Attachment 10

A GEOTECHNICAL INVESTIGATION OF THE COASTAL BLUFFS OF ERIE COUNTY, PA.

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COASTAL ZONE MANAGEMENT

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NOTE

The report is divided into two parts because of the volume of information submitted for each site. The first part of the report includes the introduction and a summary evaluation. Also included is a summary of recession data including the volumetric losses over the period. The second section (Appendix) contains aerial photographs, ground level photographs, offshore photographs of each site for each year. Also included is information pertaining to bathymetry and a process matrix.

SECTION A

INTRODUCTION

PURPOSE OF THE REPORT

The Pennsylvania Department of Environmental Resources, Coastal Zone Management Branch is committed to providing information to the shore property owners in Erie County. Such information should include an evaluation of the shoreline with respect to geology and physiography. Given the proper information, the Coastal Zone Management staff may assist the owner in improving land management with respect to all parameters present on a particular site or on a particular reach. This report provides base line information on selected sites.

METHODOLOGY

In any survey of the characteristics of a given set of variables, three choices are open to the investigator.

1) <u>Random Survey</u>

The procedure would involve a random selection of control points based on ease of access to the site. The set of supplemental sites included as a part of this report were chosen in this manner.

Disadvantages include the inability to perceive the physical interactions taking place along more remote reaches of the shore and the loss of physiographic information that might shed light on the changing character of the shoreline.

2) <u>Problem-Oriented Survey</u>

Since major concern is expressed most often in areas where shore losses or bluff recession is most active, the temptation is great to investigate those areas exclusively.

A clouded view of shore processes is generally the result of such a survey. There is a tendency to extrapolate information gained by this method to reaches where it may not apply.

3) <u>Fixed Grid Analysis</u>

This method involves making a determination of what might constitute the best grid to adequately sample the characteristics required for proper analysis. Information pertaining to bluff characteristics was the goal of the study. Recession and erosion analysis was a highly desired addition to our understanding of shoreline phenomena.

A disadvantage of this methodology is that some sites falling within a grid may provide certain constraints to investigation. These constraints include: difficulty of access, vegetation obscured slopes, slopes covered by eroded material from above, or reluctance of the property owner to permit access to field investigators.

The above was chosen as the framework for the site investigations.

A one kilometer grid system was agreed upon as an interval that could best provide extrapolation of information between sites. Some discretion was used to deviate from the grid within a tolerance of 100 meters to overcome for the constraints listed above. In several cases, there was no way such constraints could be overcome by shifting the site within tolerances. Investigations of those sites were incomplete or they were abandoned entirely.

Those points (Sites 34-43) falling on the shoreline of Presque Isle Bay were not considered. These sites could provide no information useful to an examination of the effects of open lake conditions on the shoreline of Erie County. With few exceptions, this shoreline does not experience erosional or recessional losses.

Similarly, Presque Isle peninsula was excluded from the study. Heavily studied by the Army Corps of Engineers, little purpose could be served by repetition. The main goal was information on bluff characteristics; such features are absent on Presque Isle.

PROCEDURES

Each site was located on topographic maps, aerial photographs and tax maps. The owner of each property containing a control point was notified of the project and permission to conduct a site investigation solicited. In most cases, permission was obtained. There were some exceptions. For example, the Cowell property (Site 51) was excluded because of the owner's general contempt for such investigations. Since this property covers more than one kilometer of shore, no accomodation could be made for shifting the point.

Each site was visited initially to place a large flourescent marker and subsequently to conduct a pre-study of the existing conditions. The marker was critical to aerial and boat reconnaissance to enable the site to be identified from the air and from offshore.

An aerial reconnaissance was flown and a color 35mm photo was secured. The photos were uncontrolled, taken from the open window of a Cessna 172 with a hand-held 35mm camera with a 55mm lens. The photos were deliberately under-exposed by ½ to 1 f stop to compensate for scattered light. The photographs are a part of the report.

A reconnaissance was made by boat to secure a view of the bluffs from lakeward. Such a record is invaluable in providing a base line of information for conditions existing at each site. These photographs accompany the aerial photographs as a permanent record in this report.

Location of Sites

Beginning one kilometer from the Ohio-Pennsylvania border sites for bluff recession analysis were successively located one kilometer (shoreline distance) apart. The sites extend eastward to the neck of Presque Isle, across the neck to the south shore of Presque Isle Bay, and thence eastward to the Pennsylvania-New York border. At each site a representative point was established within fifty feet of the map location.

Crest Profiles

From the survey point, defined by triangulation from two references (trees or man-made structures), a segment of crest was selected. The length of the crest line was a function of visibility from the survey point and representativeness of bluff structure. The crest line was never less than twenty-five feet in length. A plane table and alidade were positioned above the survey point and horizontal distances to the crest were determined by reading stadia intervals on a range pole held at random intervals along the crest line.

Bluff Profiles

Along the crest line a point was selected from which a profile of the bluff face would be determined. From this point a rope was stretched taut to the toe of the bluff where the bluff was concave or linear and point to point in those instances where the bluff was convex. At five foot intervals along the rope vertical distances to the bluff face were measured. Slope angle was obtained from an Abney level and the bluff height determined by the sine function of this angle.

Stratigraphy and Physiography

While traversing the bluff face observations were made of stratigraphy, stratigraphic breaks, types of weathering, erosion, mass wasting, vegetative cover, ground water, and human impact.

Stratigraphic picks were made on the basis of direct observation. It is strongly urged that a fraction analysis be made of the units. This information will complete the preliminary geotechnical investigation. The sand fraction, important for beach nourishment, is the most critical. The fraction analysis used in Section C is a generalized analysis performed on bluff materials (D'Appolonia, 1978).

Supplemental Sites

To provide information on areas between grid coordinates, several sites were visited. Thirty sites for which previous direct measurements had been taken were re-measured. Such points are areas where bluff recession is a continuing problem. The recession line diagrams for these sites were submitted with the 1982 draft of this report. The recession rate information gained from the re-measurement is included in Section C.

Re-survey

The initial investigation on the primary sits began in the summer of 1981. During that field season the sites were visited several times. Observations continued until late fall. The information gained during that first field effort became the baseline for subsequent investigation.

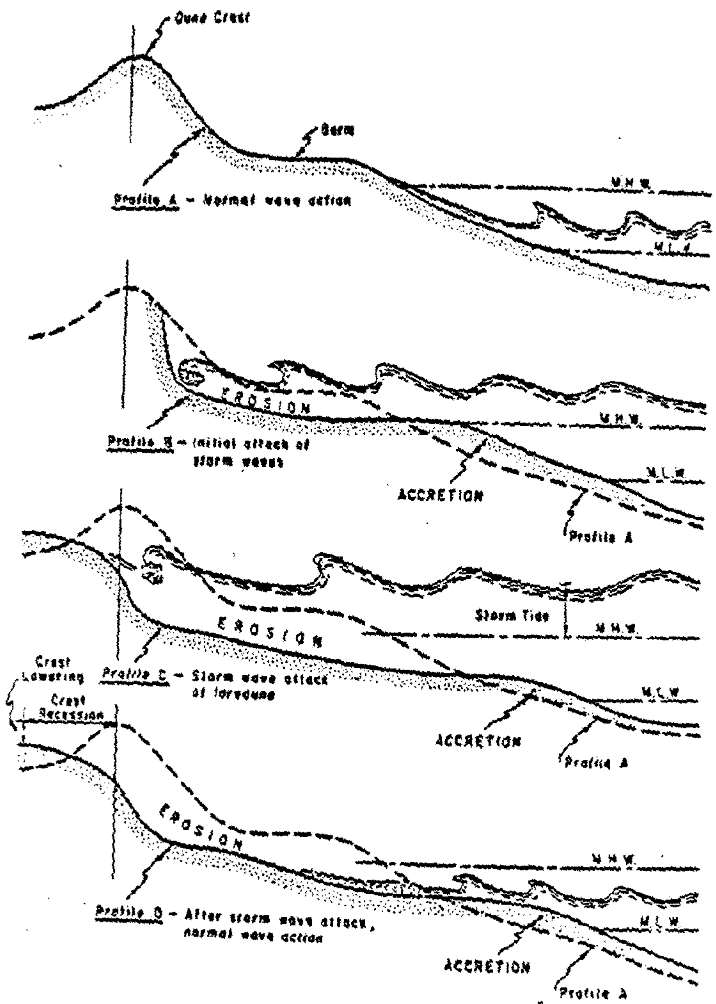
All aspects of the original investigation were repeated in 1982 and again in 1983. As a result of the comprehensive measurements taken over this time period, a clearer picture emerges of the processes of recessional retreat in a variety of stratigraphic sequences. The character of this retreat and the erosion accompanying such retreat is reviewed in the site summary section of this report.

OFFSHORE BATHYMETRY

A series of bottom profiles were obtained using a recording sonar device at each designated control point. The traverse was made shore normal over a distance of 400 yards to an average depth of twenty feet for the reach west of Presque Isle and thirty feet for the reach east of Presque Isle. The graphs obtained were transferred to a 1" equals 150' grid scale using proportional dividers. The profile lines between picks were smoothed.

Shore markers at all grid points were used to coordinate the exact position of the beginning of the profile line. The line was run at a 90° angle to the shore to maximize the accuracy of the line with respect to perceiving the influences of shore processes. The boat was operated at 1500 rpm's to maintain constant speed. At the estimated end of each run, a range finder measuring device was used to fix the position of the boat as to distance offshore. In most cases, the profile line was carried beyond the 400 yards to insure a complete profile. The extra information was recorded as part of the total profile. In some cases, the run was extended further than normal to search for changes in the offshore pattern.

Many of the profiles exhibited the normal pattern of scour and bar formation expected in near shore areas as the bottom is worked and reworked by wave conditions. (See Figure 1) Deviations from the norm are due in part to bedrock exposure be-



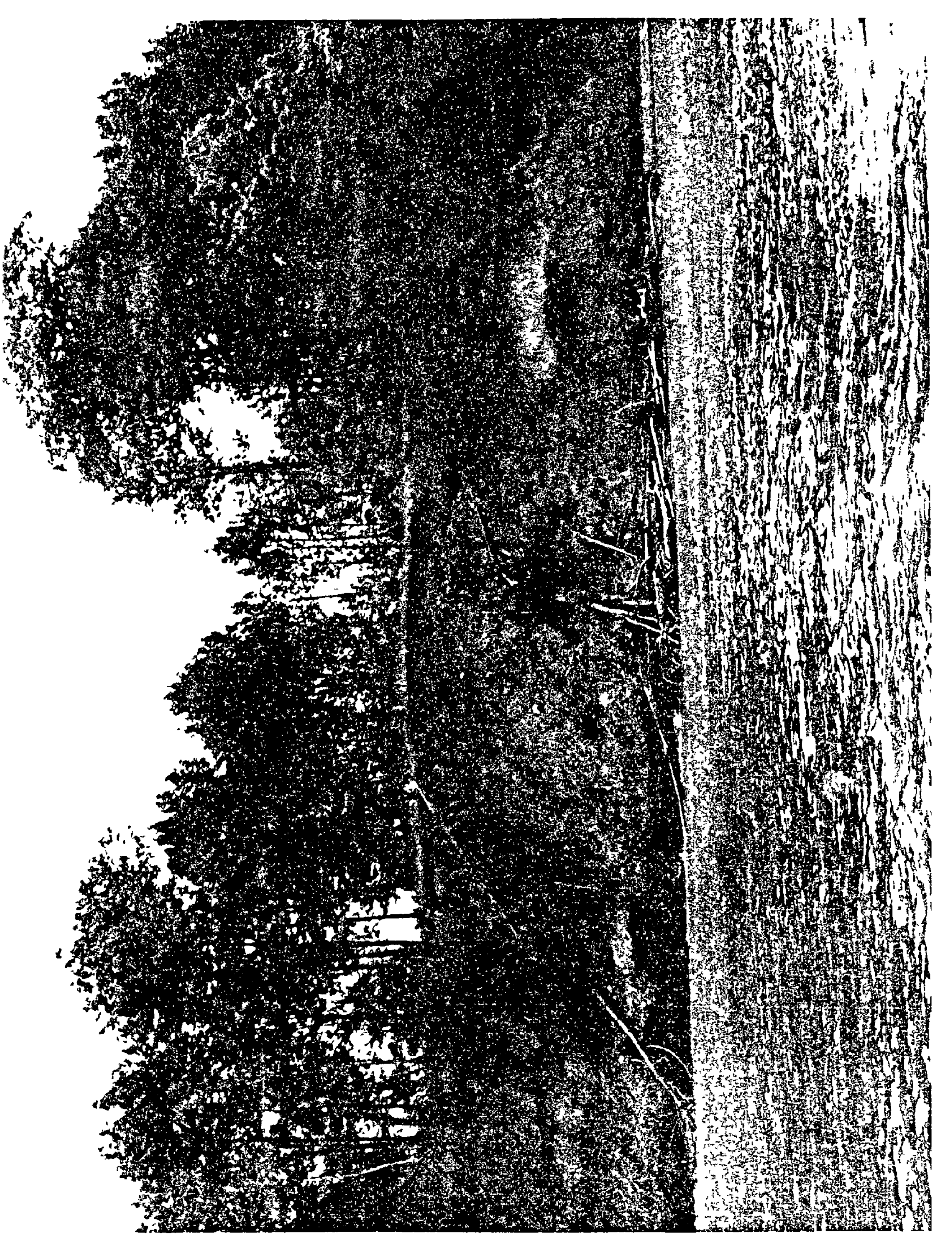
Dune Crest
Berm
M.H.W.
Profile A – Normal wave action
M.L.W.
EROSION
M.H.W.
Profile B – Initial attack of storm waves
M.L.W.
ACCRETION
Profile A
Storm Tide
M.H.W.
EROSION
Crest Lowering
Profile C – Storm wave attack of foredune
Crest Recession
M.L.W.
ACCRETION
Profile A
EROSION
M.H.W.
Profile D – After storm wave attack, normal wave action
M.L.W.
ACCRETION
Profile A

Figure 1

low the surface, the presence of shore structures, sediment deficiencies, or an abundance of sediment due to stream loading or excessive beach/bluff erosion.

