

## 7.0 Project Reports

### 7.1 *Geophysical Mapping of Submarine Environments*

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#### 7.1.1 METHODS

In April 2000 we deployed the R/V Onrust, operated by MSRC at SUNY Stony Brook, for 2 days of high resolution geophysical mapping within Jamaica Bay. Multibeam sonar, side-scan sonar and Chirp subbottom profiler data were collected as well as 4 sediment cores for the Rubenstone/Chillrud effort. Our survey operation was conducted out of Kingsborough Community College, CUNY, located on Sheepshead Bay. The first survey day focused on the inlet to Jamaica Bay between Sheepshead Inlet and the Marine Park Bridge and only the high resolution multi-beam mapping system was deployed. During the second survey day two circumferences of the entire Bay were made targeting, where water depths permitted, the interface from the deep channel to the tidal flats. For this work we deployed the multibeam bathymetric tool, the side scan sonar system and the high resolution chirp sonar. Descriptions of each of these instruments and the data processing procedures carried out are provided in the following section.

##### 7.1.1.1 Multibeam sonar

Multibeam data were acquired using an EM 3000 sonar, a 300 kHz system which provides co-registered depth and backscatter data for 120 beams over a swath width that is four times the water depth. Sonar beams are each nominally 1.5° wide and spaced 0.9° apart. In water depths of 10 m and at typical survey speeds of 8 kts, the sonar footprint is ~30 cm. The nominal depth resolution is 10 cm. Navigation and orientation data for the multibeam sonar are obtained using a POS/MV attitude sensor. A differential GPS system (supplemented by inertial navigation; also part of the POS/MV system) enables ship positioning to within 1 meter. During survey operations, real time differential corrections were provided by Omnistar. CTD casts were conducted to obtain sound velocity profiles which were integrated into the data acquisition to provide corrections for acoustic ray bending through the water column. Tide gauges were deployed to determine local sea level changes during the survey.

Processing of the multibeam data involved editing of navigation and ping files for erroneous values. During ping editing the sonar data from approximately 80 pings at a time were reviewed and outliers were flagged and excluded during final map generation. Depth data were then corrected for tidal fluctuations during the survey and gridded at a 2 m interval to create a digital terrain map (Figure 7.1-1). A sun-illuminated image was also created by shining a synthetic sun across the digital terrain map. The sun-illuminated image reveals small bathymetric features which are often difficult to resolve in contoured bathymetry data (Figure 7.1-2).

##### 7.1.1.2 Side Scan Sonar

The side scan sonar system used for this program was an Edge Tech DF-1000 dual frequency sonar with a Triton Elics ISIS data acquisition topside. The system acquires data at two frequencies (100Khz and 384 kHz) and was operated with a total swath width of 400m (200m port and starboard). The Triton Elic topside unit also recorded several auxiliary data streams including the ship's compass heading provided by a KVH compass, real time navigation

obtained from a Trimble AG-132 unit with differential corrections provided by Omnistar, as well as the navigation stream from the POS/MV system used with the EM3000.

The sidescan vehicle was towed from the stern port side of the RV Onrust. Tow points for the side-scan fish were surveyed in, so that layback corrections could be applied during post-processing. The layback corrections account for the offset between the GPS antenna mounted on the ship and the location of the side scan tow fish.

Following the field program the raw field data were demuxed, merged with layback corrected final navigation and digitally mosaicked using an in-house side-scan sonar processing package. Mosaicking was carried out assuming a flat bottom for positioning of side-scan pixels across each swath. Adjoining side-scan swaths were systematically seamed at their point of overlap. Mosaics of both the 100kHz and 384 kHz sidescan data are shown in Figure 4.1-3 and Figure 7.1-4. Navigation for the sidescan and Chirp subbottom data are shown in Figure 7.1-5.

#### 7.1.1.3 Chirp

Subbottom data were acquired using the X-Star topside data acquisition unit and the SB 4-24 tow fish, both manufactured by Edge Tech. This is a Chirp or swept frequency sonar system, which emits a broadband FM source pulse with low frequencies providing depth penetration into the subbottom and higher frequencies providing high vertical resolution. The X-Star acquisition unit controls all data transmission, recording and signal processing including Analogue to Digital (A to D) conversion, compression of the FM pulse and spherical divergence correction. The recorded signal is the output of the correlation filter used for pulse compression and is stored in SEG-Y format.

