Memo

SUBJECT
Bedrock Conceptual Site Model
Little Britain Road Service Center

TO
Jesse Gallo, Central Hudson Gas & Electric Corporation

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PROJECT NUMBER
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This memorandum presents the Conceptual Site Model (CSM) for bedrock beneath and surrounding Central Hudson Gas & Electric Corporation's (CHGE's) Little Britain Road Service Center, located at 610 Little Britian Road in New Windsor, New York (referred to hereafter as "the site").

Purpose and Scope

The CSM will serve to guide potential further investigations regarding the extent and movement of bedrock groundwater containing dissolved volatile organic compounds (VOCs) at concentrations exceeding Technical and Operational Guidance Series (TOGS) groundwater standards (New York State Department of Environmental Conservation [NYSDEC] 1998).

Work performed to prepare the CSM consisted of:

1. Conducting a literature search for documents containing regional bedrock geologic/hydrogeologic information and analyzing the documents obtained.
2. Reviewing and integrating, as necessary, historical site geological and hydrogeological information.
3. Reviewing and analyzing data contained in existing downhole geophysical logs for information regarding bedrock structure, including fracture patterns and the nature of transmissive features.
4. Preparing supporting graphics, maps, charts, and diagrams.

Site Setting, Topography, and Drainage

The site is an approximately 9-acre facility, located along Little Britain Road in the town of New Windsor, NY. The site location and topographic setting are shown on Figure 1. The service center building, which houses offices and truck/service bays, is in the center of the facility.

The site is in the Hudson-Mohawk Lowlands physiographic province of New York State (New York State Museum 2020). The province is characterized by generally low-lying lands of slight relief mantled by glacial deposits. Topographic relief in the region ranges from near sea level at the Hudson River (about 2.7 miles east of the site) to about 700 feet at the tops of hills scattered across the lowlands. Locally the site is situated in a small topographic basin that is largely occupied by Washington Lake[1]. This basin forms the Washington Lake subwatershed of the Quassaick[2] Creek watershed. The subwatershed is small, comprising only 645 acres of which 163 constitute the lake itself, and has no natural tributaries. (Orange County Planning Department 2014).

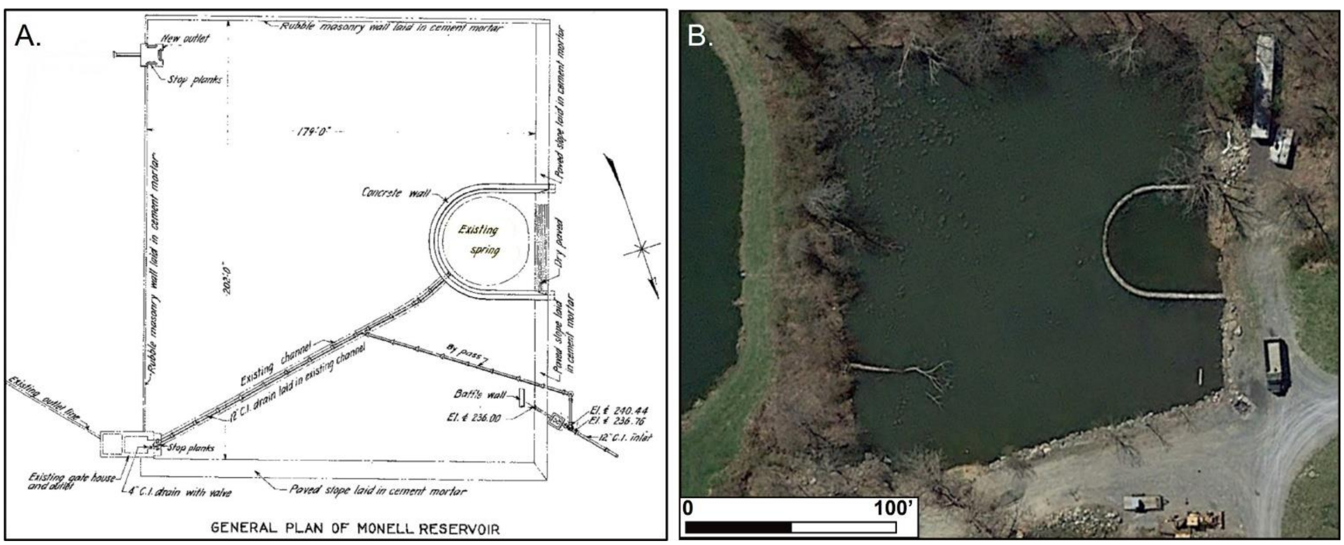
[1] Also referred to as Lake Washington.

[2] Also spelled as "Quassaic" on United States Geological Survey topographic maps.

Water from Washington Lake has served as a source of potable water for the City of Newburgh since 1852. At that time, Monell's Reservoir was constructed about ¾ mile east of Washington Lake and was reportedly fed water from the lake through "underground channels" originating at the "Swallow Hole." (Newburgh Daily Journal 1883; Nutt 1891; City of Newburgh Water Department 2023). Specifically:

> *Close by [Washington Lake] the water tumbles into the "Swallow Hole," the entrance to a natural, rocky underground passage, not to be seen again until it gushes out of the "Trout Hole Spring," around which a reservoir of masonry has been constructed. (Nutt 1891).*

Monell's reservoir has not been used to supply water to the City of Newburgh since at least 1921. It is not clear how it was determined that underground channels existed or delivered water to Monell's Reservoir; however, it is clear that Monell's Reservoir was fed by a spring. Plans for the City of Newburgh's water filtration plant, which is located about 0.1 miles southeast of Washington Lake and the site, include a drawing of Monell's Reservoir showing the spring, surrounded by a concrete wall, located along the western side of the reservoir (City of Newburgh 1921), as shown on Inset 1.

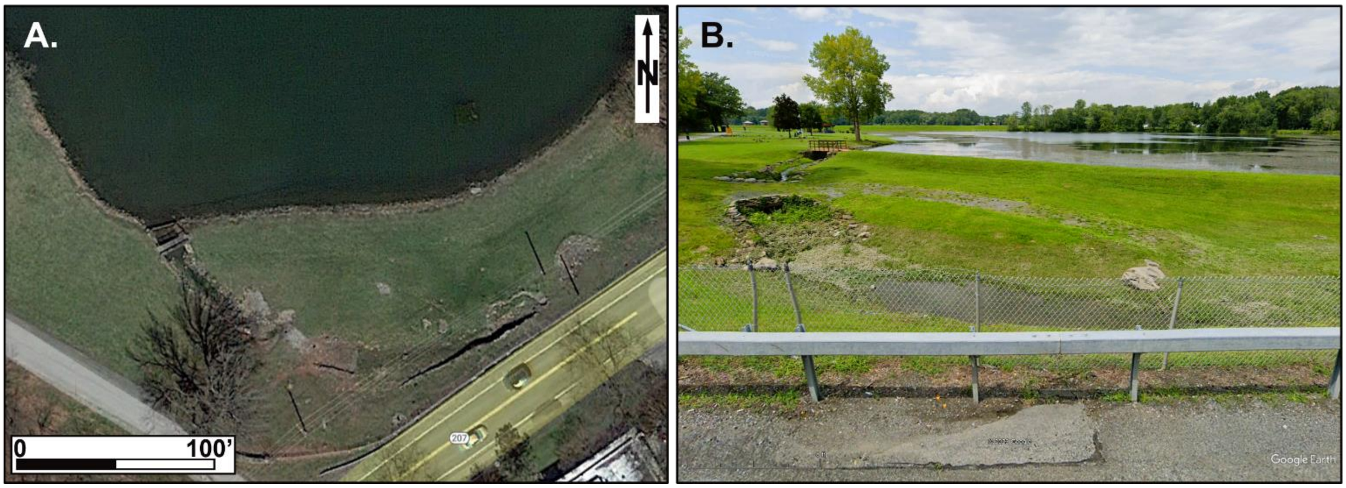


Inset 1: (A) Monell's Reservoir plan drawing showing "existing spring" within a concrete wall, 1921 (note orientation of north arrow). Elevation datum unknown. (B) Monell's Reservoir as seen on Google Earth (July 2018 imagery).

The Washington Lake Reservoir Dam has been raised multiple times over the years to increase the storage capacity of the reservoir.

The lake is replenished by rainwater and groundwater contributions, as well as water diverted from Murphy's Ditch and Silver Stream (Figure 2). Murphy's Ditch diverts water from Patton Brook. A weir and gates control the flow of water from Silver Stream to the lake via a gate structure and diversion channel. In response to detections of perfluorooctane sulfonic acid (PFOS) in Washington Lake and Silver Stream, the diversion gate was closed circa 2016. Silver Stream flows southward to Moodna Creek. Patton Brook flows eastward, joining Quassaick Creek at Brookside Pond. The perennial unnamed stream that reportedly receives water from Washington Lake through underground channels to Monell's Reservoir flows through several ponds, including Crystal Lake, before emptying into Quassaick Creek (Figure 2). Other surface water bodies in the area include Lockwood Basin, a small water body slightly separated from Washington Lake, and Harrison Pond, which is along Quassaick Creek in the reach between where Patton Brook and the unnamed tributary join it. Both water bodies are man-made.

It is not clear when Lockwood Basin was built nor its intended purpose. The basin did not exist in 1870 (Caldwell 1870); but appears on the 1902 USGS Schunemunk, NY 15-minute topographic map (USGS 1902). It is reasonable to assume that it was built to provide additional storage for water to supply the City of Newburgh in addition to Washington Lake. Review of Google Earth imagery shows an outlet at the southern end of the basin with the channel disappearing near the edge of Little Britian Road (Inset 2).



Inset 2: (A) Lockwood Basin outlet. Outlet channel ends at northern edge of Little Britain Road (2016). (B) Google Street View image of basin outlet and channel (looking northwest from Little Britain Road). Note gray-colored, presumed bedrock outcrop along channel, in foreground on right.

It is possible that the flow out of Lockwood Basin enters the bedrock in this area. A survey map prepared by Caldwell (1870) shows the former outlet from Washinton Lake ("Little Pond") to be under the present-day Lockwood Basin. From the map, it appears flow from that outlet was then piped to an area along the north side of Little Britain Road, in the same general area as shown on Inset 2.

A map dated 1783 shows a much smaller Washington Lake (i.e., prior to damming) with an apparent outlet on its eastern end that terminates near the present-day Lockwood Basin (Figure 3). "Disappearing streams" – streams where the flow disappears into the subsurface – are a common feature in many karst landscapes.

Regional Geology

The region has a long and complex geologic history, being subject to several mountain-building and rifting episodes starting approximately a billion years ago. Folding and faulting of the rocks accompanied the mountain building, though the faults in the region are very old and considered to be inactive (Budnick et al. 2010). Sedimentary rocks deposited in shallow seas (e.g., limestones, dolomites, and sandstones) and deep ocean basins (e.g., shales) are present in the region. Some of these rocks were heated, deformed, and changed into gneisses and marbles.

The distribution of rock units generally forms a northeast to southwest pattern across the county. Areas of similar bedrock types are inferred to be bounded by faults that separate them from areas of differing rock types. It is likely that many faults have gone unmapped because most of the bedrock is not exposed, being covered by glacial deposits and vegetation (Budnick et al. 2010).

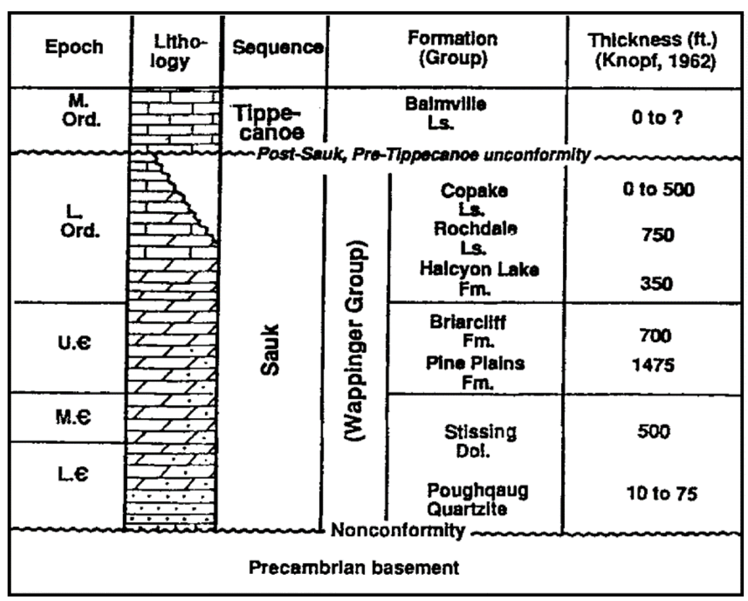
Pleistocene glaciers have excavated the surface and deposited great quantities of gravels, sands, silts, and clays in the Hudson Valley. Most of the unconsolidated deposits in the region are of glacial origin (Snavely 1980). During the most-recent glacial epoch, the Laurentide ice sheet advanced southward from Canada, extending as far south as Long Island approximately 20,000 years ago. Till, an unsorted mixture of fine material, sand, gravel, cobbles, and boulders deposited at the base of the glacier, blankets the hills in the region and underlies other glacial deposits in the valleys.

Site Geology

Geologic materials penetrated beneath the site consist of, in descending order, anthropogenic fill, till, and dolostone bedrock. The fill is generally composed of fine-to-coarse sand with little fine gravel, silt, and clay, with occasional miscellaneous anthropogenic material. Geologic descriptions of unconsolidated material penetrated at the site do not always distinguish between fill and till, potentially because the fill may have been sourced from local till deposits. As such, the range in thicknesses of the fill and till are somewhat uncertain. Regardless, the thickness of fill across the site likely varies from a few feet or less to perhaps ten feet or more. A layer of dense till generally underlies the fill and directly overlies the bedrock across much of the site. The color of the till changes from brown to gray with depth. At several boring locations, a brown silt and fine sand unit was encountered above the till, or as lenses within the till. The till was deposited directly by glacial ice and is generally composed of dense fine sand and silt with varying amounts of clay, embedded subrounded gravels, cobbles, and boulders. Till is thickest in the northern and southern portions of the site where the depth to bedrock is greater. The topography of the bedrock surface is shown on Figure 4 and depicts a northeast-southwest trending bedrock ridge. Toward the north and south of the ridge, till thickness can exceed 40 feet. The till is absent near the northeast portion of the site, where the bedrock is shallow.

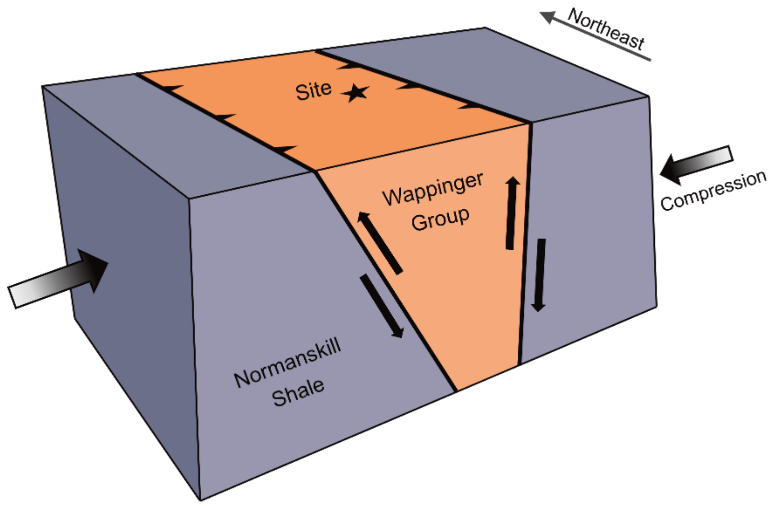
Bedrock

Bedrock penetrated beneath the site is carbonate rock of the Wappinger Group. A geologic map depicting the bedrock geology at the site and vicinity is included as Figure 5 (Fisher, et al. 1970). Guo, et al. (1996) divide the Wappinger Group into seven formations, as shown in Inset 3. The uppermost six formations represent carbonate rocks, either limestone or dolostone. The bedrock penetrated at the site is described as a dark gray, weakly-bedded, fine-grained dolostone often containing fractures filled with calcite or possibly milky quartz. Based on lithographic descriptions from rock cores collected at the site and formation descriptions contained in Fisher and Warthin (1976), the bedrock beneath the site may consist of



Inset 3: Schematic stratigraphic section of Wappinger Group showing named formations within it.

the Rochdale Limestone or the Briarcliff Formation. The Remedial Investigation report prepared for the former Macbeth Division of Kollmorgen Corporation site, located directly across Little Britian Road from the site, interpreted the bedrock to be the Stissing Dolostone member of the Wappinger Group (H2M Group 1995). The water-bearing properties of the carbonate rocks of the Wappinger group are expected to be similar. For this reason, the bedrock beneath the site is hereafter referred to as "dolostone", consistent with the terminology used in previous site reports. Based on the information in Inset 3, the thickness of the Wappinger Group beneath the site is anticipated to exceed 500 feet.



