Monitoring Cruise at the Cornfield Shoals Disposal Site
July 1990

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13. ABSTRACT (Maximum 200 words)

The Cornfield Shoals Disposal Site is the only dredged material disposal site managed as a dispersive site by the New England Division (NED) Corps of Engineers. Disposal at this site is conducted using primarily Loran-C coordinates without the aid of a taut-wire buoy. In July 1990, Science Applications International Corporation conducted field operations at Cornfield Shoals to assess both areal distribution of dredged material deposited since the previous July 1987 monitoring survey and the usefulness of REMOTS® sediment-profile photography as a survey tool at this site. Field operations included a 1000 x 1000 m bathymetric survey and a 13 station REMOTS® survey.

According to the tabulation of disposal logs, barges released 104,000 m^3 of material at the site since the 1987 survey. Volume calculations showed an estimated 16,600 m^3 of dredged material accumulated at the site.

As a result of the high energy regime at Cornfield Shoals, no significant changes in topography (e.g., the development of distinct disposal mounds) were detected. REMOTS® photography detected fresh and/or relic dredged material at several stations, supporting the utility of REMOTS® technology at Cornfield Shoals. Enlargement of the REMOTS® grid to incorporate stations outside of the dredged material dispersion area (where ambient bottom conditions persist) would assist future monitoring efforts at the site.

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EXECUTIVE SUMMARY

The Cornfield Shoals Disposal Site is the only dredged material disposal site managed as a dispersive site by the New England Division (NED) Corps of Engineers. Disposal at this site is conducted using primarily Loran-C coordinates without the aid of a taut-wire buoy. In July 1990, Science Applications International Corporation conducted field operations at Cornfield Shoals to assess both areal distribution of dredged material deposited since the previous July 1987 monitoring survey and the usefulness of REMOTS® sediment-profile photography as a survey tool at this site. Field operations included a 1000 x 1000 m bathymetric survey and a 13 station REMOTS® survey.

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1.0 INTRODUCTION

The Cornfield Shoals Disposal Site is located approximately 3.3 nm southeast of Cornfield Point in Old Saybrook, Connecticut and has been under study by the New England Division (NED) Corps of Engineers since 1978 (Figure 1-1). Cornfield Shoals occupies an area of 1 square nautical mile centered around 41° 12.68'N, 72° 21.52'W. Cornfield Shoals is the only dredged material disposal area managed by NED as a dispersive site. Disposal at this site is conducted using primarily Loran-C coordinates without the aid of a taut-wire buoy. The predominant topographic features are a smooth, sandy bottom and bedforms oriented in an east-west direction.

The 1978 monitoring survey included a study of the near-bottom current and turbidity conditions. The major currents at this site are the result of an east-west tidal flow from the Connecticut River; seasonal river effects can be quite pronounced due to spring runoff and snow melt. Tidal flow is in a northwest-southeast direction with an average maximum of 32 cm/sec. During spring runoff, peak tidal flow can reach 44 cm/sec. Non-tidal current flows to the southwest with a mean peak of 10 cm/sec. Similar tidal currents were measured approximately 2 nm southwest of the disposal site by Fenster et. al . (1990).

Because Cornfield Shoals is a dispersive site, disposal has been limited to sands and silty sands suitable for unconfined open-water disposal. The average annual volume of dredged material deposited at Cornfield Shoals since 1984 is approximately 28,000 m^3, although the actual amount varies widely from year to year (Figure 1-2).

On 24 July 1990, Science Applications International Corporation (SAIC) conducted a precision bathymetric survey and REMOTS® sediment-profile survey to provide information on the fate and effects of past and recent disposal operations. According to barge log estimates, a total of 97,700 m^3 of material was deposited at Cornfield Shoals between July 1987 and July 1990. Most of the material was coarse grained with a small percentage of fines (Table 1-1). The July 1990 monitoring cruise was designed to test the following hypotheses:

- that no significant disposal mound had been formed at Cornfield Shoals,
- that dredged material was distributed evenly throughout the disposal site, and
- that REMOTS® sediment-profile photography was a useful survey tool at this site.

2.0 METHODS

2.1 Navigation and Bathymetry

The SAIC Integrated Navigation and Data Acquisition System (INDAS) provided the precise navigation required for all field operations. This system uses a Hewlett-Packard 9920 series computer to collect position, depth, and time data for subsequent analysis as well as provide real-time navigation for the ship. Ship position was determined to an accuracy of ±3 m. A detailed description of INDAS and its operation can be found in Contribution #60 (SAIC, 1989). Shore stations were established in Old Saybrook, Connecticut, at Cornfield Point and Lynde Neck Light.

An Odom DF3200 Echotrac® Survey Recorder with a narrow beam 208 kHz transducer recorded depth to a resolution of 3.0 cm (0.1 feet). The speed of sound was determined from water temperature and salinity data measured by an Applied Microsystems CTD/DO probe. The speed of sound and the transducer depth were entered into the fathometer to correct depth values transmitted to the computer. Raw depth values were standardized to Mean Low Water during analysis of the bathymetric data by adjusting for tidal changes during the survey. Forty-one survey lanes were run east and west with a 25 meter lane spacing in a 1000 x 1000 m grid positioned on the center of the disposal site.

REMOTS® sediment-profile photography was used at Cornfield Shoals for the first time during the 1990 survey. Previous bathymetric analyses were unable to detect the presence of a disposal mound; therefore, the prescribed 13-point radial pattern of REMOTS® sampling stations was established around the geographic center of Cornfield Shoals with stations located at 50 meter intervals. Three replicate photographs were taken at each station (Figure 2-1).

3.0 RESULTS

3.1 Bathymetry

The 1990 bathymetric survey showed an irregularly shaped depression where depths range from approximately 49.5 meters in the northeast corner of the survey grid to 57.5 meters in the south central area (Figure 3-1). Visual comparisons of the surveys conducted on 24 July 1990 (Figure 3-1), 31 July 1987 (Figure 3-2), 27 January 1979 (Figure 3-3), and 30 July 1978 (Figure 3-4) showed no distinguishable disposal mound at Cornfield Shoals nor significant changes in topography. As expected, minor inconsistencies were found. It is important to note that the 1978 and 1979 surveys were conducted at 50 meter lane spacings with different fathometer and computer systems. Because of the different formats used to store data from these two earlier surveys, direct comparisons could not be made with SAIC's volume difference software. Visual comparisons were accomplished by overlaying the successive depth contour plots on a light table.

A direct comparison of the 1990 and 1987 surveys was made to determine if and where significant depth differences occurred (Figure 3-5) and to estimate the volume of material accumulated at this location since the 1987 survey. This volume calculation estimated an accumulation of approximately 16,600 m^3 of dredged material. Barge logs for July 1987 to July 1990 indicated that 104,000 m^3 of material were deposited at Cornfield Shoals. No clearly-defined disposal mound was detected in the depth difference plot at Cornfield Shoals.

3.2 REMOTS® Sediment-Profile Photography

Dredged material was found at all 13 stations of the REMOTS® sampling grid (Figure 3-6). Boundaries delineating "fresh" from "relic" material were determined easily.

The sedimentary fabric along the east axis was highly chaotic; grain sizes ranged from 1-0 phi (coarse sand) to ≥4 phi (silt-clay; Figure 3-7). At station 50E sediment identified as fresh dredged material in the REMOTS® photographs consisted of silt-clay (>4 phi) at the sediment-water interface (Figure 3-8). The sedimentary fabric of the north, south, and west axes consisted of phi sizes 1-0 (coarse sand) and 2-1 (medium sand). This sediment was considered "relic" dredged material from which the fines were winnowed. Many of the stations exhibited vertical stratification, suggesting that there has been erratic spatial deposition as well as bedload transport (Figure 3-9).

Surface boundary roughness in REMOTS® photographs is the amount of surface relief at the sediment water interface. The origin of this topographic relief may be either physical or biogenic. Small-scale surface boundary roughness values at Cornfield Shoals ranged from 0.0-0.6 cm (class 1) to 1.8-2.2 cm (class 5) with almost equal representation in all classes

(Figure 3-10). On the sandy bottom, this roughness was related to the presence of rippled bedforms. On the dredged material, small-scale boundary roughness was related to the presence of recently deposited dredged material.

Median Organism-Sediment Index (OSI) values, which characterize habitat quality, were obtained for six of thirteen stations at Cornfield Shoals. Stations 50N, 100N, 50E, 100E, 150E, and 100W had OSI values ranging from 8-11 (Figure 3-11). These values generally are indicative of undisturbed, high-diversity benthic communities; Stage III taxa were present at all of these stations (Figure 3-11). The absence of Stage I taxa (small pioneering polychaetes) could be a result of the high energy regime of Cornfield Shoals. The substratum at Cornfield Shoals is composed primarily of sand and shell hash, which restricted penetration of the REMOTS® camera prism (Figure 3-12). Because of this, the OSI values at the remaining seven stations were indeterminate. Haustorid and gammarid amphipods, which commonly are found on subtidal sandy bottoms and cannot be detected by REMOTS®, may well have been present at these stations.

The apparent redox potential discontinuity (RPD) depth is the boundary between higher reflectance near-surface sediments and the darker or less well oxygenated sediments below. The mean RPD depth was 2-4 cm for 10 of 13 stations (Figure 3-13). These RPD depths were most likely the result of physical mixing induced by the high-energy regime of this site.

