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For additional information write to:

Office of the District Chief
Water Resources Division
U.S. Geological Survey
6520 Mercantile Way, Suite 5
Lansing, Michigan 48910
INTRODUCTION

Washtenaw County, an area of 723 square miles, is in the southeastern part of Michigan’s Southern Peninsula, adjacent to Detroit. Rapid urban and industrial growth in the county has made land-use and water-use planning essential if geologic and hydrologic resources are to be developed wisely. Available land for such activities as sanitary-landfill operations, municipal water supplies and waste-water treatment, sand and gravel development, and recreation is diminishing. Prospects for increased oil and gas production and development of peat and clay resources may complicate land-use practices. An understanding of the geologic and hydrologic characteristics and their relation to the development of the county’s resources is thus necessary.

Purpose and Scope

The purpose of this study is to provide geologic and hydrologic data for environmental land-use planning in Washtenaw County. Drillers’ well records and results of other investigations, including a 1976 investigation by the U.S. Geological Survey (Twenter, F. R., Knutilla, R. L., and Nowlin, J. O., 1976), were the principal sources of data for this study. These data were used to define the thickness and permeability of surficial deposits, location and types of bedrock deposits, altitude of bedrock surface, and location of selected mineral resources. The data were also used to define groundwater levels, availability of water from surficial and bedrock deposits, and the thickness of relatively impermeable deposits. Maps showing each of these geologic and hydrologic characteristics are included in the report; maps showing surface-water bodies and oil and gas pipe lines are also included because of their significance in land-use planning.

ABSTRACT

Washtenaw County is underlain by glacial deposits that range in thickness from about 50 feet to about 450 feet. Underlying the glacial deposits are sedimentary rocks of Mississippian and Devonian age. The youngest of these rocks are the sandstones of the Marshall Formation in the western part of the county; the oldest are the limestones of the Detroit River Group in the southeast corner.

Sand and gravel deposits in some places in the county may yield more than 500 gallons per minute of water. Approximately 50 percent of the wells tapping the Marshall Formation, the most reliable bedrock aquifer, can yield as much as 60 gallons per minute.

Washtenaw County has sand and gravel deposits that are more than 50 feet thick. The deposits are mined in several areas and are of economic importance. In addition, there may be potential for peat production in the western part of the county and for clay production in the eastern part.
PHYSICAL SETTING

Altitude of Land Surface

Altitude of land surface ranges from about 1,100 feet above mean sea level in the western part of Washtenaw County, to about 650 feet in the southeastern part. The northwestern part is hilly and has numerous lakes and wetlands. Southeast of Ann Arbor, the altitude of the land surface decreases as the undulating moraines terminate and lakebed area begins. Between these two topographically different areas, local steepening of the land surface marks the shoreline of former glacial lakes.

GEOLOGIC SETTING

Rocks in Washtenaw County can be separated into two major categories: unconsolidated glacial deposits and bedrock. The bedrock, which underlies the glacial deposits, is composed of sedimentary rocks, 4,000 to 7,000 feet thick, and Precambrian igneous and metamorphic rocks (fig. 6). The sedimentary rocks, of Cambrian, Ordovician, Silurian, Devonian, and Mississippian age, dip to the northwest at about 50 feet per mile.
Glacial Deposits

Glacial deposits consist of lakebeds, outwash, deltas, and moraines. Lakebeds, composed primarily of clay and silt that 15 overlain by a thin layer of sand, predominate in the southeastern part of the county. Elsewhere in the county, moraines and outwash predominate. Moraines are composed of clay, silt, sand, and gravel mixtures. Outwash is principally sand and gravel.

The thickness of glacial deposits ranges from 50 feet to 450 feet. In the central and northeastern parts of the county, the deposits are more than 250 feet thick; in the northwestern part and in small areas to the southeast they are generally less than 100 feet thick.

Permeability of Soils and Glacial Deposits

Soils and glacial deposits having a relatively high permeability lie in a northeast-southwest belt through the central and southeastern parts of the county. At other locations, soils and glacial deposits generally have a low to intermediate permeability. Permeabilities shown are based on a soils map (Veatch and others, 1930) and on unpublished data from the files of the U.S. Geological Survey.

Bedrock

Bedrock ranges in age from Mississippian to Precambrian; average thickness and other characteristics are given in table 1.

