Groundwater potentiometric contours: Crandon Project waste disposal system: project report 7. v. 7 1981

Atlanta, Georgia: Golder Associates, Inc., 1981

GROUNDWATER POTENTIOMETRIC CONTOURS
CRANDON PROJECT
WASTE DISPOSAL SYSTEM
PROJECT REPORT 7

Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

Report on

GROUNDWATER POTENTIOMETRIC CONTOURS
CRANDON PROJECT
WASTE DISPOSAL SYSTEM
PROJECT REPORT 7

Submitted to:

Exxon Minerals Company
P. O. Box 813
Rhinelander, Wisconsin 54501

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786085

September, 1981

Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

September 30, 1981

786085/MA/321
F/N 178.1

Exxon Minerals Company
P. O. Box 813
Rhinelander, Wisconsin 54501

Attention: Mr. C. E. Fowler

Re: Waste Disposal System
Crandon Project
Crandon, Wisconsin

Gentlemen:

We are pleased to submit the final draft of Project Report 7, Groundwater Potentiometric Contours, Crandon Project Waste Disposal System. This report presents the groundwater potentiometric contour map prepared for the Crandon Project area along with the data and an explanation of the methods used to construct the contours.

We appreciate the continuing opportunity to provide services to Exxon Minerals Company for the Crandon Project and extend our thanks to you and the Exxon staff for their excellent cooperation.

Very truly yours,

GOLDER ASSOCIATES

Gary H. Collison, P.E.
Associate

GHC:dap

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1.0 INTRODUCTION

This report presents a brief explanation of the methods used to derive the groundwater potentiometric contour map (hereafter referred to as the groundwater map). This groundwater map covers the Crandon Project area from the city of Crandon south to Pickerel Lake, and from Jungle Lake west to near the Wolf River, an area of about 100 square miles (259 km^2).

This groundwater map was constructed through joint efforts by Golder Associates and Dames & Moore for the purpose of providing a single, acceptable representation of the potentiometric groundwater elevations for the area described above. The resulting map is shown in metric units on a metric ground contour base map as Figure 1 and in English units on a composite U.S.G.S. quadrangle basemap as Figure 2.

Figure 3 was prepared to show the water level measurement and water chemistry data and the locations of these data used in constructing the groundwater map. In order to be able to present this volume of data in a map format of reasonable size, the background surface topography was omitted. Streams, lakes, and major wetland areas are shown for reference and, in many cases, as data points. Tabulations of the data are included for purposes of clarity in the Appendix.

In addition to preparing the groundwater map, the data was used in determining the lakes and wetlands which are primarily groundwater discharge areas and those lakes which are primarily fed by surface water and are part of the groundwater recharge system. Head levels in closely spaced or multiple level observation wells were also reviewed to see if there are differences in the potential head levels in the various glacial strata.

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NORTH
LEGEND
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GROUNDWATER ISOPLETHS IN METERS ABOVE MSL, INTERPRETED FROM LIMITED DATA
GROUNDWATER ISOPLETH 486 METERS ABOVE MSL AS ESTIMATED EXCLUDING EFFECTS OF JUNE-JULY 1980 PUMP TEST
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Golder Associates
EXXON MINERALS COMPANY
CRANDON PROJECT
GROUNDWATER POTENTIOMETRIC CONTOURS
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Larger Scale Map in Pocket

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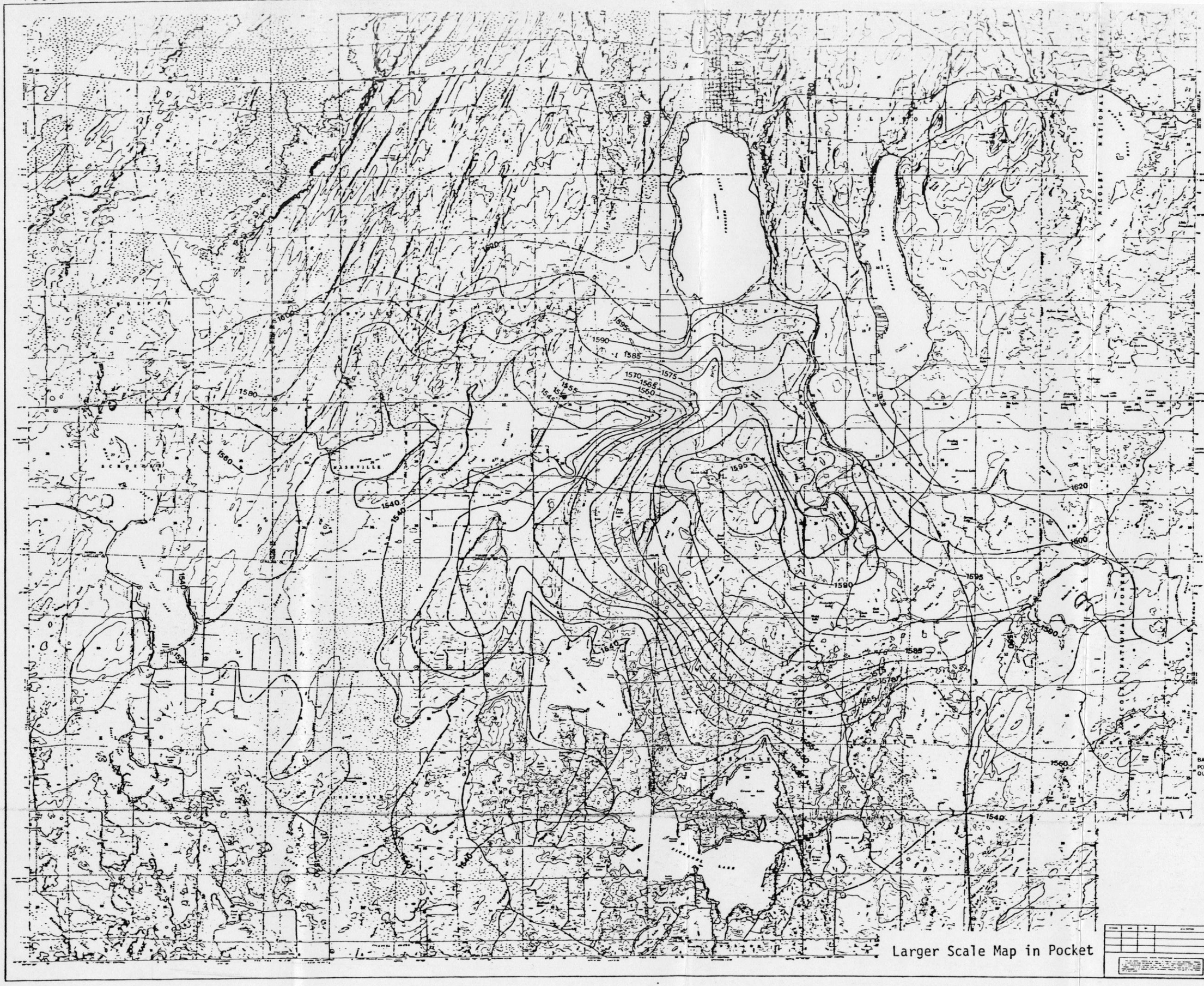
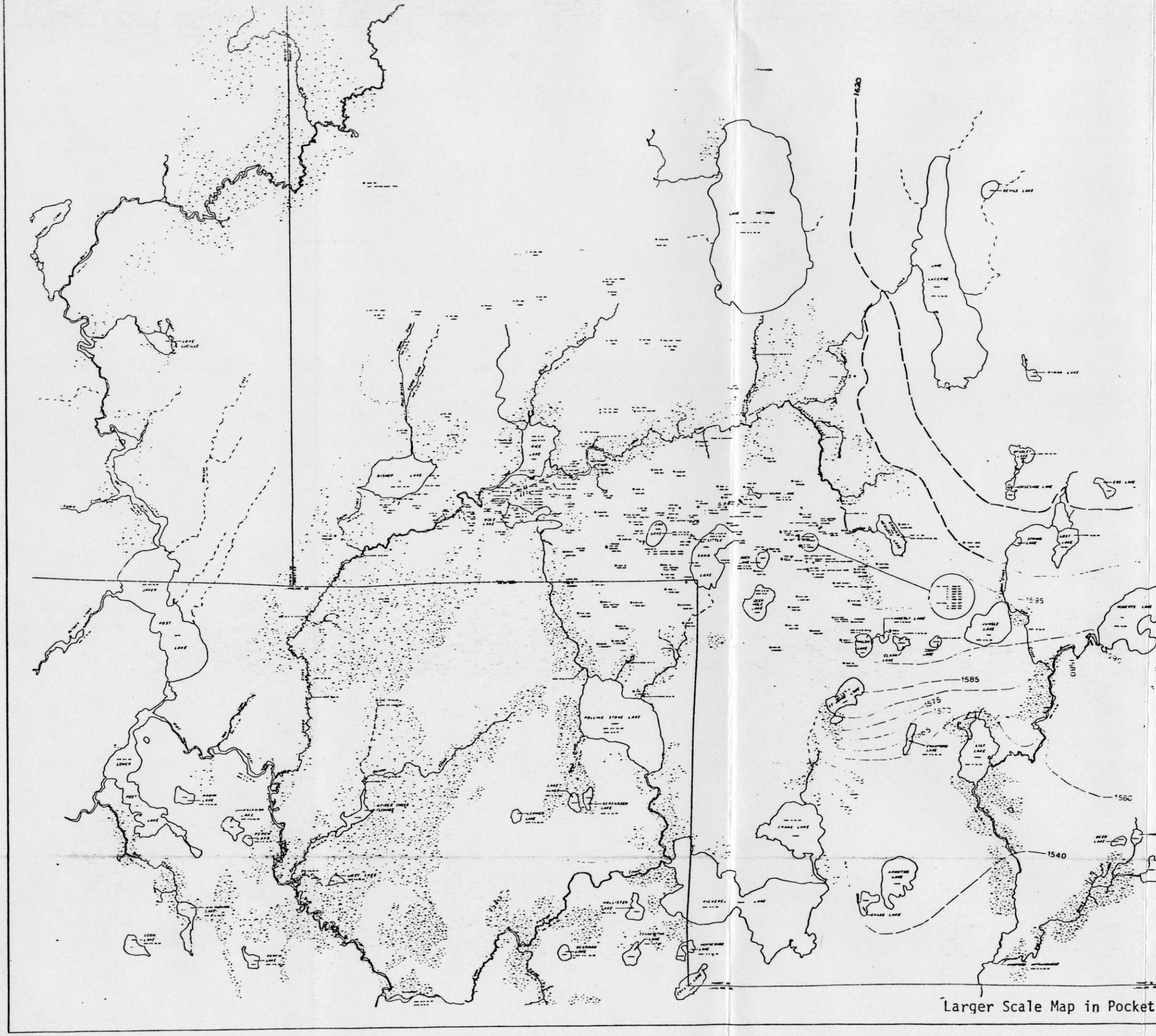


Larger Scale Map in Pocket



NORTH

LEGEND

- GOLDER ASSOCIATES BORINGS WITH OBSERVATION WELLS
- DAMES & MOORE BORINGS WITH OBSERVATION WELLS
- PUMP TEST WELL, TW-41
- USGS WELL DATA LOCATIONS

(1680) WATER SURFACE ELEVATIONS IN FEET ABOVE MSL

DNR S,M WISCONSIN DNR WATER CHEMISTRY DATA

DBM H,N DAMES & MOORE WATER CHEMISTRY DATA

WATER CHEMISTRY DATA
V = very
H = hard
S = soft
AC = acidic
AK = alkaline
N = neutral
SL = slightly
M = medium or moderately

SURFACE WATER BOUNDARIES (from USGS quadrangle maps)

MAJOR WETLAND AREAS (from USGS quadrangle maps)

GROUNDWATER ISOPLETHS (contours) IN FEET ABOVE MSL

GROUNDWATER ISOPLETHS IN FEET ABOVE MSL, INTERPRETED FROM LIMITED DATA

GROUNDWATER ISOPLETHS 1595 FEET ABOVE MSL AS ESTIMATED EXCLUDING EFFECTS OF JUNE-JULY 1980 PUMP TEST

NOTE

GROUNDWATER CONTOURS INTERPRETED BY GOLDER ASSOCIATES AND DAMES & MOORE BASED ON THE FOLLOWING DATA:

a. GOLDER ASSOCIATES AND DAMES & MOORE OBSERVATION WELL MEASUREMENTS ON SEPT. 10 AND 11, 1980.
b. WATER CHEMISTRY DATA FROM DBM AND DNR
c. SURFACE TOPOGRAPHY
d. USGS WELL DATA AND GOLDER WELL DATA FROM DIFFERENT TIME PERIODS

BASE MAP REFERENCE:
PORTIONS OF THE FOLLOWING USGS 7.5 MIN. QUAD. MAPS.
NASHVILLE, WISCONSIN, 1965
CRANDON, WISCONSIN, 1965
LAKE LUCERNE, WISCONSIN, 1965
POST LAKE, WISCONSIN, 1973
MOLE LAKE, WISCONSIN, 1973
ROBERTS LAKE, WISCONSIN, 1973

Larger Scale Map in Pocket

FIGURE 3

Golder Associates

EXXON MINERALS COMPANY
CRANDON PROJECT

DATA POINTS FOR GROUNDWATER POTENTIOMETRIC CONTOURS

050-1-81113

2.0 GROUNDWATER DATA

Groundwater elevations used in the construction of the groundwater contour map were obtained from observation wells installed under the supervision of Golder Associates and Dames & Moore, and from well data provided by the United States Geological Survey (U.S.G.S.). Observation wells were installed under Golder Associates supervision during 1979 and 1980, and under Dames & Moore supervision between 1977 and 1980. Typical observation well completion details are shown on Figure 4.