4.0 DISCUSSION AND CONCLUSIONS

A depth difference comparison between the 1990 and 1987 surveys defined a small (0.4 m) rise in the southwest corner as well as a small (0.4 m) depression on the eastern axis. It is quite possible, however, that these features or similar ones were present, but undetected by the fathometer system used in the 1987 survey. The transducer used for the 1987 survey had a beam width of 17° and integrated the returning acoustic signals over an area approximately 32 times larger than the area with the 3° beam width transducer used in 1990 (Figure 3-14). Small changes in depth that were averaged out in the integration during the 1987 survey would have been recorded in the 1990 survey. The recorded depths for a survey lane along a slope would also vary when the survey was conducted by the two different fathometers. The 3° beam width provides a more accurate reading on water depth, but it also requires better navigational accuracy when running the survey lanes to ensure that the same area of the seafloor was being measured each time a survey was repeated.

The high energy regime of Cornfield Shoals is clearly the dominant force influencing all of the measured REMOTS® parameters. Fine-grained dredged material was found at 50E and 100E. The remaining REMOTS® stations were coarser grained with some shell lag and vertical stratification. This suggests "relic" dredged material where fine-grained material had been winnowed by bottom currents. Surface boundary roughness was due to rippled bedforms at those stations located on the sandy bottom. RPD values were relatively deep, suggesting good oxygenation of the sediment pore water. Considering the sparse evidence of burrowing Stage III invertebrates, it is likely that physical mixing forces contributed to the deep apparent RPD values measured at this site.

The bathymetric analysis did not detect a disposal mound at Cornfield Shoals. If the 104,000 m^3 of material deposited at Cornfield Shoals between 1987 and 1990 were dispersed evenly throughout the site, the result would be a layer 10 cm thick. The minimum change in depth detectable by the 1990 bathymetric survey was estimated to be 15 cm. This value reflects error due to navigation, tidal elevation predictions, and any vertical boat motion experienced during the survey. Thus the dredged material deposited at Cornfield Shoals may not have been detected acoustically due to its probable dispersion across a large area.

The REMOTS® survey provided the necessary information to identify the presence of dredged material at Cornfield Shoals and characterize it as "fresh" or "relic" dredged material. The REMOTS® sediment-profile photographs also document the presence of winnowed sediments, rippled bedforms, and shallow RPD depths, all of which may be the result of the high energy regime of this site.

A summary of actual dredged material release locations was prepared from Loran-C TD values recorded on disposal logs. These points, for disposal between 1987 and 1990, were localized in an area 300 m in diameter (Figure 3-15). The disposal locations are clustered to the northeast of the area surveyed by REMOTS®. Future assessment of dredged material in this survey area would be enhanced with an orthogonal REMOTS® survey grid encompassing dredged material disposal locations.

5.0 REFERENCES

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NUSC. 1979. DAMOS Disposal Area Monitoring System Annual Data Report: Proceedings of Symposium, 14-15 May 1979. Naval Underwater Systems Center, Newport, RI.

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Table 1-1.
Grain Size Analysis of Dredged Material Source Areas Deposited at Cornfield Shoals during 1987-1990.

Year	Project	Grain Size % sand	Grain Size % fines
1987	SNE Telephone	61	39
1988	Brewer's Dauntless Shipyard	22	78
	Yacht Distributors	56	44
	Rich Lovelace	51	49
	Essex Yacht Club	53	47
	Sisti Family Partnership	32	68
1989	River Landing Marina	37	63
	Brewer's Dauntless Shipyard	22	78
	Brewer's Chandlery East	63	37
	Essex Yacht Club	53	47
1990	Saybrook Point Marina	6	94
	Pilot's Point Marina	20	80

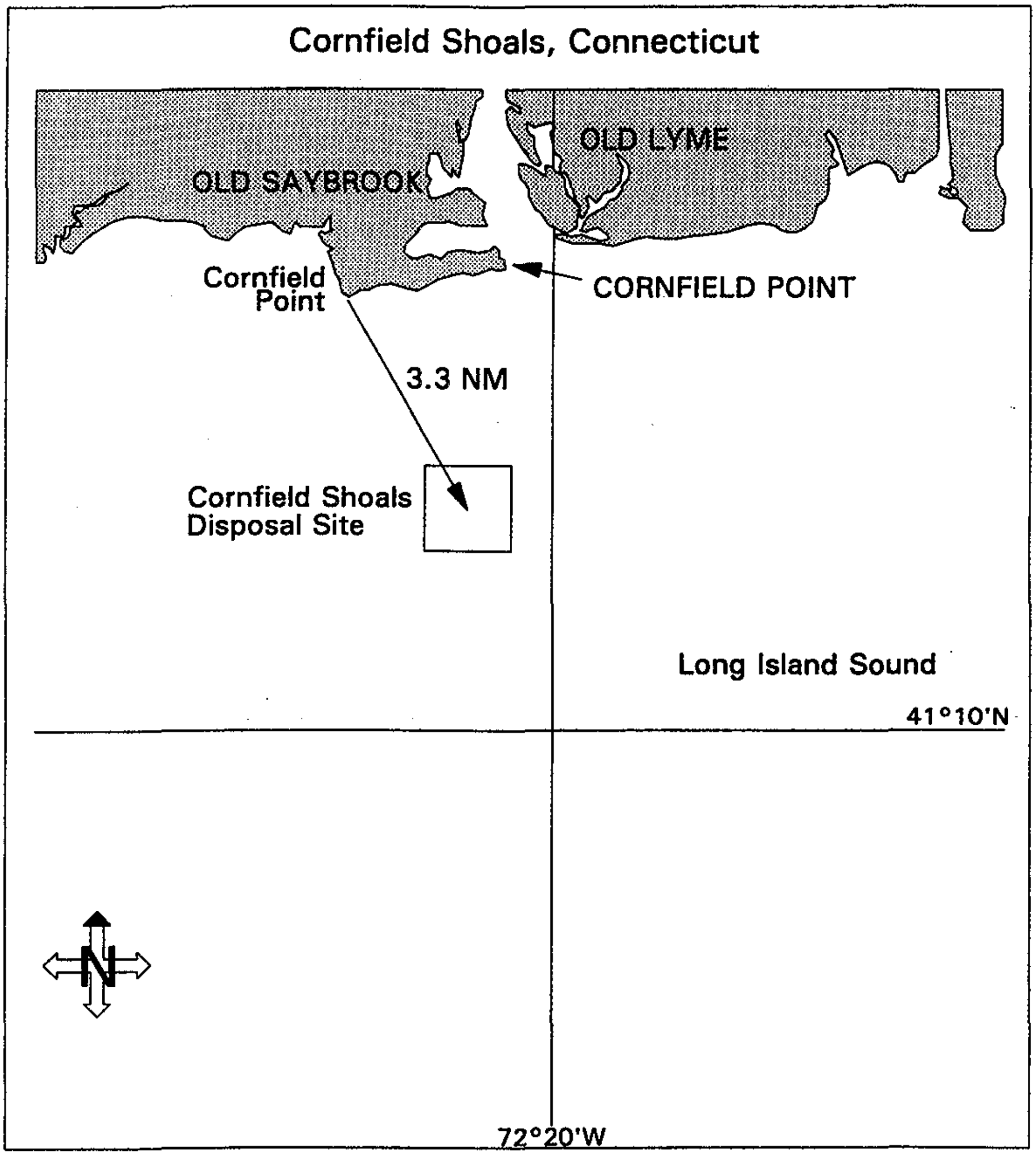


Figure 1-1. Location of Cornfield Shoals Disposal Site in relation to Old Saybrook, Connecticut.

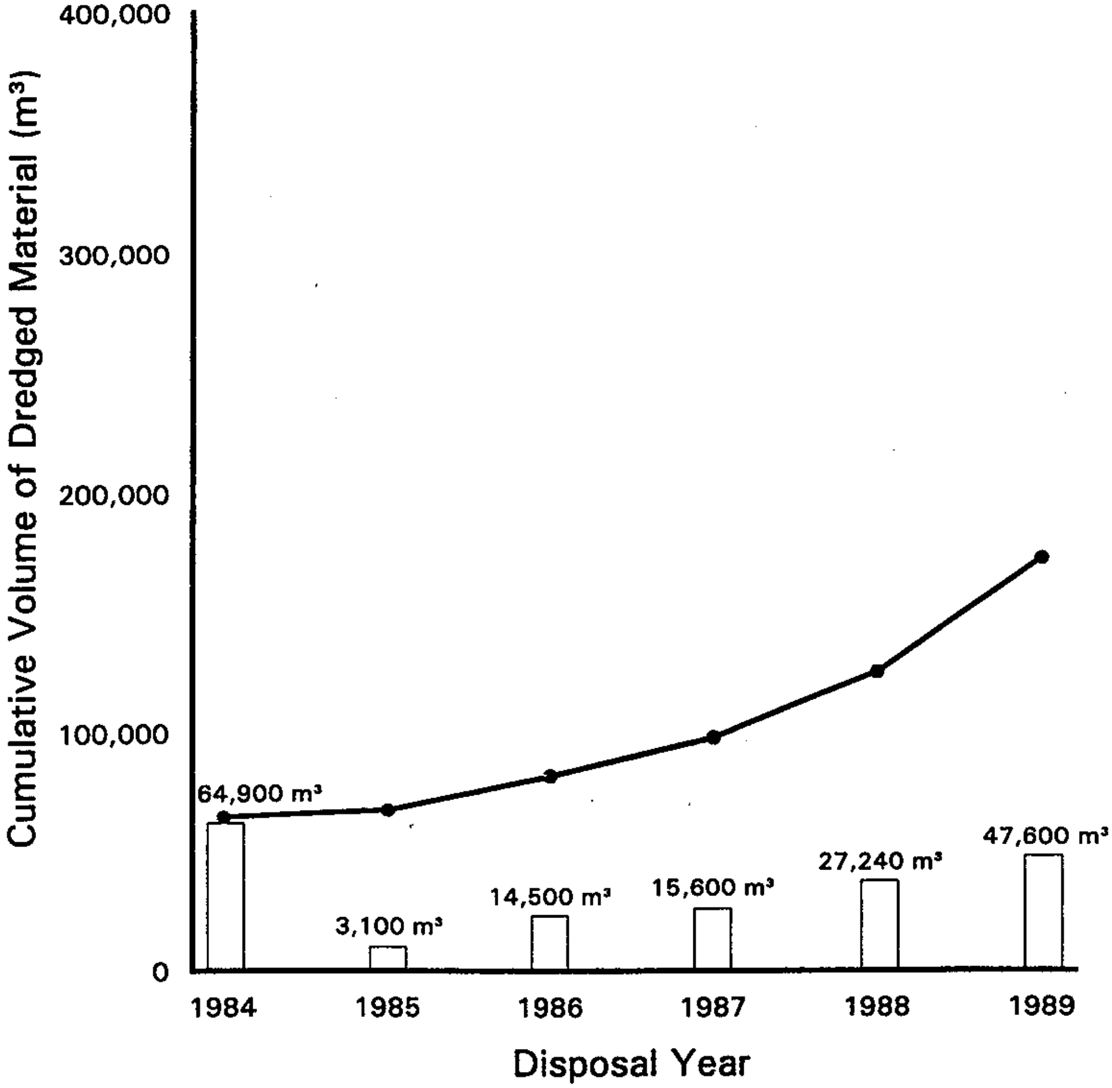


Figure 1-2. Dredged material disposal at Cornfield Shoals 1984-1989.

