ENVIRONMENTAL GEOLOGIC STUDY OF THE PROPOSED US 127 ALTERNATE ROUTES

From US 12 North to M 50
Hillsdale, Lenawee, and Jackson Counties
Job Number 00537
Control Sections 30074, 38111, 38112, 46013

MICHIGAN HIGHWAY RESEARCH LABORATORY SECTION

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

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R. W. Noyce
T. A. Herbert

Research Project 71 TI-46
Testing and Research Division
Lansing, Michigan
Research Report R-800

Ann Arbor, January 1972

GENERAL GEOLOGIC SETTING

This is a preliminary report presenting the results of a detailed geologic and hydrogeologic investigation of the area affected by the four proposed US 127 alternate routes. The study was made by R. W. Noyce, Geologist, Testing Laboratory Section, and T. A. Herbert, Geologist, Research Laboratory Section at the request of J. H. Raad, Supervisor, Environmental Liaison Unit, Transportation Planning Division to aid in evaluating the environmental impact of each of the four US 127 alternates.

Information Sources

The environmental geology of the US 127 project area was partially determined from surface formation maps in Michigan Department of Natural Resource reports by Helen M. Martin entitled, "Outline of the Geologic History of Lenawee County," and "Outline of the Geologic History of Hillsdale County." This information, along with data obtained from field investigations, was plotted on base maps and is presented in Figures 1 and 2. The surface drainage information was obtained through field investigation and from USGS topographic quadrangles (Fig. 3). Subsurface information on drift thickness, bedrock and ground water was obtained from water well and oil well drilling records and is presented in Figures 4 and 5. Soils information was obtained from U. S. Department of Agriculture maps of Jackson, Hillsdale, and Lenawee County. Figure 6 is a composite soils map for the project area. All of the above geological information was supplemented by a series of 21 continuous flight auger borings conducted by the Geophysical Unit of the Michigan Department of State Highways. Geological cross sections A-A' through F-F' were constructed from this information (Figs. 7 through 12). The locations of these borings are plotted on Figure 1.

Figure 13, the "Environmental Impact Map" is the graphical presentation of the geological and hydrogeological interpretations made for this project.

Surface Formations

The US 127 project crosses a glaciated region having a relief of less than 100 ft. The geomorphic features of an area traversed by the proposed routes are typical of a recessional interlobate glacial system. In general, the glacier at this location was stagnant and melting at a fast rate with the subsequent abundant meltwater being responsible for the deposition of many of the landforms in the project area.

The hills and ridges in the southern and western portion of the area are interlobate moraines that formed at the margin of the re-entrant Saginaw and Huron-Erie ice lobes during which the rate of advance of the ice equalled the rate of ablation. This stagnant ice front position resulted in the deposition of a till ridge (moraine) along the glacier's terminus. Till has been described as unstratified rock debris that has a wide range of textural grain sizes. However, the term till has a broad application and its composition actually represents whatever size and type of rock debris entrained in the ice at the time of melting.

As the project is in an interlobate area with one ice lobe having moved southwest from the Saginaw Bay region and another west from the Huron and Erie lake basins the lithologic composition (rock composition) of the moraines is variable. Glacial debris from the Saginaw Lobe generally has a higher percentage of sandstone which has been derived from local bedrock outcrops of sandstone. The Huron-Erie Lobe deposits have a somewhat higher percentage of limestone. The lithologic difference is reflected in the soil types that have developed on these differing parent materials.

The major portion of the US 127 project lies on a gently undulating ground moraine extending from north of Vicary Rd to just north of Ackerson Lake (Fig. 2). The till of the ground moraine is predominantly a gravelly clay or gravelly clay loam. The ground moraine appears to have been a product of the Saginaw Lobe because of the abundance of sandstone erratics.

During the time of formation of the ground moraine, meltwater was channeled in sediment-laden streams known as glacial drainageways (Fig. 2). Where these streams meandered back and forth over a broad, flat plain the resulting deposits of stratified sand and gravel are known as outwash plain or, more simply, as outwash. The outwash, due to its granular texture, has good drainage characteristics and may serve as a ground water intake area and as an aquifer for ground water.

An outwash plain extends north of the previously described ground moraine at the north end of the project area. Glacial drainageways cut through the ground moraine to the south. The Grand River now occupies segments of these drainageways.

Associated with the outwash deposits is another geomorphic feature known as an esker. The Blue Ridge Esker, as it is known locally, is a ridge of sand and gravel that formed in ice-walled channels and/or tunnels in the stagnant, melting glacier. The Blue Ridge Esker is located on a NE-SW line extending from Center Lake to Skiff Lake. Gravel mining is being carried out at several locations along the esker at a rate that will probably remove most of the remaining material by the time US 127 is constructed.

Soils

The soils of the project area reflect their glacial origins in that they exhibit a lack of uniformity in texture, structure, chemical nature, fertility, and moisture relations (Fig. 6).

The soils associated with the morainic hills in the southern part of the project area evolved from a parent material deposited by the Huron-Erie Ice Lobe. The major soil series are Miami and Hillsdale. These well-drained soils series consist mostly of loams and sandy loams with a high lime content. Internal drainage is moderate to poor and surface runoff is medium to rapid. On steep slopes these soils are subject to water erosion.

The soils developed on the moraines in the western portion of the study area consist of the Hillsdale, Bellefontaine, Coloma series and reflect the more granular nature of materials deposited by the Saginaw Ice Lobe. The Bellefontaine Soil Series is the more granular series with a sandy loam cap overlying sand and gravel with pockets of silt and clay. The Bellefontaine Series is also associated with soils on the Blue Ridge Esker. The Bellefontaine and Hillsdale soils are very susceptible to water erosion and gullying in steep slopes. The Coloma soils are well-drained deep sands relatively low in water-holding capacity and are subject to wind erosion when ground cover is removed.

The soils north of Vicary Rd are composed mostly of sandy loams derived from ground moraine and outwash deposits. The soil of the Hillsdale Series (ground moraine origin) is well drained and contains a large proportion of sandstone fragments. Soil characterized by sandy loam underlain by stratified sand and gravel (outwash origin) is grouped in the Fox Soil Series which is a well-drained soil.

Soils developed in the poorly drained swamps or in closed or partially closed ponded basins consist of fine textured and organic materials and are classified as Carlisle and Houghton Muck and Rifle Peat Soils Series. These soils have accumulated and developed in a permanently wet environment.

The Carlisle Series can occur on outwash plains and old glacial drainageways in which the underlying mineral soil could be granular. The most extensive areas are closed depressions in moraines and ground moraines. In this situation, the underlying materials could be clays and loams.

The predominate organic soil series in the study area is Rifle Peat. This soil series is widely distributed in irregular areas in association with drainageways as well as in closed depressions on ground moraines and moraines. The composition at the mineral substratum is variable.

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The major portion of the corridor lies north of the topographic divide in a watershed that serves as the headwaters of the Grand River. The Grand River in this area has a shallow granular channel with a low volume of water. In some places the channel is hard to define from the swamp through which it flows. The absence of a well-defined channel and flood plain for the Grand River is due to the relative youthfulness of the river at this location, the granular nature of adjoining soils, the low relief of the area, and the nearness to the river's point of origin. A maximum water elevation could not be obtained because of the lack of stream gaging stations on this part of the river. Likewise, water quality parameters were not available. The areal extent of the flood plain, shown in Figure 3, was derived from local inquiries and field observations. The large swamps adjoining and presently drained by the Grand River serve as a flood plain in a time of exceptionally high water. Surface runoff and ground water in this drainage basin eventually discharges into Lake Michigan.

Surface runoff in the drainage basin south of the topographic divide supplies Goose Creek, a narrow, shallow stream with little or no flood plain. This stream is a tributary of the River Raisin which flows into Lake Erie. There are no stream gaging stations on Goose Creek and information concerning high and low water levels and water quality parameters was not available.

Ground Water in the Glacial Drift

Most of the ground water information was obtained from drilling records on file at the Department of Natural Resources, Geological Survey Division. This information, along with ground water information gathered during the Highway Department's continuous flight boring program, has been plotted on cross-sections A-A' through F-F'. The geographical locations of the wells and borings are presented in Figure 1. Where possible, water samples were taken from auger holes for chloride analysis.

The topographic divide, across which all four of the proposed US 127 alternates traverse, is also the approximate phreatic (ground water) divide. North of the divide the direction of ground water migration is northwesterly. The relative imperviousness of the clay till of the ground moraine in the northern portion of the project area limits ground water migration to the more porous channels formed by the outwash and glacial drainageways. This condition of a relatively thin non-porous drift is responsible for most of the water wells north of the divide being completed in the bedrock. The clay till also acts as an aquiclude (ground water barrier) and prevents the migration of water into or out of the porous bedrock.

South of the divide, ground water conditions are significantly different. The more granular moraines allow a relatively free movement of ground water. This migration is in the southeasterly direction into the watershed of the River Raisin. The fragmentary nature of an impervious clay layer lying directly on top of the bedrock, south of the divide, allows some infiltration of the ground water into the bedrock.

At 11 of the 22 auger boring sites (Fig. 1), water samples were taken and analyzed for chloride (Table 1). The chloride ion levels in the samples ranged from 10 to 554 ppm. Only the 554 ppm value at site B-1 at the corner of Vicary and Jackson Roads exceeded the 250 ppm limit for potable water. This high value at site B-1 possibly reflects the use of de-icing salt by the Jackson County Road Commission since the boring was made in the roadside ditch.

TABLE 1

Sample Site	Chloride, ppm Cl
B-1	554
B-2	145
B-6	12
B-8	172
B-9	24
B-10	183
B-12	154
B-15	10
B-16	106
B-18	20
B-20	50

Ground Water in the Bedrock

A majority of the water wells in the area under study are artesian and are completed in the underlying sandstone bedrock. Figure 5 shows a map of the artesian water surface constructed by contouring the static water level in tightly cased wells tapping the artesian bedrock aquifer. This artesian water surface indicates that there is a general water migration to the northwest.

The existence of an artesian condition for this bedrock aquifer throughout most of the study area is indicated by a piezometric surface that rises above the confined body of the aquifer. Where the elevation of the piezometric surface is greater than the land elevation (Figs. 7 through 12), the conditions are satisfied for a flowing well. This condition exists at several places in the study area as indicated by a number of existing flowing wells shown on Figure 5.

Areas of possible ground water recharge to the bedrock artesian aquifer are indicated by mounds in the piezometric surface. A possible recharge area is indicated in the southwest corner of the study area (Fig. 5). This is a low area north of the morainic ridges with numerous closed depressions. The glacial drift thickness in this area is less than 40 ft (Fig. 4). Water well logs for the area indicate that the glacial drift is granular and that any clay layer that would act as a barrier to water infiltrating the bedrock is discontinuous.

A mound in the water surface north of the village of Liberty indicates some recharge infiltration is probably taking place. A water well record in this area shows that the drift is granular and that there is an absence of an impervious layer above the bedrock aquifer. The general drift thickness map, Figure 4, indicates an approximate thickness of 65 ft. The moraines to the immediate south of this low area provide water in the form of runoff and localized subsurface drainage.

A small amount of water infiltration is indicated south of Clark Lake. This is an area of clayey till with a thickness of less than 50 ft. Water well records indicate that there are some granular areas, with the main area of recharge probably to the east of the study area.

ANALYSIS OF GEOLOGIC AND HYDROGEOLOGIC IMPACT FACTORS

Surface Water Crossings

The major impact of highway stream crossing includes pollution due to increased sedimentation during and after construction and degrading of water quality by undiluted surface runoff from de-icing programs, and accidental spillage from tankers or motor vehicles. Depending upon the circumstances, these pollutants could cause significant harm to stream ecology. The final location of the roadway should be such that the possibility of major detrimental impacts at stream crossing points are remote.

Several other factors associated with stream crossings could be considered minor impact factors. These would include channelization and constriction of the natural channel and the subsequent reduction of floodplain.

This would have the effect of reducing the flood water storage potential of the stream.

The four proposed alternate alignments cross several streams where the hydrologic impact would be major. They will be discussed as they are plotted on the map of environmentally sensitive areas (Fig. 13).

The Jefferson Rd crossing and interchange is considered an area of major hydrologic impact. Alternate alignments A and D are identical in their point of crossing at Jefferson Rd. The possibilities of pollution stemming from accidental spillage or heavy de-icing salt applications on the southern quadrant ramps is unusually high for Alternates A and D. Alternate C parallels the existing roadway of US 127 and directly crosses the Grand River with the Jefferson Rd interchange occurring very near the river. The impact of this crossing is major. Alternate B crosses the Grand River directly, 0.2 miles north of the interchange at Jefferson Rd. The interchange would cross a small intermittent tributary creek of the Grand River. The interchange on this alignment lies further from the Grand River than those for Alternates A, C and D. The increased distance from the river of the interchange, and the direct river crossing, allows this alternate to be given a minor impact rating at this location.

The alignment of Alternate B, however, does have major impact immediately north of the Jefferson Rd area where it crosses the Grand River once more and parallels it for more than one-half mile on the west edge of the right-of-way. This swamp crossing in such close proximity to the river would have major impact because of the possibility of uncontrolled stream sedimentation and the chance of liquid spillage entering the river along this stretch.

The proposed alignments of combined Alternates A and D cross the Grand River again approximately one-half mile north of Weatherly Rd. The crossing at this point will be at a narrow point in the channel, having minor impact on the stream.

South of the Grand River approximately one mile, Alternates A, C, and D cross a small unnamed, intermittent stream. The crossing will be direct and there is a narrow flood plain. The impact at this crossing is rated as minor. Alternate B crosses the same stream approximately one mile to the east of this location, also at a point where minor impact is predicted.

A stream-crossing over Goose Creek is made by Alternates A and B at a point just east of existing US 127. Both alignments have a nearly direct crossing over this stream at a point where minor environmental impact is predicted.

Wetland or Swamp Crossings

The major hydrogeologic impact of highways crossing wetlands or swamps occurs when highway embankments reduce the amount of river floodplain and increase the possibility for upstream flooding. When swamps are not associated with river floodplains, it is possible to contaminate the ground water from liquid spillage or from de-icing programs. Swamps and wetlands in most instances are merely visible surface extentions of the ground water system and provide a ready avenue for contaminants through recharge.

