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THE PHYSICAL PROPERTIES OF THE SURFICIAL SEDIMENTS OF HAMILTON HARBOUR

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NWRI Contribution No. 95-150

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MANAGEMENT PERSPECTIVE

Data on the physical properties of the surficial sediments of Hamilton Harbour are available from a number of surveys conducted over the past 10 years. In this report they have been compiled in several formats: as a series of maps showing the areal distribution of sediment properties, as selected statistics on average values and dispersion, and as a database of detailed data including site and time references. This is the first attempt at characterization of harbour sediment properties which is based on sufficient data to be useful for studies on the source and transport of contaminated sediments and as a guide to site selection for further surveys.

ABSTRACT

Sampling and analysis of the surficial sediments of Hamilton Harbour have taken place over the past 10 years and data are now available for more than 200 samples at more than 75 sites. This report is a compilation of the physical properties of the sediments. Most of the data are on grain size but limited data are also available for particle density, water content, organic content, shear strength and magnetic susceptibility. Data are presented in the form of a computer database which provides the detailed information, and as a series of tabular and map summaries of sediment statistics and of the areal distribution of properties. Interpretation of data has been limited to assessing the changes in sediment properties over the 10-year survey period as the basis for the summary statistics. The report is the first publication of a sizable body of data on sediment properties and should be a valuable resource as a background for research on sediment dynamics and on the contaminated sediments of the harbour and their remediation.

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1 INTRODUCTION

The lack of published data on the physical properties of Hamilton Harbour bottom sediments has been a problem in studies on processes and remediation which rely on a physical framework for site selection, and for understanding the physical constraints on chemical and biological activity. This report addresses the problem by compiling bottom sediment data for 211 sites collected during 9 surveys between 1984 and 1993. It provides information on particle size, particle density, water content, organic content, shear strength and magnetic susceptibility. Data are presented in the form of tables, statistical summaries and maps. There is also a general discussion of the distribution of bottom-sediment properties and of their changes during the survey period.

2 BACKGROUND

Published information on the physical characteristics of the harbour sediments is limited to descriptive data by the Ontario Ministry of the Environment (OME 1977, 1978) and Johnson and Matheson (1968) and particle-size data for a small number of samples (Mudroch and Zeman 1975, OME 1981). Unpublished data are available from the Departments of the Environment (DOE) (Manning 1979, Mayer 1986, Thomas 1969) and the Department of Fisheries and Oceans (DFO) (Portt *et al.* 1986) and from a number of engineering reports associated with harbour development (Frazer 1987). There has been no previous attempt to characterize the physical properties of the surface sediment for the harbour as a whole.

3 FIELD PROCEDURES

3.1 General

Bottom sediments were collected during 1984, 1987, 1988, 1989, 1990 and 1993 using a variety of methods including Shipek and Ekman grab samplers, and Benthos, Mini-box and Technical Operations corers (Mawhinney and Bisutti 1987). With the exception of the 1984 samples, sample positions were fixed with a Motorola Miniranger positioning system to within ±5 m. The 1984 station positions were determined by radar, and are considered to be accurate to ±25 m. Water depths were measured by echo-sounder for some of the surveys (1984, 1987, 1987-89 cores, July 1993 cores). Water depths for the 1987 Shipek samples and the 1987 cores cores have been converted to IGLD 1955. For the 1990 and November 1993 samples, depths were estimated from the hydrographic chart for Hamilton Harbour. Sample locations and water depths are summarized in Appendix 1. Locations are reported in UTM coordinates in the datum NAD27. Maps of sample locations are given in Appendix 2.

3.2 Specific

In October 1984, the DFO collected 47 Ekman samples (V. Cairns, personal communication) at sites previously sampled by the Ontario Water Resources Commission in 1964 (Johnson and Matheson 1968). The top 5 cm of sediment were subsampled for laboratory analysis.

In July 1987, a suite of 34 samples was collected by the National Water Research Institute (N.A. Rukavina). Samples were recovered with a Shipek grab sampler along lines parallel and normal to the long axis of the harbour on a 500-m grid. A physical description of the samples was logged immediately upon recovery and subsamples of the top 3 cm were collected with a box sampler for size analysis and physical tests. Short Benthos cores were collected at a subset of 22 sites in 1987, and again at several of the stations as part of acoustic surveys (Rukavina 1989a, 1989b, 1990) in October 1988, May 1989 and October 1989. Four of the cores collected in the spring of 1989 were taken by divers using the Benthos core liners. Surface samples of the upper 2-8 cm from the cores have been used in this study to supplement data from the grab samples.

In May 1990, NWRI (T. Reynoldson, personal communication) sampled 49 sites- 22 of the 1987 Shipek sites and an additional 27 sites. An Ekman dredge was used for sampling, and subsamples of the top 3 cm were collected with a box sampler for size analysis and physical tests. Although electronic positioning was used, no records were taken for the positions of the 22 reoccupied sites from the 1987 survey. Positions were taken to be identical to the target coordinates for the 1987 fixes but actual locations may differ by as much as 20 m.

In July 1993, a joint survey by NWRI and McMaster University (Versteeg *et al.* 1994) collected 40 Benthos cores at 32 of the 1987 sites and at 8 additional sites. Magnetic susceptibility was measured through the core liner of each core and 8 of the cores were sub-sampled for geotechnical analysis. Data for the top 2 cm of the cores are reported here.

In November 1993, a set of 40 samples was collected at the July 1993 sites by NWRI (J.P. Coakley, personal communication). Sampling was done with a combination of Benthos, Technical Operations, and mini-box corers. Subsamples of the top 2 cm were taken for geotechnical analysis.

Figure 1 is a map of all the sample stations for the 5 surveys. A grid has been plotted at each station location, with individual cells filled in to represent each survey so that repeated stations can be readily identified.

4 LABORATORY AND DATA ANALYSIS

4.1 Grain Size

4.1.1 Analysis of grain size

Grain size for the 1984, 1987 and 1990 samples was measured with the then standard procedure of the NWRI Sedimentology Laboratory which included sieve and SediGraph analysis (Duncan and LaHaie 1979) and summary statistics were computed with the SIZDIST program (Sandilands and Duncan 1980). The 1993 samples were analyzed with a modified procedure which uses a different method for determining the distribution of sand-sized material and a different statistical program, SIZMERGE. The main difference between the two procedures is that the first uses hydraulic settling to separate sands (> 62.5 μm) and fines (≤ 62.5 μm) and to determine the distribution of sand sized particles, while the latter uses a sieving procedure. Sieving assigns heavy minerals to finer size classes than sedimentation. As a result, data derived from the two procedures may show small differences in the distribution of grains in the sand fraction, with the new data showing a bias toward the finer sizes. Since heavy minerals generally account for less than 5% of material in lake sediments (J.P. Coakley, personal communication), the two methodologies should provide comparable data. Sand, silt and clay percentages, and the distribution of silt and clay sized particles, are not affected by the change in procedure.

Size is expressed in PHI units as well as metric units because the logarithmic PHI scale (Krumbein and Pettijohn 1938) normalizes the size distribution and permits the use of normal statistics. The relationship between PHI and particle size is given by the expression:

$$PHI = -LOG_2\, D_{mm}$$

where D_{mm} is the particle diameter in millimetres. Appendix 3 lists PHI units and equivalent metric units.

Limited data are available on the precision and accuracy of the sieve and SediGraph analysis techniques. For the sieve technique, the precision depends on the splitting technique, the mass of sample analyzed, and the duration of sieving. The accuracy is a function of the above factors plus the condition of the sieves themselves. Sengupta *et al* (1968) have determined the accuracy to be 1.3% for coarse sand (200-700 µm) and 0.4% for fine sand (50-200 µm) and the precision to be as poor as 9.2% for coarse and 17.6% for fine sand respectively. Tests of the SediGraph by Syvitski *et al.* (1991) showed accuracies within ± 2 µm of the expected mean for a unimodal standard and within ± 7.6 µm of the expected mean for bimodal standards. Concentration of the sample suspension is one of the major factors affecting precision. Coakley and Syvitski (1991) report differences for a range of concentrations of ≤ 2% per 0.2 PHI interval which equates to a precision of ± 5% for the 0.5-PHI interval used in our study. We have assumed an error of ± 5% to be representative of the precision of the size statistics discussed below.

4.1.2 <u>Measures of grain size</u>

SIZMERGE output (Appendix 4) provides a number of size statistics. Frequency and cumulative-frequency data are listed and plotted for the 1/2-PHI intervals into which the size distribution is resolved. Size is also reported as percentages of the major size fractions: gravel (< -1.0 PHI), sand (-1.0 PHI to 4.0 PHI), silt (4.0 PHI to 8.0 PHI), and clay (> 8.0 PHI).

A number of summary statistics are computed based on moment measures (Krumbein and Pettijohn 1938) and graphical estimates (Folk 1974). These include the *mean*, a measure of the average grain size; *sorting*, a measure of the spread of the distribution; *skewness*, a measure of its symmetry; and *kurtosis*, a measure of its peakedness. For a normal distribution, the skewness is zero, and the kurtosis is one. The mean size determined from moment-measure statistics is poorly defined for distributions in which the tails (*i.e.* the fine sizes) are not resolved. A more useful measure in this case is Folk's graphic mean (Folk 1974) which requires resolution of only 84% of the size distribution. This has the expression:

$$\text{Graphic Mean} = \frac{PHI_{16} + PHI_{50} + PHI_{84}}{3}$$

where PHI_n is the n^{th} percentile. Complete details on the calculation of the moment and graphical statistics are available in Sandilands and Duncan (1980).

Textural labels are assigned by using ternary classification schemes by Shepard (1954) and Folk (1954). These are based on the relative ratios of either the gravel, mud and sand percentages, or the sand, clay, and silt percentages (Figure 2). Folk's ternary classification has the advantage that it can be used to create a distribution map by contouring the sand percentage at the 10, 50 and 90 percent values, and then contouring the silt/clay ratios of 2:1 and 1:2. The intersecting contours form cells which subdivide the map area into Folk size classes and give a better "feel" for the size pattern than plots of the individual statistics (Folk 1974).

The median, defined as the 50^{th} percentile, is the most commonly used average size parameter. It offers the advantage of being easy to determine and not requiring resolution of the tails of the distribution. It does, however, have the disadvantage of being insensitive to the shape of the distribution. Since many of the harbour samples show bimodal or stronglyskewed distributions of particle sizes, median size may not be representative of the predominant size, but should still be useful as an estimate of average size.

The mode is the most abundant size class. It is usually identified manually from the histogram of the size distribution and quoted as the central value of its 1/2 PHI class. For a bimodal or polymodal distribution, secondary modes can also be identified. The modes are important for determining sediment sources and transport mechanisms because they represent dominant sizes which should be related to factors such as hydraulic sorting and transport energy. Polymodal distributions may also indicate mixed sediments produced by dumping or dredging.

4.2 Geotechnical Parameters

4.2.1 Particle density and bulk density

Particle density was measured with a Micromeritics AccuPyc 1330 Multivolume Pycnometer. The instrument determines the specific volume of approximately 10 ml of sediment by inert-gas displacement. The sample is pre-weighed to 0.0001 g. Particle density is then computed by dividing the mass by the volume of solids. Density determinations are accurate to ±0.07% (Micromeritics 1992). Bulk density is calculated from the particle density and the water content.

4.2.2 Water content

The standard ASTM procedure, #D2216 (1958), was used for measuring water content. Samples were weighed wet and then dried overnight in an oven at 90°C. Water content was expressed as the ratio of the weight loss on drying (the weight of water) to the dry weight.

4.2.3 Organic content

Organic content was determined by loss on ignition (LOI) or with a LECO carbon analyzer. LOI is the loss of mass of a sample after heating for two hours in a Thermolyne 1400 Furnace at 500° C. Organic carbon was analyzed with a LECO-12 Carbon Determinator by heating 0.1 grams of sample at 575°C for 250 seconds, and measuring the amount of CO_2 evolved. Inorganic carbon was determined with the same apparatus, but at 1371°C and with a burn time of 60 seconds. Standards were used to ensure an accuracy of about 5%. The percent organic carbon is equal to approximately half of the LOI (M. Charlton, personal communication).

4.2.4 Shear strength

The shear strength of sediment cores was measured in the laboratory with a Geonor fall-cone penetrometer. The shear strength in kPa is determined from the depth of penetration of a series of standard cones dropped into the sediment (Hansbo 1957).

4.2.5 Magnetic susceptibility

Magnetic susceptibility is a measure of the concentration, composition, and grain size of iron minerals. Elevated levels of susceptibility in recent sediments are the result of anthropogenic activities such as coal combustion and steel refining (Thompson and Oldfield 1986), and can provide insight into sediment sources and transport patterns.

The magnetic susceptibility of sediment cores from Hamilton Harbour was measured with a Bartington Instruments MS-2 susceptibility meter with a 10 cm (ID) scanning coil (Versteeg 1994). Susceptibility measurements based on volume (κ) were made through the liner of unopened cores at 2 cm intervals with a precision of approximately 5% of the instrument reading. Accuracy is difficult to determine since it depends upon the volume of sediment within the range of the scanning coil. The presence of water will decrease the apparent susceptibility of the sample, and thus variations between samples reflect variations in both mineral magnetic susceptibility and water content. No corrections have been applied for the water content of the surficial sediments or the diamagnetism of the overlying water. Measurements were also made on selected 8 cm^3 subsamples with a Bartington Instruments susceptibility meter and an MS-2B measurement coil. Adjustments for water content were made by normalizing to the mass of dry sediment in each subsample, resulting in a mass-specific magnetic susceptibility (χ). The instrument precision is $8\pi \times 10^{-7}$ SI, and the data are accurate to 2% of the instrument reading.

5 RESULTS AND DISCUSSION

5.1 Particle size

5.1.1 Test of variations between sample sets

Differences in grain-size data for the several sample sets were tested statistically to determine whether there had been any temporal variation in particle size over the time period covered by this study. The analysis consisted of identifying samples collected at the same station (operationally defined as being within a radius of 30 m) in different years, and performing paired-sample t-tests for parameter means by using the algorithm in Quattro Pro for Windows, v.5.0. The paired-sample test has the advantage that it makes no assumption about the form of the distribution of particle size and is therefore not affected by the bias of some sample collections to deep-basin or nearshore sediments, since it only compares the differences between samples collected at the same location.

The earliest samples (1984) were observed to have a consistently higher percentage of clay (especially unresolved fines >12 PHI) than samples from subsequent years. Reanalysis of 16 of the samples for which material was still available gave results more consistent with the later data and suggested that differences in the dispersion procedure may have been responsible for the anomalous earlier data. Accordingly, we have not included the 1984 data in the t-tests and have used the 1987 data as the earliest data set. The new data are listed along with the old data in Appendix 1 but have not been included in Figure 6 or Appendices 6 and 7.

The parameters compared in the t-tests were median size, main mode, percent sand, percent silt, and percent clay. Data from the 1987 cores, the 1990 Ekman samples, and the November 1993 cores were each compared with the 1987 Shipek samples. Results are summarized in table 1 which lists the computed values of t and the critical values. Where |t| > tcritical, the difference between data sets is considered significant at α=95%; *i.e.* 19 times in 20.

Significant differences occur between the 1987 cores and the 1987 Shipek samples, for all parameters except percent sand. The core samples are coarser than the Shipek samples. There are no significant differences between the 1990 samples and the 1987 Shipek samples . Differences between the November 1993 cores and the 1987 Shipek samples are insignificant except for the percent silt which is lower in 1993.

The temporal variations in particle size at each station are shown in a series of maps in Appendix 5. The maps contain histograms of the difference in particle size distribution between samples collected at the same site in different years (*same site* here is not restricted to samples within 30 m of each other; sites may be separated by as much as 200m). The residuals were determined for each pair of samples by computing the differences in weight percent for all 1/2 PHI classes. In most instances, the differences were less than 5%, and in general there was no trend towards coarser or finer sediments between sample years. The largest differences were generally in the nearshore samples where one would expect a higher degree of temporal variation in sediment size due to wave and storm effects.

The significant differences between the 1987 Shipek samples and the 1987-1989 cores noted above are evident in the histograms of their residuals (Appendix 5). Although the residuals are still generally less than 5%, the core samples tend to have higher silt and lower clay classes, coarser modes, and better sorting than the corresponding Shipek samples. This trend occurs only for Benthos cores collected before 1990 and is absent in early diver cores and in the later Benthos cores collected in 1993. The differences appear to result from a change in the design of the Benthos corer. The early Benthos corers restricted the flow of water through the piston valve and produced a pressure wave which dispersed the fine surface sediments and resulted in a narrower, coarser size distribution for the surface sediment. This is evident in the differences between the size profiles for the earlier and later cores. The 1987-1989 Benthos cores show a coarsening in grain size in the surface sediment relative to the deeper sediment which is missing in the 1993 cores and the 1989 diver cores. Because of their bias towards coarser sizes, we have not included the 1987-89 cores in the analysis of temporal changes in size or in the summary statistics.

Comparison of the 1987 Shipek samples with the 1990 Ekman samples and 1993 cores (Appendix 5) suggests that the particle size of Hamilton Harbour bottom sediments has not changed significantly during this period. This means that it should be possible to use data from any of these years or sites in combination or interchangeably with the expectation that they would differ by less than 5% per 1/2 PHI interval, which is the analytical error. For the remainder of this report, average values of size parameters are computed using only the reliable data, *i.e.* the 1987 Shipek, the 1990 Ekman, and the 1993 core samples.

5.1.2 <u>Size statistics</u>

A summary of selected particle-size data is provided in Appendix 1. It includes the median; the main and secondary modes; gravel, sand, silt and clay percentages; and Folk's (1954) ternary-classification labels. The complete listing of size data is available electronically in NWRI's grain-size database which contains information on sample location, collection time, and sampling method; weight percentages in 1/2-PHI intervals from -3.5 to 12 PHI, percentile data, summary statistics (moment and graphic), and ternary-classification labels. Access to the database can be arranged through the senior author.

The grain-size parameters all show the same basic areal-distribution pattern (Figures 3, 4 & 5). The finest sediments occur in the central basin, intermediate sizes at mid depths and along the industrial south shore. The coarsest sizes occur in the nearshore zone along the north and east coasts. Basin sediments generally fall within the Folk class *mud*, with median size greater than 8 PHI (3.9 µm) and modal sizes between 6.5 and 8 PHI (11.1-3.9 µm). Mid-slope and south-shore sediments are *sandy muds* with median sizes in the range of 4-7 PHI (62.5-7.8 µm) and typical modal sizes of 3.25-3.75 PHI (105.1-74.3 µm). Northshore sediments are *muddy sands* and *sands* with median sizes of 1-7 PHI (500-7.8 μm) and modal size(s) of 2.25-3.75 PHI (210.1-74.3 μm) and 6.5-8.0 PHI (11.1-3.9 μm).

Appendix 6 lists the summary statistics for the sand, silt and clay fractions, for each sample set, and for all samples combined. Fraction data are also plotted as a ternary plot of sand, clay and silt percentages for all samples in Figure 6. *Mud* is the class of highest frequency, followed by *silt, sandy mud* and *sand*. The 1987 Shipek, 1990, and November 1993 samples are clustered in the *sandy mud* category. For the reasons discussed above, the 1987-89 cores are shifted towards the coarser sizes and the 1984 samples towards the finer sizes. The sample set for July 1993 has only central basin samples with a higher clay:silt ratio and lower percent sand. The average for all reliable samples is a *sandy mud* with sand, silt and clay percentages of 16.5, 47.4 and 35.9 respectively.

Descriptive statistics for median size are listed in Appendix 6 for each sample set and for all samples combined. Values range from 1.3 to 8.7 PHI, with a mean of 6.8 PHI. Variations in the average values between sample sets occur as the result of differences in the numbers of nearshore and basin samples.

For each sample set, a map of the size distribution has been produced by plotting the particle-size histograms at the sample locations (Appendix 7). They show all aspects of the size distribution (mean size, sorting, skewness and kurtosis) simultaneously and can be useful for inferences about the mode of particle transport or the dependence of sediment chemistry or biology on grain sizes. Samples from deep water in the centre of the basin have smooth, unimodal distributions which peak near the silt-clay boundary and are slightly skewed towards clay. Nearshore samples from the north shore are generally well-sorted sands with little or no silt and clay. Nearshore samples from the south shore are poorly-sorted polymodal silts or silty sands. These may be disturbed sediments since they occur in an area for which core and acoustic data show evidence of dredging and dumping (Rukavina *et al.* 1994). Intermediate samples tend to be bimodal, with a peak in the sand fraction similar to the nearshore samples, and a flatter and wider distribution which peaks at the silt-clay boundary like the deep basin samples. Appendix 6 lists the summary statistics for the principal and secondary modes for each sample set and for all samples combined. A plot of average size distribution produced by summing all 1/2-PHI classes (Figure 7) shows a principal mode at 7.25 PHI and a secondary mode at 3.75 PHI. Figure 7 also reveals that > 50% (by weight) of the sediment falls into the narrow size class of between 5.5 and 9.0 PHI (22.1-2.0μm).

5.2 Geotechnical Properties

Geotechnical properties for the surficial sediments are listed in Appendix 8, and summarized in Table 2. For some parameters, only a few samples have been analyzed, and they are not necessarily representative of the entire harbour. The only parameters for which data are distributed widely enough to permit some comments about spatial pattern are organic carbon and magnetic susceptibility. Data on temporal changes are available only for water content and organic carbon.

5.2.1 Grain density and bulk density

Grain density was determined for 10 of the 1988-89 core samples. Values ranged from 2.36 to 2.66 g/cm^3 and averaged 2.50 g/cm^3. Bulk density varied from 1.14 to 1.71 with a mean of 1.23 g/cm^3. There was no significant density difference between the cores collected by divers and the Benthos cores.

