Appendix E

E.1
Geologic History of the Doan Brook Watershed

The Doan Brook watershed is a small part of a much larger area that was shaped by a series of geologic events that began in Precambrian times, over a billion years ago. This appendix describes the processes that shaped the larger area and the place of Doan Brook in the overall geologic picture.

E.1.1
The Shaping of Northeast Ohio

A billion years ago, a great mountain chain — the Grenville orogenic belt — stood over much of North America, including the area that became northeast Ohio. Over time, the geologic activity that built these mountains ceased, and wind and rain began to wear them down. By about 600 million years ago (the beginning of the Paleozoic Era), the once-enormous mountains had been reduced to a flat plain made up of the granite and gneiss that had originally been the mountains' roots. This plain became warped, and in Ohio it was pushed far below sea level. This granite "basement," on which subsequent rock layers were built, now lies approximately 5,000 feet below sea level in the Cleveland area.

As the granite plain warped downward, the sea advanced, covering northeast Ohio and much of the North American continent. The sea that first flooded the area as much as 600 million years ago persisted for millions of years, sometimes advancing, sometimes retreating. To the east, the ancestors of the Appalachian Mountains rose and eroded, and the sea floor was covered with many hundreds of feet of mud and sand carried down from the mountains. Buried mud and sand deposits compressed into rock — shale and sandstone, respectively — beneath the weight of the overlying material. Each time the sea retreated, some of the rock that was exposed eroded away; each time the waters advanced once again, new layers of sand and mud came to rest on the eroded rock surface.

The sea withdrew from Ohio for the final time about 300 million years ago. As the land rose above the sea, the surface of the rock was again eroded by wind and rain. Erosion continued until about 2 million years ago. Then, the ice ages began and glaciers scraped over the ground, carving out the basins of the Great Lakes. East of the lake basins, the ice encountered the edge of the Appalachian Mountains (the Appalachian Plateau). The glaciers advanced across northeast Ohio four times over a period of almost 2 million years, retreating for the last time about 15,000 years ago.

When the ice finally left northeast Ohio, it left a thin layer of jumbled clay, silt, sand, and gravel soil called glacial till on the surface of the bedrock. The ancestors of the current Great Lakes were trapped between the edge of receding glaciers to the north and the land surface along the edge of the scraped out lake basins to the south. The lakes, filled with water from the melting glaciers, had considerably higher water levels than the current lakes, and their shores were typically the edge of the Appalachian Plateau. The cliffs they carved in the edge of the Plateau can now be seen many feet above Lake Erie, and the silts, sands, and clays that were deposited in their waters form the soil that lies along the current lake shore.

Doan Brook and other streams flowing north toward the lakes from the Plateau carved narrow valleys through the lifted layers of bedrock to meet the falling lake levels. Over time, lake levels declined to their current elevations, leaving a series of carved shorelines and beaches in their wake. Forests advanced from the south to blanket the newly exposed land, and northeast Ohio began to resemble the land that Moses Cleaveland found when he arrived here in 1796.

E.1.2
The Geology of the Doan Brook Watershed

The forces that shaped all of northeast Ohio left us the Doan Brook of today. The upper reaches of the watershed lie in the glacial tills that thinly coat the sedimentary bedrock of the western margin of the Appalachian Plateau. Here, the soil is a thin layer of the glacial till that was left behind when the glaciers retreated to the north. A few feet beneath the surface lie the sedimentary Meadville Shale, Sharpsville Sandstone, and Orangeville Shale that were laid down beneath the ancient sea about 330 million years ago. These bedrock units underlie much of the upper watershed. The brook flows gently across the gradually sloped surface of the bedrock, meandering and bending across a shallow valley.

Toward the western part of the upper watershed (downstream from the Lower Shaker Lake), the land becomes steeper as it approaches the Escarpment that forms the edge of the Appalachian Plateau. Here, the flow of the water quickens, and the course of the brook straightens. The slope of the land gives the water enough strength to cut a deep channel into the underlying rock, and the brook has created a narrow gorge that is as much as 50 feet deep in some places. In the gorge, the older rock units that lie beneath the shales and conglomerate of the upper watershed are exposed. Following the brook down the gorge between the Lower Shaker Lake and the intersection of Martin Luther King, Jr., Boulevard (MLK) and Ambleside, one can see layer beneath layer of the sedimentary bedrock that formed beneath the ancient seas. Orangeville Shale, Berea Sandstone, Bedford Shale (including the well-known Euclid Bluestone sandstone), Cleveland Shale, and Chagrin Shale are all exposed as Doan Brook rushes down toward Lake Erie. Bedrock outcrops along the brook are described in detail in the tour of brook geology in Appendix F.

The steep hill traversed by MLK, Fairhill, Cedar Glen, and Edgehill Roads is the main slope of the western edge of the Appalachian Plateau. The waves of one of Lake Erie's ancestral lakes once lapped at this cliff, and Doan Brook's waters flowed directly into the lake here. The soil below the Escarpment changes from the glacial silty clay till to layered silts, clays, sands, and gravels that were deposited at the bottom of the ancient lakes. The total thickness of these deposits in the lower watershed varies from a few feet to possibly as much as 600 feet near the mouth of the brook, where it crosses the buried valley of the ancient Cuyahoga River. In the buried river valley, the lake-deposited soils are layered with the jumbled till left behind by glaciers, demonstrating that glacial advances were interspersed with warmer periods during which the lower watershed was inundated by the ancient lakes. The level of Lake Erie decreased over the centuries, leaving ridges to mark the locations of a series of lake shores.