Of minor impact would be the possibility of blocking natural ground water movement by swamp backfill or displacement with granular material. In Michigan, the specifications for swamp backfill material is 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.

A wetland crossing that is given a major impact rating occurs on proposed alignment A where the Ayers Rd interchange is located. This wetland crossing is of major concern because of its close proximity to the Grand River; moreover, it crosses a tributary of the Grand, that flows from Hammer and Peter White Lakes, with the roadway and two ramps. The construction of interchange structures and connecting ramps will be in an area of extensive swamp deposits classified as Rifle Peat. The primary reason for major concern will be the possibility of increased siltation in the Grand River.

A wetland crossing on Alternate B, one mile north of the county line, is also given a major impact rating because of its length (approximately one mile) and the possibility that this area is also a ground water recharge zone. The possibility of accidental spillage of contaminants could effect ground water quality in the immediate vicinity.

Alternate alignments A, C, and D cross the westward extension of this muck area at a much narrower spot and for this reason the impact of these alignments is rated minor.

Two minor rated wetland crossings occur on Alternate B approximately one mile southwest of Ackerson Lake. These crossings are of a minor impact because of their small size and apparent isolation from the ground water system.

Ground Water Recharge Zones

The crossing of areas of ground water recharge that are otherwise not recognized as swamps or other surface expressions of the ground water table are also considered to be of major impact. These would include porous zones through which surface water percolates into either glacial drift or bedrock aquifers. Contaminants in the runoff water from highways will pollute the ground water if suitable precautions are not taken.

The only recharge area of significant impact, other than lakes, streams, or swamps, is in close proximity to Alternate A. This area was given a major impact rating because this porous zone recharges the underlying sandstone from which most of the wells in the vicinity draw their water. Contamination of this area by accidental spillage or from de-icing salts should be avoided.

Soil Erosion

Soil erosion and the subsequent disfiguration of the landscape and stream siltation are generally regarded as having minor geological impact, considering modern construction practices. 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 sodded as soon as possible after final grade is obtained. All other areas are seeded.

There are no areas where soil erosion should be given special consideration for any of the four alternate routes. The locations where the possibility of soil erosion could occur would have impact as rated under either the prior categories of stream crossings or wetland crossings.

Mineral Deposits

Highways crossing mineral deposits have geological impact if the location of the roadway blocked the removal of the mineral from the deposit. In the study area, only two types of deposits could be affected: non-metallic bedrock deposits such as limestone or sandstone, and glacial deposits of sand and gravel. The demand for either type, combined with their generally abundant supply, make this of minor impact.

The Blue Ridge Esker is the only mineral deposit of economic significance affected by this project. The geological impact is rated minor because most of the deposit has already been removed or, at the present rate of mining, should be removed by the time the project is constructed.

Rare Fossil Occurrences

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 most 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 purpose of this study was not to choose the best alternate route to be constructed across the area on the basis of geologic and hydrogeologic factors, but rather to delineate areas where special consideration should be given in the design and construction stages. The general rating of each factor for the four alternates is presented in Table 2.

TABLE 2

Geologic and Hydrogeologic Factors	Degree of Impact*			
	Alt. A	Alt. B	Alt. C	Alt. D
Surface water crossings	major	major	major	major
Wetland or swamp crossings	major	major	minor	minor
Interference with ground water recharge zones	major	minor	minor	minor
Soil erosion	minor	minor	minor	minor
Mineral deposits	minor	minor	minor	minor
Rare fossil occurrences (positive)	minor	minor	minor	minor

* All impacts considered negative unless otherwise noted.

Alternate A poses possible significant impact on the ground water recharge area located west of existing US 127, near the Jackson-Hillsdale County Line. This problem is reduced or eliminated in Alternates B, C, and D by their locations eastward, away from the recharge area. Alternate B poses the least problem because of its remote location and direction of surface and ground water movement southeastward away from the recharge area.

The large swamp between White and Liberty Roads is traversed by all four alternates with varying impacts. Alternate B, with the longest crossing, would exert the greatest impact. Alternates C and D cross the swamp at a narrow point already traversed by the existing US 127 roadway embankment. Alternate A crosses the swamp at a narrow point and then runs along the east edge of the wetland for approximately one-half mile, thus making more of an impact than Alternates C and D.

The Jefferson Rd-Alternates A, C, and D Interchange occur at the Grand River crossing. Degradation of the river water by undiluted surface runoff, from de-icing programs and accidental spillage of contaminants, is the greatest threat posed by this situation. Another problem is possible stream siltation caused by construction of an interchange at a river crossing. These impacts are reduced in the Alternate B alignment because the interchange occurs one-half mile south of the Grand River crossing. This would allow a dilution of the surface runoff and deposition of sediment before entering the river.

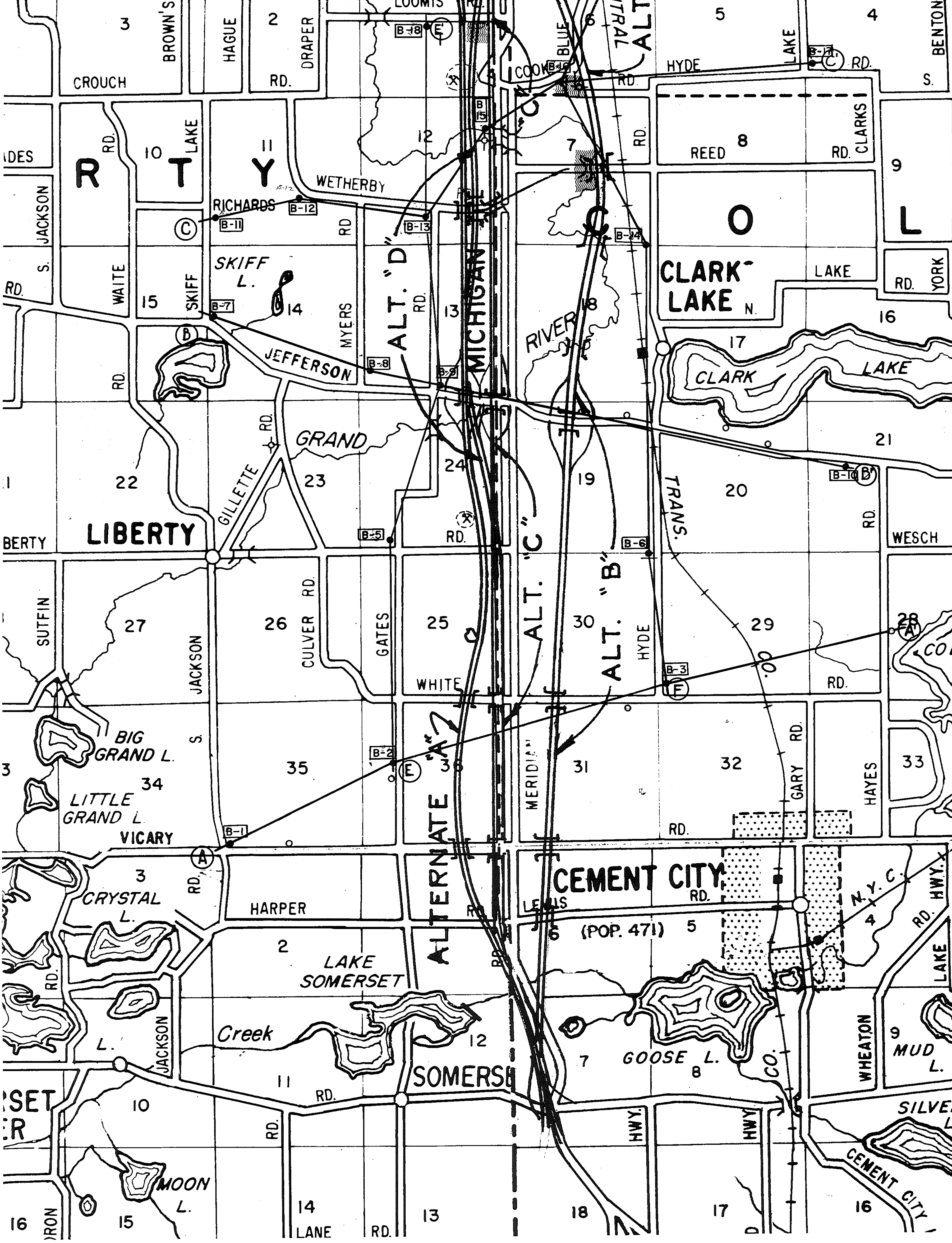
North of Jefferson Rd, Alternate B has major impact because of the long swamp crossing and parallel proximity of the roadway to the Grand River. This situation is avoided in Alternates A, C, and D.

Alternates B, C, and D avoid the major impact associated with the construction of the Ayers Rd Interchange of Alternate A through a large swamp deposit. Contaminants resulting from maintenance of this facility, and contained in surface runoff, will add to the pollution of the Grand River.

Alternate D causes the least impact on the geologic and hydrogeologic conditions of the study area. This alternate avoids the significant problem caused by the nearness of Alternate A to the recharge area. It also avoids the serious impact of the Alternate A-Ayers Rd Interchange. By using the same alignment as Alternate A between Jefferson and Loomis Roads, Alternate D avoids the impact problems of Alternate B. Alternate D would require less service road construction than Alternate C. The Jefferson Rd Interchange impact could be reduced through design and construction controls.

The impact of this route on any sand and gravel deposits that it may cross is minor because of the large number of deposits available in the area. There are no stone quarries in the area traversed by this route. The limited demand for the type of stone from the underlying bedrock formations, and the thickness of the drift, makes mining uneconomical and the impact for all alternates is minor.

Any deposits containing rare fossils that are unearthed during construction of any of the four alternates would be considered of positive impact. No known deposits occur in this area, however.



