DIVER EDUCATION SERIES

Oceanography for Divers

Nearshore Hydrographic Survey Using Divers

Lee H. Somers

Michigan Sea Grant College Program

MICHU-SG-87-502

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Michigan Sea Grant is a cooperative program of The University of Michigan and Michigan State University. It is part of a national network of Sea Grant programs offering marine and Great Lakes research, education, and extension services. In addition to diving and water safety programs, Michigan Sea Grant conducts research, produces publications, and provides extension assistance on shoreline erosion, waterfront development, commercial and sport fisheries, toxic substances, and marine transportation and engineering. Contact the address on the last page for a publications catalog or other information.

Lee H. Somers is an Associate Research Scientist, Department of Atmospheric and Oceanic Science; Assistant Professor, Division of Physical Education; and Diving Safety Coordinator, Department of Occupational Safety and Environmental Health, The University of Michigan. He is also Michigan Sea Grant's Extension Specialist in diver education, diving technology, and aquatic accident management. Dr. Somers' 30-year diving career has included commercial, research, search and rescue, saturation, polar, cave, and ocean diving, and directorship of a hyperbaric chamber facility. He holds recreational diving instructor certifications from the National Association of Underwater Instructors and Professional Association of Diving Instructors.

This publication is the result of work sponsored by the Michigan Sea Grant College Program with grant NA85AA-D-SG045 from the National Sea Grant College Program, National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce, and funds from the State of Michigan.

Price $2.50

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OCEANOGRAPHY FOR DIVERS: NEARSHORE HYDROGRAPHIC SURVEY USING DIVERS

Lee H. Somers, PhD

SECTION I

INTRODUCTION

OVERVIEW

Science and technology have provided the marine scientist with many sophisticated survey techniques and instruments. Unfortunately, proper instrumentation and support vessels are not always available to the scientist because of cost factors, remote locations, or nature of the survey operation. This booklet describes a simple and practical nearshore hydrographic survey technique which is relatively accurate, comprehensive, and inexpensive. It can be accomplished with a minimum amount of equipment by either surface swimmers (using mask, fins, and snorkel) or underwater swimmers (using scuba).

The nearshore hydrographic survey for charting bottom topography (depths) and superficial sediment distribution is a modification of the **perpendicular administrative reconnaissance technique** employed by U.S. Navy Underwater Demolition Teams and SEALs [1,2]. Portions of this publication are taken directly from referenced U.S. Navy manuals. From a military point of view, accurate knowledge of the nearshore topography can significantly affect the efficiency and effectiveness of an amphibious operation and possibly save numerous lives. In modern-day military operations, sophisticated aerial reconnaissance techniques may preclude the need for swimmer surveys. However, the techniques used in the past may still be of value for operations where other options are unavailable.

For the marine scientist and students participating in research diver training programs, this technique still offers a viable option for obtaining information that will be useful in better understanding the relationships between wind, currents, waves, shoreline configuration, sedimentation, and bottom topography. Diving students of all levels can participate in a meaningful exercise that will provide them with a basic understanding and experience in nearshore survey and chart preparation.

PERSONNEL & SAFETY

The survey may be accomplished with one or more three-person teams and an instructor/supervisor. Any number of survey teams may be used; however, the instructor must assure that the number of divers does not exceed the student-instructor ratio designated by the sanctioning organization. Skin and/or scuba diving techniques can be used.

The instructor/supervisor is responsible for assuring that all persons are properly qualified and equipped for the activity. All swimmers will be required to wear emergency flotation equipment, a signal device (whistle; smoke flare optional), and thermal/sun protection (as required). Appropriate emergency equipment will be available at the beach command post [3]. Swimmers shall not be deployed under adverse environmental conditions such as high waves (surf), swift longshore or rip currents, tidal currents or storm conditions that might present unnecessary and unacceptable risk to the swimmers.

ENVIRONMENTAL CONDITIONS

Adverse environmental conditions can significantly affect the safety, accuracy, and ultimate value of the survey. As indicated above, do not expose swimmers/divers to unnecessary and unacceptable risk. Longshore and tidal currents must be assessed and appropriate corrections made by the swimmers. If the current is too swift within the nearshore zone, the team may elect to begin the survey seaward of this current zone (generally relatively narrow). Measurement and distance plotting will be adjusted accordingly. Tidal levels and currents must also be considered. Complete tide table information will be compiled by the supervisor or a designated team member.

If high surf conditions exist, the survey measurements may have to be started well beyond the surf zone and plotting adjusted accordingly. The supervisor and teams will make the necessary evaluation of the conditions and adjustments in procedures, keeping in mind both safety and accuracy. A test traverse may be necessary to determine the most acceptable procedure for subsequent traverses.

EQUIPMENT

Swimming/Diving. Each swimmer/diver will have complete skin and/ or scuba diving equipment as required for safety (as indicated above), for operational efficiency, and to meet the standards of the sanctioning organization. The supervisor/instructor will provide an appropriate dive table, recordkeeping items, first aid kit, oxygen breathing unit, and emergency communications unit.

Measurement Equipment. Several survey techniques which require the use of measured lines will be discussed below. Many survey teams prefer the use of a measured line to determine offshore position or distance from the baseline. A **line reel** with 100 to 200 yards (or meters) of #18 (1/16 inch) or #8 (1/8 inch) braided nylon line is desirable for underwater swimmers (scuba divers). Line reels similar to those used by cave divers are excellent. The line must be marked/coded at selected intervals, depending on the survey accuracy requirements. UDT/SEAL commonly make measurements at 25 yard (meter) intervals; some scientists will elect to use a sample/measurement interval of 10 yards (or meters). For long traverses, two or more reels can be carried and used by the survey team.

Surface swimmers may prefer to use a **swimmer's style flutterboard** fitted with a hand-operated reel containing up to 400 yards (meters) of floating polypropylene line. The size of the reel will depend on the size of the line used; generally, line approximately 1/8 inch in diameter is adequate. A swimmer can easily push the flutterboard seaward to unreel the line, or the board can be positioned on the beach and the line reel controlled by beach personnel.

Line marking can be accomplished by one of several methods. The line can be tagged with small pieces of plastic tape on which the distance measurements can be written using waterproof ink. If a reel with a line guide is used, one must assure that the tapes will feed smoothly through the line guide. Some researchers prefer to use brightly colored code markings on the line. The 10 yard (meter) distance is designated by a single narrow (approximately 1/2 inch) mark or band, 20 yards (meters) by two closely spaced marks, and so on to 50 yards or meters. The 50 yard (meter) mark is a wider band (approximately 1 inch), and 60 yards (meters) is marked by a wide mark-single small mark grouping. A wide-small mark grouping is used to 100 yards (meters), which is designated by two wide marks and so on. Essentially, any marking pattern of personal preference may be used as long as all participants are aware of the meanings of the marks and the intervals designated. Some surveyors use knots or plastic or metal bands crimped on the line.

Although a diver's reel and line can be used for establishing a beach baseline, many researchers prefer to use a 100 yard (meter) **surveyor's measuring tape** (vinyl or steel) on a reel. This tape is ideal for accurately locating the baseline with respect to features of known position or a benchmark.

A **lead or sounding line** may be used by surface swimmers to accurately measure water depth. Approximately 30 feet (or 10 meters) of 1/16- or 1/8-inch braided nylon line is marked at selected intervals (usually 1 foot or 0.5 meter) using one of the marking systems discussed above. The line may be coiled on a small line retainer, reel, or in the diver's hand. The lower end of the line is fitted with a 4- to 8-ounce fishing sinker weight (personal preference). The swimmer simply lowers the line until the weight makes contact with the bottom and reads the depth to the nearest 1/2 foot or 1/4 meter, estimating the distance between markers. Contact with the bottom will be obvious by feel. This is a very effective and accurate depth measurement method for shallow water.

A **diver's depth gauge** may be used by a scuba diver to measure water depth. The depth gauge must be calibrated for accuracy prior to the survey. Calibration may be accomplished by using a precisely measured (at 1-foot or 1/2-meter intervals) corrosion-resistant chain suspended from a surface float, with the zero mark at the water's surface. A metal chain is used because it will hang straight in the water and will not stretch or shrink with time and use.

The diver submerges beside the chain and compares the depth gauge readings to the precise measurements on the chain, recording both on a slate. Depth corrections are made when the diver's measurements are recorded in the field notebook/data sheet or at the time of chart preparation. Be certain to record the depth gauge serial number on the swimmer's slate and in the field notes to avoid later confusion in data processing.

Researchers are encouraged to select a depth gauge with the highest degree of accuracy possible. Most commercially available units must be calibrated by the diver, even when new. Accuracy of $\pm 1\%$ of full scale within the first quarter or half of the depth gauge scale (depending on the model) is considered good. For example, an accuracy of $\pm 1\%$ on a 150-foot scale gauge is ± 1.5 feet. Capillary type gauges are often very accurate for shallow water applications; however, the diver may wish to carefully inscribe markings at 1-foot intervals during calibration.