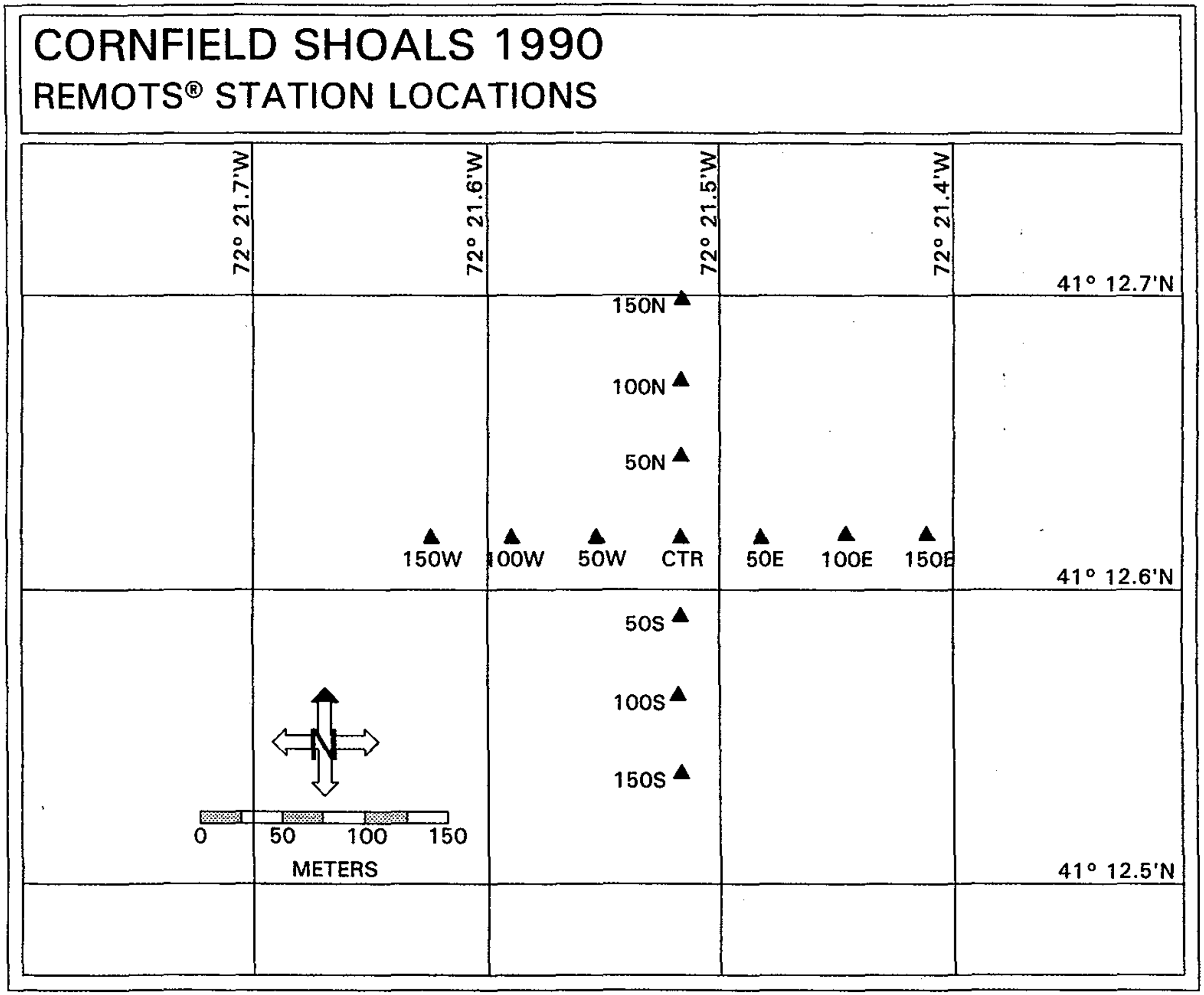


Figure 2-1. REMOTS® station locations and designations at Cornfield Shoals, July 1990.

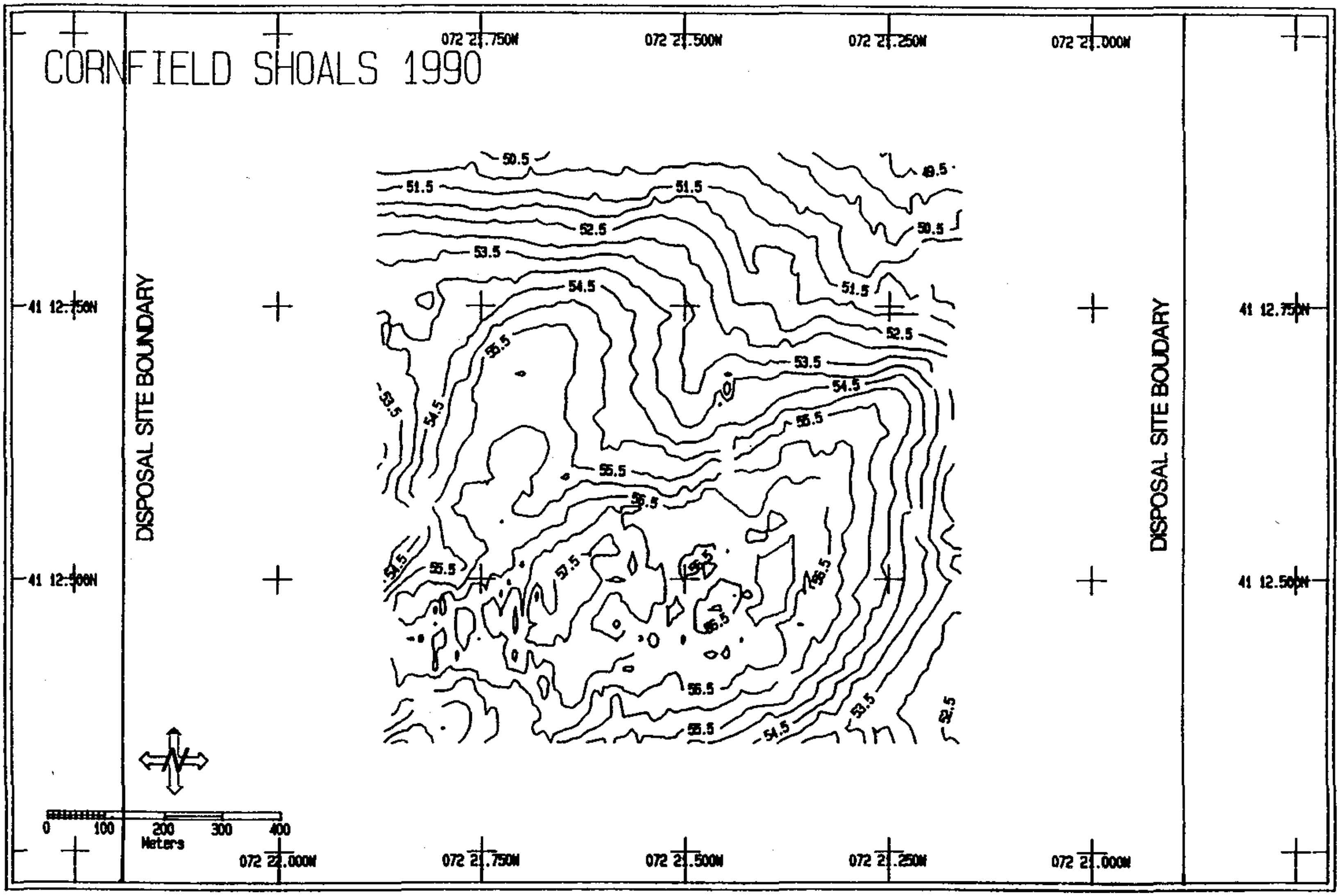


Figure 3-1. **Bathymetric contour plot of Cornfield Shoals, July 1990. Contours at 0.5 m intervals.**

