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ENVIRONMENTAL SURVEY, LITTLE SAND BAY HEADQUARTERS SITE, APOSTLE ISLANDS NATIONAL LAKESHORE, WISCONSIN

SUBMITTED TO

Midwest Regional Office
National Park Service
Department of the Interior

BY THE

Center for Lake Superior Environmental Studies
University of Wisconsin, Superior

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INTRODUCTION

The concept for this environmental review and study dates to 20 October, 1973, at which time Mr. Warren Bielenberg, Park Naturalist, Apostle Islands National Lakeshore (AINL), visited the offices of the Center for Lake Superior Environmental Studies (CLSES) on the campus of the University of Wisconsin, Superior to discuss the nature and priority of research necessary to the developmental processes of creating and opening these new National Park Service properties. Resulting from this meeting a CLSES analysis report listing four categories of studies projected over the period 1974-1978 was submitted to Mr. William Bromberg, Superintendent AINL (since retired and replaced by the present superintendent, Mr. Patrick Miller) through Warren Bielenberg. Under category A of this report, dated 1 November, 1973, two multidisciplinary projects were suggested for the summer 1974. In a return letter, dated 14 November, 1973, Mr. Bielenberg accepted in principle this report and invited submission of full scale proposals dealing with the two projected 1974 studies. These proposals were ultimately completed and multiple copies submitted to Mr. Bielenberg. Title and pertinent facts concerning each are as follows:

1. "Environmental Impact of Visitors to the Apostle Islands National Lakeshore", submitted 28 December, 1973. Requested budget $17,874.
2. "Land Planning, Immediate Headquarters Vicinity, Apostle Islands National Lakeshore", submitted 4 February, 1974. Requested budget $4,993.

Both were submitted to the Omaha, Nebraska office of the National Park Service for review. On 3 June, 1974 the second proposal listed above was tentatively approved by Mr. Max Holden, Acting Chief Scientist of the Omaha Office. By the 12th of June a contract had been drawn up and sent to CLSES by Mr. Merrill D. Beal, Acting Regional Director, Midwest Region. Finally on 19 June, signed copies were returned by Albert B. Dickas, Director of CLSES to Mr. Beal, thus officially initiating this study.

Field studies were inaugurated on the 5th of June following a meeting between CLSES and AINL personnel in the headquarters building at Little Sand Bay, Wisconsin. Studies progressed all summer and well into late September, 1974.

OBJECTIVES

The objectives of this study, as outlined in the proposal submitted to NPS (dated 4 February, 1974) and later verified in Contract #CX 6000-4-0144 (dated 12 June, 1974), were based on an initial determination of the existing physical, hydrologic, and vegetative parameters of the vicinity of Little Sand Bay. These investigations were to include topographic relief, drainage and reconnaissance soil analyses (type and depth) and a determination of the water quality of the streams and inland bodies of water of the specific study and regional area. Certain water quality parameters have been found to be of special significance in the consideration of ecological balance and thus were to be included in this study. These parameters were among others, dissolved oxygen (DO) nitrates, phosphates, and fecal coliform counts.

A vegetation cover analysis of Little Sand Bay flora would be performed with special emphasis placed on the type and location of unique or unusual forms. Later this information, along with that discussed above, would be co-ordinated with geological points of interest and utilized in the placement of a natural trail system that would maximize the appreciation of the park environment while protecting its fragile ecology.

Following the collection and interpretation of all the above parameters, maps and charts would be drawn, summarizing the findings and serving as a media basis for recommendations from the principal investigators for best use of the park as an administrative site and visitor center with the least harm to the environment.

Of immediate concern would be the placement of several service clusters already preliminarily approved for park development. These clusters include:

1. Administrative headquarters, including visitor center and concession
2. Maintenance structure
3. Picnic area (for approximately 30 campsites)
4. Parking for 250 vehicles
5. Parking for 100 vehicle-trailer combinations
6. Housing area (six (6) single families and three (3) duplex seasonal residences)
7. Sewage leaching field and/or treatment plant
8. Sewage lines
9. Marina for camper access to offshore islands
10. Living history-nature interpretative trails
11. Entrance roads

An environmentally sound recommendation relating to the placement of these clusters in the park area is one of the primary goals of this investigation. It must, however, be based on an initial, careful, and complete environmental survey of the Little Sand Bay area. These same data, serving concomitantly with the above goals, would also provide baseline data for assessment of future park development. Such baseline information is necessary for recognition and control of future environmental problems and is presented in the following section of this report.

DISCUSSION OF ENVIRONMENTAL SURVEYS

A. DRAINAGE AND TOPOGRAPHY

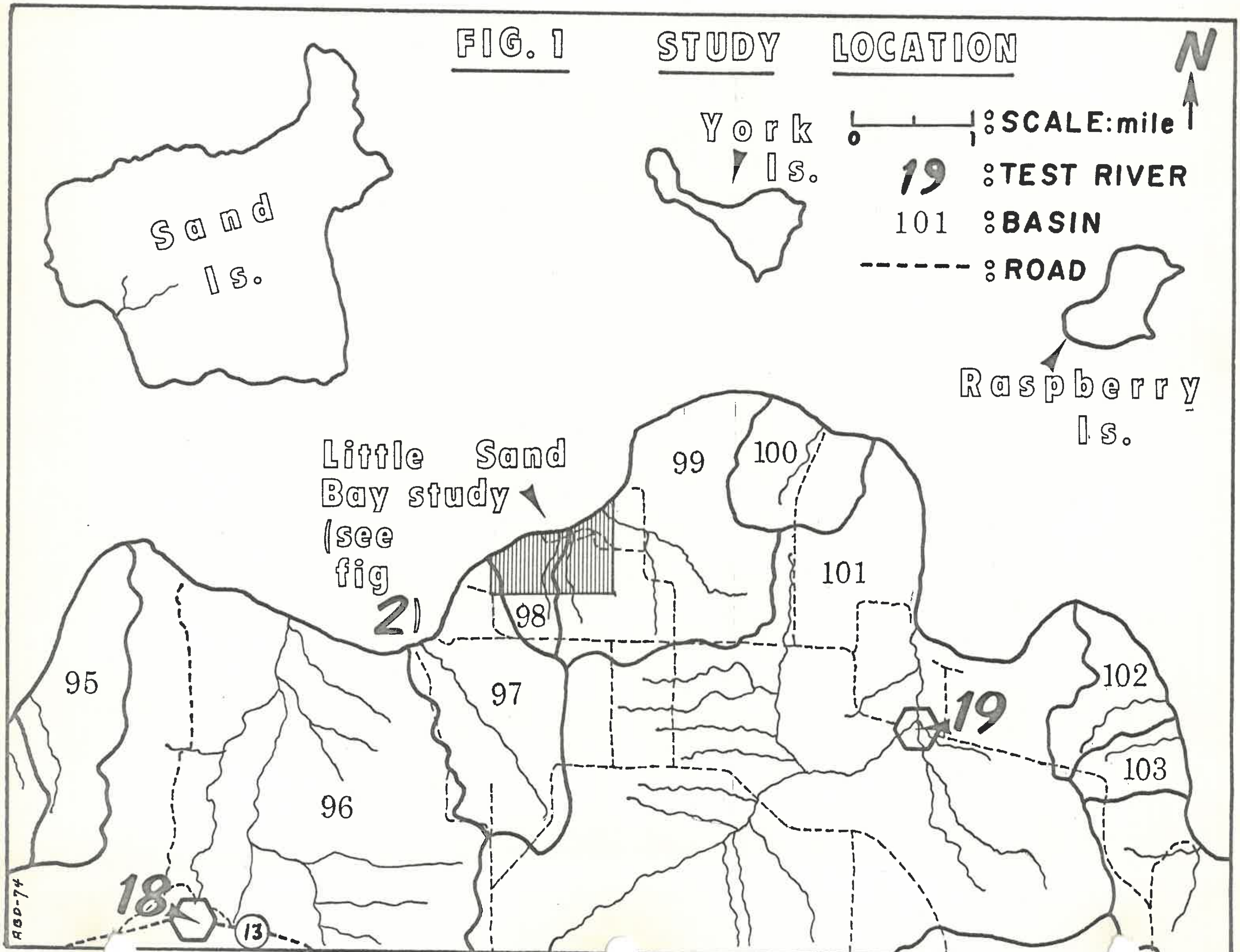
It is generally agreed that most site developments undertaken today must be compatible with both the possibilities and limitations of our national environment and its resource base. Pre-development analysis must, therefore, take into account the problems presented by physical site factors; principally, in this case, those factors of drainage patterns, relief, topography and slope.

A useful method of terrain analysis must accomplish two goals. It must provide the necessary pre-information concerning physical site factors, and at the same time take into account and be sensitive to the interactions of these factors. This section addresses itself to such analyses as relating to the Little Sand Bay site.

Drainage: Drainage is studied according to its pattern type and its texture or density and is probably the most important single identifier of land forms. The study area is divided by two small unnamed basins, herein termed basin number 98 and 99 (figure 1). As these basins contain, respectively, only 0.4 and 2.8 square miles, their contained rivers are too small for formal geometric classification. A review of the surrounding basins, however, indicates that this is an area of dendritic drainage patterns. The dendritic pattern is characterized by a treelike branching system in which the tributaries join the gently curving trunkstream at acute angles. Throughout the upper mid-west, the occurrence of this type of drainage system indicates homogeneous, uniform soils, often dissected deposits of Pleistocene glacial tills (see Soils section of this report).*

**Number coding results from a regional, two year water quality study conducted in northern Wisconsin, 1972-1974, by the Center for Lake Superior Environmental Studies. Pertinent results of this study are reported in the Water Quality section of this report.*

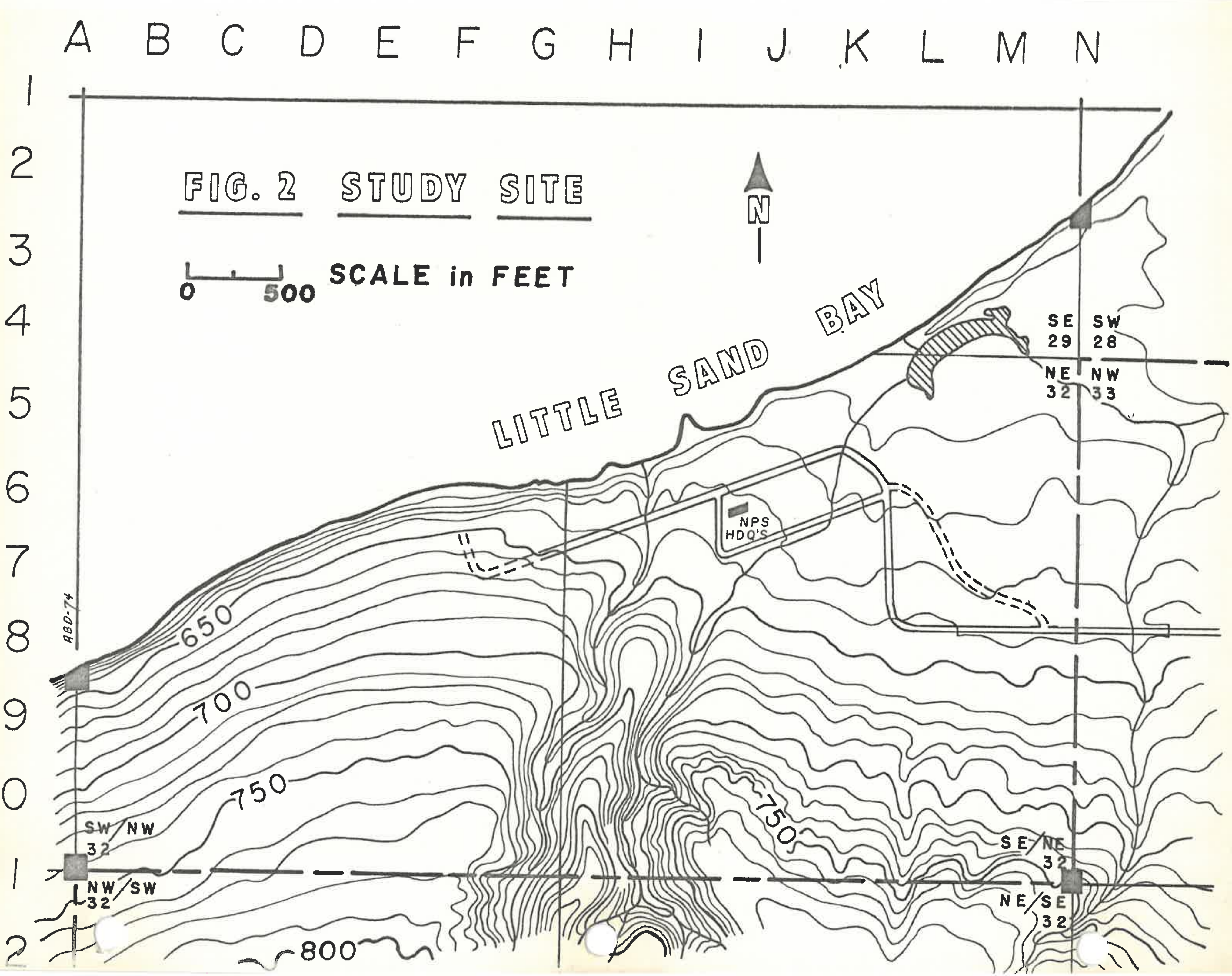
FIG. 1 STUDY LOCATION



Relief: Relief is defined as the difference between the lowest and highest elevation within the area of study. With a U. S. Lake Survey low water datum of 600 feet for Lake Superior and a maximum elevation of 786 feet (section J-11, figure 2), the AINL Headquarters study site has a relief of 186 feet. This value is considered moderate for this area.

