Memorandum

To:	Candy McGarry, County Administrator, Nelson County	**Project:**	Nelson County Groundwater Well Evaluation
From:	Sandy Warner, Project Team Leader, CHA Consulting, Inc.	**Date:**	September 5, 2025
CHA PN:	093203	**RE:**	Potable Groundwater Water Source Evaluation for the Larkin Property

1.0 EXECUTIVE SUMMARY

CHA conducted a groundwater potential assessment for the Larkin Property, owned by the County, to evaluate its suitability for groundwater supply development for either public drinking water or non-potable water uses. The study included a review of onsite geologic conditions and comparison with other production wells in similar geological settings. Based on this analysis, the site was determined to have promising potential for groundwater development, particularly if a well is drilled into subsurface features such as fractures or faults.

To identify optimal drilling locations, CHA performed an electrical resistivity survey. This geophysical investigation revealed three potential subsurface targets for test well drilling. For each target, CHA provided cost estimates for initial development and future capital investment required for well field operation.

The estimated costs for each phase of development are summarized in the table below:

Task	Estimate Range of Costs Public Drinking Water Supply	Estimate Range of Costs Non-Potable Water Supply
Well Site Preparation	$20,500-$40,000	$20,500-$40,000
Well Site Local Approval and VDH Approval for Drilling Locations	$5,000	$3,500
Drilling Well for Target 1	$15,000-$20,000	$15,000-$20,000
Drilling Well for Target 2	$15,000-$20,000	$15,000-$20,000
Drilling Well for Target 3	$15,000-$20,000	$15,000-$20,000
48-hour Drawdown Testing and Water Quality Sampling on Target 1	$12,500	$5,000-$7,000*

Task	Estimate Range of Costs Public Drinking Water Supply	Estimate Range of Costs Non-Potable Water Supply
48-hour Drawdown Testing and Water Quality Sampling on Target 2	$12,500	$5,000-$7,000*
48-hour Drawdown Testing and Water Quality Sampling on Target 3	$12,500	$5,000-$7,000*
Preliminary Engineering Report and VDH Office of Drinking Water Permitting	$50,000	$25,000*
Total Estimated Development Costs	$158,000-$192,500	$109,000-$149,000

*A 48-hour drawdown test and water quality sampling would not be required if the well is not being used for drinking water. However, we would recommend completing at least an 8-12 hour test in order to gain understanding about the capacity and sustainability of the well and conduct a limited water quality assessment. Likewise, the VDH Office of drinking water permitting would not be required, but a PER to evaluate what distribution, treatment or other improvements are required to utilize the water for non-potable uses would be recommended.

2.0 BACKGROUND AND OBJECTIVES

In 2024 CHA Consulting Inc. completed a Water and Sewer Capacity Analysis for the Nelson County Larkin property that showed additional water source(s) would be needed to support future residential and recreational site development included in the master plan for the site. This analysis estimated an additional 81,940 GPD (or approximately 0.082 MGD) of water is needed to support future development of the property. As a follow-up to the 2024 analysis, CHA evaluated the Larkin property for groundwater supply wells to support future development of this property. Figure 1 provides an overview of the Larkin Property Location.

The following objectives formed the basis of the evaluation of the groundwater wells sites on the property for development a groundwater source:

1. Evaluate the geologic factors on site and well records in the general vicinity of the property to estimate potential well yields

2. Conduct a geophysical electrical resistivity survey to determine potential subsurface fractures for drilling test water wells.
3. Evaluate potential costs for drilling test wells and performing water quality sampling and drawdown yield tests on those wells.
4. Estimate permitting costs for a groundwater supply well.

3.0 GROUNDWATER YIELD ASSESSMENT FOR THE LARKIN PROPERTY

3.1 Well Yield Requirements

To meet the estimated daily water demand of 81,940 gallons, a well must produce approximately 60 gallons per minute (gpm) if operated continuously. However, Virginia's water regulations require that wells be rated based on a "safe yield," defined as 55% of the flow measured during a 48-hour performance test. Therefore, to achieve a rated capacity of 60 gpm, the 48-hour test must demonstrate a flow of at least 110 gpm. Achieving this may require multiple wells.

3.2 Geologic Context

The Larkin Property is located in Nelson County, within the Piedmont Province of Virginia. Groundwater in this region is influenced by topography and subsurface geologic structures such as fractures, faults, and bedding planes. The site is underlain by granite and gneissic rocks, covered by 30 to 100 feet of soil and weathered rock. Figure 2 shows the geologic map of the property, and Table 1 summarizes the rock units.

Table 1: Geologic Units Within Larkin Property Groundwater Study Area

Unit Name	Primary Rock Types	Groundwater Aquifer Significance
Yal	Alkali Feldspar Leucogranite	Flow through weathered rock and fractures.
Ybg	Biotite Monzogranite-Quartz Monzodiorite	Flow through weathered rock and fractures.
Yma	Layered Quartzofeldspathic Augen Gneiss And Flaser Gneiss.	Flow through weathered rock and fractures.

3.3 Nearby Well Yields

In Virginia's Piedmont region, groundwater well yields typically range from 3 and 20 gpm, though higher rates are possible in areas with significant fracturing. Several nearby communities in

Nelson County rely on wells for a portion of their public water supply. Table 2 lists wells in a similar geologic context near the Larkin Property, including production data and construction details where available.

Table 2: Public Water Supply Wells In the Vicinity of Larkin Site

Water System		Average Annual Production 2011-2019[1]		Well Diameter (inches)	Well Depth Casing(ft)/Total (Ft)	Well Yield (GPM)
		MGY	MGD			
Lovingston	NC#2-Payne Well	3.6	0.0099	6	50/300	28
	Peverrill Well	Inactive[3]				
	Well #9 - Dawson	3.6	0.0099	NA[2]	50/325	20
	Drug Store Well	Inactive				
	Social Services Well	Inactive				
Shipman Area	State Shed Well	1.50	0.0041	6	55/405	16
	Brown Well	1.00	0.0027	6	58/305	16
	Ryan School Well	Inactive				
Colleen Area	Bowling Well #1	7.9	0.0208	8	58/300	88
	Bowling Well #2	NA	NA	8	83/300	18
	Bowling Well #3	NA	NA	8	58/300	NA
	Bowling Well #4	Inactive				
	Bowling Well #5	Inactive				
	Bowling Well #6	Inactive				
	Rainbow Well #2	5.1	0.0140	6	40/140	NA
Tye River Elementary	Well 1	NA	NA	NA	NA	7.5
	Well 2	NA	NA	NA	NA	12
Scenic Hills Subdivision	Well 1	Inactive waterworks				
	Well 2	Inactive waterworks				
Lake Nelson Campground	NA	NA	NA	NA	NA	20

Notes: [1] Virginia Groundwater Extraction Non_Domestic Wells 2009 through 2019_WFL1; [2]NA = Not Available; [3]Inactive = Well is currently not in use. The well may have been abandoned or may be capped in case of future development.

3.4 Recharge and Sustainability

Groundwater recharge in the Tye River watershed is estimated to be approximately 16.99 inches/year (USGS, 1997). To support a withdrawal of 82,000 gallons/day (or 29.93 million gallons/year), a recharge area of approximately 36 acres is needed. The actual recharge zone will be influenced by fracture orientation, not necessarily forming a circular area around the well.

The Larkin Property spans 309 acres, suggesting sufficient land area for groundwater development. However, depending on well placement and subsurface conditions, off-site private wells could be affected.

3.5 Summary of Groundwater Yield Assessment for the Larkin Property

To meet future water demands for the Larkin Property future development, two wells rated at 55 gpm or higher would be sufficient. Based on regional geology and nearby well performance, targeting subsurface fractures and secondary porosity features will be key to successfully locating high-yield wells. A geophysical study was performed in order to identify those potentially high-yield subsurface features.

