Hawaii National Marine Renewable Energy Center (HINMREC)

U.S. Department of Energy Award Number: DE-FG36-08GO18180

Task 1: Management

Kāneʻohe Wave Energy Test Site: Side Scan Data Report 2

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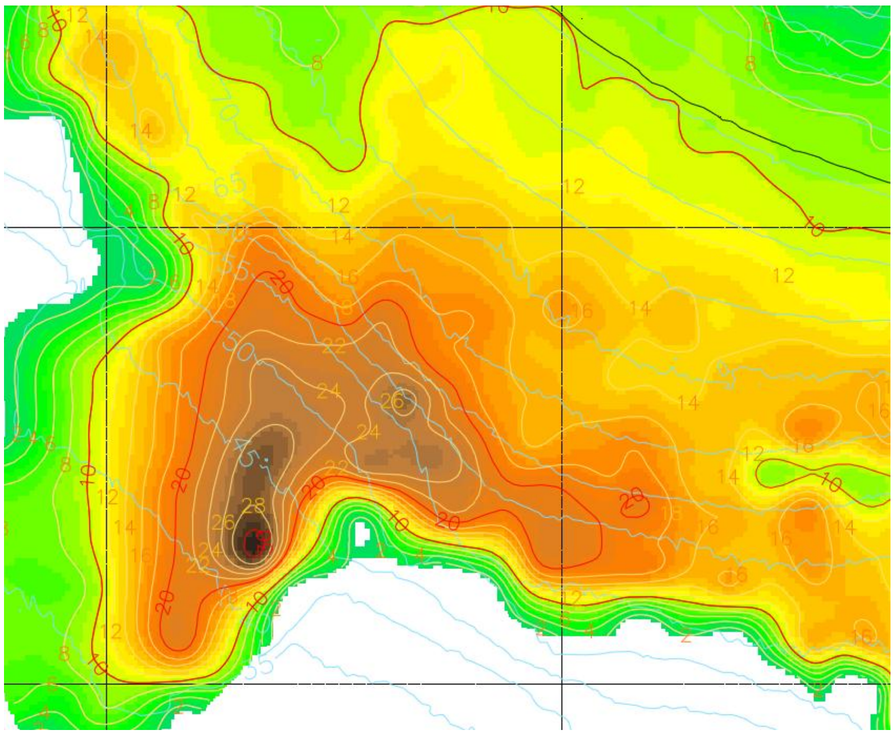
May 2013

HNEI
Hawaiʻi Natural Energy Institute
University of Hawaiʻi at Mānoa

THE WAVE ENERGY TEST SITE (WETS) AT MCBH, KANEOHE
SIDE SCAN DATA REPORT 2

OAHU, HI



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Work sponsored by the U.S. Department of Energy's Wind and Water Program under Award DE-FG36-08GO18180

Job No. 25268

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1. INTRODUCTION

The area north of Mokapu Peninsula, adjacent to Kaneohe Marine Corps Base Hawaii (MCBH), has been utilized by the U.S. Navy and Ocean Power Technologies, Inc. (OPT) for wave energy research since 2002. After a 2 year deployment, a prototype OPT PowerBuoy was recently retrieved from the 30 meter water depth offshore of North Beach at the MCBH. The Hawaii National Marine Renewable Energy Center (HNMREC) at the University of Hawaii, under contract with Department of Energy, desires to expand the present test site to water depths of 100 meters to allow for the testing of other wave energy devices.

Sea Engineering has been contracted by the HNMREC to conduct site investigations in support of the development of the expanded test site. The surveys were completed in 2011, and included multibeam bathymetry, side scan sonar, sub-bottom profiling and remotely operated vehicle (ROV) video. Results of these surveys have been previously submitted as individual survey reports following completion of each survey. Following initial design analysis using the 2011 survey results, the WETS site was expanded 1000m to the west (Site 2) to accommodate the anticipated mooring footprint of the WEC devices. Additional bathymetry, sub-bottom and side scan surveys have been completed to characterize and map this expanded area.

The project location is shown in Figure 1-1. An aerial image of the 4.4 km^2 originally proposed test site is shown in Figure 1-2. The test site is 1,600 to 2,000 meters wide and extends approximately 2,600 meters offshore from the 30 meter depth contour to the approximate 100 meter depth contour. Figure 1-3 shows Site 2 extending 1000m to the west of the original WETS site.

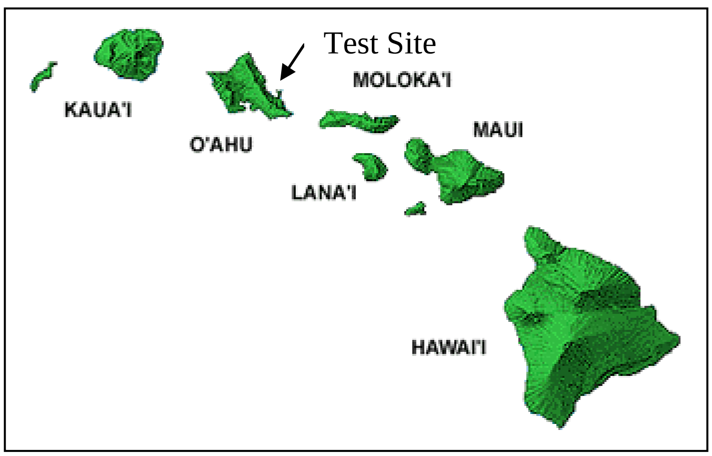

Figure 1-1. Project location.

Figure 1-2. Aerial image of project site (from Google Earth).