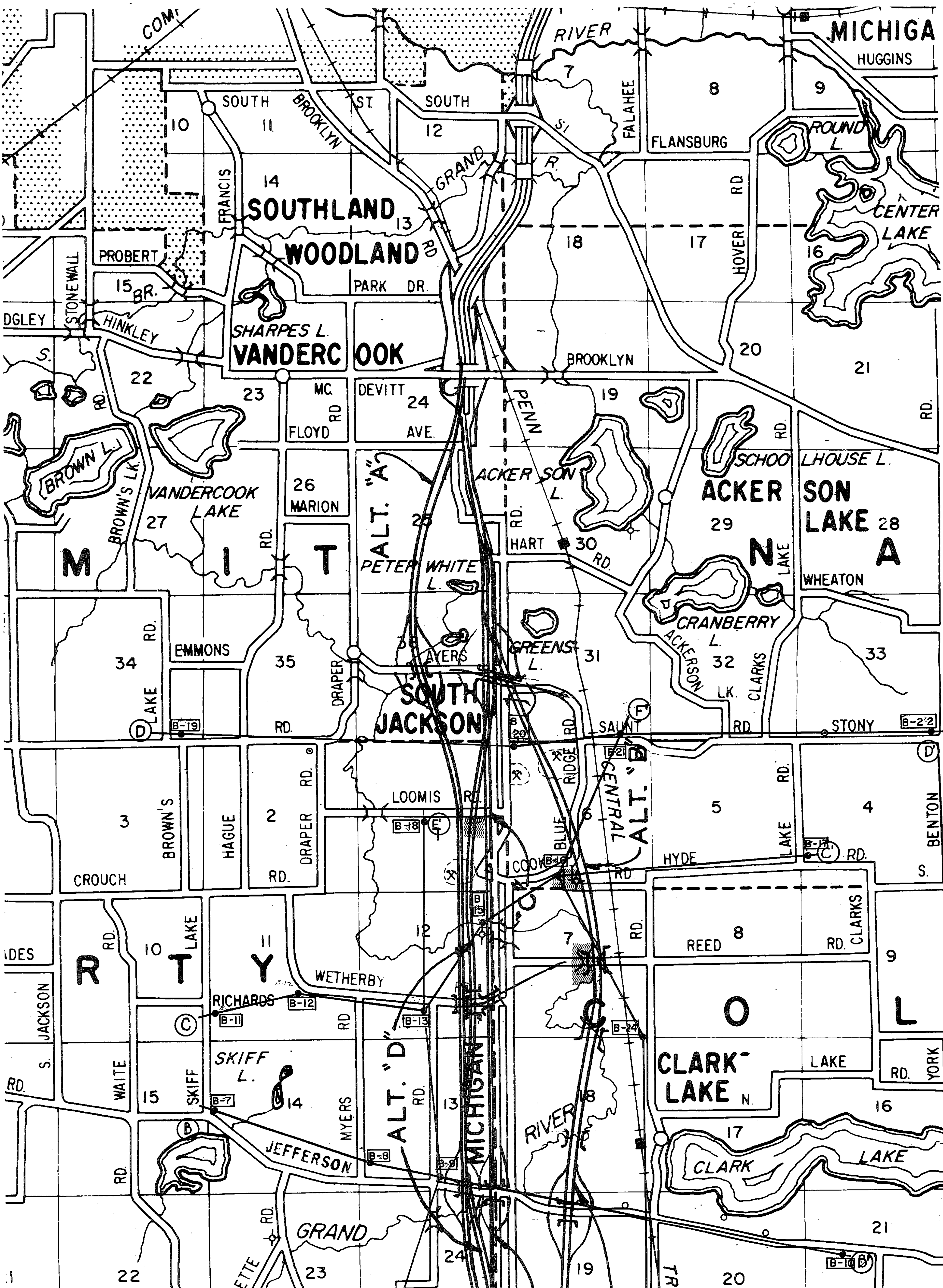
SCALE 1 0 1 2 3 MILES

POLYCONIC PROJECTION

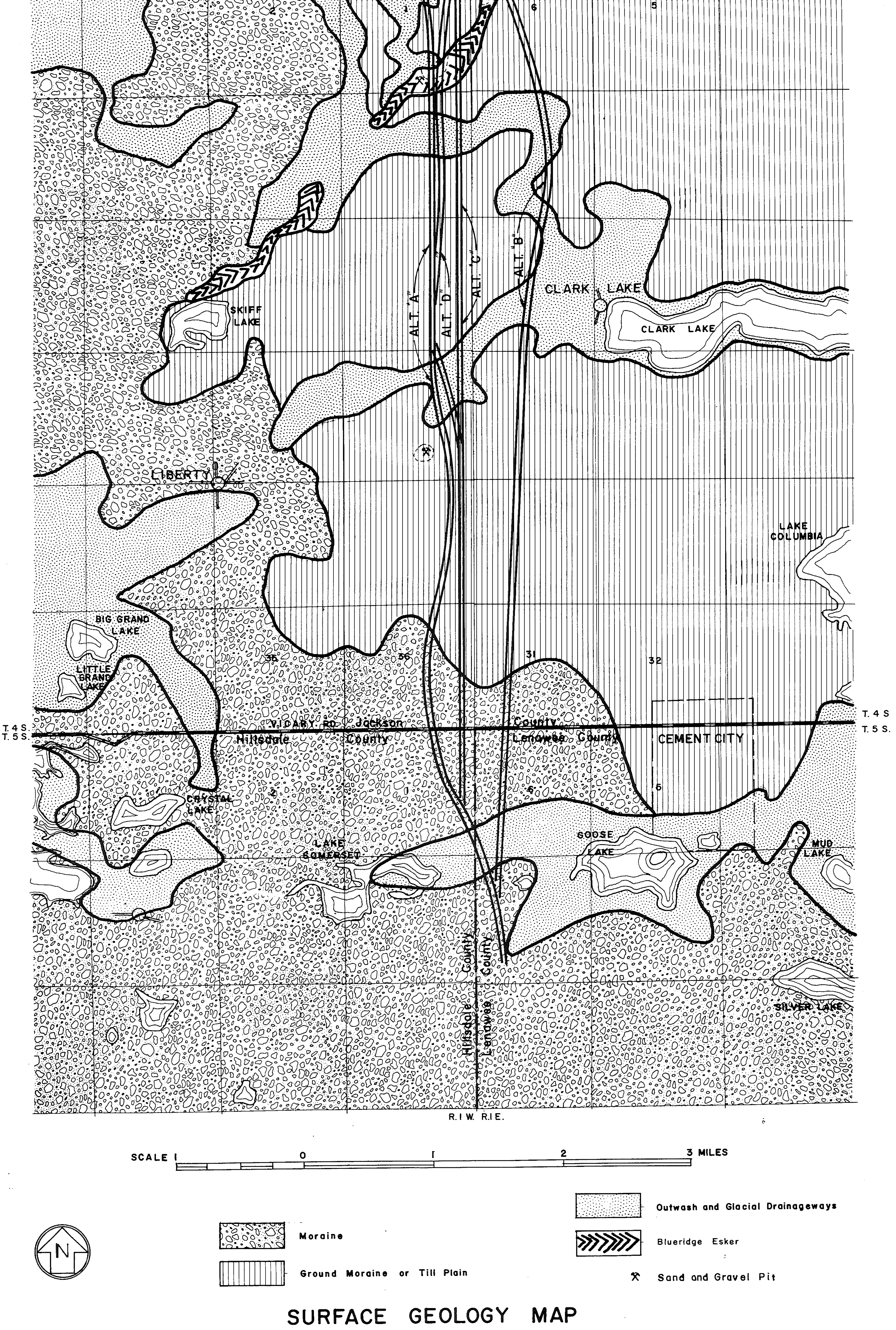
- ⚒ Sand and Gravel Pit
- Area of Manmade Ponds
- Flowing Water Well
- ● Mobile Drill Unit Boring
- ○ Water Well

GENERAL LOCATION PLAN

FIGURE 1

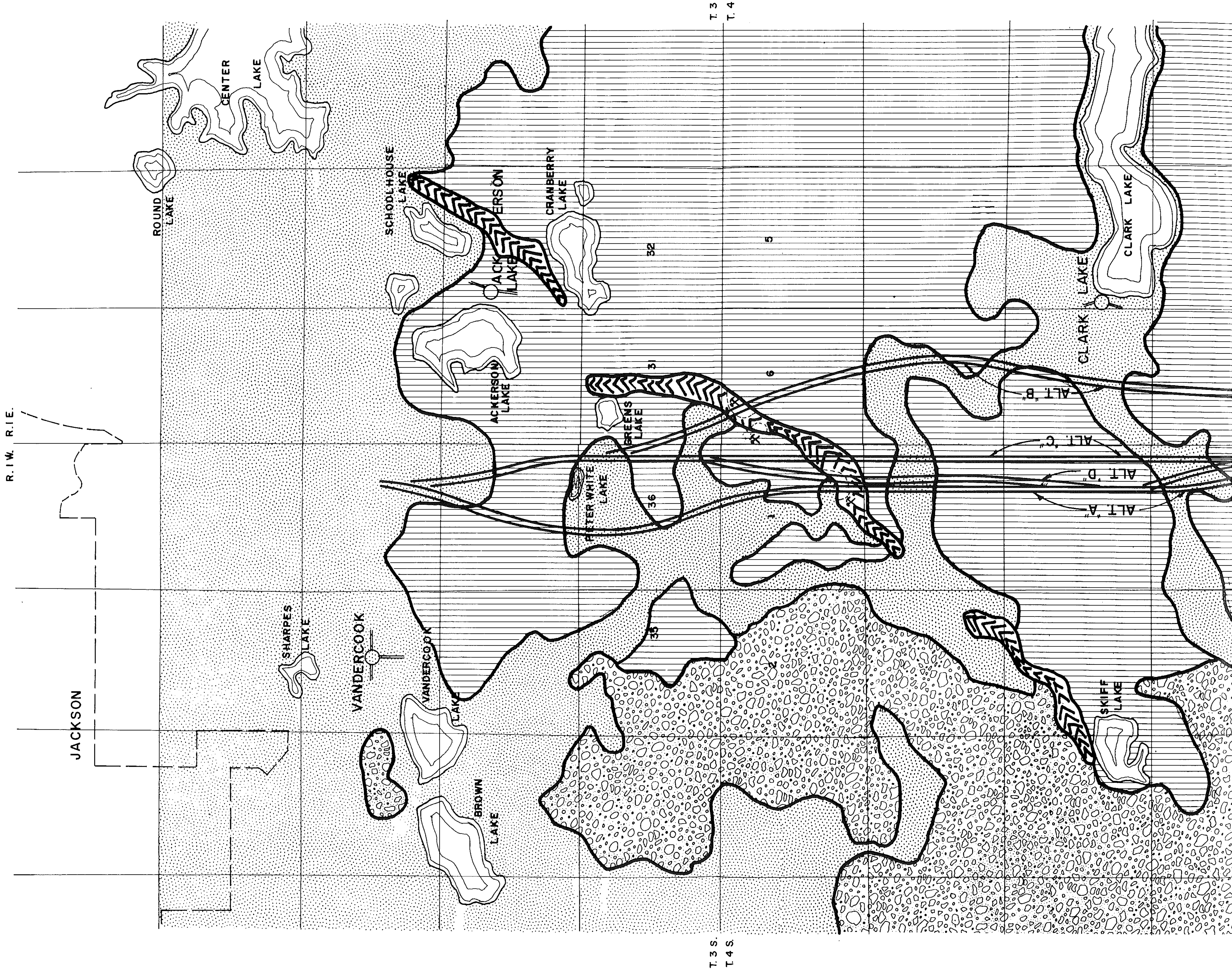


MICHIGA
HUGGINS
RIVER
FALAHEE
FLANSBURG
ROUND L.
CENTER LAKE
HOVER RD
SOUTH
BROOKLYN
SOUTH
GRAND R.
FRANCIS
SOUTHLAND
WOODLAND
PARK DR.
PROBERT
STONEWALL
BR.
HINKLEY
SHARPES L.
VANDERCOOK
BROOKLYN
PENN
MC RD
FLOYD
DEVITT AVE.
BROWN L.
BROWN'S LK.
VANDERCOOK LAKE
MARION
ALT. "A"
ACKERSON L.
HART RD.
SCHOOLHOUSE L.
ACKERSON LAKE
WHEATON
LAKE
M I T
N A
PETER WHITE L.
CRANBERRY L.
ACKERSON LK.
CLARKS
GREENS L.
AYERS
EMMONS
DRAPER
SOUTH JACKSON
STONY RD.
SAUNT
ALT. "B"
CENTRAL
RIDGE RD
LOOMIS RD.
BROWN'S
HAGUE
DRAPER RD.
CROUCH
BLUE
COOK
HYDE
LAKE RD.
BENTON S.
REED RD.
CLARKS RD.
WETHERBY
RICHARDS
SKIFF L.
SKIFF
WAITE
S. JACKSON
MYERS RD
ALT. "D"
MICHIGAN
JEFFERSON
RIVER
CLARK LAKE
YORK RD.
GRAND
R T Y
C O L
TRA

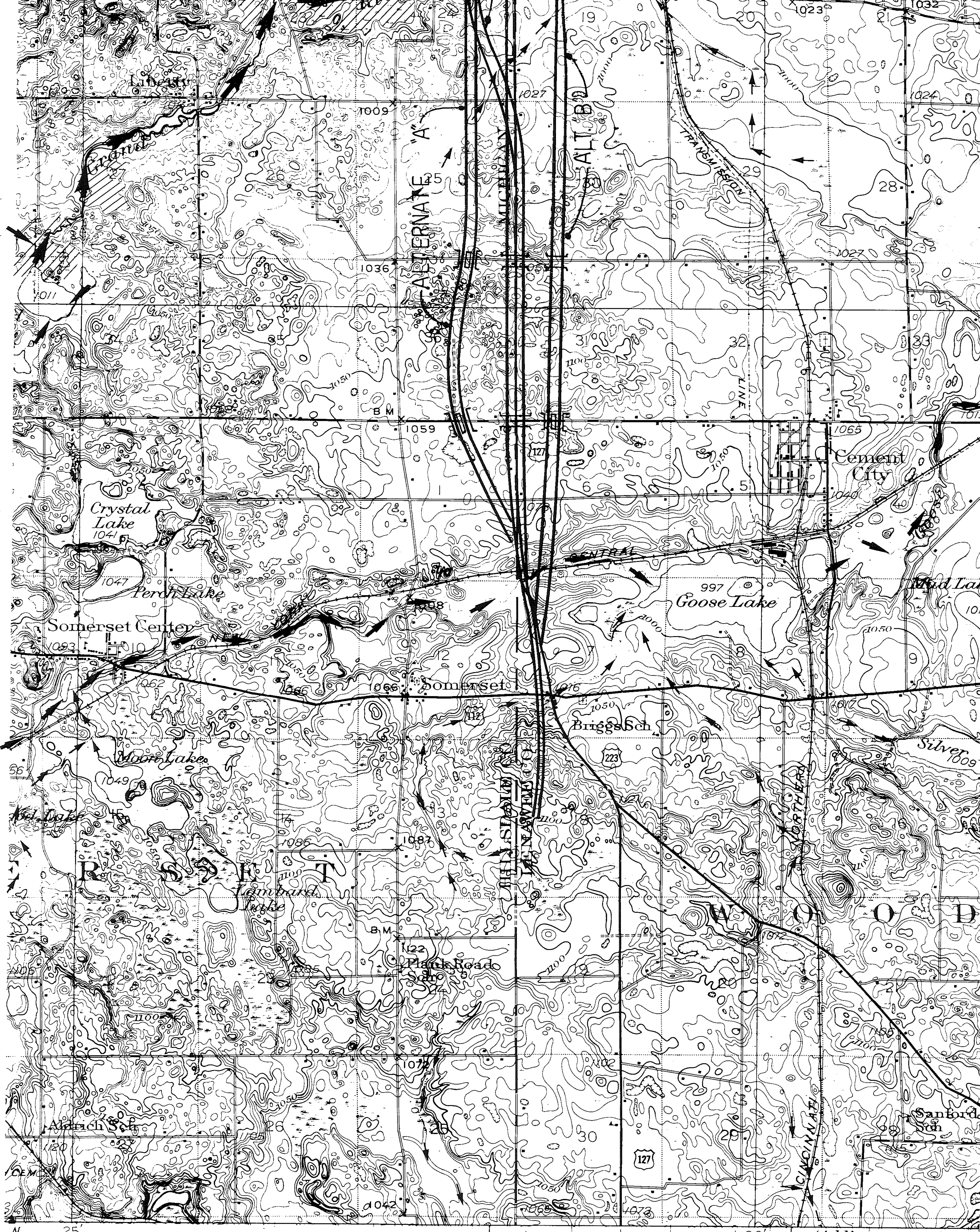


SURFACE GEOLOGY MAP

FIGURE 2



T. 3 S.
T. 4 S.
R. 1 W.
R. 1 E.
JACKSON
ROUND LAKE
CENTER LAKE
SCHOOLHOUSE LAKE
ERSON
ACK LAKE
CRANBERRY LAKE
ACKERSON LAKE
GREENS LAKE
PETER WHITE LAKE
CLARK LAKE
CLARK LAKE
ALT. "B"
ALT. "C"
ALT. "D"
ALT. "A"
SHARPES LAKE
VANDERCOOK
VANDERCOOK LAKE
BROWN LAKE
SKIFF LAKE
32
5
31
6
36
1
35
T. 3 S.
T. 4 S.