4.0 ELECTRICAL RESISTIVITY GEOPHYSICAL SURVEY

CHA, in collaboration with our teaming partner, Geoscience Professionals, completed an electrical resistivity survey of the central portion of the property to identify potential targets for test well drilling. The geotechnical report in Attachment A provides a detailed description of the study, the methods used to collect the resistivity data and the results of the survey. In summary, data for four resistivity lines were collected at the site on June 3-5, 2025. Lines 1 and 2 were oriented approximately southwest to northeast and Lines 3 and 4 were oriented southeast to northwest. Each line employed a six-meter spacing between electrodes. The lines varied in number of electrodes from 35 electrodes to 53 electrodes and varied in length from 204 meters to 312 meters. The electrodes on each line were assigned a unique identifier consisting of the line number followed by a dash and the electrode number and recorded using a handheld GPS. Linear inversion techniques were applied to the data to fit the apparent resistivities collected in field to an earth model that approximates the actual resistivities in the section.

All four of the resistivity lines display low resistivities in the shallow subsurface, which is typical of moist soils. Below the low-resistivity soil, the bedrock surface is characterized by an abrupt increase in resistivity as bedrock typically contains much less moisture than soil. Fracture zones tend to be characterized by vertical low-resistivity zones within the high-resistivity bedrock. Potential drilling targets tend to be characterized by vertical low-resistivity zones within the bedrock.

The report found three well locations with water producing potential. These are presented in Table 3 in order of priority. Their locations are shown in Appendix A: Figure 6.

Table 3: Well Targets Identified by Electrical Resistivity Survey

Target	Electrode Designation
1	2-48
2	3-56
3	4-74

5.0 POTENTIAL COSTS FOR GROUNDWATER SUPPLY DEVELOPMENT

CHA has evaluated the potential costs for groundwater supply development on the Larkin Property as both a potable drinking water source and a non-potable source. These include the costs for drilling test wells and performing water quality sampling and drawdown yield tests on those wells. A non-potable well has fewer permitting, drawdown testing and water quality testing requirements. These requirements could be done at a later date in order to convert the water source from a non-potable source to a potable one.

5.1 Test Well Site Approval – Local Health Department and Virginia Office of Drinking Water

Nelson County will be required to coordinate with the local Nelson County Health Department and the Virginia Department of Health Office of Drinking Water to obtain approval of selected test well sites in accordance with 12 VAC 5-590-200.B and local land use regulations. This typically involves an on-site visit from the inspector at the Office of Drinking Water to conduct a preliminary evaluation of the well's susceptibility to contamination. The application includes a site map that demonstrates the planned targets will meet the offset requirements (from septic systems, and sewer lines for instance). This approval letter is valid for 12-months. This process typically takes about 30 days and would cost an estimated $5,000 or less including permitting application fees.

If the well will only be used for non-potable uses, coordination with the state Office of Drinking Water is not required, so the permitting costs would be reduced to approximately $3,500.

5.2 Site Preparation

Targets 1 and 2 are located along the ridge of a moderate slope in a wooded area. Site preparation will be required in order to provide access to the targets with a drilling rig. One road could be constructed to provide access to both targets. Lidar data indicates that there may be an older logging road that could be improved, but regardless, trees would need to be cleared to build a road wide enough for a drill rig, and the soil would need to be compacted and stabilized so the equipment could access the target sites. In addition, some areas may need to add gravel to provide traction for the equipment. At the target sites themselves, trees will need to be cleared from approximately a 10-20 foot area in order to allow the drilling mast to be raised. Target Site 3 may be able to be access with a shorter road since the trees on the adjacent high school property have been cleared.

Table 4: Site Preparation Costs[1]

Site Preparation Subtasks	Estimate Costs (Range)	Estimated units	Total
Tree Clearing along new access roads and Well Drilling Sites	$500-$5000	1	$500-$5000
Road Grading and Compacting	$1000-$1500/day	10 days	$10,000-$15,000
Gravel or Matting for Stabilization where needed	--	--	$10,000-$15,000
			$20,500-$40,000

[1]These are estimates based on a conceptual road, actual costs will vary once needed quantities of each subtask is further refined. Utilizing County Resources may also lower the costs of outside contracting to develop the access to the well targets.

5.3 Test Well Drilling and Construction

The following ranges are based on recent quotes provided by well drillers for other projects similar in nature. The table includes a cost estimate for a well requiring 400 feet of drilling and 75 feet of casing, based on the per-foot estimates provided. Each well would cost approximately $15-$20K for a total of $45-$60K if all three targets are drilled.

Table 4.1. Summary of Well Drilling Cost Estimates

	Low Range	High Range
Drilling Cost (Per Foot)	$29.50	$40.00
Casing Cost (Per Foot)	$30.00	$41.50
Well Estimate[1]	$15,050	$20,112.50

[1]Includes a well set up fee of $1,000.

5.4 Drawdown Test and Water Quality Testing

The Virginia Water regulations require a 48-hour drawdown test in order to permit a public water supply well. During this test, the well driller will pump the well for 48-hours continuously and keep a record of the groundwater levels during the test. The pumping rate will vary, but the driller will work to match the rate of the water coming into the well, and then sustain that rate for the rest of the test. In addition, fecal coliform testing and other bacteriological testing is required through out the test. Once the test is nearly complete additional water quality samples will be collected. The cost for the drawdown test is up to $10,000 per well, and the water quality analysis typically costs around $2500. It is possible to complete a shorter well test and/or test for a limited amount of water quality parameters to evaluate the well's feasibility, but additional testing would be required to obtain a permit for operating the well as a public water supply. If the well were to be utilized for non-potable uses, then a 48-hour drawdown test and extensive water quality testing is not required. However, a drawdown test for a shorter duration (8-12 hours) would be needed in order to rate the sustainable capacity of the well and limited water quality sampling would be needed to determine any infrastructure needs for the water's end use. The costs for non-potable testing would range from $5,000-$7,000.

6.0 PERMITTING PROCESS FOR PUBLIC DRINKING WATER WELLS

If the facility decides to convert the wells to public drinking water wells, additional water quality testing and yield testing would be required. In addition, the facility would need to obtain a construction permit for any water treatment equipment and/or water distribution lines and a separate operating waterworks permit. A temporary Operating Permit in some cases is issued for 12-18 months to allow a facility to operate while obtaining all the monitoring data required for an Operating Permit. At a minimum, the facility would be required to complete steps 1-4 below to obtain the temporary Operating Permit.

The construction and operating permitting process includes the following steps:

1. Completion of a Preliminary Engineering Conference (PEC)
2. Submittal and approval of a Waterworks Business Operations Plan (WBOP)
3. Submittal and approval of a Preliminary Engineering Report (PER)
4. Submittal of a Permit Application
5. Submittal, review and approval of Final Plans, Specifications, and Design Criteria
6. Issuance of a Construction Permit
7. Final inspection of construction by ODW
8. Issuance of a new or amended Operation Permit

The process for having the well approved would include:

1. A 48-hour Well Yield Test that includes 20 samples collected for Bacteriological Analysis performed by a DCLS (Division of Consolidated Laboratories) approved Laboratory. (See Section 5.4)
2. In addition to monitoring the microbial characteristics of the well source, a variety of chemical, radiological and physical parameters must be checked during well development in order to ensure adequate water quality. The specific parameters required for testing and the number of samples required will be determined by VDH-ODW. Tests may include analysis of metals, inorganic chemicals (including nitrate, nitrite, and cyanide), physical parameters, radiological contaminants, (such as uranium and radium), and volatile organic chemicals (such as fuels and solvents), and synthetic organic chemicals (including pesticides and herbicides). (See Section 5.4)
3. A sampling and analysis plan would be developed, which typically involves four quarters of sampling to ensure that water quality for the well is consistently within public drinking water standards.