An explanation of each profile is found in the relevant site section of the report.

The bathymetry was repeated in the 1982 field season. The results were disappointing. While some changes were noticed, they were not valid with respect to the methodology employed. Close control, of the type necessary to pick up minor changes in bar configuration, orientation, and location, are not possible except with sophisticated equipment including that necessary for accurate positioning. Such a methodology is expensive and beyond the scope of time and dollars available for this study.



REGIONAL GEOLOGY

Physiography

The Erie County shoreline is located in the Eastern Lake section of the Central Lowland Province. The region is north and west of the Appalachian Plateau. The escarpment marking the division between these Provinces is visible from most areas of the coastal zone.

The surface of the lowland drains north to Lake Erie, locally controlled by glacial deposits. The physiography and topography have been shaped by the geologic factors of structure, bedrock strata and Pleistocene glaciation.

Bedrock

The bedrock exposures at the base of the bluffs in the reach east of Presque Isle and locally west of Presque Isle are of the Canadaway Formation, Middle Upper Devonian in age.

The rocks are variously described as:

> Alternating brown shales and sandstones; includes "Portage" Formation of northwestern Pennsylvania (Commonwealth of Pennsylvania, 1960).
>
> Undifferentiated shales. This group underlie s the Quaternary deposits. They consist of poorly differentiated sequences of interbedded shales, claystones, siltstones and sandstones (D'Appolonia, 1978).
>
> Upper Devonian shales with interbedded siltstones...comprise the cliffs bordering Lake Erie. More resistant siltstone beds...contribute large quantities of siltstone gravel to the neighboring beaches. The shale is easily weathered by comparison and does not persist in transport (Clemens,1976).

The bedrock exposures along the base of the bluff are important in three ways. First, in areas of sand deficiency, precluding beach development, these exposures present a high initial wall to wave energy. The downward deflection of this energy removes sediment from nearshore and deposits it in forms further offshore. (See Bathymetric Discussions, Section B). Sediment that might be available under other conditions is thus denied to the longshore transport system exacerbating sand deficits. Second, as noted previously (Clemens, 1976), the eroding bedrock is an important source of supply of siltstone gravels. In addition, exposures of bedrock in the zone of breaking waves promotes "plucking" which produces shingles from a few centimeters to one meter in size. The capability of the transport system to carry those shingles great distances is seen in the amount of shingles on Presque Isle Beaches several kilometers downdrift of the nearest bedrock exposures. More massive than sand, these materials tend to remain in the nearshore providing material for beach building as they weather. Third, linear joints in the shales exposed to storm waves expand by hydraulic force to produce the incised or cuspate forms seen in the reach east of Presque Isle. On a larger scale, these incisions produce headland-cove combinations allowing pocket beaches to form in the sheltered areas. In most cases, these are the only beaches forming along the reach from the City of Erie to Six Mile Creek.

Glacial History

Continental glaciation produced several ice sheet advances into Northwestern Pennsylvania. During each advance, materials were transported from the northeast and deposited locally. These deposits consist mainly of glacial tills, an unsorted, unstratified heterogeneous mixture of clay, silt, sand, gravel and boulders. The tills on the bluffs of Erie County are typically fine-grained, reflecting the shale bedrock and lake sediment sources over which the glaciers had passed. The tills overlie the Devonian shales which were eroded prior to the deposition of the till producing an irregular surface and intermittent exposures along the shore. There are two distinct till units (an upper and a lower) found in Erie County.

After the retreat of the last glacier, a series of proglacial lakes developed in the Erie Basin. As a result, there are widespread lacustrine deposits and beach (strand) deposits over much of the lake plain and exposed on the bluff face in many locations. The lacustrine deposits are not continuous along the shore.

Major strand deposits have been mapped by various researchers. Those exposed on the bluff face are associated with proglacial Lake Warren. The characteristics of these strand deposits are discussed below.

Quaternary Units

The following units may be seen at various locations. Some or all may be present in any one section. The general listing is from oldest to youngest. A discussion of each follows the listing.

1) Glacial Till - clays and silts with associated coarser fragments, resulting from sediment deposition of Wisconsin-age glacier and containing

localized pockets of glacio-lacustrine deposits formed by deposits in small lakes or ponds

2) Lacustrine Deposits- thinly interbedded clayey silts and silty clays of proglacial lakes

3) Strand Deposits- two general units (sand and gravels and sands and silty sands) associated with previous shorelines of proglacial lakes

4) Alluvial Deposits- sandy silts and clays with variable amounts of sand and gravel and minor pockets of organic soil (resulting from deposition by creeks and streams in the area)

o Glacial Till Deposits

Previous glaciation over the area has resulted in the deposition of two tills, the upper and the lower, lying one upon the other, typically with the absence of a distinct separating horizon. Uppermost exposures of the upper till, lying beneath the topsoil and lacustrine materials, are sometimes thinly stratified, consisting of laminae of irregular thicknesses, resembling lacustrine silts and clays, but containing fine gravel and being stiffer than the lacustrine materials. This pseudo-stratified material may be an ablation till phenomenon or may have resulted from water-laid depostion of ice-rafted till.

The upper till material consists of stiff to very stiff, well bonded yellow brown to gray clayey silt to silty clay with trace amounts of coarse to fine sand, gravel and shale fragments. The lower till is quite similar in description consisting of very stiff to hard, extremely well bonded, gray clayey silt to silty clay with little coarse to fine sand, gravel and shale fragments and occasional small cobbles and boulders.

The lower till is characterized as follows:

1) It contains a small amount of coarse to medium sand in a clayey matrix and contains fine gravel and shale fragments.

2) It has a dense appearance and is resistant to gouging by knife or rock hammer.

3) It has prominent vertical relief jointing.

4) It has only a trace of coarse to medium sand, and very few gravel-sized fragments.

In outcrops where both tills are present, the jointing in the lower till can be used to differentiate the lower and upper members.

- Lacustrine Deposits

The proglacial lakes provided a means for deposition of thinly interbedded clayey silt and silty clay. These deposits are found over much of the reach but are discontinuous. There are many areas where they approach ten meters in thickness while in others they are absent entirely.

- Strand Deposits

Strand deposits are bodies of silty sand, sand and sand and gravel that represent the shorelines of proglacial lakes. These ancient shorelines manifest themselves as continuous and semi-continuous ridges of low elevation. Beach ridges representing the Lake Warren shoreline are low (less than 5.5 meters) and consist of a sand and gravel core, flanked by a band of stratified fine sand. As recession has truncated these deposits, they have become exposed more or less randomly over the study reach.

The strand deposits consist of two general categories. The coarse strand deposits are generally loose to medium compact, yellow brown to grayish brown, stratified sands and gravels with trace amounts of silt and occasionally small cobbles. The fine-grained strand depostis consist of loose to dense, brown to gray, thinly stratified fine sands, with trace amounts of medium sand and silt with occasional lenses and pockets of fine sand with traces of fine gravel.

° Alluvial Deposits (Colluvium)

Alluvial materials are a mixture of the components of all units produced as a result of stream deposition or mass wasting. They produce fill features in concave portions of the bluff and can occur as forms at the base. In several of the sites investigated, the stratigraphic sequence was obscured by an accumulation of these sediments. Typically, these deposits consist of loose to medium dense, dark brown intermixed silty clay to clayey silt with variable amounts of sand and gravel. In many cases, a vegetative cover has lent organics to the makeup of these deposits.

° Fill Material

Development of the shore zone has led to the deposition of fill at the top of the bluffs to bring sites to desired grade. In many cases, the fill appears to be related to the locally occurring constituents of the bluff. They are, of course, reworked by the process of excavation and fill. In other cases, the fill is of unknown origins, transported from off site.

From D'Appolonia, 1978

A REPRESENTATIVE SECTION ALONG THE WESTERN STUDY AREA IN THE VICINITY OF RUDD ROAD IN SPRINGFIELD TOWNSHIP REVEALS THE VARIABLE THICKNESSES OF THE VARIOUS BEDS. MISSING FROM THIS PARTICULAR SECTION ARE THE LACUSTRINE DEPOSITS SEENELSEWHERE.

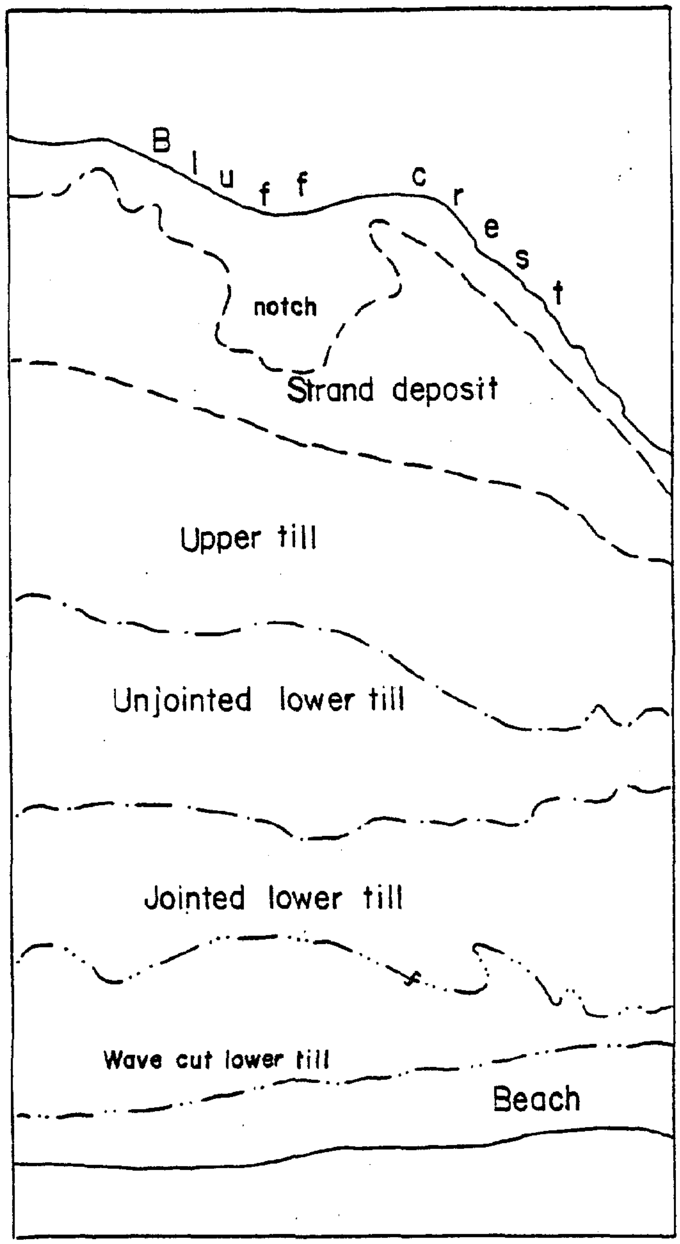


Figure 2

SELECTED REFERENCES SECTION A

1) ________________, (1960) Geologic Map of Pennsylvania, Commonwealth of Pennsylvania, Department of Environmental Resources, Topographic and Geologic Survey (Scale 1:250,000), Harrisburg, Pennsylvania.

2) ________________, (1978) Geotechnical Investigations: Greenfield Project, D'Appalonia Associates, Pittsburgh, Pennsylvania.

3) Clemens, Robert H., (1976) Selected Environmental Criteria for the Design of Artificial Structures on the Southeast Shore of Lake Erie, Technical Report No. 8-CRD, Coastal Research Division, Department of Geology, University of South Carolina, Columbia, S.C.

SECTION B

SUMMARY

The sites selected for study under the three year program were determined by fixed grid. (See Introduction). Given this methodology, it was sometimes difficult to choose actual profile lines representative of general slope conditions over any areal extent. It was frustrating to be contained within narrow parameters while upshore or downshore was a bluff face that was easier to measure, that provided a better "face" for stratigraphic description or was active and thus able to provide some change data. In some cases, the profile site was stable over the three year period while the bluffs on either side were failing.

The problem is, of course, not new to shoreline study. We knew at the outset that the methodology would have certain limitations. It is hoped that, on average, the site determinations were made in such a way as to provide a clearer picture of the variable conditions that exist on the bluffs.

As stated in previous reports, there is no average bluff. Recession rates can be averaged over time for a particular site. A rate can be determined and measured in ft./yr., in./yr. or m./yr. However a particular bluff having a rate of 1 ft./yr. may be stable for 25 years only to have 25 feet of recession in one year.

Stratigraphically, we find that bluffs vary in material composition thickness and that response to groundwater flows may vary over a matter of a few yards. It would be irresponsible to extrapolate any observations for the bluffs more than a mere few yards. It is, therefore, difficult to say with any conviction that any erosional or recessional phenomena ongoing at a particular site will persist in either time or space.

It is possible though to compile information about the interactions of bluff slope, material, development impacts and the like and produce a reasonable assessment of a particular situation. It would be possible for the trained observer to view a site, compare it with others he has seen and make an estimate as to the future of the site with at least some credibility.

Following, in two parts, is a summary of bluff conditions in Erie County based on observations over a three year period. For some sites the observation has been over a period of ten years. We should acknowledge at this point that, with the compilation of data over this time, we are just beginning to understand some of the phenomena particular to these bluffs.

The first part of the summary consists of an overview of the bluffs of Erie County and how they behave under a variety of conditions and variables. A classification system emerges as a result of this exercise. The second part looks at each site placing it within the classification scheme and discusses some of the exceptions and deviations from the norm.

Part 1 General Classification Scheme

There are a number of ways to categorize bluffs facing open water. The Corps of Engineers classes bluffs according to a combination of height and erodibility. A particular shoreline might then be classed as "high bluff erodible". This system is fine for a general coastal inventory, but falls far short of adequately describing the actual character of any bluff. For example, the Western part of the Erie County Coastal Zone is classed as high bluff erodible, just that; no sub-category. We know that, while generally this is true, there are some bluffs in that reach that have been stable for years and some areas where there is no bluff at all. The purpose of this study was, of course, to refine our knowledge or conditions to a point where a finer determination could be made.

