3. Geology of the Olentangy River Watershed

The bedrock and glacial geology of the Olentangy River Watershed controls to a great extent many of the physical aspects of the river and its tributary streams. Geologically, the watershed can be divided into three distinct areas: the Upper Geological Region consisting of Richland, Crawford, Morrow, Marion, and northern Delaware counties; the Middle Geological Region in southern Delaware County; and the Lower Geological Region in northern Franklin County. The river develops a different character in each of these three regions, owing these differences to somewhat different geological settings in the three areas.

Bedrock Geology in the Watershed

Bedrock in central Ohio consists of discrete layers of sedimentary rock (limestone, shale, sandstone) that can be distinguished on the basis of their characteristic physical features and which are termed formations. Bedrock across central Ohio is influenced by the effects of the Cincinnati-Findlay Arch system, a structural high whose axis trends roughly north-south across western Ohio, west of the central Ohio region. This causes the bedrock layers in central Ohio to slope at an angle of 26 degrees to the east and southeast, away from the axis of the arch (Figure 3-1). These eastward-dipping formations have been beveled and truncated by subsequent glaciation, which causes these bedrock layers to be arranged at the surface in broad, roughly north-south trending bands with the oldest formations to the west and the youngest formations to the east. These formations vary as to their physical and chemical characteristics, especially with regard to their hardness, resistance to erosion, and ability to store underground water. These formations, arranged in stratigraphic order from the youngest to the oldest, are listed and described in Table 1.

The parallel north-south trends of the Scioto River, the Olentangy River, Alum Creek, and Big Walnut Creek appear to be related to the surficial configurations of the bedrock formations, with the trend of the stream channels paralleling the strike of the bedrock formations. The stream channels appear to be incised where weaker, less-resistant rock layers intersect the ground surface at a low angle (Figure 3-1).

Figure 3-1: Bedrock Geology of Central Ohio - A section of the bedrock along a line drawn through Columbus from west to east. (Source: Geological Survey of Ohio.)
Glacial Geology in the Watershed

A series of continental glaciers caused large masses of ice up to 1,000 feet thick to rumble repeatedly across central Ohio, starting nearly two million years ago and melting and retreating from this portion of the state roughly 14,000 years ago. These glacial events functioned both as bulldozers - beveling, scraping, and eroding rocks and soils from the surface, and as dump trucks - dumping large quantities of clay, sand, gravel, and cobbles. This filled in low areas and left linear hills of glacial materials termed end moraines that mark the leading edges of individual ice sheets as they retreated northward from Ohio.

Glacial ice in central Ohio was part of a broad, southward-trending body of ice termed the Scioto Lobe that extended from the Lake Erie Basin to Northern Pike County. The advance of this broad lobe of ice southward followed pre-existing valleys that now comprise the Scioto River Basin. As the ice sheets advanced across the region, the crushing weight of the ice eroded and planed off the pre-glacial bedrock surface, resulting in a flat, level peneplain surface at an elevation of roughly 1,000 feet above mean sea level across most of central Ohio (Westgate, 1926). The irregular stopping, retreat, and melting of the Wisconsinan ice front between 18,000 and 14,000 years ago led to the deposition of variable thicknesses of poorly-sorted, clay-rich glacial soil termed glacial till, deposited either as smooth-surfaced, level ground moraine deposits or in a number of linear, elevated, broadly-arching end moraines across the central Ohio area (Goldthwait et al., 1965). The latter include: the Powell End Moraine trending roughly west to east across southern Delaware County and intersecting the river near High Banks Metro Park; the Broadway End Moraine which trends west to east just north of the city of Delaware and which forms the natural setting for the Delaware Dam, which dams the Olentangy River to form Delaware Lake in northern Delaware County; and the St. John's End Moraine which trends from the southwest to the northeast across central Marion County and into central Crawford County (Figure 3-2). These end moraines rise 50 to 60 feet above the surrounding till plains and are typically one to two miles wide.