Data were acquired at a transmission rate of 5-6 pings/second. Survey speeds for the combined sidescan/subbottom survey were ~5 knots. At this speed, the Chirp transmission rates provide one trace for each 0.83 m of ship motion. Pulse power was set at 50-60% of maximum available output in order to avoid ringing and generation of cross-talk interference with the side scan sonar data. The SB 4-24 tow vehicle offers the ability to transmit a variety of pulses with a frequency range from 4 to 24 kHz. For this survey, the lowest frequency sweep pulse (4 to 16 kHz) was chosen to obtain maximum possible penetration with this fish.

The Chirp vehicle was towed from the stern starboard corner using a tow line to keep the fish to the side. Tow points for the subbottom fish were surveyed in, so that layback corrections could be applied during post-processing. Real time GPS navigation was passed from the Trimble AG-132 unit directly to the X Star acquisition unit via an RS-232 serial port. Problems with the data recording system prevented acquisition of Chirp data during the portions of the survey within the western Bay ( Figure 7.1-5, JWN001 and JWN002).

Processing of the Chirp sub-bottom data was carried out using a combination of in-house code for reading the raw data files and the Seismic Unix package maintained by the Colorado School of Mines. Processing steps include demux of the field data and merging with final layback corrected navigation. Chirp technology incorporates signal processing techniques into the control units that automatically deconvolves the wide-band signal pulse during data acquisition. Hence deconvolution for pulse compression is not needed as a post-processing step. Spherical divergence corrections are also applied within the data acquisition unit.

Images of the Chirp data are shown in Fig 4. For each line the total data range is scaled to 256 grey levels, and the grey level legend is displayed on the right hand side of each image. Data are

plotted in seconds two-way travel time (twtt). Assuming a sound velocity of 1500 m/s, 0.005 sec twtt is equivalent to 3.75 m.

### 7.1.2 RESULTS

The geophysical survey has enabled us to define the major sedimentologic terrains within Jamaica Bay. These include a high energy regime close to the Marine Park Bridge where large-scale sediment waves are observed, the narrow, possibly erosional marginal channels - also characterized by intermittent sediment waves, and the deep depositional site in Grassy Bay. We had hoped to image the linkage between the marsh and the channels but were unable to detect the marsh structure in the sidescan data. This may be the result of the early spring time of our deployment.

Very minimal penetration into the sediments below the seafloor was observed with the Chirp subbottom data. This lack of penetration is likely due to the presence of methane gas bubbles within the shallow sedimentary section. In many places the gas appears to reach the seafloor giving rise to a strong seafloor reflection. Elsewhere the gas appears to lie a few 10s of cm below the seafloor (e.g. within Grassy Bay, Figure 7.1-6 and Figure 7.1-7). These differences may reflect regional variations in biological activity dependent on sedimentologic terrain. These differences could also reflect changes in the solubility of methane as a function of bottom temperature and salinity.

The 384 kHz side-scan sonar mosaic (Figure 4.1-3) reveals low backscatter, presumably fine-grained sediments covers the seafloor throughout most of the region surveyed. In contrast, the 100 kHz data (Figure 7.1-4) reveals high backscatter associated with the floor of the main channels through the Bay. Due to the lower frequency, the 100 kHz sonar can penetrate up to a few 10's of cm into the shallow subsurface. The high backscatter observed with these data could reflect shallowly buried coarse grain material or methane gas presence. Grassy Bay is a low backscatter region in both the 100 and 384 kHz data consistent with the presence of a thicker section of fine-grained sediment than elsewhere within the Bay.

Outstanding questions are the relative transport of sediment from the marshes into the main channel and the portion of the sediment budget being deposited in Grassy Bay. Other questions include what is the origin of the regional variations in methane gas content suggested by the geophysical data.