SCALE 1:62500

1 ½ 0 1 2 3 4 MILES

3000 0 3000 6000 9000 12000 15000 18000 21000 FEET

1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

N

RIVERS

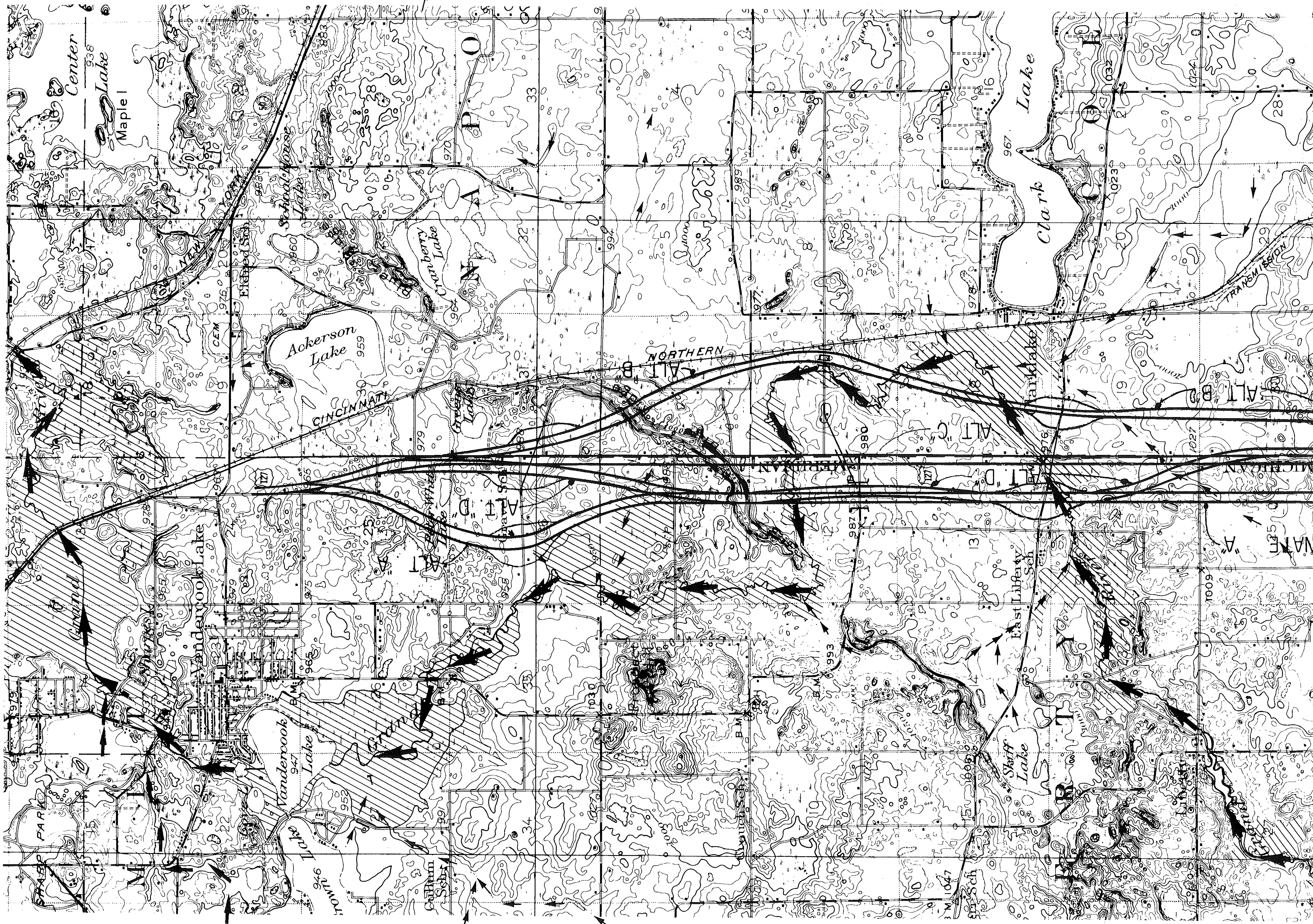
MAJOR TRIBUTARIES

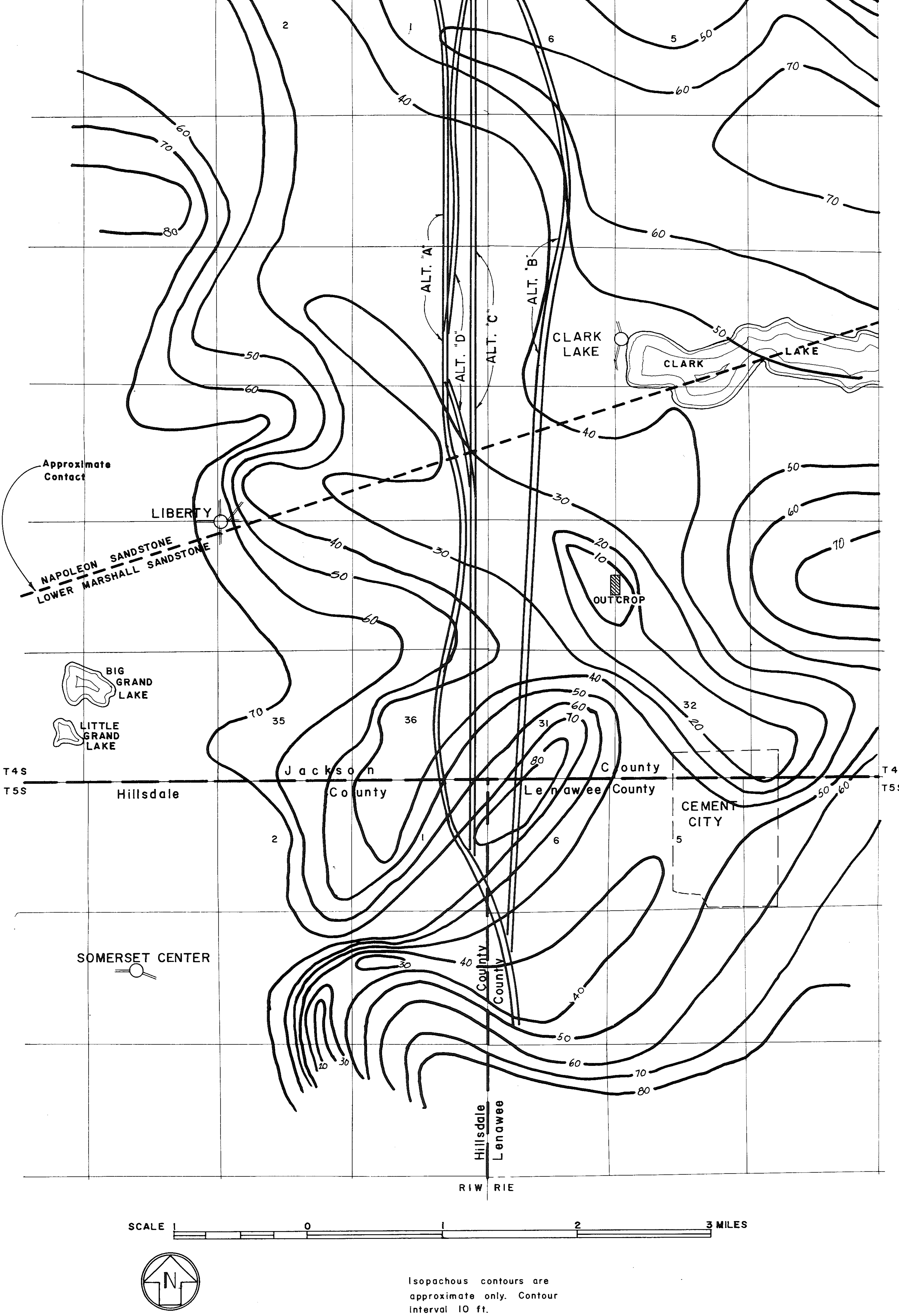
SMALL & INTERMITTANT DRAINAGE

APPROX. FLOOD PLAIN OF THE GRAND RIVER

SURFACE DRAINAGE MAP

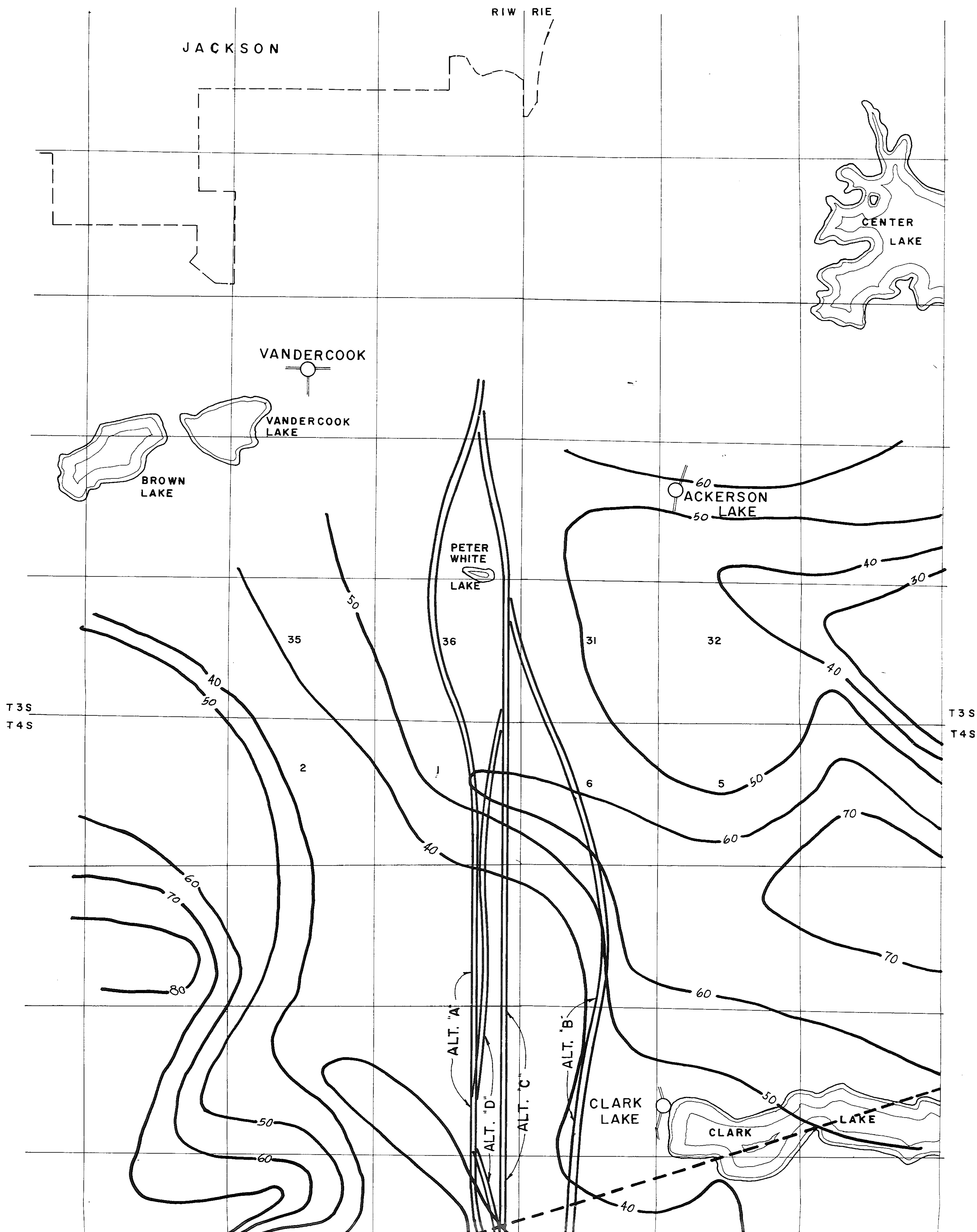
FIGURE 3

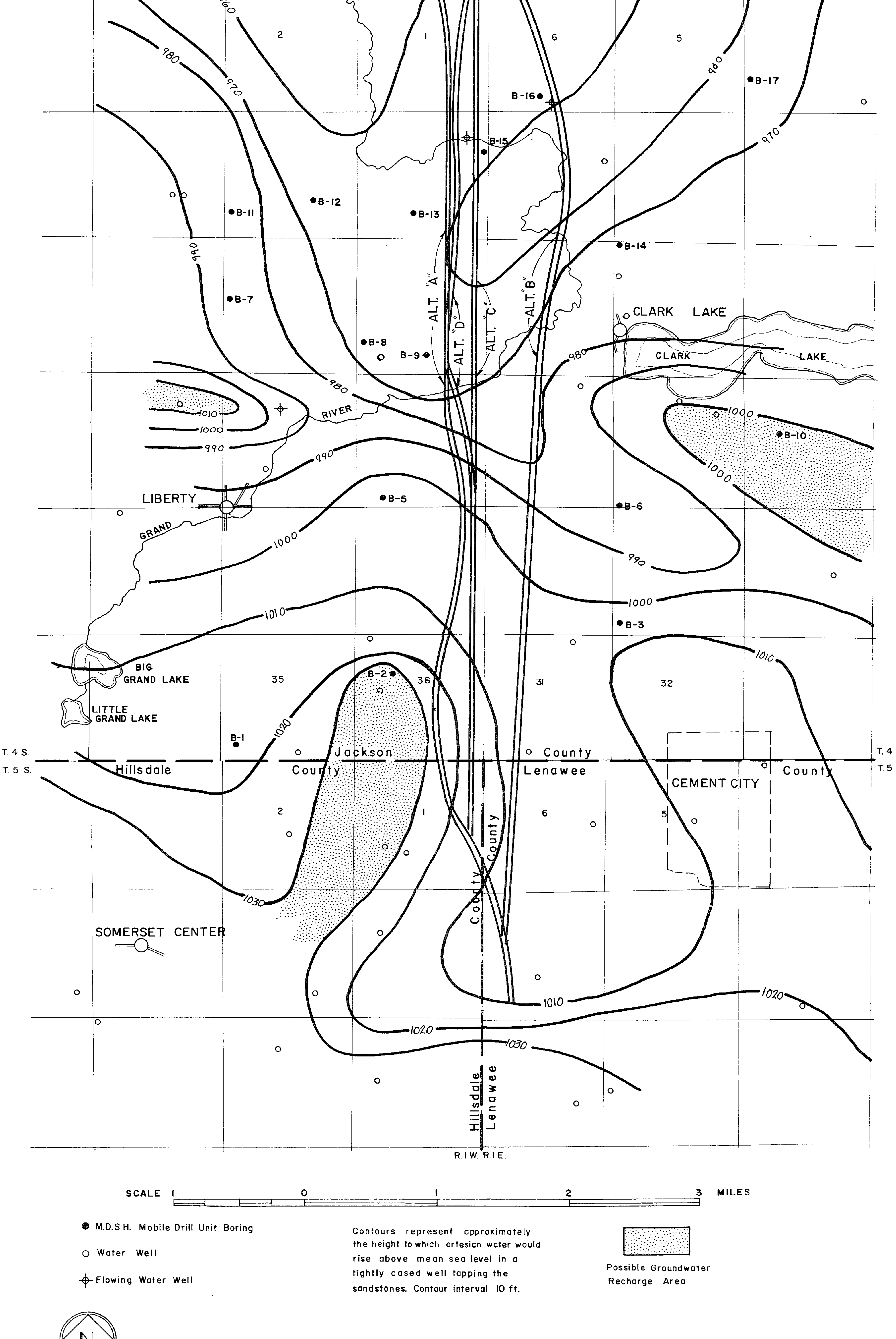

Ackerson Lake
959
CINCINNATI
NORTHERN
ALT B
ALT C
ALT D
ALT A
MICHIGAN
TRANSMISSION
Cranberry Lake
Center Lake
Maple
Clark Lake
Parklake
Vandercook Lake
Grand River
East Liberty Sch
Skiff Lake
CEM



