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TX0-LTR-0028

*ELECTRONIC DELIVERY*

November 8, 2023

Director, Office of Nuclear Material Safety and Safeguards
U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

References:
1) Docket No. 70-7027
2) TRISO-X letter from Jennifer Wheeler to Director, Office of Nuclear Material Safety and Safeguards, "TRISO-X Fuel Fabrication Facility License Application Submittal," dated April 5, 2022
3) NRC letter from Matthew Bartlett, Senior Project Manager, Fuel Facility Licensing Branch, to Jennifer K. Wheeler, "Request For Additional Information Set 4 For The Geotechnical and Hydrology Regarding The TRISO-X, LLC License Application For A New Fuel Fabrication Facility (Enterprise Project Identification Number L-2022-NEW-0005)," dated September 29, 2023

Subject: **Response to Request for Additional Information (Set 4) for the TRISO-X License Application**

TRISO-X, LLC (TRISO-X) hereby submits responses to the subject Request for Additional Information (RAI), regarding the review of the License Application for the TRISO-X Fuel Fabrication Facility (Reference 2). The enclosed responses are for the RAI set transmitted by letter dated September 29, 2023 (Reference 3).

**Requests for Withholding**

None. The enclosed submittal contains public information.

**Summary of this Submittal**

The following Enclosures and Attachments are included with this letter.

**Enclosure 1 – Geotechnical RAI Responses**

**Attachment to Enclosure 1 – Revised License Figures 1-3 through 1-8**

**Enclosure 2 – Hydrology RAI Responses**

**Attachment to Enclosure 2 – New License Figures 1-9 and 1-10, and Revised Environmental Report Figures 3.4.1-5 and 3.4.1-6**

If there are questions or if additional information is required, please contact me at (865) 850-0893 or jwheeler@triso-x.com.

Sincerely,

Jennifer Wheeler

Jennifer K. Wheeler, P.E.
Vice President, Regulatory Affairs

TRISO-X, LLC
801 Thompson Avenue
Rockville, MD 20852

Copy: Mr. Matthew Bartlett, US NRC, NMSS
TRISO-X Regulatory Records File

**RAI-1 Locations of the geotechnical borings with respect to the Process Building and Correction of geologic cross-sections:**

**Regulatory Basis:**
This information is necessary to satisfy the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) 70.22(a)(7), which states in part that applicants must provide "A description of equipment and facilities which will be used by the applicant to protect health and minimize danger to life or property." In addition, 10 CFR 70.65(b)(1) and (2) state that the integrated safety analysis summary must contain "(1) A general description of the site with emphasis on those factors that could affect safety (i.e., meteorology, seismology); and (2) A general description of the facility with emphasis on those areas that could affect safety, including an identification of the controlled area boundaries."

**Describe Issue:**
The locations of certain borings are unclear as to whether they are within or outside the footprint of the Process Building. For example, License Application (LA) Figure 1-5 (Cross Section 2) shows that Boring B-23 is outside the Process Building footprint whereas Figure 1-7 shows that B-23 is inside the footprint. In addition, the log of Boring B-3 given in Cross Section 1 (LA Figure 1-4) do not match with the log given in Cross Section 5 (LA Figure 1-8). All Rock Quality Designation (RQD) values are 54 in Cross Section 5. Additionally, the RQD values reported at deeper depths (e.g., below 720 ft elevation) of Boring B-23, shown in Cross Section 2 (LA Figure 1-5) and Cross Section 4 (LA Figure 1-7), do not match. Similarly, RQD values at deeper depths of Boring B-27 do not match in Cross Section 2 (LA Figure 1-5) and Cross Section 5 (LA Figure 1-8).

**Information Needed:**
Provide an updated LA Figure 1-3 of the geotechnical boring locations superimposed on the footprint of the Process Building. Additionally, update the cross-sections provided in LA Figures 1-4 through 1-8.

