HYDRAULICS DIVISION
TECHNICAL NOTE

DATE: April, 1984 **REPORT NO:** 84-14

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TITLE: Comments on survey procedures for monitoring of bottom sediment changes in the vicinity of the Darlington Nuclear Generating Station, Lake Ontario.

REASON FOR REPORT: Prepared for Ontario Hydro in response to a request for advice on nearshore sediment monitoring techniques

CORRESPONDENCE FILE: 1180, 5760

1.0 INTRODUCTION

During a meeting between staff of Shore Processes Section and Ontario Hydro, advice was sought regarding procedures for close monitoring of nearshore bottom sediments in the vicinity of the thermal outfall for the proposed Darlington Nuclear Generating Station (NGS), on the north shore of Lake Ontario (Figure 1). Such a program, while designed to meet the specific concerns of Ontario Hydro, would be of interest to Hydraulics Division, relating, in particular, to the prediction of bottom sediment response to hydrodynamic conditions.

Hydraulics Division agreed to prepare a short technical note on how the program might best be structured to meet the specific concerns of Ontario Hydro. While a more detailed definition of survey procedures and measured parameters must eventually be made by Hydro based on its own priorities and resources, it is essential that the surveys be carried out to a standard sufficiently high to enable future cause/effect inferences regarding the diffuser operation to be made with confidence. This report, and any further consultation that might follow, is directed toward that goal.

2.0 BOTTOM SURVEY APPROACH

As the first step in characterizing changes in bottom-sediment conditions (deposit type and distribution both in space and time) a detailed reconnaissance survey of target area is required. The initial survey should be carried out prior to the construction of the diffuser ports (i.e., Summer 1984). Details on recommended survey techniques are presented later in the section on survey techniques.

Assuming operation of the diffuser would begin in 1987, then a number of resurveys of the site could be scheduled at the suggested intervals shown below:

Initial reconn. survey: (Summer 1984)
Resurvey 1: (late Fall, 1984)
Resurvey 2: (late Spring - early Summer, 1985)
Resurvey 3 (Optional): (late Fall, 1985)
Resurvey 4: (Summer, 1986)
Resurvey 5 (Optional): (Fall, 1986)
Resurvey 6: (Summer, 1987)

On the basis of the initial reconnaissance survey, smaller areas for detailed substrate monitoring (for fish studies, for example) could be defined and resurveyed at the above (or at another) frequency. Some techniques for these smaller-scale surveys are included in the section on survey techniques.

3.0 SURVEY SCOPE

For the reconnaissance survey and resurveys, an area extending out to 500 m beyond the end of the diffuser, and 500 m to each side is suggested (Figure 2). The areal extent and the survey parameters may be defined to accommodate the proposed fish-related studies in the area. The survey area ends at the shoreline. This area can be subdivided into two sub-areas (Zones A and B) on the basis of the resolution required. Zone A, the more detailed survey zone 50 m on each side of the emergent diffuser line, is expected to experience the most bottom changes, so it is suggested that it be surveyed at a resolution of 1 m. Zone B, the more peripheral area, is important mainly in tracing pathways of sediments showing up in Zone A. This area can thus be surveyed at a lower resolution, e.g., 5 or 10 m. The accurate characterization of the bottom sediments at these levels of resolution is critical for any meaningful analysis of bottom changes due to natural conditions prior to diffuser impact.

4.0 SURVEY TECHNIQUES

A. Zones A and B

The prime aim of the survey is to map bottom sediment distribution. Bathymetry is not a critical parameter in this case. The survey is generally conducted from a small boat or launch, capable of coming in close to shore (water depths less than 2 m). Survey lines are oriented onshore-offshore, and referred to a surveyed baseline near the shoreline. It is suggested that Hydro contract with one of the many private firms competent to carry out such work to exacting specifications. However, if Hydro decides to do the work in-house, then the equipment needed is presented below. Reference should also be made to Rukavina (1981) for an example of a similar survey near Bluffers Park, to the west.

Equipment: Survey-quality echosounder (Atlas, Raytheon; frequency 100 to 200 kHz).
Side-scan sonar (Klein, EG&G).