Swimmer's Slate. An excellent slate may be constructed of 1/4-inch white or clear plexiglass (or plastic). A slate approximately 3 inches wide and 10 inches long is convenient for handling and data recording. Both surfaces are roughened with fine sand paper to give a frosted effect. This creates a surface which can be easily written upon with a #2 pencil. A length of cord should be attached to the slate so that it can be secured to the diver's flotation unit or hung around the diver's neck. The pencil is also secured to a length of line to prevent loss. Some divers will sharpen both ends of the pencil and protect the unused end point with a plastic cap (from an old ball point pen). This provides an immediately available backup writing device. Others simply tape an additional pencil or two to the side of the slate or its lanyard or carry them in the buoyancy unit pocket. It is a good idea to always use point protectors on the spare pencils. The slate is marked-off and coded prior to the survey swim so that all the diver has to do is fill in the blanks. Ideally, a separate slate is used for each traverse and the data is transferred to a permanent record book or data sheet upon completion of the survey.

Compasses. Some teams use a **surveyor's compass** to determine the position of and establish the baseline. A variety of **underwater compasses** are available for divers. Some traverse technique options require the use of accurate underwater compass navigation. Wrist-mounted compasses are generally less accurate and more difficult to use than board-mounted or hand-carried compasses. A hiker's style fluid-filled compass may be hand-carried or mounted to a shaped plastic compass board. These relatively inexpensive compasses are excellent for accuracy and, with care, hold up quite well for shallow water diving. If the compass is not mounted on a board, it should be fitted with a lightweight lanyard and may be carried in the buoyancy unit pocket when not in use.

Range Poles and Beach Markers. Surface swimmers must maintain a straight course while swimming seaward. The use of **range poles** enables the swimmers to maintain a given course by keeping two range poles in line. Range poles many be constructed or wood or light-weight metal. These poles are of slightly different heights (approximately 5 feet and 6 feet) and fitted with different colored flags. One pole will be positioned vertically in the sand on the baseline and the longer one a few yards landward (to be discussed later). For accurate surface swimmer survey traverses, each pair of swimmers should have a set of range poles. Several pairs of brightly colored, numbered (by pair; 1/1A, 2/2A, etc.) **plastic stakes** (approximately 1 foot long) are useful for marking the baseline and traverse lines.

Data Recording Items. The supervisor must have a clipboard and paper or a field notebook in order to document all information relative to the survey. This information will include sketch maps, personnel assignments, measurement data, baseline positioning data, survey times (for tidal cycle reference), and so on. Several pencils and/or pens should be retained with the book or clipboard. If working in an area where tide changes will influence survey measurements, an accurate timepiece and appropriate tide table will be required. Some surveyors include a small calculator for conversions and correction purposes.

Surface Float and Tow Line. Some swimmers prefer to tow a small surface float for safety, resting, supporting a diver's flag, and carrying samples. The diver's flag is mandatory by law for both skin and scuba diving in most areas as an alerting signal to boaters. The float must be of sufficient size to support the flag and sample-containing net bags. Many divers will suspend the sediment samples below the float in a net bag. A tow line on a line retainer is convenient for handling the float during offshore swims.

Sample Containers. If samples of superficial bottom sediments are required, small plastic wide-mouth bottles with snap or screw tops may be used. Each bottle should be large enough to hold several ounces of sediment. The number of samples will depend upon the survey objectives. A surface on the bottle or cap should be roughened to facilitate labeling.

SECTION II

SURVEY PROCEDURES

ESTABLISHING BEACH CONTROL

1. Determine which flank (the right or left side when facing in the direction of the objective) of the beach will be used as a starting point. If there is a littoral or longshore current, the starting point will be upstream of the current.

2. Establish Point No. 1 at the selected flank as near the waterline as possible, taking into account wave activity and water level changes that might occur as a result of tidal variations during the survey. Document the position of Point No. 1 relative to a benchmark or a relatively permanent man-made or natural feature that is evident on U. S. Geological Survey topographic maps of the area or on coastal charts. Exact position of the baseline is important in most scientific studies. This position can be determined by compass and tape measure, taking into account elevation changes to the best of your ability. For very accurate surveys, surveying instruments should be considered.

3. By compass, determine the bearing to an object or survey marker or to the opposite flank of the beach. This is the **Baseline Bearing** (BB). The baseline should be near the waterline, but not in the water.

4. Establish Point Nos. 2, 3, 4, etc., at selected intervals (generally 25 yards or meters) by measuring with a surveyor's tape toward the opposite flank on the BB from Point No. 1. The numbered beach markers can be placed at each point.

5. Calculate the Right Angle Bearing (RAB) which is the bearing pointing seaward 90 degrees from the BLB.

6. Establish Point Nos. 1A, 2A, 3A, etc., which are points several yards (meters) landward of Point Nos. 1, 2, 3, etc., respectively, on the **reciprocal bearing** of the RAB. Mark with the appropriately numbered stakes. Range poles will be placed at these points during offshore traverses. Procedure number 6 is required for the surface swimmer traverse option only. It may be useful for submerged surveys if a diver surfaces offshore to confirm or correct orientation during a traverse.

SURVEY TECHNIQUES

The actual offshore survey may be conducted using one of several techniques including:

1. Surface swimmers with beach-controlled reel and measurements.

2. Surface swimmers with swimmer-controlled reel and measurements.

3. Submerged swimmer (scuba diver) using compass bearings and swimmer-controlled reel and measurements.

4. Submerged swimmer (scuba diver) using compassbearings and controlling distance by counting kicks or timed swimming.

Beach Controlled Swimmer Survey. The flutterboard/reel is placed at Point No. 1, and the free end of the measurement line is secured to a swimmer with a quick-release mechanism/knot. The swimmers move seaward on range and maintain visual contact with the beach person. When the first distance marker is reached, the beach person signals (verbal, whistle blast, or flag) the swimmers. The line swimmer assures that the line is taut and that the team is on range. The second swimmer measures depth and dives to the bottom to make observations and/or collect a sample. The second swimmer records information on a slate and stows the sample. The line swimmer is responsible for maintaining course (direction) and distance.

When the seaward extent of the survey area is reached, the beach person moves the range poles to Point No. 2/2A, 25 yards (meters) down the beach and repositions the flutterboard/reel. The swimmers parallel the beach until they are on range and assure that the line is taut. Upon command signal from the beach, the swimmers proceed landward as the beach person reels in the measurement line and take soundings/observations on signal as before.

The effectiveness of this procedure will depend upon the skill and experience of the team, as well as the environmental conditions. Ideally, student teams should include a reel control person, a signal/range person, and two swimmers. Teams should limit initial practice swims to 200 yards (meters) and make soundings at 25 yard (meter) intervals. A denser sounding pattern (closer intervals) may be used if there is a significant offshore slope. Longer swims (up to 400 yards [meters]) present a higher degree of difficulty in line handling, signaling, and remaining on range. The team can increase the length of swims with experience.

Swimmer Controlled Survey. The end of the measurement line is secured to an anchoring system with the "0" mark at Point No. 1. The swimmers move seaward with the flutterboard/reel or a hand reel on range and make soundings/observations at designated intervals. The line swimmer controls the reel and assures that the team remains on range and sounds at the appropriate locations. Care must be taken to keep the line taut. The second swimmer makes soundings and observations. When the seaward extent of the traverse has been reached, the swimmers signal the beach person to move the range poles and measurement line to

Point 2. The swimmers parallel the beach until they are on range, pull the line taut, and swim landward taking soundings, etc. If using a light-weight reel line, special care must be taken to not stretch the line.

Three Swimmer Team Deployment. Using the surface swimmer technique, three teams of swimmers can deploy simultaneously to survey a 75 yard (meter) strip of seafloor while swimming seaward and 75 yards during the beachward swim (or six traverse lines). Only the middle pair of swimmers (guide pair) carry the measurement line. When the measurement marker is reached, the guide pair or the range pole person will signal (depending on who controls the reel), and all three swimmer pairs will make depth measurements (and observations/samplings, if required). When the guide pair has reached the seaward extent of the survey, the beach crew will move the range poles and beach end of the survey line 75 yards (meters) down the beach. The swimmers will parallel the beach until the guide pair are on range. Then, on command of the guide pair, all swimmers will proceed toward the beach making measurements as before. At the water's edge, the swimmers emerge, the range poles are moved 75 yards (meters) down the beach and the procedure is continued until the area to be surveyed has been covered.

Some consider this technique to be less accurate than one where each swimmer pair uses a separate measurement line. However, it may enable a team to cover more area in less time and with less equipment. A skilled team can cover the distance off shore and maintain a relatively accurate position by visual estimation of distance from the guide pair. Range poles for each pair of swimmers will improve directional and spacing accuracy.

Submerged Line and Reel Survey. The end of the measurement line is anchored with the "0" mark at Point No. 1. Two scuba divers move seaward and play out the line. The lead or compass swimmer will maintain an accurate course using a compass board. The reel person will play out the line directly beside the compass swimmer and signal when the first sounding/sampling mark is reached. The reel person is responsible for maintaining a taut measurement line without stretching the line. The lead diver will then measure and record depth and other observations. If a sample is required, either diver may take the sample; however, the reel person will often carry the sampling containers. The data recording slate can be attached to the back of the compass board. When all tasks have been accomplished, the compass swimmer will establish orientation and the team will proceed to the next sampling point. Generally, a surface float is towed by one of the divers so that the instructor/supervisor may be aware of the submerged swimmers' position and as a signal to boaters. This also allows the supervisor to monitor directional accuracy by lining up the range poles and float (or diver's bubbles). Allowance must be made for float drift and the amount of float line played out by the divers.

Many teams use a small float and relatively lightweight float line. The amount of float line required is estimated prior to the swim. The line is then secured to the reel person's arm with a releasable Velcro strap. This leaves both hands free to control the measurement line reel.

