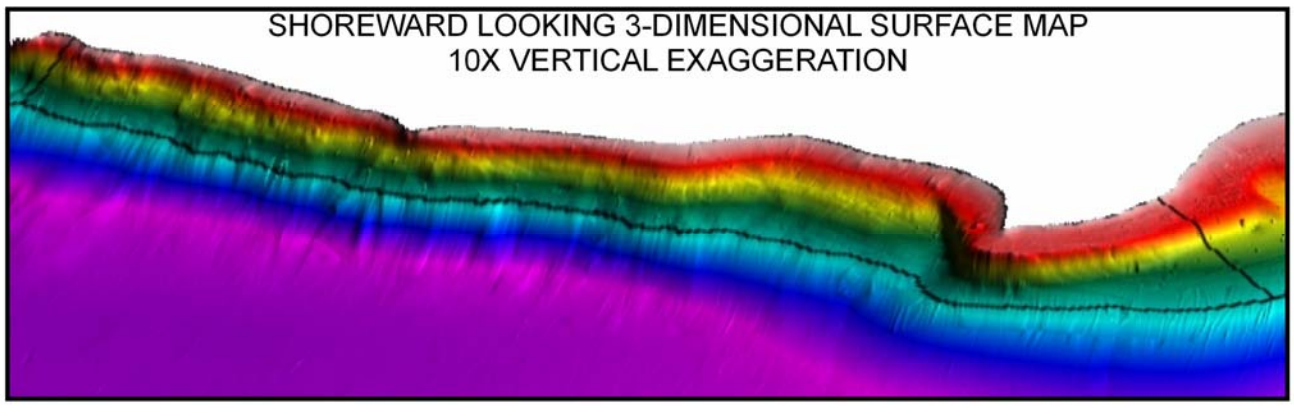
FIGURE 8

BATHYMETRIC CONTOUR MAP AND ARTIFICIALLY ILLUMINATED SURFACE MAP OF SMU 3, ONONDAGA LAKE
1.0 FOOT CONTOUR INTERVAL





NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Soundings were collected using a 200 kHz precision fathometer.
3. Contours were calculated based on interpolation between data collected along survey transects spaced 25 to 200 feet apart.
4. Grid: NY State Plane (Central), NAD83, US Foot.
5. Not for Navigation.

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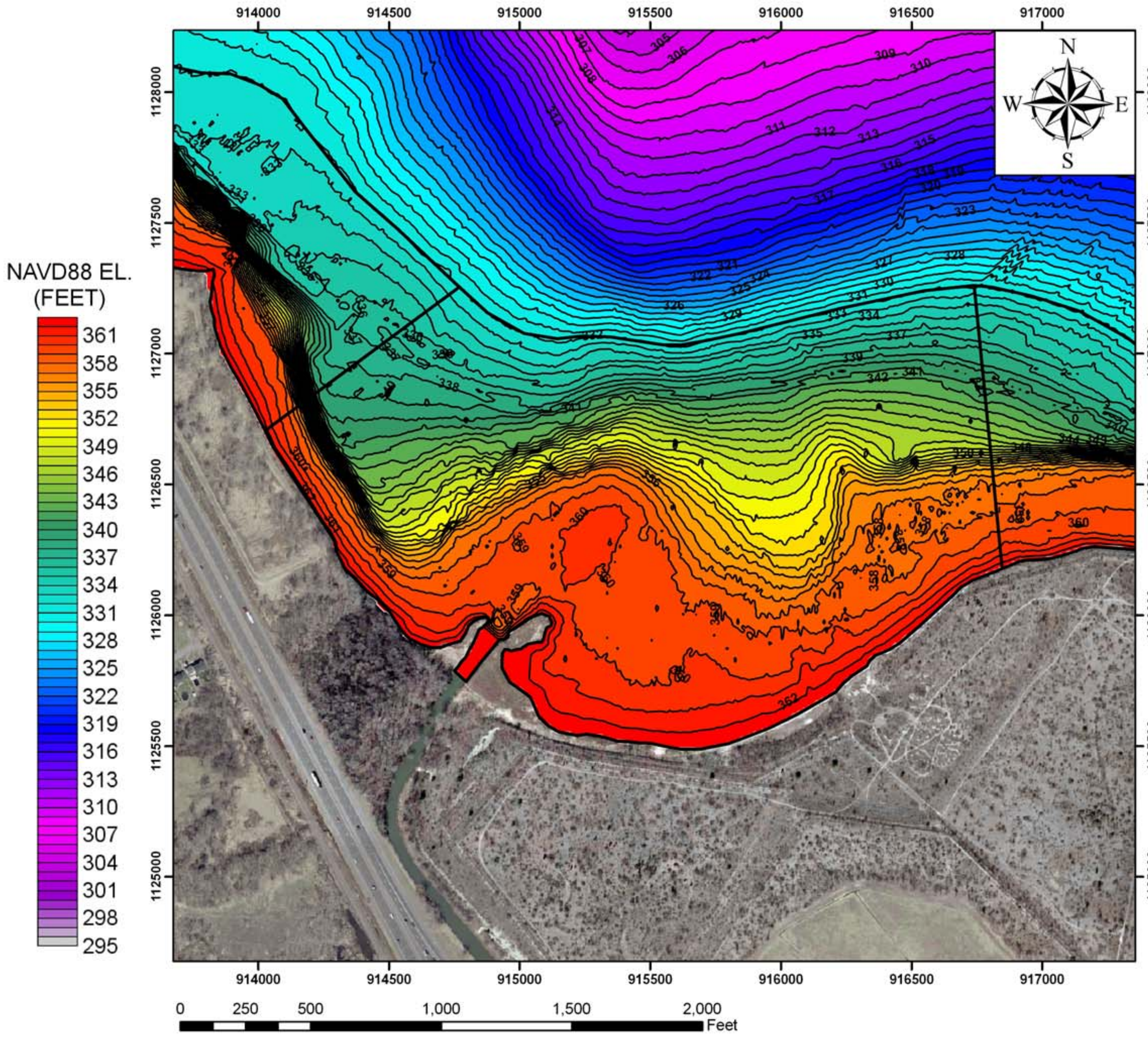
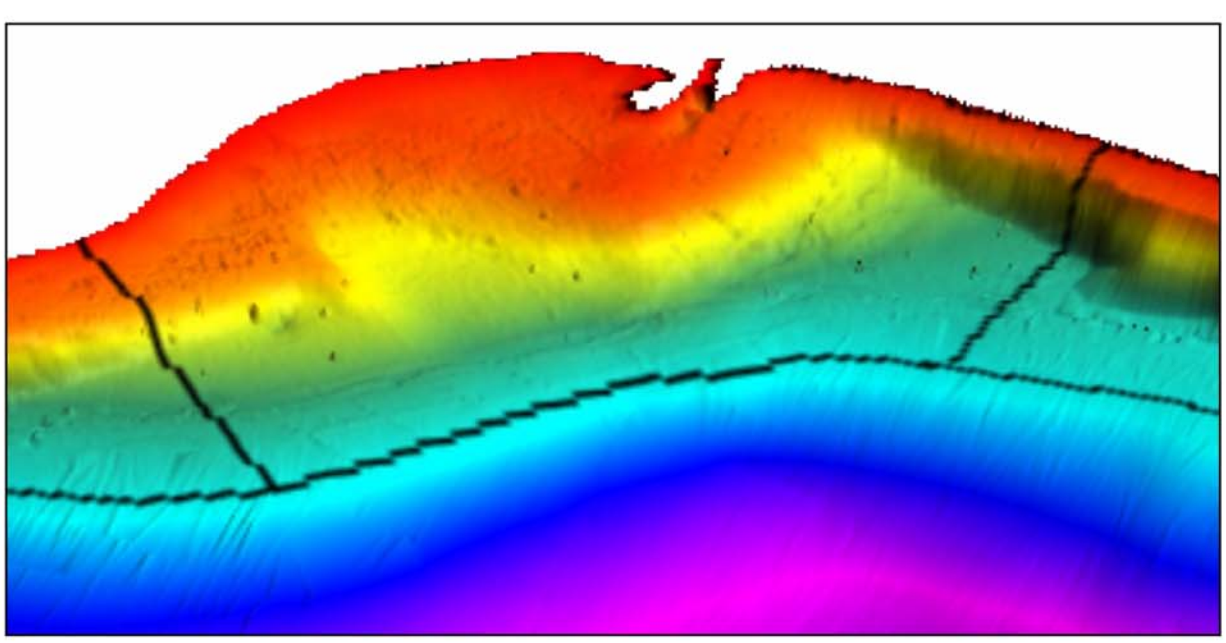
FIGURE 9

BATHYMETRIC CONTOUR MAP AND ARTIFICIALLY ILLUMINATED SURFACE MAP OF SMU-4, ONONDAGA LAKE
1.0 FOOT CONTOUR INTERVAL



SHOREWARD LOOKING 3-DIMENSIONAL SURFACE MAP
10X VERTICAL EXAGGERATION



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Soundings were collected using a 200 kHz precision fathometer.
3. Contours were calculated based on interpolation between data collected along survey transects spaced 25 to 200 feet apart.
4. Grid: NY State Plane (Central), NAD83, US Foot.
5. Not for Navigation.

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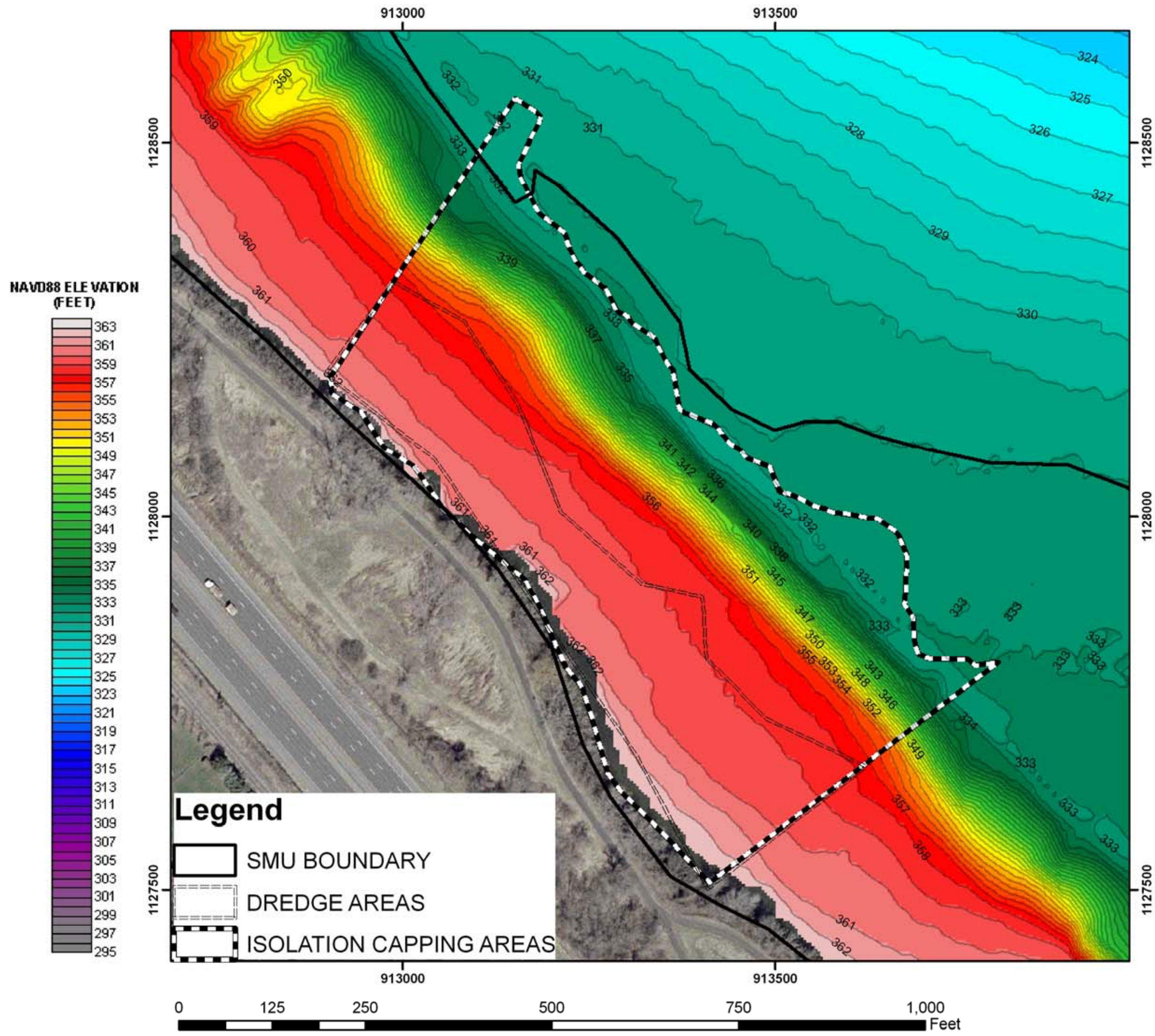
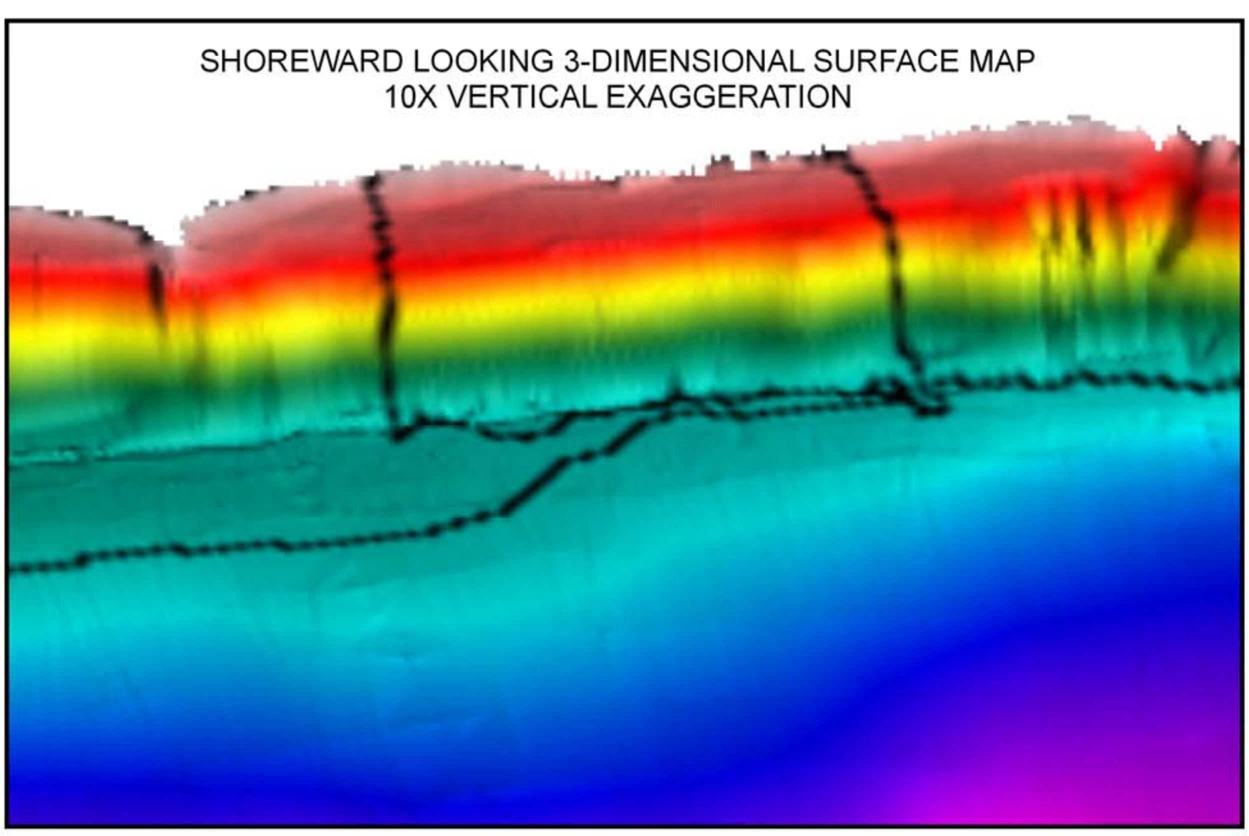
FIGURE 10

BATHYMETRIC CONTOUR MAP AND ARTIFICIALLY ILLUMINATED SURFACE MAP OF SMU 5 – AREA "A", ONONDAGA LAKE 1.0 FOOT CONTOUR INTERVAL





NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Soundings were collected using a 200 kHz precision fathometer.
3. Contours were calculated based on interpolation between data collected along survey transects spaced 25 to 200 feet apart.
4. Grid: NY State Plane (Central), NAD83, US Foot.
5. Dredge areas and isolation capping areas as shown are approximate boundaries of potential remediation areas based on the November 2004 Feasibility Study Report. These boundaries may change in the future.
6. Not for Navigation.

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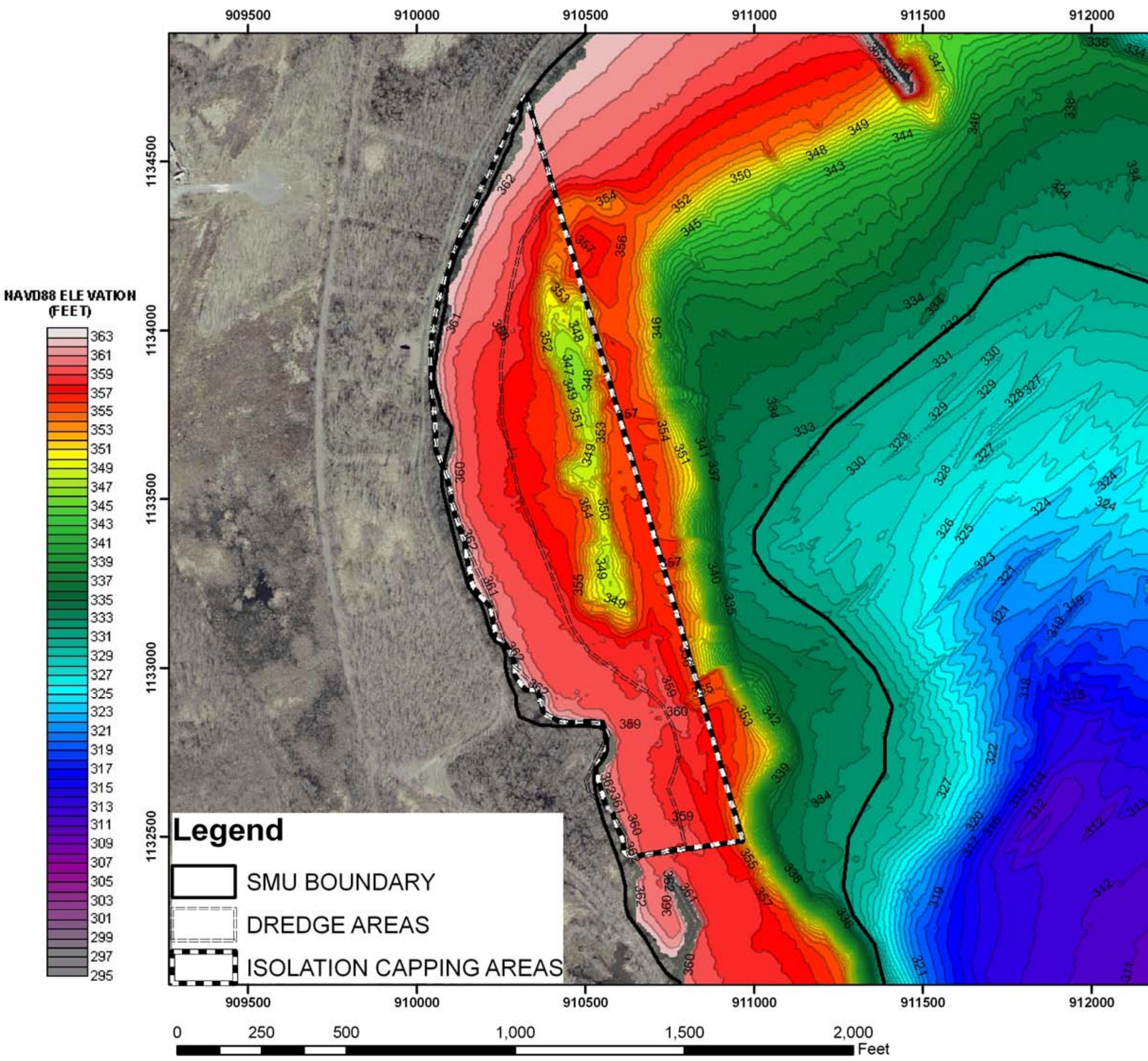
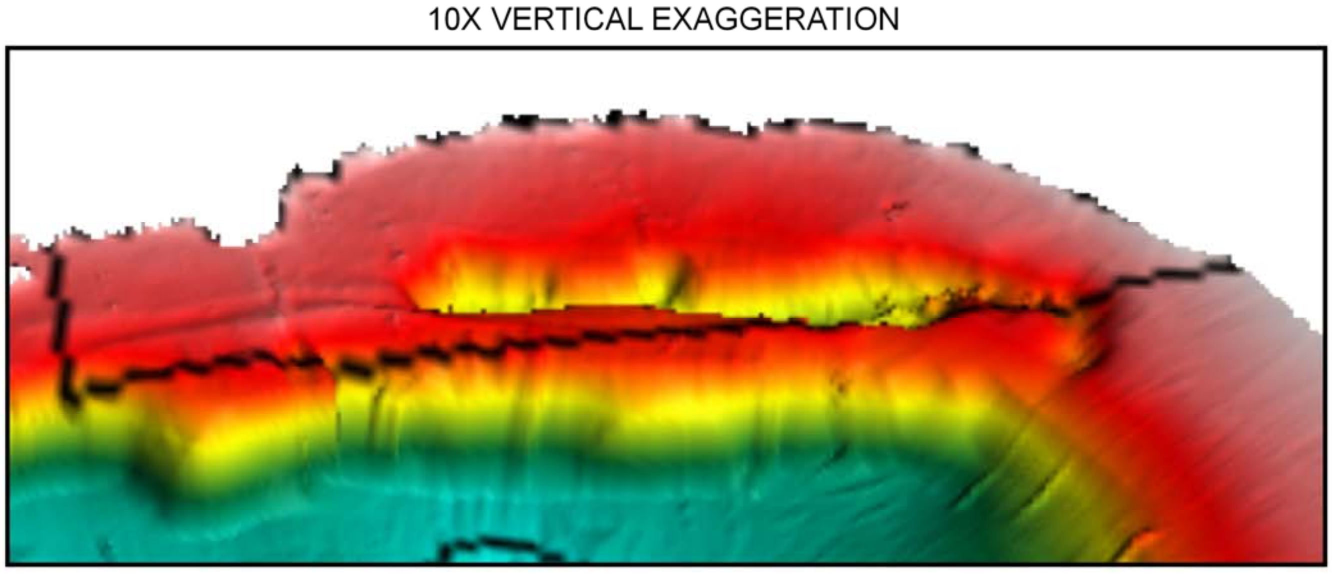
FIGURE 11

BATHYMETRIC CONTOUR MAP AND ARTIFICIALLY ILLUMINATED SURFACE MAP OF SMU 5 – AREA “B”, ONONDAGA LAKE 1.0 FOOT CONTOUR INTERVAL



SHOREWARD LOOKING 3-DIMENSIONAL SURFACE MAP
10X VERTICAL EXAGGERATION



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Soundings were collected using a 200 kHz precision fathometer.
3. Contours were calculated based on interpolation between data collected along survey transects spaced 25 to 200 feet apart.
4. Grid: NY State Plane (Central), NAD83, US Foot.
5. Dredge areas and isolation capping areas as shown are approximate boundaries of potential remediation areas based on the November 2004 Feasibility Study Report. These boundaries may change in the future.
6. Not for Navigation.

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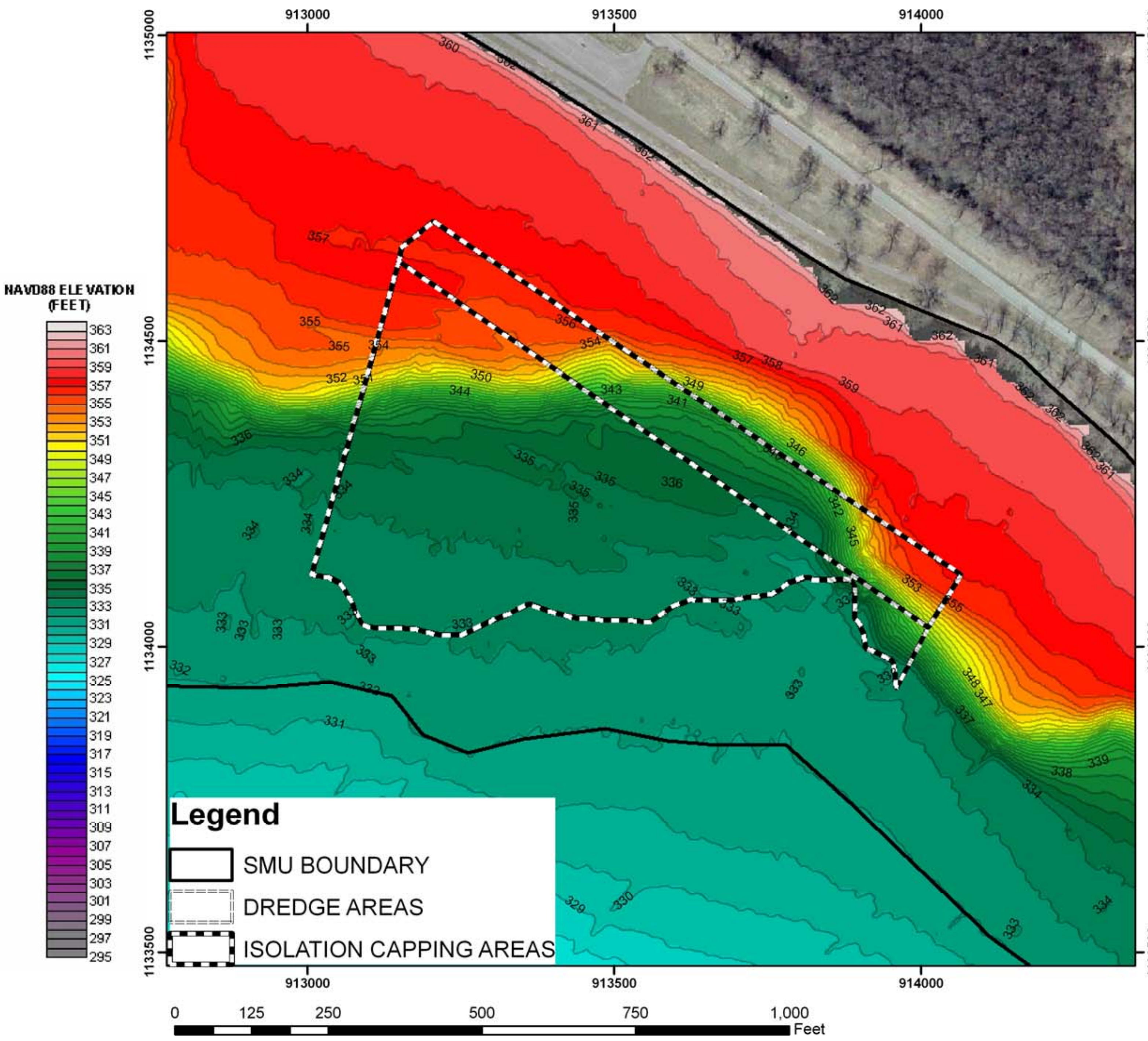
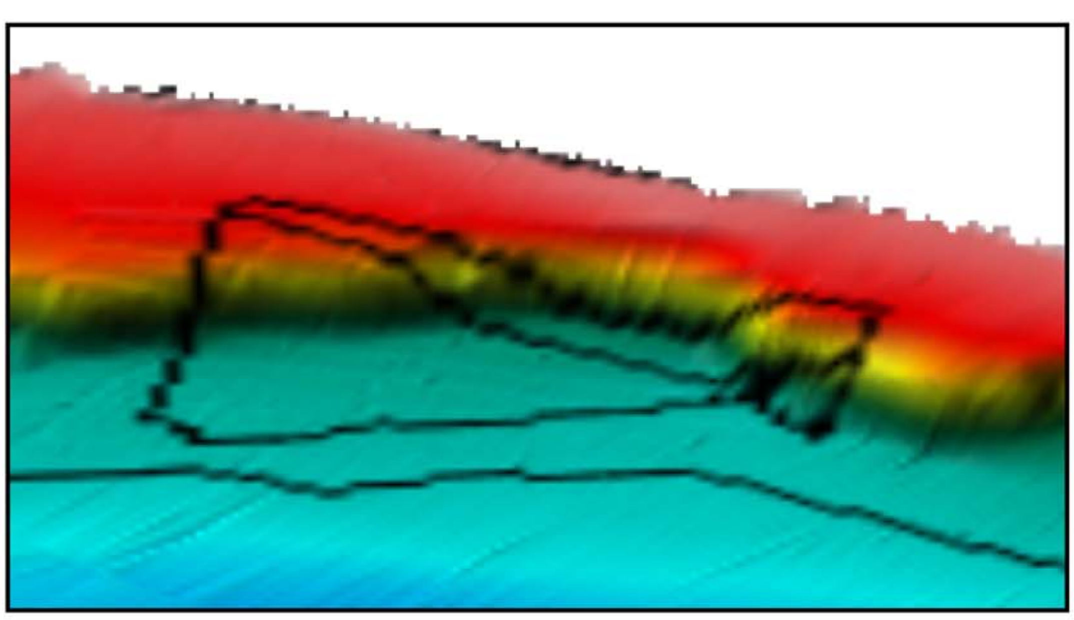
FIGURE 12

BATHYMETRIC CONTOUR MAP AND ARTIFICIALLY ILLUMINATED SURFACE MAP OF SMU 5 – AREA “C”, ONONDAGA LAKE
1.0 FOOT CONTOUR INTERVAL



SHOREWARD LOOKING 3-DIMENSIONAL SURFACE MAP
5X VERTICAL EXAGGERATION



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Soundings were collected using a 200 kHz precision fathometer.
3. Contours were calculated based on interpolation between data collected along survey transects spaced 25 to 200 feet apart.
4. Grid: NY State Plane (Central), NAD83, US Foot.
5. Dredge areas and isolation capping areas as shown are approximate boundaries of potential remediation areas based on the November 2004 Feasibility Study Report. These boundaries may change in the future.
6. Not for Navigation.

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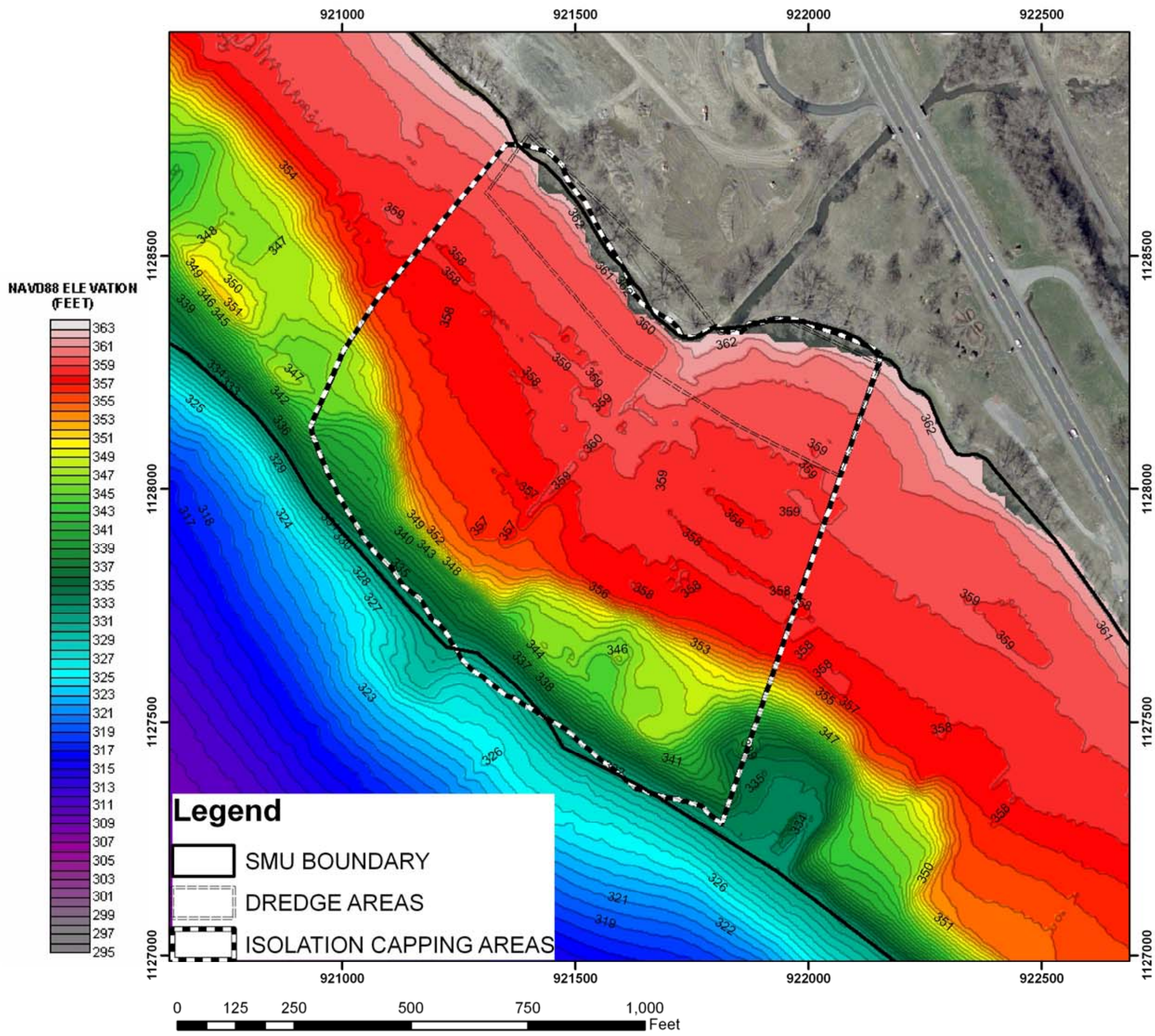
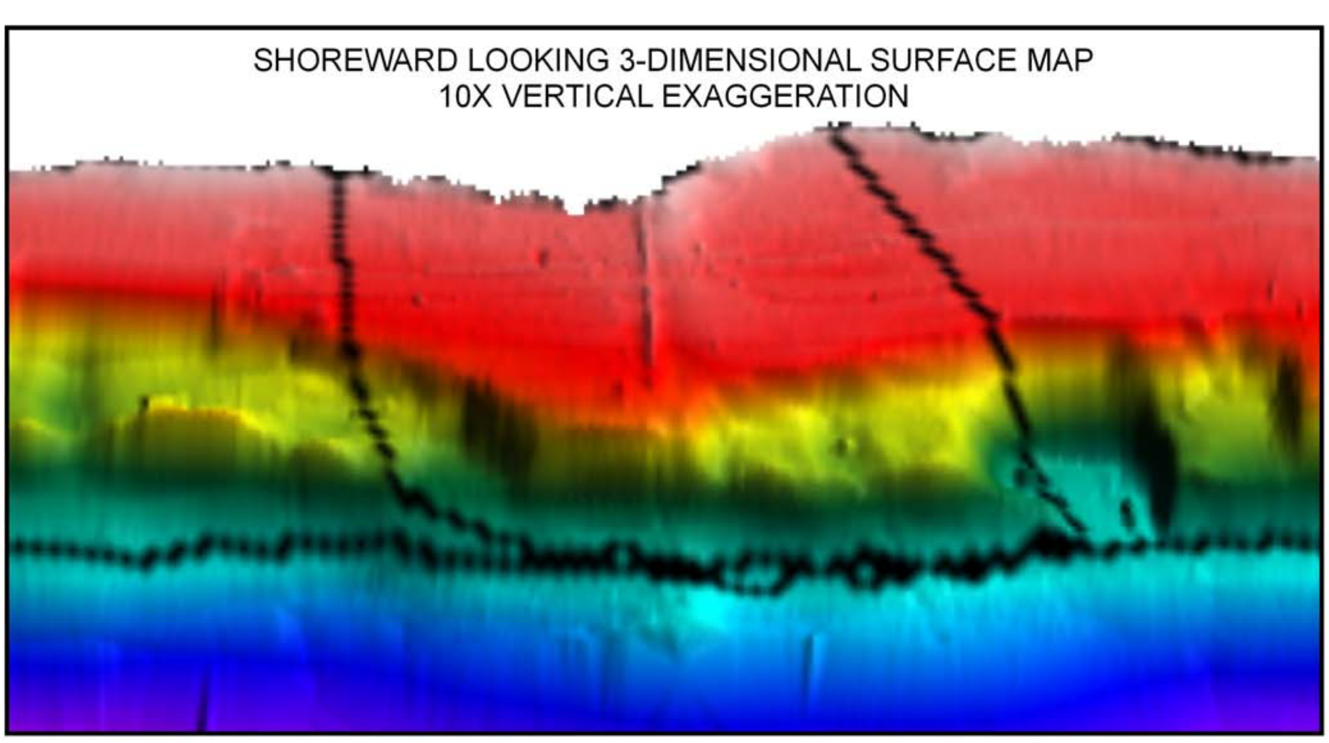
FIGURE 13

BATHYMETRIC CONTOUR MAP AND ARTIFICIALLY ILLUMINATED SURFACE MAP OF SMU 5 – AREA “D”, ONONDAGA LAKE 1.0 FOOT CONTOUR INTERVAL





NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Soundings were collected using a 200 kHz precision fathometer.
3. Contours were calculated based on interpolation between data collected along survey transects spaced 25 to 200 feet apart.
4. Grid: NY State Plane (Central), NAD83, US Foot.
5. Dredge areas and isolation capping areas as shown are approximate boundaries of potential remediation areas based on the November 2004 Feasibility Study Report. These boundaries may change in the future.
6. Not for Navigation.

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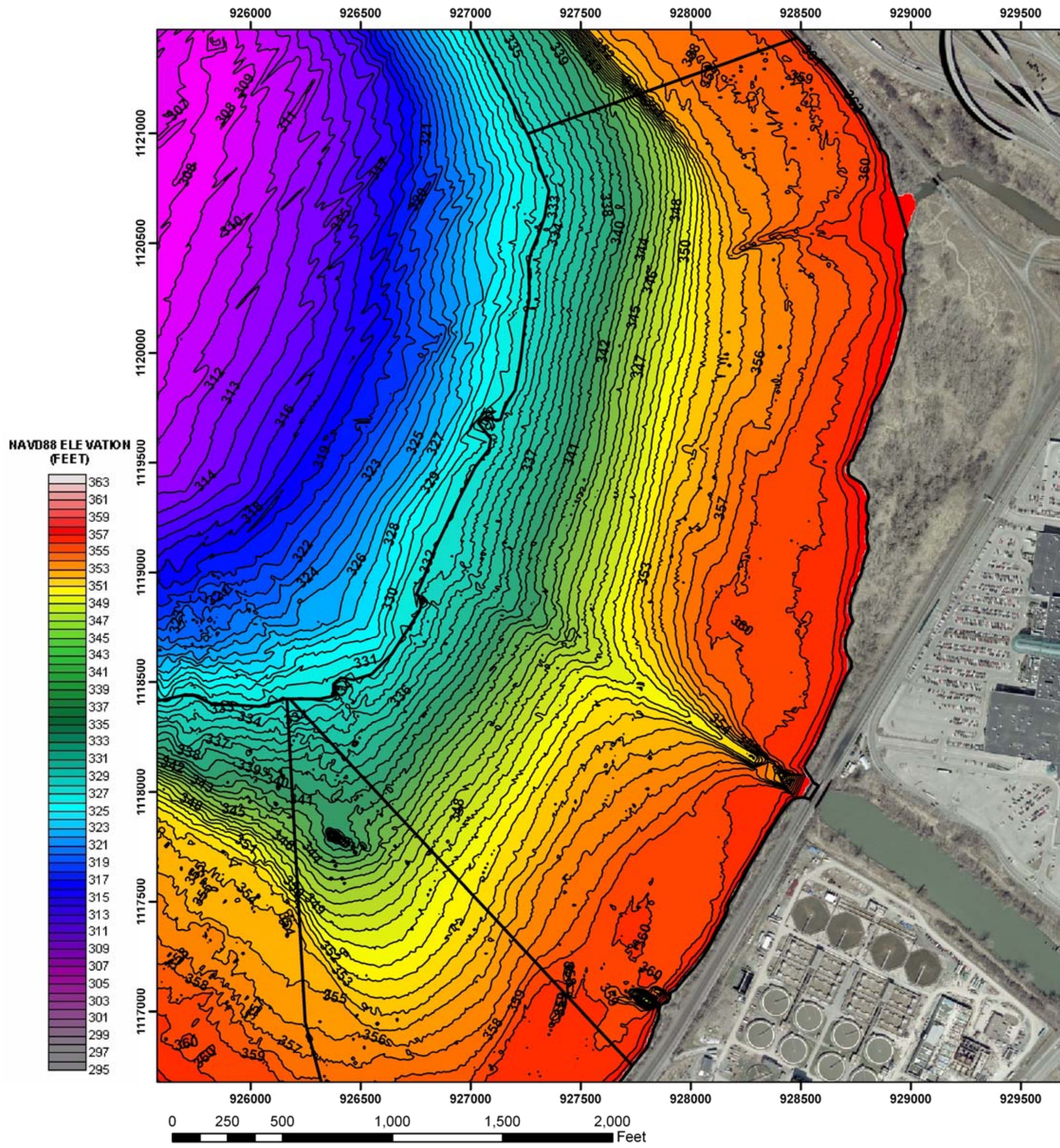
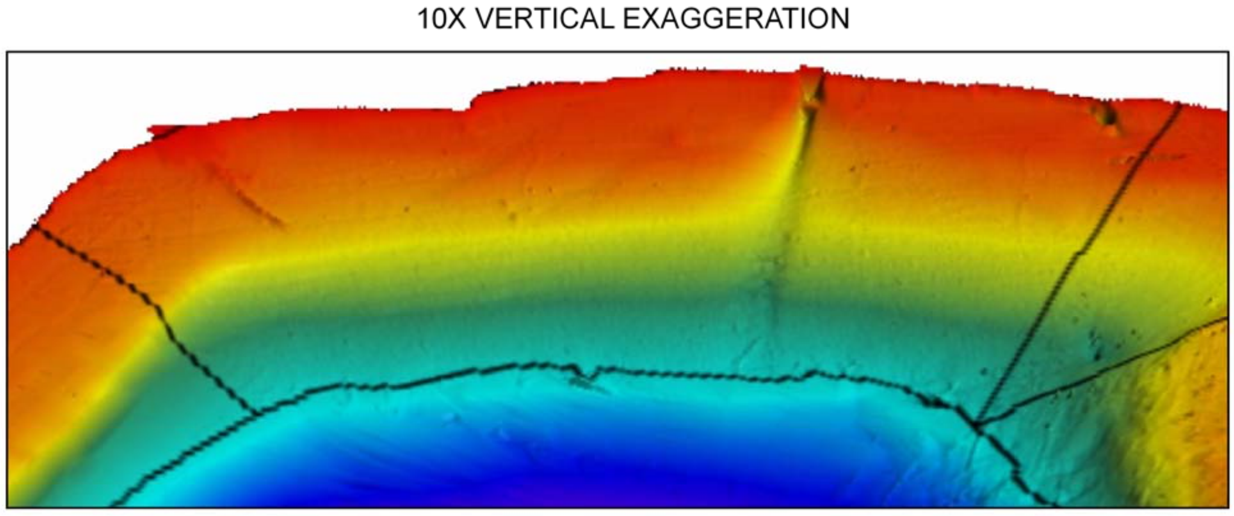
FIGURE 14

BATHYMETRIC CONTOUR MAP AND ARTIFICIALLY ILLUMINATED SURFACE MAP OF SMU-6, ONONDAGA LAKE
1.0 FOOT CONTOUR INTERVAL



SHOREWARD LOOKING 3-DIMENSIONAL SURFACE MAP
10X VERTICAL EXAGGERATION

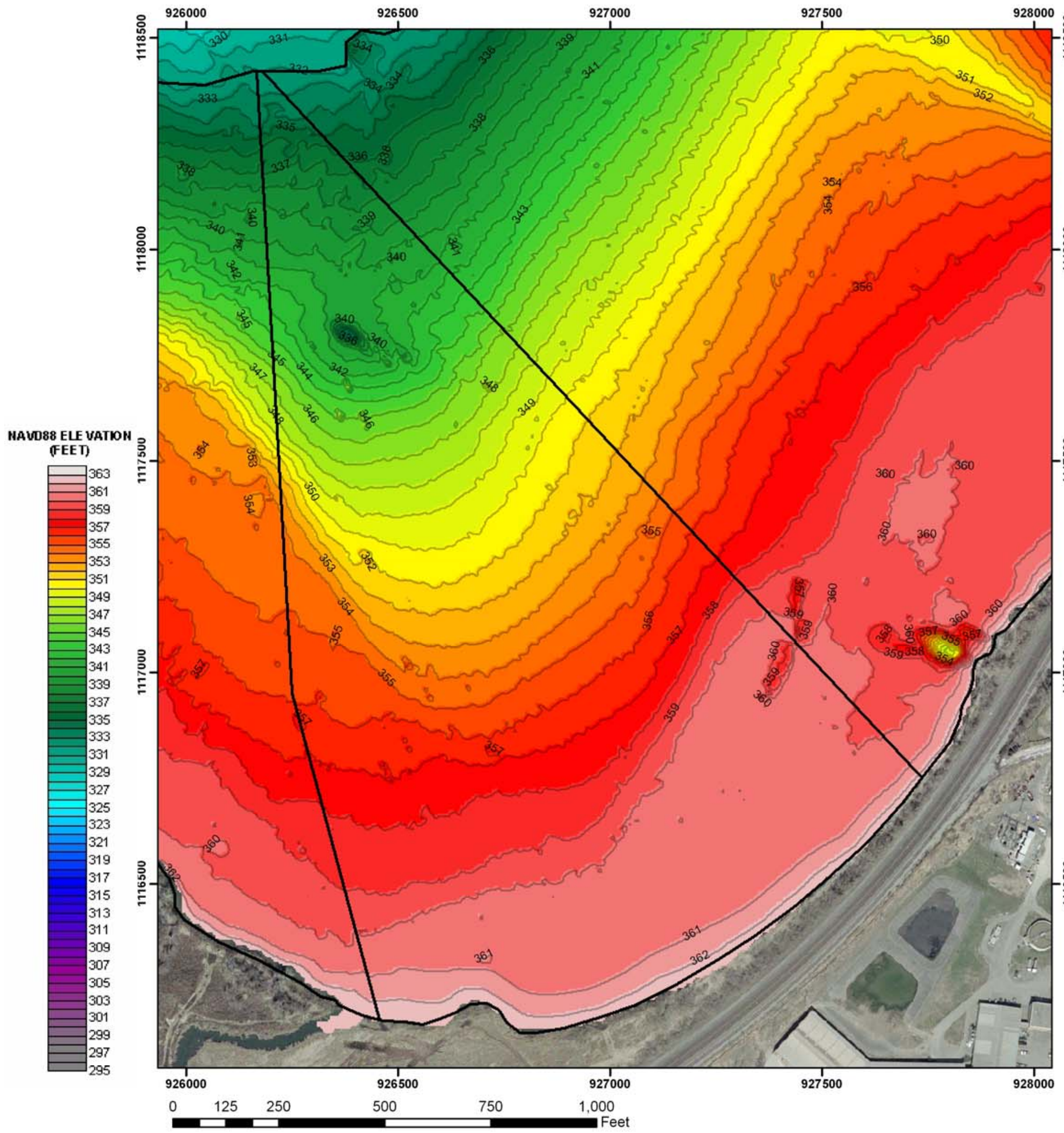


NOTES:

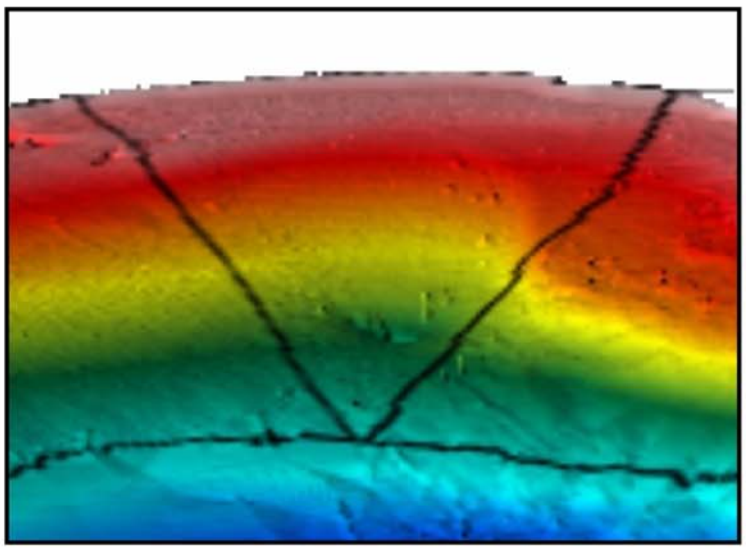
1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Soundings were collected using a 200 kHz precision fathometer.
3. Contours were calculated based on interpolation between data collected along survey transects spaced 25 to 200 feet apart.
4. Grid: NY State Plane (Central), NAD83, US Foot.
5. Not for Navigation.

FIGURE 15

BATHYMETRIC CONTOUR MAP AND ARTIFICIALLY ILLUMINATED SURFACE MAP OF SMU 7, ONONDAGA LAKE
1.0 FOOT CONTOUR INTERVAL



SHOREWARD LOOKING 3-DIMENSIONAL SURFACE MAP
10X VERTICAL EXAGGERATION



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Soundings were collected using a 200 kHz precision fathometer.
3. Contours were calculated based on interpolation between data collected along survey transects spaced 25 to 200 feet apart.
4. Grid: NY State Plane (Central), NAD83, US Foot.
5. Not for Navigation.

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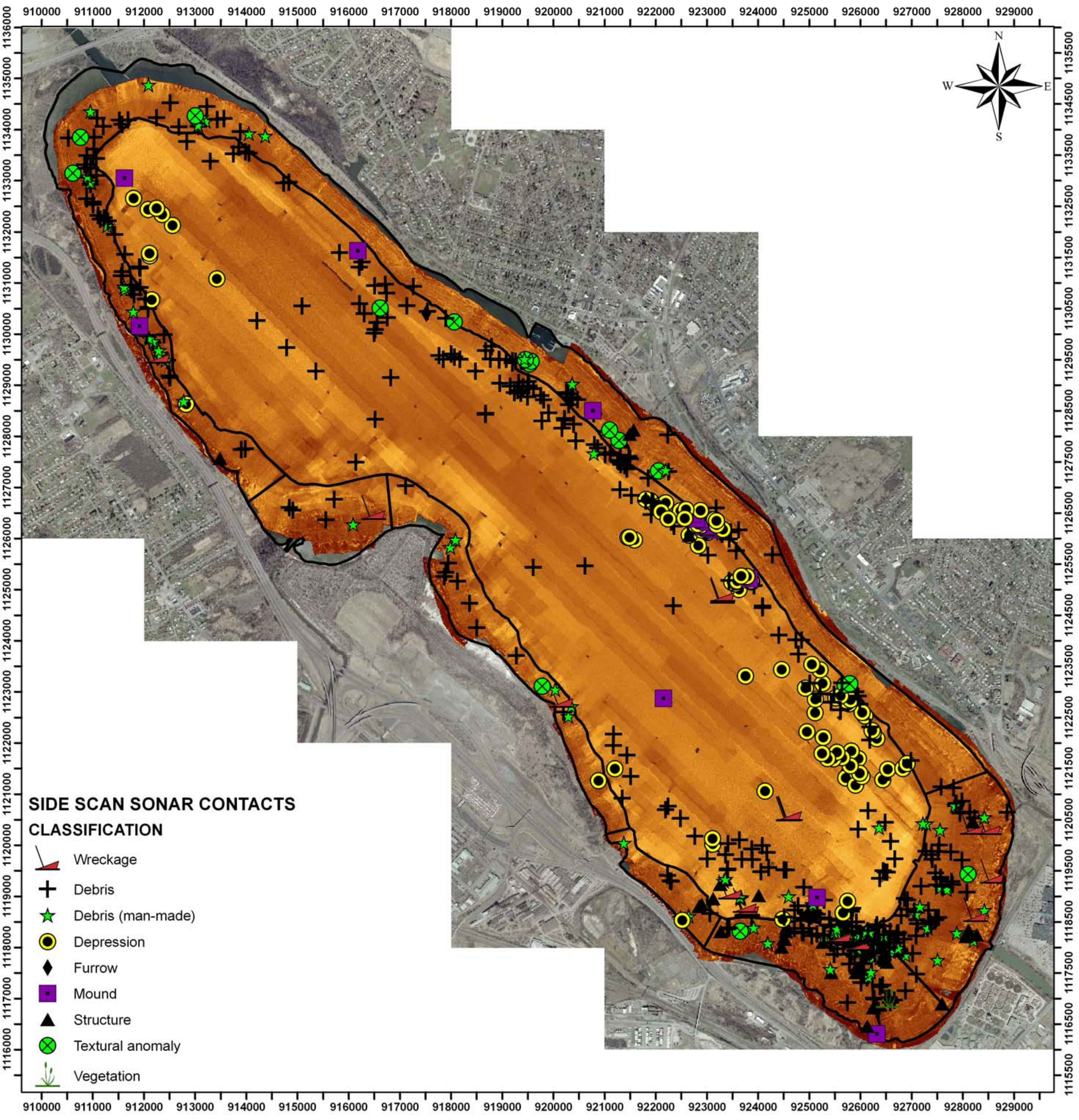
FIGURE 16

SIDE SCAN SONAR MOSAIC AND DIGITIZED SONAR CONTACTS
ONONDAGA LAKE



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Sonar data was collected using a 100 kHz signal and ranges of 25 and 50 meters. Digitized Contacts limited to features >5 feet in any dimension.
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Not for Navigation.