Topography: The topography of a landform is verbally described by indicating its degree of dissection and continuity. Generally speaking, the subject area is composed of a gently rounded slope plunging northward toward the shore of Lake Superior. The central sector (H-7 to H-11, figure 2) is broken up into two sub-parallel steepsided stream valleys, each possessing average relief of fifty (50) to sixty (60) feet. The 1964 Bayfield Quadrangle (USGS - N4645-W9045/15) does not accurately display the series of two wave cut bench and cliff systems mapped in the southwestern sector of the study area (see figure 7). These high-water glacial Lake Superior erosion features are found approximately at the 710 and 740 foot elevation. W. R. Farrand, in his report on the Quaternary History of Lake Superior (1969), reports that a number of individual glacial lake stages have been recognized in the time interval "today to 12,000 years ago" in the Lake Superior Basin, but that most are weakly developed and apparently mark minor halts in the period of rapidly falling lake level associated with the demise of the Pleistocene glacial period in North America. The lake level erosion effects mapped at Little Sand Bay are post-Beaver Bay, pre-Manitou stage in age. According to Farrand, these wave cut bench and cliff systems were formed by glacial lake erosion approximately 10,800 years ago.

Slope: Slope analysis is an indication of the steepness of topography of an area and is related directly to soil erosion potential, susceptibility

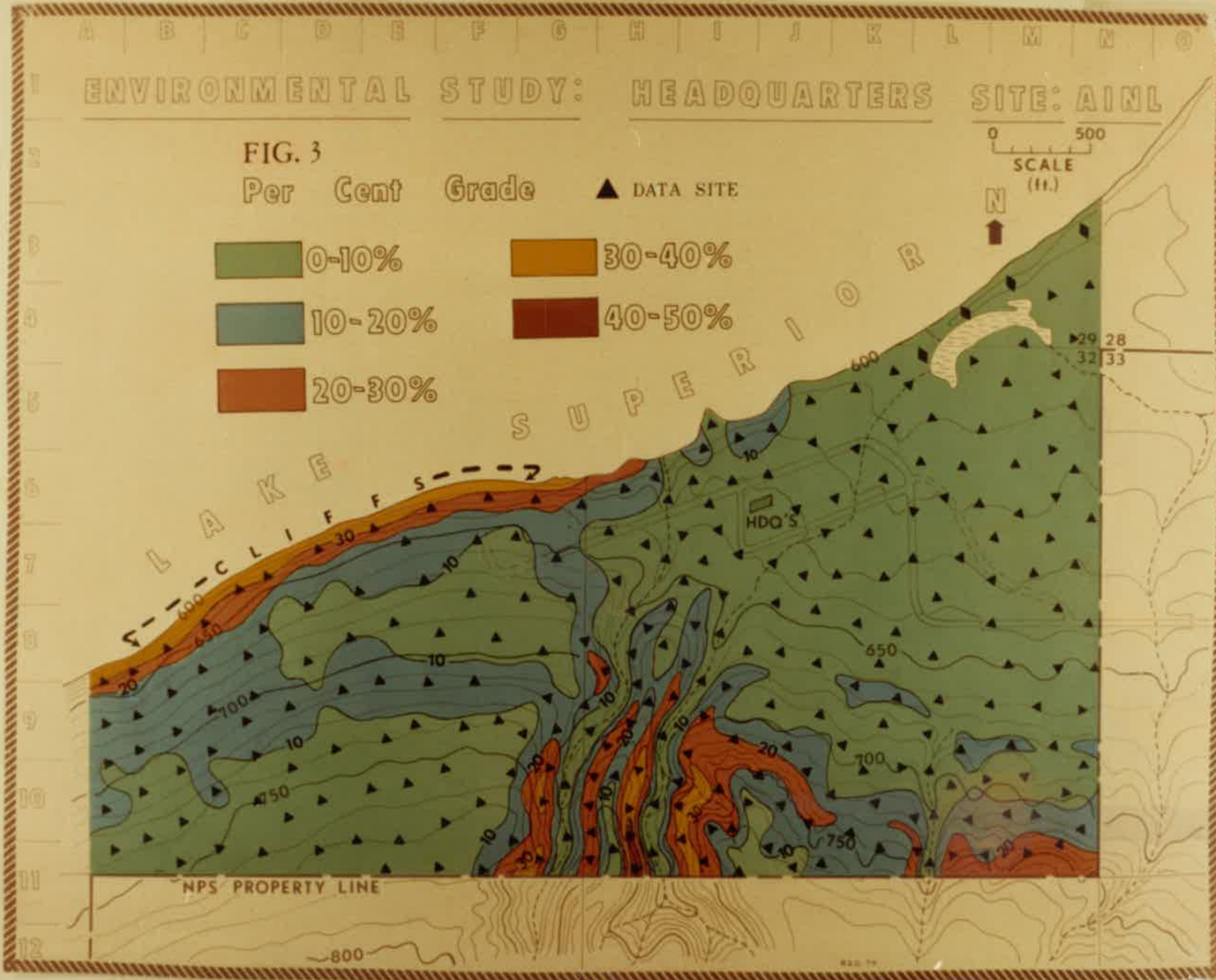

A B C D E F G H I J K L M N
1 2 3 4 5 6 7 8 9 10 11 12
FIG. 2 STUDY SITE
0 500 SCALE in FEET
N
LITTLE SAND BAY
NPS HDQ'S
650
700
750
750
800
SE 29
SW 28
NE 32
NW 33
SW/NW 32
NW/SW 32
SE/NE 32
NE/SE 32
ABD-74

to gullying (channelized surface water flow) and relief development. The inclination of a sloping surface may be expressed as a ratio, an angle measured in degrees from the horizontal or as a percentage. The latter presentation was chosen for this report. On figure 3, each black triangle thus represents a slope calculation relating to the ratio of vertical distance to horizontal distance and expressed as percent grade. In this study, the site topographic map was laboratory analyzed at over 270 sites and the resulting slope plotted in units of ten percent. The finished map (see figure 3) displays two large areas of normal, regional slope lying within the 0-20 percent grade range and located in the western sector and the eastern sector of the study area. Localized points of interest and greater than regional slope include the following:

1. Vertical slope, composed of very ancient (Keweenawan; over 600 million years of age) sandstone, forming the shoreline in the area H-6 to A-9.
2. A triangular shaped area of excessive and abrupt slope change associated principally with the valleys of the aforementioned unnamed river systems. This area is bounded by N-10 northwest to H-8 and southwest to F-11. Considering future use, this area should be avoided except for potential employment as a partial site for a nature trail.

B. SOILS

The Little Sand Bay area is located in Bayfield County within the Lake Superior Lowland physiographic province of Wisconsin. Elevations here generally range between 580 and 1000 feet above sea level and the entire north boundary of Bayfield County consists of rugged shoreline--portions of which face out toward the Apostle Islands. Sand and York Islands are the two members of the


ENVIRONMENTAL STUDY: HEADQUARTERS SITE: AINL
FIG. 3
Per Cent Grade
DATA SITE
0-10%
10-20%
20-30%
30-40%
40-50%
SCALE (ft.)
0
500
N
LAKE SUPERIOR
CLIFFS
HDQ'S
NPS PROPERTY LINE
600
650
700
750
800
29 28
32 33

Checking Slopes and Soils in the Field. Sector G-9
Left to Right: Mr. Paul Ruez, Geologist
Dr. Albert Dickas, Geologist
Dr. Paul Tychsen, Geologist
In Right Background, Left to Right
Dr. Rudy Koch, Biologist
Mr. Warren Bielenberg,
Apostle Island National Lakeshore, Park Naturalist

Shoreline, Rock face, Bearing Cryptogams, Typical of Cliff Zone In Northwest Section of Study Area.

Photo Taken in F-6 Sector in June, 1974

Apostle group closest to Little Sand Bay; Sand Island is approximately two and one-third miles offshore and York Island lies two and one-half miles to the northeast. These islands, as well as prominent headlands such as Sand Point to the west and Point Detour immediately to the east, afford some wind and wave protection to the Little Sand Bay locality.

By virtue of being located in the southern portion of the Canadian Shield, the bedrock is entirely of Precambrian age (over 600 million years) and consists of Keweenawan age lava flows (not exposed) and overlying sandstone units of late Keweenawan time which comprise the Lake Superior Sandstone. The specific unit of the Lake Superior Sandstone exposed in the Little Sand Bay area is the Chequamegon Sandstone (Thwaites, 1912) which has a maximum thickness of 1000 feet and outcrops within the project boundaries and along the shoreline immediately to the west. Prominent headlands such as Sand Point and Point Detour are underlain by this unit.

The Chequamegon Sandstone is composed predominantly of quartz grains with thin lenticular beds of red sandy shale and generally dips to the southeast at less than five degrees to the horizontal. The outcrops of this sandstone in the western portion of the project area (see figure 7) are conglomeritic in part and represent areas where the bedrock has been exposed by wave action during times when the lake level was considerably higher than present levels. There is considerable variance, however, in depth to bedrock from zero depths at the outcrop areas mentioned above to maximum depth in the bayhead area. The depth to bedrock at Sand Bay (NE 1/4 of Sec. 1, T, 51N., R. 5 W.)is 225 feet while the maximum bedrock depth at the Little Sand Bay head (beach zone) is estimated to be over 40 feet (personal communication, local well-diggers, August 1974). This situation is typical of most of the bays on this portion of the peninsula and the writer is of the opinion that ice lobes extending out from the parent glacier within the Lake Superior basin scoured and greatly deepened the bay areas as the lobes moved toward the south. The present headlands along the coast represent rock masses which partially escaped severe degradation by the ice.

As mentioned above, the outcrops which occur in the western portion of the project area are ancient shorelines developed at high glacial lake levels. The most prominent shoreline occurs at an elevation of approximately 740 feet and a second, less conspicuous shoreline is found at 710 feet. The 740 line, represented by a wave cut bench and cliff system, displays a cliff slope of 11 degrees (19% grade) while the 710 line indicates a cliff slope of slightly over 8 degrees (14% grade). The upper or 740 wave cut cliff averages approximately 135 feet wide while the lower cliff at 710 feet is 155 feet in width. Both fossil beaches are well exposed along the north-south road (A-8 to A-12, figure 7) which marks the western boundary of the project area. The 740 shoreline is the more continuous of the two, is marked by more frequent outcrops, and would form a more desirable visitor attraction sector.

A narrow sand beach averaging between 20-25 feet in width extends along the shore in the eastern portion of the project area and consists of clean, medium to coarse size fragments predominantly of quartz. As previously mentioned, maximum depth to bedrock will be found within this portion of the project area.