The estimate cost for preparing the permit application, including completing a preliminary engineering report (PER) for the treatment system required for operation would be $50,000. This permitting process is not required for non-potable water use, but it is recommended that a PER be completed to determine any infrastructure needs associated with the non-potable water system. The estimated cost for the limited engineering study would be $25,000.

7.0 LIST OF ACRONYMS & KEY TERMS

Aquifer: An underground formation that stores and transmits water. How much water the aquifer can store and transmit is a characteristic of the how much pore space is in the formation and how connected those pore spaces are. At this facility, the formation is metamorphic bedrock with very limited porosity, but can have fractures that are larger in size and transmit more water.

Recharge: Surface water that infiltrates through the soils and into the aquifer. This term is also to describe water entering the well after pumping the well.

PPM: Parts per million. One part per million is generally illustrated a drop of water in an Olympic sized swimming pool.

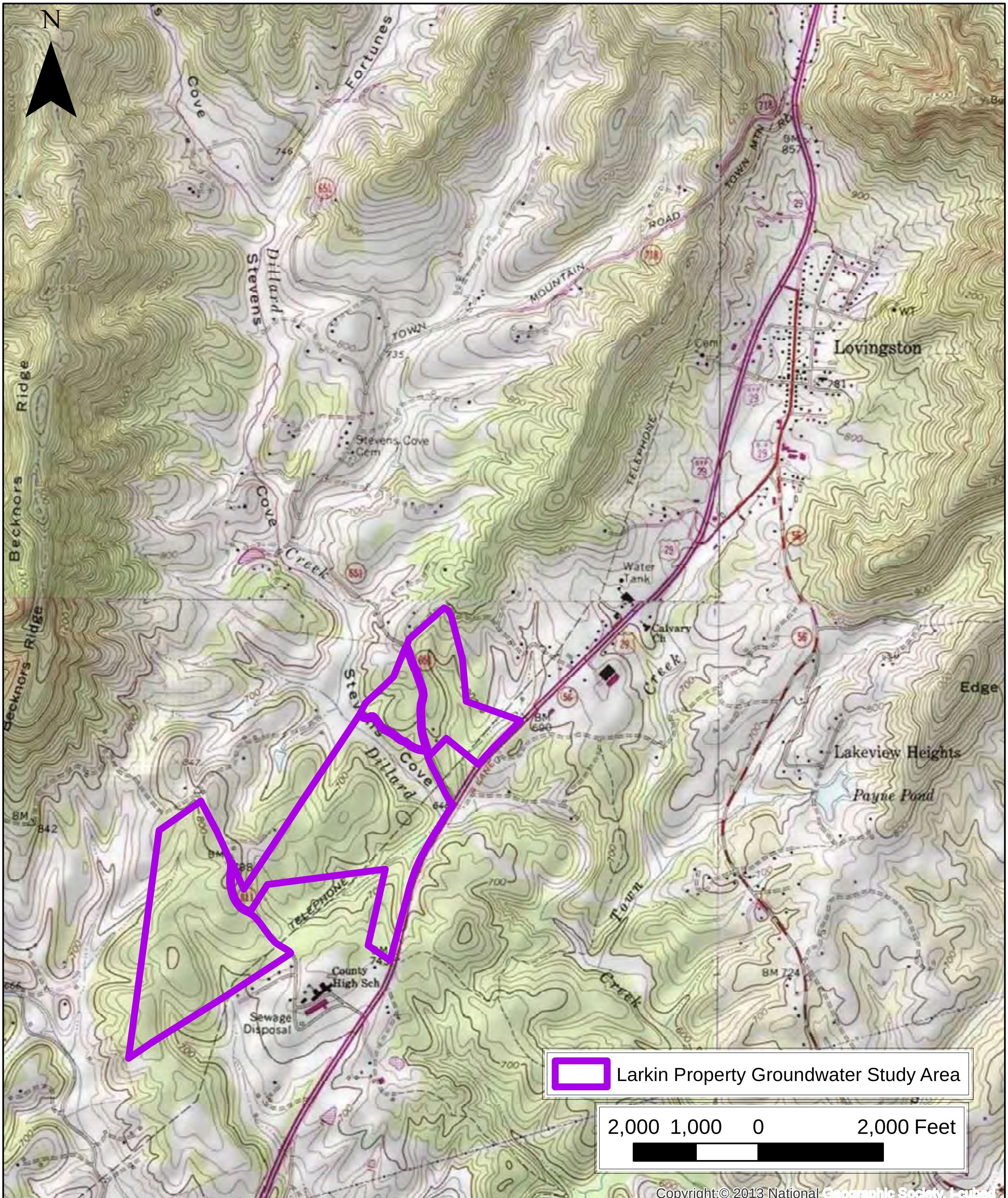
gpm – Gallons Per minute

8.0 REFERENCES

1. University of Richmond, 2020: GIS Dataset “Virginia Groundwater Extraction Non_Domestic Wells 2009 through 2019_WFL1”, accessed August 2025.

2. Draper Aden & Associates, 2009. “Region 2000 Local Government Council Regional Water Supply Plan”.

FIGURES



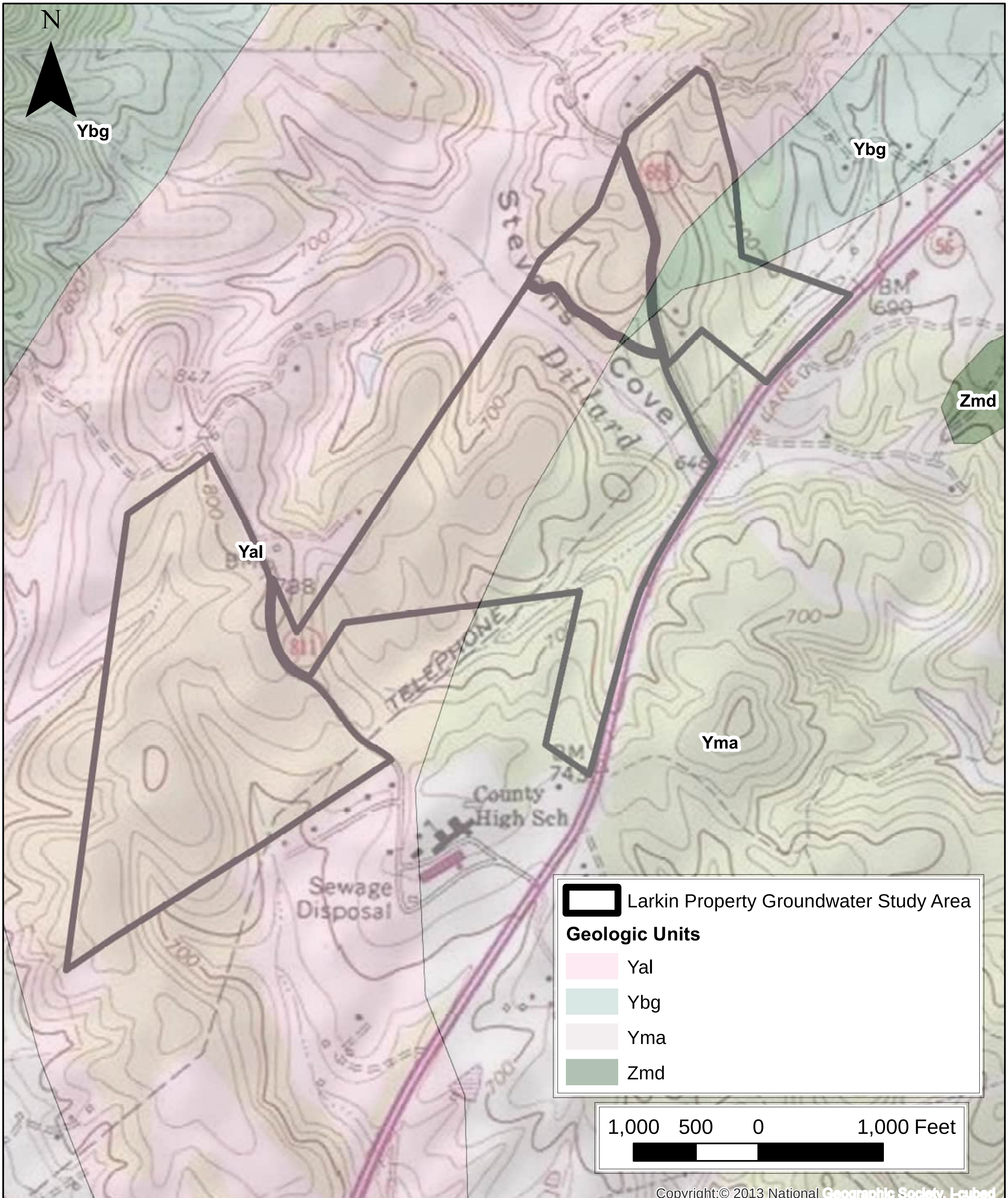
1341 Research Center Drive, Suite 2100 • Blacksburg, VA 24060
Main: (540)552-5548 • www.chasolutions.com