The parameters considered in the classification were as follows:

Height (low,medium,high)
Slope (low angle,moderate angle,high angle)
Slope geometry(linear, concave, convex, compound)
Stratigraphy
Beach (none, narrow, moderate, broad)
Human impact
Erosion at toe (rate)
Erosion of face (rate)
Recession

Missing from the above classification is time. In any geomorphic classification system some consideration for time should be made. The inclusion of ime in a geomorphic classification of the bluffs is fruitless however. For example, we know that geomorphic change of the bluffs may be due to action at the base (wave-induced erosion) or by groundwater sapping at the crest, or by a combination of the above. Since wave erosion is largely a function of water levels and since water levels change over time in an unpredictable manner, to say that a bluff will continue to do what it's now doing is pointless. Similarly, recession at the crest may be due to failure of the upper layers (ground water). We know that the amount and the direction of ground water flow can vary at any time. To establish that a particular bluff crest will continue to respond over time in the same manner is equally pointless.

The bluffs are then classed according to what they are doing now; frozen in time. If water levels change, erosion may abate or accelerate. If such is the case, the bluff may then be thrown into a different category; perfectly permissable. If the bluffs are not static, why should a scheme to classify them be static?

Classification Scheme

The classification scheme will be composed of three parameters. The first place will categorize stability based on observation as follows:

A- Stable
B- Stable Crest, Unstable Toe
C- Stable Toe, Unstable Crest
D- Overall Instability

The second place categorizes the bluffs as to height as follows:

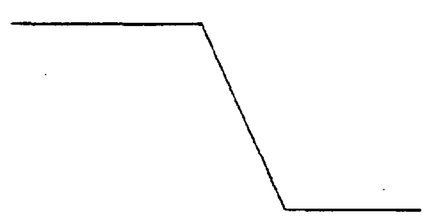
a- Low (to 20')
b- Medium (to 40')
c- High (over 40')

The third place categorizes the bluff as to shape as follows:

1- Linear, high angle
1'- Linear, low angle
2- Convex
3- Concave
4- Compound

Examples of the above include:

1) Linear, high angle



CLASSIFICATION OF SITES

1	Db1	44	Ab1
2	Da1	45	Ab3
3	Dc4	46	Ab3
4	Dc4	47	Cb4
5	Bc1'	48	Ca4
6	Db1'	49	Cc4
7	Da1	50	Ac3
8	Ac1'	51	N.D.
9	Dc4	52	Aa2
10	Dc4	53	Ca2
11	Dc4	54	Dc4
12	Dc4	55	Bc4
13	Dc4	56-	Ac1'
14	Db4	57	Dc1'
15	Bc4	58	Cc4
16	Dc1'	59	Dc4
17	Aa1	60	Dc4
18	Dc4	61	Dc4
19	Dc4	62	Dc4
20	Dc4	63	Dc4
21	Dc4	64	Dc4
22	Dc4	65	Db4
23	Aa1	66	Ab1
24	Da1	67	Ac4
25	Cc4	68	Db4
26	Aa	69	Db2
27	Cc4	70	Cb3
28	Bc4	71	Ab1
29	Bc4	72	Aa1
30	Dc1	73	Ba1
31	Dc4		
32	Bc1'		
33	Bc4		

KEY TO SYMBOLS

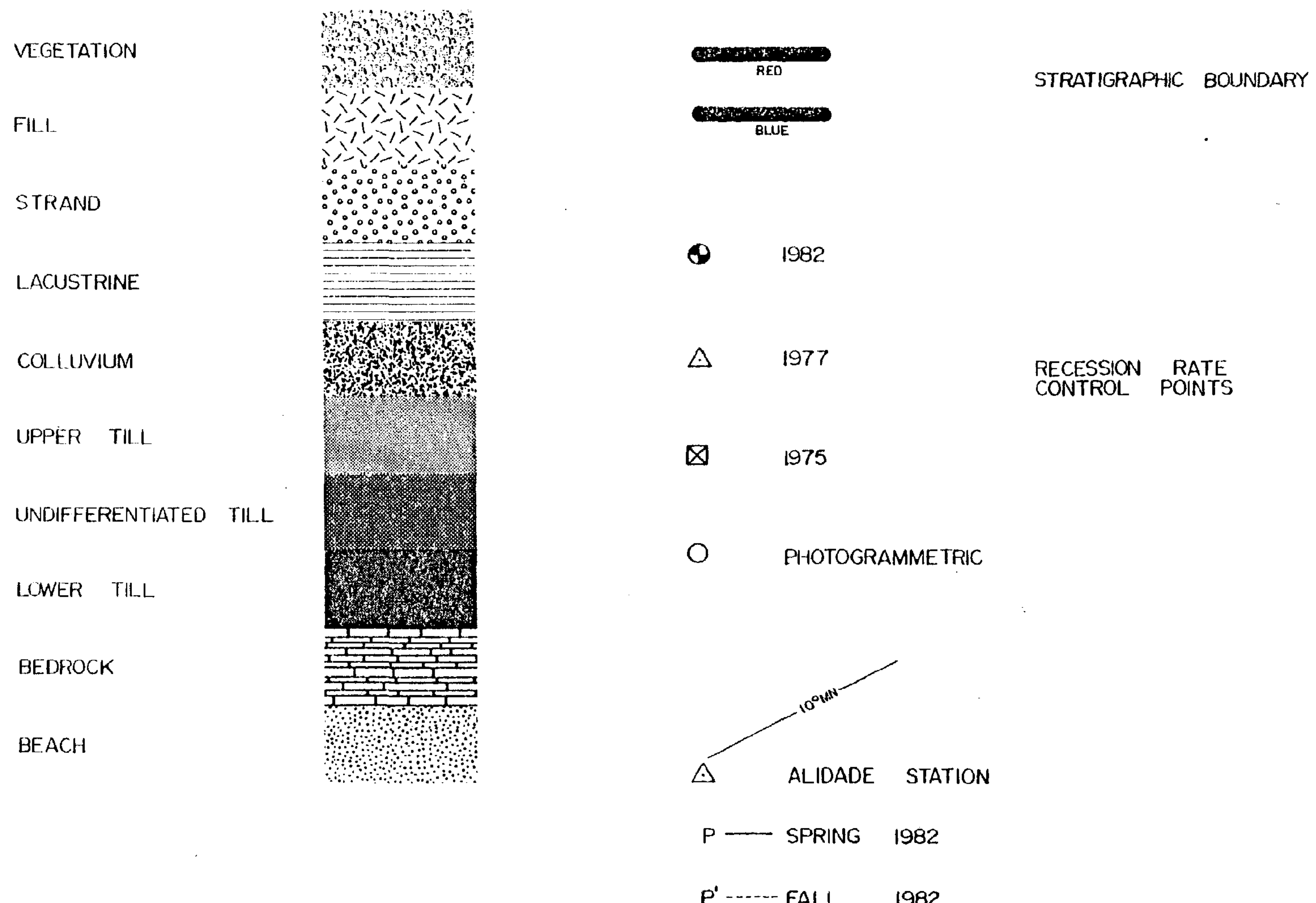
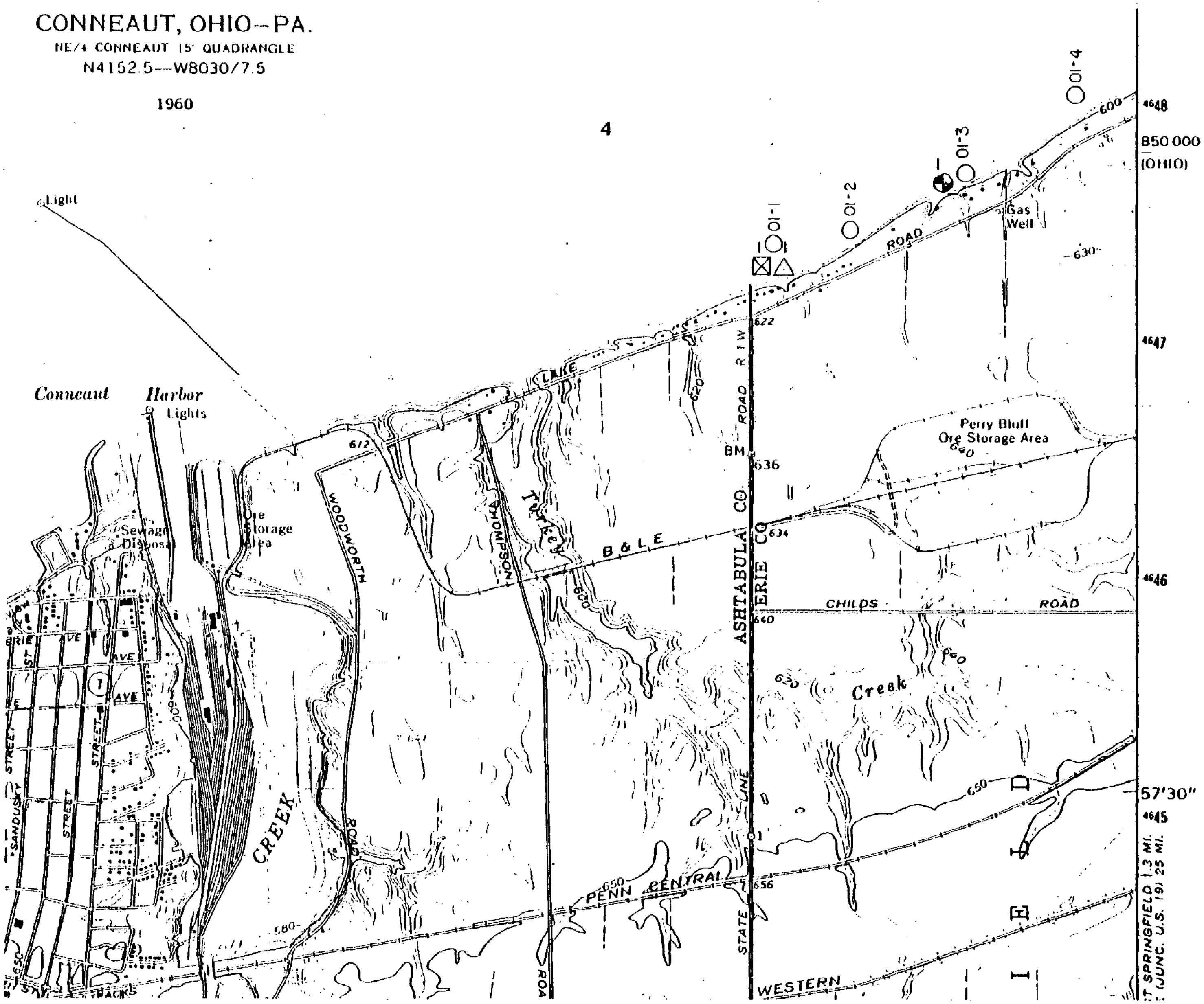