The bottom of the ancient lake became flat as soil was deposited, and the slope between the edge of the Escarpment and the current Lake Erie shore became very gradual. As the brook flows across this flat plain, it begins to meander once more, as long as it is not confined within retaining walls. Over many years, the stream's meanderings across this broad plain created the relatively wide valley that now accommodates both the confined brook and MLK.

E.2
Doan Brook Watershed Soils

Soils found in the upper Doan Brook watershed consist almost entirely of glacial tills. In the lower watershed, soils are primarily made up of intermixed layers of lacustrine[1] silts, clays, and fine sands deposited by the ancient glacial lakes. Some layers of till are intermingled with the lacustrine materials in the lower watershed, indicating that the lakes periodically retreated and were replaced by glaciers. Table E-1 describes the watershed soils in some detail. More information about the watershed's soils, including maps that show the locations of different soil units and tables that give technical data about the soil, can be found in the U.S. Soil Conservations Service's *Soil Survey of Cuyahoga County.*

1 Lacustrine is used to indicate soil materials that are deposited by lake waters.

Table E-1	Significant Soils in the Doan Brook Watershed[2]	
Location	**Soil Type**	**Description**
Lower Watershed: General	UeA – Urban land-Elnora complex	Mixture of urban land and a deep, moderately well-drained Elnora loamy fine sand with slopes ranging from 0-3%. Soil is typically very dark grayish brown, very friable loamy fine sand. Soil has moderate permeability and slow runoff (Hydrologic Soil Group B[3]). Area is about 70% urban land, 30% Elnora soil.
Lower Watershed: Brook Valley Sides	OsF – Oshtemo sandy loam	Deep, very friable sandy loam on steep or very steep Doan Brook valley sides. Permeability is moderately rapid and runoff is rapid (Hydrologic Soil Group B, with 25–55% slopes).
Lower Watershed: Brook Valley Bottom	Tg – Tioga loam, frequently flooded	Deep, nearly level, well drained soil with slope 0–2%. Dark brown, very friable loam with surface soil about 8 inches thick. Permeability is moderate to moderately rapid, and runoff is slow (Hydrologic Soil Group B).
Escarpment: Lower Area	Ub – Urban land	More than 80% of the area (University Circle) is covered by buildings and pavement.
Escarpment: South of Norfolk and Western/RTA Tracks	LuC – Loudonville-Urban land complex	Mixed urban land (50%), Loudonville silt loam (35%) and Ellsworth soils (15%). Loudonville surface soil is dark grayish brown, friable silt loam about 6 inches thick. Deeper strata are friable silt loam, silty clay loam and friable channery silt loam. Bedrock lies at a depth of about 25 inches (Hydrologic Soil Group C).
Upper Watershed: General	LuC – Loudonville-Urban land complex	See above. There is a moderately large area of this soil in the western part of the upper watershed.
Upper Watershed: General	UnB – Urban land-Mitiwanga complex	Mixture of urban land (70%) and moderately deep, somewhat poorly drained, undulating Mitiwanga silt loam (20%) (other soils 10%). Mitiwanga surface soil is dark grayish brown, friable silt loam about 11 inches thick. Deeper strata are friable flaggy loam, with sandstone bedrock at a depth of about 30 inches. Permeability is moderate and soil may be strongly acid (Hydrologic Soil Group C). Large areas of this soil are mixed with smaller areas of LuC in the western part of the upper watershed.
Upper Watershed: General	UmB – Urban land-Mahoning complex	Mixture of urban land (70%) and deep, somewhat poorly drained Mahoning silt loam (20%) (other soils 10%). Mahoning surface soil is dark grayish brown, friable soil loam about 7 inches thick. Deeper strata are silty clay loam and clay loam. Permeability is slow to very slow, and soil may be strongly acid. Runoff is slow or medium (Hydrologic Soil Group D). This soil forms most of the general watershed soil in the eastern part of the upper watershed.
Upper Watershed: Brook	Tg – Tioga Loam, frequently flooded LuC – Loudonville-Urban land complex EsC – Ellsworth-Urban land complex ElB, C, D– Ellsworth silt loam	See above for descriptions of Tg and LuC. Ellsworth-Urban land complex consists of a mixture of urban land (30%) and Ellsworth silt loam (55%) (other soils 15%). Ellsworth soil has a dark brown, friable silt loam surface layer about 7 inches thick. Permeability is slow or very slow, and runoff is rapid or very rapid (Hydrologic Soil Group C). Near the headwaters of Doan Brook, some land becomes exclusively Ellsworth silt loam with slow or very slow permeability and moderate to rapid runoff.

2 Data on soils are from United States Department of Agriculture Soil Conservation Service. Undated. *Soil Survey of Cuyahoga County*.

3 Hydrologic Soil Groups are designations used by hydrologists to indicate the tendency of rainfall to run off from or infiltrate into a particular soil. Hydrologic Soil Group designations are as follows (after Bras 1990): A — Low runoff potential. Soils such as drained sands and gravels with high infiltration rates; B — Moderate runoff potential. Soils such as fine sands and silts with moderately fine to moderately coarse textures and moderate rates of infiltration and water transmission; C — Moderately high runoff potential. Soils such as fine silts and moderate clays with moderately fine to fine texture and slow infiltration rates and rates of water transmission; D — High runoff potential. Clay soils with permanently high water table and very slow infiltration rates and rates of water transmission.