**TRISO-X Response to RAI-1:**
License Chapter 1, Figure 1-3 (Plan View of Geologic Cross Sections) has been revised to show the boring locations superimposed on the footprint of the Process Building. Cross Sections depicted in License Chapter 1, Figures 1-4 through 1-8 have been revised to address the comments provided in RAI-1. License Chapter 1, Figure 1-7 (Cross-Section 4) depicts borings B-13 to B-22 in a two-dimensional format, viewing the cross section from the SW direction. Boring B-23, which physically does fall outside the Process Building footprint, is shown as falling within the footprint in Figure 1-7 because the cross section is viewed on a single plane, with no integration of depth.

**License Changes:**
License Chapter 1, Figures 1-3 through 1-8 will be revised as described above. Revised figures are included in the Attachment to Enclosure 1.

**RAI-2 Backfill and site work:**

**Regulatory Basis:**
This request for additional information (RAI) has the same regulatory basis as RAI 1.

**Describe Issue:**
Based on the five cross-sections of the site (Figures 1-4 through 1-8 of LA), a major portion of the footprint area of the Process Building is below the proposed top of the building foundation 811 ft above mean sea level (MSL). Consequently, major site work

including use of significant amount of backfill or engineered material(s) would be necessary to bring the top of subsurface at the 811 ft above MSL grade level to construct the foundation for the Process Building. Currently, high plasticity clay and low plasticity clay are present in the subsurface at depths from 3.6 to 18 ft below the existing ground surface within the Process Building footprint. Presence of fat clay with swelling potential in presence of moisture may affect the stability of the overlying foundation.

**Information Needed:**
Describe the characteristics that would be suitable for use as the backfill to raise the level of the surface to the desired elevation of the Process Building foundation. Confirm whether “fat clays” would be part of the backfill or part of the subsurface of the Process Building. Describe the plan to improve the subsurface soil characteristics, if any, to increase the load bearing capacity of the subgrade and minimize the potential settlement.

**TRISO-X Response to RAI-2:**
Site grading will include the use of improved on-site soils including lime treatment of the fat clays (CH) prior to use as fill material. The on-site fat clays will be treated with lime in accordance with the project specification regarding lime mix, placement and compaction requirements. The soil-lime mixture will have a minimum unconfined compressive strength of 100 psi when compacted to a 98.0% +1.0% of the maximum dry density as determined by ASTM D698 and when tested in accordance with ASTM D5102 Method A. The structural fill that supports structures, buildings and foundations will be compacted to 98% of the maximum dry density as determined by ASTM D698 and the general fill will be compacted to 95% of the maximum dry density as determined by ASTM D698. The clay soils mixed with the proper amount of lime exhibit lower plasticity and are less sensitive to moisture change. Therefore, the lime treated soils have reduced swelling characteristics. The fill with improved engineering properties increases the bearing capacity of the subgrade and reduces the potential settlement.

For the Process Building (PB) foundation, a Rigid Inclusion (RI) system will be installed underneath the PB foundation to minimize the total settlement and the differential settlement across the mat foundation. See further description regarding the RI system in the response to RAI-3.

**License Changes:**
None.

## RAI-3 Foundation of the Process Building:

**Regulatory Basis:**
This RAI has the same regulatory basis as RAI 1.

**Describe Issue:**
The proposed foundation system of the Process Building will be a large mat foundation with a Rigid Inclusion (RI) and associated Load Transfer Platform (LTP). This composite matrix foundation system with overall improved engineering properties is relied upon to: (1) support the loads of the Process Building (i.e., adequate bearing capacity under both static and seismic loads), (2) reduce settlement given the characteristics of the in situ soil and backfill, and presence of the karst environment (e.g., voids present in the subsurface, as evidenced in LA Figures 1-4 through 1-8), and (3) minimize differential settlement within the design specifications of the Process Building. In addition, the Standard Penetration Test blow counts N measured in the subsurface clay layers, present at depths between 3.6 and 18 ft below the existing ground surfaces within the footprint of the Process Building,

are low, as shown in the boring logs (LA Figures 1-4 through 1-8). Minimum N of 2 was measured in Boring B-1. Maximum N recorded was 35 in Boring B-25. Majority of the N values are below 20. LA Section 1.1.1.4 provides the concept of the foundation system, i.e., a composite matrix foundation with the RI and the LTP; however, a description of the foundation system design (e.g., size and thickness of the mat foundation, size and thickness of the LTP including the material(s) characteristics, and size, number, and pattern of the cement grout columns of the RI) along with its capability to withstand the anticipated loads with minimum foundation settlement is currently lacking.