Positioning system: For Zone A resolution, systems such as Motorola RPS or Miniranger (accuracy: greater than 5 m) might be adequate. Loran-C is not accurate enough for these purposes. For the Zone A and small-area surveys, transits mounted onshore and equipped with a high-accuracy ranging system (Wild Distomat, for example) are recommended. These can best be used in range-distance mode, for keeping the vessel on line as distance measurements are taken. Communication between the vessel and the shore transits is by walkie-talkie. The expected positional accuracy is estimated to be less than 2 m, for distances less than 3000 m.

For identification of bottom materials and delineation of deposits, ground-truthing of the echo-sounder and sonar records is essential. This can be carried out by diver, underwater TV, or underwater cameras, or a combination of all three. In any event bottom samples or photographs should be collected for defining bottom-type references. Diver observations and sampling/photographing can be carried out as described in the next subsection (surveying small areas).

The preferred technique is using both echosounder and side-scan. Thus, line spacing could be much larger than that for echosounder alone, i.e., 50 m or more, depending on equipment used and water depths. Ground truthing is still a necessity, and is usually done using a towed U/W TV apparatus or spot diver observations. Using side-scan sonar, the possibility for enhanced position-fixing exists in the use of surveyed-in bottom-mounted transponders. These are activated by the outgoing sonar pulse to send back a signal which is recorded as a clear, dark spot on the sonargram. When the actual diffuser port structures are in place, they can also be imaged by the side-scan beam to provide a means of horizontal control for the side-scan survey.

Surveying smaller areas

These techniques might be considered for high-precision characterizing and monitoring of more restricted areas, such as Zone A or the fish-related substrate studies. The higher level of repeatability or precision is provided by laying out permanent rectangular grid or radial patterns or reference points on the bottom, which a diver or U/W TV could easily re-occupy. Examples of these are shown in Figure 2. Equipped with a standard quadrat sampler (about .25 m square), a diver could record the bottom types in the area according to a pre-determined classification system (see section on mapping). A tape recorder, grease pencil/plexiglass plate, or wide-angle U/W camera could be used for recording.

Zone A (roughly 1000x100 m in dimensions) could also be covered using a technique of resurveying along wires or rope traverse lines attached to the bottom. The rope or wire could be pre-measured, and a diver could then swim along the traverse taking measurements (or photographs) at set intervals. Depending on visibility, a minimum of two 1000 m lines would be necessary for area coverage. This, combined with the strenuous diver effort required, makes the side-scan option more practical at first glance.

5.0 MAPPING BOTTOM TYPES

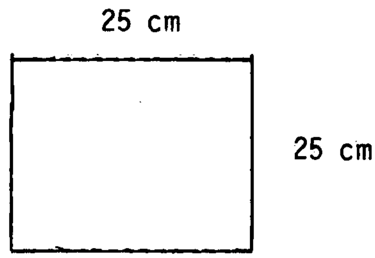
The side-scan (slant-range-corrected) and echo-sounder records, ground-truth data, and position fixes (converted to rectangular coordinates) should be compiled into interpretive maps of bottom sediment maps at a scale of 1/5000 or larger (i.e., perhaps 1/2500). Map scale for the more detailed areas, such as Zone A and the small monitored areas, could be as small as 1/1000. This latter scale would resolve bottom features (such as large boulders and sand patches) 1 m in diameter. Maximum map dimension for Zones A and B would thus be less than 70 cm (or 30 ins.). The maps should also show water depths over the areas. Bathymetry is not expected to change signficantly over the time period involved, so the successive sediment distribution plots could be overlain over the detailed bathymetric maps that Hydro now possesses.

Table 1 shows an example of a sediment type description scheme that could be applied, using either diver observation data (using the standarad quadrat for consistent sample area), or from scaled TV or photograph records. It could easily be expanded or modified to include other bottom parameters useful for specific studies. The important factor is that the parameters be measured consistently in each survey. Bottom types could be represented on the map by selected map-symbols or patterns for visual display.

REFERENCES

Rukavina, N.A. 1981. Survey of artificial shoals, Bluffers Park, Lake Ontario. Hydr. Div. NWRI Tech. Note 81-29, 6 p.

TABLE 1



Till surface not visible (Probe or estimate mobile sed. thickness)				Till surface visible		
				% mobile sed. cover		
Boulders, Cobbles	Pebbles, Granules	Sand	Mud	5% TILL	5 to 50% TILL with (x)% (mob. sed. type)	50 to 100% (Mob. sed. type) with (x)% till
Size range, max. size, Algae?	Rounded?, max. size,					
		Ripples? (spacing, orientation, height)			1.	2.
4.		3.				

