



TOWN OF NORTH CASTLE
WATER DISTRICT NO. 2
WILLOW POND LANE
PARCELS ASSESSMENT

(T) NORTH CASTLE, NEW YORK

PROJECT NO.: 31402081.000

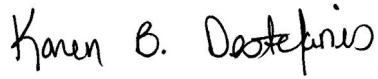
DATE: OCTOBER 2020

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1.0 INTRODUCTION

On behalf of the Brynwood Golf Club (Brynwood), WSP USA, Inc., and related company Hydrogeologic, Architecture, Land Surveying, Landscape Architecture Services, P.C. (WSP), formerly Leggette, Brashears & Graham, Inc. has evaluated the potential to develop a groundwater supply on two Town-owned parcels located on Willow Pond Lane at the Town of North Castle's request. The Town-owned parcels are located south of the Brynwood property (figure 1). Potential wells located on the Town-owned parcel(s) would be used to support the proposed Brynwood project which includes the development of 73-residential units and the renovation of an existing community clubhouse.

2.0 WATER DEMAND

The average water demand for the Brynwood project using the 2014 New York State Department of Environmental Conservation (NYSDEC) design standards is 34,154 gpd (gallons per day), which is about 23.7 gpm (gallons per minute). The New York State Department of Health (NYSDOH) requires that a water-supply source capacity equal or exceed the peak water demand of a service area with the best well out of service. For a proposed development, the peak water demand is calculated as twice the average water demand. Therefore, the water-supply source developed for Brynwood would need to have the capacity to produce 68,308 gpd or approximately 47.4 gpm with the most productive well (best well) out of service.

Brynwood has petitioned the Town of North Castle for extension of the District to encompass the approximate 156-acre Brynwood property and is currently in the District. However, a condition of the inclusion is that Brynwood will need to provide the District with additional water capacity.

In order to produce a sufficient volume of water for potable use by the proposed Brynwood development, it will be necessary to construct a well(s) with a minimum yield of 47.4 gpm. However, the Town has requested that a minimum of 100 gpm be developed by Brynwood from a new groundwater source(s). A bedrock groundwater exploration program was conducted in Winter 2020 on the southern portion of the Windmill Farms well field and was unsuccessful in developing a high-yielding well(s). The results of the bedrock groundwater exploration program were reviewed with the Town and the Town recommended a follow-up evaluation of potential groundwater exploration of alternative sites including two Town-owned undeveloped properties located on Willow Pond Lane (Parcels 101.04-1-44.4 and 101.04-1-40). The evaluation of developing a potential groundwater supply at these locations is presented below.

3.0 HYDROGEOLOGIC SETTING

Groundwater in the study region is primarily developed from the bedrock aquifer. Surficial maps show that the area is underlain by Ridgebury Loam soils (RdB) which are described as gently sloping to nearly level soils that are poorly drained. The overburden deposits underlying the area are mapped as glacial till. Till is characterized by non-sorted, non-stratified sediments which consist of poorly sorted clay, silt, sand, gravel and boulders that were deposited by glacial activity. This material is unsuitable for well development.

Bedrock underlying the till is comprised exclusively of Fordham Gneiss (f) (figure 2). Fordham Gneiss is a metamorphic bedrock unit that is typically described as hard, light-dark banded, occasionally foliated, coarse-grained gneiss and amphibolite. The dense fabric of gneiss bedrock units is generally unfavorable for storage or transmission of groundwater and is resistant to weathering. This unit exhibits very low primary permeability based

on the porosity of the rock. However, the permeability of a bedrock unit depends on the degree of secondary porosity and permeability. Groundwater occurs in bedrock units in these secondary pores, joints and fractures and the yield of bedrock aquifers can vary greatly, depending not only on the bedrock type, but the secondary porosity and permeability (degree of interconnection of the fractures, joints and other secondary openings).

4.0 BEDROCK AQUIFER

The private water supplies in the area of Willow Pond Lane are developed in the bedrock aquifer that underlies the entire study region. Typically, wells drilled in the Fordham Gneiss unit will likely not yield sufficient water for development as a public water-supply well. However, test wells that were drilled in this bedrock unit on the Brynwood property have yields ranging from 40 to 55 gpm.

