ENVIRONMENTAL GEOLOGIC STUDY OF THE PROPOSED I 69 ALTERNATE ROUTES

From US 27 Easterly to Morrice,
Clinton and Shiawassee Counties
Control Sections 19042 and 76024

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

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Testing and Research Division
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ENVIRONMENTAL IMPACT STUDY

I 69 ALTERNATE ROUTES FROM US 27 EASTERLY TO M 78

This report presents the results of a detailed geologic and hydrogeologic investigation of the area affected by the proposed I 69 from US 27 in Dewitt Township, Clinton County, easterly to the commencement of the M 78 Freeway near Morrice in Perry Township, Shiawassee County.

In the study corridor between Center Road and Warner Road there are three possible alternate alignments to be considered. Alternate 1 passes through this section south of M 78, Alternate 2 maintains an alignment north of M 78, and Alternate 3 remains adjacent to the north side of M 78. The entire proposed route with the three alternates are shown on Figure 1.

The study was made by Frank G. Belobraidich, Geologist, Testing Laboratory Section, at the request of J. H. Raad, Supervisor, Environmental Liaison Unit, Transportation Planning Division, to aid in evaluating the environmental impacts of the proposed freeway.

Information Sources

The environmental geology of the I 69 project area was partially determined from surface formation maps in a Michigan Department of Natural Resources report by Helen M. Martin entitled, "Outline of the Geologic History of Shiawassee County." Information was also obtained from the Technical Report by the Tri-County Regional Planning Commission. This information, along with data obtained by field investigations, was plotted on base maps and is presented in Figure 2.

The surface drainage information was obtained by field investigation and from USGS topographic quadrangles. Subsurface information was obtained from water well and oil well drilling records. The bedrock information is from the Centennial Geologic Map of the Southern Peninsula of Michigan. The soils information is from U. S. Department of Agriculture Maps and Field Manual of Soil Engineering, MDSH.

GENERAL GEOLOGIC SETTING

Surface Formations

The I 69 study area crosses a glaciated region formed by the Saginaw Lobe of the Wisconsin Glacier. The resulting geomorphic features are due to the different rates of melting action and to the amount and character of the soil and rock materials in the ice.

During the advance of the ice, a large amount of soil and bedrock was pulverized and incorporated in the ice sheet and was later redeposited. This material is known as glacial drift. In the area traversed by I 69 the drift is approximately 100 to 200 ft thick. When the forward movement of the ice sheet equalled the melting at the face, drift accumulated along the ice front forming a ridgelike deposit known as a moraine. Material comprising the moraine may be either predominantly clayey or granular in texture. Where melting caused significant water action and where the ice was heavily laden with coarse debris, extensive sorting resulted in the construction of granular moraines. Clay moraines comprised of a clayey drift have relatively low relief and in some areas are merely a slight swelling of the terrain.

Three east - west trending moraines are located in the I 69 study area. The Grand Ledge moraine runs from Grand Ledge, northeasterly to the southern portion of Woodhull Township, Shiawassee County. A re-advance of the glacier formed the Ionia Moraine which encircled the Saginaw Lobe from Ionia through Clinton, Shiawassee, and into Genesee County. The Portland Moraine runs along the northern part of Bath, Woodhull, and Perry Townships.

Ground moraines are level to gently undulating plains of unstratified glacial drift spread out behind the terminal moraines. They developed during periods when the ice front melted from the position of one terminal moraine to the next. Between the Grand Ledge Moraine and the Ionia Moraine the glacial materials were deposited partly by accretion beneath actively moving ice and partly from debris carried in the basal part of the ice as it melted.

The glacial drift known as till is comprised of unsorted clay, silt, sand, and gravel and usually contains scattered boulders called erratics.

Flowing rivers along the edge of a melting glacier spread material composed of sorted and stratified sand and gravel over ground moraines of clayey till. These outwash plains are level to gently undulating and exist along the southern edge of the Ionia Moraine in the I 69 corridor. Pitted outwash plains exist in the southeastern part of Clinton County and in smaller number throughout the study area. These pits are caused by ice blocks isolated from the ice front and subsequently partially or completely buried by the granular outwash materials. These ice blocks eventually melted leaving depressions or steep-sided pit lakes in the granular outwash. Many of these pit lakes slowly filled with organic matter from decaying plants and became muck and peat swamps.

The flooding of the drift in front of the melting glacier formed the flat lake beds which in the study area is known as the Chandler Marsh.

In Dewitt Township there is a glacial feature running north and south known as the Mason Esker. This feature was formed either in drainage channels in the surface of the ice from melt waters flowing off the surface or in crevasses or in tunnels beneath the ice. It is composed of stratified granular material. The surface geology is shown in Figure 2.

Soils

The soils encountered in this project area reflect their glacial origin and have a significant influence on surface and subsurface drainage. The erosional characteristics, permeability, natural drainage conditions, and stability of these deposits are divided into four categories. The four categories as shown on Figure 3 are Cohesive, Granular-Cohesive, Granular, and Organic.