5.2.2 Water content

Water content was measured for 40 samples from the 1987, 1988, 1989 and 1993 cores. Values, expressed as a percentage of dry weight, range from 41% to 560%, with a mean of 332%. Comparisons between samples collected at the same sites in 1987, 1988, 1989, and 1993 reveal differences which range from 0.5% to over 100%. There are insufficient data to warrant rigorous statistical analysis, but there does not appear to be any consistent trend in these differences. The high degree of variability is likely due to the difficulty of subsampling at the sediment-water interface which leads to more or less of the overlying water being included in the subsamples.

5.2.3 Organic content

Organic carbon was determined for 8 of the July 1993 cores and 40 of the November 1993 cores, and ranged from 0.1% to 6.1% with a mean of 2.5%. Values for the 7 samples collected at the same sites at different times are generally in close agreement; differences range from 0.002% to 4.9% and most are less than 0.5%. Six of the 7 samples from July have a greater organic carbon content than the November samples but there are insufficient data to determine whether this represents a seasonal effect. Carbon content was determined by LOI for 9 of the 1989 core samples. Values ranged from 1.9% to 11.5% with a mean of 7.1% which is slightly greater than twice the mean of organic carbon.

The distribution of organic carbon values is plotted in Figure 8, and is similar to the distribution of the grain size parameters. Organic carbon values are highest in the central basin, and get lower toward the shore, with the lowest values occurring along the northshore.

5.2.4 Shear strength

Shear strength was measured on 4 of the 1988-89 core samples. Values ranged from 0.07-2.60 kPa and averaged 0.60 kPa. The low values are at the lower limit of resolution of the instrument. The number of analyses was limited because the fluidized sediments at the tops of cores were generally subsampled before the core was opened for analysis.

5.2.5 Magnetic susceptibility

Magnetic susceptibility (κ) was measured on 50 cores collected in July 1993. Values for the top 2 cm ranged from 8×10^{-6} to 209×10^{-6} cgs (or $4\pi \times 8 \times 10^{-6}$ to $4\pi \times 209 \times 10^{-6}$ SI), with a geometric mean of 58.84×10^{-6} cgs. Magnetic susceptibility is highest in the sediments of the industrialized south shore (Figure 9) and lowest in the central and western basins. Localized zones of low susceptibility are found in the north-east and south-east areas of the harbour. A prominent low-susceptibility plume extends from the western end of the harbour, where Grindstone Creek and the Desjardin Canal input into the harbour, to the deep central basin, and represents the input of sediments with low magnetic-mineral content from these non-industrial sources. The reason for the low values in the south-east corner is that the recent, high-susceptibility sediment has been removed by localized dredging (Versteeg *et al.* 1994).

6 CONCLUSIONS

This report summarizes geotechnical data for 211 surficial-sediment samples from Hamilton Harbour collected during 9 surveys between 1984 and 1993. Its focus is on particle size and its spatial and temporal variations. Limited data are also available for water content, organic content, grain density, shear strength and magnetic susceptibility.

Statistical comparison of sediment-size distributions between collections identified significant differences which could be attributed to sampling and analytical errors, but not to temporal changes. Based on the comparison of 135 samples from 1987, 1990, and 1993, we conclude that there have been no significant changes in the distribution of particle sizes in Hamilton Harbour over this period. This permits us to combine the data from these collections to determine average values of several size parameters and to map their distribution.

Average median grain size is 6.8 PHI (9.0 µm). The most prominent size mode occurs at 7.25 PHI and there is a secondary mode at 3.75 PHI. Average sand, silt, and clay percentages are 16.5, 47.4, and 35.9% respectively, and the Folk classification is *sandy mud*.

In general, particle size is finest in the centre of the harbour and coarsens toward the shores. Northshore sediments are coarser and better sorted than southshore sediments. The size distribution for central harbour sediments is broad and symmetrical with a single mode at the silt-clay boundary. Samples at intermediate depths are often bimodal mixes of these two end-members. Several samples, especially those near the south shore, have highly irregular size distributions which may be indicative of sediment disturbance.

Only a small number of data are available for many of the geotechnical parameters. Grain density averages 2.50 g/cm^3. Water content is highly variable, with a mean of 332.4%. Organic content as determined by organic carbon analysis averaged 2.5%, while LOI analysis gave an average of 7.1%. Organic carbon values are highest in the central basin, and get lower toward the shore, with the lowest values occurring along the northshore. Average shear strength is 0.60 kPa. Mean magnetic susceptibility is 58.84 x 10^{-6} cgs, and is highest in southshore sediments, and lowest in the central basin. A plume of low values from the west to the central basin reveals the influx of non-magnetic sediment from the Desjardin Canal and Grindstone Creek.

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	t(critical)	t	1987 Shipek mean	Data mean	Number of Samples
1987 Cores					
med phi	2.306	**5.148**	7.271	6.729	9
main Mode	2.365	**3.862**	7.406	6.969	8
sand	2.306	-0.994	8.412	11.426	9
silt	2.306	**-2.533**	52.074	62.831	9
clay	2.306	**5.254**	39.512	25.747	9
1990					
med phi	2.080	1.911	7.165	6.840	22
main Mode	2.080	1.735	7.000	6.409	22
sand	2.080	-0.925	12.686	14.301	22
silt	2.080	-1.103	48.930	51.332	22
clay	2.080	1.813	38.304	34.367	22
1993 Nov.					
med phi	2.080	0.640	6.985	6.855	22
main Mode	2.080	1.604	6.750	6.295	22
sand	2.080	-1.304	13.552	17.050	22
silt	2.080	**2.859**	50.535	44.100	22
clay	2.080	-1.307	35.905	38.823	22

Table 1: Summary of statistical comparisons between sample sets. Comparison between 1987 Shipek and other data sets. Comparisons are t-test, for paired samples, where the pairs are stations within 30 m of each other. Where |t|>t critical (highlighted t values), there is a significant difference between the two data sets.

Table 2: Summary of Geotechnical Properties

All Samples	***Water Depth (m)***	***Particle Density (g/cm^3)***	***Water Content (% dry weight)***	***LOI (%)***	***Organic Carbon (%)***	***Total Carbon (%)***	***Shear Strength (kPa)***	***K (*10^-6 cgs)***	***X (*10^-8 m^3/kg)***
Mean	13.2	2.50	332.3	7.1	2.5	5.9	0.75	59	579.4
Standard Error	0.4	0.01	8.6	0.2	0.1	0.1	0.44	1	1.2
Median	10.2	2.49	327.0	7.1	2.4	5.8	0.18	68	743.6
Standard Deviation	5.7	0.11	131.0	2.6	1.1	1.2	1.23	2	1.9
Variance	32.5	0.01	17152.7	6.9	1.2	1.3	1.52	1	1.2
Kurtosis	-1.3	22.77	5.1	36.8	5.4	33.9	7.78	17	
Skewness	-0.0	4.95	2.5	6.0	2.4	5.9	2.78	0	
Range	23.0	0.30	519.2	9.6	6.0	3.0	2.53	201	860.3
Minimum	0.5	2.36	41.0	1.9	0.1	4.2	0.07	8	218.7
Maximum	23.5	2.66	560.1	11.5	6.1	7.3	2.60	209	1079.0
Count	209	10	40	9	48	8	4	50	8
Confidence Level(0.95)	0.8	0.07	40.6	1.7	0.3	0.8	1.21	1	1.5

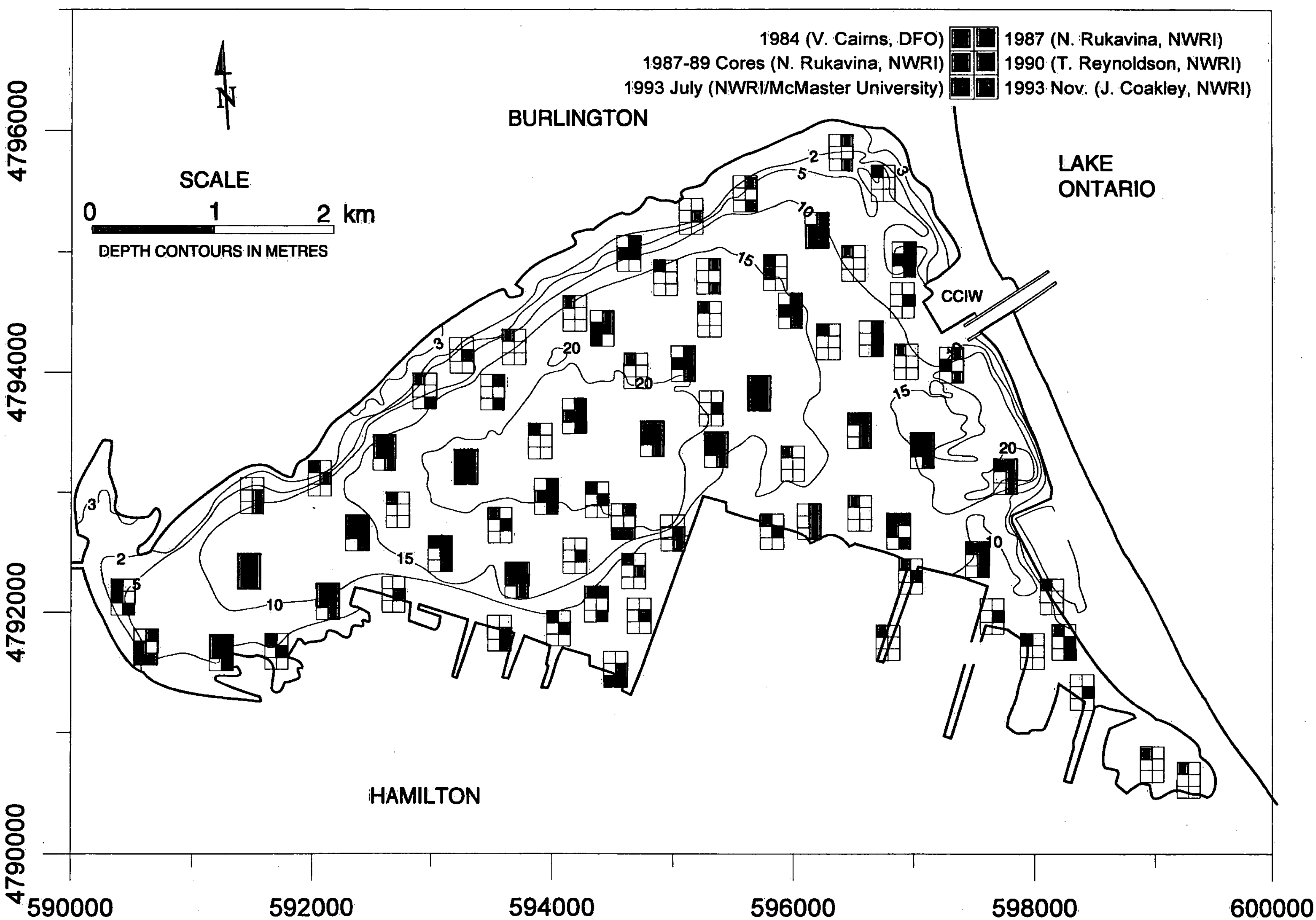


Fig. 1 Map of All Sample Stations

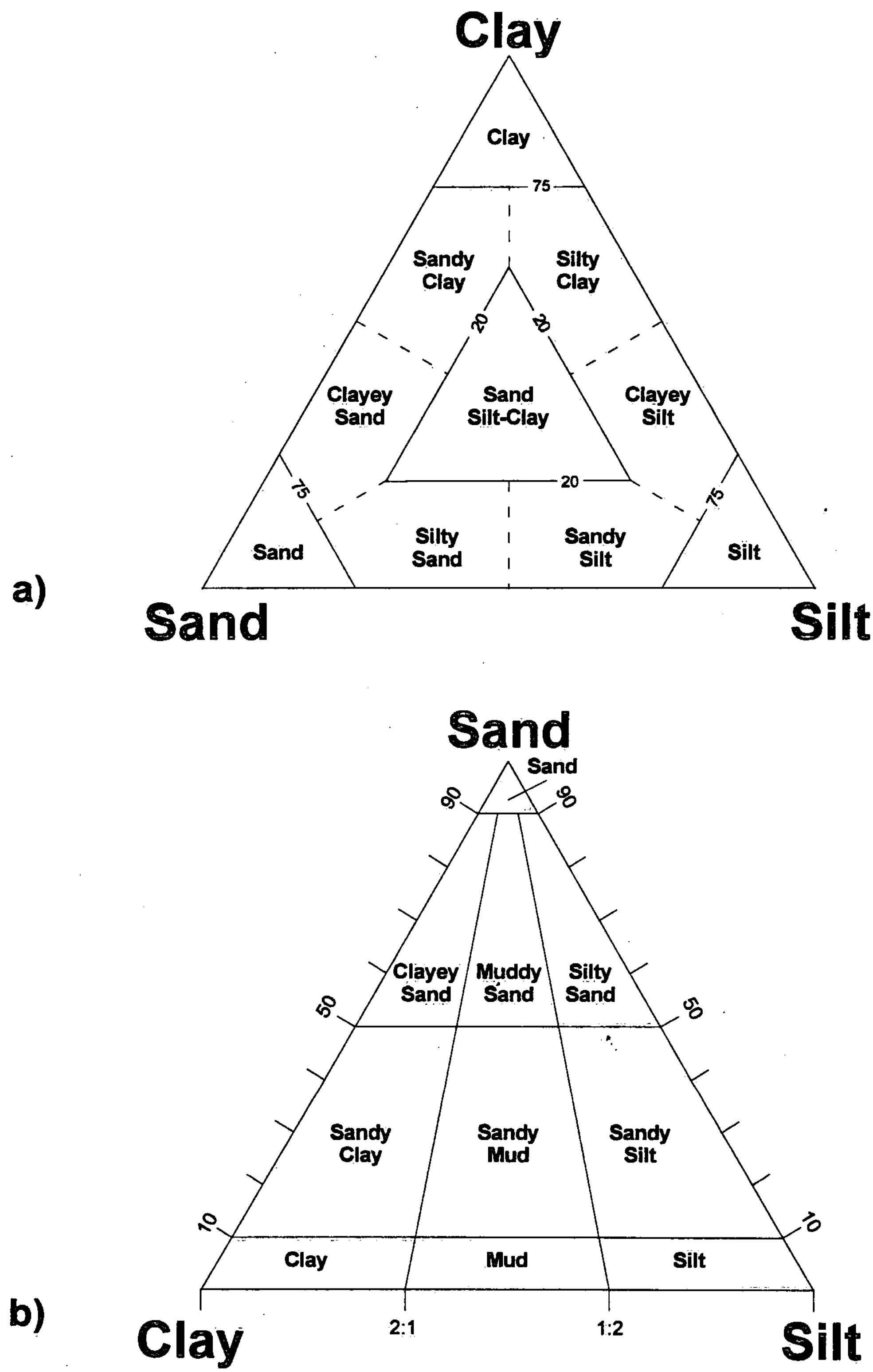


Fig. 2 a) Shepard (1954) and b) Folk (1954) ternary sediment classification systems.

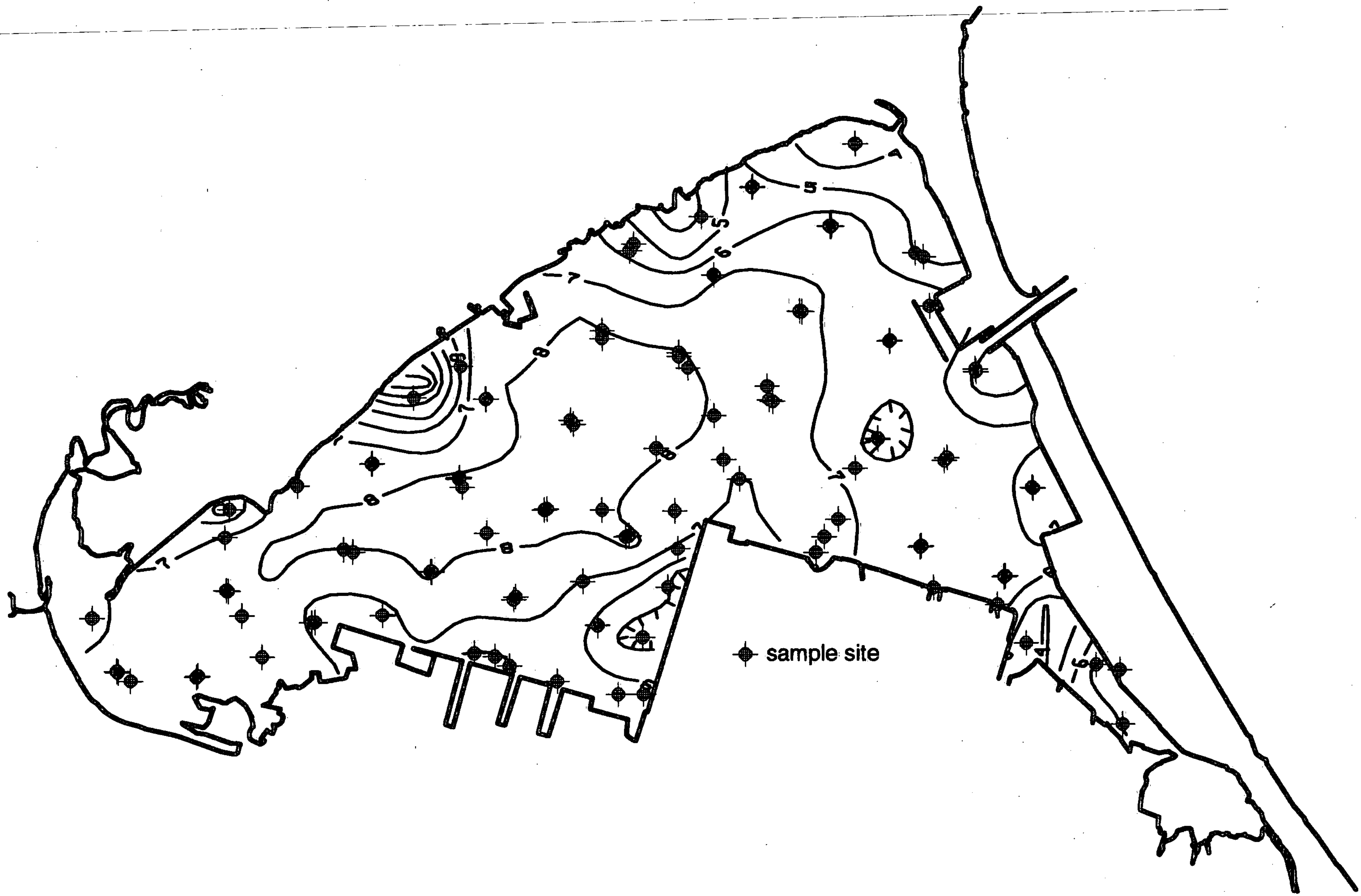


Fig. 3 Median Grain Size Contours in PHI Units

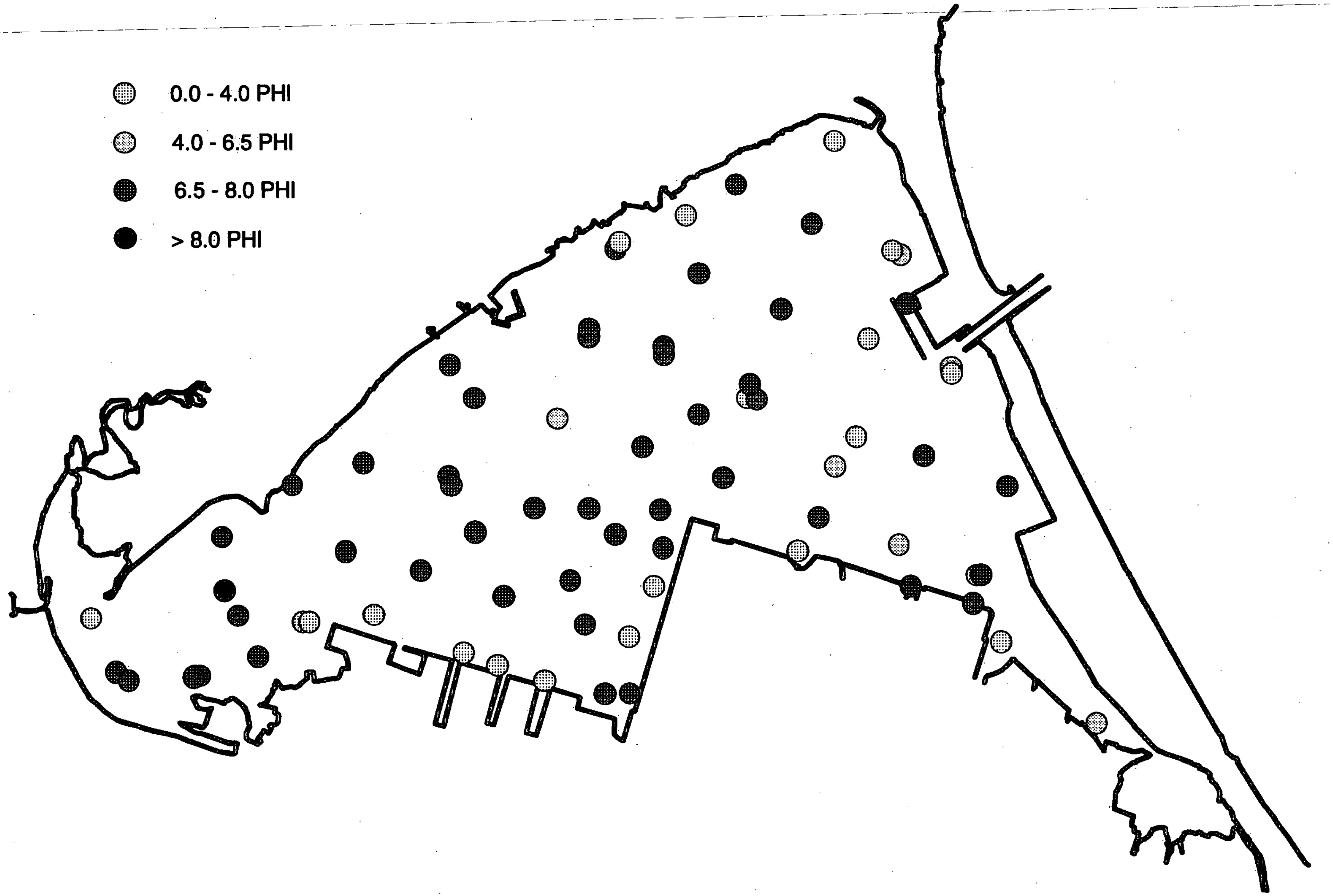


Fig. 4 Distribution of Main Mode (PHI)