The Golder Associates and Dames & Moore observation wells have been monitored since installation. However, some of the wells have only had water levels measured on a few occasions during the period of 1977 to 1980. As a result, there was not a complete set of well measurements from all wells within a single season. The seasonal fluctuation of water levels necessitated having concurrent measurements on all of the wells in order to construct the groundwater map.

On September 10 and 11, 1980, personnel from Golder Associates and Dames & Moore obtained water level measurements from all of the observation wells installed as of that date which were accessable. The results of the field measurements are shown in Table 1 in the appendix. Elevations of the bottom of the slotted sections of the observation wells are also shown in Table 1. These elevations are needed for evaluation of perched groundwater conditions and in determining why a specific well may be "dry".

Shown in Table 2 (appendix) are the groundwater level elevations from observation wells which were furnished by the Water Resources Division of the U.S.G.S. in Madison,

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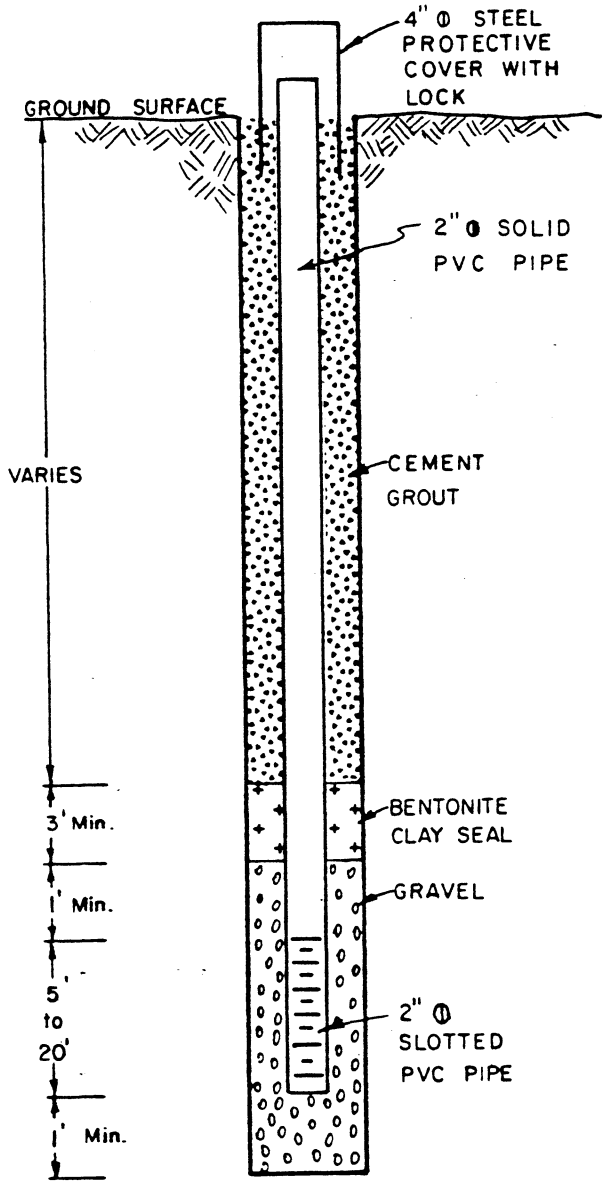
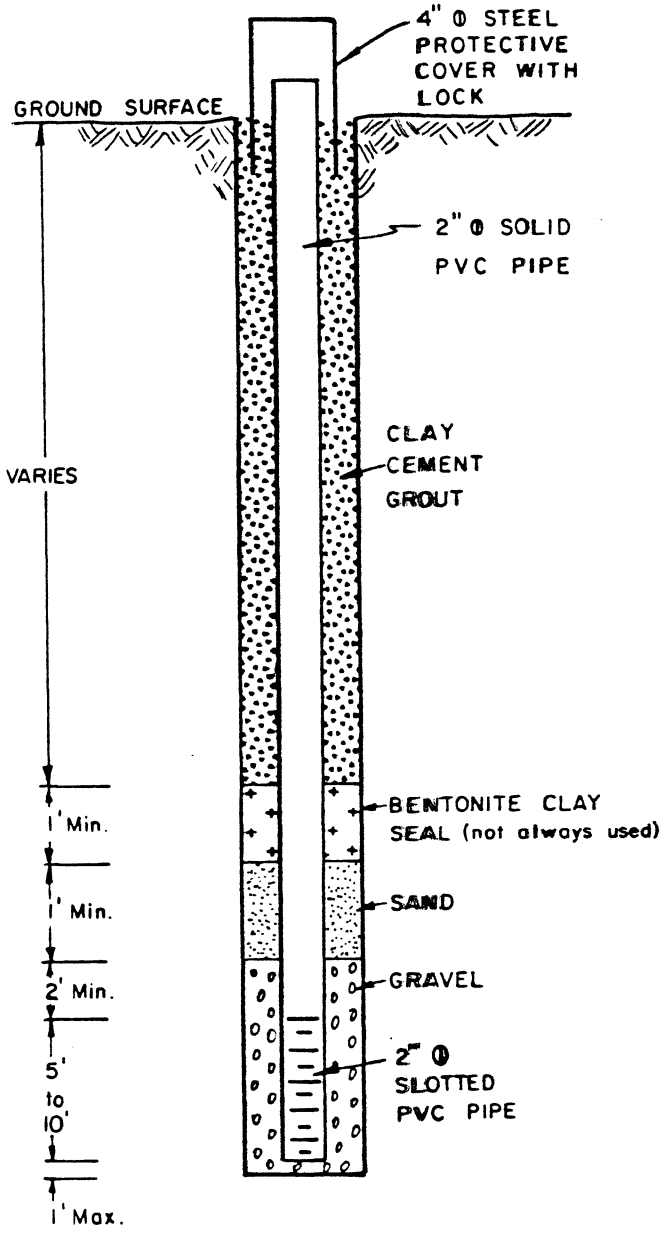


Dames & Moore



JOB NO. 786085	SCALE NOT TO SCALE	TYPICAL OBSERVATION WELL INSTALLATIONS
DRAWN SKB	DATE 9-25-81	
CHECKED JFC	DWG. NO. ____	
Golder Associates	EXXON CRANDON PROJECT	FIGURE 4

GAF DRAFTING MEDIA

Wisconsin. Neither details of the type and construction of these wells, nor their dates of monitoring were furnished.

In addition to water level measurements, water chemistry data was also used to aid in delineation of areas where groundwater discharges to the surface system. This data includes relative hardness and pH measurements made by Dames & Moore and the Wisconsin DNR (Ref. 3 through 7). These data are listed in Table 3 (appendix). Groundwater chemistry data indicate that the groundwater of the main aquifer system has higher carbonate hardness and is more alkaline than the surface water (Ref. 5). This difference in hardness and alkalinity was used in identifying the source of water inflow to various lakes, streams, and wetlands.

3.0 GROUNDWATER CONTOUR CONSTRUCTION

The groundwater potentiometric contours shown on Figures 1 and 2 were constructed jointly by Golder Associates and Dames & Moore between September 10, 1980, and January 15, 1981. The prominent lines on Figures 1 and 2 represent isopleths connecting the points of equal potentiometric head. Water elevations used from field measurements to construct the isopleths are those which are considered to be representative of the continuous groundwater system above bedrock. Excluded from consideration were water elevations from lakes and wetlands believed to be perched above the main groundwater system.

Subsurface data from numerous test borings (Ref. 2) and results of analyses of a pump test, located between Duck Lake and Ground Hemlock Slough (Ref. 1) suggest that a coarse grained stratified drift deposit exists over most of the area and acts as the main layer through which horizontal groundwater flow is expected. In some areas this coarse grained stratified drift layer is covered by saturated glacial till while in other areas it is evident at or near the ground surface. Groundwater movement is viewed as vertical flow through the overlying, saturated till to the coarse grained stratified drift, then flow is predominantly lateral to groundwater discharge areas. Measured differences in potential head between the coarse grained stratified drift and overlying saturated till are small and believed to be transient. This is discussed in more detail in Section 5.0 of this report. For purposes of this groundwater map construction there has been little attempt to differentiate between the two.

The type of data used in constructing the groundwater map varied widely. The level of confidence associated with

each type of data also varied widely. The types of information used, listed in order of decreasing confidence, were:

1. Water level elevations obtained from Golder Associates' and Dames & Moore's observation wells measured on September 10 and 11, 1980 (Table 1). These measurements were referenced to the protector pipe tops of the observation wells which were previously surveyed. Therefore, the potentiometric elevations for these wells are accurate to the nearest one tenth of a foot. Although this degree of accuracy could not be reflected in the groundwater map, the data was of primary importance in developing the map.

2. Water elevations inferred from assumed groundwater and ground surface intersections such as wetlands, lakes, and creeks. These inferences were based on a few observation well readings, published groundwater chemistry data (Table 3), and topographic mapping. In order to determine possible areas of groundwater discharge, two publications of the Department of Natural Resources (References 3 and 4) and data collected by Dames & Moore (References 5 and 6) were used. These publications give water chemistry data for lakes and creeks in the area which made it possible to estimate whether surface water is hydrologically connected to the groundwater. This is based on the fact that within the general site area water originating from the groundwater system is harder and more alkaline than surface water (Reference 5). This data was considered to be of secondary importance.

3. Water level elevatons provided by the Water Resources Division of the U.S.G.S. for various wells (Table 2). This data was considered good to poor due to inconsistencies and lack of details. Well locations were generally far from the main areas of interest.

Two levels of interpretation confidence are delineated for the potentiometric contours shown on Figures 1 and 2. Solid lines indicate a high degree of confidence. Interpretations in this area are based on Golder Associates and Dames & Moore observation readings, surrounding probable

groundwater discharge locations, and some U.S.G.S. well data. Dashed line areas indicate a much lower degree of confidence. Interpretations in this area are based on probable groundwater discharge locations, extrapolation of potentiometric contour trends from areas of higher confidence, and a scatter of well data.

The pump test in the area between Duck Lake and Ground Hemlock Slough had a very pronounced effect on the groundwater elevations in that area (Ref. 1). About 50 million gallons (186,000 m^3) of water were removed from the groundwater system. The removal of this amount of water resulted in about a 2 foot (0.6 m) decrease in the measured water levels within about a 2,000 foot (600 m) radius from the well. The groundwater system had not fully recovered by September, 1980 when the observation wells were measured for purposes of map preparation. Therefore, observation well measurements for about the same period from the previous year were used in the area of the pump test to supplement the available data. This supplemental data indicates that a 1,595 foot (486 m) contour is probable for the area if the pump test effects are neglected.

4.0 PERCHED CONDITIONS

Potentiometric head elevations may differ from groundwater surface elevations in that the potentiometric head represents the elevation of zero pressure head associated with a particular stratum or water body. In many areas across the site there exist wetlands and lakes where the potential head (surface of standing water) is well above the groundwater surface. Observation wells which are sealed just below the bottom of such lakes and wetlands may measure water levels equal in elevation to those of the free standing water in the lake or wetland. However, if the ground between the lake or wetland bottom is not completely saturated and mounding of the groundwater system to the lake or wetland bottom has not occurred, then a second observation well sealed below the main groundwater system surface will show a lower water level. In such instances, the potential head in the lake or wetland is higher than the potential head of the main groundwater system. Such conditions in the context of this report are termed perched conditions. Shallow, sealed observation wells which measure higher elevations than surrounding deeper observation wells are believed to represent such perched conditions and were not used in the groundwater map construction. Observation wells exhibiting these conditions are noted on Table 1.

Based on water level and water chemistry data, some of the lakes in the area can be described as being perched (Ref. 5). These lakes are recharged by surface water flow (overland or interflow) and the lake water drains from these lakes into the groundwater system. The extent to which complete mounding beneath these lakes has developed is not known, but it is suspected to be minimal for lakes with bottoms above the main body of the groundwater system. Where mounding is fully developed the radius of influence of

this mounding is very small in relationship to the area covered by the groundwater map. In either case, mounded or not, lake levels higher than surrounding groundwater levels provide a higher potential head over the lake. Thus, water flows out of these lakes into the groundwater system. Table 4 lists those lakes which are around the Crandon Orebody and indicates which are believed to be primarily groundwater fed (groundwater discharge areas) and which are believed to be perched and hence primarily surface water fed (groundwater recharge areas).

5.0 VERTICAL VARIATION IN POTENTIAL HEAD LEVELS

As noted in Section 3.0, groundwater movement through the fully saturated groundwater system is viewed as primarily vertical to the coarse grained stratified drift, then laterally to groundwater discharge areas. This flow system model is primarily based on general knowledge of the overall hydrogeologic system and the results of the pumping test of TW-41 (Ref. 1). However, the variation in head levels between the coarse grained stratified drift and overlying till is expected to be small and transient and therefore difficult to accurately monitor.

Figure 5 shows hydrographs of Dames & Moore's multiple level observation wells for 1977-78. The specific glacial stratum in which each screened well section is sealed is difficult to determine from the available data. Thus, consistent head level differences cannot be ascribed to particular strata. However, all multiple well (except for DWIU, DWIL, and apparent spurious measurements) measurements are within about 6 inches (152 mm) of each other, and in many cases even closer, for a given measurement date.