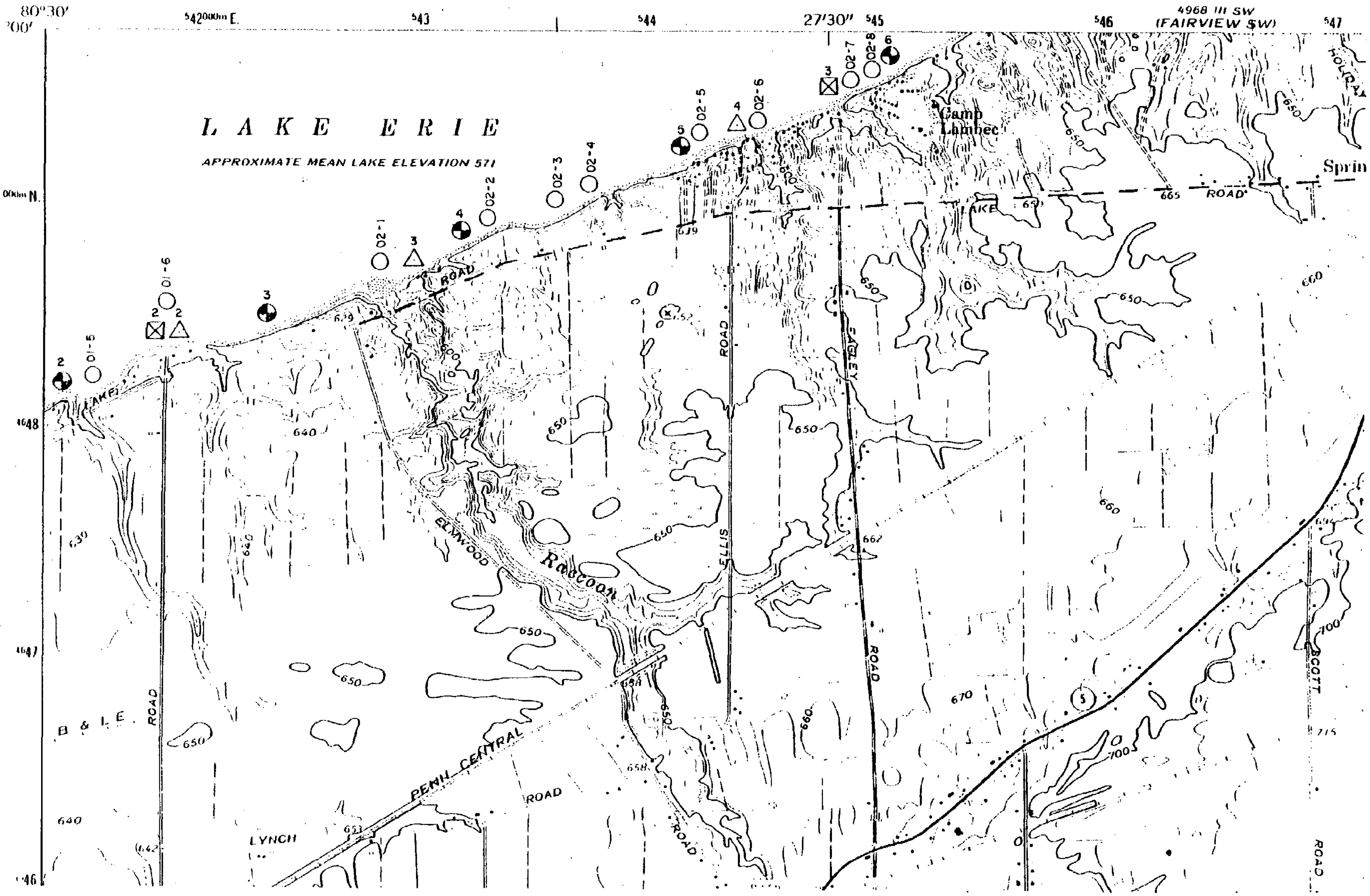
FIG 3

CONNEAUT, OHIO–PA.
NE/4 CONNEAUT 15' QUADRANGLE
N4152.5—W8030/7.5

1960

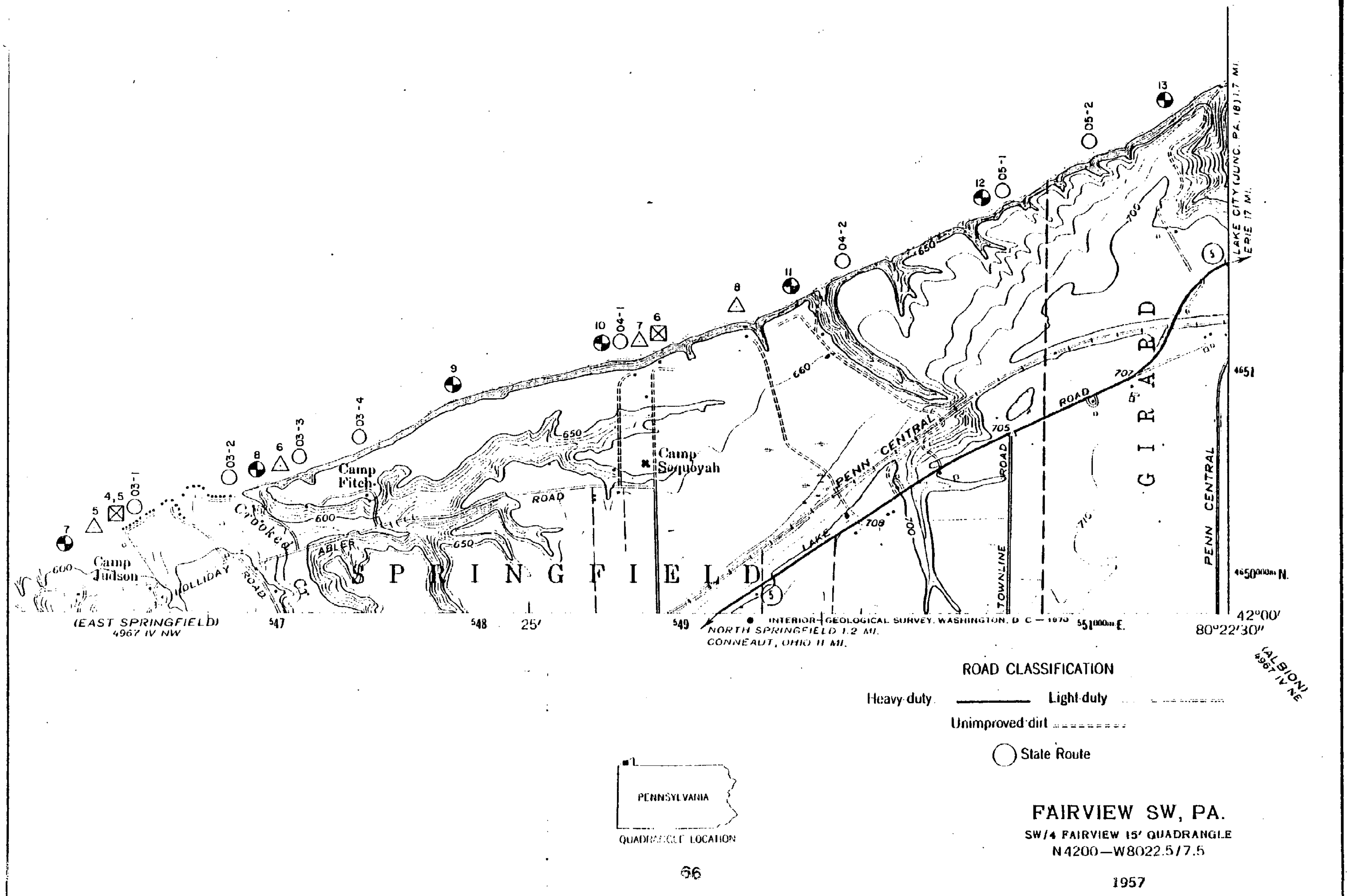
4

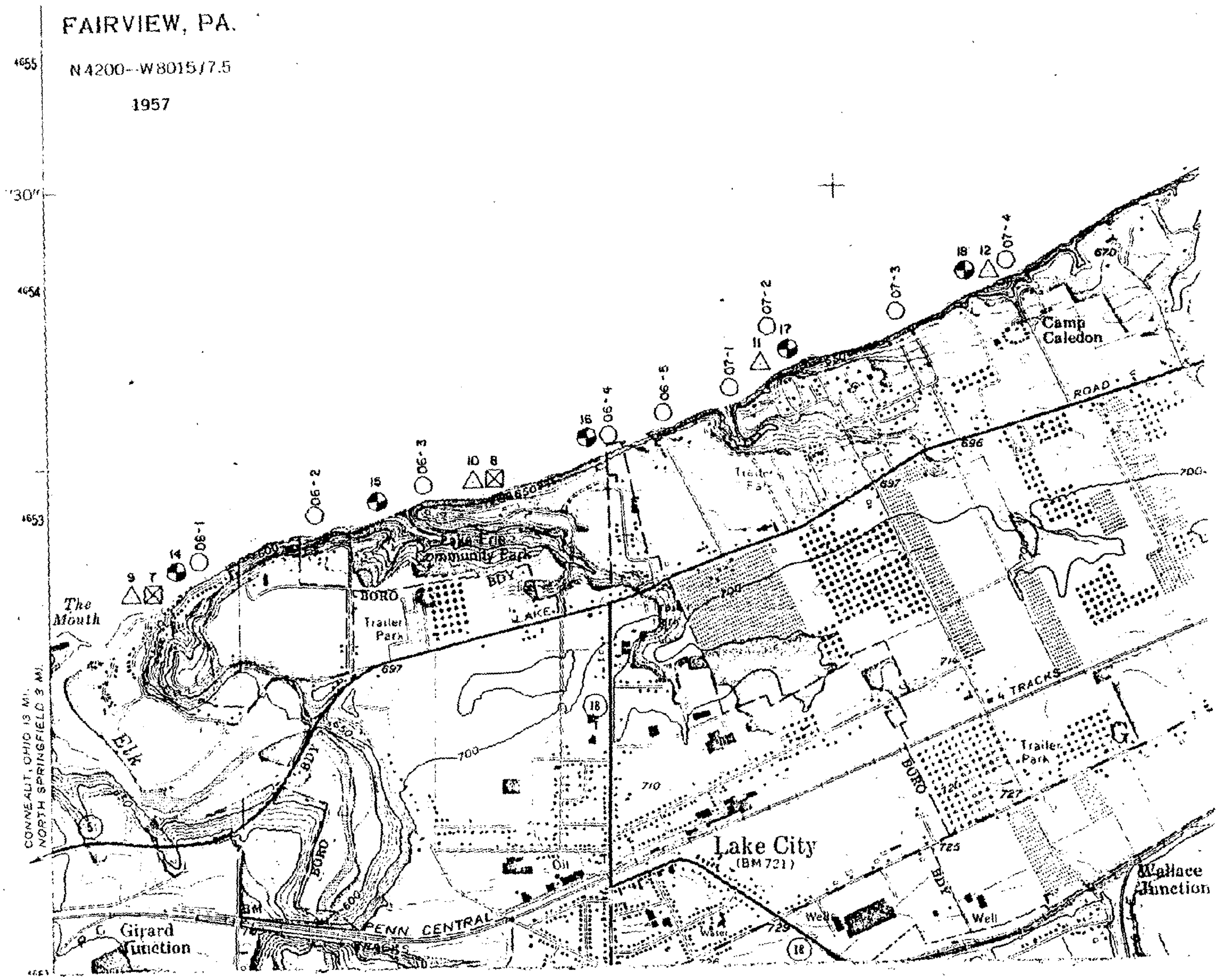




EAST SPRINGFIELD, PA.
NW/4 GIRARD 15' QUADRANGLE
N4152.5—W8022.5/7.5

1959

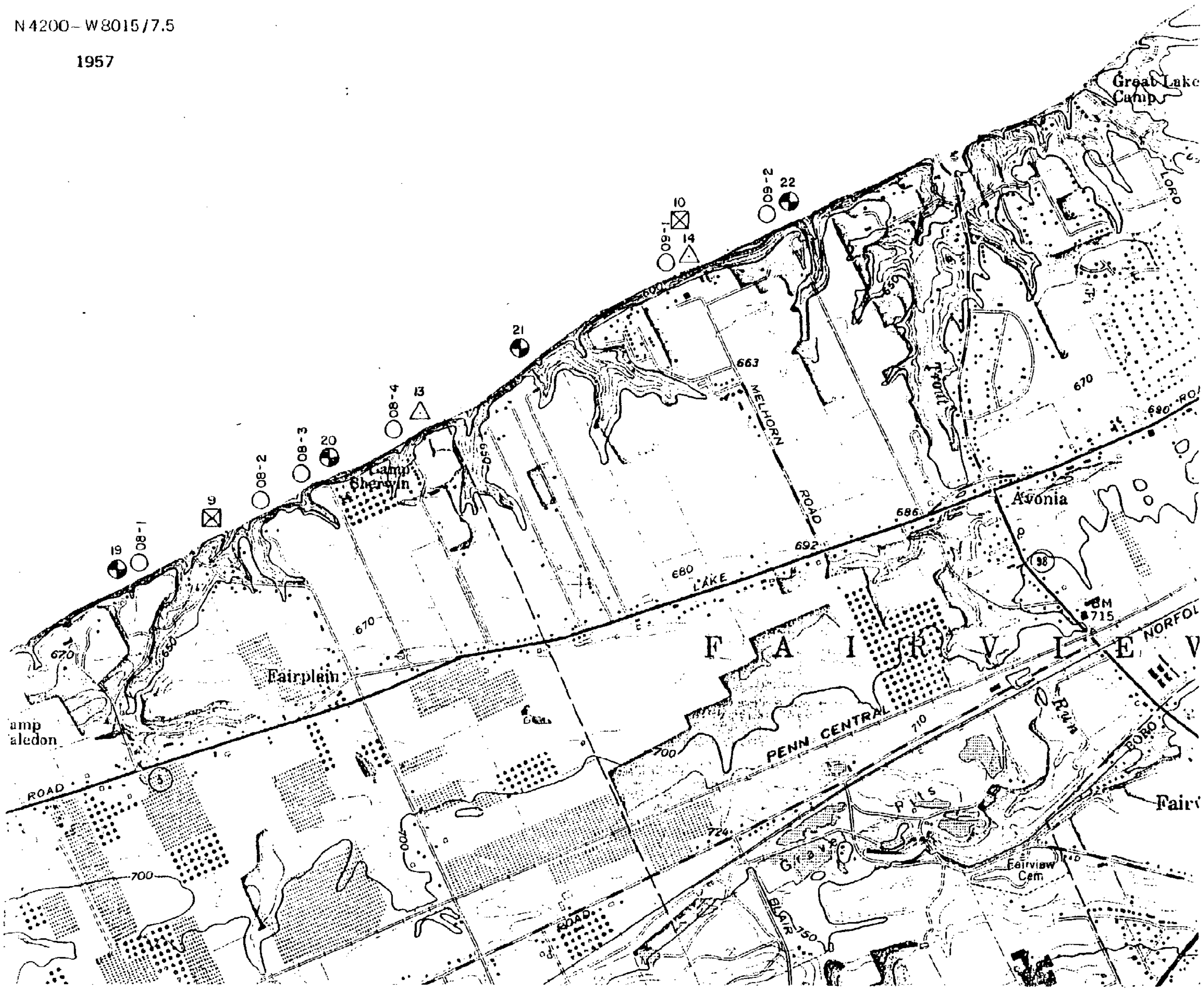

FAIRVIEW SW, PA.
SW/4 FAIRVIEW 15' QUADRANGLE
N4200—W8022.5/7.5
1957
ROAD CLASSIFICATION
Heavy-duty
Light-duty
Unimproved dirt
State Route
PENNSYLVANIA
QUADRANGLE LOCATION
(EAST SPRINGFIELD)
4967 IV NW
(ALBION)
4967 IV NE
LAKE CITY (JUNC. PA. 18) 1.7 MI.
ERIE 17 MI.
NORTH SPRINGFIELD 1.2 MI.
CONNEAUT, OHIO 11 MI.
SPRINGFIELD
GIRARD
Camp Judson
Camp Fitch
Camp Sequoyah
PENN CENTRAL
LAKE ROAD
TOWNLINE ROAD
ABLER ROAD
HOLLIDAY ROAD
Crooked Cr
42°00'
80°22'30"
25'
547
548
549
551000m E.
4651
4650000m N.
03-1
03-2
03-3
03-4
04-1
04-2
05-1
05-2


FAIRVIEW, PA.
N4200--W8015/7.5
1957
4655
30″
4654
4653
CONNEAUT, OHIO 13 MI.
NORTH SPRINGFIELD 3 MI.
The Mouth
Elk
Camp Caledon
Lake Erie Community Park
BORO
BDY
LAKE
Trailer Park
ROAD
4 TRACKS
Lake City
(BM 721)
PENN CENTRAL
Girard Junction
Wallace Junction
Well
Oil
06-1
06-2
06-3
06-4
06-5
07-1
07-2
07-3
07-4
7
8
9
10
11
12
14
15
16
17
18

FAIRVIEW, PA.