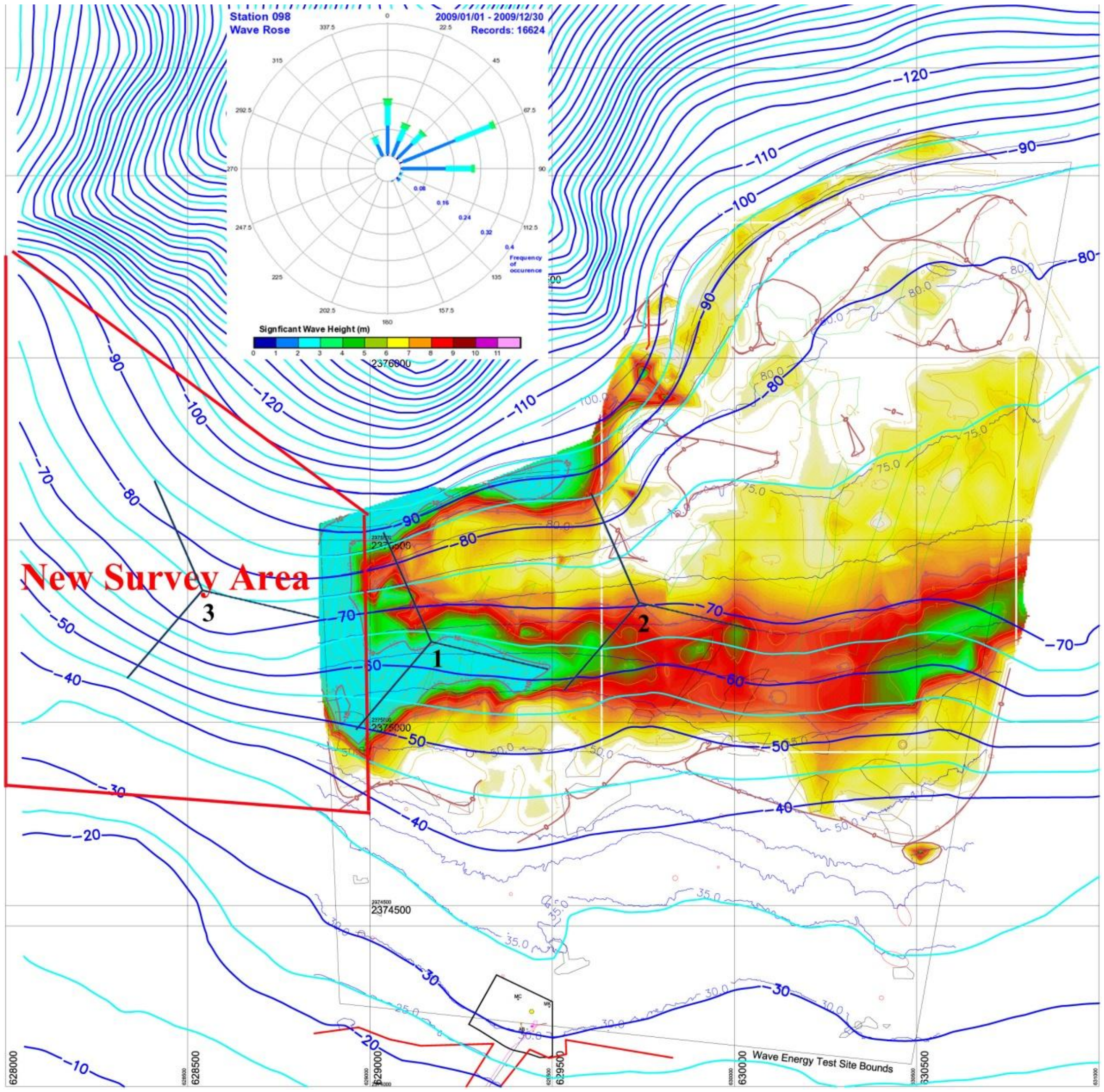

Figure 1-3. Site 2 – new survey area extending 1000m to the west of the original WETS site.

2. METHODOLOGY

2.1 Survey Schedule

Surveys were conducted during periods when sea conditions were favorable at the site. The schedule was as follows:

- Side scan sonar – May 16, 18, 2011; October 3, 2012; March 8, 2013
- Multibeam bathymetry – September 8-9, 2011; October 2-3, 2012
- Single beam bathymetry – October 3, 2012; March 8, 2013
- Sub-bottom profiler – November 17-18, 2011; July 7, 2012

2.2 Units and Coordinate System

The project coordinate system is the Universal Transverse Mercator (UTM), Zone 4, meters, NAD 83.

2.3 Navigation and Positioning

A differential GPS (DGPS) receiver utilizing the U.S. Coast Guard differential beacon correction was used for horizontal positioning. The U.S. Coast Guard operates a network of ground based reference stations that broadcast correction signals on marine radio beacon frequencies to improve the accuracy of GPS-derived positions. The typical accuracy of the DGPS position is 1 to 3 meters.

Hypack survey software was used to integrate the DGPS positions with the hydrographic and geophysical survey data. Static offsets (i.e. “layback”) for the towed sub-bottom profiler and side scan sonar were used during post-processing to generate corrected tracklines.

2.4 Multibeam and Single Beam Bathymetry Survey Methods

Sea Engineering conducted the multibeam survey using an Odom Echoscan multibeam echosounder system. The Odom provides 3 degree beamwidths. The multibeam was operated at 200 kHz with 30 beams and a 90 degree swath. The system was compensated for boat motion (heave, pitch, roll, and yaw) using an Teledyne DMS 25. Numerous quality control and quality assurance procedures are used to calibrate the multibeam system and ensure system accuracy. The depth limit of the Echoscan system is approximately 85m. Single beam bathymetry was collected using an Odom Hydrotrac in water depths greater than 85m.

2.4.1 Tide Corrections

Multibeam data were corrected to the MLLW datum using tidal data from the NOAA Mokuoloe tide gage (#1612480) in Kaneohe Bay.

2.4.2 System Draft Correction

The distance of the multibeam transducer head below the water surface is called the draft. The draft was measured on installation and checked using a standard hydrographic survey technique known as a “bar check”. The bar check consist of lowering a calibration plate a short distance below the multibeam transducer head. A draft correction is input into the system processor until the correct reading is obtained.

2.4.3 Sound Velocity

The velocity of sound is a critical component for hydrographic survey measurement. Sound velocity changes with water temperature and salinity variations. Sound velocity casts to 90 meter were periodically taken with an Odom Digibar.

2.4.4 Patch Test

The patch test procedure is a standard operational test to determine the installation configuration of the multibeam transducer head. The procedure consists of collecting data over short line segments at various speeds, offsets, and directions. Comparison of the data within the processing software allows calculation of the following parameters:

- System latency – the processing time lag in the GPS navigation device
- Multibeam pitch – the fore and aft angle of the multibeam head
- Multibeam roll - the port and starboard angle of the multibeam head
- Multibeam yaw- the angle of the multibeam with respect to boat heading.

2.4.5 Multibeam processing

The multibeam data were processed using Hypack/Hysweep hydrographic survey software. The software incorporates the system correction from the patch test results, as well as the transient corrections for heave, pitch, roll, and heading from the system motion sensors. Data spikes and other errors are edited from the data set. The edited data set is further reduced by dividing the survey area into a grid of cells, and averaging the data within those cells.

2.5 Side Scan Sonar Methods

A side scan sonar transmits acoustic signals with wide vertical beam widths out to either side of the sonar towfish. A receiver then records the signals that are reflected back from the seafloor to the towfish. Hard bottom areas and features produce more intense reflections than sediments. The result is a plan view acoustic image of seafloor characteristics. Areas with no reflection, because they lie behind or are blocked by an object, appear white, and are indicative of an object protruding above the seafloor.

For this survey a C-MAX CM2 Side Scan Sonar system was utilized. The CM2 system contains dual 325 and 780 kHz transducers. The 325 kHz transducer was used for the survey. Survey lines were conducted at intervals of 100 meters. The side scan range was set at 100 meters (328 feet) per side, for a 200 meter (656 foot) swath width. This allowed a data overlap of over 100% per side, or over 200% total coverage – i.e. each point on the bottom was imaged at least two times.

Side scan data were reviewed on-site using C-Max Maxview software and post processed into a GeoTiff mosaic imagery using SonarWiz software. The data lines with the best overall imagery were selected for inclusion into the sonar mosaic.

2.6 Sub-bottom Profiling Methods

Geophysical sub-bottom profiling systems are a form of echo-sounder that uses lower acoustic frequencies to penetrate into the substrate. A sub-bottom system transmits an acoustic signal directly below the towfish. A portion of the acoustic signal is reflected back from the seafloor while a portion penetrates the sediment layer. A receiver records the signals that are reflected back from the seafloor and underlying substrate. The time delay between the signal returns allows for the differentiation of sediment layers. Where common echo-sounders may use an acoustic frequency in the vicinity of 200 kHz, sub-bottom system frequencies are typically between 500 Hz and 20 kHz. The term sub-bottom refers to a generally hard layer of sediment or rock that underlies recent soft sediment deposition. The lower the acoustic frequency, the deeper into the bottom the system can penetrate.

For this survey, an EdgeTech 0512i "chirp" sub-bottom profiler was used with an EdgeTech 3200XS processing system. The EdgeTech 0512i system is a specialized system for use in coarse sand environments. Different signal pulses are available with the system for use in different terrains. The optimal pulses for substrates in Hawaii have been found to be 500 Hz to 7 kHz and 700 Hz to 12.0 kHz. This is a low frequency range, but necessary for penetration into the coralline limestone sands and gravels found in Hawaii. The 500 Hz to 7 kHz pulse was used for this survey.

Survey tracklines were spaced 100 meters apart, oriented both parallel and perpendicular to shore.

The sub-bottom data were reviewed with EdgeTech software and sub-bottom horizons were digitized for processing. Sediment thickness data were contoured using Digital Terrain Model (DTM) software, and final charts created using AutoCAD.

3. SURVEY RESULTS

3.1 Multibeam Bathymetry Survey

Results of the multibeam survey are presented in
Figure 3-1.
Figure 3-1 shows the bathymetry of the entire area with 1-meter contour intervals.
Key features of the seafloor in the area include the following:

- The nearshore portion of the project area, between depths of 30 to 35 meters is relatively featureless and flat, with slopes ranging from 1V:34H to 1V:54H.
- A steeply sloping, irregular bottom is present at water depths between 35 and 45 meters. Slopes as steep as 1V:8H occurs between 40 and 45 meter water depths.
- Between depths of 50 to 75 meters, the seafloor appears featureless, with little vertical relief, and typical slopes of 1V:25H.
- Between depths of 75 and 85 meters in the northeastern corner of the project site, the bottom is relatively flat (1V:65H), and has barchan bedform features. The multibeam results indicate that the barchans are approximately 1.5 meters high, 150 to 200 meters long, and up to 100 meters wide. They do not appear to be connected. Barchans are arcuate, isolated dune forms, characteristic of an environment with a limited supply of sand.
- In the western portion of the site, at water depths deeper than 55 meters, the bottom slopes steeply into a pronounced submarine canyon.