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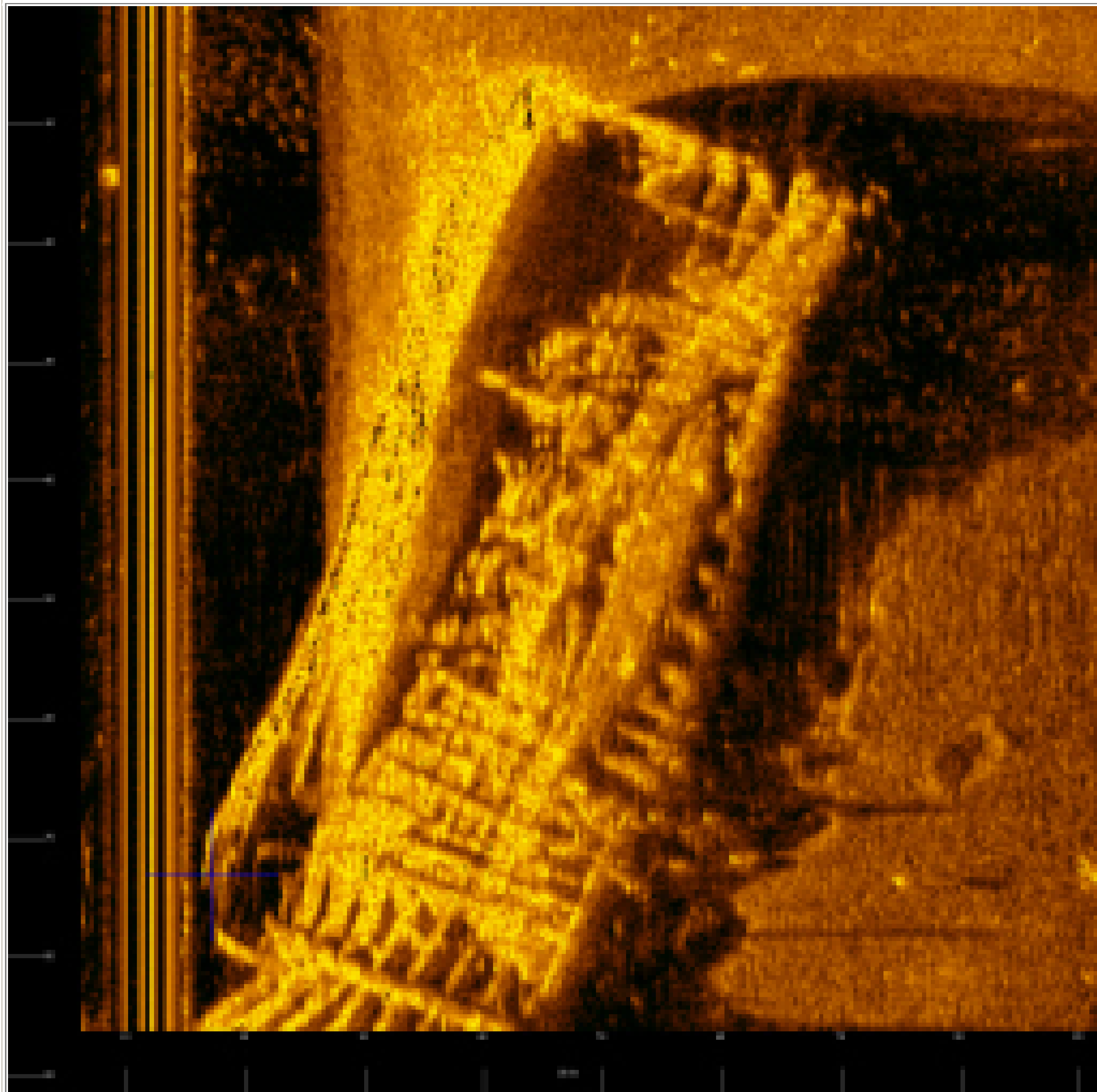
FIGURE 17A

SIDE SCAN SONAR DATA COLLECTED IN SMU 4
LIKELY BARGE WRECKAGE



Target: Contact0501

Sonar Time at Target: 11/06/2005 15:32:47
Target Capture Time Local: 03/31/06 14:36:07
Target Capture Time UTC: 03/31/06 19:36:07
Target Click Position (GEO): 43° 05.48701' N 076° 13.37278' W
Target Click Position (NY83-CF): N:1126611.95 E:916488.59
Acoustic Source File: I:\onondaga_sss\raw\hr\misc500-50-2___I.xtf, Ping:1148
Horizontal range to target: 10.52 meters to Stbd side
Slant range to target: 1.65 meters to Stbd side
Event Number: 0
Line Name: misc500-50-2___I

Target Description: Wreckage
Target Height=11.07 US Feet
Target Length: 84.52 US Feet
Target Width: 34.46 US Feet
Target Shadow: 31.84 US Feet
Range to Target: 5.60 US Feet

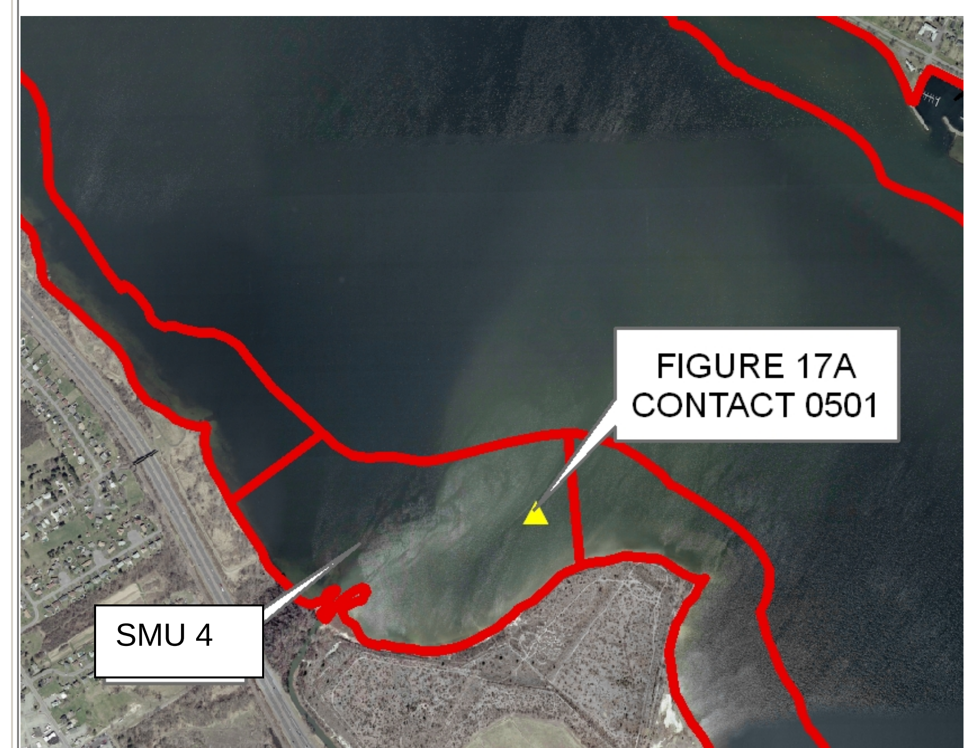
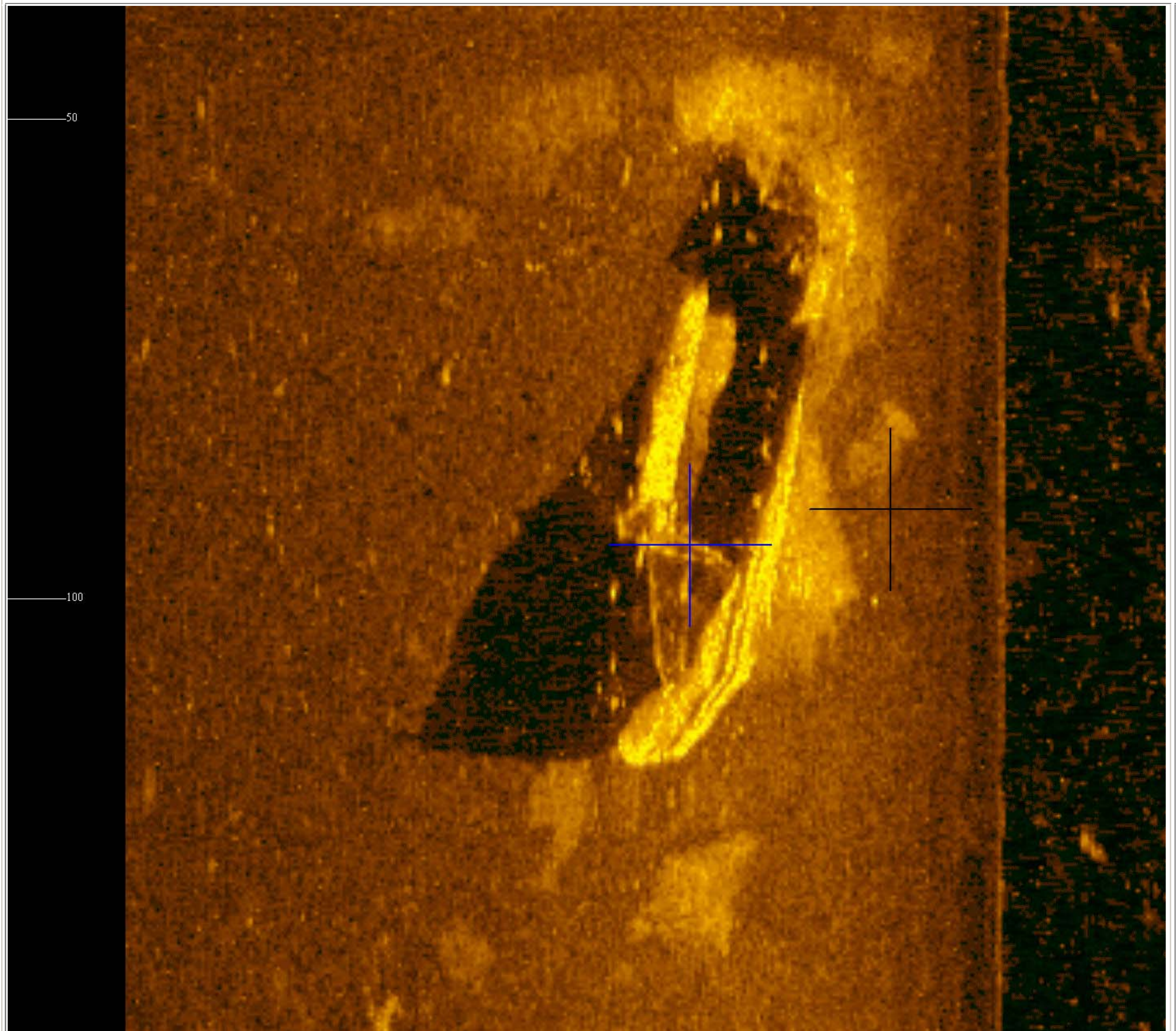


FIGURE 17B

SIDE SCAN SONAR DATA COLLECTED IN SMU 8, SOUTHERN BASIN SHIP WRECKAGE



Target: Contact0355

Sonar Time at Target: 11/06/2005 20:00:27
Target Capture Time Local: 03/31/06 14:52:38
Target Capture Time UTC: 03/31/06 19:52:38
Target Click Position (GEO): 43° 04.50946' N 076° 11.56030' W
Target Click Position (NY83-CF): N:1120710.06 E:924585.10
Acoustic Source File: I:\onondaga_sss\raw\hr\wreck4-1___A.xtf, Ping:1131
Horizontal range to target: 20.17 meters to Port side
Slant range to target: -26.59 meters to Port side
Event Number: 0
Line Name: wreck4-1___A

Target Description: N/A
Target Height=12.02 US Feet
Target Length: 58.64 US Feet
Target Width: 16.27 US Feet
Target Shadow: 23.98 US Feet
Range to Target: 87.42 US Feet
User Classification (1): Wreck

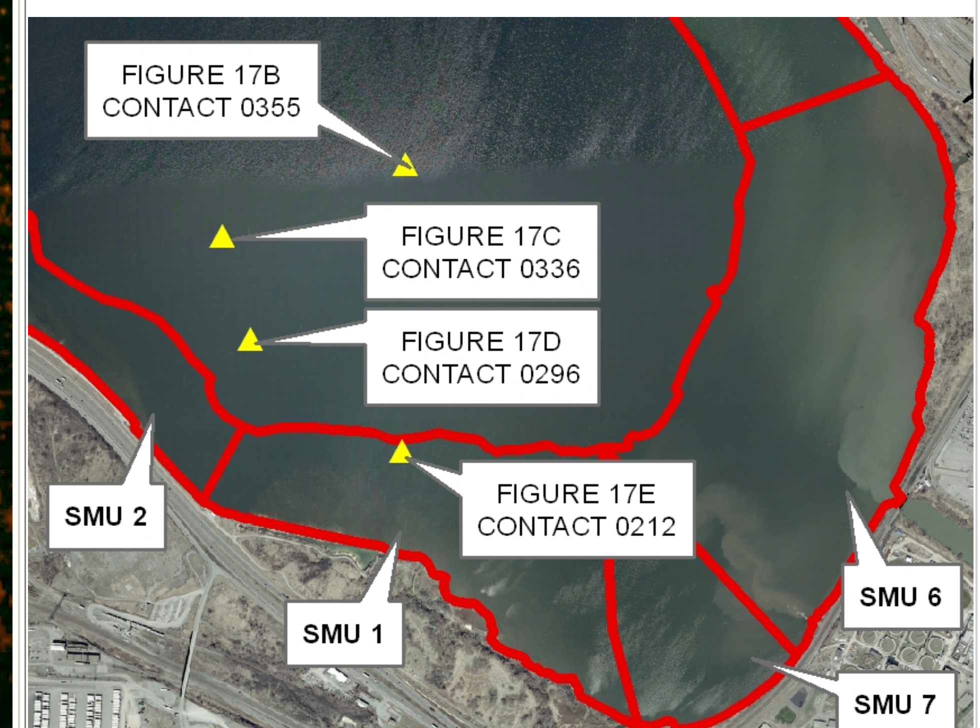
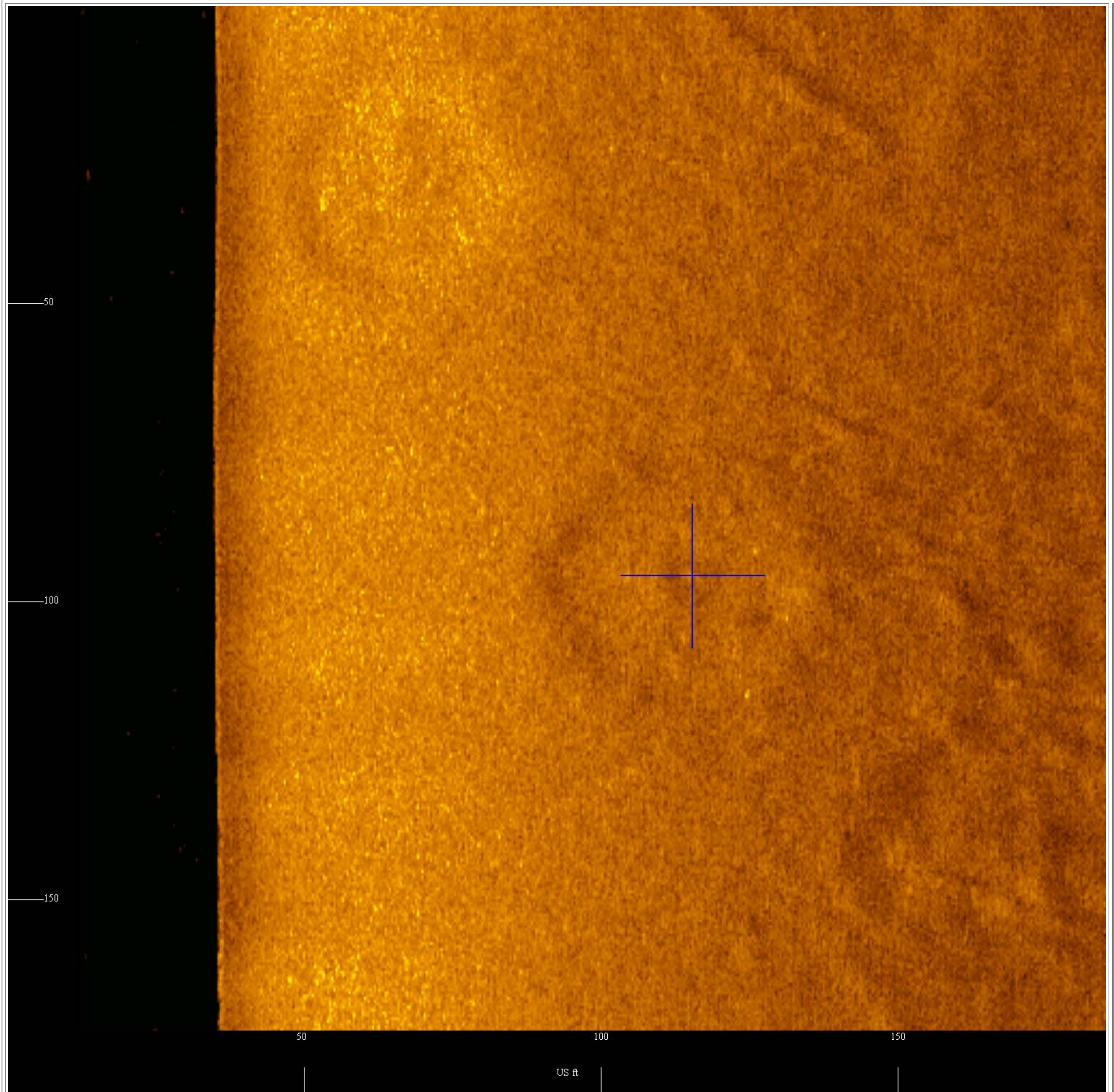


FIGURE 17C

SIDE SCAN SONAR DATA COLLECTED IN SMU 8 ADJACENT TO SMU 2
CIRCULAR DEPRESSIONS LOCATED ~1,480 FEET FROM SHORE



Target: Contact0336

Sonar Time at Target: 10/17/2005 17:58:42
Target Capture Time Local: 03/30/06 17:08:57
Target Capture Time UTC: 03/30/06 22:08:57
Target Click Position (GEO): 43° 04.41516' N 076° 11.89245' W
Target Click Position (NY83-CF): N:1120130.44 E:923108.65
Acoustic Source File: I:\onondaga_SSS\raw\17-212_1___A.xtf, Ping:3692
Horizontal range to target: 31.05 meters to Stbd side
Slant range to target: 35.05 meters to Stbd side
Event Number: 0
Line Name: 17-212_1___A

Target Description: Note concentric inner & outer rings.
Target Height=0.00 US Feet
Target Length: 38.12 US Feet
Target Width: 36.26 US Feet
Target Shadow: 0.00 US Feet
Range to Target: 101.63 US Feet
User Classification (1): depressions

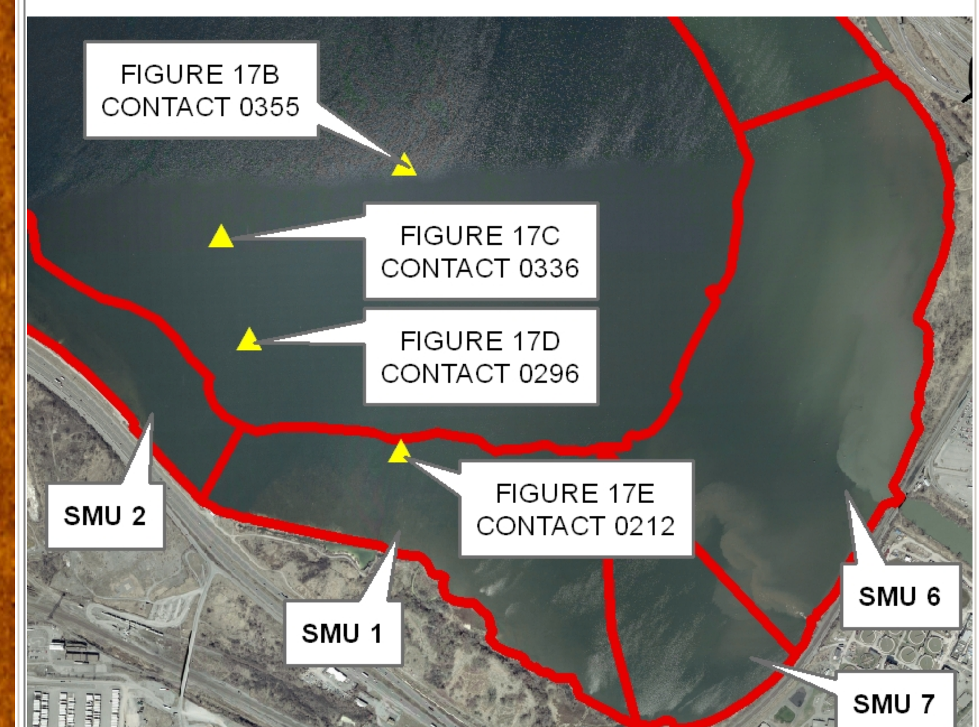
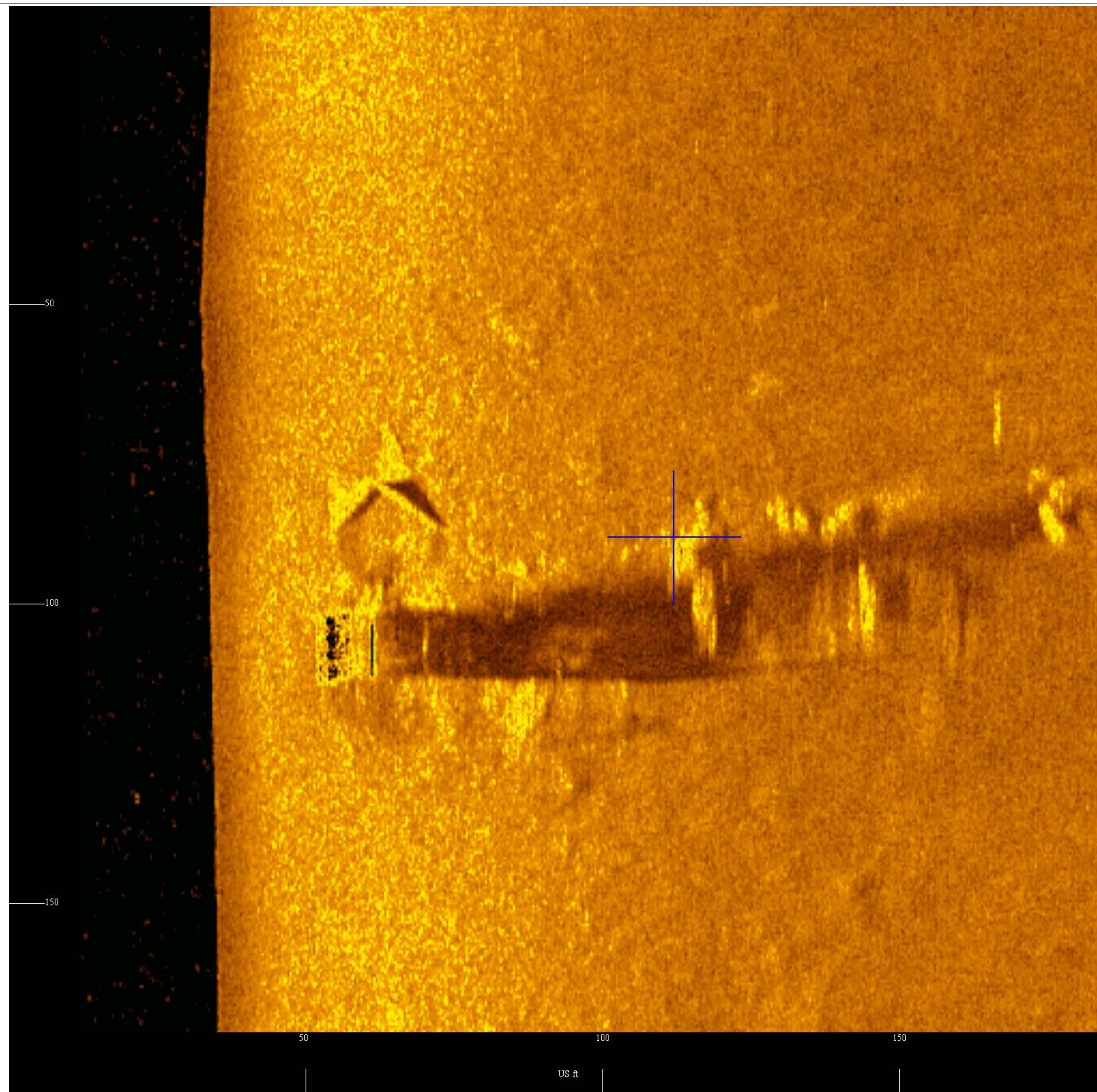


FIGURE 17D

SIDE SCAN SONAR DATA COLLECTED IN SMU 8 ADJACENT TO SMU 2 OUTFALL AND SURROUNDING DEBRIS



Target: Contact0296

Sonar Time at Target: 10/17/2005 18:43:24
Target Capture Time Local: 03/30/06 17:11:34
Target Capture Time UTC: 03/30/06 22:11:34
Target Click Position (GEO): 43° 04.27801' N 076° 11.84349' W
Target Click Position (NY83-CF): N:1119298.32 E:923330.53
Acoustic Source File: I:\onondaga_SSS\raw\17-213_2___A.xtf, Ping:6763
Horizontal range to target: 34.03 meters to Stbd side
Slant range to target: 35.50 meters to Stbd side
Event Number: 0
Line Name: 17-213_2___A

Target Description: N/A
Target Height=1.75 US Feet
Target Length: 18.79 US Feet
Target Width: 6.18 US Feet
Target Shadow: 6.17 US Feet
Range to Target: 101.28 US Feet
User Classification: Structure

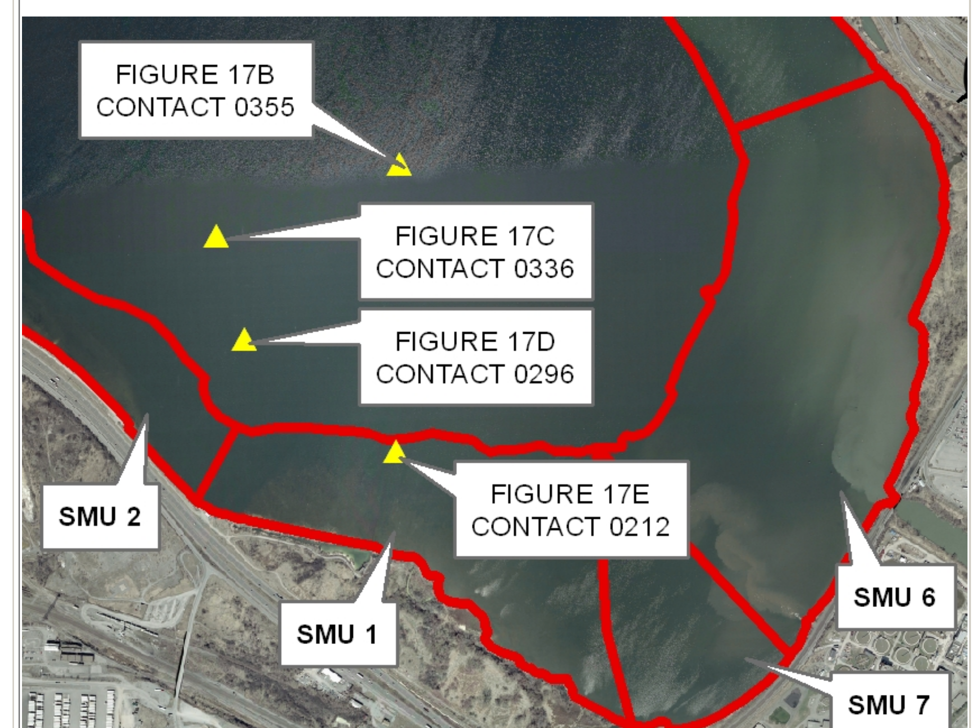
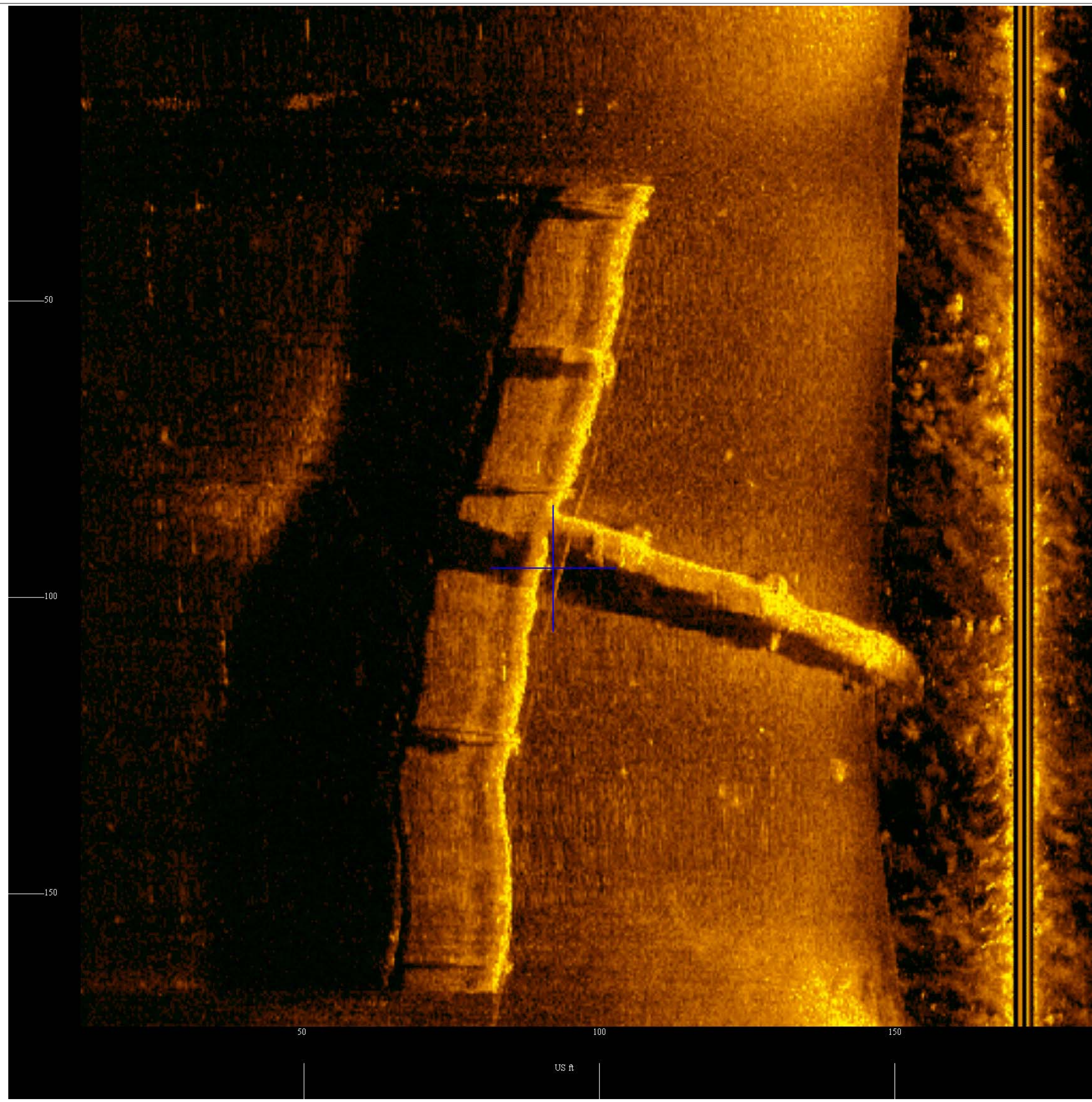


FIGURE 17E

SIDE SCAN SONAR DATA COLLECTED IN SMU 1
OUTFALL



Target: Contact0212

Sonar Time at Target: 11/06/2005 18:49:22
Target Capture Time Local: 03/31/06 14:45:11
Target Capture Time UTC: 03/31/06 19:45:11
Target Click Position (GEO): 43° 04.12896' N 076° 11.56927' W
Target Click Position (NY83-CF): N:1118398.64 E:924555.89
Acoustic Source File: I:\onondaga_sss\raw\hr\south_shr_500-50.xtf, Ping:10719
Horizontal range to target: 24.32 meters to Port side
Slant range to target: 25.58 meters to Port side
Event Number: 0
Line Name: south_shr_500-50

Target Description: Outfall
Target Height=5.05 US Feet
Target Length: 138.07 US Feet
Target Width: 2.98 US Feet
Target Shadow: 30.91 US Feet
Range to Target: 84.21 US Feet
User Classification (1):

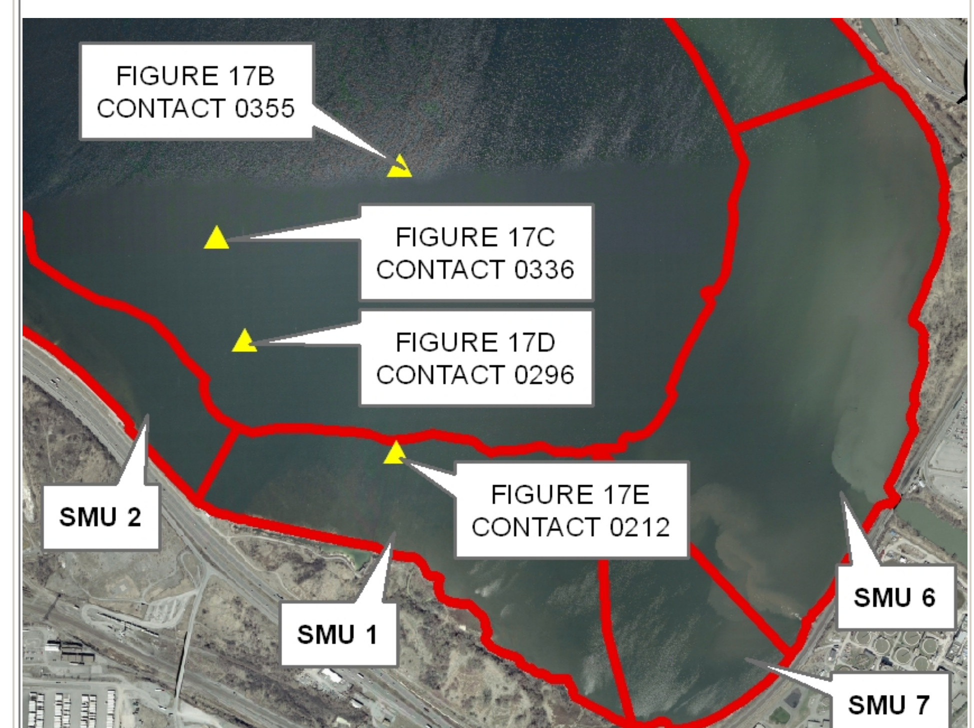
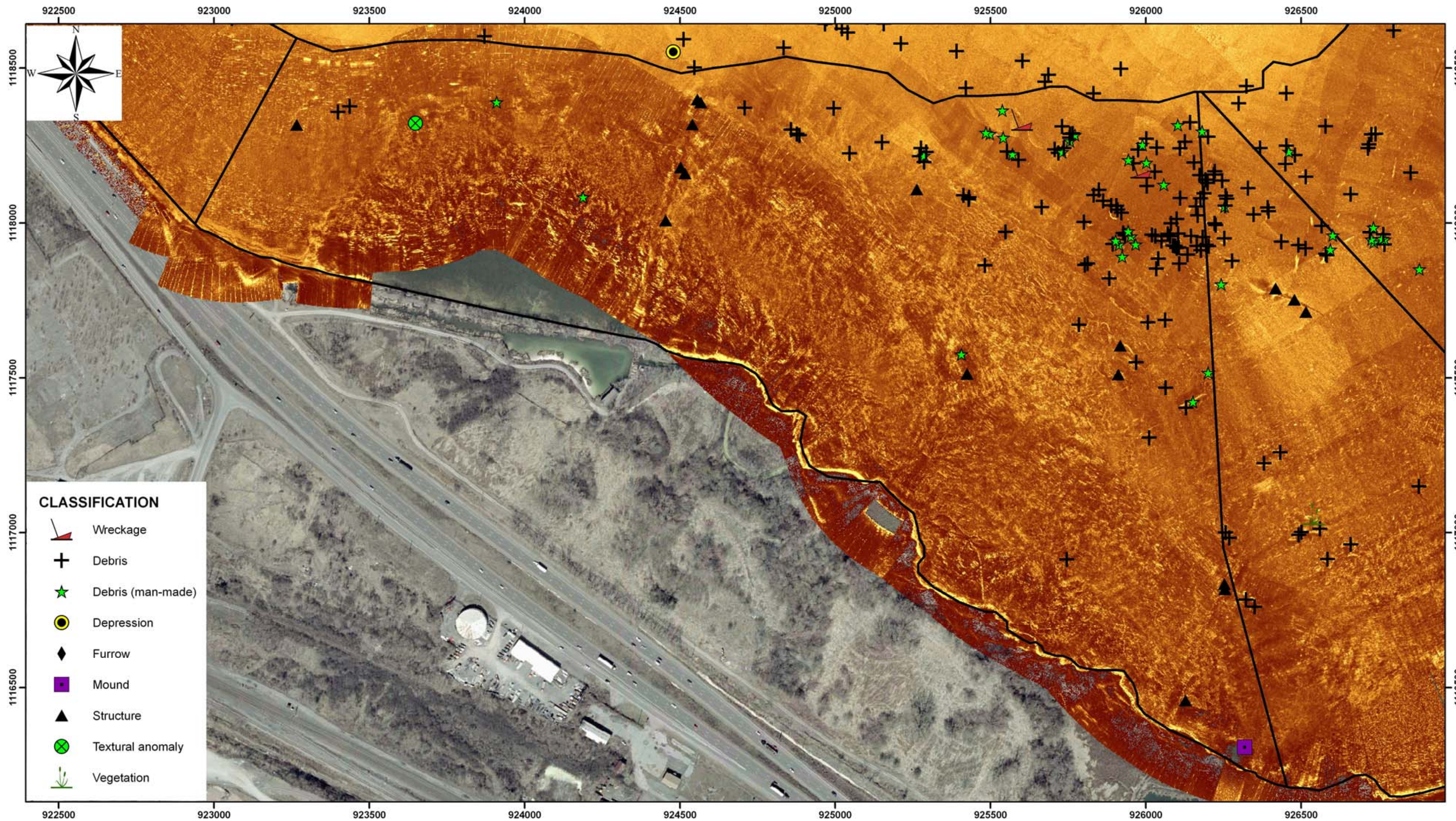


FIGURE 18

SIDE SCAN SONAR MOSAIC AND DIGITIZED SONAR CONTACTS
ONONDAGA LAKE
SMU 1



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Sonar data was collected using a 100 kHz signal and ranges of 25 and 50 meters. Digitized Contacts limited to features > 5 feet in any dimension.
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Not for Navigation.

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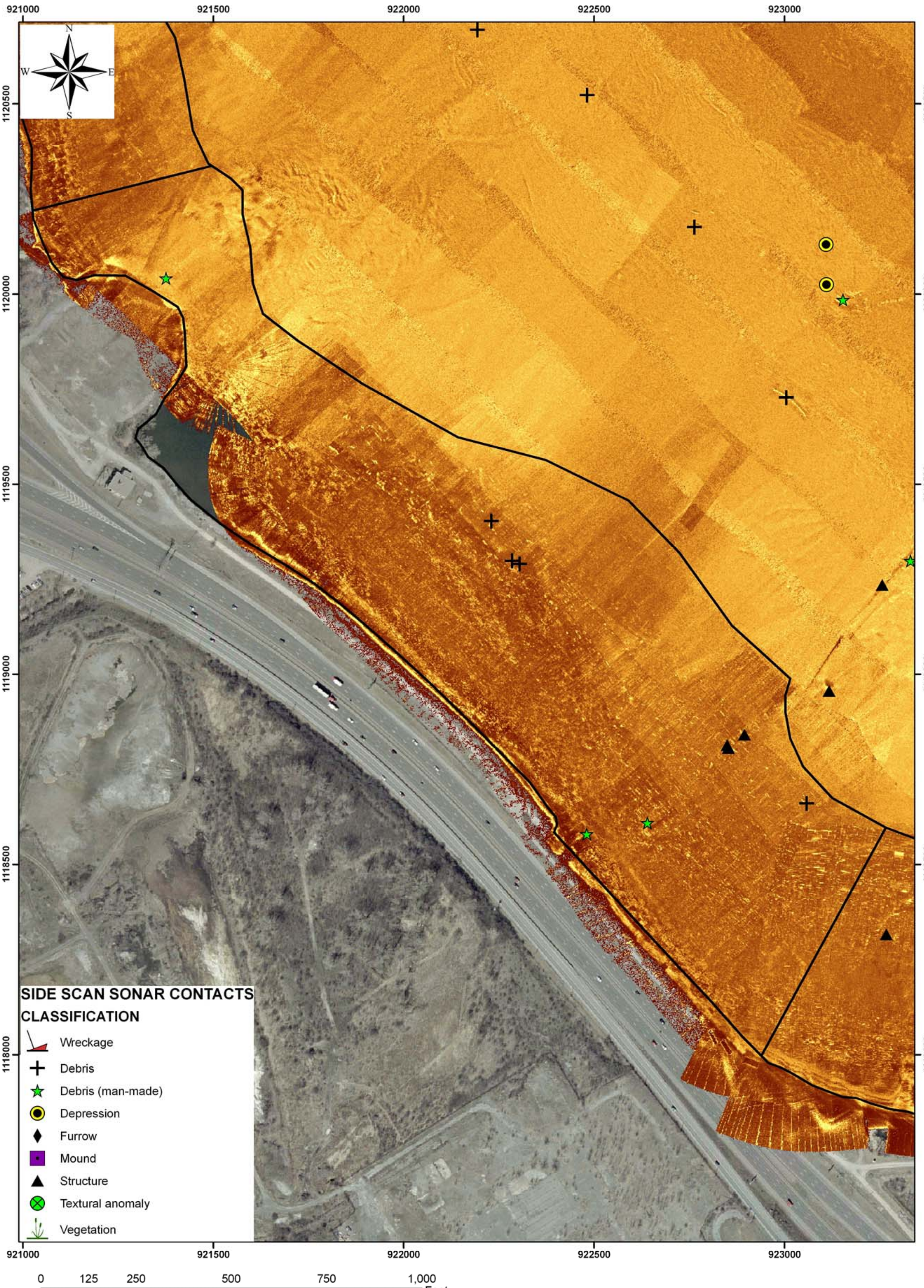
FIGURE 19

SIDE SCAN SONAR MOSAIC AND DIGITIZED SONAR CONTACTS
ONONDAGA LAKE
SMU 2



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Sonar data was collected using a 100 kHz signal and ranges of 25 and 50 meters. Digitized Contacts limited to features >5 feet in any dimension.
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Not for Navigation.

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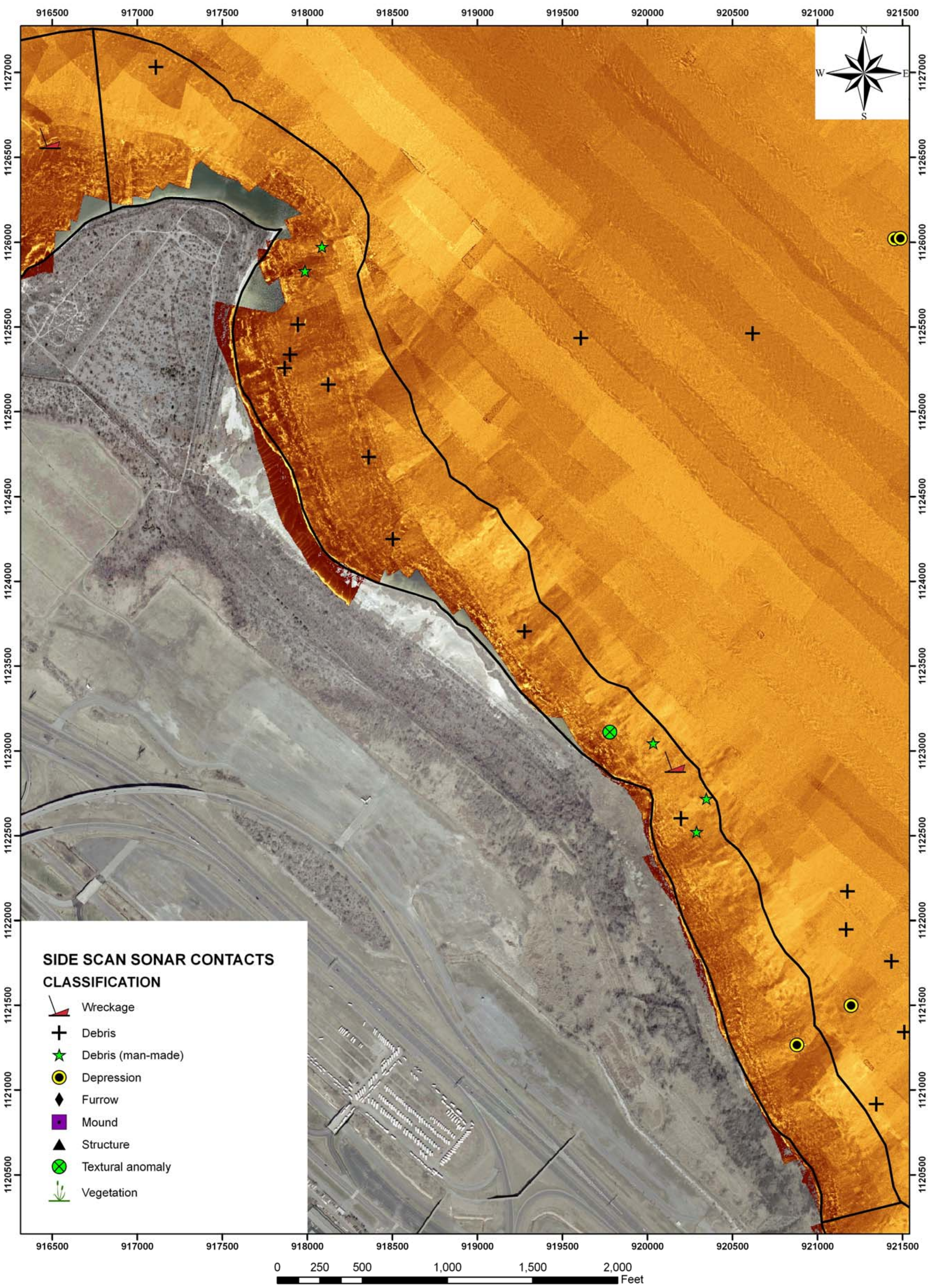
FIGURE 20

SIDE SCAN SONAR MOSAIC AND DIGITIZED SONAR CONTACTS
ONONDAGA LAKE
SMU 3



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Sonar data was collected using a 100 kHz signal and ranges of 25 and 50 meters. Digitized Contacts limited to features >5 feet in any dimension.
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Not for Navigation.

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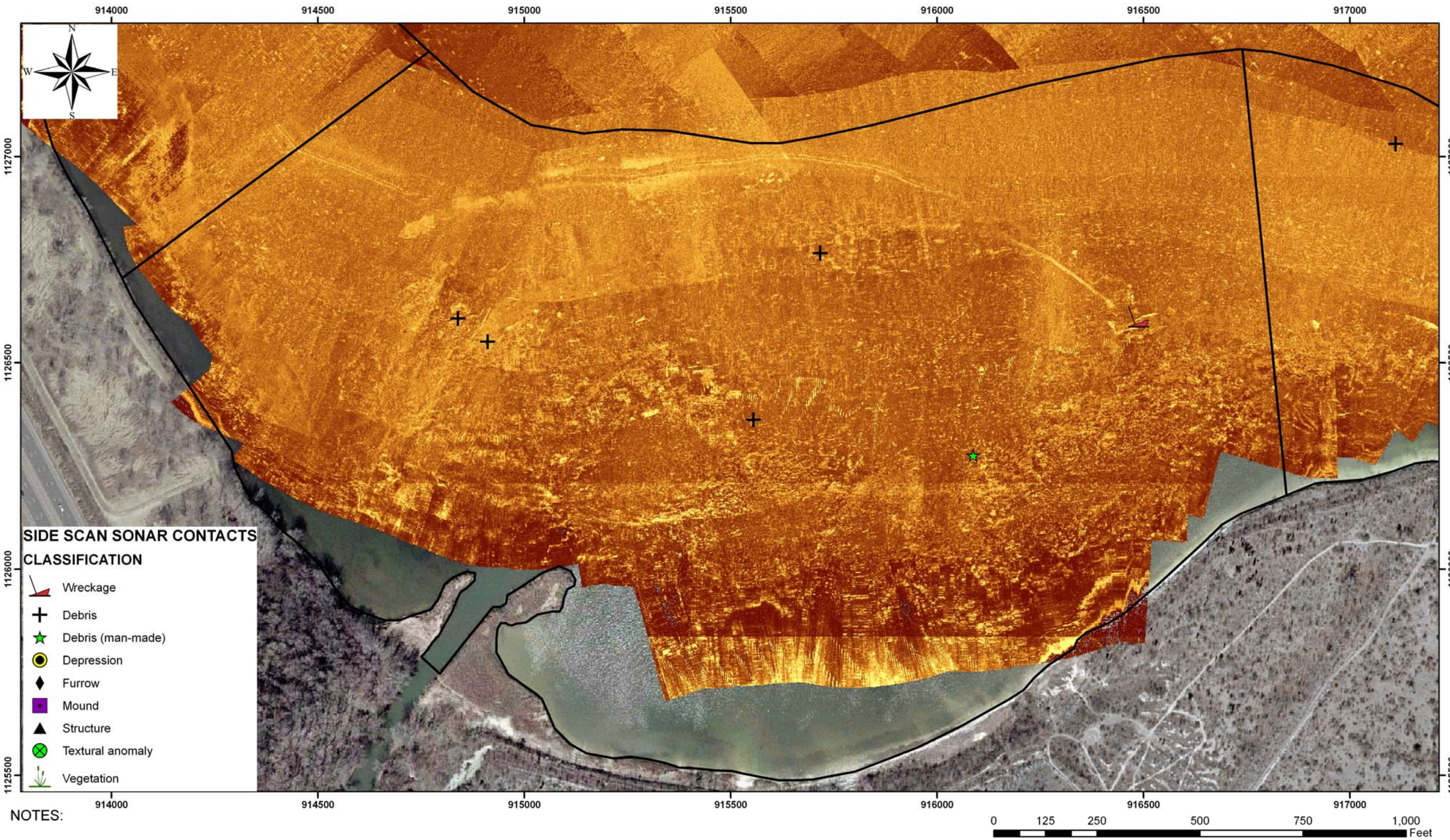
FIGURE 21

SIDE SCAN SONAR MOSAIC AND DIGITIZED SONAR CONTACTS
ONONDAGA LAKE
SMU 4



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Sonar data was collected using a 100 kHz signal and ranges of 25 and 50 meters. Digitized Contacts limited to features >5 feet in any dimension.
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Not for Navigation.

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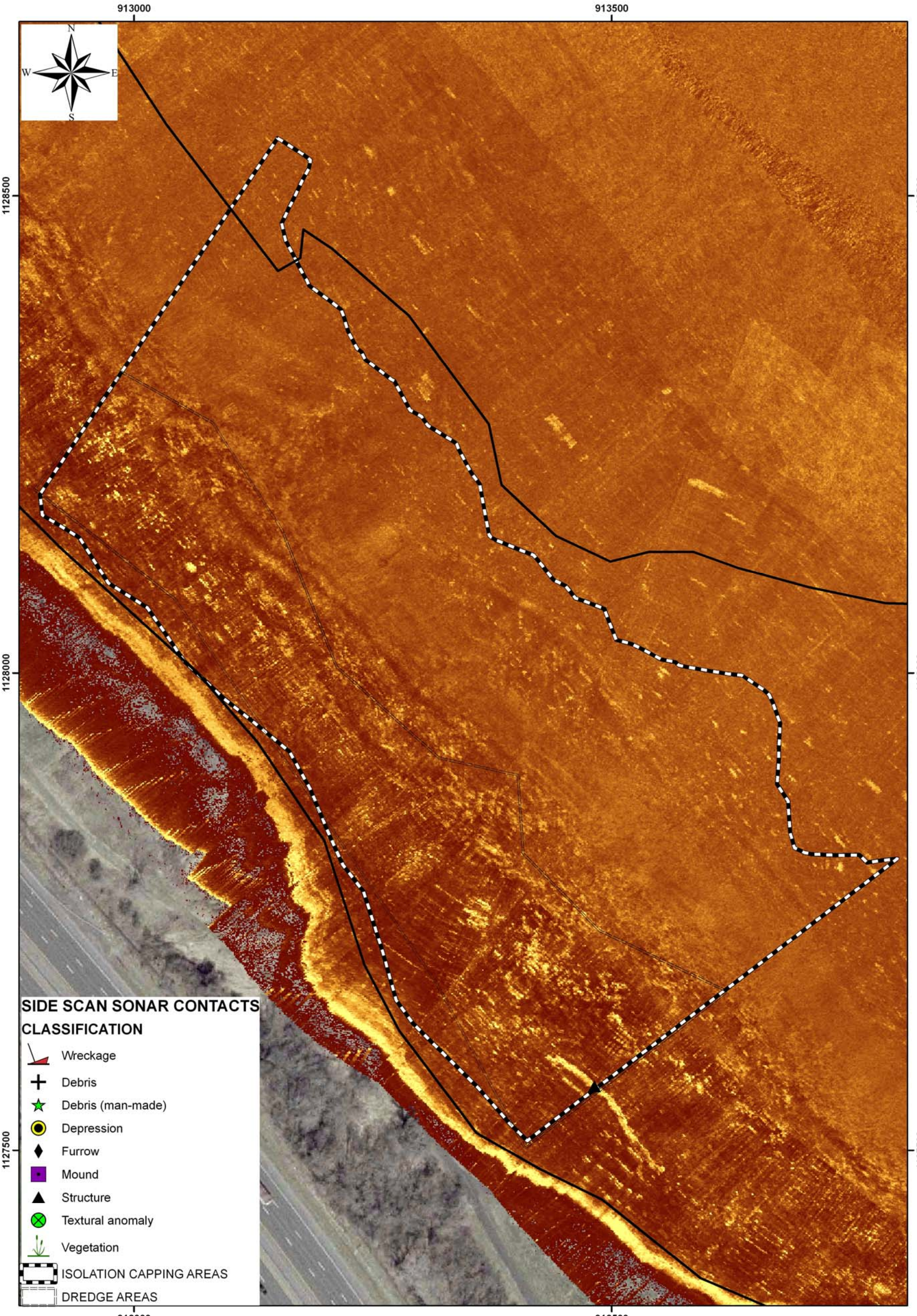
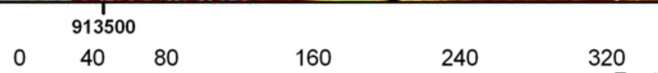
FIGURE 22

SIDE SCAN SONAR MOSAIC AND DIGITIZED SONAR CONTACTS
ONONDAGA LAKE SMU 5, AREA "A"





NOTES:
1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Sonar data was collected using a 100 kHz signal and ranges of 25 and 50 meters. Digitized Contacts limited to features >5 feet in any dimension.
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Dredge areas and isolation capping areas as shown are approximate boundaries of potential remediation areas based on the November 2004 Feasibility Study Report. These boundaries may change in the future.
5. Not for Navigation.

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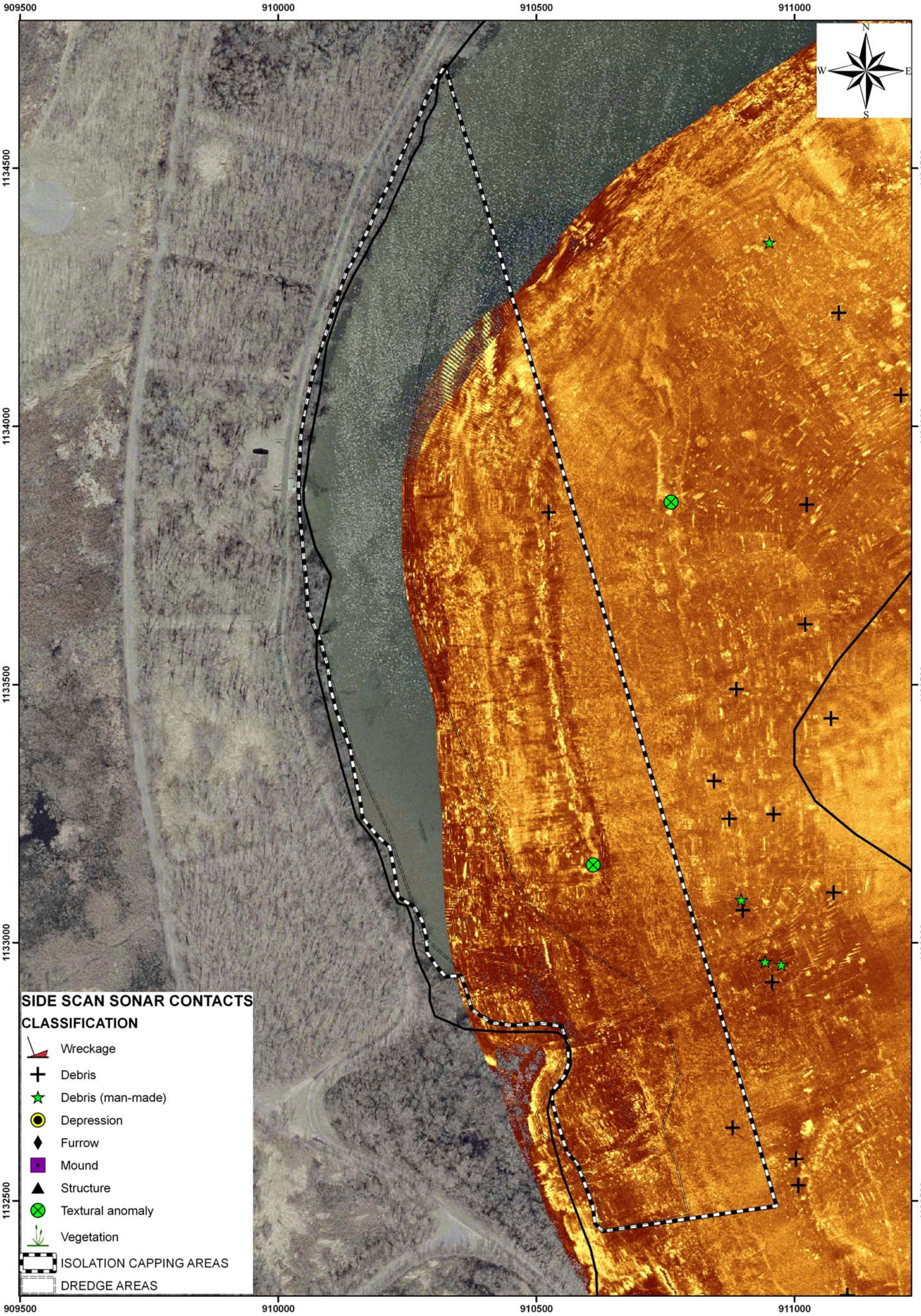
FIGURE 23

SIDE SCAN SONAR MOSAIC AND DIGITIZED SONAR CONTACTS
ONONDAGA LAKE SMU 5, AREA "B"



NOTES:
1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Sonar data was collected using a 100 kHz signal and ranges of 25 and 50 meters. Digitized Contacts limited to features >5 feet in any dimension.
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Dredge areas and isolation capping areas as shown are approximate boundaries of potential remediation areas based on the November 2004 Feasibility Study Report. These boundaries may change in the future.
5. Not for Navigation.

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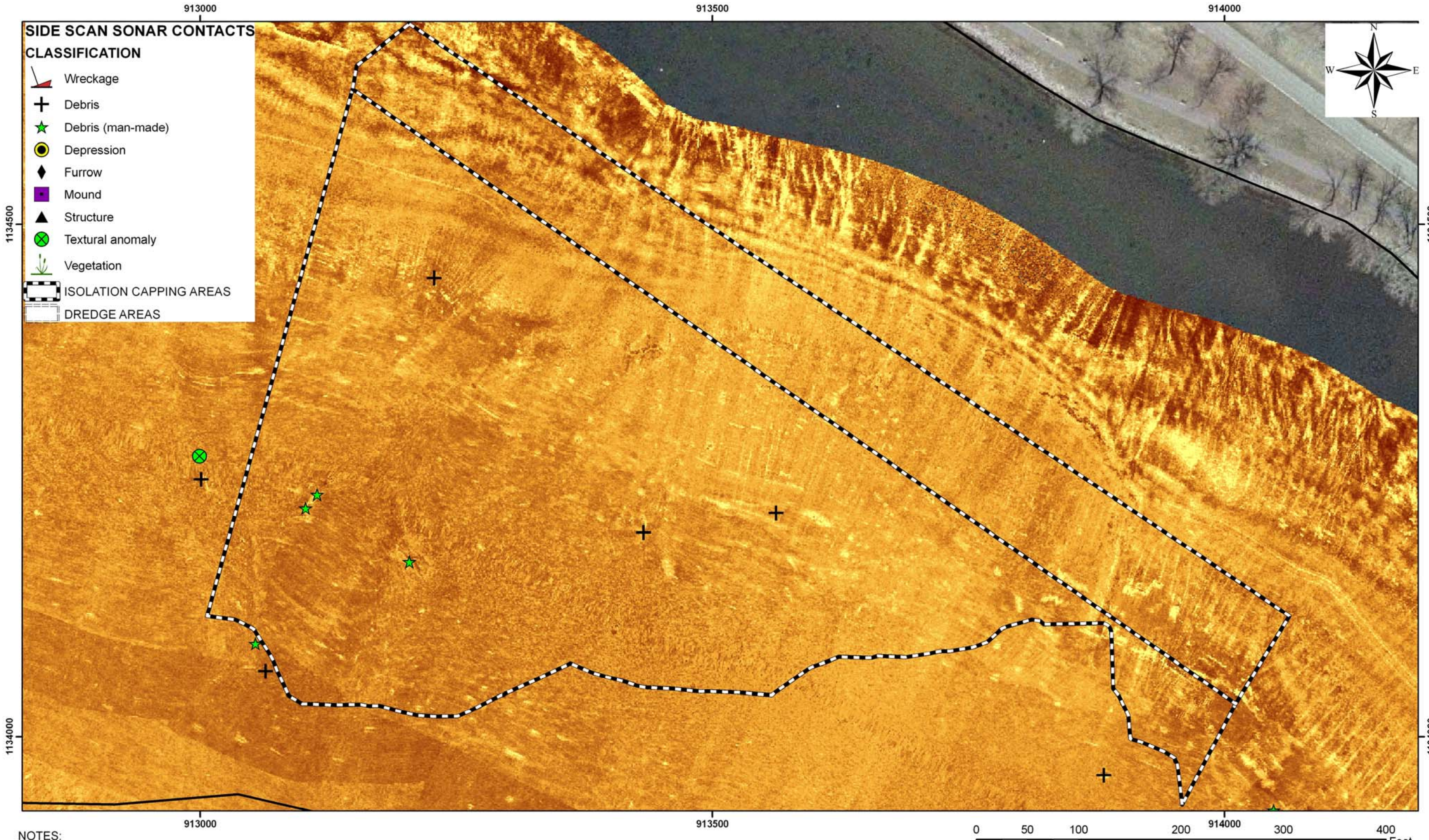
FIGURE 24

SIDE SCAN SONAR MOSAIC AND DIGITIZED SONAR CONTACTS
ONONDAGA LAKE SMU 5, AREA "C"



NOTES:
1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Sonar data was collected using a 100 kHz signal and ranges of 25 and 50 meters. Digitized Contacts limited to features >5 feet in any dimension.
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Dredge areas and isolation capping areas as shown are approximate boundaries of potential remediation areas based on the November 2004 Feasibility Study Report. These boundaries may change in the future.
5. Not for Navigation.