4.1 Fracture-Trace Analysis

One of the techniques employed in selecting well locations for developing high-yield water wells from the bedrock aquifers in the study region is a fracture-trace analysis. Fracture-trace maps include the delineation of faults, fracture-trace joint systems, old river and stream courses and major unconformities. These features frequently are indications of fractured or weathered zones within the bedrock and their identification is a useful tool in selecting favorable well sites for bedrock wells. The fracture-trace analysis completed for the study parcel is located on figure 3. Several prominent fracture features have been identified on the northern parcel 101.04-1-44.4. In addition to the fracture traces, a fault line has been mapped on the western half of the northern parcel 101.04-1-44.4 and to a lesser degree the southern parcel (101.04-1-40) (figure 3).

The significant fault line, fracture trace area and the area where the fracture traces intersect on the property are the most promising features to develop a high-yield well (potentially up to 100 gpm).

5.0 GROUNDWATER EXPLORATION

In order to determine the yield of potential favorable well sites, test wells are recommended. Based on regional maps and information from the Brynwood property, the overburden material is limited in depth (ranging from 7 to 26 feet thick) and composed of till that will not yield appreciable water. Therefore, the exploratory drilling will focus on the bedrock. Prior to drilling, permits (i.e., Town wetland permit, Westchester County Department of Health) will need to be obtained, in addition to obtaining clearance from underground utilities. The NYSDOH also requires a minimum 100-foot radius of ownership and a 200-foot radius of sanitary control for a proposed public supply well.

WSP has identified five (5) proposed well locations, four located on parcel 101.04-1-44.4 and one located on 101.04-1-40, based on the hydrogeologic assessment that meet the NYSDOH well siting requirements for public water-supply wells (figure 4). WSP is recommending that one bedrock well be drilled initially to determine if sufficient quantities of water is present. The first location should be in close proximity to the on-site fractures that have been identified (Section 4.1).

A preliminary review of the NYSDEC online wetland map does not show a NYSDEC wetland or checkzone over either property. However, during a site inspection, onsite wetlands were observed and appear to be localized around the stream and pond. The Town of North Castle has jurisdiction of wetlands in this area and will likely

require a permit if the well(s) is located within a wetland or wetland buffer area. The wetland boundary may need to be flagged and surveyed to obtain the necessary permit from the Town prior to drilling.

5.1 Bedrock Well Drilling

The yield of a bedrock aquifer can be determined only by drilling a test well and conducting a pumping test. For the bedrock test wells proposed, and the anticipated rates based on the Brynwood wells, WSP recommends that an 8-inch diameter casing be installed and a 6-inch diameter test hole be drilled into the bedrock. The casing (minimum of 100 feet) should be installed and grouted into competent rock. The test well(s) would be drilled to a minimum depth of 500 feet, if a suitable yield is not encountered at a shallower depth. A hydrogeologist would analyze the water-production data obtained to 500 feet to determine if the well should be extended beyond 500 feet.

The test well(s) would be drilled by the conventional air rotary method, which is relatively fast and efficient in the type of rock found in the region. Installation of an 8-inch diameter well casing and drilling a 6-inch diameter borehole to 500 feet can usually be accomplished in three to four days. A hydrogeologist should provide partial supervision to examine the drill cuttings as they are flushed from the borehole and would also determine the depths at which water enters the hole by observing the flow during drilling. Knowledge of the depths of the water-bearing fractures is essential information for interpreting pumping test data and in determining the depth at which to set the permanent pump.

A 72-hour pumping test would be required to be conducted on any successful test well(s). If nearby domestic wells are located within the area of the test well, an offsite well monitoring program would also be required. If two or more wells are to be tested, a simultaneous pumping test may be conducted to save costs and to simulate multiple-well pumping conditions. The pumping test should include water-level recovery measurements periodically on both the pumping and offsite monitoring wells for a minimum of 72 hours following shut down of the test.