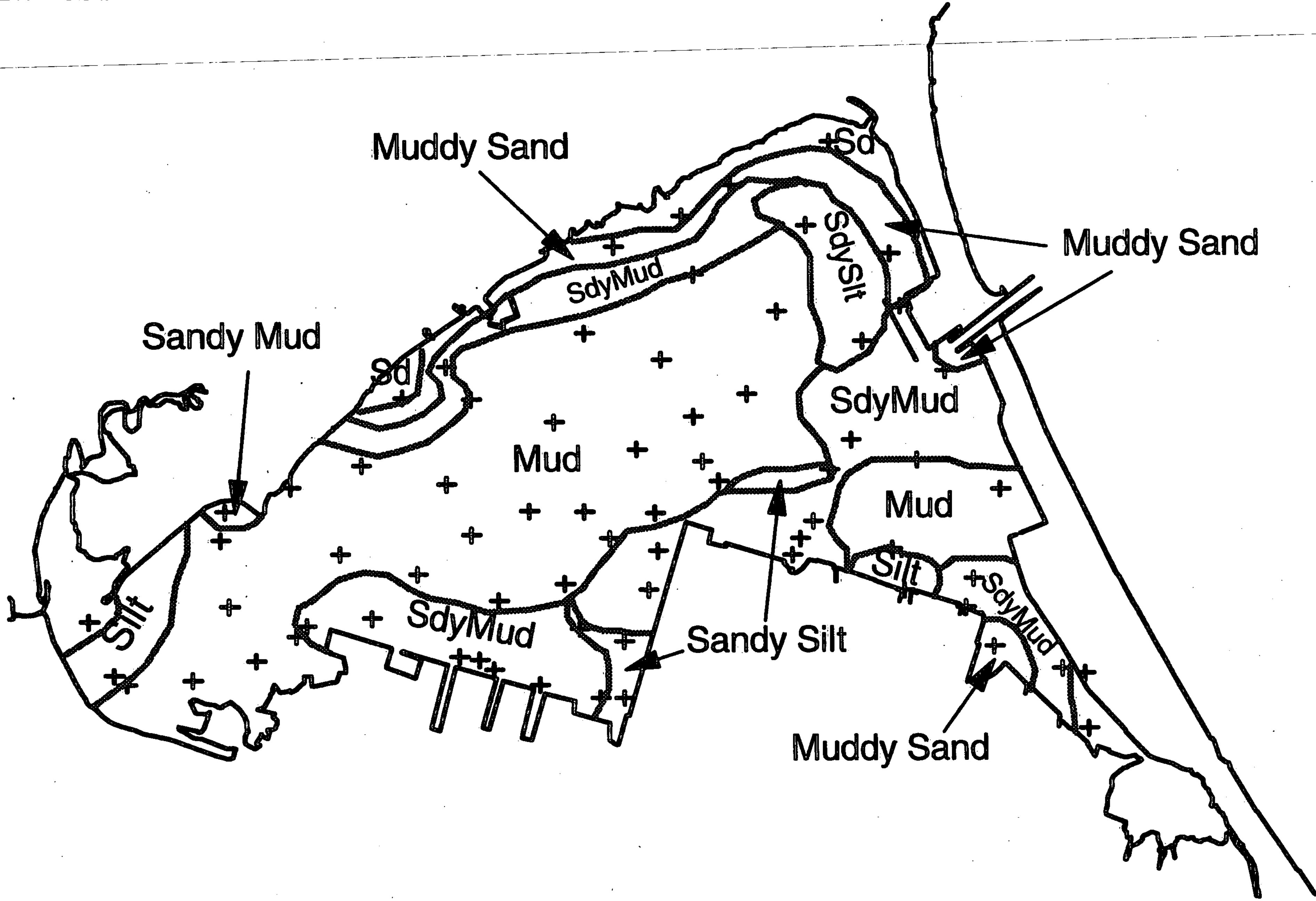


Fig. 5 Folk Classification Labels

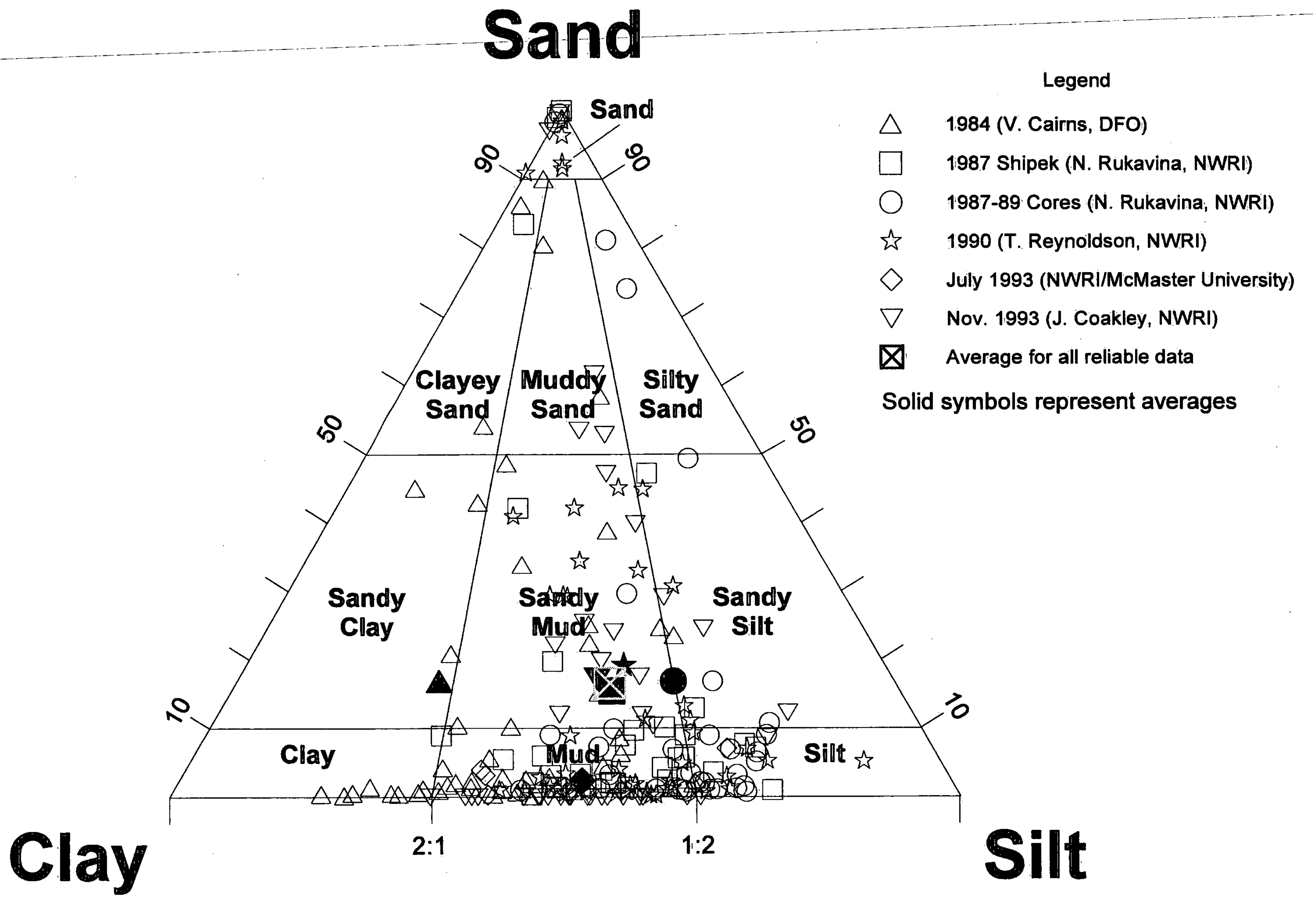


Fig. 6 Folk Ternary Plot of all Hamilton Harbour Surface Sediment Data

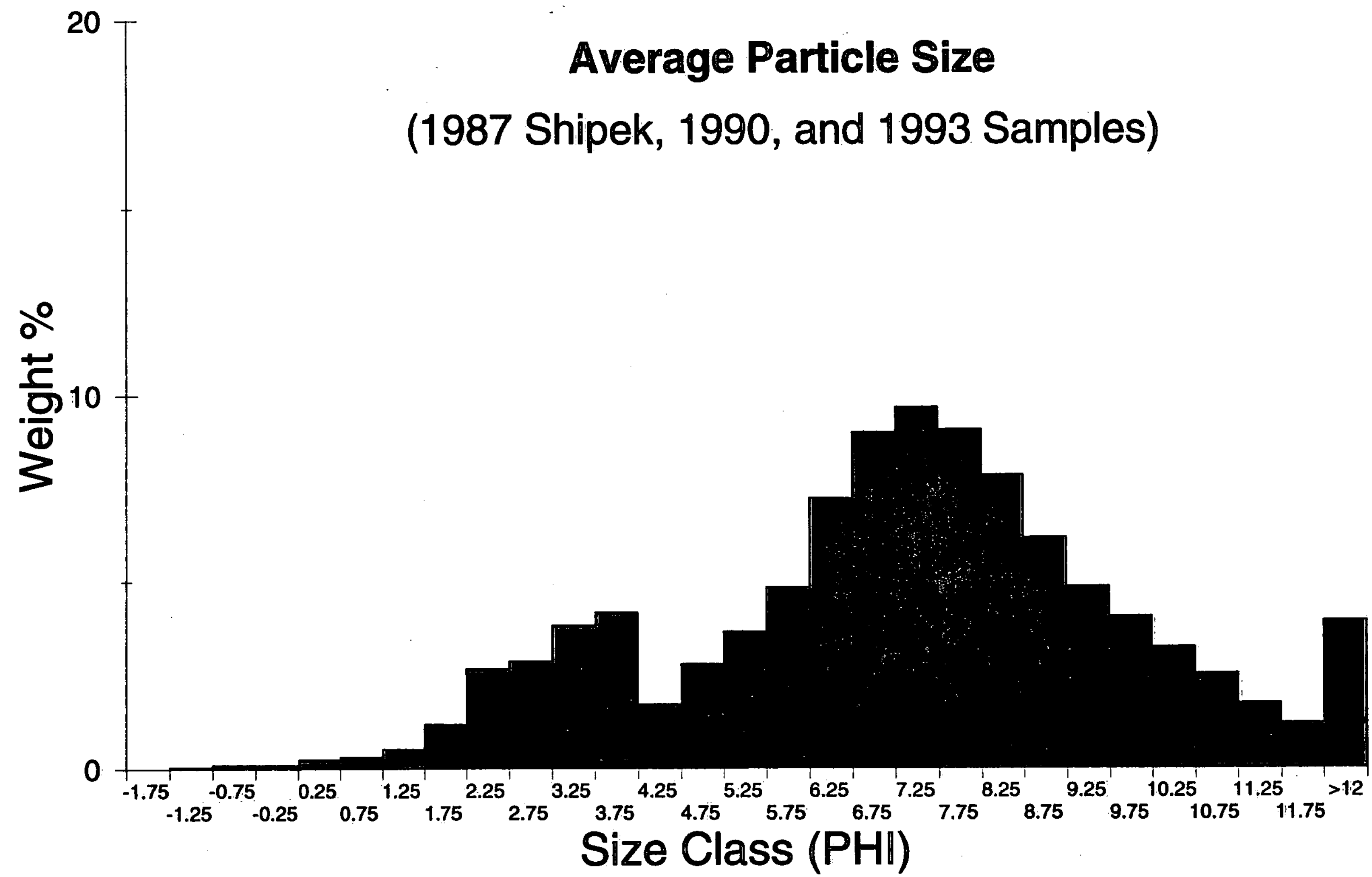


Fig. 7 Average histogram for all reliable data

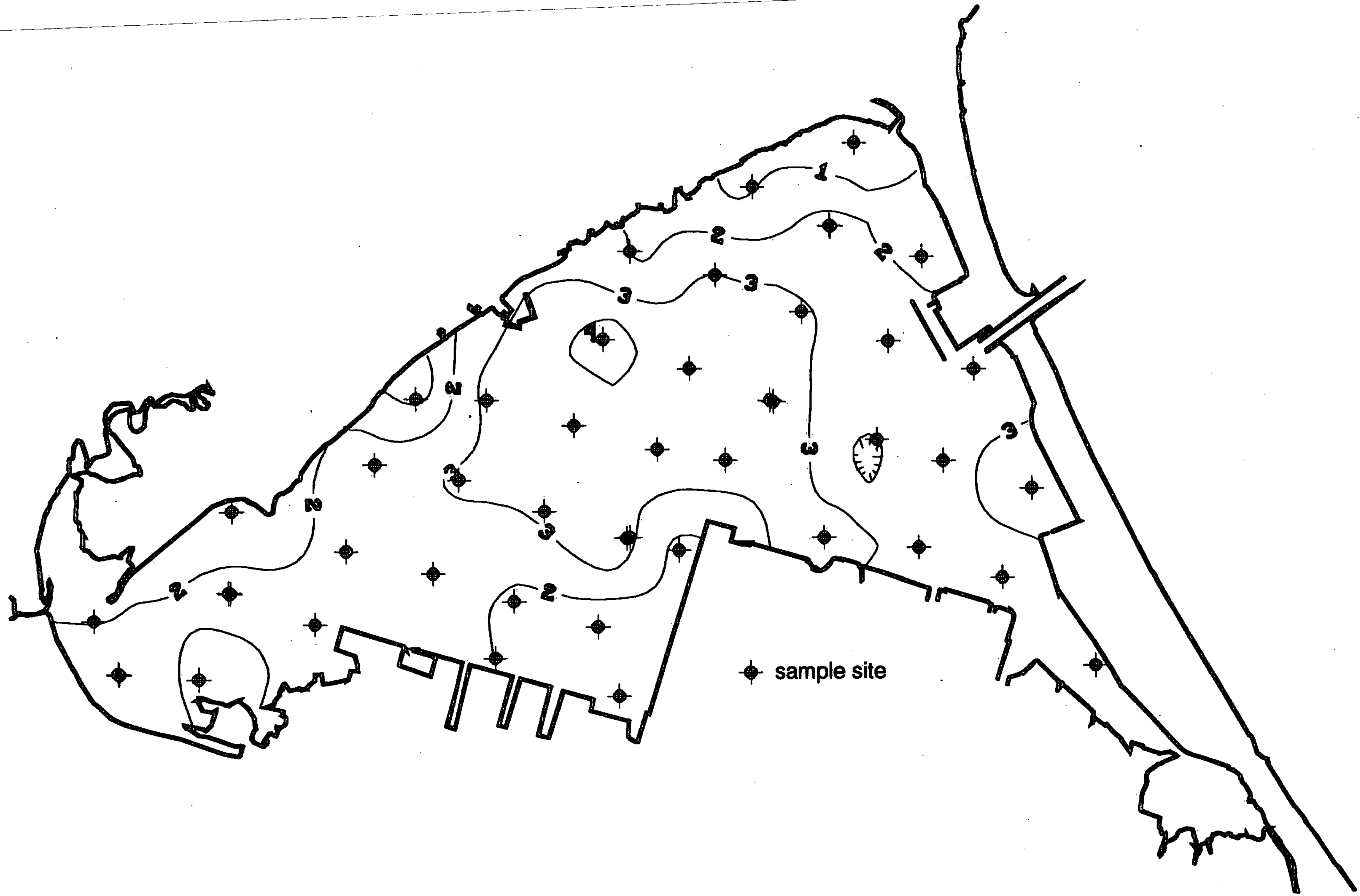


Fig. 8 Organic Carbon (%) Distribution for 1993 Core Samples

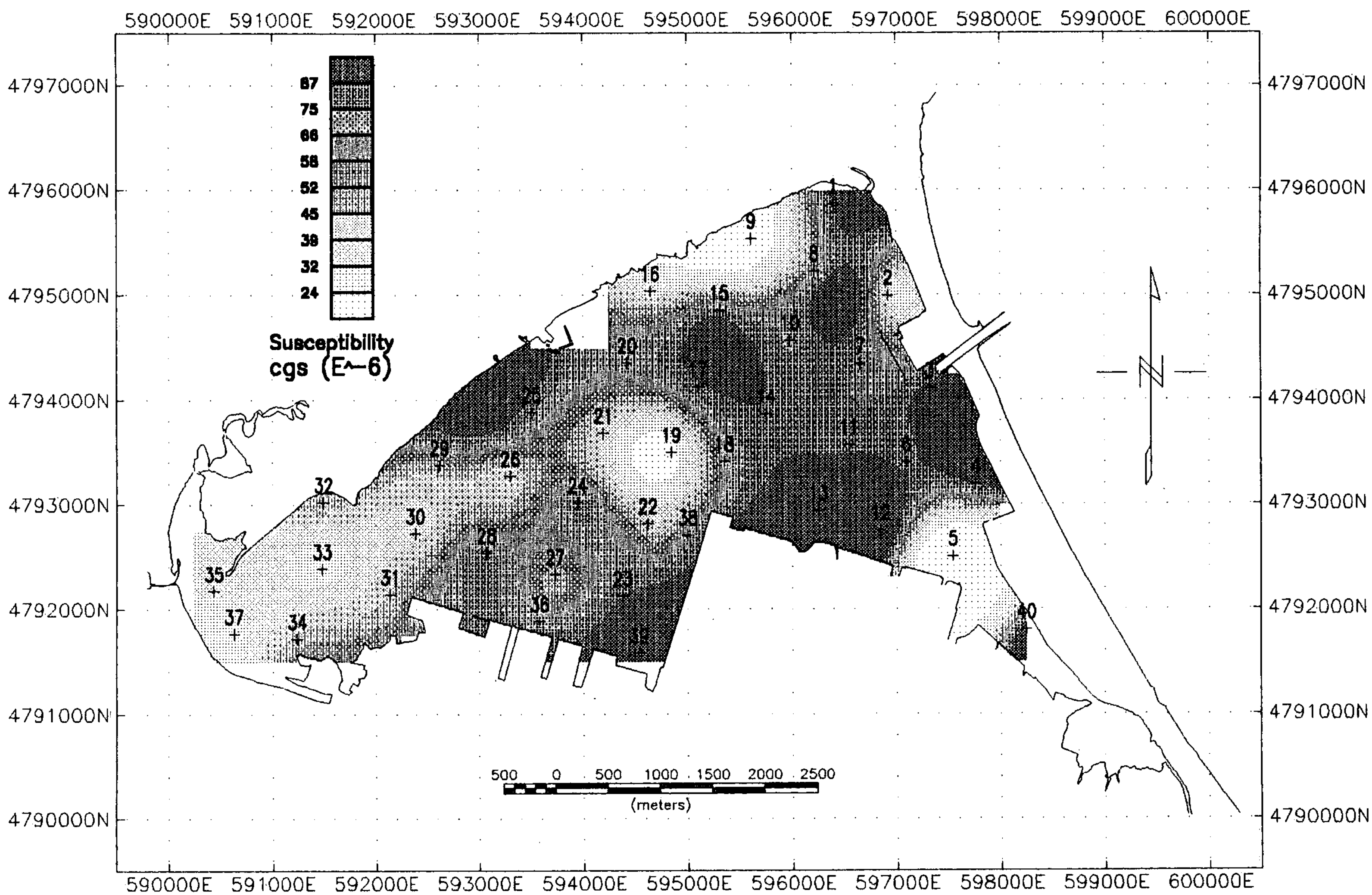


Fig. 9 Surface Sediment Magnetic Susceptibility

APPENDIX 1

Sample labels, positions, water depths, and particle size summary.