3.2 Sub-bottom Profiler Survey

The sub-bottom survey was completed along tracklines spaced 100 meters apart, oriented both parallel and perpendicular to shore. The subbottom survey showed an offshore morphology consisting of a series of terraces, or shelves formed during ancient low sea level stands by wave-induced erosion of the reef limestone. The terraces have a stair-step appearance, with the wide, gently sloping surfaces separated by steeper slopes or scarps. The terrace surfaces are often buried by wedge-like deposits of sediment, typically sand. This morphology is common in the Hawaiian Islands.

Figure 3-2 presents contour charts of the measured sediment thickness. Sediment thickness is greatest along the west side of the project area where a large area up to 500m wide appears to contain sediment greater than 10 meters thick.

3.3 Side Scan Sonar

Results of the side scan survey are presented in Figure 3-3. Figure 3-3 shows a side scans mosaic of the entire area. Proposed mooring anchor locations are labeled in red. Figures 3-4 to 3-12 present high zoom, high resolution side scan snap shots of the proposed mooring locations and the cable route.

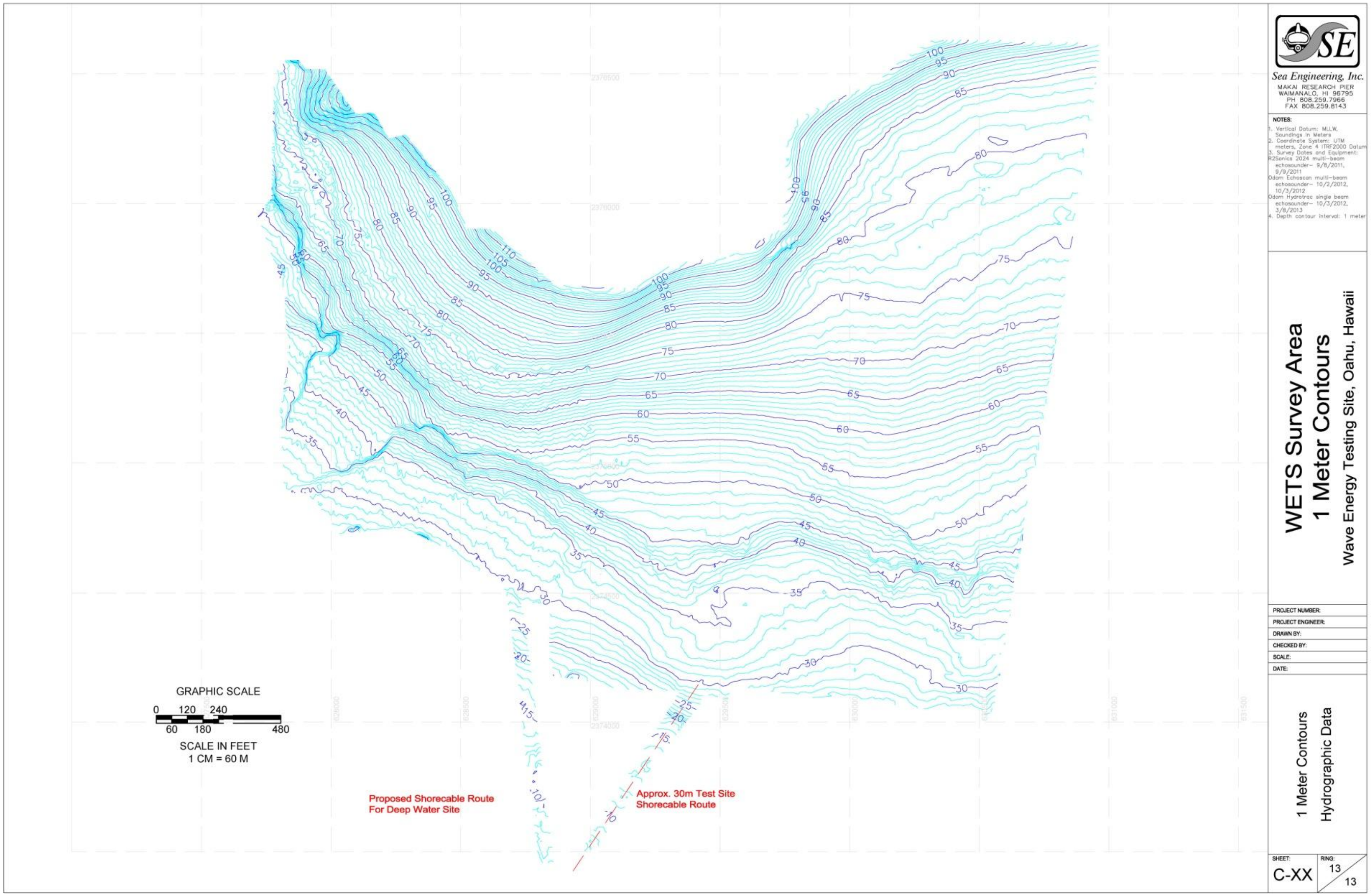

Figure 3-1. Wave energy test site bathymetry (1 meter contour interval).