Prior to shut down, water samples should be collected for analysis of all constituents listed in the New York State Sanitary Code, Part 5, Subpart 5-1, as well as for radon gas and microscopic particulate analysis (MPA), if required. MPA is required for any water source within 200 feet of surface water to determine if the groundwater source is under the direct influence of surface water (“Surface Water Treatment Rule”). The NYSDOH has recently promulgated maximum contaminant levels (MCL) values for the perfluorinated compounds PFOS and PFOA and for 1,4-dioxane. These compounds would also be included with the Part 5 analyses conducted on any successful test well. The data collected during the test would support an application for a public water supply permit from the NYSDEC.

6.0 CONCLUSIONS

The proposed connection of the Brynwood project to Water District #2 would require the development of an additional water-supply well(s). The current permitted yield of the Windmill Farms well field is 290 gpm with the best well out of service. This current yield is not sufficient to supply the combined peak water demand of Water District #2 and the Brynwood development of 295 gpm with the best well out of service.

Because the results of the bedrock groundwater exploration program at the Windmill Farms well field were unsuccessful, the Town recommended a follow-up evaluation of potential groundwater exploration at several locations, including the two Town-owned properties located on Willow Pond Lane.

Based on WSP's assessment, five potential bedrock test well locations have been identified that meet NYSDOH well siting requirements. Based on regional bedrock maps and confirmed by driller geologic well logs of the nearby Brynwood property, the underlying bedrock is the Fordham Gneiss formation. Typically this formation does not produce high-yielding wells unless they can be located in or in close proximity to any identified fractures. Fractures have been identified on the property in conjunction with a north-south running fault line. Test wells located at or near intersecting fractures and/or faults have a better probability of producing higher yielding wells (up to 100 gpm).

If a groundwater investigation of the Town-owned properties is pursued, WSP is recommending the proposed bedrock well location(s) be drilled using the conventional air-rotary drilling method to assess the yield potential for the bedrock underlying the study area. WSP would provide recommendations for additional well drilling based on the findings from the drilling of preliminary well location.

Prior to drilling any test well locations, a well site permit from WCDH would be needed in order to drill the test wells. In addition, a site survey and flagging of the onsite wetlands (wetlands need to be flagged before winter) will likely be required. Based on WSP's preliminary assessment it is likely that Town-regulated wetlands are present. WSP would work with the Town wetland consultant to obtain a Town Administrative Wetlands Permit to drill the test wells.

