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2.6 GEOLOGY

{This section contains a brief description of the geologic conditions that are present at and in the vicinity of the Nine Mile Point 3 Nuclear Power Plant (NMP3NPP). Groundwater and surface water are discussed in Section 2.3. The NMP3NPP Final Safety Analysis Report (FSAR) presents detailed geological, seismological and geotechnical site evaluations in Section 2.5.}

2.6.1 GEOLOGIC SETTING

{The NMP3NPP site is located in the Central Lowland Physiographic Province as shown in Figure 2.6-1 and Figure 2.6-2. The NMP3NPP site and region (within 50 miles (80 km) of the power block) topography consists of a flat terrain with gently rolling elevations ranging from 245 ft (75 m) mean sea level (msl) to nearly 500 ft (152 m) msl at the base of the Allegheny Escarpment, which is at the bottom of the Appalachian Plateau Physiographic Province about 40 mi (64 km) to the south.

The NMP3NPP site is drained by overland and groundwater flow to Lake Ontario. There are no formally named streams within the area of influence of the project. There are, however, local drainages that flow through various portions of the Nine Mile Point Nuclear Station (NMPNS) site. All of those discharge into Lake Ontario. A short intermittent stream, unnamed on topographic maps, but referred to as Lakeview Creek, exists adjacent to the NMPNS site to the south, flowing directly into Lake Ontario. The Oswego River, a major watercourse, discharges to Lake Ontario about 8 mi (12.9 km) to the west.

An extensive wetland system exists on parts of the NMP3NPP site and upstream of the site. The wetlands generally result from disruption of drainage caused by topography shaped by glacial deposits, and generally consist of shallow ponds, shrub swamps, wood swamps, and intermittently wet bottomland-like forests. Many are wet for only a limited period each year.

The Lake Ontario shoreline forms the northern boundary of the NMP3NPP site and generally consists of a low slope with narrow beaches at their base. Beaches consist of exposed bedrock with no surficial material other than isolated areas of coarse gravel and cobbles. Where present, the slope to the beach has elevation varying from about 248 ft (76 m) to 255 ft (78 m) msl along and adjacent to the NMP3NPP site's shoreline. The exposed slope face consists of almost entirely dense glacial till and is stable based on an analysis described in FSAR Section 2.5.5. The limited amount of vegetation on the slope and its steepness indicates that the slope is in a state of ongoing gradual erosion. The erosion is primarily caused by wave action on the beach. Although there is no direct measurement of the rate of erosion, the location of the NMPNS site on a point strongly indicates that this local section of the lake shore is relatively resistant to erosion. During plant construction, the shore front slope will be graded and protected with rip rap to provide appropriate long-term stability and resistance to wave erosion.

Slope failure analysis along Lake Ontario is discussed in FSAR Section 2.5.5. Approximately 3,150 ft (960 m) of the shoreline east of the NMP3NPP site, extending from the existing NMP Unit 1 and Unit 2 boundary with NMP3NPP eastward to the James A. FitzPatrick Nuclear Power Plant, is stabilized against shoreline erosion along much of its length. Likewise, the NMP3NPP plant shoreline will be protected.

NMP3NPP will be constructed at a grade elevation of approximately 270 ft (82 m) msl with the plant Nuclear Island set back approximately 900 ft (274 m) from the Lake Ontario shoreline. The bearing layer for the foundation of the plant structures is in the Oswego sandstone. The Oswego is underlain by the Pulaski formation, which contains a confining unit with respect to groundwater migration.}