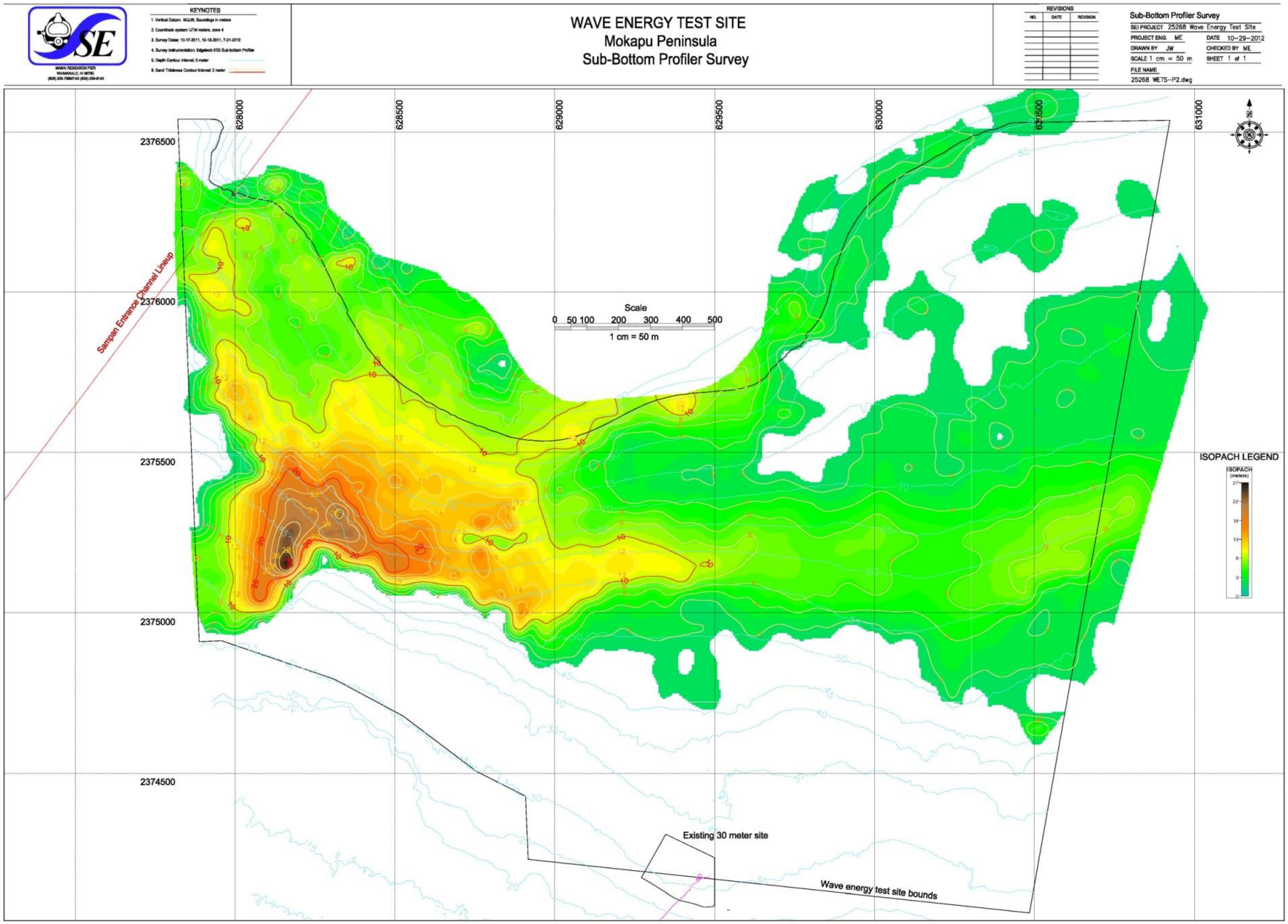

Figure 3-2. Sediment Thickness in Project Area

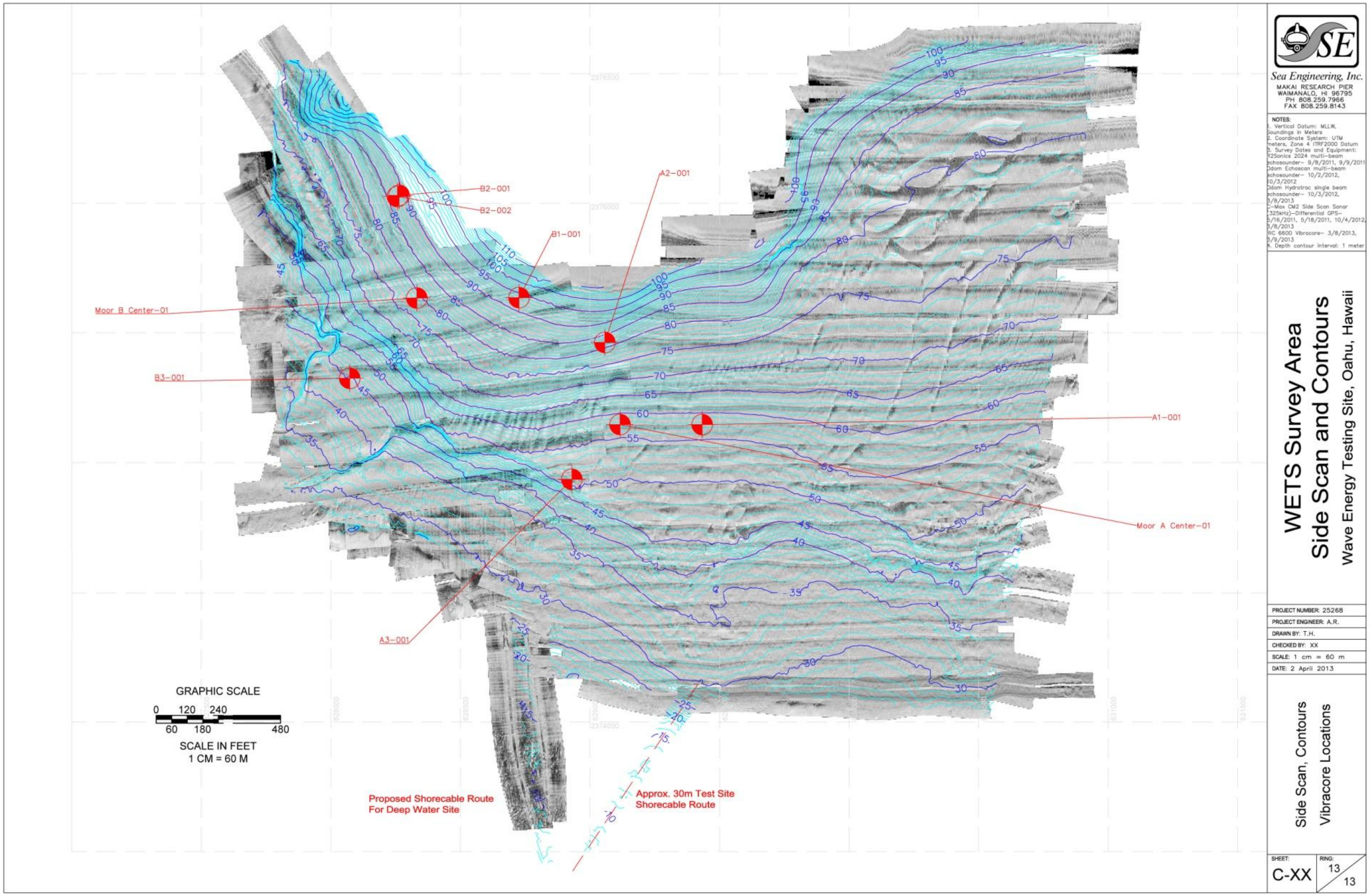

Figure 3-3. side scan mosaic of WETS

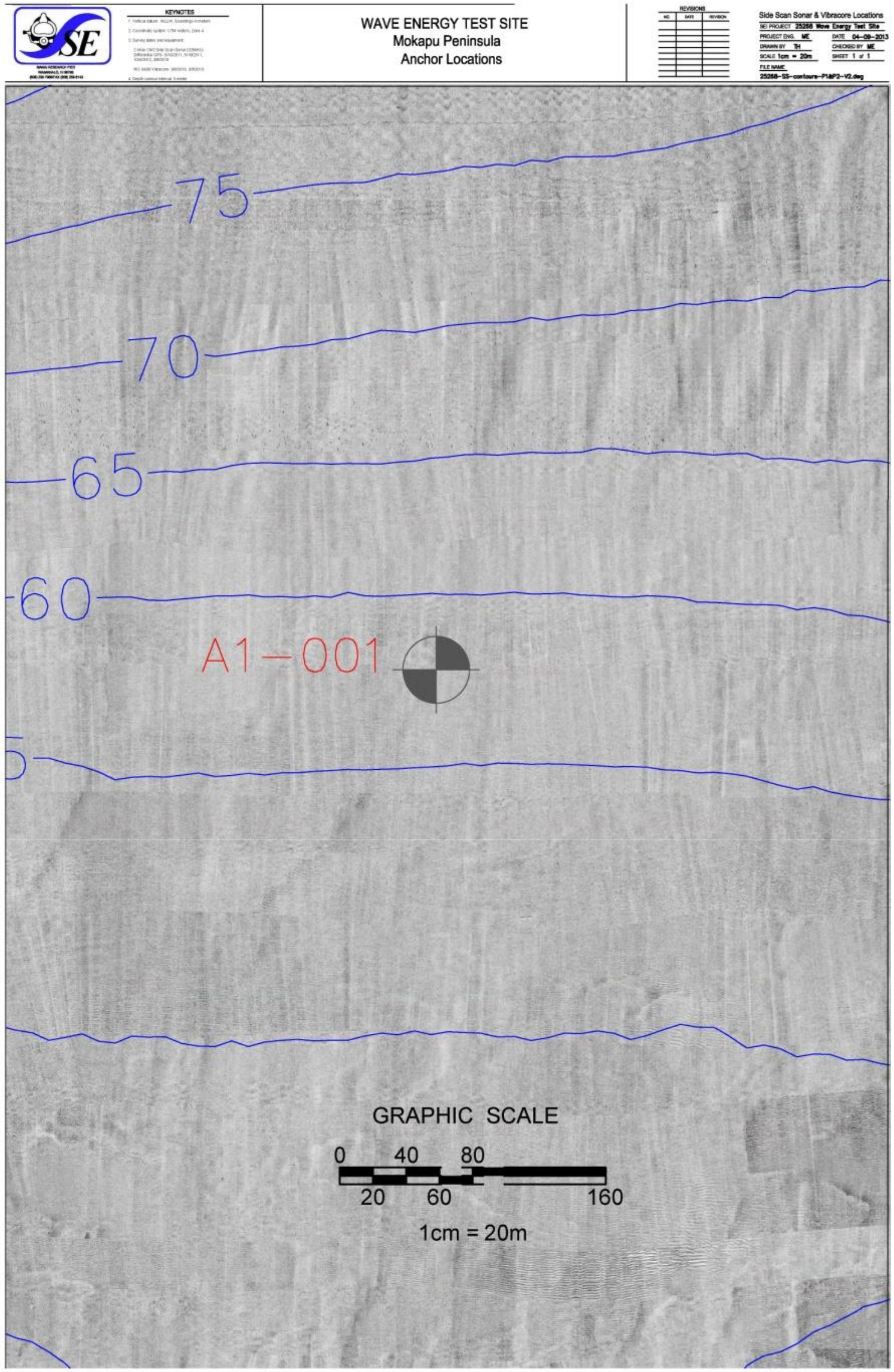