Table 1. Stratigraphic succession of Paleozoic rocks

<table>
<thead>
<tr>
<th>Age</th>
<th>Group</th>
<th>Sandstone</th>
<th>shale, sandstone, or gravel</th>
<th>bedrock aquifer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mississippian</td>
<td>Siltstone</td>
<td>Shale, sandstone</td>
<td>shale, sandstone, or gravel</td>
<td>bedrock aquifer</td>
</tr>
<tr>
<td>Carboniferous</td>
<td>Shale</td>
<td>Sandstone</td>
<td>shale, sandstone, or gravel</td>
<td>bedrock aquifer</td>
</tr>
<tr>
<td>Ordovician</td>
<td>Limestone</td>
<td>Conglomerate</td>
<td>sandstone, or gravel</td>
<td>bedrock aquifer</td>
</tr>
<tr>
<td>Silurian</td>
<td>shale</td>
<td>Sandstone</td>
<td>shale, sandstone, or gravel</td>
<td>bedrock aquifer</td>
</tr>
<tr>
<td>Devonian</td>
<td>Sandstone</td>
<td>Sandstone</td>
<td>shale, sandstone, or gravel</td>
<td>bedrock aquifer</td>
</tr>
<tr>
<td>Permian</td>
<td>Sandstone</td>
<td>Sandstone</td>
<td>shale, sandstone, or gravel</td>
<td>bedrock aquifer</td>
</tr>
<tr>
<td>Triassic</td>
<td>Sandstone</td>
<td>Sandstone</td>
<td>shale, sandstone, or gravel</td>
<td>bedrock aquifer</td>
</tr>
<tr>
<td>Jurassic</td>
<td>Sandstone</td>
<td>Sandstone</td>
<td>shale, sandstone, or gravel</td>
<td>bedrock aquifer</td>
</tr>
<tr>
<td>Cretaceous</td>
<td>Sandstone</td>
<td>Sandstone</td>
<td>shale, sandstone, or gravel</td>
<td>bedrock aquifer</td>
</tr>
<tr>
<td>Tertiary</td>
<td>Sandstone</td>
<td>Sandstone</td>
<td>shale, sandstone, or gravel</td>
<td>bedrock aquifer</td>
</tr>
<tr>
<td>Quaternary</td>
<td>Sandstone</td>
<td>Sandstone</td>
<td>shale, sandstone, or gravel</td>
<td>bedrock aquifer</td>
</tr>
</tbody>
</table>

Throughout most of the county, shale underlies the glacial deposits, except in the western part where it is underlain by sandstone, and in the southeastern part, where it is underlain by limestone (fig. 10). The Marshall Formation, which underlies glacial deposits along the west edge of the county, is the most productive bedrock aquifer. Most wells tapping it yield as much as 60 gpm (gallons per minute). The Coldwater Shale, which subcrops throughout the central two-thirds, is relatively impermeable. It is more than 1,000 feet thick in the western part, but it gradually thins to the southeast. The Sunbury Shale, Berea Sandstone, Bedford Shale, and Antrim Shale underlie the Coldwater Shale. Limestones
of the Traverse Group, Dundee Limestone, and Detroit River Group underlie these rocks.

Figure 10.—Bedrock.

Configuration of Bedrock Surface
The configuration of the bedrock surface indicates the general drainage pattern before glaciation. The altitude of the bedrock surface in Washtenaw County ranges from 900 feet above mean sea level in the western part to about 600 feet in the eastern part; it is less than 350 feet in the northeastern part. The bedrock surface was generally drained southeastward, and the major drains were in the south and southeastern parts.

Figure 11.—Configuration of bedrock surface.

GROUND-WATER RESOURCES
Approximately 20 percent (6 inches) of the average annual precipitation in Washtenaw County infiltrates glacial deposits and recharges aquifers. On reaching the water table, the water moves downgradient (fig. 12) and discharges into streams or flows out of the county as underflow. Ground-water discharge to streams maintains streamflow during dry periods.

The availability of water in glacial deposits is shown in figure 13. Generally, water-table conditions prevail in shallow aquifers and artesian conditions in deep aquifers. In most places, 50 feet of saturated thickness is available for drawdown and a properly developed well can theoretically yield is much as 500 gpm (figs. 8 and 12).

In other areas in Michigan, large supplies of ground water have been located in buried stream valleys (valleys in the bedrock surface). Several buried stream valleys are shown in figure 11. These valleys may merit investigation to determine their potential for development of ground water.

Figure 12.—Altitude of water table.