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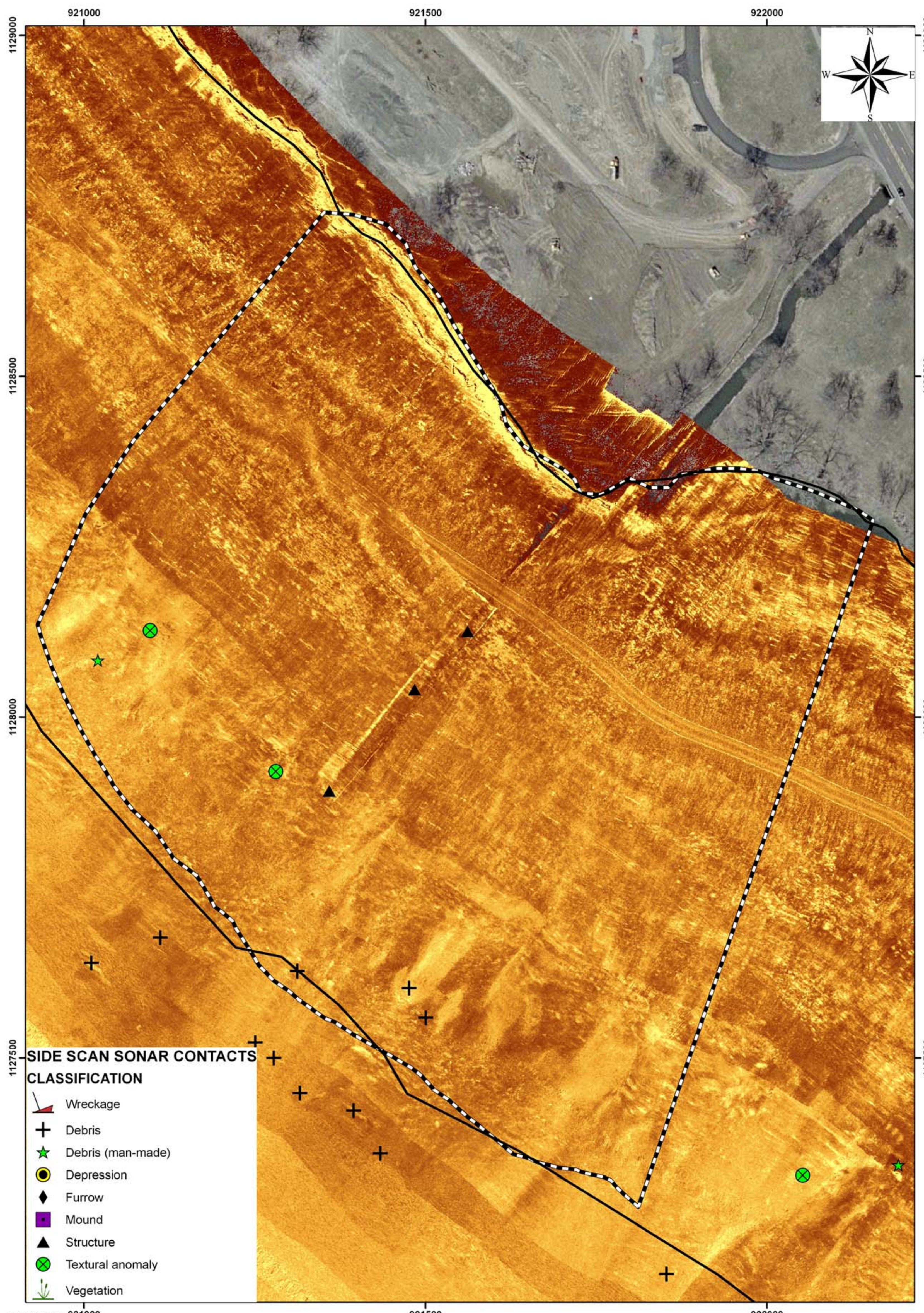
FIGURE 25

SIDE SCAN SONAR MOSAIC AND DIGITIZED SONAR CONTACTS
ONONDAGA LAKE SMU-5, AREA "D"



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Sonar data was collected using a 100 kHz signal and ranges of 25 and 50 meters. Digitized Contacts limited to features >5 feet in any dimension.
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Not for Navigation.

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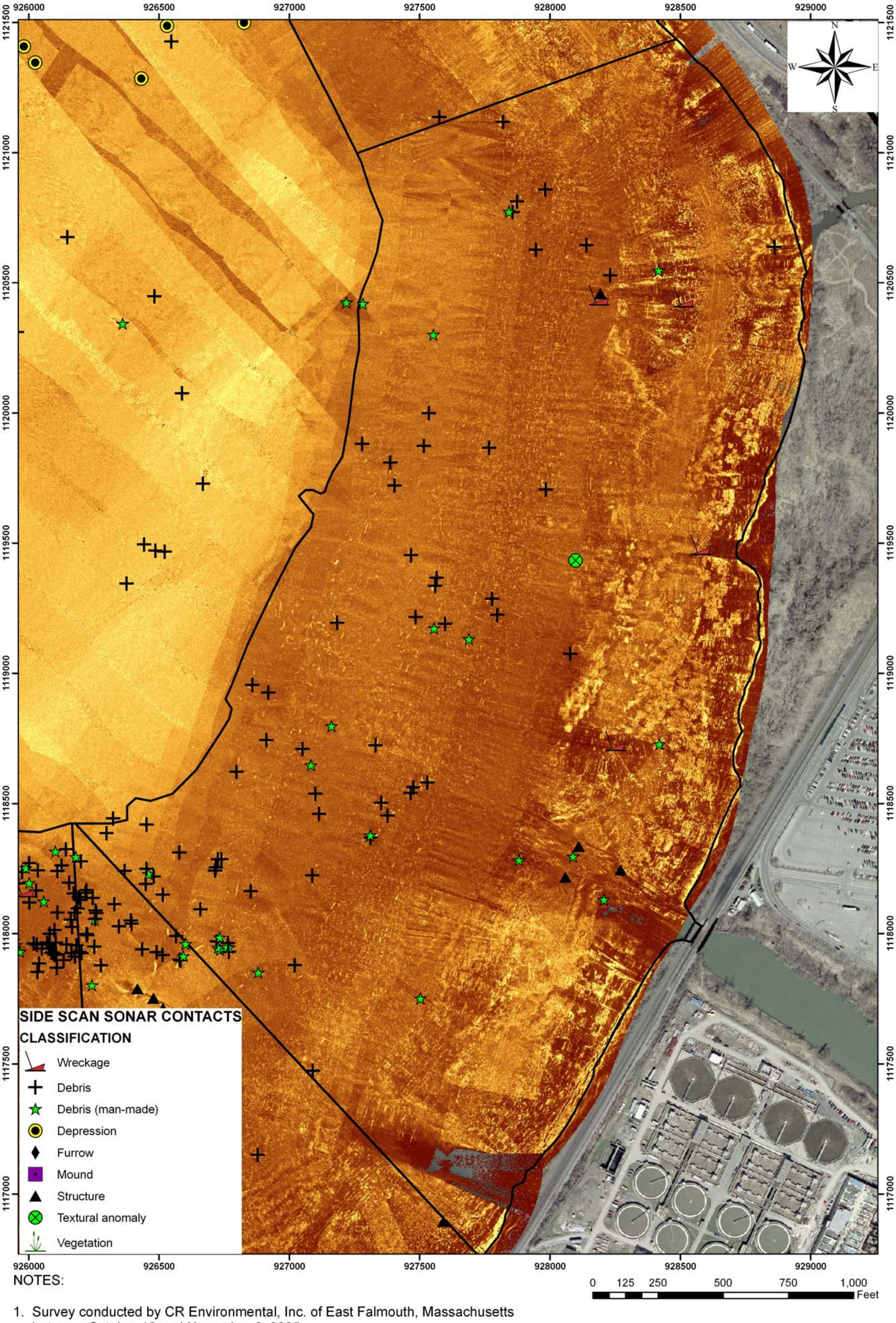
FIGURE 26

SIDE SCAN SONAR MOSAIC AND DIGITIZED SONAR CONTACTS
ONONDAGA LAKE
SMU 6



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Sonar data was collected using a 100 kHz signal and ranges of 25 and 50 meters.
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Not for Navigation.

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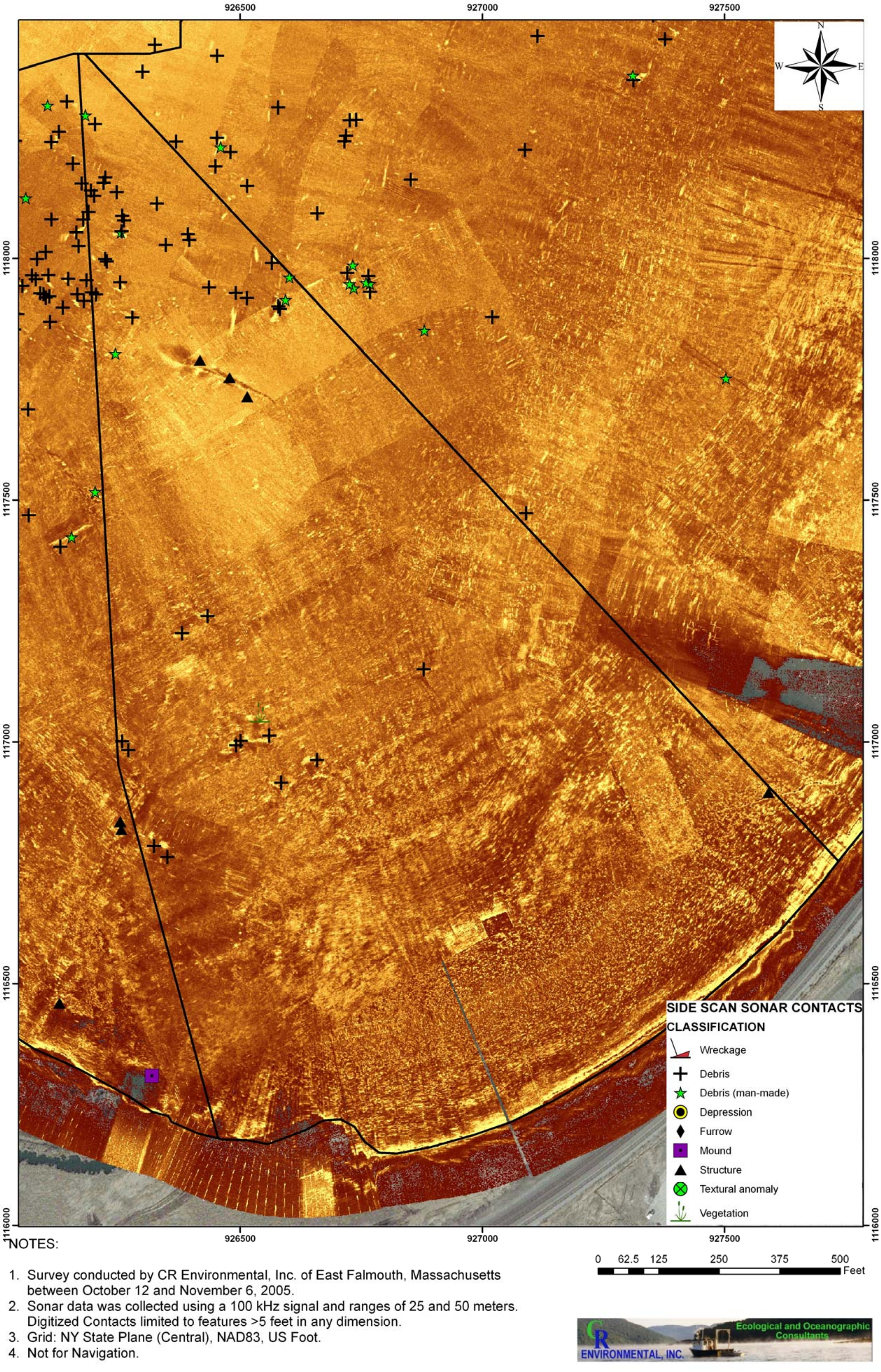
FIGURE 27

SIDE SCAN SONAR MOSAIC AND DIGITIZED SONAR CONTACTS
ONONDAGA LAKE
SMU 7



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Sonar data was collected using a 100 kHz signal and ranges of 25 and 50 meters. Digitized Contacts limited to features >5 feet in any dimension.
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Not for Navigation.

FIGURE 28
SIDE SCAN SONAR MOSAIC DEPICTS SONAR CONTACTS AND ANOMALIES
SMU 8

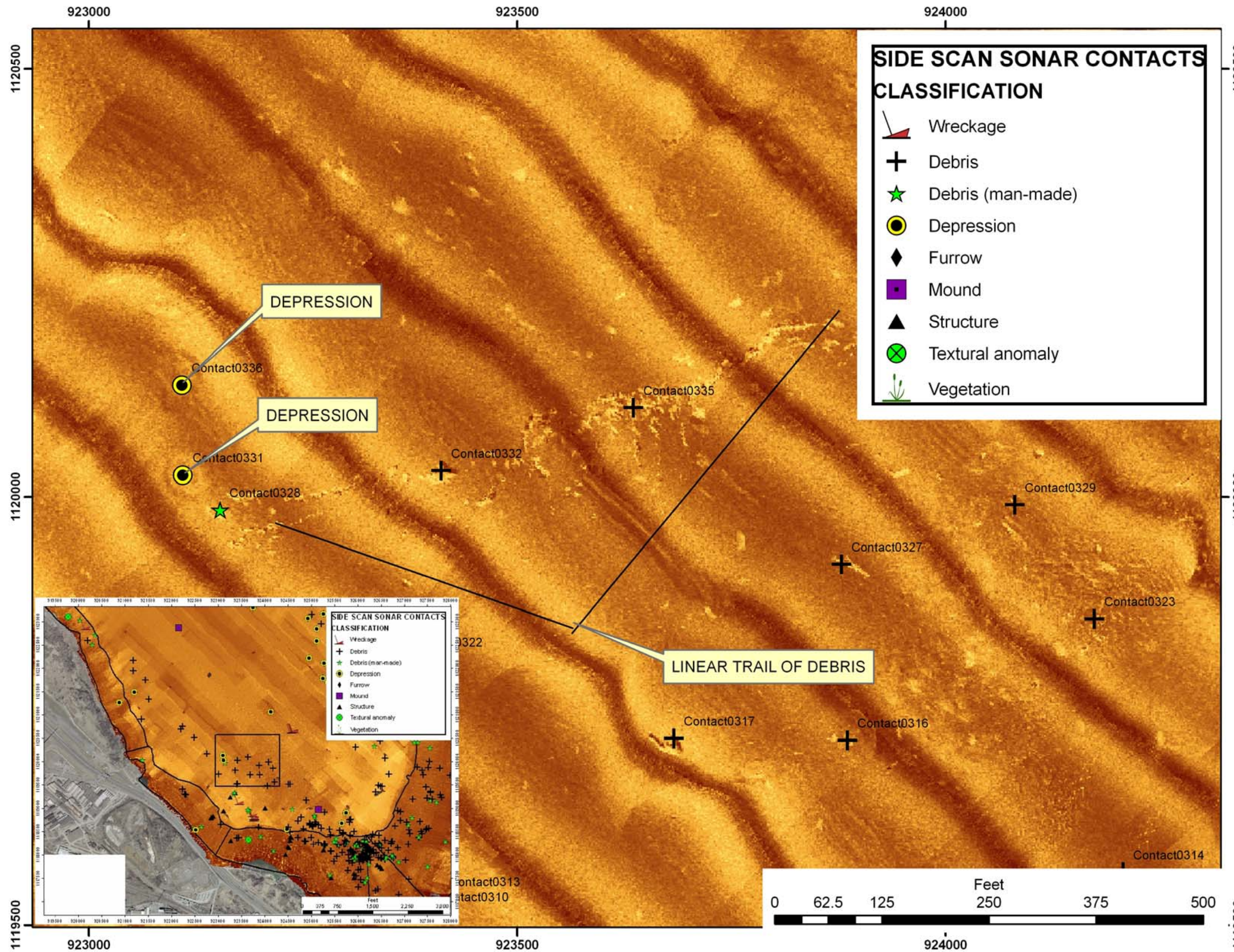


FIGURE 29A

SIDE SCAN SONAR MOSAIC DEPICTS FIELD OF SMALL SONAR CONTACTS
SMU 8

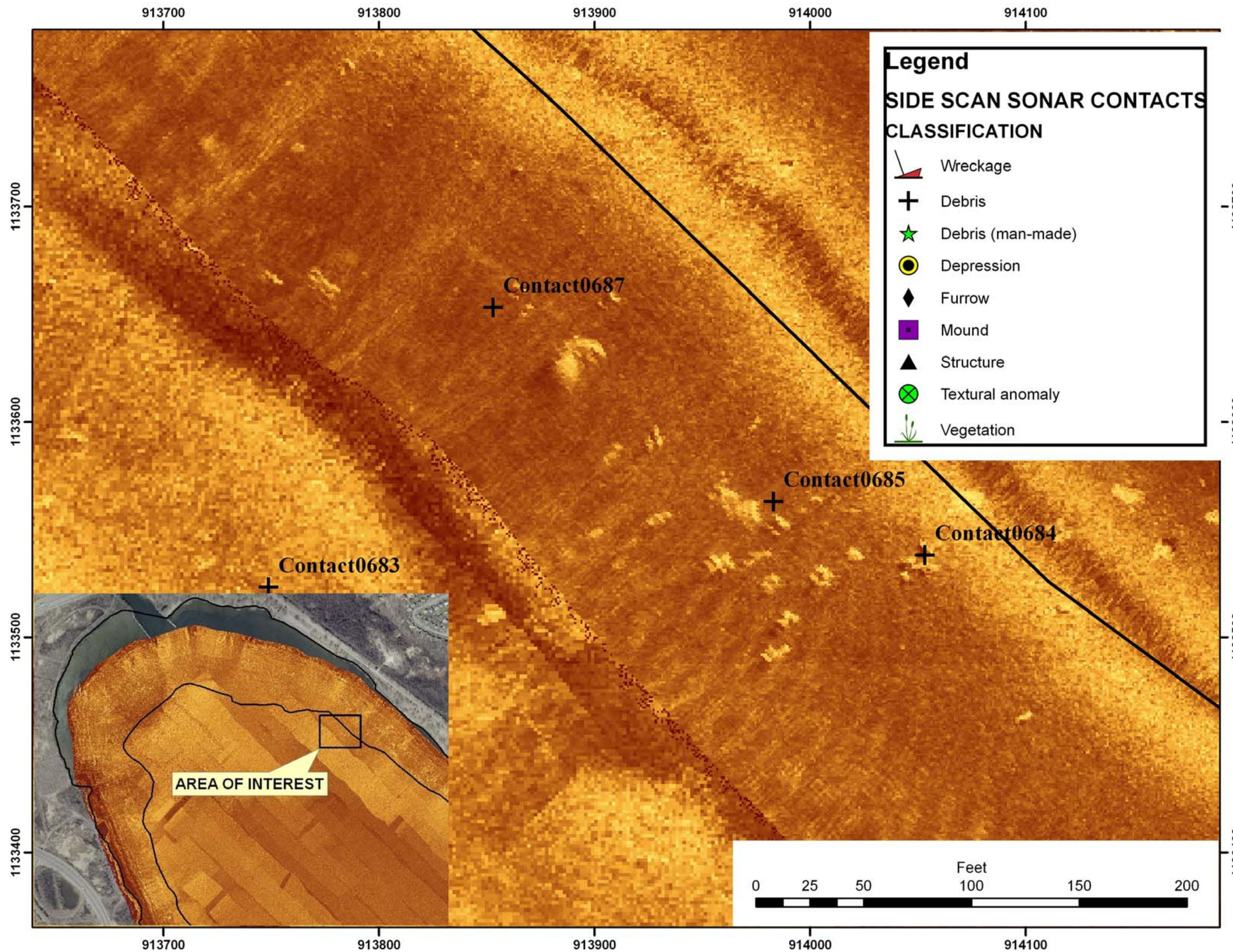


FIGURE 29B

RAW SIDE SCAN SONAR WATERFALL DEPICTS FIELD OF SMALL SONAR CONTACTS
SMU 8

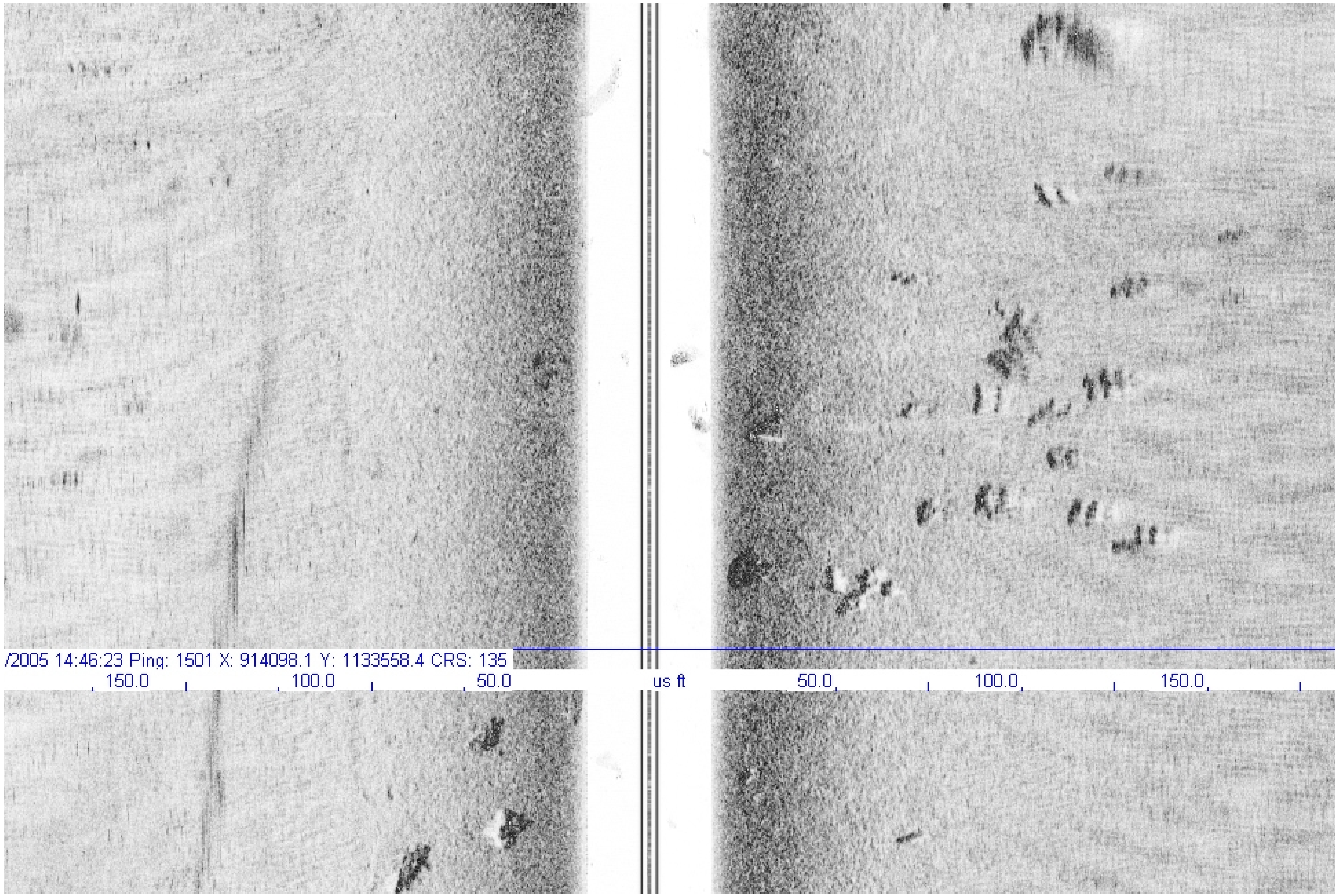


FIGURE 30

SIDE SCAN SONAR MOSAIC DEPICTS DENSE NETWORK OF FURROWS
SMU 8

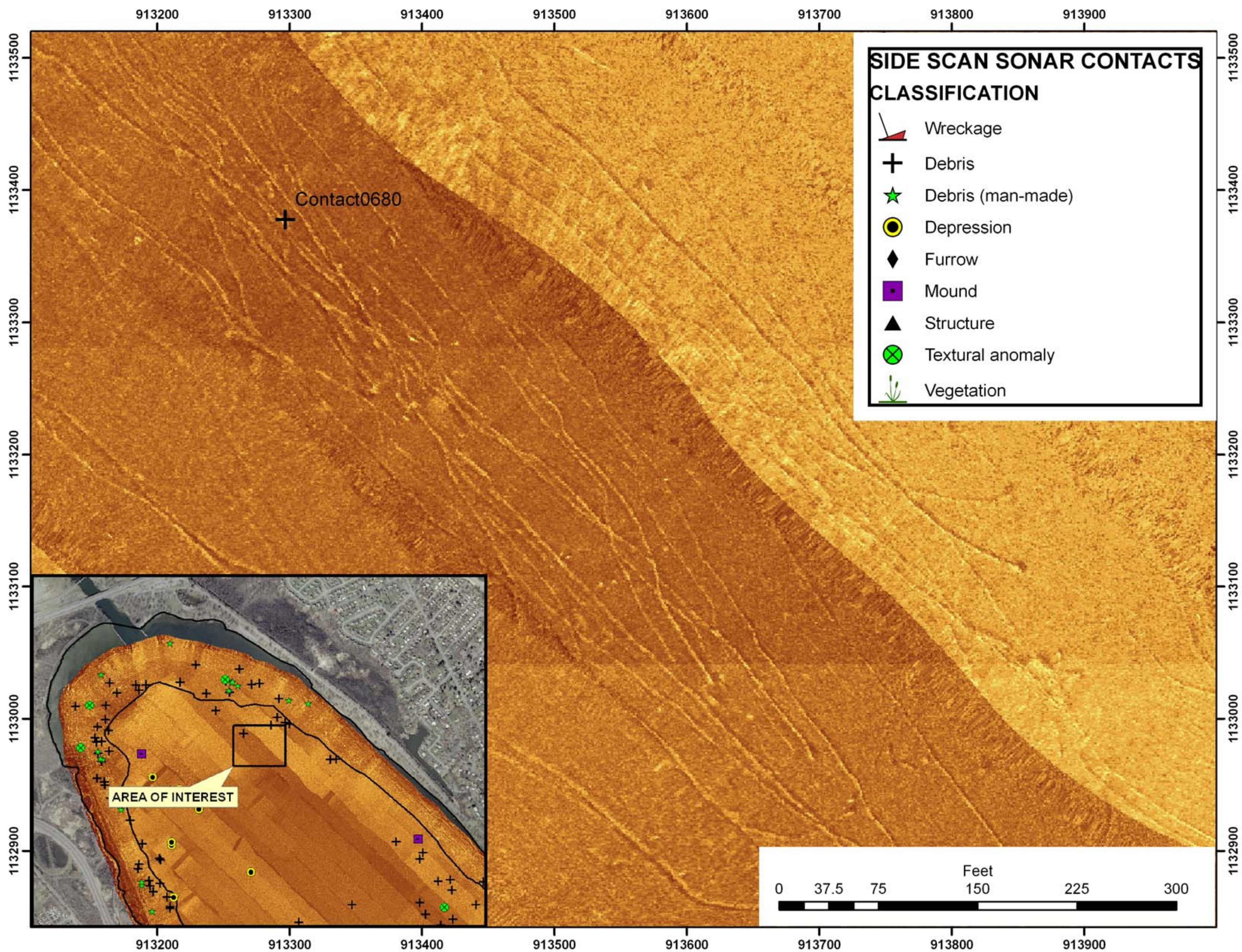
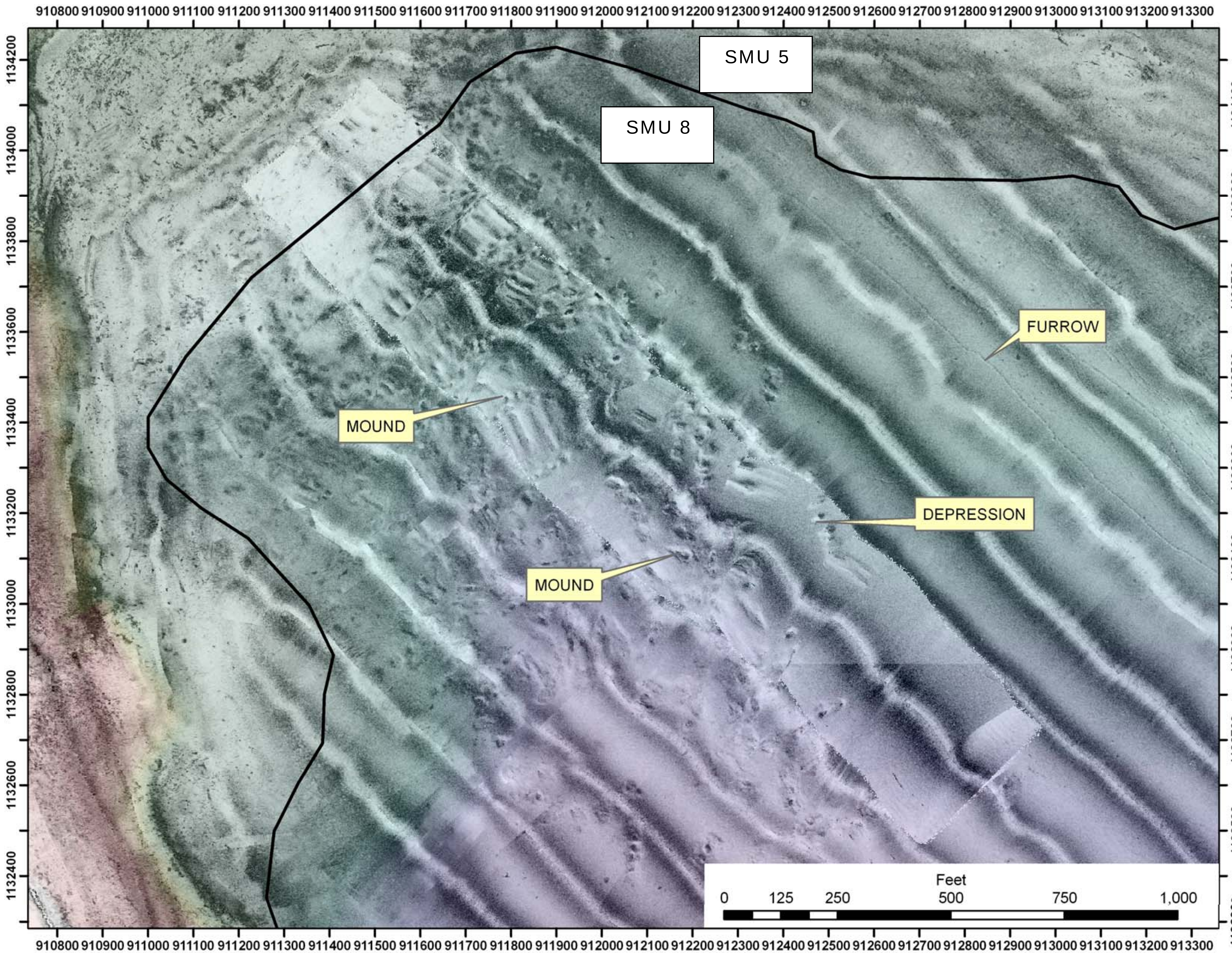


FIGURE 31A

SIDE SCAN SONAR MOSAIC DEPICTS DEBRIS FIELD IN NORTHERN SMU 8



(Colorized bathymetry used as transparency)

FIGURE 31B

SIDE SCAN SONAR WATERFALL DEPICTS DEBRIS FIELD IN NORTHERN SMU 8

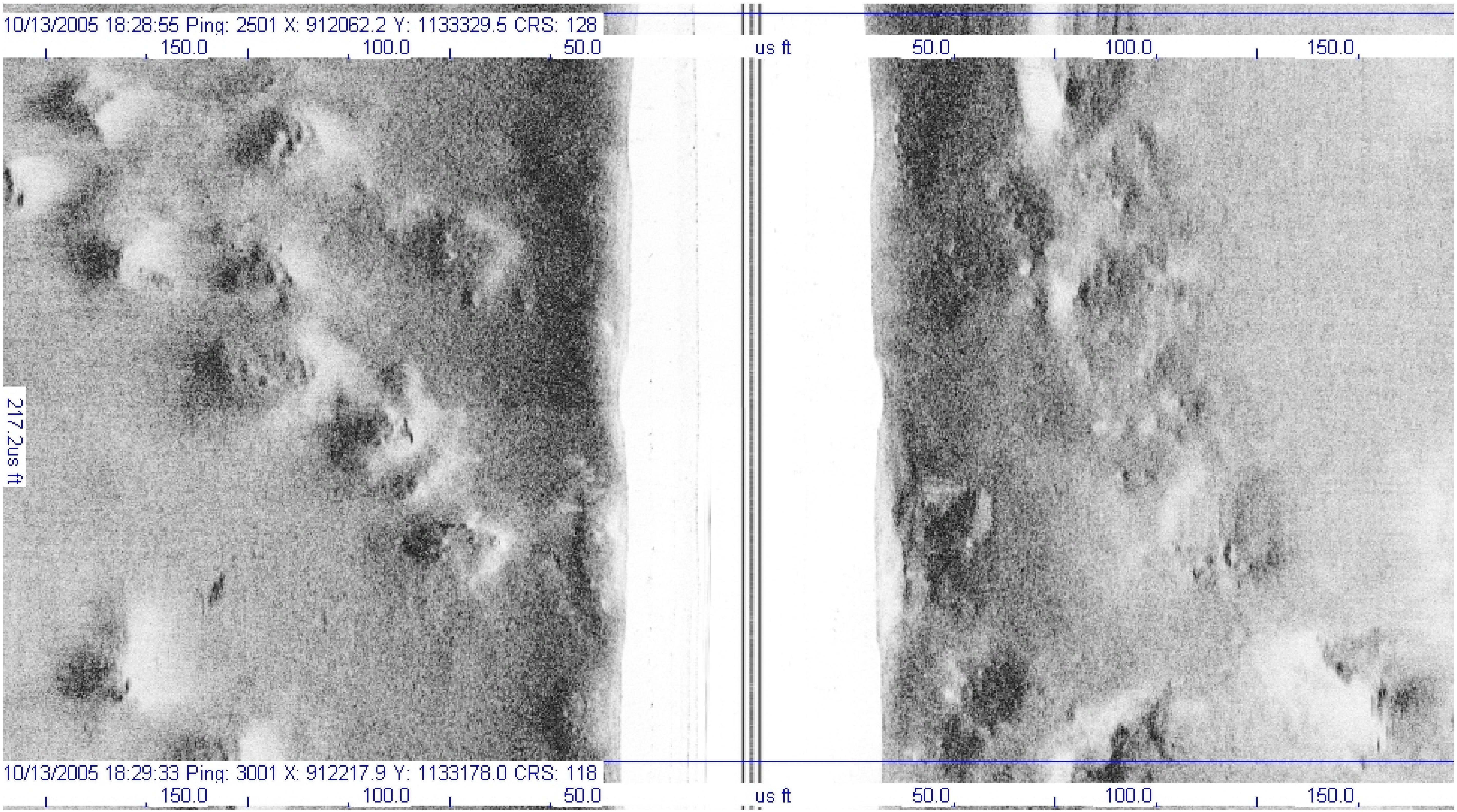
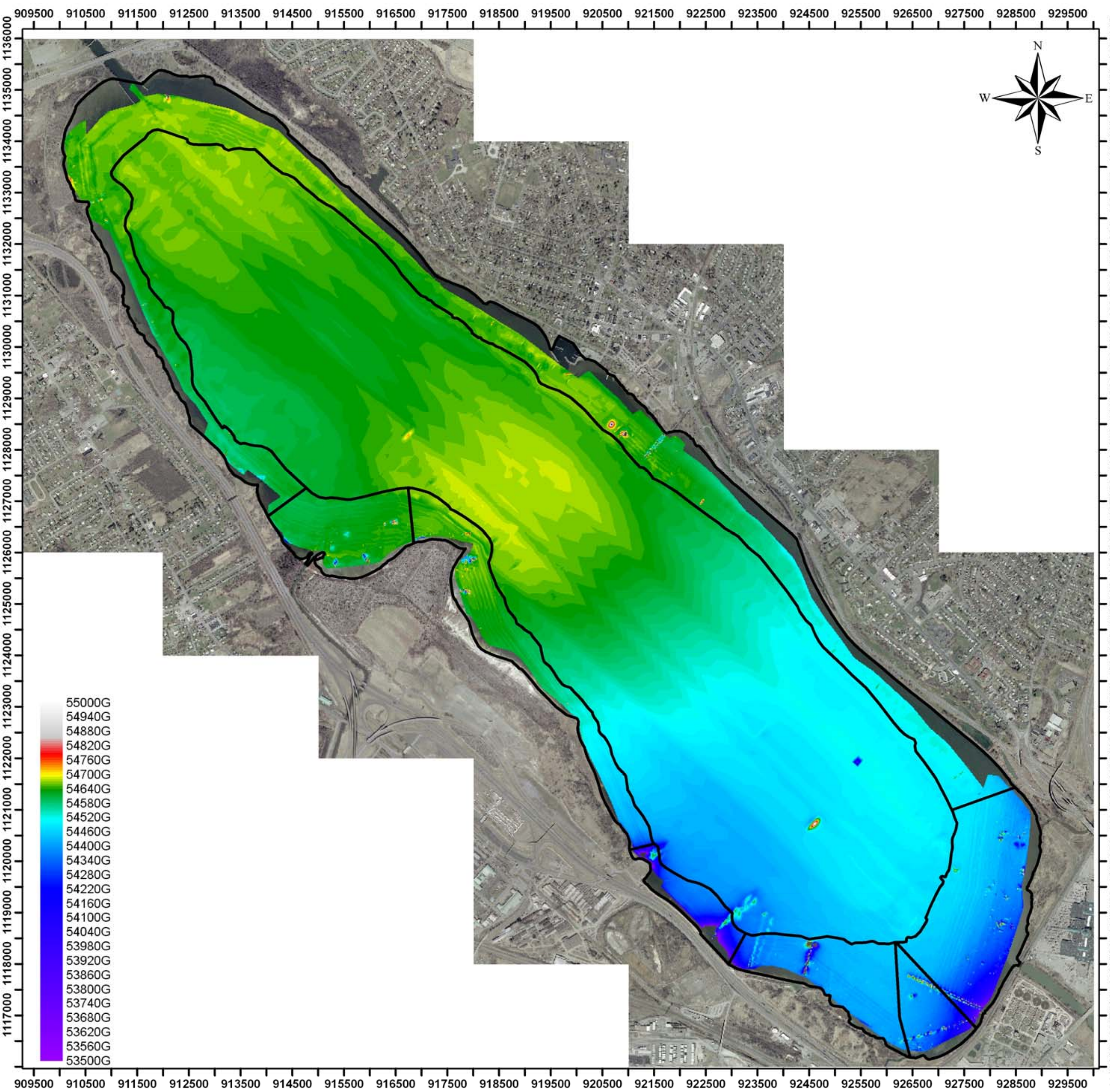


FIGURE 32

**CONTOURED TOTAL FIELD MAGNETIC DATA
ONONDAGA LAKE**



Miles
0 0.125 0.25 0.5 0.75 1

NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Magnetic data was collected using a Geometrics 881 CV magnetometer and transect spacing ranging from 25 to 200 feet (see text).
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Not for Navigation.

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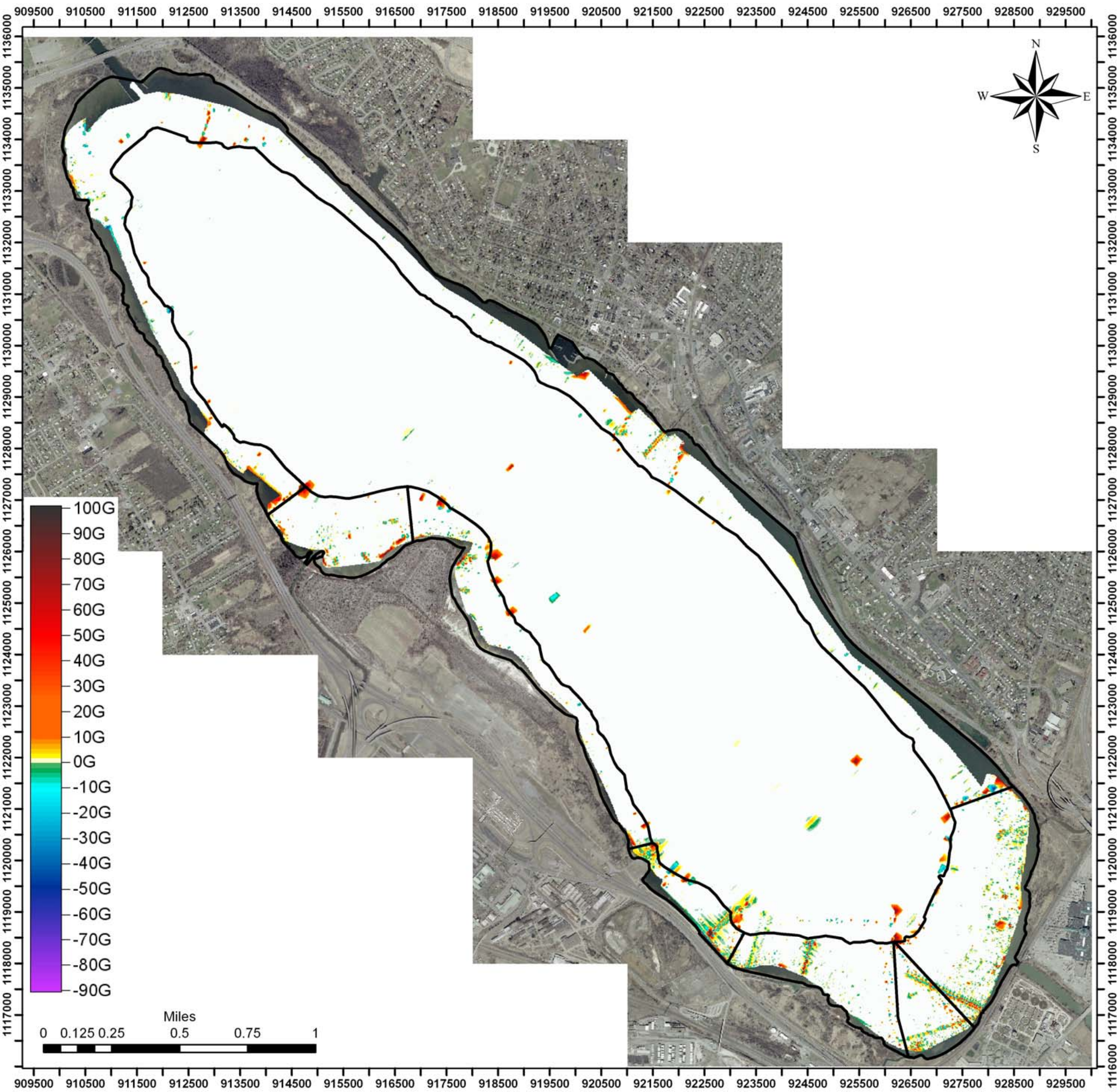
FIGURE 33

**CONTOURED POLE-REDUCED MAGNETIC DATA
ONONDAGA LAKE**



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Magnetic data was collected using a Geometrics 881 CV magnetometer and transect spacing ranging from 25 to 200 feet (see text).
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Not for Navigation.

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FIGURE 34

MAP OF TOTAL MAGNETIC INTENSITY
ONONDAGA LAKE – SOUTHERN BASIN

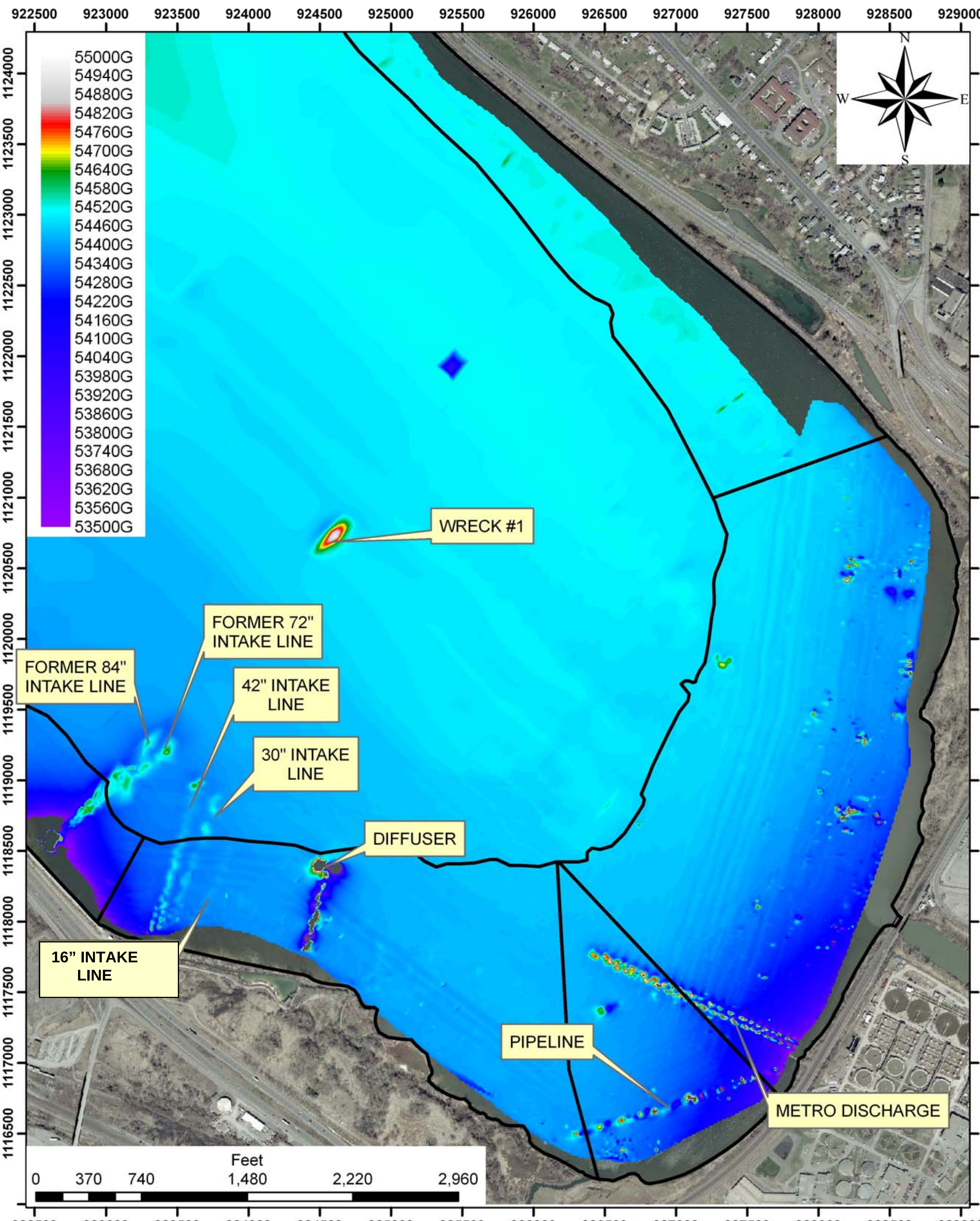


FIGURE 35

MAP OF POLE-REDUCED MAGNETISM
ONONDAGA LAKE – SOUTHERN BASIN

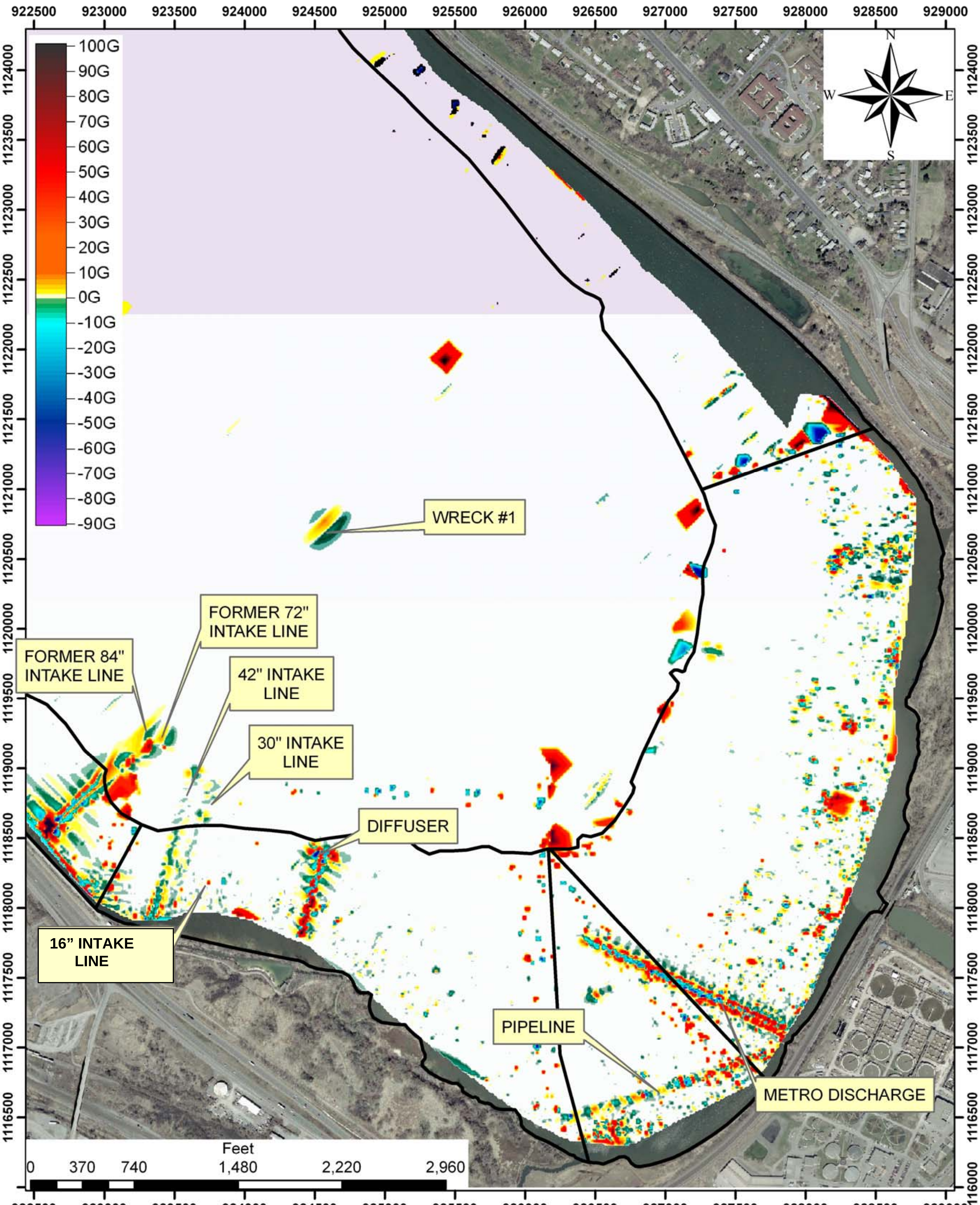
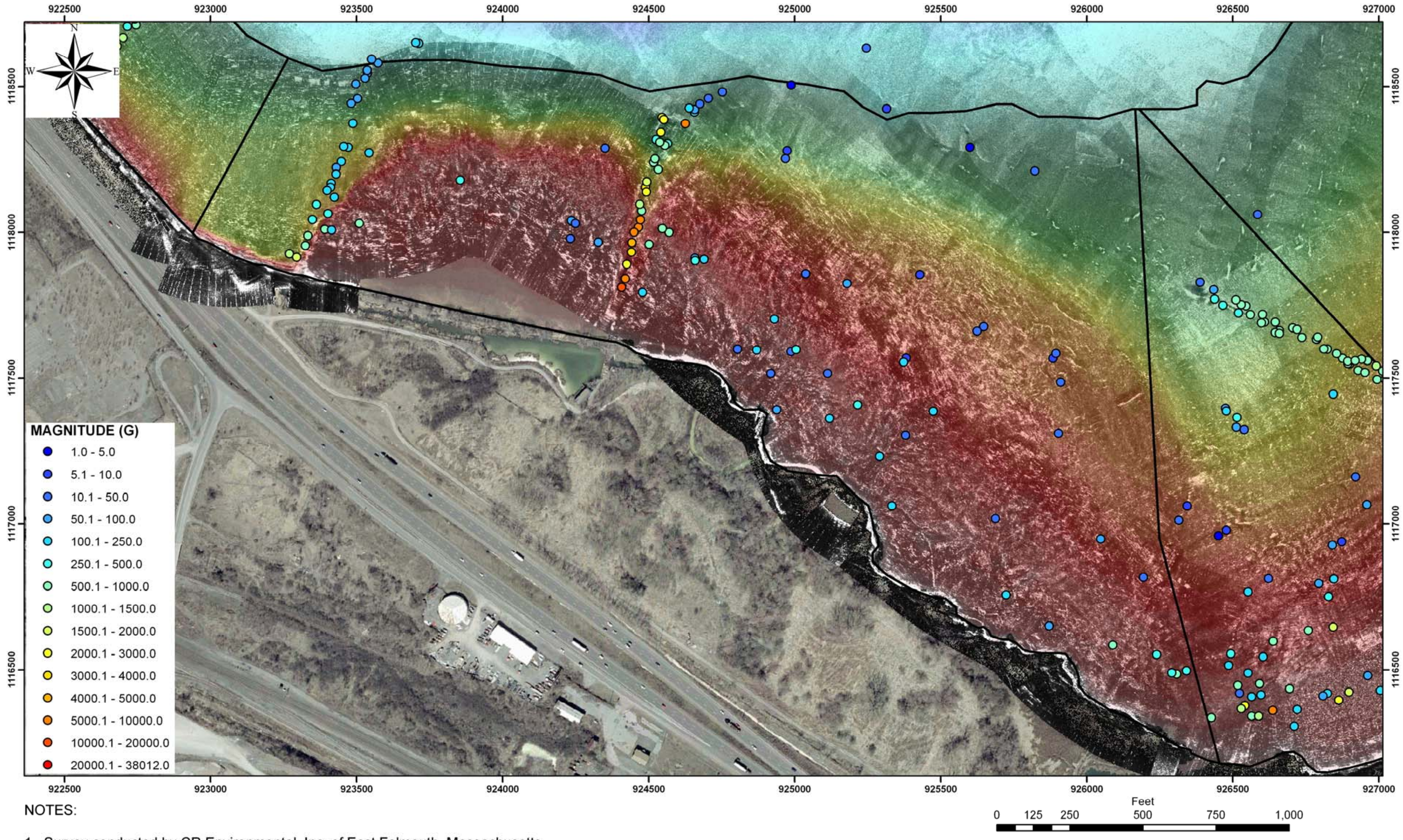


FIGURE 36

MAGNETIC ANOMALIES
ONONDAGA LAKE
SMU 1



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Magnetic data was collected using a Geometrics 881 CV magnetometer and transect spacing ranging from 25 to 200 feet (see text).
3. Grid: NY State Plane (Central), NAD83, US Foot.

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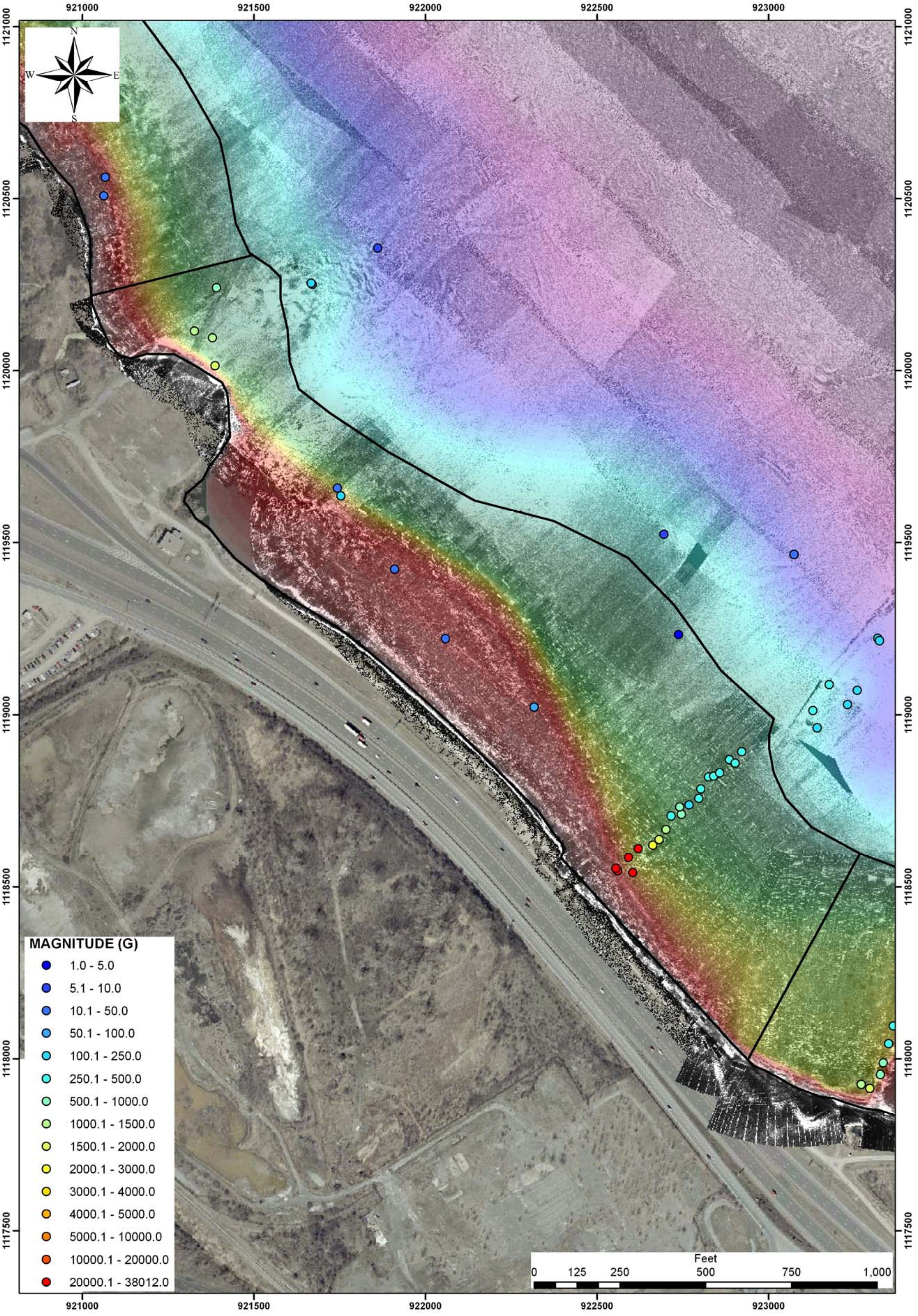
FIGURE 37

MAGNETIC ANOMALIES
ONONDAGA LAKE
SMU 2



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Magnetic data was collected using a Geometrics 881 CV magnetometer and transect spacing ranging from 25 to 200 feet (see text).
3. Grid: NY State Plane (Central), NAD83, US Foot.