Figure 6 shows hydrographs of eleven groundwater observation wells installed in specific glacial strata and monitored during the TW-41 pumping test. The observation wells in the two G41-G14 series and the G41-E13 and DMB-1A pair are spaced between about 15 and 25 feet (4.6 and 7.6 m) apart. The three observation wells in the G41-G15 series are about 40 feet (12.2 m) or more apart. The specific strata in which the screened interval of each observation well is sealed is noted on Figure 6. The water level measurements from December, 1979 to June, 1980 are mostly within 9 inches or less (229 mm) of each other. Although these head level differences are very small, the head levels in

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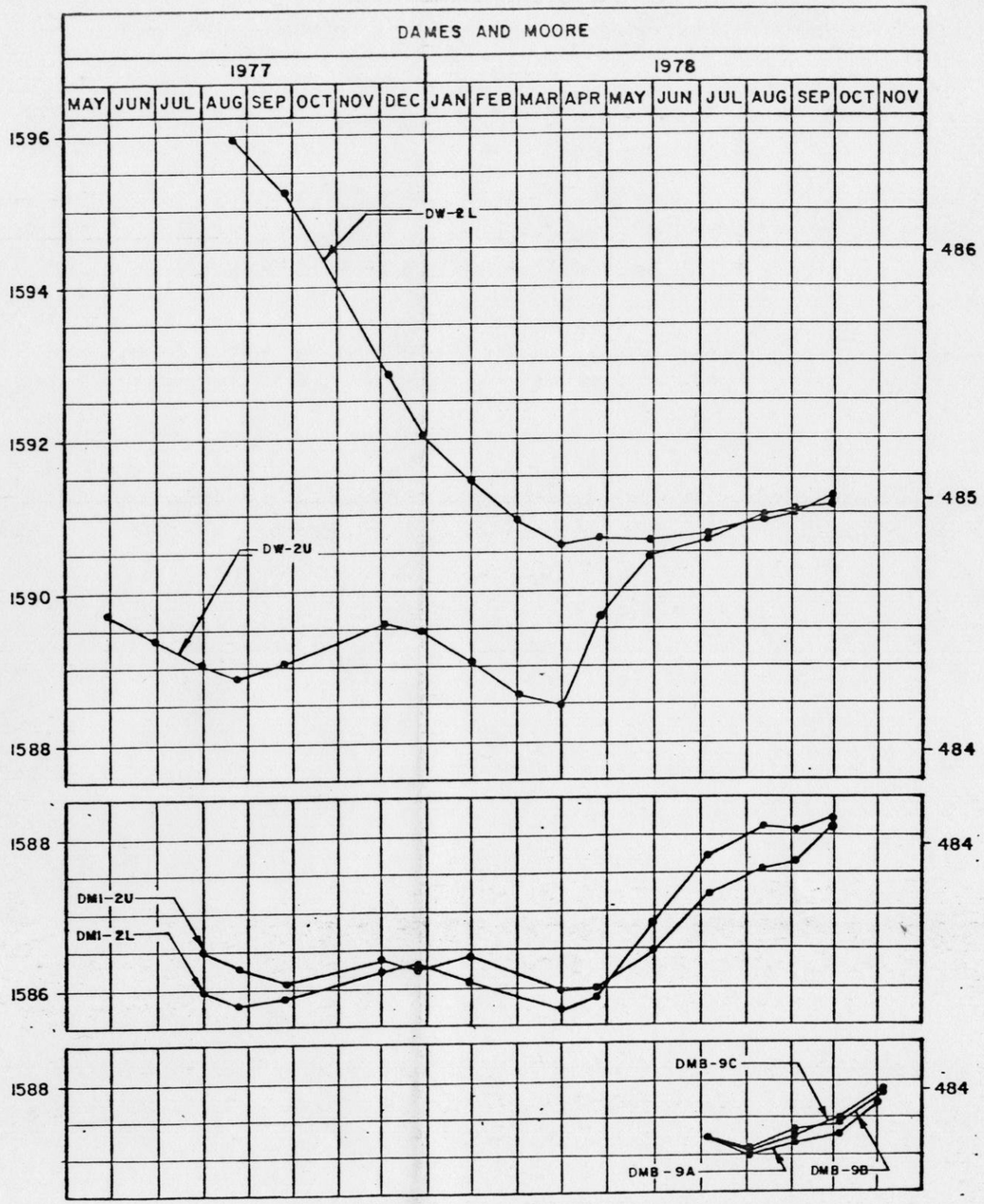
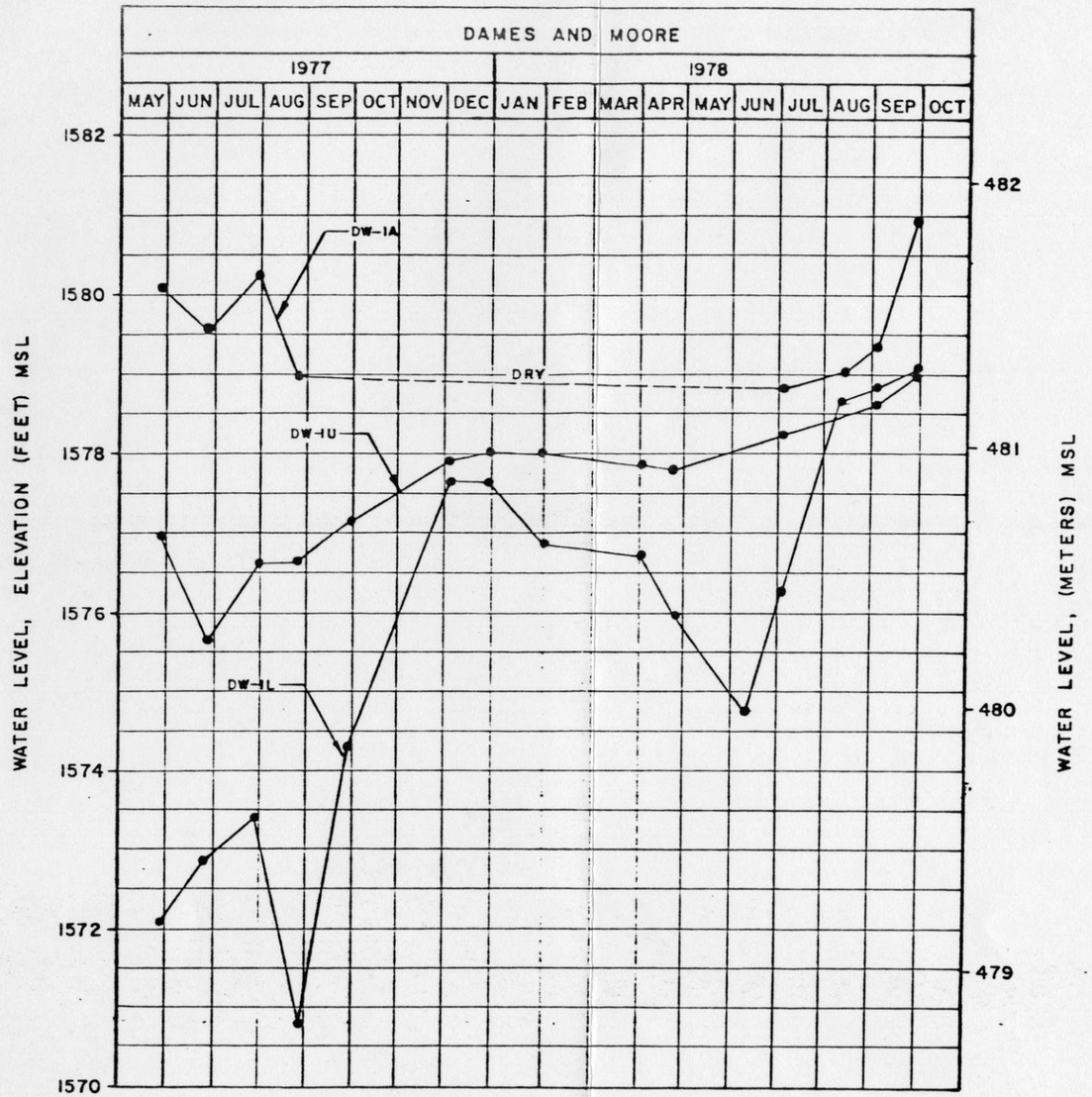


Well	Screened Interval feet (meters)	Well	Screened Interval feet (meters)
DW-2L	1515 - 1510 (461.7 - 460.2)	DW-2U	1545 - 1530 (470.9 - 466.3)
DMI-2L	1495 - 1490 (455.7 - 454.2)	DMI-2U	1579 - 1576 (481.3 - 480.4)
DMB-9A	1444 - 1430 (440.1 - 437.1)	DMB-9B	1471 - 1461 (443.1 - 445.3)
DMB-9C	1509 - 1499 (459.9 - 456.9)		



Well	Screened Interval feet (meters)
DW-1A	1590 - 1578 (484.6 - 480.9)
DW-1U	1556 - 1551 (474.3 - 472.7)
DW-1L	1511 - 1501 (460.6 - 457.5)

JOB NO. 786085	SCALE AS SHOWN	HYDROGRAPHS FOR DAMES & MOORE MULTIPLE LEVEL OBSERVATION WELLS
DRAWN SKB	DATE 9-29-81	
CHECKED JVK	DWG. NO. _____	
Golder Associates		EXXON CRANDON PROJECT — FIGURE 5

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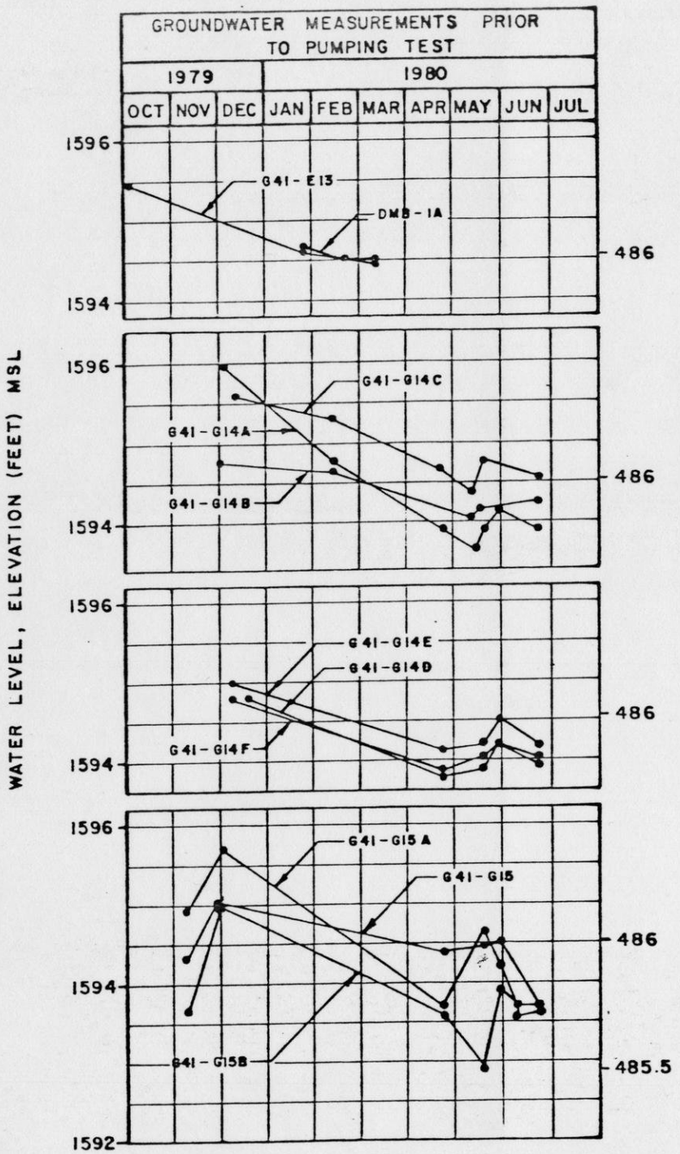