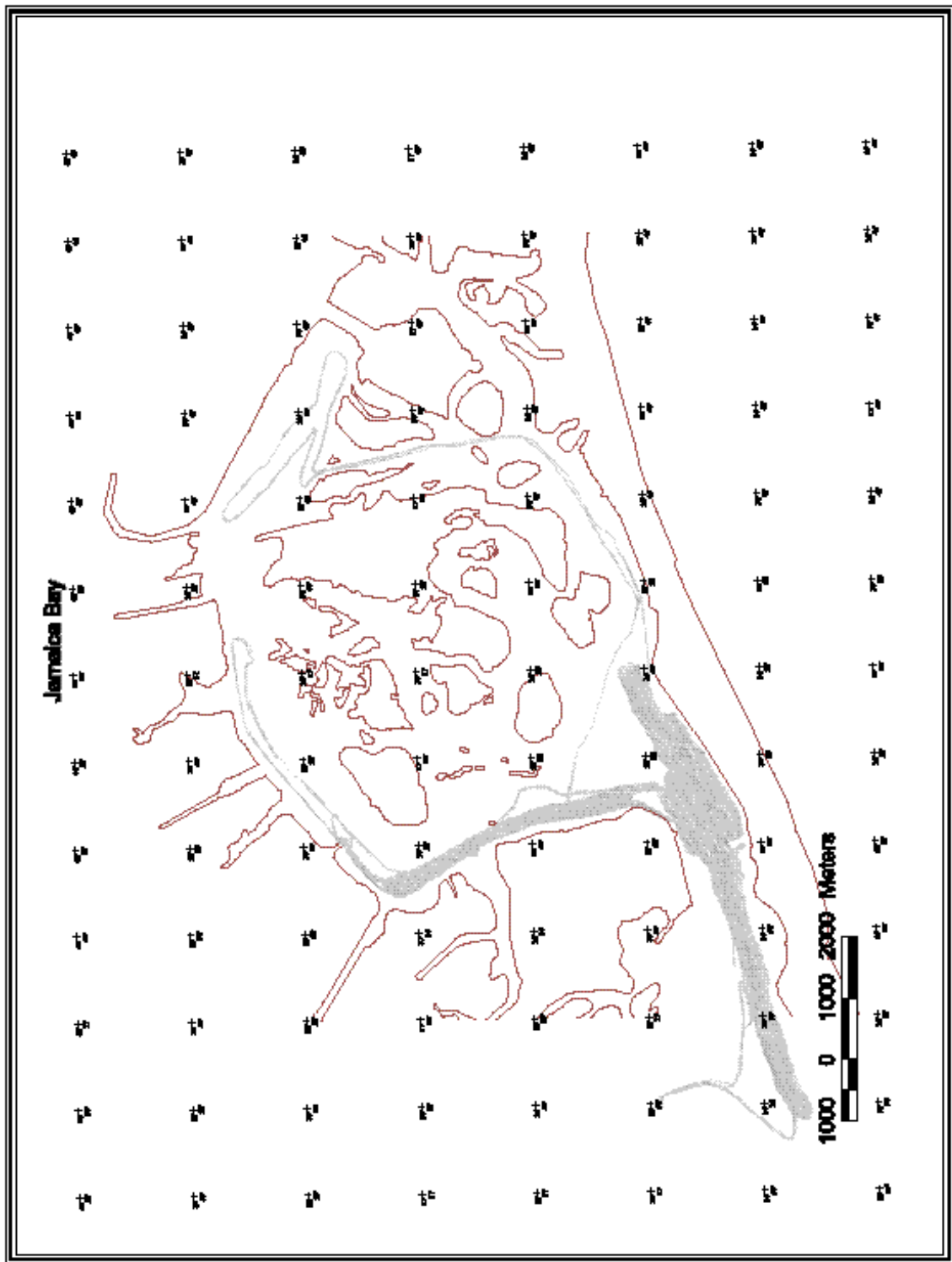


Figure 7.1-1

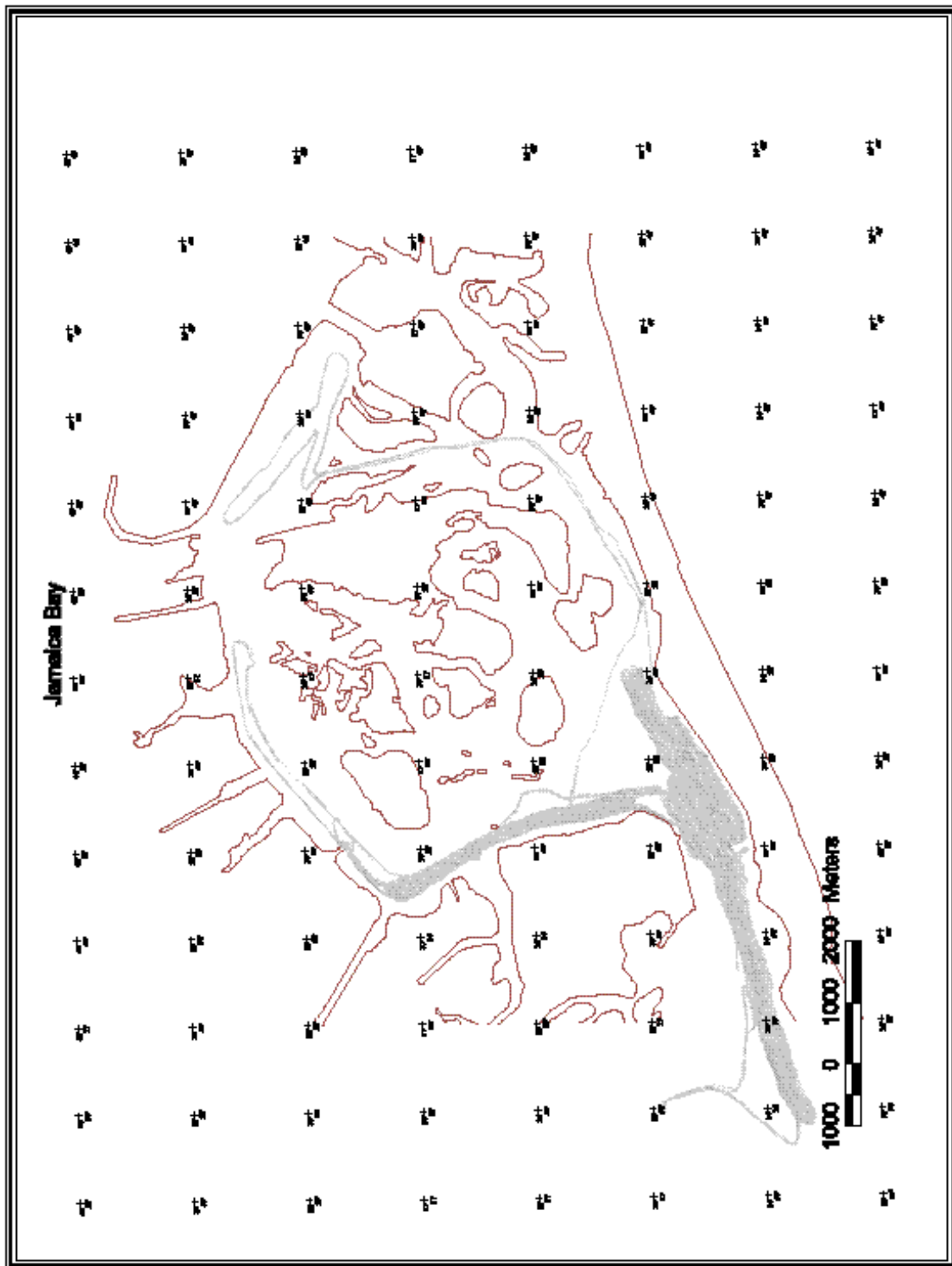


Figure 7.1-2