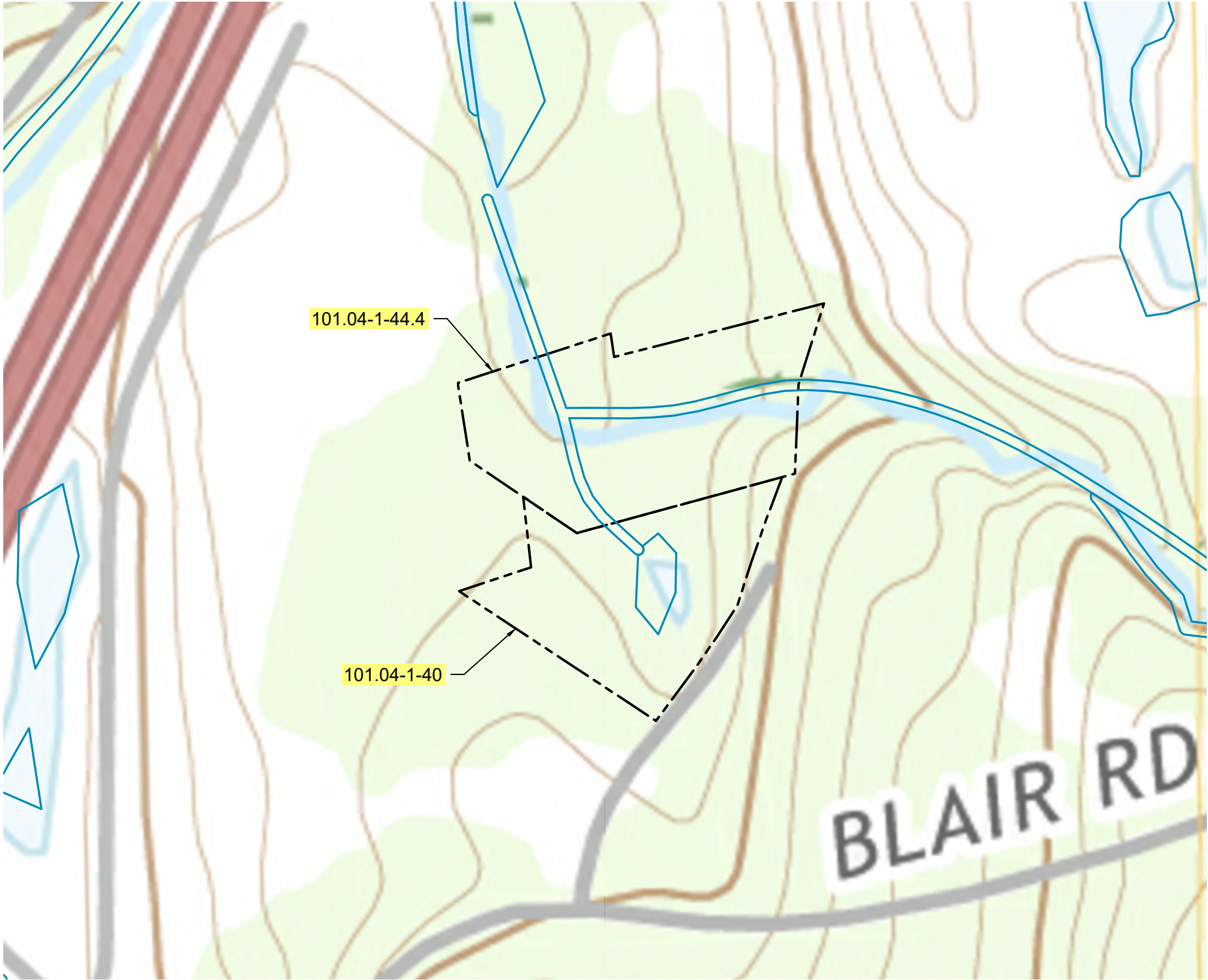
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October 2, 2020