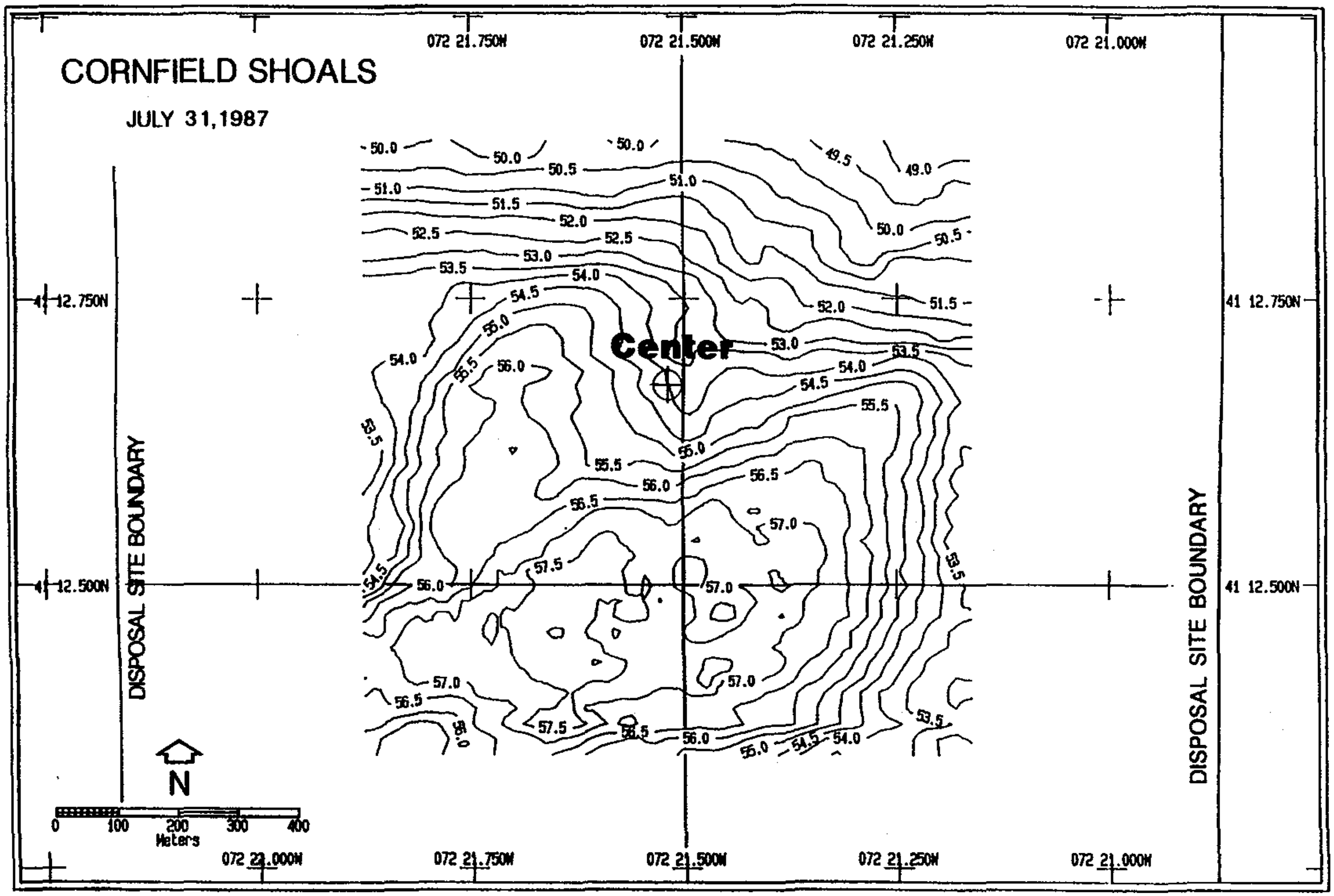


Figure 3-2. Bathymetric contour plot of Cornfield Shoals, July 1987. Contours at 0.5 m intervals.

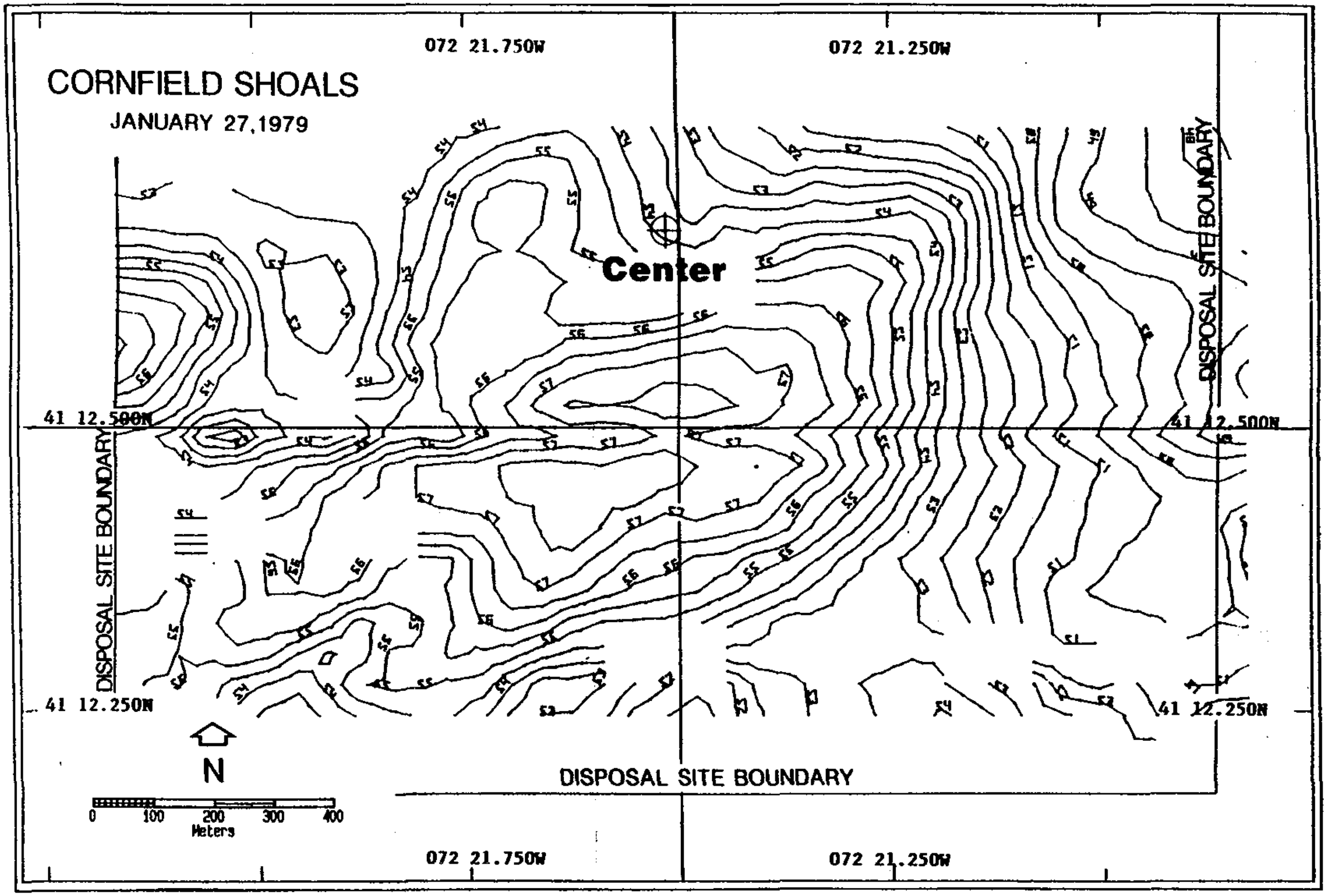


Figure 3-3. Bathymetric contour plot of Cornfield Shoals, January 1979. Contours at 0.5 m intervals.