Soils differ from rocks in that they are composed of layers called horizons which are roughly parallel to the land surface on which they formed. These horizons differ from each other as well as from the underlying rock as a result of prolonged weathering and related processes such as time, topography, parent material, biotic factor, etc. The particular soil which occurs within the project area is the Gray Wooded type, subdivided into the Ontonagon-Pickford-

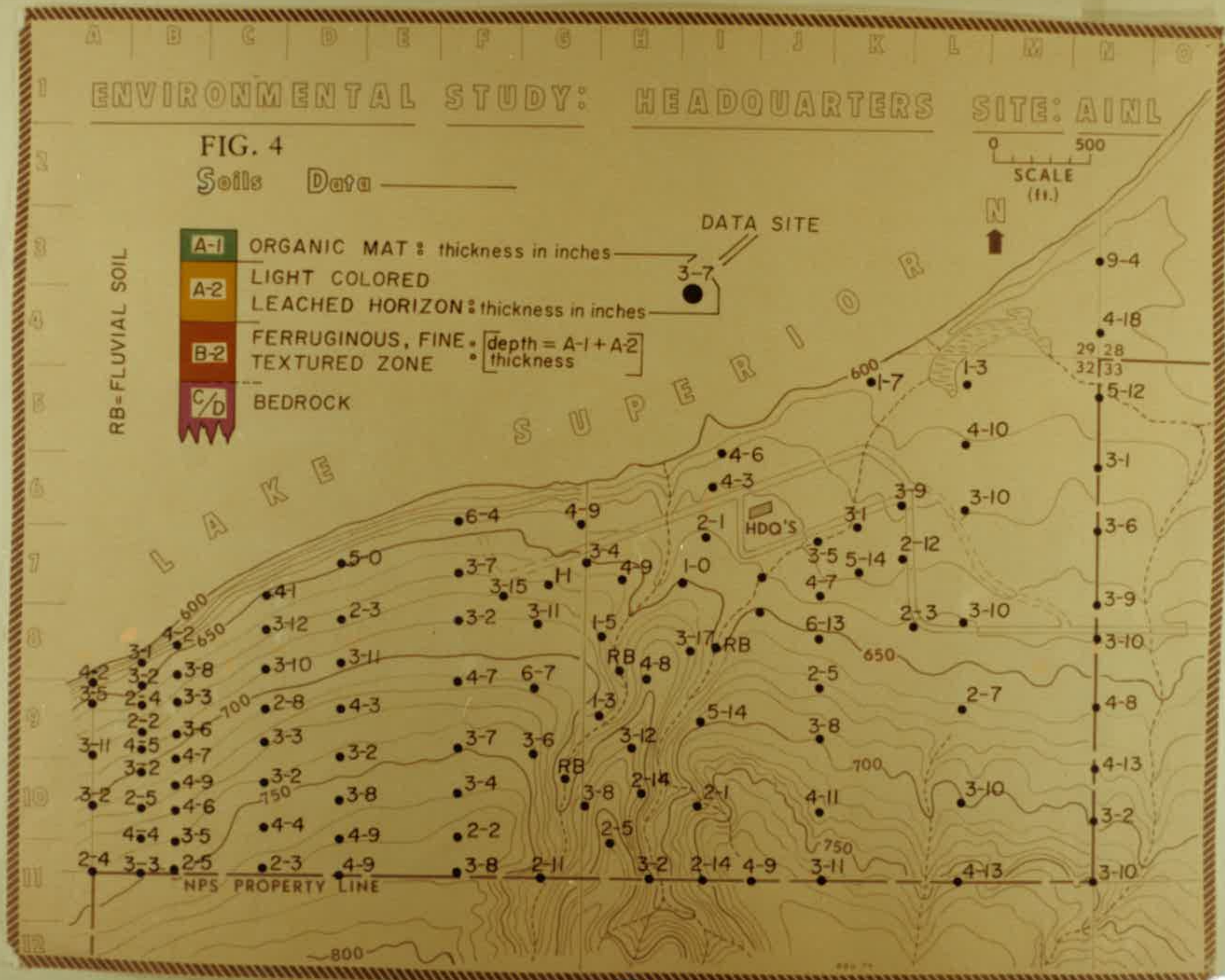
Dr. Paul Tychsen, Soils Geologist, Points Out Contact Between Leached A-2 (Hidden in Shadow) and Ferruginous B-2 (Red) Soil Horizons. Located in 1-7 Sector.

Photos Taken in June of 1974.

Partial Exposure of Wave Cut Cliff In Sector A-11.

Bergland soils (Soils of North Central Region of U.S., 1960). The Gray Wooded soil typically develops under a forest cover of deciduous, coniferous, or mixed deciduous and coniferous trees (the forest type studied here) and under nearly level to strongly rolling or steep relief created by stream activity. The parent material is a thin, unconsolidated, calcareous glacial deposit lying over the Lake Superior sandstone unit.

As displayed on the soils map (figure 4), a fairly well-developed organic mat averaging 3 to 4 inches in thickness forms the top horizon and is referred to as the A_1 horizon. It is somewhat thinner on steep slopes adjoining stream valleys within the project area. Immediately beneath this horizon occurs a light-colored, gray, leached horizon which constitutes one of the most distinctive features of the Gray Wooded soil type. This so-called A_2 horizon was found to vary considerably in thickness from a minimum of 1 inch (B-8, figure 4) to a maximum of 18 inches (N-3, figure 4), the thicker horizons occurring on more level terrain. This is a thoroughly leached horizon, low in sesquioxides, and unique in its ash-like appearance. The B_1 horizon, when present, is a thin, dark-colored unit enriched in humus. It is often missing or not recognizable and was not detected within the project area profiles. The underlying B_2 horizon is typically a ferruginous color, enriched in sesquioxides, and extends down to parent bedrock material. The thickness of the B_2 horizon to the bottom of the pit varied from a minimum of 2 inches (G-7; figure 4) to a maximum of 60 inches in exposures along the shore. In many of the test pits, a bouldery horizon was encountered at the base of the B_2 horizon and consisted of sub to well-rounded pebbles, cobbles, and boulders representing ancient high-energy shoreline deposits. In places, however, particularly along the shoreline in the western portion of the project area, red clay immediately underlies


ENVIRONMENTAL STUDY: HEADQUARTERS SITE: AINL
FIG. 4
Soils Data
RB=FLUVIAL SOIL
A-1 ORGANIC MAT: thickness in inches
A-2 LIGHT COLORED LEACHED HORIZON: thickness in inches
B-2 FERRUGINOUS, FINE TEXTURED ZONE: [depth = A-1 + A-2 ; thickness]
C/D BEDROCK
DATA SITE
3-7
SCALE (ft.)
0
500
N
LAKE SUPERIOR
HDQ'S
NPS PROPERTY LINE
600
650
700
750
800

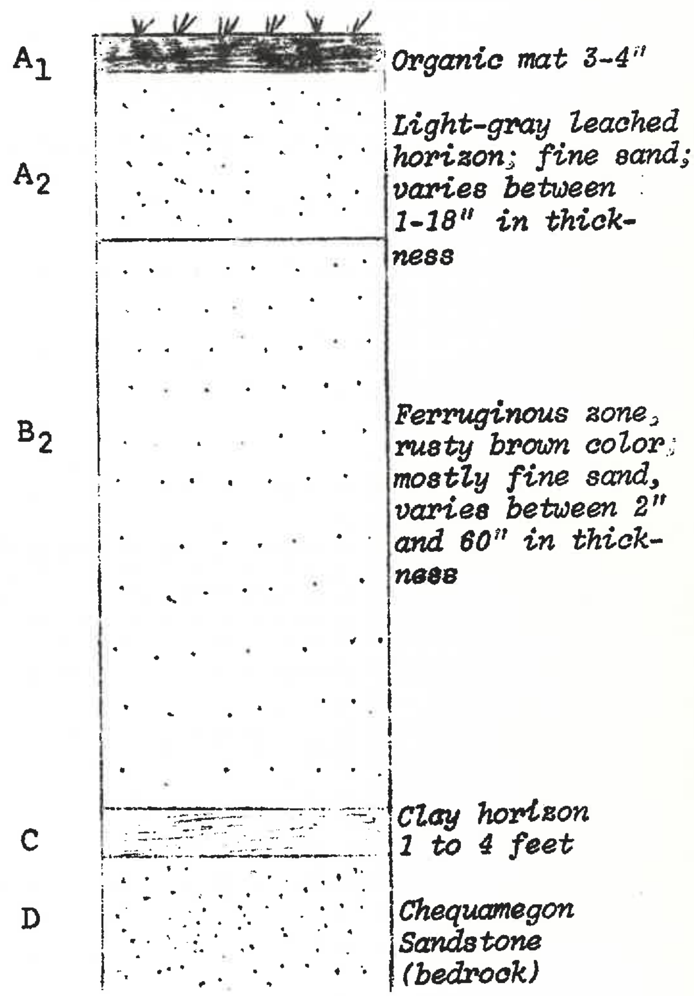
the B_2 horizon and in turn rests directly on weathered bedrock (C horizon). The red clay varies in thickness and represents the parent material for much of the overlying B_2 horizon.

Percolation tests carried out in the area immediately south of the present National Park Headquarters Building (because of availability of clear water) indicated a varying rate of water movement through the upper soil horizons. On August 22, 1974, a test pit 12 inches in diameter and 12 inches deep required 7 minutes to drain the first test and 7 minutes, 20 seconds to drain the second test. The table below indicates the rate of water withdrawal from the pit after the second filling:

Time	Water Level Distance Below Reference Point
After 1 minute(s)	2 1/2 inches
After 2 minute(s)	3 1/2 inches
After 3 minute(s)	4 inches
After 4 minute(s)	4.5 inches
After 5 minute(s)	5 inches
After 6 minute(s)	5.7 inches
After 7 minute(s)	5.9 inches
After 7 minute(s) 20 seconds	6.0 inches

The rate of downward water percolation, as indicated on the above table, is fair and the absorbing qualities of the A_2 and B_2 horizons would be maximum for the entire soil profile. However, clay horizons exist at the base of the B_2 horizon and considerable lateral drainage may be anticipated when these horizons are encountered by the downward percolating water. Young and Skinner (1974) indicate a general permeability rating for this immediate area is 0.05-0.2 inches per hour under a 0.5 inch head. This figure indicates a low permeability *rate. The State Health Code H. 62.20 (1969) defines unsuitable sites (for conventional septic tank-soil disposal systems) as those having a percolution rate slower than 60 minutes/inch.*

Typical Soil Profile



Soil samples taken from the A_2 and the B_2 horizon were measured for particle size distribution. The two sites were believed to be representative of the soil types within the project area. Folk and Ward's (1957) method for determination of "Inclusive Graphic Standard Deviation" presents a statistical estimate of the degree of sorting based on a modal analysis of various particle size (∅) ranges. Utilizing this method, both of the above samples fall into the "poorly sorted" category with the sample from the A_2 horizon showing a slight skewing toward the coarser size ranges and the B_2 horizon site showing a very slight tendency towards the finer size particles. The graphic mean of the A_2 horizon was 1.92 ∅ and for the B_2 horizon was 2.26 ∅. This indicates that both areas are represented by generally fine to medium sand (1/16 to 1/4 mm. in diameter particles).

The above data substantiated the data indicated by the percolation test, namely the fair to low permeability of the soils. Poor sorting indicates a relatively low percentage of void space (filled in by smaller particles) and subsequent low rate of percolation. Greater amounts of void space and better permeability would be found in better sorted (fewer size ranges) soils.

C. VEGETATION

Part I: General Habitat Description

For purposes of discussion, it seems best to divide the study area into a number of sites. These can be located on the map (figure 5), and the following descriptions will serve as a general guide to the vegetation of the specific sites. A list of species collected appears in Appendix A. Nomenclature generally follows that of Gleason and Cronquist (1952). Voucher specimens for species cited are available in the herbarium of the University of Wisconsin-Superior.

Beach: adjacent to the marsh on the lake side; a small remnant of sand beach typical of the Great Lakes is found. Dominant species here include beach grass (Ammophila breviligulata), beach pea (Lathyrus maritimus), wild rye (Elymus canadensis), and evening primrose (Oenothera biennis). Behind this stand is a small forest element with a higher composition of pine (Pinus sp.). Blueberry (Vaccinium sp.) is common, and the ground cover is similar to that found in the forests described below, though more grasses and sedges are present. This is an unusually small example of the beach vegetation community, but its location on the headquarters site suggests that it be used for education and demonstration purposes.

Wetlands: There is a small water impoundment formed by wave action and associated beach sand transport which closes off the lake entry of a small stream. In the pond is found the yellow water lily (Nuphar microphyllum), bur-reed (Sparganium sp.) and bladderwort (Utricularia vulgaris). Sedges (Carex sp.), sweet gale (Myrica gale), and sweet flag (Acorus calamus) are abundant around the margin of the pond. Along the course of the stream is a marsh community dominated by sedges (Carex sp.), leather-leaf (Chaemedaphne calyculata), and Sphagnum. In some areas Typha is present. The margin of the marsh supports stands of alder (Alnus sp.) and some ash (Fraxinus sp.). Common herbaceous


ENVIRONMENTAL STUDY: HEADQUARTERS SITE: AINL
FIG. 5
Vegetation
Beach Community
sand
beach forest
Wetlands
pond
marsh
Clearing
Forests
I
II
northern hardwood
lowland
SCALE (ft.)
0
500
N
LAKE SUPERIOR
HDQ'S
600
650
700
750
800
NPS PROPERTY LINE
29 28
32 33

species here include iris (Iris versicolor), water arum (Calla palustris), and two mosses common in such mesic environments (Mnium sp. and Drepanocladus sp.). On the marsh proper is the rose pogonia (Pogonia ophioglossoides), pitcher plant (Sarracenia purpurea) and the sundew (Drosera sp.). The occurrence of these species indicates that the wetland has bog-like features, but it is not a typical bog. Consideration should be given to locating a trail into or out part of the wet land, however, so visitors can see this habitat.

Forests: A detailed analysis of the forests appears in Part II. Although there is a differing composition between areas in the forest element, only two types of forest are recognized. The northern hardwoods forest comprises the bulk of the landscape. Woody species are listed in Part II. Dominant herbaceous species include Clinton's lily (Clintonia borealis), Canadian dogwood (Cornus canadensis), and twin-flower (Trientalis borealis). Various species of violet (Viola sp.) occur in moist areas. The ravines and low spots also support large growths of marsh marigold (Caltha palustris) and numerous species of sedge (Carex sp.). Later in the growing season one finds the broad-leaved orchid (Habenaria orbiculatus) which is locally very abundant as is twisted stalk (Streptopus roseus) and club moss (Lycopodium sp.). A variety of ferns, especially in lower, more mesic areas, is abundant. The forest floor frequently supports a dense stand of maple (Acer sp.) seedlings. Wild sarsparilla (Aralia nudicaulis) is conspicuous, and the broad-leaved aster (Aster macrophyllum) is common.