Site Location Map
Larkin Property
Groundwater Evaluation

Date: AUG 2025

Project: 93203

Figure 1



1341 Research Center Drive, Suite 2100 • Blacksburg, VA 24060
Main: (540)552-5548 • www.chasolutions.com

Geologic Map
Larkin Property
Groundwater Evaluation

Date: AUG 2025

Project: 93203

Figure 2

Appendix A

Electrical Resistivity Study

40 Nancy Court
Christiansburg, VA 24073
Phone: (540) 998-8861
info@geoscience-pros.com
www.geoscience-pros.com

Water Supply Well Study at the Larkin Well Site

Nelson County, Virginia

prepared for

Ms. Sandra Warner
CHA
1341 Research Center Dr Suite 2100
Blacksburg, VA 24060

June 12, 2025

GEOSCIENCE
-PROFESSIONALS-

40 Nancy Court
Christiansburg, VA 24073
(540) 998-8861
info@geoscience-pros.com

June 12, 2025

Ms. Sandra Warner
CHA
1341 Research Center Dr Suite 2100
Blacksburg, VA 24060

RE: Water Supply Well Study at the Larkin Well Site, Nelson County, Virginia

Dear Ms. Warner,

GeoScience Professionals has completed the water supply well study at the Larkin Well site in Nelson County, Virginia. The objective of this study was to use resistivity imaging techniques to identify prospective drilling targets. The following report documents our methodologies and findings.

We value our professional relationship with CHA and hope that you will contact us with any similar needs in the future. If you have any questions regarding this report, or if we can be of any further service to you, please do not hesitate to contact us.

Best regards,

Warren T. "Ted" Dean, P.G.
President

Table of Contents

List of Figures

Executive Summary

GeoScience Professionals, LLC (GSP) was retained by CHA to conduct a water supply well study at the Larkin well site in Nelson County, Virginia. The objective of this study was to identify one or more drilling targets for water supply wells. The study area consists of approximately 140 acres on the west side of US 29 north of Nelson County High School.

No detailed geologic maps have been published for the site. The state-wide geologic map of Virginia indicates that the site is underlain by Proterozoic age alkali feldspar leucogranite. The published geologic map does not depict any of the local geologic structures that could help in siting water supply wells. The topography of the site and surrounding area was examined for topographic patterns that might reveal faults or fracture zones, but no patterns are observable.

To provide continuous imaging of the subsurface beneath the site for evaluation of geologic features, two-dimensional surface resistivity imaging methods were employed. Two-dimensional resistivity methods provide cross-sectional images of the resistance of subsurface materials to electric current, from which geologic conditions can be inferred.

Data for four resistivity lines were collected at the site between June 3 and June 5, 2025. Fracture zones tend to be characterized by low-resistivity zones within the high-resistivity bedrock. Potential drilling targets tend to be characterized by vertical or near-vertical low-resistivity zones within the bedrock. The most promising drilling targets are those with a very high contrast in resistivity between the low-resistivity zones and that of the surrounding bedrock. Three drilling targets were identified at electrodes 2-48, 3-56, and 4-74. These targets were ranked according to their perceived likelihood of productivity, but this ranking is subjective and the actual yield of the wells may not follow this order.

1. Introduction

GeoScience Professionals, LLC (GSP) was retained by CHA to conduct a water supply well study at the Larkin well site in Nelson County, Virginia. The objective of this study was to identify one or more drilling targets for water supply wells. The study area consists of approximately 140 acres on the west side of US 29 north of Nelson County High School (Figure 1).

2. Geologic Setting

No detailed geologic maps have been published for the site. The state-wide geologic map of Virginia indicates that the site is underlain by Proterozoic age alkali feldspar leucogranite (Figure 2). The published geologic map does not depict any of the local geologic structures that could help in siting water supply wells. The topography of the site and surrounding area was examined for topographic patterns that might reveal faults or fracture zones, but no patterns are observable (Figure 3).

3. Resistivity Imaging

To provide continuous imaging of the subsurface beneath the site for evaluation of geologic features, two-dimensional surface resistivity imaging methods were employed. Two-dimensional resistivity methods provide cross-sectional images of the resistance of subsurface materials to electric current, from which geologic conditions can be inferred. Electrical resistivity is a parameter intrinsic to the material describing how easily it can transmit electrical current. High values of resistivity imply that the material is very resistant to the flow of electricity; low values of resistivity imply that the material transmits electrical current very easily.

3.1. Principles of Resistivity

Experiments by George Ohm in the early 19th century revealed the empirical relationship between the current flowing through a material and the potential required to drive that current. This relationship is described by

$$V = IR$$

where V is voltage in volts, I is the current in amperes, and R is the proportionality constant. Rearranging the equation to

$$\frac{V}{I} = R$$

gives resistance with the units of volts divided by amperes, or ohms.

The resistance of a material is dependent not only on the property of the material but also the geometry of the material. Specifically, a longer travel path for the current or smaller cross-sectional area would cause the resistance to increase. The geometry-independent property used to quantify the flow of electric current through a material is resistivity, given by

$$\rho = \frac{RA}{L}$$

where ρ is resistivity, R is resistance, A is the cross-sectional area through which the current flows, and L is the length of the current flow path. With all length units expressed in meters, the units associated with resistivity are ohm-meters.

Resistivity data are collected by inducing an electric current into the ground between two electrodes and measuring the potential at other electrodes. Numerous configurations of electrode placement are commonly employed, each with unique data characteristics. The configuration utilized for this study was the dipole-dipole array with strong gradient (Stummer et al., 2004). For the dipole-dipole array, a current is applied to two adjacent electrodes positioned a predetermined distance apart (distance a). The voltage across two other electrodes is measured simultaneously with the applied current. The two sets of electrodes are always spaced distance a apart, and the distance between the current and voltage electrodes is always a multiple of a ($n \bullet a$).

3.2. Field Methods

Data for four resistivity lines were collected at the site between June 3 and June 5, 2025. Field data were collected using a SuperSting R8 IP® multi-electrode resistivity system manufactured by

Advanced Geosciences Inc. Data were collected using the dipole-dipole array with injected current of up to 2,000 milliamps. For each electrode configuration in the array, measurements were repeated a minimum of two times or until the error between measurements was less than or equal to two percent.

Because the topography did not reveal fracture or fault patterns, the resistivity lines were collected in a variety of orientations to intercept potential fracture zones at may have no expression in the topography. All of the resistivity lines consisted of 84 electrodes spaced six-meters (19.7 feet) apart for total line lengths of 498 meters (1,633 feet) each. The electrodes on each line were assigned a unique identifier consisting of the line number followed by a dash and the electrode number. For example, the first electrode on Line 1 is 1-1, the first electrode on Line 2 is 2-1, etc. The locations of every fifth electrode were marked in the field with a vinyl wire stake flag labeled with the electrode identifier. These electrode locations were also recorded with a handheld GPS and plotted onto a color relief terrain model of the site (Figure 4). The elevations of the electrodes were digitized from the terrain model of the area and were incorporated into the resistivity data so that the resulting resistivity sections would approximate the local topographic relief.