2.6.2 STRATIGRAPHY

{The NMP3NPP site is located on glacial till which bears directly on the bedrock of the Oswego sandstone, which will provide bearing for all the plant's safety-related structures. The Oswego sandstone is the top formation in a sequence of Paleozoic clastic and carbonate sedimentary rocks that rest at depth on the Precambrian basement rock. The till is late Pleistocene (Wisconsinan age, the youngest of four Pleistocene glaciations that have occurred over the past 2 to 3 million years). The geologic ages of the underlying sedimentary rock formations range from late to middle Ordovician. The basement rock beneath those formations consists of igneous and metamorphic rocks similar to those found east of the NMP3NPP site in the Adirondack Physiographic Province. The Precambrian basement rocks range in age from 560 million to 4.5 billion years old. Figure 2.6-3 is a generalized stratigraphic column showing the geologic formations present beneath the NMP3NPP site and vicinity. Figure 2.6-4 and Table 2.6-1 provide a summary of site stratigraphic information. To the north and east, the Paleozoic sedimentary rock thins to 0 ft (0 m) exposing the Precambrian basement in Canada and in the Adirondack Mountains. To the south, those formations thicken and interfinger with other Paleozoic formations, forming the roots of the Appalachian Plateau and the Appalachian Mountains where up to 9,000 ft (2,438 m) of such rock overlie the Precambrian Basement (USGS, 2008). The surficial materials at the NMP3NPP site consist mostly of glacial till with very minor amounts of man-made fill, topsoil and lake sediments. These deposits have an average combined range of thickness of about 5 to 15 ft (1.5 to 4.6 m).

The bedrock formations encountered in the borings were:

- Oswego Sandstone (including Oswego Transition Zone)
- Pulaski Formation (subdivided into Units A, B, and C)
- Whetstone Gulf Formation

All of these formations consist primarily of gently dipping sandstone, siltstone, and shale. The boundaries between units are often gradational, and the units are lithologically similar. Depths and thicknesses of the site bedrock units are shown in Table 2.6-1.

The Oswego Sandstone consisted of hard, fresh to slightly weathered, non-fossiliferous, greenish-gray, fine to medium grained, massive to distinctly bedded or cross-bedded sandstone. Thin dark gray siltstone and shale beds were minor and siltstone clasts were common. The sandstone was typically composed of subangular to subrounded quartz grains, sometimes with well-rounded lithic fragments, feldspar crystals, and a clay matrix.

The Pulaski Formation was informally subdivided into Units A, B, and C during the investigation for NMP Unit 2. All three units consisted of interbedded sandstone, siltstone, and shale. The relative amount of siltstone and shale increased in the lower portions of the Pulaski Formation. Lithologic contacts are gradation and the relative amount of siltstone and shale increased in the lower portions of the Pulaski Formation. All three units contained marine fossil shell debris. Unit A is the uppermost unit and consisted of slightly weathered, medium hard, dark gray argillaceous sandstone interbedded with light gray sandstone and a few beds of dark gray shale and siltstone. Unit B consisted of slightly weathered, medium hard, interbedded light gray sandstone, dark gray siltstone, and shale. Unit B had relatively more sandstone than Unit A and relatively less fossil debris than Unit A. Natural gas was detected during the a subsurface investigation between El. 150 and El. 118, which corresponds to the elevation range of the Pulaski Formation, Unit B. The presence of natural gas is not considered significant to the foundation design of NMP3NPP because it was encountered at depths greater than 60 feet below the proposed deepest foundation mats. Unit C consisted of slightly weathered, medium

hard dark gray siltstone and shale, interbedded with light gray sandstone. Unit C was darker and had more siltstone and shale than Units A and B.

The top of the Whetstone Gulf Formation is lithologically very similar to the Pulaski Formation Unit C. The Whetstone Gulf Formation was informally subdivided into Units A and B during the investigation for NMP Unit 2. The upper unit (Unit A) consists of dark gray siltstone and shale with occasional light gray sandstone beds. The lower unit (Unit B) consists of siltstone and shale interbedded with sandstone. Sandstone interbeds became more common in Unit B.

Underlying the Whetstone Gulf Formation is the carbonate rock of the Trenton and Black River Groups. Those bear directly on basement rock. Stratigraphic data from gas wells is available for the site area from the State of New York. Those wells extend into the basement rock providing a basis for these data.}

2.6.3 GEOLOGIC IMPACT EVALUATION

{Based on the NMP3NPP site and vicinity geologic conditions described in the previous subsection, long-term adverse impacts on the geology are not anticipated as a result of construction or operation of NMP3NPP. For example:

- The absence of capable faults (as discussed in FSAR Sections 2.5.1.2 and 2.5.3) at the NMP3NPP site and in its regional area eliminates the possibility for a surface fault rupture as a result of construction or operation of the proposed facility.
- Surface settlement (as a result of facility construction) will not adversely affect the drainage of surface water.
- The geologic units at the site are not subjected to dissolution and permanent dewatering is not needed after construction.
- There are no natural slopes in proximity to the proposed facility that could be adversely impacted by: foundation excavation, loading resulting from construction of the proposed structures, or infiltration of precipitation as a result of surface modifications
- Any potentially negative impacts that could result from the placement of fill in the proposed plant area will be mitigated by the earthwork design.
- Some short-term geologic impacts could occur during construction. These impacts could be a result of excavation or temporary dewatering.
- Disposal of excavated material will likely be required either on-site or off-site. Generally accepted, best-practice methods will be used to mitigate the potential for erosion of this material at the disposal site. Such methods may include the use of silt fences, seeding, and drainage control. Excavated soil surfaces exposed during construction will be protected to mitigate their erosion and control surface runoff.
- Temporary dewatering of foundation excavations could result in an impact on groundwater levels, however the low permeability of the bedrock at the NMP3NPP site and the generally limited areal extent of impact from bedrock dewatering (NRC, 2006) are inferred to minimize any affects of construction dewatering.}

2.6.4 REFERENCES

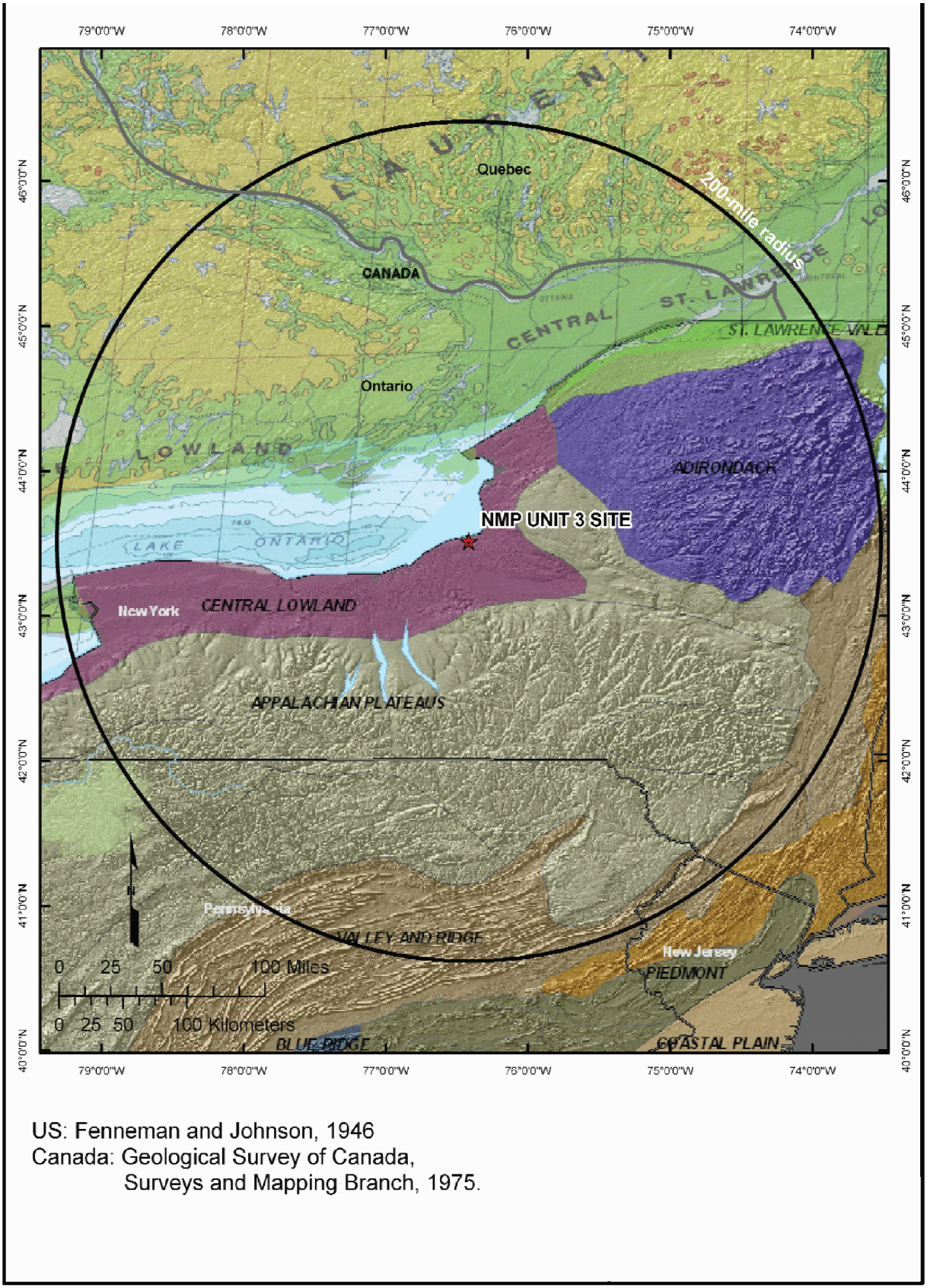
{**USGS, 2008.** Ryder, R.T., Swezey, C.S., Crangle, R.D., Jr., and Trippi, M.H., 2008. "Geologic cross section E-E' through the Appalachian basin from the Findlay arch, Wood County, Ohio, to the Valley and Ridge province, Pendleton County, West Virginia: U.S. Geological Survey Scientific Investigations Map 2985, 2 sheets, 48-p. pamphlet."