The second, or lowland forest is dominated by conifers (white cedar, fir, and hemlock) and is found on the poorly drained soils near the marsh. Most of the species listed above are present in this stand. There is a significant increase in the amount of bare soil exposed, and the moss cover is more extensive here.

Cleared and Disturbed Sites: A small portion of the site is currently occupied by cabins and other dwellings and associated activities of human use. Road margins, parking lots, camp sites, and abandoned cabin sites have a vegetative cover which is characterized by "weedy" species. Various knotweeds, grasses, and composites are present. This region, though present, will not be described further. Old cabin sites will return to the surrounding vegetative type quickly, and other areas will probably be the site of future development.

There appears to be no specific location in the area which is either botanically unique or unusual. The beach community is small, fragile, and subject to disturbance by visitors. All efforts should be made to minimize visitor impact in this area, though a trail would be desirable to allow visitors to view this small habitat. The wetlands are typical of the area. Again prohibitions about taking particularly interesting plant species, including sundew, pitcher plant, and all orchids, should be incorporated into use plans. Like the beach, this area is quite fragile, and visitors should be allowed only to look. Elevated walkways are recommended. A loop trail passing through the beach area, over the marsh, and returning in the lowland forest, though somewhat expensive to construct, would provide the best view of the area.

On the other side of the site the predominant vegetative stand is the northern hardwoods. A trail located at random would allow visitors to see the elements of that vegetative type. There are no significantly large trees, (i.e., the large trees are well distributed throughout the stand). A logical trail site is suggested, however, by the presence of the ravines. Entering a ravine and crossing over, then moving quickly to the ravine summit, and then looping through the forest to return to headquarters will allow maximum exposure to micro-habitat types. Additionally, there are two large white pines near the ravine head which are noteworthy, and one of these illustrates fire damage (G-10, figure 7). Again, some species of woodland plants present should be protected, but there seems to be no reason to suggest that any specific locality be declared "off-limits." This trail loop should pass by former beach lines (of greater interest geologically than botanically) which are quite striking in the southwest section of the region. It should return along the lakeshore since the rock cliff is striking and supports a very rich growth of cryptogams. Safety considerations are a necessary factor in this particular location.

The rich diversity of vascular plants found on the site is unusual. More intensive study will undoubtedly reveal additional species, though the bulk of the flora is listed in Appendix B. Three species are considered as rare or endangered by the DNR. One, Ammophila breviligulata Fern, is restricted to the sand beach community. It is a characteristic species of this unusual habitat, but is fairly abundant within the community. Habenaria orbiculata (Pursh) Torr. is rare in Wisconsin, but locally abundant. Osmorhiza chilensis H. & A. is also rare in Wisconsin, but locally abundant in Bayfield County. Due care is indicated, but on this site, many other species are less common than these three.

Part II: Forest Analysis

As John T. Curtis has written in his book, The Vegetation of Wisconsin (1959), the northern floristic province in Wisconsin contains a wide variety of vegetational types. "The forests are typically characterized by the presence of coniferous trees, which include pine, spruce, hemlock, fir, cedar, and tamarack, although a large hardwood element is also present." In the present study, sampling in five areas of the Apostle Islands Headquarters Site Area resulted in data which showed a wide range of conifer-hardwood forests. All of the conifers mentioned by Curtis except Tamarack were found in the five sample sites.

In order to assess the forest ecosystems of the headquarters site area, five transects using the point-centered quarter method were established in the study area, with 10 points being sampled (40 trees) on 4 of the transects, and 31 (124 trees) being sampled on the 5 transects for trees (4.0" d.b.h.* and over). The same number of points were sampled in each of the stands for saplings (1.0 d.b.h. to 3.96" d.b.h.). The transects were sampled along uniform elevation generally running from west to east.

Data were analyzed by means of computing importance values for the trees and saplings of each of the five study areas. The importance value was determined as follows. Basal area data for the trees and saplings were converted to relative dominance, which totaled 1.0 for each stand. The density of the trees and saplings were also converted to relative density, which totaled 1.0 for each stand. Summing the total relative density and relative dominance for each stand gives an importance value of 2.0 for the sapling and 2.0 for the trees (see Appendix B).

Stands 1 to 4 represent the northern hardwoods I forest. General reference locations are noted on figure 5.

Stand 1: Located in the southwest corner (A-11) of the site area. Examination of Appendix B, Table I shows that Acer saccharum (Sugar Maple) was the dominant tree in this stand, with an Importance Value of 0.72 out of 2.0. Other important trees were Betula papyrifera (Paper Birch) 0.33, Betula lutea (Yellow Birch) 0.26, and Acer rubrum (Red Maple) 0.15. The two conifers present in the

*Diameter at Breast Height (4.5 ft.)

stand were Abies balsamea (Balsam Fir) 0.28 and Tsuga canadensis (Hemlock) 0.26.

In the sapling or reproduction layer, there were three species present, compared with six in the canopy layer. The species with the highest importance value was Acer saccharum 1.15, with Abies balsamea 0.52 and Acer rubrum also present. The dominant tree (Sugar Maple) is replacing itself in the sapling layer.

Stand 2: Located just north of stand #1 (A-11) in the southwest corner of the Headquarters site study area.

In this stand in the tree layer, Betula papyrifera (Paper Birch) was the dominant species (Importance value of 0.71) with other deciduous species present being Acer rubrum (Red Maple) 0.42, Acer saccharum 0.23, Betula lutea 0.20, and Quercus rubra (Red Oak) 0.01. The conifers present were Abies balsamea (Balsam Fir) 0.58 and Tsuga canadensis (Hemlock) 0.03.

In the sapling layer Abies balsamea was the dominant species, 1.17, and the only coniferous species present. The deciduous species included Acer rubrum 0.41, Acer saccharum 0.24, Betula papyrifera 0.15, and Betula lutea 0.02. (Appendix B, table II). The dominant tree in this stand (Acer saccharum) is not the major species in the sapling layer, which is Abies balsamea.

Stand 3: Located just north of stand #2 (A-10) in the southwest corner of the Headquarters site.

In this stand in the tree layer, Betula papyrifera is the dominant species 0.50. Other hardwoods found include Acer rubrum 0.41, Betula lutea 0.26, and Acer saccharum 0.07. Among the conifers, Abies balsamea was dominant 0.38, with Tsuga canadensis 0.31, and Picea glauca 0.07 also present. (Appendix B, table III).

In the reproduction layer Abies balsamea was dominant 1.41. In the hardwoods, Betula papyrifera 0.24, Acer rubrum 0.19, Acer saccharum 0.08, and Acer spicatum 0.07, a favored deer browse species. Abies balsamea is the dominant species in the sapling layer, and the Betula papyrifera, which was dominant in the tree layer, is less important than Abies balsamea in the sapling layer.

Stand 4: Located east of the two ravines (J-10), in the southeast portion of the Headquarters site.

In this stand in the tree layer, Acer saccharum was dominant 0.55. Other hardwoods were Acer rubrum 0.45, Betula papyrifera 0.32, Betula lutea 0.13, and Ostrya virginiana (Ironwood) 0.05. Among the conifers, Abies balsamea 0.25, Tsuga canadensis 0.19 and Picea glauca 0.05 were present. (Appendix B, table IV).

In the reproduction layer Abies balsamea was dominant with 1.06, and was the only conifer present. Among the hardwoods, Acer saccharum was present with 0.40, Acer rubrum 0.37, Acer spicatum 0.09, Quercus rubra 0.04, and Tilia americana 0.03. In this stand, the dominant tree (Acer saccharum) was important in the sapling layer 0.55, but was not the dominant tree (which was Abies balsamea 1.06).

Stand 5: (Lowland Forest) Located in the northeast corner of the Headquarters site area, in an area of poor drainage in a lowland area. This stand was distinctive from the four others discussed previously. The canopy layer in this stand is dominated by conifers, with Abies balsamea 0.78, Thuja occidentalis (Northern White Cedar) 0.69, and Tsuga canadensis 0.12 present. The hardwoods included Acer rubrum 0.19, Betula papyrifera 0.14, Betula lutea 0.04, and Fraxinus nigra 0.04 (Appendix B, table V).

In the reproduction layer, Abies balsamea 0.86 and Tsuja occidentalis 0.85 were dominant. Deciduous species present were Acer rubrum 0.23, Betula papyrifera 0.03 and Acer saccharum 0.03. The dominant conifers are reproducing themselves in this stand. The dominant species in the canopy (Abies balsamea) was also dominant in the sapling layer. _Acer saccharum_ was not present in the canopy but was present in the sapling layer.

Ravines: The two large ravines of the south central sector of the Headquarters site were examined by reconnaissance, and no data were collected because of tree sparsity. This area was found to contain northern hardwoods II forest cover. Large Yellow Birch, Hemlock, White Pine and Paper Birch were found in the ravines, along with other species found in the five study areas. Ravine margins tended to support a greater number of conifers, but there is no sharp demarcation between the subtle shifts of vegetational change.

The forests of the Headquarters Site Study Area are quite diverse on an individual basis. However, they are principally northern hardwoods with several coniferous species also present. A total of ten species of hardwoods were found in the study area and four species of conifers (Table I below).

TABLE I

LIST OF TREES FOUND BY SAMPLING IN THE PARK HEADQUARTERS SITE AREA

Deciduous Hardwoods	Conifers
Acer rubrum (Red Maple)	_Abies balsamea_ (Balsam Fir)
Acer saccharum (Sugar Maple)	_Picea glauca_ (White Spruce)
Acer spicatum (Mountain Maple)	_Thuja occidentalis_ (Northern White Cedar)
Betula lutea (Yellow Birch)	_Tsuga canadensis_ (Hemlock)
Betula papyrifera (Paper Birch)	
Fraxinus nigra (Black Ash)	
Ostrya virginiana (Ironwood)	
Quercus rubra (Northern Red Oak)	
Tilia americana (Basswood)	

The patterns of dominance are variable, within some cases an Abies balsamea dominated canopy layer and a hardwood dominated sapling layer, and in other cases a hardwood dominated canopy layer will have an Abies balsamea dominated reproduction layer. The area had apparently been logged off in the past, with the exception of the two deep ravine areas which have many very large old-growth trees present. Data were not gathered in the ravine forests. The forests can thus be said to be recovering from the disturbance of logging, and in at least one area, fire had occurred in the past. In all of the five stands studied, either Acer saccharum or Abies balsamea were the dominant species in the reproduction layer.

With continued protection against disturbance, the forests of the Headquarters Site Area can be expected to continue to develop into mesic old-growth hardwood-conifer forests with in some cases Acer saccharum becoming the dominant and in other cases Abies balsamea becoming the dominant.

D. WATER QUALITY

Part I: Study Area

Three small unnamed streams flow into and through the study area. The westernmost enters directly into Lake Superior at the western extremity of the beach area (H-6, figure 6). The central stream discharges into a small water impoundment (L-4), while the easternmost stream flows into the southeast portion of the same impoundment (M-4).

The parameters studied are those which are usually employed to characterize water quality. Since the purpose of the water quality portion of this study is to establish baseline data for the immediate area, the normal parameters were measured. The parameters measured are as follows:

Conductivity: which is an indicator of the number of ions present; normal values for adjacent streams and for Lake Superior range from 90 to 120 micromhos.