3.3. Inversion Modeling

The resistivity measurements collected in the field are called apparent resistivities. They may differ from the actual resistivities because of passage through inhomogeneous materials and the distance of travel through the media. Therefore, linear inversion techniques were applied to the data. Linear inversion modeling fits the apparent resistivities to an earth model that approximates the actual resistivities in the section. The inversion modeling is completed by calculating apparent resistivity from the earth model for comparison to the measured data. If the comparison is within reasonable limits, the earth model can be accepted as an approximation of subsurface conditions. Details of the inversion process may be found in Lines and Treitel (1984), Loke and Barker (1995), and Loke and Barker (1996).

The modeling software allows the removal of bad data points when initially reading the data file, and during the efforts to bring the model to a reasonable solution. The models for all four data sets solved to less than a root mean square error of six percent with minimal data trimming, indicating high-quality, reliable field data.

4. Results and Recommended Drilling Targets

The primary factors affecting the resistivity of earth materials are porosity, water saturation, clay content, and mineralogy. In general, the minerals making up soils and rock do not readily conduct electric current and thus most of the current flow takes place through the material's pore water. The relatively high levels of pore water in soils and other unconsolidated materials tend to result in low resistivity values for the upper subsurface. Rock contains significantly less pore water than soils resulting in generally higher resistivity values at depth.

Another significant factor affecting resistivity is material grain size. Resistivity tends to be correlated to grain size so that fine-grained materials such as clay or shale tend to have lower resistivity than course-grained materials such as sand, gravel, sandstone, etc.

All four of the resistivity lines display low resistivities in the shallow subsurface which is typical of moist soils. Below the low-resistivity soil, the bedrock surface is characterized by an abrupt increase in resistivity because bedrock typically contains much less moisture than soil (Figure 5). Fracture zones tend to be characterized by low-resistivity zones within the high-resistivity bedrock. Potential drilling targets tend to be characterized by vertical or near-vertical low-resistivity zones within the bedrock. The most promising drilling targets are those with a very high contrast in resistivity between the low-resistivity zones and that of the surrounding bedrock. Such a feature is displayed on Line 2 beneath electrodes 2-47 and 2-48 (Figure 5). Though the resistivity contrast is not as large as we would like to see, we consider this the most promising drilling target and have identified it as Target #1. Because the feature has a slight dip to the west, we have identified the target at electrode 2-48.

A similar but slightly weaker resistivity contrast is displayed on Line 3 beneath electrodes 3-33 and 3-34. Because this feature displays a slight dip to the west, we have identified this drilling target at 3-56 as Target #2.

A third potential target is located at the northern end of Line 4 beneath electrodes 4-71 through 4-75. Because this target is at the tapered end of the resistivity section we cannot tell if this zone is vertically extensive. As such, this target is deemed the least prospective of the targets and is designated Target #3 at 4-74. It should be noted that the ranking of these targets is subjective based on the pattern of resistivities and our previous experience. This ranking does not mean that the higher ranked targets will necessarily produce more water than the lower ranked targets. All of these recommended drilling locations are presented in map view on Figure 6.

5. Limitations

This study was conducted by qualified professionals with extensive experience in the collection, processing, and interpretation of geophysical data. However, no scope of work or extent of professional experience can guarantee successful well drilling.

6. References

Lines, L.R., and S. Treitel, 1984. A review of least-squares inversion and its application to geophysical problems, Geophysical Prospecting, Vol. 32, Pages 159-186.

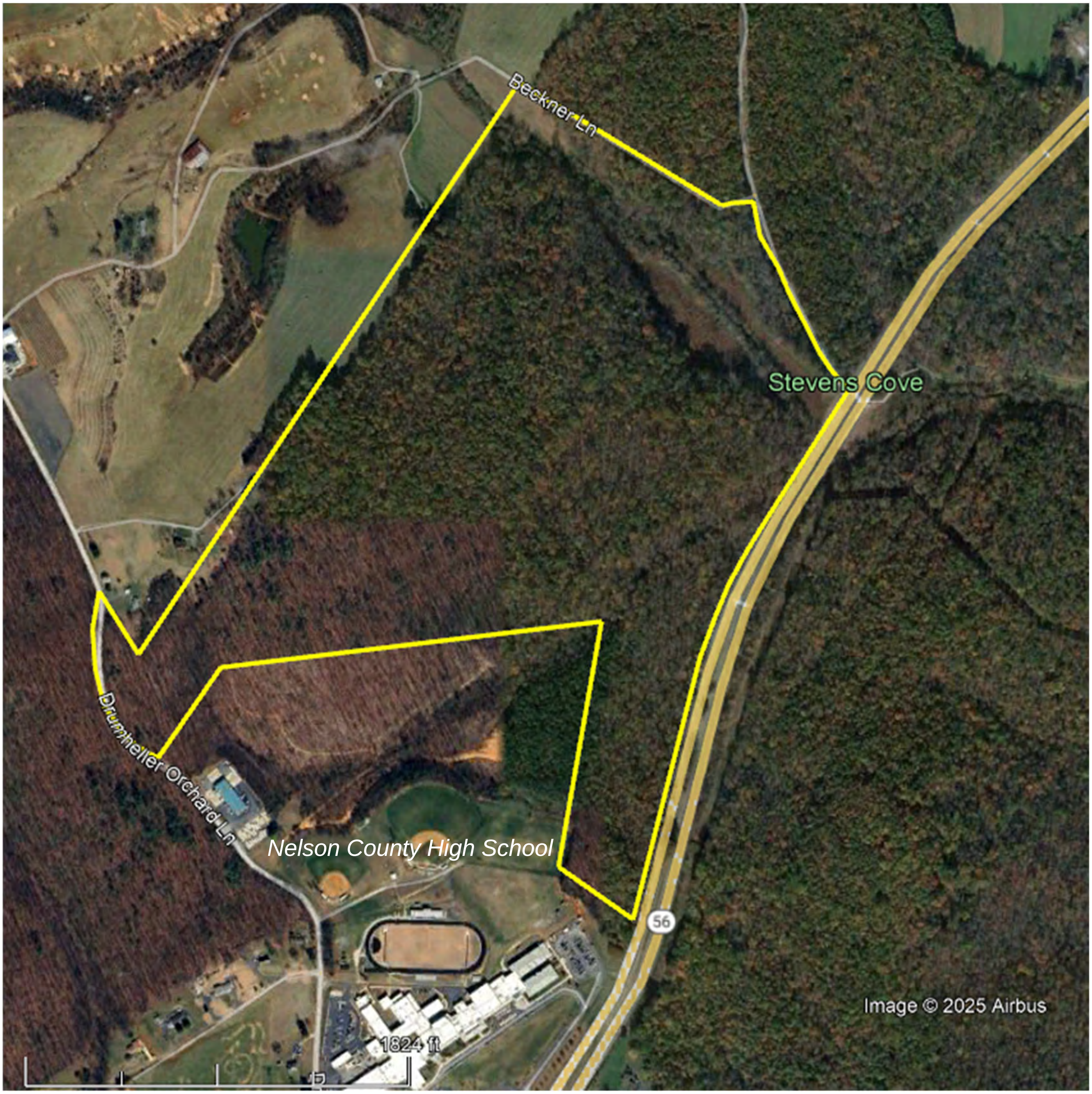
Loke, M.H., and R.D. Barker, 1995. Least-squares deconvolution of apparent resistivity pseudosections, Geophysics, Vol. 60, No. 6, Pages 1682 1690.