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FIGURES



QUADRANGLE LOCATION

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE NATIONAL WETLANDS INVENTORY WETLANDS BOUNDARY

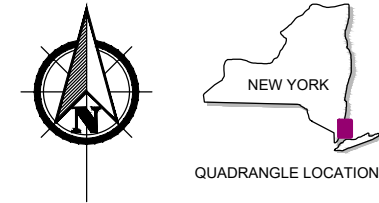
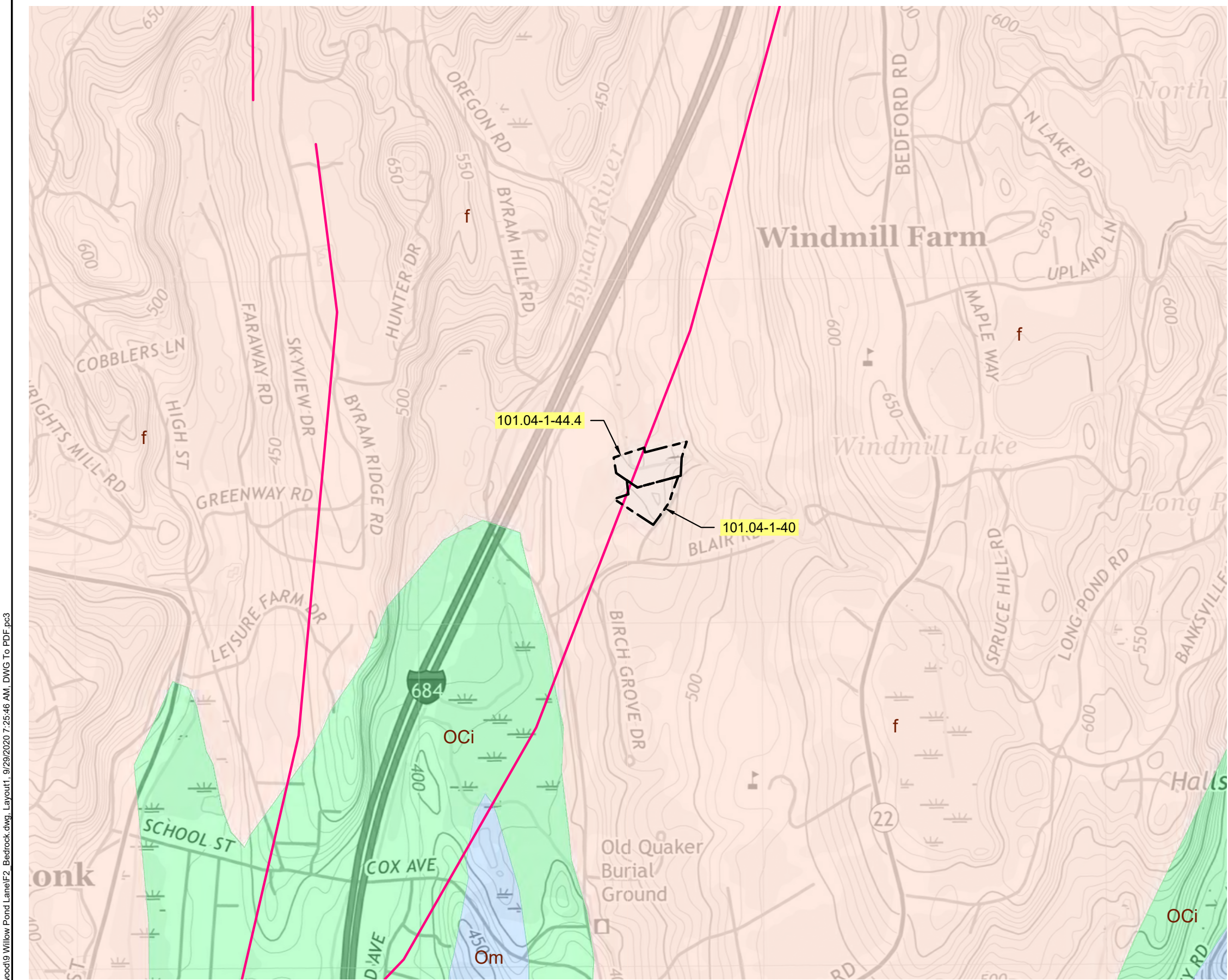
BRYNWOOD GOLF & COUNTRY CLUB
NORTH CASTLE, NEW YORK

WILLOW POND LANE PARCELS

DATE	REVISED	PREPARED BY:			
		 WSP USA 4 Research Drive Suite 204 Shelton, Connecticut 06484 (203) 929-8555			
DRAWN:	RAC	CHECKED:	KD	DATE:	09/24/20
				FIGURE:	1

SOURCE:
USGS TOPOGRAPHIC QUADRANGLE MOUNT KISCO, NEW YORK-CONNECTICUT (2019).

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- LEGEND**
- PROPERTY BOUNDARY
 - FAULT LINE
 - f FORDHAM GNEISS
 - OCi INWOOD MARBLE
 - Om MANHATTAN FORMATION