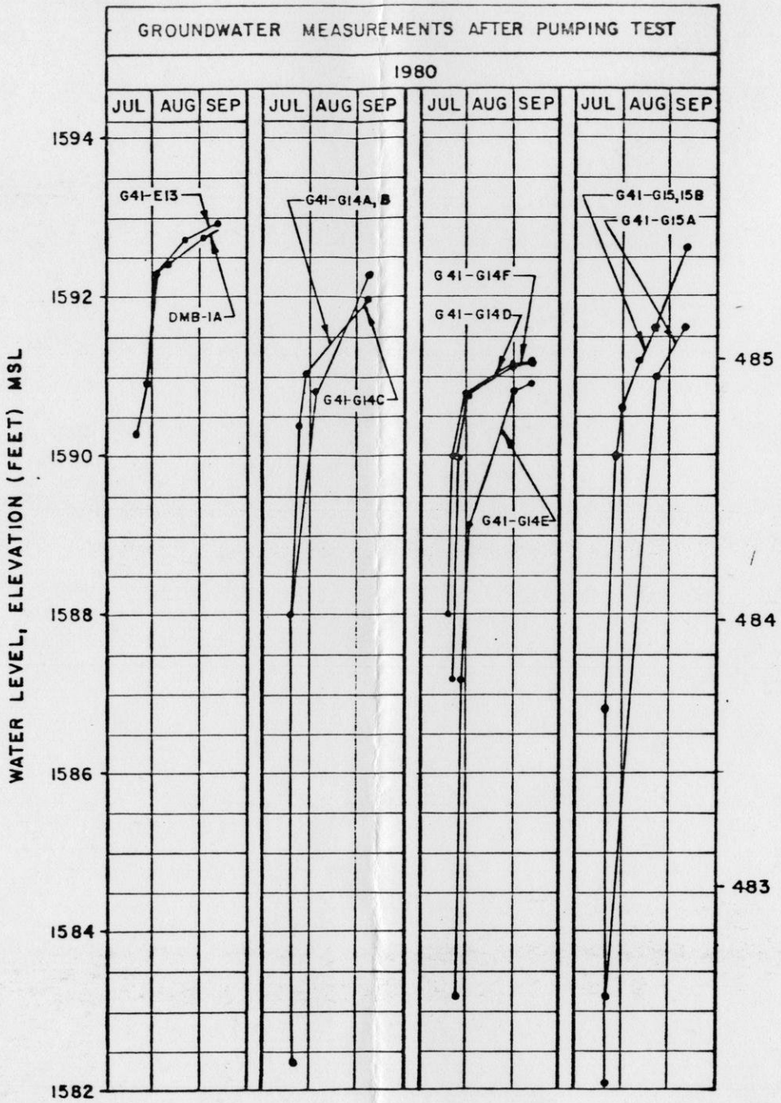

OBSERVATION WELL DATA

Well	Screened Interval feet (meters)	Comments
G41-G14A	1485 - 1465 (452.6 - 446.5)	Coarse Grained Stratified Drift
G41-G14B	1434 - 1414 (437.1 - 430.9)	Lower Till/Basement Rock
G41-G14C	1545 - 1555 (470.9 - 473.9)	Upper Till
G41-G14D	1483 - 1463 (452.3 - 445.9)	Coarse Grained Stratified Drift
G41-G14E	1541 - 1551 (469.6 - 472.7)	Upper Till
G41-G14F	1413 - 1393 (430.7 - 424.6)	Lower Till
DMB-1A	1559 - 1549 (475.2 - 472.1)	Upper Till
G41-E13	1400 - 1390 (426.7 - 423.7)	Upper Till
G41-G15A	1591 - 1581 (484.9 - 481.8)	Upper Till
G41-G15B	1534 - 1524 (467.6 - 464.5)	Upper Till/Coarse Grained Stratified Drift
G41-G15	1451 - 1441 (442.3 - 439.2)	Lower Till/Basement Rock

JOB NO. 786085	SCALE AS SHOWN	HYDROGRAPHS FOR MULTIPLE LEVEL OBSERVATION WELLS MONITORED DURING TW-41 PUMPING TEST	
DRAWN SKB	DATE 9-29-81		
CHECKED JVK.	DWG. NO. ———		
Golder Associates		EXXON CRANDON PROJECT	FIGURE 6

the coarse grained stratified drift are consistently lower than the levels in the overlying till for the closely spaced wells, therefore showing a downward vertical gradient. The G41-G15 series observation wells appear to be far enough apart that overall gradients could affect comparison of the head differences of the various strata. The head levels in the glacial formations below the coarse grained stratified drift are shown to be essentially governed by the head level in the drift. The hydrographs of the observation wells monitored closely after the pumping test, also on Figure 6, show, as expected, that recovery of the overlying till lags behind that of the coarse grained stratified drift and underlying materials.

Based on the available data, there appears to be no significant difference in head levels in the various glacial materials. However, there does appear to be a downward vertical gradient to the coarse grained stratified drift from the overlying till based on the G41-G14 series water level measurements.

6.0 SUMMARY

The groundwater potentiometric contour plan constructed by Golder Associates and Dames & Moore for the Exxon Crandon Project and surrounding area is shown as Figures 1 and 2. This map was constructed using observation well readings, water chemistry data, and ground topography. The groundwater levels in the immediate project area were derived from a set of observation well measurements on September 10 and 11, 1980. A very high level of confidence was placed on this data. The groundwater levels for the surrounding area were based on a scatter of observation well readings not all taken at the same period of time, water chemistry data, and topographic data. The groundwater levels for this surrounding area are of a lower confidence level than those for the project site and are represented on the map by the change in contour interval and the dashing of isopleths. Approximate delineation of isopleth reliability is indicated on Figures 1 and 2. Figure 3 was prepared to illustrate in detail the relative density of data that was used to construct the groundwater map.

Based on the groundwater level measurements and water chemistry data, a distinction can be made between those lakes which are primarily groundwater discharge areas and those which are primarily surface water fed. Those lakes with water levels above the main groundwater system are considered to be perched and part of the recharge mechanism. Water from those lakes flows into the main groundwater system.

Review of the water level measurements in multiple level groundwater observation wells and closely spaced individual observation wells indicates that there is no significant difference in the potential head levels of the various

glacial strata. Therefore, the groundwater map is considered to represent the head levels for the entire groundwater system.

GOLDER ASSOCIATES

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Geotechnical Engineer

Gary H. Collison, P.E.
Associate

JFC:GHC:dap

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4. Andrews, L.M., and R. Steuck, Surface Water Resources of Forest County, Department of Natural Resources, Madison, Wisconsin, 1977.

5. Dames & Moore, Crandon Project Environmental Report, Preliminary Draft No. 2, Section 2.3, Groundwater, September 29, 1980.

6. Dames & Moore, Crandon Project Environmental Project, Preliminary Draft, Section 2.5, Aquatic Ecology Studies, September, 1980.

7. Dames & Moore, Exxon Minerals Company Crandon Project, Environmental Baseline Study, Preliminary Draft, Section 2.2, Geology Study and Study Methods, April, 1981.

APPENDIX

TABLE 1

GOLDER ASSOCIATES AND DAMES AND MOORE OBSERVATION WELL MEASUREMENTS FOR GROUNDWATER CONTOUR CONSTRUCTION

Observation Well No.[1]	Elevations ft. (m) m.s.l.[1] Ground Surface	Top of Casing	Completion Interval (bottom screen to top gravel)	Date	Measured Depth[2] ft. (m)	Elevation ft. (m)	Comments
G41-C15	1615.61 (492.438)	1617.30 (492.953)	1411 to 1426 (430.1) (434.6)	9/10/80	25.92 (7.900)	1591.38 (485.053)	(3) Below wetland north of Duck Lake
				11/7/79	23.15 (2.056)	1594.15 (485.90)	(4)
				11/12/79	21.9 (6.67)	1593.7 (485.76)	(4) From ground surface
G41-C15B	1611.60 (491.216)	1613.92 (491.923)	1585 to 1593 (483.1) (485.5)	9/10/80	21.49 (6.550)	1592.43 (485.373)	(3) In wetland north of Duck Lake
				11/12/79	16.9 (5.15)	1594.7 (486.06)	(4) From ground surface
G41-E13	1627.28 (495.995)	1629.46 (496.656)	1390 to 1402 (423.7) (427.3)	9/10/80	36.58 (11.150)	1592.87 (485.507)	(3)
				11/7/79	33.55 (10.226)	1595.61 (486.430)	(4)
G41-E17	1666.36 (507.907)	1668.49 (508.556)	1421 to 1438 (433.1) (438.3)	9/10/80	77.23 (23.540)	1591.26 (485.016)	(3)
				11/12/79	72.7 (22.16)	1593.7 (485.76)	(4) From ground surface
G41-F24	1653.50 (503.987)	1656.61 (504.935)	1560 to 1578 (475.5) (480.9)	9/10/80	69.36 (21.141)	1587.25 (483.794)	
G41-G12	1675.73 (510.763)	1678.61 (511.640)	1656 to 1661 (504.7) (506.2)	9/10/80	14.79 (4.508)	1663.82 (507.132)	Near edge of upland wetland Data not used in basemap
G41-G14A	1706.91 (520.266)	1708.62 (520.787)	1466 to 1486 (446.8) (452.9)	9/10/80	116.55 (35.524)	1592.07 (485.263)	(3)
				12/4/79	112.1 (34.17)	1594.8 (486.09)	(4) From ground surface
G41-G14B	1706.80 (520.223)	1708.87 (520.864)	1415 to 1444 (431.3) (440.1)	9/10/80	116.87 (35.622)	1592.00 (485.242)	(3)
				12/4/79	110.7 (33.74)	1596.1 (486.49)	(4) From ground surface

TABLE 1 (Continued)

GOLDER ASSOCIATES AND DAMES AND MOORE OBSERVATION WELL MEASUREMENTS FOR GROUNDWATER CONTOUR CONSTRUCTION

Observation Well No.[1]	Elevations ft. (m) m.s.l.[1] Ground Surface	Top of Casing	Completion Interval (bottom screen to top gravel)	Date	Measured Depth[2] ft. (m)	Elevation ft. (m)	Comments
G41-G14C	1706.33 (520.089)	1708.68 (520.806)	1555 to 1582 (473.9) (482.2)	9/10/80	116.31 (35.451)	1592.37 (485.354)	(3)
				12/11/79	110.7 (33.74)	1595.6 (486.34)	(4) From ground surface
G41-G14D	1705.56 (519.855)	1707.60 (520.476)	1464 to 1491 (446.3) (454.4)	9/10/80	115.63 (35.244)	1591.97 (485.232)	(3)
				12/19/79	110.8 (33.77)	1594.8 (486.09)	(4) From ground surface
G41-G14E	1705.61 (519.870)	1708.00 (520.598)	1552 to 1577 (473.1) (480.7)	9/10/80	116.29 (35.445)	1591.71 (485.153)	(3)
				12/11/79	110.4 (33.65)	1595.2 (486.22)	(4) From ground surface
G41-G14F	1703.47 (519.218)	1706.92 (520.269)	1394 to 1423 (424.9) (433.7)	9/10/80	114.89 (35.018)	1592.03 (485.251)	(3)
				12/11/79	108.6 (33.10)	1594.9 (486.13)	(4) From ground surface
G41-G15	1691.47 (515.560)	1694.24 (516.404)	1442 to 1458 (439.5) (444.4)	9/10/80	102.37 (31.202)	1591.87 (485.202)	(3)
				11/12/79	97.1 (29.60)	1594.4 (485.97)	(4) From ground surface
				12/3/79	96.4 (29.38)	1595.1 (486.19)	(4) From ground surface
G41-G15A	1692.75 (515.950)	1695.71 (516.852)	1581 to 1601 (481.4) (488.0)	9/10/80	104.18 (31.754)	1591.53 (485.098)	(3)
				11/9/79	100.80 (30.724)	1594.91 (486.129)	(4)
				11/12/79	98.2 (29.93)	1594.6 (486.03)	(4) From ground surface
				12/3/79	97.0 (29.57)	1595.8 (486.40)	(4) From ground surface
G41-G15B	1692.09 (515.749)	1694.72 (516.551)	1524 to 1546 (464.5) (471.2)	9/10/80	102.81 (31.336)	1591.91 (485.211)	(3)
				11/9/79	100.00 (30.480)	94.72 (486.071)	(4)
				11/12/79	98.5 (30.02)	1593.6 (485.73)	(4) From ground surface
				12/3/79	97.1 (29.60)	1595.0 (486.16)	(4) From ground surface

TABLE 1 (Continued)

GOLDER ASSOCIATES AND DAMES AND MOORE OBSERVATION WELL MEASUREMENTS FOR GROUNDWATER CONTOUR CONSTRUCTION

Observation Well No.[1]	Elevations ft. (m) m.s.l.[1] Ground Surface	Top of Casing	Completion Interval (bottom screen to top gravel)	Date	Measured Depth[2] ft. (m)	Elevation ft. (m)	Comments
G41-G21	1664.83 (507.440)	1666.91 (508.074)	1566 to 1598 (477.2) (487.1)	9/10/80	76.62 (23.354)	1590.29 (484.720)	
G41-H17	1684.46 (513.423)	1687.02 (514.204)	1651 to 1664 (503.2) (507.2)	9/10/80	DRY		Below wetland above estimated regional phreatic surface
G41-H18	1684.28 (513.369)	1686.44 (514.027)	1657 to 1672 (505.1) (509.6)	9/10/80	DRY		Below wetland above estimated regional phreatic surface
G41-H18A	1680.38 (512.180)	1684.46 (513.423)	1660 to 1664 (506.0) (507.2)	9/10/80	5.43 (1.655)	1679.03 (511.768)	In wetland Data not used in basemap
G41-J18	1679.70 (511.973)	1683.07 (513.000)	1647 to 1657 (502.0) (505.1)	9/10/80	33.25 (10.135)	1649.82 (502.865)	Near wetland, mud drilled. Possibly trapped water in well. Data not used in basemap.
G41-K13	1699.67 (518.059)	1702.92 (519.050)	1430 to 1460 (435.9) (445.0)	9/10/80	111.14 (33.875)	1591.78 (485.175)	(3)
				11/12/79	105.2 (32.07)	1594.5 (486.00)	(4) From ground surface
				12/3/79	105.0 (32.00)	1594.7 (486.06)	(4) From ground surface
G41-K13A	1699.87 (518.120)	1702.99 (519.071)	1581 to 1594 (481.9) (485.8)	9/10/80	110.81 (33.775)	1592.18 (485.296)	(3)
				11/12/79	105.1 (32.03)	1594.8 (486.09)	(4) From ground surface
				12/3/79	104.5 (31.85)	1595.4 (486.28)	(4) From ground wurface
G41-K13B	1696.83 (517.194)	1698.79 (517.791)	1677 to 1682 (511.1) (512.7)	9/10/80	DRY		In wetland
G41-M24	1653.11 (503.867)	1655.11 (504.477)	1622 to 1632 (494.4) (497.4)	9/10/80	32.92 (10.034)	1622.44 (494.519)	In upland-wetland northwest of Walsh Lake. Data not used in basemap
G41-N21	1727.36 (526.499)	1729.50 (527.152)	1579 to 1589 (481.3) (484.3)	9/10/80	139.53 (42.529)	1589.97 (484.623)	
G41-P18	1588.88 (484.291)	1591.51 (485.092)	1479 to 1489 (450.8) (453.8)	9/10/80	4.65 (1.417)	1586.86 (483.675)	At edge of Hemlock Slough
G41-P18B	1589.05 (484.342)	1591.27 (485.019)	1549 to 1554 (472.1) (473.7)	9/10/80	2.52 (0.768)	1588.75 (484.251)	At edge of Hemlock Slough
G41-P24	1681.95 (512.658)	1684.37 (513.396)	1569 to 1579 (478.2) (481.3)	9/10/80	94.15 (28.697)	1590.22 (484.699)	