Figure 3-4. Side scan snap shot of location A1-001

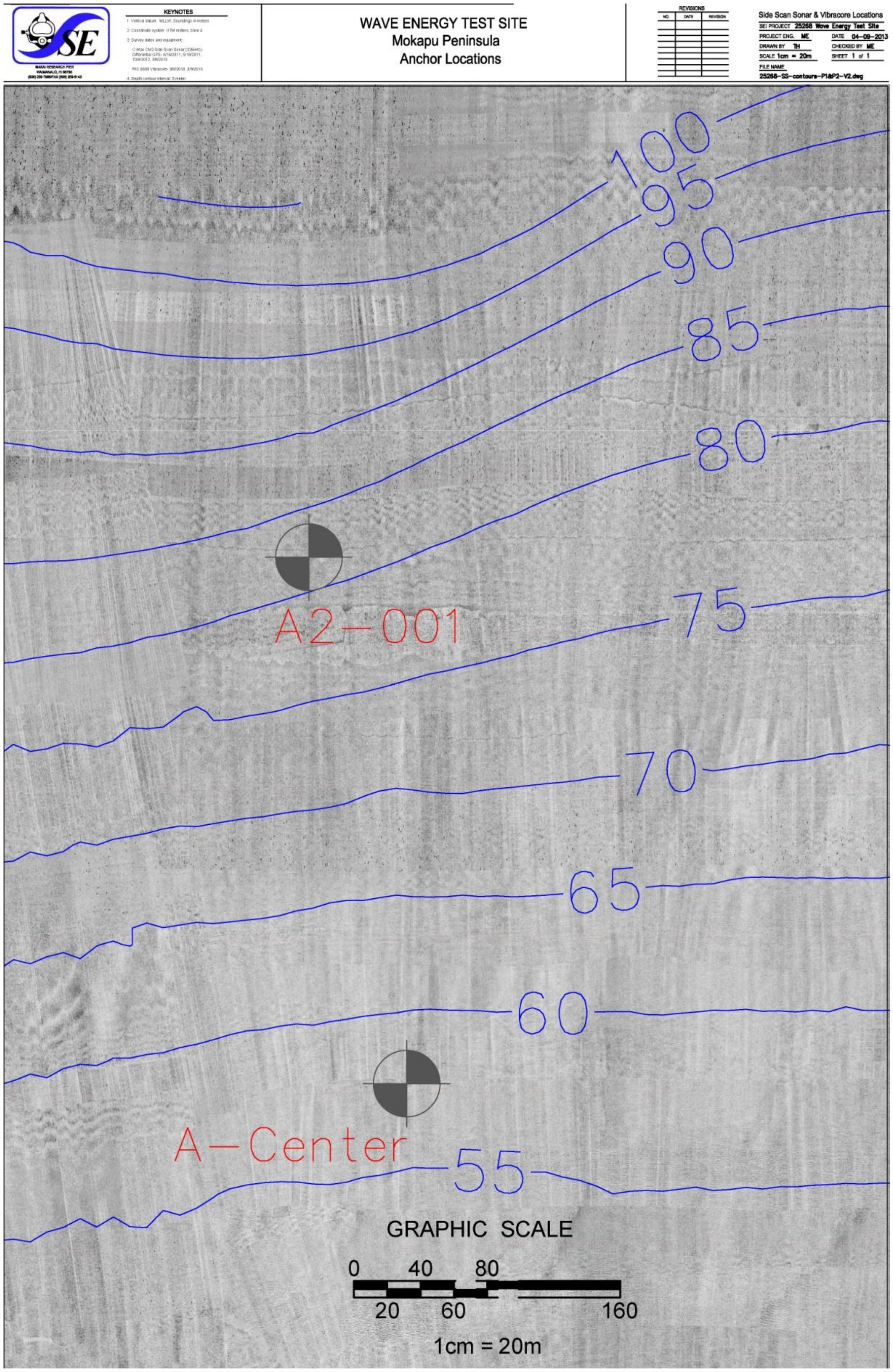

Figure 3-5. Side scan snap shot of location A2-001

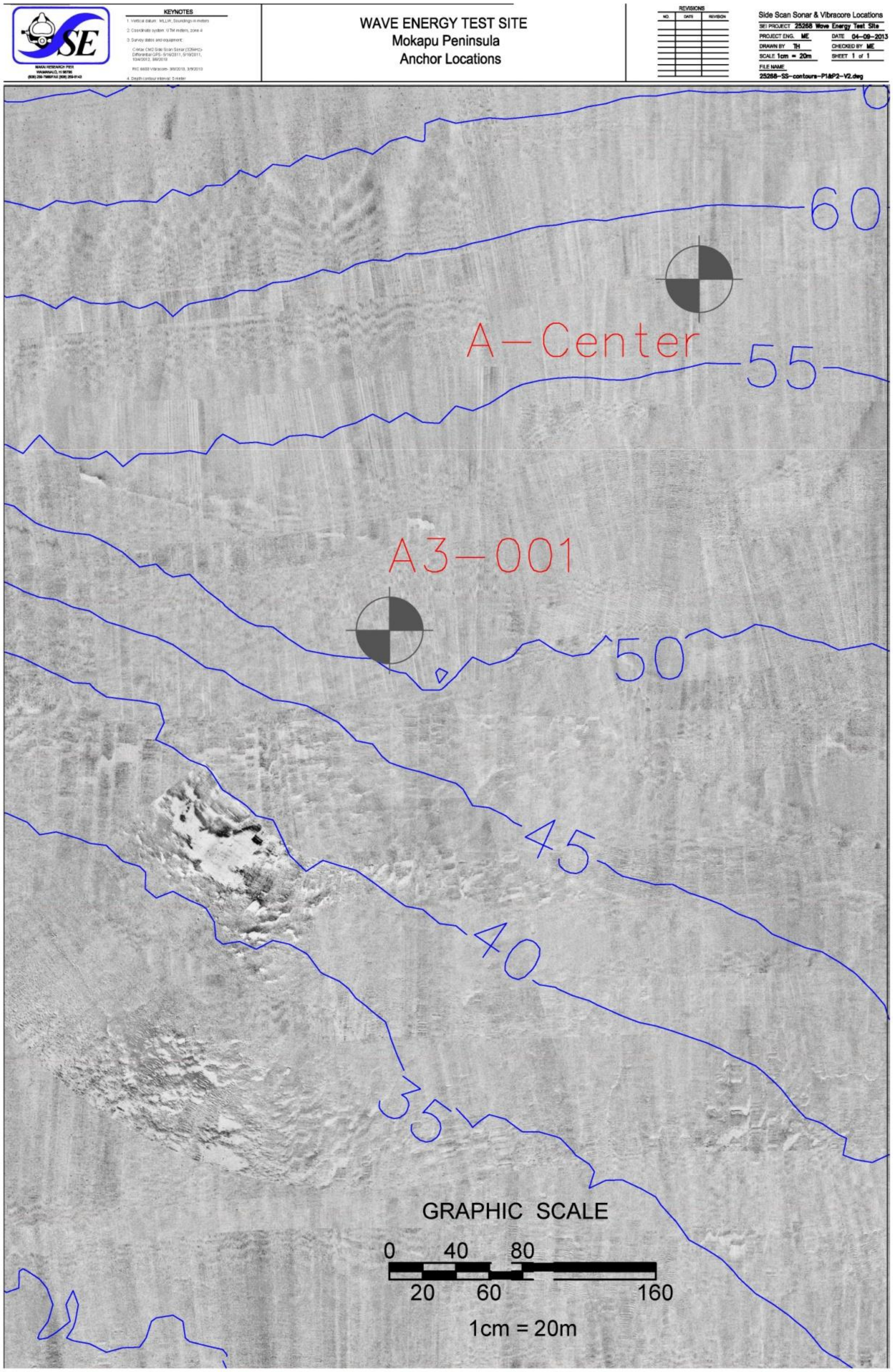