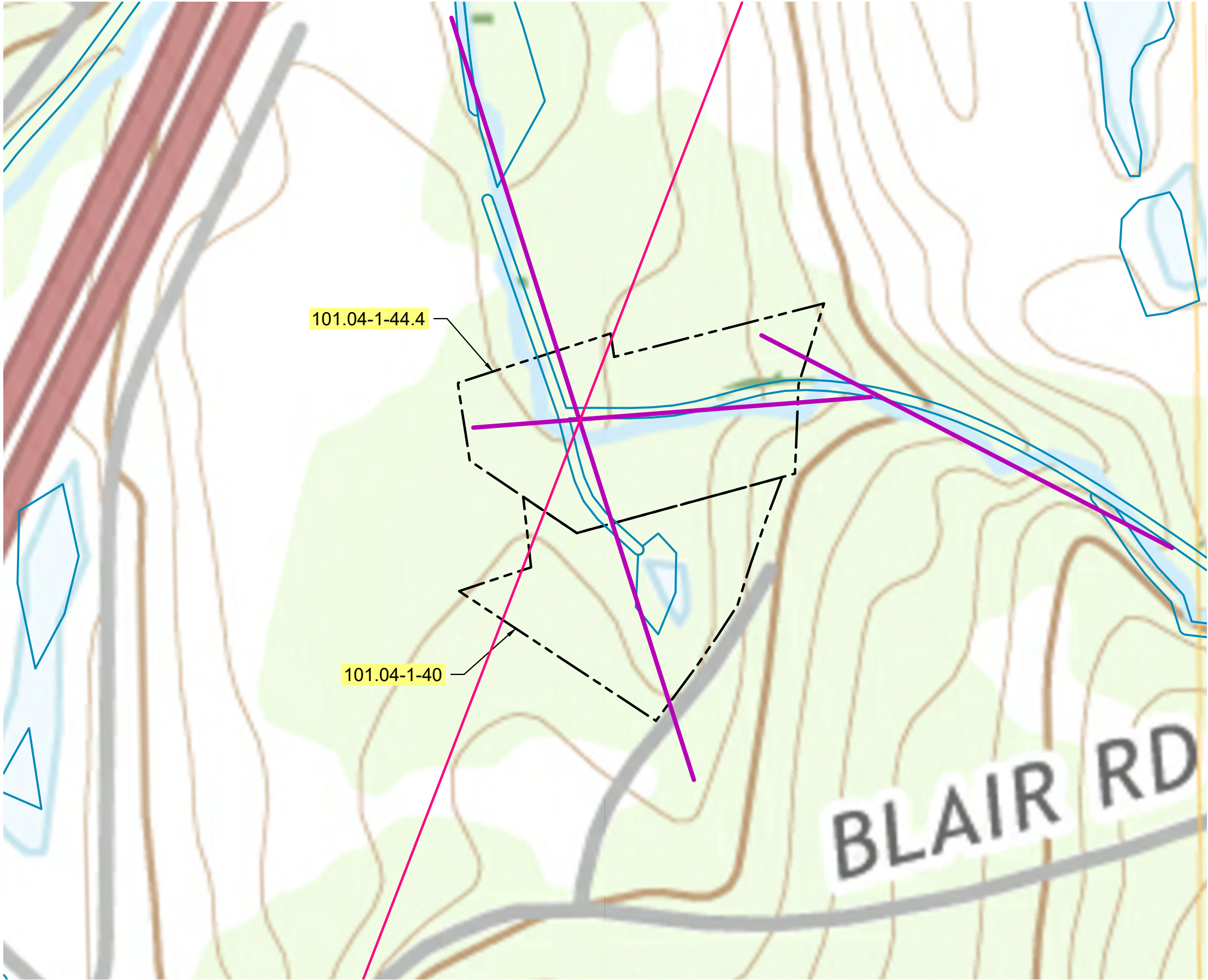
**BRYNWOOD GOLF & COUNTRY CLUB
NORTH CASTLE, NEW YORK**

BEDROCK GEOLOGY					
DATE	REVISED	PREPARED BY:			
		 WSP USA 4 Research Drive Suite 204 Shelton, Connecticut 06484 (203) 929-8555			
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				FIGURE:	2

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SOURCE:
USGS TOPOGRAPHIC QUADRANGLE MOUNT KISCO, NEW YORK-CONNECTICUT (2019).

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QUADRANGLE LOCATION

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE NATIONAL WETLANDS
INVENTORY WETLANDS BOUNDARY
- FRACTURE TRACE LINEAGE
- FAULT LINE