Jamaica Bay 1 - Sidescan Freq. 384 kHz

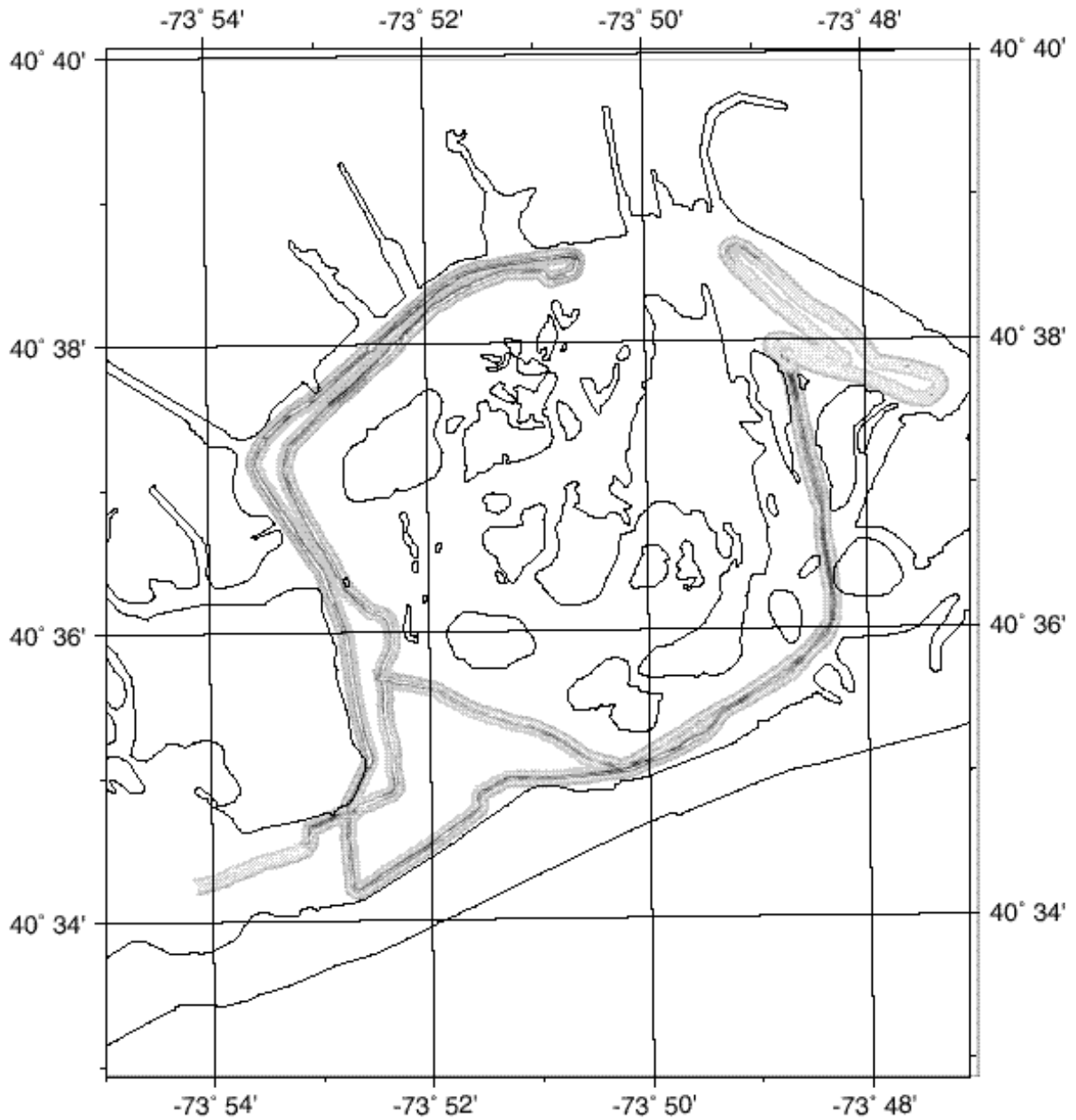


Figure 7.1-3

Jamaica Bay 1 - Sidescan Freq. 100 kHz