The two major soil series of the cohesive group are Miami and Conover. These soils occur throughout the area and are comprised of sandy loams, loams, and silt loams. They are well drained and the internal drainage is moderate to poor.

Erosion of Miami soils on the rolling to hilly land surfaces may cause removal of surface material exposing underlying clay loams. Some slopes may exceed a gradient of 15 percent and when unprotected can develop severe gully erosion. The water table depth is deep with occasional perched water tables at any subsurface location.

The Miami and Conover soils are found throughout both Clinton and Shiawassee Counties.

The Granular-Cohesive group of soils is made up of Hillsdale, Berrien, Brookston-Washtenaw complex, and Sebewa Soils Series.

These soils have moderate to poor internal drainage depending upon the quantity of clays and silts relative to that of sand in the substratum. The Hillsdale and Lapeer Soils Series occupy the higher ground which constitutes the moraines and ground moraines.

The Berrien and Brookston Series occur in a limited amount in the western half of the proposed I 69 area. The Berrien Series is a moderately to imperfectly-drained sand or loamy sand over clay. It occurs on nearly level to undulating outwash and lake plains. Some wind erosion may occur where topsoil has been removed.

The Brookston Series consists of loam and clay loam developed from heavy-textured glacial drift on level areas. Both external and internal drainage are poor. These are subject to frequent flooding by runoff.

The Brookston-Washtenaw complex occupies low areas in association with soils of rolling to hilly lands. Drainage is fair to poor and soils are of extreme textural variations. Almost every combination of imperfectly drained soils, poorly drained, and organic soils are found in this complex where they have been washed in from the adjacent slopes. The areas lack outlets and are subject to flooding during the wet seasons.

The Granular Soils Series consists of those associated with morainic deposits and include the Bellefontaine, Coloma, Spinks, and Boyer while those associated with outwash deposits include soils of the Fox, Oshtemo, and Plainfield series.

The Bellefontaine and Boyer Soils Series consist of well-drained sand and gravel. They are deposited as ice-contact features such as kames, eskers, crevasse fillings, and kame terraces. These features are major sources for commercial sand and gravel operations. Due to their highly porous texture, these soils are intake areas for ground water recharge.

The surface texture of the Coloma Series is either sand or loamy sand and the subsoil is a well-drained deep sandy soil that developed on moraines. The relief is rolling to extremely hilly. The water table is deep but seepage zones may exist due to pockets of fine sands, silts, and clays. Coloma soils are relatively low in water-holding capacity and are subject to water and wind erosion where the vegetation has been removed. The Spinks soils are similar to Coloma soils in texture, drainage, and geologic origin, but have a higher lime content. The Coloma soils are found in Dewitt and Bath Townships whereas the Spinks soils occur in the eastern part of the study, namely, Woodhull and Perry Townships.

The Fox soils occur on well-drained gravelly outwash plains and are generally free from boulders. The surface relief ranges from level to pitted, with gravel pits common. The relief of areas on which Fox soils occur does not allow rapid runoff and the pervious character of these soils allows free internal drainage. Clayey till may occur at depths of 10 to 25 ft. Water can be found in the sand immediately above the underlying till clay. Erosion by water is of comparatively little importance because of the nearly level land surface, but wind erosion may cause some damage.

The Oshtemo and Plainfield Series are similar to the Fox in geologic origin and relief. They are both well drained and underlain by glacial till. Oshtemo Series are intermediate in texture between the Fox and Plainfield. The Oshtemo soils generally have less gravel in the substratum than the Fox Series. The level land of these soils does not allow free runoff, but the extremely porous soil allows free internal drainage. Water erosion is of no great importance but these soils are subject to wind erosion where the vegetation is removed.

As in the Fox Series till clay may occur at depths of 10 to 25 ft. Water may be present in the sands and gravel immediately above the till materials.

Organic soils occupy lake basins, drainage valleys and seepage spots where the moisture supply has been sufficiently high to favor an excessive accumulation of organic materials. These materials consist of deposits of plant residues varying greatly in the degree of decomposition and ranging in thickness from 1 ft to more than 50 ft. The shallow deposits are generally underlain by sand or clay, but marl is also common.

In the area of Proposed I 69 the two major organic soils are Carlisle muck and Rifle peat. The surface layer of the Carlisle muck consists of a dark brown or black granular organic material. The material below the surface becomes fibrous with depth. The character of this underlying organic material is subject to considerable variation, and mineral material--in places mixed with marl--occurs below a depth of 3 ft.

The Rifle peat surface material is granular and mucky in character and is very similar to the Carlisle muck. The surface layer is underlain by a fibrous peaty material which becomes more fibrous with increasing depth. The Rifle peat is intermediate between some of the other organic soils in profile character and transitions are common. The Carlisle muck and other poorly drained soils border around most bodies of this soil. The most extensive area of this material is found in southeastern Clinton County known as the Chandler Marsh.