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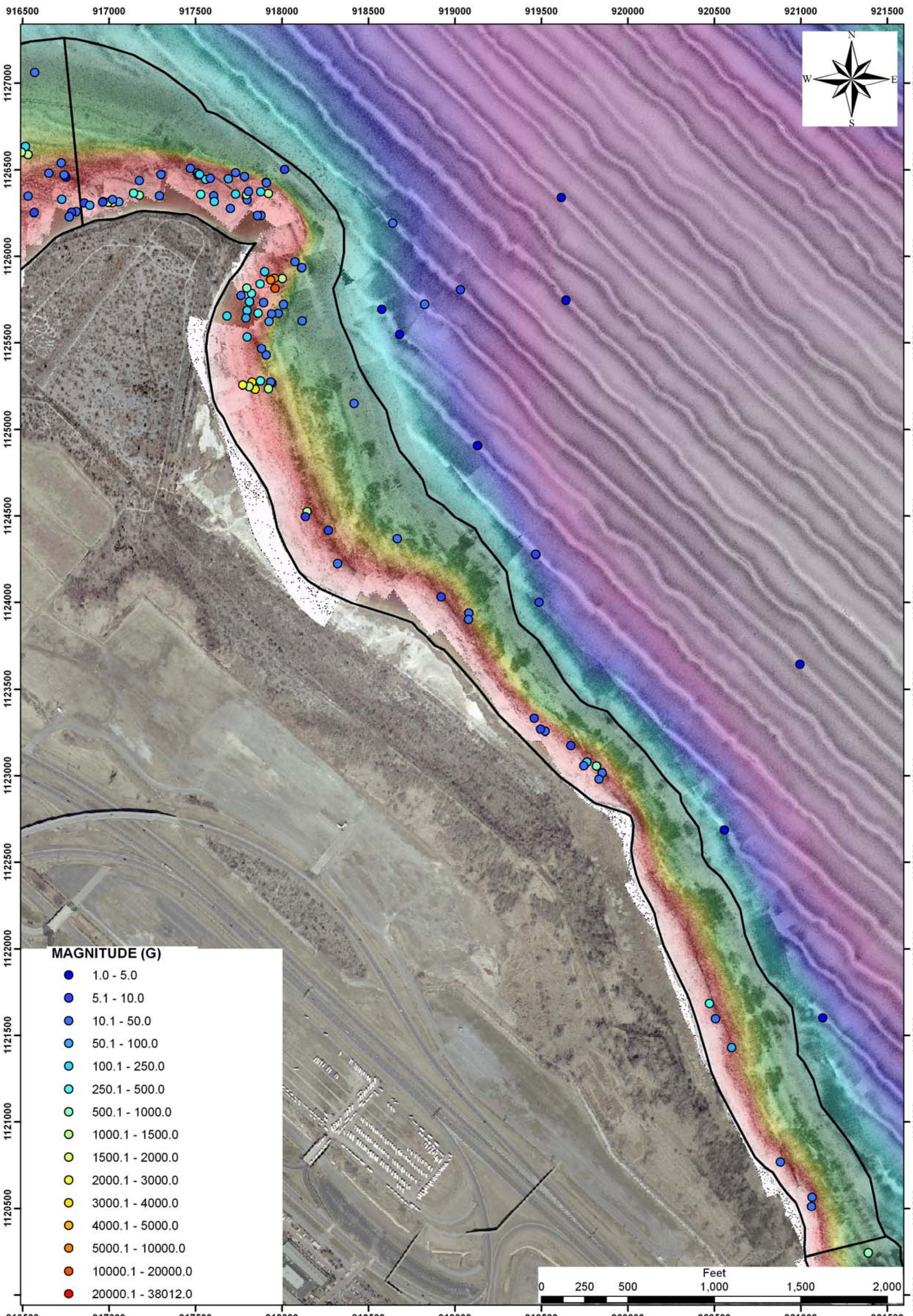
FIGURE 38

MAGNETIC ANOMALIES
ONONDAGA LAKE
SMU 3



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Magnetic data was collected using a Geometrics 881 CV magnetometer and transect spacing ranging from 25 to 200 feet (see text).
3. Grid: NY State Plane (Central), NAD83, US Foot.

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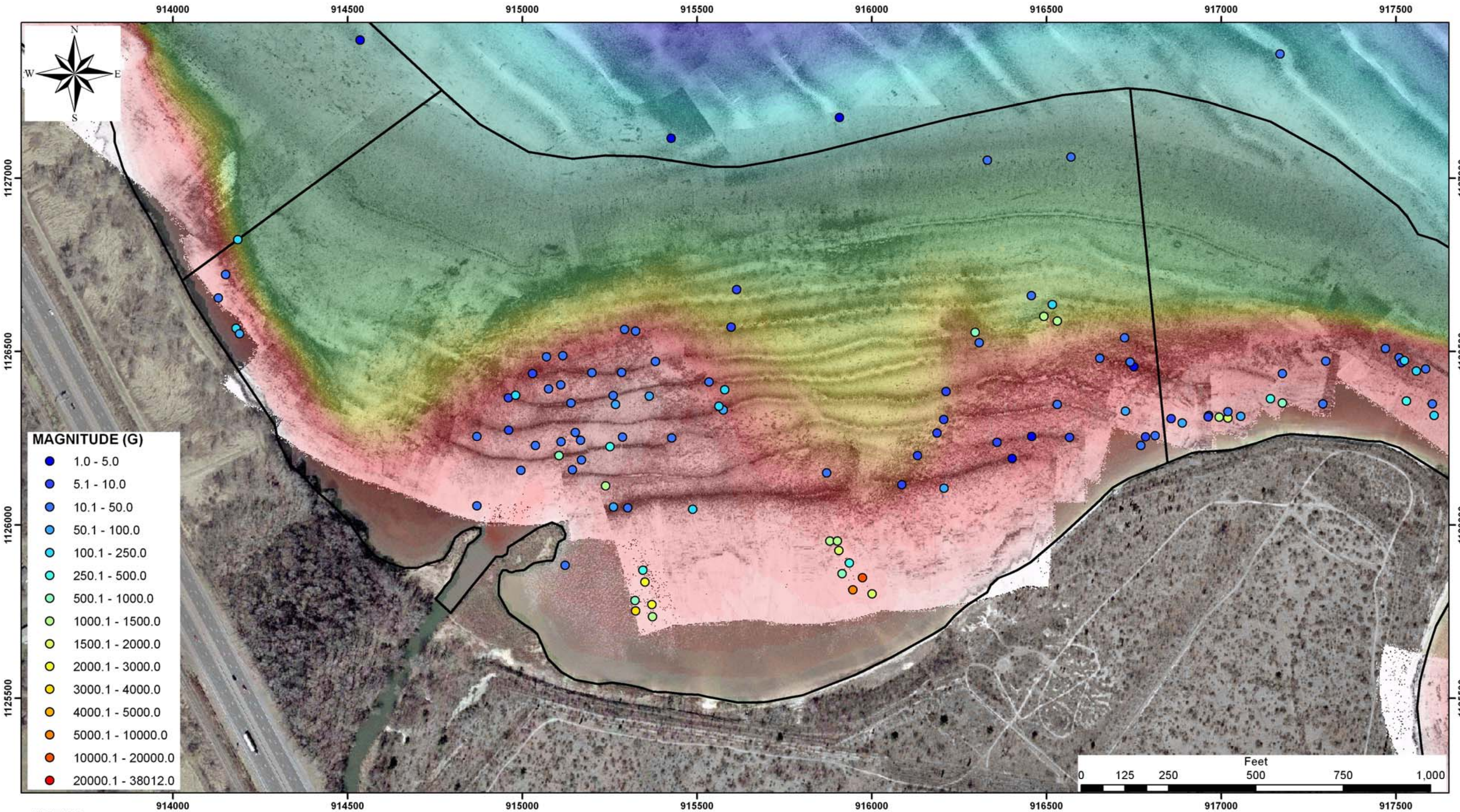
FIGURE 39

MAGNETIC ANOMALIES
ONONDAGA LAKE, SMU 4



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Magnetic data was collected using a Geometrics 881 CV magnetometer and transect spacing ranging from 25 to 200 feet (see text).
3. Grid: NY State Plane (Central), NAD83, US Foot.

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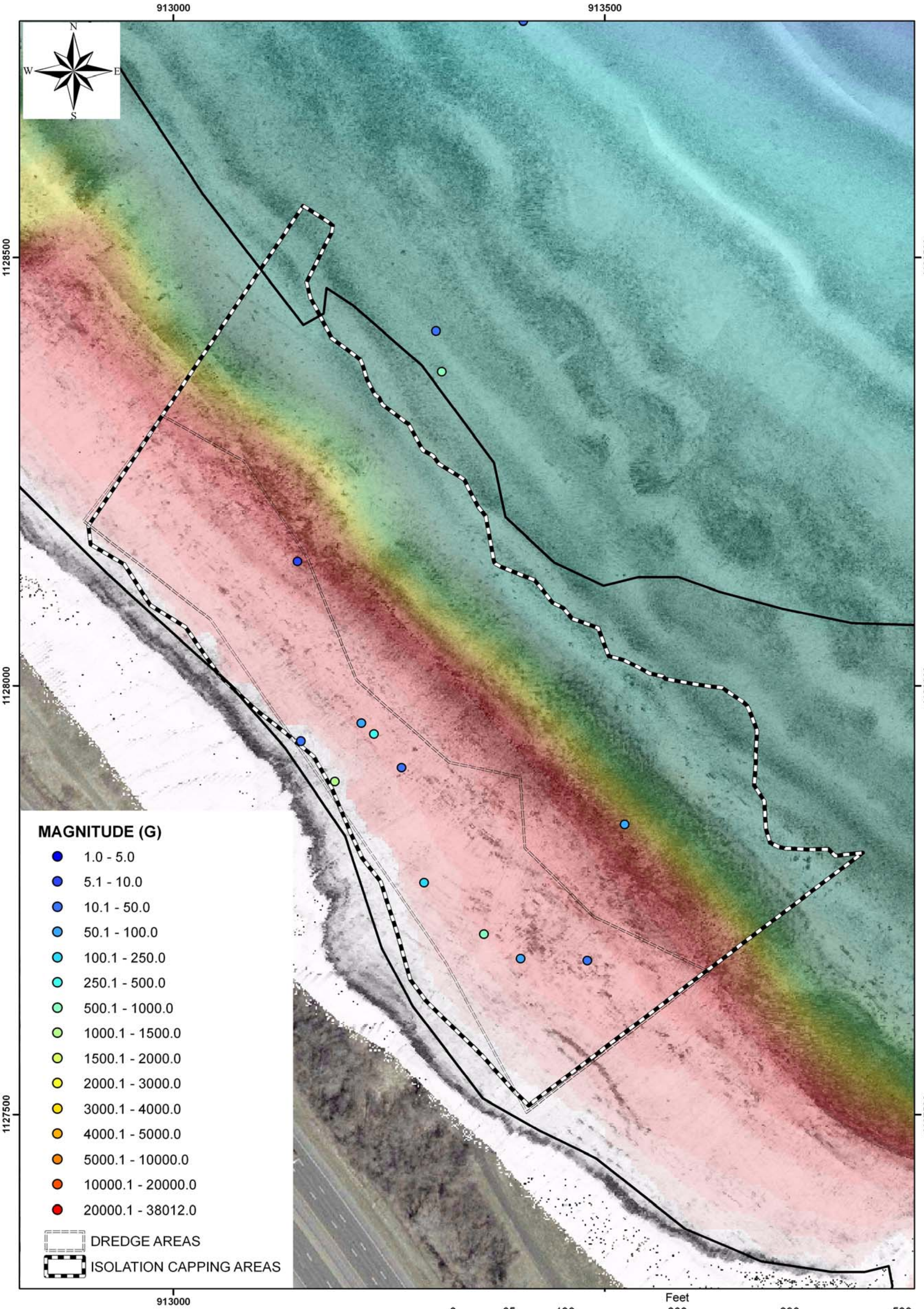
FIGURE 40

MAGNETIC ANOMALIES
ONONDAGA LAKE, SMU 5 AREA "A"



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Magnetic data was collected using a Geometrics 881 CV magnetometer and transect spacing ranging from 25 to 200 feet (see text).
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Dredge areas and isolation capping areas as shown are approximate boundaries of potential remediation areas based on the November 2004 Feasibility Study Report. These boundaries may change in the future.

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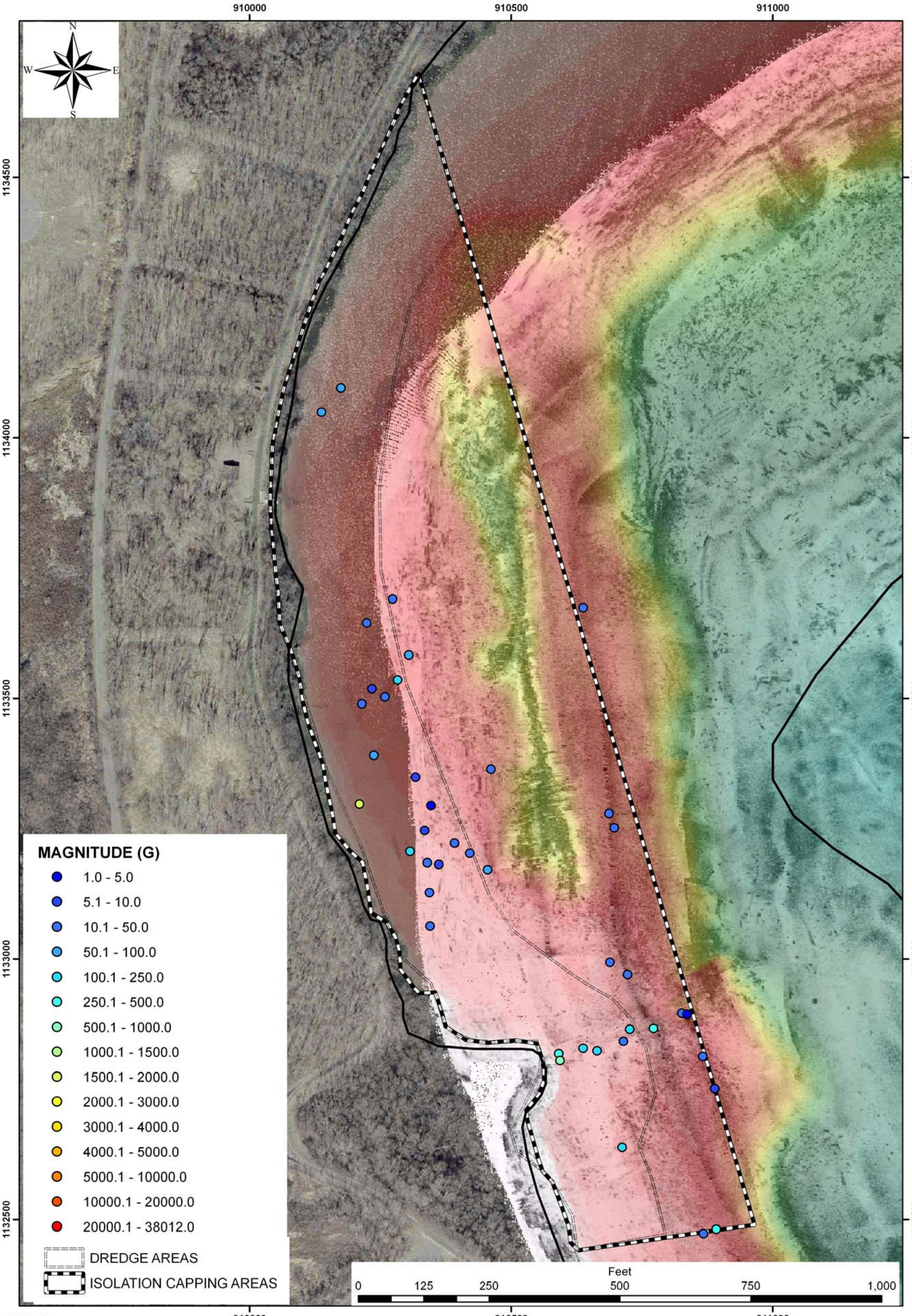
FIGURE 41

MAGNETIC ANOMALIES
ONONDAGA LAKE, SMU 5 AREA "B"



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Magnetic data was collected using a Geometrics 881 CV magnetometer and transect spacing ranging from 25 to 200 feet (see text).
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Dredge areas and isolation capping areas as shown are approximate boundaries of potential remediation areas based on the November 2004 Feasibility Study Report. These boundaries may change in the future.

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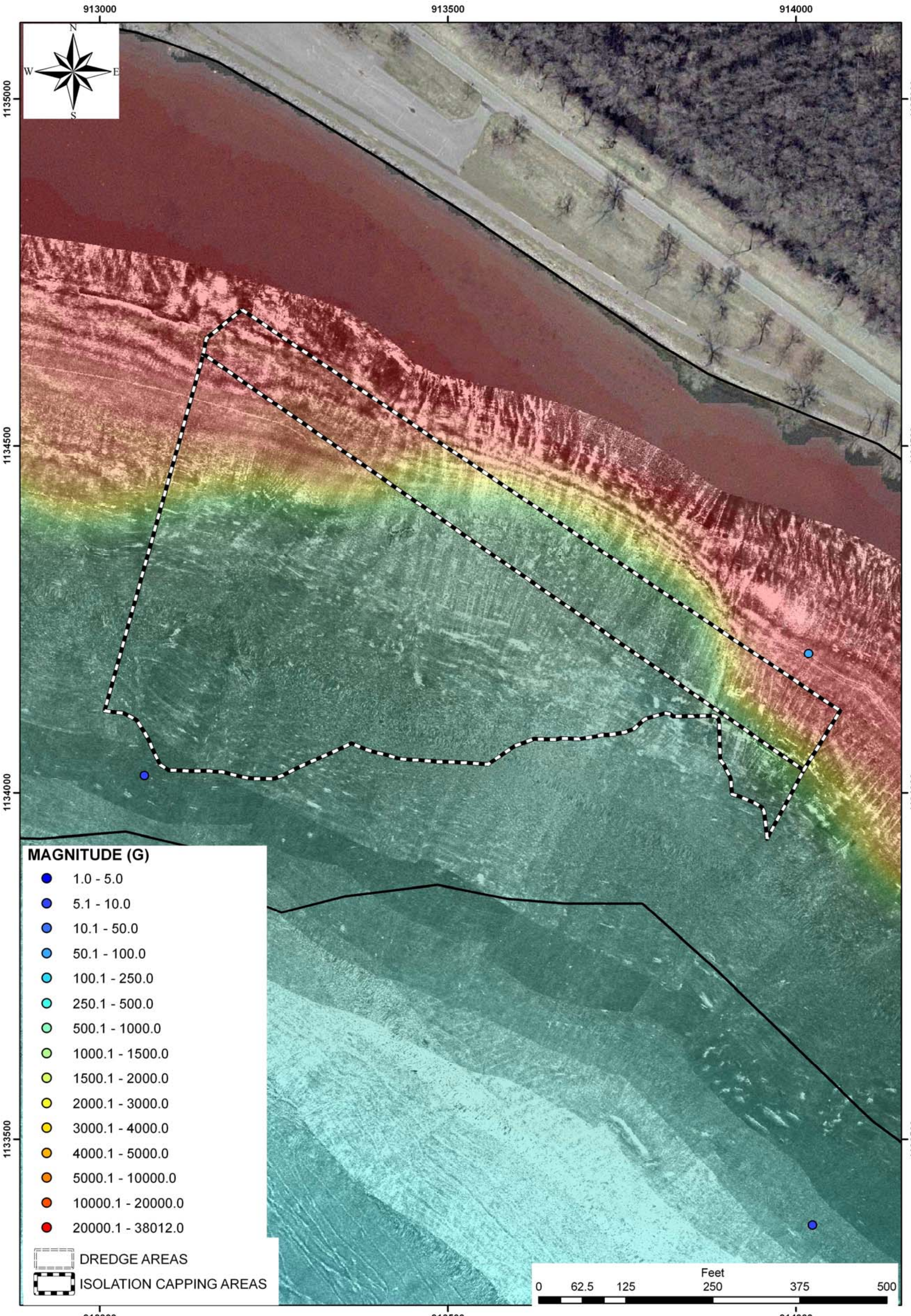
FIGURE 42

MAGNETIC ANOMALIES
ONONDAGA LAKE, SMU 5 AREA "C"



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Magnetic data was collected using a Geometrics 881 CV magnetometer and transect spacing ranging from 25 to 200 feet (see text).
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Dredge areas and isolation capping areas as shown are approximate boundaries of potential remediation areas based on the November 2004 Feasibility Study Report. These boundaries may change in the future.

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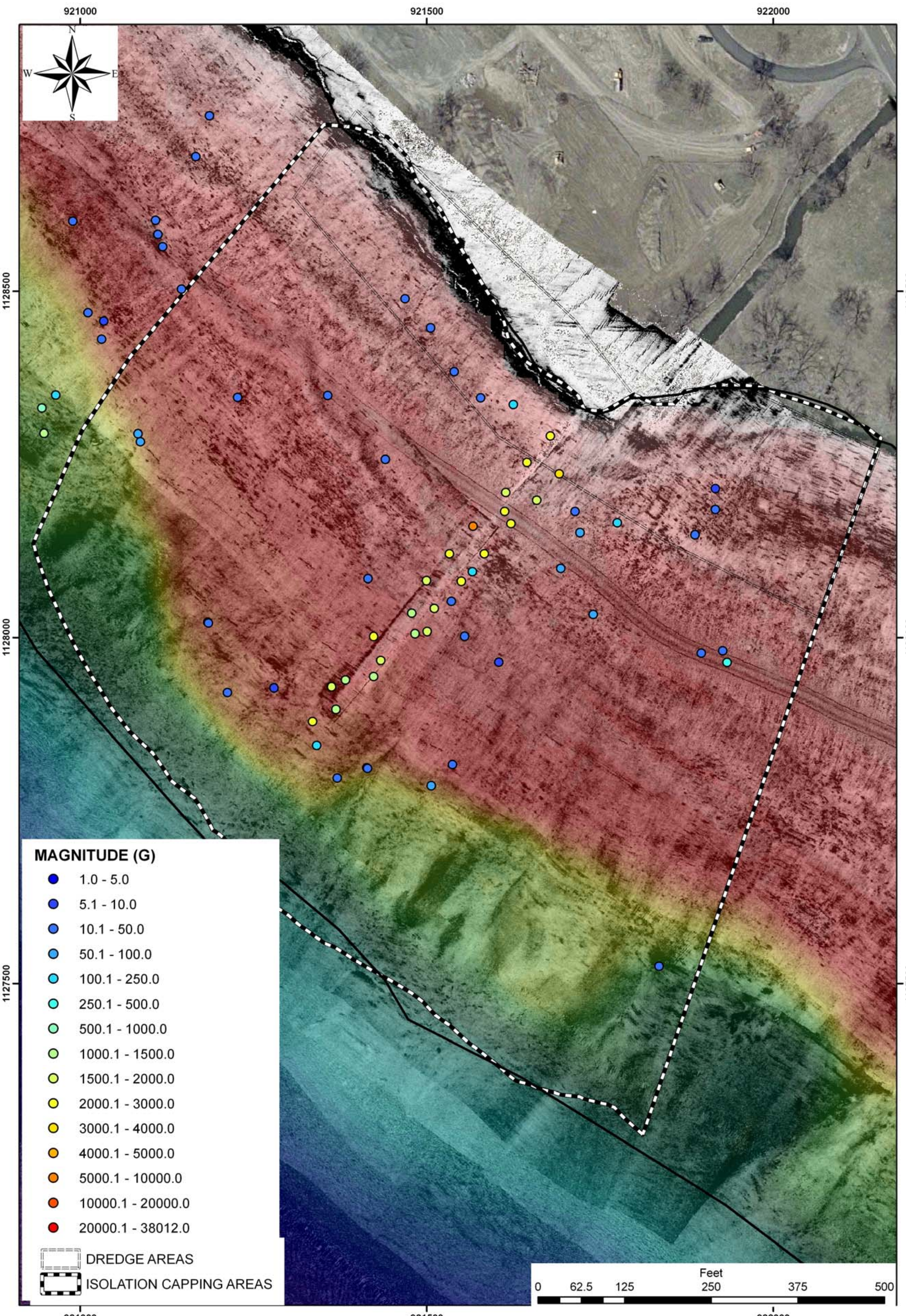
FIGURE 43

MAGNETIC ANOMALIES
ONONDAGA LAKE, SMU 5 AREA "D"



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Magnetic data was collected using a Geometrics 881 CV magnetometer and transect spacing ranging from 25 to 200 feet (see text).
3. Grid: NY State Plane (Central), NAD83, US Foot.
4. Dredge areas and isolation capping areas as shown are approximate boundaries of potential remediation areas based on the November 2004 Feasibility Study Report. These boundaries may change in the future.

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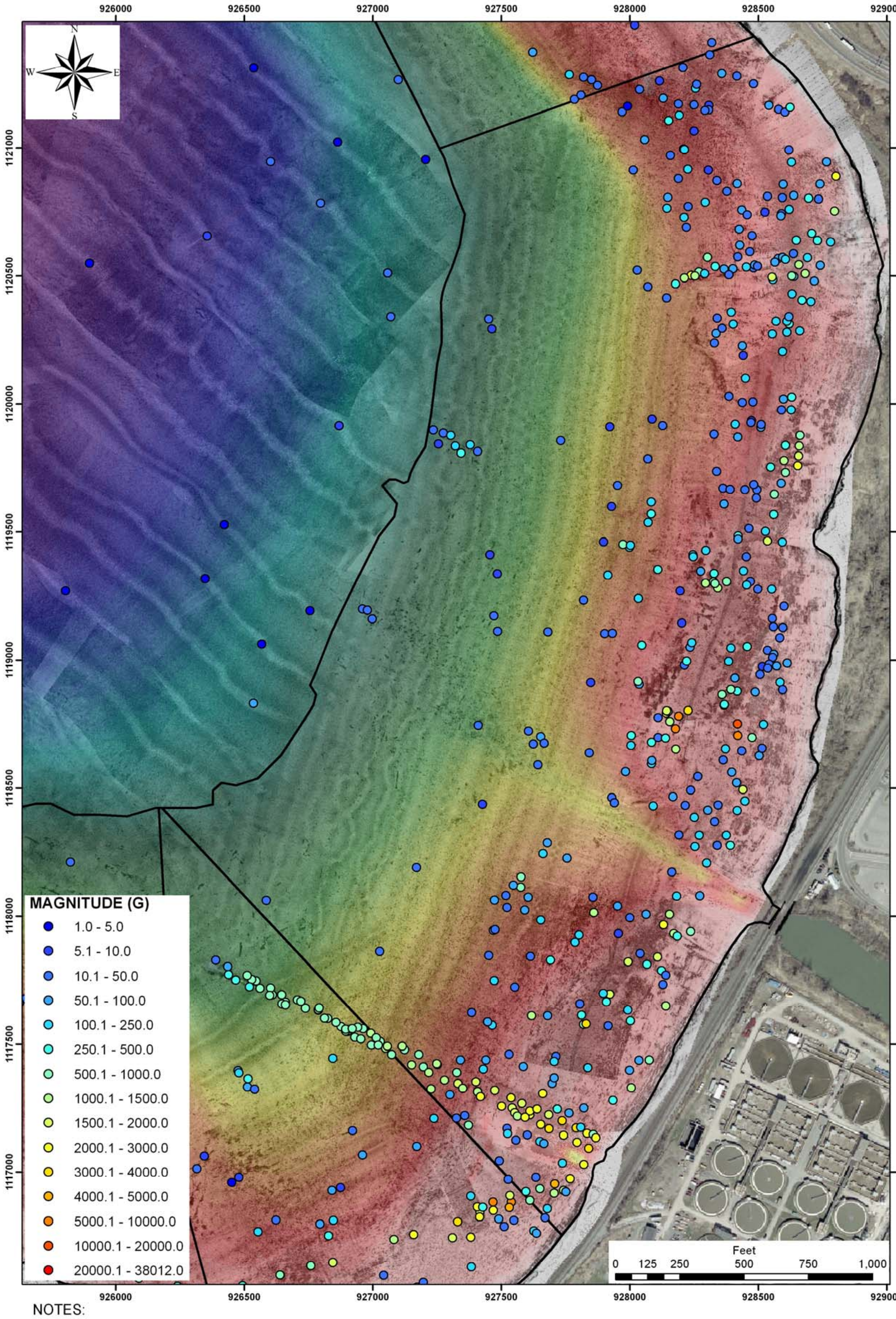
FIGURE 44

MAGNETIC ANOMALIES
ONONDAGA LAKE, SMU 6



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Magnetic data was collected using a Geometrics 881 CV magnetometer and transect spacing ranging from 25 to 200 feet (see text).
3. Grid: NY State Plane (Central), NAD83, US Foot.

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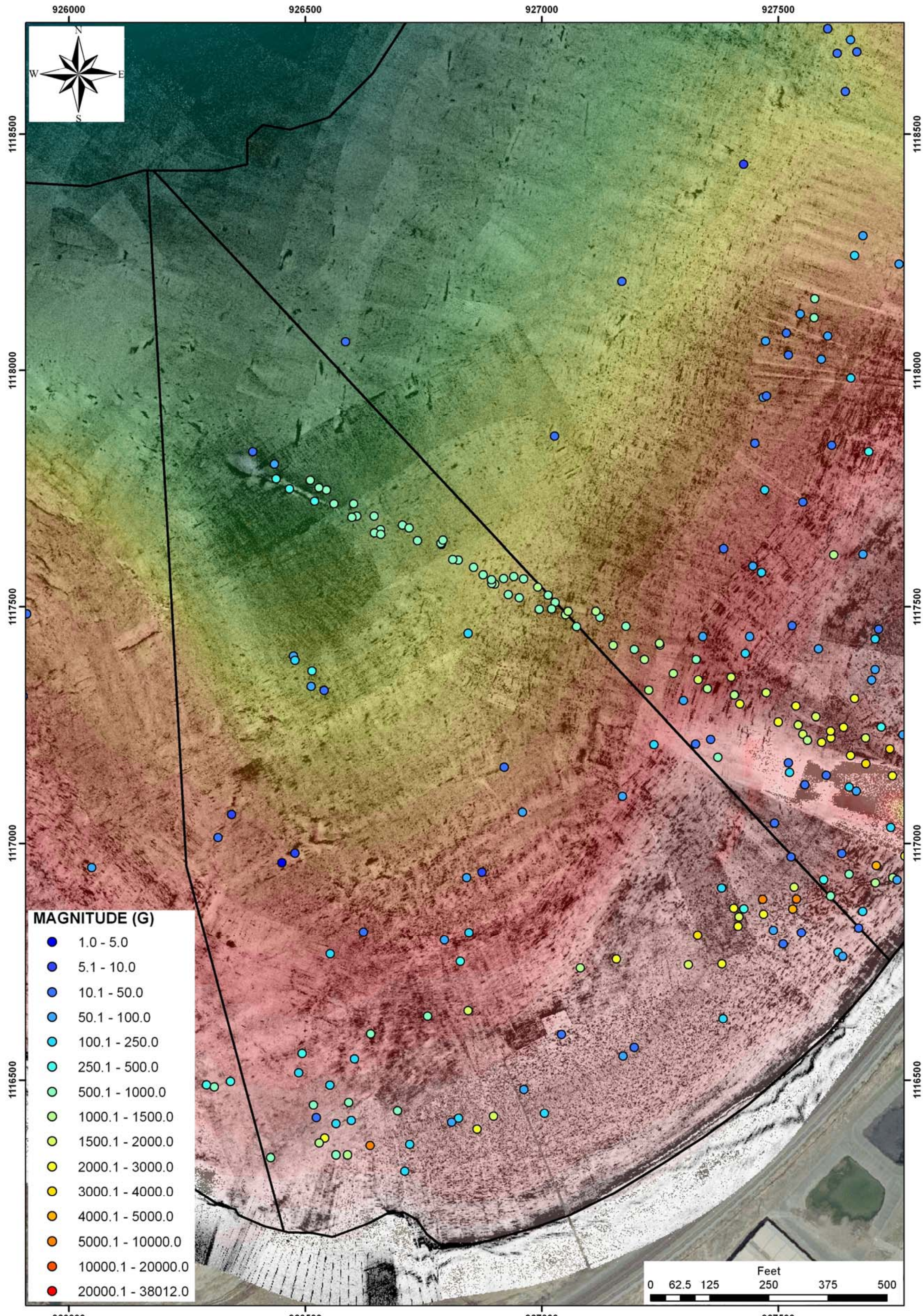
FIGURE 45

MAGNETIC ANOMALIES
ONONDAGA LAKE, SMU 7



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Magnetic data was collected using a Geometrics 881 CV magnetometer and transect spacing ranging from 25 to 200 feet (see text).
3. Grid: NY State Plane (Central), NAD83, US Foot.

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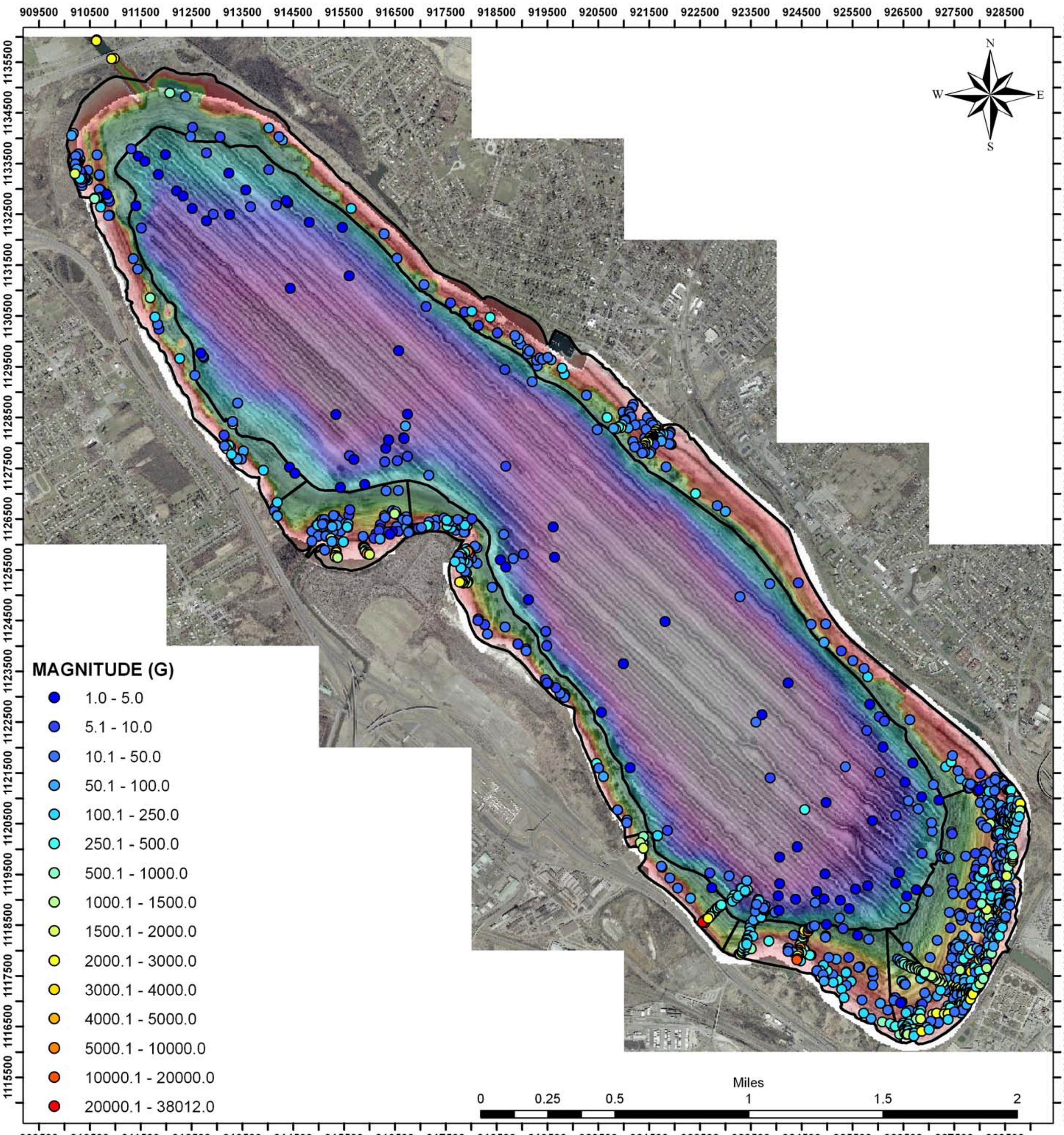
FIGURE 46

MAGNETIC ANOMALIES
ONONDAGA LAKE, SMU 8



NOTES:

1. Survey conducted by CR Environmental, Inc. of East Falmouth, Massachusetts between October 12 and November 6, 2005.
2. Magnetic data was collected using a Geometrics 881 CV magnetometer and transect spacing ranging from 25 to 200 feet (see text).
3. Grid: NY State Plane (Central), NAD83, US Foot.

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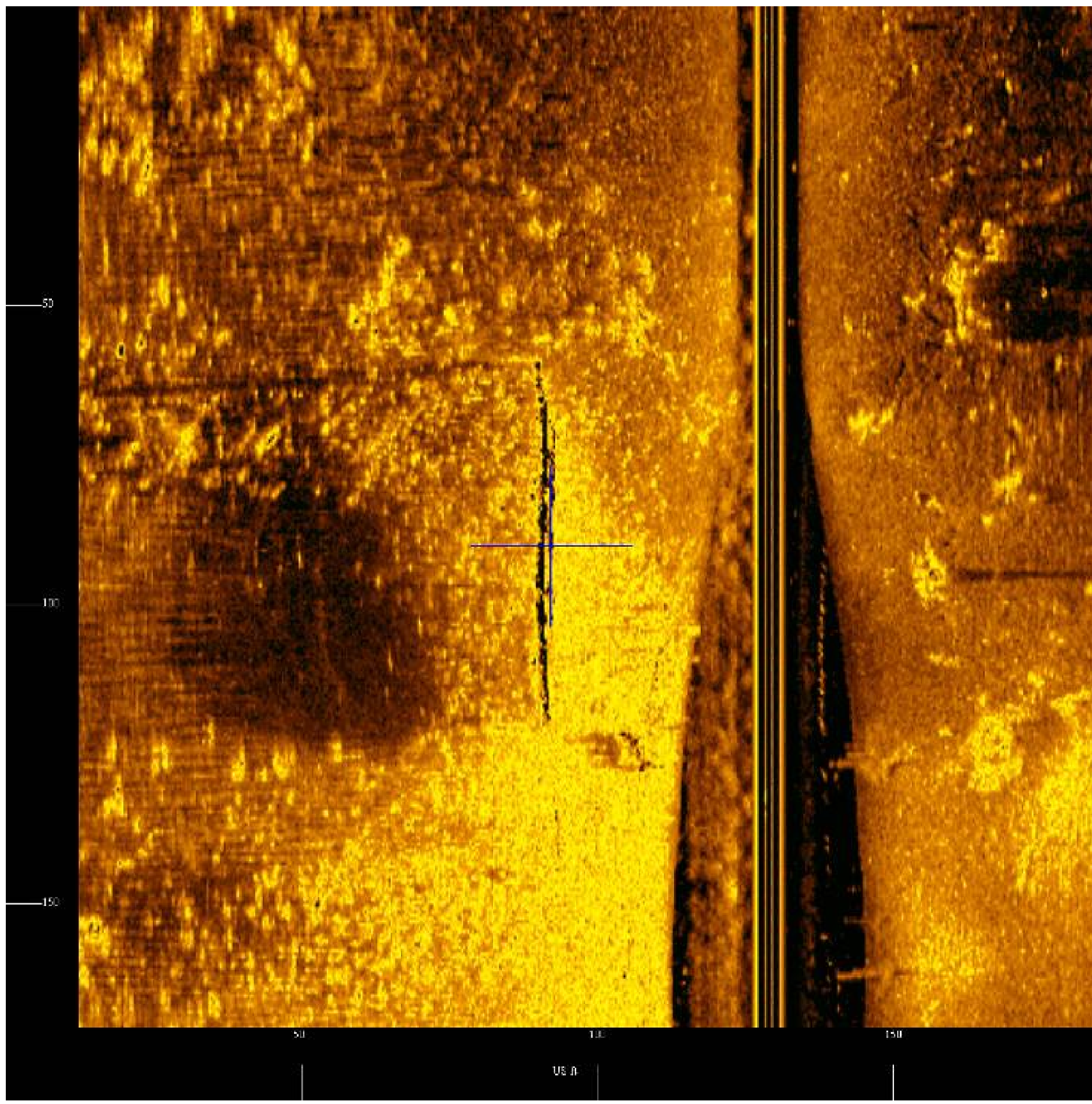
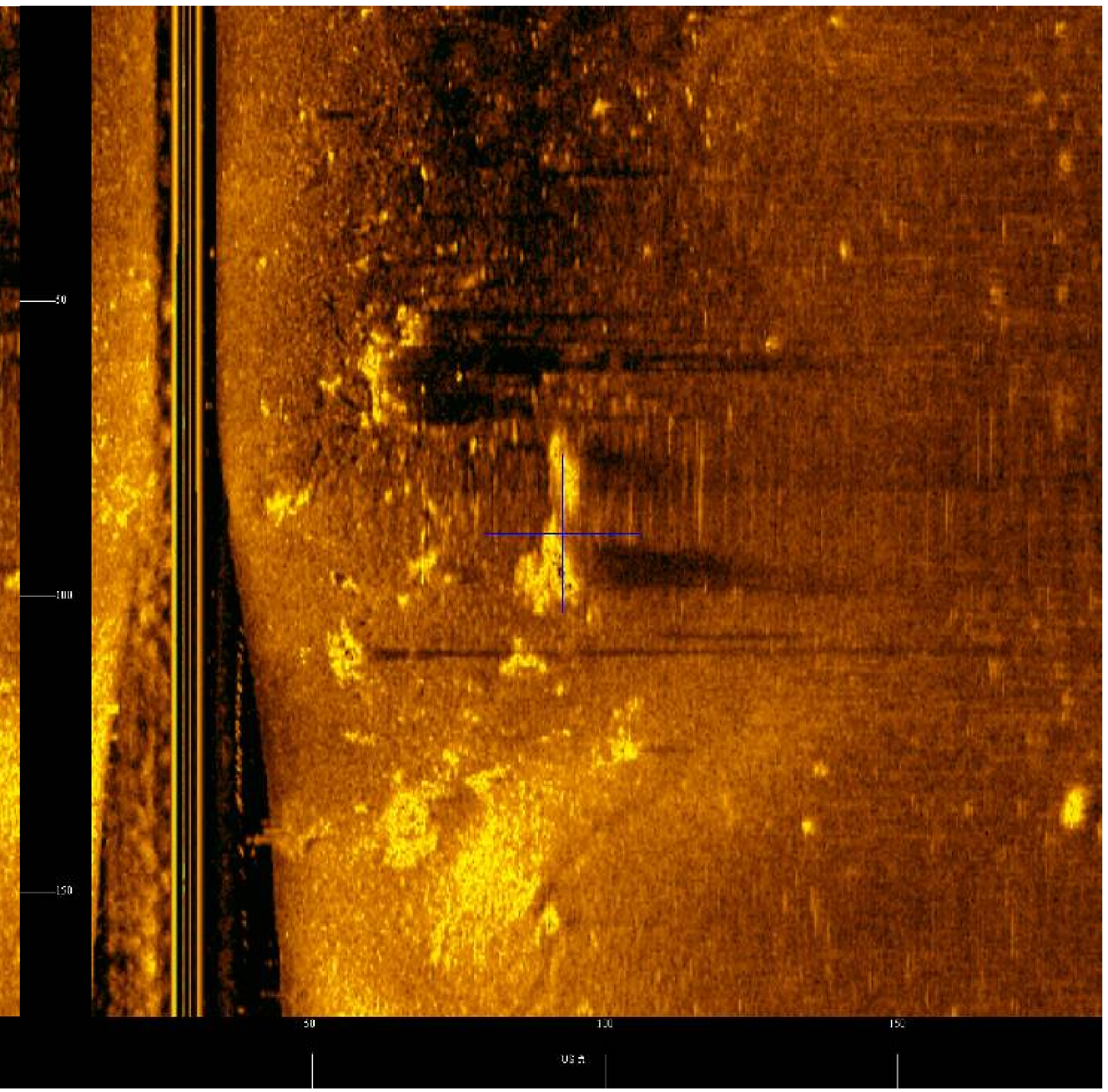
FIGURE 47

SONAR CONTACTS 0669 AND 0670
DEPICT THE TERMINAL END OF A STRUCTURE
WITHIN SOUTHERN SMU 5B



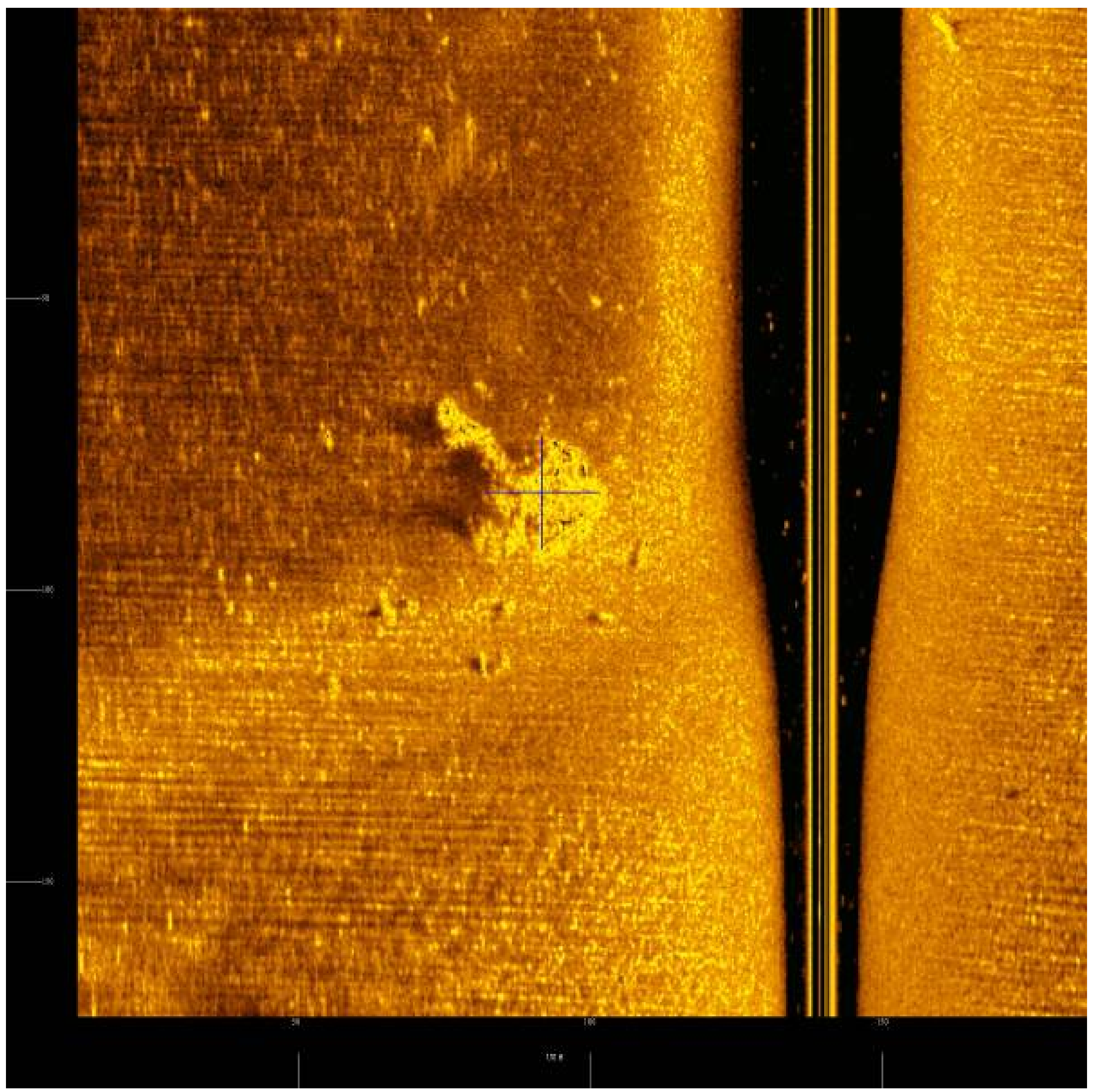
Contact 0670



Contact 0669

FIGURE 48

SONAR CONTACTS 0565 AND 0567
POTENTIAL AIRCRAFT WRECKAGE
SMU 5



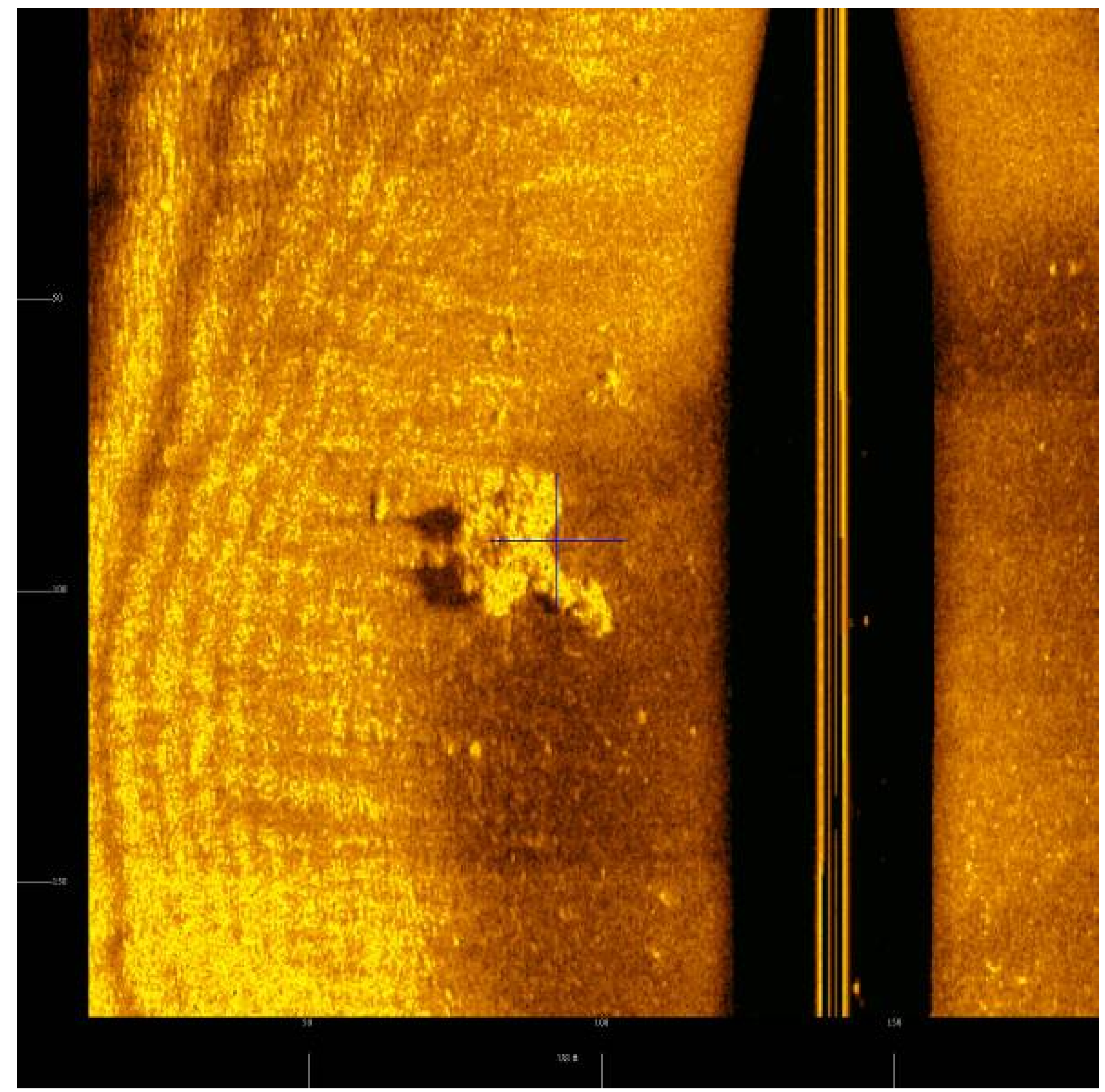


FIGURE 49

SONAR CONTACT 0345
PIPELINE AND INTAKE STRUCTURE
SMU 6

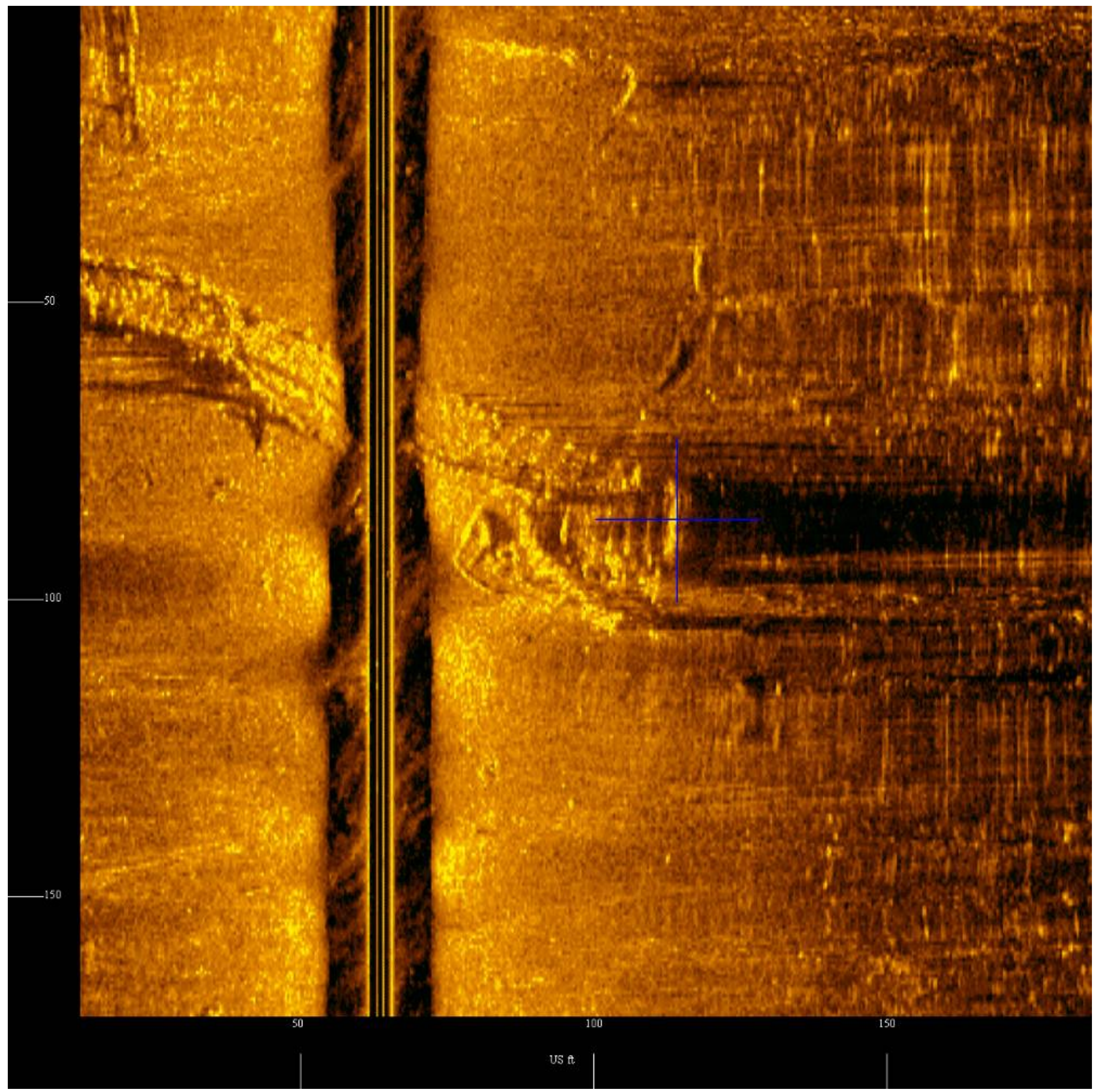


FIGURE 50

SONAR CONTACTS 0355 AND 0356
SHIPWRECK
SMU 8

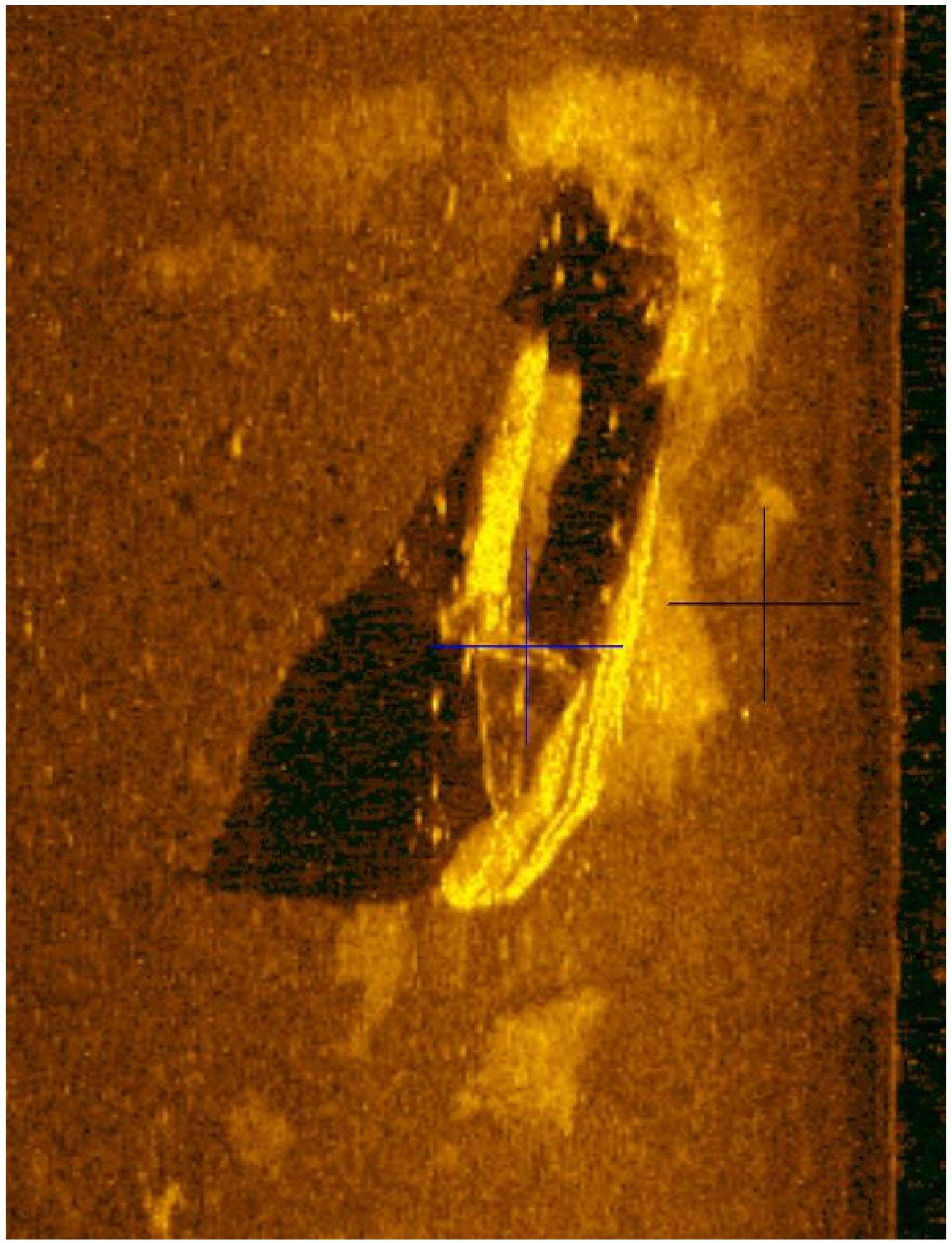
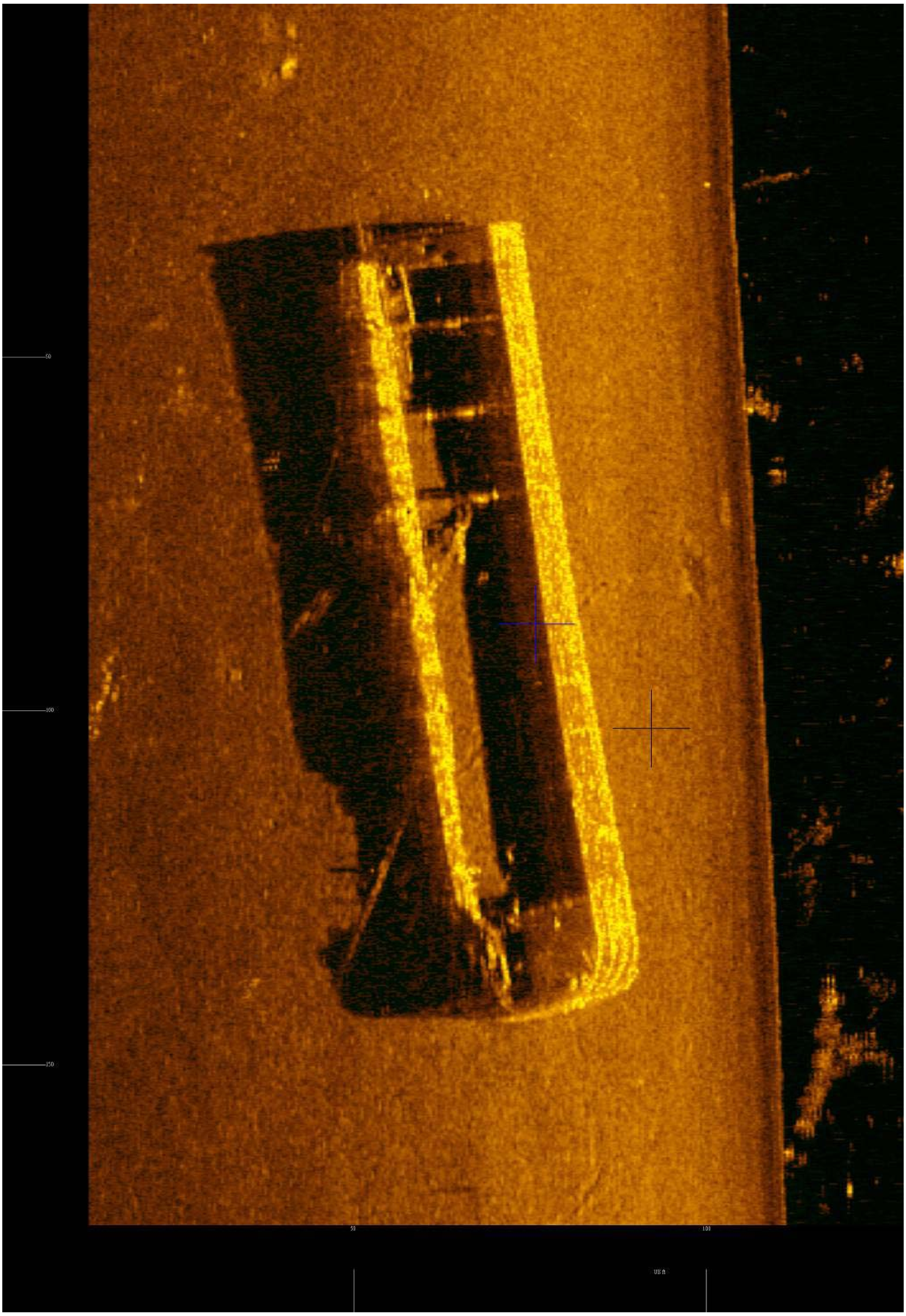