NRC, 2006. U.S. Nuclear Regulatory Commission (NRC), 2006. NUREG-1437, Supplement 24, Section 2.2.2, Water Use, "License Renewal Generic Environmental Impact Statement."}

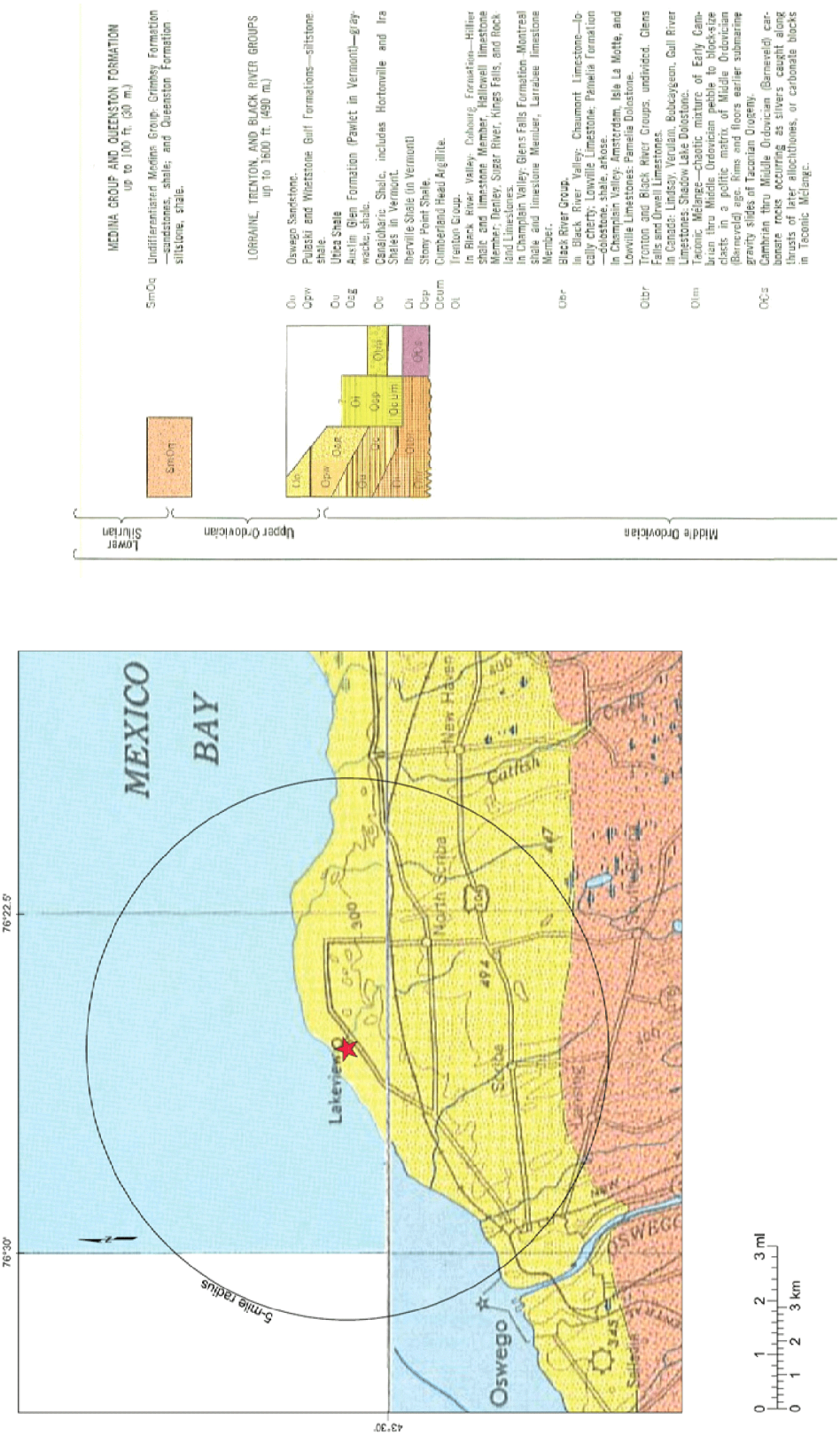
Table 2.6-1—{Assessment of Area Stratigraphy from NMP3NPP Field Investigations}