Bedrock Geology

The bedrock underlying the I 69 proposed routes ranges in depth from 100 to 200 ft. From drilling information, the area is on the southeastern rim of the central part of the Michigan Basin and the bedrock gently slopes or dips to the northwest. The bedrock is the primary source of ground water in the area. The Saginaw Formation, Pennsylvanian Period, is the principal aquifer and underlies nearly all of the area being crossed by this study. The formation varies between 300 and 500 ft thick and is composed principally of beds of sandstone and shale, but includes some thin beds of coal and limestone. In Perry Township, Shiawassee County, in a small area around the city of Perry, the bedrock consists of Marshall Sandstone and Coldwater Shale Formations, Mississippian Period.

GENERAL HYDROGEOLOGIC SETTING

Surface Drainage

The surface configuration represents a youthful stage in the geologic erosional cycle. The constructional glacial surface has been only slightly altered by the development of a system of drainage where the streams tra-

verse the area from east to west, largely in old glacial drainage valleys. Natural drainage is poorly developed. Extensive poorly drained glacial lake plains and swampy lowlands occur in most parts of the area. Much of the better agricultural land has been artifically drained. The I 69 study area lies between two major rivers, the Looking Glass and the Grand. The area in which the route traverses is entirely within the Looking Glass watershed. The surface drainage, as shown on Figure 4, is in a northwest direction via several small creeks that discharge into the Looking Glass River which flows into the Grand River west of the study area. The two major tributaries to the Looking Glass are Vermilion Creek and the Ramey-Chandler Drain. The lakes in the drainage basin include Park Lake, which is the largest, and several smaller lakes in Bath Township of Clinton County. The Ramey-Chandler Drain serves as an outlet for Park Lake and flows to the west. At Chandler Road it begins a northwest direction crossing the flat-lying old lake bed known as the Chandler Marsh. This marsh is underlain by sediments of low permeability causing highly variable ground water flow. It is susceptible to flooding from storm or meltwater runoff. As little ground water is supplied to it, it also becomes very dry during periods of sustained drought.

The Vermilion Creek begins south of Shaftsburg and flows toward the northwest, connecting a tributary from Rose Lake, then flows north along the Clinton County and Shiawassee County lines. The entire I 69 corridor from US 27 to Perry lies north of the topographic divide between the Looking Glass and the Grand River. There are topographic divides within the Looking Glass basin that follow the Ionia Moraine. Surface runoff along the north side of Drumheller Road from Chandler Road to Webster Road flows to the north, and runoff on the south side flows into the Chandler Marsh and Park Lake area.

Ground Water in the Glacial Drift

Geological formations regarding the quantity and quality of ground water are most significant. The ground water movement, its recharge and discharge, are all controlled by the character and structure of rock formations and the kind of unconsolidated materials overlying the bedrock. The granular glacial features encountered by the Proposed I 69 route are granular moraines, outwash, buried outwash, and an esker.

These porous features allow a relatively free movement of the ground water. The regional ground water movement is in a northwestern direction. Although the direction of local ground water movement in places varies, the topographic divide is also the approximate ground water divide. The ground water contained in the glacial drift follows to some degree the surface topography. The ground water tends to flow from the higher water elevations in the morainic areas to the more stable lower levels. The relative imperviousness of the clay till of the ground moraine, especially in

the western half of the project area, limits ground water movement to the more porous deposits such as buried outwash materials. The surface outwash deposits in the Bath Township area constitute a shallow unconfined aquifer which is variable in thickness and permeability. The ground water can be subject to contamination from surface sources.

The eastern part of the study area tends to be more granular in texture and allows a relatively free movement of ground water.

The inferred water table map (Fig. 5) shows elevations of the unconfined ground water and areas of possible recharge.

Ground Water in the Bedrock

Figure 6 shows a map of the artesian water surface constructed by contouring the static water level in tightly cased wells tapping the bedrock aquifer. The water surface indicates that there is a general water migration to the northwest.

The availability of recharge is larger where the porous sandstones are overlain by permeable sand and gravel. In areas where streams are underlain by granular materials over sandstone, water can be induced into the formation by percolation of these waters downward through the drift into the porous bedrock. Where streams in this area are underlain by cohesive soils any major recharge is negligible. The major source of recharge comes from southeast of the study area.

ANALYSES OF GEOLOGIC AND HYDROGEOLOGIC IMPACT FACTORS

Surface Water

Significant impact can be associated with highway construction either in close proximity to, or crossing open water areas such as streams, lakes, and wetlands. The sedimentation during and after construction, the degrading of water quality by undiluted surface runoff from deicing programs, and other pollutants that are associated with motor vehicles can all have a serious environmental impact.

The Proposed I 69 route from US 27 crosses two important small tributaries of the Looking Glass River. The first is the Ramey-Chandler Drain. Within approximately two miles the proposed route will cross the drain three times. This alignment, however, has been predetermined by the US 127 alignment. The Ramey-Chandler Drain has a low gradient and small variable flow. The construction of the nearby interchange and crossings of the drain will cause some increase in the sediment load. Periodic increases in chloride content and sediment loads after construction will occur although the impact should be minimal.