BEDROCK AND DRIFT THICKNESS MAP

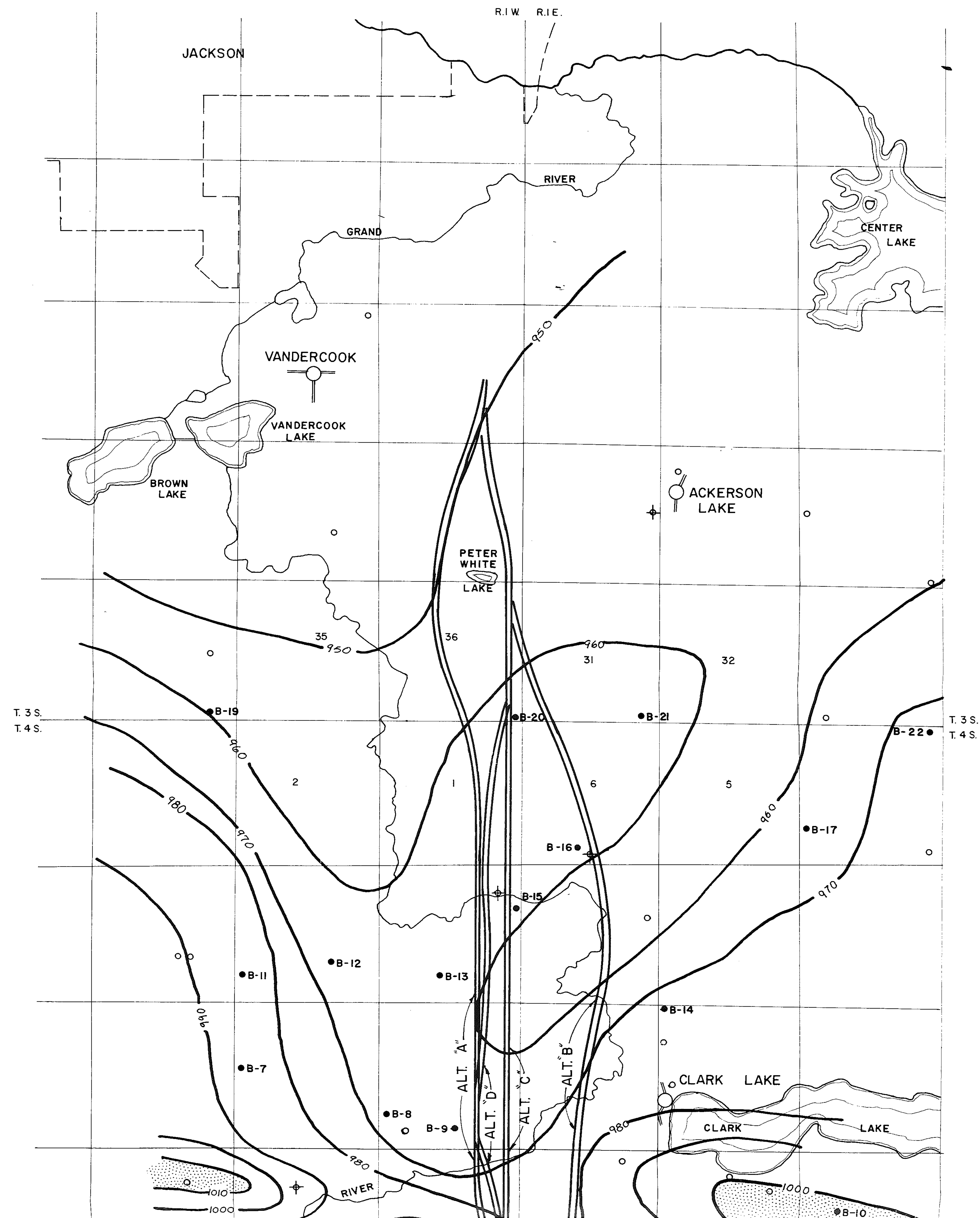
FIGURE 4


RIW
RIE
JACKSON
CENTER LAKE
VANDERCOOK
VANDERCOOK LAKE
BROWN LAKE
ACKERSON LAKE
PETER WHITE LAKE
CLARK LAKE
CLARK
LAKE
T3S
T4S
T3S
T4S
35
36
31
32
2
1
6
5
30
40
50
60
70
80
ALT. "A"
ALT. "B"
ALT. "C"
ALT. "D"

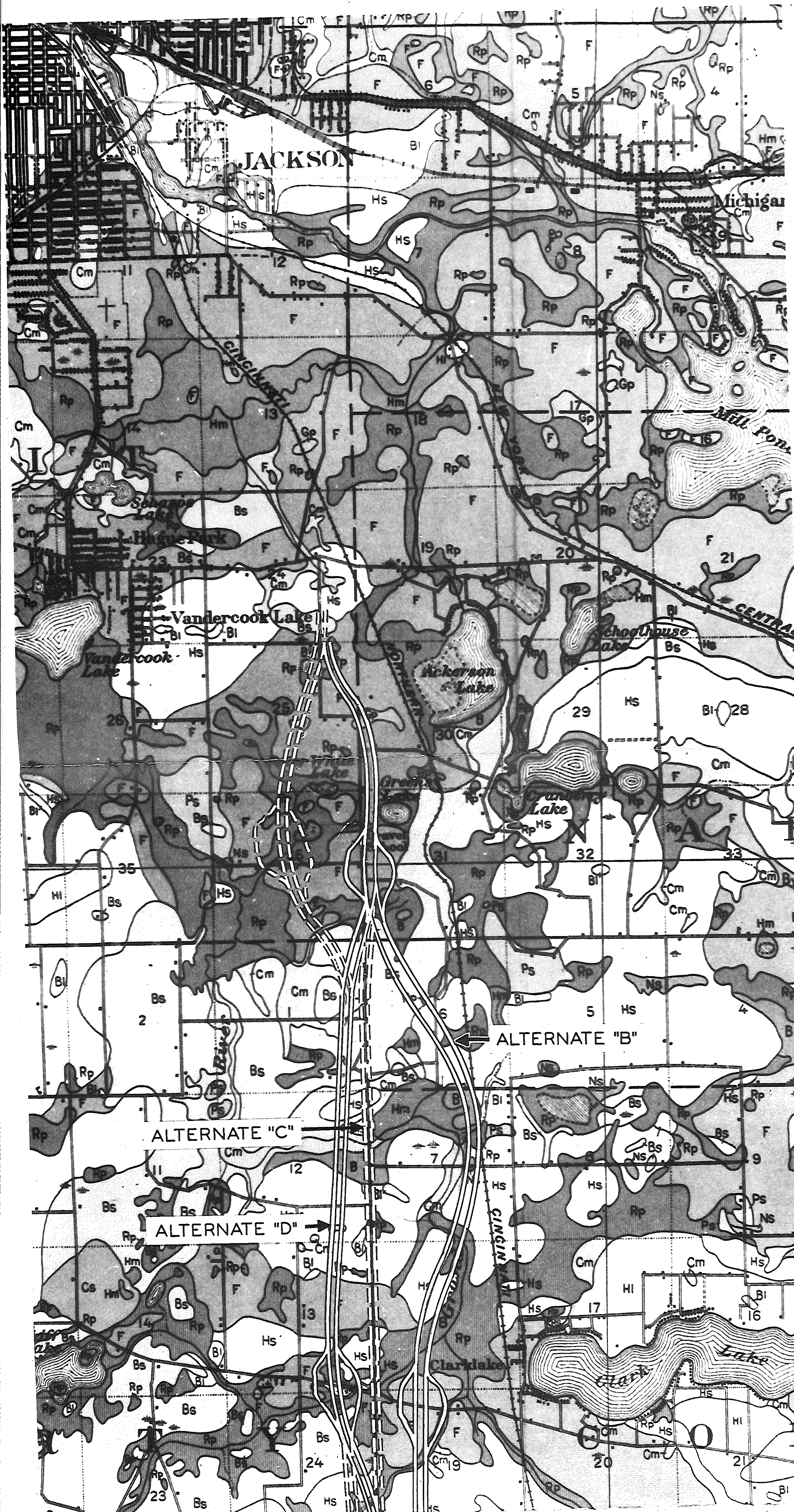


PIEZOMETRIC MAP

FIGURE 5



R.1 W.
R.1 E.
JACKSON
GRAND
RIVER
CENTER
LAKE
VANDERCOOK
VANDERCOOK
LAKE
BROWN
LAKE
ACKERSON
LAKE
PETER
WHITE
LAKE
35
36
31
32
2
1
6
5
T. 3 S.
T. 4 S.
B-19
B-20
B-21
B-22
B-17
B-16
B-15
B-12
B-13
B-11
B-14
B-7
B-8
B-9
B-10
ALT. "A"
ALT. "D"
ALT. "C"
ALT. "B"
CLARK LAKE
CLARK
LAKE
RIVER
950
960
970
980
990
1000
1010



JACKSON COUNTY AND HILLSDALE COUNTY

LEGEND

Name	Symbol	Name	Symbol
Bellefontaine sandy loam	Bs	Griffin loam	Gl
Berrien loamy sand	B	Hillsdale sandy loam	Hs
Brady sandy loam	By	Hillsdale loam	Hl
Brookston loam	Bl	Shallow phase	Hl
Brookston clay loam	Bc	Miami loam	Ml
Coloma loamy sand		Newton loamy sand	Ns
Conover loam	Cl	Plainfield loamy sand	Ps
Fox sandy loam	F	Carlisle muck	Cm
Fox stony loam	Fs	Greenwood peat	Gp
Fox loam	Fl	Houghton muck	Hm
Genesee sandy loam	G	Rifle peat	Rp

N

LENAWEE COUNTY

SYMBOL	NAME
AaA	Adrian muck, 0-3 percent slopes
BaA	Barry sandy loam, overwashed, 0-3 percent slopes
BbA	Berrien loamy sand, 0-3 percent slopes
BbB	Berrien loamy sand, 3-7 percent slopes
BbB2	Berrien loamy sand, 3-7 percent slopes, moderately eroded
BcA	Berrien sandy loam, 0-3 percent slopes
BcB	Berrien sandy loam, 3-7 percent slopes
BcB2	Berrien sandy loam, 3-7 percent slopes, moderately eroded
BcC	Berrien sandy loam, 7-15 percent slopes
BdA	Berville loam, 0-3 percent slopes
BeA	Berville sandy loam, 0-3 percent slopes
BfA	Blount loam, 0-3 percent slopes
BfA2	Blount loam, 0-3 percent slopes, moderately eroded
BfB	Blount loam, 3-7 percent slopes
BfB2	Blount loam, 3-7 percent slopes, moderately eroded
BgA	Blount loam and Pewamo clay loam, 0-3 percent slopes
BhA	Brady sandy loam, 0-3 percent slopes
BkA	Brady and Macomb loams, 0-3 percent slopes
BmA	Brady and Macomb sandy loams, 0-3 percent slopes
BnA	Bronson sandy loam, 0-3 percent slopes
BnB	Bronson sandy loam, 3-7 percent slopes
BoA	Brookston loam, 0-3 percent slopes
BpA	Brookston loam, overwashed, 0-3 percent slopes
CaB	Cadmus loam, 3-7 percent slopes
CaB2	Cadmus loam, 3-7 percent slopes, moderately eroded
CbA	Cadmus sandy loam, 0-3 percent slopes
CbB	Cadmus sandy loam, 3-7 percent slopes
CbB2	Cadmus sandy loam, 3-7 percent slopes, moderately eroded
CcA	Cadmus and Blount loams, 0-3 percent slopes
CdA	Carlisle muck, 0-3 percent slopes
CeA	Colwood very fine sandy loam, 0-3 percent slopes
CfA	Colwood and Wauseon fine sandy loams, 0-3 percent slopes
CgA	Conover loam, 0-3 percent slopes
CgB	Conover loam, 3-7 percent slopes
CgB2	Conover loam, 3-7 percent slopes, moderately eroded
EaA	Edwards muck, 0-3 percent slopes
FaA	Fox cobbly gravelly loam, 0-3 percent slopes
FaB	Fox cobbly gravelly loam, 3-7 percent slopes
FaC2	Fox cobbly gravelly loam, 7-15 percent slopes, moderately eroded
FbA	Fox loam, 0-3 percent slopes
FbB	Fox loam, 3-7 percent slopes
FbC	Fox loam, 7-15 percent slopes
FbC2	Fox loam, 7-15 percent slopes, moderately eroded
FcA	Fox sandy loam, 0-3 percent slopes
FcB	Fox sandy loam, 3-7 percent slopes