TABLE 1 (Continued)

GOLDER ASSOCIATES AND DAMES AND MOORE OBSERVATION WELL MEASUREMENTS FOR GROUNDWATER CONTOUR CONSTRUCTION

Observation Well No.[1]	Elevations ft. (m) m.s.l.[1] Ground Surface	Top of Casing	Completion Interval (bottom screen to top gravel)	Date	Measured Depth[2] ft. (m)	Elevation ft. (m)	Comments
G40-D24	1629.93 (496.803)	1632.28 (497.519)	1446 to 1463 (440.7) (445.9)	9/10/80	78.59 (23.954)	1553.69 (473.565)	
G40-H16	1617.07 (492.883)	1619.42 (493.599)	1462 to 1507 (445.6) (459.3)	9/10/80	58.99 (17.980)	1560.43 (475.619)	
G40-H27	1602.12 (488.326)	1604.02 (488.905)	1421 to 1445 (433.1) (440.4)	9/10/80	54.52 (16.618)	1549.50 (472.288)	
G40-J15	1603.63 (488.786)	1605.62 (489.393)	1557 to 1568 (474.6) (477.9)	9/10/80	42.38 (12.917)	1563.24 (476.476)	Below large wetland west of Oak Lake
G40-K13	1600.94 (487.967)	1603.81 (488.841)	1557 to 1576 (474.6) (480.4)	9/10/80	38.51 (11.738)	1565.30 (477.103)	In large wetland west of Oak Lake
G40-L23	1639.28 (499.653)	1641.20 (500.238)	1552 to 1565 (473.0) (477.0)	9/10/80	78.87 (24.040)	1562.33 (476.189)	
G40-M15	1637.55 (499.125)	1639.20 (499.019)	1364 to 1374 (415.7) (418.8)	9/10/80	70.16 (21.385)	1569.04 (478.243)	About 500 ft. (152 m) southwest of Oak Lake
G40-P20	1641.09 (500.204)	1643.30 (500.878)	1565 to 1581 (477.0) (481.9)	9/10/80	71.85 (21.900)	1571.45 (478.978)	About 2300 ft. (701 m) south of Oak Lake and west of Little Sand Lake
G40-Q7	1608.07 (490.140)	1609.92 (490.704)	1541 to 1558 (469.7) (474.9)	9/10/80	44.75 (13.640)	1565.17 (477.064)	
G40-R23	1620.30 (493.867)	1622.45 (494.523)	1544 to 1560 (470.6) (475.5)	9/10/80	52.99 (16.151)	1569.46 (478.371)	
DMI-1	1636.74 (498.878)	1638.29 (499.351)	1528 to 1585 (465.7) (483.1)	9/11/80	48.92 (14.911)	1589.37 (484.440)	
DMI-2U	1629.43 (496.650)	1630.77 (497.059)	1576 to 1589 (480.4) (484.3)	9/11/80	41.80 (12.741)	1588.97 (484.318)	
DMI-2L	1629.43 (496.650)	1630.77 (497.059)	1490 to 1541 (454.1) (469.7)	9/11/80	43.86 (13.369)	1586.91 (483.690)	
DW-1A	1648.49 (502.460)	1649.64 (502.810)	1578 to 1597 (481.0) (486.8)	9/11/80	68.08 (20.751)	1581.56 (482.059)	(3)
DW-1U	1648.32 (502.408)	1649.68 (501.908)	1551 to 1565 (472.7) (477.0)	9/11/80	68.57 (20.900)	1581.11 (481.922)	
DW-1L	1648.32 (502.408)	1649.68 (501.908)	1501 to 1518 (457.5) (462.7)	9/11/80	71.08 (21.665)	1578.60 (481.157)	

TABLE 1 (Continued)

GOLDER ASSOCIATES AND DAMES AND MOORE OBSERVATION WELL MEASUREMENTS FOR GROUNDWATER CONTOUR CONSTRUCTION

Observation Well No.[1]	Elevations ft. (m) m.s.l.[1] Ground Surface	Top of Casing	Completion Interval (bottom screen to top gravel)	Date	Measured Depth[2] ft. (m)	Elevation ft. (m)	Comments
DW-2U	1600.74 (487.906)	1601.86 (488.247)	1531 to 1554 (466.6) (473.7)	9/11/80	9.79 (2.984)	1592.07 (485.263)	
DW-2L	1600.74 (487.906)	1601.86 (488.247)	1511 to 1525 (460.5) (464.8)	9/11/80	8.99 (2.740)	1592.87 (485.507)	
DW-3U	1657.07 (505.075)	1658.74 (505.572)	1559 to 1574 (475.2) (479.7)	9/11/80	81.56 (24.859)	1577.18 (480.724)	
DW-3L	1657.07 (505.075)	1658.74 (505.572)	1524 to 1536 (464.5) (466.2)	9/11/80	81.58 (24.866)	1577.16 (480.718)	
TW-1	1601.19 (488.043)	1602.63 (488.482)	1546 to 1571 (471.2) (478.8)	9/11/80	10.84 (3.304)	1591.79 (485.178)	
WW-2	1645.39 (501.515)	1645.92 (501.676)	1490 to 1505 (454.1) (458.7)	9/11/80	66.15 (20.163)	1579.77 (481.514)	
DMS-1	1661.65 (506.471)	1663.79 (497.979)	1557 to 1612 (474.6) (491.3)	9/11/80	70.29 (21.424)	1593.50 (485.699)	
DMS-2	1641.19 (500.235)	1643.35 (500.893)	1551 to 1591 (472.7) (484.9)	9/11/80	53.09 (16.182)	1590.26 (484.711)	
DMA-1N	1637.96 (499.250)	1638.87 (499.528)	1620 to 1628 (493.8) (496.2)	9/10/80	DRY		About 200 ft. (91 m) southwest of Oak Lake
DMA-1S	1637.96 (499.250)	1638.89 (499.534)	1583 to 1593 (482.5) (485.5)	9/10/81	DRY		About 200 ft. (91 m) southwest of Oak Lake
DMA-3	1647.51 (502.161)	1648.84 (502.566)	1605 to 1616 (489.2) (492.6)	9/10/81	DRY		About 450 ft. (137 m) northeast of Oak Lake
DMA-4	1612.03 (491.347)	1613.57 (491.816)	1582 to 1598 (482.2) (487.1)	9/10/81	25.83 (7.873)	1587.74 (483.943)	In wetland associated with Duck Lake and south of Duck Lake
DMA-10	1593.58 (485.723)	1595.18 (486.211)	1548 to 1562 (471.8) (476.1)	9/10/81	19.63 (5.983)	1575.55 (480.228)	Edge of wetland south of Little Sand Lake, about 650 ft. (198m) from Little Sand Lake
DMA-12	1621.18 (489.136)	1623.04 (494.703)	1576 to 1586 (480.4) (483.4)	9/10/81	31.02 (9.455)	1592.02 (485.248)	About 400 ft. (122 m) west of Skunk Lake
DMA-13	1554.66 (473.860)	1555.99 (474.266)	1516 to 1522 (462.1) (463.9)	9/10/81	2.19 (0.668)	1553.80 (473.598)	In wetland between Mole Lake and Rolling Stone Lake
DMA-16	1589.93 (484.611)	1591.32 (485.034)	1530 to 1538 (466.3) (468.8)	9/10/81	37.74 (11.503)	1553.58 (473.531)	

TABLE 1 (Continued)

GOLDER ASSOCIATES AND DAMES AND MOORE OBSERVATION WELL MEASUREMENTS FOR GROUNDWATER CONTOUR CONSTRUCTION

Observation Well No.[1]	Elevations ft. (m) m.s.l.[1] Ground Surface	Top of Casing	Completion Interval (bottom screen to top gravel)	Date	Measured Depth[2] ft. (m)	Elevation ft. (m)	Comments
DMA-18	1619.36 (493.581)	1621.18 (494.136)	1549 to 1564 (472.1) (476.7)	9/10/81	58.56 (17.849)	1562.62 (476.287)	
DMA-19	1597.24 (486.839)	1598.54 (487.234)	1571 to 1575 (478.8) (480.1)	9/11/80	8.40 (2.560)	1590.14 (484.675)	
DMA-20	1591.97 (485.232)	1593.15 (485.592)	1538 to 1556 (468.8) (474.3)	9/10/80	30.67 (9.348)	1562.48 (476.244)	
DMA-22B	1629.19 (496.577)	1630.92 (497.104)	1529 to 1553 (466.0) (473.4)	9/10/80	27.77 (8.464)	1603.15 (488.640)	
DMA-29AU	1536.69 (468.383)	1538.38 (468.898)	1491 to 1498 (454.5) (456.6)	9/10/80	3.57 (1.088)	1534.81 (467.810)	At wetland area west of site near Wolf Creek and Swamp Creek junction
DMA-29AL	1536.69 (468.383)	1538.38 (468.898)	1484 to 1489 (452.3) (453.8)	9/10/80	3.50 (1.067)	1534.88 (467.831)	
DMA-31	1592.09 (485.269)	1593.49 (485.696)	1568 to 1577 (477.9) (480.7)	9/11/80	7.85 (2.393)	1585.64 (483.303)	At edge of major wetland northeast of site adjoining Swamp Creek wetland
DMA-32A	1592.14 (485.284)	1593.54 (485.711)	1555 to 1562 (474.0) (476.1)	9/10/80	9.56 (2.914)	1583.98 (482.797)	In Hemlock Slew
DMA-34	1535.92 (468.148)	1537.03 (468.487)	1514 tp 1521 (461.5) (463.6)	9/11/80	2.14 (0.652)	1534.89 (467.834)	In wetland adjoining Squaw Creek
DMA-38	1772.00 (540.106)	1773.49 (540.560)	1744 to 1753 (531.6) (534.3)	9/11/80	DRY		
DMA-43	1624.70 (495.209)	1626.62 (495.794)	1585 to 1600 (483.1) (487.7)	9/10/80	0.22 (0.067)	1626.40 (495.727)	In wetland west of Lake Metonga
DMA-47	1573.62 (479.639)	1574.84 (480.011)	1547 to 1557 (471.5) (474.6)	9/10/80	19.49 (5.941)	1555.35 (474.071)	At edge of Swamp Creek wetland
DMA-48	1547.42 (471.654)	1548.68 (472.038)	1519 to 1527 (463.0) (465.4)	9/10/80	11.05 (3.368)	1537.63 (468.670)	At edge of Swamp Creek wetland
DMB-1A	1627.94 (496.196)	1629.70 (496.733)	1549 to 1604 (472.1) (488.9)	9/10/80	36.93 (11.256)	1592.77 (485.476)	
DMB-2	1706.28 (520.074)	1708.13 (520.638)	1606 to 1661 (489.5) (506.4)	9/10/80	DRY		
DMB-3	1587.93 (484.001)	1589.48 (484.474)	1528 to 1548 (465.7) (471.8)	9/10/80	9.70 (2.957)	1579.78 (481.517)	In Hemlock Creek wetland

TABLE 1 (Continued)

GOLDER ASSOCIATES AND DAMES AND MOORE OBSERVATION WELL MEASUREMENTS FOR GROUNDWATER CONTOUR CONSTRUCTION

Observation Well No.[1]	Elevations ft. (m) m.s.l.[1] Ground Surface	Top of Casing	Completion Interval (bottom screen to top gravel)	Date	Measured Depth[2] ft. (m)	Elevation ft. (m)	Comments
DMB-4	1644.49 (501.241)	1646.03 (501.710)	1565 to 1585 (477.0) (483.1)	9/10/80	53.55 (16.322)	1592.48 (485.388)	Northwest of Little Sand Lake
DMB-5	1688.77 (514.737)	1690.37 (515.225)	1590 to 1634 (484.6) (498.0)	9/10/80	DRY		
DMB-5A	1689.33 (514.908)	1690.95 (515.402)	1569 to 1593 (478.2) (485.5)	9/10/80	98.83 (30.123)	1592.12 (485.278)	
DMB-6	1666.47 (507.940)	1668.26 (508.486)	1581 to 1613 (481.9) (491.6)	9/10/80	76.43 (23.296)	1591.83 (485.190)	
DMB-7	1653.67 (507.039)	1655.08 (504.468)	1575 to 1599 (480.1) (487.4)	9/10/80	65.07 (19.833)	1590.01 (484.635)	
DMB-8	1622.74 (494.611)	1624.57 (495.169)	1573 to 1588 (479.5) (484.0)	9/10/80	36.56 (11.143)	1588.01 (484.025	
DMB-9A	1661.61 (506.459)	1663.23 (506.953)	1435 to 1447 (437.4) (441.0)	9/10/80	72.50 (22.098)	1590.73 (484.855)	
DMB-9B	1661.61 (506.459)	1663.23 (506.953)	1462 to 1488 (445.6) (453.5)	9/10/80	72.50 (22.098)	1590.73 (484.855)	
DMB-9C	1661.61 (506.459)	1663.23 (506.953)	1500 to 1532 (457.2) (467.0)	9/10/80	72.41 (22.071)	1590.82 (484.882)	
DMB-10	1619.11 (493.505)	1620.81 (494.023)	1520 to 1560 (463.3) (475.5)	9/10/80	60.37 (18.401)	1560.44 (475.622)	
DMB-11	1656.85 (505.008)	1659.06 (478.249)	1557 to 1573 (474.6) (479.5)	9/10/80	88.44 (26.957)	1570.62 (478.725)	
DMB-12	1586.05 (483.428)	1587.72 (483.937)	1506 to 1526 (459.0) (465.1)	9/10/80	21.91 (6.678)	1565.81 (477.259)	
DMB-13	1609.39 (490.542)	1611.15 (481.079)	1549 to 1563 (472.1) (476.4)	9/10/80	57.57 (17.547)	1553.58 (473.531)	
DMB-16	1674.63 (510.427)	1676.27 (510.927)	1576 to 1616 (480.4) (492.6)	9/10/80	DRY		
DMB-17	1648.95 (502.600)	1650.50 (503.072)	1569 to 1584 (478.2) (482.8)	9/11/80	DRY		
DMB-18	1601.04 (487.997)	1602.59 (488.469)	1521 to 1561 (463.6) (475.8)	9/10/80	45.39 (13.835)	1557.20 (474.635)	