Vermilion Creek is crossed by three alternates and is of significant concern. The Vermilion Creek area represents the area of greatest relief along the proposed route. The granular terrain along the route in this area features natural slopes with grades in excess of 20 percent. Banks exposed by construction will allow eroded material to add to the sediment load of the creek. Impact factors that also should be considered with this stream crossing are channelization and constriction of the natural channel which would reduce the local flood storage potential.

Areas of open water such as swamps and lakes are often open expressions of the water table and can be an intake source for pollution to degrade water quality of lakes or to enter the ground water. In the Park Lake area in Bath Township the proposed alignment crosses a highly sensitive pitted outwash containing an extensive concentration of poorly drained muck and peat deposits.

Of possible impact would be the interference of natural ground water movement by swamp backfilling. In Michigan the specifications for swamp backfill material are such that the permeability of the fill is greater than the surrounding muck or peat. This would preclude the possibility of detrimental impact on ground water movement in swamps and wetlands. The method of muck removal and disposal would have significant impact if proper procedures were not used.

Many small lakes and ponds like Grass Lake and Perch Lake are former lake beds that impound surface water suring certain times of the year. Grass Lake is surrounded by extensive muck areas 30 ft deep in certain places. Perch Lake has a swamp deposit at the south end of the lake. Both of these lakes have neither an inlet nor an outlet and are dependent upon direct precipitation and surface runoff. Water is lost from the lakes through evaporation and ground water discharge. The proposed route crosses the Grass Lake area and along the southern end of Perch Lake through the swamp deposit. Park Lake, the largest of the lakes in this study area, has no inlet, but is drained by the Ramey-Chandler Drain. The lake has a surface area of 185 acres and a maximum depth of 27 ft. The drainage area outlet is approximately two square miles.

Park Lake is a permanent lake in which the bottom of the lake basin is always below the water table. The recommended alignment runs 1,000 ft to the north of Park Lake in which surface runoff or ground water infiltration of pollutants will have a significant effect on the lake. Park Lake is unfit for swimming during part of the summer period and the increase of polluted waters would reverse any attempt to restore a sound water resource program.

Potters Lake and Mud Lake are surrounded by extensive Rifle peat deposits and lie north of the proposed route which follows a granular-cohesive ridge. The impact on these two lakes would be less than Park Lake area because of the distance and material over which the route will pass.

There are several small lakes and extensive muck deposits throughout the rest of the corridor. East of Center Road is the beginning of three alternate alignments. The impact on these lakes and swamps and other impacts will be discussed under the individual alternates.

At a point just south of Colby Lake the three alternates terminate and a single proposed I 69 alignment continues to the east. The proposed interchange at Shaftsburg Road encounters a deep muck deposit on the east side of Shaftsburg Road. The blocking of ground water movement to the north would be a major concern, but with proper construction and inspection procedures the impact of the crossing should be minor.

At Bath Road and Woodhull - Perry Township line the Proposed I 69 follows the south end of a shallow muck deposit. The impact will be minor.

Hickory Lake, east of Beardslee Road, is directly to the north of the proposed alignment. The lake will be subject to a significant impact by the direct runoff because of the cohesive and granular-cohesive soils in the area. Three shallow muck deposits west of Ruess Road will be crossed with minor impact.

The proposed alignment will cross a muck deposit west of M 52. The proposed interchange will be partially within this swamp area. With the prevention of blocking the water movement and the extent of distance before reaching open water to the north, the pollutants would be diluted and have a minor impact.

GEOLOGIC AND HYDROGEOLOGIC IMPACTS OF ALTERNATES 1, 2, AND 3

Alternate 1

From Upton Road, Alternate 1 encounters muck deposits south of Fox Knoll Lake. The impact of the Proposed M 78 interchange could be of some significance to the lake. East of the M 78 interchange a swamp crossing is short, direct and of insignificant impact; however, the alternate then parallels the deposit for approximately one mile. This parallel proximity could cause a significant impact on ground water by highway surface runoff.

The impact on Fox Knoll Lake and Rose Lake to the north would be insignificant. Alternate 1 crosses a small but deep muck deposit to the west of Vermilion Creek with an insignificant impact. The crossing of Vermilion Creek and the muck floodplain will have a significant impact by sedimentation during construction and long-term degradation of water quality by spillage and deicing processes. A small muck deposit is crossed just west of Warner Road Depth of muck is approximately 9 ft and should have little impact. Moon Lake is far to the north and impact would be negligible. Alternate 1 from Upton Road to Warner Road traverses predominantly a cohesive soil with little effect on surface infiltration of the ground water.

Alternate 2

This alignment runs from Center Road vicinity easterly to Fox Knoll Lake. The route crosses a muck area to the east of Fox Knoll Lake that drains into Rose Lake to the north. The close proximity to Fox Knoll Lake will have significant impact. This alignment then crosses a small muck deposit just west of Peacock Road. On the east side of Peacock Road the route skirts along the south edge of an old gravel pit which could be a small recharge area.