N4200 - W8015/7.5

1957



FAIRVIEW, PA.

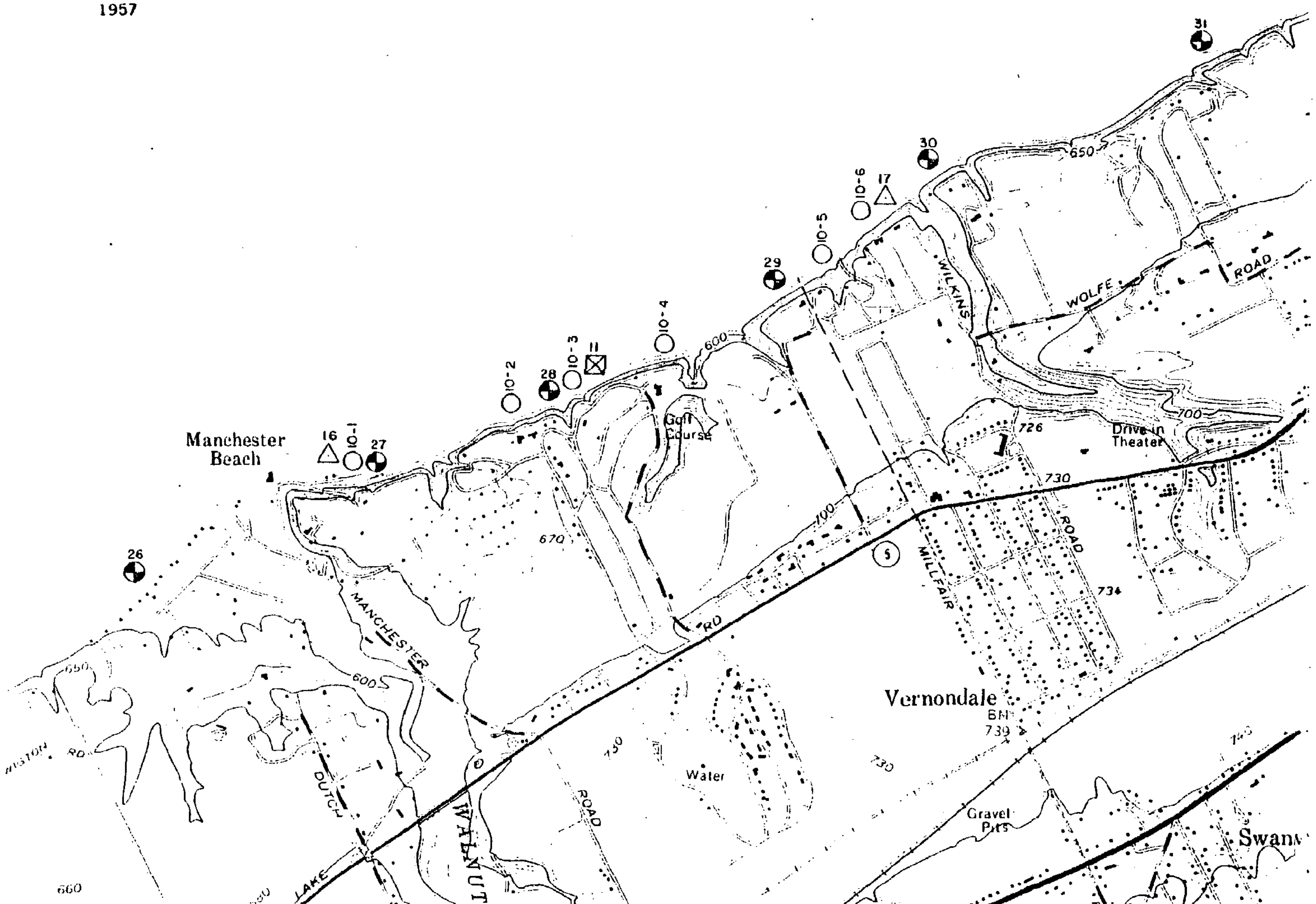
N4200—W8015/7.5

1957

SWANVILLE, PA.

N4200—W8007.5/7.5

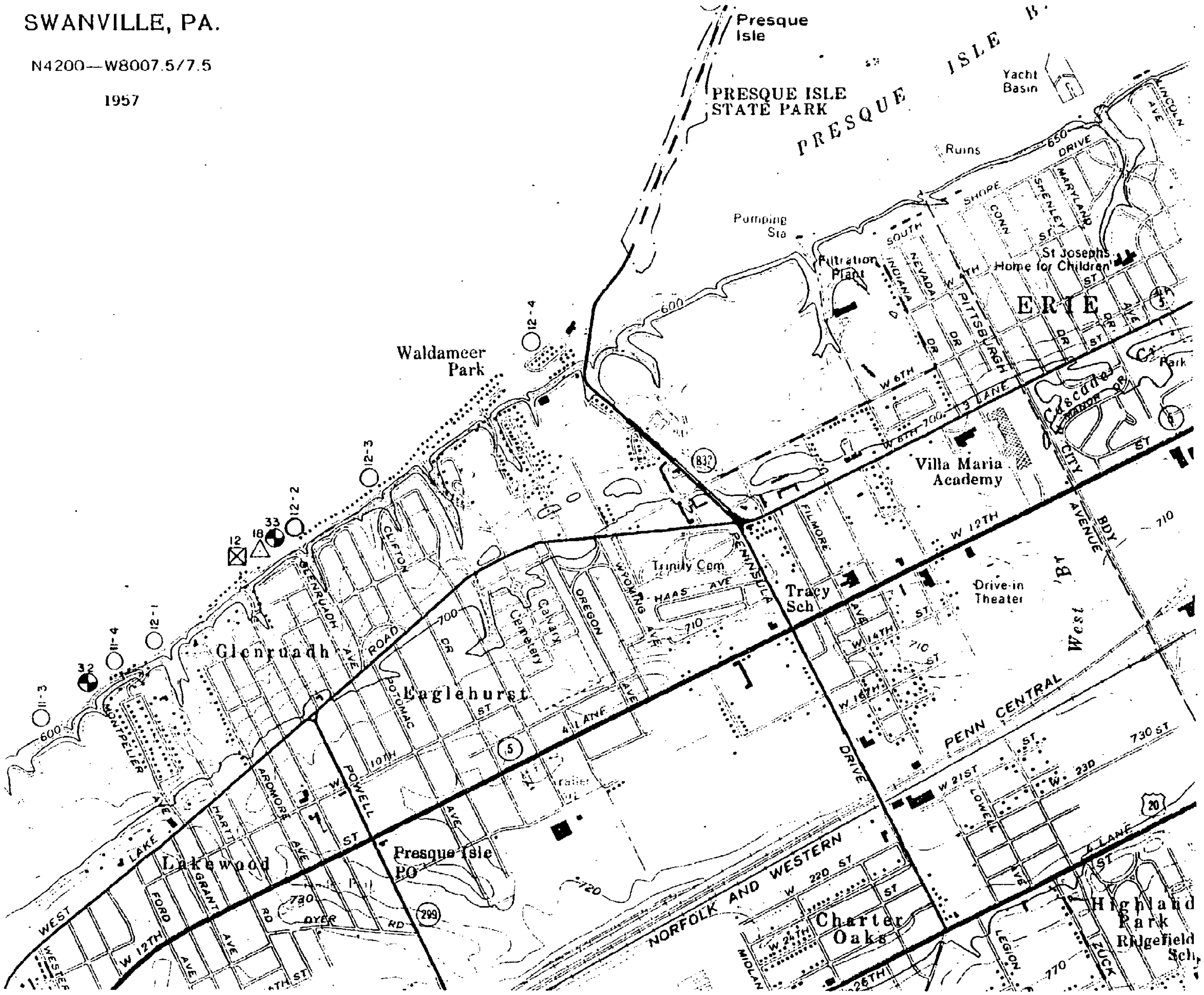
1957

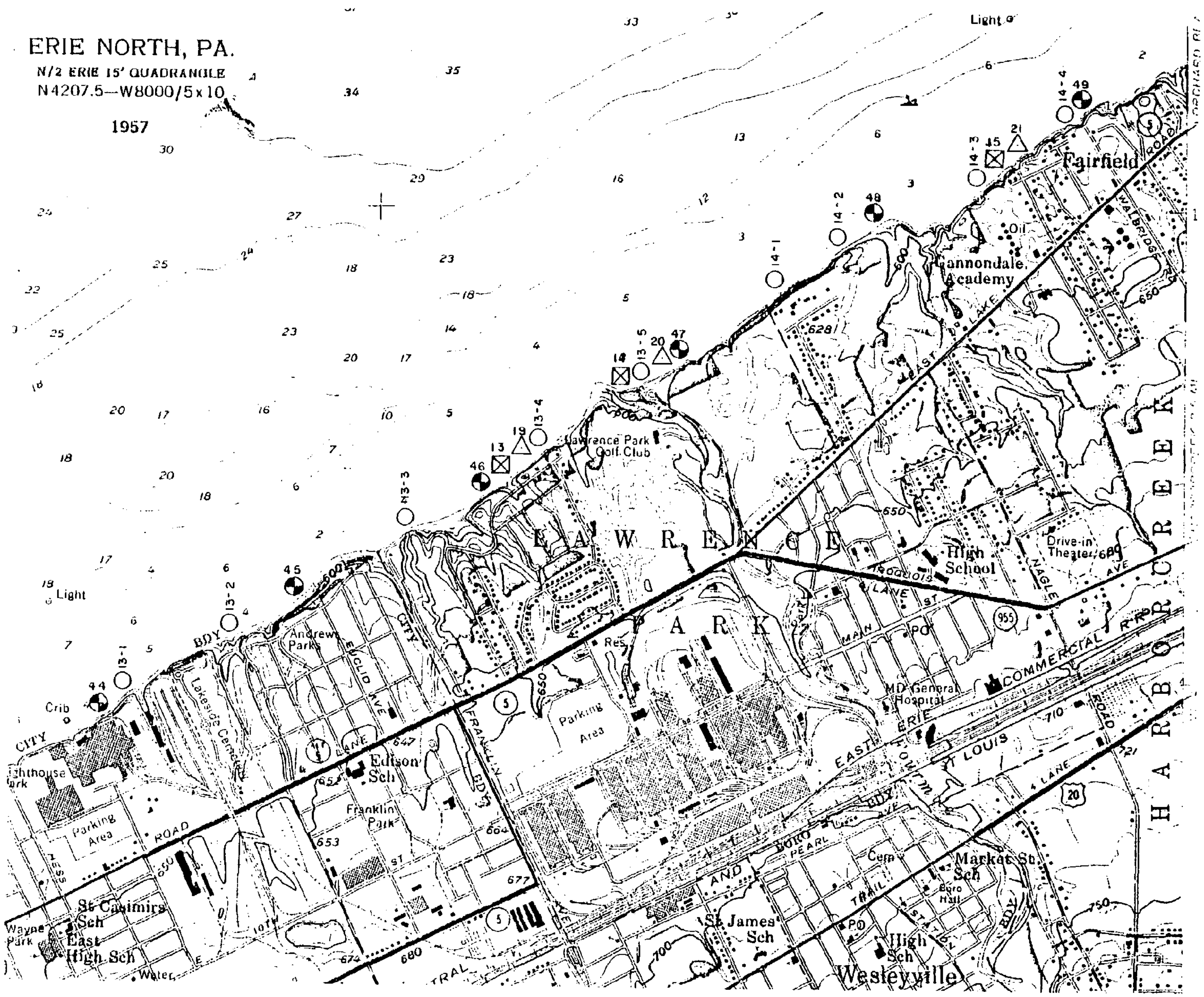


SWANVILLE, PA.