TABLE 1 (Continued)

GOLDER ASSOCIATES AND DAMES AND MOORE OBSERVATION WELL MEASUREMENTS FOR GROUNDWATER CONTOUR CONSTRUCTION

Observation Well No.[1]	Elevations ft. (m) m.s.l.[1] Ground Surface	Top of Casing	Completion Interval (bottom screen to top gravel)	Date	Measured Depth[2] ft. (m)	Elevation ft. (m)	Comments
DMB-19	1554.64 (473.854)	1556.30 (474.360)	1468 to 1490 (447.4) (454.2)	9/10/80	FLOWING		In wetland between Mole Lake and Rolling Stone Lake
DMB-20	1605.80 (489.265)	1607.69 (490.024)	1567 to 1580 (477.6) (481.6)	9/10/80	27.99 (8.531)	1579.70 (481.493)	In large wetland west of Oak Lake (clay layer about 30 ft. down). Data not used in basemap.
DMB-20A	1606.20 (489.570)	1607.91 (490.091)	1522 to 1541 (463.9) (469.7)	9/10/80	45.21 (13.780)	1562.70 (476.311)	Below large wetland west of Oak Lake
DMB-21	1559.32 (475.281)	1561.36 (475.903)	1510 to 1533 (460.2) (467.3)	9/10/80	6.04 (1.841)	1555.32 (474.062)	At edge of wetland between Mole Lake and Rolling Stone Lake
DMB-22	1616.48 (492.703)	1618.32 (493.264)	1538 to 1552 (468.8) (473.1)	9/10/80	57.87 (17.639)	1560.45 (475.625)	
DMB-23	1563.30 (476.494)	1565.05 (477.027)	1464 to 1480 (446.2) (451.1)	9/10/80	10.33 (3.149)	1554.72 (473.879)	At edge of wetland associated with and east of Mole Lake
DMB-24	1565.43 (477.143)	1567.00 (477.622)	1517 to 1526 (462.4) (465.1)	9/10/80	27.21 (8.294)	1539.79 (469.328)	About 500 ft. (152 m) north of Rolling Stone Lake
DMB-25	1644.66 (501.292)	1646.10 (501.731)	1515 to 1532 (461.8) (467.0)	9/10/80	97.18 (29.620)	1548.92 (472.111)	At edge of wetland between Mole Lake and Rolling Stone Lake
DMB-26	1712.98 (522.116)	1714.49 (522.577)	1579 to 1596 (481.3) (486.5)	9/10/80	129.49 (39.469)	1585.00 (483.108)	
DMB-27	1649.04 (502.627)	1650.83 (503.173)	1565 to 1578 (477.0) (481.0)	9/10/80	62.77 (19.132)	1588.06 (484.041)	
DMB-28	1642.13 (500.521)	1643.88 (501.055)	1573 to 1581 (479.5) (481.9)	9/10/80	55.31 (16.858)	1588.57 (484.196)	
DMB-29	1629.98 (496.818)	1631.48 (497.275)	1561 to 1569 (475.8) (478.2)	9/10/80	42.54 (12.966)	1588.94 (484.309)	
DMC-1	1614.34 (492.051)	1615.99 (492.554)	1567 to 1580 (477.6) (481.6)	9/10/80	30.01 (9.147)	1585.98 (483.407)	On bank of Ground Hemlock Lake
DMC-2	1588.60 (484.205)	1590.17 (484.684)	1540 to 1554 (469.4) (473.7)	9/10/80	10.57 (3.222)	1579.60 (481.462)	At edge of Swamp Creek wetland about midway between Lake Metonga and Lake Lucerne
DMC-3	1610.02 (490.734)	1611.97 (491.328)	1565 to 1584 (477.0) (482.8)	9/10/80	20.16 (6.145)	1591.81 (485.181)	Near water east of Walsh Lake
DMP-1	1647.62 (502.195)	1649.55 (502.783)	1577 to 1588 (480.7) (484.0)	9/11/80	61.41 (18.718)	1588.14 (485.065)	

TABLE 1 (Continued)

GOLDER ASSOCIATES AND DAMES AND MOORE OBSERVATION WELL MEASUREMENTS FOR GROUNDWATER CONTOUR CONSTRUCTION

Observation Well No.[1]	Elevations ft. (m) m.s.l.[1] Ground Surface	Top of Casing	Completion Interval (bottom screen to top gravel)	Date	Measured Depth[2] ft. (m)	Elevation ft. (m)	Comments
DMP-2	1595.58 (486.333)	1597.20 (486.827)	1560 to 1567 (475.5) (477.6)	9/11/80	11.97 (3.648)	1585.23 (483.178)	About 250 ft. (26 m) north of Little Sand Lake
DMP-3	1623.55 (494.858)	1625.36 (495.410)	1558 to 1570 (474.9) (478.5)	9/10/80	46.90 (14.295)	1578.46 (481.114)	About 600 ft. (183 m) west of Little Sand Lake

NOTES: 1. G series well data from Reference 1.
D, T, W series well data from Reference 7.
2. Depths are from top of casing unless indicated as from ground surface in comments
3. After TW-41 pump test in June and July, 1980.
4. Measurements taken in November and December, 1979 are the nearest in date to being one year prior to the concurrent September, 1980 measurements. These are included as supplemental data in estimating the 1595 foot (486.2 m) potentiometric contour in the TW-41 pump test area.

TABLE 2

U.S.G.S. WELL DATA

Observation Well	Meas. Date	Water Elevation Ft. (m)	Comments
FR-36	Unknown	1534 (467.6)	3
FR-96	Unknown	1534 (467.6)	3
FR-97	1977	1531 (466.6)	4
FR-98	"	1537 (468.5)	4
FR-99	"	1534 (467.6)	4 Next to Swamp Creek
FR-100	"	1536 (468.2)	4 Between Mole Lake and Rice Lake
FR-103	"	1534 (467.6)	4
FR-104	"	1534 (467.6)	4
FR-105	"	1535 (467.9)	4
FR-106	"	1534 (467.6)	4 Between Mole Lake and Rice Lake
FR-107	"	1536 (468.2)	4 Between Mole Lake and Rice Lake
FR-108	Unknown	1535 (467.9)	3 Between Mole Lake and Rice Lake
FR-109	1977	1535 (467.9)	4 Between Mole Lake and Rice Lake
FR-110	Unknown	1536 (468.2)	3 Between Mole Lake and Rice Lake

TABLE 2 (Continued)

U.S.G.S. WELL DATA

Observation Well	Meas. Date	Water Elevation Ft. (m)		Comments
FR-111	1977	1537 (468.5)	4	Between Mole Lake and Rice Lake
FR-112	"	1534 (467.6)	4	Next to Swamp Creek
FR-113	"	1535 (468.9)	4	Between Mole Lake and Rice Lake
FR-114	"	1534 (467.6)	4	Between Mole Lake and Rice Lake
FR-115	"	1535 (467.9)	4	Between Mole Lake and Rice Lake
FR-116	Unknown	1534 (467.6)	3	Between Mole Lake and Rice Lake
FR-117	1977	1538 (468.8)	4	Between Mole Lake and Rice Lake
FR-118	"	1538 (468.8)	4	Between Mole Lake and Rice Lake
FR-119	"	1520 (463.3)	4	Next to Swamp Creek
FR-120	"	1534 (467.6)	4	Next to Swamp Creek
FR-121	"	1538 (468.8)	4	
FR-122	"	1536 (468.2)	4	
FR-123	"	1537 (468.5)	4	Between Mole Lake and Rice Lake
FR-124	"	1534 (467.6)	4	Between Mole Lake and Rice Lake
FR-125	"	1537 (468.5)	4	
FR-126	"	1533 (467.3)	4	
FR-127	"	1537 (468.5)	4	Next to Swamp Creek

TABLE 2 (Continued)

U.S.G.S. WELL DATA

Observation Well	Meas. Date	Water Elevation Ft. (m)	Comments
FR-128	1977	1536 (468.2)	4
FR-131	"	1536 (468.2)	4 Next to Swamp Creek
FR-132	"	1542 (470.0)	4
FR-133	"	1543 (470.3)	4 Next to Mole Lake
FR-134	"	1534 (467.6)	4
FR-135	Unknown	1541 (469.7)	3 Next to Mole Lake wetland
FR-136	1977	1540 (469.4)	4
FR-138	Unknown	1551 (472.7)	3 Next to Mole Lake
FR-139	"	1552 (473.0)	3 Next to Mole Lake wetland
FR-140	"	1535 (467.9)	3
FR-142	"	1565 (473.0)	3 About 700 ft. (213 m) north of Oak Lake
FR-143	"	1575 (480.1)	3
FR-144	1977	1577 (480.7)	4
FR-145	Unknown	1580 (481.6)	3 Next to Little Sand Lake
FR-146	"	1575 (480.1)	3 Next to Little Sand Lake
FR-147	"	1577 (480.7)	3 Next to Little Sand Lake

TABLE 2 (Continued)

U.S.G.S. WELL DATA

Observation Well	Meas. Date	Water Elevation Ft. (m)		Comments
FR-148	Unknown	1583 (482.5)	3	Next to Little Sand Lake
FR-149	"	1569 (478.2)	3	Next to Little Sand Lake
FR-150	1977	1535 (467.9)	4	Next to Bishop Lake
FR-151	"	1534 (467.6)	4	Near Bishop Lake
FR-152	"	1538 (468.8)	4	Next to Bishop Lake
FR-153	"	1538 (468.8)	4	Next to Bishop Lake
FR-154	"	1542 (470.0)	4	Next to Bishop Lake
FR-156	Unknown	1549 (472.1)	3	
FR-157	"	1539 (469.1)	3	Next to Bishop Lake
FR-157	1977	1554 (473.7)	4	Northeast of Rice Lake
FR-158	"	1556 (474.3)	4	
FR-159	"	1594 (485.9)	4	
FR-160	"	1591 (484.9)	4	
FR-161	"	1599 (487.4)	4	
FR-162	"	1604 (488.9)	4	
FR-163	"	1603 (488.6)	4	

TABLE 2 (Continued)

U.S.G.S. WELL DATA

Observation Well	Meas. Date	Water Elevation Ft. (m)	Comments	
FR-164	Unknown	1611 (491.0)	3	
FR-165	1977	1618 (493.2)	4	
FR-166	Unknown	1580 (481.6)	3	
FR-167	"	1602 (488.3)	3	
FR-168	"	1592 (485.2)	3	
FR-169	"	1640 (499.9)	3	
FR-170	"	1660 (506.0)	3	
FR-171	"	1649 (502.6)	3	
FR-172	"	1536 (468.2)	3	
FR-173	"	1575 (480.1)	3	
FR-174	"	1592 (485.2)	3	
FR-175	"	1575 (480.1)	3	
FR-176	1977	1534 (467.6)	4	Between Mole Lake and Rice Lake
FR-179	"	1545 (470.9)	4	Next to Rice Lake wetland
FR-180	"	1545 (470.9)	4	Next to Rice Lake wetland
FR-181	"	1537 (468.5)	4	

TABLE 2 (Continued)

U.S.G.S. WELL DATA

Observation Well	Meas. Date	Water Elevation Ft. (m)	Comments	
FR-182	1977	1536 (468.2)	4	
FR-183	"	1543 (470.3)	4	
FR-185	"	1558 (474.9)	4	
FR-186	Unknown	1572 (479.1)	1	
FR-187	1977	1539 (469.1)	4	Next to Hoffman Pond
FR-188	"	1549 (472.1)	4	
FR-189	"	1545 (470.9)	4	Next to Bishop Lake wetland
FR-190	Unknown	1548 (471.8)	3	Next to Bishop Lake wetland
FR-191	1977	1541 (469.7)	4	Next to Bishop Lake wetland
FR-194	Unknown	1541 (469.7)	3	Next to Bishop Lake
FR-195	"	1534 (467.6)	3	
FR-197	"	1533 (467.3)	3	
FR-198	"	1536 (468.2)	3	
FR-199	"	1538 (468.8)	3	
FR-200	"	1538 (468.8)	3	
FR-201	"	1575 (480.1)	3	