For long submerged swims, two or more measurement lines may be laid in series. This enables the swimmers to carry line reels of smaller, more manageable size rather than one large reel.

When the swimmers reach the seaward extent of the survey area, they simply retrace the traverse back to the beach, retrieving the measurement line as they return. It is very difficult, if not impossible, to move a submerged lightweight line. Unlike the floating line used on the flutterboard reel, the submerged line will catch on underwater objects and incur considerable water resistance. Admittedly, this procedure requires more diving time and air supply. However, it will be more accurate overall and much less difficult than attempting to move a submerged line. Two teams can rotate using the same reel system, with one team resting and changing scuba cylinders while the other swims. Or several scuba teams can be deployed along a stretch of beach at a time.

For short traverses on unobstructed seafloor areas, a survey team may wish to experiment with moving the traverse line while the swimmers are offshore. When the swimmers reach the seaward extent of the survey area, they can surface and signal the beach person to move the range poles, anchor, and "0" mark to Point No. 2/2A. The swimmers parallel the beach until on range, submerge, and swim a compass course back to the beach taking soundings and samples as before; the reel person retrieves the line.

Submerged Swimmer Compass-Kick Survey. This is potentially the least accurate survey technique; however, it may be conducted without the use of lines and reels. The scuba divers move seaward on a given compass course. Distance between soundings is measured by the diver's kick. The distance covered per kick cycle can be determined by counting the number of kicks required to swim a 100 yard (meter) course and dividing 100 by the number of kicks. The divers will stop at each sounding/sampling location, record depth/collect sample, and proceed to the next location on the traverse. With practice a team of divers may develop reasonably good accuracy in distance measurement. This technique is similar to measuring distance on land by pace or step length on land.

When the divers reach the seaward extent of the survey area, they swim 25 yards (meters) at a right angle to the traverse course. When they reach the seaward end of their return traverse, they proceed landward on the reciprocal of the prior seaward traverse course direction. Upon reaching the beach (or a point roughly 25 yards [meters] seaward of the baseline), they repeat the procedure.

SELECTING A SURVEY TECHNIQUE

The selection of a survey technique is dependent on several factors. In selecting a proper technique, the supervisor or instructor must consider the following:

* Purpose of the survey and accuracy requirements;
* Number of personnel;
* Size of area to be surveyed;
* Time available to complete survey;
* Environmental conditions;
* Personnel experience;
* Personnel safety; and
* Local residents/population factors.

SECTION: III

PREPARATION OF A FIELD SURVEY CHART

SPECIFICATIONS

Dimensions. The maximum dimension of original charts shall be 36 in x 36 in. Many clients/instructors will specify a short dimension not to exceed 26 in. If the chart will not fit within 36 in x 36 in, it shall be drawn in two or more sections. Survey teams using metric units may use a dimension of 100 cm x 100 cm.

Units. Most charts commonly used in the United States are still in U. S. units of measure (i. e., feet, yards). Consequently, the description of chart preparation given below is in U. S. units. However, survey teams desiring to use metric units of measure may do so and make the appropriate notations on the chart.

Scale. The scale will normally be 1:900 (1 in = 25 yd). In circumstances where the beach length is unusually long, scales of 1:1,800 (1 in = 50 yd), 1:2,700 (1 in = 75 yd), or 1:3,600 (1 in = 100 yd) are permissible to permit inclusion of the entire survey area on one chart. The scale will be indicated on charts both numerically and by a graphic bar scale.

Format. Data will be neatly and symmetrically plotted on survey charts. Leave room in each corner and at the top and bottom of the chart for identifying data, page numbers, etc. In most cases lettering on charts will be done with mechanical lettering guides. However, it is permissible to draw a chart freehand during field operations and later draw an ink overlay using good drafting paper and a light table. Mechanical lettering guides are used for final copy. Standard nautical chart symbols and abbreviations should be used whenever practical. If non-standard symbols are used, their meaning should be indicated.

Vertical Cross-Sections. Normally, three or more vertical cross-sections shall be included on field survey charts to show bottom conditions opposite beach centers and right and left flanks. Vertical and horizontal scales shall be 1 in = 10 ft and 1 in = 50 yd, respectively.

Contour Interval. The chart will be contoured at 2 foot intervals or other designated intervals depending on local conditions and purpose of the survey. The contour interval will be indicated.

PROCEDURES

1. **Layout Sheet.** Lay out a sheet of 10 x 10 graph paper large enough to accommodate the prospective chart. (Do not exceed

36 x 36 in.) Allow enough space for a 1-in margin all around the chart (which is to be included in the 36 x 36 in), the amount of backshore to be included, corrected soundings and an additional 8 in or more for the legend, scale bar, area inset, north arrow and cross-sections.

NOTE: The 10 x 10 graph paper is marked off in 1-in squares which are in turn sub-divided into 100 equal squares. On a horizontal scale of 1:900, each 1 in square equals 25 yd of "ground distance," thus, each 1/10th in square equals 2.5 yd.

2. **Baseline.** Lightly draw in the Baseline across the upper portion of the sheet of graph paper, about where the High Water Line (HWL) will be:

   a. The base line will NOT show on the completed chart but will serve as a reference in drawing it.

   b. The base line will immediately establish the shape of the beach being drawn. Once the base line is on the chart and affixed with a bearing, everything put down after the base line becomes, in distance and bearing, relative to it.

3. **Draw in the High Water Line (HWL).**

   a. Starting at the left flank (LF) draw a light dot every 25 yards along the base line, either right on or to the landward or seaward of the base line as indicated by the field notes.

   b. Draw in a heavy black line, in a series of french curves, connecting all the dots.

   c. The HWL will terminate at the lanes marking the left and right flanks of the beach.

   d. The letters "HWL" will be printed at either end of the cut-off line.

4. **Establish Beach Flanks.** The letters LF and RF will be used to pinpoint the location of the left and right flanks of the beach being drawn. They are located between the HWL and Datum Line (see no. 6) whenever possible.

5. **Correct and enter soundings.**

   a. All soundings are corrected to area datum and are expressed in feet (relative to tidal range).

b. Individual soundings are drawn in on range, at designated intervals, from the base line, seaward.

c. Soundings are drawn in lightly, relative to the heaviness of the HWL, Datum Line, and contour lines.

d. For precise survey position plotting, the actual chart position of soundings made during submerged swimmer (scuba diver) surveys may be mathematically corrected using the formula,

$$H^2 = B^2 - D^2$$

where H is actual surface or chart distance, B is the distance measured on the bottom, and D is the water depth at that sounding point. Be certain that all measurements are in the same units (i. e., feet, yards, meters). For example, a sounding of 15 feet is made at a measured distance of 100 yards (300 feet) seaward of the baseline. The actual chart (water surface) distance to that sounding from the base line is determined by the calculation,

$$H = \sqrt{300^2 - 15^2}$$

$$H = 299.6$$

The correction factor is small for gently sloping near shore areas and, as evident above, correction of each depth sounding position may not be significant considering all of the potential errors in this type of survey. However, for steeply sloping near shore areas, the correction factor may be significant.

NOTE: For inland lakes, tidal corrections are not necessary.

6. **Draw in the Datum Line.**

a. Draw a heavy black line in a series of french curves interpolating between the seaward-most zeros and the first sounding. (The distance depends on the depth of the first sounding.)

b. Like the HWL, the Datum Line (e.g., MLLW or Mean Lower Low Water) will terminate at the lanes marking the left and right flanks of the beach.

c. The letters designating the Datum Line (e.g., MLLW) will be printed at both ends of the cut-off line.

d. This line is often referred to as the reference or datum planes.

NOTE: For inland lakes, the Datum Line shall be the Water Line.

7. **Contour Lines.** Draw contour lines at designated intervals (normally 2 or 5 ft). The contour line is a line connecting points of equal depth with reference to a datum level. It is often necessary to interpolate depths between soundings based on apparent bottom gradient, etc.

8. **Draw in Obstacles.**

a. Draw in both man-made and natural obstacles (e.g., cusps, submerged rocks, partially awash or submerged objects, berm scarps, sand bars, etc.).

b. Obstacles shall be drawn on the chart in proper proportion to the rest of the information as near to scale as possible.

c. Obstacles will be recorded on the swimmer's slates and the field notes.

9. **Draw in Backshore.**

a. Draw in as much backshore as is appropriate in as much detail as is specified by the mission objectives.

b. Include prominent landmarks (especially if they appear on the reference chart or map used in conjunction with the charts).

10. **Establish Reference Point.**

a. Ensure that the reference point is a prominent land feature. Indicate the location of the reference point by drawing in a small cross, with the intersection of the cross at the exact geographical point in the chart, and by printing in the abbreviation REF. PT.

b. The base line and reference point or points can be related to each other by taking compass cuts from known positions along the base line, or by a range and bearing to the reference point from a known position on the base line.

NOTE: For a reference point, try to choose some prominent natural terrain feature (mountain, river mouth, etc.) that may be found on Hydrographic Office (H.O.) reference charts or maps that were used in locating and setting up the beach position. The reference point will be named in the legend. If there is absolutely no feature available, the LF or RF will be used for a reference point.