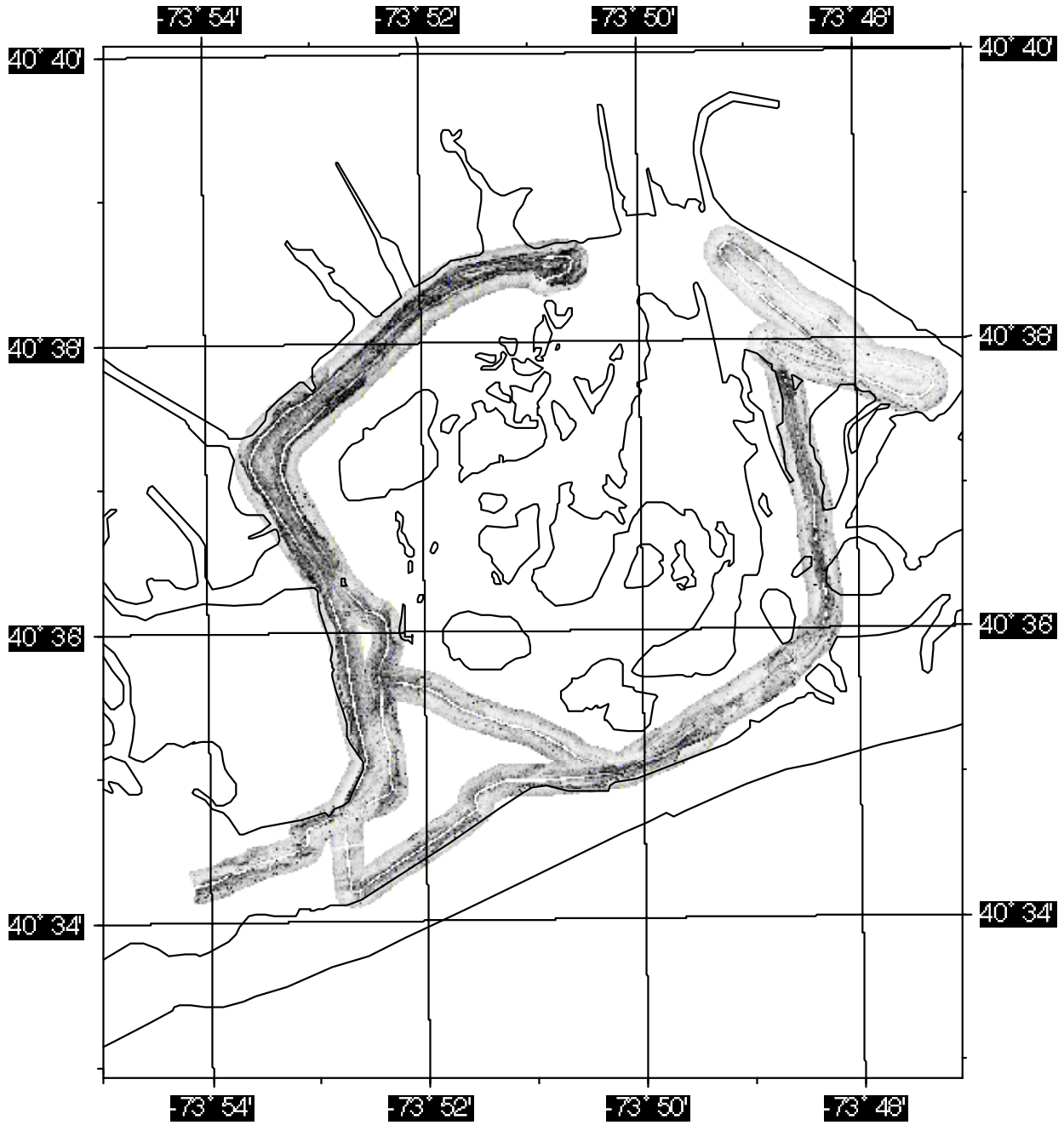


Figure 7.1-4

CGIF - Jamaica Bay Survey Navigation