From the Clinton - Shiawassee County line Alternate 2 crosses the most extensive muck deposit of the three alternates in the Vermilion Creek area. As in Alternate 1, the impact of crossing the muck deposits and creek will be significant. Two muck deposits are encountered within close proximity of Moon Lake. The chance of degradation of water quality would be greater than the other two alternates.

Alternate 2 from Upton Road to Warner Road crosses extensive granular and granular-cohesive soils. In general the impact of this alignment on the ground water should be insignificant.

Alternate 3

The Alternate 3 alignment follows the same route as Alternate 2 between Center Road and the Clinton - Shiawassee County line. From the county line east, Alternate 3 runs parallel to, and adjacent to the north side of M 78 for approximately two miles. The impacts from Center Road vicinity to the county line will be the same as on Alternate 2.

The most significant impact of Alternate 3 will be the crossing of Vermilion Creek. Like the other alternates, this impact will be due to sedimentation during construction and deposition of pollutants by highway maintenance. Between Vermilion Creek and Colby Lake Road Alternate 3 encounters two muck swamps of considerable depth. The impact on Moon Lake to the north will be less than Alternate 2 but more than Alternate 1. The soils of Alternate 3 consist of predominately granular materials.

Ground Water

A highway's impact on the ground water can be manifested by changes in the water table or water quality. The changes in water table conditions are caused by affecting the areas of ground water recharge or by the interception of the water table by roadway cuts and ditches. This can be either of positive or negative impact. Degradation of water quality by contaminants from highway runoff infiltrating the ground water would be of negative impact.

In the western portion of the study area, especially in southeastern Bath Township, the crossing through extensive swamp deposits will definitely have some effect on ground water levels and quality. By uncovering some of the higher granular soils it may have a positive impact in that it would open a possible recharge area. This is also a sensitive condition in that the pollution of water in these zones could mean degradation in quality of the ground water. Possible ground water recharge areas are shown on Figure 5.

The open waters and swamps can also be avenues for degradation in ground water quality. On Figure 5 the arrows show the direction of the unconfined ground water flow. The glacial drift in the eastern portion is relatively granular and permeable. Recharge from the surface extends over a large area and the influence of the proposed highway on the ground water should be minor.

Soil Erosion

The highway's impact on soil erosion is an important geological factor. With the Michigan Department of State Highway's construction practices and controls the effects should be insignificant. The clearing and grubbing, excavation, filling, and other construction activities are usually immediately followed by a program of reseeding and sodding. Steep cut slopes, embankments, ditches, and other areas subject to wind or water erosion are stabilized as soon as possible.

The areas in the proposed alignment that may be of some concern are the granular morainic soils. These soil series tend to have occasional pockets of fine sands and clay. Road cuts made through such deposits could encounter many seepage zones. Many of the granular soils on the more strongly sloping features are subject to wind and water erosion where the vegetation has been removed.

Mineral Deposits

Excavation of sand and gravel deposits are the only mineral resources in the study area. Extractive lands that may be affected by the proposed route are south of Drumheller Road on both sides of the Penn Central Railroad. Both these areas would have their haul routes crossed by the present alignment. The extraction and use of sand and gravel for construction constitutes a long-term mineral resource depletion of minor impact. There may be a positive economic impact resulting from the increased demand for sand and gravel deposits for highway construction, although most of the geological impact would be considered negative. The preventing of removal of a deposit by landlocking will also be of negative impact.

Many oil wells have been drilled in the study area. They are all dry holes and their locations, along with active and inactive gravel pits, are shown on Figure 1.

Rare Fossil Occurrances

Highway construction through fossil beds in bedrock formations and muck deposits in more recent glacial formations, is considered to be of minor and favorable geological impact. Excavations into the underlying rock or glacial drift strata are the only way exposures of rare fossils are found. The highway program in Michigan has significantly aided the scientific investigation of the recent geological events of the Pleistocene epoch. Excavations associated with construction have unearthed many significant remains of flora and fauna that would otherwise have gone undetected.

SUMMARY

The construction and maintenance of the I 69 highway will have a significant environmental impact on the geologic and hydrogeologic aspects of the area.

The purpose of this study was to detect environmentally sensitive areas where special consideration should be given. The general rating of each factor for the proposed route is presented in Table 1.

Impacts of the proposed alternates on the surface water of the study area will require some special consideration.

The proposed alignment poses a possible moderate impact on the Ramey-Chandler Drain. Most of this impact will occur during construction. Highway usage and maintenance effects will be insignificant.

The most critical area in the Proposed I 69 alignment is in southeastern Bath Township between Webster Road and Center Road. This is an area of extensive deep muck concentration with Park, Grass, and Perch Lakes in the immediate vicinity. The impact will be of major significance.

The impact on Potter and Mud Lakes to the north of the proposed route will be insignificant.

The close proximity of Alternates 2 and 3 to Fox Knoll Lake will result in a significant impact on the lake. The minor impact of Alternate 1 on the lake is more desirable. The impact by the three alternates on Rose Lake will be insignificant.