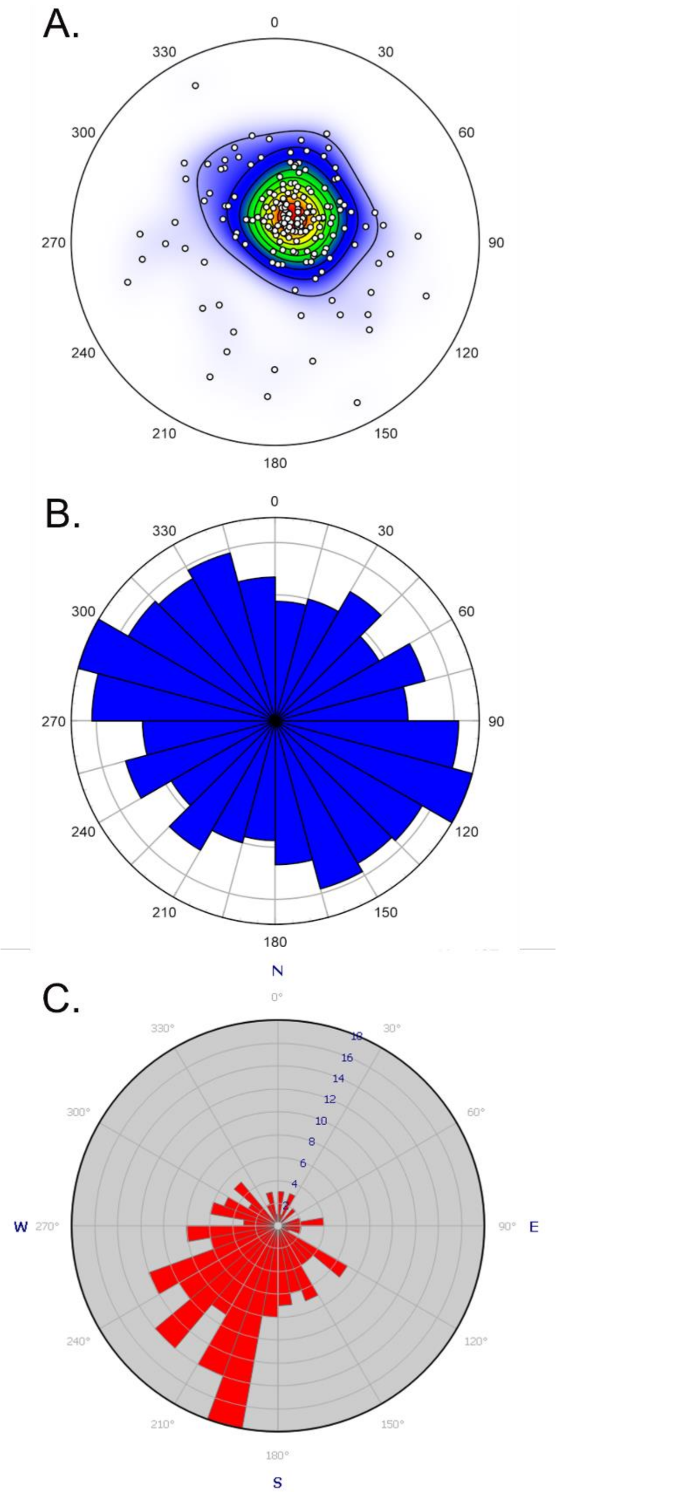
Inset 4: Block diagram showing the general structural relationship of the bedrock beneath and surrounding the site. Dip angles of the faults are unknown. Not to scale.

The Wappinger Group is interpreted to be bound by a reverse or thrust fault, where its rocks have been thrust upward and are now bounded to the southeast and northwest by the younger rocks of the Normanskill Formation (Inset 4).

Downhole geophysical logging has been performed at 12 bedrock holes drilled at the site[3]. Logging at wells MW94-1B, MW01-8B, and the upper portion of MW05-8C (from 50' to 124' below land surface) was performed by Geophysical Applications, Inc., Holliston, MA. Logging at the remaining locations was performed by Enviroprobe Service, Inc., Mount Laurel, NJ. In total, over 1,590 linear feet of bedrock have been logged. Arcadis analyzed data for planar features (e.g., fractures) identified by the logging using stereonets and circular histograms, after correcting the data for local magnetic declination. Data provided by Geophysical Applications, Inc. were also corrected for borehole deviation[4]. Data sets analyzed included bedding planes, all fractures, partially-open fractures, open fractures, and solution features. Open fractures are fractures in the rock that appear to be open based on caliper data. Partially-open fractures are fractures that appear not to be fully open in the borehole. Closed fractures have no significant caliper enlargement. Solution features are identified based on a combination of characteristics including one-or-more of the following: unusually large apertures or apertures that vary considerably across the feature, smoothed or rounded faces, appearance of a weathered rind, and the presence of sediment. Arcadis used the software package "Orient" (Vollmer 1995) to analyze the data.

[3] MW94-1B, MW01-8B, MW05-8C, MW-10C, MW-11C, MW-12C, MW-13C, MW-14C, MW21-15, MW21-16, MW21-18, and MW21-19.

[4] Data from Enviroprobe Service, Inc. were not corrected for borehole deviation; however, it is Arcadis' opinion that the effects of borehole deviation do not materially affect the findings of the analysis.



Inset 5: (A) Equal-area stereographic projection (with Kamb contours) of poles to 182 bedding planes. Contour interval is 2σ. (B) bedding strike and (C) dip direction histograms.

The results of the bedding plane analysis are shown on Inset 5. A total of 182 bedding planes were identified by the geophysics vendors (Enviroprobe Service, Inc., Mount Laurel, NJ and Geophysical Applications, Inc., Holliston, MA). Inset 5A presents an equal-area stereographic projection of bedding-plane poles. Pole densities are contoured using the modified Kamb method (Vollmer, 1988, 1990, 1993, 1995) with contour intervals specified in increments of the standard deviation, σ. The figure shows a statistically significant data cluster with a “mean” strike of approximately 121° (southeast), a dip direction of 211° (southwest), and a dip angle of approximately 12°. These values are derived by calculating the maximum eigenvector, which essentially represents a best-fit plane through the data (Vollmer 2023). Inset 5B is an equal-area circular histogram of the strike of the bedding showing a predominant strike of approximately 114°, which is similar to that calculated above. The slight difference in strike values is attributed to data averaging used to calculate the best-fit plane through the data and the fact that, for gently dipping beds, minor local variations in the geometry of bedding at the borehole scale due to variables such as localized minor folding or undulation of beds can obscure their true regional dip. Inset 5C is an equal-area circular histogram depicting the dip direction of the bedding, which is predominantly toward the south-southwest.

The results of the fracture analyses are shown on Figures 6 through 9. The data were analyzed using the same methodology as described for the bedding planes. It is important to note that borehole fracture data are inherently biased toward low-angle fractures. The probability of intersecting such fractures with a vertical borehole is high, while the probability of intersecting steeply dipping fractures is low. Based on this, the frequency of steeply dipping fractures is likely underrepresented in the data set.

Figure 6 depicts the orientations of all 1,141 fractures identified by the downhole geophysics. Two significant fracture sets (data clusters) are apparent on the stereographic projection, identified using dashed ellipses. The first is nearly identical to the orientation of bedding planes (Inset 5A), suggesting that this fracture set constitutes fractures along bedding planes. The second is a set of steeply dipping fractures with a dip direction of approximately 355° (north-northwest) and an approximate dip angle of 77°. This is apparent on the histogram depicting dip direction, with most fractures dipping either northward or southward.

Figure 7 depicts the orientations of the 793 partially-open fractures identified. A notable difference between this figure and Figure 6 is that the cluster of fractures that dip steeply toward the north-northwest is less pronounced, indicating that many of these fractures are closed. Accordingly, the histogram of dip direction shows a greater proportion of fractures dipping towards the south-southwest. Figure 8 presents data for open (likely transmissive) fractures that have not been appreciably widened by dissolution. The stereographic projection shows a statistically significant data cluster with a representative strike of approximately 85°, a dip direction of 175° (south), and a dip angle of approximately 10 degrees. These values are similar to those determined for the bedding, indicating that most open fractures penetrated likely represent bedding-plane fractures. The histogram representing the direction of dip also shows more variability; however, most open fractures dip to the southeast, south, and southwest.

Figure 9 presents the data for solution-widened features, of which only 14 were identified. The best-fit plane through the data cluster shown on the stereographic projection strikes at 86° and dips at 176° (south) at an angle of 13°, similar to bedding. The dip direction histogram shows that most of these features dip southward. Care must be taken when interpreting these results for two reasons. The first is the small number of data points comprising the data set. As is discussed later in this memorandum, transmissive, solution-widened features in karst terranes are rarely penetrated by borings. Second, the geometries of solution-porosity networks that form in karst bedrock are complex and difficult to reliably map or predict.

Selected statistical data regarding the features penetrated by the boreholes where downhole geophysics was performed are presented in the following table:

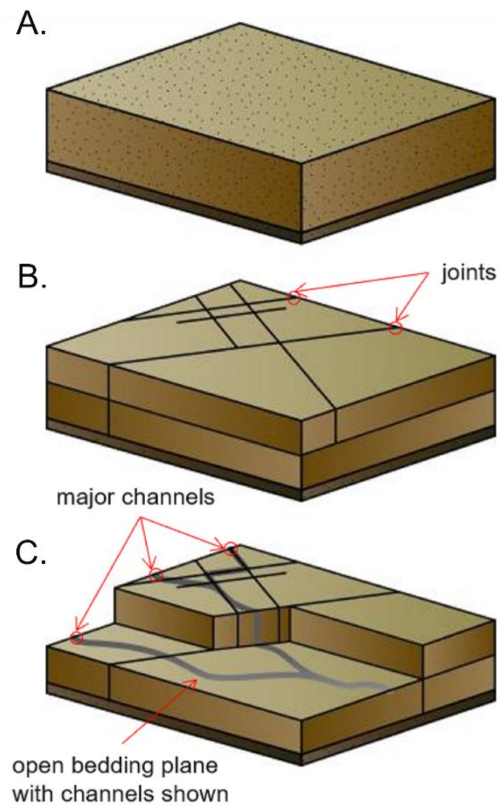
Feature Type	Number Penetrated	% of Total	Frequency Per 100 Feet Drilled	Average # of Feet Drilled to Intercept 1 Feature
Partially-Open Fractures	793	69.5%	49.9	2.0
Closed Fractures	291	25.5%	18.3	5.5
Open Fractures	43	3.8%	2.7	37.0
Solution-Widened Features	14	1.2%	0.9	113.6

Several observations can be made from these data. Clearly, partially-open fractures are most commonly penetrated, followed by closed fractures; but the features that are most important for transmitting water, open fractures and solution-widened features, are intercepted far less often. On average, 37 feet of bedrock was drilled to intercept one open fracture. To intercept one solution feature required drilling nearly 114 feet of rock.

Karst

The ways by which groundwater is stored in and moves through karst aquifers are different from most other aquifers. Groundwater in all aquifers is stored in, and moves through, interconnected pores in the geologic medium. Most bedrock aquifers have two types of porosity: primary and secondary. Primary porosity refers to the solid rock itself, while secondary porosity refers to fractures in the rock. Karst aquifers are triple-porosity systems that form in soluble rock – rock that is dissolved relatively rapidly (in geologic time) by water (Ewers 2006). The third, or “tertiary”, porosity is comprised of a network of pathways, often fractures or portions of fractures, that have been widened significantly by dissolution of the rock. Characteristics of karst aquifers that are important relative to how water is stored and moves through them include:

- *The majority of groundwater in karst aquifers is stored in the primary porosity (See Inset 6)*. The term “stored” in this context does not mean that the water is immobile, rather, it means that the water is typically moving very slowly. Worthington (1999) analyzed data from four contrasting, highly studied karst aquifers, including the Mississippian-aged aquifer at Mammoth Cave, Kentucky. He found that the fraction of aquifer water stored in the matrix porosity was greater than 96% in all four aquifers.
- The majority of groundwater that is drained by karst aquifers, moves through the tertiary porosity (sometimes referred to as “channels” or “conduits”). In the aquifers studied by Worthington (1999), the fraction of aquifer flow occurring in the tertiary porosity was greater than 94%.
- *The tertiary porosity typically occupies a very small volume of the rock*. In the aquifers studied by Worthington (1999), the tertiary-porosity estimates ranged from 0.003 to 0.5 percent. For the Mammoth Cave aquifer, the tertiary porosity was estimated to be 0.06 percent.
- Solution enlarged pathways will form dendritic, convergent networks (often called “conduit networks”) in most karst aquifers (Worthington and Ford 2009).
- Groundwater moving through conduit networks typically discharges at the land surface, or subaqueously into surface water bodies, through springs (Ford and Williams 2007); that is, springs are the primary outflow points of karst aquifers.



Inset 6: Types of porosity in karst aquifers. (A) Primary porosity; interconnected pores in the rock matrix. (B) Secondary porosity (fractures). (C) Tertiary porosity; solution-widened channels or conduit networks.

Important implications of these facts are that:

- Borings drilled in karst aquifers formed in crystalline carbonate rock, such as occurs beneath the site, are not likely to intercept important elements of the permeability structure draining the aquifer; most of the rock penetrated will be relatively unweathered.
- The common practice of estimating groundwater-flow directions using potentiometric maps is not very reliable in karst. However, these maps can be used in a broad sense to infer general directions of groundwater movement in the bedrock; but, the actual path that groundwater takes may be significantly different than inferred from the potentiometry.
- The quality of water samples collected from wells whose screens intercept tertiary porosity (that is, a region in the rock that is highly permeable) is most indicative of the quality of groundwater that is moving through the aquifer. Conversely, the quality of samples collected from wells that screen bedrock that is unfractured, or contains sparse, unweathered fractures (that is, bedrock that is poorly permeable) is indicative of water that is

moving slowly. Most of this water can be expected to move toward, and drain into, the tertiary porosity at some point within the aquifer.

- Because of their convergent nature: 1. contaminated groundwater moving through conduit networks tends to be focused in the downgradient direction, rather than spread out, and 2. If the conduit network(s) extend beyond the source of contamination, which is often the case, contaminant concentrations in groundwater moving through the network(s) can be diluted as conduits carrying clean groundwater join the network.
- With distance from a contaminant source area, contaminated groundwater becomes increasingly confined to the tertiary porosity.

The above model for groundwater movement through karst aquifers applies to the site area and forms the basis for the following discussion of site-specific hydrogeology.

Site Hydrogeology

The water table occurs in the overburden, except at the central portion of the site, where the bedrock is near the land surface. The measured depth to the water table beneath the land surface has ranged from as little as 0.25 feet (MW18-10A) to approximately 16 feet (MW94-3) and averages about 8 feet. The configuration of the water table is depicted on Figure 10. The elevation of water in the adjacent Lockwood Basin and nearby Washington Lake is estimated using Google Earth and the United States Geological Survey (USGS) Cornwall-on-Hudson 7.5-minute topographic map (USGS 2023) to be approximately 290 feet above Mean Sea Level (famsl)[5]. The figure shows a trough in the water table centered over the area where the water table occurs in the bedrock, suggesting that the horizontal component of groundwater flow in the overburden is toward that area. Comparison of water elevations obtained from well-cluster locations indicates that there is a downward gradient from the overburden to the bedrock, and generally a downward gradient from shallow to deeper bedrock. In summary, groundwater in the overburden moves towards and enters the bedrock. Groundwater will not enter the bedrock uniformly, rather, it will primarily enter open fractures and solution features (if present) along the bedrock surface.

Groundwater beneath the site is recharged by infiltration of precipitation falling on and near the site, and likely from seepage out of Washington Lake and the Lockwood Basin. The latter is expected because the levels of the basin and lake are artificially elevated due to damming and introducing water from Patton Brook (via Murphy's Ditch), and until recently, Silver Stream (via the Silver Stream diversion).

Figures 11 and 12 present hydrographs of water-level data collected for a three-month period in 2021 from shallow bedrock well MW18-10B and deep bedrock well MW18-12C and include groundwater temperature and precipitation data. During a portion the data-collection period, bedrock coring was performed which induced a hydraulic stress to the borehole and surrounding aquifer. The graphs reveal several important characteristics about the bedrock aquifer. Both hydrographs show a good correlation between precipitation and groundwater elevations. Shortly after the onset of rainfall, the water level in both wells rises in response. During a particularly high rainfall event, where over 7 inches of rain fell in less than 24 hours, the water level rose nearly 16 feet in MW18-10B and 17 feet in MW18-12C over approximately 60 hours. The temperature data for both wells do not exhibit a signal of the recharging, warmer precipitation. These observations indicate that precipitation recharges the bedrock aquifer relatively quickly but diffusely (that is, there is not significant focused recharge, as through sinking streams or sinkholes) and that the aquifer is unconfined. This is consistent with the surrounding terrane, which is generally mantled by a layer of silty-sandy till, and suggests the till is moderately permeable. Both

[5] Elevations noted in this memorandum are referenced to the North American Vertical Datum of 1988, unless noted otherwise.

hydrographs also show a response to hydraulic stresses induced during bedrock drilling conducted at the site, although the response observed at the deep well is dampened. Shallow well MW18-10B also shows a temperature response to the drilling, indicating the drilling activities caused water of a different temperature to enter the well. In contrast, deep well MW18-12C showed no such temperature response. The responses to rainfall and drilling stresses suggest that there is a degree of hydraulic communication between the shallow and deep bedrock intervals screened by the wells.