Side-scan and Chirp sonar lines

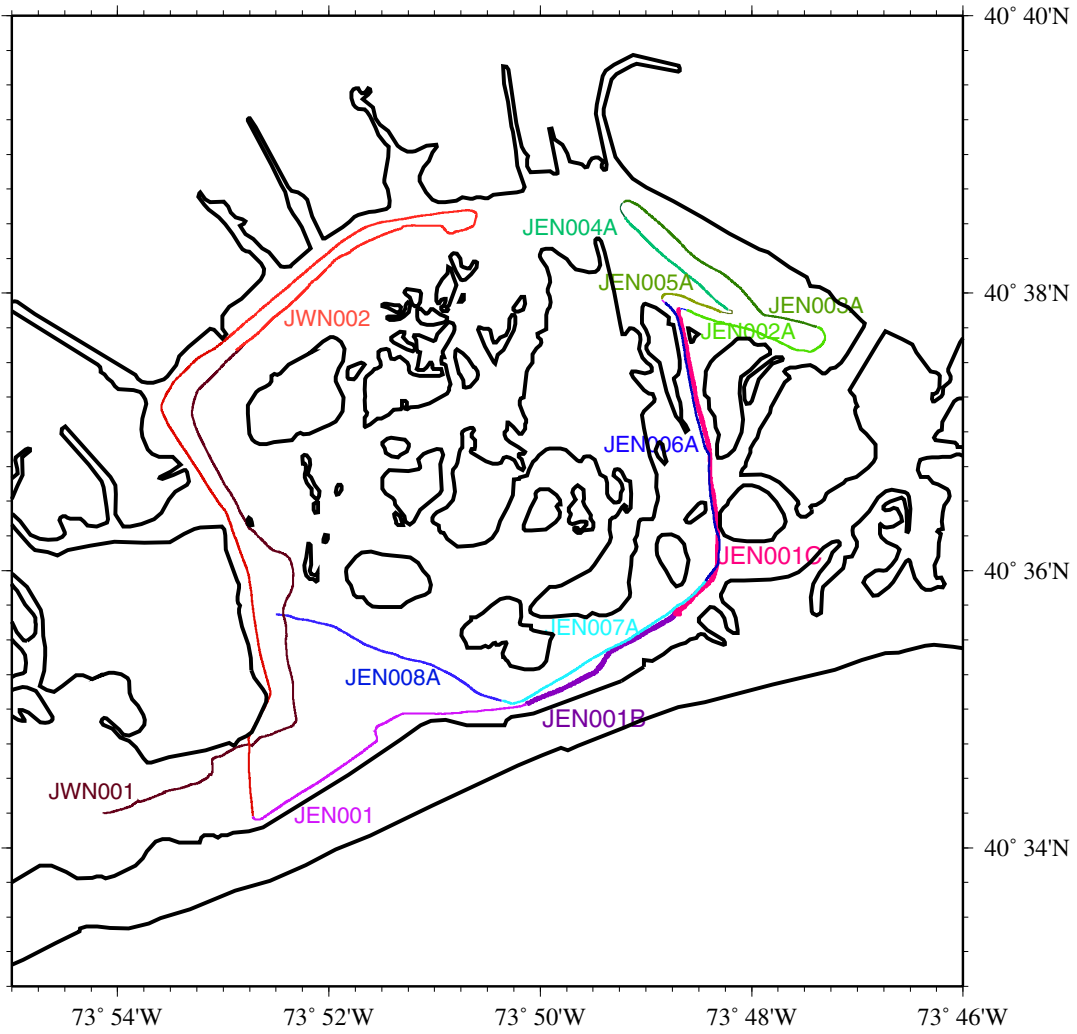


Figure 7.1-5



Chirp subbottom profile