LENAWEE COUNTY

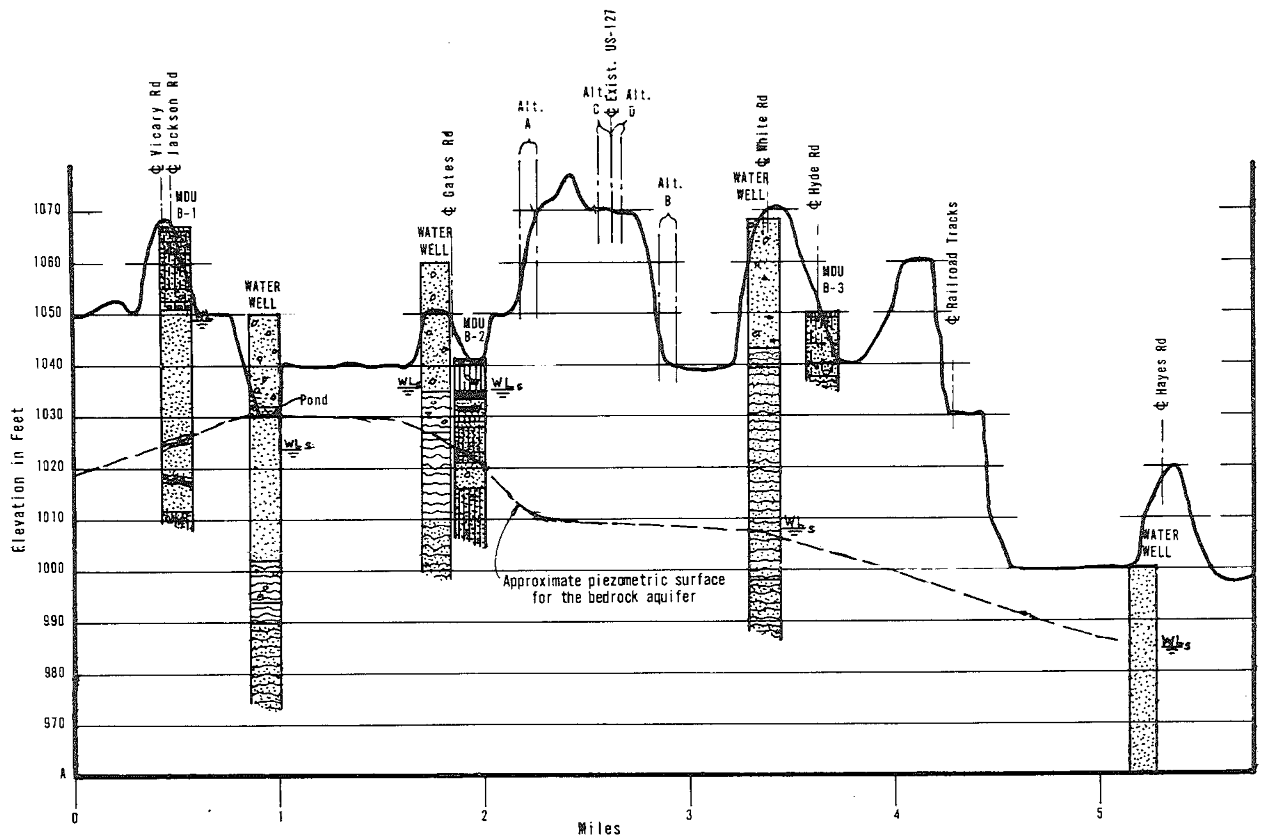
SYMBOL	NAME
AaA	Adrian muck, 0-3 percent slopes
BaA	Barry sandy loam, overwashed, 0-3 percent slopes
BbA	Berrien loamy sand, 0-3 percent slopes
BbB	Berrien loamy sand, 3-7 percent slopes
BbB2	Berrien loamy sand, 3-7 percent slopes, moderately eroded
BcA	Berrien sandy loam, 0-3 percent slopes
BcB	Berrien sandy loam, 3-7 percent slopes
BcB2	Berrien sandy loam, 3-7 percent slopes, moderately eroded
BcC	Berrien sandy loam, 7-15 percent slopes
BdA	Berville loam, 0-3 percent slopes
BeA	Berville sandy loam, 0-3 percent slopes
BfA	Blount loam, 0-3 percent slopes
BfA2	Blount loam, 0-3 percent slopes, moderately eroded
BfB	Blount loam, 3-7 percent slopes
BfB2	Blount loam, 3-7 percent slopes, moderately eroded
BgA	Blount loam and Pewamo clay loam, 0-3 percent slopes
BhA	Brady sandy loam, 0-3 percent slopes
BkA	Brady and Macomb loams, 0-3 percent slopes
BmA	Brady and Macomb sandy loams, 0-3 percent slopes
BnA	Bronson sandy loam, 0-3 percent slopes
BnB	Bronson sandy loam, 3-7 percent slopes
BoA	Brookston loam, 0-3 percent slopes
BpA	Brookston loam, overwashed, 0-3 percent slopes
CaB	Cadmus loam, 3-7 percent slopes
CaB2	Cadmus loam, 3-7 percent slopes, moderately eroded
CbA	Cadmus sandy loam, 0-3 percent slopes
CbB	Cadmus sandy loam, 3-7 percent slopes
CbB2	Cadmus sandy loam, 3-7 percent slopes, moderately eroded
CcA	Cadmus and Blount loams, 0-3 percent slopes
CdA	Carlisle muck, 0-3 percent slopes
CeA	Colwood very fine sandy loam, 0-3 percent slopes
CfA	Colwood and Wauseon fine sandy loams, 0-3 percent slopes
CgA	Conover loam, 0-3 percent slopes
CgB	Conover loam, 3-7 percent slopes
CgB2	Conover loam, 3-7 percent slopes, moderately eroded
EaA	Edwards muck, 0-3 percent slopes
FaA	Fox cobbly gravelly loam, 0-3 percent slopes
FaB	Fox cobbly gravelly loam, 3-7 percent slopes
FaC2	Fpx cobbly gravelly loam, 7-15 percent slopes, moderately eroded
FbA	Fox loam, 0-3 percent slopes
FbB	Fox loam, 3-7 percent slopes
FbC	Fox loam, 7-15 percent slopes
FbC2	Fox loam, 7-15 percent slopes, moderately eroded
FcA	Fox sandy loam, 0-3 percent slopes
FcB	Fox sandy loam, 3-7 percent slopes
FcB2	Fox sandy loam, 3-7 percent slopes, moderately eroded
FcC	Fox sandy loam, 7-15 percent slopes
FcC2	Fox sandy loam, 7-15 percent slopes, moderately eroded
FcD	Fox sandy loam, 12-25 percent slopes
FcD2	Fox sandy loam, 12-25 percent slopes, moderately eroded
FcE	Fox sandy loam, 25+ percent slopes
FdC3	Fox soils, 7-15 percent slopes, severely eroded
FdD3	Fox soils, 12-25 percent slopes, severely eroded
FdE2	Fox soils, 25+ percent slopes, moderately or severely eroded
GaA	Genesee loam, 0-3 percent slopes
GbA	Genesee sandy loam, 0-3 percent slopes
GbB	Genesee sandy loam, 3-7 percent slopes
GcA	Genesce and Eel loams, 0-3 percent slopes
GdA	Granby loamy sand, 0-3 percent slopes
GeA	Granby sandy loam, 0-3 percent slopes
GfA	Griffin and Genesee loams, 0-3 percent slopes
GgA	Griffin and Sloan loams, 0-3 percent slopes
GhA	Griffin and Sloan sandy loams, 0-3 percent slopes
HaB	Hillsdale sandy loam, 3-7 percent slopes
HaC2	Hillsdale sandy loam, 7-15 percent slopes, moderately eroded
HbA	Houghton muck, 0-3 percent slopes
HcA	Hoytville clay loam and silty clay loam, 0-3 percent slopes
HdA	Hoytville mucky clay loam, 0-3 percent slopes
HeA	Hoytville clay loam and Rimer sandy loam, 0-3 percent slopes
HfA	Hoytville and Wauseon loams, 0-3 percent slopes
IaA	Ionia loam, 0-3 percent slopes
IaB	Ionia loam, 3 7 percent slopes
KaC	Kendallville loam, 7-15 percent slopes
KaC2	Kendallville loam, 7-15 percent slopes, moderately eroded
KbC	Kendallville sandy loam, 7-15 percent slopes
KcC2	Kendallville soils, 7-15 percent slopes, moderately or severely eroded
KdA	Kerston muck and loams, 0-3 percent slopes
KeA	Kibbie and Colwood fine sandy loams, 0-3 percent slopes
KeB	Kibbie and Colwood fine sandy loams, 3-7 percent slopes
KfA	Kokomo and Barry loams, 0-3 percent slopes
KgA	Kokomo, Barry, and Wallkill loams, overwashed, 0-3 percent slopes
LaA	Lake borders
LbA	Lenawee silty clay loam, 0-3 percent slopes
LcA	Linwood muck, 0 3 percent slopes
MaA	Macomb fine sandy loam, 0-3 percent slopes
MbA	Macomb sandy clay loam and Hoytville clay loam, 0-3 percent slopes
McA	Maumee loamy sand, 0-3 percent slopes
MdA	Miami loam, 0-3 percent slopes
MdB	Miami loam, 3-7 percent slopes
MdB2	Miami loam, 3-7 percent slopes, moderately eroded
MdC	Miami loam, 7-15 percent slopes
MdC2	Miami loam, 7-15 percent slopes, moderately eroded
MdD2	Miami loam, 12-25 percent slopes, moderately eroded
MeD	Miami loam and Boyer sandy loam, 12-25 percent slopes
MeD2	Miami loam and Boyer sandy loam, 12-25 percent slopes, moderately eroded
MeE	Miami loam and Boyer sandy loam, 25+ percent slopes
MfC3	Miami soils, 7-15 percent slopes, severely eroded
MfD3	Miami soils, 15-25 percent slopes, severely eroded
MgD3	Miami and Boyer soils, 12-25 percent slopes, severely eroded
MgE2	Miami and Boyer soils, 25+ percent slopes, moderately eroded
MhA	Morley loam, 0-3 percent slopes
MhB	Morley loam, 3-7 percent slopes
MhB2	Morley loam, 3-7 percent slopes, moderately eroded
MhC	Morley loam, 7-15 percent slopes
MhC2	Morley loam, 7-15 percent slopes, moderately eroded
MhD	Morley loam, 12-25 percent slopes
MhD2	Morley loam, 12-25 percent slopes, moderately eroded
MhE	Morley loam, 25+ percent slopes
MkB3	Morley soils, 3-7 percent slopes, severely eroded
MkC3	Morley soils, 7-15 percent slopes, severely eroded
MkD3	Morley soils, 12-25 percent slopes, severely eroded
MkE2	Morley soils, 25+ percent slopes, moderately or severely eroded
NaA	Nappanee silt loam, 0-3 percent slopes
NaB	Nappanee silt loam, 3-7 percent slopes
NaB2	Nappanee silt loam, 3-7 percent slopes, moderately eroded
NbB	Nappanee loam, 3-7 percent slopes
NbB2	Nappanee loam, 3-7 percent slopes, moderately eroded
OaA	Ogden muck, 0-3 percent slopes
ObA	Oshtemo loamy sand, 0-3 percent slopes
ObB	Oshtemo loamy sand, 3-7 percent slopes
ObB2	Oshtemo loamy sand, 3-7 percent slopes, moderately eroded
ObC	Oshtemo loamy sand, 7-15 percent slopes
OcC	Ottawa loamy sand, 7-15 percent slopes, slightly or moderately eroded
PaA	Palms muck, 0-3 percent slopes
PbA	Pewamo clay loam, 0-3 percent slopes
PcA	Pewamo mucky clay loam, 0-3 percent slopes
PdA	Plainfield and Berrien loamy sands, 0-3 percent slopes
PdB	Plainfield and Berrien loamy sands, 3-7 percent slopes
PeA	Plainfield and Ottawa loamy sands, 0-3 percent slopes
PeB	Plainfield and Ottawa loamy sands, 3-7 percent slopes
PeB2	Plainfield and Ottawa loamy sands, 3-7 percent slopes, moderately eroded
PeC	Plainfield and Ottawa loamy sands, 7-15 percent slopes
PeC2	Plainfield and Ottawa loamy sands, 7-15 percent slopes, moderately eroded
RaA	Rifle peat, 0-3 percent slopes
RbA	Rollin muck, 0-3 percent slopes
SaA	Sebewa loam, 0-3 percent slopes
SbA	Sebewa sandy loam, 0-3 percent slopes
ScB	Spinks, Boyer, Plainfield, and Hillsdale soils, 3-7 percent slopes
ScB2	Spinks, Boyer, Plainfield, and Hillsdale soils, 3-7 percent slopes, moderately eroded
ScC	Spinks, Boyer, Plainfield, and Hillsdale soils, 7-15 percent slopes
ScC2	Spinks, Boyer, Plainfield, and Hillsdale soils, 7-15 percent slopes, moderately eroded
ScD2	Spinks, Boyer, Plainfield, and Hillsdale soils, 12-25 percent slopes, moderately eroded
SdC	St. Clair loam, 7-15 percent slopes
SdC2	St. Clair loam, 7-15 percent slopes, moderately eroded
SdD2	St. Clair loam, 12-25 percent slopes, moderately eroded
SdE	St. Clair loam, 25+ percent slopes
SdE2	St. Clair loam, 25+ percent slopes, moderately eroded
SeC3	St. Clair soils, 7-15 percent slopes, severely eroded
TaA	Tawas muck, 0-3 percent slopes
WaA	Wallkill loam, overwashed, 0-3 percent slopes
WbA	Warners muck and marl, 0-3 percent slopes
WcA	Wauseon loam, 0-3 percent slopes
WdA	Willette muck, 0-3 percent slopes

0 1 2 3

MILES

COMPOSITE SOILS MAP FOR US127 ENVIRONMENTAL STUDY

FIGURE 6



CROSS SECTION A - A'

NOTE: Correlation Boring Log symbols taken from Page 271 of the Field Manual of Soils Engineering, Fourth Edition.

WL = Water Level in Drill Hole.

WL_s = Artesian Water Level in Tightly Cased Holes Tapping the Sandstones.