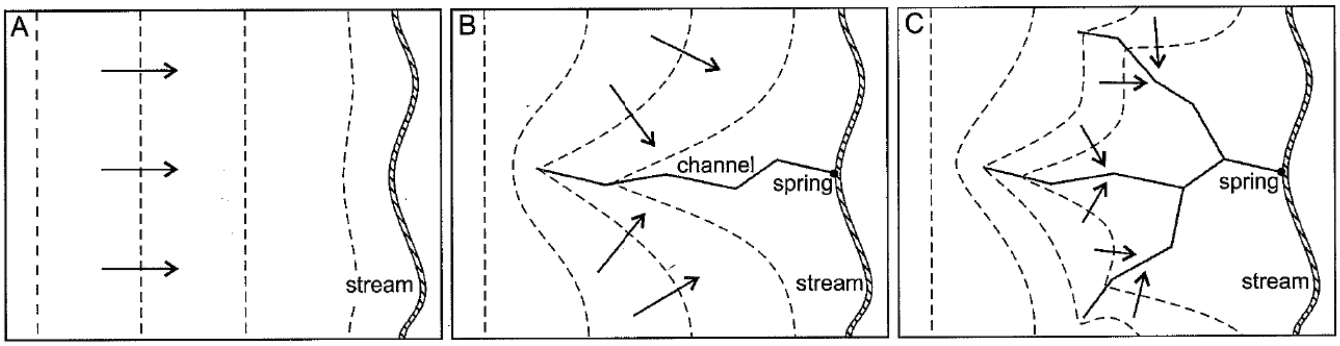
As noted in the discussion of karst geology, above, the nature of groundwater movement through karstic bedrock differs significantly from that of other bedrock aquifers. Most of the water moves through the tertiary porosity (conduit networks) in the rock; but because these networks occupy a very small volume of the work, they are rarely intercepted by monitoring wells and details regarding their location and orientation cannot typically be remotely sensed or mapped. At the local scale, groundwater in the primary and secondary porosity of the bedrock moves toward and discharges into the nearest branch of the conduit network (tertiary porosity). The relationship between groundwater velocities in the three types of porosities can be described as:

primary velocity (rock matrix) << secondary velocity (fractures) << tertiary velocity (conduits)

This means that groundwater in the primary porosity of the rock moves very slowly toward the nearest open fracture or conduit. The rate of movement is so slow, that groundwater in the primary porosity of the rock is effectively in storage in the aquifer. Groundwater in fractures moves at a moderate rate toward the nearest conduit. Groundwater in conduits moves rapidly toward the spring (or springs) that drain the network. Groundwater velocities in conduit networks measured through tracer studies conducted in karst aquifers are commonly on the order of tens to hundreds of feet per day or more.

While we cannot produce a detailed map of the conduit networks draining the bedrock beneath Washington Lake and the site, we can make reasonable inferences regarding their nature that are helpful in conceptualizing flow patterns. The primary factor in the development of conduit networks is the direction of the regional hydraulic gradient. Groundwater will move in response to that gradient, flowing from regions of higher hydraulic head to lower hydraulic head. Figure 13 contours hydraulic head in the deeper bedrock wells and suggests that the regional hydraulic gradient in the rock slopes toward the southeast. In fractured, karstic bedrock, not all the migration pathways are aligned with the direction of the gradient, so the actual path that groundwater takes depends on the geometry of the conduit networks and therefore may be in a direction that differs from the direction of the regional gradient, especially at the local scale. A reasonable analogy is the path a slalom skier takes down a mountain. While a line connecting the start and end points of the run is oriented more-or-less perpendicular to the slope, the actual path the skier takes at any given point along the run varies. Over time, a subset of the fracture pathways, those that are most transmissive, are preferentially widened by dissolution.

In bedded rocks, conduits tend to form along the strike of the beds in the saturated zone (Worthington 1984, Ginsberg and Palmer 2002, Hurd et al. 2010). Furthermore, studies have shown the conduit networks that develop in most karst aquifers exhibit geometries analogous to drainage patterns in surface water basins, where small tributaries join in the downstream direction, forming larger branches (Worthington and Ford 2009). This concept is depicted in Inset 7. In places the conduits may jog downward (or upward), forming along steeply



Inset 7: Development of conduit (channel) networks, showing (A) the initial flow field ("regional gradient"), (B) the modified flow field after one channel reaches the groundwater discharge boundary (spring along stream), and (C) after tributary channels have joined the initial channel. Dashed lines represent equipotential contours and arrows represent flow lines (Worthington and Ford 2009).

dipping open fractures, to the next transmissive bedding plane, adding a third dimension to the network geometry. Groundwater moving through conduit networks typically discharges at springs.

Conduit networks are formed by recharged precipitation, where acidity is enhanced by microbial processes as the water percolates downward to the water table. With depth in the bedrock, the corrosive nature of the groundwater is decreased and eventually exhausted. Solution features at the site have been observed as deep as approximately 178 feet below the land surface (elevation 116 famsl), indicating the network extends at least to that depth. The formation of conduit networks is also governed by the elevation of the discharge boundary – the spring or springs discharging the groundwater in the network. These represent the low points in the groundwater flow system.

Applying the above observations to the site area, groundwater in the bedrock is expected to generally move downward and southeastward. At the local scale, groundwater in most of the rock, which is poorly permeable, moves relatively slowly toward the nearest branch of the conduit network. Once in the conduit network, groundwater moves relatively quickly, discharging at one or more downgradient springs. Primary branches of the conduit network will tend to form along the strike of the bedding (i.e., east-southeastward), which happens to align with the direction or the regional gradient in the bedrock at the site area. Tributary conduits may be oriented in different directions but will move toward and link up with primary conduits. The conduit network will include segments that are steeply dipping, having formed along steeply dipping joints. These segments will join conduits formed along other transmissive bedding planes. For the conduit network, it is expected that most of it will form along bedding planes. Historical mention of a swallow hole, presumably near Washington Lake, and "natural channels" that feed water to Monell's reservoir suggest that the conduit network feeding the spring at the former reservoir may extend to near Washington Lake and the site. Swallow holes, sinkholes that form and accept surface drainage, are not uncommon in karst terranes.

Given the depth of several observed solution features, it is possible that more than one conduit network exists. A shallower network may discharge to one spring, while a deeper network may discharge to a different spring. Looking at the hydraulic heads (groundwater elevations) measured in bedrock wells, the lowest heads are typically in the range of 255 to 260 famsl. This helps target the reaches of streams where springs transmitting bedrock groundwater will occur, because they must exist at elevations lower than 255 to 260 famsl. There will be head loss between the site area and the spring(s); therefore, we estimate that the reaches of streams where springs may discharge will be below elevation 245 famsl. Reviewing surface topography in the area, springs potentially discharging groundwater may exist along Quassaick Creek or the unnamed tributary to it, as shown on Figure 14. It is important to note that karst drainage basins do not necessarily align with surface water drainage basins, which are determined based on topography. As such, it is possible for groundwater in a karst drainage basin to move from one to another surface water drainage basin (Ford and Williams 2007).

Several factors combine to suggest that it is more likely that bedrock groundwater near Washington Lake and the site will discharge from one-or-more springs in the unnamed tributary to Quassaick Creek, than Quassaick Creek itself:

- The inferred regional direction of the bedrock hydraulic gradient is toward the unnamed tributary.
- The unnamed tributary follows the fault that marks the boundary between the dolostone and the Normanskill Shale. Springs commonly form along faults where karst-forming rocks meet insoluble rocks such as the Normanskill Shale.
- Primary conduits often form along the strike of slightly dipping beds, and the estimated azimuth of strike is oriented toward the unnamed tributary.
- A spring exists near and apparently drains to the unnamed tributary. This unnamed spring feeds Monell's Reservoir.

Because more than one conduit network may exist near Washington Lake and the site, and even a single conduit network may discharge to several springs, dye-tracer studies are commonly implemented to confirm groundwater discharge points in karst terranes.

Model for VOC Occurrence and Movement in Bedrock Groundwater

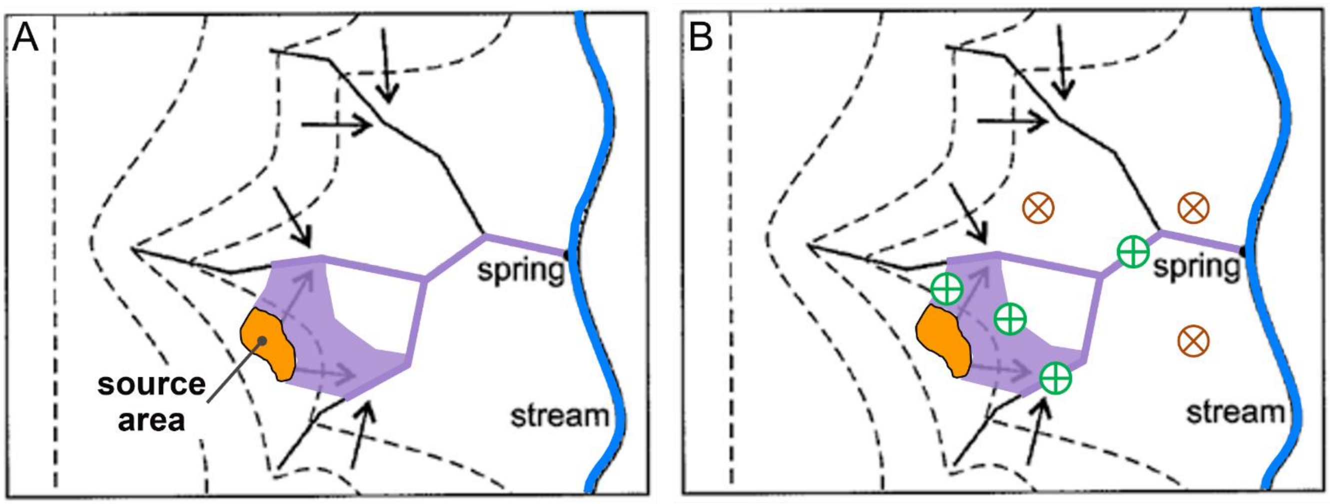
Regions of bedrock groundwater contain dissolved volatile organic compounds above NYSDEC TOGS Water Quality Standards. As depicted in the Remedial Investigation Summary Report (Arcadis 2022), the compounds most commonly detected above their respective TOGS standards in recent sampling events are trichloroethene (TCE) and its associated degradation products: cis-1,2-dichloroethene, trans-1,2-dichloroethene, and vinyl chloride. Also occurring at concentrations exceeding TOGS Standards in samples collected from comparatively fewer bedrock wells, and generally at lower concentrations, are 1,1,1-trichloroethane and one of its degradation products (1,1-dichloroethane). A few other VOCs, including benzene, toluene, and methylene chloride are also detected at concentrations exceeding their associated TOGS Standards in samples collected from a few bedrock wells. Impacts are higher and more widespread in intermediate-depth and deep bedrock wells.

VOCs were identified in the samples collected from the initial bedrock wells installed at the site in 1995 (BBL 1996). Subsequent investigations identified an area of subsurface soil that contained VOCs above applicable criteria. The area is shown on Figure 4 and the impacted soil was remediated in 2001 (BBL 2001). This area is interpreted to represent a place where VOCs historically migrated downward into the bedrock. CHGE purchased the parcels comprising the site in late 1977 and 1978. Records of materials usage from CHGE were reviewed and no evidence was found of usage or generation of wastes containing TCE (BBL 1996). Review of a historical aerial photograph from 1971 suggested that the area where the impacted soils were later discovered was used by the prior owner of the property (J&H Smith Manufacturing Company) for material handling and storage, including the usage of drums and tanks (BBL 1996). Based on this information, it is inferred that the release(s) responsible for the observed VOC impacts occurred prior to late 1977, over 45 years ago.

The observed present-day distribution of dissolved VOCs is best explained by a historical release of one-or-more liquid solvents, particularly TCE, potentially as a spent solvent that would likely contain lesser concentrations of degradation byproducts and other VOCs. Chlorinated solvents such as TCE are dense nonaqueous phase liquids (DNAPL), meaning they are denser than, and do not mix readily with, water. Solvents released at or near the land surface moved relatively rapidly downward to the bedrock, spreading along its surface and entering the bedrock through open fractures and solution features (if present). Downward migration occurred along the near-vertical set of partially-open fractures identified through the downhole geophysical work, explaining the presence of impacts in regions of the intermediate and deep bedrock monitoring intervals. The higher concentrations of VOCs in samples collected from intermediate and deep wells in the MW18-12 and MW21-19 well clusters, which are located generally down dip of the area where VOCs formally occurred in subsurface soils, suggest the DNAPL may also have migrated some distance southward along the dip of bedding-plane fractures. The present-day concentrations in samples collected from these wells, however, are below the United States Environmental Protection Agency's "1% of pure-phase solubility rule of thumb" for suggesting DNAPL presence (USEPA 1992). This suggests that either DNAPL did not migrate to near these wells and the concentrations reflect transport of dissolved VOCs from an upgradient source, or that DNAPL did migrate to near these wells in the past, but in the decades since it became immobile, a significant amount of its mass has dissolved away. The timescale of TCE DNAPL migration for a moderate release is estimated to be on the order of several years, after which the DNAPL will become immobile (Reynolds and Kueper 2004). This suggests that the DNAPL likely reached its maximum extent decades ago. Residual DNAPL then diffused from the fractures and solution features into the rock matrix (primary porosity). Over time, as the quality of water in the fractures and solution features improved, the process of diffusion began working in reverse (which is called "back diffusion") and has been slowly releasing the VOCs stored within the rock matrix back into the fractures and karst features where it is transported away and diluted along the transport pathway, especially in the case of conduits, where the volume of flow and opportunity for mixing with clean water is much greater than in unweathered fractures.

Monitoring groundwater quality in karst aquifers is more challenging than in other settings. The permeability structure of karst aquifers is extremely heterogeneous and anisotropic. As explained in the karst section, above, this complexity means that typical approaches used to characterize the nature and extent of impacts to groundwater aren't as reliable as in other geologic settings. Monitoring wells don't often intercept the important transport pathways through which most of the groundwater flow occurs. Wells are more likely to screen intervals in the rock where groundwater is moving slowly, and the relative amount of flow (the flux) is slight. Some of these regions in the rock act as secondary sources of VOCs to groundwater, because in the past, unweathered fractures were invaded by DNAPL that is now slowly back diffusing out into the active flow system. Wells monitoring such zones will continue to exhibit elevated concentrations of VOCs for an extended period, even though the contaminant mass flux through them is relatively slight. Samples collected from such wells are effectively measuring the concentration of VOCs *stored* in the bedrock. Wells exhibiting some of the highest concentrations of VOCs, including MW18-12B, MW18-12C, MW18-14C, MW21-19C, and MW21-19D screen zones of relatively low-to-moderate permeability[6]. Samples collected from wells that monitor more permeable zones are a better measure of the quality of the water that is in transit through the aquifer. Such wells include MW06-9C, MW18-13C, MW21-16D, MW21-18C, MW21-18D, and MW21-20D.

The complexity of transport pathways in karst aquifers plays an important role in the distribution of impacted groundwater. Traditional "plumes" of impacted groundwater that extend long distances from the source area do not form in karst (Ewers et al. 2012). Groundwater in the primary porosity and much of the secondary porosity is moving relatively slowly toward, and bleeding into, the tertiary porosity (conduit network) that drains the bedrock. This means that the further one moves from the sources of contamination, the more the "plume" of impacted water resembles the geometry of the conduit network. This concept is illustrated in Inset 8.



Inset 8: (A) Conceptual extent of contamination (purple) emanating from a fixed contaminant source in a karst aquifer. With distance from the source, impacted groundwater becomes confined to the conduit network draining the aquifer; a true contaminant plume does not form. (B) Monitoring wells denoted with a "+" are useful in determining the extent of impacted groundwater. Wells denoted with an "x" monitor unimpacted regions of the aquifer. While not useless, data from such wells may be falsely interpreted to infer that the extent of impacted groundwater has been characterized.

Also apparent in panel (B) of Inset 8 is the concept that tributary conduits that join the network downgradient of the contaminant source serve to dilute the concentration of dissolved contaminants along the flow path.

In karst aquifers, the extent of impacted groundwater cannot be defined with the accuracy that is practicable in other geologic settings. Conducting dye tracing can help bound the impacted region and pinpoint the areas where groundwater-of-interest discharges at the surface, supplementing monitoring well data and supporting risk assessment and remedial decision making. Tracing must be performed by practitioners who are knowledgeable and experienced in performing such studies. The necessary first step in scoping a potential tracer study is performing reconnaissance of stream reaches-of-interest to identify springs and other potential tracer-monitoring sites. Results of the reconnaissance can be used to develop a tracer-study work plan.

[6] Permeability is qualitatively estimated based on pumping rate and drawdown data collected during well sampling.