Sample #	Northing UTM	Easting UTM	Water Depth (m)	GRAV %	SAND %	SILT %	CLAY %	Median (PHI)	Main Mod (PHI)	2nd Mode (PHI)	Folk's (SCS) Label
1984 Ekman Samples (0-5cm), Collected by V. Cairns, DFO, October, 1984. Positions determined by Radar.											
1	4792238	590359	4	1.98	78.64	7.26	12.11	2.1	1.8	6.8	muddy sand
1-Repeat	4792238	590359	4	2.64	90.19			1.8	1.8		sand
2	4791911	590978	8	0.00	1.30	48.36	50.34	8.0	6.8		mud
2-Repeat	4791911	590978	8	0.00	0.33	64.85	34.81	7.3	7.3		mud
3	4792328	591450	11	0.00	0.34	40.86	58.80	9.3	7.3		mud
3-Repeat	4792328	591450	11	0.00	0.75	49.72	49.52	8.0	8.3		mud
4	4791572	591664	8	0.00	5.63	37.75	56.62	8.9	7.3		mud
4-Repeat	4791572	591664	8	0.00	14.00	61.05	24.95	7.0	7.3		sandy silt
5	4791997	592107	10	0.00	1.15	31.63	67.22	11.0	7.8		clay
5-Repeat	4791997	592107	10	0.00	1.58	63.58	34.83	7.3	7.0		mud
6	4793147	592053	10	0.00	10.38	31.37	58.26	9.4	4.8		sandy mud
7	4793319	592390	12	0.00	86.28	1.65	12.07	2.4	2.3		clayey sand
7-Repeat	4793319	592390	12	0.00	98.43	0.00	0.00	2.3	2.3		sand
8	4792457	592499	14	0.00	20.82	25.34	53.84	8.5	7.3	5.3	sandy clay
9	4792951	592677	16	0.00	1.43	24.64	73.93		7.3		clay
10	4793994	593006	6	0.00	45.02	8.80	46.18	6.8	3.3		sandy clay
10-Repeat	4793994	593006	6	0.00	82.90			3.2	2.8		muddy sand
11	4792287	593028	10	0.00	54.20	12.82	32.97	3.9	3.3	5.3	clayey sand
11-Repeat	4792287	593028	10	0.00	83.05	13.58	3.36	3.3	3.3		silty sand
12	4793317	593350	19	0.00	0.52	22.88	76.60		7.3		clay
12-Repeat	4793317	593350	19	0.00	0.99	47.77	51.24	8.1	7.8		mud
13	4794315	593641	12	0.00	4.20	32.57	63.23	10.9	7.3		mud
14	4792149	593491	13	0.00	48.70	18.47	32.83	4.8	3.3	7.3	sandy mud
15	4792597	593609	19	0.00	0.38	18.93	80.69		7.8		clay
15-Repeat	4792597	593609	19	0.00	0.34	59.58	40.09	7.6	7.3		mud
16	4793526	593865	21	0.00	0.42	28.88	70.70	11.9	7.3		clay
16-Repeat	4793526	593865	21	0.00	0.42	32.50	67.08	8.7	8.3		clay
17	4794588	594147	19	0.00	0.17	21.96	77.87		7.3		clay
18	4791987	594024	9	0.97	32.86	27.79	38.38	6.0	3.3		sandy mud
19	4793032	594333	21	0.00	0.52	27.86	71.63	11.1	7.3		clay
19-Repeat	4793032	594333	21	0.00	0.52	29.47	70.01	8.7	8.3	4.3	clay

no

wo

Sample #	Northing UTM	Easting UTM	Water Depth (m)	GRAV %	SAND %	SILT %	CLAY %	Median (PHI)	Main Mod (PHI)	2nd Mode (PHI)	Folk's (SCS) Label
20	4794111	594650	21	0.00	0.62	31.30	68.07	9.5	7.8		clay
21	4794887	594895	17	0.00	0.67	43.70	55.62	8.4	7.3		mud
22	4791855	594455	8	0.00	8.65	52.53	38.83	6.7	4.8		mud
23	4792441	594631	22	0.00	10.22	38.16	51.62	8.1	7.3		sandy mud
24	4793439	594921	20	0.00	1.67	34.42	63.91	10.6	7.3		mud
24-Repeat	4793439	594921	20	0.00	2.76	44.83	52.41	8.1	7.8		mud
25	4794546	595259	17	0.00	0.91	33.69	65.40	9.5	7.3		mud
26	4793094	595278	19	0.00	2.35	37.11	60.54	8.8	7.3		mud
27	4793992	595553	17	0.00	1.03	41.57	57.40	8.7	7.3		mud
27-Repeat	4793992	595553	17	0.00	0.91	40.11	58.97	8.4	8.3	9.3	mud
28	4794857	595802	12	0.00	1.45	37.45	61.10	9.8	6.8		mud
29	4792774	595768	11	0.00	90.03	2.62	7.34	2.5	2.3		sand
30	4793334	595950	16	0.00	2.79	40.83	56.38	9.1	7.0		mud
31	4794360	596249	16	0.00	2.56	43.85	53.59	8.4	6.8		mud
32	4795009	596456	10	0.00	6.35	53.85	39.80	7.0	5.3	6.3	mud
33	4795666	596708	6	0.00	58.57	25.27	16.16	3.8	3.3	5.3	muddy sand
34	4792923	596517	12	0.00	24.67	49.72	25.61	6.3	6.3	2.3	sandy mud
35	4793615	596716	14	0.00	38.83	35.98	25.19	5.2	3.3	5.3	sandy mud
35-Repeat	4793615	596716	14	0.00	29.24	33.33	37.43	6.9	3.3	7.8	sandy mud
36	4794190	596890	12	0.00	42.93	17.71	39.36	5.3	3.3	5.3	sandy mud
37	4792569	596999	3	0.00	0.82	50.58	48.60	7.9	6.3		mud
38	4791766	596825	9	0.00	2.94	46.59	50.47	8.1	6.5		mud
39	4792303	596990	13	0.00	2.03	35.27	62.70		6.5		mud
40	4793487	597235	15	0.00	2.33	50.19	47.48	7.9	7.3		mud
40-Repeat	4793487	597235	15	0.00	0.83	55.13	44.04	7.7	7.8	9.3	mud
41	4792355	597714	9	0.00	15.14	46.67	38.19	6.8	5.3	6.3	sandy mud
42	4793002	597915	20	0.77	24.39	40.41	34.42	7.0	7.3		sandy mud
43	4791768	598021	7	0.00	22.42	41.89	35.69	7.0	7.3	3.3	sandy mud
44	4792130	598093	8	0.00	23.48	52.04	24.49	6.2	6.3		sandy silt
45	4791637	598345	8	0.00	4.52	52.52	42.97	7.6	7.3		mud
46	4790835	598924	1	0.00	1.89	65.24	32.87	6.9	5.8		mud
47	4790716	599230	1	0.00	1.33	62.65	36.01	7.3	7.3		mud

Sample #	Northing UTM	Easting UTM	Water Depth (m)	GRAV %	SAND %	SILT %	CLAY %	Median (PHI)	Main Mod (PHI)	2nd Mode (PHI)	Folk's (SCS) Label
1987 Shipek Samples (0-3cm), Collected by N. Rukavina, NWRI, July 1987											
Water depths converted to IGLD 1955.											
1	4795871	596406	0.8	0.00	99.85			2.3	2.3		sand
2	4795019	596864	5.6	0.00	98.90			2.4	2.3		sand
3	4794092	597324	13.3	0.00	47.26	36.82	15.92	4.3	3.3	5.3	sandy silt
4	4793187	597755	21.6	0.00	1.00	75.73	23.26	7.0	6.8		silt
5	4792496	597540	8.6	0.00	5.73	62.22	32.05	7.1	7.3	6.3	mud
6	4793421	597094	17.7	0.00	7.53	53.83	38.63	7.5	7.5		mud
7	4794336	596659	10.0	0.00	5.65	61.47	32.87	7.0	6.3	7.3	mud
8	4795231	596220	8.8	0.00	7.70	68.84	23.47	6.8	7.3	6.3	silt
9	4795540	595612	6.4	0.00	12.92	59.90	27.18	6.6	6.5	3.8	sandy silt
10	4794566	595966	13.7	0.00	1.41	57.21	41.39	7.6	6.8		mud
11	4793573	596556	13.5	0.00	42.15	23.16	34.68	5.8	3.3	8.0	sandy mud
12	4792732	596890	11.8	0.00	7.18	70.54	22.28	6.5	6.3	8.8	silt
13	4792942	596248	13.7	0.00	9.69	53.85	36.46	7.4	7.3		mud
14	4793982	595707	15.7	0.00	1.97	55.38	42.65	7.7	7.3		mud
15	4794847	595307	15.3	0.00	3.30	50.28	46.42	7.9	7.3		mud
16	4795091	594677	5.2	0.00	83.53	3.38	13.10	3.1	2.8	10.0	clayey sand
17	4794212	595022	17.0	0.00	1.44	48.16	50.40	8.0	7.8		mud
18	4793257	595486	13.8	0.62	9.50	57.53	32.35	7.0	6.8		sandy mud
19	4793497	594838	20.5	0.00	2.06	45.02	52.92	8.1	7.8		mud
20	4794416	594424	17.3	0.00	1.67	51.76	46.57	7.9	7.5		mud
21	4793719	594169	19.0	0.00	5.97	44.19	49.84	8.0	7.5	9.5	mud
22	4792815	594620	20.9	0.00	8.91	30.06	61.03	8.5	8.3	10.8	clay
23	4792116	594372	8.8	0.00	8.96	60.73	30.32	6.8	6.5	3.8	silt
24	4793025	593976	20.7	0.00	3.13	46.70	50.16	8.0	7.5		mud
25	4793883	593506	16.7	0.00	2.15	54.70	43.15	7.7	7.8		mud
26	4793198	593318	19.4	0.00	0.29	45.74	53.96	8.2	7.8		mud
27	4792341	593730	12.5	0.00	4.26	60.16	35.58	7.3	7.5		mud
28	4792538	593072	17.2	0.00	2.04	54.69	43.27	7.8	7.8		mud
29	4793379	592611	14.0	0.00	3.91	52.68	43.40	7.7	7.5		mud
30	4792690	592461	13.9	0.00	5.44	39.57	54.99	8.3	7.8	9.8	mud
31	4792142	592163	9.9	0.00	19.75	38.65	41.60	7.4	10.3	7.8	sandy mud

Sample #	Northing UTM	Easting UTM	Water Depth (m)	GRAV %	SAND %	SILT %	CLAY %	Median (PHI)	Main Mod (PHI)	2nd Mode (PHI)	Folk's (SCS) Label
33	4792191	591591	10.9	0.00	2.41	61.72	35.87	7.6	7.3	8.8	mud
34	4791723	591250	6.5	0.00	1.29	48.37	50.34	8.0	7.3		mud
37	4791685	590728	5.8	0.00	3.57	66.97	29.46	7.1	6.8		silt
1987 Benthos Core Samples, Collected by N. Rukavina, NWRI, July 1987 Water depths converted to IGLD 1955.											
2A	4794994	595888	9.1	0.00	49.37	41.01	9.62	4.1	5.3	7.3	sandy silt
3A	4794099	597320	12.8	0.00	74.17	20.95	4.89	3.8		7.0	silty sand
6A	4793406	597094	17.7	0.00	6.87	67.52	25.61	7.1	7.3	9.8	silt
8B	4795230	596215	9.0	0.00	6.44	71.11	22.45	6.6	6.3		silt
10A	4794561	595989	13.7	0.00	0.70	72.65	26.65	7.1	6.8		silt
12A	4792749	596848	12.2	0.00	10.75	70.51	18.74	6.5	6.3		sandy silt
14B	4793890	595747	16.3	0.00	1.23	71.12	27.66	7.1	7.3		silt
16B	4795026	594655	5.3	0.00	99.41			2.5	2.3		sand
17A	4794129	595099	17.5	0.00	1.02	67.80	31.18	7.2	7.3		silt
18B	4793409	595344	14.4	0.00	9.01	70.97	20.02	6.6	6.3		silt
19A	4793498	594845	20.8	0.00	2.00	66.64	31.36	7.3	7.3		silt
20B	4794355	594423	18.1	0.00	1.11	60.93	37.96	7.5	7.3		mud
21B	4793681	594194	19.9	0.00	1.01	63.85	35.14	7.4	7.3		mud
24B	4793010	593945	21.2	0.00	1.08	68.75	30.17	7.2	7.0		silt
26A	4793207	593306	20.2	0.00	0.96	64.38	34.67	7.4	7.3		mud
27A	4792331	593731	12.8	0.00	6.89	60.22	32.90	7.3	7.3		mud
29B	4793373	592625	15.2	0.00	1.57	71.85	26.58	7.0	6.8		silt
30B	4792721	592395	14.4	0.00	2.12	66.07	31.81	7.3	7.3		silt
31B	4792054	592188	9.4	0.00	16.82	60.31	22.87	6.6	7.3	5.3	sandy silt
33B	4792384	591482	11.4	0.00	0.76	65.00	34.24	7.4	7.3		mud
34B	4791710	591245	7.0	0.00	3.23	70.16	26.61	7.0	7.0	10.8	silt
37A	4791763	590633	6.1	0.00	5.12	71.63	23.25	6.8	6.5		silt

Sample #	Northing UTM	Easting UTM	Water Depth (m)	GRAV %	SAND %	SILT %	CLAY %	Median (PHI)	Main Mod (PHI)	2nd Mode (PHI)	Folk's (SCS) Label
1988-89 Core Samples, Collected by N. Rukavina, NWRI, 1988-89											
	Water depths are Field Depths.										
14a-88	4793867	595746	14.0?	0.00	1.21	53.77	45.02	7.8	7.5		mud
26C-88	4793271	593298	20.0	0.00	29.61	43.06	27.33	6.8	7.3		sandy mud
2A-89	4794999	596919	11.0	0.00	81.22	14.81	3.97	3.3	3.3		silty sand
14B-89	4793917	595744	18.0	0.00	3.37	64.22	32.40	7.3	6.8		mud
16C-89	4795043	594669	5.5	0.00	98.24			2.8	2.8		sand
26C-89	4793227	593248	21.5	0.00	0.95	44.00	55.05	8.2	7.3		mud
31C-89	4792058	592070	12.5	0.00	7.28	50.63	42.10	7.6	7.8		mud
37C-89	4791919	590606	7.5	0.00	3.24	53.99	42.77	7.7	7.3		mud
31B-89	4792149	592134	12.0	0.00	8.90	63.84	27.26	6.8	4.3	7.8	silt
31C-2-89	4792149	592134	12.0	0.00	8.96	43.70	47.34	7.9	7.3		mud
31D-89	4792149	592134	12.0	0.00	9.89	51.18	38.93	7.5	7.8		mud

Sample #	Northing UTM	Easting UTM	Water Depth (m)	GRAV %	SAND %	SILT %	CLAY %	Median (PHI)	Main Mod (PHI)	2nd Mode (PHI)	Folk's (SCS) Label
1990 Ekman Samples (0-3cm), Collected by T. Reynoldson, NWRI, May 1990											
	Water depths estimated from Hydrographic Chart.										
1	4791335	598452	8	0.00	4.87	62.41	32.71	7.2	6.3		mud
2	4795019	596864	3	0.00	96.26	1.87	1.87	2.3	2.3		sand
3	4791972	597699	7	3.69	87.21			1.9	1.3		sand
4	4793187	597755	19	0.00	1.87	57.94	40.18	7.6	7.3		mud
5	4792274	597476	4	0.00	34.40	34.73	30.87	6.7	7.3	0.8	sandy mud
6	4793421	597094	19	0.00	11.26	54.53	34.22	7.3	7.3	3.3	sandy mud
7	4794336	596659	11	0.00	30.68	48.39	20.93	4.9	3.5		sandy silt
8	4795231	596220	9	0.00	5.21	73.00	21.79	6.8	6.8		silt
9	4795303	595210	1	0.00	98.33	0.84	0.83	2.2	2.3		sand
10	4794566	595966	15	0.00	1.26	62.95	35.80	7.5	7.3		mud
11	4793341	596381	14	0.00	11.08	60.31	28.61	7.1	6.3	3.5	sandy silt
13	4792942	596248	14	0.00	13.18	58.47	28.35	7.0	6.8	2.3	sandy silt
14	4793982	595707	17	0.00	1.07	70.31	28.62	7.2	6.8		silt
15	4792406	596982	12	0.00	5.17	85.18	9.65	6.7	6.8		silt
16	4795091	594677	3	0.00	91.53	4.24	4.23	2.7	2.8		sand
17	4794242	595022	18	0.00	2.95	68.97	28.09	7.1	6.8		silt
18	4793257	595486	15	0.00	6.98	69.55	23.47	6.9	6.8		silt
19	4793497	594838	22	0.00	1.66	57.38	40.96	7.7	7.3		mud
20	4794416	594424	18	0.00	0.73	57.26	42.01	7.7	7.3		mud
21	4793719	594169	20	0.00	0.50	56.20	43.30	7.7	6.3		mud
22	4793207	592028	1	0.00	0.23	60.74	39.03	7.6	7.3		mud
23	4792460	594256	14	0.00	0.84	67.44	31.71	7.0	6.8		silt
24	4793025	593976	22	0.00	0.48	49.76	49.76	8.0	7.8		mud
25	4794138	593315	9	0.00	0.23	61.39	38.37	7.5	7.0		mud
26	4793198	593318	21	0.00	1.19	48.57	50.24	8.0	7.8		mud
27	4792341	593730	15	0.00	1.52	47.36	51.12	8.0	7.8		mud
28	4792538	593072	19	0.00	0.91	44.54	54.56	8.2	7.8		mud
29	4793379	592611	15	0.00	0.68	58.86	40.46	7.6	7.3		mud
30	4792690	592461	15	0.00	0.58	60.02	39.40	7.5	6.8		mud
31	4792142	592163	12	0.00	45.11	34.30	20.58	4.6	3.3	7.8	sandy mud
32	4792804	591461	8	0.00	0.62	59.99	39.39	7.5	6.8		mud

Sample #	Northing UTM	Easting UTM	Water Depth (m)	GRAV %	SAND %	SILT %	CLAY %	Median (PHI)	Main Mod (PHI)	2nd Mode (PHI)	Folk's (SCS) Label
33	4792191	591591	12	0.00	0.81	51.51	47.68	7.9	7.8		mud
34	4791723	591250	8	0.00	1.15	62.30	36.55	7.4	7.0		mud
35	4791870	591748	10	0.00	0.66	52.32	47.02	7.9	7.8		mud
36	4792199	592691	12	0.00	29.36	33.54	37.10	6.7	3.3	8.3	sandy mud
37	4794605	596971	3	0.00	2.22	62.20	35.58	7.4	7.0		mud
38	4792838	593507	22	0.00	2.82	45.51	51.67	8.1	7.8		mud
39	4791899	593407	8	0.00	40.91	23.20	35.89	6.4	1.8	8.8	sandy mud
40	4791801	593679	8	0.00	29.31	35.23	35.45	6.7	3.3	8.3	sandy mud
41	4791680	594050	8	0.00	32.99	42.83	24.18	6.1	3.3	6.8	sandy mud
42	4791578	594726	7	0.00	9.24	61.64	29.12	6.9	6.8		silt
43	4792022	594722	6	0.00	44.89	37.52	17.59	4.4	3.3	6.8	sandy silt
44A	4792414	594922	8	0.00	42.12	30.25	27.63	5.0	3.3	8.8	sandy mud
44B	4792414	594922	8	0.00	92.31	3.85	3.84	3.3	3.3		sand
45	4793017	594411	24	0.00	0.95	41.32	57.73	8.3	7.8		mud
46	4793007	594979	23	0.00	8.88	46.26	44.87	7.8	7.8		mud
47	4793752	595293	19	0.00	3.36	48.42	48.22	7.9	7.3		mud
48	4792683	596074	10	0.00	29.13	35.83	35.04	6.9	2.3	7.3	sandy mud
49	4791760	598432		0.00	4.00	54.76	41.24	7.6	7.3		mud

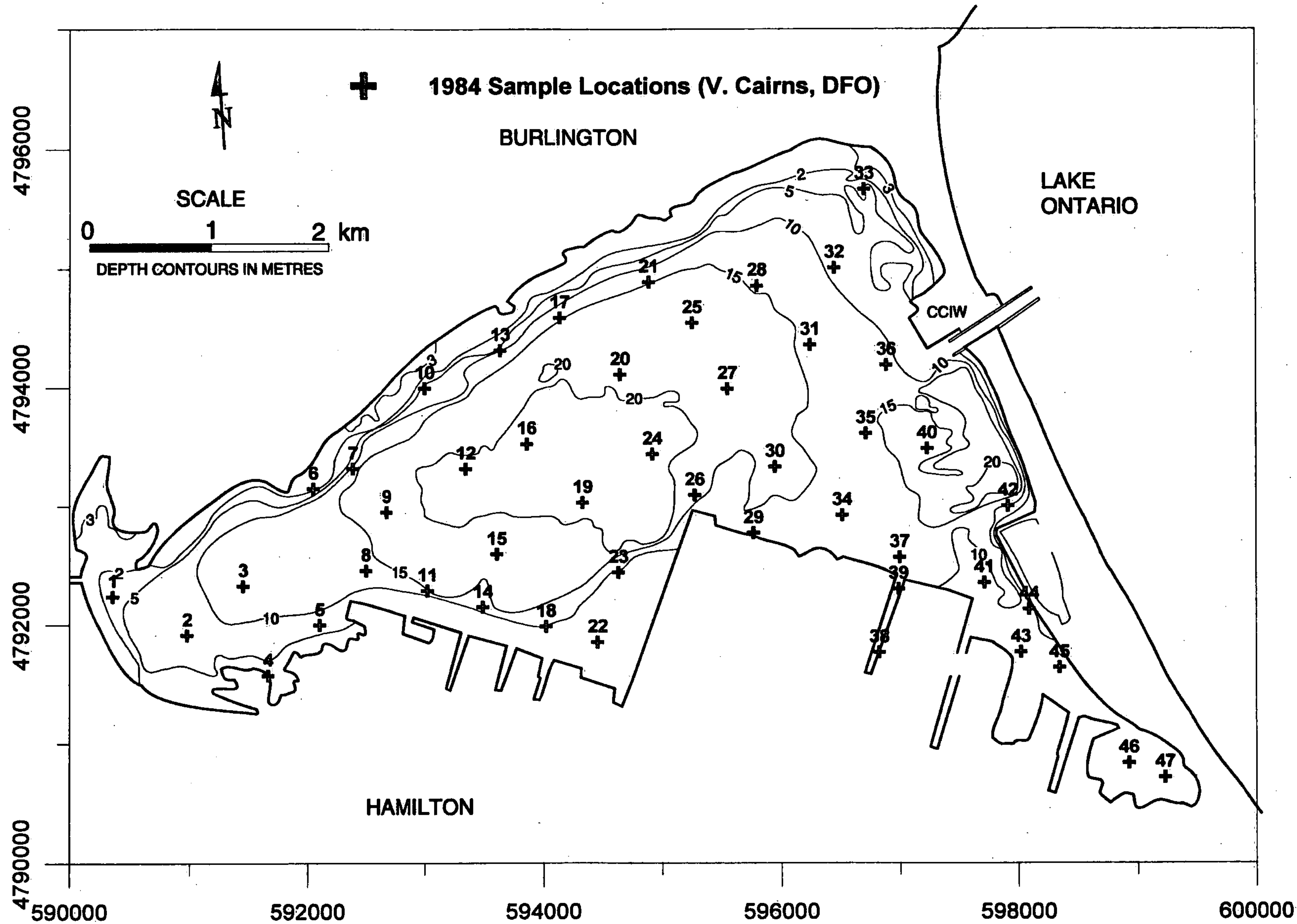
Sample #	Northing UTM	Easting UTM	Water Depth (m)	GRAV %	SAND %	SILT %	CLAY %	Median (PHI)	Main Mod (PHI)	2nd Mode (PHI)	Folk's (SCS) Label
1993 Benthos Core Samples (0-2cm), Collected by NWRI/McMaster University, July 1993											
	Water depths are Field Depths										
01A	4795869	596405	4.6								
01B	4795872	596400	4.2								
02	4794994	596922	10.4								
03	4794110	597319	14.4								
04	4793192	597761	21.4								
05	4792502	597540	10.2								
06	4793404	597094	19.8								
07	4794342	596657	11.6								
✓08	4795226	596215	10.0	0.00	3.28	73.76	22.97	6.5	6.8		silt
09	4795537	595613	6.4								
10	4794566	595983	15.4								
11	4793572	596547	14.6								
12	4792748	596847	13.2								
13	4792937	596250	14.6								
✓14	4793863	595749	17.4	0.00	1.21	63.77	35.02	7.3	6.8		mud
15	4794850	595309	16.4								
16	4795033	594646	5.2								
17	4794123	595102	18.6								
18	4793410	595352	19.2								
19	4793496	594845	22								
20A	4794354	594422	19.2								
20B	4794354	594423	19.0								
20C	4794346	594414	19?								
✓20D	4794347	594412	19?	0.00	0.55	51.62	47.82	7.9	7.8		mud
21	4793680	594196	20.8								
22A	4792807	594608	22.6								
22B	4792814	594626	22.6								
22C	4792814	594619	22.6								
22D	4792824	594604	22.6?								
✓22E	4792827	594622	22.6?	0.00	1.01	46.16	52.83	8.1	7.8		mud
23	4792124	594376	9.6								