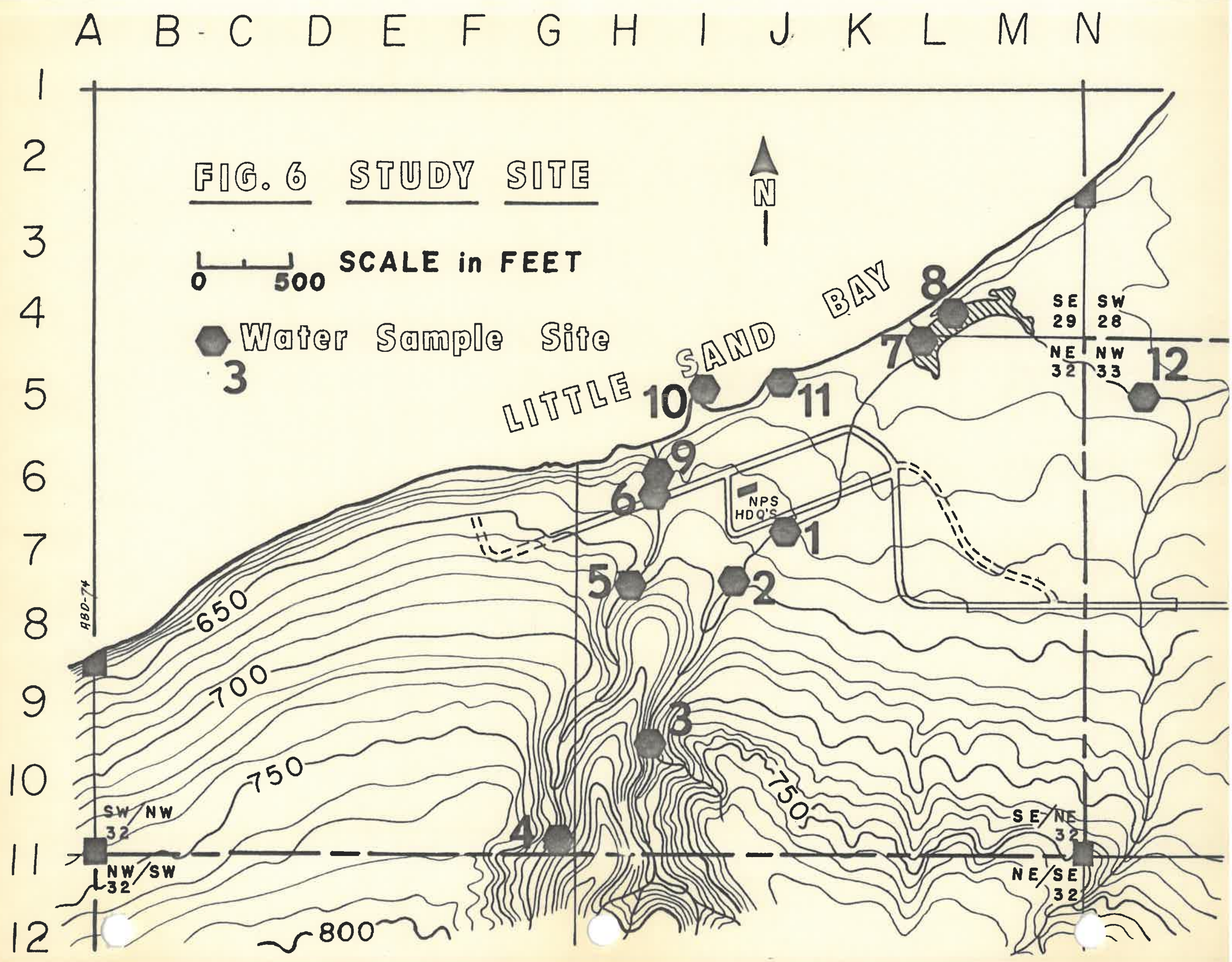
pH: relates to the activity of hydrogen ion, with decreasing values yielding greater hydrogen ion activity. Waters in surrounding areas including Lake Superior vary about one (1) pH unit to either side of the neutral point, namely, pH equal to 7. Normal range should be expected between 6 and 9.

Dissolved Oxygen: Amount of oxygen in water usually determined for fish need but also important for microorganism life and oxidation of organic matter in water. Good water generally remains above 80 percent saturation.

Nitrate and Phosphates: These are nutrients which generally have their origin from sewage wastes. Streams along the south shore of Wisconsin are usually around 100 ppb for total soluble phosphate level and 75 ppb for orthophosphate. Normal nitrate levels for the area should be between 100-200 ppb.

Suspended solids: Mainly, are an indication of soil erosion in this area.

Chemical Oxygen Demand: provides a measure of the oxygen equivalent required to oxidize a portion of the organic matter in water which is susceptible to



A B C D E F G H I J K L M N
1 2 3 4 5 6 7 8 9 10 11 12
FIG. 6 STUDY SITE
N
0 500 SCALE in FEET
Water Sample Site
3
LITTLE SAND BAY
1
2
3
4
5
6
7
8
9
10
11
12
NPS HDQ'S
650
700
750
750
800
SE 29
SW 28
NE 32
NW 33
SW/NW 32
NW/SW 32
SE/NE 32
NE/SE 32
ABD-74

oxidation by a strong oxidant.

Fecal Coliform: *a measure of the density of fecal coliform organisms. High fecal coliform counts usually indicate sewage pollution, although, frequently there maybe a large natural background count. Fecal coliform counts were used instead of total coliform since the new State of Wisconsin Code is written in reference to fecal coliform counts.*

A total of nineteen samples were taken from twelve different sites (shown on figure 6) within the study area and Lake Superior. The samples were collected and stored in brown polyethylene containers and refrigerated until analyses were complete (the following day). Colorimetric analytical determinations were performed with a Coleman Model 14 spectrophotometer.

Temperature and Conductivity: *These were measured in situ with a Yellow Springs SCT Meter Model 33.*

Hydrogen ion Concentration: *pH measurements were taken with a Sargent-Welch Model PBX pH Meter.*

Dissolved Oxygen: *The Azide Modification of the Iodometric Method was used to determine the dissolved oxygen concentrations (A.P.H.A. 1971).*

Chemical Oxygen Demand: *Analysis was by the method of titration with standard potassium dichromate (A.P.H.A. 1971).*

Nitrate: *The nitrate content was determined by reduction to nitrite using amalgamated cadmium filings and diazotizing the nitrite with sulphanilamide and coupling with N-(1-naphthyl)-ethylenediamine. The absorbance of the azo dye is measured colorimetrically (A.P.H.A. 1971).*

Total Soluble Phosphate and Orthophosphate: *The total soluble phosphate concentrations were obtained by refluxing filtered samples in strong acid and using the stannous chloride methods (A.P.H.A. 1971). Orthophosphate was determined by the Stannous Chloride Method without extraction (A.P.H.A. 1971).*

View Of Beach Area Looking West. Sector 1-6.

Testing Lithology of River Boulder In Valley Of Central Study Area Stream. Water Sample Site #3.

Dissolved Solids: Gravimetric determinations were made on samples which were first filtered using 0.45 membrane filters and then evaporated at 110°C in preweighed beakers.

Total Solids: Unfiltered samples were evaporated at 110°C in preweighed beakers.

Suspended Solids and Turbidity: Suspended solids and turbidity values were determined by use of a Hach Meter Model No. DR-A.

Fecal Coliform: Samples were collected in sterile plastic bags. Fecal coliforms were determined by the method using Millipore Membrane filters. Incubation of samples was for 24 hours.

The streams in the study area drain basically fine to medium sand sized quartzose soil. The streams are only naturally affected with nutrients, dissolved solids, and microorganisms and therefore, minimally affected by man.

Samples collected during a prolonged dry period in early July were very low in conductivity, chemical oxygen demand, nitrate, phosphate, dissolved solids, and fecal coliform (see table 2). pH values ranged from 7.04 to 6.46.

The second sampling took place on the second day of two days of heavy rainfall (August 3, 1974). Streams barely had doubled their water flow on the second day indicating soil drainage to be only fair to medium. With the exception of fecal coliform, only small changes in water quality occurred. Conductance, pH, phosphate and dissolved solids showed very little change. Nitrate showed a decrease, probably indicating dilution of the waters. Turbidity, in most cases, doubled or tripled, but still remained low when compared to adjacent watersheds. For the two turbidity measurements, the July samples ranged from 5 ppm to 22 ppm and the August samples ranged from 9 ppm to 72 ppm. The most pronounced changes occurred with the fecal coliform count, which were raised significantly. This rise is attributed to some increase in run-off and washing of stagnant areas of the streams. The microorganisms have their source from wildlife wastes.

In late August, fecal coliform counts were more normal (and within State Code limitations) than in the previous sampling period when fecal counts were unusually high.

Overall, the water quality of the streams and the water impoundment are as expected; normal, and exhibiting no perturbation. The tabulated data of Table II is to serve as base line data of water quality.

Part II: Adjacent Watersheds

The following section presents a summary of chemical water quality characteristics of adjacent major river basins. These two basins, as shown on figure 1, are numbered 96 and 101* and named respectively, Sand River Basin and Raspberry River Basin.

The Sand River basin is sparsely populated, has a total drainage area of 40.3 square miles and lies about 2 miles to the west of the Little Sand Bay study area (figure 1). The Sand River system drains almost entirely a region of lake basin glacial deposits (red, arenaceous clays) with the exception of a small region in the headwaters where end moraine soil conditions are present. While the basin is rather well drained it is periodically subjected to destructive flash flooding, with river levels of more than twelve feet above normal recorded.

The water quality described below was determined from samples collected at site 18 (see figure 1). The samples were collected during the summers of 1972 and 1973. Determined pH values are within the normal acceptable range of 6.9 to 8.0. Dissolved oxygen analysis indicate good oxygenation of this river, with values ranging from 77 to 98 percent saturation. Chemical oxygen demand

*Number coding results from a regional, two year water quality study conducted in northern Wisconsin 1972-1974 by the Center for Lake Superior Environmental Studies.

TABLE II

SAMPLE SITE	DATE	SPECIFIC CONDUCTANCE μMHOS	COD mg 0/1	do % SAT'N	pH	NO_3 ppb	o-PO_4 (t-SOL. PO_4) ppb	DISSOLVED SOLIDS ppm	SUSPENDED SOLIDS ppm	TOTAL SOLIDS ppm	TURBIDITY ppm	FECAL COLIFORM 100 ml	TEMPERATURE °C
1	8/ 4 /74	—*	—	— —	—	—	— —	—	—	—	—	498	—
	8/26 /74	—	—	— —	—	—	— —	—	—	—	—	72	—
2	7/5,6/74	20	20.90	6.44 (68%)	6.83	143	23 (66)	67	--	--	17	--	18.5°
	8/3,4/74	43	179.90	9.26 (86%)	6.65	141	27	68	11	82	33	279	12.5°
	8/26 /74											78	
3	7/5,6/74	42	--	7.00 (68%)	6.54	129	29	63.5	--	--	22	78	14°
	8/3,4/74	41	78.41	9.54 (89%)	6.58	77	13	60	37	95	72	222	12°
4	7/5,6/74	60	48.66	5.51 (53%)	6.85	100	23	67.5	--	--	4.5	2	14°
5	7/5,6/74	50	--	7.41 (69%)	6.74	170	27	67	--	--	8	4	12.5°
	8/3,4/74	49	59.74	9.71 (90%)	6.46	94	29	62	19	100	49	388	12°
6	7/5,6/74	49	--	7.38 (71%)	6.72	184	24	72.5	--	--	7.5	4	13.5°
	8/26 /74											310	
7	7/5,6/74	68		6.58 (79%)	7.04	117	5	66.5	--	--	16	5	25°
	8/3,4/74	62	74.00	7.08 (72%)	6.52	53	3	65	4	--	9	291	16°
8	7/5,6/74	240	42.89	6.91 (72%)	7.01	129	6	63.5	--	--	12	1	17.5°
9	8/3,4/74	53	80.45	9.28 (86%)	6.70	95	26 (39)	63	16	125	49	650	12°
10	8/26 /74	—	—	— —	—	—	— —	—	—	—	—	20	—
11	8/26 /74	—	—	— —	—	—	— —	—	—	—	—	145	—
12	8/26 /74	—	—	— —	—	—	— —	—	—	—	—	>800	—

*Dash signifies no analysis

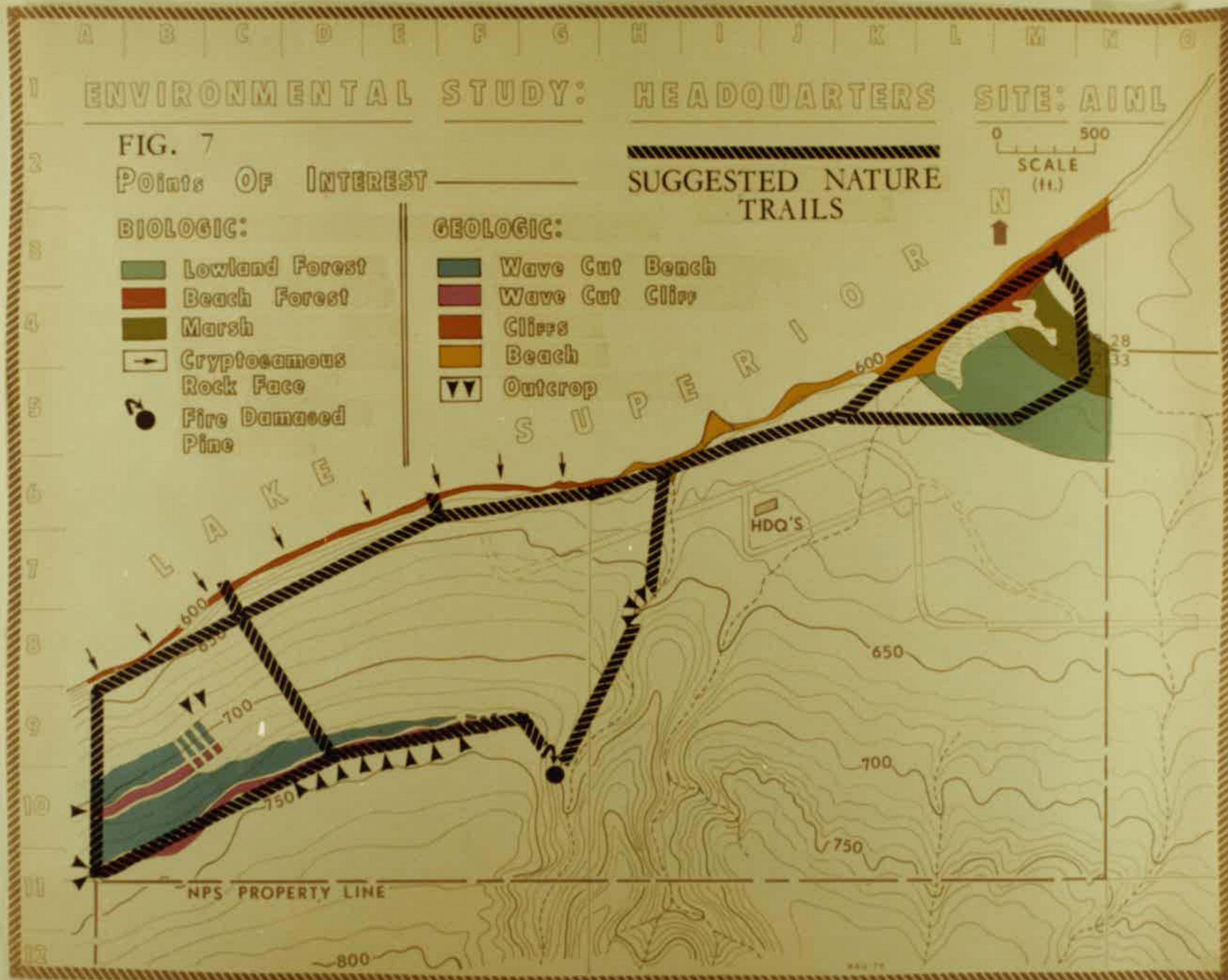
was low with a mean value of approximately 25 mg O/l. Total phosphate values were within normal limits, being recorded as a low of 35 ppb to a high of 105 ppb. Concentrations of nitrate fluctuated between 25 ppb and 270 ppb. Four samples collected in late summer yielded total coliform counts greater than 20,000 organisms per 100 ml. Fecal coliform counts for the summer of 1973 had a geometric mean of 587 MFCC/100 ml.