Soils across the bulk of the watershed consist primarily of clay-rich, high-lime glacial drift soils (Blount-Pewamo Soils) formed from the fine-grained glacial tills characteristic of the region. The Upper Olentangy River Sub-basin is part of the “Clayey High-Lime Till Plains Ecoregion” (#55a) characterized by clay-rich, low-permeability soils. The Lower Olentangy River Sub-basin, especially in Franklin County, is within the "Loamy High-Lime Till Plains Ecoregion" (#55b) and its soils are somewhat sandier and more permeable. Both soil types tend to be poorly drained due to the level topography across much of the watershed and the high percentage of clay in these soils. However, these soils have moderate to high natural fertility due to the moderate to high lime content of the soils. These fertile soils are the basis for the current agricultural land use that constitutes the bulk of the economies in many central Ohio counties, especially those in the Upper Olentangy River Sub-basin.

The soils in the lower part of the Olentangy watershed exhibit two general trends. The first is that moving from east to west, the pH of the soils increases because of the higher content of limestone rock fragments in the glacial till west of the river itself. As a result, the soils are generally more productive for cropland and for agriculture in general in the western half of
Figure 3-2: End Moraines in the Olentangy Watershed
In terms of soil series, the eastern part of the watershed is best characterized by Bennington, Cardington, and Pewamo soils. The western part of the watershed is best characterized by Blount, Pewamo, and Glynwood soils. The better drained Cardington and Glynwood soils are more common in sloping areas, and Blount, Bennington, and Pewamo are more common in less sloping areas. In Franklin County, the soils west of the River are formed in less clayey glacial till, and they are best characterized by the Crosby and Celina soils on broad areas of less sloping soils and by the Miamian and Celina soils on the sloping areas. The general pattern is evident on the Soil Regions of Ohio map published by ODNR in 1996. According to the OSU Extension Bulletin 896 “Suitability of Ohio Soils for Treating Wastewater” the Celina and Miamian soils are suited for mound systems only. The Bennington, Blount, Cardington, Crosby and Glynwood soils are not suited for soil-based wastewater treatment, but may be suited for irrigation of treated wastewater. Pewamo soils are wet, seasonally saturated (hydric) and are not suited to onsite wastewater treatment.

The melting of the glacial ice produced large volumes of meltwater whose often catastrophic release carved new stream channels and/or exploited old bedrock valleys, taking the path of least resistance across the new glacial landscape, re-routing post-glacial stream flow in central Ohio to the south to the Ohio River. These meltwater flows also reworked the sediments deposited by the glaciers and flushed these downstream of the retreating ice front. Stream currents moved variably-sorted accumulations of sand, gravel, and cobbles downstream where they were spread across the floodplains and often back-filled stream valleys forming locally thick deposits of glacial outwash. Outwash deposits in central Ohio are typically important aquifers – sources of underground water supplies.

Upper Geological Region (“Farmland River”)

The Upper Geological Region corresponds to the Upper Olentangy River Sub-basin, from the river’s source east of Galion in Richland County, to the confluence with Delaware Run at the city of Delaware in Delaware County. This region includes portions of Richland, Crawford, Marion, Morrow, and Delaware counties.

This section of the Olentangy River has a “youthful” stream configuration, flowing across a young glacial landscape of level till plains over peneplaned bedrock. The river channel is shallowly entrenched, at most 20-30 feet below the level of the till plain. Glacial cover is 50-60 feet thick in northern Marion County, thinning to 30-40 feet of glacial till at the Marion-Delaware County line (Crowell, 1979; ODNR well logs). The entire area is currently agricultural with most of the region in row crops, either corn or soybeans.

The Olentangy River has its start at the confluence of several small streams just east of Galion (elevation = 1,189 feet above sea level) in westernmost Richland County. The drainage divide that separates the Olentangy Watershed and the adjacent Mohican River.
Watershed comprises a distance of only about 1,000 feet. The fledgling Olentangy River initially flows a short distance to the northwest of Galion until it meets the SW-NE trending St. John’s End Moraine where it is deflected to the southwest, paralleling the trend of the moraine (Figure 3-2). The river continues to flow to the south-southwest across level to gently rolling portions of eastern Marion County and into northern Delaware County (3-3).
The river across much of this latter region is highly sinuous with a relatively low stream gradient of 4.7 feet per mile (Westgate, 1926).