Moon and Colby Lakes will be subjected to minor impacts.

The impact on Hickory Lake will be quite significant in that the nearness of the route will result in degradation by the highway runoff.

The crossing of Vermilion Creek will be made by each of the three alternates. Siltation during construction and long-term surface runoff will have a moderate impact. Concern should be given to the location of muck disposal areas so they do not contribute sediment to the stream.

Numerous swamp and wetlands are traversed by the proposed alternates. The impacts on these surface expressions of the ground water table vary from insignificant to significant with Alternate 2 having the greatest impact. Factors influencing these impacts are disturbance of the natural balance, compaction of organic deposits by disposal, and degradation of water quality.

The glacial drift in the eastern half of the study project is a granular and permeable material. The highway's influence on the ground water will be insignificant. The western half of the study area alignments traverse a pitted outwash underlain by a discontinuous impermeable clayey till. Ground water in the shallow unconfined outwash aquifer could be influenced significantly by the highway.

Modern construction practices and regulations concerning soil erosion should prevent any impact on the three alternates. Seepage zones encountered in granular soils could be of some concern.

Crossing or blocking the removal of gravel, especially in the western portion of this study, would have a significant impact. Gravel pits shown on Figure 1 do not reveal this to be a problem.

Any deposits containing rare fossils that are unearthed during construction of the proposed highway would be considered a positive impact. No known deposits of rare fossils occur in this area.

TABLE 1

ASSESSMENT OF IMPACT

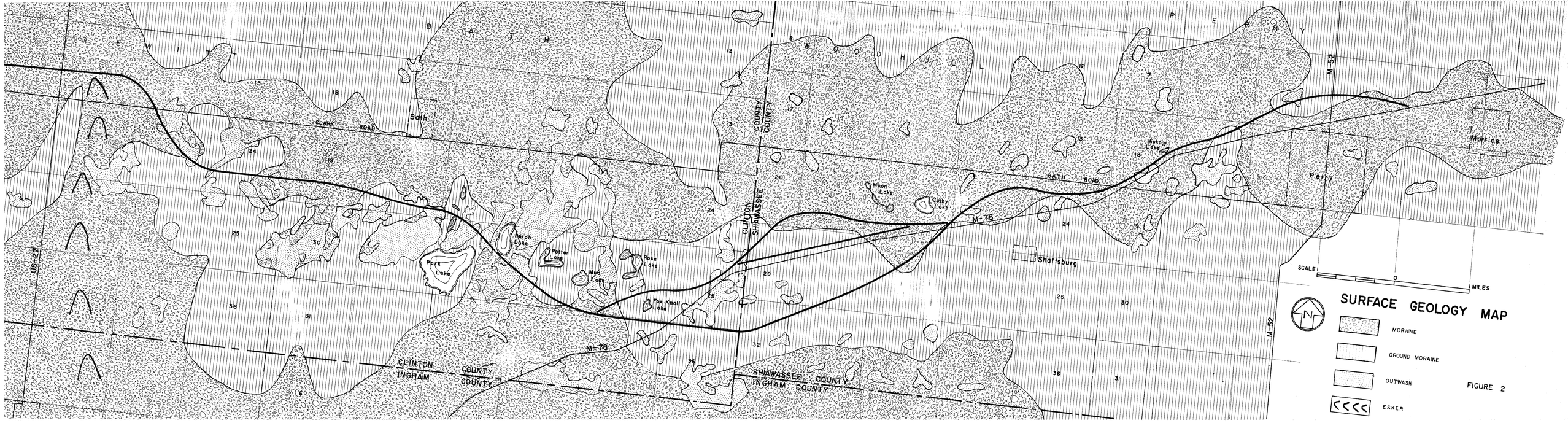
(Impacts are rated on a scale of 1 to 5, with 1 representing the least important impact and 5 the greatest. All impacts considered negative unless otherwise noted by + sign)

		Specific Problems	Degree of Impact[1]					
			Alt 1		Alt 2		Alt 3	
Geologic and Hydrogeologic Factors	Surface Water	Remey-Chandler Ditch	2	1				
		Grass Lake	4	4				
		Park Lake	3	4				
		Perch Lake	4	4				
		Potter Lake	1	1				
		Mud Lake	1	1				
		Fox Knoll Lake	2	1	4	3	4	3
		Rose Lake			1	1	1	1
		Vermilion Creek	2	2	3	2	2	2
		Moon Lake			1	1	1	1
		Colby Lake	1	1	1	1	1	1
		Hickory Lake	3	2				
	Wetlands Floodplains Swamps	Chandler Marsh	2	1				
		Grass Lake Area	4	3				
		Vermilion Creek Area	3	1	3	1	2	1
	Ground Water	Water Table	1	1	1	1	1	1
		Quality	2	2	2	2	2	2
	Soil Erosion	Cohesive	1	1	1	1	1	1
		Granular-Cohesive	1	1	1	1	1	1
		Granular	1	2	1	2	1	2
	Mineral Deposits	Sand and Gravel	1	1	1	1	1	1
	Paleon-tology	Rare Fossil Occur-rences	+1		+1		+1	

[1] Number in left-hand box indicates short-term impact resulting from highway construction activities. Number in right-hand box indicates long-term usage and maintenance impacts.