Sample #	Northing UTM	Easting UTM	Water Depth (m)	GRAV %	SAND %	SILT %	CLAY %	Median (PHI)	Main Mod (PHI)	2nd Mode (PHI)	Folk's (SCS) Label
24	4793014	593947	22								
25	4793882	593504	18.4								
26	4793272	593297	20.6	0.00	0.28	40.21	59.51	8.4	7.8		mud
27	4792332	593728	14								
28	4792538	593070	18.8								
29	4793376	592623	16.4								
30	4792719	592389	15.4								
31	4792140	592138	11.2								
32A	4793894	592951	2								
32B	4793021	591496	2								
33	4792385	591484	12.6	0.00	0.86	57.50	41.64	7.7	7.3		mud
34	4791713	591240	8.2								
35	4792172	590431	4								
36	4791878	593576	9.4								
37A	4791765	590625	7								
37	4791753	590630	7.0	0.00	1.58	69.94	28.48	7.1	7.3		silt
38	4792703	595002	19								
39	4791577	594530	8.0	0.00	7.05	66.97	25.98	6.8	6.8		silt
40	4791801	598247	8.8								

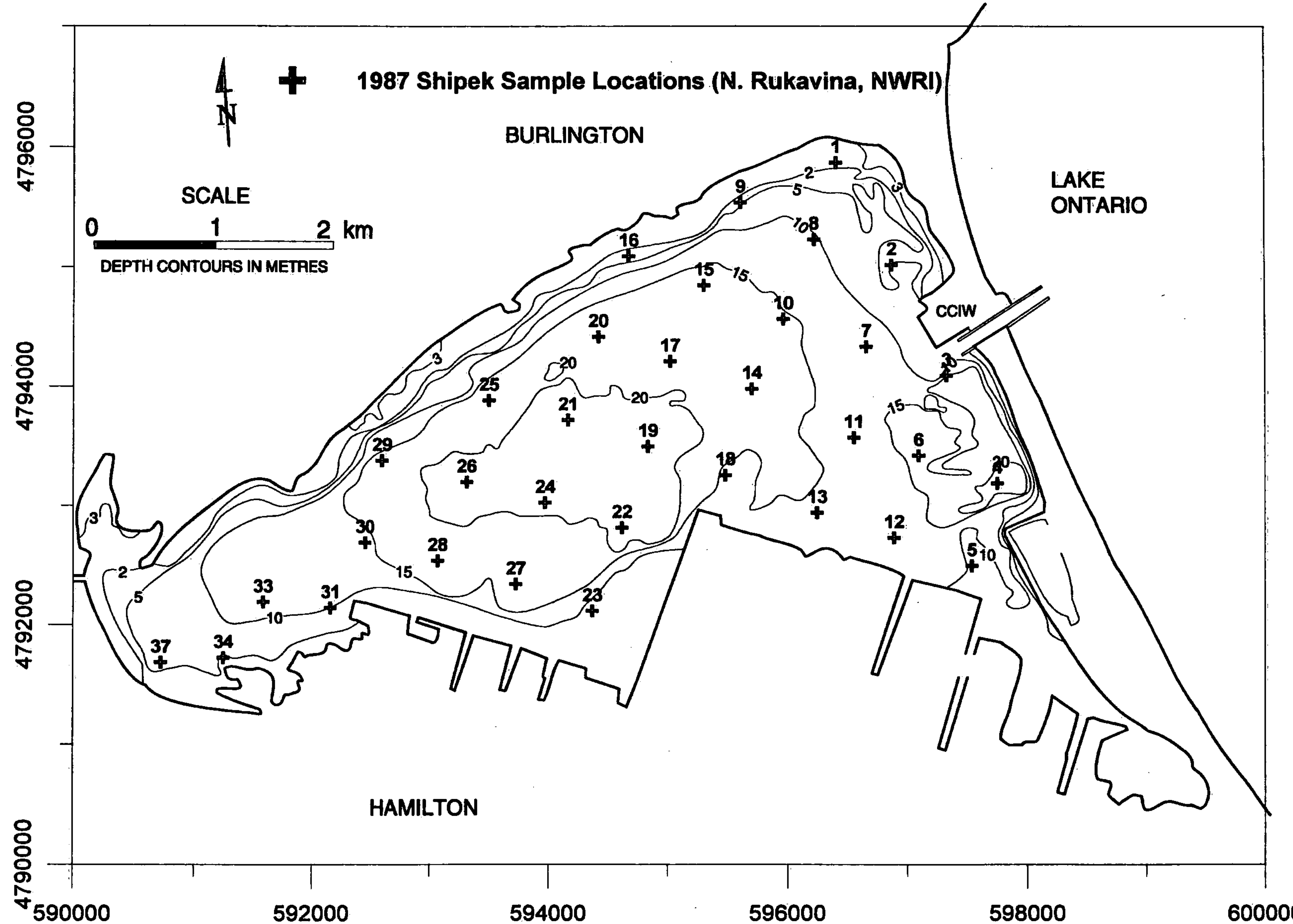
Sample #	Northing UTM	Easting UTM	Water Depth (m)	GRAV %	SAND %	SILT %	CLAY %	Median (PHI)	Main Mod (PHI)	2nd Mode (PHI)	Folk's (SCS) Label
1993 Core Samples (0-2cm), Collected by J. Coakley (NWRI), November 1993											
	Water depths estimated from Hydrographic Chart.										
C1	4795872	596409	2	0.00	99.50			3.1	3.3		sand
C2	4794988	596927	8	0.00	24.50	55.30	20.20	5.5	3.8	4.8	sandy silt
C3	4794112	597320	13	0.00	61.70	23.00	15.40	3.7	3.8	4.8	muddy sand
C4	4793182	597764	20	0.00	0.00	55.30	44.70	7.8	7.3		mud
C5	4792490	597530	10	0.00	22.10	37.80	40.10	7.3	7.8	2.3	sandy mud
C6	4793398	597076	18	0.00	0.00	54.60	45.40	7.8	7.3		mud
C7	4794331	596655	11	0.00	8.60	71.30	20.10	6.3	6.3		silt
C8	4795230	596207	9	0.00	0.00	67.10	32.90	6.9	6.3		silt
C9	4795532	595607	6	0.00	52.90	28.70	18.40	3.9	3.8		muddy sand
C10	4794563	595982	15	0.00	0.00	59.80	40.20	7.6	7.3		mud
C11	4793565	596557	14	0.00	53.50	25.20	21.20	3.9	3.3		muddy sand
C12	4792725	596880	13	0.00	0.00	59.40	40.60	7.5	7.3		mud
C13	4792805	596140	14	0.00	11.90	53.80	34.30	7.2	7.3		sandy mud
C14	4793875	595722	17	0.00	16.10	46.50	37.40	7.2	7.3	3.8	sandy mud
C15	4794850	595304	17	0.00	0.00	52.80	47.20	7.9	7.3		mud
C16	4795038	594644	5	0.00	24.00	44.20	31.90	6.5	3.8	6.8	sandy mud
C17	4794124	595093	19	0.00	0.00	46.90	53.10	8.2	7.3		mud
C18	4793408	595365	19	0.00	0.00	53.10	46.90	7.9	7.3		mud
C19	4793496	594836	22	0.00	0.00	38.30	61.70	8.6	7.8		mud
C21	4793686	594190	21	0.00	0.00	46.70	53.30	8.2	7.8		mud
C22	4792807	594595	23	0.00	0.00	37.50	62.50	8.5	7.8		mud
C23	4792119	594370	10	0.00	29.10	48.00	22.90	5.2	3.8		sandy silt
C24	4793017	593957	22	0.00	0.00	33.10	66.90	8.7	8.3		clay
C25	4793884	593513	18	0.00	0.00	50.50	49.50	8.0	7.3		mud
C26	4793262	593293	21	0.00	0.00	44.90	55.10	8.2	7.8		mud
C27	4792318	593714	14	0.00	10.30	56.00	33.60	7.1	7.3		sandy mud
C28	4792536	593079	19	0.00	0.00	39.10	60.90	8.5	7.8		mud
C29	4793382	592617	16	0.00	0.00	49.50	50.50	8.0	7.3		mud
C30	4792710	592388	15	0.00	0.00	47.90	52.10	8.1	7.8		mud
C31	4792140	592138	11	0.00	12.00	43.40	44.60	7.7	7.3	3.8	sandy mud
C32-1	4793895	592951	6	1.10	95.80			1.3	1.3		sand

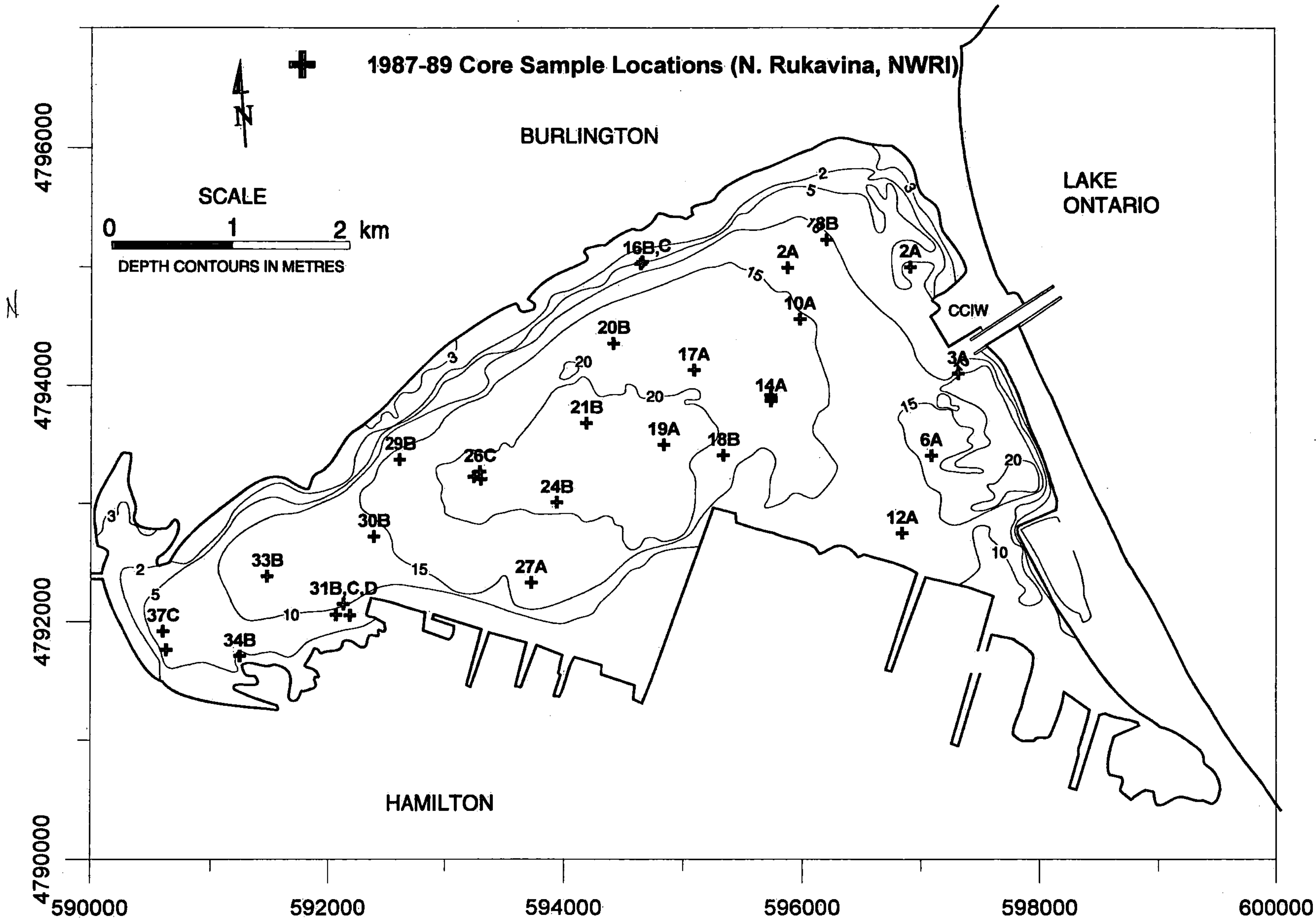
Sample #	Northing UTM	Easting UTM	Water Depth (m)	GRAV %	SAND %	SILT %	CLAY %	Median (PHI)	Main Mod (PHI)	2nd Mode (PHI)	Folk's (SCS) Label
C32-2	4793021	591496	3	0.00	39.80	39.10	21.10	4.6	3.8		sandy mud
C33	4792389	591471	12	0.00	0.00	50.70	49.30	8.0	7.3		mud
C34	4791713	591240	8	0.00	25.40	39.80	34.80	6.8	3.8	7.3	sandy mud
C35	4792175	590431	4	0.00	12.20	72.10	15.70	6.7	7.3	3.8	sandy silt
C36	4791875	593568	9	0.00	47.20	31.70	21.10	4.2	3.8		sandy mud
C37	4791760	590621	7	0.00	0.00	65.40	34.60	7.3	7.3		mud
C38	4792713	595000	20	0.00	19.80	44.70	35.50	6.9	3.8	7.3	sandy mud
C39	4791577	594530	8	0.00	17.50	50.70	31.80	6.9	7.0		sandy mud
C40	4791801	598247	6	0.00	0.00	57.30	42.70	7.6	7.3		mud

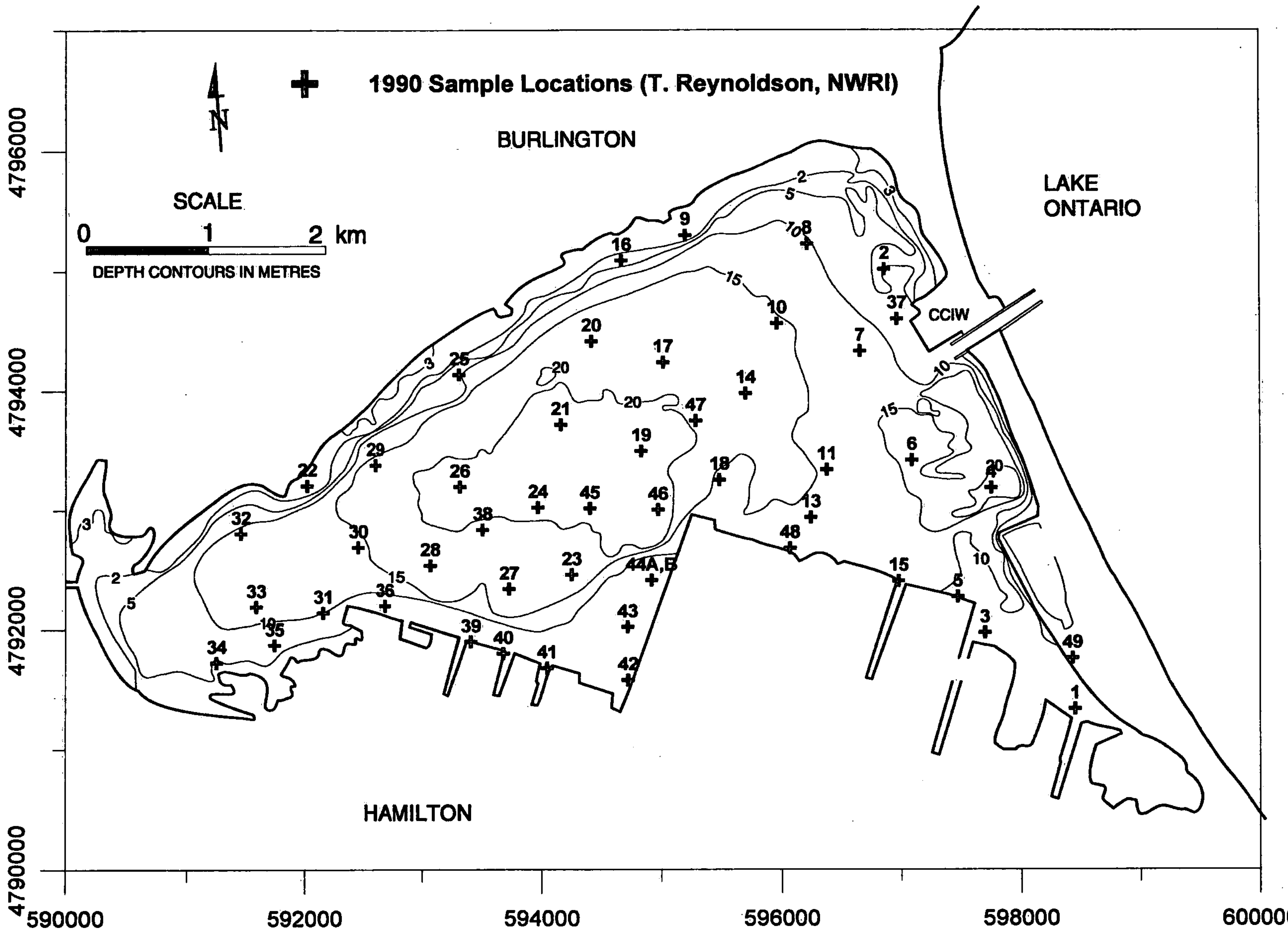
APPENDIX 2
Maps of sample locations.