11. **Draw in Beach Profiles.**

a. A minimum of three profiles is desired. They will show bottom conditions opposite the part of the beach for which they are drawn.

b. They will be labeled in order from LF to RF; A-A', B-B', C-C', etc. In selecting a lane to profile, try to choose one that illustrates average bottom conditions in the beach area it represents.

c. Profiles will be drawn to a horizontal scale of 1:1,800 (1 in = 50 yd) with the yard scale printed under each separate profile enclosure. They will be drawn to a vertical scale of 1 in = 10 ft with the foot scale printed vertically, in 2/3 ft increments, to the left of each separate profile enclosure (label each scale).

d. The area of the chart shown in profile will be indicated by a broken line (the break in the line will normally extend from the HWL or Water Line (inland lake) to the maximum sounding depth; however, it will start below the HWL if there is more than 50 yards of foreshore) labeled at its upper end with the letters A, B, or C and the lower end with the symbols A', B', or C'.

e. The outside dimensions of the three profile enclosures will be governed by the size of the largest one. They will be of equal length and height on the complete chart and will be drawn to the next longest 50 yd.

The length of the largest profile enclosure will be determined by the length of the longest of the three nearshore gradient lines.

If the terminate point of the nearshore gradient line falls on a mark 205 yd to the right of Datum (0 point), the profile enclosure will extend to the 250 yd mark. Profile enclosures will always be drawn to an even 50 yd mark. If the terminate point falls on the 195 or 200 yd mark, then the enclosure will be 200 yd long. PROVIDED - neither of the other two nearshore profile lines exceeds 200 yd in length.

f. Foreshore profiles will show all of the foreshore if there is 50 yd or less and at least 50 yd if the foreshore is greater than 50 yd.

g. The nearshore profile will be drawn in from the Datum (0 point) to the maximum sounding mark as determined from the vertical scale to the left of each profile enclosure.

It will not be drawn in the profile enclosure until the corrected soundings have all been printed in on the chart.

The nearshore profile line will be drawn in a series of french curves.

h. The foreshore profiles will be drawn in from the Datum (0 point) to the HWL provided the distance between these two points is not greater than 50 yd. If the distance between them is greater than 50 yd, the foreshore profile line will terminate at the left border line of the profile enclosure.

The distance between the Datum and HWL is determined by actual measurement of the distance between the two lines already plotted on the chart. This is done in the following manner:

a) Starting at "0" Datum, move left on a horizontal plane until the actual, measured distance to the HWL is reached, even if you have to travel beyond the left border of the profile enclosure.

b) When the HWL is reached, move upward vertically until the height of the Diurnal Tide Range (shown in the Tide Tables for the reference station used to obtain correction) is reached and make a mark.

c) Place a straightedge connecting the mark at the tide range and the "0" point Datum inside the enclosure. If the mark is on or inside the left border of the enclosure, draw a solid line connecting the two points. If the mark is to the left of the left border of the enclosure (as in the case of a foreshore distance greater than 50 yd), draw a solid line starting at the left border and terminating at the "0" point Datum.

The HWL will be drawn in by drawing a solid, horizontal line across the profile enclosure on the Diurnal Tide Range Level.

If the foreshore distance is greater than 50 yd or exactly 50 yd in length, it will terminate at both enclosure borders.

If the distance is less than 50 yd, the line will start at the mark made when plotting the foreshore gradient and be drawn to the right border of the enclosure and drawn down to the bottom enclosure.

12. **Print in Each Gradient.** The foreshore gradient figure will be printed in the foreshore area of the chart just beneath the lowest part of the upper profile indicator lines.

The correct figure is determined from the foreshore plot already made in the profile enclosures:

<u>SAMPLE BEACH GRADIENT PROBLEM</u>

Distance from "0" point to HWL = 40 yards
Distance up to Diurnal Tide Level = 6 feet

a. Change horizontal distance to feet. Answer: 120 ft
b. Divide height of Diurnal Tide Level into horizontal distance. Answer: 20 ft
c. Foreshore rises toward Diurnal Tide Level 1 ft every 20 ft. Foreshore Gradient - 1:20

13. **Place North Arrows.** True and magnetic north arrows are required. The true north'line will be topped with a star and the magnetic north line will be topped with a half arrow. The variation information may be printed at the apex of the north arrows (taken from reference chart). The annual increase or decrease will not be put on the chart.

The north arrows are drawn in at angles that are properly related to each other and to the base line.

The north arrows are drawn in on chart center directly above the graphic bar scale and between the legend and area inset enclosures, when space and symmetry permit.

Variation between true north and magnetic north will be brought up-to-date. Variation should be taken from reference chart if it is to be put on the chart.

14. **Draw in the Graphic Bar Scale.** A graphic bar scale is drawn on the chart center just above the lower margin line.

Printed above the bar scale will appear:

"Scale 1:900" (or whatever scale is used).

Printed under the bar scale will be the word "Yards" to indicate the increments, which have a separate scale included adjacent to the profile enclosures.

A graphic bar scale is used on charts to provide an accurate scale, even if the chart has been reduced or enlarged for operational purposes.

"When working with gradients - work in like terms."

15. **Draw in Area Inset.** The area inset is a 4 in x 4 in actual tracing of an appropriate section of the reference chart or map.

It will include some prominent features, a true north arrow (oriented due north - straight up and down), a small arrow pointing to the center of the beach where the survey took place or to a flank (label arrow LF or RF accordingly), and if practicable, the reference point shown on the chart. Outside and under the lower right hand corner will be printed the number of the reference chart from which the tracing was made. If it was drawn without the use of an H.O. chart, the words "not to scale" will be outside and under the lower right hand corner.

16. **Print in Bottom Type.** In various representative areas of the chart, Nearshore, Foreshore, and Backshore, print in the type bottom found at that spot, e.g., sand, rock, lava, mud, gravel, etc. Bottom type symbols may be abbreviated.

17. **Draw in Legend.** The legend enclosure will be in the lower right hand corner of the chart whenever practical and will include all of the following information:

a. Beach name and general location
b. Reference chart
c. Reference point
d. Geographic/grid coordinates of the reference point (or the coordinates of some other identifiable point if reference point is not on the chart).
e. Organization and personnel conducting survey
f. Date
g. Datum plane and units in which soundings are expressed (preferably feet)
h. Person drawn by
i. Person checked by
j. An evaluation of the accuracy of the chart (Good, Fair, or Poor)
k. Symbols (as necessary)

NOTE: Examples of completed nearshore survey charts are included in Appendix V. A classroom exercise in chart preparation is included in Appendix IV.

REFERENCES

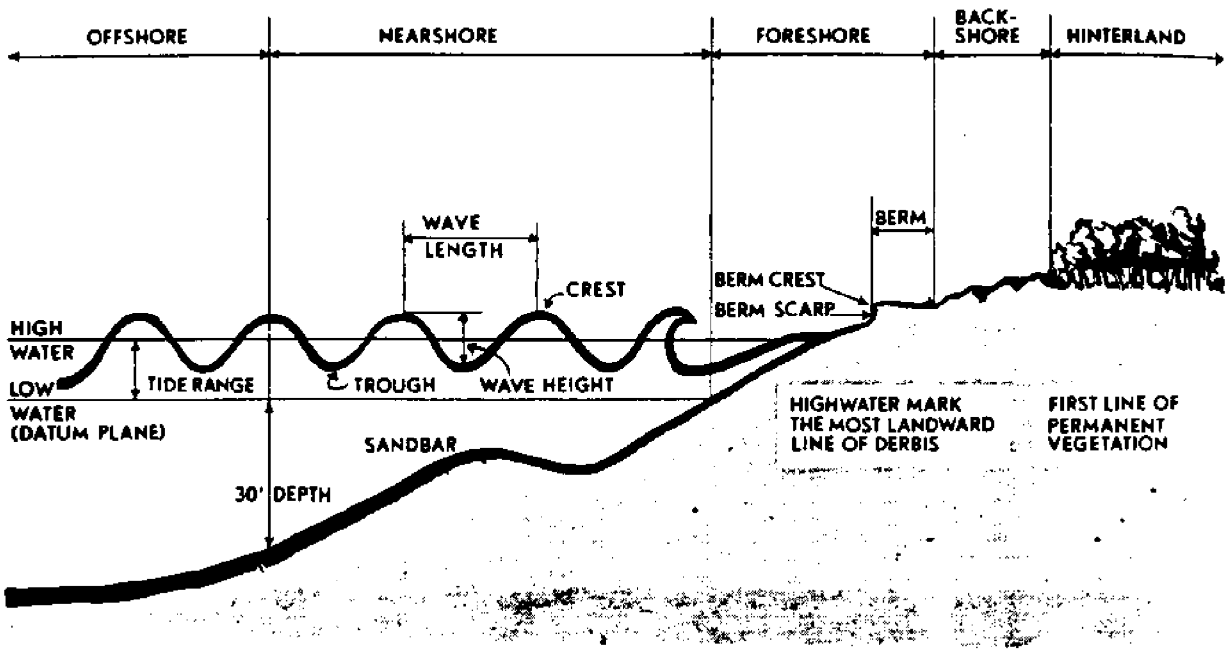
1. Dunne, T. (ed.), Underwater Demolition Team Handbook (San Diego: Naval Operations Support Group, Pacific, 1965).

2. Brereton, R. (ed.), The Naval Special Warfare Training Handbook: U.S. Navy Seal Combat Manual (Millington, TN: Naval Technical Training Center, 1974).