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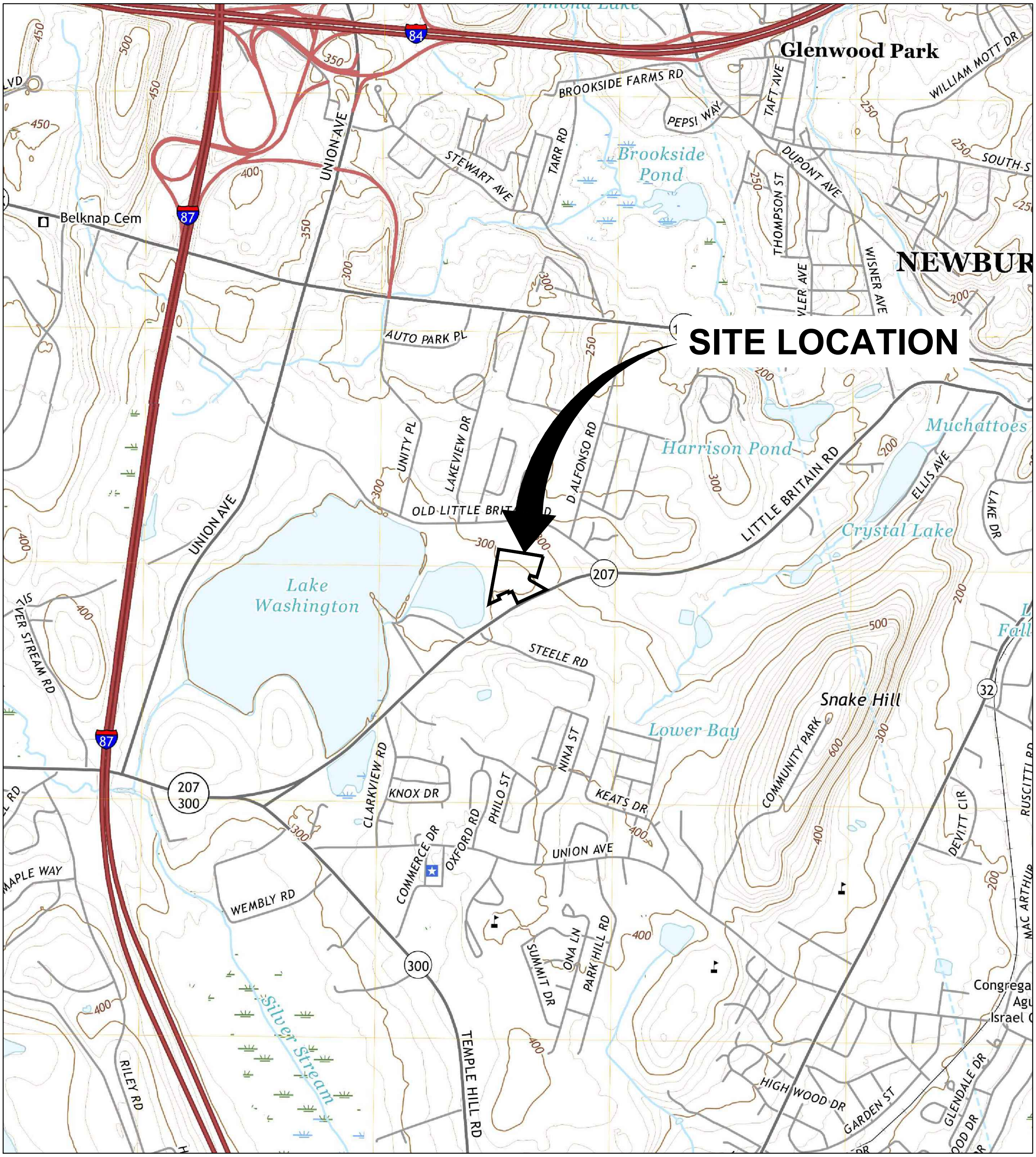
Enclosures:

Figure 1 – Site Location and Topographic Setting
Figure 2 – Surface Water Bodies and Drainage Channels
Figure 3 – Comparison of Historical and Current Mapping
Figure 4 – Bedrock Surface Map
Figure 5 – Bedrock Geologic Map
Figure 6 – Fracture Analysis Results – All Fractures
Figure 7 – Fracture Analysis Results – Partially Open Fractures
Figure 8 – Fracture Analysis Results – Open Fractures
Figure 9 – Fracture Analysis Results – Solution-Widened Features
Figure 10 – Water Table Map, December 2021
Figure 11 – MW18-10B Hydrographs
Figure 12 – MW18-12C Hydrographs
Figure 13 – Deep Bedrock Regional Hydraulic Gradient, December 2021
Figure 14 – Potential Discharge Locations for Site Groundwater

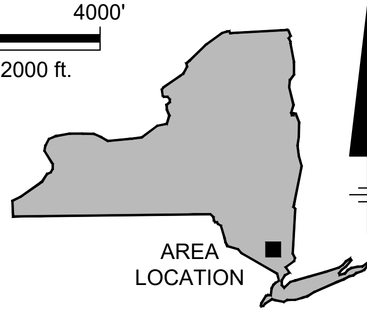
Figures



REFERENCE: BASE MAP USGS 7.5. MIN. TOPO. QUAD., CORNWALL-ON-HUDSON, NY, 2019 AND NEWBURGH, 2019, NY.

0 2000' 4000'

Approximate Scale: 1 in. = 2000 ft.



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BEDROCK CONCEPTUAL SITE MODEL

SITE LOCATION AND TOPOGRAPHIC SETTING

ARCADIS

FIGURE
1

IMAGES:
NY_Cornwall-on-Hudson_20190916_TM_geo.tif
NY_Newburgh_20190923_TM_geo.tif

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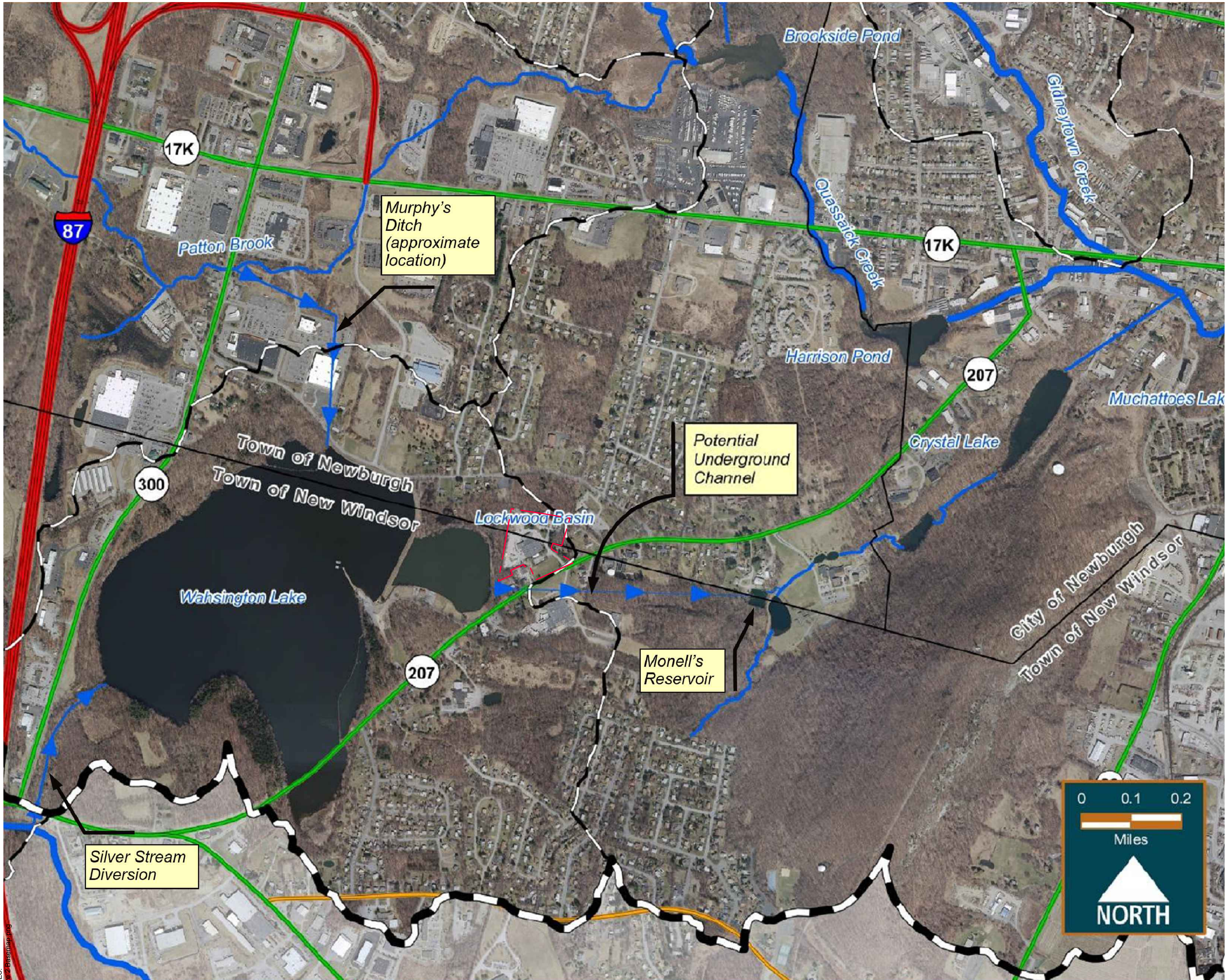

LEGEND:

- SITE BOUNDARY
- WATERSHED BOUNDARY
- SUBWATERSHED BOUNDARY
- CHANNEL
- STREAM

SOURCE:

ORANGE COUNTY PLANNING DEPT. 2014. QUASSAICK CREEK WATERSHED MANAGEMENT PLAN. JUNE

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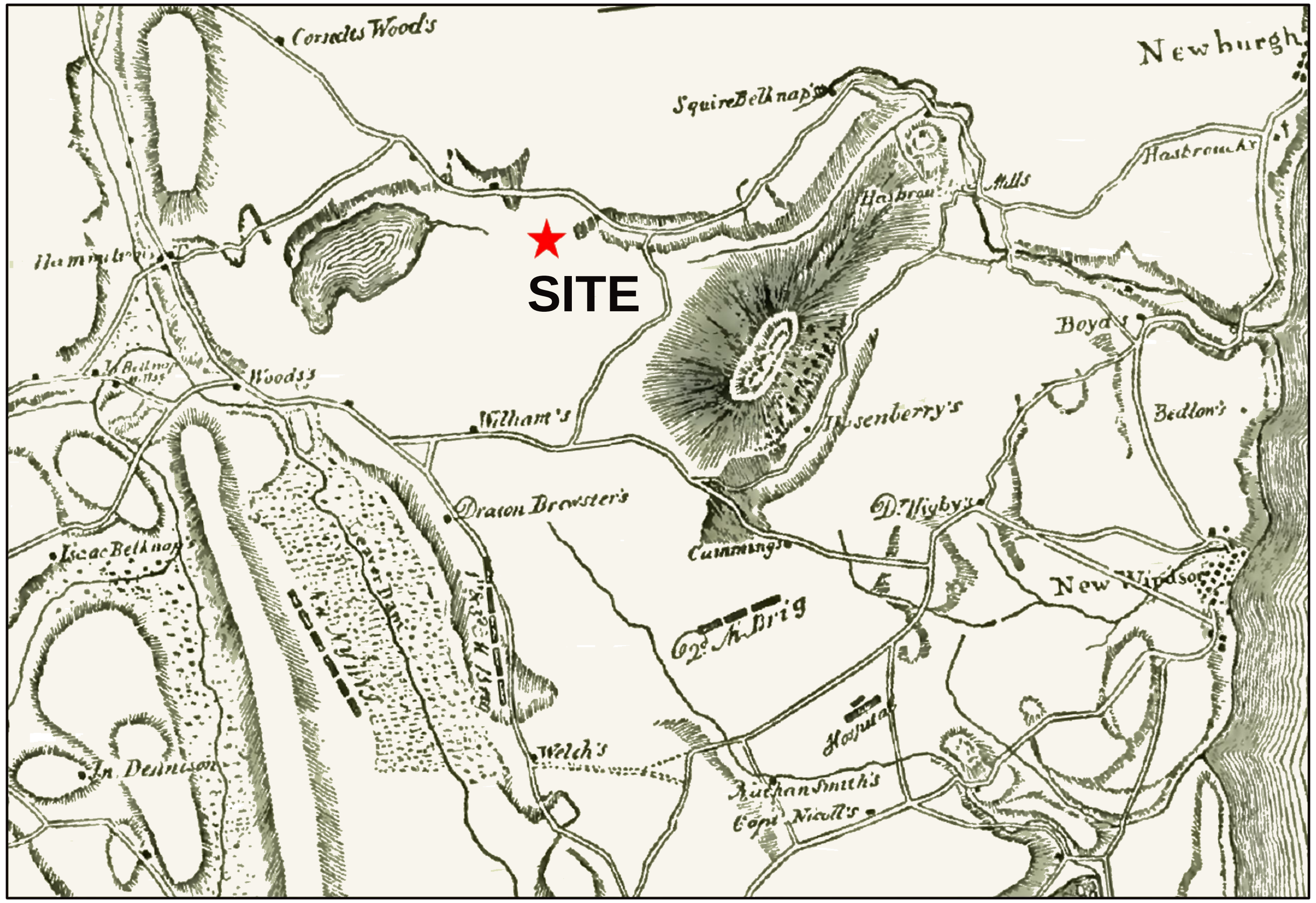
SURFACE WATER BODIES AND DRAINAGE CHANNELS

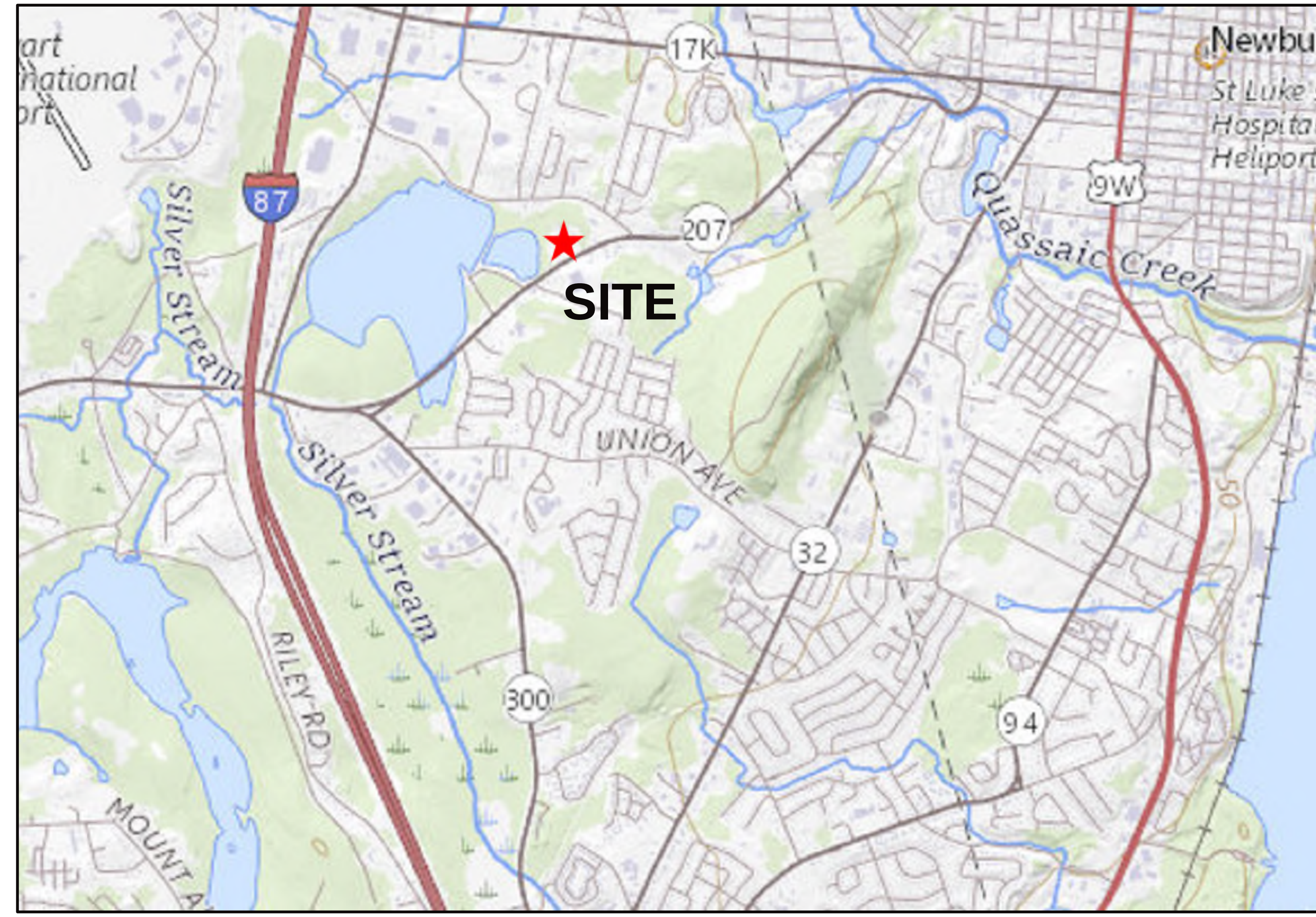
ARCADIS

FIGURE
2

1783



CURRENT



0 0.5 1.0

MILES

NOTES:

1. 1783 MAP IS AN EXCERPT FROM A MAP ENTITLED “THE WINTER CANTONMENTOF THE AMERICAN ARMY AND ITS VICINITY FOR 1783”, PREPARED BY S. DEWITT AND CONTAINED IN RUTTENBER (1911). MAP HAS BEEN ROTATED APPROXIMATELY 6 DEGREES WEST TO ACCOUNT FOR THE MAGNETIC DECLINATION AT THE TIME OF MAPPING.
2. SOURCE OF CURRENT MAP IS THE UNITED STATES GEOLOGICAL SURVEY NATIONAL MAP, AVAILABLE AT https://apps.nationalmap.gov/viewer/.