Figure 3-6. Side scan snap shot of location A3-001

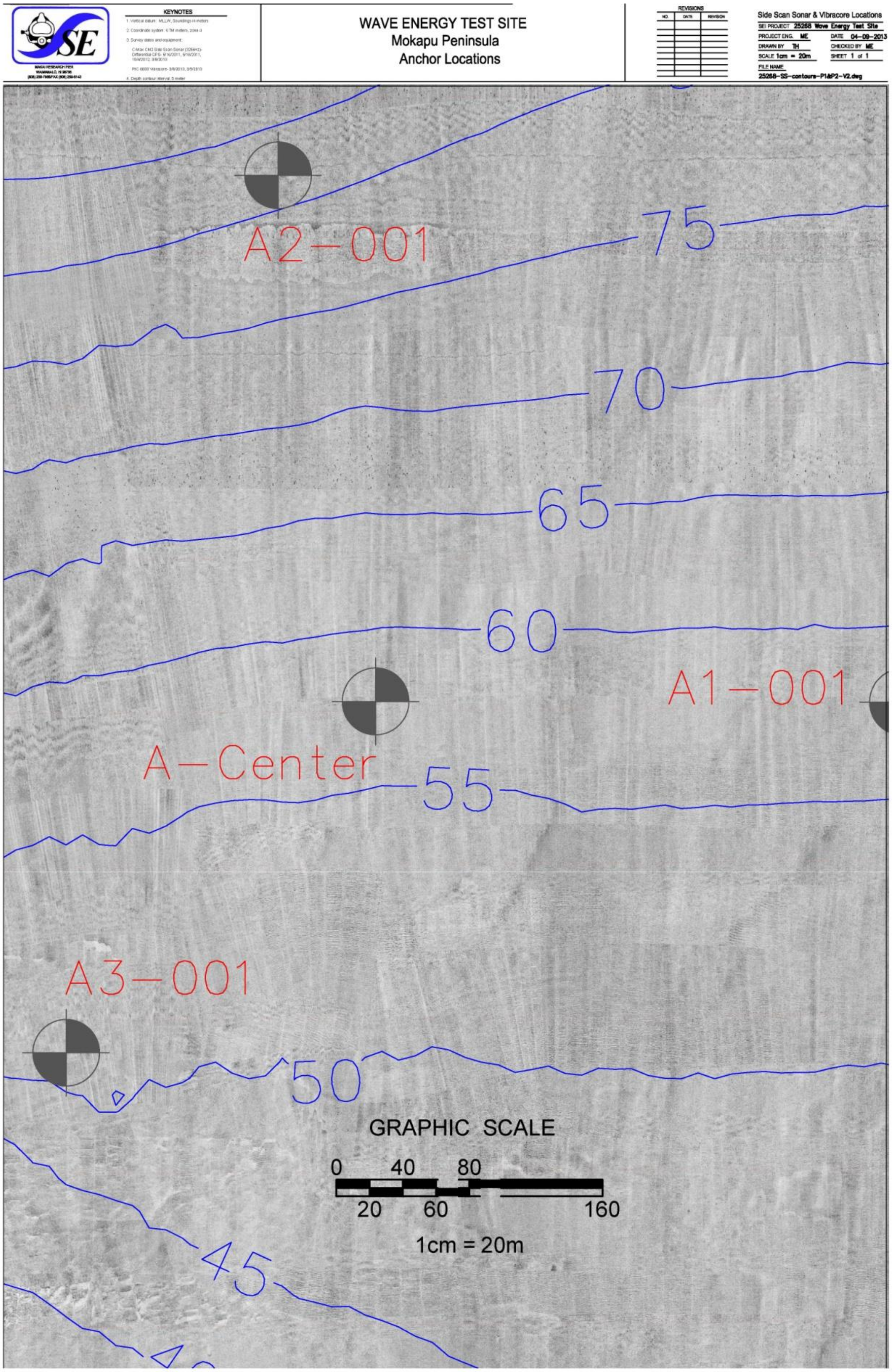

Figure 3-7. Side scan snap shot of location Moor A Center

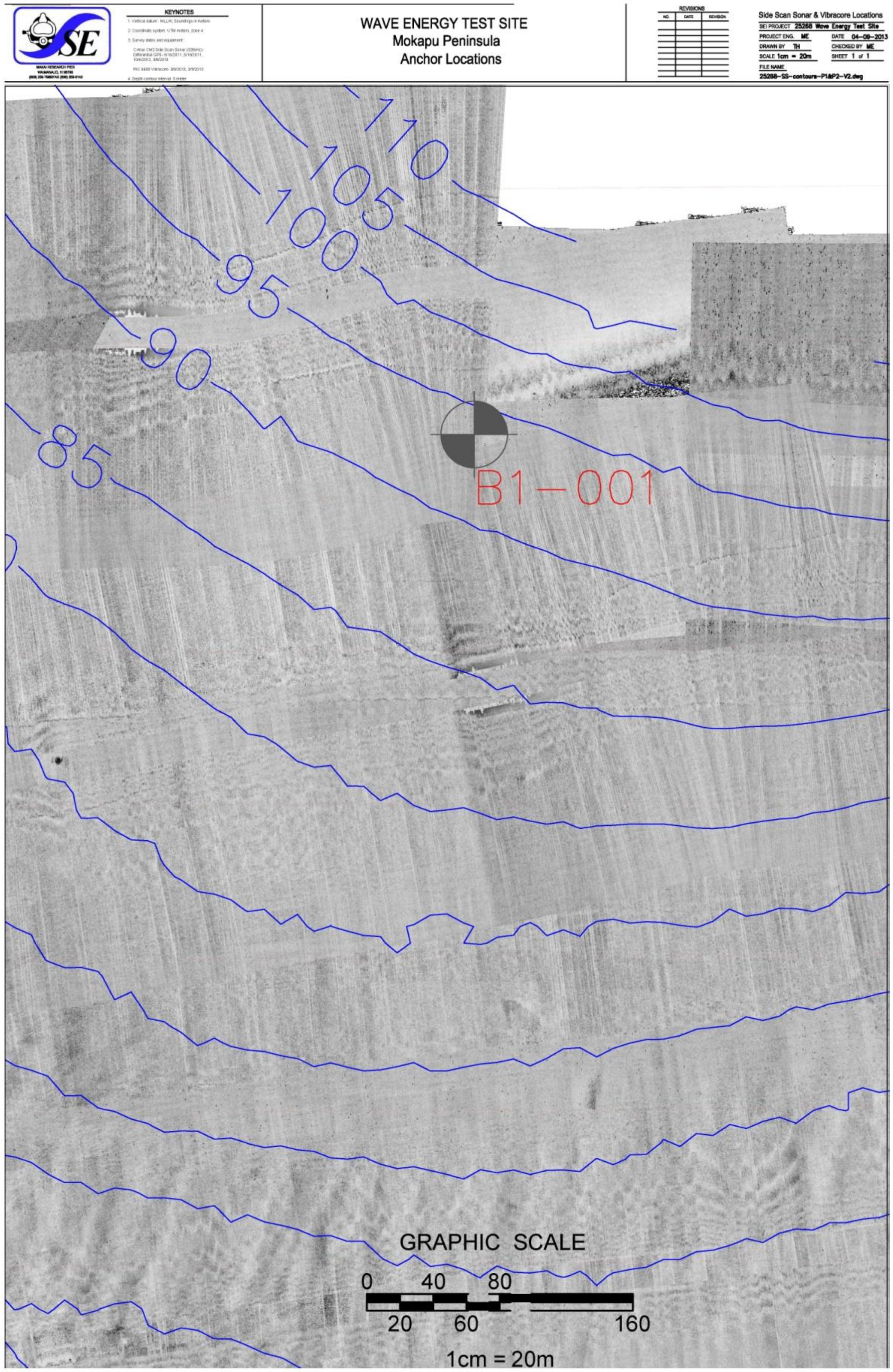

Figure 3-8. Side scan snap shot of location B1-001