**Information Needed:**
Describe the foundation system (mat foundation, LTP, and RI) of the Process Building (e.g., dimensions, materials of construction, strength, stiffness, etc.). Description of the LTP should include, at a minimum, the size, thickness, characteristics of the material(s) used. Description of the RI should include, at a minimum, the number, size, and depth of the cement grout columns, material(s) used with specific characteristics, and characteristics of the grid pattern (e.g., spacings between the grout columns, square or rectangular pattern with regular or staggered column placement, etc.), and the estimated strength of the resulting subsurface. Also, summarize the results of the design analysis showing that the proposed foundation system design will have sufficient bearing capacity against both static and dynamic loads and the expected settlements would be within the acceptable range of the design of the Process Building.

**TRISO-X Response to RAI-3:**
The RI system for the PB will be design-built by a specialty RI contractor. Specific details of the RI system design are not available until the design is completed later in the project. The design and construction of the RI system will meet the project RI performance specification for minimum design and performance criteria. The RI system will be Portland cement grout columns with a minimum diameter of 12 inches and installed to practical refusal with auger equipment (expected at top of rock). The design of the LTP (material characteristics and thickness) and the RI system (layout pattern and spacings) will meet the maximum anticipated long-term structural PB loads with a factor of safety of 3.0, the maximum permitted total settlement of 1 inch, and the differential settlement of 1 inch across the PB mat foundation.

**License Changes:**
None.

## RAI-4 Liquefaction:

**Regulatory Basis:**
This information is necessary to satisfy the requirements of 10 CFR 70.22(a)(7), which state in part to provide, “A description of equipment and facilities which will be used by the applicant to protect health and minimize danger to life or property.” In addition, 70.64(a)(2) requires consideration of the “(2) Natural phenomena hazards. The design must provide for adequate protection against natural phenomena with consideration of the most severe documented historical events for the site.” According to 10 CFR 70.65(b)(1) and (2) the integrated safety analysis summary must contain “(1) A general description of the site with emphasis on those factors that could affect safety (i.e., meteorology, seismology); and (2) A general description of the facility with emphasis on those areas that could affect safety, including an identification of the controlled area boundaries.”

**Describe Issue:**
Discussion of the liquefaction potential of the subsurface soil layers including the fill material(s) is not provided.

**Information Needed:**
Summarize the results of an analysis showing that the soil layers including the backfill(s) below the foundation will not liquefy under the design-basis seismic load.

**TRISO-X Response to RAI-4:**
A liquefaction analysis was performed to evaluate the liquefaction potential based on the soil data from 28 soil borings documented in two site-specific soil reports (References 1 and 2 in the response to RAI-6) using the liquefaction screening technique in accordance with the requirements of:

- NRC Regulatory Guide 1.198 (2003), "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites", and
- Criteria for fine-grained soils outlined in the 2021 National Academies of Sciences report titled "State of the Art and Practice in the Assessment of Earthquake-Induced Soil Liquefaction and Its Consequences". These criteria include:
    - Modified Chinese criteria proposed by Andrews & Martin (2000),
    - Seed, et. al. (2003), and
    - Bray & Sancio (2006).

NRC Regulatory Guide 1.198 (2003) page 1.198-5, states:

> "Cohesive soils with fines content greater than 30 percent and fines that either (1) are classified as clays based on the Unified Soil Classification system OR (2) have a Plasticity Index (PI) greater than 30 percent should generally not be considered susceptible to liquefaction."

Therefore, based on Regulatory Guide 1.198, Condition (1) above, the site soils encountered in the soil borings that are classified as clays (both lean clay and fat clay) are not considered susceptible to liquefaction.

Additionally, based on each of the three screening methods presented in the 2021 State of the Art and Practice report by National Academies of Sciences, it is concluded that all on-site soils (including all clays and a few small zones of elastic silts) are not susceptible to liquefaction.

The proposed structural fill and general fill materials with lime treatment, which will be obtained from the native site soils, are also considered not to be susceptible to liquefaction provided that they are lime treated, placed, and compacted per project specifications.