GUNNISONVILLE
BATH
WOODHULL
SHAFTSBURG
PERRY
(POP. 1420)
SOLON
UNIVERSITY AIRPARK
ART DAVIS AIRPORT
GRASS L.
PARK L.
PERCH L.
POTTER L.
MUD L.
ROSE L.
FOX KNOLL
BURKE L.
BRINDLE L.
BULLHEAD L.
N. GRAHAM L.
S. GRAHAM L.
DUNN LAKES
MARSH L.
MOON L.
COLBY L.
TWIN LAKES
LOOKING GLASS RIVER
PENN CENTRAL
GRAND TRUNK
S. BRANCH
Mud Creek
Vermilion
SCALE
1 MILE
GENERAL LOCATION MAP
Gravel Pits
Oil Exploration Hole, Dry

FIGURE 1


SCALE
0
MILES
SURFACE GEOLOGY MAP
MORAINE
GROUND MORAINE
OUTWASH
ESKER
FIGURE 2
Bath
Perry
Morrice
Shaftsburg
CLARK ROAD
BATH ROAD
M-78
M-52
US-27
CLINTON COUNTY
INGHAM COUNTY
SHIAWASSEE COUNTY
Park Lake
Porter Lake
Mud Lake
Rose Lake
Fox Knoll Lake
Miller Lake
Moon Lake
Colby Lake
Hickory Lake