Loke, M.H., and R.D. Barker, 1996. Rapid least squares inversion of apparent resistivity pseudosections by a quasi Newton method, Geophysical Prospecting, Vol. 44, No. 1, Pages 131 152.

U.S. Geological Survey, 2025. Online resource, URL https://naturalatlas.com/geologic-formations/alkali-feldspar-leucogranite-2769266.

Virginia Division of Mineral Resources, 1993. Geologic Map of Virginia: Virginia Division of Mineral Resources, scale 1:500,000.

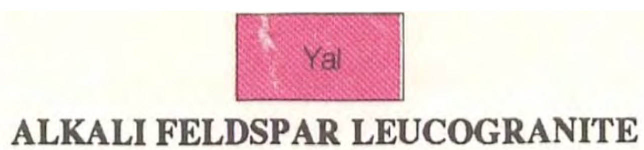
7. Figures

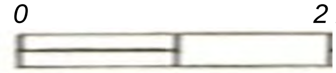


N

Report Title: *Water Supply Well Study at the Larkin Well Site, Nelson County, Virginia*	*Figure 1. Air photo depicting the approximate site boundary.*
File Name: *Larkin pt.ppt*	
Date: *06/12/25* Project No: *P25-04*	

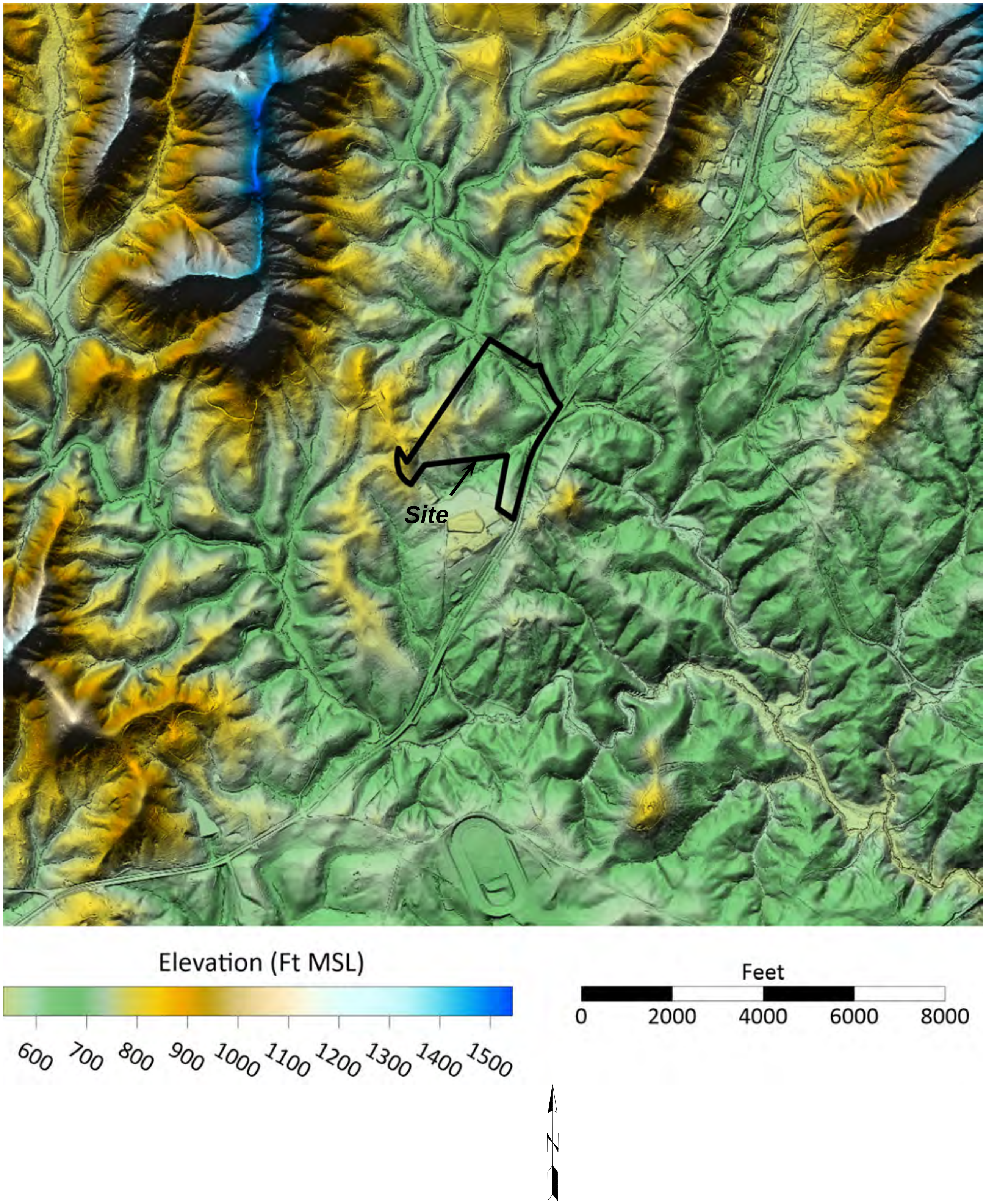
GEOSCIENCE PROFESSIONALS
Hydrogeology • Engineering Geology • Geophysics
40 Nancy Court
Christiansburg, VA 24073
Phone: (540) 998-8861
www.geoscience-pros.com





Leucocratic, coarse grained to megacrystic, equigranular to porphyritic granite contains white alkali feldspar phenocrysts and interstitial blue quartz, with accessory biotite, pyroxene, and garnet (USGS, 2025).

Report Title: *Water Supply Well Study at the Larkin Well Site, Nelson County, Virginia*	*Figure 2. A portion of the published geologic map of the site depicting the local geology. After Virginia Division of Mineral Resources (1993) and U.S. Geological Survey (2025).*	GEOSCIENCE -PROFESSIONALS- *Hydrogeology • Engineering Geology • Geophysics*
File Name: *Larkin pt.ppt*		40 Nancy Court Christiansburg, VA 24073 Phone: (540) 998-8861 www.geoscience-pros.com
Date: *06/12/25* Project No: *P25-04*		



Report Title:

Water Supply Well Study at the Larkin Well Site, Nelson County, Virginia

Figure 3. A color relief terrain model of the topography of the site and surrounding area.