As no major industries or recreational sites exist, there is no unnatural pressure placed upon this watershed or stream. The water quality of this stream is somewhat afflicted by generally high water color and is subject to high suspended solids load from red clay erosion. High coliform counts observed do not necessarily reflect a problem condition, but may be inherent to the area and occur from natural sources.

The second basin, namely the Raspberry River basin, lies 3 to 4 miles to the southeast of the Little Sand Bay study area. This basin drains the crestal region of the extreme northeastern section of the Bayfield Peninsula. The drainage area of this basin totals only 17.1 square miles. The area drained is characterized by red arenaceous clay soils. Location number 19 on figure 1, was sampled during the summers of 1972 and 1973.

The pH for this stream ranged from 6.7 to 7.7. Percent saturation of oxygen ranged from 69% to 92%. Phosphate concentrations were below 95 ppb. Nitrate levels were found to fall between 23 ppb and 220 ppb. Total coliform values were generally fairly high. Fecal coliforms were more normal.

This basin is presently not utilized to any great extent for public water supply, recreational, or industrial use; its prime importance is for maintenance of fish reproduction. Turbidity caused by erosion of red clay soil does, and will continue to, plague this stream.


ENVIRONMENTAL STUDY: HEADQUARTERS SITE: AINL
FIG. 7
Points Of Interest
SUGGESTED NATURE TRAILS
BIOLOGIC:
Lowland Forest
Beach Forest
Marsh
Cryptogamous Rock Face
Fire Damaged Pine
GEOLOGIC:
Wave Cut Bench
Wave Cut Cliff
Cliffs
Beach
Outcrop
SCALE (ft.)
0
500
N
LAKE SUPERIOR
HDQ'S
NPS PROPERTY LINE
600
650
700
750
800

SERVICE CLUSTER PLACEMENT RECOMMENDATIONS

This section presents a general plan for the location of the Apostle Island National Lakeshore headquarters site service clusters as defined in the study contract. This recommended plan has been created with considerations to all environmental factors, from soil type and drainage, to vegetation and its fragility, to geological and biological points of interest.

In this plan full employment of already cleared areas is highly recommended. On the other hand, consideration of aesthetic tree borders around each individual service site is also recommended. This total plan takes also into account not only visitor access and ease of movement but likewise park management ease of operation.

The following section, for the sake of clarity, is presented in outline form and includes a list of each service cluster followed by the reason(s) for the particular suggested location. Visual reference should be made to figure 8. The reader should, however, be cautioned that the conceptualized service cluster areas of figure 8 are not drawn to scale but rather scaled to effective geographic location.

SITE NUMBER	NAME OF, AND REASON FOR, SPECIFIC LOCATION
1	Administrative Headquarters, including Visitor Center and Concession. (J, K-5 sector) a. Impressive overview of Little Sand Bay and offshore islands. b. Probable proximity to mooring and boat launching ramp facilities. c. Close to beach recreation and swimming area. d. Minimizes environmental impact as the area is presently cleared of forest vegetation.
2	Maintenance structure (M-8,9 sector) a. Isolates structure from other service clusters. b. Minimizes distance to housing, thus faciliting use of maintenance equipment. c. Located on well drained interfluve.

ENVIRONMENTAL STUDY: HEADQUARTERS SITE: AINL
FIG. 8
Service Cluster Location
HEADQUARTERS
MAINTENANCE
PICNIC (30 Sites)
PARKING
—100 Trailer
—250 Auto
—EXCESS
TRAILS
HOUSING (6 Single; 3 Duplex)
ENTRANCE ROADS
SEWAGE
—Leaching
—Treatment
—Lines
0
500
SCALE
(ft.)
N
LAKE SUPERIOR
Marsh
Trail
Woods Trail
HDQ'S
NPS PROPERTY LINE
600
650
700
750
800

SITE NUMBER	NAME OF, AND REASON FOR, SPECIFIC LOCATION

3 *Picnic area (approximately 30 campsites and comfort station) (G-6,7 sector)*

a. *Overview of both beach and cliff shoreline (safety precautions regarding children should be observed in cliff region).*
b. *Cooling breezes resulting in relative lack of disturbing insects.*
c. *Isolation from main visitor impact area.*
d. *Area presently offers semi-open growth conditions necessary for picnic privacy.*

4 *Parking for 250 vehicles (assumed short term parking) (J, K-6 sector)*

a. *Near Visitor's Center*
b. *Provides easy but non-visible access to picnic area thus retaining aesthetics of latter area.*
c. *Minimizes entrance road mileage.*
d. *Access to marina area.*
e. *Location conveniently contained by traffic loop.*

Caution: Present surface drainage would have to be submerged through the eastern portion of this area.

5. *Parking for 100 vehicle-trailer combinations (J, K, L-7 sector)*

a. *Recognizes central unnamed stream valley which is located basically between parking areas.*
b. *Access to Visitor's Center and Marina*
c. *Minimizes entrance road mileage.*
d. *Further removed from visitor activity areas recognizing probable long term parking prospects.*

6 *Housing area (6 single families and 3 duplex seasonal residences) (J, K-8,9)*

a. *Isolation from main visitor activity with resulting low noise pollution.*
b. *Recognition of best remaining areas after other clusters are considered. Topographically recommended due to general low (0-10%) grade and slight (40 foot) relief in area thus enhancing aesthetics.*
c. *Located in well-drained interfluve region.*

7 *Sewage leaching field and/or treatment plant.*

Considering the less than ideal permeability conditions described in the soil section of this report, it is recommended that every consideration be given to tertiary treatment facilities. In this case, the recommended location would be sector F-7, with effluent discharge northeastward into adjacent stream valley.

a. *Isolation from all cluster areas.*
b. *Hidden in dense hardwood forest area.*
c. *Reasonably close to natural drainage for discharge of potable effluent.*

SITE NUMBER NAME OF, AND REASON FOR, SPECIFIC LOCATION

Recognizing the tremendous cost of tertiary, as compared to secondary, sewage treatment facilities, an alternative, but second priority, recommendation would be the construction of secondary sewage treatment facilities with an associated leaching field.
A recommended on-site location for this facility would again be section F-7 with an associated leaching field located about 100 feet to the southwest. This placement might require some relocation of the nature (Woods) trail between visitor sites 8 and 9 and sites 11 and 12. This leaching field should be rather sizable in area recognizing the less than desirable permeability of the soils (see soil section).
A third priority would be consideration of location of sewage treatment facilities to the east or west of the study area.

8 Sewage Lines.

a. South branch line
   1. East to West between maintenance and housing area. Gravity feed line with 10 feet relief.
   2. South to North from housing area to junction with north branch sewage line in sector I-6. Gravity feed with about 15 feet relief. Partially along route of existing road.
b. North branch line
   1. Southwest from Visitor's Center to junction with south branch line. Force main with about 15 feet relief.
c. Composite north-wouth branch line
   1. From junction (I-6 sector) southwest to sewage plant (either tertiary or secondary) location along route of existing road. Force main with 40 foot relief.
   2. If tertiary treatment employed, then potable effluent line northeast from sewage plant to stream valley in sector H-7. Gravity feed with 35 foot relief.
   3. If secondary treatment employed, southwest to outflow into leaching field. Force main with 45 foot relief.

The reasons for these sewage line recommendations are as follows:

a. Minimizes total sewage line length in headquarters area.
b. Maximizes utilization of present road sites for trenching.
c. Maximizes ratio of gravity to force main sewage lines.

9 Marina for camper access to Sand Island.
Environmental assessment presently being conducted for proper placement of this service cluster by the University of Wisconsin-Superior under contract #CX-2000-5-0013.

10 Living History Nature Interpretative Trails
The proposed design for a "living history" nature trail consists of a double loop system, herein termed the Marsh Trail (to the east) and the Woods Trail (to the west). The Woods Trail plan presented contains an alternate loop. (see also figure 7)

SITE NUMBER	NAME OF, AND REASON FOR, SPECIFIC LOCATION
	Marsh Trail (containing visitor stops 1, 2, 3, 4, 5, and 6) Stop 1. High littoral beach with view of Little Sand Bay and offshore islands. Stop 2. Sand beach community illustrating sand beach vegetative succession. Between Stop 2 and 3. A boardwalk is suggested because of peric storm induced waves. Stop 3. Beach forest community illustrating the climax stage of beach succession. Stop 4. Marsh community illustrating biota typical of the wetlands of the north, including some species with bog affinities. Stop 5. Lowland forest illustrating tree species common to northern lowland forest. Between stops 3 and 5. It will be necessary to bridge certain of the wetlands. Stop 6. Return to Visitor's Center.
	Wood Trail (containing visitor stops 6, 7, 8, 9, 10, 11, and 12; alternate loop 6, 7, 8, 9, 11, and 12) Stop 6. Visitor's Center Stop 7. Outcrop of Precambrian sandstones (approximately 700 million years in age) typical of bedrock underlying surface glacial deposited soils. At this location one can also observe the main component species of the northwood forest, especially, fir. Stop 8. Fire scarred pine. Surviving remnant of pre-existing forest. Stop 9. Outcrops representative of glacial lake stage fossil shoreline (wave cut bench and cliff). At this location one can also see the main component species of the hardwood forest, especially maple, birch, and hemlock. Stop 10. Viewing to the north--two well defined wave cut cliff and bench systems. They are the result of wave action of previous (10,800+ years ago) high water Lake Superior. Stop 11 and 12. Scenic lookout over the cliff lined shore of "Gitche Gumee" (Lake Superior). It is recommended that adequate safety precautions be taken at these stops. For a shorter version of the Woods Trail the visitor may progress directly from stop 9 to 11.
11	Entrance Roads. Picking up present east-west road at sector N-8 (eastern boundary section 32) the proposed park headquarters entrance route is as follows:

SITE NUMBER   NAME OF, AND REASON FOR, SPECIFIC LOCATION

a. *Northwest to Administrative headquarters and Visitor's Center; entrance drives to maintenance building and Visitor's Center (partial utilization of existing road-bed).*
b. *West-Southwest to sector I-6; entrance drive to boat-launching area (utilization of existing road-bed).*
c. *South to position I-7 (partial utilization of existing road-bed).*
d. *East-Northeast to K-6, thus completing entrance road loop; entrance drive in this sector to vehicle-trailer parking lot (utilization of existing road-bed).*

It is suggested that this travel loop be routed one-way in a counter clockwise direction.