SOIL TEXTURE MAP

FIGURE 3

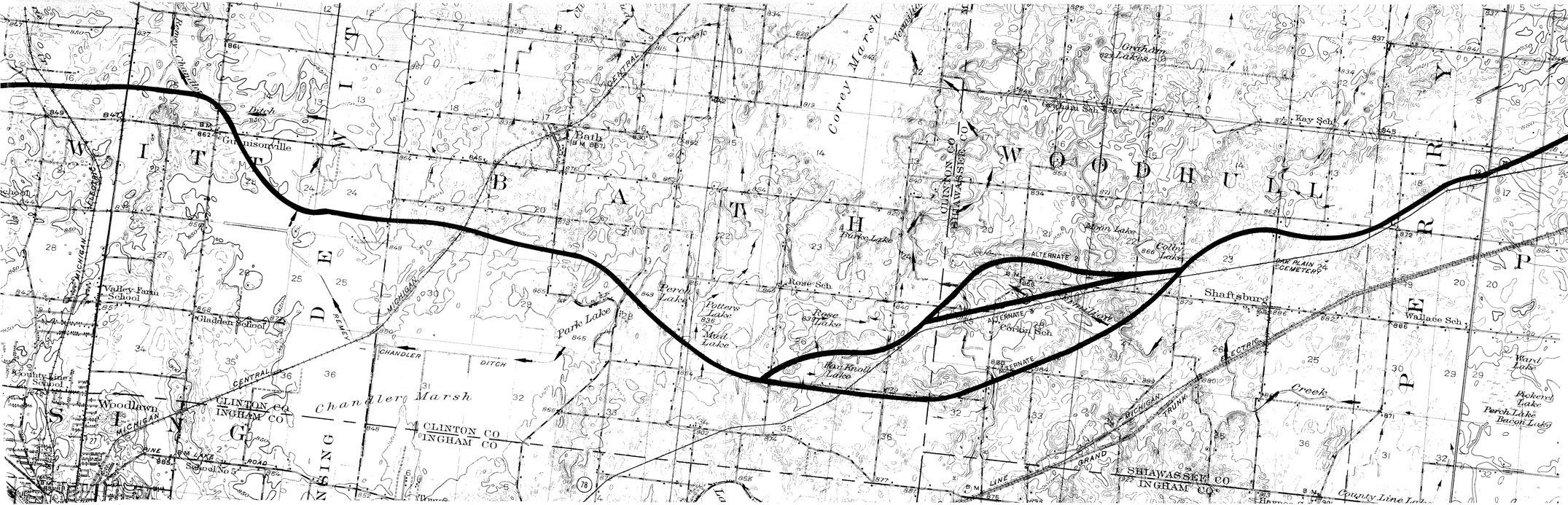

SCALE
MILES
TOPOGRAPHIC AND
DRAINAGE MAP
MAJOR TRIBUTARIES
SMALL & INTERMITTANT DRAINAGE

FIGURE 4

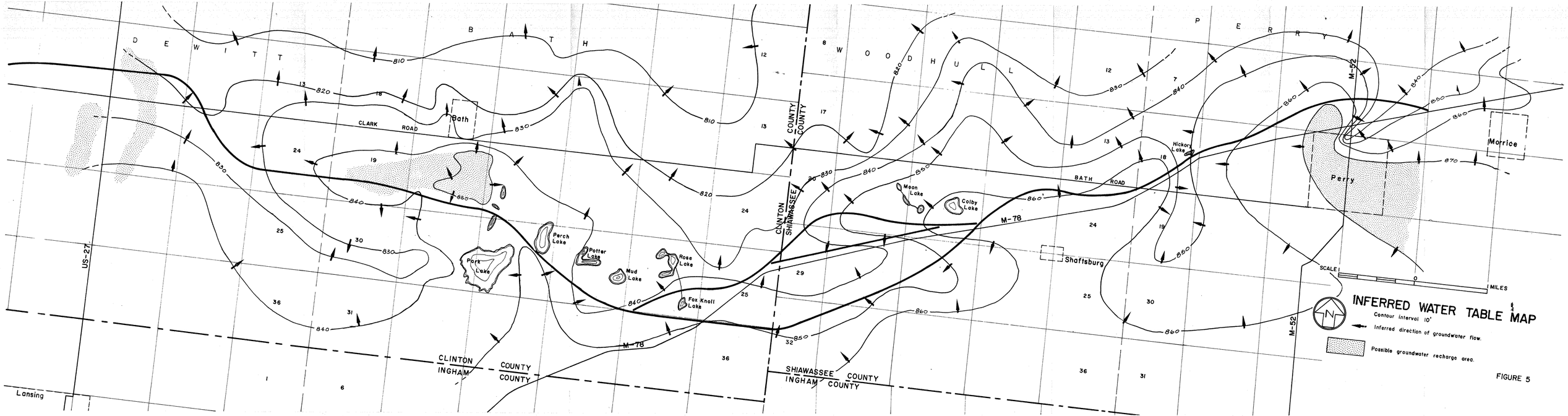
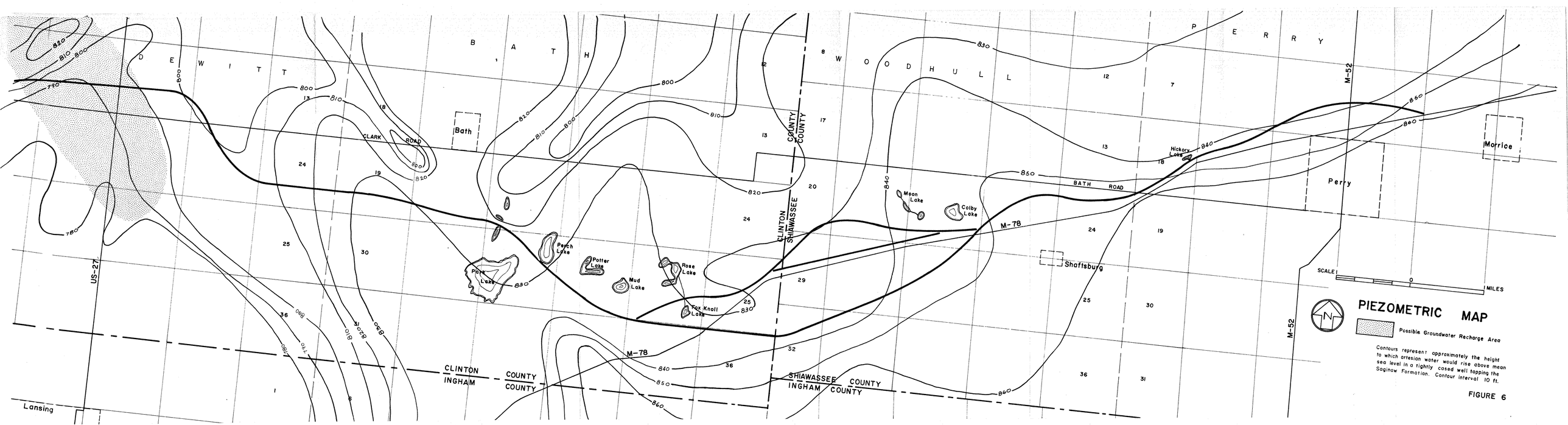

DEWITT
BATH
WOODHULL
PERRY
CLARK ROAD
BATH ROAD
Bath
Morrice
Perry
Shaftsburg
Lansing
US-27
M-78
M-52
CLINTON COUNTY
INGHAM COUNTY
SHIAWASSEE COUNTY
Perch Lake
Potter Lake
Mud Lake
Rose Lake
Fox Knoll Lake
Park Lake
Moon Lake
Colby Lake
Hickory Lake
SCALE 1
0
MILES
INFERRED WATER TABLE MAP
Contour interval 10'
Inferred direction of groundwater flow.
Possible groundwater recharge area.

FIGURE 5


DEWITT
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Potter Lake
Mud Lake
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Fox Knoll Lake
Moon Lake
Colby Lake
Hickory Lake
SCALE
MILES
PIEZOMETRIC MAP
Possible Groundwater Recharge Area
Contours represent approximately the height to which artesian water would rise above mean sea level in a tightly cased well tapping the Saginaw Formation. Contour interval 10 ft.
FIGURE 6