NOTES:

APPENDIX I: TERMINOLOGY

BEACH TERMINOLOGY



Beach and Nearshore Profile

awash. The condition of being exposed at any stage of the tide between high water and the chart datum.

backrush. The seaward return of the water following the uprush of the waves.

backshore. The area between the high water line and the line of first permanent vegetation.

bar. See sand bar.

beach. A strip of sand, pebbles, or other unconsolidated material extending from the mean lower low water (MLLW) line inland to the line of first permanent vegetation. Beaches are comprised of a foreshore and a backshore. There are two main types of beaches: straight and curved. There are two types of curved beaches: convex and concave.

beach exit. Any artificial or natural feature of the terrain that may be used for the movement of personnel and vehicles from the beach to the coastal terrain.

beach firmness. The ability of the beach to support weight for traffic and movement.

beach flanks. Imaginary boundaries of any beach. Every beach has a left and right flank (labeled as viewed from seaward).

beach gradient. The slope of the beach expressed as a ratio. When working with gradients, work in like terms:

FLAT	less than 1:120
MILD	1:120 to 1:60
GENTLE	1:60 to 1:30
MODERATE	1:30 to 1:15
STEEP	More than 1:15

beach length. The length along the beach at the water's edge at high water and/or low water between the ends of the beach. Usable beach length is the overall length minus any unusable parts; that is, separated or obstructed portions.

beach profile. A graphic representation of a cross section of a beach at right angles to the shoreline at a given point indicating the widths and gradients of the foreshore and backshore as well as the nearshore underwater gradients.

beach swale. An elongated depression in the foreshore or backshore or behind the beach, generally paralleling the shoreline and formed by wave action. Swales separate beach ridges.

beach width. The horizontal dimensions of the beach measured at right angles to the shoreline from the line of extreme low water inland to the landward limit of the beach (the coastline).

berm. An almost horizontal portion of the beach formed by wave action (usually during higher than normal tides). It generally has a landward slope. The composition is usually softer and more loosely packed than the rest of the backshore. Two important features are the berm crest and the berm scarp.

berm crest. The peak of the berm at the top of the scarp.

berm scarp. The vertical wall on the seaward side of the berm, and may vary in height from a few inches to several feet.

bottom sediments. Unconsolidated material such as sand, clay, gravel, mud, ooze, pebbles, rock, shell, and shingle that covers the bottom of an ocean or other body of water.

breaker. A wave breaking on the shore, over a reef, etc. Breakers may be roughly classified into three kinds (defined below), although there is much overlap.

breaker height. The vertical distance from the top of the wave crest at breaking to the trough line. (The trough line is essentially at the same elevation as the trough immediately preceding the breaking crest.)

breaker, plunging. The wave crest advances so much faster than the base of the wave that it falls into the trough of the preceding wave with a violent action. The resulting foam appears almost instantly over the complete front. At times, air is caught in the breaker as it tumbles downward.

breaker, spilling. The wave becomes unstable at the crest and forms white water at the crest. The white water (foam) expands slowly down the front face of the breaker. The breaking action is mild.

breaker, surging. The wave crest tends to advance faster than the base of the wave, suggesting the formation of a plunging breaker. However, just before breaking completely, the wave base advances faster than the crest, the plunging is arrested, and it surges up on the beach as a wall of water.

chart datum. The plane or level to which soundings on a chart are referred. It usually corresponds to a low water stage of the tide. Also the intersection of a given parallel and meridian to which horizontal positions are referred; commonly the Equator and the meridian of Greenwich.

coastline. The line separating the backshore part of the beach from the coastal terrain; the landward limit of ordinary storm waves. It may be marked by a change to a belt of old beach deposits and dunes more or less stabilized by permanent vegetation or by wave-cut cliffs and an immediate change to land forms and vegetation characteristic of the interior.

current. A horizontal movement of water. There are four types of currents: TIDAL: caused by change of tide. WIND: caused by local winds. LITTORAL: moves parallel to the beach and caused by quartering surf. RIP: narrow current running seaward through surf zone. Usually an escape for littoral currents.

cusps. A hydrographic feature usually occurring on a single beach and having the appearance of a succession of semicircles of equal size. They vary in length from about 20 to 30 feet to over 100 feet and in vertical depth from one-to-two feet.

drift. Speed (generally, in knots) with which a current moves.

fathom. The common unit of depth in the ocean for countries using the English system of units, equal to 6 feet (1.83 meters).

firm beach. A beach which will support the weight of personnel and vehicles and allow their movements without special equipment or aids.

flank. The right or left side, when facing in the direction of the objective or viewed from seaward; normally identified by compass bearings.

foreshore. The area between the high water line (HWL) and the mean lower low water (MLLW) line.

gradient. The slope or inclination of a line of surface as compared to the horizontal, usually expressed as a ratio.

highwater line. (HWL.) The line of debris formed at the maximum height reached by each rising tide.

hinterland. The area landward from the line of first permanent vegetation.

nearshore. The area between mean lower low water (MLLW) line and the five fathom curve.

offshore. The area seaward of the five fathom curve.

ripple marks. Small, fairly regular ridges in the sand or silt. As their form is normal, or perpendicular, to the direction of wind and/or current , they indicate both the presence and the direction of winds and/or currents.

runnell. An elongated shallow depression formed by waves and/or tidal action in the foreshore and usually filled with water. Generally parallel to the shoreline.

sand bar. An underwater mound of sand formed by water currents.

sand dune. A hill or mound of windblown sand which may or may not have vegetation on top. A dune is always shifting because of wind action.

sea, state of. Description of the sea surface with regard to wave characteristics:

CODE	DESCRIPTION	WAVE HEIGHT (FT)
0	Calm	0
1	Smooth	Less than 1
2	Slight	1 to 3
3	Moderate	3 to 5
4	Rough	5 to 8
5	Very rough	8 to 12
6	High	12 to 20
7	Very high	20 to 40
8	Mountainous	40 and over

shoreline. The intersection of a specified plane of water with the shore.

soft beach. A beach which will support personnel and equipment, but which, because of the unconsolidated character of the beach materials or the presence of mud or marsh, will require the use of special vehicles for vehicular movement.

set. Direction in which current moves.

surf zone. The more or less continuous belt of breakers along a shore or over an obstruction such as a shoal or reef; the area between the outermost breakers and the limit of wave up-rush.

trough. The lowest point between two waves.

water line. The point where the water touches the beach. Changes with every breaker.

wave crest. The highest part of a wave. Also that part of the wave above still-water level.

wave direction. The direction from which a wave approaches.

wave height. The vertical distance between a wave crest and the preceding trough.

wave length. The horizontal distance between corresponding points on two successive waves measured perpendicularly to the crest.

wave period. The time for a wave crest to traverse a distance equal to one wavelength; the time for two successive wave crests to pass a fixed point.

wave uprush. The rush of water onto the beach following the breaking of a wave.

TIDE TERMINOLOGY

charted depth. Water depth as measured from Datum.

current. A horizontal movement of water.

datum. The standardized plane from which water depth is measured.

depth. The actual water level, which equals charted depth plus height of the tide at that time.

diurnal tides. See Tide, Diurnal.

drift. The velocity in knots that the current is moving.

drift of current. The velocity of a current expressed in knots.

ebb current. The horizontal motion of water away from land or down a tidal stream, during ebbing tide.

flood current. Current when the rising tide causes water motion toward the land or up a tidal stream.

half tide level. The plane midway between mean high and mean low water.

high water. (High Tide.) The highest level reached by an ascending tide.

littoral current. A movement of water close to and parallel to the shoreline (generally wave-induced).

low water. (Low Tide.) The minimum level reached by a descending tide.

lower low water. The lower of two low tides in any one day.

lunar day. Time reckoned by the passage of the moon around the earth. (Usually 24 hours and 50 minutes, as it takes this long for the moon to make one complete revolution.) (See Solar Day.)

mean high water. (MHW.) The average height of high waters measured over a long period of time.

mean low water. (MLW.) The average height of all low tides. (This is the reference datum used for Atlantic and Gulf Coasts of U.S.)

mean low water spring. The average height of the low water at spring tides. (Most British admiralty charts use mean low water spring.)

mean lower low water. (MLLW.) The average of the lower of the two daily tides, measured over a 19 year period. (This is the reference datum used for the Pacific Coast of U.S., Hawaiian Islands, Philippines and Alaska.)

mean sea level. Average level of the ocean.

mixed tides. See Tide, Mixed.

neap tides. See Tides, Neap.

ocean current. A movement of water which is more or less permanent in its characteristics, such as the Gulf Stream.

range of tide. Ordinarily, the difference in height between mean high water and mean low water; less commonly, the difference in height between any given high water and the preceding or following low water.

reference stations. Some principal ports and points, listed in Table 1 of the U.S. National Ocean Service Tide and Current Tables.

rip current. (Rip Surf.) A narrow current of water flowing seaward through the breaker zone.

secondary stations. These are contained in Table 2 of the Tide and Current Table and consist of most of the ports and points that are not listed in Table 1.

set of current. Direction toward which current moves.

slack water. The state of a tidal current when its velocity is near zero. The term is also applied to the entire period of low velocity near the time of turning of the current when it is too weak to be of any practical importance in navigation. (See Stand.)

solar day. Time reckoned by the passage of the sun around the earth. Usually 24 hours is considered to be one solar day. (See Lunar Day)

spring tides. See Tides, Spring.

stand. A brief period at high or low water during which there is no change in the water level. (See Slack Water.)

subordinate station. See Secondary Station.

tidal current. The horizontal movement of water caused indirectly by the tide-producing forces.

tidal period. The time interval between two consecutive like phases of the tide.

tide. The periodic rise and fall of sea water which results from the gravitational attraction of the moon and sun acting upon the rotating earth.

tide, diurnal. The condition wherein there is only a single high and a single low water each tidal day.

tide, high. (1) High Water (HW), the maximum height reached by a rising tide. (2) Higher High Water (HHW), the higher of the two high waters of any semidiurnal tidal day.

tide, low. (1) Low Water (LW), the minimum height reached by a falling tide. (2) Lower Low Water (LLW), the lower of the two low waters of any semidiurnal tidal day.

tide, mixed. The condition wherein the tides are usually semidiurnal but occasionally are diurnal. The high water and/or low water height differ greatly in an area experiencing mixed tides.

tide, neap. A term applied to tides of decreased range (lower highs and higher lows) occurring semi-monthly when the moon is in the first and last quarters, as a result of the tide-producing forces of the sun and moon acting in opposition to each other. (See Tides, Spring.)

tide, semidiurnal. The condition wherein there are two high and two low waters each tidal day with relatively small inequalities in the high and low water heights.

tide, set of. The direction towards which a tidal current flows given in compass points, or preferably, in degrees.

tide, spring. A term applied to tides of increased range (higher and lower than average) occurring semi-monthly when the moon is new and full as a result of the tide-producing forces of the sun and moon acting in conjunction with each other. (See Tides, Neap.)

wind current. A movement of water produced in the open sea by local, impermanent winds.