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Mr. Patrick Miller,	*Present Superintendent, Apostle Islands National Lakeshore (effective July, 1974)*
Mr. Warren Bielenberg,	*Park Naturalist, Apostle Islands National Lakeshore*
Mr. Douglas Barnard,	*Supervisory Park Ranger, Apostle Islands National Lakeshore (presently stationed at Big Bend National Park, Texas)*
Mr. Robert Lanane,	*Park Ranger, Apostle Islands National Lakeshore*
Mr. Robert Melin,	*Area Well-Driller. Ashland, Wisconsin*
Mrs. Denese Drake,	*Secretary, Center for Lake Superior Environmental Studies*

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APPENDIX A

LIST OF VASCULAR PLANTS FOUND ON LITTLE SAND BAY SITE

MAY-SEPTEMBER, 1974

PTERIDOPHYTA

Lycopodiaceae, Clubmoss Family		
Lycopodium annotinum L.	-	*Interrupted Clubmoss*
L. clavatum L.	-	*Running Pine*
L. complanatum L.	-	*Ground Cedar*
L. inundatum L.	-	*Bog-Clubmoss*
L. obscurum L.	-	*Ground Pine*
Equisetaceae, Horsetail Family		
Equisetum fluviatile L.	-	*Horsetail*
E. sylvaticum L.	-	*Wood-Horsetail*
Ophioglossaceae, Adder's-Tongue Family		
Botrychium multifidum (S.G. Gmel.) Rapr.	-	*Leather grape-fern*
B. virginianum (L.) Sw.	-	*Rattlesnake Fern*
Osmundaceae, Royal Fern Family		
Osmunda claytoniana L.	-	*Interrupted Fern*
Polypodiaceae		
Athyrium angustum (Willd.) Presl.		
Dryopteris disjuncta (Ledeb.) Mortonx		
D. phegopteris (L.) C.Chr.		
D. spinulosa (O.F. Mull.) Wats.		
Onoclea sensibilis L.	-	*Sensitive Fern*
Polypodium virginianum L.		
Pteretis pensylvanica (Willd.) Fernald		
Pteridium aquilinum (L.) Kuhn	-	*Bracken fern*

SPERMATOPHYTA

Gymnospermae

Taxaceae, Yew Family		
Taxus canadensis Marsh.	-	*Ground Hemlock*
Pinaceae, Pine Family		
Abies balsamea (L.) Mill.	-	*Balsam Fir*
Picea glauca (Moench) Voss	-	*White Spruce*
Tsuga canadensis (L.) Carr.	-	*Hemlock*
Pinus strobus L.	-	*White Pine*
P. resinosa Ait.	-	*Red Pine*

Cupressaceae, Cypress Family		
Thuja occidentalis L.	-	White Cedar

Angiospermae

Typhaceae, Cat-Tail Family		
Typha latifolia L.	-	Cat-tail
Sparganiaceae, Bur-reed Family		
Sparangium angustifolium Michx. (Immature-identity uncertain)	-	Bur-reed
Alismaceae, Water-Plantain Family		
Sagittaria latifolia Willd.	-	Arrow-head
Gramineae, Grass Family		
Agropyron repens (L.) Beauv.	-	Quack Grass
A. hyemalis (Walt.) B.S.P.		
Agrostis perennans (Walf) Tuckerm.		
A. stolonifera L.		
Brachyelytrum erectum (Schreb.) Beauv. var. *septentrionale* Babel		
Calamagrostis canadensis (Michx.) Beauv	-	Bluejoint
Danthonia spicata (L.) Beauv.	-	Wild rats grass
Deschampsia flexuosa (L.) Trin.	-	Hair grass
Elymus canadensis L.	-	Wild rye
Echinochloa microstochya (Wieg.) Rydb.	-	Barnyard Grass
Festuca ovina L.	-	Sheep fescue
Glyceria grandis S. Wats.	-	Manna grass
G. striata (Lam.) Hitchc.	-	Manna grass
Oryzopsis asperifolia Michx.	-	Rice grass
Paspalum ciliatifolium Michx.		
Phalaris arundinacea L.	-	Reed canary grass
Phleum pratense L.	-	Timothy
Poa annua L.	-	Speargrass
P. compressa L.	-	Canada Bluegrass
Setaria glauca (L.) Beauv.	-	Foxtail grass
Cyperaceae		
Carex sp.	-	Sedges
Eleocharis palustris (L.) Res.	-	Spike rush
Eriophorum angustifolium Honckeny	-	Cotton Grass
Scirpus atrovirens Willd.	-	Bulrush
S. cyperinus (L.) Kunth.	-	Wool grass
Araceae, Arum Family		
Acorus calamus L.	-	Sweet flag
Arisaema triphyllum (L.) Schott.	-	Indian Turnip
Calla palustris L.	-	Water Arum

Juncaceae, Rush Family

- Juncus brevicaudatus (Engelm.) Fern. - Rush
- J. brachycephalus
- J. effusus L.
- J. tenuis Willd.

Liliaceae, Lily Family

- Clintonia borealis (Ait.) Raf. - Clinton's lily
- Lilium tigrinum Ker. - Tiger lily
- Maianthemum canadense Desf. - Wild Lily of the Valley
- Smilacina racemosa (L.) Desf. - False Solomon's Seal
- Streptopus roseus Michx. - Twisted Stalk
- Trillium cernuum L. - Nodding Trillium

Amaryllidaceae

- Narcissus poeticus L. - Narcissus

Iridaceae, Iris Family

- Iris versicolor L. - Blue Flag
- Sisyrinchium montanum Greene - Blue-eyed grass

Orchidaceae, Orchid Family

- Corallorhiza maculata Raf. - Spotted Coral Root
- C. trifida Chat. - Early Coral Root
- Cypripedium acaule Ait. - Stemless Lady-Slipper
- Goodyera oblongifolia Raf. - Rattlesnake Orchid
- Habenaria hyperborea (L.) R. Br.
- H. orbiculata (Pursh) Torr. - Round-Leaved Orchid
- H. obtusata (Pursh) Richards - Blunt-leaved Orchid
- H. viridis (L.) R. Br. - Bracted Orchid
- Listera convallarioides (Sw.) Torr.
- Malaxis unifolia Michx.
- Pogonia ophioglossoides (L.) Ker. - Rose Pogonia
- Spiranthes gracilis (Bigel.) Beck.
- S. vernalis Englem & Gray

Salicaceae, Willow Family

- Populus grandidentata Michx. - Big-toothed Aspen
- P. tremuloides Michx. - Quaking Aspen
- Salix interior Roulee - Sandbar Willow

Myricaceae, Bayberry Family

- Myrica gale L. - Sweet Gale

Betulaceae, Birch Family

- Alnus crispa (Ait.) Pursh - Green Alder
- Betula lutea Michx. f. - Yellow Birch
- B. papyrifera Marsh. - Paper Birch
- Corylus cornuta Marsh. - Beaked Hazel
- Ostrya virginiana (Mill.) K. Koch - Ironwood

Fagaceae, Beech Family

- Quercus borealis Michx. f. - Red Oak

Polygonaceae, Smartweed Family

Polygonum achoreum Blake		
P. aviculare L.		
P. cilinode Michx.	-	Bindweed
P. punctatum Ell.		
P. ramosissimum		
P. sagittatum L.	-	Arrow-Leaved Tear Thumb
Rumex acetosella L.	-	Red Sorrel
R. crispus L.	-	Sour dock
R. obtusifolius L.	-	Bitter Dock

Chenopodiaceae, Goosefoot Family

Chenopodium album L.	-	Lamb's quarter

Caryophyllaceae, Pink Family

Cerastium vulgatum L.	-	Mouse-eared Chickweed
Dianthus barbatus L.	-	Sweet William
Lychnis alba Mill.	-	White Campion
Silene cucubalus Wibel	-	Bladder campion

Nymphaeaceae, Water Lily Family

Nuphar microphyllum (Pers.) Fern.	-	Yellow Water Lily

Ranunculaceae, Crowfoot Family

Actea alba (L.) Mill.	-	White Baneberry
A. rubra (Ait.) Willd.	-	Red Baneberry
Anemone quinquefolia L.	-	Wood anemone
Coptis trifolia (L.) Salisb.	-	Gold thread
Caltha palustris L.	-	Marsh Marigold
Ranunculus abortivus L.	-	Small-flowered Crowfoot
R. acris L.	-	Buttercup
R. recurvatus Poir.		
R. septentrionalis Poir.	-	Swamp Buttercup
Thalictrum dasycarpum Fisch. and Ave-Lall	-	Meadow Rue

Cruciferae, Mustard Family

Barbarea vulgaris R. Br.	-	Yellow Rocket
B. orthoceras Ledeb.	-	Winter cress
Cardamine pensylvanica Muhl.	-	Bitter cress
Erysimum cheiranthoides L.	-	Wormseed-mustard
Thlaspi arvense L.	-	Penny cress

Sarraceniaceae, Pitcher Plant Family

Sarracenia purpurea L.	-	Pitcher-plant

Droseraceae, Sundew Family

Drosera rotundifolia L.	-	Sundew

Saxifragaceae, Saxifrage Family

Mitella nuda L.	-	Mitrewort

Rosaceae, Rose Family

Agrimonia striata Michx.	-	Agrimony
Amelanchier interior Nielson	-	June Berry
A. humilis Wiegand	-	June Berry
Fragaria virginiana Duchesne.	-	Strawberry
Potentilla norvegica L.	-	Five-Finger
P. palustris (L.) Scop.	-	Marsh Five-finger
Prunus pensylvanica L. f.	-	Pin Cherry
Rosa blanda Ait.	-	Wild Rose
Rubus hispidus L.	-	Dewberry
R. parviflorus Nutt.	-	Thimbleberry
R. pubescens Raf.	-	Drawf Blackberry
R. strigosus Michx.	-	Red raspberry
Sorbus americana Marsh.	-	Mountain Ash
Spiraea alba DuRoi.	-	Meadow-Sweet

Leguminosae, Bean Family

Lathyrus maritimus (L.) Bigel.	-	Beach Pea
Lupinus perennis L.	-	Lupine
Melilotus alba Desr.	-	White Sweet clover
Trifolium pratense L.	-	Red clover
T. procumbens L.	-	Hop-Clover
T. repens L.	-	White Clover
Vicia americana Muhl.	-	Vetch

Oxalidaceae, Wood Sorrel Family

Oxalis acetosella L.	-	Wood Sorrel
O. dillenii Jacq.	-	Wood Sorrel
O. stricta L.		

Anacardiaceae, Cashew Family

Rhus typhina L.	-	Staghorn-Sumac

Aceraceae, Maple Family

Acer rubrum	-	Red Maple
A. saccharinum L.	-	Silver-Maple
A. spicatum Lam.	-	Mountain Maple

Balsaminaceae, Touch-me Not Family

Impatiens biflora Walt.	-	Jewel weed
I. pallida Nutt.	-	Jewel weed

Tiliaceae, Linden Family

Tilia americana L.	-	Basswood

Hypericaceae, St. John's-Wort Family

Hypericum perforatum L.	-	St. John's Wort

Violaceae, Violet Family

Viola eriocarpa Schwein	-	Smooth yellow violet
V. nephrophylla Greene		
V. pallens (Banks) Brainerd	-	Wild White Violet
V. serpyllifolia		

Onagraceae, Evening Primrose Family

- Circaea alpina L. - Enchanter's nightshade
- Epilobium adenocaulon Haussk.
- E. angustifolium L. - Great Willow-herb
- E. coloratum Biehler - Willow-herb
- Oenothera biennis L. - Evening Primrose
- O. perennis L. - Sundrops

Araliaceae, Ginseng Family

- Aralia hispida Vent. - Bristly sarsaparilla
- A. nudicaulis L. - Wild sarsaparilla
- A. racemosa L. - Spikenard

Umbelliferae, Parsley Family

- Carum carvi. L. - Caraway
- Cicuta maculata L. - Water-hemlock
- Heracleum lanatum Michx. - Cow parsnip
- Osmorhiza chilensis H. and A. - Sweet Cicely

Cornaceae, Dogwood Family

- Cornus canadensis L. - Bunchberry
- C. stolonifera Michx. - Red Osier Dogwood

Ericaceae, Heath Family

- Chamaedaphne calyculata (L.) Moench. - Leather-leaf
- Gaultheria procumbens L. - Wintergreen
- Kalmia angustifolia L. - Sheep laurel
- Pyrola elliptica Nutt. - Shinleaf
- P. virens Schweigg.
- Moneses uniflora (L.) Gray. - One-flowered Wintergreen
- Monotropa Hypopithys L. - Pinesap
- Vaccinium angustifolium Ait. - Blueberry
- V. macrocarpon Ait. - Cranberry
- V. myrtilloides Michx.

Primulaceae, Primrose Family

- Lysimachia ciliatum L. - Loosestrife
- Lysimachia terrestris (L.) B.S.P. - Loosestrife

Oleaceae, Olive Family

- Fraxinus nigra Marsh. - Black Ash

Gentianaceae, Gentian Family

- Gentiana rubricaulis Schw. - Gentian

Apocynaceae, Dogbane Family

- Apocynum androsaemifolium L. - Dogbane
- A. cannabinum L. - Indian hemp

Boraginaceae, Borage Family

- Myosotis sylvatica Hoffm. - Garden Forget-me-not

Labiatae, Mint Family

Species		Common name
Galeopsis tetrahit L.	-	Hemp-nettle
Lycopus americanus Muhl.	-	Water horehound
L. uniflorus Michx.	-	Water horehound
L. virginicus L.	-	Water horehound
Mentha arvensis L.	-	Mint
Prunella vulgaris L.	-	Self-heal
Scutellaria lateriflora L.	-	Mad-dog Skullcap

Scrophulariaceae, Figwort Family

Species		Common name
Melampyrum lineare Desr.	-	Cowwheat
Mimulus glabratus HBK	-	Monkey-flower
Scrophularia lanceolata Pursh.	-	Figwort
Verbascum thapsus L.	-	Mullein
Veronica serpyllifolia L.	-	Speedwell

Lentibulariaceae, Bladderwort Family

Species		Common name
Utricularia vulgaris L.	-	Bladderwort

Plantaginaceae, Plantain Family

Species		Common name
Plantago lanceolata L.	-	English Plantain
P. major L.		