FIGURE 51

SONAR CONTACT 0267
SHIPWRECK
SMU 8



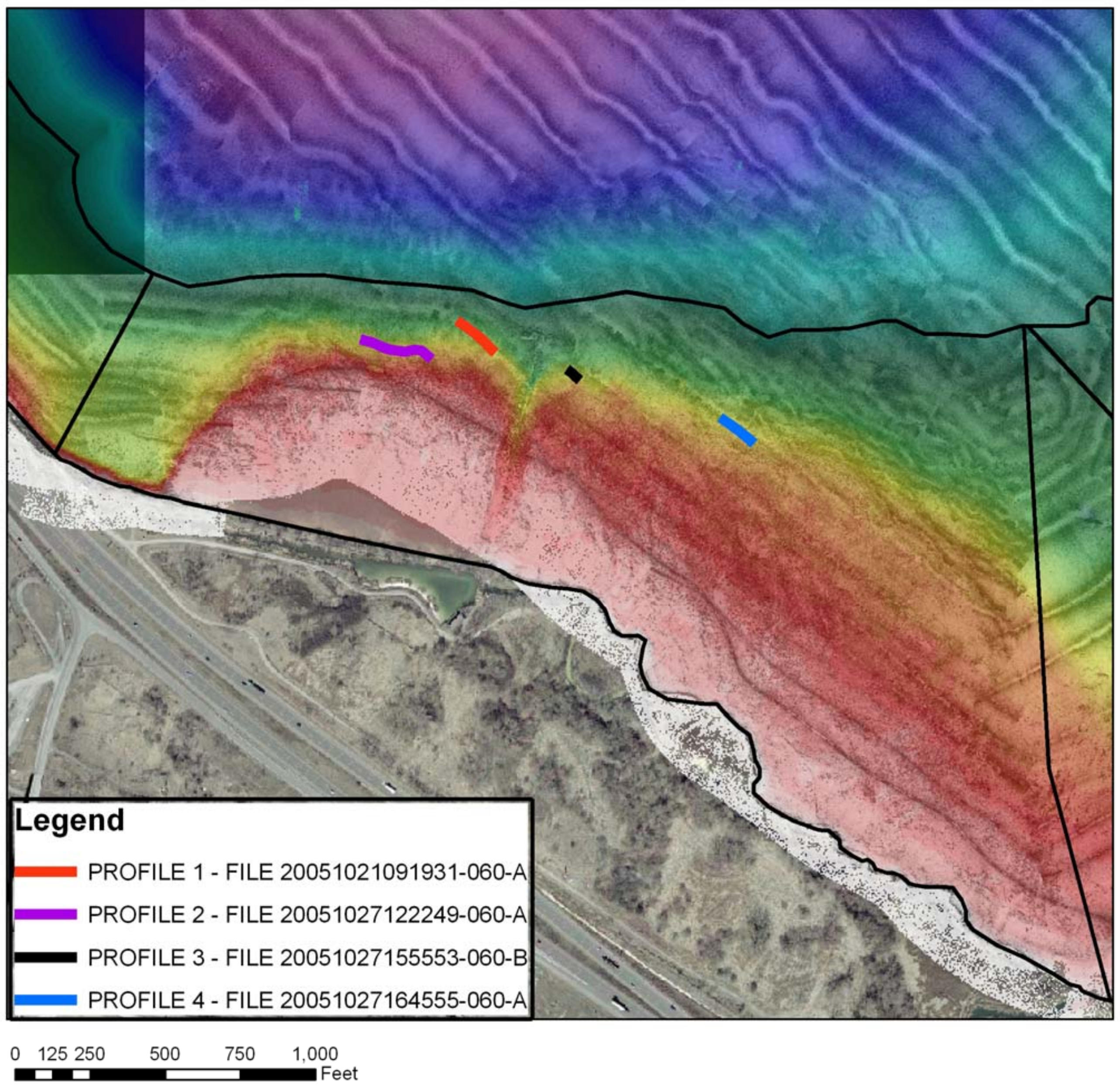
APPENDICES

APPENDICES A-1 TO A-8

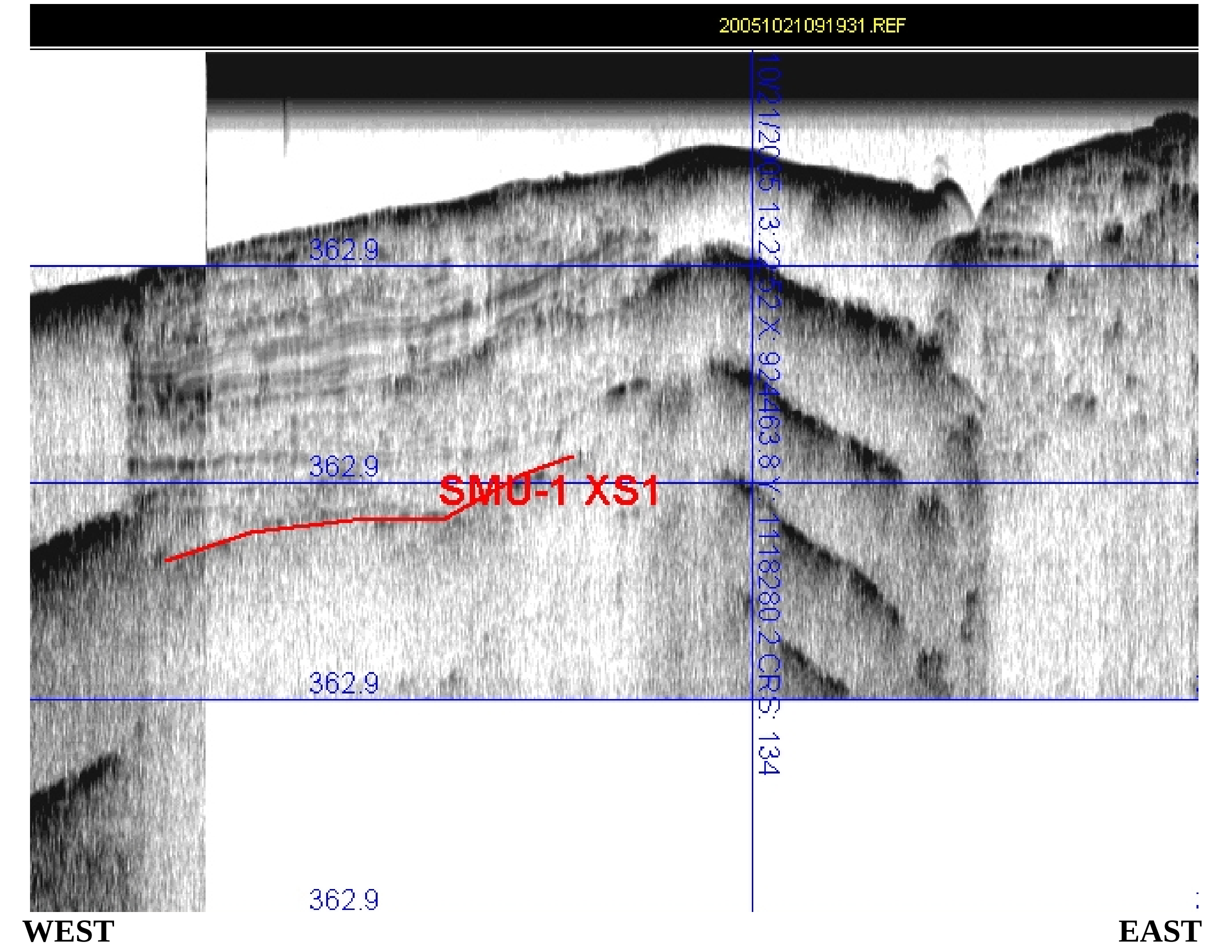
Indexes to and Sample Sub-bottom Sonar Profiles for Onondaga Lake SMU 1 through SMU 8

APPENDIX A-1

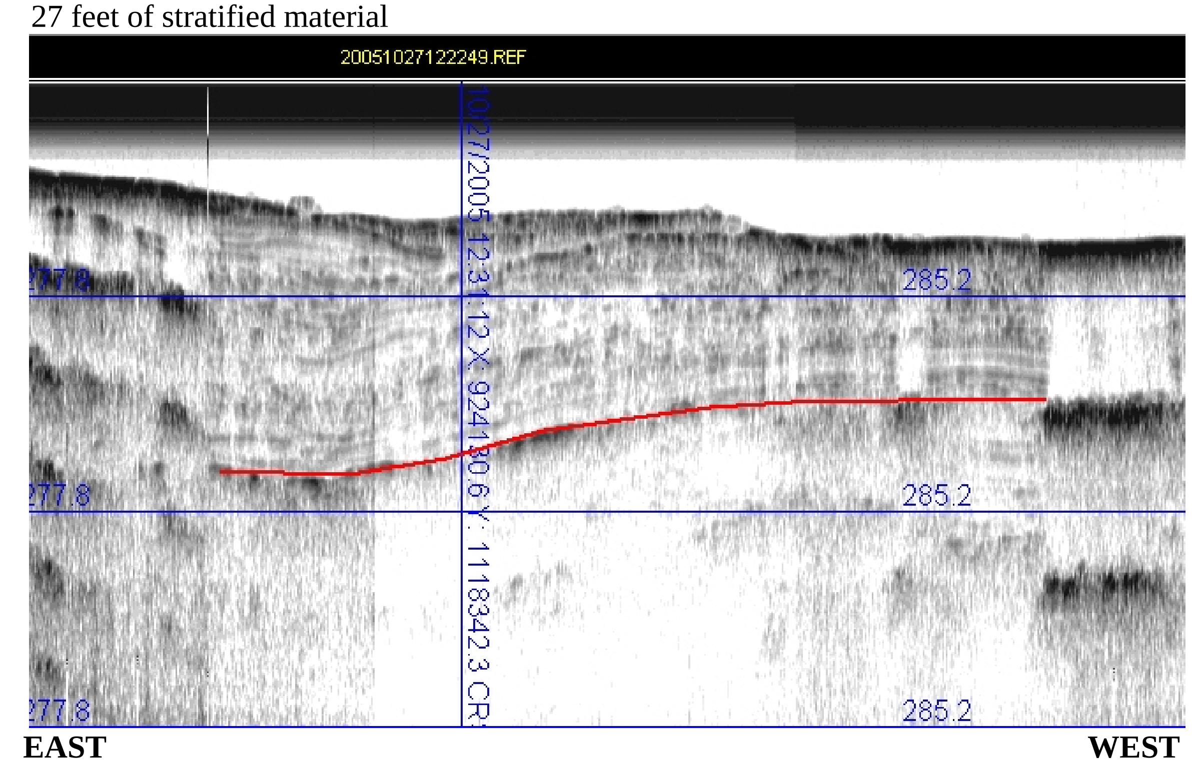
INDEX TO SAMPLE SUB-BOTTOM SONAR PROFILES
ONONDAGA LAKE
SMU 1



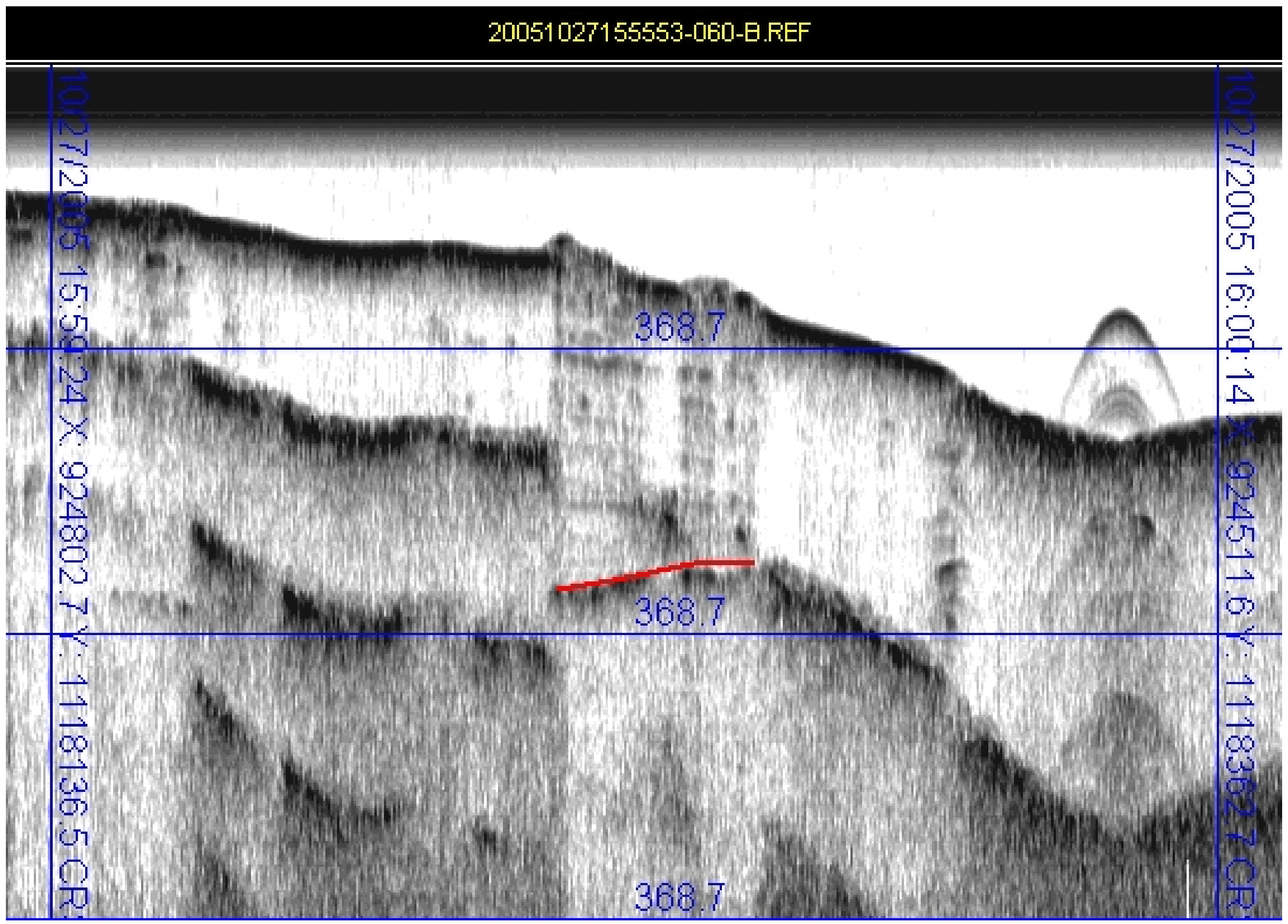
Orthophoto, color indexed bathymetric map and side scan sonar mosaic have been used as background data to provide spatial reference.



PROFILE 1 - FILE 20051021091931: 170 foot long segment of sub-bottom record depicting 27 feet of stratified material

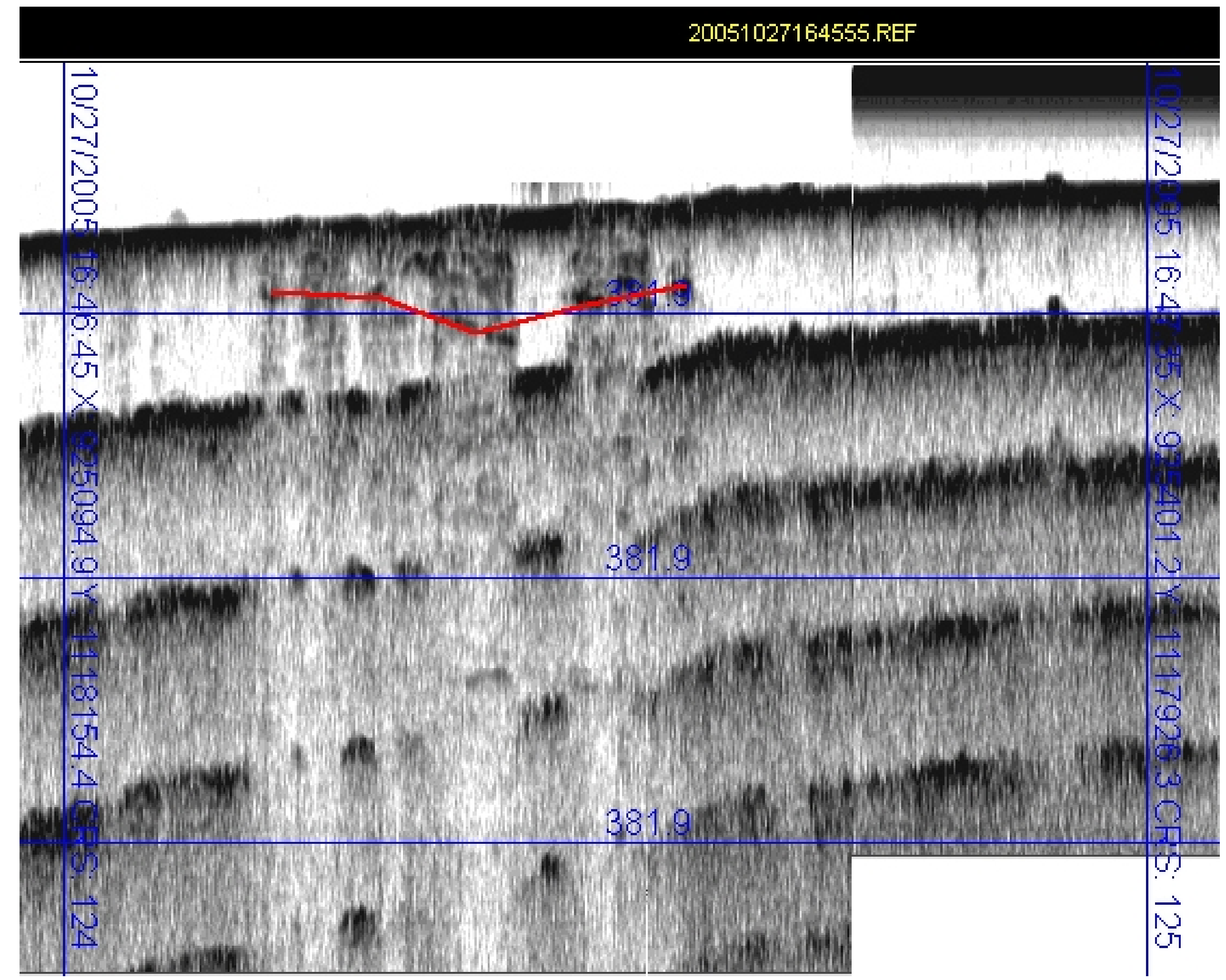


PROFILE 2 - FILE 20051027122249: 300 foot long segment of sub-bottom record depicting 15-5 feet of stratified material



EAST WEST

PROFILE 3 - FILE 20051027155553-060-B: 300 foot long segment of sub-bottom record. Penetration of 25 feet was achieved for a 70 linear foot portion. Outfall shown as parabolic reflector to right (west).

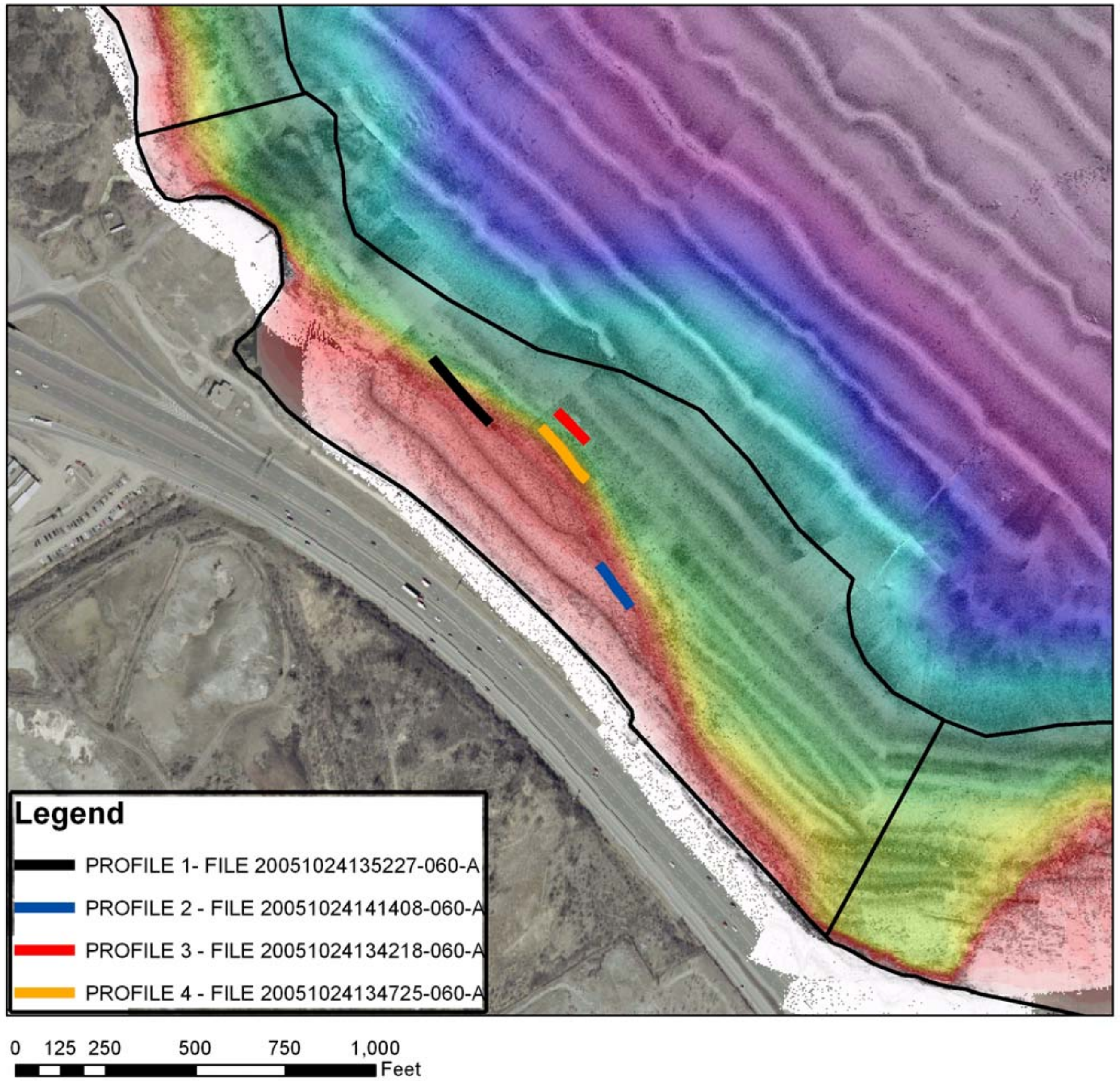


NORTHWEST SOUTHEAST

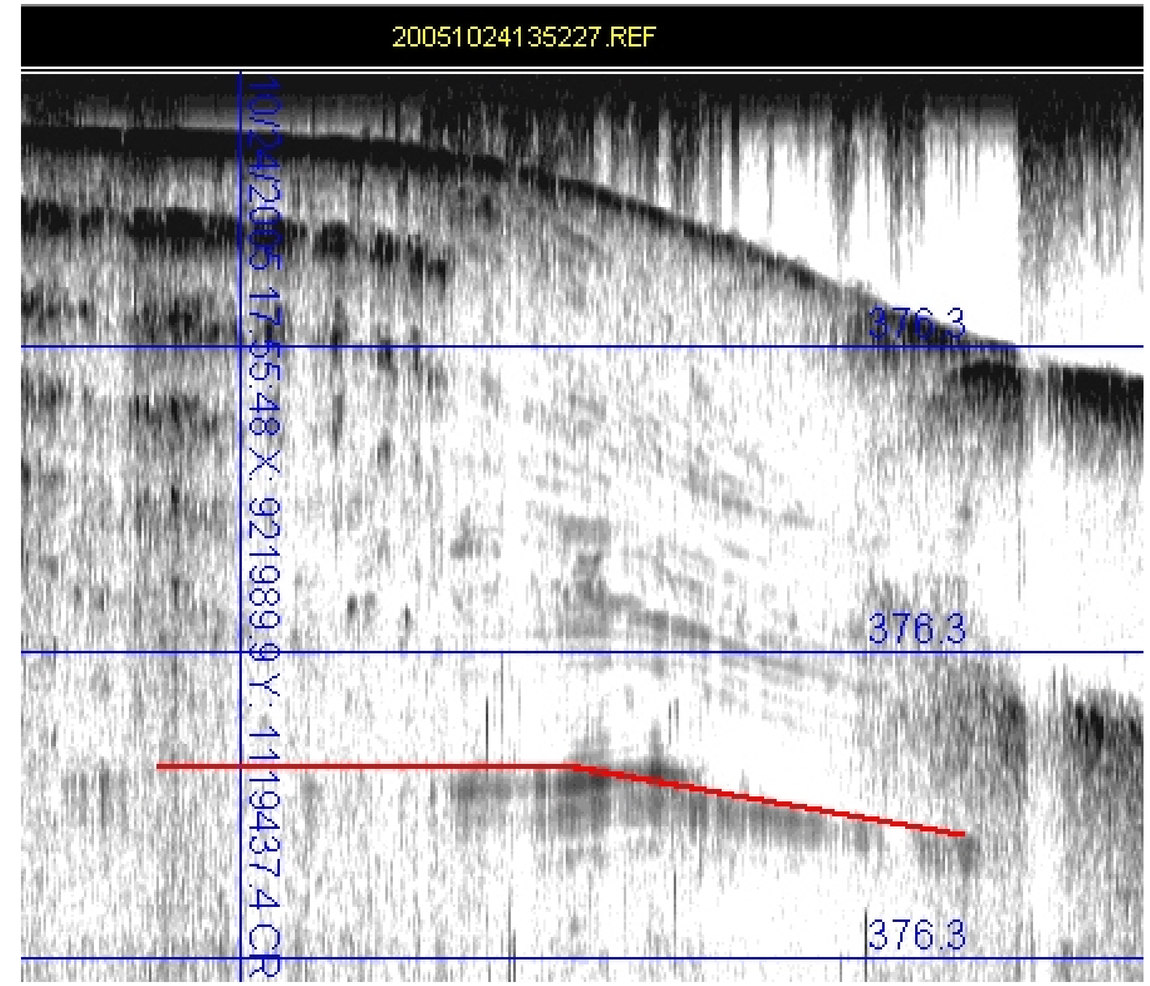
PROFILE 4 - FILE 20051027164555: 145 foot long segment of sub-bottom record depicting 6-10 feet of stratified material

APPENDIX A-2

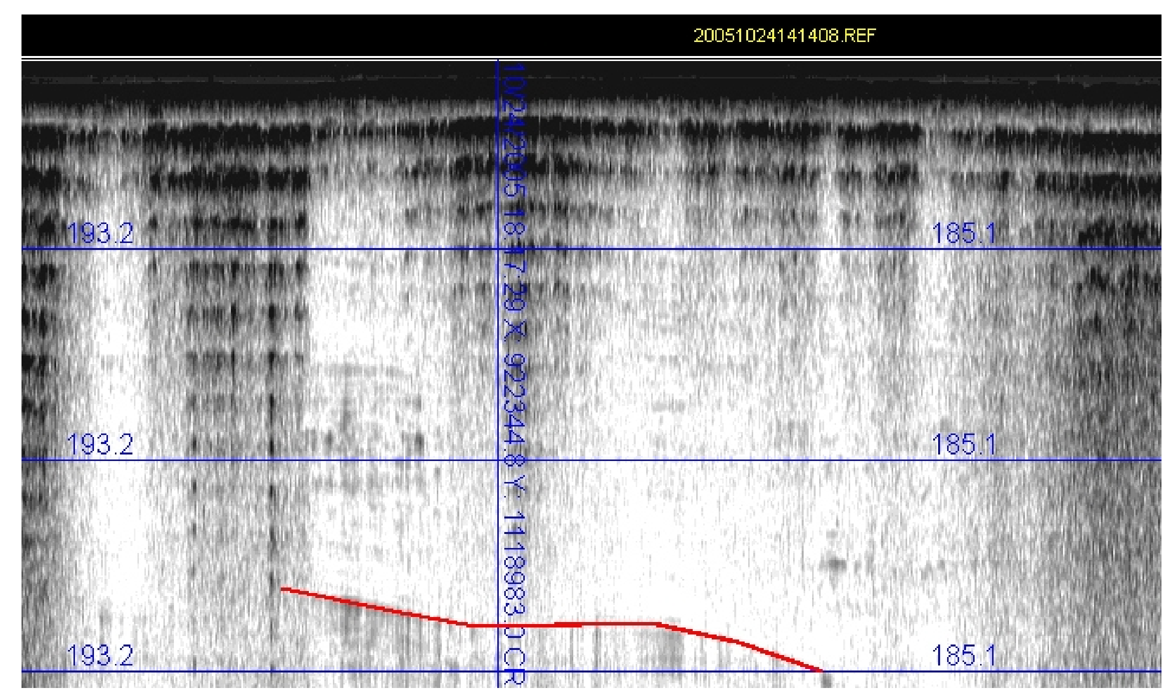
INDEX TO SAMPLE SUB-BOTTOM SONAR PROFILES
ONONDAGA LAKE
SMU 2



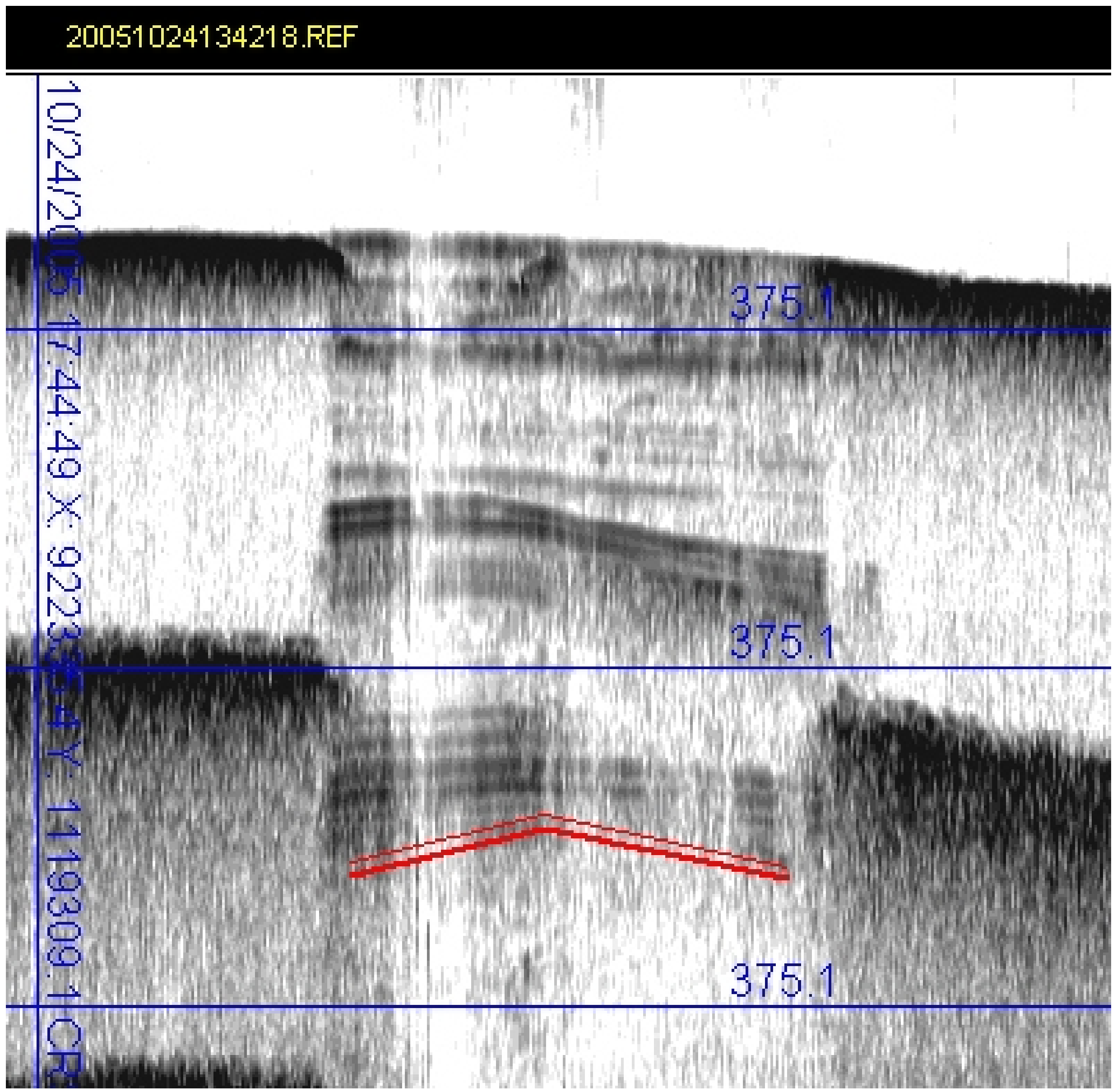
Orthophoto, color indexed bathymetric map and side scan sonar mosaic have been used as background data to provide spatial reference



PROFILE 1- FILE 20051024135227: 240 foot long segment of sub-bottom record *suggests* 40 feet of overburden material

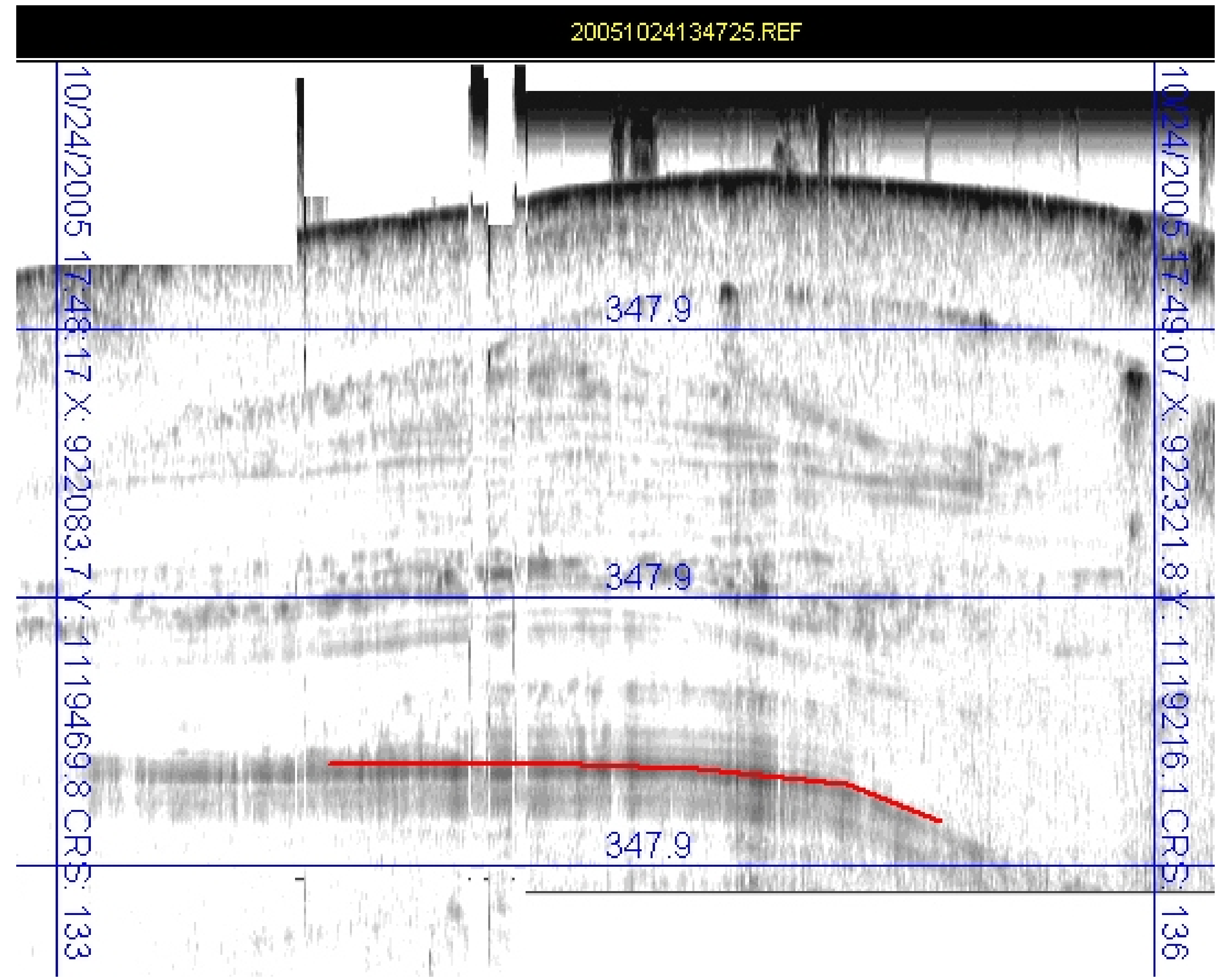


PROFILE 2 - FILE 20051024141408-060-A: 155 foot long segment of sub-bottom record *suggests* 50 feet of overburden material



NORTHWEST **SOUTHEAST**

PROFILE 3 - FILE 20051024134218: 145 foot long segment of sub-bottom record suggests 37 feet of stratified overburden material.

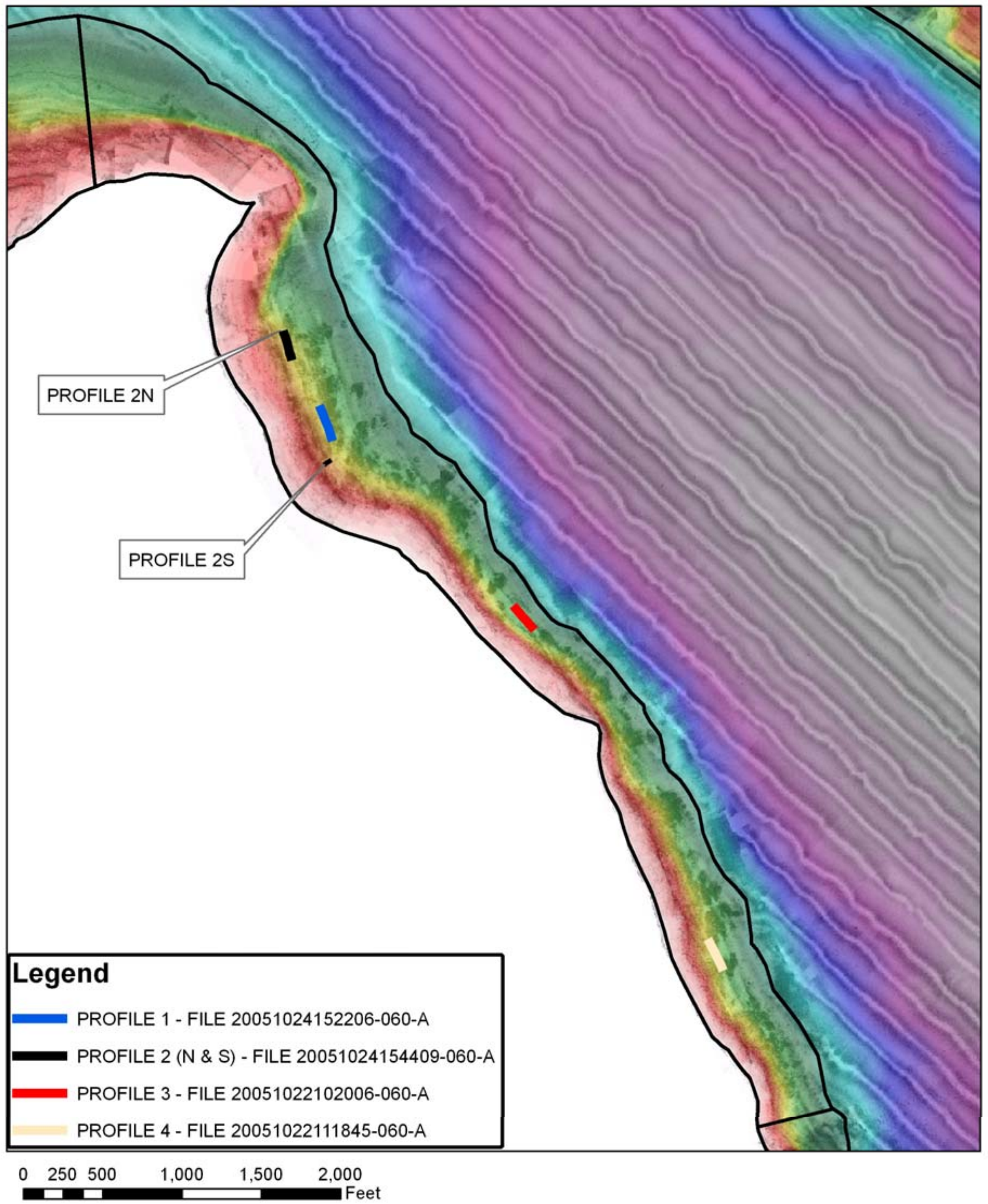


SOUTHEAST **NORTHWEST**

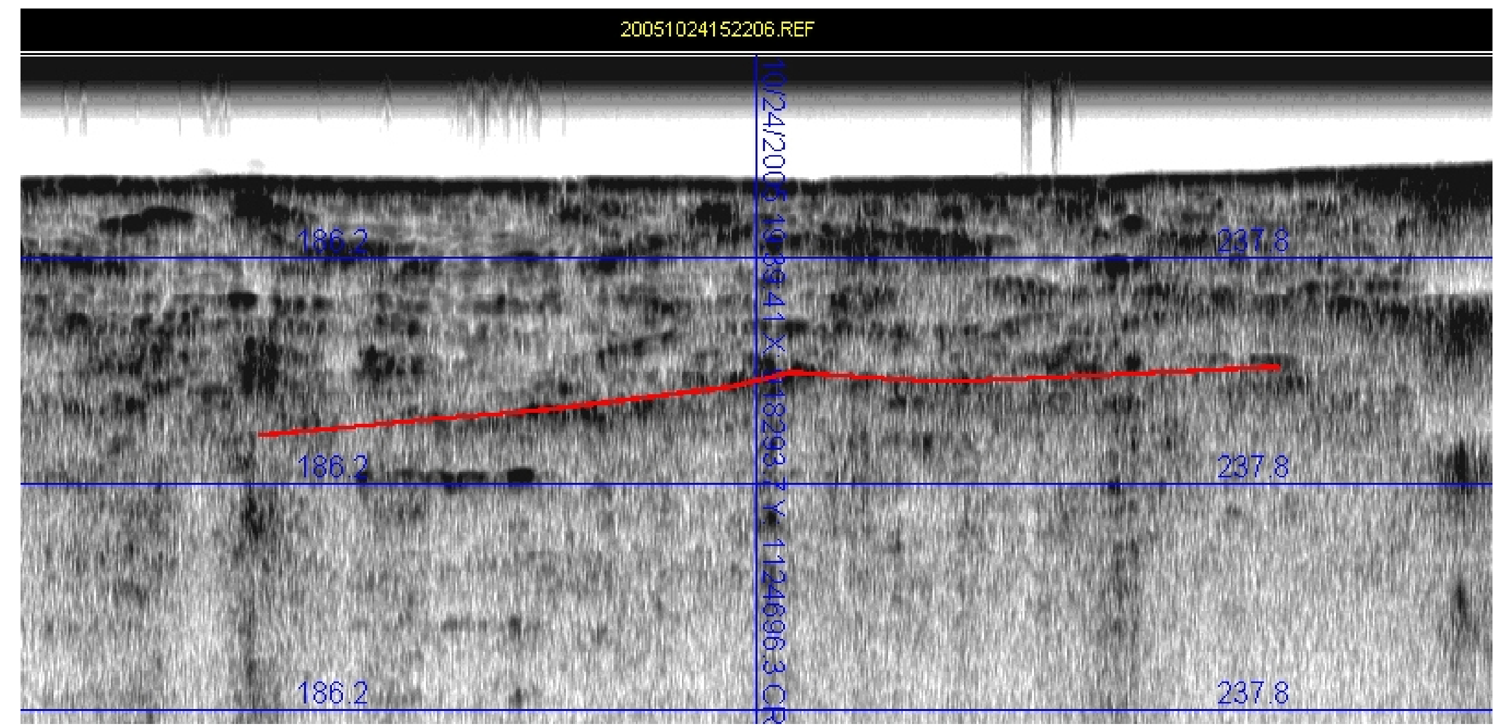
PROFILE 4 - FILE 20051024134725: 180 foot long segment of sub-bottom record suggests 44 feet of stratified overburden material.