System/Age	Series	Group	Formation	Top to Bottom Depths in ft (m) and Elevations of Formation in ft (m)	Formation Thickness in ft (m)
Late Ordovician	Cincinnatian	Medina	Oswego Sandstone	Depth 15 [4.6) to 100 (30.5) (Elev. 255 (77.7) to 170 (51.8))	85 (25.9)
		Lorraine	Pulaski Formation	Depth 100 (30.5)to 200 (61) (Elev. 170 (51.8) to 70 (21.3))	100 (30.5)
			Whetstone Gulf Formation	Depth 200 (61) to 970 (295.7) (Elev. 70 (21.3) to -700 (-213.4))	770 (234.7)
Ordovician			Trenton Group	Depth 970 (295.7) to 1,770 (539.5) (Elev. -700 (-213.4) to -1,500 (-457.2)	800 (243.8)
			Black River Group		
Precambrian	Grenville		Grenville Basement rock	Depth 1,770 (539.5) to NA (Elev. -1,500 (-457.2) to NA)	NA

Figure 2.6-1—{Map of Physiographic Provinces}



US: Fenneman and Johnson, 1946
Canada: Geological Survey of Canada,
Surveys and Mapping Branch, 1975.



NOTE: FOR DESCRIPTION OF MAP UNITS SEE FIGURES 2.5.1-7b AND 7c.

SOURCES:
1. GEOLOGIC MAP OF NEW YORK, ADIRONDACK SHEET, NEW YORK STATE GEOLOGIC SURVEY, 1970.
2. GEOLOGIC MAP OF NEW YORK, FINGER LAKES SHEET, NEW YORK STATE GEOLOGIC SURVEY, 1970.