**License Changes:**
None.

**RAI-5 Differential settlement across the Process Building:**

**Regulatory Basis:**
This RAI has the same regulatory basis as RAI 1.

**Describe Issue:**
Based on the five cross-sectional plots of the proposed site (Figures 1-4 through 1-8 of the LA), location of the rock-soil interface below the Process Building footprint varies significantly. In addition, the thickness of the soil above this interface significantly varies spatially. As stated in LA Section 1.1.1.4 Geology, "the overburden soil thickness below the final grade is expected to vary generally from less than 5 feet to approximately 25 feet within the footprint of the process building." Use of backfill to bring the Process Building foundation to 811 ft elevation introduces another material in the subsurface with potentially different material characteristics. Consequently, the potential for settlement varies spatially resulting in differential settlement. Design of the Process Building should be able to tolerate the anticipated differential settlement.

**Information Needed:**
Summarize the results of an assessment showing that the foundation design achieves the goal of acceptable differential settlement throughout the Process Building.

**TRISO-X Response to RAI-5:**
The RI system is proposed to reduce the differential settlement across the PB foundation. As indicated in the response to RAI-3, the RI system (including the LTP) will be design-built by the specialty RI contractor based on the design and performance criteria according to the project specification. The permitted differential settlement of 1 inch will be met in the RI system design to satisfy the design requirement.

**License Changes:**
None.

**RAI-6 Geotechnical parameters**

**Regulatory Basis:**
This RAI has the same regulatory basis as RAI 1.

**Description of Issue:**
There is no discussion in the LA regarding the geotechnical tests conducted on both soil and rock samples collected at the proposed site. In addition, the LA does not discuss how the results of these geotechnical tests are used to develop the design of the foundation of the Process Building.

**Information Needed:**
Describe the tests conducted on both soil and rock samples collected at the site and summarize the results of the parameters that would be used in the geotechnical design of the proposed facility.

**TRISO-X Response to RAI-6:**
Representative soil samples obtained from the exploratory borings (References 1 and 2) were tested at WSP's testing laboratory in Atlanta, Georgia to evaluate their index and engineering properties. The testing was conducted on disturbed and undisturbed samples of soil and rock obtained during the subsurface exploration activities. The laboratory testing program consisted of the following:

- Moisture Content (ASTM D2216),
- Grain Size Analysis including Hydrometer Test (ASTM D422),
- Atterberg Limits (ASTM D4318),
- Unconfined Compression (ASTM D2166)
- Organics Content (ASTM D2974),

- One-dimensional Consolidation (ASTM D2435),
- One-dimensional Swell of Soils (ASTM D4546)
- pH, Soluble Sulfates, Soluble Chlorides (EPA 9045 and EPA 9056)
- Moisture-Density Relationships (ASTM D1557)
- Unconfined Compression of Rock (ASTM D7012, Method C)
- Triaxial Compression of soils (ASTM D2850)
- pH Values for Soil-Lime Proportion Requirements for Soil Stabilization (ASTM D6276)
- Fabrication and Curing of Lime Stabilized Samples (ASTM D3551)
- California Bearing Ratio (ASTM D1883)
- Unconfined Compression on Lime Stabilized Samples (ASTM D5102)
- Thermal Conductivity of Soil (IEEE 442)
- Soil Resistivity (ASTM G57)

The soil index test results including moisture content, grain sizes, and Atterberg limits (liquid limit and plasticity index) are used to screen the liquefaction potential of the soils. These index test results are also used to classify the site soils and identified the presence of high plasticity clay (CH), which led to the proposal of ground improvement measures using lime treatment. The suite of laboratory tests associated with the use of lime provided the basis of design and performance requirements for the lime stabilization specification. The field Standard Penetration Testing (SPT) results, consolidation and swell test results, with the aid of the unconfined compression and triaxial compression test results, are used to evaluate the settlement of the PB foundation, which led to the decision of using the RI system to increase the bearing capacity and control the settlement within design requirements.