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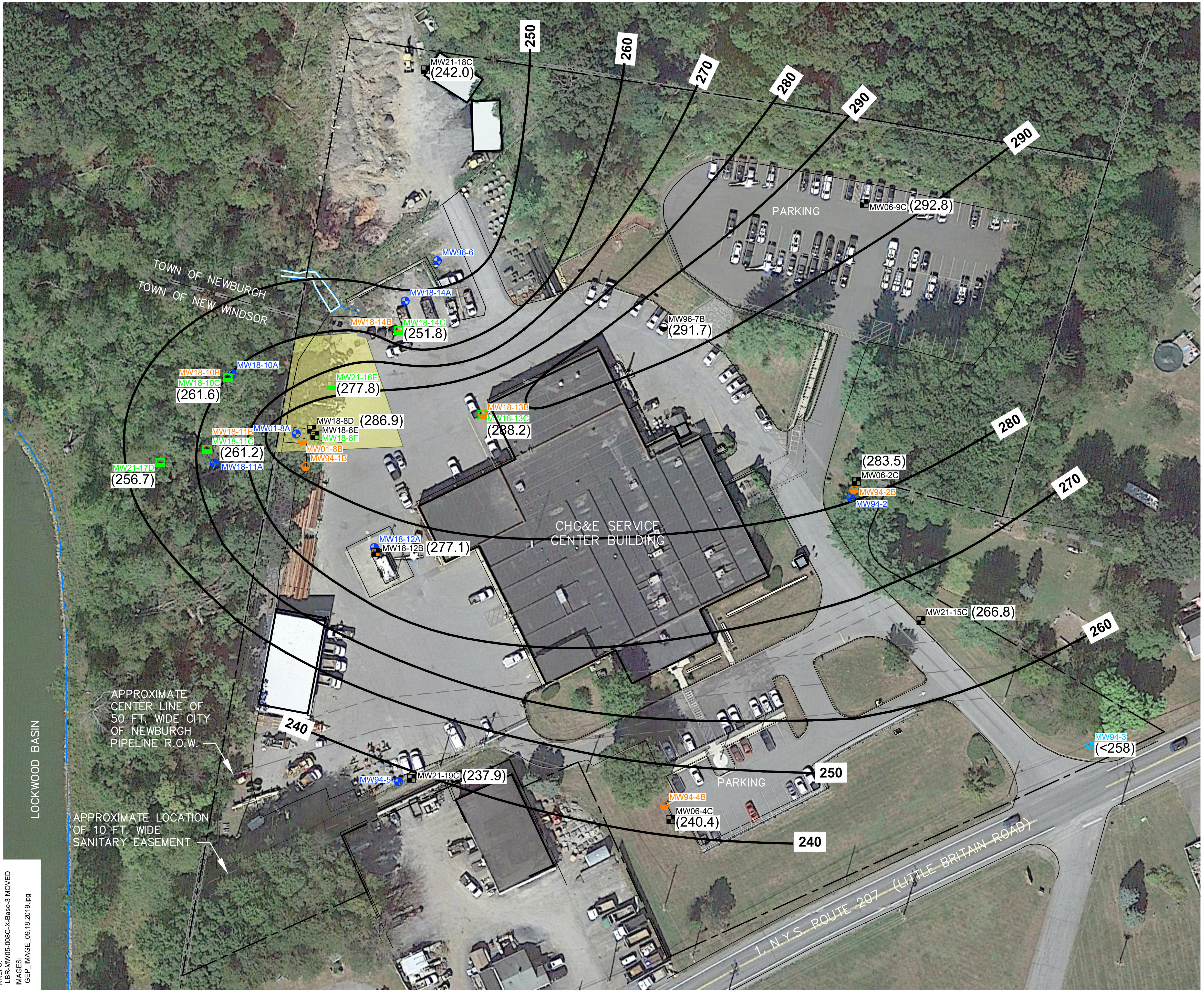
COMPARISON OF HISTORICAL AND CURRENT MAPPING

ARCADIS

FIGURE
3



LEGEND:

- OVERBURDEN MONITORING WELL
- UPPER BEDROCK MONITORING WELL
- INTERMEDIATE BEDROCK MONITORING WELL
- DEEP BEDROCK MONITORING WELL
- SITE PROPERTY LINE
- ADJACENT PROPERTY LINE
- PROPERTY EASEMENT
- FENCE
- STONE WALL
- (283.5) BEDROCK ELEVATION (FEET ABOVE MEAN SEA LEVEL)
- BEDROCK SURFACE CONTOUR
- ESTIMATED AREA OF SOIL REMEDIATION IN 2001

NOTES:

1. BASE MAP PREPARED FROM SURVEY PERFORMED BY CHAZEN ENGINEERING, LAND SURVEYING & LANDSCAPE ARCHITECTURE, CO., D.P.C., DATED 09/14/2017 TITLED: MAP OF ENVIRONMENTAL EASEMENT SURVEY PREPARED FOR CENTRAL HUDSON GAS AND ELECTRIC CORP., AT A SCALE OF 1"=50'.
2. ALL INVESTIGATION LOCATIONS AND BEDROCK CONTOURS ARE APPROXIMATE.
3. GOOGLE AERIAL IMAGE DATED 9/18/2019 DOWNLOADED ON 10/26/2021.
4. ELEVATIONS REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.

0 80' 160'

GRAPHIC SCALE

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BEDROCK CONCEPTUAL SITE MODEL

BEDROCK SURFACE MAP

ARCADIS

FIGURE
4

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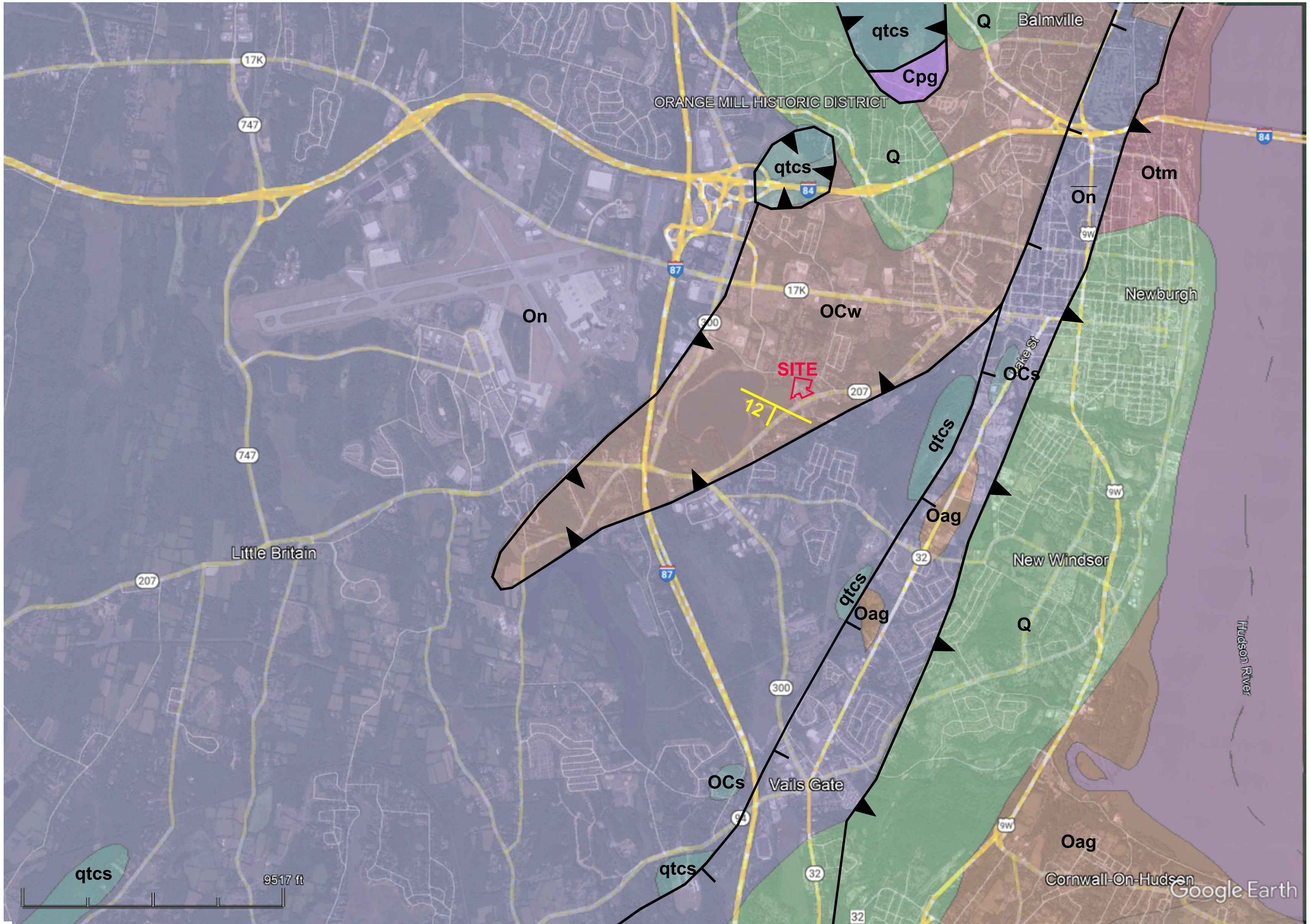

LEGEND:

THRUST OR REVERSE FAULT; SAW TEETH ON OVERTHRUST BLOCK

NORMAL FAULT; HACHURES ON DOWNTHROWN SIDE.

12 STRIKE AND DIP OF BEDDING (SEE NOTE 1)

Q	Glacial and alluvial deposits. Underlying bedrock geology unknown.
Oag	Austin Glen Formation – graywacke, shale.
On	Normanskill Formation – shale, argillite, siltstone.
Otm	Taconic Melange – chaotic mixture of pebble to block-size clasts in a pelitic matrix.
OCw	Wappinger Group dolostone.
OCs	Carbonate rocks occurring as slivers along thrusts of later allochthones.
Cpg	Poughquag quartzite – locally conglomeratic.
qtcs	Garnet-biotite-quartz-feldspar gneiss, quartzite, quartz-feldspar gneiss, calcsilicate rock.

NOTES:

1. FOR STRIKE AND DIP SYMBOL, THE LONG LINE REPRESENTS STRIKE DIRECTION, THE SHORT LINE THE DIP DIRECTION, AND THE NUMBER REPRESENTS THE APPROXIMATE DIP ANGLE.
2. STRIKE AND DIP SHOWN ARE BASED ON THE CALCULATED MAXIMUM EIGENVECTOR USING 182 BEDDING PLANES IDENTIFIED IN 1,590.6 FEET OF BOREHOLE LOGGED WITH ACOUSTICAL AND OPTICAL TELEVIEWERS.
3. BASE MAP FROM GOOGLE EARTH.

SOURCE:
SOURCE: FISHER, D.W., Y.W. ISACHSEN, AND L.V. RICKARD. 1970. GEOLOGIC MAP OF NEW YORK, LOWER HUDSON SHEET. NEW YORK STATE MUSEUM AND SCIENCE SERVICE, MAP AND CHART SERIES NO. 15.

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BEDROCK CONCEPTUAL SITE MODEL

BEDROCK GEOLOGIC MAP

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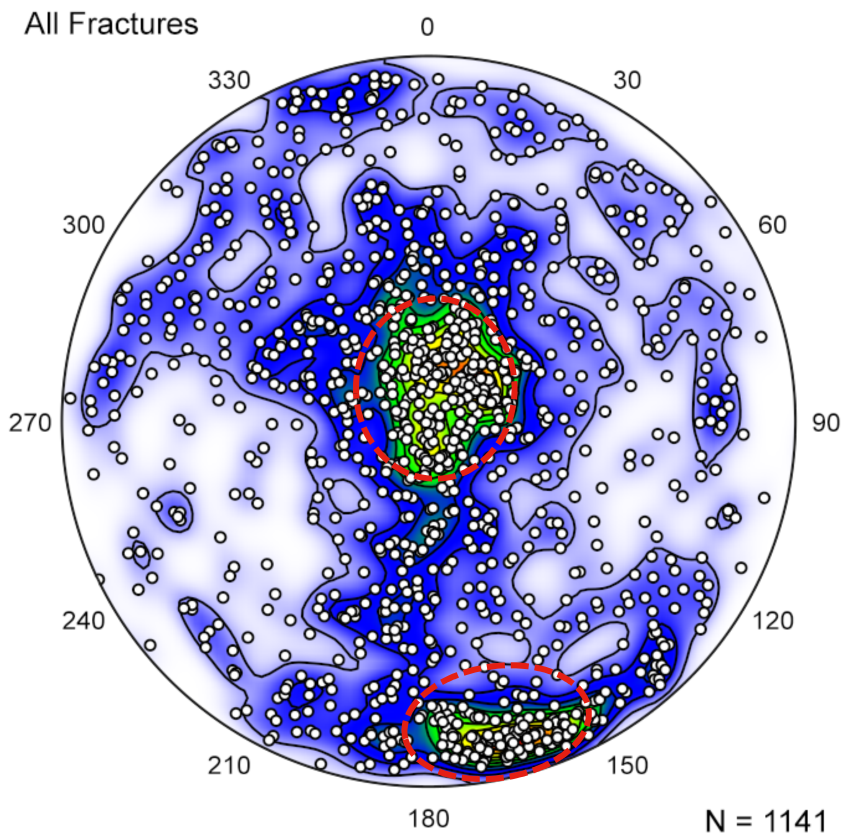
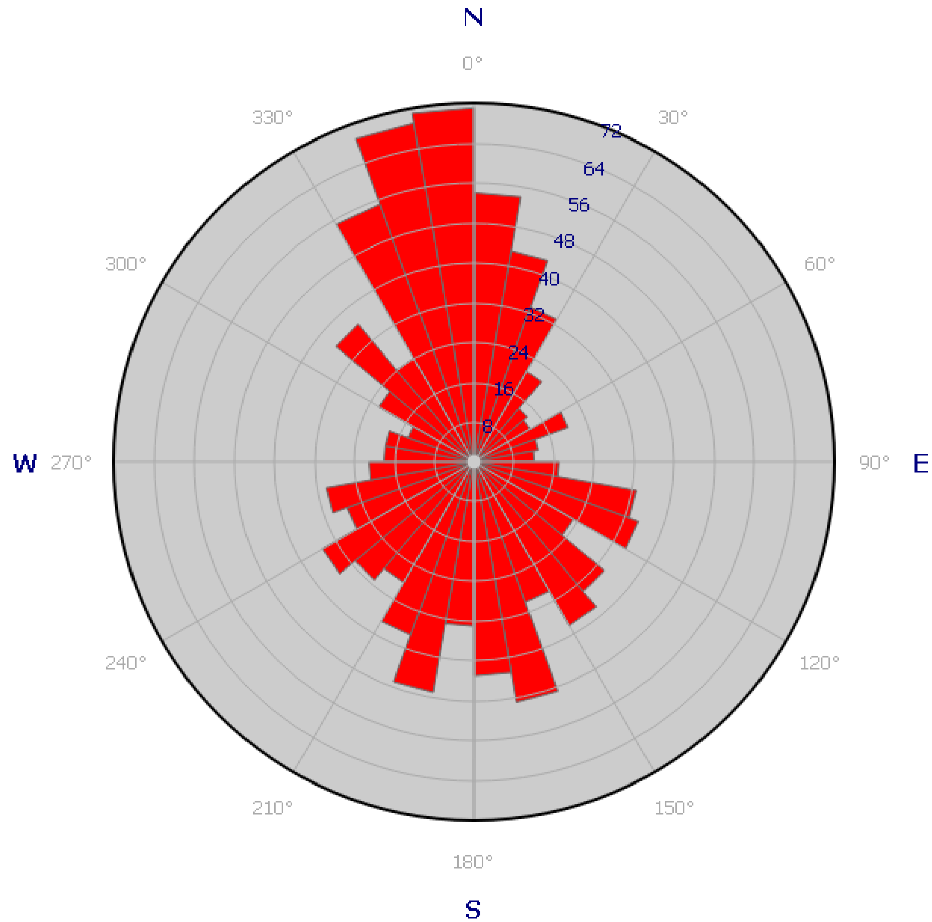
FIGURE
5



EQUAL AREA STEROGRAPHIC PROJECTION OF FRACTURE PLANE POLES WITH KAMB CONTOURS



EQUAL AREA HISTOGRAM OF FRACTURE DIP DIRECTION

NOTES:

1. CONTOUR INTERVAL IS 2 SIGMA (σ).
2. N = NUMBER OF FRACTURES.
3. DASHED ELLIPSES DENOTE DATA CLUSTERS.
4. FRACTURES IDENTIFIED USING DOWNHOLE OPTICAL AND ACOUSTIC TELEVIEWER LOGS, WHERE A TOTAL OF 1,590.6 FEET OF BOREHOLE WERE LOGGED AT 12 DRILLING LOCATIONS.