Figure 2.6-2—{Site Area Geologic Map}

Figure 2.6-3—{Generalized Site Stratigraphy}

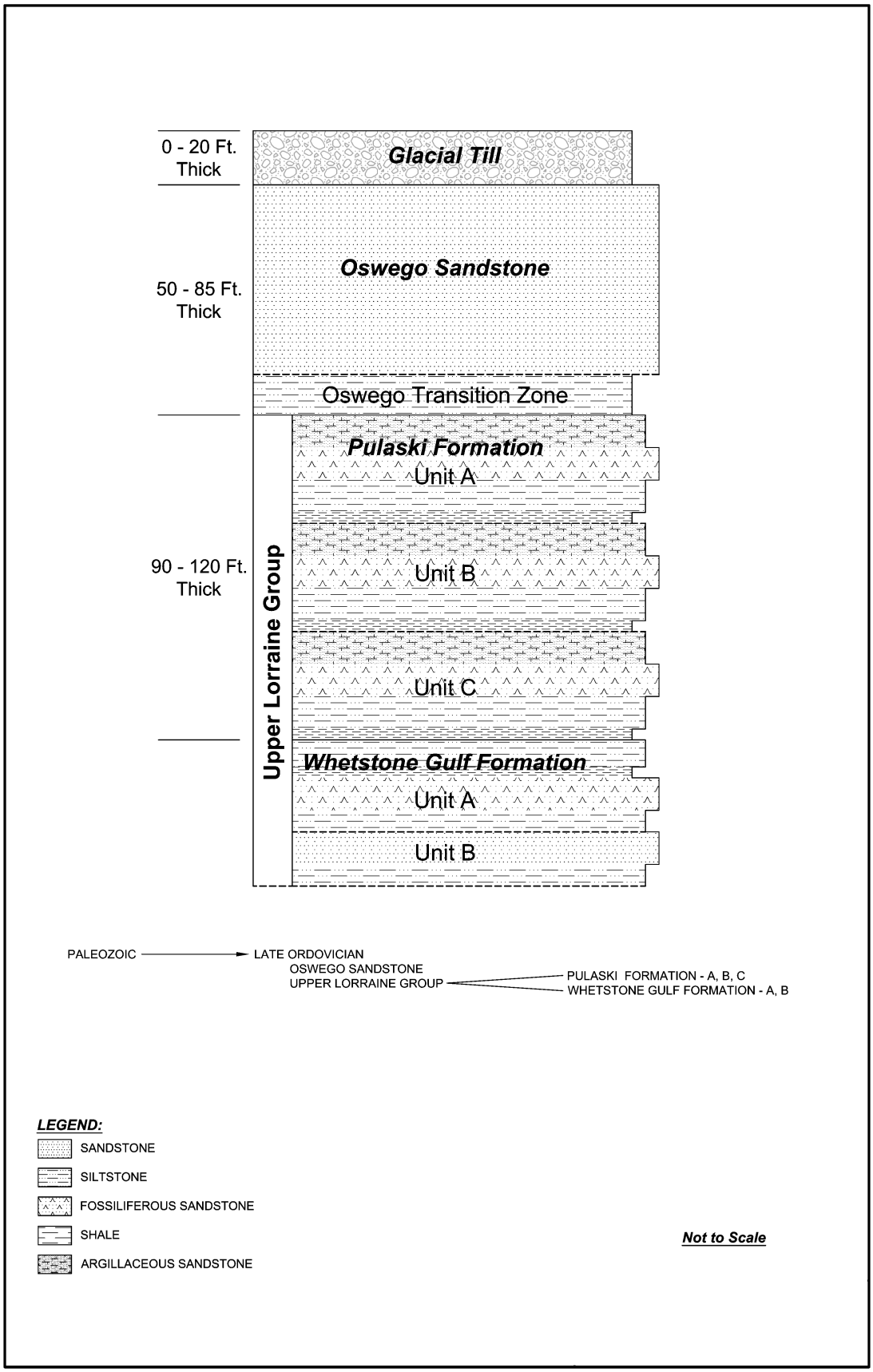


Figure 2.6-4—{NMPNS Site Specific Stratigraphic Column}

EON	ERA	PERIOD	EPOCH	AGE (Ma)	UNIT	THICKNESS (FT.)
Phaneozoic	Cenozoic	Quarternary	Holocene	0.01	Topsoil Surficial Soils (Sand, Silt, Clay, Peat) Till	2 - 20
			Pleistocene	1.8		
				2.6	NA	—
				65.5	NA	—
	Mesozoic	Cretaecous		145.5	NA	—
		Jurassic		199.6	NA	—
		Triassic		251.1	NA	—
	Paleozoic	Permian		299.0	NA	—
		Carboniferous		359.2	NA	—
		Devonian		416.0	NA	—
		Silurian		443.7	NA Unconformity	—
		Ordovician	Upper		Oswego Sandstone	50 - 85
					Pulaski Formation	90 - 120
					Whetstone Gulf Formation	~ 784
					Trenton Group - - - - - - - - - - - - Black River Group	800 ± 200
			Middle	460.9	NA	—
			Lower	471.8	NA	—
		Cambrian		488.3	NA Unconformity	—
Precambrian	Proterozoic	Neo-proterozoic		542.0	Grenville-gneiss	Unknown

Time scale modified from "A Geologic Time Scale 2004"
by F.M. Gradstein, J.G. Ogg, A.G. Smith et al. 2004.