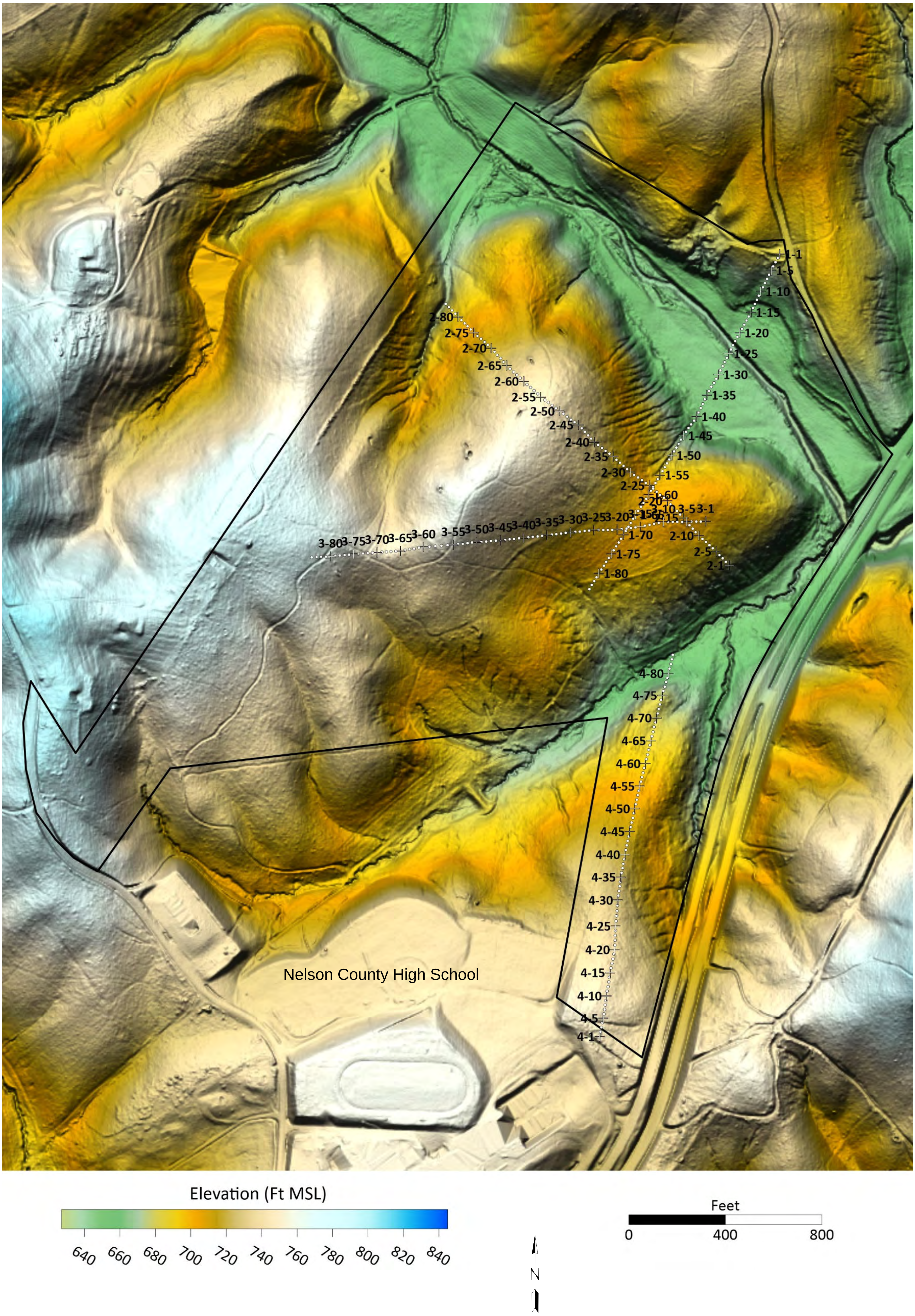
File Name: *Larkin pt.ppt*

Date: *06/12/25* | Project No: *P25-04*

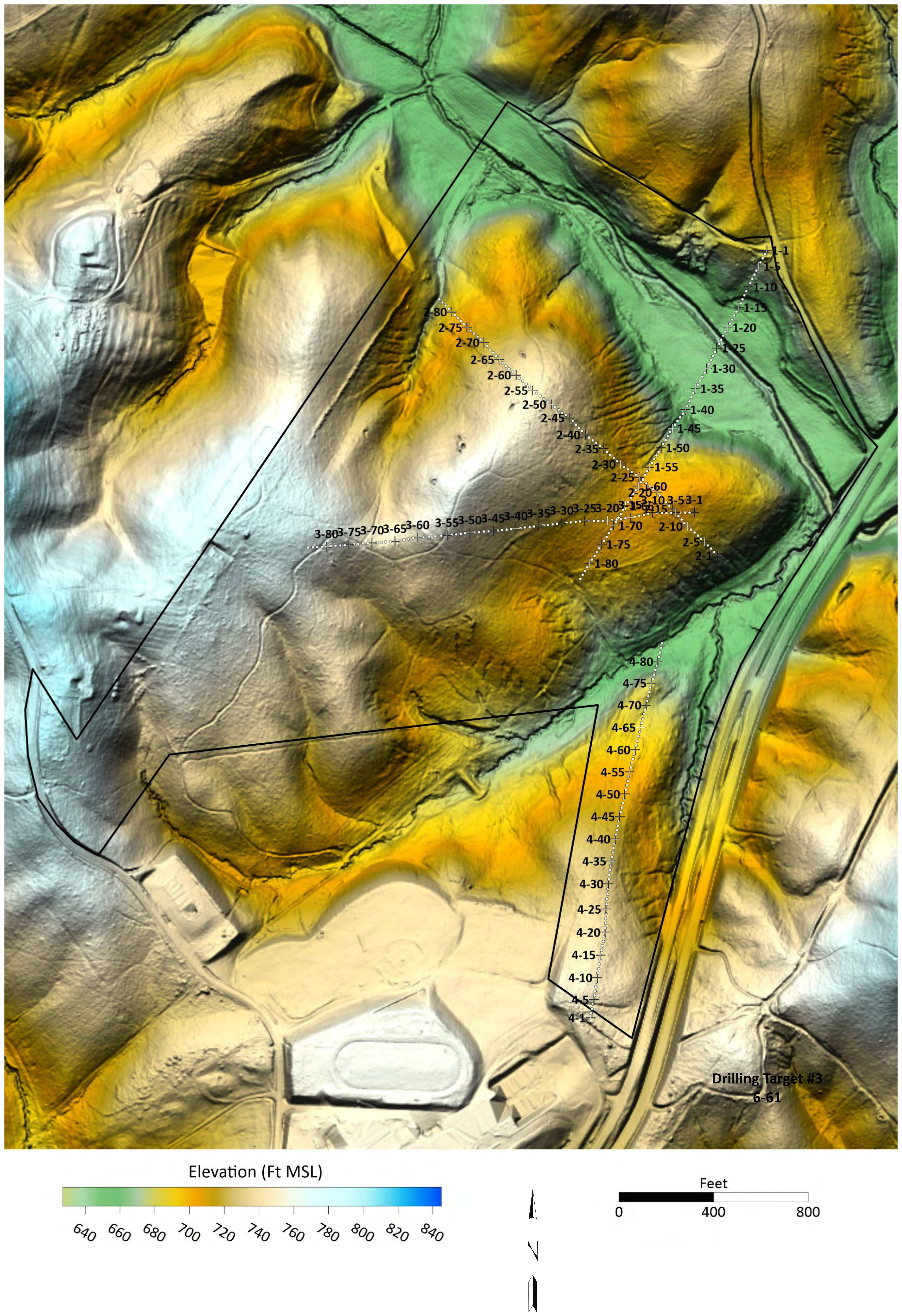
GEOSCIENCE PROFESSIONALS

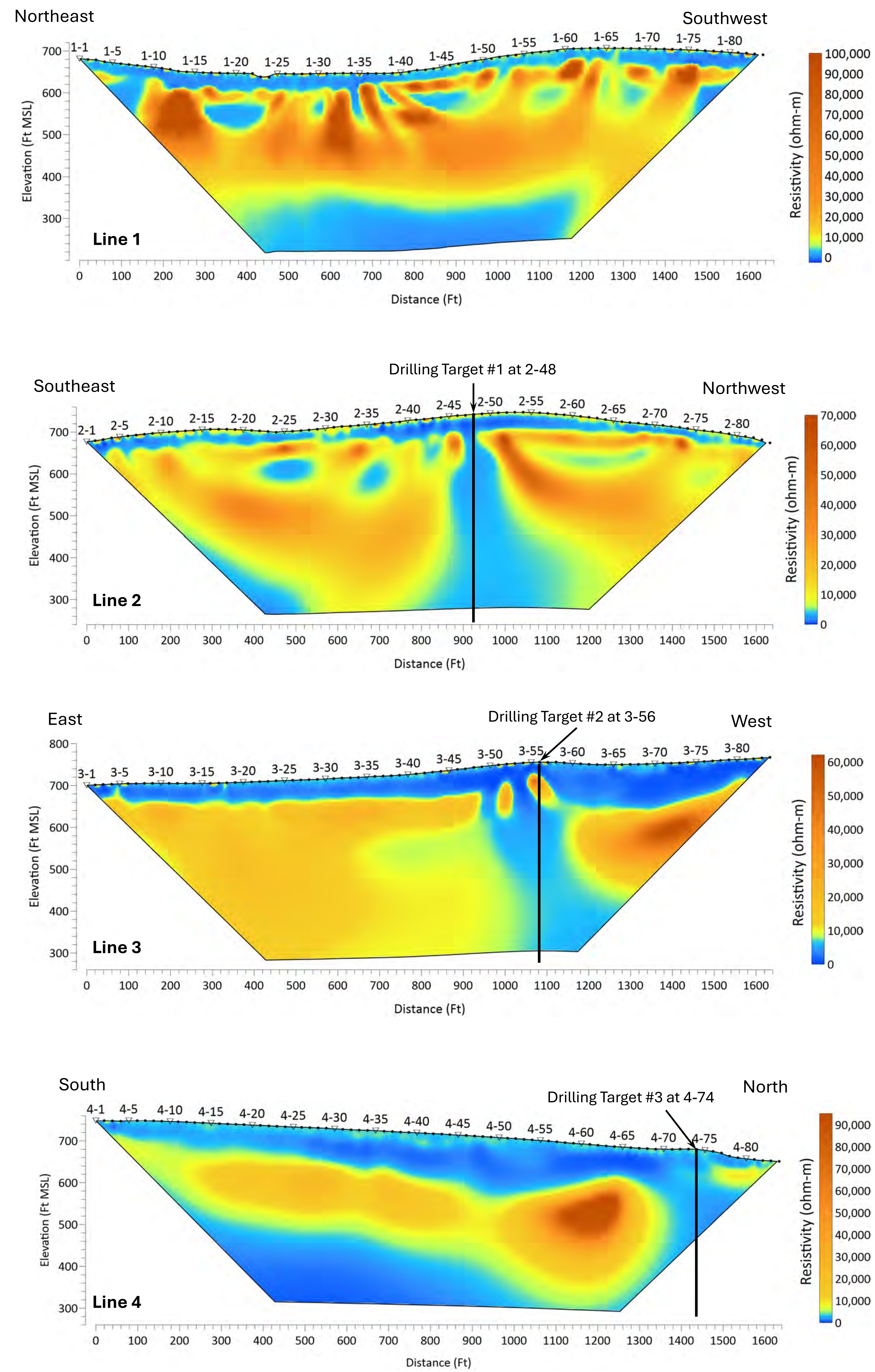
Hydrogeology • Engineering Geology • Geophysics

40 Nancy Court
Christiansburg, VA 24073
Phone: (540) 998-8861
www.geoscience-pros.com



Report Title: *Water Supply Well Study at the Larkin Well Site, Nelson County, Virginia*	*Figure 4. A color relief terrain model of the site depicting the four resistivity lines.*	GEOSCIENCE -PROFESSIONALS- *Hydrogeology • Engineering Geology • Geophysics*
File Name: *Larkin tb pt,pptx*		
Date: *06/12/25* GSP Proj. No.: *P25-04*		40 Nancy Court Christiansburg, VA 24073 Phone: (540) 998-8861 www.geoscience-pros.com