<u>Sample description examples:</u>

1. TILL with 30% sand veneer, rippled (N85, Ht.: 2 cm, spac.: 15 cm). Sand up to 5 cm thick.

2. COBBLES with 10% till, 40 to 100 cm, rounded, algae-covered; some mud in interspaces.

3. Clean SAND, thickness: 30 cm; ripples absent.

4. BOULDER bottom, 30 to 200 cm diam.; algae on surface.

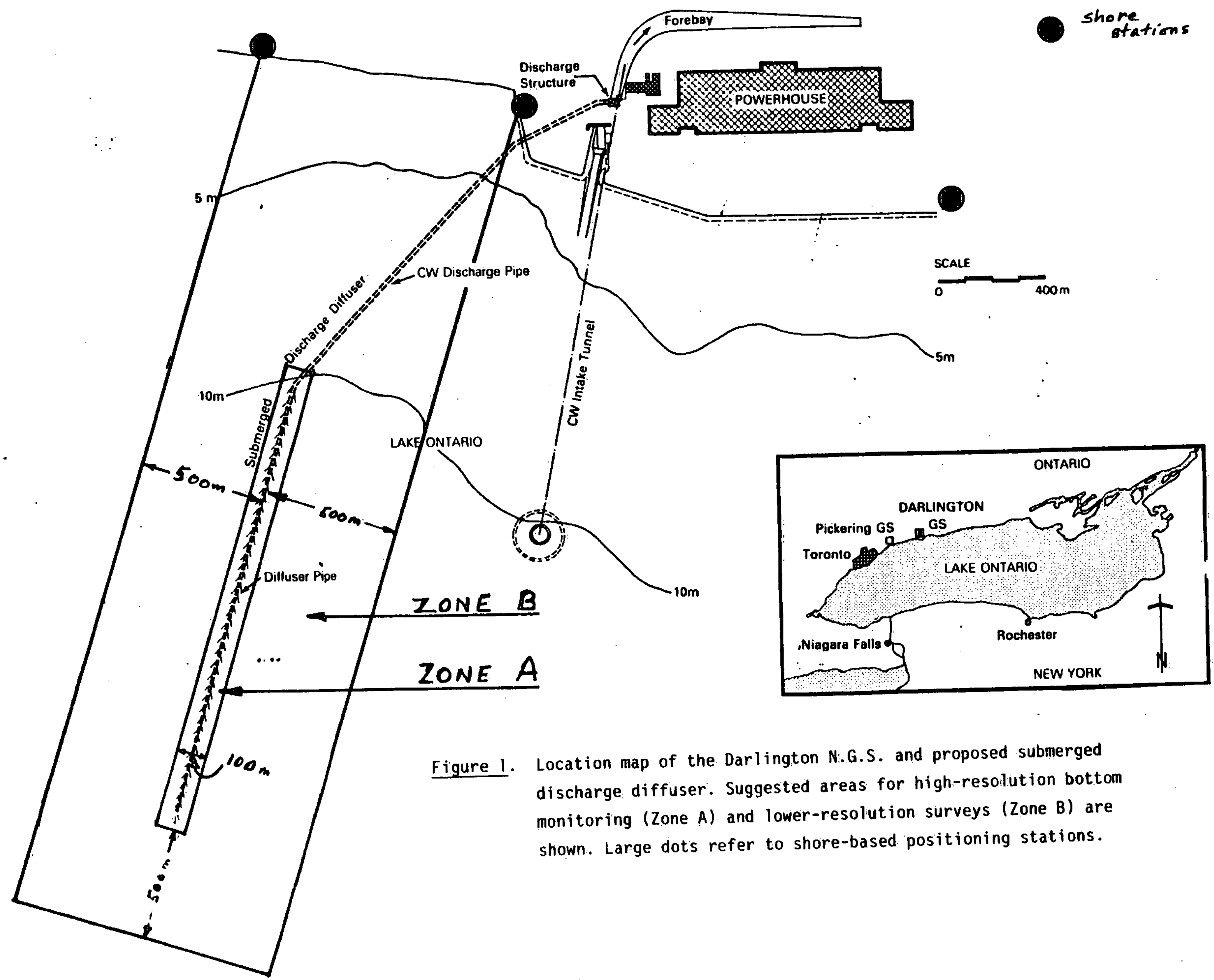


Figure 1. Location map of the Darlington N.G.S. and proposed submerged discharge diffuser. Suggested areas for high-resolution bottom monitoring (Zone A) and lower-resolution surveys (Zone B) are shown. Large dots refer to shore-based positioning stations.