The river is dammed at the point where it intersects the W-E trending Broadway End Moraine, several miles north of Delaware. The dammed portion of the river forms Delaware Lake, a sinuous, rather narrow body of water that extends five miles to the north of the dam to the Marion-Delaware County line (Figure 3-4). Whetstone Creek, a major southwest-flowing tributary of the Olentangy River (watershed area = 114 square miles), joins the river near the upper end of the lake (Figure 2-2). The river was dammed and the lake formed primarily for flood-control in 1948. Flow out of the lake is controlled by the U.S. Army Corps of Engineers. At summer pool, the level of the lake is at 915 feet above sea level with a storage capacity of 13,024 acre-feet of water. Flow out of the lake at the dam is highly variable depending on rainfall events, with minimum outflows averaging from 5 cubic feet per second from November through July to 27.5 cubic feet per second from July through October (US ACOE, pers. comm., 2000).

Middle Geological Region (“Scenic River”)

The Middle Geological Region includes the stretch of the Olentangy River from the Delaware Dam north of the city of Delaware downstream to the Delaware-Franklin County line. This is the 22-mile State Scenic section of the Olentangy River. It is quite distinct in most of its physical aspects from the Upper Geological Region. This section of the Olentangy flows in a narrow, deeply-incised, pre-Wisconsinan “Deep Stage” bedrock valley (Stout, Steeg, and Lamb, 1943) with an average stream gradient of 8 feet per mile (Westgate, 1926). The course of the river follows a nearly straight north-south trend, flowing in a narrow valley rarely exceeding ¼ of a mile in width. The width of the river channel along this stretch averages from 40 to 50 feet across. This narrow river valley is nestled between rising cliffs carved into the Olentangy and Ohio Shale formations, with vistas overlooking the river at heights in excess of 100 feet at High Banks Metro Park near the Delaware-Franklin county line (Figure 3-5).
The bedrock flanks of the river are higher and steeper along the east bank of the river, leading to the development of short, nearly straight tributary streams like Weisner Run and Deep Run with very high gradients (up to 173 feet per mile). The somewhat more gentle slopes of the west bank, developed largely in the less resistant Olentangy Shale, allow for the formation of lengthier tributaries (Bartholomew Run) with lower gradients (50 feet per mile). Ephemeral springs often flow from the valley walls following rainfall events, marking the contact of the hard, fractured Ohio Shale with the soft, impermeable clays of the Olentangy Shale.

In the vicinity of the city of Delaware (elev. = 850 feet), the river flows on the bedrock of the Delaware Limestone with only a thin veneer of unconsolidated alluvial sand, gravel and cobble. At least five low-head dams impede the flow of the river in this same area as it skirts the eastern edge of the city. The river continues to flow on the bedrock of the Delaware Limestone formation from the U.S. Rt. 23 bridge (elev. = 825 feet) south and downstream to the vicinity of the Home Road bridge in Liberty Township (elev. = 780 feet).

Below the Home Road Bridge, the Olentangy River flows on an increasing thickness of alluvial fill flooring the flood plain. Upstream and downstream of the West Orange Road bridge (elev. = 770 feet), the river runs on sand, gravel, and cobbles, most of which are derived from the local bedrock. Downstream of the Powell Road bridge at the High Banks Metro Park (elev. = 765 feet), the river bottom consists of alluvial sand, gravel, and cobbles, derived from native bedrock and also contains a greater number of glacial erratics, quartzites and gneiss whose origins are far to the north in southern Ontario. These kinds of sediments continue to floor the Olentangy’s channel as it flows past the mouth of Bartholomew Run (elev. = 765 feet) and the scenic overlook at High Banks Metro Park (elev. = 870 feet). Below the High Banks overlook, the channel of the river (elev. = 760 feet) is also littered with broken remains of large spherical concretions weathering out of the cliffs cut in the Ohio Shale (Figure 3-6).
Below the mouth of Bartholomew Run, the western bank of the river broadens into a wide floodplain nearly ½ mile in width with the river curving broadly to the east. This former agricultural field is now the site of the Olentangy Environmental Control Center (OECC), a Delaware County wastewater treatment plant. The shale cliffs to the east generate large quantities of weathered and eroded shale chips which wash into the river and floor most of the river's channel from the effluent outflow of the OECC to the northern edge of the village of Mount Air, just below the Delaware-Franklin County line.