TABLE 2 (Continued)

U.S.G.S. WELL DATA

Observation Well	Meas. Date	Water Elevation Ft. (m)	Comments	
FR-202	Unknown	1539 (469.1)	3	
FR-203	"	1534 (467.6)	3	
FR-205	"	1535 (467.9)	3	Next to Swamp Creek
FR-207	"	1534 (467.6)	3	Next to Bishop Lake
LN-478	1977-78	1538 (468.8)	2	

NOTE: Data sources as listed by the U.S.G.S. are as follows:
1 - Unknown
2 - data from Dames & Moore
3 - data from Wisconsin Logs
4 - data from JRE

TABLE 3

WATER CHEMISTRY DATA (FROM DNR AND D&M)

NAME	D&M HARDNESS CLASS.(1)	D&M pH CLASS.(1)	DNR HARDNESS CLASS.(2)	DNR pH CLASS.(2)
Agnes Lake			Soft	Slight Alkaline
Anninan Lake			Very Soft	Slight Acid
Berendsen Lake			Soft	Slight Alkaline
Bishop Lake			Med. Hard	Slight Alkaline
Bogbrook Impoundment			Med. Hard	Slight Acid
Bogbrook Lake			Med. Hard	Slight Alkaline
Bradley Lake			Med. Hard	Slight Alkaline
Clark Lake			Very Soft	Slight Acid
Cook Lake			Very Soft	Slight Alkaline
Crane Lake			Hard	Slight Alkaline
Crawford Lake			Very Soft	Slight Acid
Deadman Lake			Very Soft	Slight Acid
Deep Hole Lake	Soft	Neutral	Very Soft	Acid
Duck Lake	Soft	Slight Acid	Very Soft	Acid
Ground Hemlock Lake	Mod. Hard	Neutral to Slight Alkaline	Hard	Alkaline
Hollister Lake			Very Soft	Acid
Horse Shoe Lake			Very Soft	Slight Acid
Jungle Lake			Med. Hard	Alkaline
Kimberly Lake			Very Soft	Slight Acid
Lake Lucerne			Soft	Slight Acid
Lake Metonga			Med. Hard	Slight Alkaline
Learned Lake			Very Soft	Slight Acid
Lily Lake			Very Soft	Slight Acid
Little Sand Lake	Soft	Slight Acid	Very Soft	Slight Alkaline
Loon Lake			Very Soft	Slight Alkaline
Lost Lake(3)			Very Soft	Slight Acid
Lost Lake(4)			Soft	Slight Alkaline

TABLE 3 (Continued)

WATER CHEMISTRY DATA (FROM DNR AND D&M)

NAME	D&M HARDNESS CLASS.	D&M pH CLASS.	DNR HARDNESS CLASS.	DNR pH CLASS.
Lower Post Lake			Med. Hard	Alkaline
Miniwakan Lake			Med. Hard	Slight Alkaline
Mole Lake	Soft	Neutral	Soft	Neutral
Oak Lake	Soft	Neutral to Slight Acid	Very Soft	Slight Acid
Perch Lake(5)			Very Soft	Slight Acid
Perch Lake(6)			Very Soft	Slight Acid
Pickerel Lake			Med. Hard	Alkaline
Rice Lake	Mod. Hard	Neutral	Hard	Alkaline
Rolling Stone Lake	Mod. Hard	Neutral	Med. Hard	Slight Alkaline
Saint John's Lake	Soft	Neutral	Very Soft	Slight Acid
Skunk Lake	Soft	Slight Acid	Very Soft	Acid
Tekakwitha Lake			Very Soft	Acid
Upper Post Lake			Med. Hard	Slight Alkaline
Wabikon Lake			Hard	Alkaline
Walsh Lake	Soft	Neutral	Very Soft	Slight Acid
Wamin Lake			Very Soft	Slight Acid
Agnes Creek			Soft	Slight Alkaline
Gliske Creek			Hard	Slight Alkaline
Hemlock Creek	Mod. Hard	Neutral	Hard	Slight Alkaline
Lily River			Hard	Slight Alkaline
Logan Creek			Hard	Slight Alkaline
Lost Creek(7)			Med. Hard	Neutral
Lost Creek(8)			Very Soft	Slight Acid
Metonga Creek	Mod. Hard	Neutral	Hard	Slight Alkaline
Mud Creek(9)			Soft	Slight Alkaline
Mud Creek(10)			Med. Hard	Slight Acid
Pickerel Creek	Mod. Hard	Neutral	Med. Hard	Slight Alkaline
Pollock Creek			Hard	Slight Alkaline
Spider Creek			Med. Hard	Slight Acid
Spider Creek Flowage			Med. Hard	
Spring Creek			Hard	Alkaline

TABLE 3 (Continued)

WATER CHEMISTRY DATA (FROM DNR AND D&M)

NAME	D&M HARDNESS CLASS.	D&M pH CLASS.	DNR HARDNESS CLASS.	DNR pH CLASS.
Squaw Creek			Med. Hard	Slight Alkaline
Swamp Creek(11)	Mod. Hard	Neutral	Hard	Slight Acid
Swamp Creek(12)	Mod. Hard	Neutral	Med. Hard	Slight Alkaline
West Branch Logan Creek			Hard	Slight Alkaline
Wolf River(13)	Soft	Neutral	Med. Hard	Neutral
Wolf River(14)	Soft	Neutral	Med. Hard	Slight Alkaline

NOTES:
(1) Reference 5 and 6
(2) Reference 3 and 4
(3) Located in Langlade County
(4) Located in Forest County, east of Ground Hemlock Lake
(5) Located east of Anninan Lake
(6) Located east of Miniwakan Lake
(7) Located in Forest County
(8) Located in Langlade County, south of Spider Creek
(9) Located in Langlade, tributary to Wolf River
(10) Located in Langlade, tributary to Lower Post Lake
(11) Located in Langlade County below Rice Lake
(12) Located in Forest County above Rice Lake
(13) Located in Forest County
(14) Located in Langlade County

TABLE 4

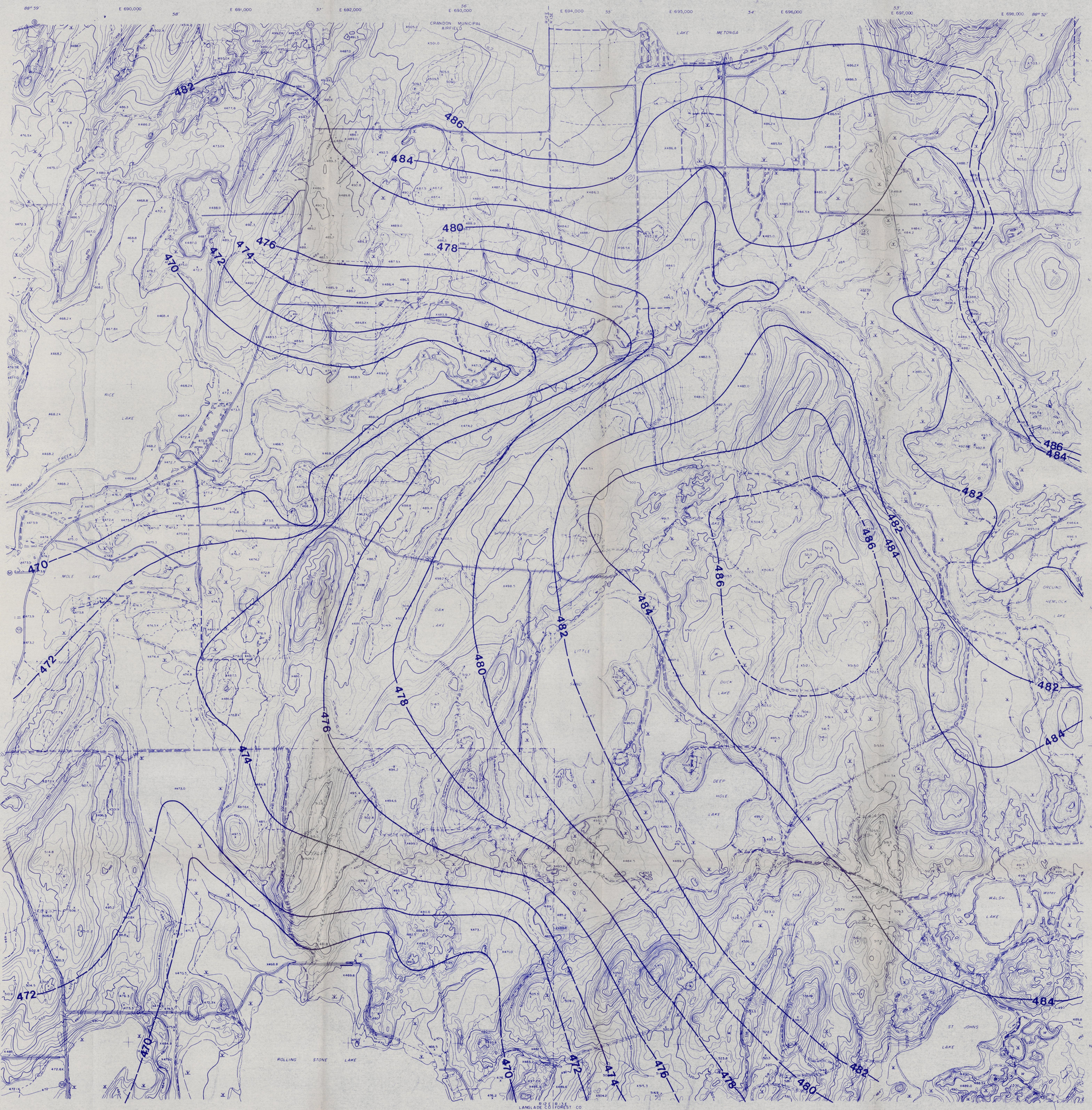
LAKE RELATIONSHIP TO GROUNDWATER SYSTEM

Lake	Relationship	Comments
Duck Lake	Perched	Contains very soft to soft and neutral to acidic water. Wells DMA-4, G41-C15B, and G41-C15 show water about 15 to 20 feet (4.6 to 6.1 m) below the lake surface.
Deep Hole Lake	Perched	Contains very soft to soft and neutral to acidic water. Wells upgradient (DMA-4, DMB-27, etc.) show water about 15 feet (4.6 m) below the lake surface.
Little Sand Lake	Perched	Contains very soft to soft and slightly acidic to slightly alkaline water. Wells located adjacent to the lake (DMP-2, DMP-3, DMA-10) show water levels 6 to 16 feet (1.8 to 4.9 m) below the lake surface.
Oak Lake	Perched	Contains very soft to soft and neutral to slightly acidic water. Wells G40-M15, DMA-15, and DMA-3 show water levels at least 49 to 63 feet (14.9 to 19.2 m) below the lake surface.
Skunk Lake	Perched	Contains very soft to soft and slightly acidic to acidic water. Well DMA-12 shows water about 5 to 10 feet (1.5 to 3.0 m) below the lake surface.
Ground Hemlock Lake	Groundwater	Contains moderately hard to hard and neutral to alkaline water. Well DMC-1 on the bank of the lake shows water about 7 feet (2.1 m) above the lake surface.
Lake Metonga	Groundwater	Contains medium hard and slightly alkaline water. The lake is topographically a valley in the area.

TABLE 4 (Continued)

LAKE RELATIONSHIP TO GROUNDWATER SYSTEM

Lake	Relationship	Comments
Rice Lake	Groundwater	Contains moderately hard to hard and neutral to alkaline water. U.S.G.S. wells show water at or above the level of the lake surface.
Mole Lake	Inconclusive	Contains soft and neutral water. Data inconclusive to determine whether primary recharge is from groundwater or surface water.
Rolling Stone Lake	Groundwater	Contains moderately or medium hard and neutral to slightly alkaline water. Well DMB-24 about 500 feet away (152 m) shows water about 5 feet (1.5 m) below the lake surface.
Pickerel Lake	Groundwater	Contains moderately or medium hard and neutral to alkaline water.
Crane Lake	Groundwater	Contains hard and slightly alkaline water.
St. John's Lake	Perched	Contains very soft to soft and neutral to slightly acidic water. Well DMB-29 located upgradient has water about 1 foot (0.3 m) below the surface.
Walsh Lake	Perched	Contains very soft to soft and neutral to slightly acidic water. Wells located around the lake (DMB-7, DMB-29, DMC-3, G41-P24) show water about 10 to 13 feet (3.0 to 4.0 m) below the lake surface.
Lake Lucerne	Perched	Contains soft and slightly acidic water.
Bishop Lake	Groundwater	Contains medium hard and slightly alkaline water. Surrounding U.S.G.S. wells show water levels near



LEGEND

——— GROUNDWATER ISOPLETHS (contours) IN METERS ABOVE MSL

— — GROUNDWATER ISOPLETHS IN METERS ABOVE MSL, INTERPRETED FROM LIMITED DATA

—·—·— GROUNDWATER ISOPLETH 486 METERS ABOVE MSL AS ESTIMATED EXCLUDING EFFECTS OF JUNE-JULY 1980 PUMP TEST

NOTE

GROUNDWATER CONTOURS INTERPRETED BY GOLDER ASSOCIATES AND DAMES & MOORE BASED ON THE FOLLOWING DATA:

a. GOLDER ASSOCIATES AND DAMES & MOORE OBSERVATION WELL MEASUREMENTS ON SEPT. 10 AND 11, 1980
b. WATER CHEMISTRY DATA FROM D&M AND DNR
c. SURFACE TOPOGRAPHY
d. USGS WELL DATA AND GOLDER WELL DATA FROM DIFFERENT TIME PERIODS