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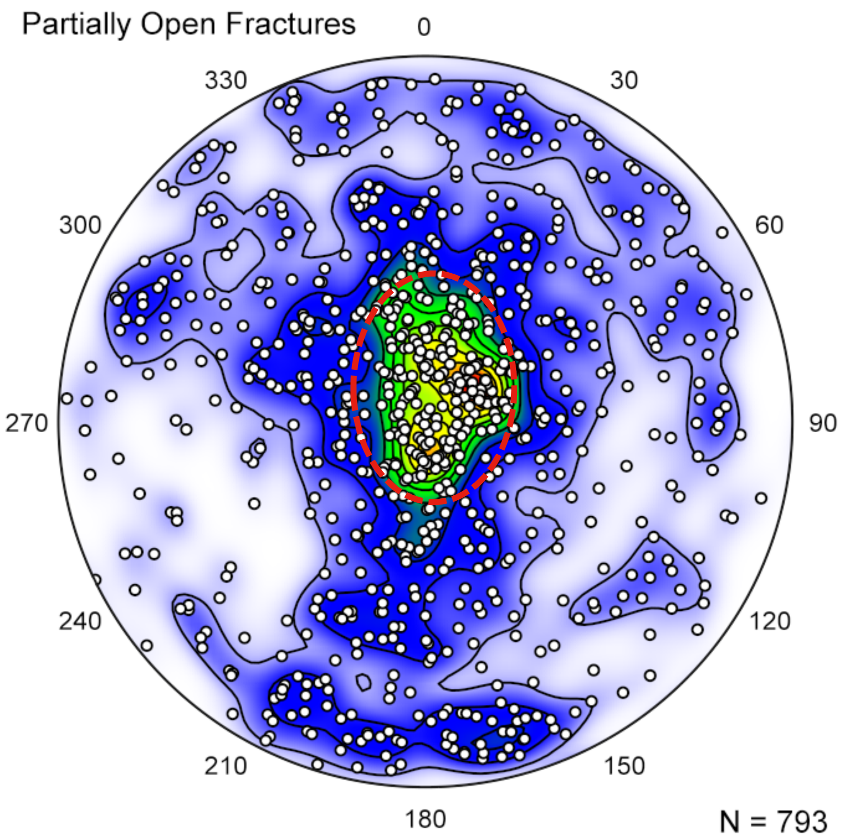
BEDROCK CONCEPTUAL SITE MODEL

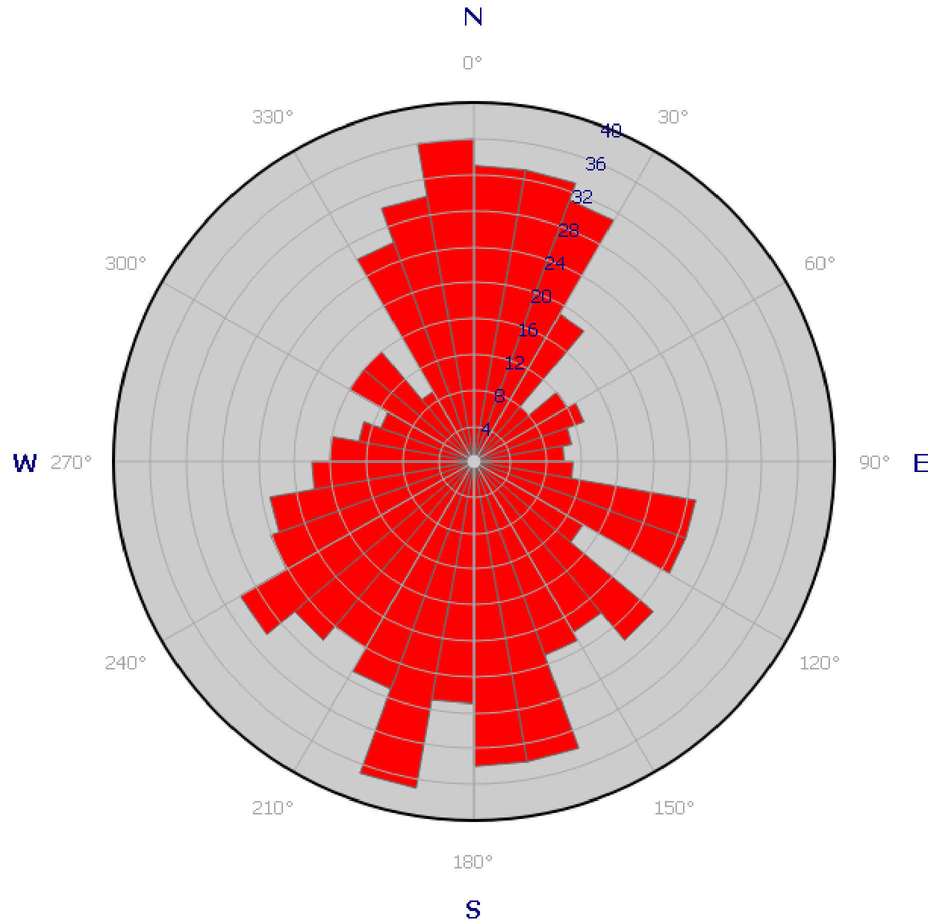
FRACTURE ANALYSIS RESULTS – ALL FRACTURES

ARCADIS

FIGURE
6



EQUAL AREA STEROGRAPHIC PROJECTION OF FRACTURES WITH KAMB CONTOURS



EQUAL AREA HISTOGRAM OF FRACTURE DIP DIRECTION

NOTES:

1. CONTOUR INTERVAL IS 2 SIGMA (σ).

2. N = NUMBER OF FRACTURES.

3. DASHED ELLIPSE DENOTES DATA CLUSTER.

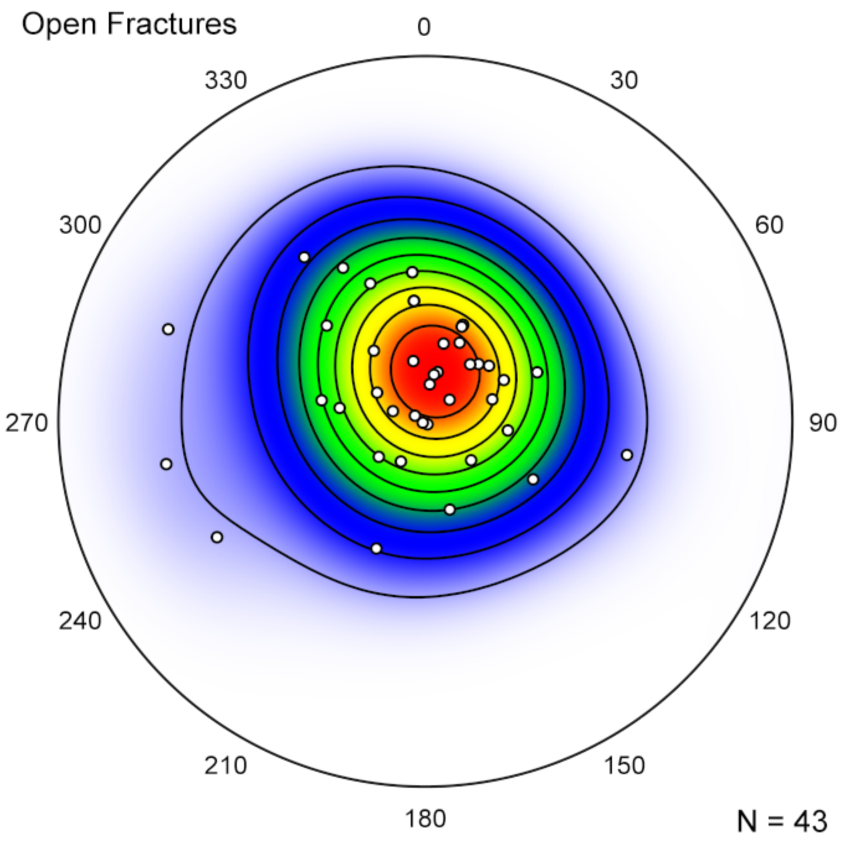
4. FRACTURES IDENTIFIED USING DOWNHOLE OPTICAL AND ACOUSTIC TELEVIEWER LOGS, WHERE A TOTAL OF 1,590.6 FEET OF BOREHOLE WERE LOGGED AT 12 DRILLING LOCATIONS.

CENTRAL HUDSON GAS & ELECTRIC CORPORATION
LITTLE BRITAIN ROAD SERVICE CENTER
NEW WINDSOR, NEW YORK
BEDROCK CONCEPTUAL SITE MODEL

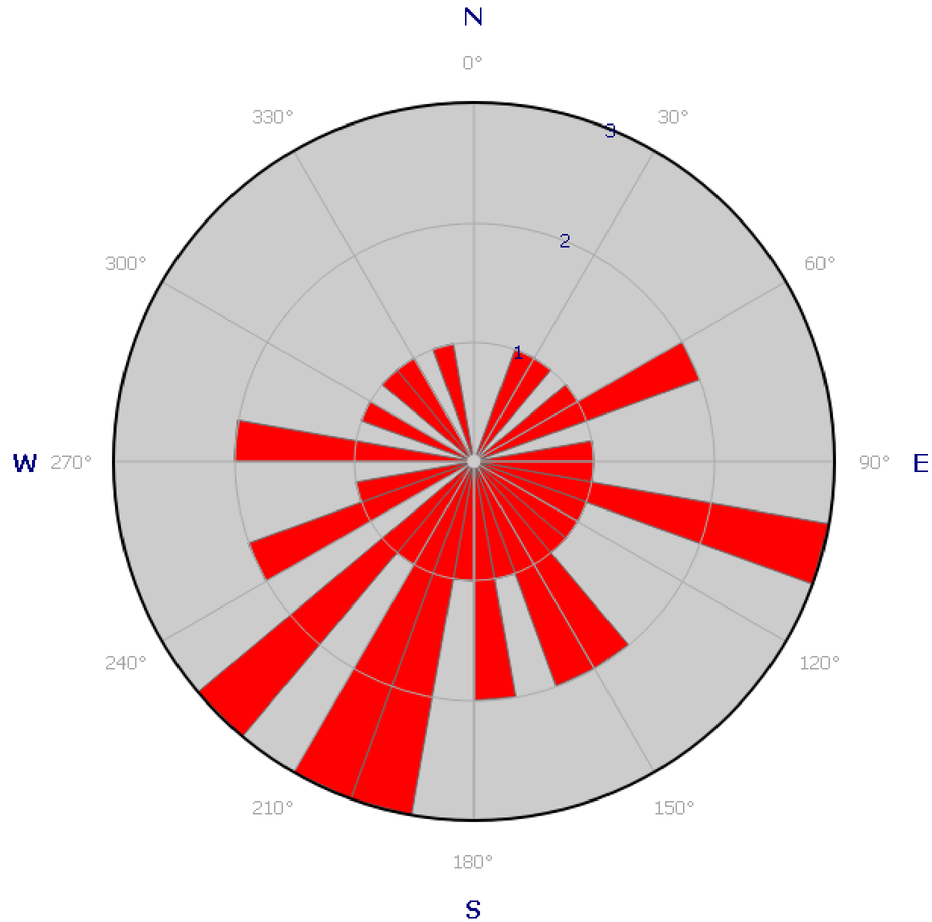
FRACTURE ANALYSIS RESULTS – PARTIALLY OPEN FRACTURES

ARCADIS

FIGURE 7



EQUAL AREA STEROGRAPHIC PROJECTION OF FRACTURES WITH KAMB CONTOURS



EQUAL AREA HISTOGRAM OF FRACTURE DIP DIRECTION

NOTES:

1. CONTOUR INTERVAL IS 2 SIGMA (σ).

2. N = NUMBER OF FRACTURES.

3. FRACTURES IDENTIFIED USING DOWNHOLE OPTICAL AND ACOUSTIC TELEVIEWER LOGS, WHERE A TOTAL OF 1,590.6 FEET OF BOREHOLE WERE LOGGED AT 12 DRILLING LOCATIONS.

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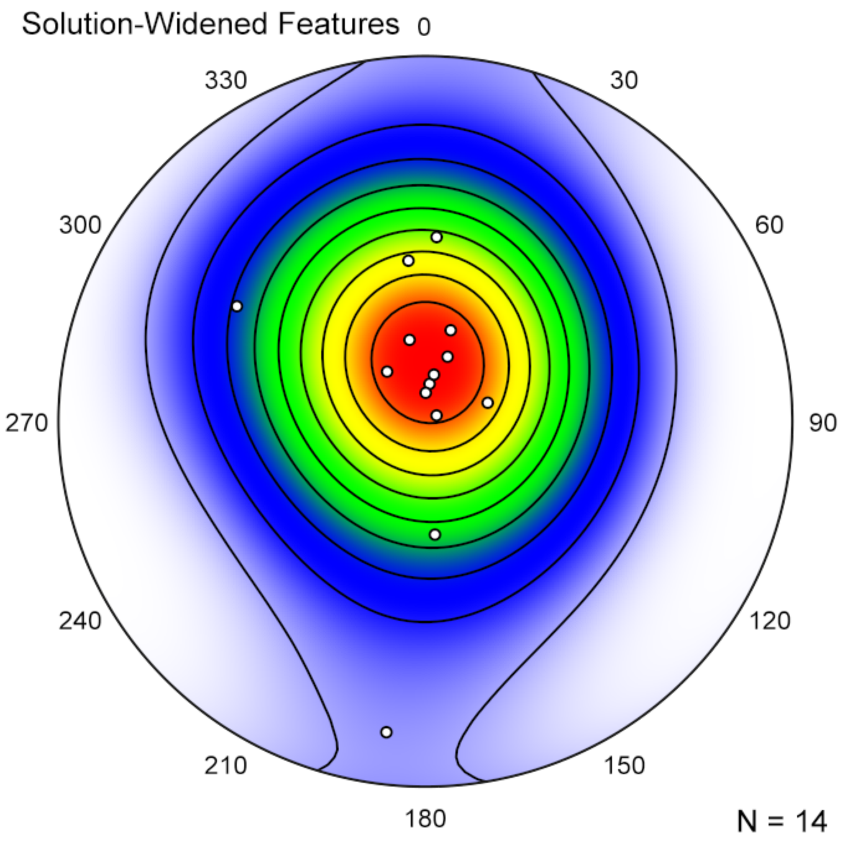
NEW WINDSOR, NEW YORK
BEDROCK CONCEPTUAL SITE MODEL

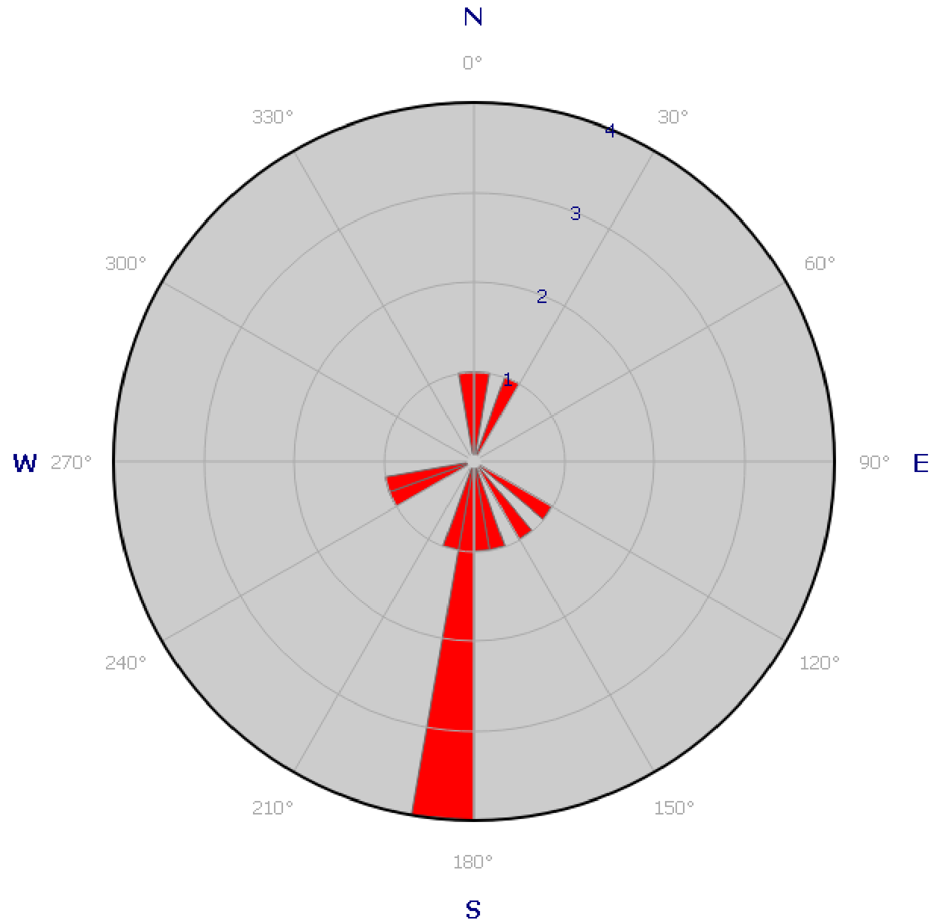
FRACTURE ANALYSIS RESULTS – OPEN FRACTURES

ARCADIS

FIGURE
8



EQUAL AREA STEROGRAPHIC PROJECTION OF FEATURES WITH KAMB CONTOURS



EQUAL AREA HISTOGRAM OF FEATURE DIP DIRECTION

NOTES:

1. CONTOUR INTERVAL IS 2 SIGMA (σ).

2. N = NUMBER OF FEATURES.

3. FEATURES IDENTIFIED USING DOWNHOLE OPTICAL AND ACOUSTIC TELEVIEWER LOGS, WHERE A TOTAL OF 1,590.6 FEET OF BOREHOLE WERE LOGGED AT 12 DRILLING LOCATIONS.