APPENDIX A-3

INDEX TO SAMPLE SUB-BOTTOM SONAR PROFILES
ONONDAGA LAKE
SMU 3

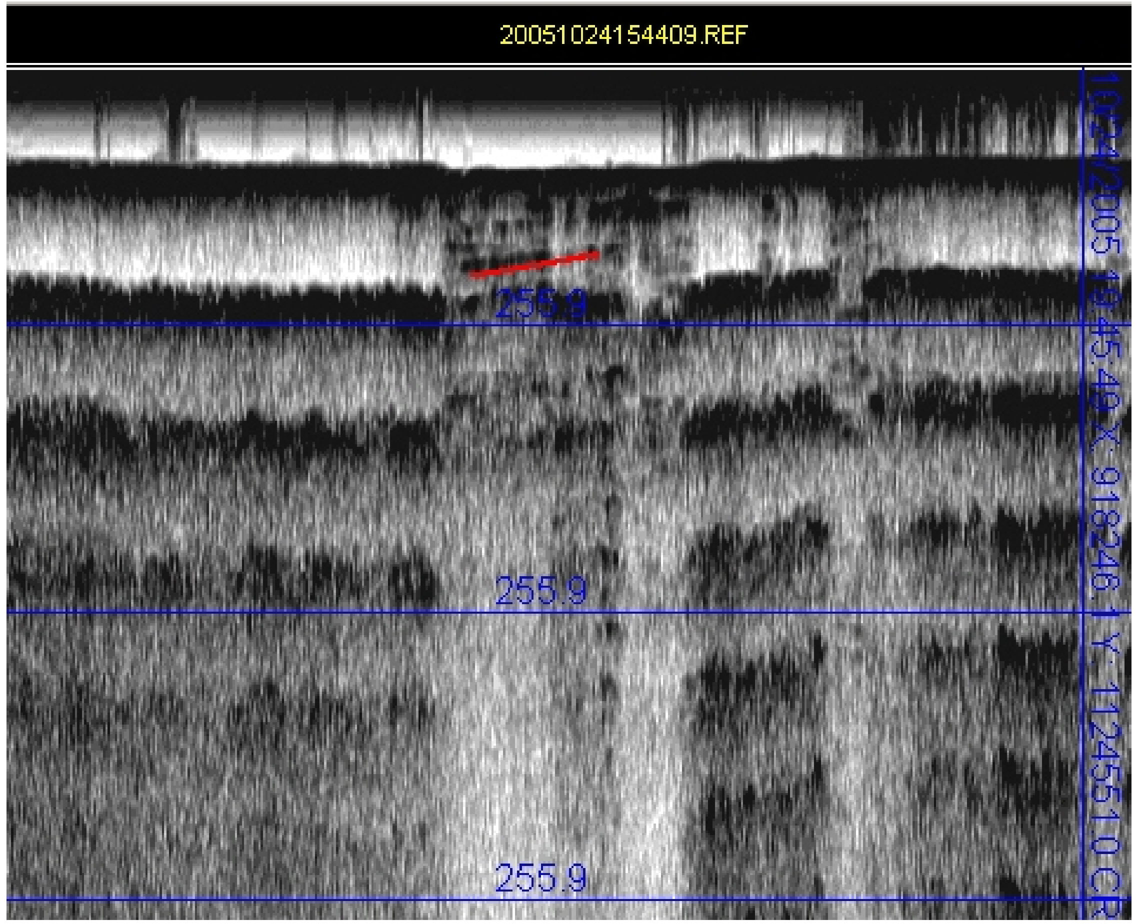


Orthophoto, color indexed bathymetric map and side scan sonar mosaic have been used as background data to provide spatial reference



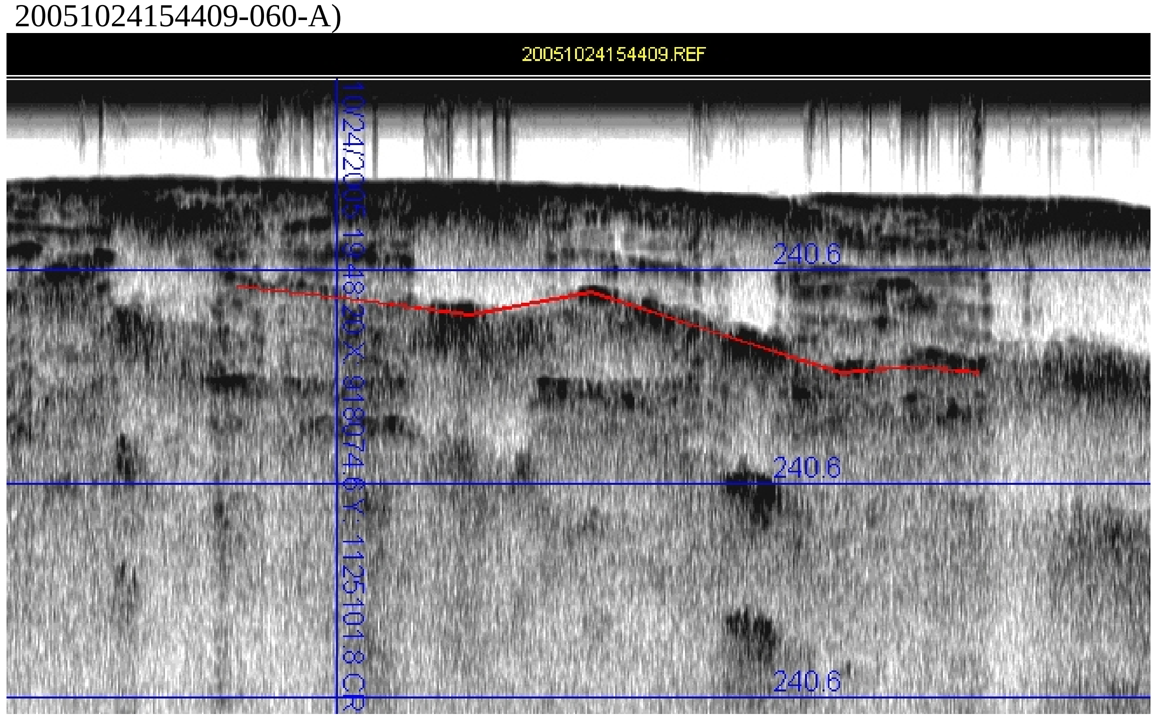
NORTH **SOUTH**

PROFILE 1 - FILE 20051024152206: 240 foot long segment of sub-bottom record *suggests* 17-23 feet of layered overburden material



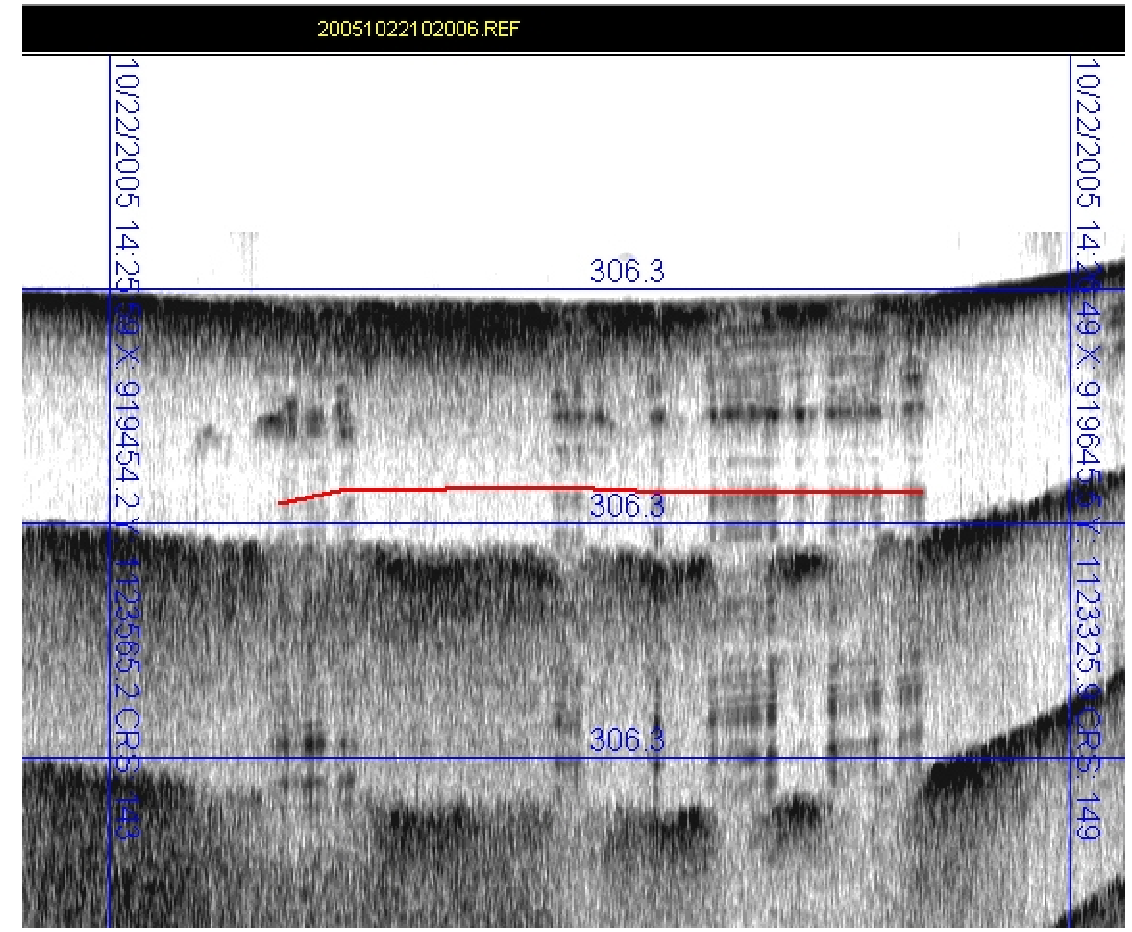
NORTHWEST **SOUTHEAST**

PROFILE 2 (S) - FILE 20051024154409: 30 foot long segment of sub-bottom record *suggests* 7 feet of overburden material. (South of two depicted line segments for file 20051024154409-060-A)



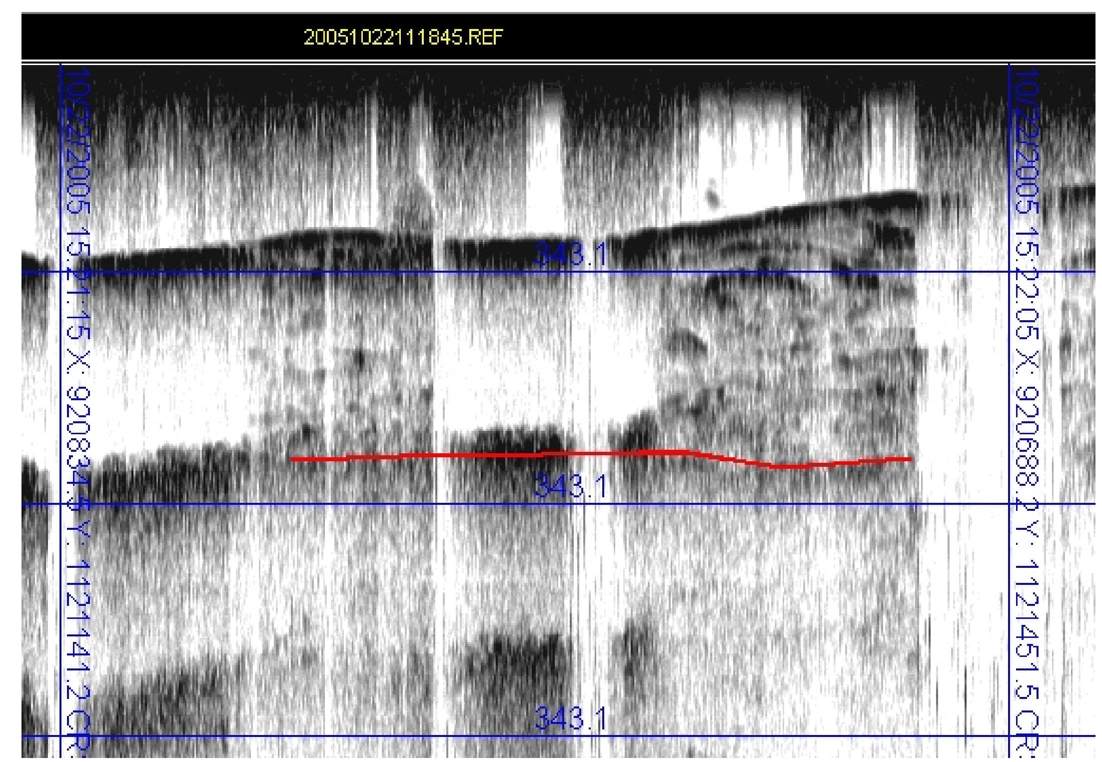
SOUTH **NORTH**

PROFILE 2 (N) - FILE 20051024154409: 197 foot long segment of sub-bottom record *suggests* 10-16 feet of stratified overburden material. (North of two depicted line segments for file 20051024154409-060-A)



NORTHWEST **SOUTHEAST**

PROFILE 3 - FILE 20051022102006: 205 foot long segment of sub-bottom record *suggests* 17 **f**eet of stratified overburden material

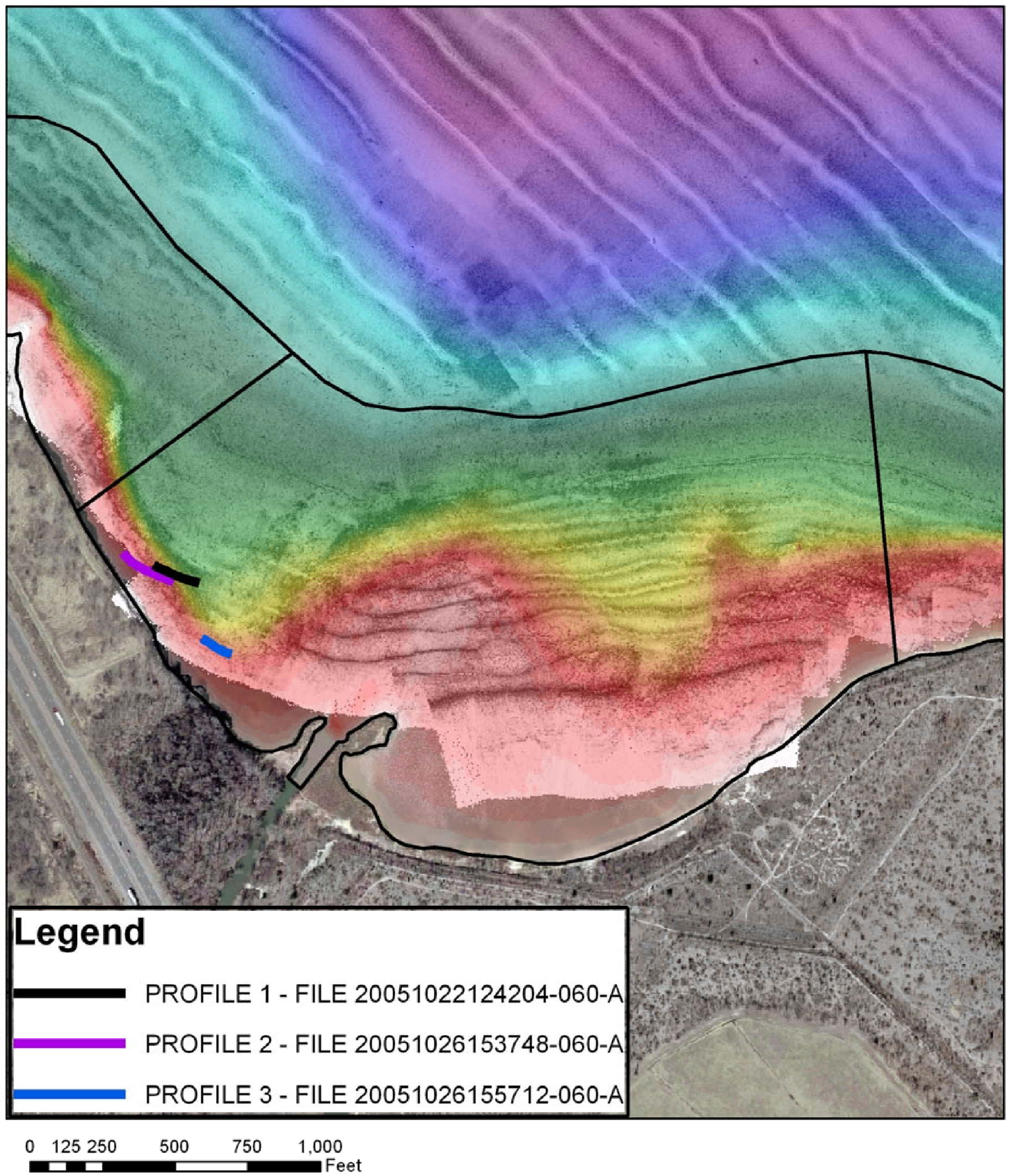


SOUTHEAST **NORTHWEST**

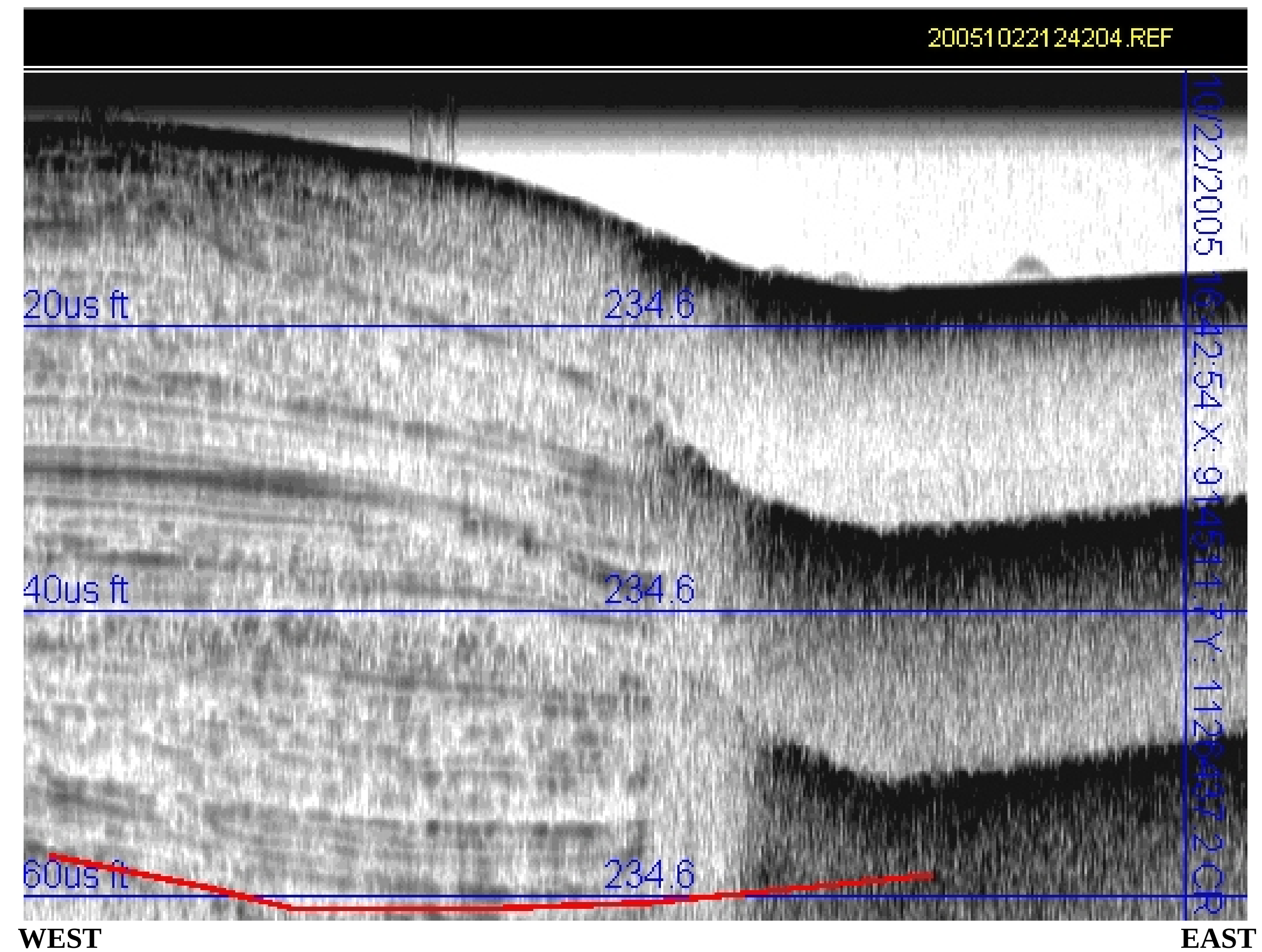
PROFILE 4 - FILE 20051022111845: 205 foot long segment of sub-bottom record *suggests* 20-22 feet of mixed overburden material

APPENDIX A-4

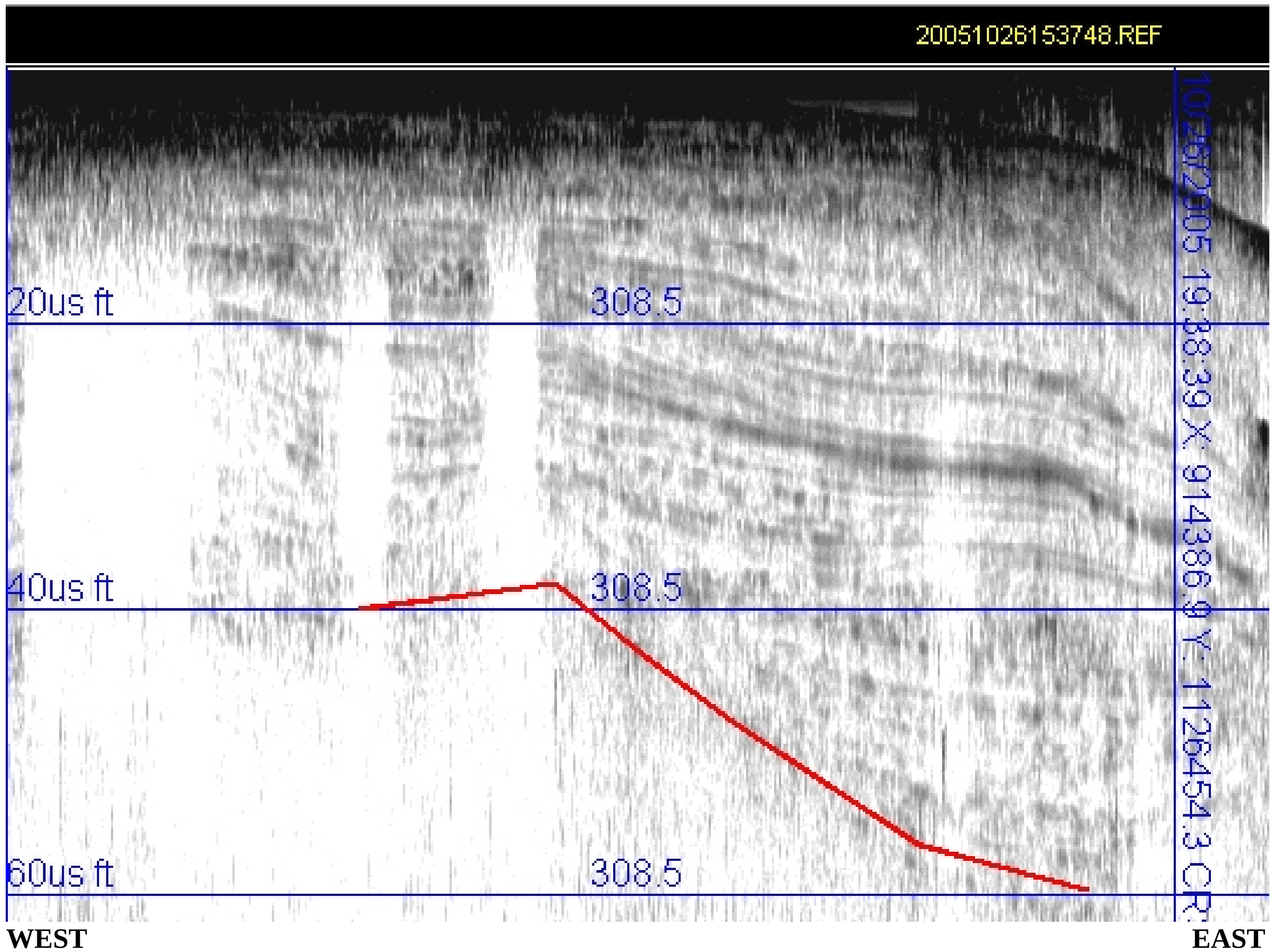
INDEX TO SAMPLE SUB-BOTTOM SONAR PROFILES
ONONDAGA LAKE
SMU 4



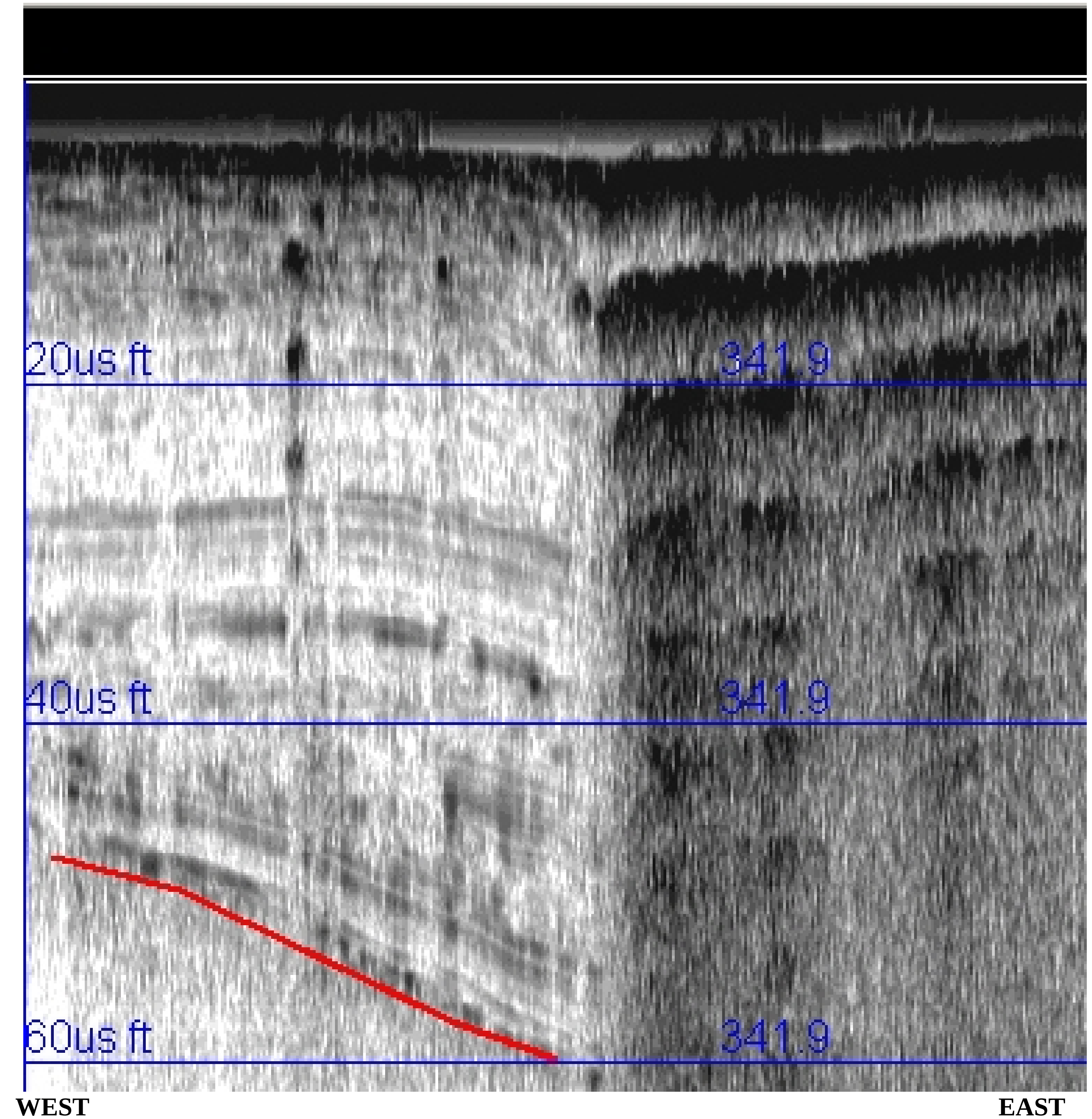
Orthophoto, color indexed bathymetric map and side scan sonar mosaic have been used as background data to provide spatial reference



PROFILE 1 - FILE 20051022124204: 195 foot long segment of sub-bottom record *suggests* 55-60 feet of layered overburden material.



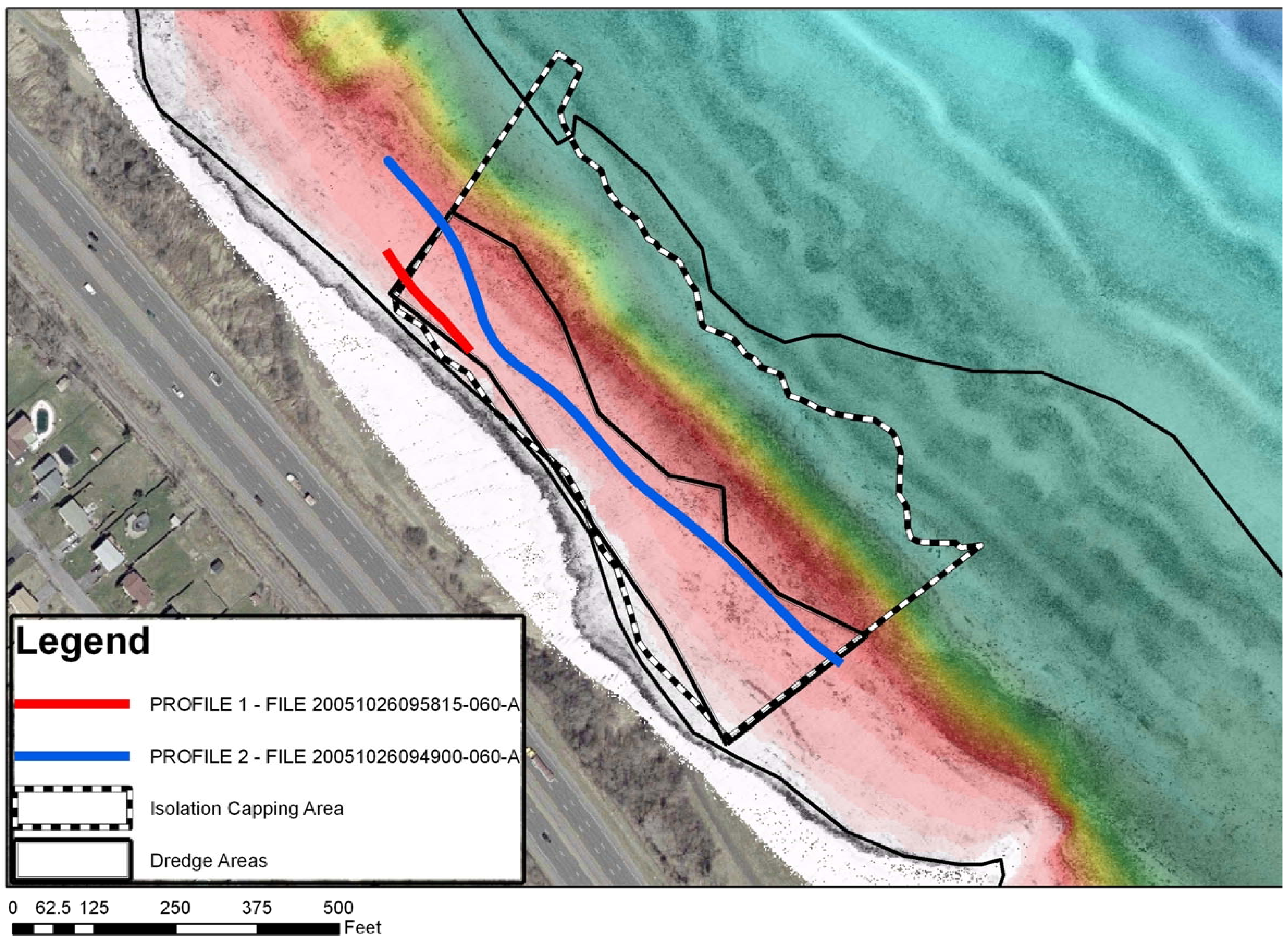
PROFILE 2 - FILE 20051026153748: 205 foot long segment of sub-bottom record *suggests* 35-52 feet of layered overburden material



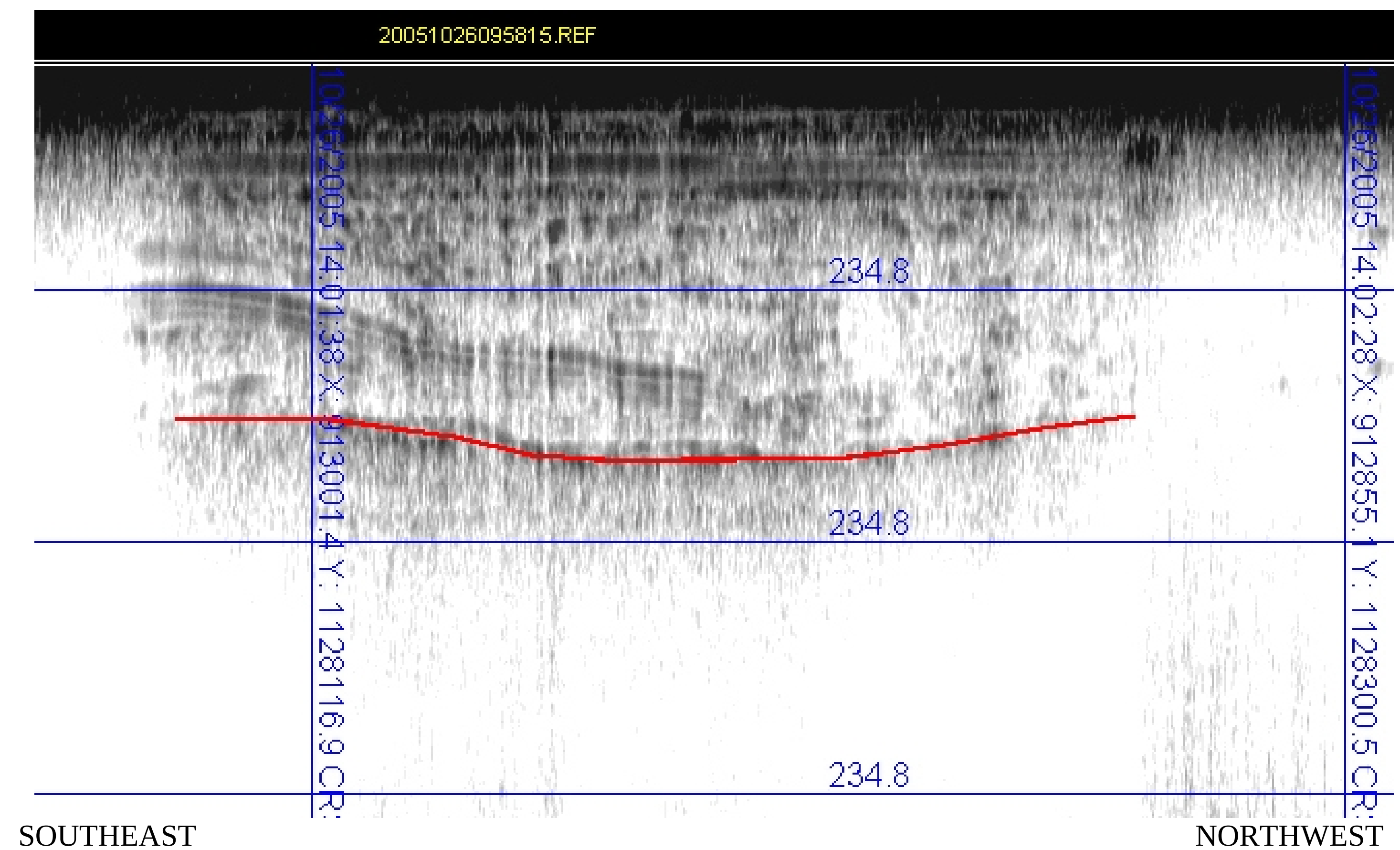
PROFILE 3 - FILE 20051026155712: 115 foot long segment of sub-bottom record suggests as much as 60 feet of stratified overburden material. The right hand side of the record depicts typical data for SMU4, with negligible penetration and strong multiple returns

APPENDIX A-5A

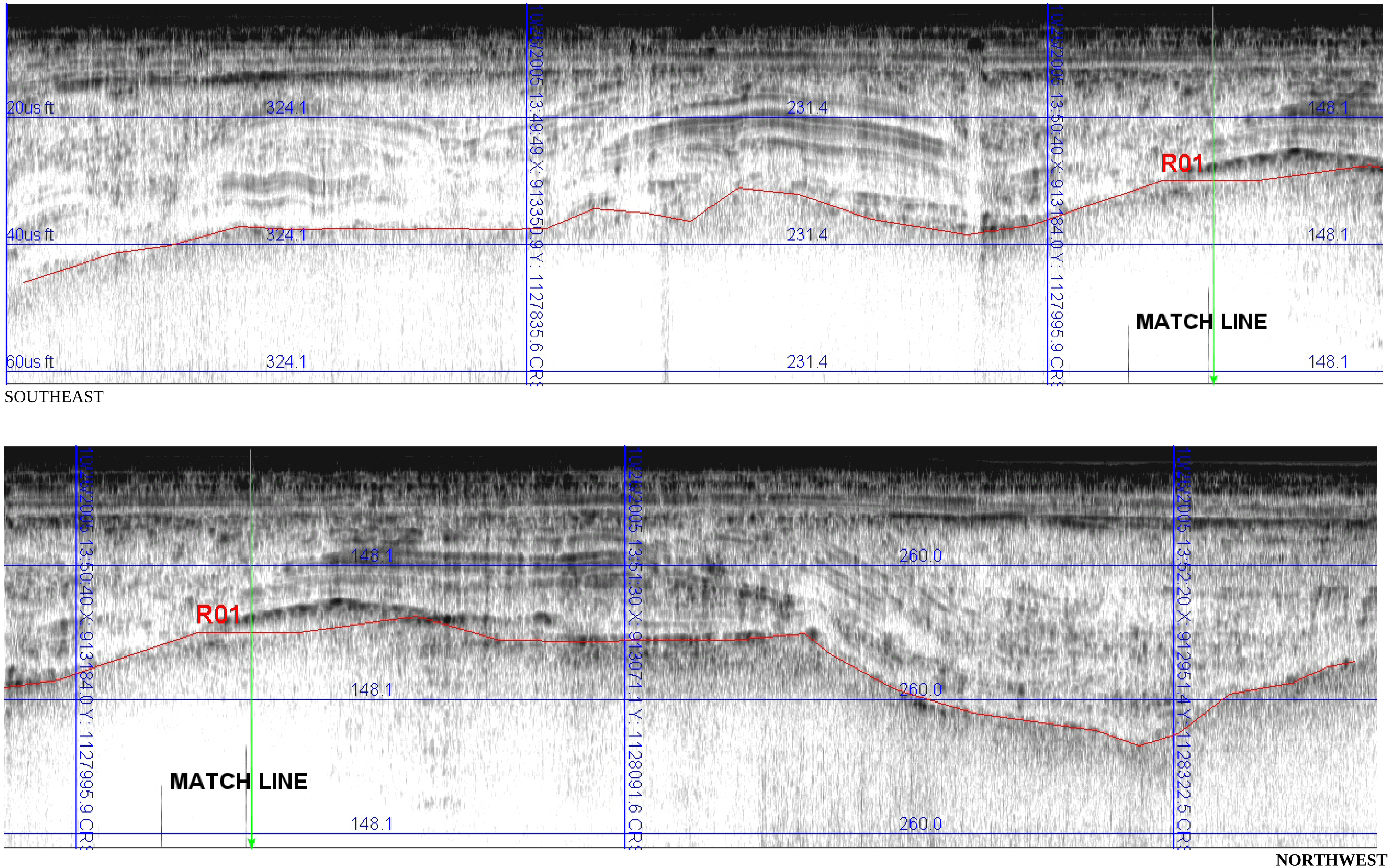
INDEX TO SAMPLE SUB-BOTTOM PROFILES
ONONDAGA LAKE
SMU 5, AREA A (Western Shore)



Orthophoto, color indexed bathymetric map and side scan sonar mosaic have been used as background data to provide spatial reference



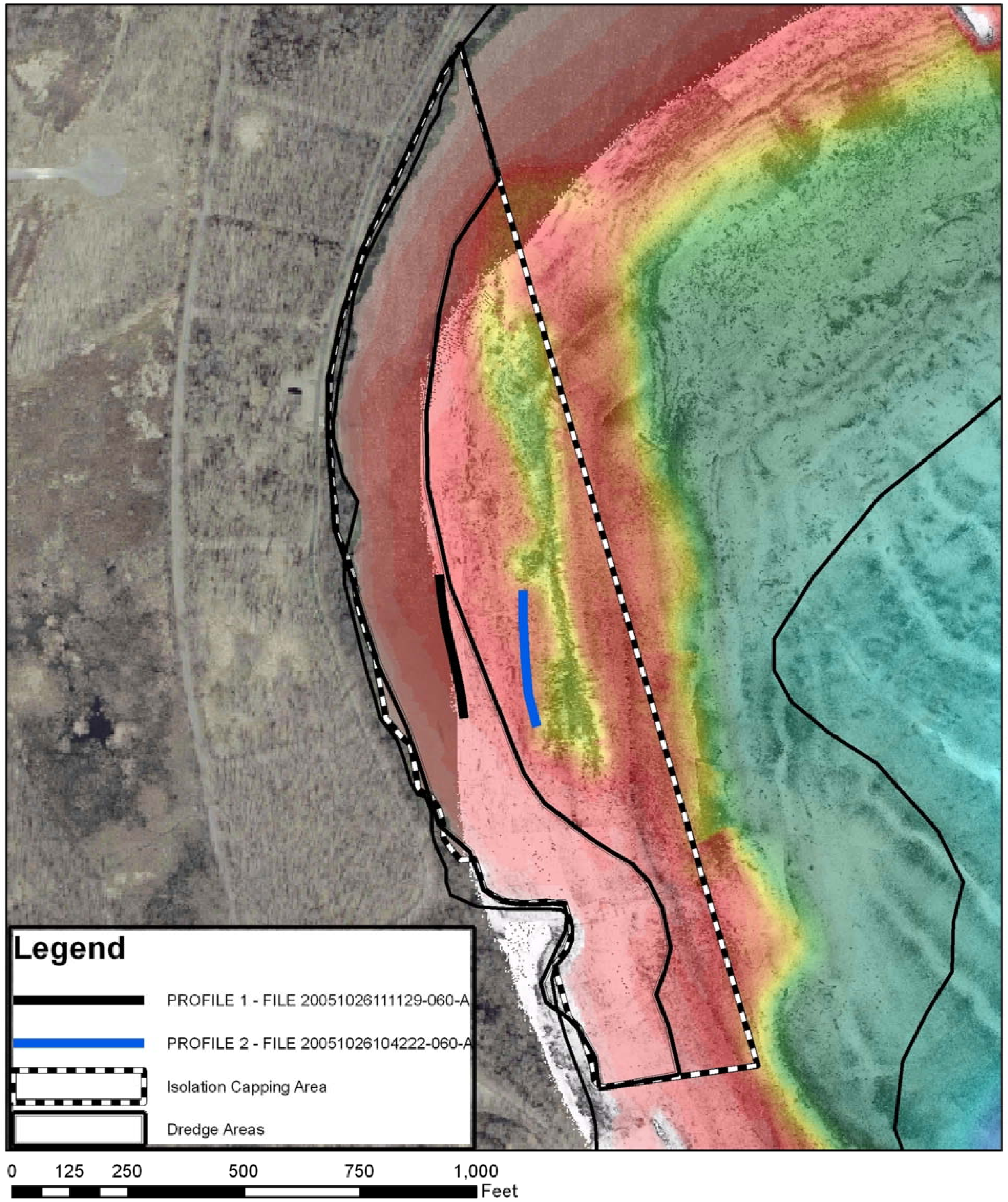
PROFILE 1 - FILE 20051026095815: 205 foot long segment of sub-bottom record suggests 29 feet of layered overburden material



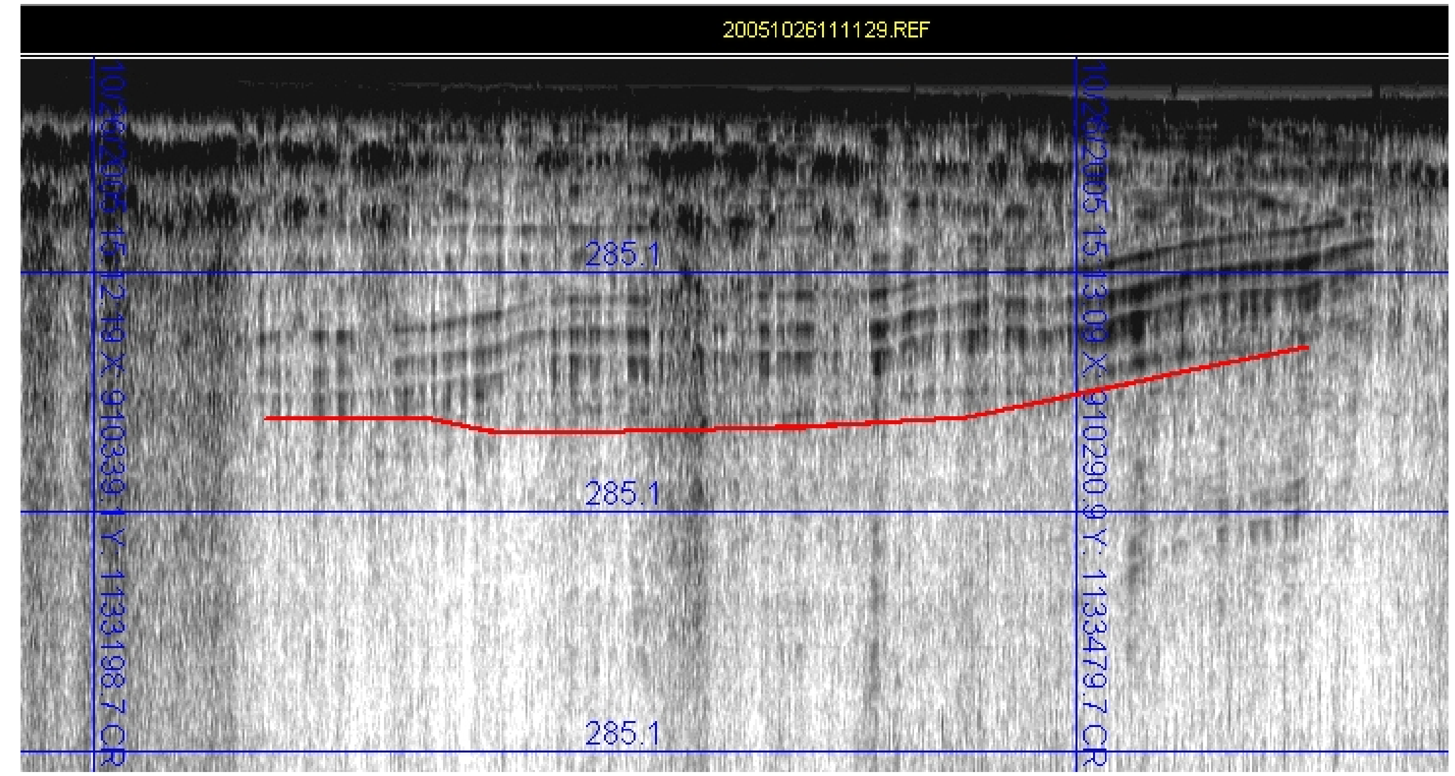
PROFILE 2 - FILE 20051026094900-060-A: 1,065 foot long segment of sub-bottom record suggests 29-42 feet of layered overburden material

APPENDIX A-5B

INDEX TO SAMPLE SUB-BOTTOM SONAR PROFILES
ONONDAGA LAKE
SMU 5 AREA B (Northwestern Shore)

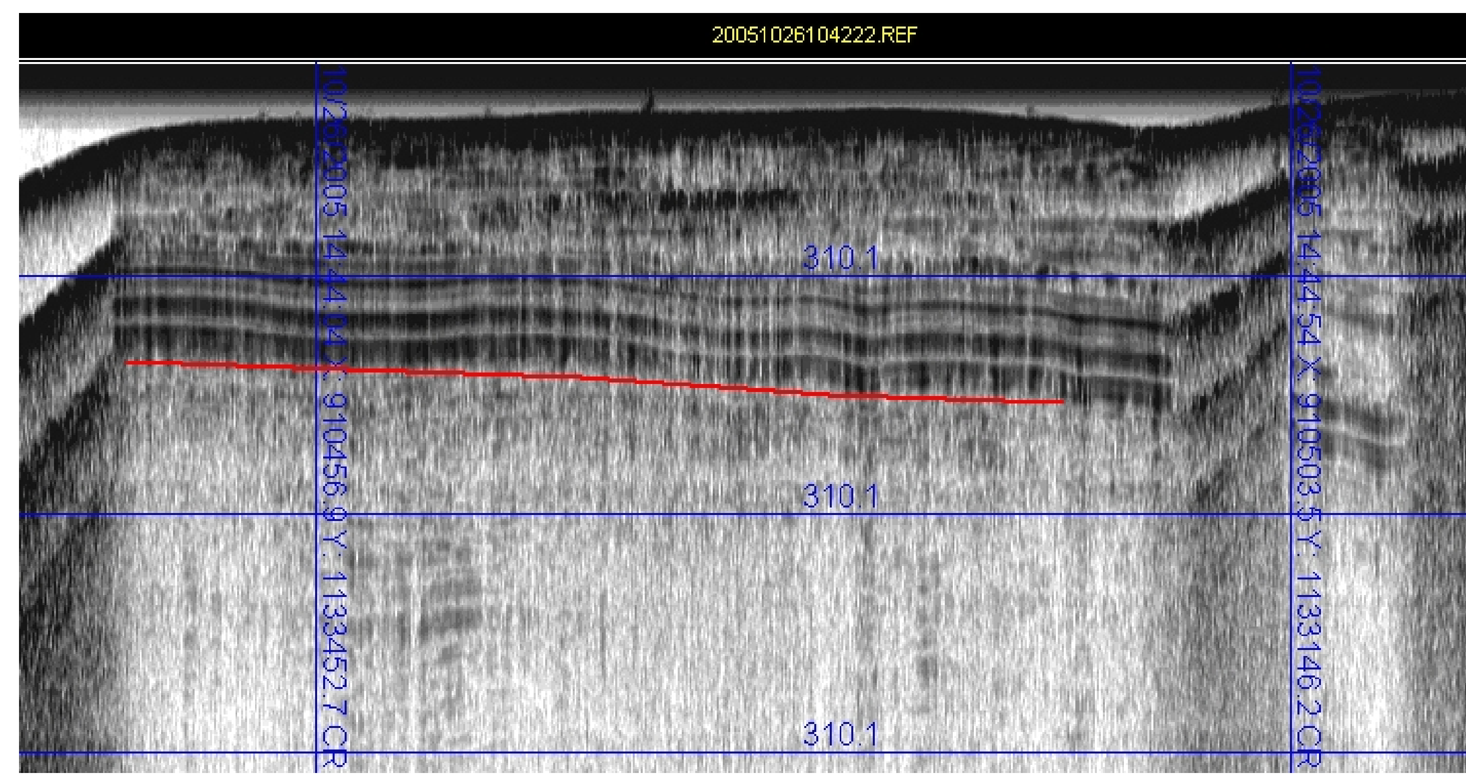


Orthophoto, color indexed bathymetric map and side scan sonar mosaic have been used as background data to provide spatial reference



SOUTH NORTH

PROFILE 1 - FILE 20051026111129: 310 foot long segment of sub-bottom record suggests 26-32 feet of layered overburden material

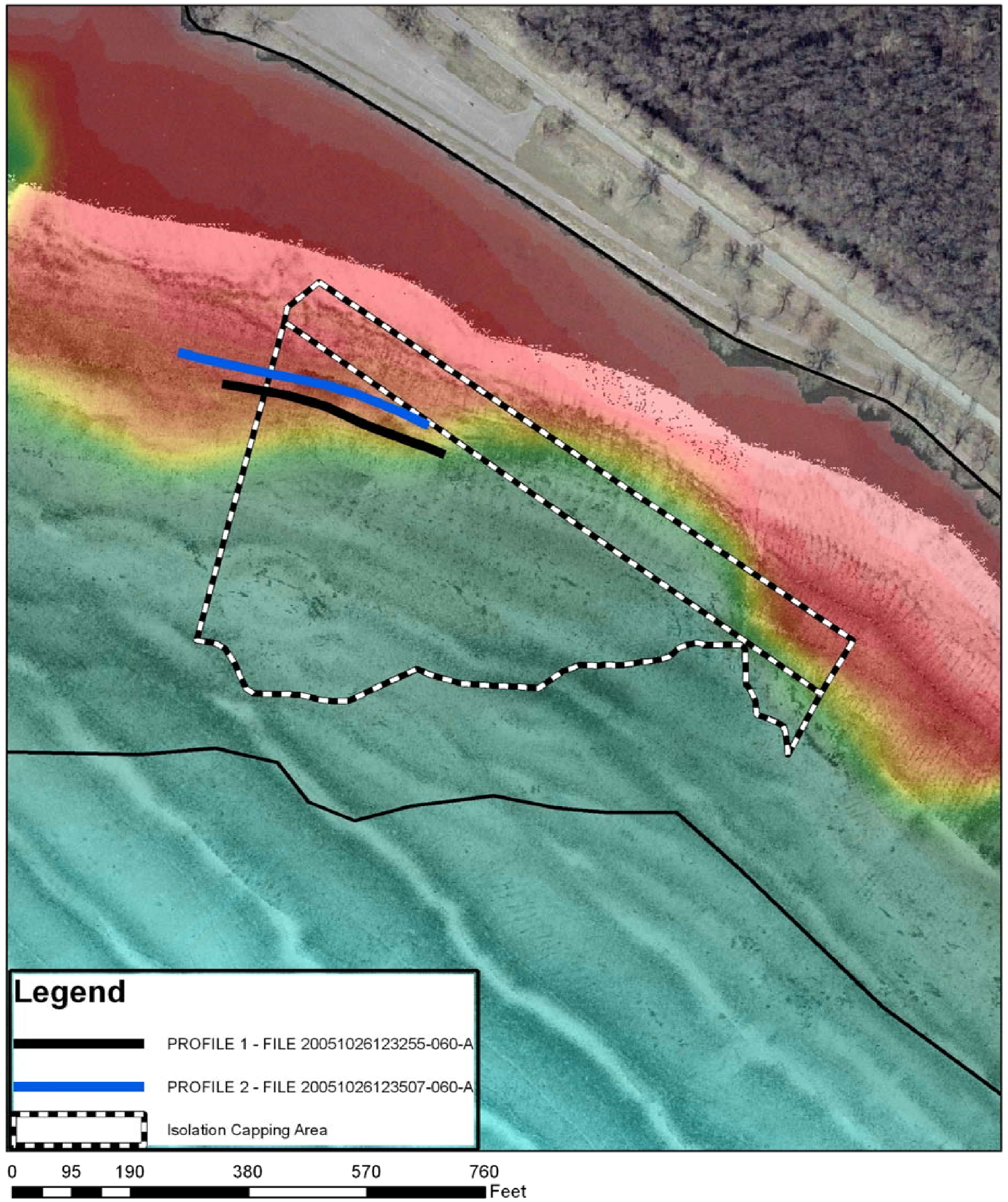


NORTH SOUTH

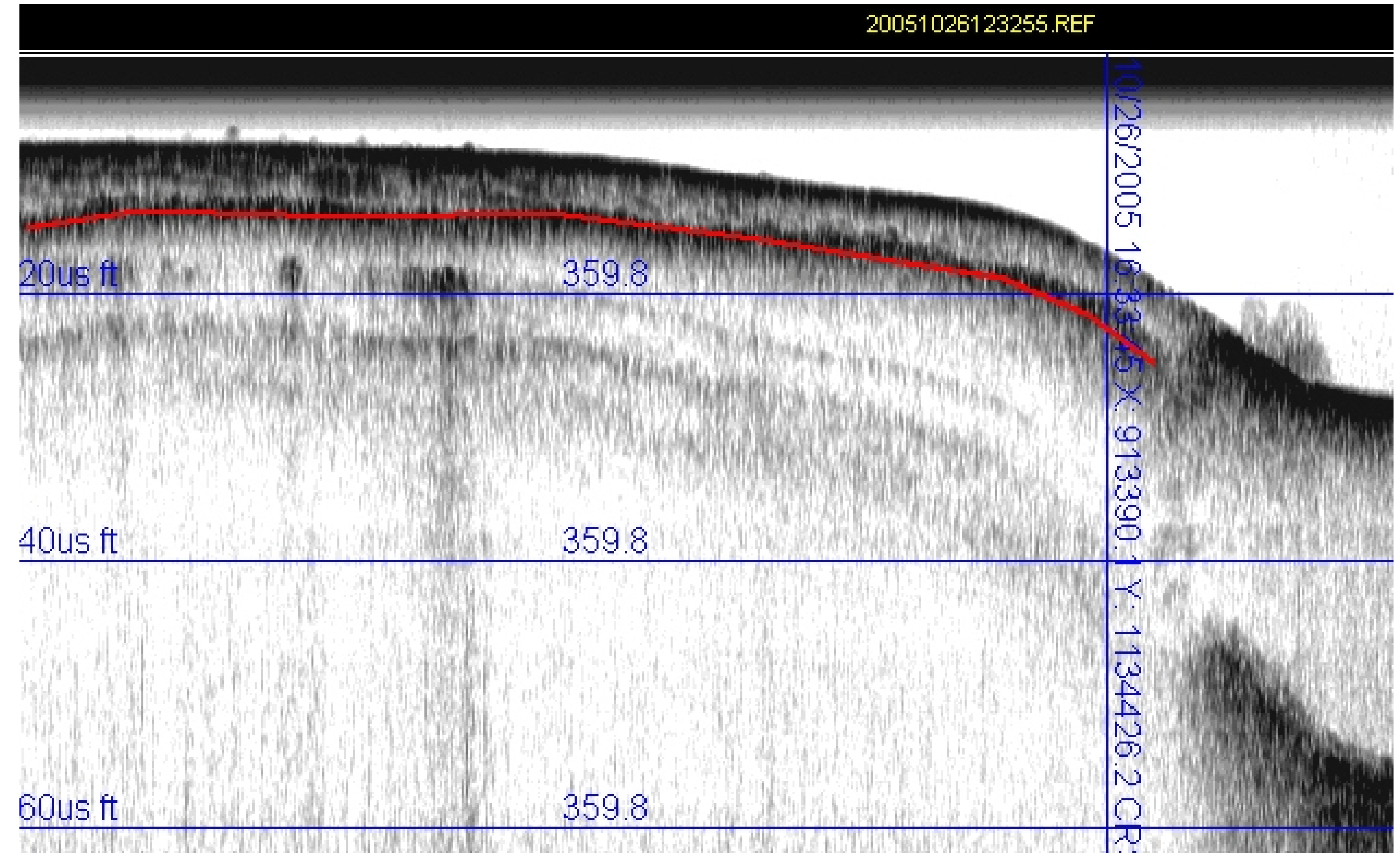
PROFILE 2 - FILE 20051026104222: 305 foot long segment of sub-bottom record suggests 19-23 feet of layered overburden material

APPENDIX A-5C

INDEX TO SAMPLE SUB-BOTTOM SONAR PROFILES
ONONDAGA LAKE
SMU-5, AREA C (Northeastern Shore)

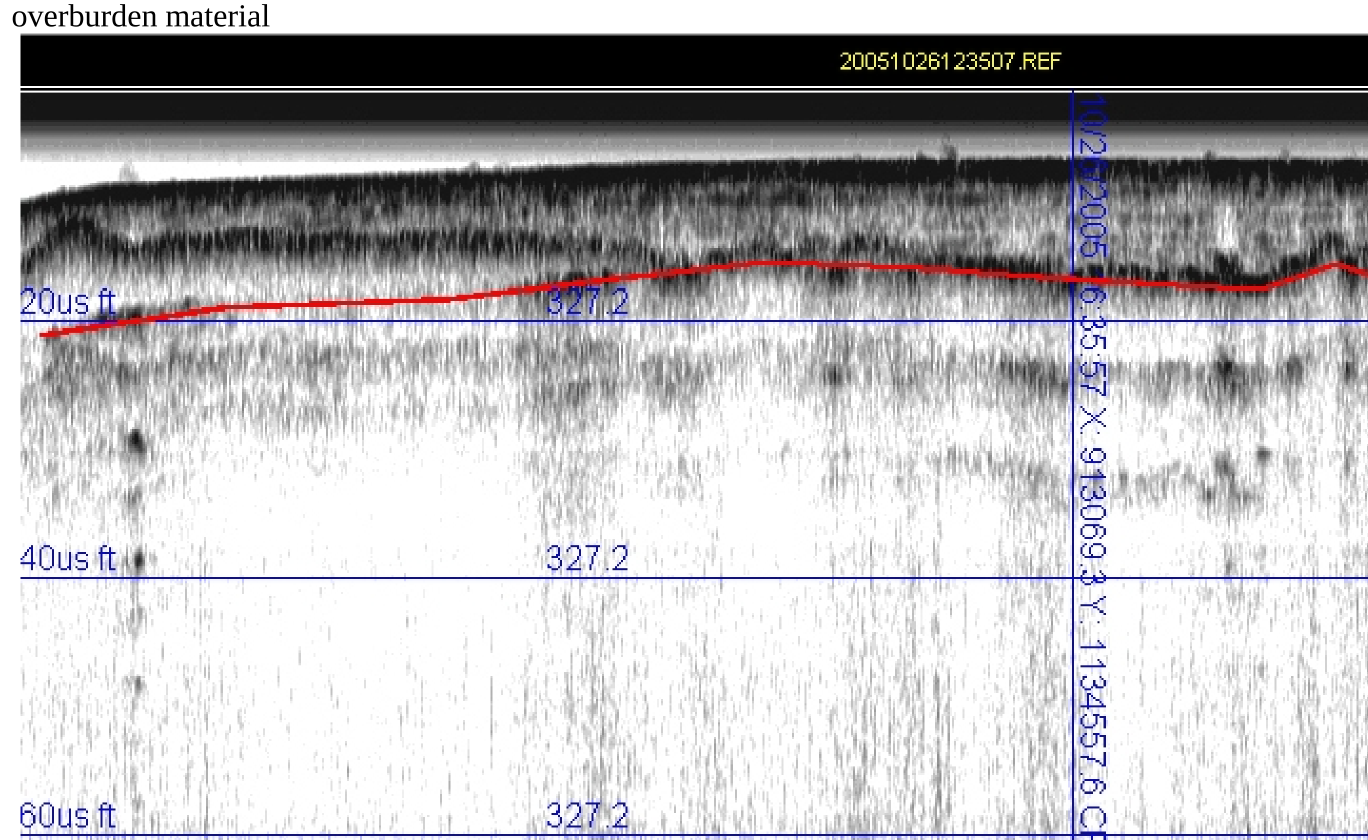


Orthophoto, color indexed bathymetric map and side scan sonar mosaic have been used as background data to provide spatial reference



EAST **WEST**

PROFILE 1 - FILE 20051026123255: 425 foot long segment of sub-bottom record suggests 7-9 feet of overburden material