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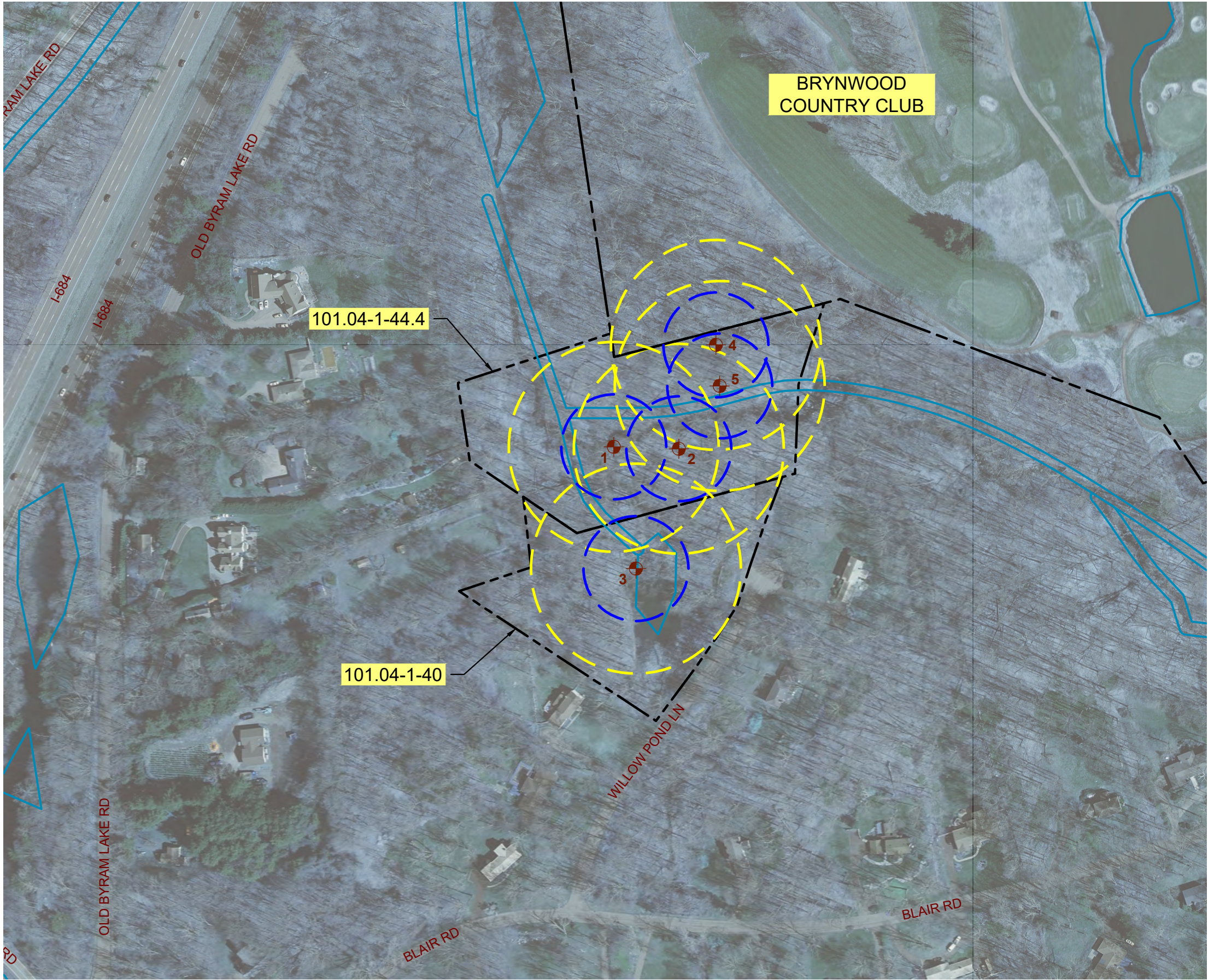
FRACTURE TRACE LINEAGE

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		 WSP USA 4 Research Drive Suite 204 Shelton, Connecticut 06484 (203) 929-8555		
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				FIGURE: 3

SOURCE:
USGS TOPOGRAPHIC QUADRANGLE MOUNT KISCO, NEW YORK-CONNECTICUT (2019).

0 200
SCALE IN FEET

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LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE NATIONAL WETLANDS INVENTORY WETLANDS BOUNDARY
- PROPOSED WELL LOCATION
- 100-FOOT RADIUS OF OWNERSHIP
- 200-FOOT RADIUS OF SANITARY CONTROL

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PROPOSED WELL LOCATIONS

DATE	REVISED	PREPARED BY:			
		WSP WSP USA 4 Research Drive Suite 204 Shelton, Connecticut 06484 (203) 929-8555			
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				FIGURE:	4

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SCALE IN FEET