BASE MAP PROVIDED BY EXXON MINERALS COMPANY

250 0 250 500 750 1000
SCALE IN METERS

REVISED	DATE	BY	DESCRIPTION

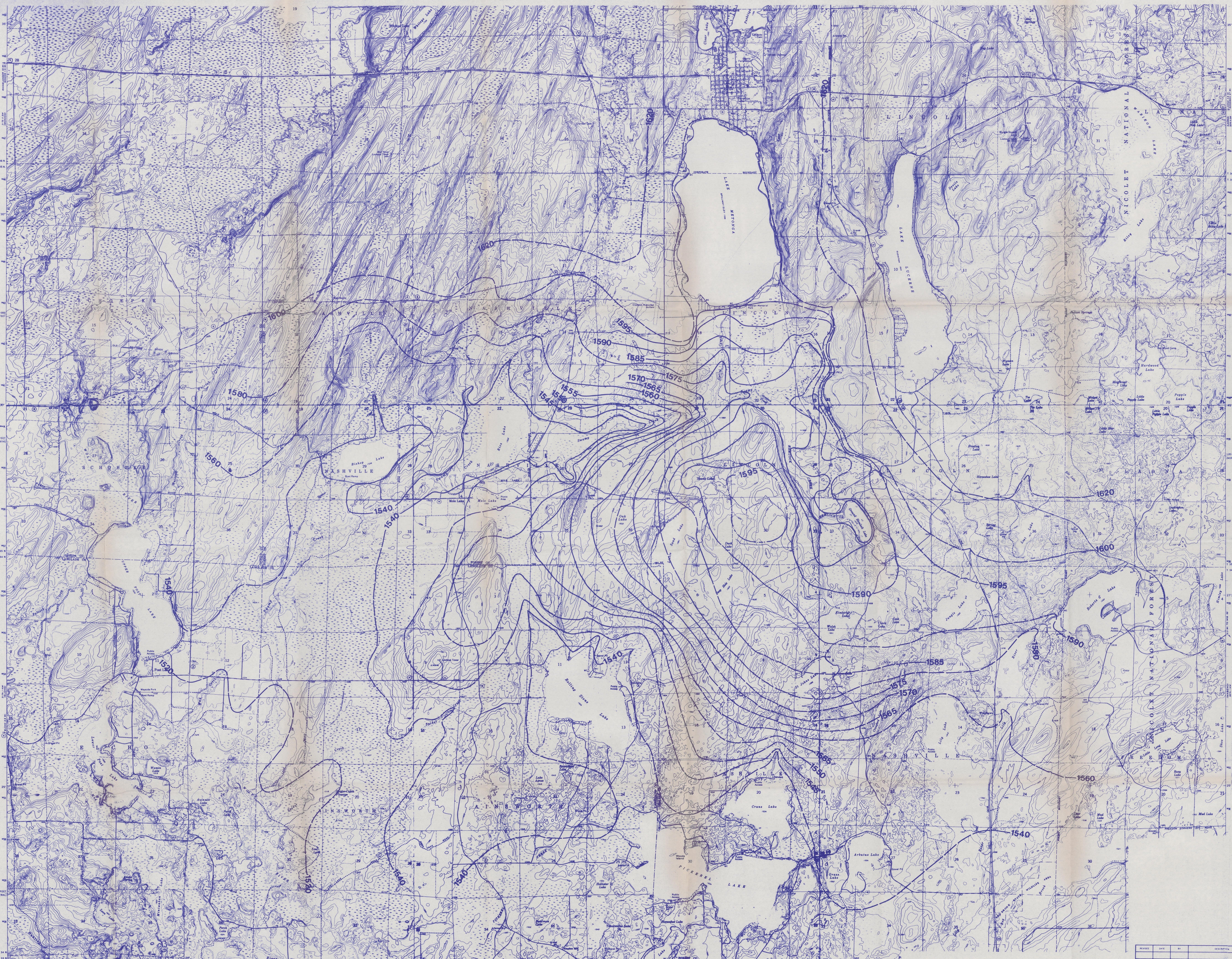
FIGURE

Golder Associates
Atlanta, Georgia

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
GROUNDWATER POTENTIOMETRIC CONTOURS

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST, LANGLADE		
DRAWN BY SKB	DATE 9-2-81	CHECKED BY RMS	DATE 9/4/81		
APPROVED BY GHC	DATE 9/4/81	APPROVED BY	DATE		
APPROVED BY	DATE	EXXON	DATE		
DRAWING NO. 050-1-81111		SHEET — OF —	REVISION NO.		



LEGEND

- GROUNDWATER ISOPLETHS (contours) IN FEET ABOVE MSL
- GROUNDWATER ISOPLETHS IN FEET ABOVE MSL, INTERPRETED FROM LIMITED DATA
- GROUNDWATER ISOPLETHS 1595 FEET ABOVE MSL AS ESTIMATED EXCLUDING EFFECTS OF JUNE-JULY 1980 PUMP TEST

NOTE

GROUNDWATER CONTOURS INTERPRETED BY GOLDER ASSOCIATES AND DAMES & MOORE BASED ON THE FOLLOWING DATA:

a. GOLDER ASSOCIATES AND DAMES & MOORE OBSERVATION WELL MEASUREMENTS ON SEPT. 10 AND 11, 1980
b. WATER CHEMISTRY DATA FROM D&M AND DNR
c. SURFACE TOPOGRAPHY
d. USGS WELL DATA AND GOLDER WELL DATA FROM DIFFERENT TIME PERIODS

WISCONSIN
QUADRANGLE LOCATION

SCALE 1:24 000

BASE MAP REFERENCE:
PORTIONS OF THE FOLLOWING U.S.G.S. 7.5 MIN. QUAD. MAPS.

NASHVILLE, WISCONSIN, 1965
CRANDON, WISCONSIN, 1965
LAKE LUCERNE, WISCONSIN, 1965
POST LAKE, WISCONSIN, 1973
MOLE LAKE, WISCONSIN, 1973
ROBERTS LAKE, WISCONSIN, 1973

REVISED	DATE	BY	DESCRIPTION

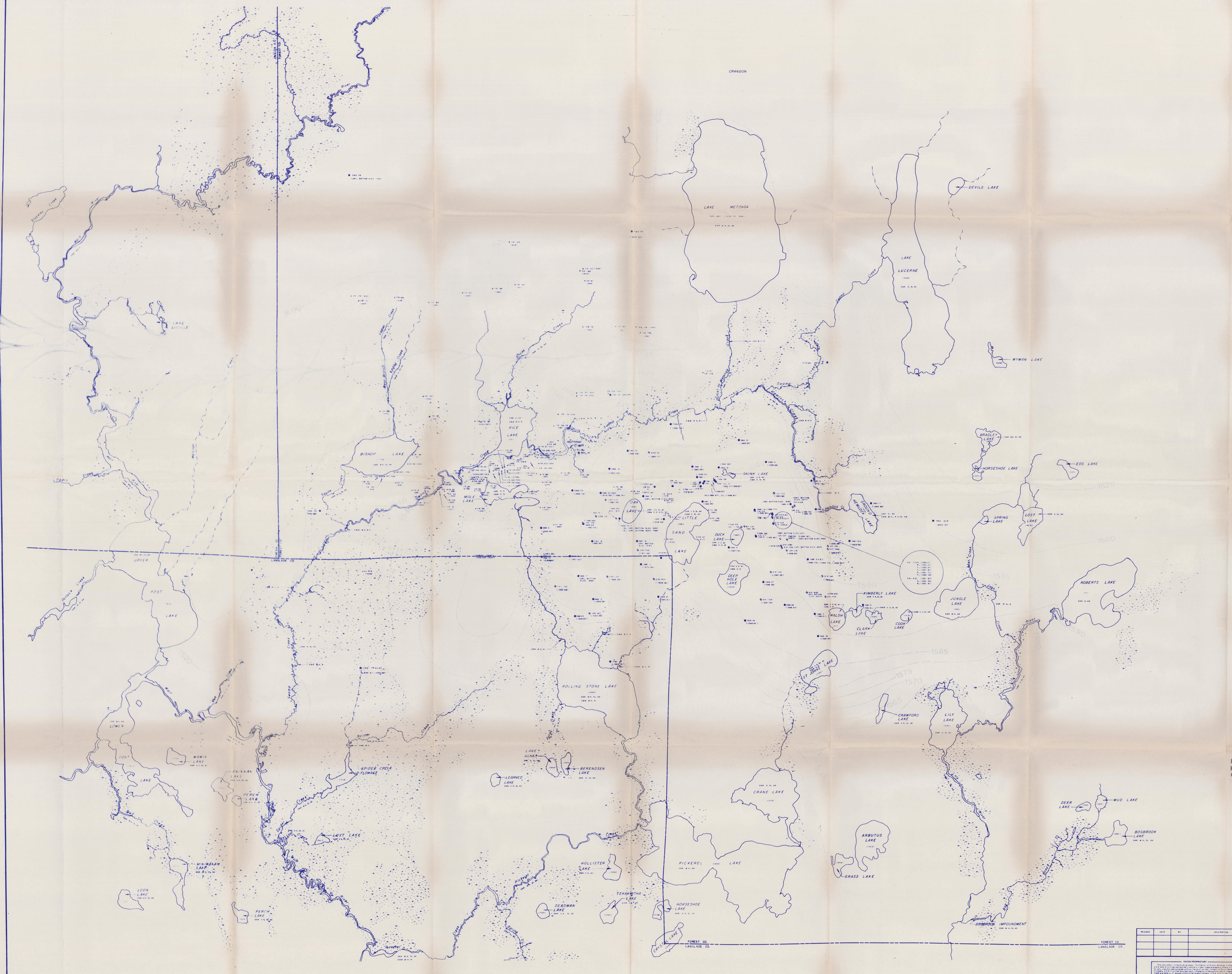
FIGURE 2

Golder Associates
Atlanta, Georgia

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
GROUNDWATER POTENTIOMETRIC CONTOURS

SCALE	STATE	COUNTY	
AS SHOWN	WISCONSIN	FOREST, LANGLADE	
DRAWN BY SKB	DATE 9-2-81	CHECKED BY JFC	DATE 9/8/81
APPROVED BY GHC	DATE 9/8/81	APPROVED BY	DATE
APPROVED BY	DATE	EXXON	DATE
DRAWING NO. 050-1-81112		SHEET OF	REVISION NO.



LEGEND

- ⌖ GOLDER ASSOCIATES BORINGS WITH OBSERVATION WELLS
- ● DAMES & MOORE BORINGS WITH OBSERVATION WELLS
- ▲ PUMP TEST WELL, TW-41
- * USGS WELL DATA LOCATIONS

(1680) WATER SURFACE ELEVATIONS IN FEET ABOVE MSL

DNR: S,M WISCONSIN DNR WATER CHEMISTRY DATA

D&M: H,N DAMES & MOORE WATER CHEMISTRY DATA

WATER CHEMISTRY DATA

V = very	
H = hard	N = neutral
S = soft	SL = slightly
AC = acidic	M = medium or moderately
AK = alkaline	

SURFACE WATER BOUNDARIES (from USGS quadrangle maps)

MAJOR WETLAND AREAS (from USGS quadrangle maps)

GROUNDWATER ISOPLETHS (contours) IN FEET ABOVE MSL

GROUNDWATER ISOPLETHS IN FEET ABOVE MSL, INTERPRETED FROM LIMITED DATA

GROUNDWATER ISOPLETHS 1595 FEET ABOVE MSL AS ESTIMATED EXCLUDING EFFECTS OF JUNE-JULY 1980 PUMP TEST

NOTE

GROUNDWATER CONTOURS INTERPRETED BY GOLDER ASSOCIATES AND DAMES & MOORE BASED ON THE FOLLOWING DATA:

a. GOLDER ASSOCIATES AND DAMES & MOORE OBSERVATION WELL MEASUREMENTS ON SEPT. 10 AND 11, 1980.
b. WATER CHEMISTRY DATA FROM D&M AND DNR
c. SURFACE TOPOGRAPHY
d. USGS WELL DATA AND GOLDER WELL DATA FROM DIFFERENT TIME PERIODS

WISCONSIN
QUADRANGLE LOCATION

BASE MAP REFERENCE:
PORTIONS OF THE FOLLOWING U.S.G.S 7.5 MIN. QUAD. MAPS.

NASHVILLE, WISCONSIN, 1965
CRANDON, WISCONSIN, 1965
LAKE LUCERNE, WISCONSIN, 1965
POST LAKE, WISCONSIN, 1973
MOLE LAKE, WISCONSIN, 1973
ROBERTS LAKE, WISCONSIN, 1973

FIGURE 3

Golder Associates
Atlanta, Georgia

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: DATA POINTS FOR GROUNDWATER POTENTIOMETRIC CONTOURS

SCALE: AS SHOWN	STATE: WISCONSIN	COUNTY: FOREST, LANGLADE
DRAWN BY: SKB	DATE: 9-2-81	CHECKED BY: JFC — DATE: 9/8/81
APPROVED BY: GAC	DATE: 9/8/81	APPROVED BY: — DATE:
APPROVED BY:	DATE:	EXXON — DATE:
DRAWING NO: 050-.1-81113	SHEET ___ OF ___	REVISION NO

REVISED	DATE	BY	DESCRIPTION