**Lower Geological Region (“Urban River”)**

The Lower Geological Region extends from just below the Delaware-Franklin county line to the confluence of the Olentangy River with the Scioto River near downtown Columbus. The river along this stretch runs in the same pre-Wisconsinan “Deep Stage” bedrock valley as it did in the Middle Geological Region. This portion of the valley, however, is broader and deeper and has been back-filled with silty alluvium and glacial outwash sand and gravel to depths as great as 120 feet below the ground surface (House et al., 1997). The thickness of the outwash valley fill increases downstream towards the mouth of the river, ranging from a thickness of 40 feet at Mt. Air to 70 feet thick in Clintonville to thicknesses in excess of 100 feet below the Ohio State University campus in Columbus (ODNR well logs). Public drinking water supplies in Mt. Air and Worthington Hills are from wells 40 to 55 feet deep that are screened in these glacial outwash deposits (Ohio EPA, pers. comm., 2001). The valley also broadens as it deepens downstream, from roughly ½ mile in width in the vicinity of Mt. Air to greater than a mile wide in the vicinity of the OSU campus. The width of the river’s channel also broadens with portions of the river near the OSU campus locally up to 100 feet across. The gradient along this portion of the river is about 3.7 feet per mile. Along this stretch of the river, extensive urban development impinges on the river’s floodplain from I-270 all the way to the confluence with the Scioto (Figure 3-7).

The Olentangy River follows a more natural course from Mount Air to the I-270 Bridge and between River Lea and the West North Broadway bridge in Clintonville. In these areas, the river shows a tendency to develop broad meanders and complex in-stream habitat – the development of bars, islands, extensive shallow riffle zones, runs, flats, and small pools – flanked by a variably developed, forested riparian corridor (Figure 3-8). Throughout these stretches, the river flows on a substrate of sand, gravel, and cobbles.

Elsewhere in the Lower Geological Region, the Olentangy has been extensively modified through channelization and the installation of low-head dams. This is particularly true of those portions of the river to the north of the State Rt. 161 Bridge in Worthington, and to the south in the vicinity of the OSU campus in Columbus. In late 1960s, the river's channel in the Worthington area (elevation =743 feet) was moved 1,000 feet to the east and straightened to make way for the interchange between State Rt. 315 and the I-270 outerbelt. Five man-made riprap dams were placed across the river’s straightened channel, evidently to give the channelized river a more natural look and possibly to provide better habitat for fish. However, good in-stream habitat is still limited along this portion of the river, even 30 years after its realignment.
The Olentangy River has more low-head dams than any other stream in Franklin County (MORPC, 1997). Two low-head dams are present in the Worthington area, south of the State Rt. 161 bridge: one less than ½ mile downstream of the Rt. 161 bridge and the other just below the mouth of Rush Run. Three additional dams occur within a one-mile stretch of the river between the West North Broadway and Dodridge Street bridges (Figures 3-9, 3-10). In the vicinity of the OSU campus, north of the 5th Avenue Bridge, the river has been dammed up behind an 8-foot high concrete low-head dam (Figure 3-11). This causes the river at OSU to become more of a lake, consisting of a broad, stagnant pool extending from the dam upstream to the Dodridge Street Bridge. This stretch of the river is floor with muck, silt, and clay with locally abundant aquatic vegetation. More natural in-stream habitat, including riffles on gravel substrates, returns below the 5th Avenue dam and downstream to the 3rd Avenue Bridge.