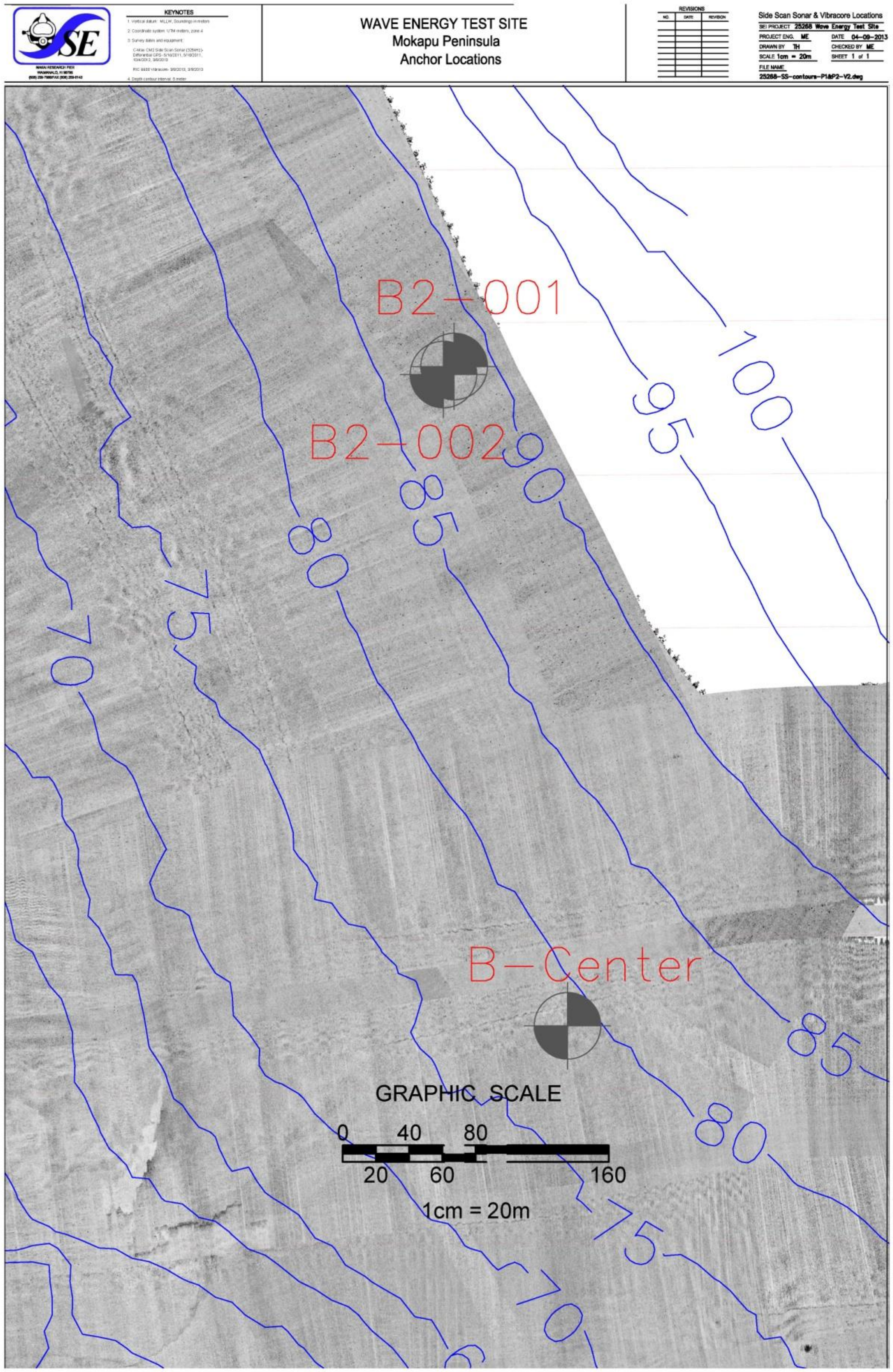

Figure 3-9. Side scan snap shot of location B2-001

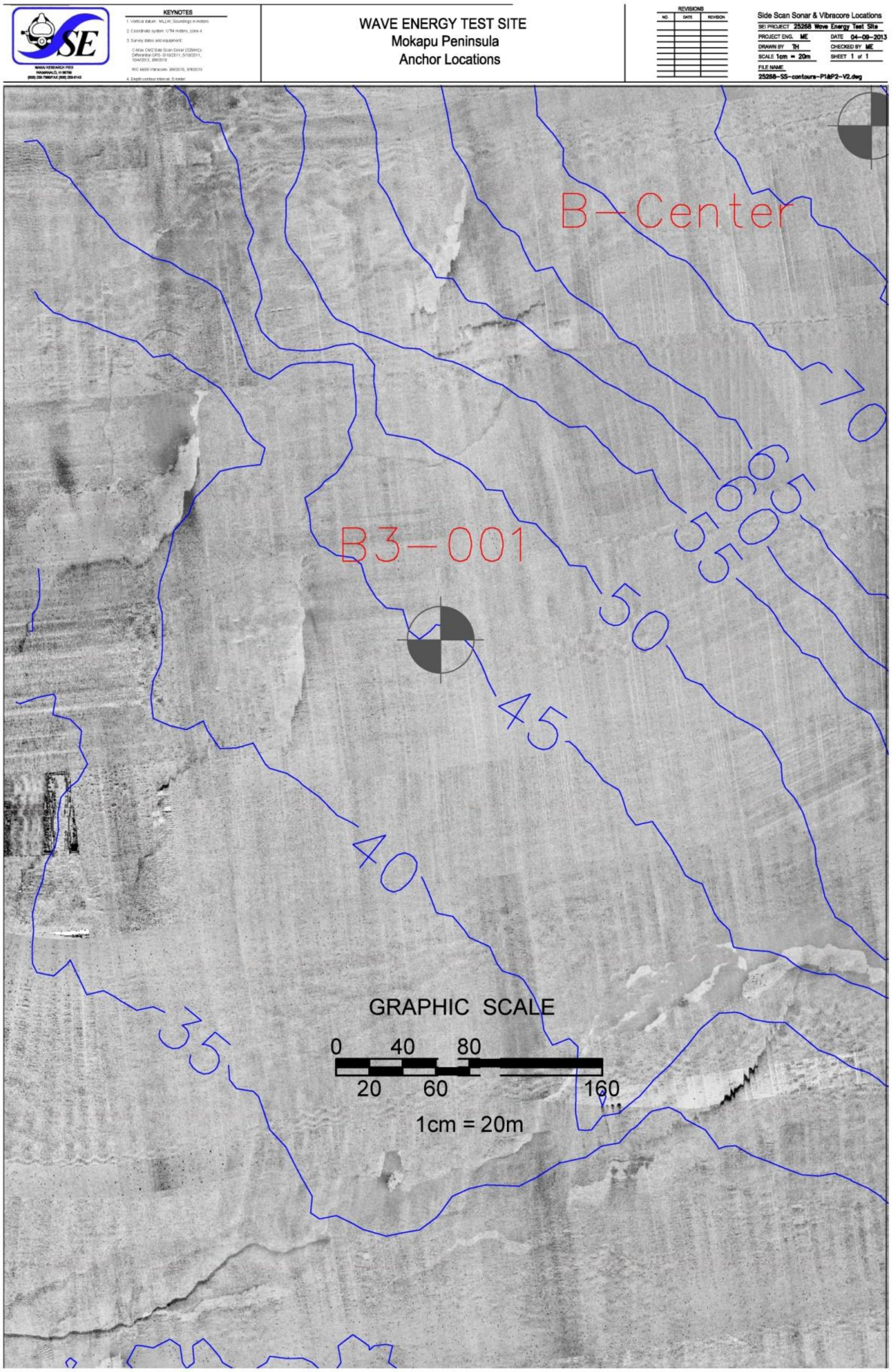

Figure 3-10. Side scan snap shot of location B3-001