Rubiaceae, Madder Family

Species		Common name
Galium asprellum Michx.	-	Bedstraw
G. trifidum L.	-	Bedstraw
G. triflorum Michx.	-	Sweetscented Bedstraw
Mitchella repens L.	-	Partridge-berry

Caprifoliaceae, Honeysuckle Family

Species		Common name
Diervilla Lonicera Mill.	-	Bush Honeysuckle
Linnaea borealis L.	-	Twinflower
Lonicera canadensis Marsh.	-	Fly, Honeysuckle
Sambucus pubens Michx.	-	Red-berried Elder

Campanulaceae, Harebell Family

Species		Common name
Campanula aparionides Pursh.	-	Marsh-bellflower

Compositae, Composite Family

Species		Common name
Achillea millefolium L.		
Antennaria plantaginifolia (L.) Richards	-	Everlasting
Anaphalis margaritacea (L.) Benth. and Hook.	-	Pearly Everlasting
Aster ciliolatus Lindl.		
A. lateriflorus (L.) Britt.		
A. macrophyllus L.	-	Large-leaved Aster
A. puniceus L.		
A. simplex Willd.		
A. umbellatus Mill.		
Chrysanthemum leucanthemum L.	-	Ox-eye Daisy

Compositae, *Composite Family*

Cirsium vulgare (Savi) Airy-Shaw	-	*Common Thistle*
Conyza canadensis (L.) Cronq.	-	*Horseweed*
Erigeron philadelphicus L.	-	*Fleabane*
Eupatorium maculatum L.	-	*Joe-Pye Weed*
Hieracium aurantiacum L.	-	*King-devil*
Lactuca canadensis L.	-	*Lettuce*
Matricaria matricarioides (L.) Porter	-	*Pineapple-weed*
Petasites palmatus (Ait.) Gray	-	*Sweet coltsfoot*
Solidago altissima L.	-	*Goldenrod*
S. canadensis L.	-	*Goldenrod*
S. graminifolia (L.) Salisb.	-	*Goldenrod*
Taraxacum officinale Weber	-	*Common dandelion*

SUMMARY

FAMILIES	GENERA	SPECIES
64	165	237

APPENDIX B

FOREST ANALYSIS DATA

TABLE I

Northern Hardwoods; Site 1, SW

	TREE DATA		*BASAL AREA*
Species:	*Betula papyrifera*		3.0440
	Acer saccharum		6.0850
	Abies balsamea		1.9788
	Tsuga canadensis		3.6235
	Betula lutea		3.4639
	Acer rubrum		.8802
			19.0754
Relative Dominance:	*Betula papyrifera*		.1596
	Acer saccharum		.3189
	Abies balsamea		.1037
	Tsuga canadensis		.1899
	Betula lutea		.1816
	Acer rubrum		.0461
			.9998
Relative Density:	*Betula papyrifera*	7	.1741
	Acer saccharum	16	.3980
	Abies balsamea	7	.1741
	Tsuga canadensis	3	.0746
	Betula lutea	3	.0746
	Acer rubrum	4	.0995
		40	.9949
Importance Value:	*Betula papyrifera*		.3337
	Acer saccharum		.7169
	Abies balsamea		.2778
	Tsuga canadensis		.2645
	Betula lutea		.2562
	Acer rubrum		.1456
			1.9947

Table I Continued

	SAPLING DATA		BASAL AREA
Species:	Acer saccharum		.9027
	Abies balsamea		.3843
	Acer rubrum		.2745
			1.5615
Relative Dominance:	Acer saccharum		.5781
	Abies balsamea		.2461
	Acer rubrum		.1758
			1.0000
Relative Density:	Acer saccharum	23	.5721
	Abies balsamea	11	.2736
	Acer rubrum	6	.1493
		40	.9950
Importance Value:	Acer saccharum		1.1502
	Abies balsamea		.5197
	Acer rubrum		.3251
			1.9950

TABLE II

Northern Hardwoods, Site 2, SW

	TREE DATA	*BASAL AREA*
Species:	*Abies balsamea*	*11.1574*
	Acer saccharum	*4.3280*
	Betula papyrifera	*13.8227*
	Tsuga canadensis	*.9218*
	Acer rubrum	*7.6354*
	Betula lutea	*.4418*
	Quecus alba	*.1009*
		38.4080
Relative Dominance:	*Abies balsamea*	*.2904*
	Acer saccharum	*.1127*
	Betula papyrifera	*.3599*
	Tsuga canadensis	*.0240*
	Acer rubrum	*.1988*
	Betula lutea	*.0115*
	Quercus alba	*.0026*
		.9999
Relative Density:	*Abies balsamea*	*.2899*
	Acer saccharum	*.1127*
	Betula papyrifera	*.3543*
	Tsuga canadensis	*.0081*
	Acer rubrum	*.2174*
	Betula lutea	*.0081*
	Quercus alba	*.0081*
		.9986
Importance Value:	*Abies balsamea*	*.5803*
	Acer saccharum	*.2254*
	Betula papyrifera	*.7142*
	Tsuga canadensis	*.0321*
	Acer rubrum	*.4162*
	Betula lutea	*.0196*
	Quercus alba	*.0107*
		1.9985

Table II Continued

	SAPLING DATA	BASAL AREA
Species:	Abies balsamea	5.5652
	Betula papyrifera	.4911
	Acer rubrum	2.0905
	Acer saccharum	.7072
	Betula lutea	.0707
		8.9247
Relative Dominance:	Abies balsamea	.6235
	Betula papyrifera	.0550
	Acer rubrum	.2342
	Acer saccharum	.0792
	Betula lutea	.0079
		.9998
Relative Density:	Abies balsamea	.5475
	Betula papyrifera	.0966
	Acer rubrum	.1771
	Acer saccharum	.1610
	Betula lutea	.0161
		.9983
Importance Value:	Abies balsamea	1.1710
	Betula papyrifera	.1516
	Acer rubrum	.4113
	Acer saccharum	.2402
	Betula lutea	.0240
		1.9981

TABLE III

Northern Hardwoods, Site 3, SW

	TREE DATA		*BASAL AREA*
Species:	*Betula papyrifera*		4.7171
	Abies balsamea		2.3023
	Betula lutea		4.4004
	Picea glauca		.9360
	Tsuga canadensis		4.9797
	Acer rubrum		3.4960
	Acer saccharum		.3562
			21.1877
Relative Dominance:	*Betula papyrifera*		.2226
	Abies balsamea		.1087
	Betula lutea		.2076
	Picea glauca		.0442
	Tsuga canadensis		.2350
	Acer rubrum		.1650
	Acer saccharum		.0168
			.9999
Relative Density:	*Betula papyrifera*	11	.2736
	Abies balsamea	11	.2736
	Betula lutea	2	.0498
	Picea glauca	1	.0249
	Tsuga canadensis	3	.0746
	Acer rubrum	10	.2488
	Acer saccharum	2	.0498
		40	.9951
Importance Value:	*Betula papyrifera*		.4962
	Abies balsamea		.3823
	Betula lutea		.2574
	Picea glauca		.0691
	Tsuga canadensis		.3096
	Acer rubrum		.4138
	Acer saccharum		.0666
			1.9950

Table III Continued

	SAPLING DATA		BASAL AREA
Species:	Acer spicatum		.0325
	Abies balsamea		.9159
	Betula papyrifera		.1444
	Acer saccharum		.0747
	Acer rubrum		.1213
			1.2888
Relative Dominance:	Acer spicatum		.0252
	Abies balsamea		.7107
	Betula papyrifera		.1120
	Acer saccharum		.0579
	Acer rubrum		.0941
			.9999
Relative Density:	Acer spicatum	2	.0492
	Abies balsamea	28	.6965
	Betula papyrifera	5	.1244
	Acer saccharum	1	.0249
	Acer rubrum	4	.0995
		40	.9945
Importance Value:	Acer spicatum		.0744
	Abies balsamea		1.4072
	Betula papyrifera		.2364
	Acer saccharum		.0828
	Acer rubrum		.1936
			1.9944

TABLE IV

Northern Hardwood, Site 4, East of Ravines on East Side

	TREE DATA		*BASAL AREA*
Species:	*Abies balsamea*		2.2711
	Acer rubrum		5.2311
	Betula papyrifera		5.8530
	Picea glauca		.8118
	Tsuga canadensis		3.4983
	Acer saccharum		8.8446
	Betula lutea		2.5224
	Ostrya virginiana		.6013
			29.6336
Relative Dominance:	*Abies balsamea*		.0766
	Acer rubrum		.1765
	Betula papyrifera		.1975
	Picea glauca		.0274
	Tsuga canadensis		.1181
	Acer saccharum		.2985
	Betula lutea		.0851
	Ostrya virginiana		.0203
			1.0000
Relative Density:	*Abies balsamea*	7	.1741
	Acer rubrum	11	.2736
	Betula papyrifera	5	.1244
	Picea glauca	1	.0249
	Tsuga canadensis	3	.0746
	Acer saccharum	10	.2488
	Betula lutea	2	.0498
	Ostrya virginiana	1	.0249
		40	.9951
Importance Value:	*Abies balsamea*		.2507
	Acer rubrum		.4501
	Betula papyrifera		.3219
	Picea glauca		.0523
	Tsuga canadensis		.1927
	Acer saccharum		.5473
	Betula lutea		.1349
	Ostrya virginiana		.0452
			1.9951

Table IV Continued

	SAPLING DATA	BASAL AREA
Species:	*Quercus alba*	.0459
	Abies balsamea	1.2902
	Acer rubrum	.4951
	Acer spicatum	.0403
	Acer saccharum	.4001
	Tilia americana	.0107
		2.2823
Relative Dominance:	*Quercus alba*	.0201
	Abies balsamea	.5653
	Acer rubrum	.2169
	Acer spicatum	.0177
	Acer saccharum	.1753
	Tilia americana	.0049
		1.0002
Relative Density:	*Quercus alba*	.0248
	Abies balsamea	.4975
	Acer rubrum	.1493
	Acer spicatum	.0746
	Acer saccharum	.2239
	Tilia americana	.0248
		.9949
Importance Value:	*Quercus alba*	.0449
	Abies balsamea	1.0628
	Acer rubrum	.3662
	Acer spicatum	.0923
	Acer saccharum	.3992
	Tilia americana	.0297
		1.9951

TABLE V

Lowland Forest, #5

	TREE DATA	BASAL AREA
Species:	*Abies balsamea*	5.1906
	Thuja occidentalis	5.1976
	Tsuga canadensis	1.4492
	Betula papyrifera	1.5004
	Acer rubrum	1.8203
	Betula lutea	.1835
	Fraxinus nigra	.0917
		15.4333
Relative Dominance:	*Abies balsamea*	.3363
	Thuja occidentalis	.3368
	Tsuga canadensis	.0939
	Betula papyrifera	.0937
	Acer rubrum	.1179
	Betula lutea	.0119
	Fraxinus nigra	.0059
		.9964
Relative Density:	*Abies balsamea*	.4478
	Thuja occidentalis	.3483
	Tsuga canadensis	.0249
	Betula papyrifera	.0498
	Acer rubrum	.0746
	Betula lutea	.0249
	Fraxinus nigra	.0249
		.9952
Importance Value:	*Abies balsamea*	.7841
	Thuja occidentalis	.6851
	Tsuga canadensis	.1188
	Betula papyrifera	.1435
	Acer rubrum	.1925
	Betula lutea	.0368
	Fraxinus nigra	.0308
		1.9916

Table V Continued

	SAPLING DATA	BASAL AREA
Species:	*Thuja occidentalis*	1.5676
	Acer rubrum	.6560
	Abies balsamea	1.9354
	Betula papyrifera	.0341
	Acer saccharum	.0092
		4.2023
Relative Dominance:	*Thuja occidentalis*	.3730
	Acer rubrum	.1561
	Abies balsamea	.4606
	Betula papyrifera	.0081
	Acer saccharum	.0022
		1.0000
Relative Density:	*Thuja occidentalis*	.4726
	Acer rubrum	.0746
	Abies balsamea	.3980
	Betula papyrifera	.0249
	Acer saccharum	.0249
		.9950
Importance Value:	*Thuja occidentalis*	.8456
	Acer rubrum	.2307
	Abies balsamea	.8586
	Betula papyrifera	.0330
	Acer saccharum	.0271
		1.9950

APPENDIX C

SLIDES OF SAND BAY AREA PLANTS

1. *Iris Versicolor* L.
2. *Goodyera oblongifolia* Raf.
3. *Habenaria hyperborea* (L.) R. Br.
4. *Malaxis unifolia* Michx.
5. *Spiranthes vernalis* E. and G.
6. *Alnus* sp.
7. *Coptis trifolia* (L.) Salisb.
8. *Acer spicatum* Lam.
9. *Linnaea borealis* L.
10. *Antennaria plantaginifolia* (L.) Richards
11. Northern hardwoods forest floor, June
12. Fire damage evidence
13. Tree coring
14. Northern hardwoods forest floor, August
15. *Lycopodium*
16. *Osmunda claytoniana* L.

Refer to packet of 35 millimeter colored slides next page.

Slides associated with APPENDIX C have deteriorated and not able to scan to include with this submission.