APPENDIX II: USING TIDE AND TIDAL CURRENT TABLES

TIDE TABLES

Following is the method used to obtain the condition of the tide at a particular place and time, using the current edition of the Tide Tables published by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service:

1. Enter Table 1 (Daily Tidal Predictions) for the base station and obtain the predicted high and low water, one of which is before and the other after the desired time (or one hour before the desired time, if on Daylight Saving Time).

2. Enter Table 2 (Tidal Differences and Other Constants) for the substation, and find and apply the proper corrections to the information obtained from Table 1. Calculate:

   a. The DURATION of the rise (or fall). That is, the time difference between the high and low tides.

   b. The RANGE of the rise (or fall). That is, the height difference between the high and the low tides.

   c. The TIME ELAPSED between the desired time and the time of the nearest high or low tide.

3. Enter Table 3 (Height of Tide at Any Time) as follows:

   a. In the section labeled "Time from the Nearest High Water or Low Water" enter the left hand-column at the number which most nearly agrees with the DURATION found above.

   b. Reading across that horizontal line, find the time which most nearly agrees with the TIME ELAPSED found in 2.c. above.

   c. Read down that column into the "Correction to Height" Section directly below. The CORRECTION sought is in that column and on a line with the RANGE of tide calculated in 2.b. above. (Found in the left-hand column).

4. Apply the correction:

   a. When the NEAREST tide (used in 2.c. above) is high water, subtract the correction.

b. When the NEAREST tide (used in 2.c. above) is low water, ADD the CORRECTION.

c. The result will be the height of the tide at the time desired.

CURRENT TABLES

Following is the method used to obtain the condition of the current at a particular place and time using the current edition of the Tidal Current Tables published by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service.

1. Enter Table 1 (Daily Current Predictions) and obtain the predicted slack water and maximum current time and VELOCITY.

   One is before and the other after the desired time (or one hour before the desired time, if on Daylight Saving Time).

2. Enter Table 2 (Current Differences and Other Constants and Rotary Tidal Currents) and find and apply the proper correction to the figures obtained from Table 1. Calculate:

   a. The TIME INTERVAL between slack and maximum current.

   b. The TIME INTERVAL between slack current and the desired time.

3. Enter Table 2.

   a. Enter at the top at the figure which most nearly agrees with the INTERVAL obtained in 2.a. above.

   b. Read that column down to the CORRECTION which is on a line with the TIME INTERVAL calculated in 2.b. above (found in the left hand column).

   c. Multiply the maximum current VELOCITY obtained in 1. above. The result will be the velocity of the current at the time desired.

Table 4, (Duration of Slack) when used in conjunction with Tables 1 and 2, is very useful for determining periods during which swimmers will not be greatly affected by the current.

Tide Tables, Tidal Current Tables, Tidal Current Charts, United States Coast Pilots, Distance Tables, and Nautical Charts are for sale by the National Ocean Service, Rockville, MD 20852. A list of other sales agents appears semiannually in the Notice to Mariners, published weekly by the Defense Mapping Agency Hydrographic Center or may be obtained on request from the National Ocean Service.

NOTES:

APPENDIX III

(Date of Report)

NEARSHORE SURVEY REPORT FORMAT

Note: Use applicable phrases shown in parenthesis.

(Survey Team)(Other): Survey Report of (name assigned to beach)

Date and Time of Survey: ______________________

Reference(s): (H.O.)(L.S.)(Other) Chart________(Scale 1:_______)

Special Map No.________________(Scale 1:_______)

Photographs (ground) attached______________ Other______________

Location: (Left flank) (Right flank) (Center)

Latitude______________ Longitude______________

(Beach, Lake, County, State)______________________

____

Reference Point:

Latitude______________ Longitude______________

Introduction. Include type of reconnaissance; i.e., swimmer (surface, submerged, line controlled, administrative) or other. Describe appearance and location, in relation to the beach, of the reference point (an easily identifiable semi-permanent landmark). Give method used to determine location coordinates (from chart, by navigational fix, etc.) and hinterland features (from photography, chart, or by eye and distance pacing). List other beach information such as (1) location relative to landmarks such as town, rivers and reference point; (2) the facing of the beach in degrees; (3) the shape of the beach and the length surveyed; (4) prominent features which would aid ships in locating the beach from offshore.

Offshore. Include depths, navigational hazards, bottom conditions, currents and anchorages between open sea and the five fathom curve.

Nearshore. Include conditions between the five fathom curve and the sea level datum line, such as the nature of the bottom, underwater obstacles (natural and artificial), depths and gradients tabulated as follows from the three fathom curve to the datum line:

Average distance from datum line to 1 fathom curve:________yards

Average distance from 1 fathom curve to 2 fathom curve:_____yards

Average distance from 2 fathom curve to 3 fathom curve:_____yards

Average gradient from datum line to 1 fathom curve: 1:___________

Average gradient from 1 fathom curve to 2 fathom curve: 1:_______

Average gradient from 2 fathom curve to 3 fathom curve: 1:_______

Average nearshore gradient (datum line to 3 fathom curve):1:_____

Winds, Tides, Currents and Surf. Describe the state of the tide, currents, surf, and wind force and direction at the time of the survey.

Foreshore. Give the length of the beach, the length of the usable portion(s), the width of the foreshore measured from the datum line to the upper limit of normal wave action, the composition of the beach and the foreshore gradient. Give an estimate of trafficability in terms of foot trafficability (running and walking) and the type of wheeled/tracked vehicles that can be supported. Use available clues such as vehicle tracks and heel prints; state what made them and give their depths. Locate and describe obstacles on the foreshore and exits to the backshore.

Backshore. Give length, width and gradient. Include the height and continuity of berm scarp, sand dunes, and cliffs. Indicate the composition of the backshore and make a trafficability estimate. Describe exits from the beach and into the hinterland including information on bridge and road capacities, etc.

Hinterland. Give a succinct description of the terrain behind the beach, including mention of such factors as slope, vegetation, drainage, habitation, roads, obstacles, installations and other significant features. Locate and describe possible helicopter landing sites.

APPENDIX IV

NEARSHORE BOTTOM SURVEY

CLASSROOM EXERCISE

INTRODUCTION

This exercise illustrates a nearshore bottom survey method utilized to gather relatively accurate data with minimum logistic support, cost and personnel. Although the data and location given are hypothetical, the exercise is a practical field technique.

The situation is based on the need for knowledge of the effects on bottom topography of dumping large quantities of fine sand **on the beach** several weeks prior. The distribution of dumped sand must also be determined.

HOMEWORK

1. Using the data provided, lay out and draw a field survey chart. Follow procedures given in "Preparation of Survey Chart" and by instructor.

2. Complete cross-sections for survey lines 1, 8 and 16.

3. On the right flank of the survey area, estimate the depth of "fine sand."

4. Outline and label the sediment distributions on the chart with a light dashed line.

5. Sketch the probable real bottom on the right flank profile (cross-section).

6. In one well organized paragraph, discuss the geologic nature of the bottom in the survey area, the implications of the sand dumping on the beach, the probable current conditions (direction) in the area.

NEARSHORE BOTTOM SURVEY DATA*

Location: Lake Michigan, Van Buren County, 4.8 miles south of South Haven, Michigan, northern flank of survey area: intersection of Cherry Lane access road with beach.

Purpose: Determine effects of dumping of large quantities of sand on beach at southern end of survey area.