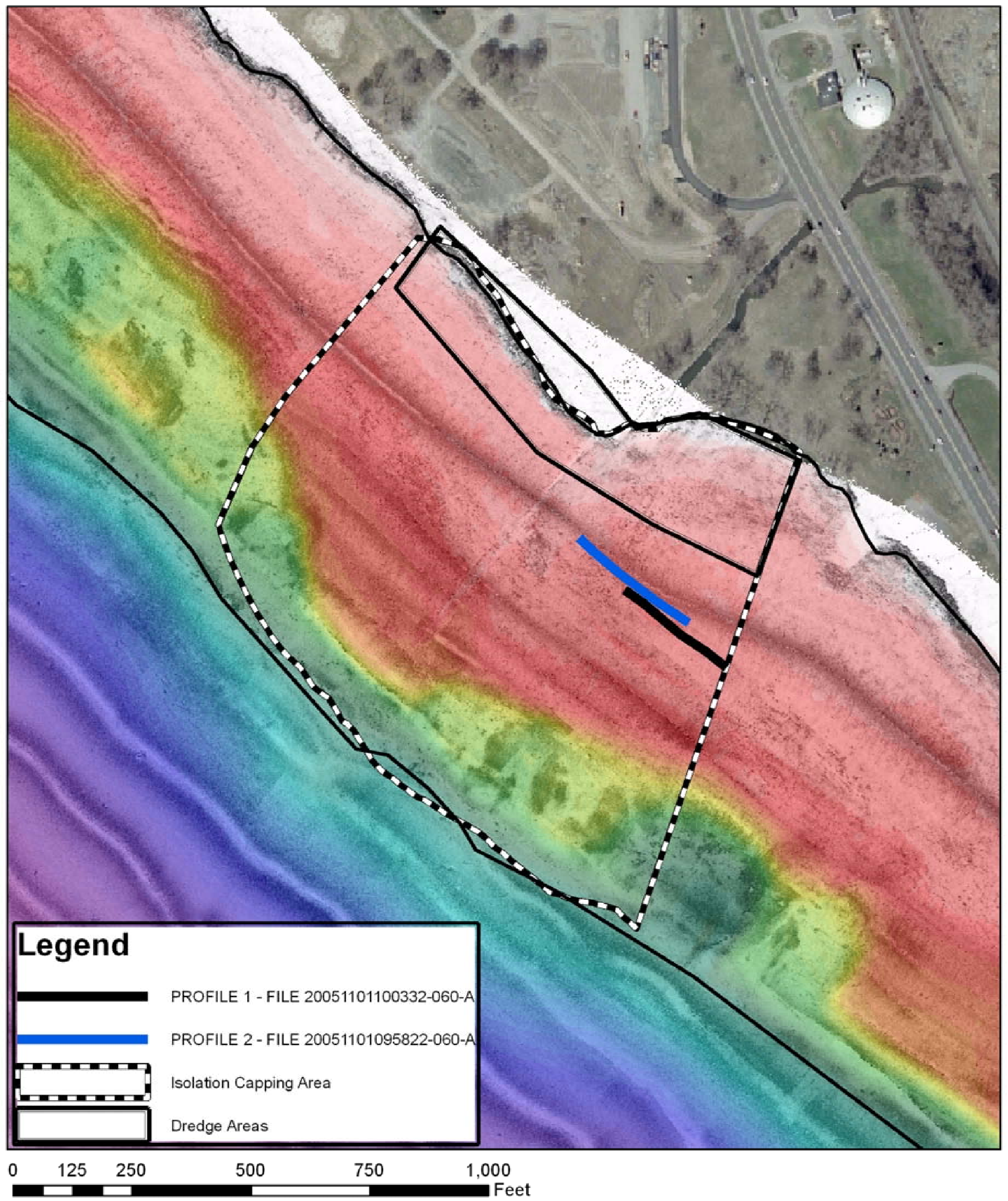


WEST **EAST**

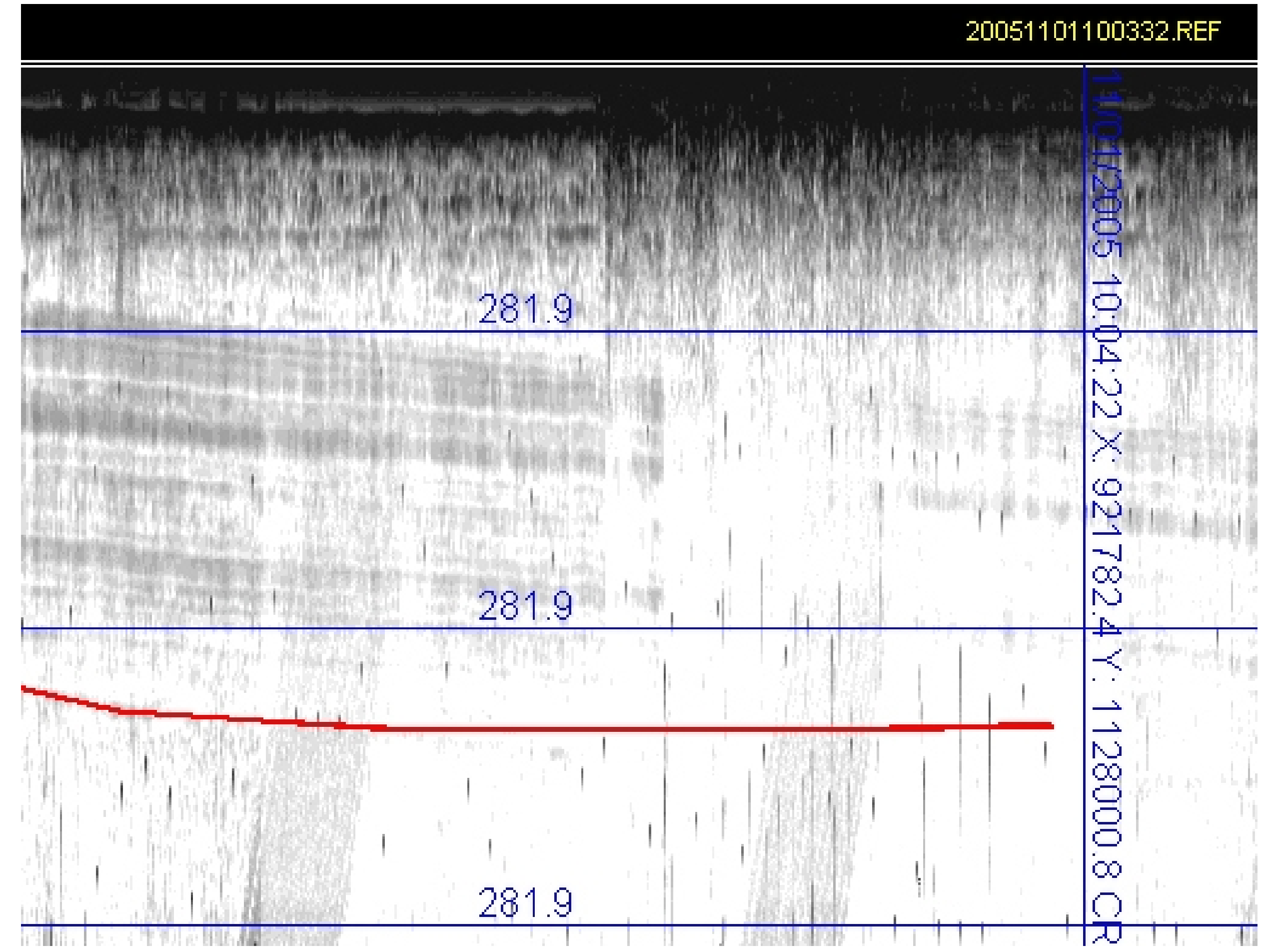
PROFILE 2 - FILE 20051026123507: 375 foot long segment of sub-bottom record suggests 5-7 feet of overburden material

APPENDIX A-5D

INDEX TO SAMPLE SUB-BOTTOM SONAR PROFILES
ONONDAGA LAKE
SMU 5, AREA D (Eastern Shore)

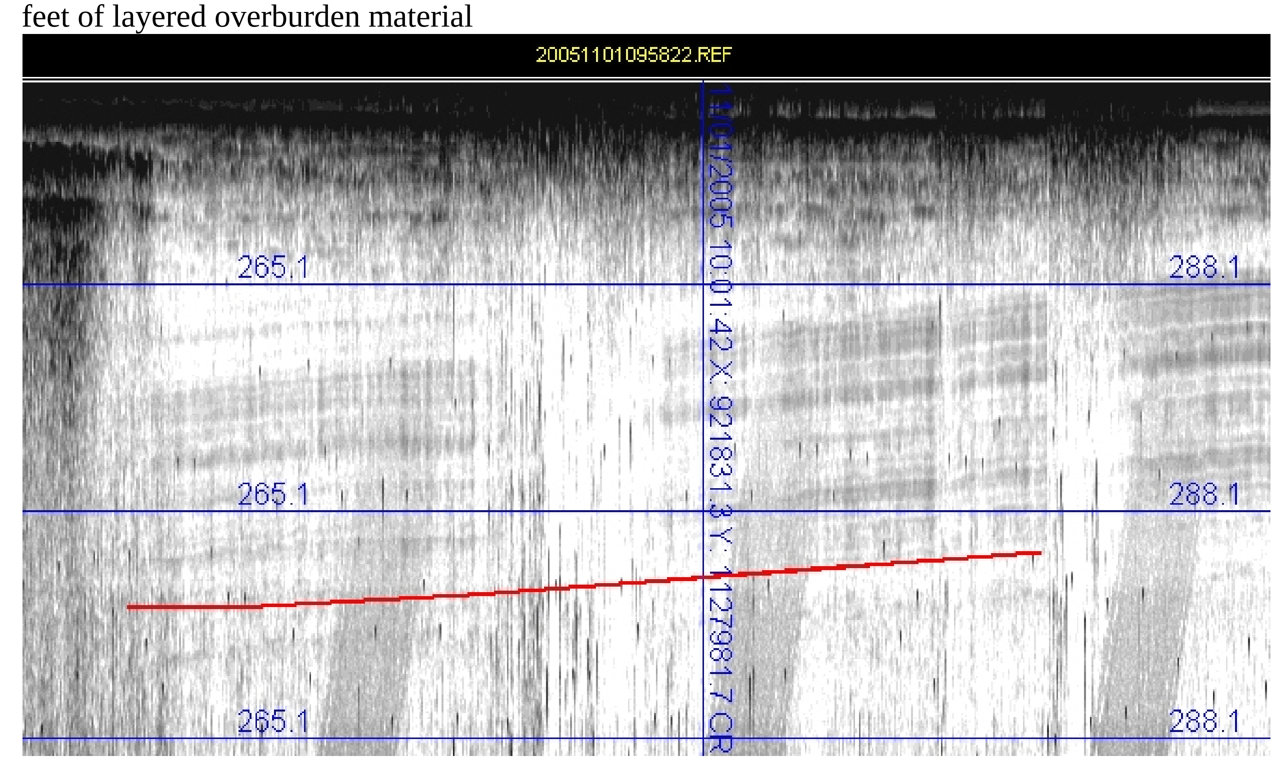


Orthophoto, color indexed bathymetric map and side scan sonar mosaic have been used as background data to provide spatial reference



SOUTHEAST **NORTHWEST**

PROFILE 1 - FILE 20051101100332: 270 foot long segment of sub-bottom record suggests 38-40 feet of layered overburden material

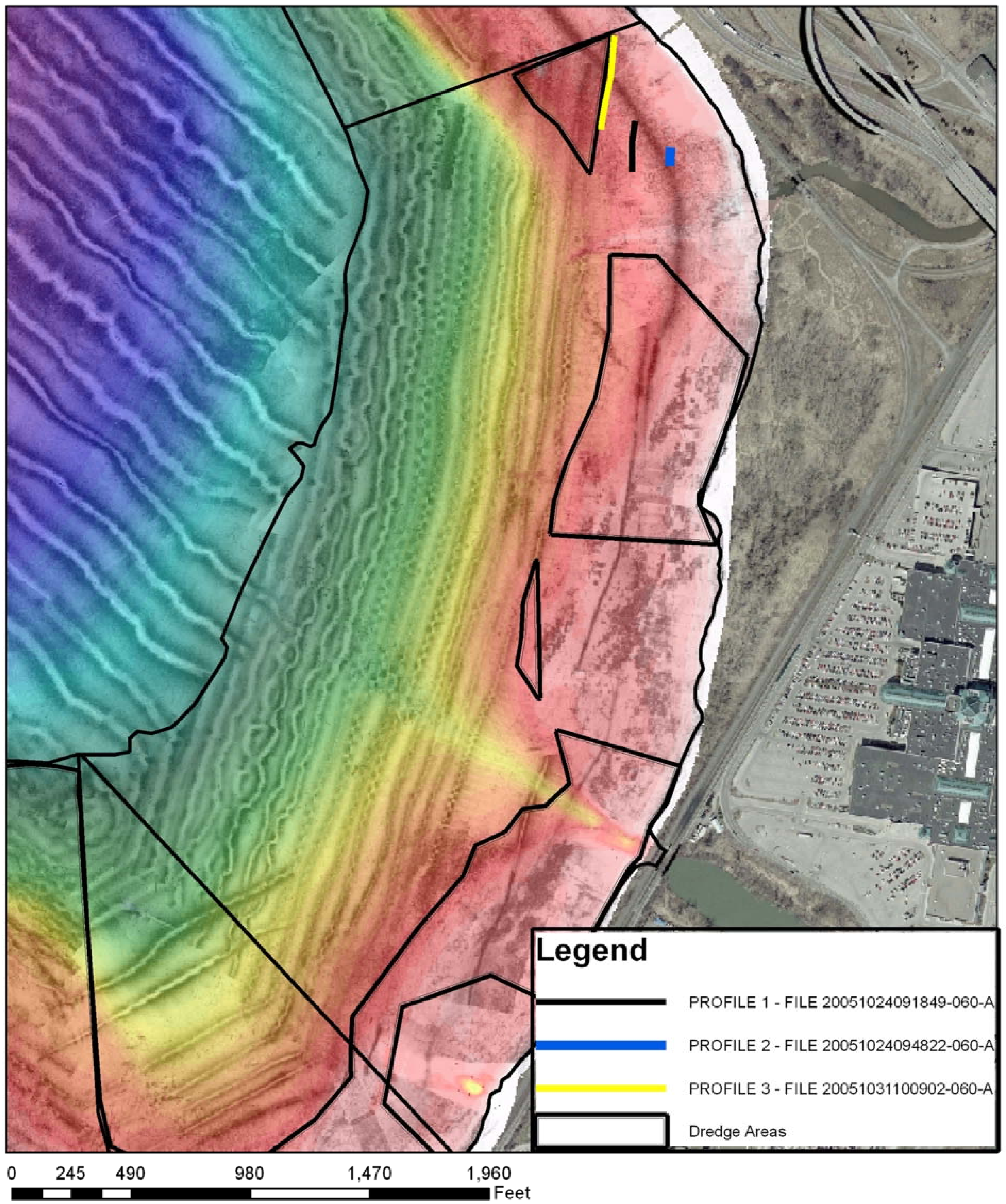


NORTHWEST **SOUTHEAST**

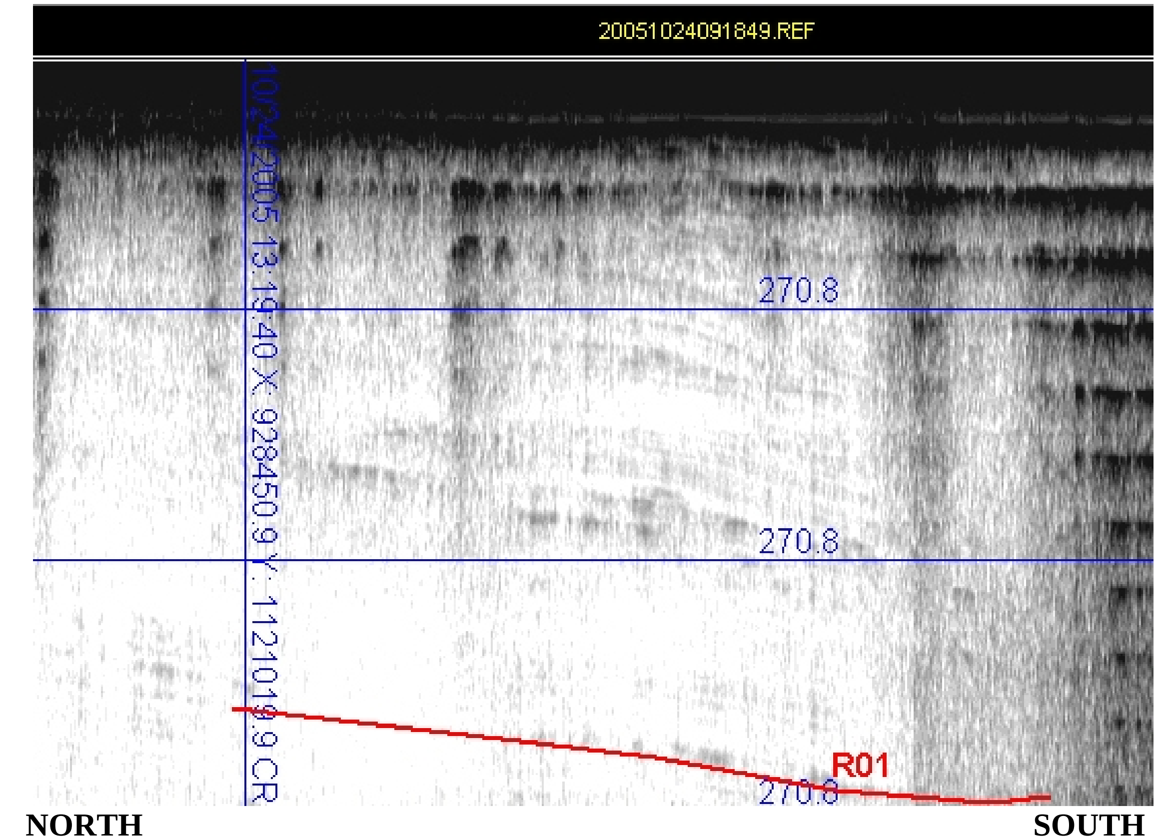
PROFILE 2 - FILE 20051101095822: 375 foot long segment of sub-bottom record suggests 38-43 feet of layered overburden material

APPENDIX A-6

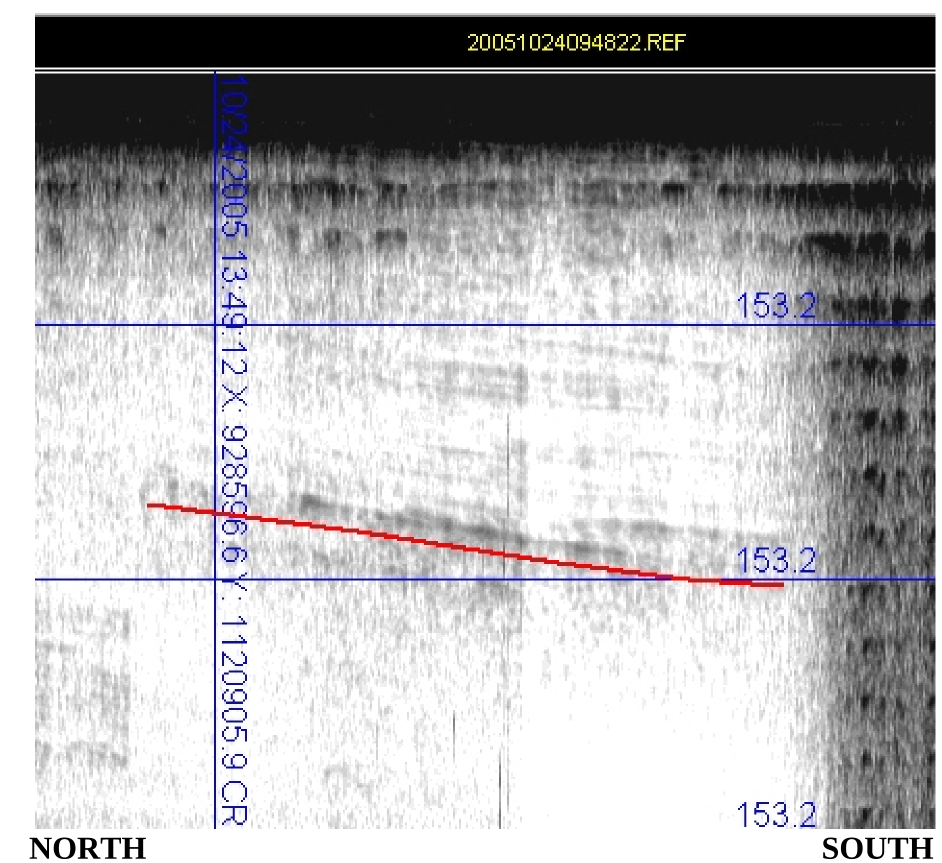
INDEX TO SAMPLE SUB-BOTTOM SONAR PROFILES
ONONDAGA LAKE
SMU 6



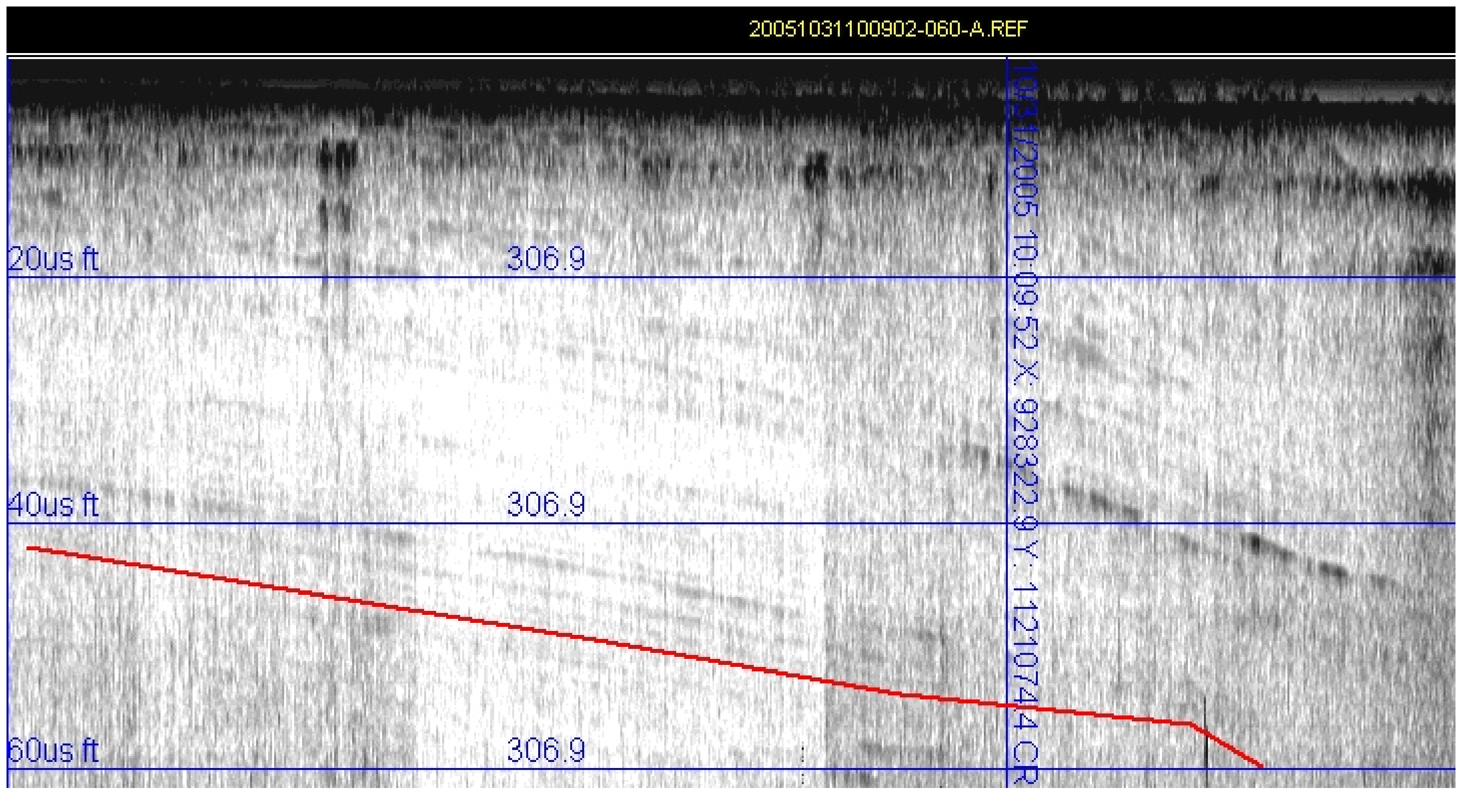
Orthophoto, color indexed bathymetric map and side scan sonar mosaic have been used as background data to provide spatial reference



PROFILE 1 - FILE 20051024091849: 270 foot long segment of sub-bottom record suggests 46-54 feet of layered overburden material (note the abrupt loss of penetration at the right (southern) portion of the record)



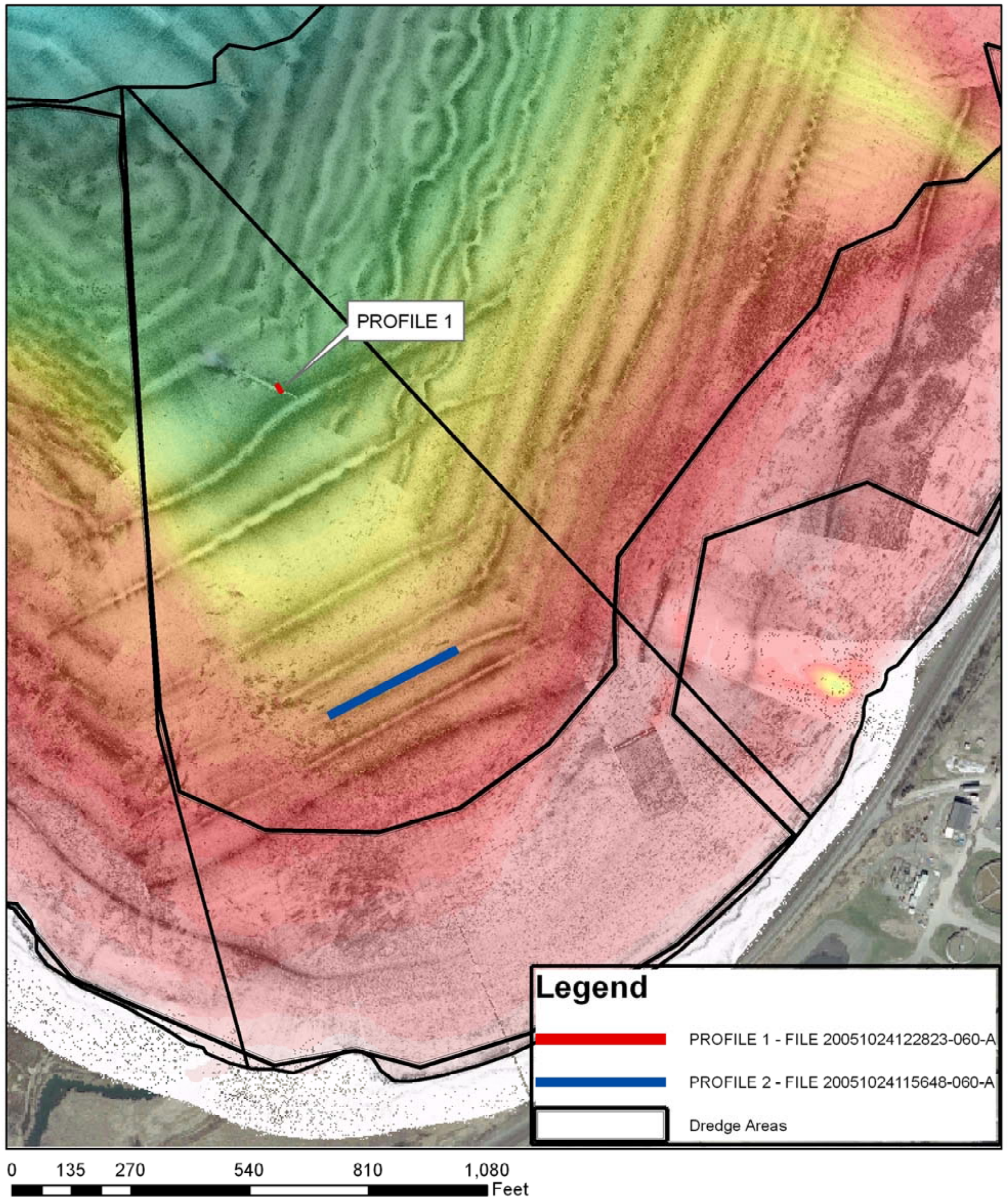
PROFILE 2 - FILE 20051024094822: 80 foot long segment of sub-bottom record suggests 31-37 feet of layered overburden material (note the abrupt loss of penetration at the right (southern) portion of the record)



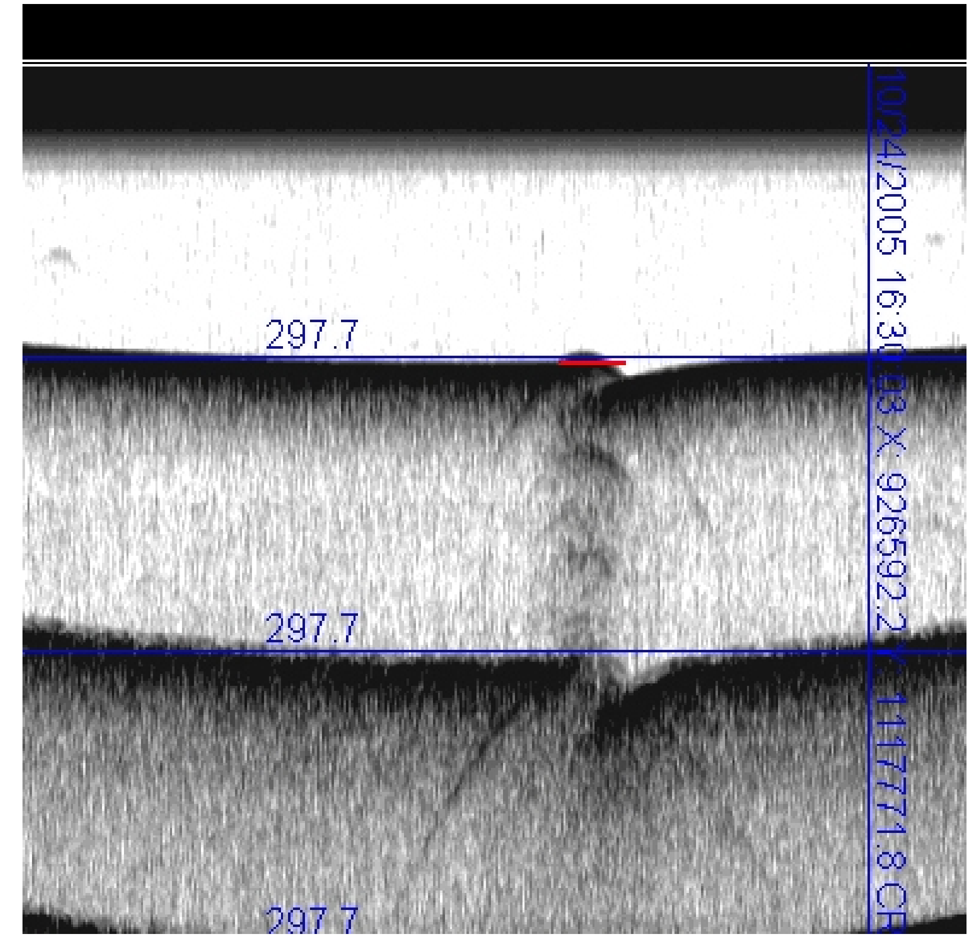
PROFILE 3 - FILE 20051031100902-060-A: 420 foot long segment of sub-bottom record suggests 37-50 feet of layered overburden material (note the abrupt loss of penetration at the right (southern) portion of the record)

APPENDIX A-7

INDEX TO SAMPLE SUB-BOTTOM PROFILES
ONONDAGA LAKE
SMU 7

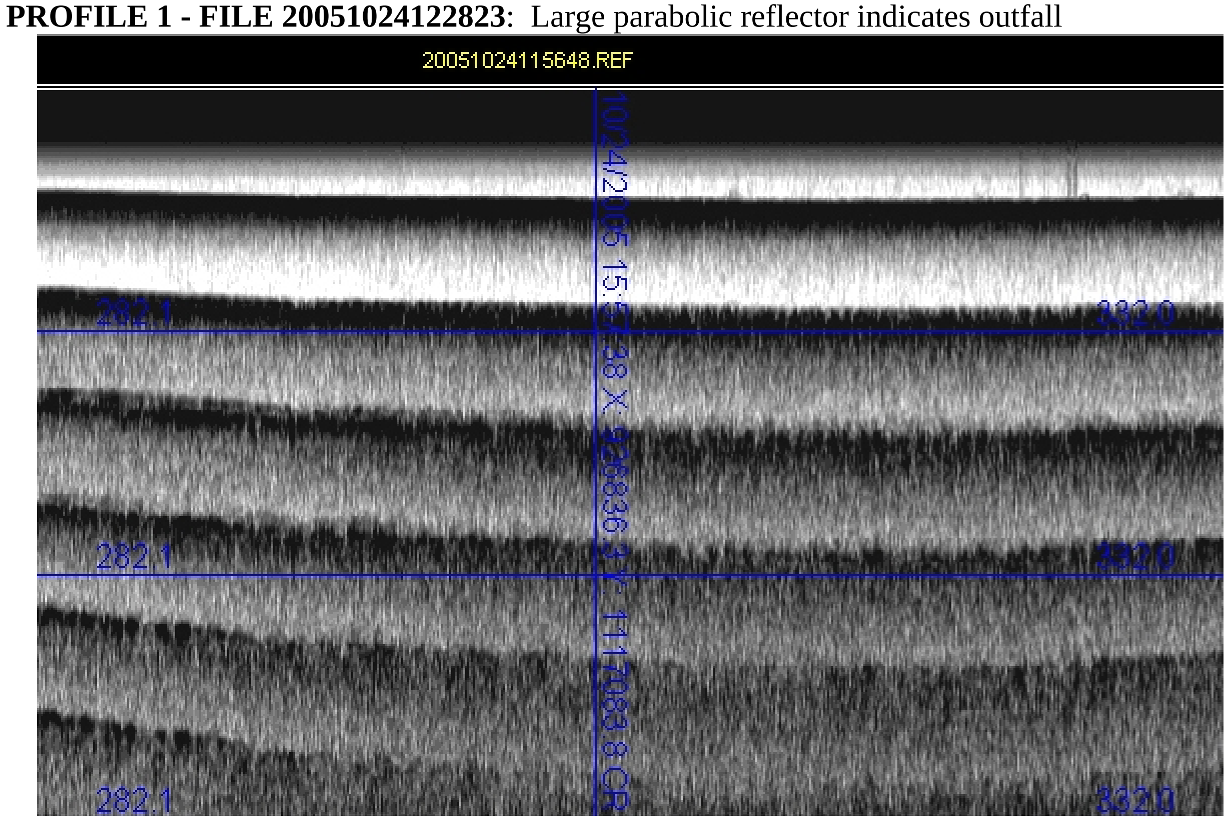


Orthophoto, color indexed bathymetric map and side scan sonar mosaic have been used as background data to provide spatial reference



SOUTHWEST **NORTHEAST**

PROFILE 1 - FILE 20051024122823: Large parabolic reflector indicates outfall

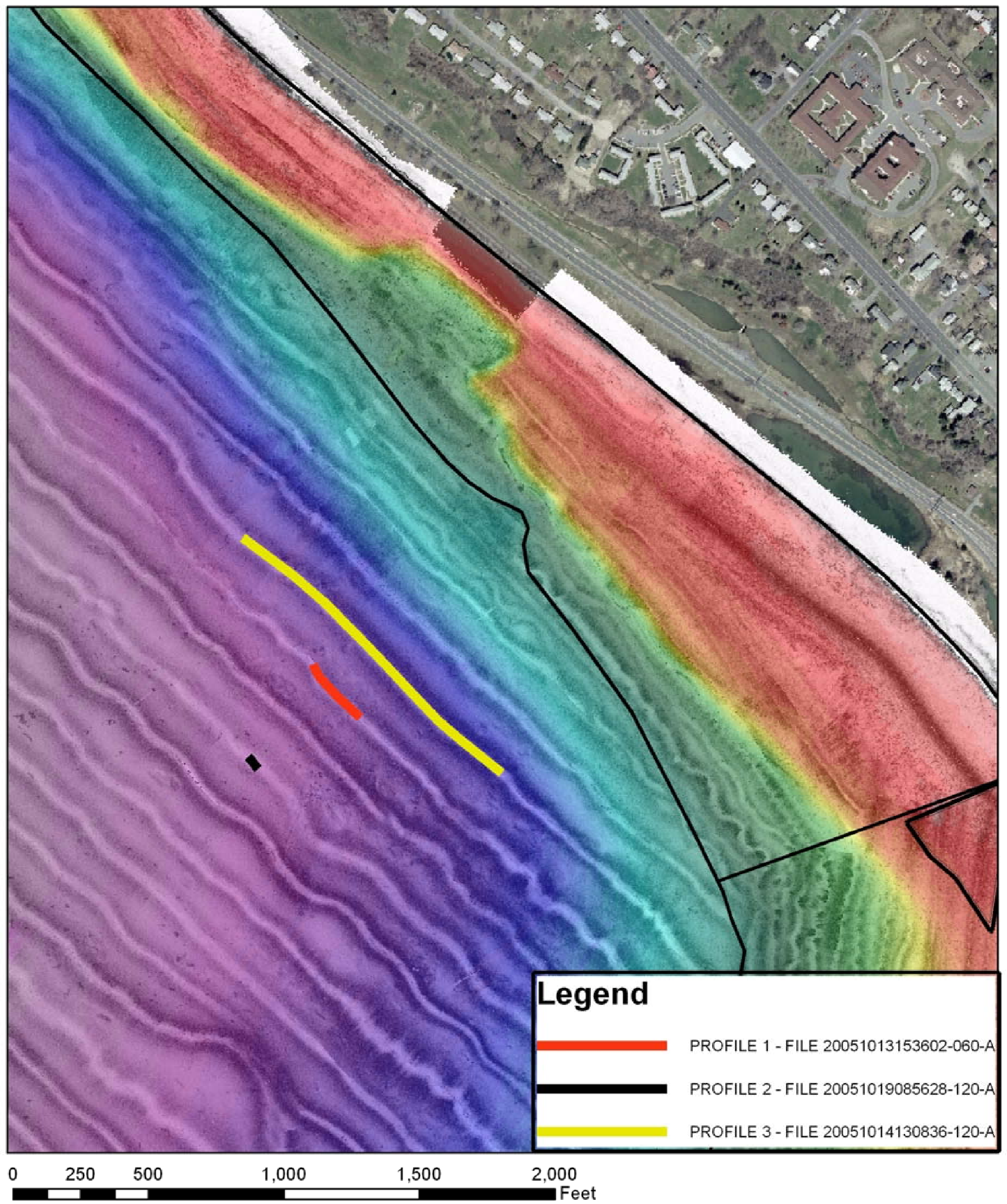


SOUTHWEST **NORTHEAST**

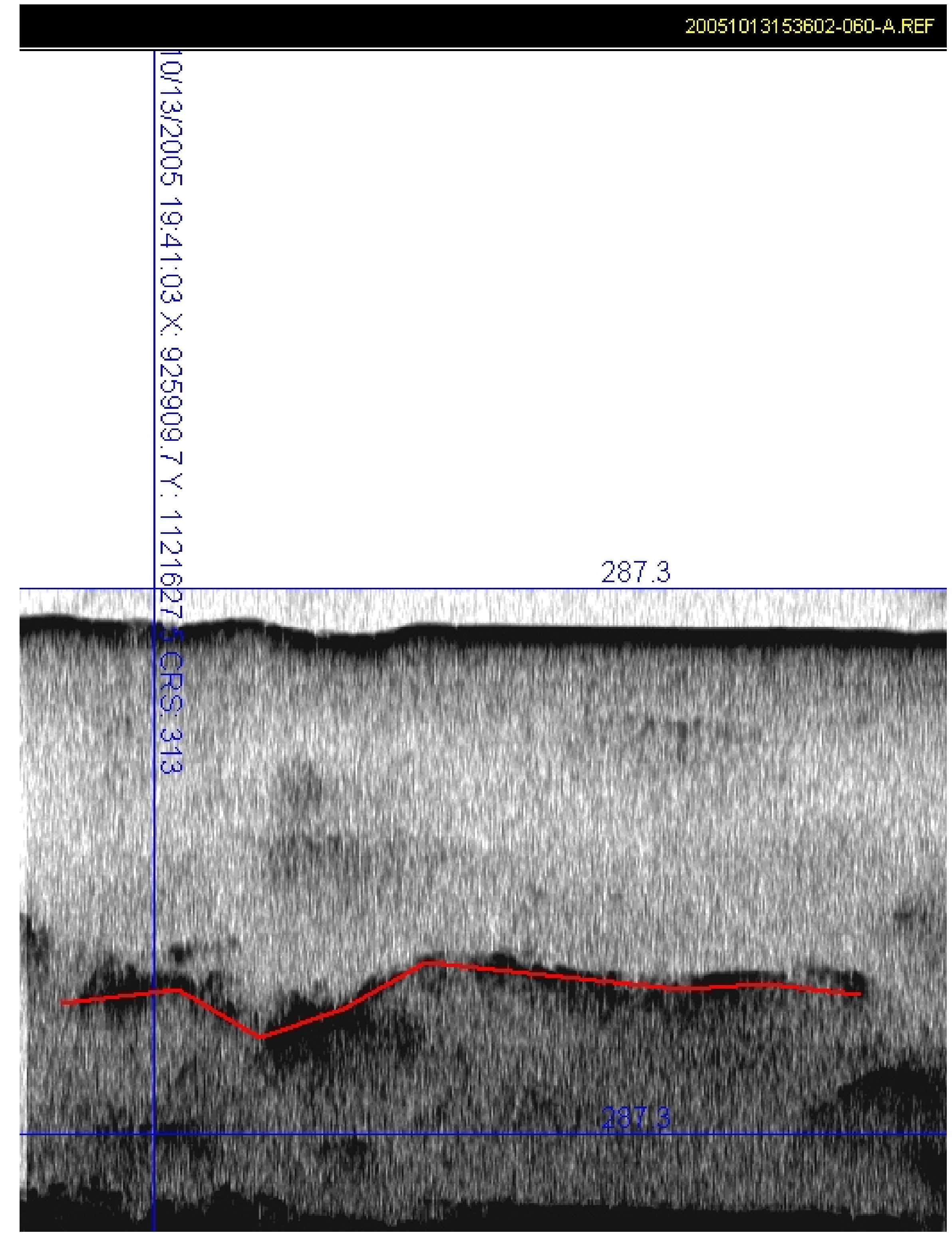
PROFILE 2 - FILE 20051024115648: Typical sub-bottom record for SMU 7. The sonar signal did not penetrate the sediment. The record above depicts the sediment surface and five multiple returns.

APPENDIX A-8

INDEX TO SUB-BOTTOM SONAR PROFILES
ONONDAGA LAKE
SMU 8

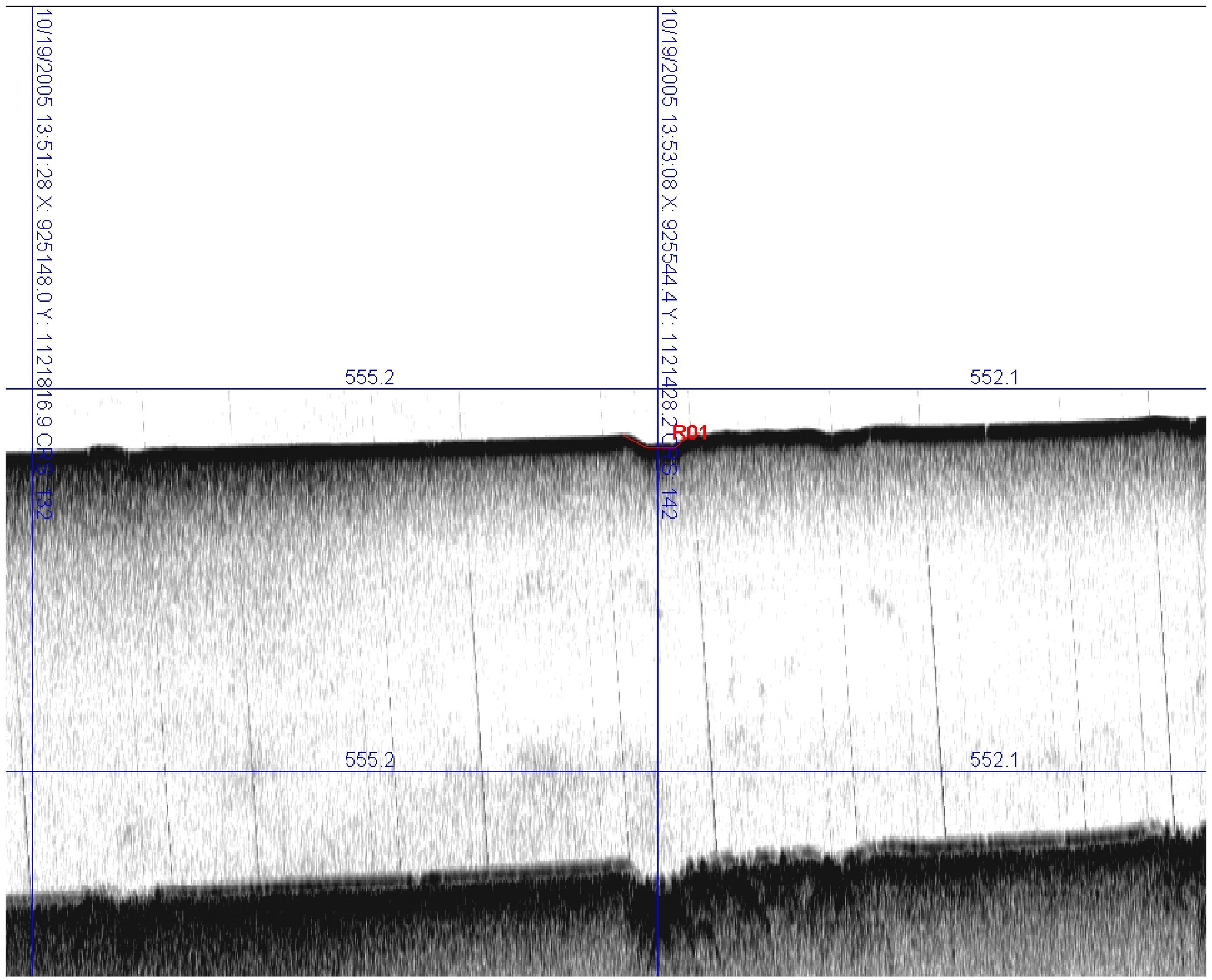


Orthophoto, color indexed bathymetric map and side scan sonar mosaic have been used as background data to provide spatial reference



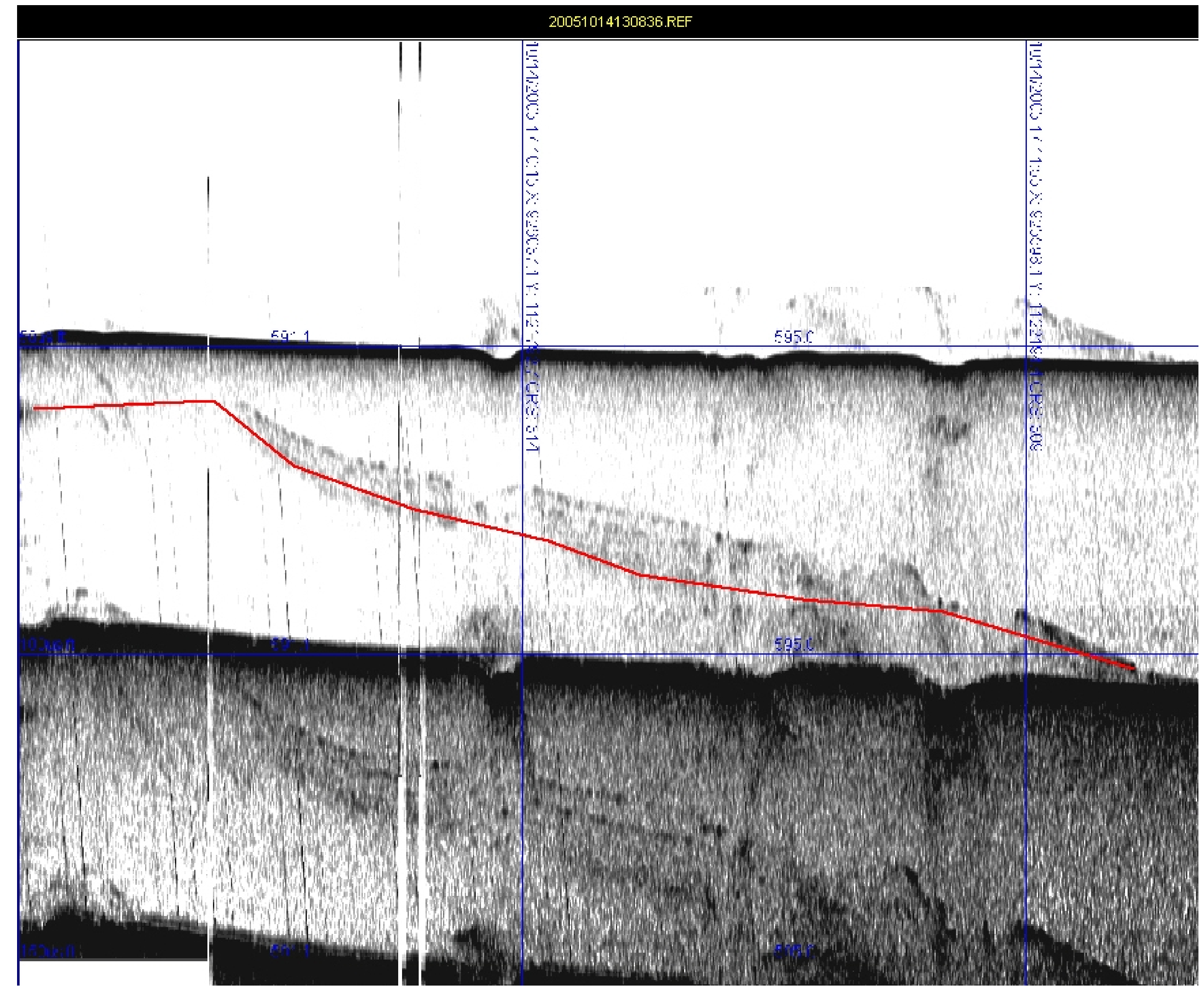
SOUTHEAST **NORTHWEST**

PROFILE 1 - FILE 20051013153602-060-A: 260 foot long segment of sub-bottom record *suggests* at least 37 feet of overburden material



NORTHWEST **SOUTHEAST**

PROFILE 2 - FILE 20051019085628-120-A: Anomalous depression approximately 2 feet deep and 55 feet wide



NORTHWEST **SOUTHEAST**

PROFILE 3 - FILE 20051014130836-120-A: This 1,300 foot long portion of sub-bottom sonar record *suggests* up to 50 feet of sediment and depicts three anomalous depressions. The indicated reflector is suspect due to potential multipath interference. The depths of the depressions are approximately 2.5 – 3 feet and widths are approximately 60 – 80 feet. Turbulence is present in the water column directly above one of the depressions.

APPENDIX B

NYSDEC COMMENTS AND PARSONS/HONEYWELL RESPONSES TO COMMENTS

Follow Up to NYSDEC's January 22, 2007 Comments on "Onondaga Lake Phase 1 Pre-Design Investigation Geophysical Report: Prepared by CR Environmental, Inc. for Honeywell/Parsons October 2006
[included are Figures 1-10 referenced in the responses]

Follow Up to NYSDEC's May 25, 2007 Comments on "Onondaga Lake Phase 1 Pre-Design Investigation Geophysical Report: Prepared by CR Environmental, Inc. for Honeywell/Parsons October 2006

Responses to August 27, 2007 NYSDEC Comments on Redlined Text and Response to Comments for "Onondaga Lake Phase 1 Pre-Design Investigation Geophysical Report: Prepared by CR Environmental, Inc. for Honeywell/Parsons
Revised July 3, 2007

Follow Up to NYSDEC Comments on "Onondaga Lake Phase I Pre-Design Investigation Geophysical Survey Report: Prepared by CR Environmental, Inc. for Honeywell/Parsons October 2006

Honeywell has reviewed NYSDEC's comments on the above-referenced report dated January 22, 2007. Following review of this report and NYSDEC's comments, the available geophysical and bathymetric data are considered suitable to meet design needs for the project. However, it is recognized that pre-dredging, post-dredging, and other construction-related bathymetric surveys will be conducted as part of future efforts following design. Additional information pertaining to the revision of the 2006 Geophysical Survey Report, the use of this data for design and responses to NYSDEC comments are summarized below.

Based on your comments the October 2006 Geophysical Survey Report will be revised to update or clarify the following:

- Bathymetric data and files (see Items B.3, D.3, and D.4 below);
- Citations and a reference listing for cited documents (see Item B.5 below); and.
- Clarification about the 25-foot bathymetric survey transect spacing (see Item C.1 below).

A. Uses for Geophysical Data Anticipated During Remedial Design

The conclusion that the available geophysical data are suitable for design purposes is based on the following types of data, which are relevant for the Onondaga Lake design:

1. Bathymetry Data - Update 1992 bathymetric data.
2. Side-Scan Sonar Data - Within dredge footprints, identify boundaries of areas where surface debris/obstructions exist. Also, within areas where an isolation cap is proposed, identify locations where debris/obstructions protrude more than 12 inches above the sediment-water interface (also called the mudline).
3. Magnetometer Data - Identify where debris/obstructions containing iron are present within or on top of lake sediment. Also within dredge and cap footprints, identify pipeline routes and potential cultural resources beneath the mudline.
4. Sub-Bottom Profiling Data – Together with side-scan sonar data, assist with interpreting geologic conditions between boring locations as needed. Also, these data may be useful to help characterize gas generation beneath the mudline.

B. Responses to General NYSDEC Comments

1. (Comment G.1) Lake bottom image, multibeam technology, and various subbottom profilers – The work plan for Phase I (Parsons, 2005) was approved prior to the Phase I geophysical survey and specifies use of single-beam technology. One reason for using single-beam equipment is the lake's extensive shallow water depths within potential dredge and cap areas. Within such areas, multibeam or swath technologies are not as effective due to swath widths and frequent equipment collisions with debris. The standard for engineering practice is to use methods that meet task goals as simply and effectively as possible. Single beam technology remains widely used for sediment remediation project design. One of Honeywell's team members, Anchor Environmental, indicates based on their review of completed sediment remediation projects that the level of accuracy for design grades, area limits, and dredge volumes is approximately the same using single beam and multibeam technologies. An accurate bathymetric survey will be required prior to dredge or capping activities within the lake. The use of multi-beam equipment will be considered for future pre-dredge, post-dredge, pre-cap and post-cap surveys.

   A higher resolution image of the lake bottom is not needed for the Onondaga Lake remedial design. Sediment within SMU 8 is being covered naturally on an ongoing basis by solids entering the lake resulting in continuing changes to SMU 8 surface sediment characteristics. The Phase I work plan specified a 200-foot spacing for transects in SMU 8 on this basis.

2. (Comment G.2) Data processing - The purpose of the sonar mosaic is to provide an overview of the relative distribution of features and acoustic backscatter properties of various portions of the lake. Regardless of the overlap method employed, survey line spacing, or signal processing approach, projection of side-scan sonar data into real-space (i.e., geo-referencing) deforms or "muddles" raw data. For this reason, side-scan sonar contacts (objects/features) were digitized from "raw" waterfall imagery and provided in a separate database along with representative imagery and measurements. High-resolution geo-referenced imagery was also delivered for each survey trackline / data file. Data users with access to current GIS or CAD software can use the sonar database to create mosaics customized to address individual needs.

3. (Comment G.3) Data usability and resolution – Data usability is discussed in Part A above. Discussions of bathymetric resolution and accuracy are provided in Sections 4 and 6 of the October 2006 report (for example, see pages 5 and 16 of the report for a discussion of bathymetric data accuracy and resolution). The "large number of small anomalies" in the bathymetric maps reflects true bottom conditions rather than data defects. The appearance of bathymetric irregularities would certainly increase with increasing data density.

   The accuracy estimate of 0.5 percent of the water depth presented on page 5 in the October 2006 report was based on a published manufacturer's specification for both of the echo sounders employed during the survey (SyQwest B500 MF and SyQwest HydroBox). This 0.5 percent value was recently found by SyQwest to be an error, so SyQwest has published new specification sheets with a corrected value of 0.1 percent of the indicated depth. Information in the October 2006 report will be updated on page 5 to clarify this point. Note this accuracy estimate is theoretical assuming the use of a 200 kHz transducer (as used on Onondaga Lake) and driven by the echo sounder's internal processing clock. Actual bathymetric accuracy is strongly influenced by water column sound velocity conditions and on corrections for water surface elevations. As discussed in Section 6.1.1 (page 16) of the October 2006 report, a comparison of co-located points collected on different survey days suggests an actual accuracy for the entire bathymetric survey of 0.14 feet, which is suitable for design needs and consistent with US Army Corps of Engineers guidance (EM 1110-2-1003).

4. (Comment G.4) Historical information – Results from the Phase 1A cultural resource survey, other historical information as appropriate, and results from the geophysical survey will be assessed together as part of the remedial design effort.

5. (Comment G.5) Report references – The only referenced citation is presented with a complete citation in Section 4.1 on page 5. Citations for project and guidance documents will be added to the October 2006 report.

C. Responses to Specific NYSDEC Comments

1. (Comment 1) SOP clarification – Bathymetric survey lines were spaced 25 feet apart in SMUs 1 through 7 and in a portion of SMU 8 adjacent to SMU 1. Side-scan sonar data in SMUs 1 through 7 were collected along transects spaced 25 meters (82 feet) apart. The information on page 3 of the report will be modified to clarify this point.

2. (Comment 2) Historical information – Historical information will be assessed further as part of the remedial design effort as indicated in Item B.4 above.

3. (Comment 3) Area of SMU 8 adjacent to SMU 1 - An additional portion of SMU 8 was surveyed for bathymetry using a 25-foot spacing between transects. This area is depicted on Figure 3 and Figure 4 of the October 2006 report.

4. (Comment 4) SMU 8 depressions - Similar features are common in organic-rich deposits in both marine and freshwater substrates. The value of Phase III Pre-Design Investigation work to further assess these depressions is currently being evaluated.

   Note, however, that the referenced sonar features are not akin to those identified in Golder's 1992 survey report (Section 4.2, "Type 2" reflections). PTI's summary of these "Type 2" images more accurately represents these features (PTI, 2002, page 7, paragraph 4) as "crater and mound structures on the order of 10 meters (33 feet) in diameter".

5. (Comment 5) Cross sections and profiles – Follow up work to prepare sections/profiles for the pipelines as suggested here will be conducted as appropriate as part of the remedial design effort.

D. Follow Up to NYSDEC Attachment 1

1. (Page 1 in Attachment 1, Paragraph 2) Data assessment - The cited limitation of ArcView 3.1 (which is no longer supported or available from ESRI) has been overcome with recent software versions (ESRI is currently licensing ArcMAP 9.2).

2. (Page 1 in Attachment 1, Paragraphs 3 and 4) Navigation - Navigation was conducted with differential GPS using the OMNISTAR satellite service rather than USCG (or other) land-based beacons. Thus, differential corrections were not a source of uncertainty for positioning. With the exception of sonar data collected in the northern canal (an area which was outside of the work scope and did not receive the same level of scrutiny as the Lake), poor GPS corrections were not present in any of the data sets due to real-time filtering per the SOP. The cited navigation error in file "canal3-75__A_" was associated with data acquisition underneath a bridge. Nonetheless, all bathymetric, side-scan sonar, sub-bottom profiler, and magnetometer navigation data were inspected during processing to ensure adequate GPS quality (i.e., HDOP, SNR, and number of satellites).

3. (Page 2 in Attachment 1, Paragraphs 1 and 2) Bathymetry - Each of the anomalies reported in these paragraphs have been reviewed. The attached Figures 1 through 5 present the locations and sounding tracklines associated with each anomaly. Without exception, each of the five reported anomalies was found to be associated with the HYPACK data export process. Specifically, three of the five anomalies were associated with files which were not intended to be exported (see Figures 1, 2 and 5 attached). Anomalies associated with two mounded structures (see Figures 3 and 4 attached) resulted from export of files from which errant points (outliers) had been removed, but the exported data included the outliers. Revised soundings data, bathymetric contours, and associated files will be provided.

   The true top elevation of the mounds can be determined by manually digitizing the *.odc backup sounding file and applying the appropriate water surface elevation correction. These manually digitized soundings will be incorporated into the revised database. The approximate elevations of the northern and southern mounds are 355 and 353 feet, respectively. Figures 6, 7 and 8 attached show sub-bottom sonar records which intersected these mounds. These figures depict the extensive stratification of sub-surface materials. While the cited sub-bottom file, 20051018131204-120-A.odc, did clip the upper portions of each mound due to sonar operator minimum range settings (which were appropriate for the remainder of the file, but could not be adjusted quickly enough as the small mounds were encountered), other records clearly depict the sub-bottom nature of these features.

4. <u>(Pages 2 and 3 in Attachment 1) Bathymetry grid</u> - A revised grid in binary and ASCII format will be provided. The correct grid interval is 10.0 feet. The triangulation grid algorithm was selected because (at least in Surfer) it honors individual data points more closely than other non-exacting methods such as Kriging or IDW. Triangulation is a preferred method of interpolation for engineering surveys. Additionally, and of equal importance, the computing time for the triangulation method is significantly less than other methods.

   The colorized geo-referenced TIF representing bathymetric contours was created using an image resolution of 200 DPI to maximize image clarity. The pixel size of the image resulting from the export was dependant upon the scaled size of the original map rather than on grid density. As identified in the world file for the image (i.e., *.tfw), the pixel resolution was 3.75 feet.