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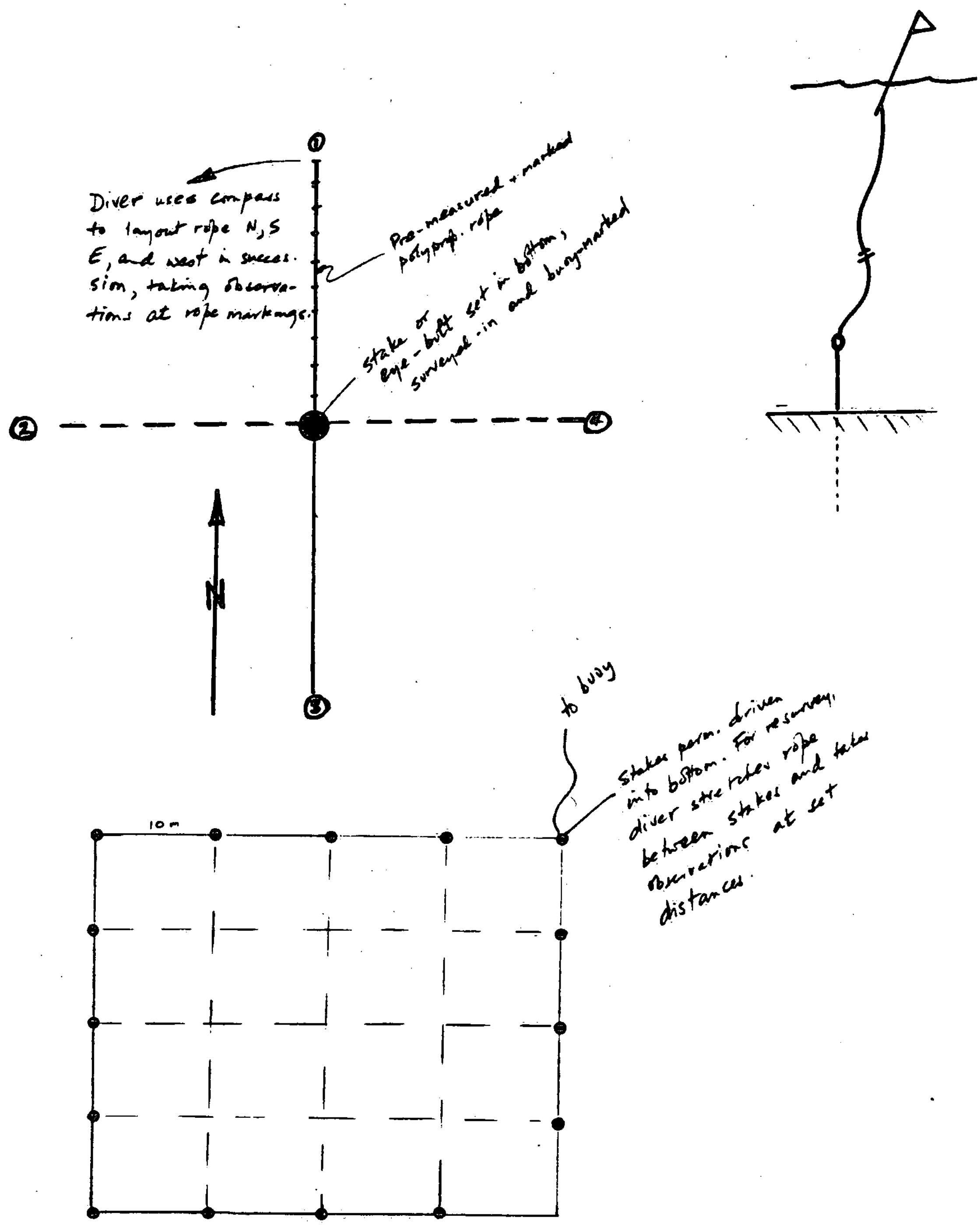

<u>Figure 2</u>. Radial (top) and grid (bottom) patterns for diver monitoring and sampling of restricted areas on the lake bottom.