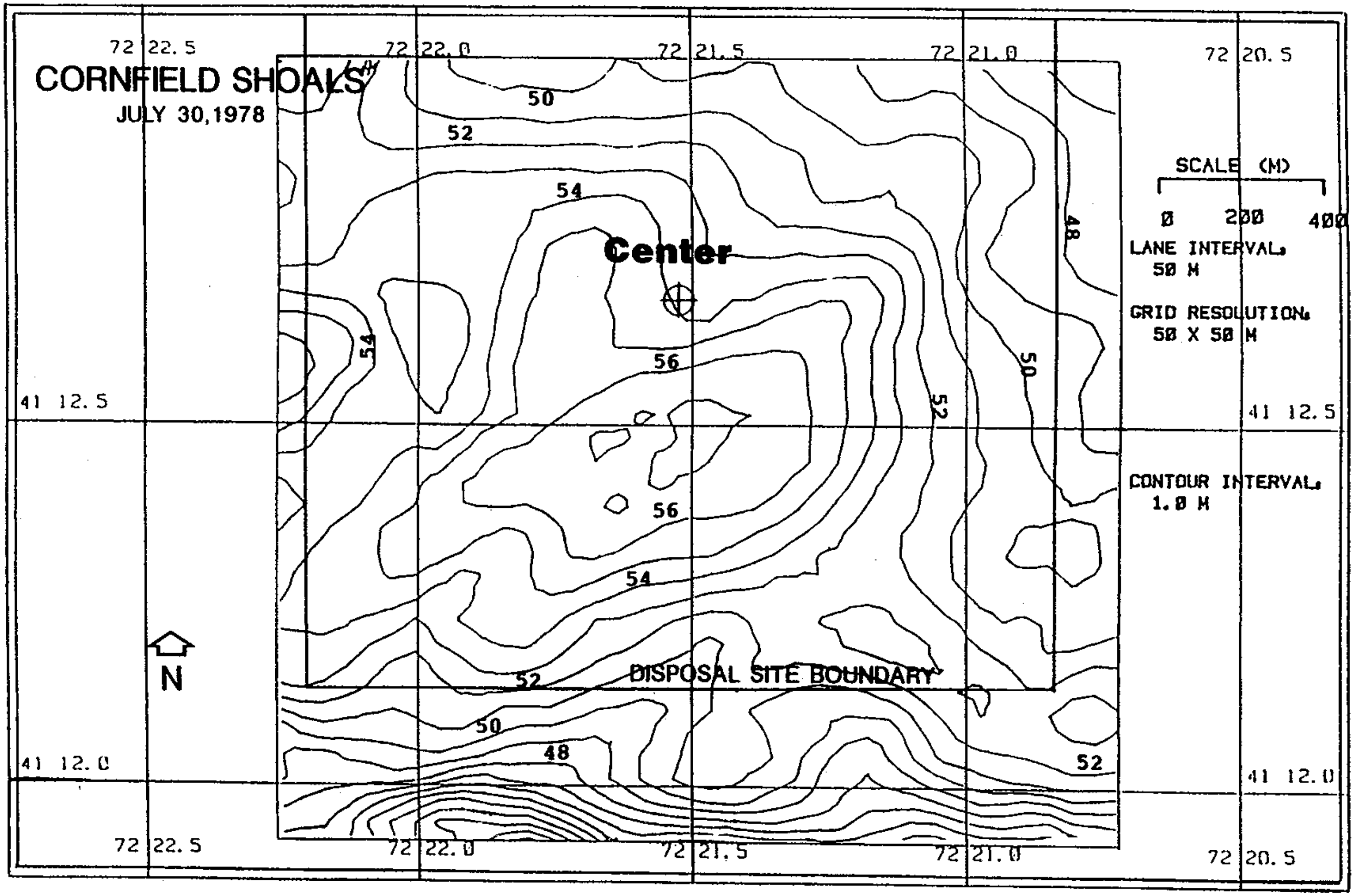


Figure 3-4. Bathymetric contour plot of Cornfield Shoals, July 1978. Contours at 1.0 m intervals.

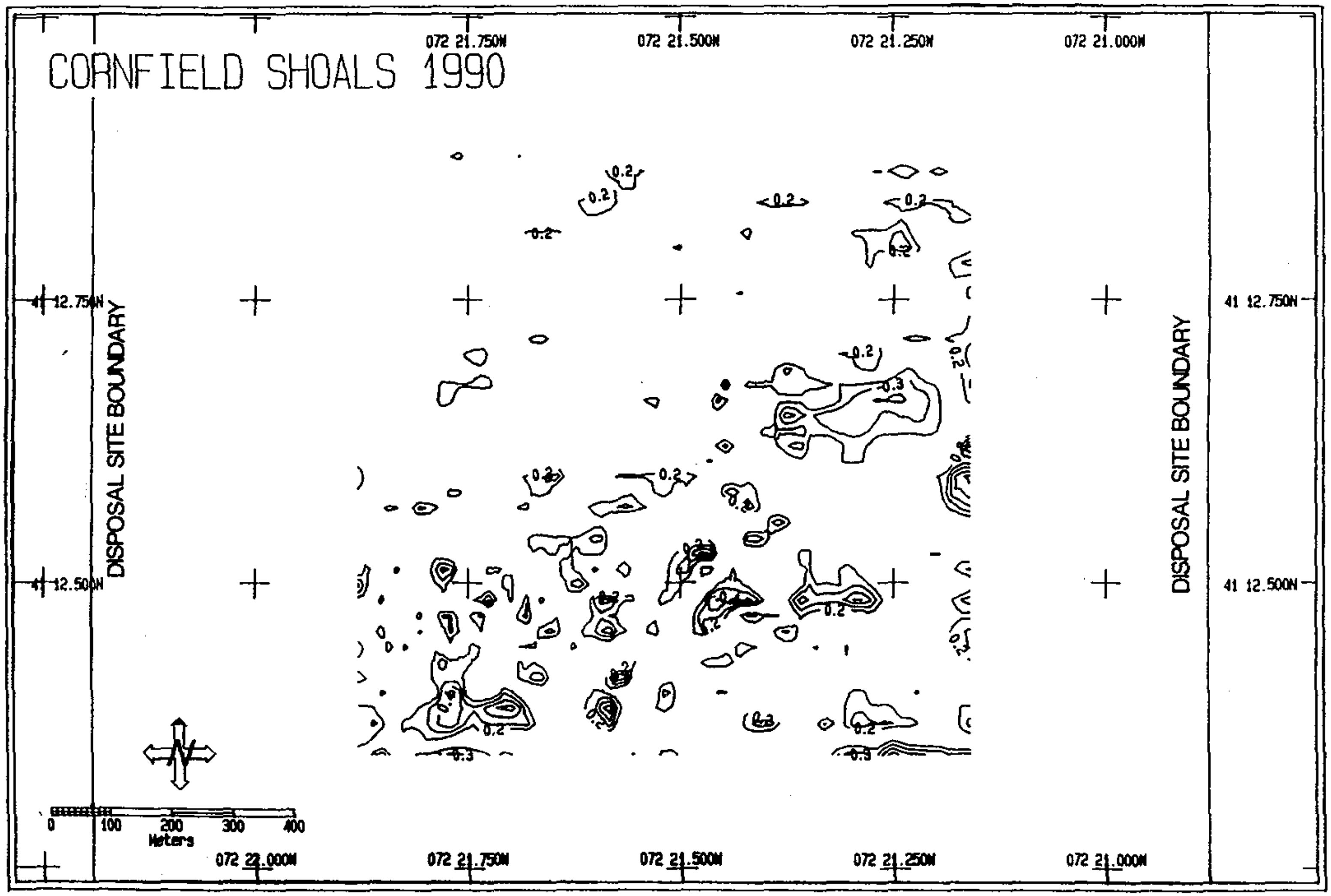


Figure 3-5. Depth difference contour plot of Cornfield Shoals, July 1990. Contours at 0.1 m intervals.

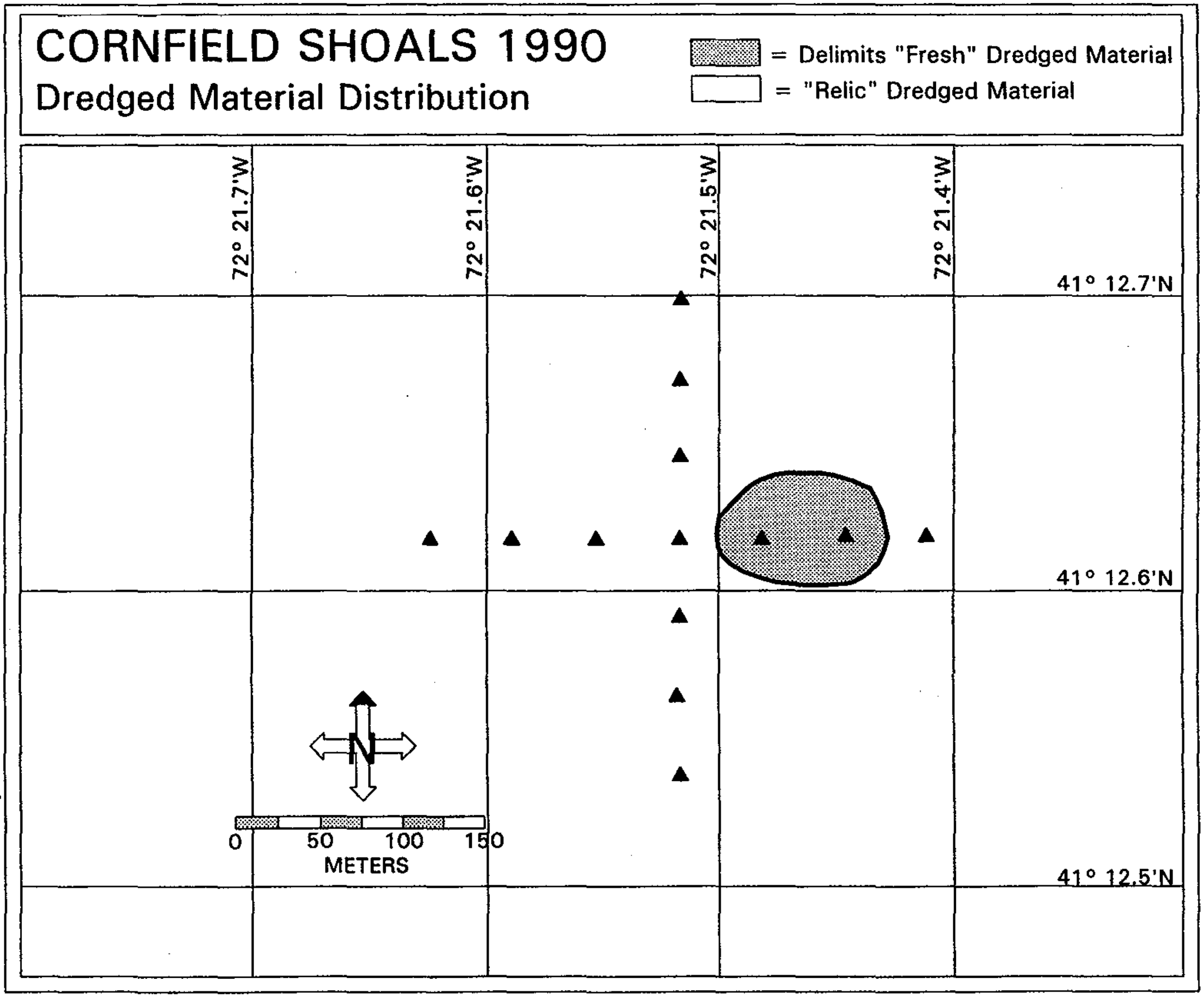


Figure 3-6. The mapped distribution of fresh dredged material at Cornfield Shoals, July 1990. The presence of relic dredged material is also indicated.