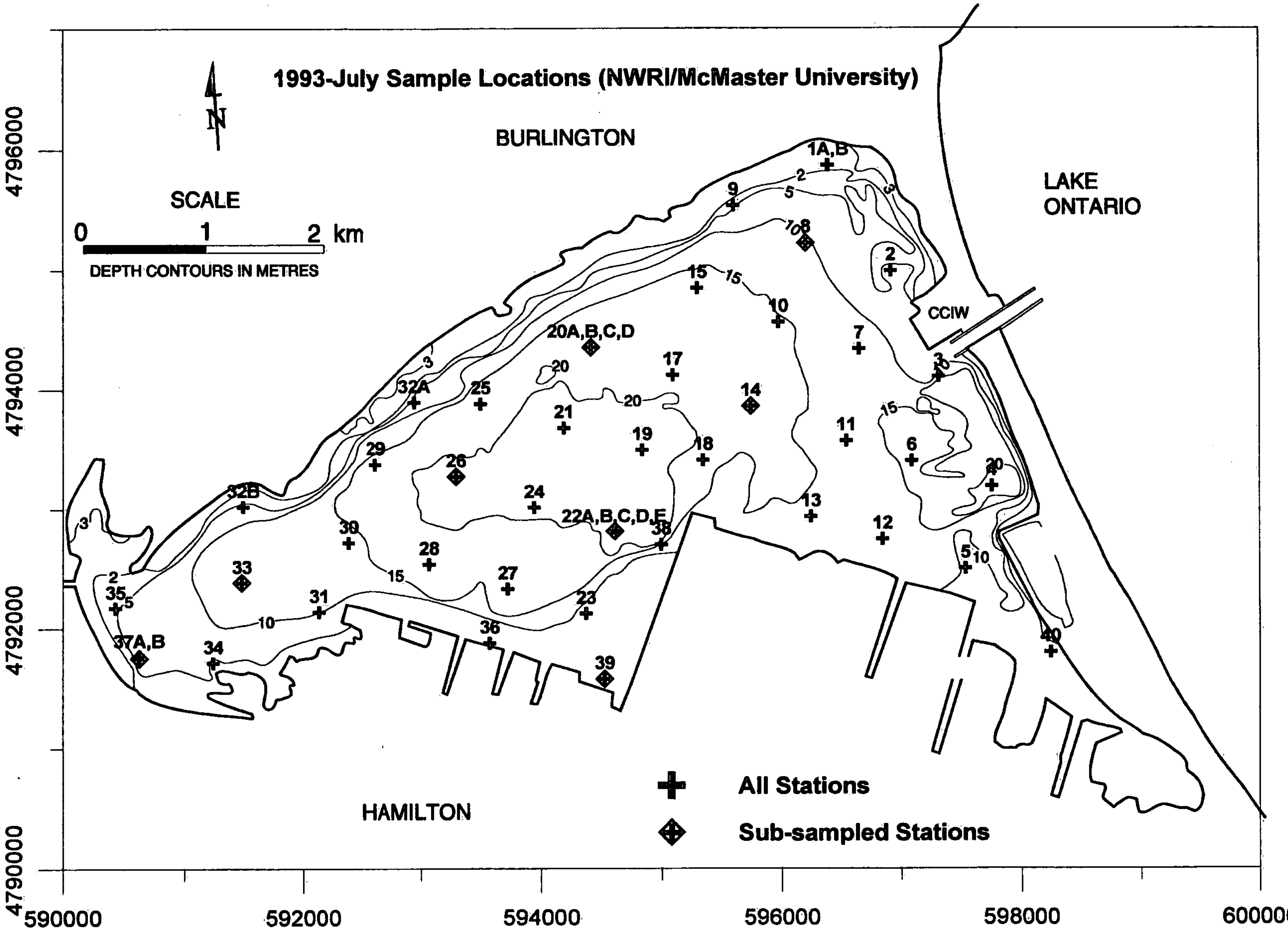


1984 Sample Locations (V. Cairns, DFO)
N
BURLINGTON
SCALE
0
1
2 km
DEPTH CONTOURS IN METRES
LAKE ONTARIO
CCIW
HAMILTON
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000

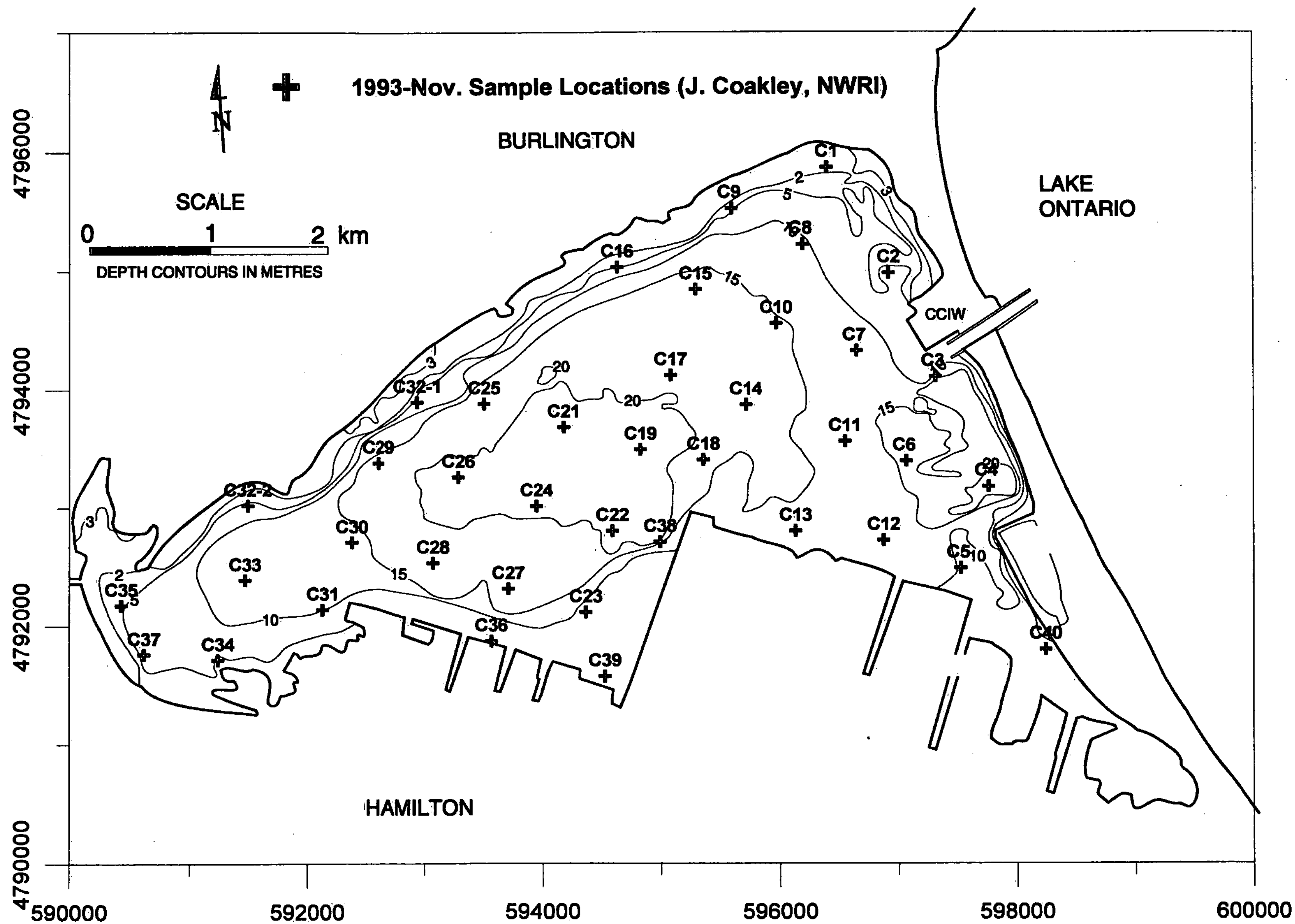

1987 Shipek Sample Locations (N. Rukavina, NWRI)
N
SCALE
0 1 2 km
DEPTH CONTOURS IN METRES
BURLINGTON
LAKE ONTARIO
CCIW
HAMILTON
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000


1987-89 Core Sample Locations (N. Rukavina, NWRI)
N
BURLINGTON
SCALE
0
1
2 km
DEPTH CONTOURS IN METRES
LAKE
ONTARIO
CCIW
HAMILTON
16B,C
18B
2A
2A
10A
20B
17A
14A
3A
21B
19A
18B
6A
29B
26C
24B
12A
30B
27A
33B
31B,C,D
37C
34B
2
3
5
10
15
20
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000


1990 Sample Locations (T. Reynoldson, NWRI)
N
SCALE
0 1 2 km
DEPTH CONTOURS IN METRES
BURLINGTON
LAKE ONTARIO
CCIW
HAMILTON
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000


1993-July Sample Locations (NWRI/McMaster University)
BURLINGTON
HAMILTON
LAKE ONTARIO
CCIW
SCALE
0 1 2 km
DEPTH CONTOURS IN METRES
N
All Stations
Sub-sampled Stations
1A,B
2
6
7
8
9
10
11
12
13
14
15
17
18
19
20
20A,B,C,D
21
22A,B,C,D,E
23
24
25
26
27
28
29
30
31
32A
32B
33
34
35
36
37A,B
38
39
40
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000

no data


1993-Nov. Sample Locations (J. Coakley, NWRI)
N
BURLINGTON
SCALE
0 1 2 km
DEPTH CONTOURS IN METRES
LAKE ONTARIO
CCIW
HAMILTON
C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 C11 C12 C13 C14 C15 C16 C17 C18 C19 C21 C22 C23 C24 C25 C26 C27 C28 C29 C30 C31 C32-1 C32-2 C33 C34 C35 C36 C37 C38 C39 C40
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000

APPENDIX 3
PHI units and equivalent metric units.

PHI CONVERSION TABLE

PHI		MM		MICRONS	WENTWORTH SIZE
-8.0		256.000			
-7.5		181.019			
-7.0		128.000			boulder
-6.5		90.510			
-6.0	---------	64.000	----------	----------	----------
-5.5		45.255			
-5.0		32.000			
-4.5		22.627			
-4.0		16.000			pebble
-3.5		11.314			
-3.0		8.000			
-2.5		5.657			
-2.0	---------	4.000	----------	----------	----------
-1.5		2.828			granule
-1.0	---------	2.000	-----------	2000.00	--------------------
-0.5		1.414		1414.21	very coarse sand
0.0	---------	1.000	-----------	1000.00	--------------------
0.5		0.707		707.11	coarse sand
1.0	---------	0.500	-----------	500.00	--------------------
1.5		0.354		353.55	medium sand
2.0	---------	0.250	-----------	250.00	--------------------
2.5		0.177		176.78	fine sand
3.0	---------	0.125	-----------	125.00	--------------------
3.5		0.088		88.39	very fine sand
4.0	---------	0.063	-----------	62.50	--------------------
4.5		0.044		44.19	
5.0		0.031		31.25	
5.5		0.022		22.10	
6.0		0.016		15.63	silt
6.5		0.011		11.05	
7.0		0.008		7.81	
7.5		0.006		5.53	
8.0	---------	0.004	-----------	3.91	--------------------
8.5		0.003		2.76	
9.0		0.002		1.95	
9.5		0.001		1.38	
10.0				0.98	clay
10.5				0.69	
11.0				0.49	
11.5				0.35	
12.0				0.24	

APPENDIX 4

Typical listing of grain-size analysis output.

NWRI SEDIMENTOLOGY LABORATORY

SAMPLE INFORMATION

Sample ID: HH CORE #20D 0-2
Analysis Type: Sieve, Sedigraph
Date: 11-25-1994 Time: 16:49:37
Sample Weight (G): 3.9957

PARTICLE-SIZE DISTRIBUTION

Phi	Microns	Class Freq.(%)	Cum.(%) Coarser	Histogram (*) and Cumulative Frequency Curve (+)
1.50	353.55	0.07	0.07	+
2.00	250.00	0.06	0.13	+
2.50	176.78	0.06	0.20	+
3.00	125.00	0.05	0.25	+
3.50	88.39	0.07	0.31	+
4.00	62.50	0.24	0.55	+
4.50	44.19	0.35	0.90	+
5.00	31.25	0.92	1.83	* +
5.50	22.10	2.39	4.22	** +
6.00	15.63	4.76	8.98	***** +
6.50	11.05	7.48	16.46	******* +
7.00	7.81	10.58	27.03	*********** +
7.50	5.52	12.55	39.58	************* +
8.00	3.91	12.59	52.18	************* +
8.50	2.76	9.46	61.64	********* +
9.00	1.95	7.70	69.34	******** +
9.50	1.38	5.95	75.29	****** +
10.00	0.98	5.02	80.32	***** +
10.50	0.69	3.87	84.19	**** +
11.00	0.49	2.93	87.12	*** +
11.50	0.35	2.28	89.39	** +
12.00	0.24	1.34	90.74	* +

% Gravel = 0.00 % Sand = 0.55 % Silt = 51.62 % Clay = 47.82

Gravel+Sand= 0.55 Silt/(Silt+Clay)= 0.52 Grav+Sand/Silt+Clay= 0.01

Folk: -GMS -SCS MUD Shepard CLAYEY SILT

SUMMARY STATISTICS

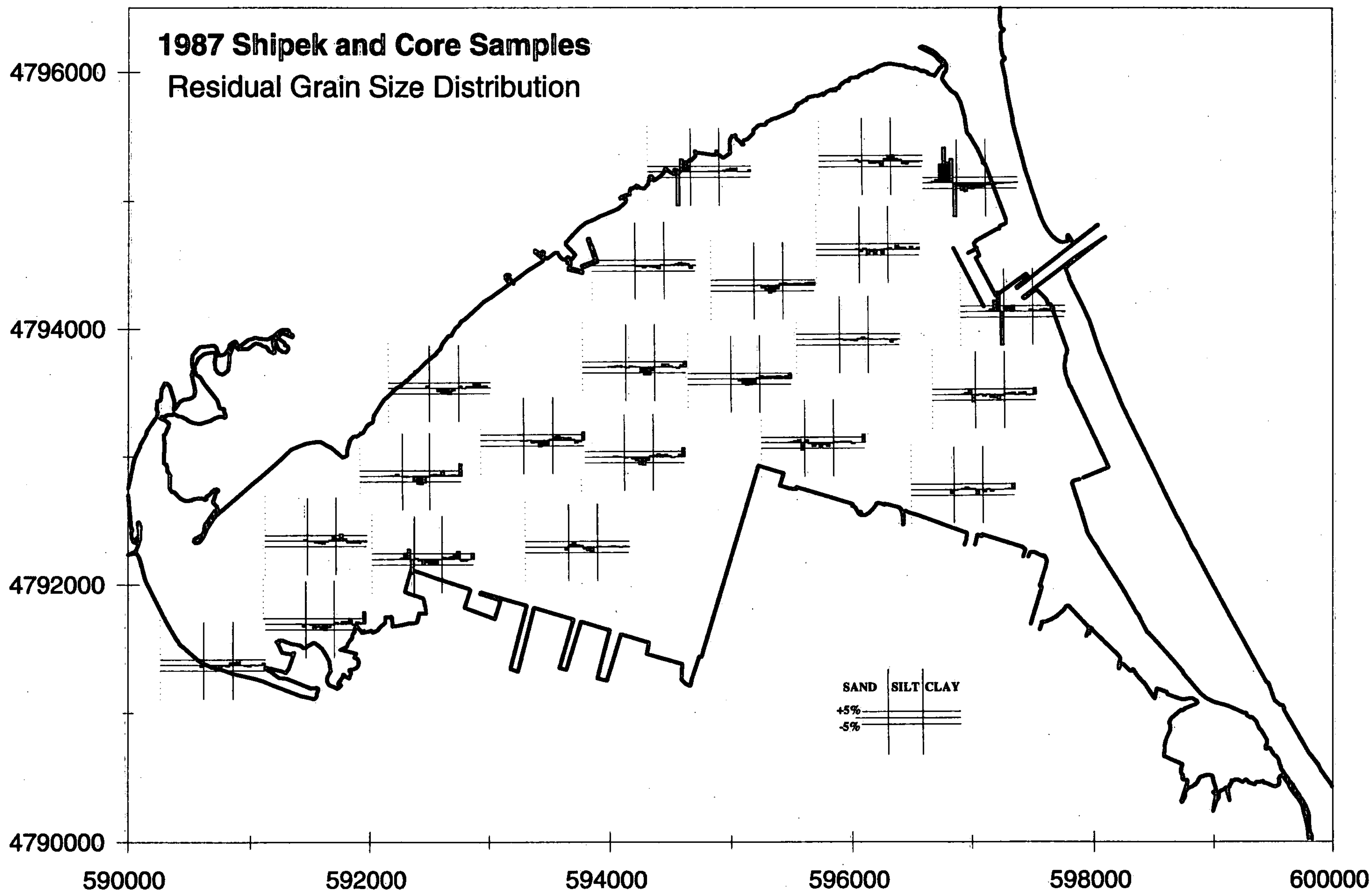
	Percentiles						
	5	16	25	50	75	84	95
Phi	5.58	6.47	6.90	7.91	9.48	10.48	*****
Microns	20.88	11.28	8.35	4.15	1.40	0.70	*****

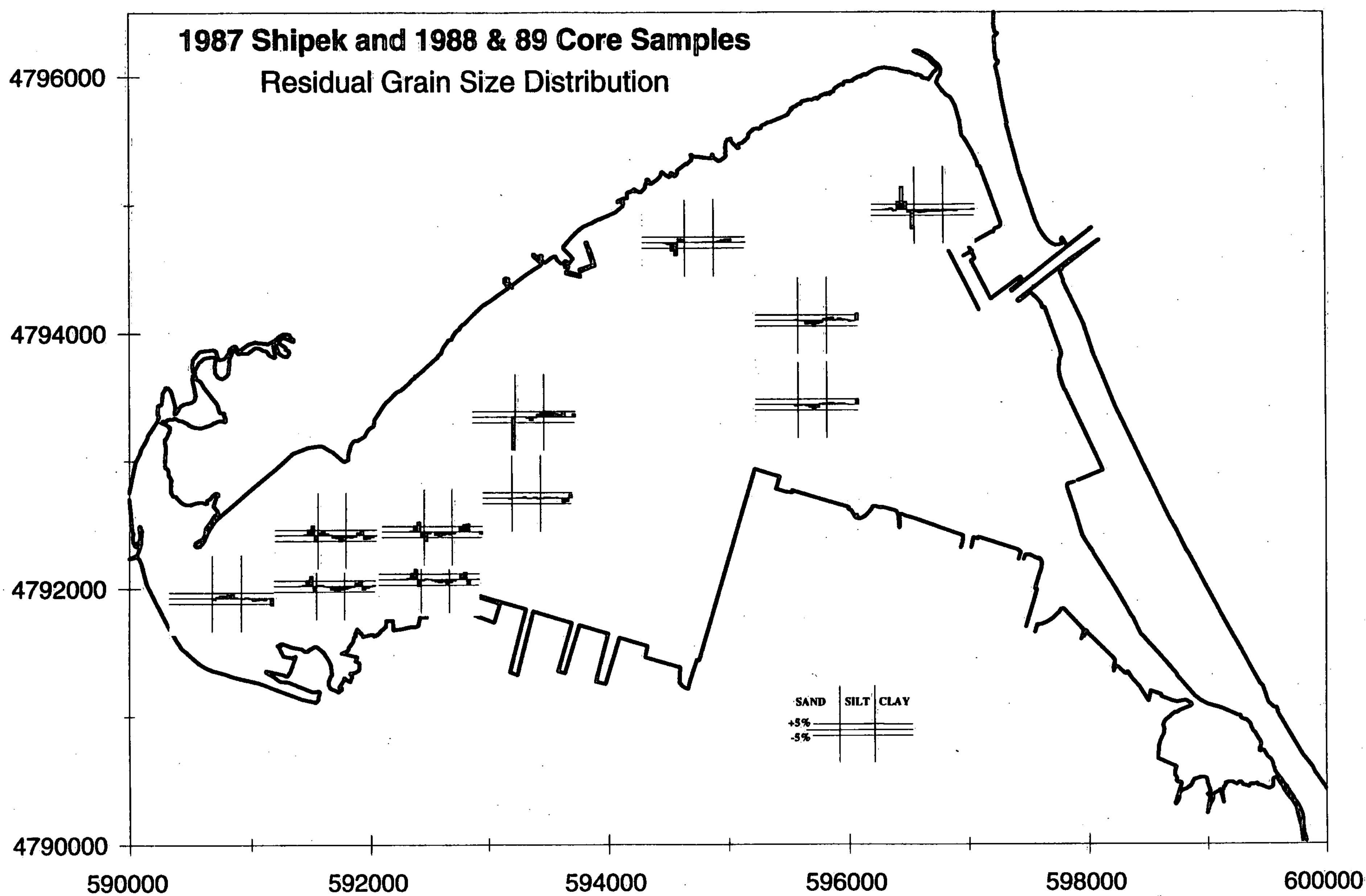
	Mean Phi	Mean Microns	Std. Dev. Phi	Skewness	Kurtosis
Moment	7.89	4.21	1.60	0.09	0.12
Folk(Graphic)	8.29	3.20	2.00	0.28	*****

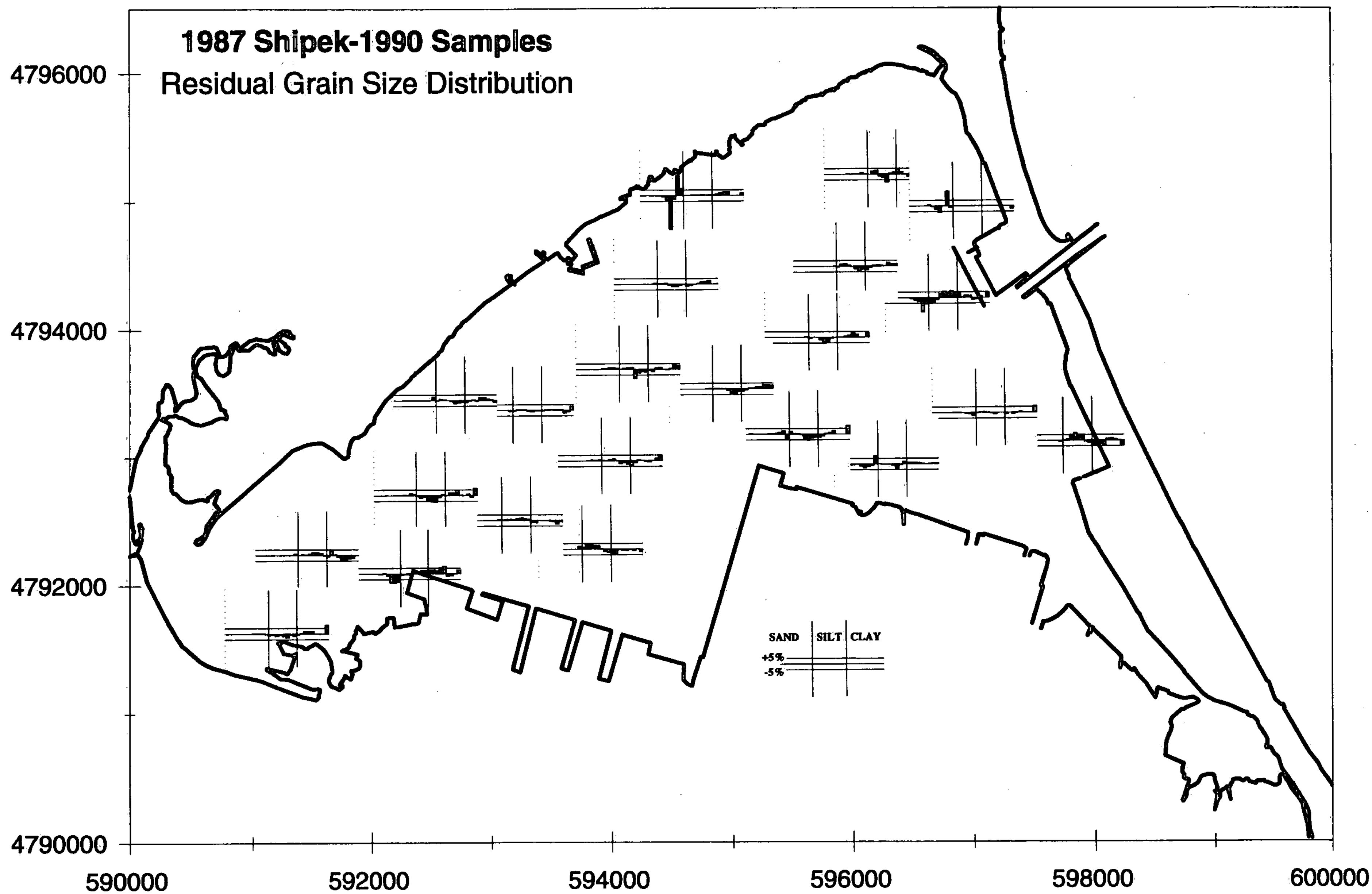
Folk Interpretation - VERY POORLY SORTED, FINE-SKEWED