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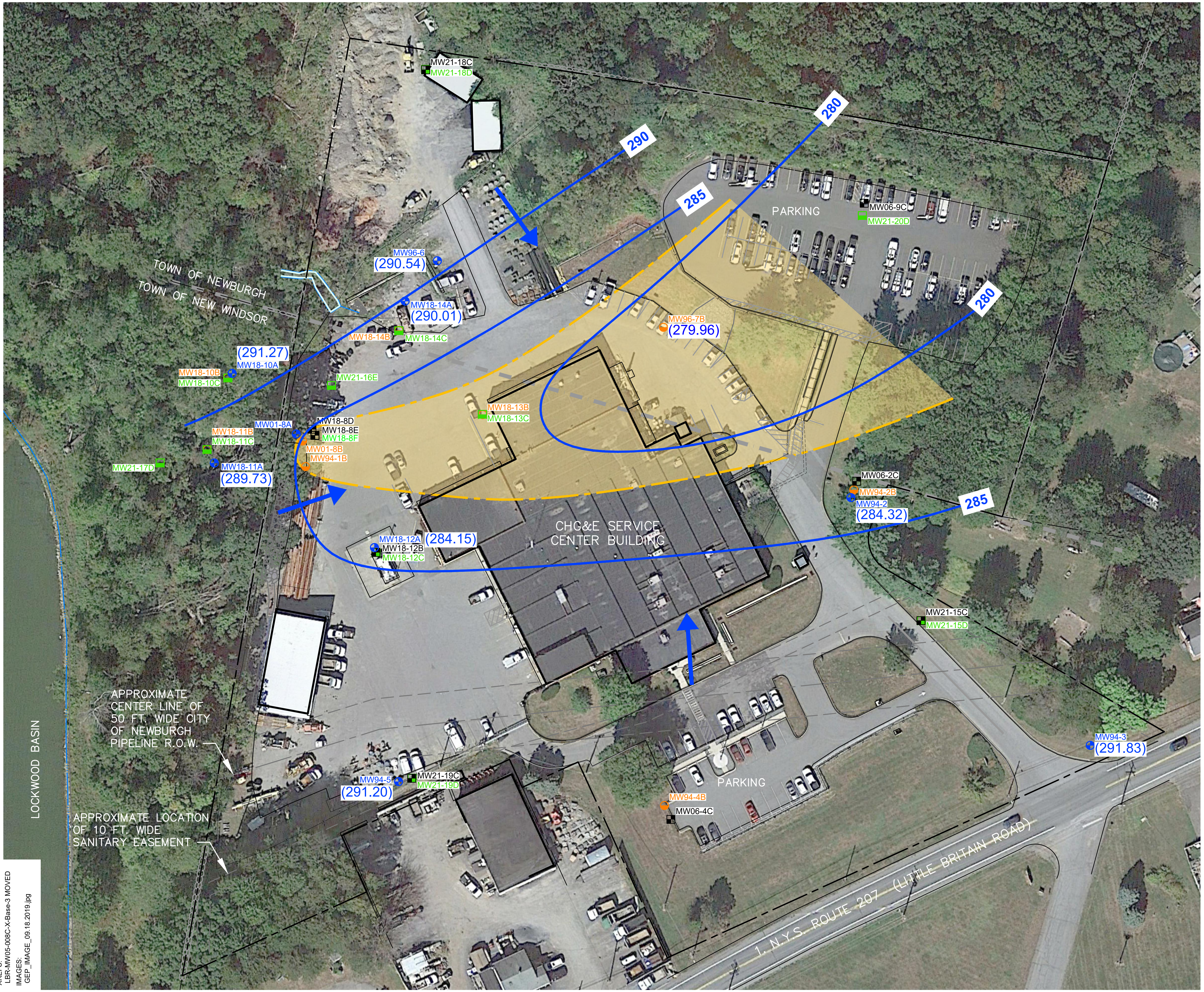
NEW WINDSOR, NEW YORK
BEDROCK CONCEPTUAL SITE MODEL

FRACTURE ANALYSIS RESULTS – SOLUTION-WIDENED FEATURES

ARCADIS

FIGURE
9



LEGEND:

- OVERBURDEN MONITORING WELL
- UPPER BEDROCK MONITORING WELL
- INTERMEDIATE BEDROCK MONITORING WELL
- DEEP BEDROCK MONITORING WELL
- SITE PROPERTY LINE
- ADJACENT PROPERTY LINE
- PROPERTY EASEMENT
- FENCE
- STONE WALL
- (290.54) GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
- WATER TABLE CONTOUR
- INFERRED DIRECTION OF SHALLOW GROUNDWATER MOVEMENT
- UNSATURATED OVERBURDEN (APPROXIMATE)

NOTES:

1. BASE MAP PREPARED FROM SURVEY PERFORMED BY CHAZEN ENGINEERING, LAND SURVEYING & LANDSCAPE ARCHITECTURE, CO., D.P.C., DATED 09/14/2017 TITLED: MAP OF ENVIRONMENTAL EASEMENT SURVEY PREPARED FOR CENTRAL HUDSON GAS AND ELECTRIC CORP., AT A SCALE OF 1"=50'.
2. ALL INVESTIGATION LOCATIONS AND GROUNDWATER CONTOURS ARE APPROXIMATE.
3. GOOGLE AERIAL IMAGE DATED 9/18/2019 DOWNLOADED ON 10/26/2021.
4. ELEVATIONS REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.

0 80' 160'
GRAPHIC SCALE

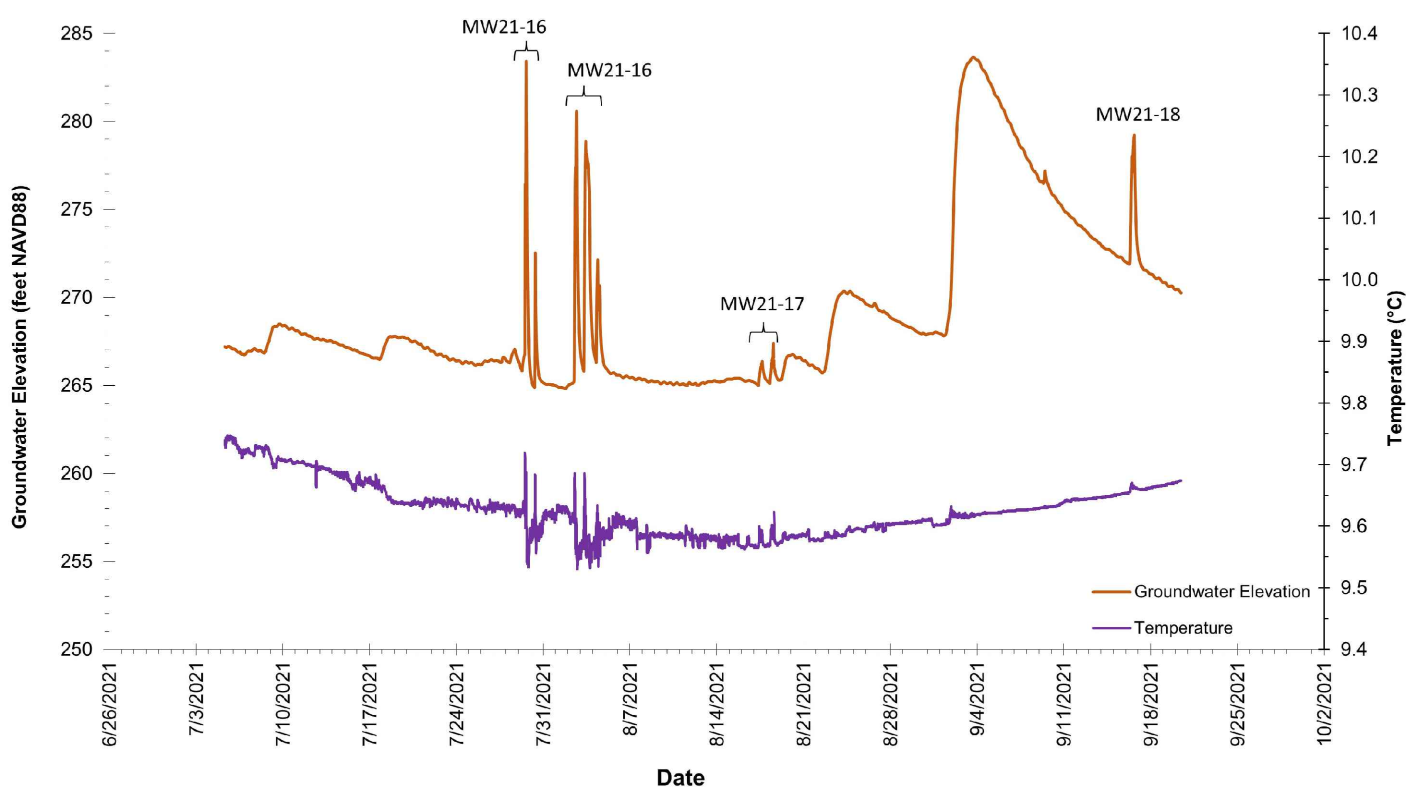
CENTRAL HUDSON GAS & ELECTRIC CORPORATION
LITTLE BRITAIN ROAD SERVICE CENTER
NEW WINDSOR, NEW YORK
BEDROCK CONCEPTUAL SITE MODEL

WATER TABLE MAP
DECEMBER 2021

ARCADIS

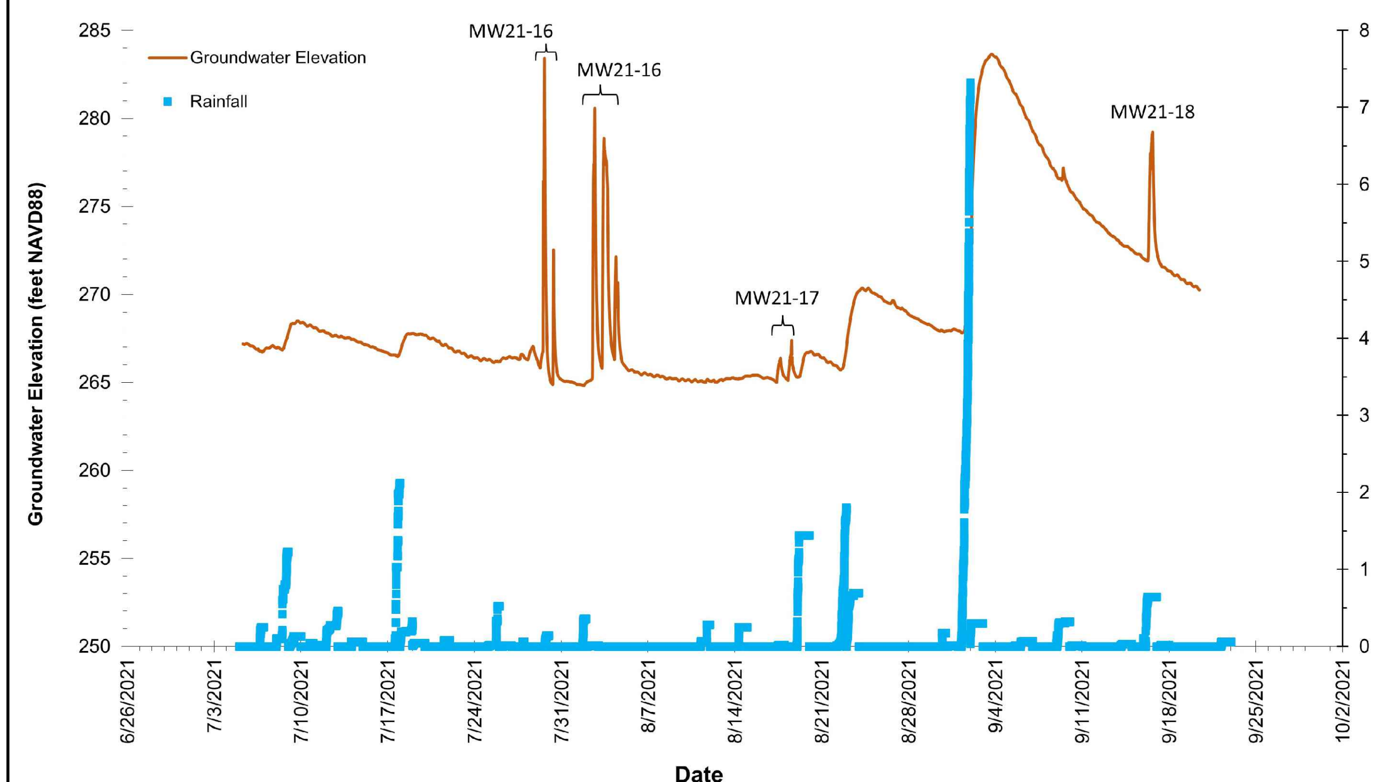
FIGURE
10

Hydrograph With Temperature Data



Notes:
Well ID labels denote hydraulic stresses imposed during drilling at those locations.
NAVD88 = North American Vertical Datum of 1988.

Hydrograph with Precipitation Data



Notes:
Well ID labels denote hydraulic stresses imposed during drilling at those locations.
NAVD88 = North American Vertical Datum of 1988.
Precipitation data from Weather Underground, Station KNYROCKT3.