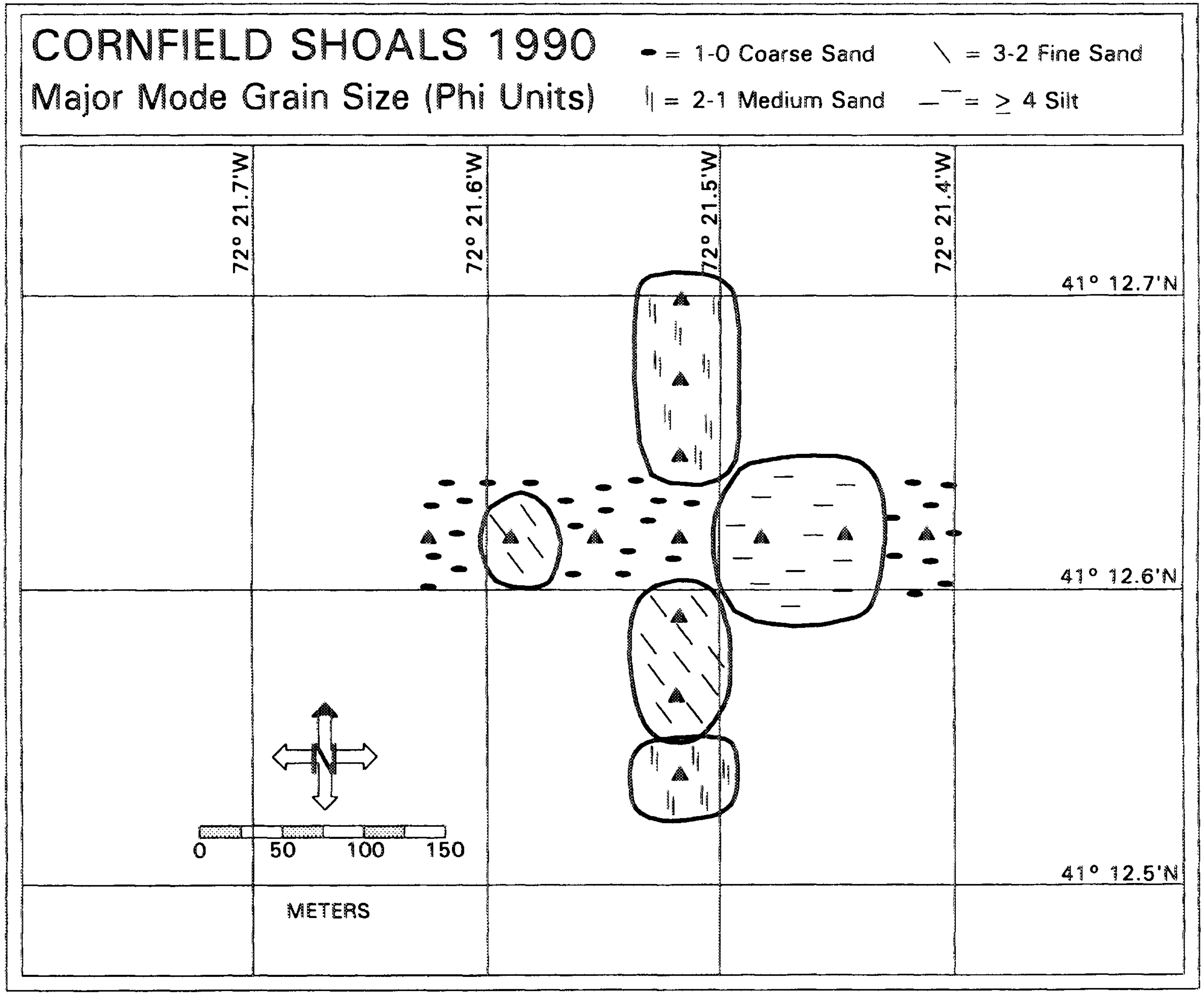


Figure 3-7. The mapped distribution of grain size major mode, Cornfield Shoals, July 1990.

Figure 3-8. REMOTS® photograph from disposal site station 50E, July 1990.

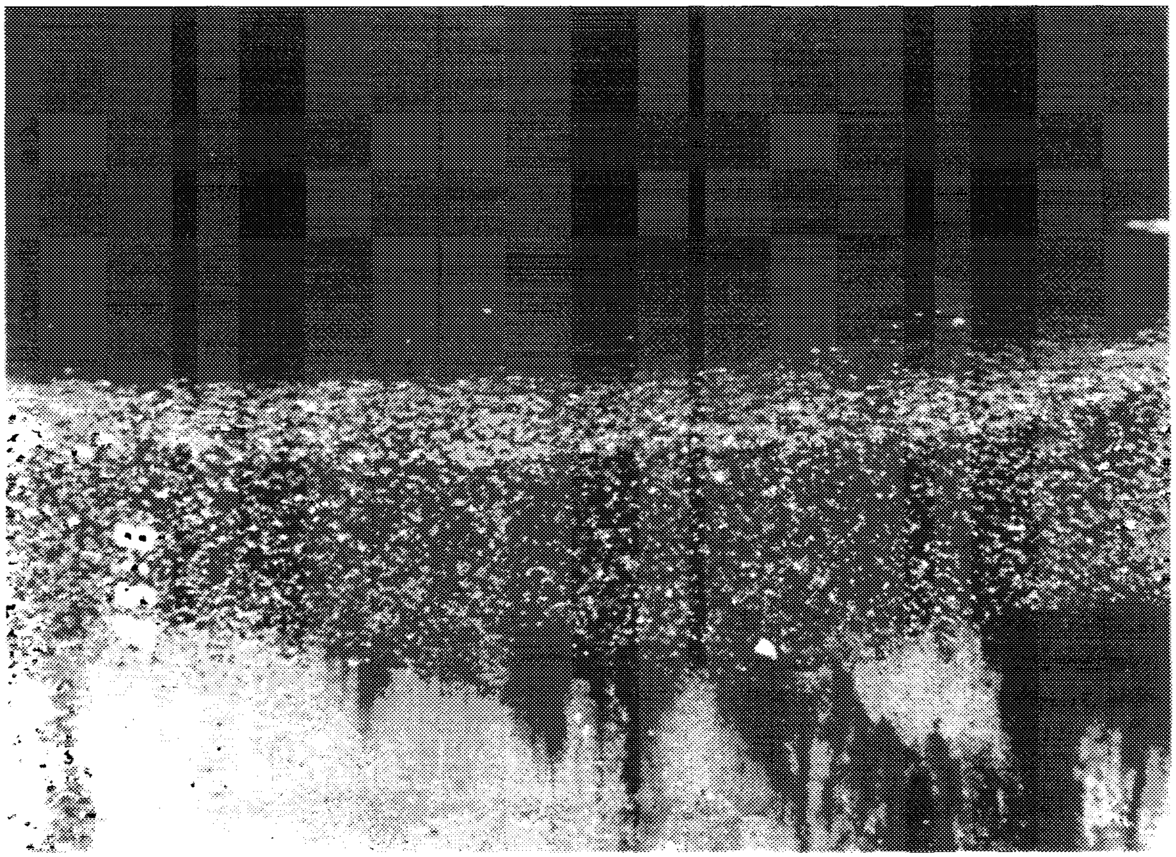
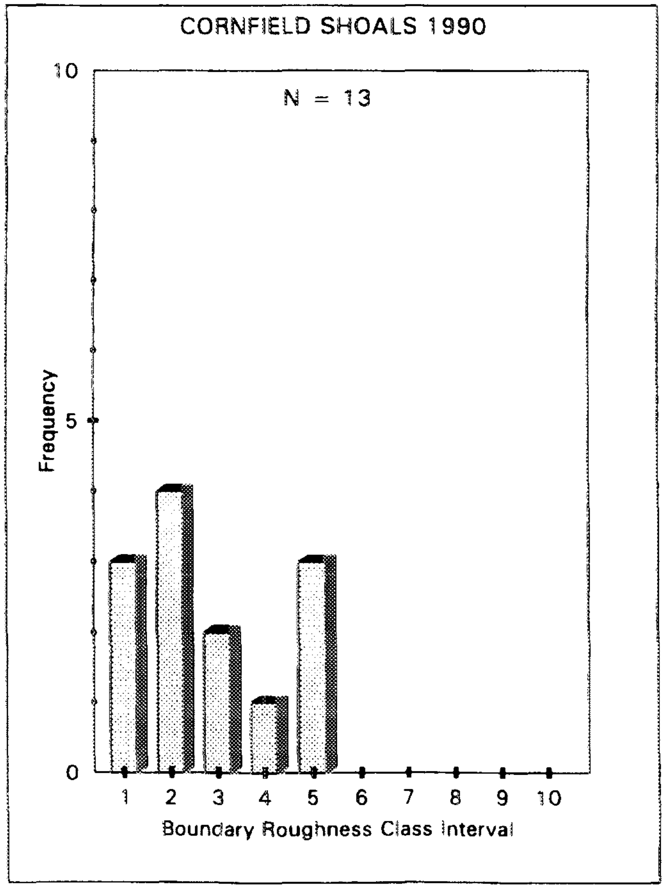


Figure 3-9. REMOTS® photograph from disposal site station 150S, July 1990.