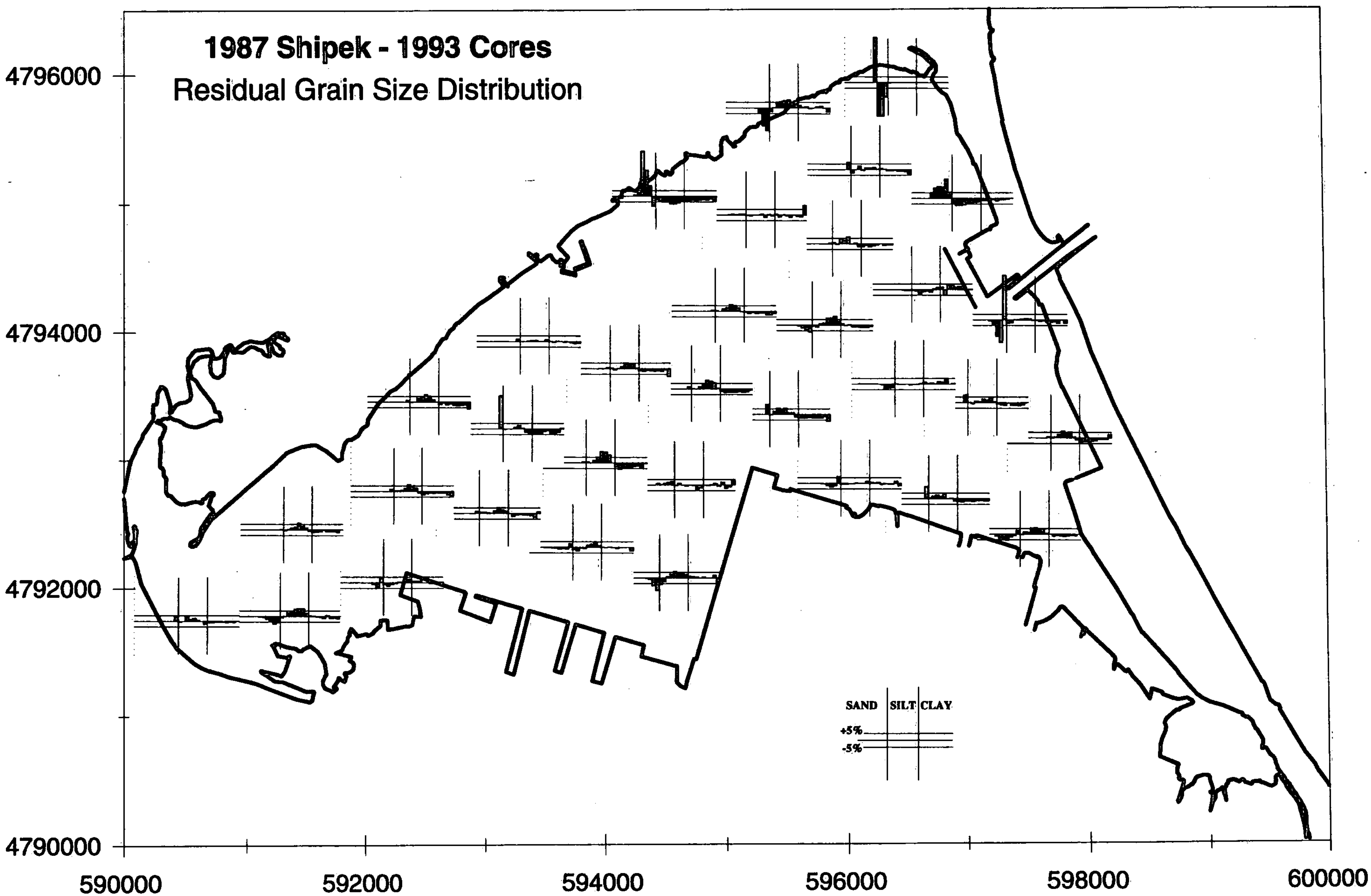
APPENDIX 5

Residual grain size distribution maps.


1987 Shipek and Core Samples
Residual Grain Size Distribution
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000
SAND
SILT
CLAY
+5%
-5%


1987 Shipek and 1988 & 89 Core Samples
Residual Grain Size Distribution
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000
SAND
SILT
CLAY
+5%
-5%


1987 Shipek-1990 Samples
Residual Grain Size Distribution
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000
SAND
SILT
CLAY
+5%
-5%


1987 Shipek - 1993 Cores
Residual Grain Size Distribution
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000
SAND
SILT
CLAY
+5%
-5%

APPENDIX 6
Particle size summary statistics.

	1984	1987	87-89 (core)	1990	July 1993	Nov.1993	Average *
% Sand							
Mean	16.78	15.37	16.80	19.06	1.98	17.10	17.38
Standard Error	3.54	4.63	5.02	4.11	0.79	4.03	2.28
Median	2.94	5.55	3.31	4.00	1.11	4.30	3.28
Standard Deviation	24.26	26.97	28.85	28.76	2.24	25.52	27.62
Variance	588.61	727.45	832.30	827.30	5.04	651.10	762.93
Kurtosis	2.21	5.18	3.90	2.23	28.04	3.43	3.34
Skewness	1.72	2.48	2.25	1.79	5.03	1.90	2.08
Range	89.86	99.56	98.71	98.10	6.77	99.50	99.85
Minimum	0.17	0.29	0.70	0.23	0.28	0.00	0
Maximum	90.03	99.85	99.41	98.33	7.05	99.50	99.85
Count	47	34	33	49	8	40	135
Confidence Level(0.95)	6.94	9.07	9.84	8.05	1.56	7.91	4.66
% Silt							
Mean	34.76	48.24	55.35	47.88	58.74	45.53	47.46
Standard Error	2.17	3.18	3.49	2.83	4.22	2.46	1.52
Median	35.98	53.26	62.39	52.32	60.64	47.40	48.57
Standard Deviation	14.88	18.56	20.04	19.80	11.94	15.55	18.41
Variance	221.40	344.65	401.51	392.06	142.56	241.82	339.01
Kurtosis	-0.19	1.82	0.18	0.83	2.67	2.20	-0.16
Skewness	-0.32	-1.39	-1.25	-1.05	2.08	-1.10	-1
Range	63.59	75.73	72.65	85.18	33.55	72.10	85.18
Minimum	1.65	0.00	0.00	0.00	40.21	0.00	0.00
Maximum	65.24	75.73	72.65	85.18	73.76	72.10	85.18
Count	47	34	33	49	8	40	135
Confidence Level(0.95)	4.25	6.24	6.84	5.54	8.27	4.82	3.11

*Averages are for 1987 Shipek, 1990 and 1993 core samples.

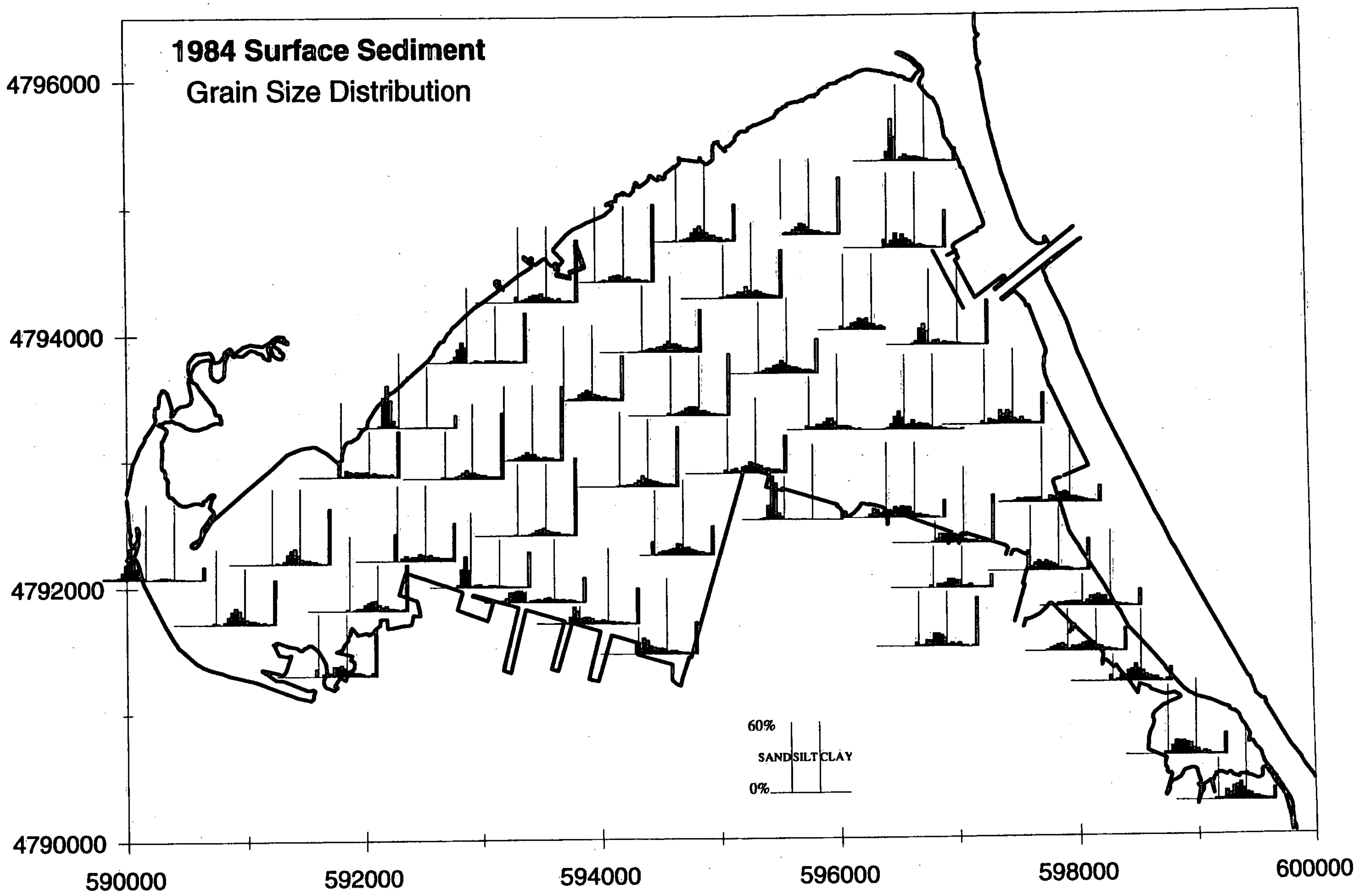
	1984	*1987*	*87-89 (core)*	*1990*	*July 1993*	*Nov.1993*	*Average **
% Clay							
Mean	48.38	36.34	27.77	32.81	39.28	37.26	35.01
Standard Error	2.69	2.52	2.28	2.07	4.72	2.58	1.27
Median	50.47	37.55	27.30	35.58	38.33	38.75	35.04
Standard Deviation	18.45	14.68	13.12	14.46	13.36	16.31	15.37
Variance	340.32	215.41	172.09	209.02	178.44	266.05	236
Kurtosis	-0.51	0.55	-0.45	0.12	4.39	-0.26	-0.60
Skewness	-0.36	-0.81	-0.41	-0.74	2.35	-0.37	-0.49
Range	73.35	61.03	55.05	57.73	36.54	66.90	66.90
Minimum	7.34	0.00	0.00	0.00	22.97	0.00	0.00
Maximum	80.69	61.03	55.05	57.73	59.51	66.90	66.90
Count	47	34	33	49	8	40	135
Confidence Level(0.95)	5.27	4.93	4.48	4.05	9.26	5.05	2.59
Median Grain Size (PHI)							
Mean	7.50	6.95	6.62	6.66	7.49	6.78	6.77
Standard Error	0.35	0.27	0.26	0.24	0.24	0.28	0.14
Median	7.33	7.45	7.09	7.21	7.52	7.30	7.21
Standard Deviation	2.37	1.59	1.49	1.67	0.67	1.75	1.67
Variance	5.62	2.52	2.22	2.79	0.45	3.05	2.79
Kurtosis	-0.09	3.48	1.85	2.03	1.93	1.45	1.12
Skewness	-0.82	-2.04	-1.73	-1.72	1.95	-1.41	-1.52
Range	9.84	6.17	5.73	6.38	1.92	7.40	8.70
Minimum	2.05	2.30	2.47	1.89	6.52	1.30	1.30
Maximum	11.89	8.47	8.20	8.27	8.44	8.70	8.70
Count	42	34	33	49	8	40	135
Confidence Level(0.95)	0.72	0.53	0.51	0.47	0.46	0.54	0.28

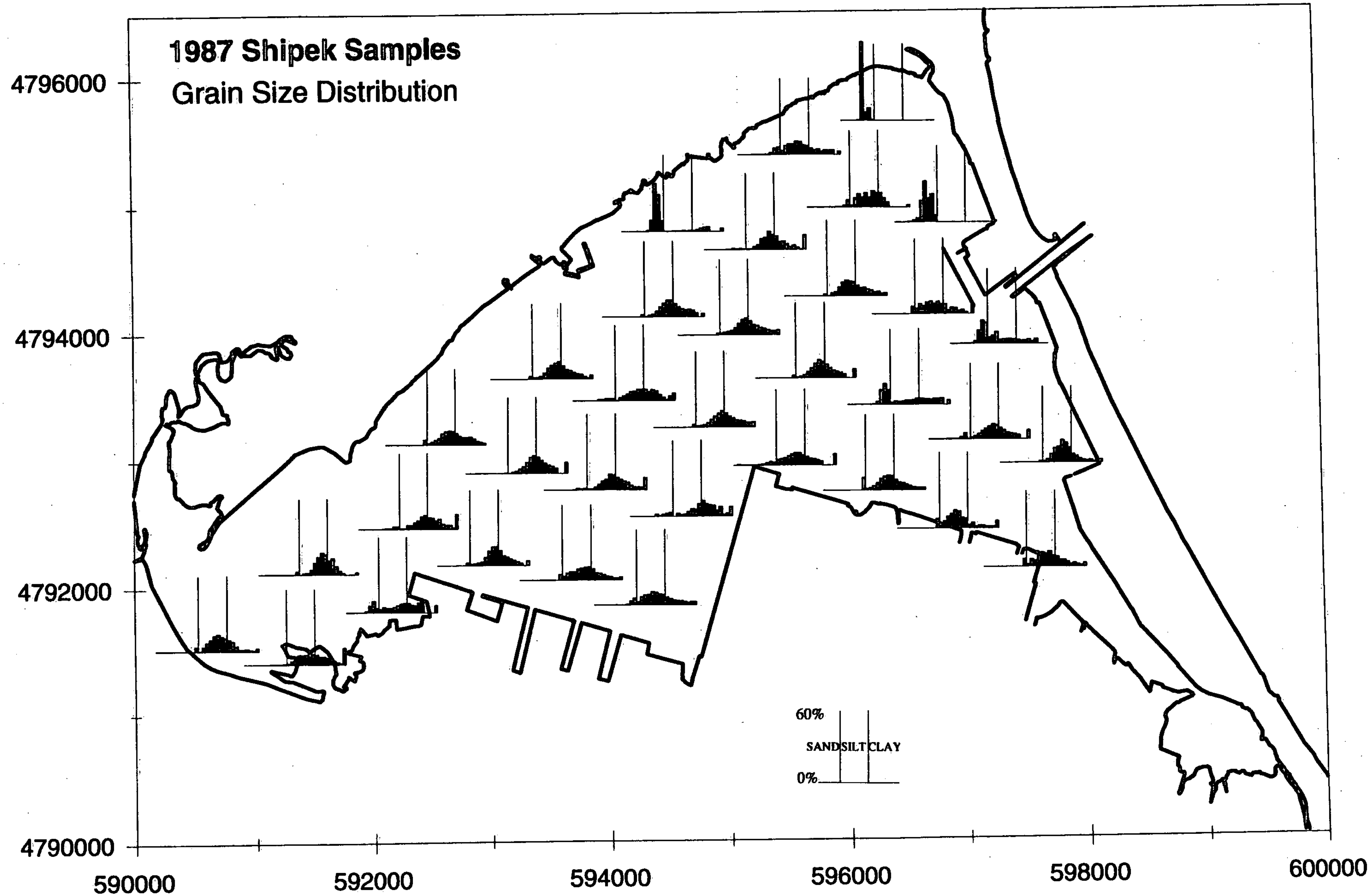
*Averages are for 1987 Shipek, 1990 and 1993 core samples.

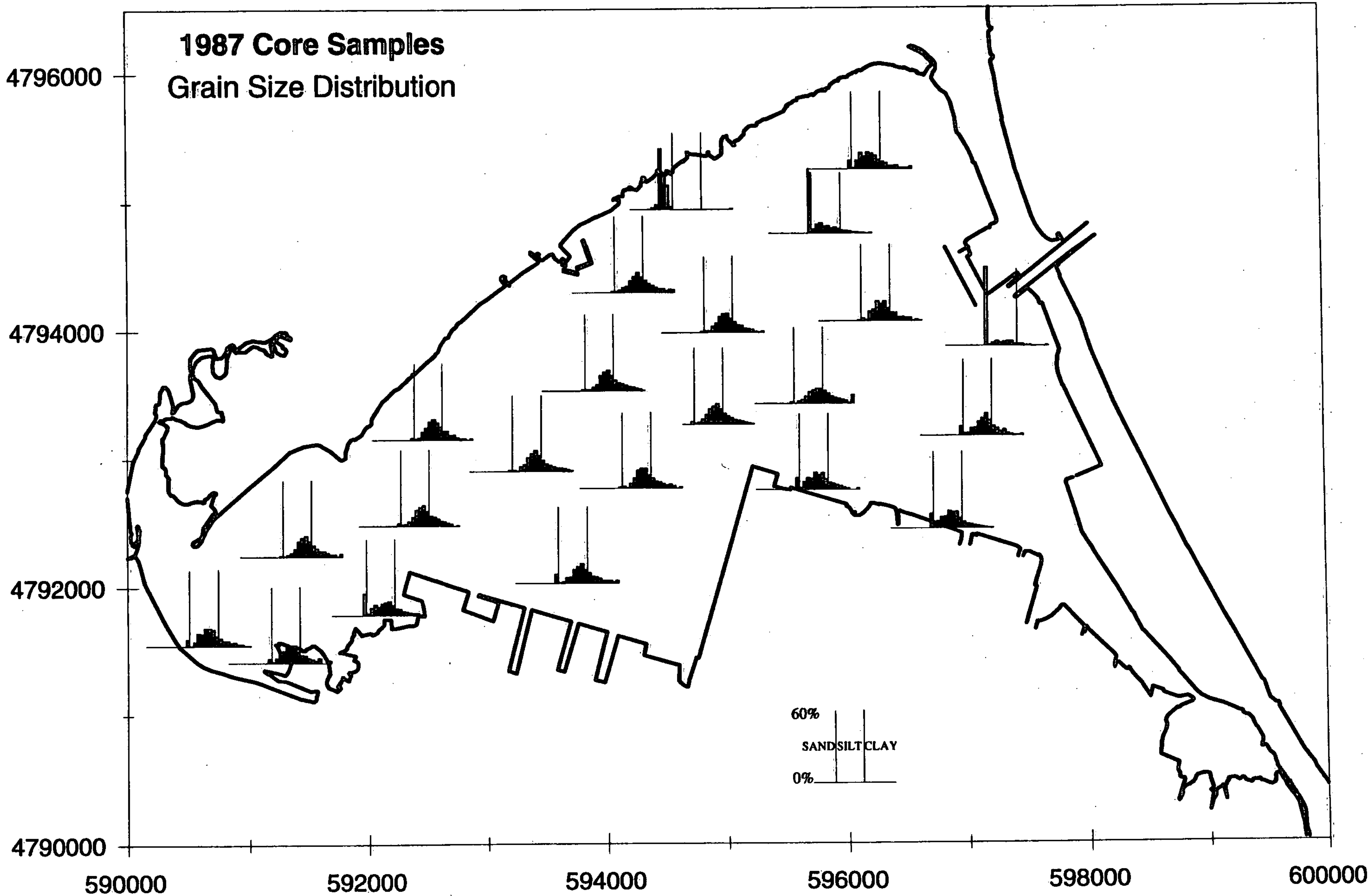
	1984	1987	87-89 (core)	1990	July 1993	Nov.1993	Average *
Main Mode (PHI)							
Mean	6.00	6.68	6.53	5.88	7.25	6.17	6.23
Standard Error	0.26	0.31	0.25	0.29	0.16	0.30	0.16
Median	7.00	7.25	7.13	6.75	7.25	7.25	7.00
Mode	7.25	7.25	7.25	6.75	6.75	7.25	7.25
Standard Deviation	1.79	1.80	1.42	2.06	0.46	1.87	1.92
Variance	3.20	3.24	2.02	4.25	0.21	3.49	3.68
Kurtosis	-0.29	1.76	1.20	-0.72	-2.10	-0.49	-0.07
Skewness	-1.09	-1.39	-1.61	-0.97	0.00	-0.98	-1.09
Range	6.00	8.00	5.50	6.50	1.00	7.00	10.25
Minimum	1.75	2.25	2.25	1.25	6.75	1.25	1.25
Maximum	7.75	10.25	7.75	7.75	7.75	8.25	10.25
Count	47.00	34	32	49	8	40	135.00
Confidence Level(0.95)	0.51	0.61	0.49	0.58	0.32	0.58	0.32
2nd Mode (PHI)							
Mean	5.30	7.55	8.00	6.02		4.92	6.35
Standard Error	0.44	0.60	0.99	0.81		0.60	0.43
Median	5.25	7.88	7.25	7.00		4.75	7
Mode	5.25	3.75	NA	6.75		3.75	3.75
Standard Deviation	1.46	2.25	2.22	2.80		1.79	2.53
Variance	2.12	5.05	4.94	7.86		3.19	6.40
Kurtosis	0.89	-0.80	-1.59	-0.85		-1.23	-0.79
Skewness	-0.97	-0.46	0.15	-0.83		0.22	-0.34
Range	5.00	7.00	5.50	8.00		5.00	10.00
Minimum	2.25	3.75	5.25	0.75		2.25	0.75
Maximum	7.25	10.75	10.75	8.75		7.25	10.75
Count	11	14	5	12		9	35
Confidence Level(0.95)	0.86	1.18	1.95	1.59		1.17	0.84