CENTRAL HUDSON GAS & ELECTRIC CORPORATION
LITTLE BRITAIN ROAD SERVICE CENTER
NEW WINDSOR, NEW YORK
BEDROCK CONCEPTUAL SITE MODEL

MW18-10B HYDROGRAPHS

ARCADIS

FIGURE
11

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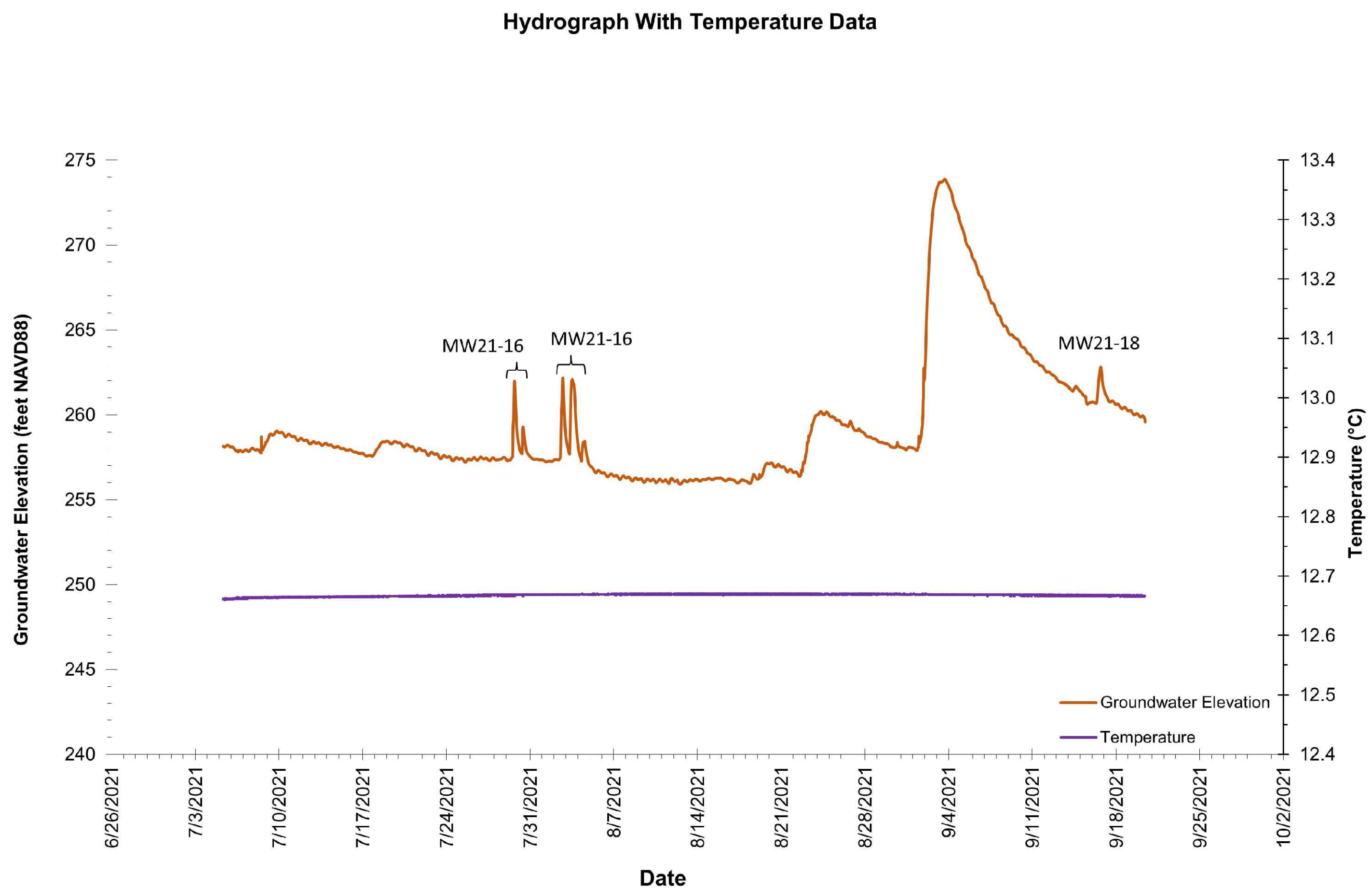
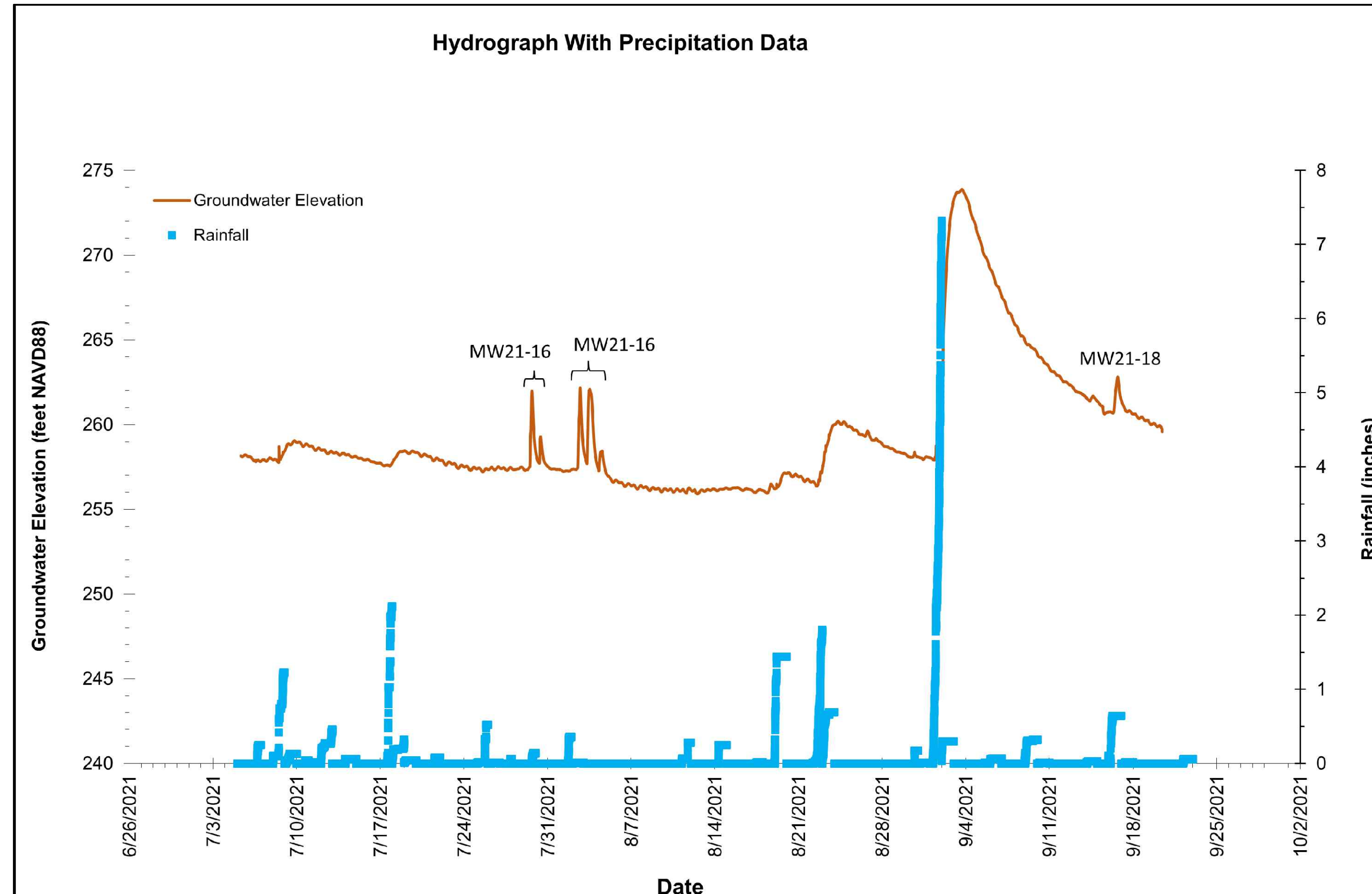
C-PA-PDF PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 10/19/2023 11:08 AM BY: POSENAUER, LISA
IMAGES:
MW18-12C PRECIP.png
MW18-12C TEMP.jpg



Notes:
Well ID labels denote hydraulic stresses imposed during drilling at those locations.
NAVD88 = North American Vertical Datum of 1988.



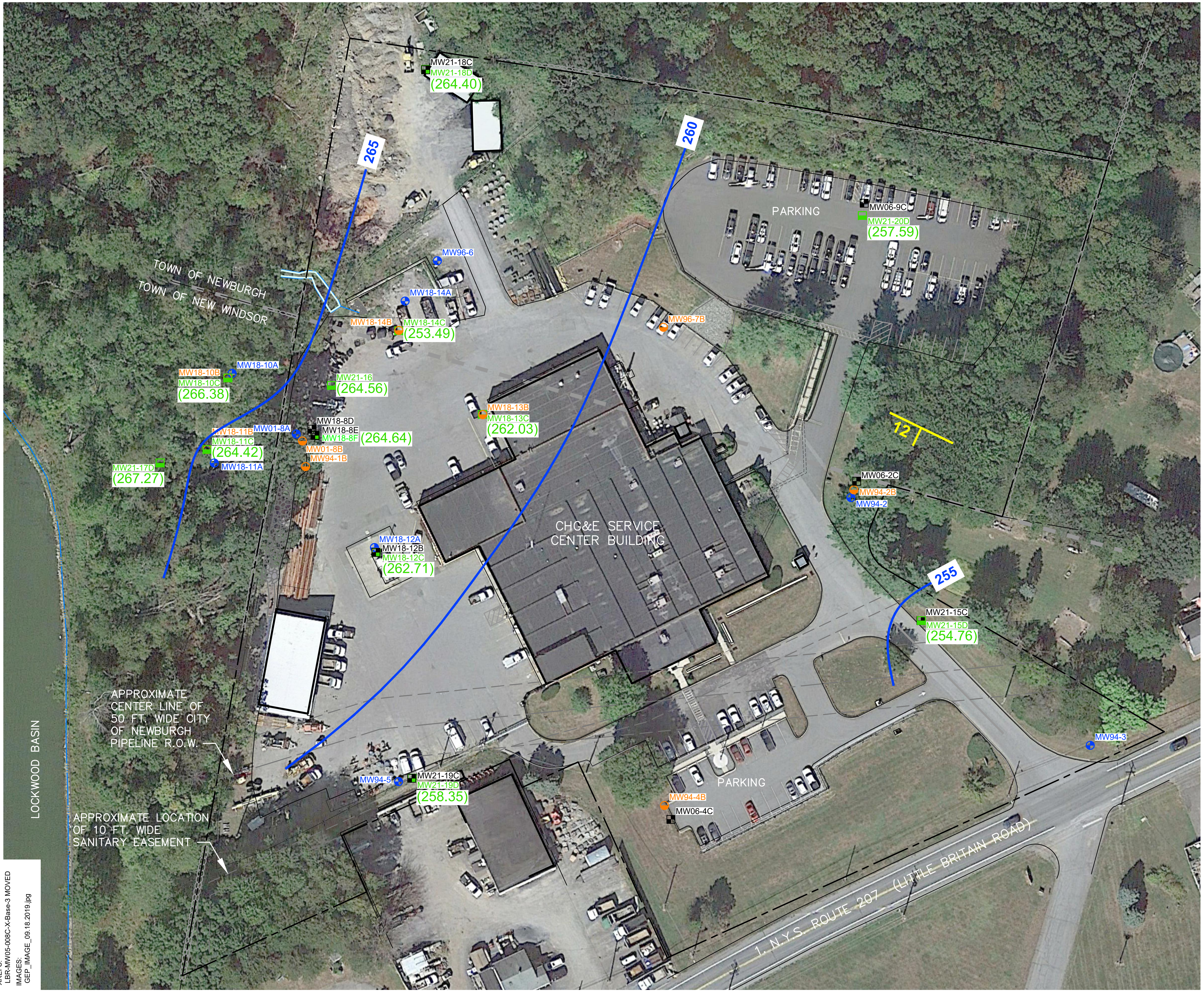
Notes:
Well ID labels denote hydraulic stresses imposed during drilling at those locations.
NAVD88 = North American Vertical Datum of 1988.
Precipitation data from Weather Underground, Station KNYROCKT3.

CENTRAL HUDSON GAS & ELECTRIC CORPORATION
LITTLE BRITAIN ROAD SERVICE CENTER
NEW WINDSOR, NEW YORK
BEDROCK CONCEPTUAL SITE MODEL

MW18-12C HYDROGRAPHS

ARCADIS

FIGURE
12



LEGEND:

- OVERBURDEN MONITORING WELL
- UPPER BEDROCK MONITORING WELL
- INTERMEDIATE BEDROCK MONITORING WELL
- DEEP BEDROCK MONITORING WELL
- SITE PROPERTY LINE
- ADJACENT PROPERTY LINE
- PROPERTY EASEMENT
- FENCE
- STONE WALL
- (254.76) GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
- POTENTIOMETRIC CONTOUR (FT NAVD88)
- 12 STRIKE AND DIP OF BEDDING (SEE NOTE 4)

NOTES:

1. BASE MAP PREPARED FROM SURVEY PERFORMED BY CHAZEN ENGINEERING, LAND SURVEYING & LANDSCAPE ARCHITECTURE, CO., D.P.C., DATED 09/14/2017 TITLED: MAP OF ENVIRONMENTAL EASEMENT SURVEY PREPARED FOR CENTRAL HUDSON GAS AND ELECTRIC CORP., AT A SCALE OF 1"=50'.
2. ALL INVESTIGATION LOCATIONS ARE APPROXIMATE.
3. GOOGLE AERIAL IMAGE DATED 9/18/2019 DOWNLOADED ON 10/26/2021.
4. FOR STRIKE AND DIP SYMBOL, THE LONG LINE REPRESENTS STRIKE DIRECTION, THE SHORT LINE REPRESENTS THE DIP DIRECTION, AND THE NUMBER REPRESENTS THE APPROXIMATE DIP ANGLE.
5. ELEVATIONS REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.

0 80' 160'

GRAPHIC SCALE

CENTRAL HUDSON GAS & ELECTRIC CORPORATION
LITTLE BRITAIN ROAD SERVICE CENTER
NEW WINDSOR, NEW YORK
BEDROCK CONCEPTUAL SITE MODEL

DEEP BEDROCK REGIONAL HYDRAULIC GRADIENT DECEMBER 2021

ARCADIS

FIGURE
13

XREFS:
LBR-MW05-008C-X-Base-3 MOVED
IMAGES:
GEP_IMAGE_09.18.2019.jpg

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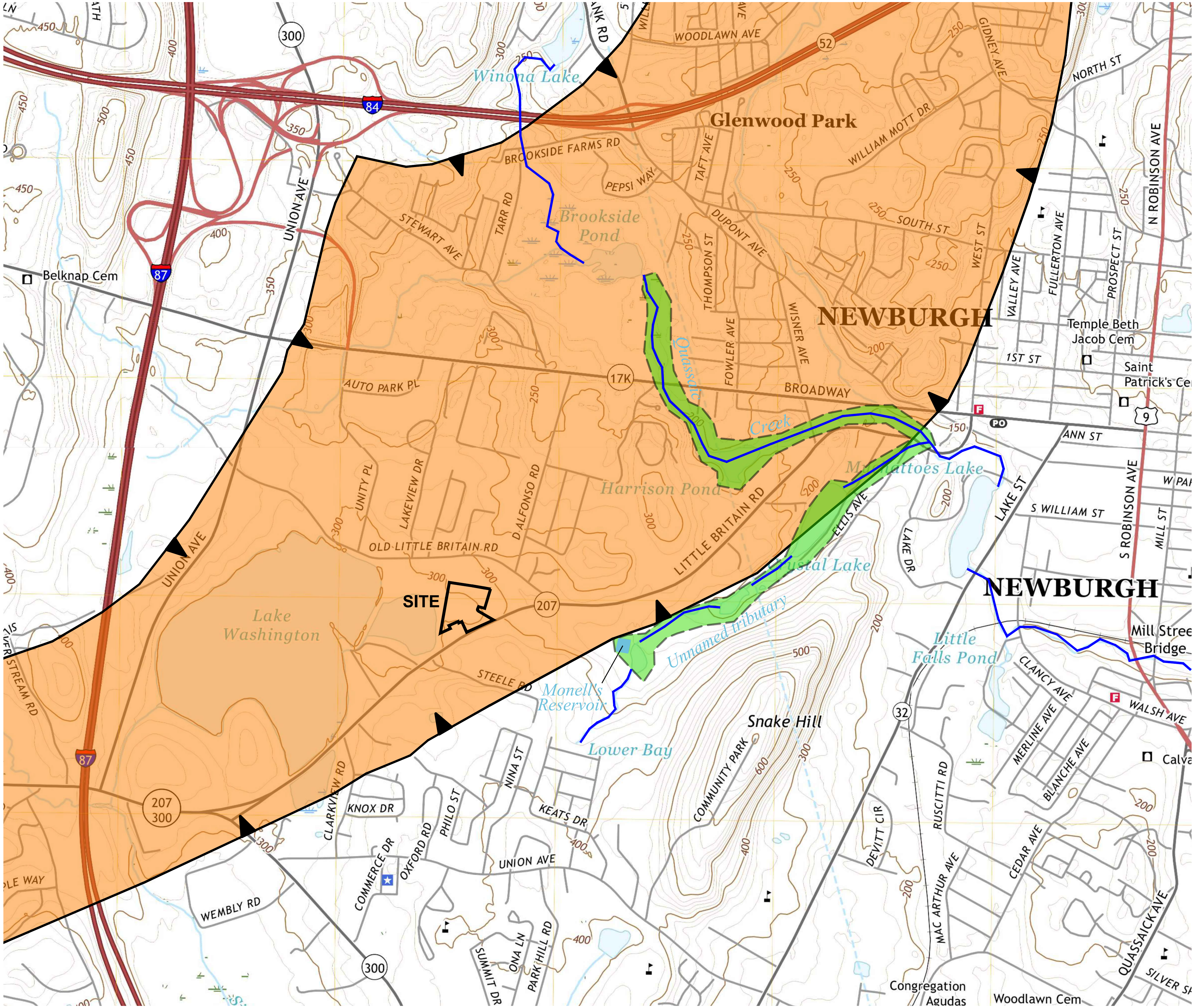

LEGEND:

WAPPINGER GROUP DOLOSTONE

STREAM REACHES THAT MAY CONTAIN SPRINGS DRAINING SITE BEDROCK GROUNDWATER

THRUST OR REVERSE FAULT; SAW TEETH ON OVERTHRUST BLOCK

NOTES:

1. BASE MAP USGS 7.5. MIN. TOPO. QUAD., CORNWALL-ON-HUDSON, NY, 2019 AND NEWBURGH, 2019, NY.
2. LIMITS OF WAPPINGER GROUP INFERRED FROM FISHER ET AL. (1970).

0 1500' 3000'
GRAPHIC SCALE

CENTRAL HUDSON GAS & ELECTRIC CORPORATION
LITTLE BRITAIN ROAD SERVICE CENTER
NEW WINDSOR, NEW YORK
BEDROCK CONCEPTUAL SITE MODEL

POTENTIAL DISCHARGE LOCATIONS FOR SITE GROUNDWATER

ARCADIS

FIGURE
14