5. <u>(Pages 3 and 4 in Attachment 1) Side-scan sonar data</u> - The size of the mosaic files has not been found to be prohibitively large. The primary purpose of the side-scan sonar (and magnetic) survey was to identify debris and features pertinent to remedial activities rather than creation of a uniform mosaic of better use for substrate classification or habitat mapping. Thus, gains were adjusted by the operator to maximize data usability for the project goals. The time and locations of gain settings *are* recorded in the raw XTF file. As specified and described, the survey employed an analog towfish (Edgetech 272TD) interfaced to the recording hardware/software using an ACI interface. This configuration does not permit "monitor only" gain adjustment.

   Given the dynamic range of the system, it was impossible to avoid some degree of data "clipping" in shoal areas. The sample of clipped data shown on Figure 3 in Attachment 1 was shoreward (a quick review suggests seven feet up-slope on port channel) and the increased angle of incidence in this example further complicates signal normalization across the swath. These clipped portions of the record do not possess "shadows" and likely represent coarse deposits rather than vegetation or debris. Given the late season and the shallow nature of the survey, wave-induced water column noise was frequently observed in data and cannot be avoided, regardless of the sonar system or method of deployment.

   NYSDEC's Attachment 1 text is correct that a "smart" towfish with a heading, motion and depth sensor would allow more precise positioning than a towfish without these sensors. However, with the exception of data collected in SMU 8, the towfish was deployed from the bow at fixed and accurately measured distances from the vessel point of reference. In addition, several times during the survey the side-scan sonar towfish collided with impacted debris, wreckage and the lake bottom. It is highly likely that the sensors on a "smart" towfish would have been destroyed early due to such collisions. The calculated locations of side-scan sonar targets identified in even the deepest portion of the lake agreed strongly with bathymetric and magnetic anomalies. Several of these coordinates were provided to a dive team contracted by Parsons during the 2006 Phase II Pre-Design Investigation, and the divers were able to locate sonar contacts without difficulty.

As described in detail in the October 2006 report, the database of side-scan sonar contacts (i.e., objects and anomalies of interest) was developed from "waterfall" versions of data rather than the projected data used to create mosaics. This database was created using a separate software package using different navigation review and editing tools. Two reasons for the decision to use separate software were detailed in the report, but are briefly reviewed here as well. First, the process of creating geo-referenced images in two-dimensions, whether photographs or sonar data, requires re-sampling (under-sampling in the case of side-scan) and reorientation. A substantial loss of clarity is associated with these projections. Second, use of the separate software package greatly expedited production of a GIS database of sonar contacts, including high resolution imagery, mensurations and locations. These locations are *not* necessarily identical to locations depicted on the mosaic due to different navigation processing methods.

With regards to towfish yaw and examples cited for Line 19-91 (Figure 4 in NYSDEC's Attachment 1), it is useful to consider the mechanics of side-scan sonar towing and the methods used to estimate sensor locations. Particularly in circumstances when substantial tow cable is deployed for the side-scan sonar, the heading of the towfish is not identical to the heading of the survey vessel. This is because the behavior of the towfish is buffered by the length of the cable. Therefore, the calculation (estimation) of towfish position is conducted by applying a smoothing filter to raw DGPS position data (for instance, by calculating the course-made good over a five-second period) and estimation of layback. The appropriate smoothing period would best be chosen on a file-specific basis, allowing consideration of cable length and vessel motion. However, while the SonarWeb software used to create project mosaics allows the user to specify towfish offsets on a file-specific basis, navigation smoothing parameters are set for the entire mosaic (i.e., all files receive the same degree of smoothing). CR Environmental selected a smoothing factor which was biased towards the short layback distance and bow-mounted deployment used for the vast majority of the survey (virtually all of each littoral SMU). The sonar file cited as an example of the effects of yaw, Line 19-91.xtf) has been reviewed to provide a clear example of both yaw effects and navigation smoothing effects, with particular focus on the comment that the same feature was recorded twice on this file due to yaw. Figure 9 attached presents examples of several manipulations of the navigation smoothing options for this file.

Vessel motion did induce towfish yaw during acquisition of the cited survey file. The maneuver associated with this yaw may have been conducted in order to avoid collision with a buoy located directly on the survey transect approximately 400 feet to the northwest or some other floating debris or marker buoy. Sonar contacts likely associated with the mooring system for a large buoy are evident at the northwestern extent of Figure 4 in NYSDEC's Attachment 1. Review of adjacent sonar files 19-90 and 19-92 demonstrate the presence of two objects at this approximate location rather than a single object imaged twice (see Figure 10 attached). The absence of the larger Contact on the geo-referenced image for 19-91 appears to be associated with the position of the data relative to the start of the sonar file and on the navigation smoothing applied to the file. The deformed "U" shape of the larger Contact depicted on Figure 10 attached and the misrepresented orientation between the smaller and larger Contacts are the result of yaw.

The BAC algorithm does not remove gain information. Rather, the algorithm is designed to minimize across-track variations in signal intensity, particularly near the nadir. The algorithm does utilize a modest along-track period to calculate a running average return signal.

6. <u>(Page 5 in Attachment 1) Subbottom profiles</u> - As previously described, in some instances (e.g., see Figure 2 in NYSDEC's Attachment 1), topographic anomalies appeared on subbottom records abruptly and left little opportunity for the operator to adjust range settings. The subbottom profiler used for this survey was a 10 kHz continuous wave system. The 1992 survey used 3.5 kHz and 12 kHz signals. Although CR Environmental has not had an opportunity to review any but the coarsest photocopies of 1992 records, it appears that areas of acoustic transparency and the degree of penetration were similar for both surveys.

FIGURE 1

BATHYMETRIC COMMENT #1

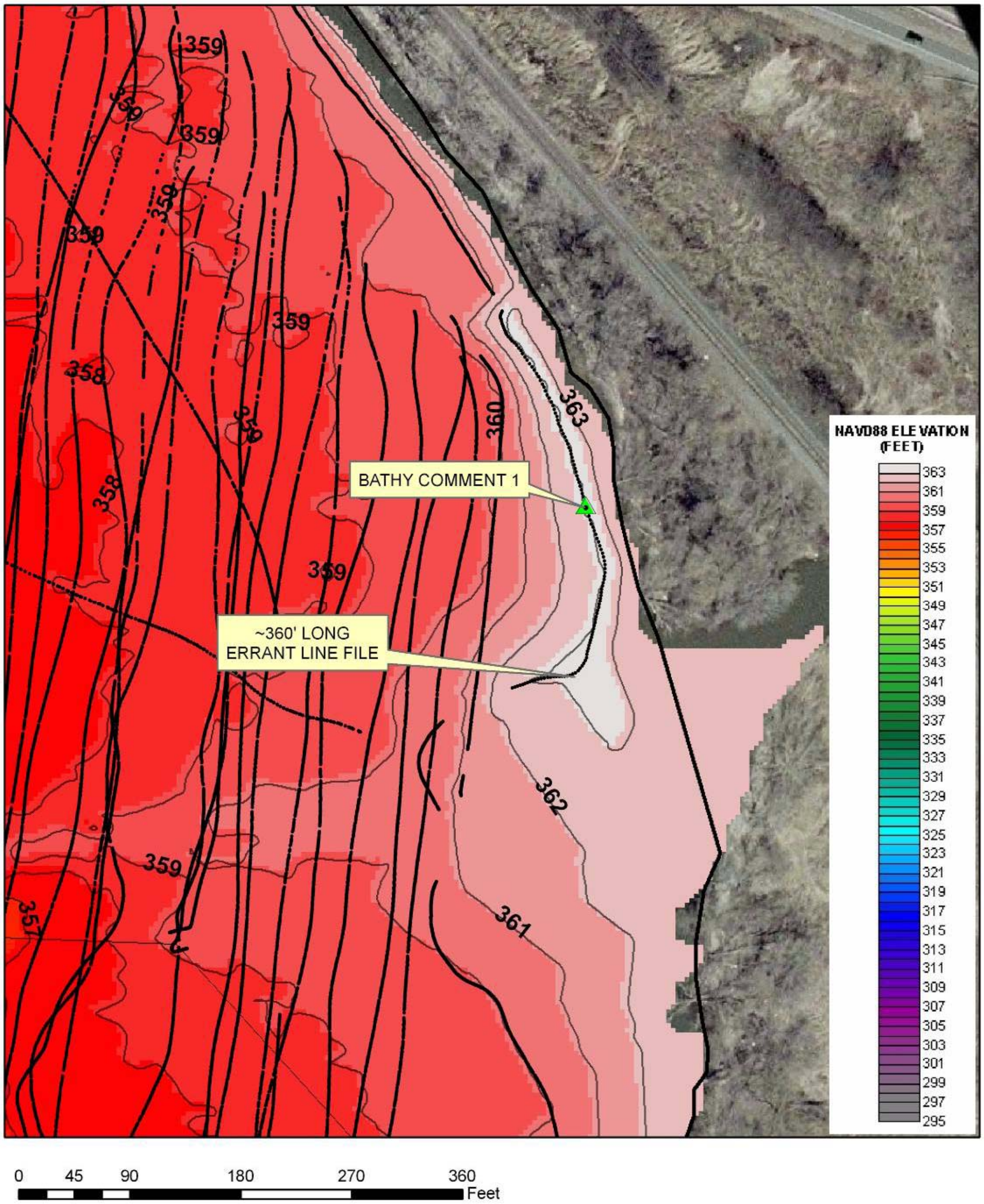


FIGURE 2

BATHYMETRIC COMMENT #2

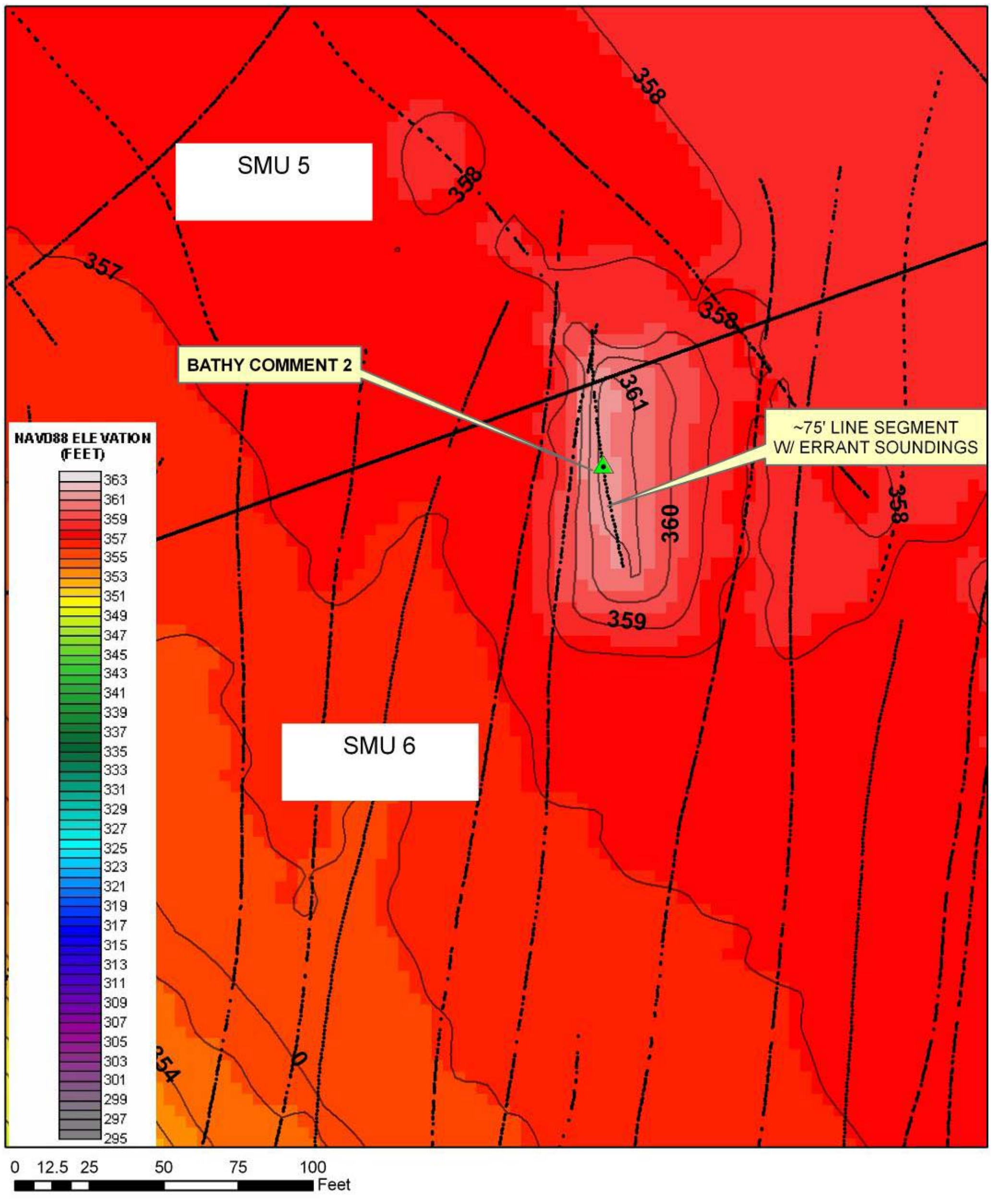


FIGURE 3

BATHYMETRIC COMMENTS 3 & 4

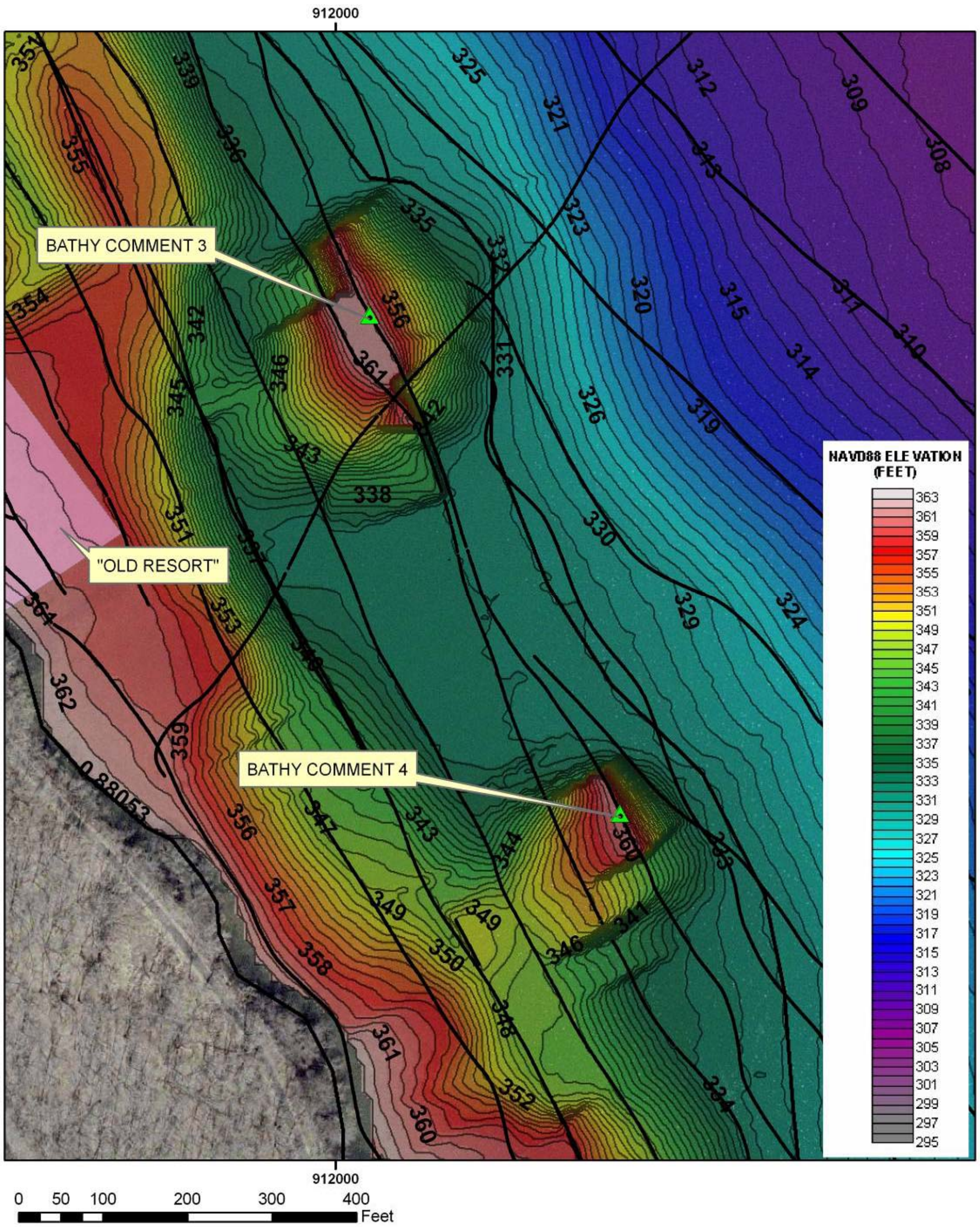


FIGURE 4

DIGITAL PROFILE AT LOCATION OF COMMENTS # 3 & 4 (MOUNDS)

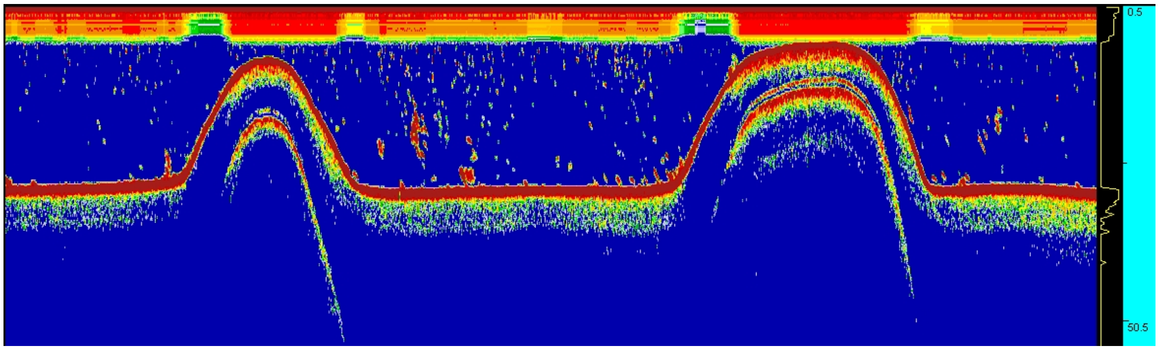


FIGURE 5

BATHYMETRIC COMMENT #5

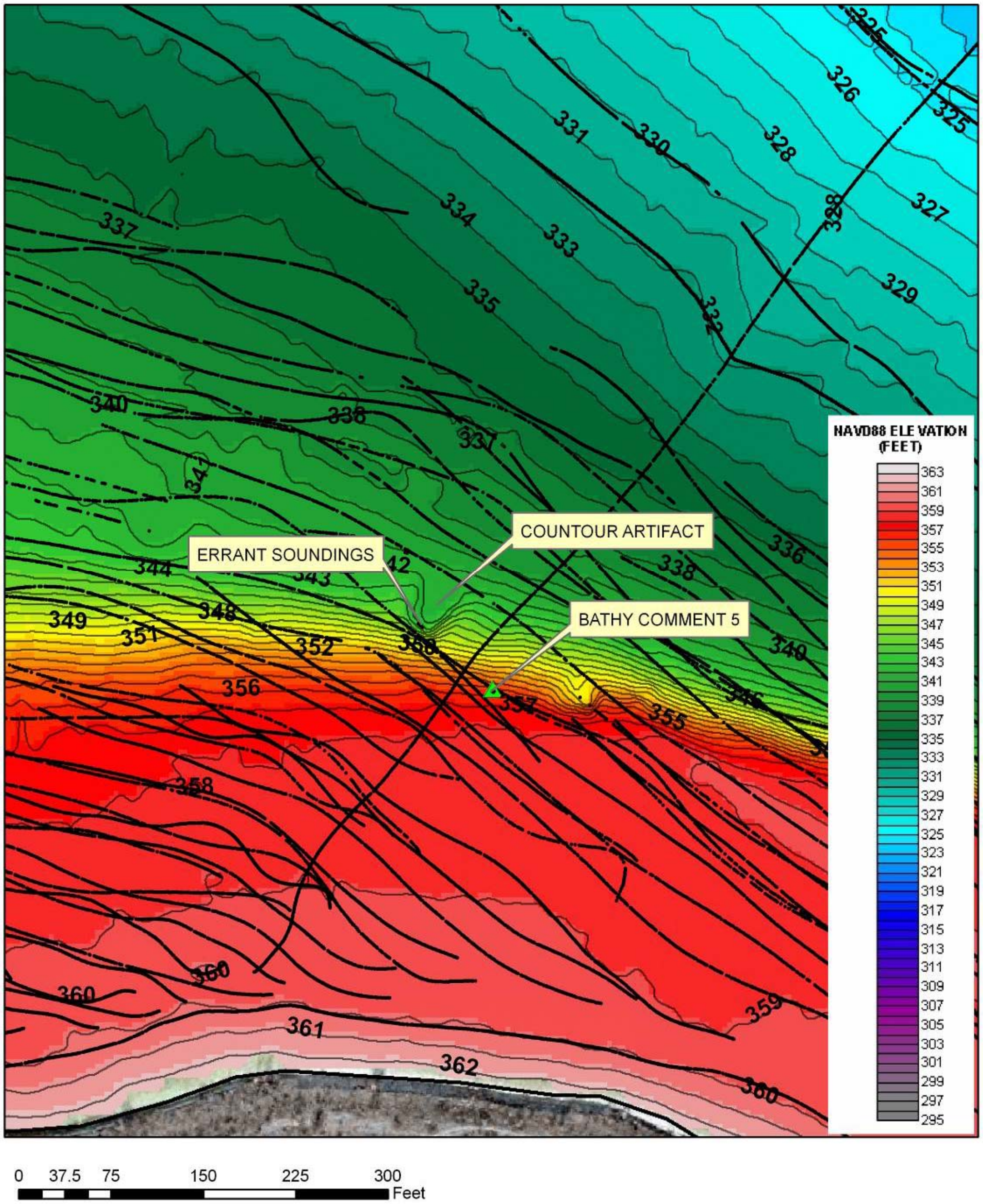


FIGURE 6

SUB-BOTTOM SONAR RECORD OF NORTHERN MOUND

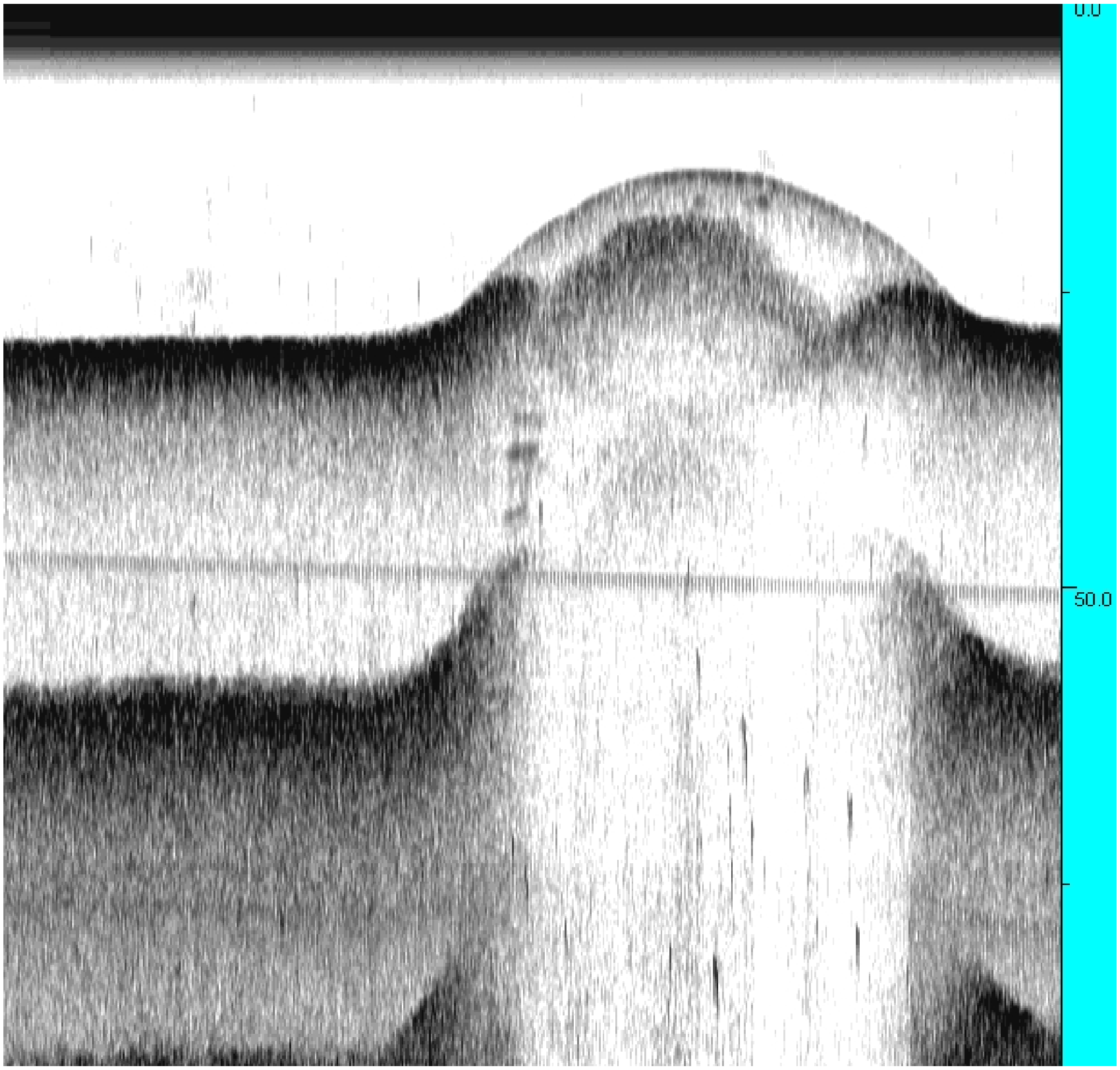


FIGURE 7

SUB-BOTTOM SONAR RECORD OF SOUTHERN MOUND

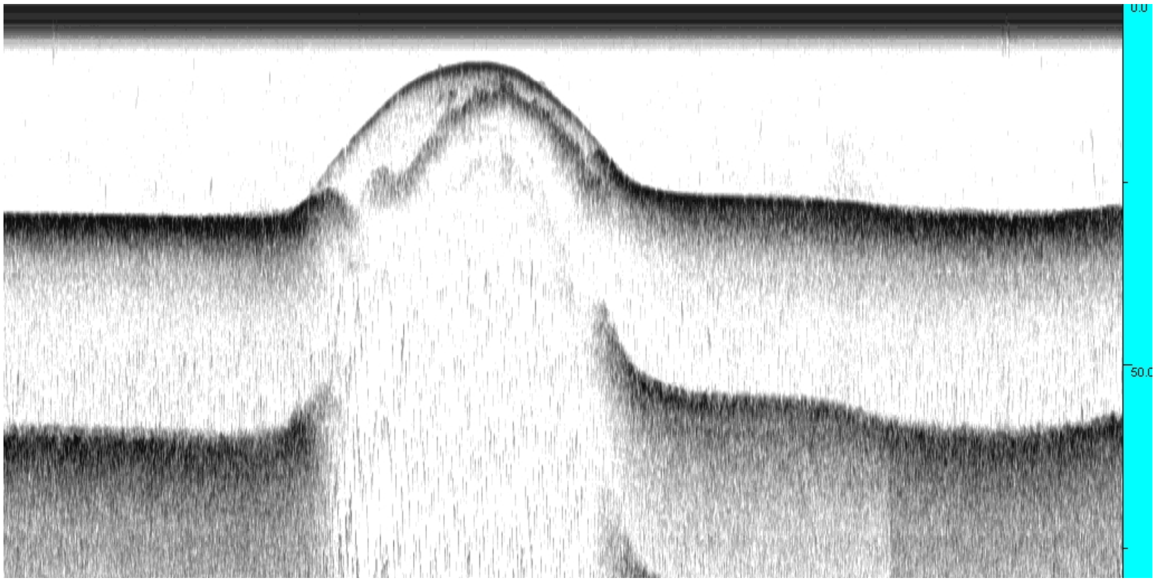


FIGURE 8

SUB-BOTTOM SONAR RECORD OF NEAR-SHORE PORTIONS OF THE MOUNDS

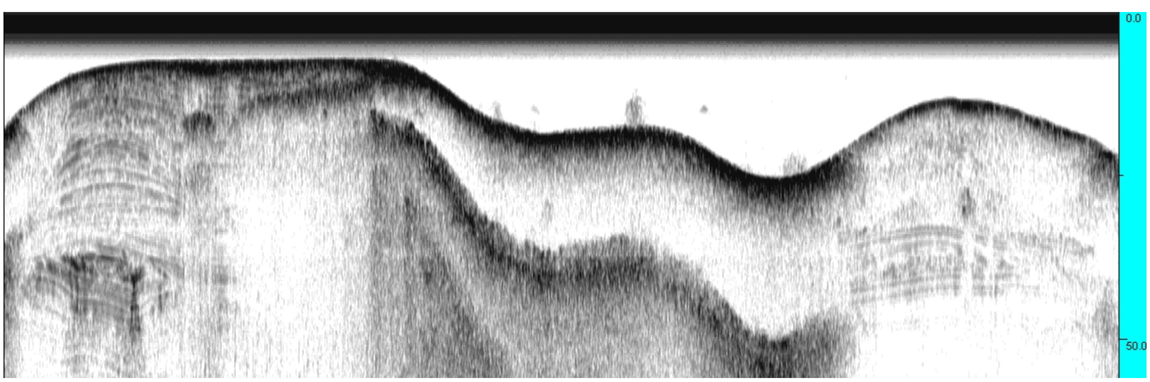


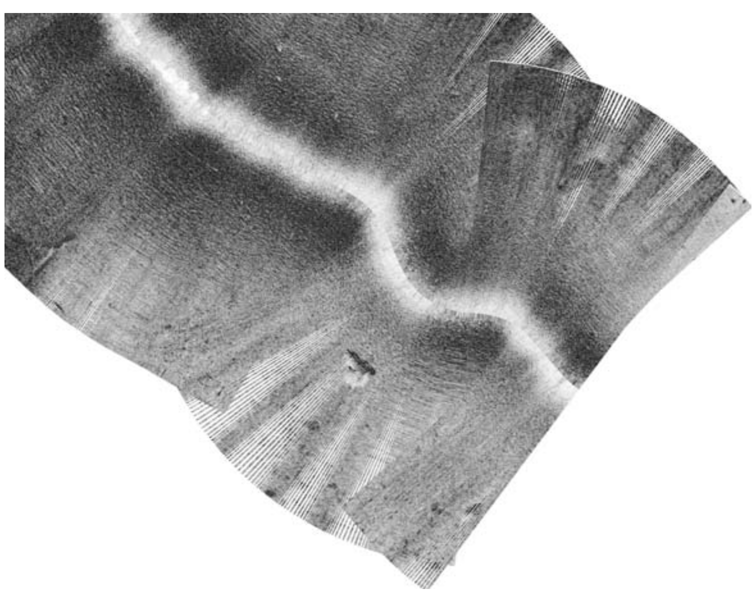
FIGURE 9

EXAMPLES OF THE EFFECTS OF NAVIGATION SMOOTHING ON PROJECTED SIDE SCAN SONAR DATA

“RAW” WATERFALL DATA FROM SIDE SCAN SONAR LINE 19-91

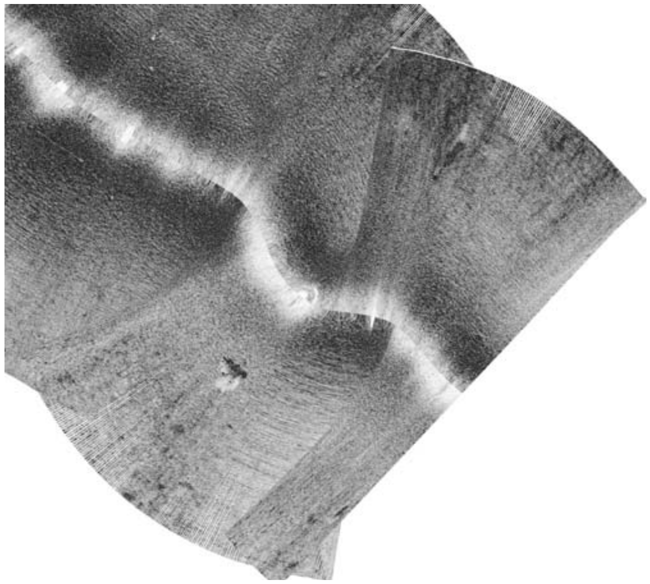
Raw data from sonar file 19-91.xtf depicts large objects (Contacts or Targets “A” and “B") on port (left) channel, smaller targets on starboard channel. The vessel’s heading was roughly northwest and the beginning of the recording is the upper portion off the record. Note that Contact “A” is observed almost immediately after beginning the recording (~120 pings or 8 seconds).

SEGMENT OF LINE 19-91 SIDE SCAN SONAR DATA PROCESSED WITHOUT NAVIGATION SMOOTHING



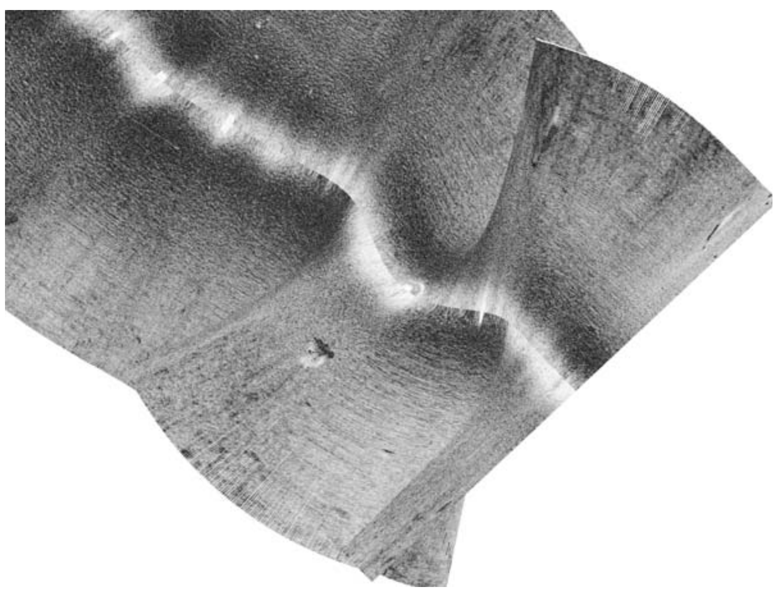
Same data as above, projected into real-space coordinates (i.e., georeferenced). Vessel track used as navigation, using an incorrect assumption that towfish yaw mimics vessel heading. Note that the large Contact “A” is masked by improperly projected data.

SEGMENT OF LINE 19-91 SIDE SCAN SONAR DATA PROCESSED WITH 50-PING (~3 SECOND) NAVIGATION SMOOTHING



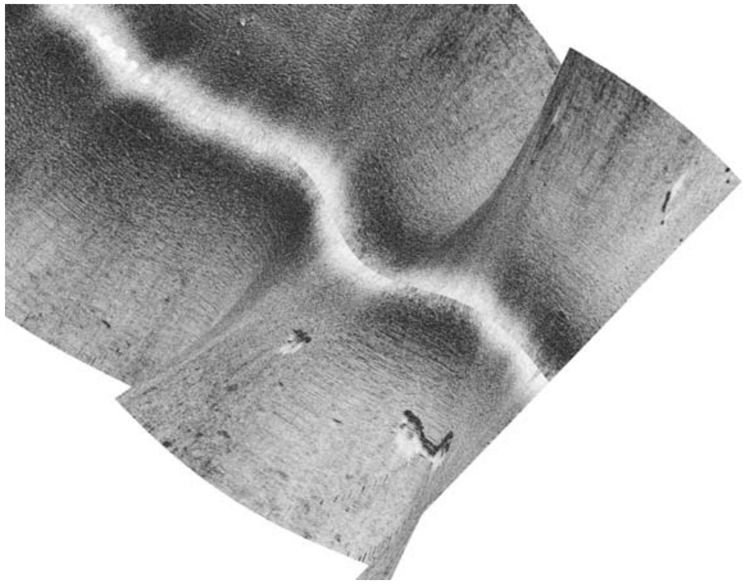
Same data as above, georeferenced using a short period smoothing algorithm. Contact "A" still masked by improperly projected pings due to its position relative to the start of the file.

SEGMENT OF LINE 19-91 SIDE SCAN SONAR DATA PROCESSED WITH 100-PING (~6.5 SECONDS) NAVIGATION SMOOTHING



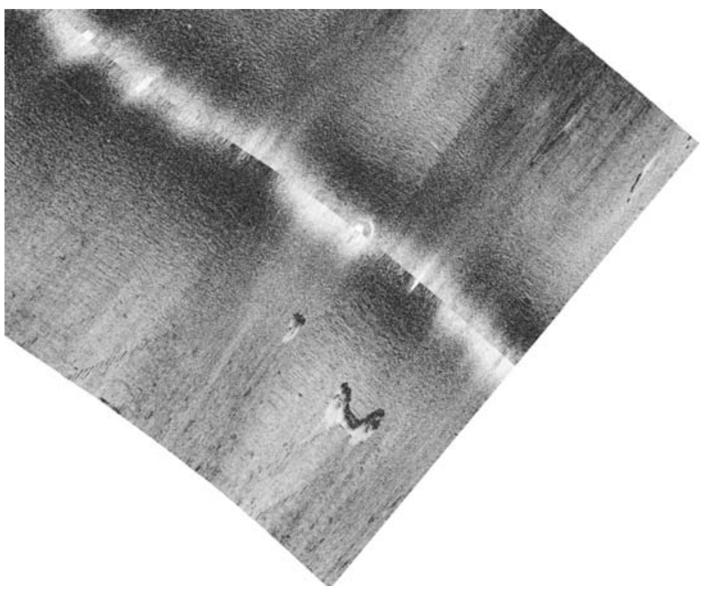
Same data as above, georeferenced using a longer period smoothing algorithm. Contact "A" still masked by improperly projected pings due to its position relative to the start of the file.

SEGMENT OF LINE 19-91 SIDE SCAN SONAR DATA PROCESSED WITH 200-PING (~13 SECONDS) NAVIGATION SMOOTHING



Same data as above, georeferenced using a longer period smoothing algorithm. Contact "B" and starboard Contacts visible as yaw period experienced by the towfish is approached.

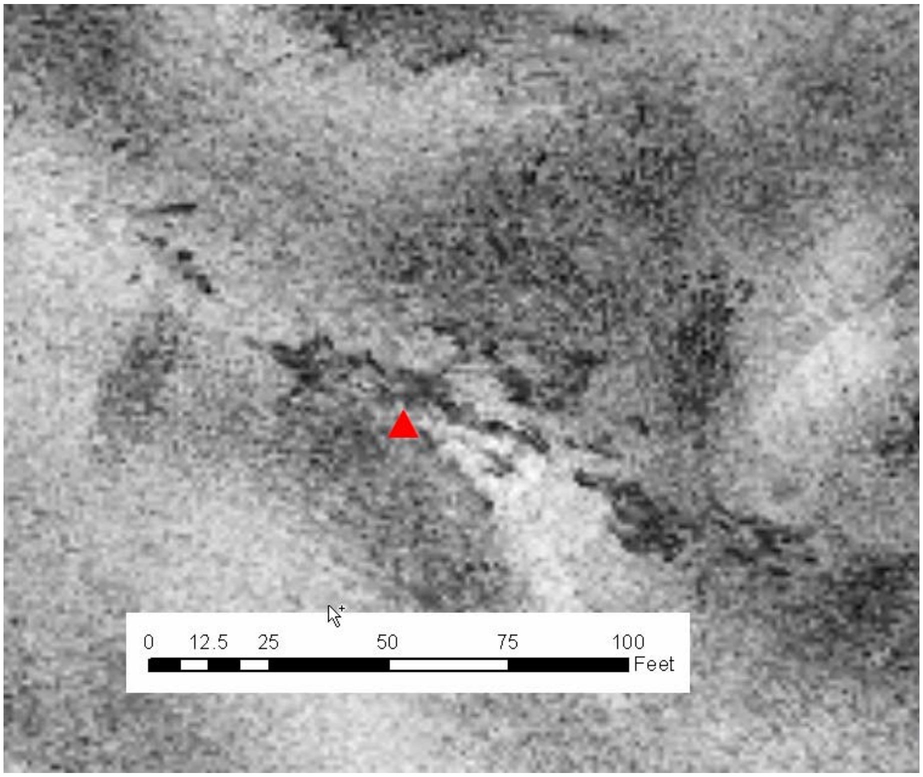
SEGMENT OF LINE 19-91 SIDE SCAN SONAR DATA PROCESSED WITH 500-PING (~33 SECONDS) NAVIGATION SMOOTHING



Same data as above, georeferenced using an extremely long period smoothing algorithm. Contact "B" and starboard Contacts visible, but towfish yaw is completely (and likely inappropriately) masked by navigation smoothing.

FIGURE 10

LARGE SONAR CONTACT "A" ON MOSAIC:



LARGE SONAR CONTACT "A" ON LINE 19-90:

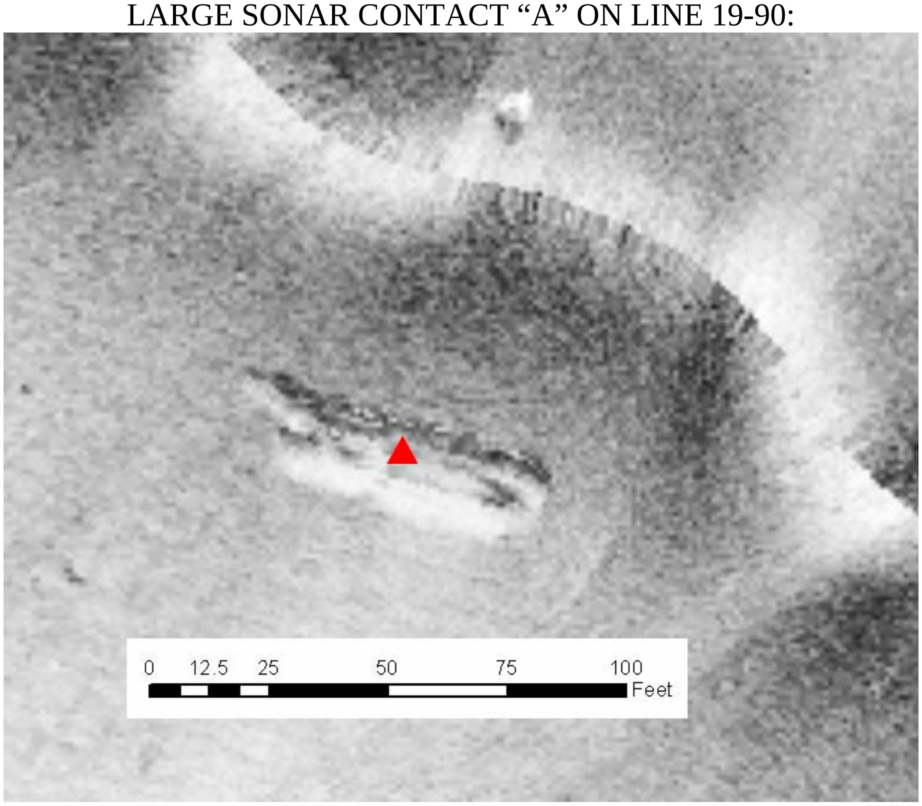
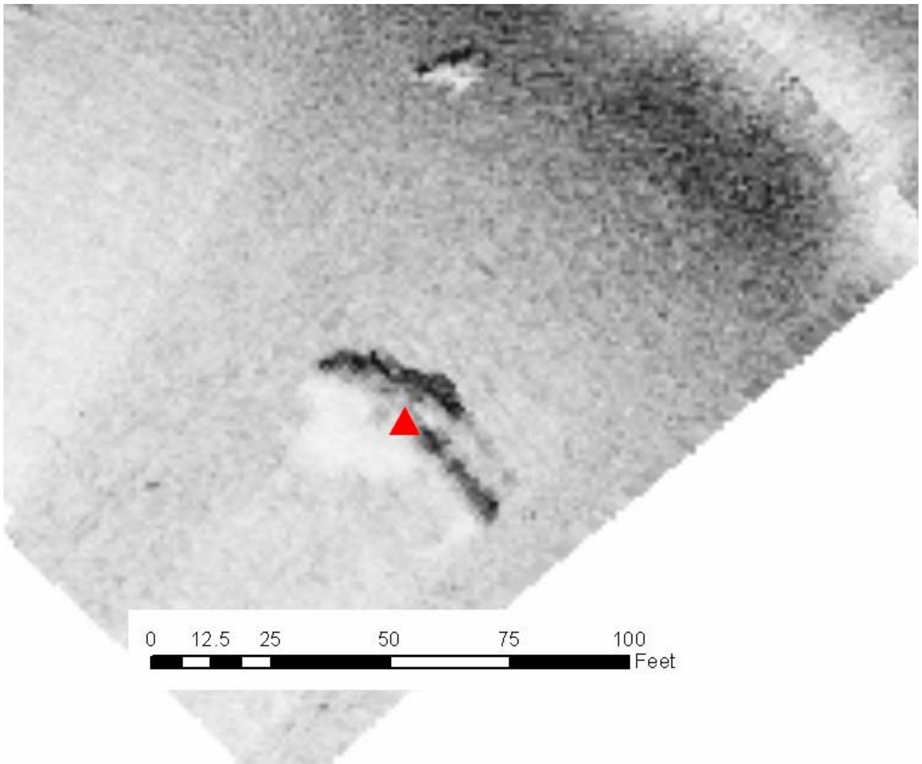


FIGURE 10 (Cont.)

LARGE SONAR CONTACT “A” ON LINE 19-92:



LARGE SONAR CONTACT “A” ON LINE 19-91 (OVERLY SMOOTHED DATA):

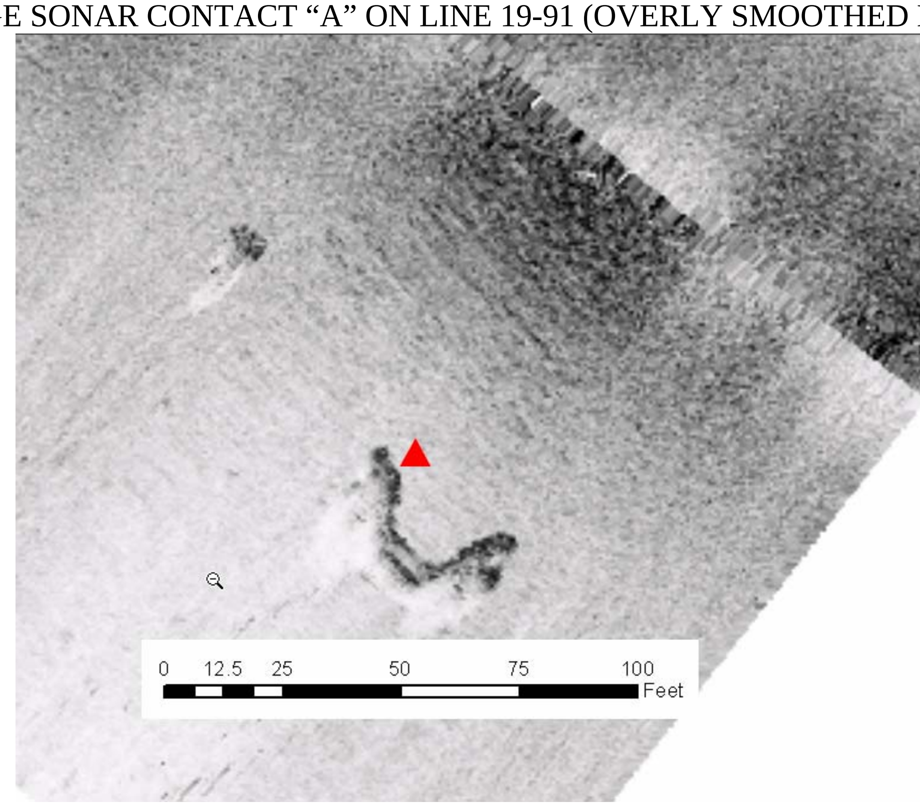
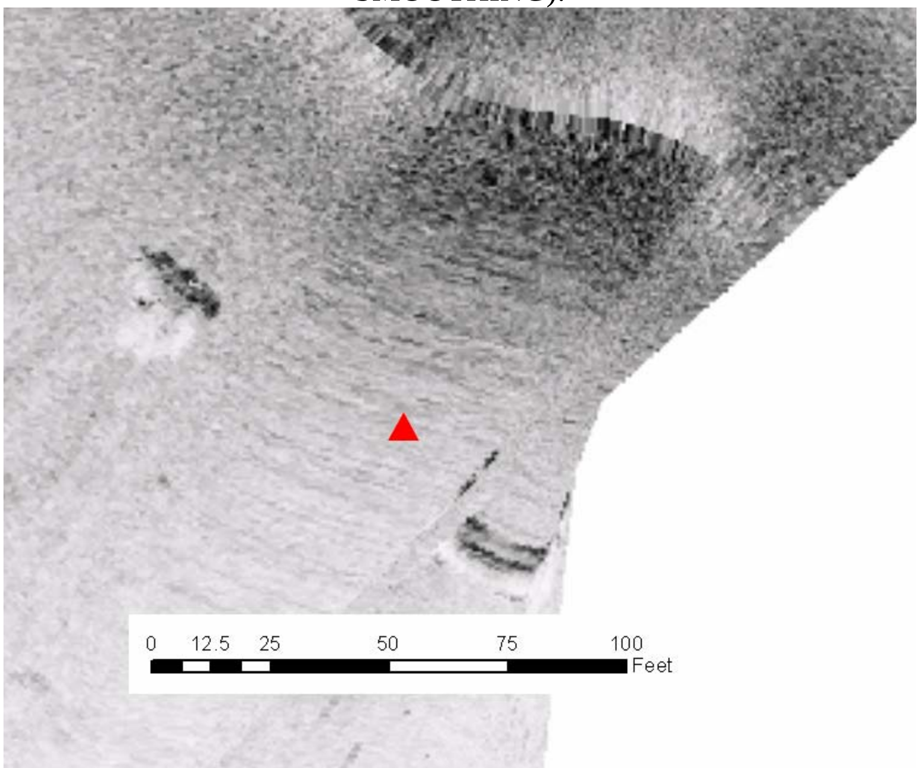


FIGURE 10 (Cont.)

LARGE SONAR CONTACT “A” ON LINE 19-91 (FIRST 100 PINGS FROM DATA FILE CLIPPED TO PLACE CONTACT AT START OF FILE, ~2 SECOND SMOOTHING):



Follow Up to NYSDEC's May 25, 2007 Comments on "Onondaga Lake Phase I Pre-Design Investigation Geophysical Survey Report: Prepared by CR Environmental, Inc. for Honeywell/Parsons October 2006

Honeywell/Parsons has reviewed NYSDEC's second set of comments on the above-referenced report dated May 25, 2007. Responses to NYSDEC comments are summarized below.

A. Responses to General Comments

1. (Comment G.1) Revised tables and figures– Table 1 and Figures 5, 9, 14, 34, and 35 have been revised since the report was issued. A copy of these tables and figures is provided with these responses, and a copy will be inserted into the report. The May 25, 2007 comments requested an opportunity be provided for NYSDEC to review these tables and figures prior to Honeywell/Parsons resubmitting the report.
2. (Comment G.2) Documenting comments and responses – A copy of both sets of NYSDEC comments on this report (dated January 22, 2007 and May 25, 2007) will be inserted into the report as a new Appendix (i.e., Appendix B) along with Honeywell/Parsons' responses.
3. (Comment G.3) Side-scan position accuracy – Within the various geographic sections of the lake, the position error ranges from 4 to 25 feet as explained below. Section 6.1.2 of the report text has been revised accordingly.

   In order to estimate the likely magnitude of position errors on data collected in the deepest water (see Figure 2 in the report for vessel track lines), several adjacent data files, which intersected the central "ridge" between basins, were inspected. Estimated laybacks for the selected lines ranged from 75 feet to 105 feet. The differences between object positions depicted on these files were measured. Position errors ranged from 4 feet to 25 feet (average 12.5 feet). The maximum position error was associated with a change in vessel heading.
4. (Comment G.4) Updated bathymetry file – This updated file will be provided on CD as part of the revised Attachment A of the report.
5. (Comment G.5) Subbottom image profiles – Two sub-bottom profile processing artifacts were identified and removed. The first artifact resulted in compressed vertical range scales on a small number of files. The developer of the processing software, Chesapeake Technologies, Inc., revised and recently released a new version of processing software which corrected this isolated problem. The second artifact resulted in exaggerated vertical scales when processed (as opposed to played back using SyQwest's Stratabox software). This condition affected only four of the 524 data files. Chesapeake Technologies identified the condition as spurious range and delay values in distinct header lines of the raw files. The files were corrected using a text editor and re-processed.

In addition, the size of fonts for time and navigation annotation to the entire data set's HTML profile imagery was increased substantially.

Images of profiles used in Appendix A-1 through A-8 were inspected for the legibility of annotation, and were replaced where appropriate. Revised images are provided with these responses and will be included with the report.

6. (Comment G.6) Raw data files – Honeywell/Parsons will provide raw data files to NYSDEC as requested. However, before significant time is expended by NYSDEC to use these raw data files, please contact Honeywell/Parsons so we can be sure the files are properly understood and that suitable software is applied. These data files are very specific tools that are likely best employed by the creators of the files. NYSDEC is welcome to ask Honeywell/Parsons to apply these data files to meet an objective and then check the application once complete.

   Regarding magnetometer profiles, Honeywell/Parsons previously provided the xyz file for the entire merged data set as well as JPEG images for each transect (see Attachment A to the report). Using GIS, a user can extract and plot any transect from the data previously delivered. The data were not thinned or "binned" prior to the xyz database export process. Feel free to contact us with any questions about extracting and/or plotting magnetometer profiles.

B, Responses to Specific Comments

1. (Comment 1) Text addition in Section 6.2 – The phrase, "followed by capping" has been added in Section 6.2 as requested.
2. (Comment 2) Elevations for three intake pipes – This is an example application of raw data that we request be discussed with Honeywell/Parsons prior to using raw data files as discussed above in the response to Comment G.6. We believe a more suitable way to obtain data to document the horizontal and vertical extent that these pipes stick up above the mudline may be via diver measurements. This is a detailed design item that Honeywell/Parsons will address in the future at an appropriate time.
3. (Comment 3) Reference citation for Phase I work plan – The Parsons, 2005 citation has been added as requested.

Responses to August 27, 2007 NYSDEC Comments on Redlined Text and Response to Comments for "Onondaga Lake Phase 1 Pre-Design Investigation Geophysical Survey Report" Prepared by CR Environmental, Inc. for Honeywell/Parsons, Revised July 3, 2007

Parsons/Honeywell's responses to NYSDEC's most recent comments on the above-referenced report are presented below following each comment. NYSDEC's comments are in bold type followed by the Parsons/Honeywell response.

A1 (NYSDEC Comment G.1). The note on Table 1 should also indicate that the water volume calculations assume some shoreline elevation.

Parsons/Honeywell's response to Comment A1: The note at the bottom of Table 1 has been revised as follows. "Mean and maximum water depths and water volume values were calculated based on an assumed shoreline water level elevation of 362.82 ft, NAVD88."

A2 (NYSDEC Comment G.2). Text should be added to the Introduction referring to the two sets of NYSDEC comments and Honeywell/Parsons/CR responses that will be included in Appendix B.

Parsons/Honeywell's response to Comment A2: Text requested in the comment has been added.

A3 (NYSDEC Comment G.3). This statement on side-scan position accuracy is acceptable. The statement and the inclusion of comments and responses (Item A2) indicate that a user of the sonar data will need to check on the position accuracy for any particular target of interest.

No additional input is needed from Parsons/Honeywell to address Comment A3.

A4 (Comment G.4). Response noted.

No additional input is needed from Parsons/Honeywell to address Comment A4.

A5 (NYSDEC Comment G.5). The annotations on the revised images of the subbottom profile records provided in the Appendices are now clear and readable. However, one issue remains. The exported seismic profile images provided (attached Figure 1) still do not have the resolution of the profile in Figure 8 as provided in "Geophysical Responses 3-19-07.pdf" (attached Figure 2). It is assumed that this is due to a defect in the software used to create the images from the raw data files (attached Figure 3), but maybe that isn't correct. In any case, it needs to be explained why the images created from the raw data differ so dramatically from the delivered images. It is important to deliver subbottom images with the best possible resolution because the profiles can indeed show important information about the structure of

the sediments where layering is imaged. For example, Profile 2 of Appendix A-1 appears to show a lens of very recent sediment at the location of the vertical event mark, but the profile image appears somewhat garbled.

Parsons/Honeywell's response to Comment A5: We have communicated with the owner of the processing software company, Chesapeake Technology, Inc about these "step-like" artifacts in processed sub-bottom data. Chesapeake Technology, after consulting with the sonar manufacturer, SyQwest, has identified the source of these artifacts. While the degree of these artifacts is minor and has not adversely impacted our assessment of data, we will submit revised profile images as requested based on the sample in the attached file (zoom in on the sample at least 200% on the sediment surface).

A6 (NYSDEC Comment G.6). Response noted.

No additional input is needed from Parsons/Honeywell to address Comment A6.

B1 (NYSDEC Comment 1). Response noted.

No additional input is needed from Parsons/Honeywell to address Comment B1.

B2 (NYSDEC Comment 2). Response noted. However, the text in the report regarding these pipes notes that "side-scan sonar data clearly identifies the surficial expression of the terminus of each of the three pipes." If the elevation of the terminus of these pipes is known, it should be specified in the text as was done for the Metro discharge pipe later in this chapter.

Parsons/Honeywell's response to Comment B2: Elevations for the terminus of these pipes are not yet available. These elevations will be quantified and provided later during the design effort.

B3 (NYSDEC Comment 3). Response noted.

No additional input is needed from Parsons/Honeywell to address Comment B3.

Additional comment: The report acknowledges the web site www.local.live.com for Photographs 2, 3, and 4. Photographs 5, 6, and 7 are also from that web site, but their source isn't acknowledged. The source of those photographs should also be acknowledged. Photograph 5 is referred to on page 50 and Photographs 6 and 7 are referred to on page 54.

Parsons/Honeywell's response to the additional comment: The web site source for Photographs 5, 6, and 7 has been added in the report.

ATTACHMENT A

Data DVD and Report DVD