Date: 19 July 1980 and 20 July 1980

Investigators: J. Jones, J. Pitt, T. Lee

Bottom Topography Data:

Distance Offshore (Yards)	Survey Line No. (Soundings in Feet)							
	1	2	3	4	5	6	7	8
5	2	1.5	1	2	-	1	1.5	1
10	1	1	1	2	1	1	1.5	1
15	2.5	2.5	2	2	0.5	0.5	2	1
20	3	2.5	2.5	2.5	1.5	2	2	1.5
25	3	3	3	2.5	2.5	2	2	1.5
30	4	3.5	4	3	2.5	3	3	2
35	3.5	4	4.5	5	3	3.5	3.5	2.5
40	5	3	7	7	5	4.5	4	3
45	7	7	8	8	7	6	5	5
50	9	9	9	8.5	8	7	6.5	6
60	11.5	12	11	10	10.5	10	8.5	8
70	13	13	12.5	12	12	11	10	10
80	13	14	13	13	12.5	12	11	10.5
90	14	14.5	13.5	14	13	13	12.5	11
100	15	15	15	14.5	14	14	13	12
110	16	16.5	16	15	15	15	14	13
120	17	17	17	16.5	16	16	15.5	14.5
130	17.5	17	17	17	16.5	16.5	16	14
140	18	18	18	18	17	17	16	15
150	19	18.5	18.5	18.5	18	17.5	17	17
160	19	19	19	19	19	18	18	18
170	20	20	20	19.5	19.5	19	19	18.5
180	21	20	20	20	20	19	19.5	18.5
190	20	20.5	21	20	20	20	20	19
200	20.5	20.5	20.5	20.5	20.5	20	20	19.5

*Hypothetical location and data.

Distance Offshore (Yards)	Survey Line No. (Soundings in Feet)							
	9	10	11	12	13	14	15	16
5	0.5	-	-	-	-	-	-	-
10	0.5	0.5	-	-	-	-	-	-
15	0.5	0.5	1	-	-	-	-	-
20	0.75	1	1	0.5	0.5	0.25	0.5	0.5
25	1	1	1.5	1	0.5	0.5	1	1
30	1.5	1	1.5	1	0.5	1	1	1
35	2	1.5	2	1.5	1	1	1.5	1.5
40	3	2	2	2.5	1	2	2	2
45	4	3	3	3	2	2.5	2.5	2.5
50	5.5	4.5	4	3.5	3	3	3	3
60	7	6	5	5	4.5	5	4	4
70	9	8	7.5	7	6.5	6.5	5	6
80	10	8	8	8	7	7	5	6
90	11	10	9	9	8	8	5.5	4.5
100	11.5	11	10	9.5	9	8	6.5	5
110	13	12	11	11	11	10	7	6.5
120	14	13	12.5	12	12	11	9	8
130	15	13.5	13	13	12.5	12	10.5	9
140	16	14	14	14	13	13	12	10
150	16	15	15	15.5	14	14	13	12
160	17	16	16	16	15	15	14	13
170	18	18	17	17	17	16	15	14
180	18.5	18.5	18	17.5	18	17	15	15
190	19	19	18.5	18	18	18	17	16
200	19.5	19	19	18.5	19	18.5	17.5	17

NOTES:

Bottom Sediment Data:

Distance Offshore (Yards)	Survey Line No. 1	2	3	4	5	6	7	8
5	M/S	M/S	M/S	F/S	-	F/S	F/S	F/S
25	M/S	M/S	M/S	M/S	M/S	M/S	F/S	F/S
50	G	G	M/S	G	T	M/S	F/S	F/S
70	T	G	T	G	C/S	C/S	F/S	F/S
100	C/S	C/S	G	C/S	T	G	G	C/S
150	C/S	S/S	C/S	C/S	S/S	T	T	T
200	S/S	S/S	S/S	S/S	S/S	S/S	S/S	S/S

Distance Offshore (Yards)	9	10	11	12	13	14	15	16
5	F/S	F/S	-	-	-	-	-	-
25	F/S	F/S	F/S	F/S	F/S	F/S	F/S	F/S
50	F/S	F/S	F/S	F/S	F/S	F/S	F/S	F/S
70	F/S	F/S	F/S	F/S	F/S	F/S	F/S	F/S
100	F/S	C/S	C/S	F/S	F/S	F/S	F/S	F/S
150	G	T	G	F/S	F/S	F/S	F/S	F/S
200	S/S	S/S	C/S	C/S	F/S	F/S	F/S	F/S

Symbols:

F/S = Fine Sand
C/S = Coarse Sand
G = Gravel
M/S = Medium Sand
S/S = Silty Sand
T = Till

NOTES:

FIELD NOTE: COOK BEACH SITE

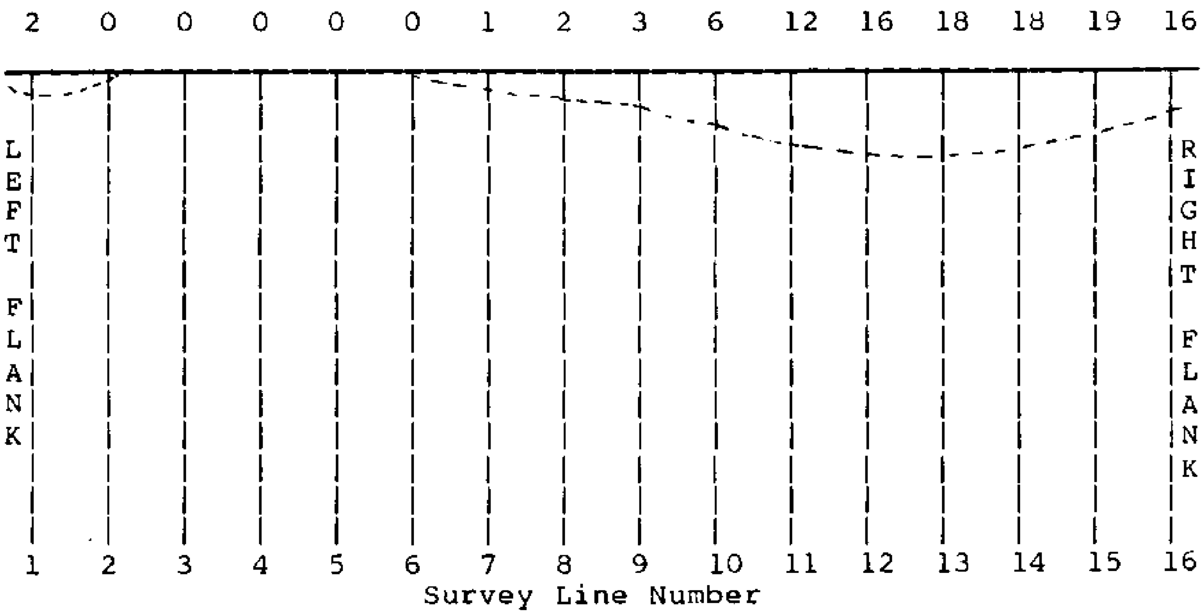
Date: July 19-20, 1972

Baseline Bearing: 0° Magnetic

RAB Bearing: 270° Magnetic

Reference: U. S. Lake Chart No. 75

Distance from baseline to water in yards (water line = dashed line):



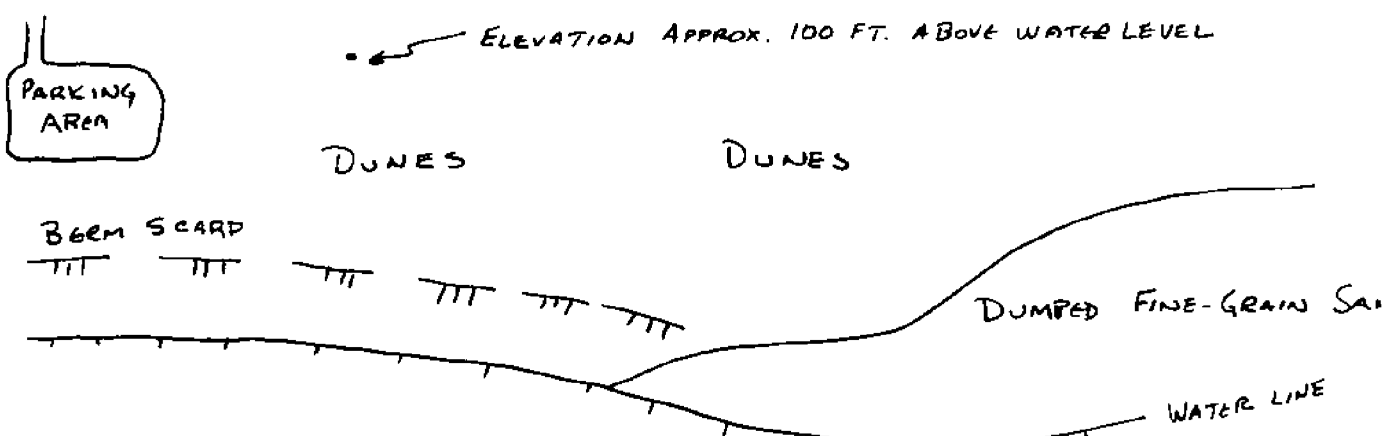
Estimated beach gradient: Line 1=1:20 Line 8=1:18 Line 16=1:10

No evident littoral current.