N4200—W8007.5/7.5

1957

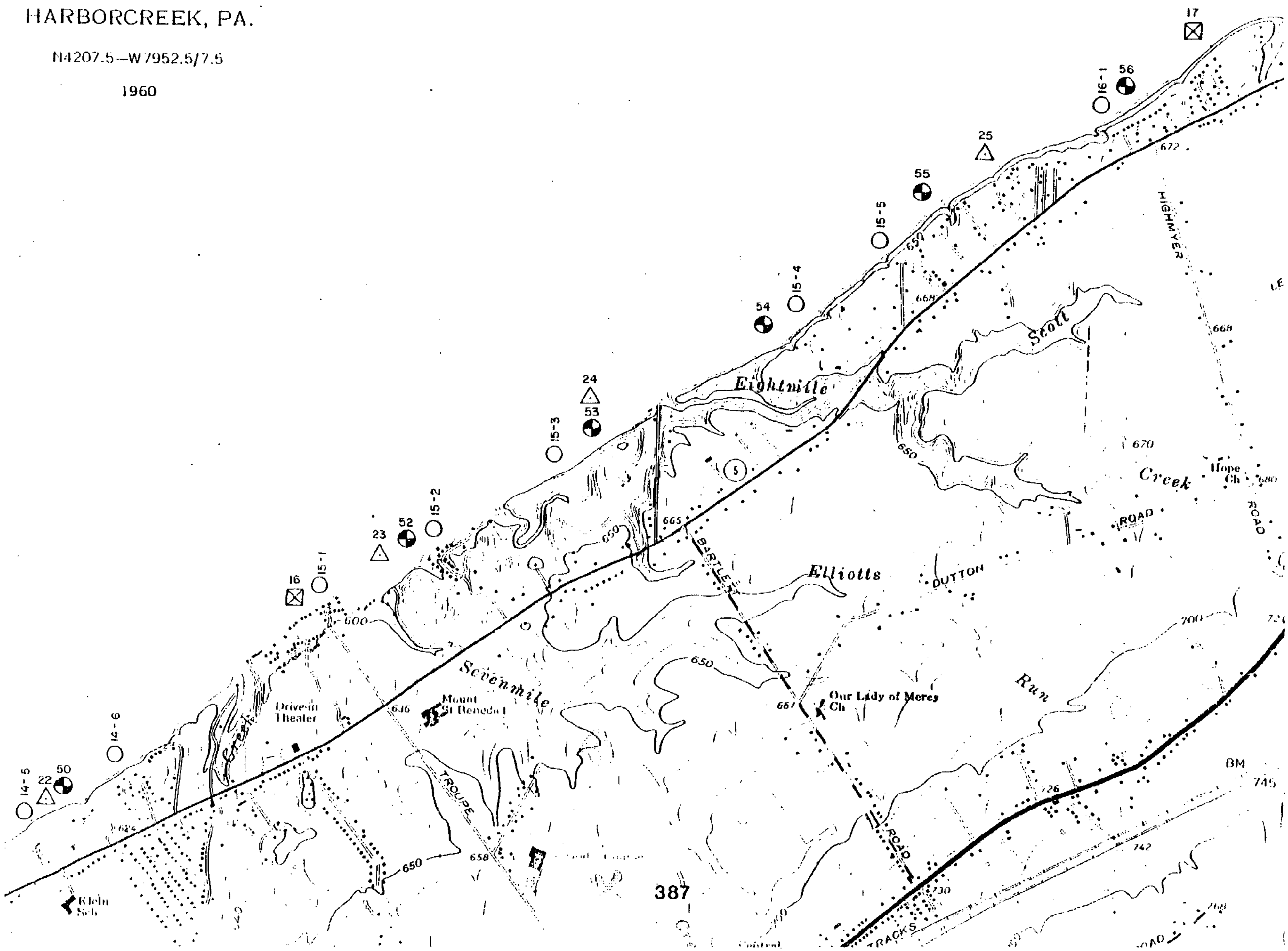



ERIE NORTH, PA.
N/2 ERIE 15' QUADRANGLE
N4207.5—W8000/5x10
1957
Fairfield
Cannondale Academy
Lawrence Park Golf Club
LAWRENCE PARK
HARBOR CREEK
High School
Drive-in Theater
MD General Hospital
Andrews Park
Lakeside Cemetery
Edison Sch
Franklin Park
Parking Area
St Casimirs Sch
East High Sch
Wayne Park
St James Sch
Market St Sch
High Sch
Wesleyville
Light
Crib

HARBORCREEK, PA.

N4207.5—W7952.5/7.5

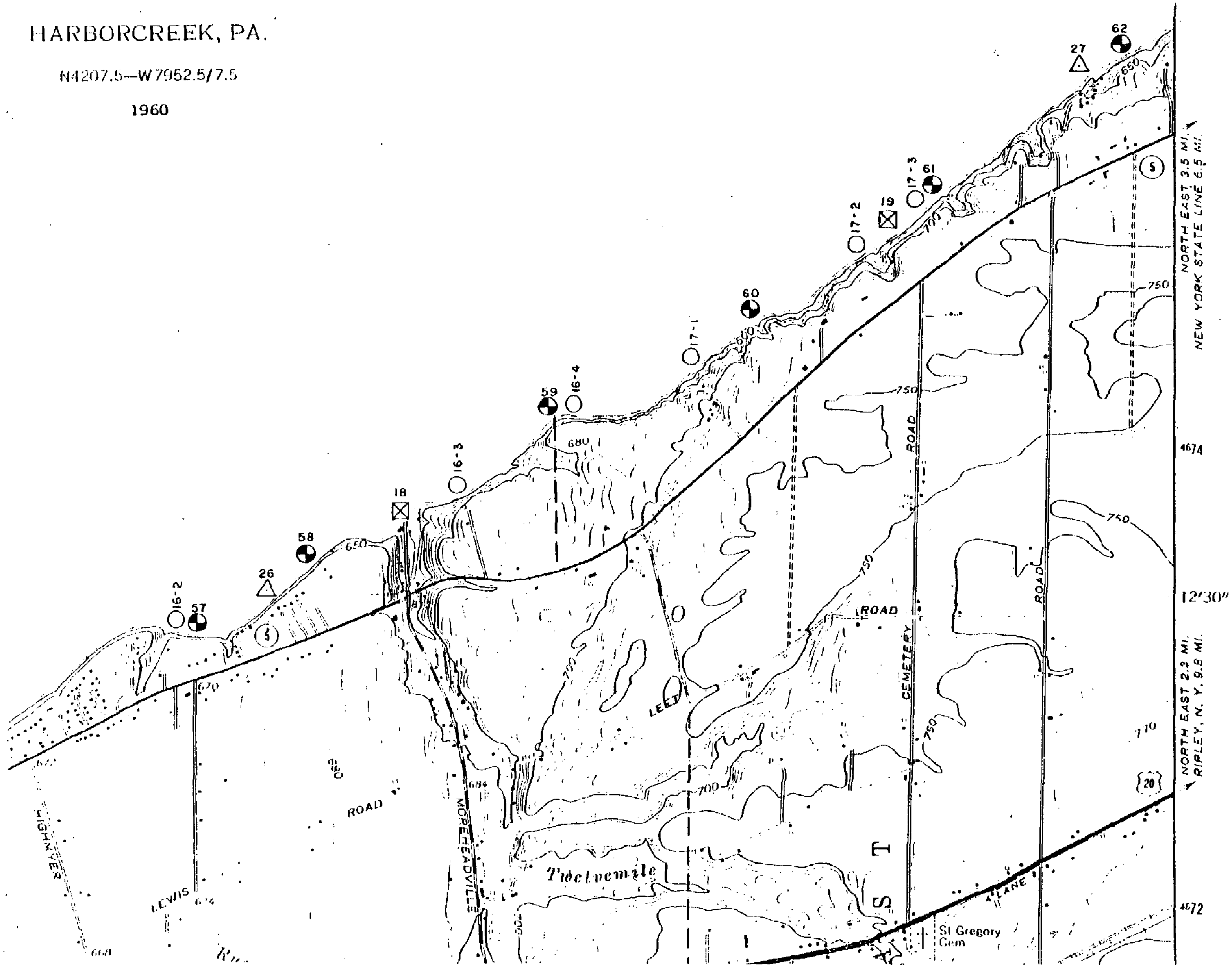
1960



HARBORCREEK, PA.

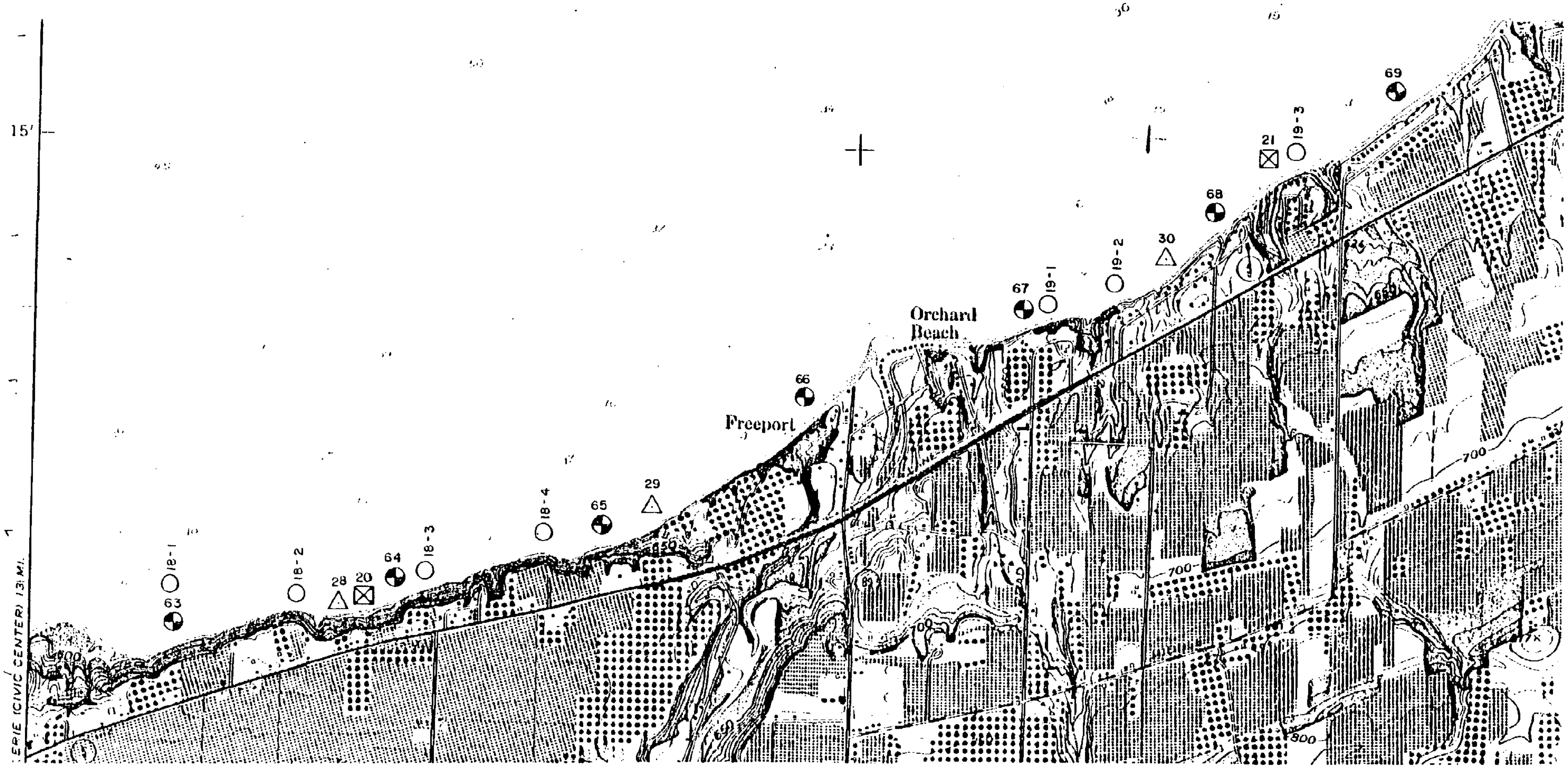
N4207.5—W7952.5/7.5

1960

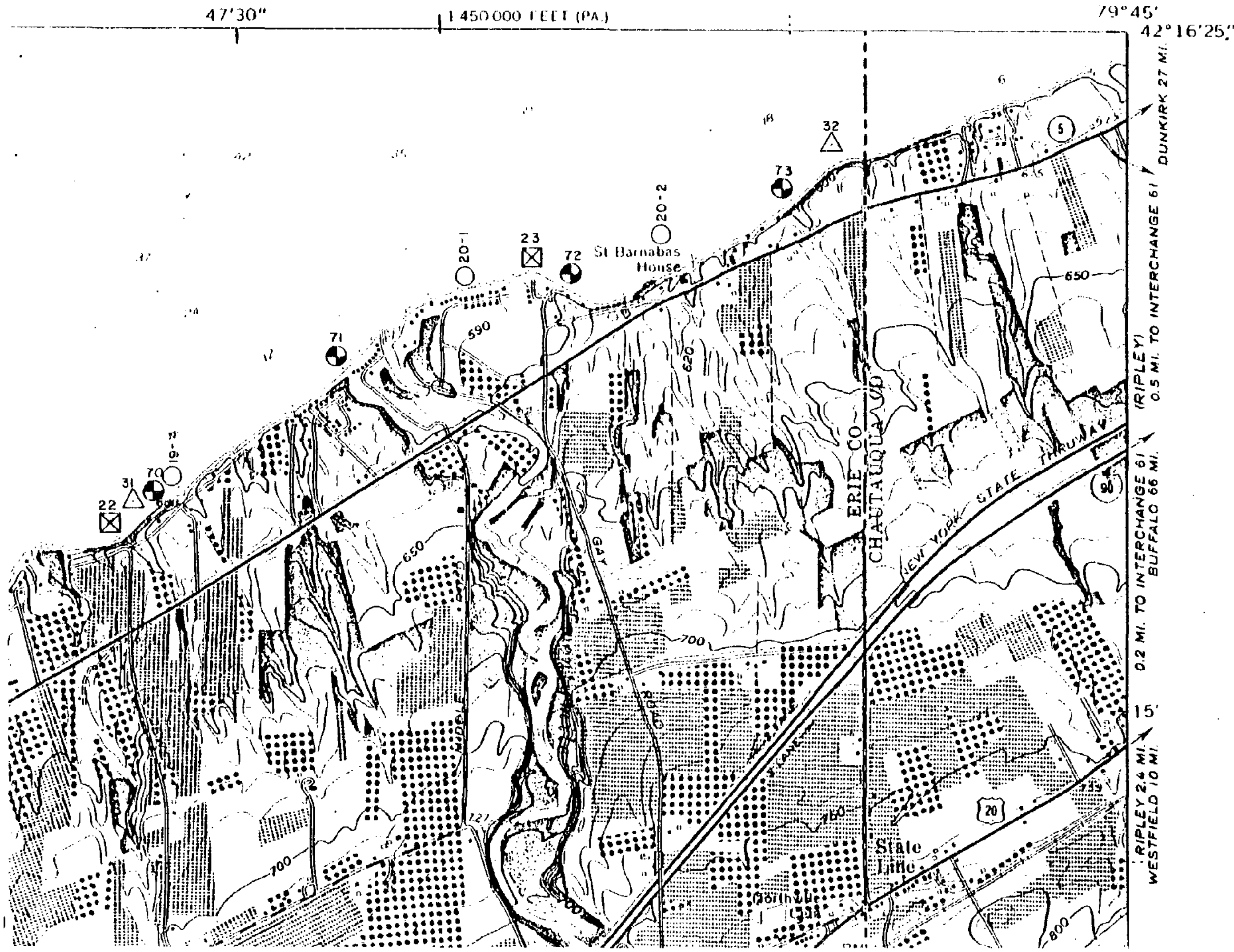


NORTH EAST, PA.–N. Y.
NE/4 NORTH EAST 15' QUADRANGLE
N4207.5—W7945/8.9×7.5

1960



NORTH EAST QUADRANGLE
PENNSYLVANIA–NEW YORK
7.5 MINUTE SERIES (TOPOGRAPHIC)
NE 4 NORTH EAST 15' QUADRANGLE



SECTION C

RECESSION RATE DATA AND VOLUMETRIC LOSS DATA

EXPLANATION OF TABLE ONE (1975 Cont. Pt.)