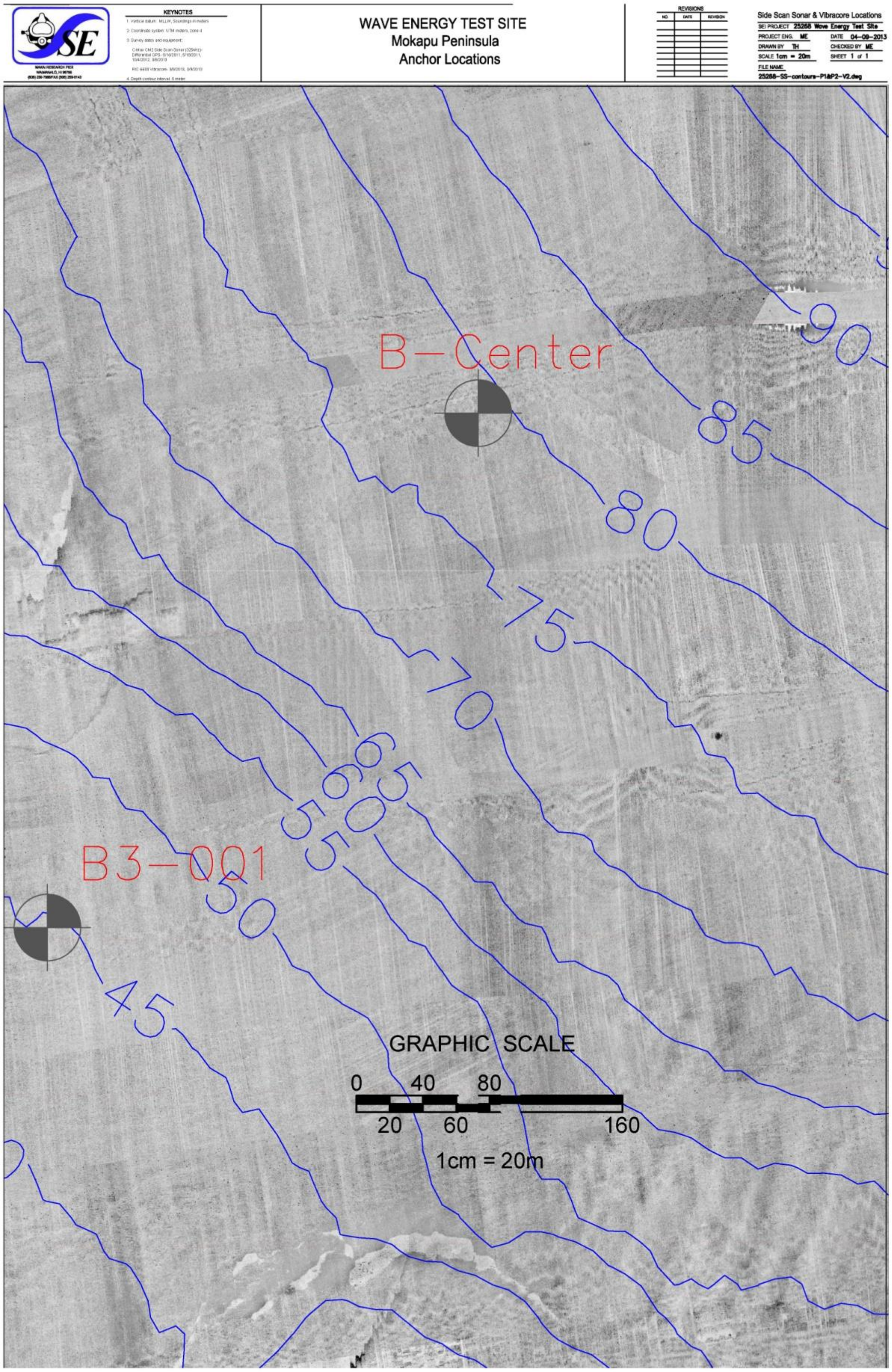

Figure 3-11. Side scan snap shot of location Moor B Center

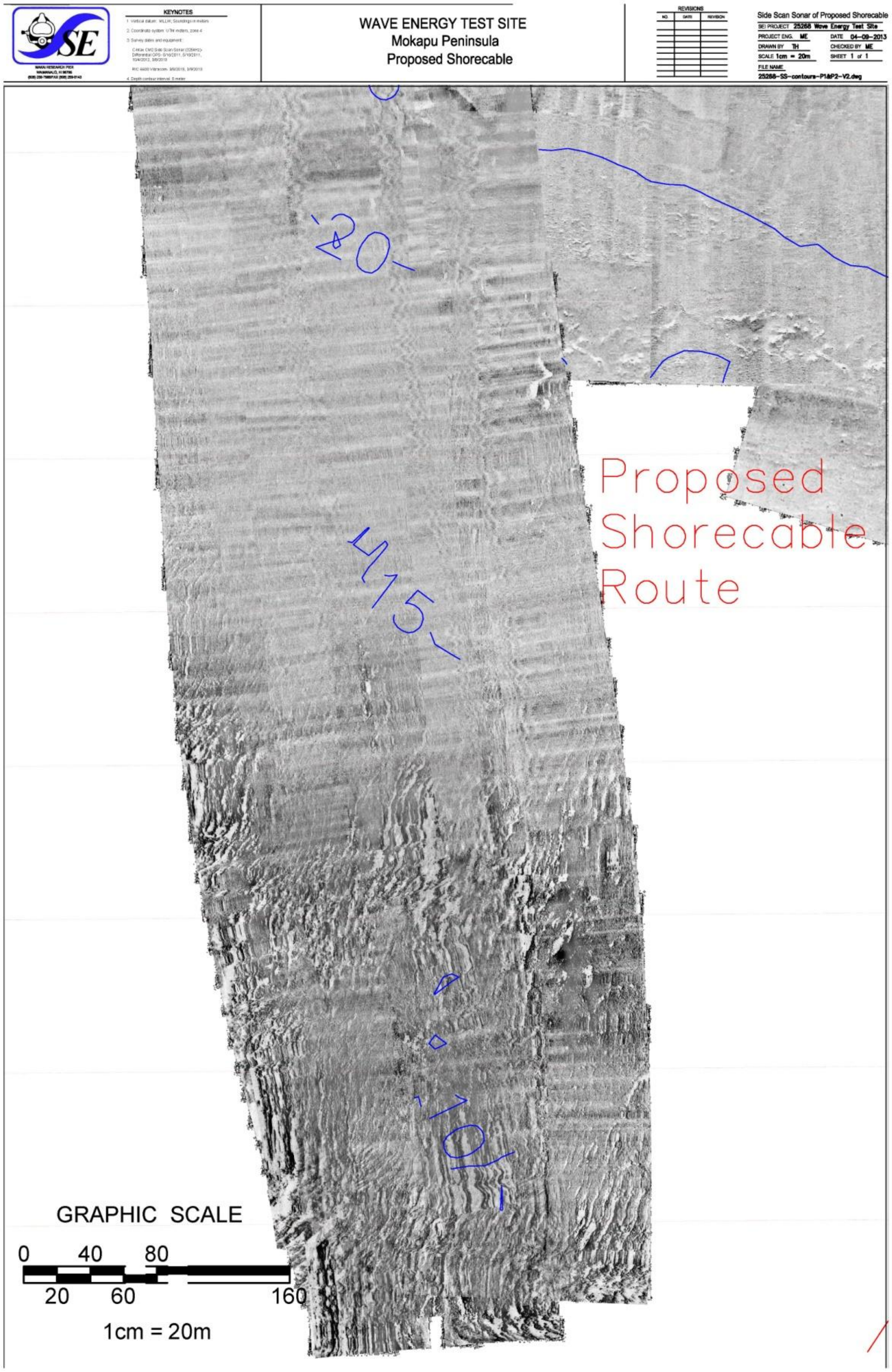

Figure 3-12. Side scan snap shot of location Shorecable route