Sea State: 7/19 = calm; no waves 7/20 = <1 ft waves

Weather: 7/19 Clear, 78°F, light breeze
7/20 Pattly cloudy, 74°F, light breeze

Sketch Map of Beach (Not to Scale):

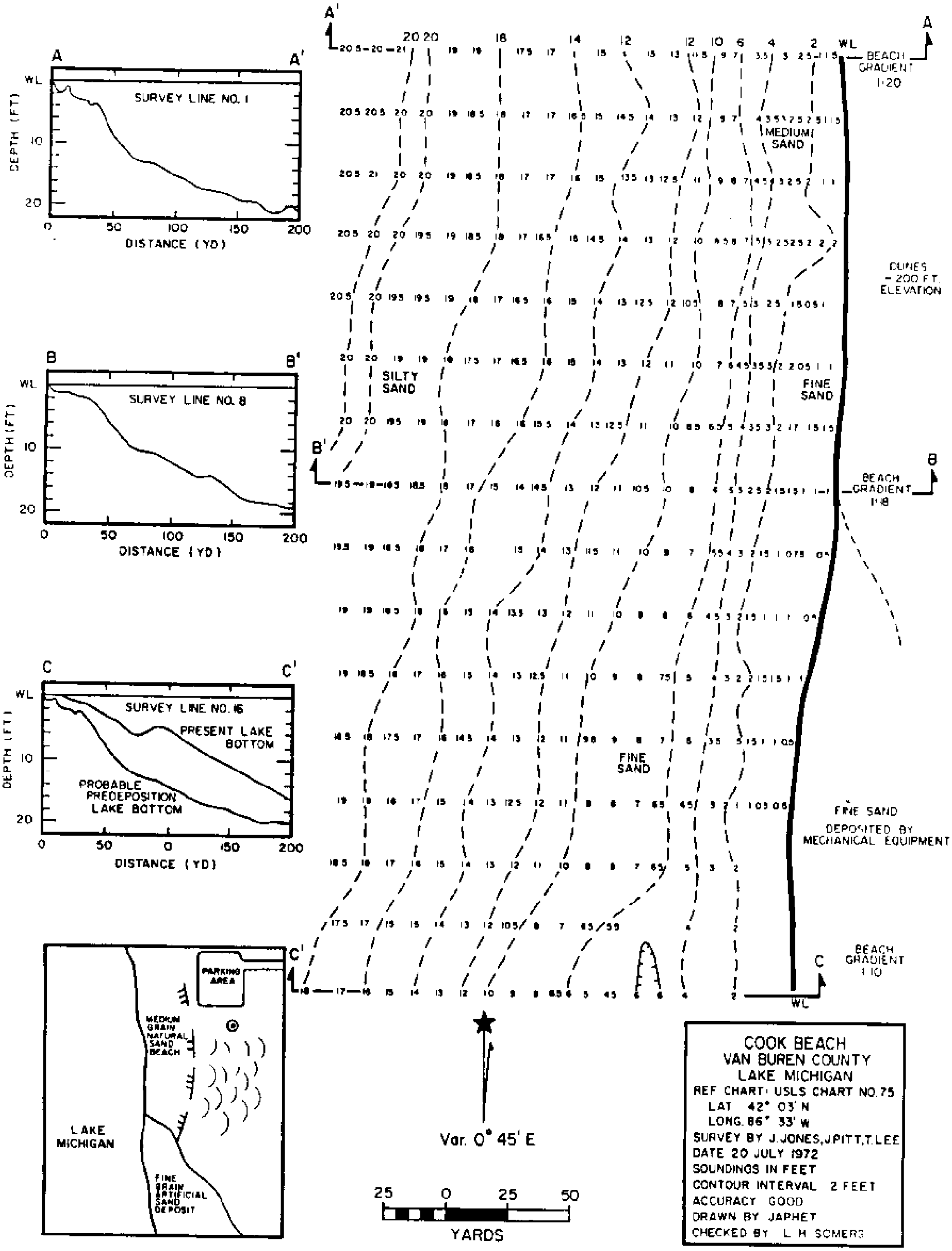


APPENDIX V

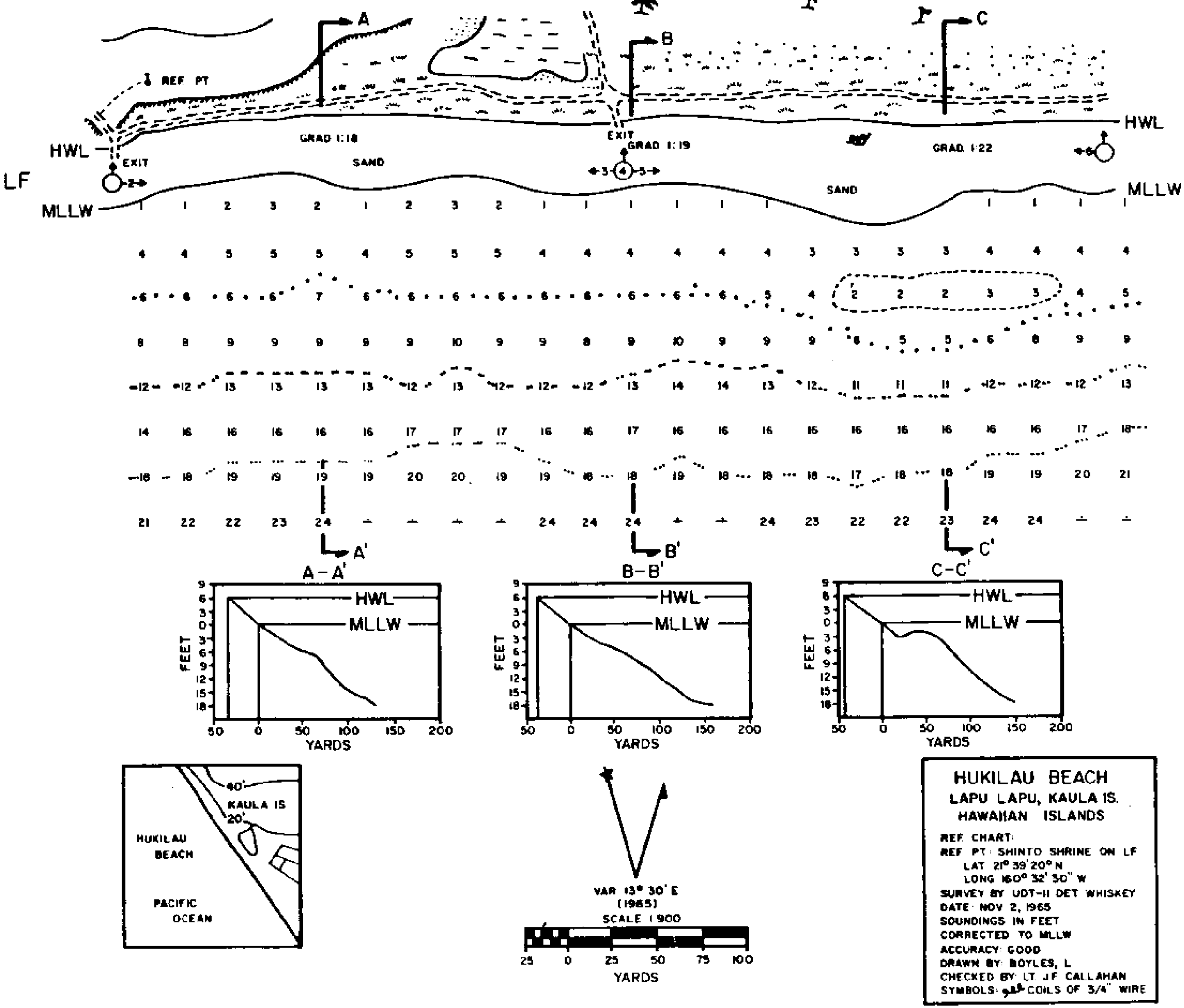
EXAMPLES OF COMPLETED FIELD SURVEY CHARTS

Cook Beach: Freshwater Lake Without Tides

Hukilau Beach: Ocean Beach With Tides



SURVEY LINE NO. 1
DEPTH (FT)
DISTANCE (YD)
SURVEY LINE NO. 8
SURVEY LINE NO. 16
PRESENT LAKE BOTTOM
PROBABLE PREDEPOSITION LAKE BOTTOM
BEACH GRADIENT 1:20
MEDIUM SAND
DUNES ~200 FT. ELEVATION
SILTY SAND
FINE SAND
BEACH GRADIENT 1:8
FINE SAND
FINE SAND DEPOSITED BY MECHANICAL EQUIPMENT
BEACH GRADIENT 1:10
PARKING AREA
MEDIUM GRAIN NATURAL SAND BEACH
LAKE MICHIGAN
FINE GRAIN ARTIFICIAL SAND DEPOSIT
Var. 0° 45' E
YARDS
COOK BEACH
VAN BUREN COUNTY
LAKE MICHIGAN
REF CHART: USLS CHART NO. 75
LAT 42° 03' N
LONG. 86° 33' W
SURVEY BY J. JONES, J. PITT, T. LEE
DATE 20 JULY 1972
SOUNDINGS IN FEET
CONTOUR INTERVAL 2 FEET
ACCURACY GOOD
DRAWN BY JAPHET
CHECKED BY L. H. SOMERS


HUKILAU BEACH
LAPU LAPU, KAULA IS.
HAWAIIAN ISLANDS
REF CHART:
REF PT: SHINTO SHRINE ON LF
LAT 21° 39' 20" N
LONG 160° 32' 30" W
SURVEY BY UDT-11 DET WHISKEY
DATE: NOV 2, 1965
SOUNDINGS IN FEET
CORRECTED TO MLLW
ACCURACY: GOOD
DRAWN BY: BOYLES, L
CHECKED BY: LT. J.F. CALLAHAN
SYMBOLS: COILS OF 3/4" WIRE
LF
RF
HWL
MLLW
REF PT
EXIT
GRAD 1:18
GRAD 1:19
GRAD 1:22
SAND
A-A'
B-B'
C-C'
FEET
YARDS
KAULA IS
HUKILAU BEACH
PACIFIC OCEAN
40'
20'
VAR 13° 30' E
(1965)
SCALE 1:900
YARDS

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