As a part of field work conducted in 1974-75, twenty-three sites were selected based on representative characteristics. The sites were randomly selected based on 1) ease of access, 2) type of bluff, and 3) presence of accelerated recession and/or erosion.

The sites were remeasured in 1982 and again in 1983 as an uncontracted addition to the current work. Additional information about recession losses was the anticipated goal. The location of each site is shown on the topographic index map accompanying Section B and is shown by /$\overline{\underline{X}}$/. The sites are numbered consectutively west to east.

TABLE 1

1975 CONTROL POINTS

Site #	1975	1982 (in ft)	1983	Loss	Average/Yr. n=8yr.
1	320	306	301	19	2.380
2	340	329	329	11	1.380
3	198	198	198	0	0
4	89	81	81	8	1.000
6	53	52	45.3	7.7	0.960
7	58.2	47	47	11.2	1.400
8	87	82	79.5	7.5	0.940
9	80	70	70	10	1.250
10	157	154	147	10	1.250
11	25	25	25	0	0
12	70	-	64	6	0.750
13	146	146	146	0	0
14	72.5	66.5	63	9.5	1.190
15	67	-	64	3	0.380
16	-	-	-	-	-
17	172	170	170	2	0.250
18	-	-	-	-	-
19	-	-	-	-	-
20	147	147	147	0	0
21	23.5	-	16	7.5	0.940
22	104	-	-	-	-
23	82	-	-	-	-

EXPLANATION OF TABLE 2 (1977 Cont. Pts.)

In 1977, working on a small grant, data was obtained for thirty-two selected sites. These sites were selected in the same manner as for the 1975 control points (See Figure 1). In some cases, these points were a duplication of the '75 markers. The sites were remeasured, where warranted, in 1982 and again in 1983 as a means of providing additional information on recession losses.

The locations of the sites are shown on the series of topographic map indexes accompanying Section B and are shown by △ .

TABLE 2

1977 CONTROL POINTS

Site #	1977	1982	1983	Loss	Average/Yr. n=6yr.	
		(in feet)				
1	-	-	-	-	-	(marker gone)
2	-	-	-	-	-	"
3	62.3	52	48	14.3	2.380	
4	92.6	75.9	73.2	19.4	3.320	
5	134	111	96	38	6.330	
6	-	-	-	-	-	
7	49.2	49	47.5	1.7	0.290	
8	-	-	-	-	-	
9	63.5	-	52.1	11.4	1.890	
10	72.3	70	67	5.6	0.880	
11	49	41	41	8	1.330	
12	164.6	-	-	-	-	
13	113.1	-	113	0	0	
14	-	-	-	-	-	
15	81.46	-	-	-	-	
16	33.65	33.6	-	0	0	
17	91.23	91	91	.2	0.040	
18	114.7	108.5	106	8.7	1.450	
19	41	-	-	-	-	
20	60	54	54	6	1.000	
21	71.75	-	-	-	-	
22	47.7	47	47	.7	0.110	
23	124.75	116	116	8.8	1.460	
24	47.6	36	34	13.6	2.270	
25	87.6	-	87.6	0	0	
26	58.5	58.5	58.5	0	0	
27	79.4	59	59	20	3.300	
28	46.4	-	46	.3	0.060	
29	34.4	32	32	2.4	0.400	
30	60	46 ?	48	12	2.000	
31	92	-	84.8	7.3	1.210	
32	58.5	-	-	-	-	

EXPLANATION OF TABLE 3 (1982-83 Cont. Pt.)

Table 3 displays the data obtained since the spring of 1982. The averages taken are for a two year period and for a one and one-half year period. The one and one-half year period is more proper given the time span between measurements. Despite the brief time involved, some sites showed considerable loss while, expectedly, most sites showed little measureable loss during the period. The table does not list the sites for which there was no recession. The location of the sites is shown as  on the index maps in Section B.

TABLE 3

1982-83 CONTROL POINTS

Site #	S '82	F '82	1983	Loss	Average/yr n=2	Average/yr n=1.5
		(in feet)				
1	52	45	45	7	3.50	4.67
2	41	41	40	1	0.50	0.67
3	29	29	26	3	1.50	2.00
4	50	49	46	4	2.00	2.67
6	54	54	53	1	0.50	0.67
7	104	103	101.5	2.5	1.25	1.67
10	33	29	29	4	2.00	2.67
13	65	65	62	3	1.50	2.00
14	50	49	48	2	1.00	1.30
18	80	80	79	1	0.50	0.67
19	41	38	33	8	4.00	5.33
21	74	72	70	4	2.00	2.67
22	51	51	50	1	0.50	0.67
25	49	49	47	2	1.00	1.30
31	51	51	49	2	1.00	1.30
47	55	55	53	2	1.00	1.30
53	42	41	40	2	1.00	1.30
58	38	38	37	1	0.50	0.67

EXPLANATION OF FIGURE 4 (1975 Photo. Points)

The data portrayed on Figure 4 is from the photogrammetric analysis made for the 1974 Shoreline Flooding and Erosion study. The data was obtained by MICROGAUGE measurement of scale-corrected aerial photographs. The technique was new at the time, and subject to some criticism. The subsequent data from direct measurement indicates that the reliability factor for the method is quite high. The sites are located on the index maps in Section B as ◯ .

TABLE 4

1975 PHOTOGRAMMETRIC CONTROL POINTS

Township	Site #		ft/yr	m/yr
Springfield Twp.	01	1	1.567	.478
	01	2	2.133	.650
	01	3	1.075	.328
	01	4	1.375	.419
	01	5	1.917	.584
	01	6	1.540	.469
	01	7	1.592	.485
	01	8	1.442	.440
	02	1	3.033	.924
	02	2	1.725	.526
	02	3	1.408	.429
	02	4	2.050	.625
	02	5	1.908	.582
	02	6	.492	.150
	02	7	.375	.114
	02	8	.617	.188
	03	1	1.467	.447
	03	2	.842	.257
	03	3	1.575	.480
	03	4	3.425	1.044
	04	1	.225	.069
	04	2	.800	.244
	05	1	3.067	.935
Girard Twp.	05	2	3.858	1.176
	06	1	4.391	1.338
	06	2	.242	.074
	06	3	1.025	.312
	06	4	1.208	.368
	06	5	1.058	.322
	07	1	.167	.051
	07	2	2.642	.851
	07	3	1.992	.607
	07	4	.567	.173
	08	1	.541	.165
	08	2	.333	.101
	08	3	.425	.112
	08	4	.150	.046
Fair. T.	09	1	.267	.081
	09	2	.425	.130
	09	3	3.208	.918
	09	4	.325	.305
	09	5	.250	.076
	10	1	.167	.051
	10	2	.741	.226
	10	3	2.458	..749
	10	4	2.275	.693
Millcreek T.	10	5	1.900	.579
	10	6	.725	.221
	11	1	.125	.038
	11	2	.808	.246
	11	3	2.583	.787
	11	4	1.183	.361
	12	1	.483	.147
L.P. Twp.	12	2	.558	.170
	12	3	.267	.081
	12	4	.208	.063
	13	1	.242	.074
	13	2	.358	.112
	13	3	.500	.152
	13	4	.600	.183
	13	5	3.085	.932
Harborcreek Twp.	14	1	.367	.112
	14	2	.217	.066
	14	3	.742	.226
	14	4	1.017	.310
	14	5	.658	.353
	14	6	.083	.025
	15	1	.875	.267
	15	2	.442	.135
	15	3	.467	.142
	15	4	.508	.155
	15	5	.367	.112
	16	1	.417	.127
	16	2	.242	.074
	16	3	.433	.132
North East Twp.	16	4	1.633	.498
	17	1	.950	.290
	17	2	1.425	.434
	17	3	.517	.157
	18	1	1.108	.338
	18	2	.492	.150
	18	3	.433	.132
	18	4	.158	.048
	19	1	.375	.114
	19	2	.658	.201
	19	3	.633	.193
	19	4	.167	.051
	20	1	1.150	.351
	20	2	1.177	.538

TABLE 5

RECESSION RATE SUMMARY
(in ft. per yr.)

n=37yr. 1938-1975	n=8yr. 1975	n=6yr. 1977	n=2yr. 1982-1983	n=1.5yr. 1982-1983	
1.075 (n=89)	.827 (n=17)	1.351 n=22)	.505 (n=51	.671 (n=51)	Average Loss /yr. All Sites
.874 (n=82)	.827 (n=17)	.883 (n=19)	.434 (n=50)	.671 (n=50)	Loss /yr.; Anom. Removed
1.075 (n=89)	1.082 (n=13)	1.118 (n=15	1.276 (n=17)	1.700 (n=17)	Loss /yr.; Stable Sites Removed

TABLE 6

RECESSION RATE SUMMARY BY TOWNSHIP

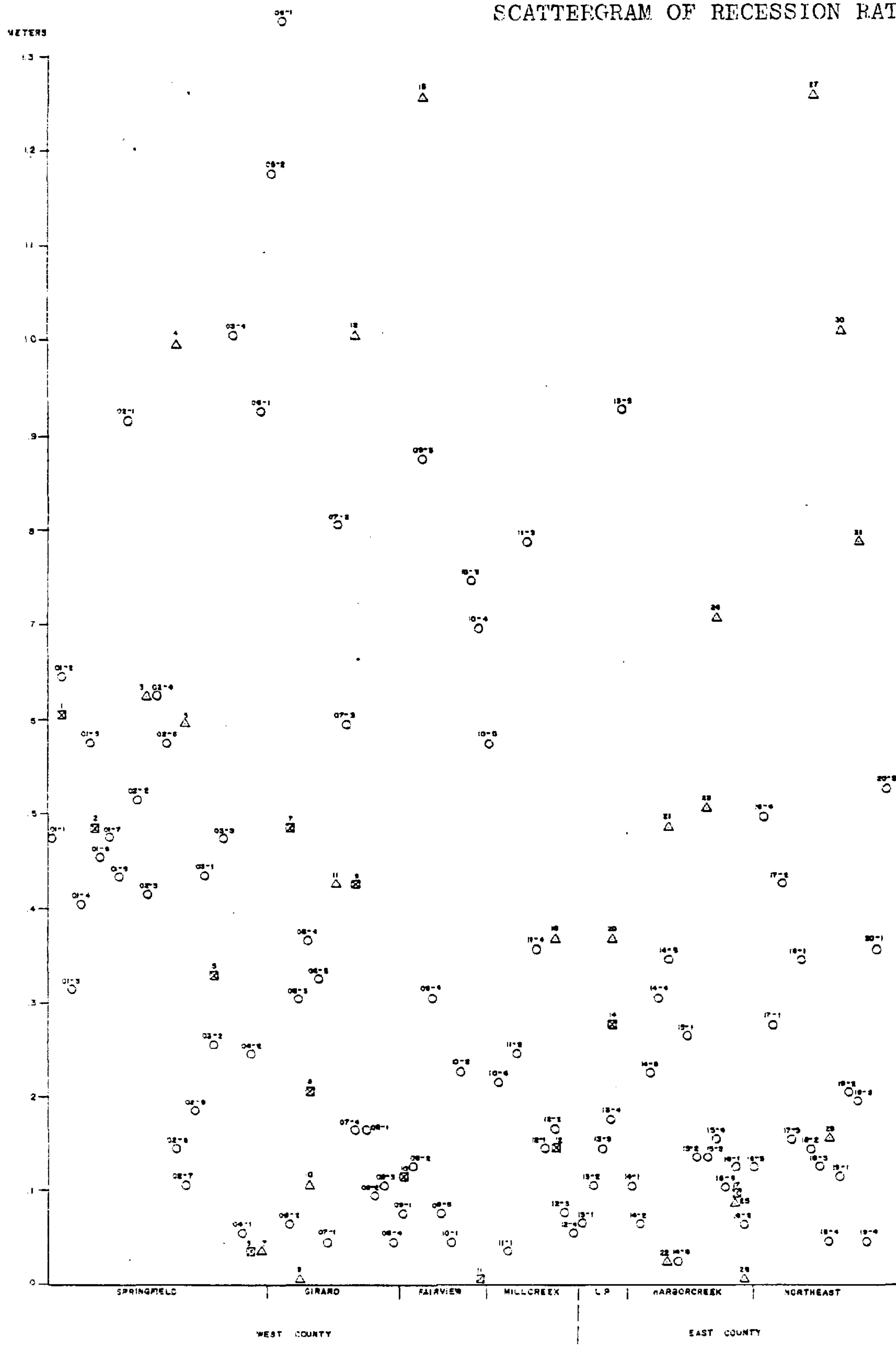
	m/yr	ft/yr	n (4)
Springfield Township			
(1) 1938-1974	.460	1.51	23
(2) 1975-1982	.290	.95	5
(3) 1977-1982	.560	1.84	4
Girard Township			
1938-1974	.380	1.25	14
1975-1982	.370	1.21	4
1977-1982	.400	1.31	4
Fairview Township			
1938-1974	.360	1.18	9
1975-1982	.060	.20	2
1977-1982	1.250	4.10	1
Millcreek Township			
1938-1974	.330	1.08	7
1975-1982	.152	.50	1
1977-1982	.180	.59	2
Lawrence Park Township			
1938-1974	.220	.72	8
1975-1982	.274	.90	1
1977-1982	.336	1.20	1
Harborcreek Township			
1938-1974	.160	.52	14
1975-1982	.091	.30	1
1977-1982	.310	1.02	6
North East Township			
1938-1974	.250	.82	14
1975-1982	-	-	-
1977-1982	.540	1.77	6

TABLE 6 (cont)

(1) Based on photogrammetric analysis of 1938 ASCS imagery and 1974 special coverage imagery and reported in a previous report (Knuth and Crowe, 1974).
(2) Based on measurements taken by survey technique from control points established incidental to previous recession studies (Knuth and Crowe, 1974).
(3) Based on measurements taken by survey technique from control points established as part of ongoing recession studies.
(4) n equals number of control points providing average loss per year.