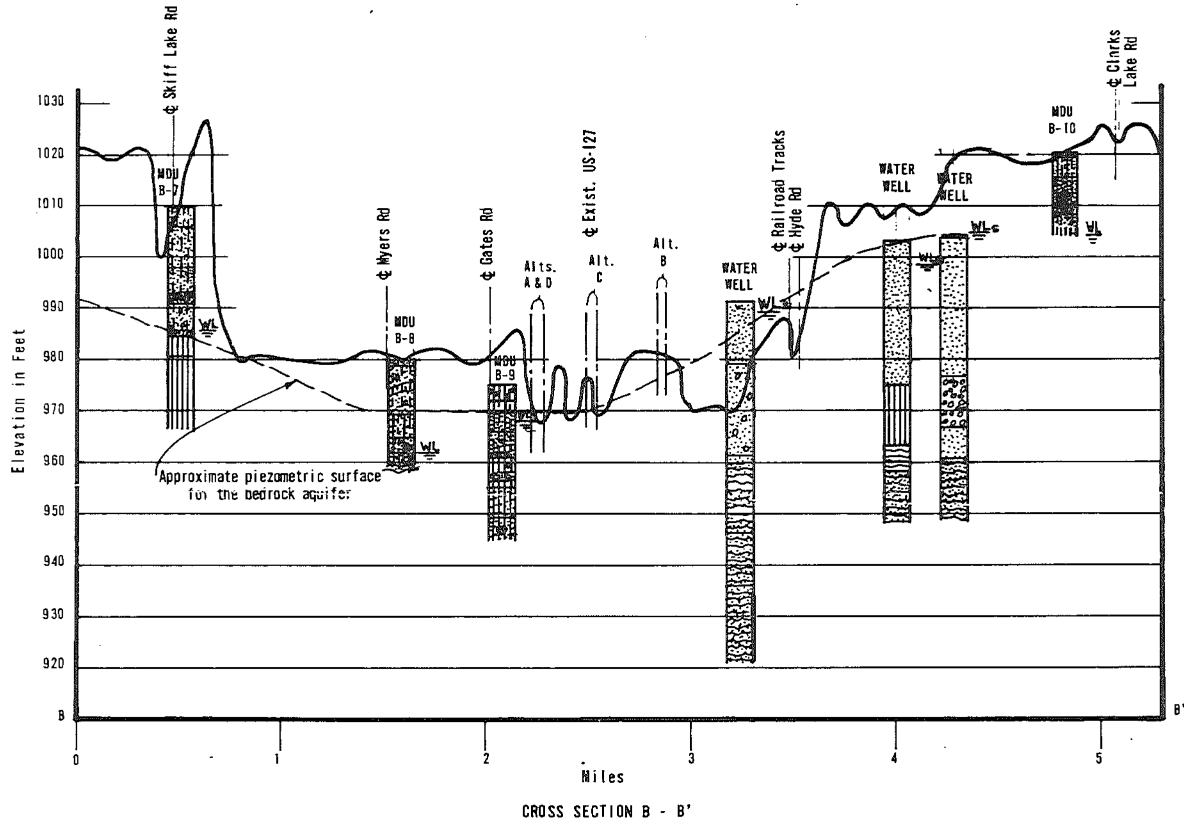
MICHIGAN DEPARTMENT OF STATE HIGHWAYS
OFFICE OF TESTING AND RESEARCH
TESTING LABORATORY DIVISION
GEOPHYSICAL SECTION
ANN ARBOR

ENVIRONMENTAL GEOLOGY STUDY

US-127 Relocation from US-12
North to M-50
Hillsdale, Lenawee, and
Jackson Counties
November 1971

CHECKED BY: G.O. Hoyer
APPROVED BY: D.J. Malcolt

Figure 7



NOTE: Correlation Boring Log symbols taken from Page 271 of the Field Manual of Soils Engineering, Fourth Edition.

WL = Water Level in Drill Hole.

WL_s = Artesian Water Level in Tightly Cased Holes Tapping the Sandstone.

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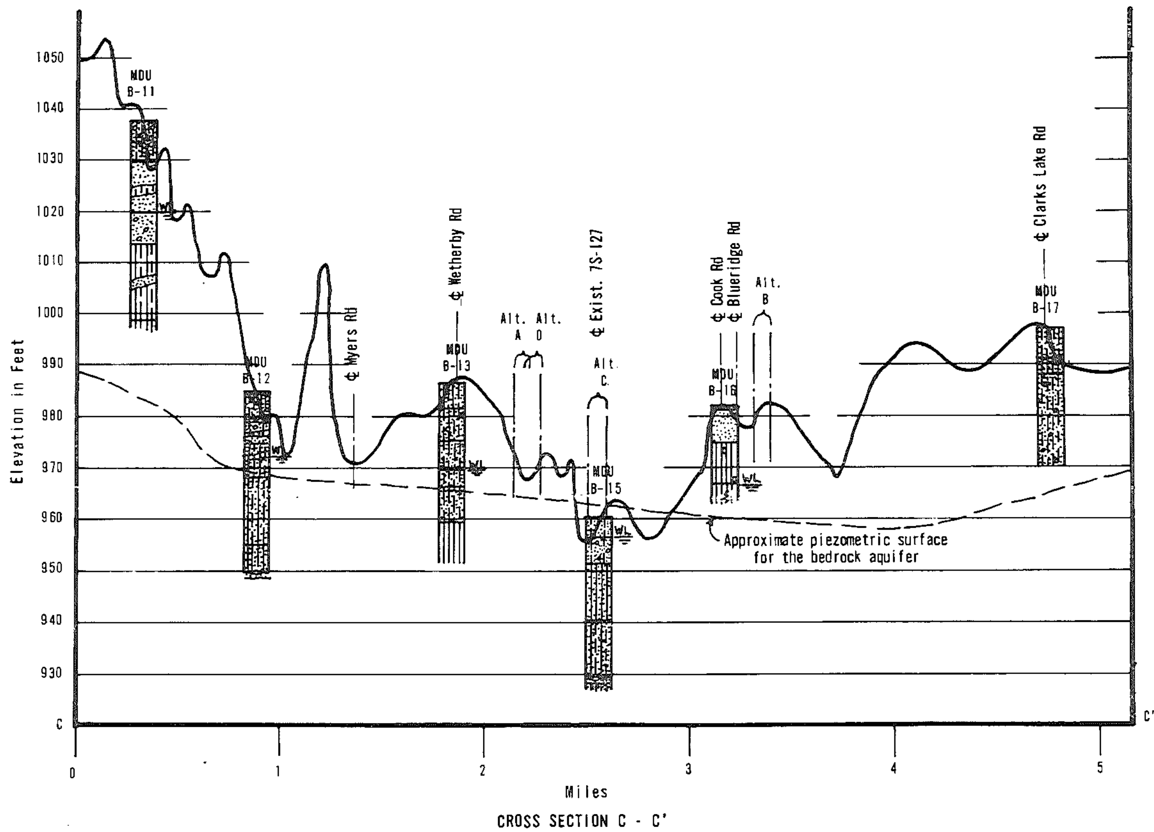
ENVIRONMENTAL GEOLOGY STUDY

US-127 Relocation from US-12
North to M-50
Hillsdale Lenawee, and
Jackson Counties
November 1971

CHECKED BY: R.W. Noyes
APPROVED BY: D.J. Malott

Figure 8



NOTE: Correlation Boring Log symbols taken from Page 271 of the Field Manual of Soils Engineering, Fourth Edition.

WL - Water Level in Drill Hole.

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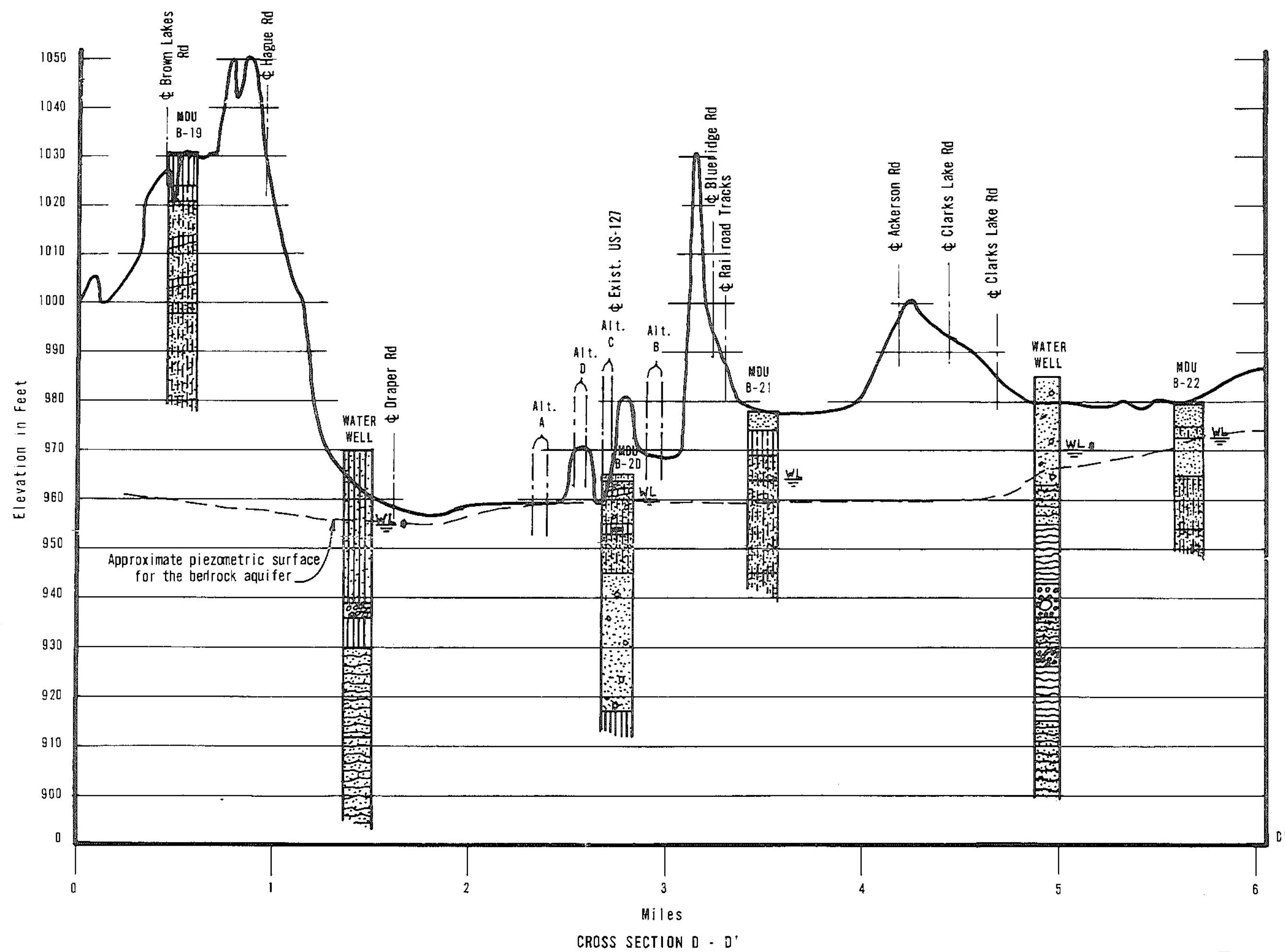
CHECKED BY: R.W. Noyce APPROVED BY: D.L. Malott

Figure 9



NOTE: Correlation Boring Log symbols taken from Page 271 of the Field Manual of Soils Engineering, Fourth Edition.

WL = Water Level in Drill Hole.
WL_{6} = Artesian Water Level in Tightly Cased Holes Tapping the Sandstone.

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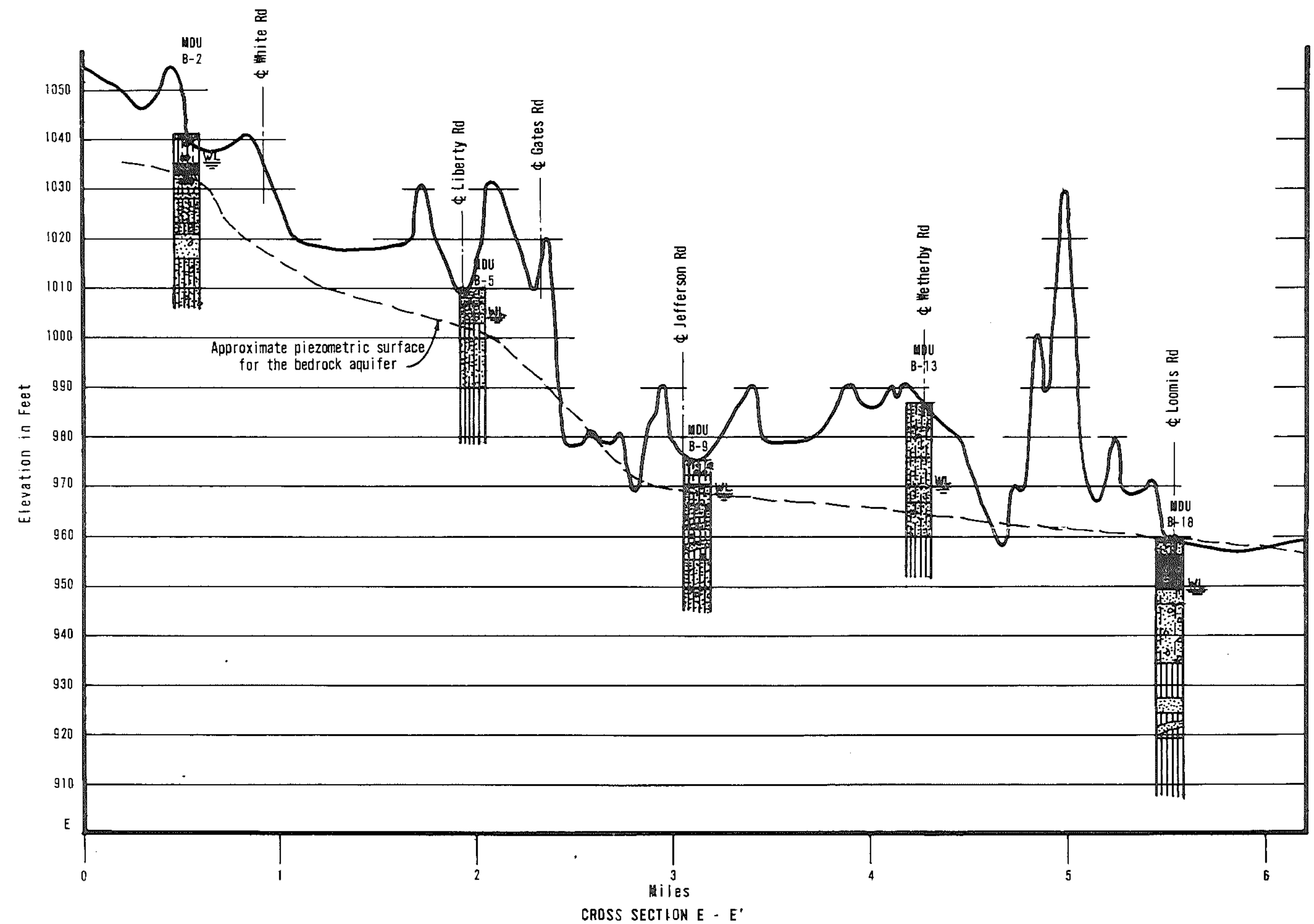
ENVIRONMENTAL GEOLOGY STUDY

US-127 Relocation from US-12
North to M-50
Hillsdale, Lenawee, and
Jackson Counties
November 1971

CHECKED BY: [signature]
APPROVED BY: [signature]

Figure 10



NOTE: Correlation Boring Log symbols taken from Page 271 of the Field Manual of Soils Engineering, Fourth Edition.