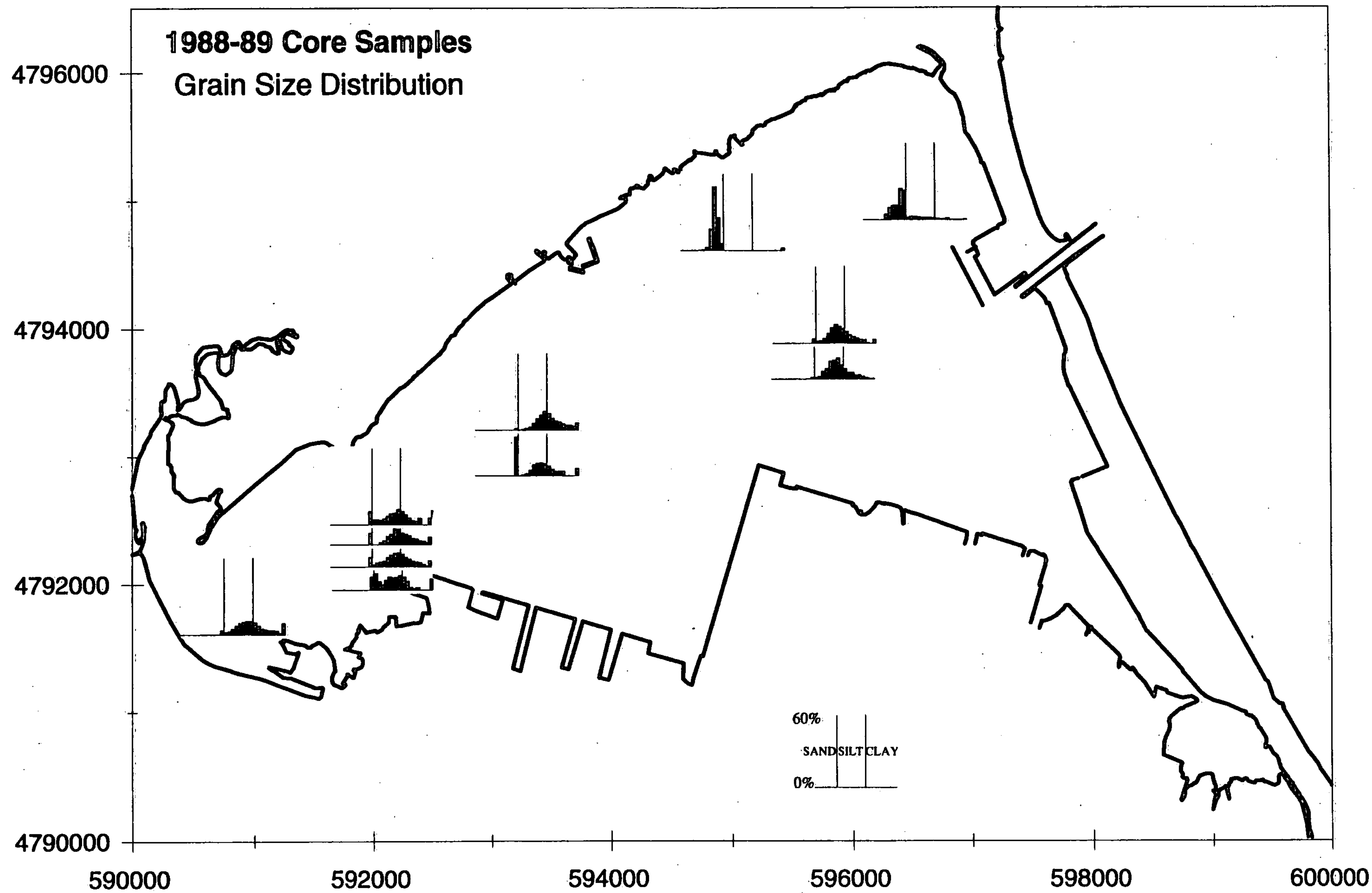
*Averages are for 1987 Shipek, 1990 and 1993 core samples.

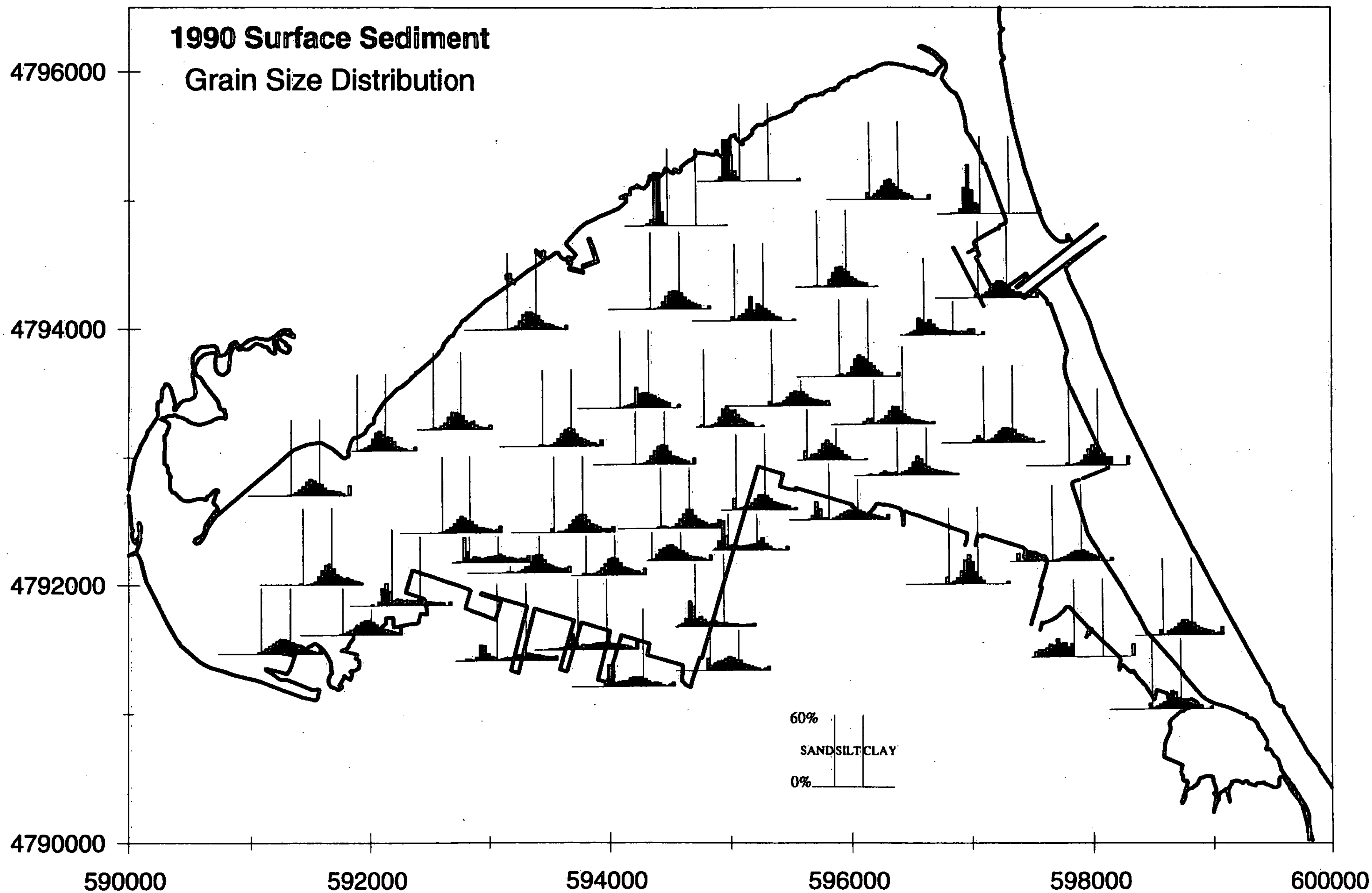
APPENDIX 7
Histogram maps.

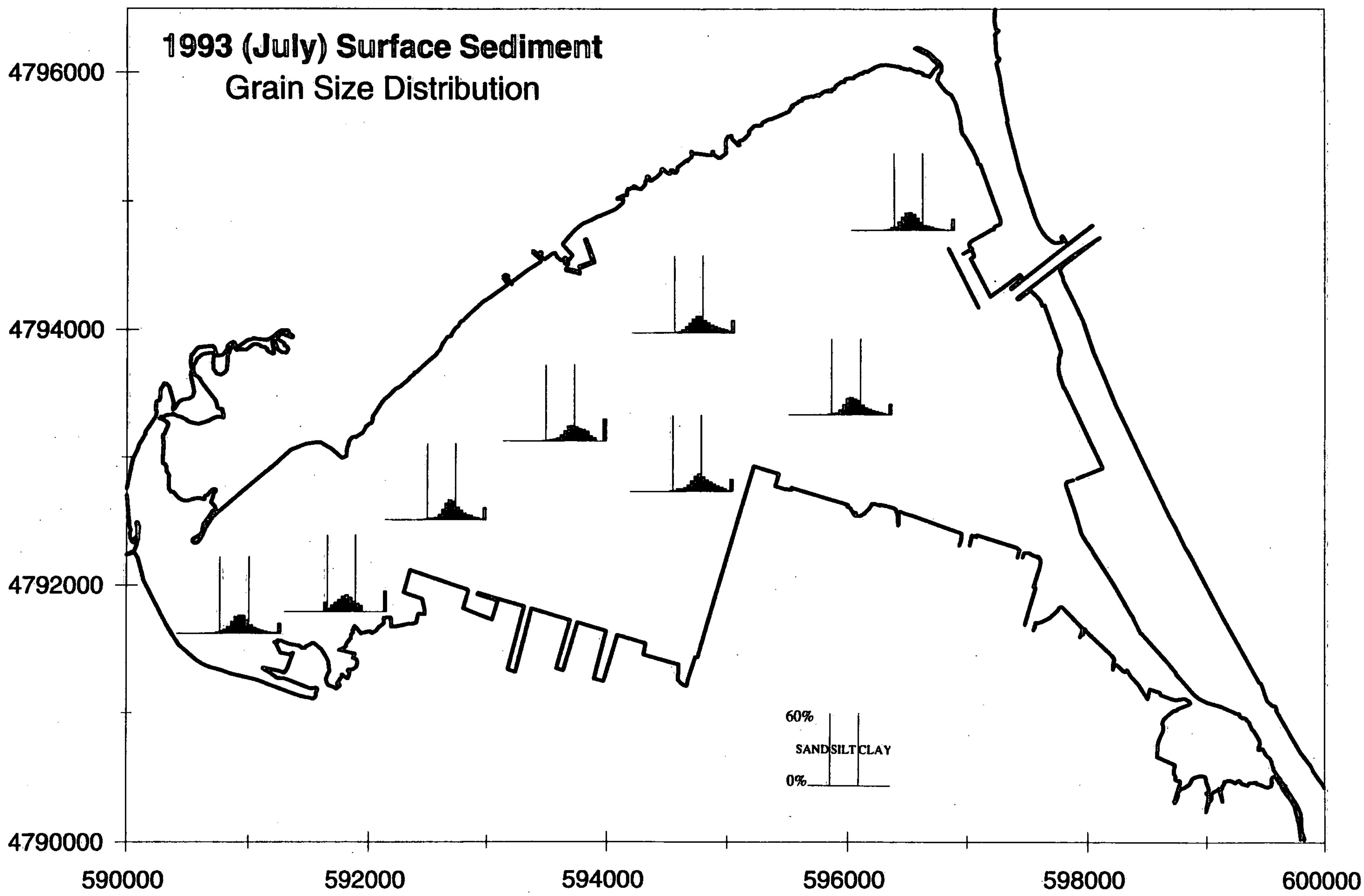

1984 Surface Sediment
Grain Size Distribution
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000
60%
SAND SILT CLAY
0%

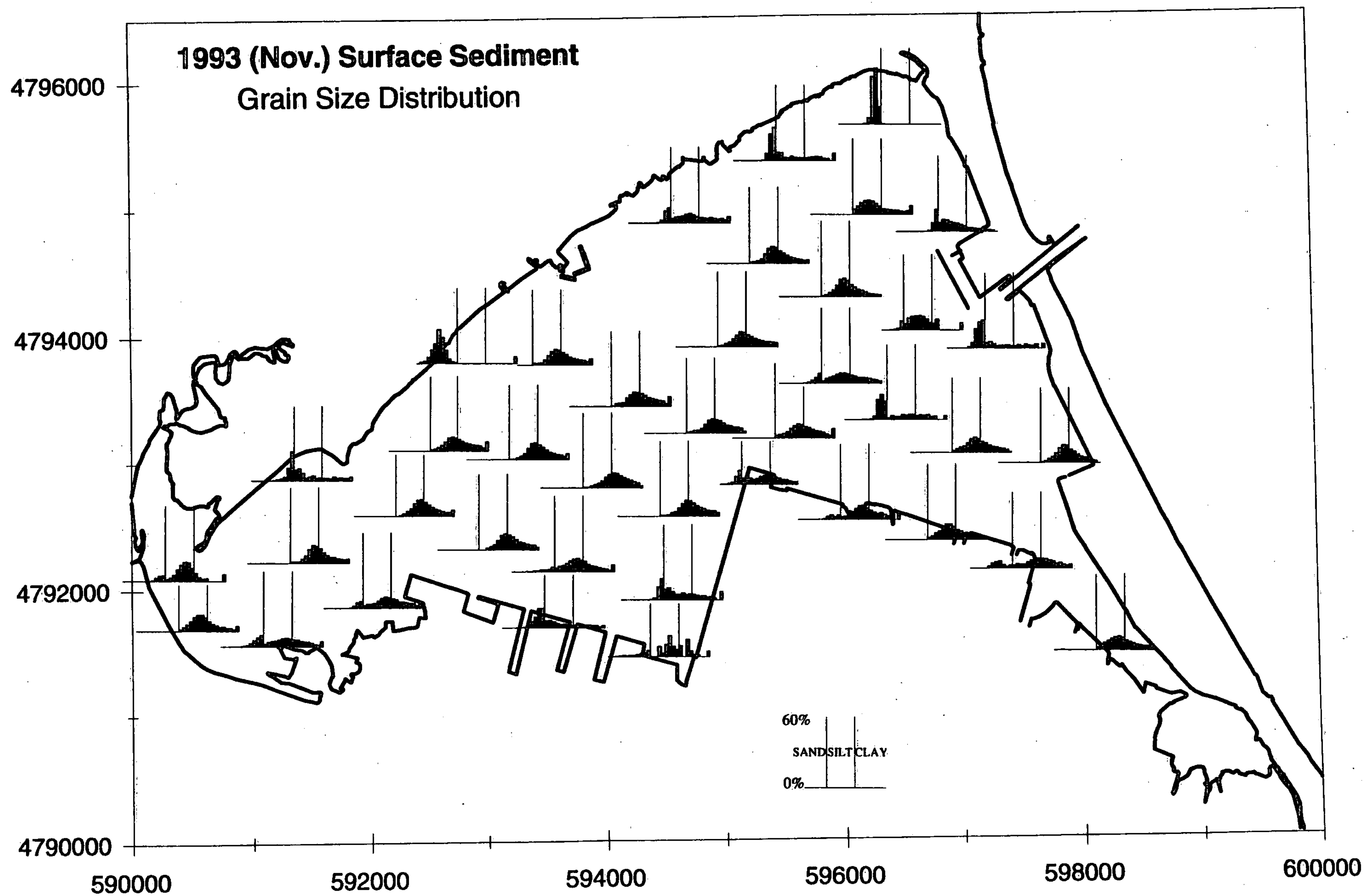

1987 Shipek Samples
Grain Size Distribution
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000
60%
SAND
SILT
CLAY
0%


1987 Core Samples
Grain Size Distribution
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000
60%
SAND SILT CLAY
0%


1988-89 Core Samples
Grain Size Distribution
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000
60%
SAND SILT CLAY
0%


1990 Surface Sediment
Grain Size Distribution
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000
60%
SAND
SILT
CLAY
0%


1993 (July) Surface Sediment
Grain Size Distribution
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000
60%
SAND SILT CLAY
0%


1993 (Nov.) Surface Sediment
Grain Size Distribution
4796000
4794000
4792000
4790000
590000
592000
594000
596000
598000
600000
60%
SAND SILT CLAY
0%

APPENDIX 8

Geotechnical data.

Sample #	Water Content (%DW)
1987 Core Samples, NWRI	
2A	159.6
3A	95.4
6A	311.7
8B	261.0
10A	444.6
12A	234.4
14B	386.8
16A	41.0
17A	441.8
18B	351.1
19A	499.6
20B	472.1
21B	560.1
24B	413.0
26A	549.7
27A	456.0
29B	459.0
30B	405.4
31B	294.2
33B	329.4
34B	270.0
37A	224.9

Sample #	Water Content (%DW)	Grain Density (g/cm^3)	Bulk Density (g/cm^3)	Shear Strength (kPa)	LOI %
1988-89 Core Samples, NWRI					
14a-88	342.2	2.474	1.156	0.25	
26C-88					
14B-89	386.7	2.388	1.136		7.2
16C-89	49.5	2.634	1.709	2.60	1.9
26C-89	397.3	2.587	1.141		11.5
2A-89	187.0	2.662	1.278	0.11	6.2
31B-89	311.9	2.513	1.171		5.6
31C-89	324.7	2.449	1.162	0.07	8.8
31C-89	288.5	2.515	1.184		8.7
31D-89	299.1	2.357	1.169		7.1
37C-89	220.1	2.371	1.220		7.1

1993 Benthos Core Samples (0-2cm), Collected by NWRI/McMaster University, July 1993

Sample #	Water Content (%DW)	Organic Carbon %	Total carbon %	Magnetic Susceptibility K(*10^-6 cgs)	Magnetic Susceptibility X(*10^-8 m^3/kg)
01A				156	
01B				99	
02				31	
03				97	
04				96	
05				8	
06				77	
07				70	
08	320.66	2.520	4.214	58	525.3
09				12	
10				72	
11				80	
12				209	
13				126	
14	329.88	3.542	6.073	86	754.1
15				91	
16				34	
17				89	
18				67	
19				16	
20A				108	
20B				76	
20C				60	
20D	496.03	4.826	7.256	57	1032.5
21				39	
22A				41	
22B				33	
22C				72	
22D				50	
22E	512.62	4.202	7.099	42	747.2
23				93	
24				82	
25				71	
26	499.77	3.224	4.826	39	740.0
27				45	
28				85	
29				45	
30				35	
31				47	
32A				186	
32B				50	
33	222.01	2.388	5.015	28	218.7
34				47	
35				34	
36				72	
37A				32	
37	220.58	2.435	5.482	33	237.9
38				69	
39	224.08	1.216	6.961	155	1079.0
40				130	

1993 Core Samples (0-2cm),
Collected by J. Coakley (NWRI), November 1993

Sample #	Organic Carbon %
C1	0.075
C2	1.919
C3	2.130
C4	3.721
C5	2.490
C6	2.909
C7	1.991
C8	2.193
C9	0.725
C10	3.252
C11	1.633
C12	2.954
C13	3.185
C14	2.304
C15	3.342
C16	1.812
C17	3.083
C18	3.468
C19	3.474
C21	3.292
C22	3.470
C23	0.837
C24	3.121
C25	3.364
C26	3.222
C27	1.618
C28	2.730
C29	2.221
C30	2.045
C31	2.066
C32-1	0.149
C32-2	1.204
C33	2.081
C34	1.771
C35	1.929
C36	2.034
C37	2.092
C38	1.597
C39	6.086
C40	2.796

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P.O. BOX 5050, BURLINGTON, ONTARIO L7R 4A6

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Pensez à recycler !