TABLE 7

SCATTERGRAM OF RECESSION RATES



DISTRIBUTION OF AVERAGE RECESSION RATES BY TOWNSHIP

ERIE COUNTY PA

VOLUMETRIC LOSS DIGITIZING PROGRAM
ROUTINE AND DATA

AREA/DISTANCE INSTRUCTIONS

This program will compute the distance of any drawn line and the area/perimeter of any closed figure.

The program requires the input of the scale of the drawing or map. This is required of the program prior to the start of the drawing. Almost all maps provide a scale. An example is shown below.

```
0     10     20     30     40     50     60
I-----I-----I-----I-----I-----I-----I
              MILES
```

This scale is input to the computer by placing the versawriter pointer at one end of the scale on the map(for example, 0 above) when requested and then placing the pointer at the other end of the scale (for example 50 above) when requested. Finally, the scale's length and the units (for example, 50 miles) is input when requested.

If wishing to use a true size drawing, input a true size scale as follows. Using a ruler, a line exactly six inches is drawn on a blank sheet of paper. The versawriter pointer is positioned at one end of the drawn line and then at the other end of the line as directed by the program. Then 6 inches is input when requested.

In general, input the longest scale possible. The longer the scale, the better the accuracy of the area/distance calculation.

This mode is automatically entered at the beginning of the program. At any time during the program, a new "scale" may by specified by typing "I" (Initialization).

After specifying the scale of the drawing, the screen will display "enter mode" and a flashing curscr. The position of the flashing cursor is indicative of the position of the versawriter pointer on the drawing board.

Position the versawriter pointer at the beginning of the map or drawing. Then press"D" to begin drawing. Move the versawriter pointer as desired. The current distance covered will be continually displayed. At any time, the drawing may be stopped by pressing the space bar. Press "D" to continue drawing. If this new point is not the same point as the last point plotted when the space bar was pressed, a line will be immediately drawn from the last point to this new point. This function is very useful for drawing straight lines.

When a figure has been closed (the current pointer position returns to the beginning) just press "A" and the area and perimeter of the figure will be displayed.

"A" may be pressed even if the figure is not closed. The program will"close" the figure by plotting a straight line from the current position to the starting point. This line may be removed by pressing"D". Drawing may now be continued.

Other commands available are:

*Erase (E) - clears the screen and zeroes the distance and area counters.

*List (L) - displays the available commands. Entering this mode does not destroy the drawing. The space bar is pressed to return to it.

*Help (H) - displays these instructions.

*Quit (Q) - the approved method of exiting this program.

AREA/DISTANCE PROGRAM   Copyright 1979

```
10 GOTO300
100 CALL L1:X=PEEK (L2) + PEEK (L3) * 256:Y=PEEK (L4) / K1
105 IF ABS (X - XL) < 1 THEN X=XL
106 IF ABS (Y - YL) < 1 THEN Y=YL
110 X=(X + XL * SM) / (SM + 1):Y=(Y + YL * SM) / (SM + 1):XL=X:YL=Y:RETURN
300 A5=- 16384:A6=- 16368:A7=64668
310 L1=16416:L2=16411:L3=16412:L4=16413:SM=2.5
350 N1=256:N2=279:N3=0:N4=200.9:N5=127:N6=196:N7=193:N8=5:N9=1:N0=0.50
351 U1=23:U2=12:K1=.66
360 HCOLOR= 3:QQ=208:TWO=2
370 DI=0:AR=0:DL=0:AL=0
375 W1=201:W2=160:W3=204:W4=197:W5=196:W6=193:W7=200:W8=209
377 FT=0
380 UL=1E30
390 POKE 232,209:POKE 233,68:ROT= 0:SCALE= 1
400 GOTO4000
1000 FT=0:GOTO3500
1500 REM *** AREA ****
1550 HPLOT XS,YS * K1 TO XB,YB * K1
1560 AH=AR:DH=DI
1580 DI=DL + ( SQR ((XS - XB) * (XS - XB) + (YS - YB) * (YS - YB))) / UL
1600 AR=AL + ((XB * YS) - (YB * XS)) / (2 * UL * UL)
1620 PRINT:PRINT:PRINT:PRINT:PRINT"ENTER COMMAND"
1621 PRINT"AREA ="; ABS (AR);" SQUARE";UL$
1622 PRINT"PERIMETER =";DI;" ";UL$
1650 GOSUB 100
1660 XDRAW 1 AT X,Y * K1:V8=2 * V8 / 2:XDRAW 1 AT X,Y * K1
1670 QQ=PEEK (A5)
1680 IF QQ < 128 THEN 1650
1690 AR=AH:DI=DH
1700 HCOLOR= 0:HPLOT XS,YS * K1 TO XB,YB * K1:HCOLOR= 3
1710 GOTO5500:REM GOTOQQ TEST*
2000 REM **** DRAW ****
2020 IF FT=N9 THEN 2060
2025 GOSUB 100
2030 XB=X:YB=Y:XS=X:YS=Y
2040 FT=N9
2060 PRINT:PRINT:PRINT:PRINT:PRINT"ENTER COMMAND"
2062 PRINT:PRINT"DISTANCE ="
2070 HPLOT XB,YB * K1
2150 GOSUB 100
2160 HPLOT TO X,Y * K1
2165 DI=DL + ( SQR ((X - XB) * (X - XB) + (Y - YB) * (Y - YB))) / UL
2200 AR=AL + ((XB * Y) - (YB * X)) / (TWO * UL * UL)
2220 REM ***AREA CLOSED FIGURE******************************
2250 VTAB U1:HTAB U2:CALL A7
2252 PRINT DI;" ";UL$
2270 XB=X:YB=Y
2275 DL=DI:AL=AR
2280 QQ=PEEK (A5)
```

```
2290 IF QQ > NS THEN 5500
2300 GOTO2150
2700 REM **LIST OF COMMANDS(L)**
2730 GOSUB 5000
2760 GOTO5520
2800 REM ****UNIT LENGTH(I)****
2804 SR=SM:SM=0
2810 PRINT:PRINT:PRINT:PRINT
2820 PRINT"PLACE POINTER AT ONE END OF SCALE"
2830 PRINT"PRESS SPACE BAR WHEN READY"
2840 QQ=PEEK (AS):IF QQ=160 THEN 2865
2841 IF QQ > NS THEN 4065


2845 GOSUB 100
2850 XDRAW 1 AT X,Y * K1:VB=2 * VB / 2:XDRAW 1 AT X,Y * K1
2860 GOTO2840
2865 POKE A6,N3:X1=X:Y1=Y
2870 PRINT:PRINT:PRINT:PRINT
2880 PRINT"PLACE POINTER AT";:INVERSE:PRINT"OTHER";:NORMAL:PRINT" END OF
     SCALE"
2885 PRINT"PRESS SPACE BAR WHEN READY"
2890 QQ=PEEK (AS):IF QQ=160 THEN 2910
2891 IF QQ > NS THEN 4065
2895 GOSUB 100
2900 XDRAW 1 AT X,Y * K1:VB=2 * VB / 2:XDRAW 1 AT X,Y * K1
2905 GOTO2890
2910 POKE A6,N3:X2=X:Y2=Y
2915 PRINT:PRINT:PRINT:PRINT
2920 PRINT"WHAT IS LENGTH OF SCALE (EG 12 MILES) ?
2925 INPUT SC$
2930 G2=LEN (SC$)
2940 SC=VAL (SC$)
2950 G1$=STR$ (SC)
2960 G1=LEN (G1$)
2970 G3=G2 - G1
2980 IF G3=0 OR G2=0 OR SC=0 THEN PRINT:PRINT:PRINT:PRINT:PRINT"WHAT ????
     A NUMBER AND UNIT PLEASE":PRINT:GOTO2920
2990 UL$=RIGHT$ (SC$,G3)
3060 UL=( SQR ((X2 - X1) * (X2 - X1) + (Y2 - Y1) * (Y2 - Y1))) / SC
3070 IF UL=0 THEN PRINT:PRINT:PRINT:PRINT:PRINT"ENTRY IN ERROR":GOTO2820
3090 SM=SR
3100 GOTO3720:REM GOTOERASE (&CURSOR)
3500 REM ****CURSOR(SB)****
3502 PRINT:PRINT:PRINT:PRINT:PRINT"ENTER COMMAND"
3503 PRINT
3505 PRINT"DISTANCE =";DI;"";UL$
3510 GOSUB 100
3520 XDRAW 1 AT X,Y * K1:VB=2 * VB / 2:XDRAW 1 AT X,Y * K1
3530 QQ=PEEK (AS)
```

```
3540 IF QQ > N5 THEN 5500
3550 GOTO3510
3700 REM ***ERASE(E)****
3710 HGR
3720 FT=0
3740 DI=0:DL=0:AR=0:AL=0
3745 XS=0:YS=0:XB=0:YB=0
3850 GOTO3500
4000 IF PEEK (7)=0 THEN HGR:PRINT"BLOAD MACHINE ROUTINES"
4010 IF PEEK (7)=8 THEN 4065
4050 SPEED= 100
4065 GOSUB 5000
4067 POKE 7,8
4068 IF A$ ="H" THEN PRINT"RUN HELP"
4070 GOTO2800
5000 TEXT
5001 POKE A6,N3
5005 CALL - 936
5009 PRINT
5010 PRINT" ** AREA/DISTANCE **"
5013 PRINT:PRINT" A VERSAWRITER APPLICATION PROGRAM"
5015 PRINT" BY G.R. SEE & V.W. BAUMAN"
5020 PRINT
5030 PRINT" COPYRIGHT 1979 VERSA COMPUTING INC."
5040 PRINT
5045 SPEED= 255
5050 PRINT"COMMANDS ARE:":PRINT
5060 PRINT"I INITIALIZE"
5070 PRINT"E ERASE"
5080 PRINT"D START DRAWING"
5090 PRINT"A COMPUTE AREA"
5091 PRINT"T TRANSFER TO DISK"
5092 PRINT"R RECALL FROM DISK"
5093 PRINT"N START AT NEW POINT"
5095 PRINT"L LIST OF COMMANDS"
5097 IF PEEK (7)=8 THEN 5099
5098 PRINT"H HELP-INSTRUCTIONS"
5099 PRINT"Q QUIT SESSION"
5100 PRINT"SPACE BAR STOP DRAWING"
5106 IF PEEK (7)=8 THEN PRINT:PRINT:GOTO5110
5107 PRINT" PRESS 'H' FOR MORE HELP":PRINT
5110 INVERSE:PRINT" PRESS SPACE BAR TO CONTINUE"
5112 NORMAL:HTAB 17:GET A$
5113 QQ=ASC (A$) + 128
5114 IF A$ ="Q" THEN CALL - 936:GOTO7000
5120 HTAB 0:VTAB 24
5122 POKE - 16304,0:POKE - 16297,0
5130 HCOLOR= 3
5140 RETURN
5500 REM ****QQ LOOKUP****
5510 POKE A6,N3
5520 IF QQ=W1 THEN 2800:REM (I)
```

```
5540 IF QQ=W2 THEN 3500:REM (SB)
5560 IF QQ=W3 THEN 2700:REM (L)
5580 IF QQ=W4 THEN 3700:REM (E)
5600 IF QQ=W5 THEN 2000:REM (D)
5620 IF QQ=W6 THEN 1500:REM (A)
5650 IF QQ=W8 THEN 7000:REM (Q)
5660 IF QQ=212 THEN 8000:(T)
5670 IF QQ=210 THEN 9000:(R)
5680 IF QQ=206 THEN 1000:(N)
5800 GOTO3500 REM DEFAULT**
7000 PRINT:PRINT:PRINT:PRINT:PRINT"ADIOS":PRINT:PRINT:PRINT"RUN VERSAWRITER"
8000 PRINT:PRINT:PRINT:INPUT"SAVE PICTURE BY WHAT NAME? (RTN CANCELS)";A$
8005 IF A$ ="" THEN 2700
8010 PRINT"BSAVE";A$;",A$2000,L$2000"
8020 GOTO2700
9000 PRINT:PRINT:PRINT:INPUT"RECALL WHAT PICTURE NAME? (RET CANCELS)";A$
9005 IF A$ ="" THEN 2700
9010 PRINT"BLOAD";A$
9020 GOTO2700
```

Notes on Volumetric Loss Data

1. Positive readings occur when material from above or from the side of the measured line is depositied on the bluff face. Wasting of the strand may, for example deposit material on any of the horizons below giving the impression that the bluff is "growing". Eventually, such material will continue down the bluff face and be eroded by waves and currents.

2. Recent sediments weathered from any of the horizons tend to "fluff". Therefore, the cubic foot gain at the base is out of proportion with the cubic foot loss at the crest.

3. The volumetric loss is for the measured line only. In many cases, losses to either side of the line were extreme. These losses are not reflected in the volumetric data. (See Section A)

4. In all cases, the loss was computed over the length of the bluff face and over a width of one foot at the profile line.

VOLUMETRIC LOSS (ft^3)
(1982 - 1983)

Site #	STRAND	LACUS.	TILL I	TILL II	BEDROCK	COLLUVIUM
1	-	99.82	55.28	46.39	-	-
2	1.90	7.52	7.25	9.56	-	-
3	3.32	35.34	37.60	115.22		
4	10.36	63.45	51.02	112.75		
6		14.11	20.39	93.74		
7		4.03	12.09	1.81		
10		7.49	161.61	+ 19.76		
13	6.90	18.10	90.00	0		
14	42.5	-	-	19.95		
18	18.84	+74.31	+275.81	-		73.98
19		73.47	215.16	185.79		67.14
20		5.20	111.84	315.02		
21		19.36	86.99	170.46		
22		16.00	148.38	129.91		
24				8.21		
28				+24.61		
30		36.25		+71.04		
33			20.30	62.91		
47	11.14			19.71		
49				+ 8.05		
53				10.59		
54	16.86	62.20	113.23	35.79		
55				+120.94		
69			5.83	35.36		
70			3.50	34.44		