Water Table
The water table is the surface of the saturated zone. In Washtenaw County, the altitude of the water table is generally highest in the western and northern parts, and lowest in the southeastern part. Locally, water in the saturated zone moves toward major streams; overall movement is south and southeast.

Water Availability in Glacial Deposits
Favorable areas for development of large supplies of ground water occur throughout the county. The most favorable areas are near Ann Arbor and Ypsilanti and southwest of Manchester. Much of the southeastern part of the county and small isolated areas elsewhere are not favorable for development of large supplies; in places yields may be inadequate even for a domestic supply. Water in the glacial deposits occurs under both artesian and water-table conditions.

Confining Beds
In many areas, aquifers may be overlain by confining beds of relatively impermeable clay or till. Except in scattered areas, confining beds in most of the central part of the county are at land surface. In the western part and in the southeastern corner, confining beds are below land surface.

Confining beds may be as thick as 200 feet; average thickness is 50 to 100 feet. Beds in most of the county are at least 20 feet thick.
Water Availability in Bedrock

Water under artesian conditions is available from bedrock. On the basis of hydrologic properties, bedrock is separated into three areas, as shown in figure 15. Figure 16 shows the probability of obtaining a given yield from each area. The sandstone in area A is likely to yield sufficient quantities of water for domestic supplies and may yield supplies adequate for small municipalities and industries. Areas B and C have less potential. Area 

B is generally capable of yielding supplies adequate for domestic purposes; in places, area C may not supply enough water even for these needs.

Bedrock wells are sparse in a broad belt extending from the northeastern part of the county to the southwest corner. This area coincides with some of the thickest glacial deposits in the county (fig. 8). Because of the great thickness of glacial deposits, drilling to a potentially productive bedrock aquifer is generally unnecessary.

Oil, Gas, and Sand and Gravel

Oil, gas, and sand and gravel are economically important in Washtenaw County. The location of oil and gas fields and gravel pits are shown on figure 17. Also, shown on this figure are the locations of clay and peat deposits. At present, clay and peat are not mined, although the potential exists. Clay for pottery, brick, tile, and light-weight aggregate has been mined in neighboring Wayne and Monroe Counties. In the past, some peat was mined near Salem in the northeastern part of the county (deposits are small and not shown on figure 17).
The areal distribution and approximate thickness of potentially valuable sand and gravel deposits are shown on figure 18. Other sand and gravel deposits may lie at shallow depths in other places.

Certain types of geologic structures are required for the accumulation of oil and gas. A typical structure is an anticline in the northeastern part of Washtenaw County and in adjacent Wayne, Oakland, and Livingston counties; the Northville oil and gas field is on this anticline (fig. 20). Production is from the Dundee Formation and Niagara, Trenton, and Black River Groups (table 1). The Northville field is only one of many fields associated with this anticlinal structure.

A series of parallel anticlines is oriented northwest to southeast across Washtenaw County (fig. 20). Associated with these anticlines are the Lyndon, Freedom, and Clinton oil and gas fields. Known oil and gas deposits in these fields occur in rocks older than the Traverse Group.

In developing land for mineral resources or waste disposal, consideration is generally given to power lines, pipe lines, and housing complexes. Pipe lines, because they are buried, are not always considered. Locations of the larger oil and gas pipe lines in Washtenaw County are shown in figure 21.

In irony areas in the western part of the county, peat has been produced, and further production is possible.

**Areal Distribution of Resources**

Sand and gravel deposits have been mined in many areas throughout the county. Oil and gas have been obtained from the Lyndon, Freedom, Clinton, and Northville fields.

**Sand and Gravel Resources**

Sand and gravel deposits occur in large areas along the west edge and in the southeast corner of the county and in scattered, smaller areas elsewhere (fig. 18). Many of these deposits have been mined in the past.

In addition to the mineral value of sand and gravel, these deposits are generally areas of recharge to underlying aquifers.
Buried Oil and Gas Pipe Lines

Buried gas pipe lines radiate from two compressor stations, and crisscross the county. Three buried oil pipe lines cross the county.

Figure 21.--Location of oil and gas pipe lines (Michigan Public Service Commission, 1970: Consumers Power Company, 1971).

SELECTED REFERENCES

Consumers Power Company, 1971, Michigan major gas pipe lines and franchise map, Jackson, Michigan, 1 sheet.


Michigan State Highway Department, 1959, Gravel pit inventory, Lower Peninsula, 370 p.