KEY

CLASS INTERVAL	RANGE OF VALUES (CM)
1	0.0 - 0.6
2	0.6 - 1.0
3	1.0 - 1.4
4	1.4 - 1.8
5	1.8 - 2.2
6	2.2 - 2.6
7	2.6 - 3.0
8	3.0 - 3.4
9	3.4 - 3.8
10	3.8 - 4.2
11	4.2 - 4.6

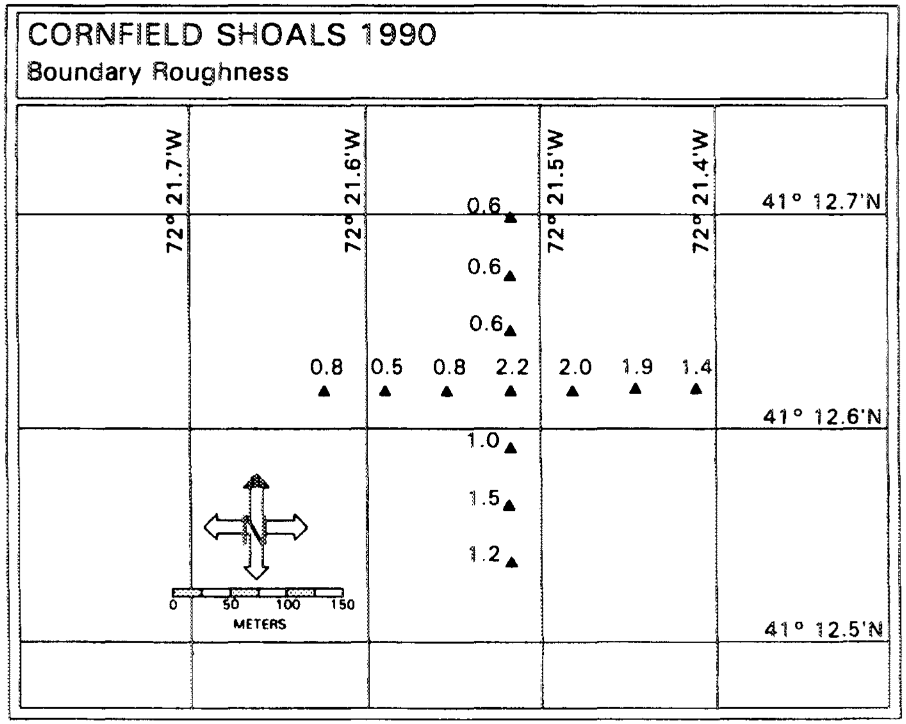


Figure 3-10. The mapped small-scale surface boundary roughness values for Cornfield Shoals, 1990.

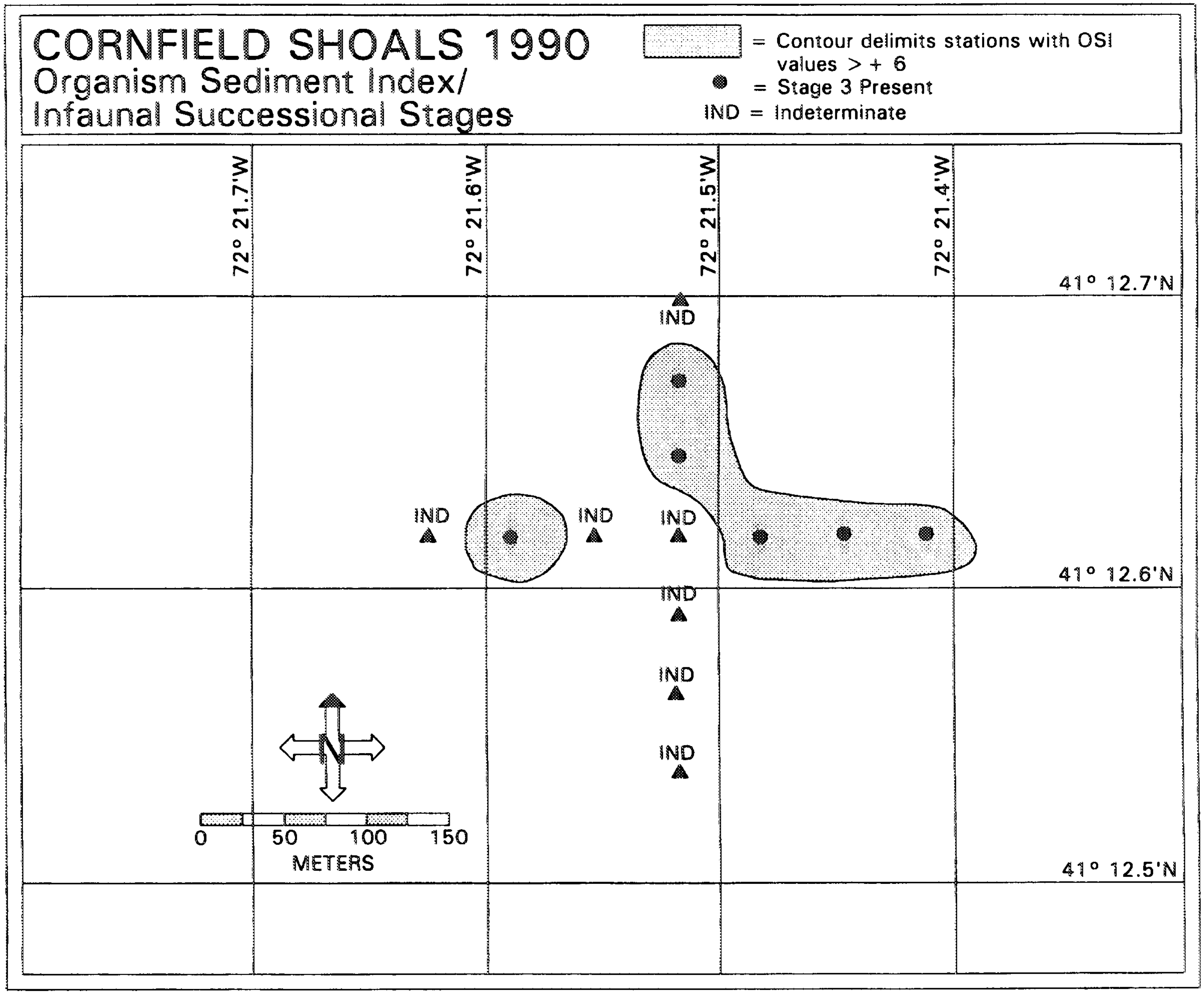


Figure 3-11. The distribution of infaunal successional stages and median Organism-Sediment Index values at Cornfield Shoals, July 1990. Contour delineates stations with OSI values > +6.

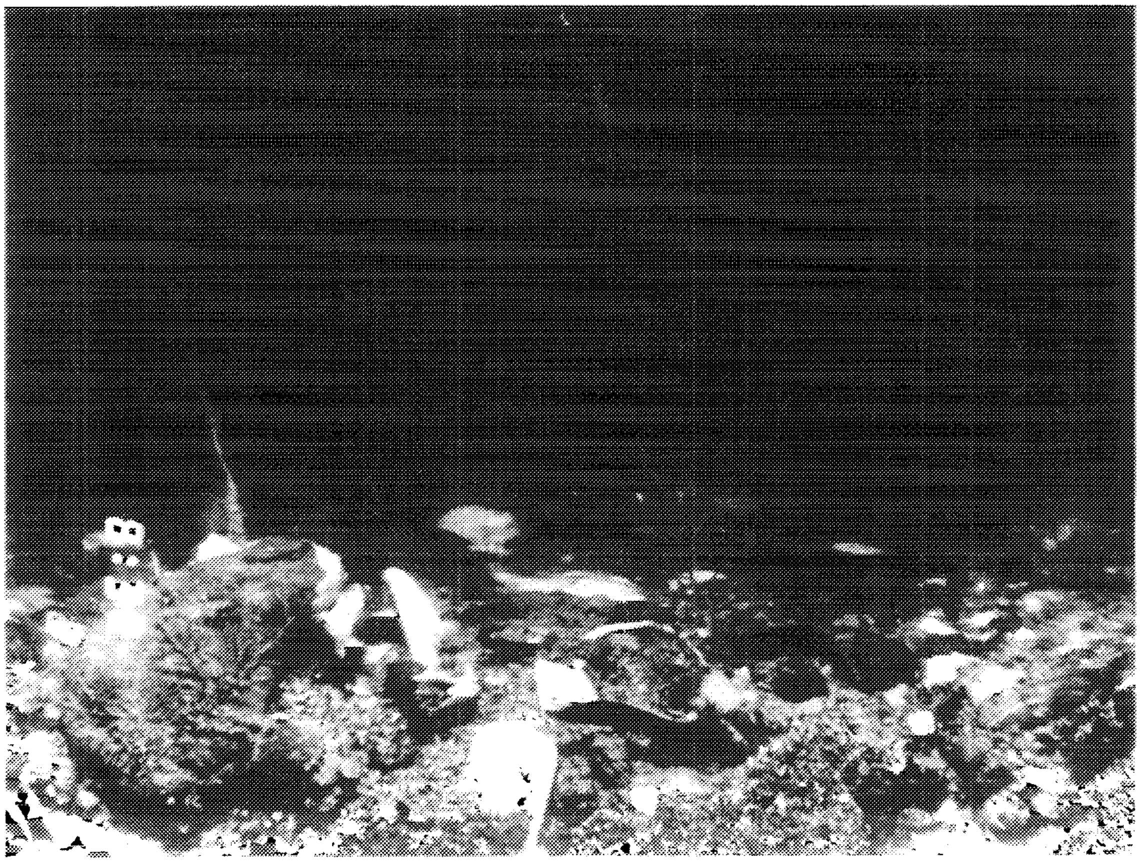


Figure 3-12. REMOTS® photograph from disposal site station 50W, July 1990.