Downstream of the 3rd Avenue Bridge and to the confluence with the Scioto River, the Olentangy is constrained within its channel by steep banks (Figure 3-12). Diverse in-stream habitat is variably developed with limited bars and riffle areas between the 3rd Avenue Bridge and the confluence (elevation = 702 feet). This portion of the river has historically been degraded due to discharges of toxic chemicals from nearby industrial facilities and untreated sewage from old combined sewer outflows. More recently this portion of the river has been impacted by the on-going construction of the Spring-Sandusky interchange off of State Rt. 315.
Figure 3-7: Urban Encroachment in the Olentangy Watershed in Franklin County. Aerial Photography from Franklin County. The red line overlay indicates the watershed boundary.
In the Lower Geological Region, the cliffs in the Ohio Shale are reduced in elevation and assume a more gradual slope to the east of the river. Bedrock is locally exposed east of the I-270/State Rt. 315 interchange, at Olentangy River Park off of Wilson Bridge Road, and in a number of ravines carved by west- or southwest-flowing tributary streams (Figure 3-13). These include: Potter’s Run, Rush Run, and Bill Moose Run in Worthington; Adena Brook, east of Whetstone Park; Walhalla Hollow in Clintonville; and Glen Echo and Iuka Ravines in the vicinity of the OSU campus. Shale bedrock is also exposed on the west bank of the Olentangy River near Linworth in highland areas dissected by tributary streams north and south of I-270. Shale exposures largely disappear from the west bank south of the State Rt 161 Bridge. Gradients of tributary streams in Franklin County remain high with proximal portions of Turkey Run having a gradient of 55 feet per mile and Adena Brook having a gradient of 83 feet per mile. Ravine areas on both sides of the river are largely suburban or urban, serving as scenic backdrops for a number of housing developments with homes often built right on the edges of the ravines (Figure 3-14).

Figure 3-8: The Olentangy River in the Vicinity of the Henderson Rd. Bridge and Whetstone Park.
Figure 3-9: Lowhead Dam on the Olentangy River below North Broadway Bridge

Figure 3-10: Lowhead Dam on the Olentangy River at Dodridge Rd. Bridge
Figure 3-11: Fifth Avenue Dam and Impounded River at The Ohio State University Campus

Figure 3-12: The Olentangy River below the Third Avenue Bridge
Figure 3-13 Ravines in the Lower Olentangy Watershed
Figure 3-14: Aerial Photograph of Bill Moose Run at its Confluence with the Olentangy River. USGS 1994. The blue line highlights the stream bed.
<table>
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<th>Formation</th>
<th>Description</th>
<th>Outcrop Area</th>
<th>Groundwater Resources</th>
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<tr>
<td>Mississippian Formations</td>
<td>Soft gray clay shale, resistant massive-bedded sandstone, and black shale overlain by over 100 feet of interbedded gray sandy shales and thin sandstones.</td>
<td>Exposed primarily in the Big Walnut Creek valley in eastern Franklin and Delaware counties and near the source of the Olentangy in Crawford and western Richland counties</td>
<td>Thicker sandstone units (Berea and Black Hand Sandstones) locally productive aquifers; thin sandstone layers, shales, and clays poor sources of groundwater.</td>
</tr>
<tr>
<td>Ohio Shale</td>
<td>In excess of 600 feet of hard, brittle, fissile black or brown shale, locally with beds of large (up to 6 ft across) spherical “cannonball” concretions.</td>
<td>Best exposed in ravines and bluffs along the Olentangy River in Franklin and southern Delaware counties.</td>
<td>Poor source of groundwater due to low permeability. Surface water may infiltrate into bedrock along fracture zones and result in springs at contact with underlying Olentangy Shale.</td>
</tr>
<tr>
<td>Olentangy Shale</td>
<td>30-35 feet of soft, easily-eroded, blue clay shale and interbedded calcareous shale</td>
<td>Best exposed in ravines and bluffs along the Olentangy River in Franklin and southern Delaware counties.</td>
<td>Poor source of groundwater due to low permeability of the clay shale lithology.</td>
</tr>
<tr>
<td>Delaware Limestone</td>
<td>36+ feet of less-resistant, thin-bedded, blue-gray fine-grained limestone and interbedded blue calcareous shale</td>
<td>Best exposed in the Olentangy River valley just east and south of the city of Delaware in southern Delaware County</td>
<td>Mostly poor source of groundwater due to the low permeability of most limestone beds and intervening clay shale layers.</td>
</tr>
<tr>
<td>Columbus Limestone</td>
<td>Over 100 feet of ledgy, hard, resistant, gray crystalline limestone, locally cherty, occasionally sandy, with abundant fossils.</td>
<td>Best exposed in quarries and along valley walls along the Scioto River in western Franklin and Delaware counties.</td>
<td>Moderately good aquifer with yields high enough for domestic wells. Water often with high levels of iron.</td>
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