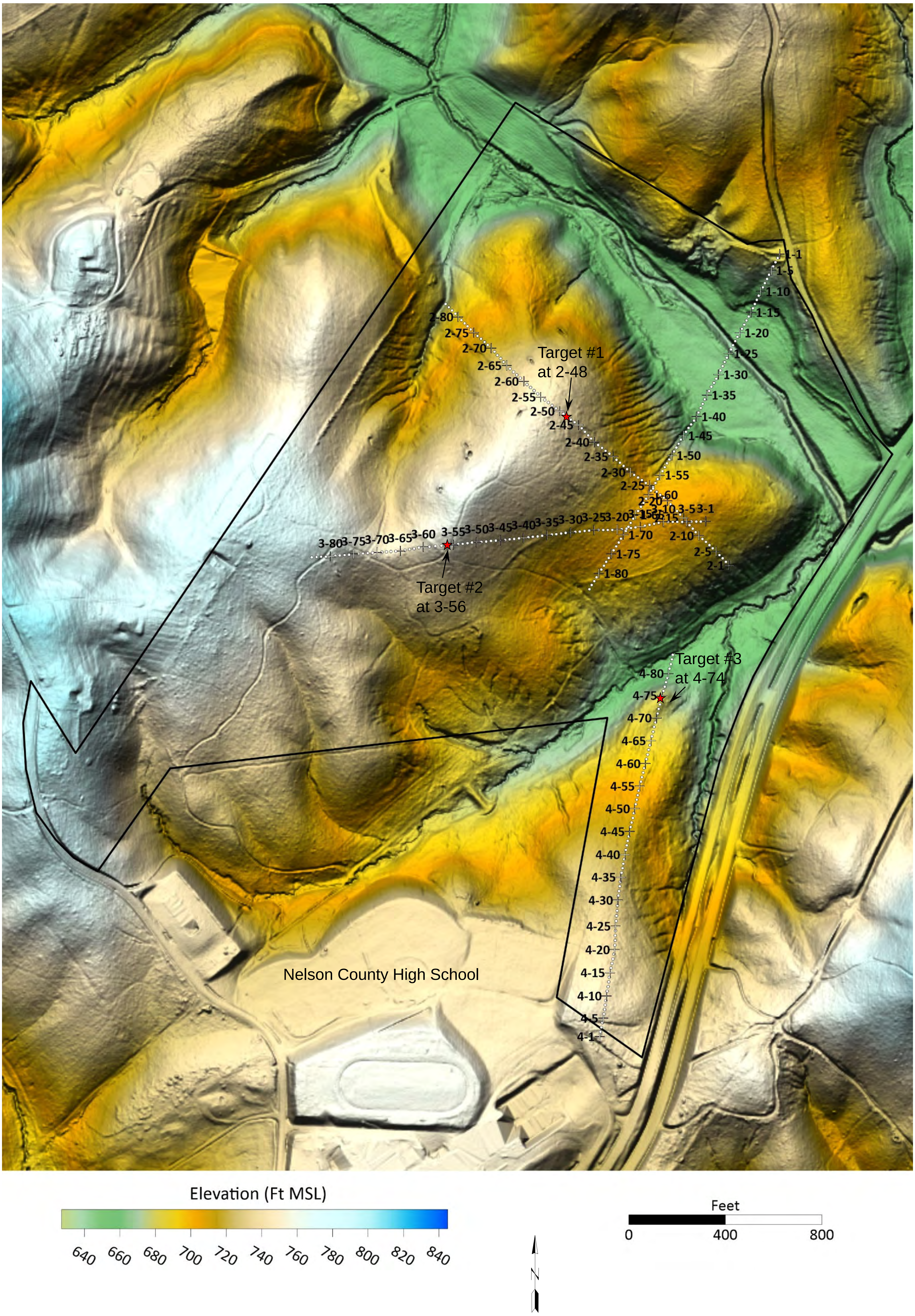
GEOSCIENCE
PROFESSIONALS
Opening Windows to the World Below
40 Nancy Court
Christiansburg, VA 24073
(540) 998-8861
www.geoscience-pros.com

Figure 5. Resistivity results and prospective drilling targets.

Report Title:
Water Supply Well Study at the Larkin Well Site, Nelson County, Virginia

File Name: *Larkin 24X18 ls.pptx*

Date: *06/12/25* Project No: *P25-04*



Report Title:

Water Supply Well Study at the Larkin Well Site, Nelson County, Virginia

Figure 6. Map locations of the drilling targets.

File Name: *Larkin tb pt,pptx*

Date: *06/12/25* GSP Proj. No.: *P25-04*

GEOSCIENCE PROFESSIONALS
Hydrogeology • Engineering Geology • Geophysics
40 Nancy Court
Christiansburg, VA 24073
Phone: (540) 998-8861
www.geoscience-pros.com