WL = Water Level in Drill Hole.

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ENVIRONMENTAL GEOLOGY STUDY

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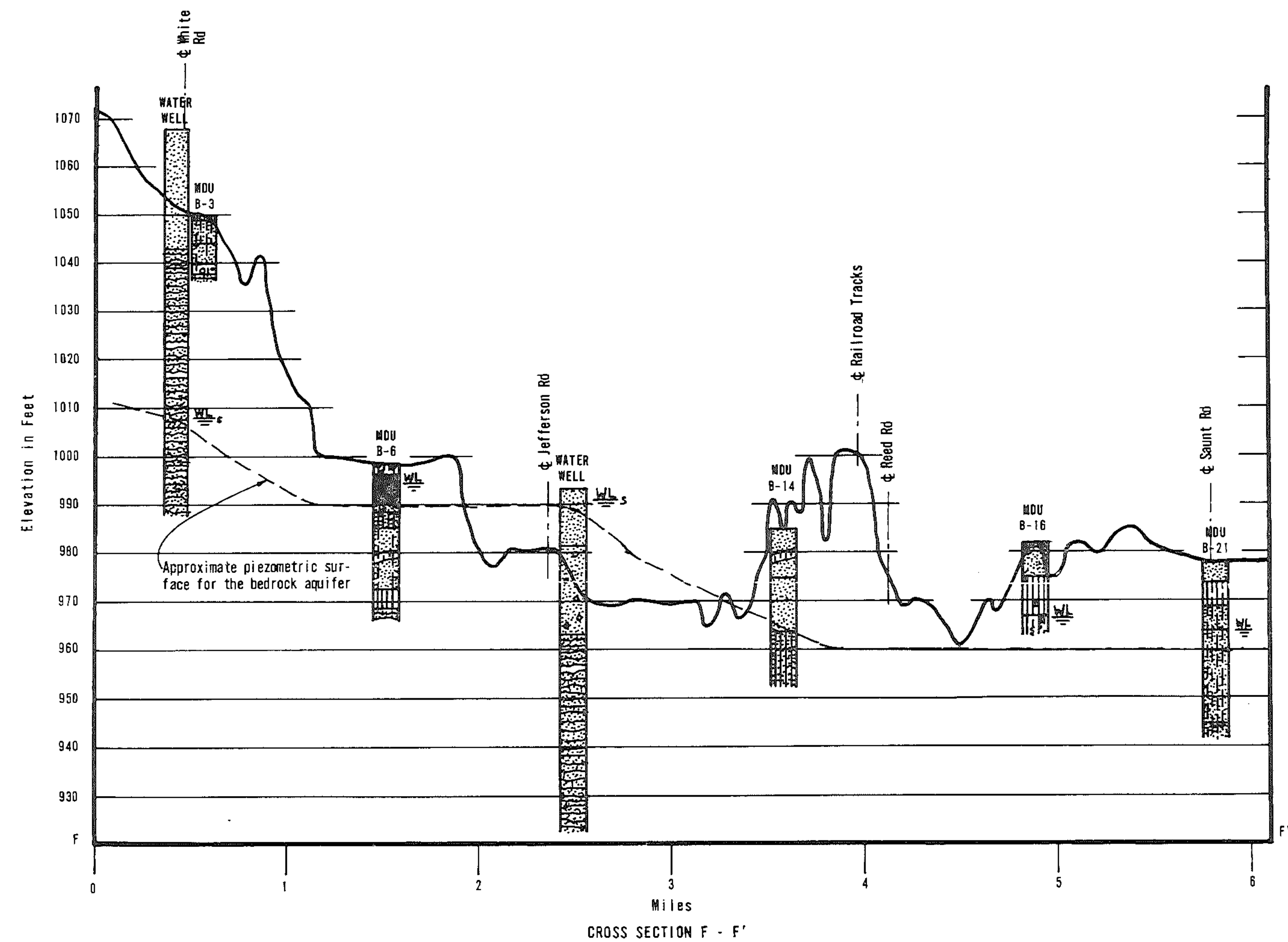
North to M-50
Hillsdale, Lenawee, and
Jackson Counties
November 1971

CHECKED BY R W Noyce
APPROVED BY: D J Malott

Figure 11



NOTE: Correlation Boring Log symbols taken from Page 271 of the Field Manual of Soils Engineering, Fourth Edition.

WL = Water Level in Drill Hole.

WL_s = Artesian Water Level in Tightly Cased Holes Tapping the Sandstone.

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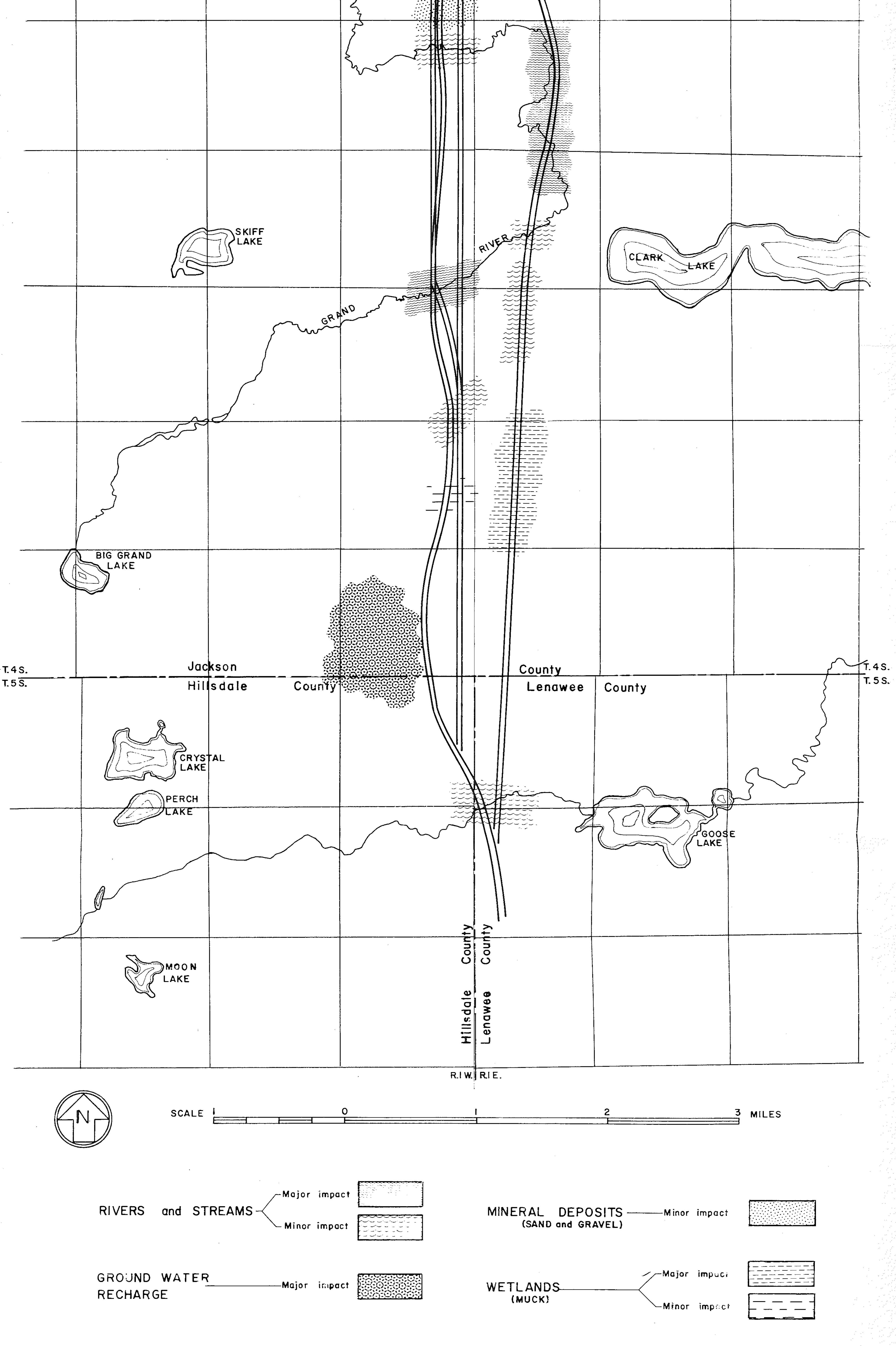
ENVIRONMENTAL GEOLOGY STUDY

US-127 Relocation from US-12
North to M-50
Hillsdale, Lenawee, and
Jackson Counties
November 1971

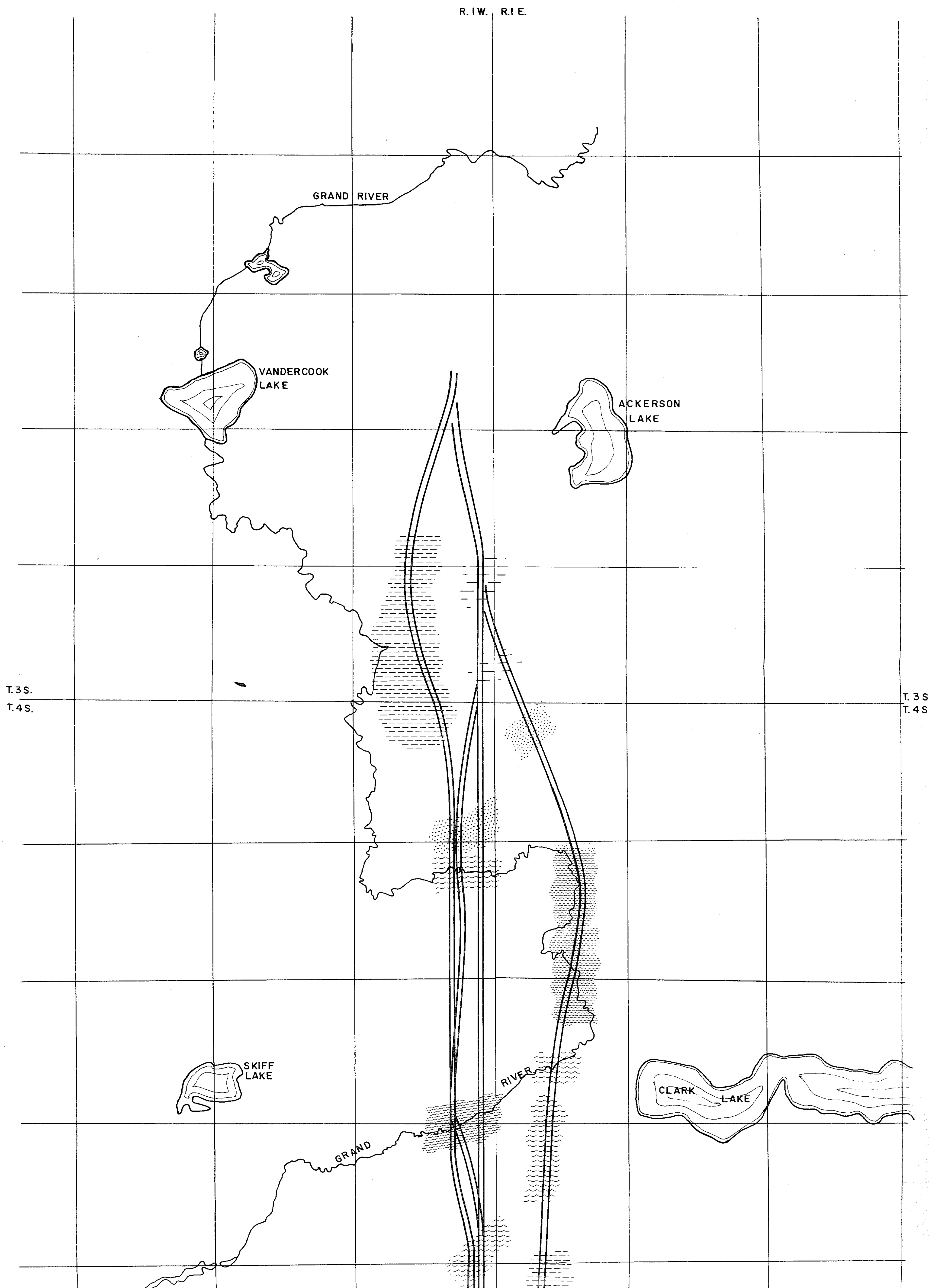
CHECKED BY: GPW [signature]
APPROVED BY: DJ Mellott [signature]

Figure 12



ENVIRONMENTAL IMPACT MAP

FIGURE 13



R.I W.
R.I E.
GRAND RIVER
VANDERCOOK LAKE
ACKERSON LAKE
T. 3 S.
T. 4 S.
T. 3 S.
T. 4 S.
SKIFF LAKE
RIVER
GRAND
CLARK LAKE