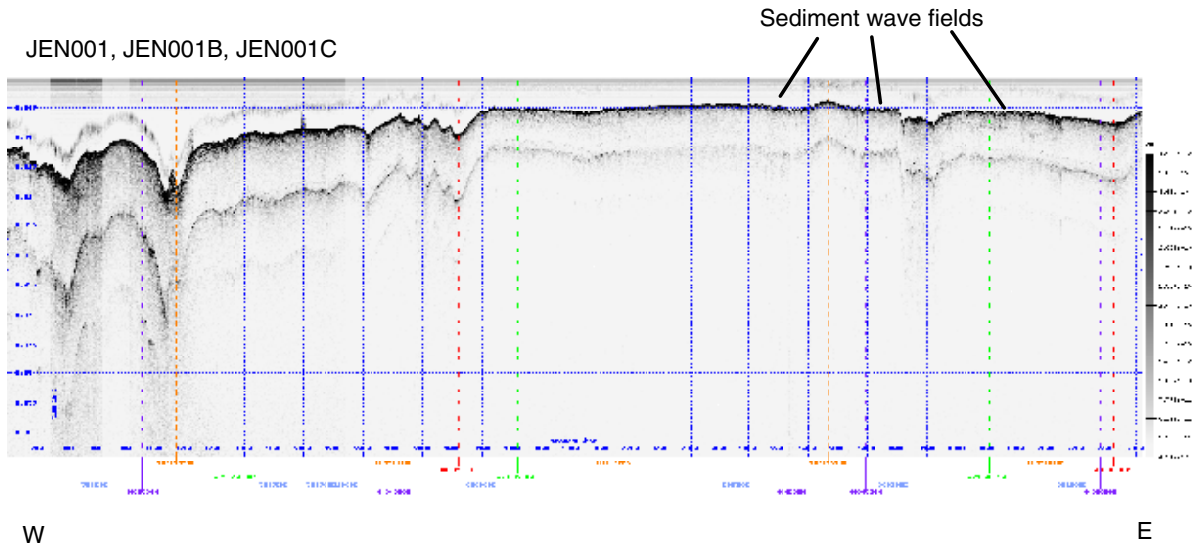
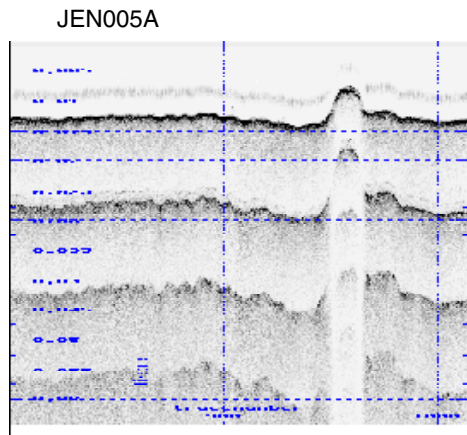
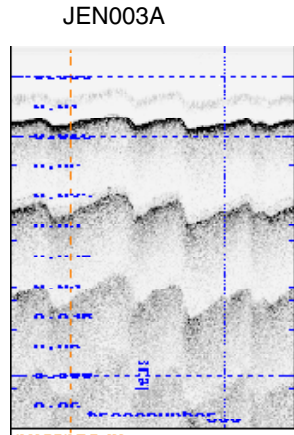