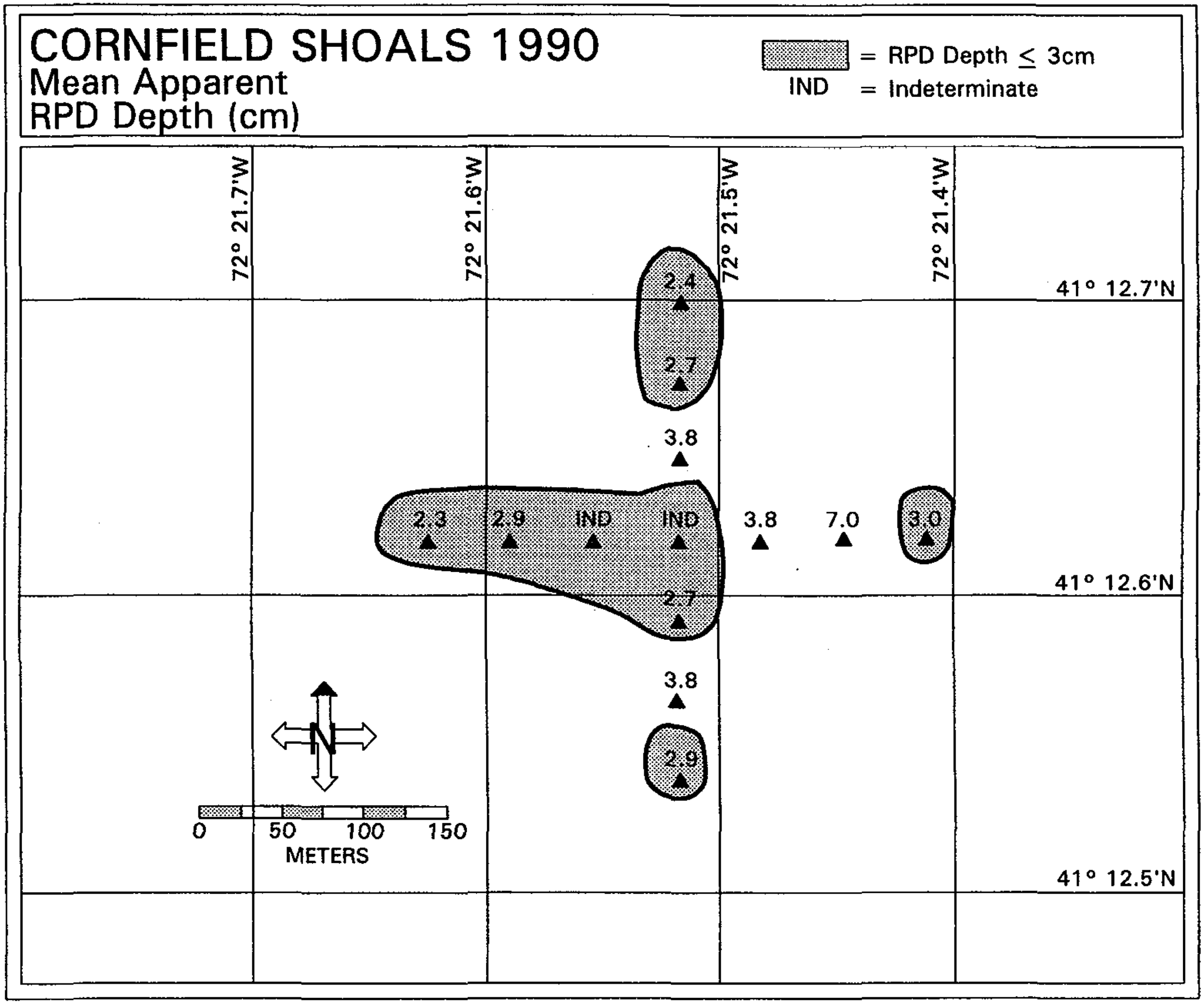


Figure 3-13. The distribution of mean apparent RPD depth as determined from the REMOTS® survey at Cornfield Shoals, July 1990. Contour delineates stations where RPD depth ≤ 3 cm.

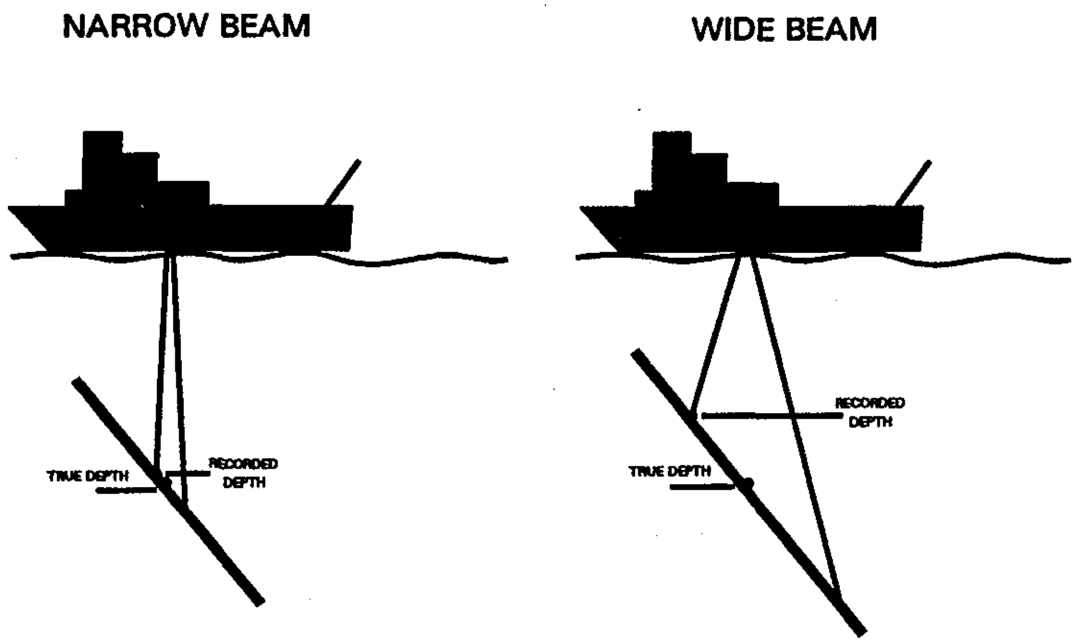


Figure 3-14. Changes in transducer beam width can affect the depths recorded during consecutive bathymetric surveys. Notice the apparent decrease in water depth recorded by the "wide beam" transducer.

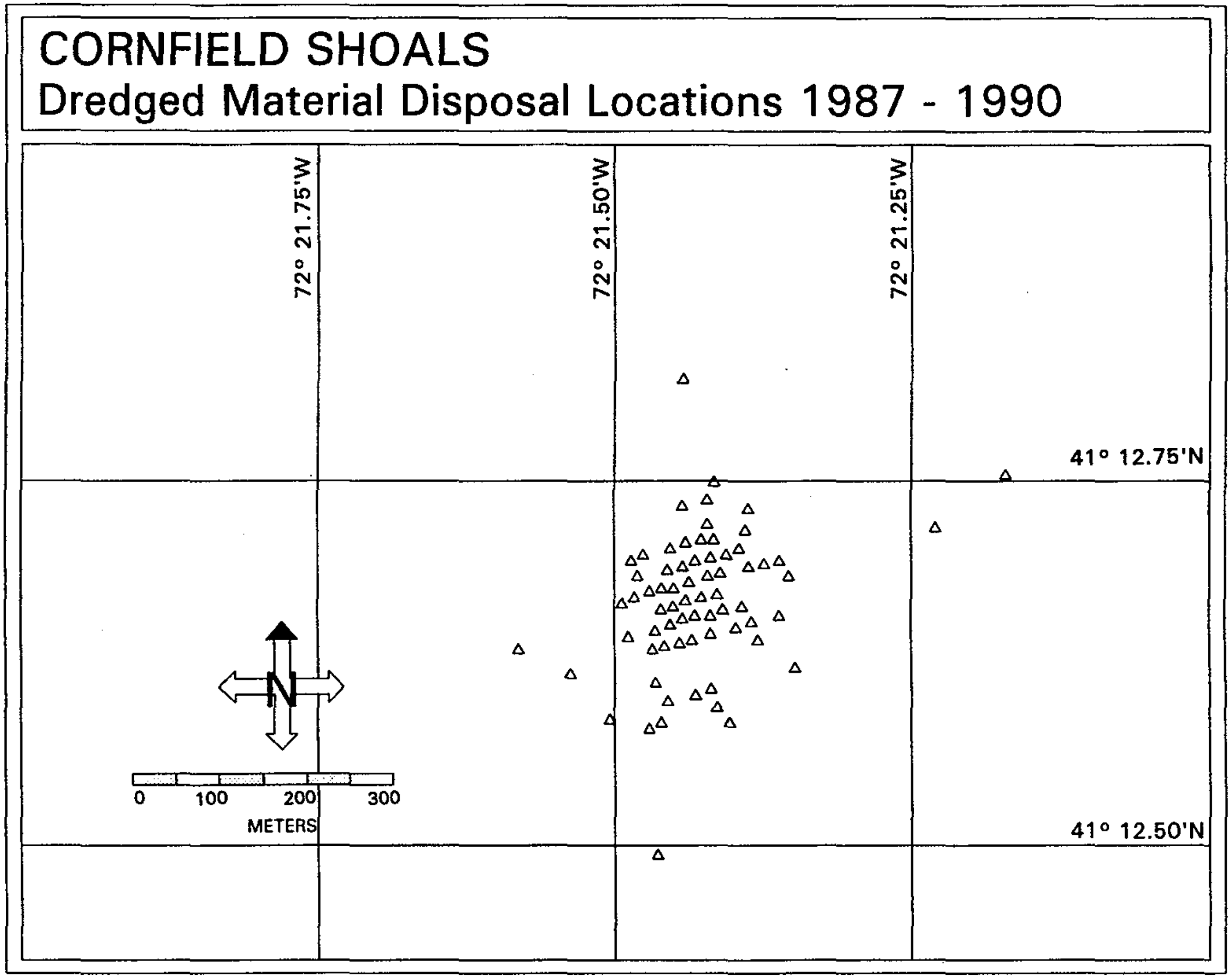


Figure 3-15. Mapped Loran-C disposal log locations for Cornfield Shoals from July 1987 to July 1990.