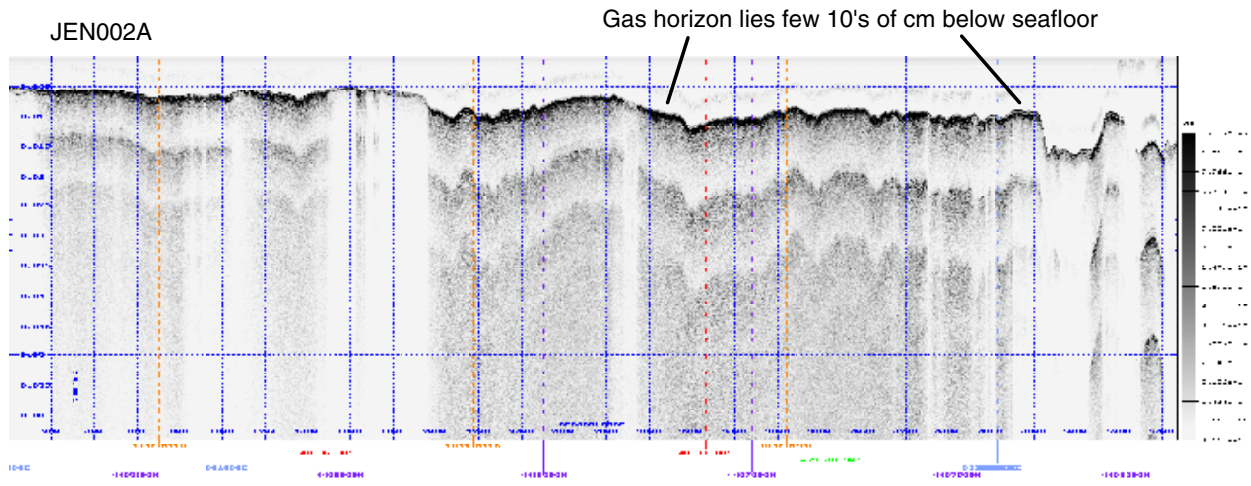


Figure 7.1-6



Chirp Subbottom profiles within Grassy Bay

Figure 7.1-7