**References:**

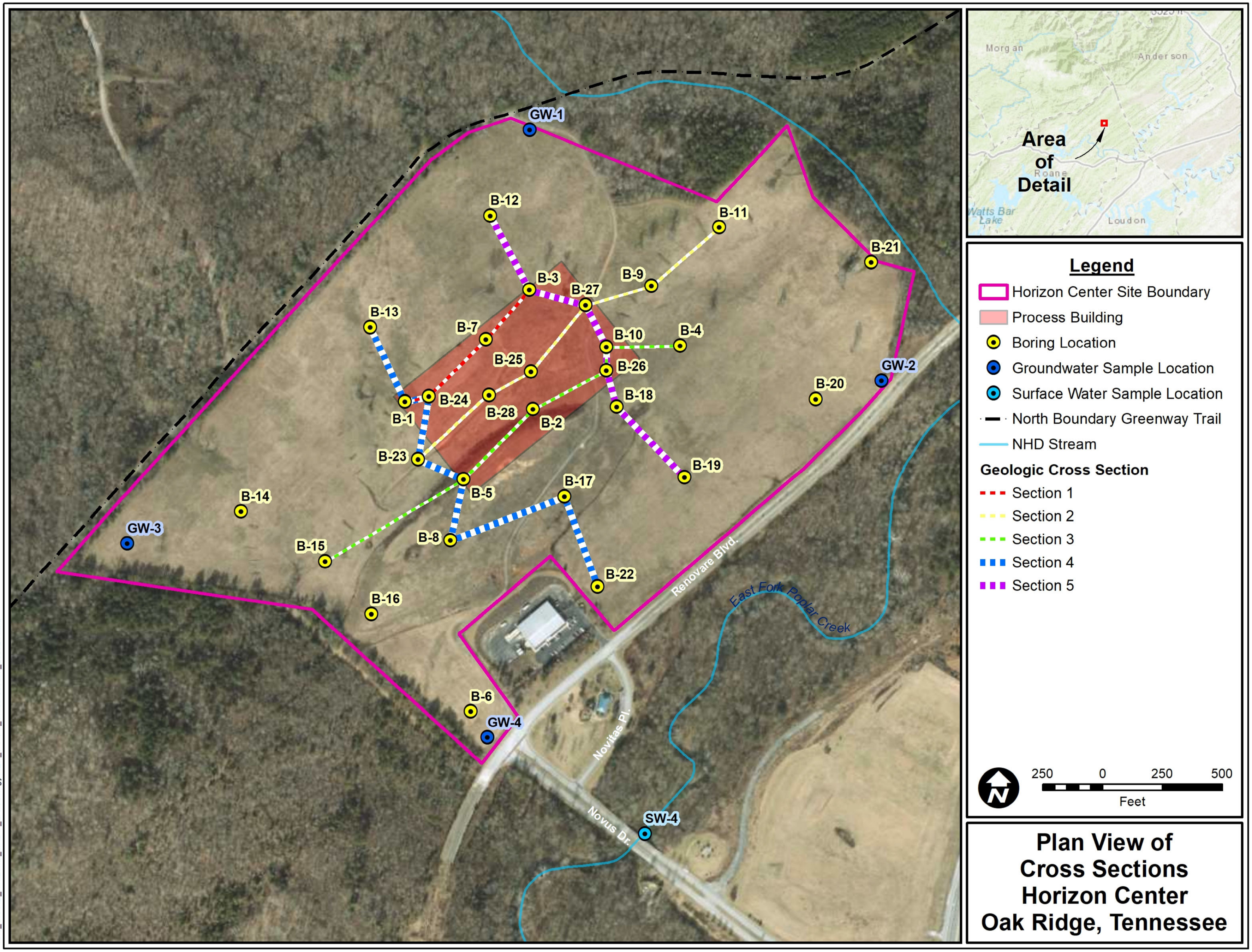
1. Wood Environment & Infrastructure Solutions Inc., “Data Report of Geotechnical Investigation for TRISO-X Facility Horizon Site”, dated June 19, 2023, including Geophysical Report dated 5/20/22 by Geovision.
2. Wood Environment & Infrastructure Solutions Inc., “Supplemental Data Report of Supplemental Geotechnical Investigation for TRISO-X Facility Horizon Site”, dated June 19, 2023.

**License Changes:**

None.

Attachment to Enclosure 1

Revised License Figure 1-3: Plan View of Geologic Cross Sections

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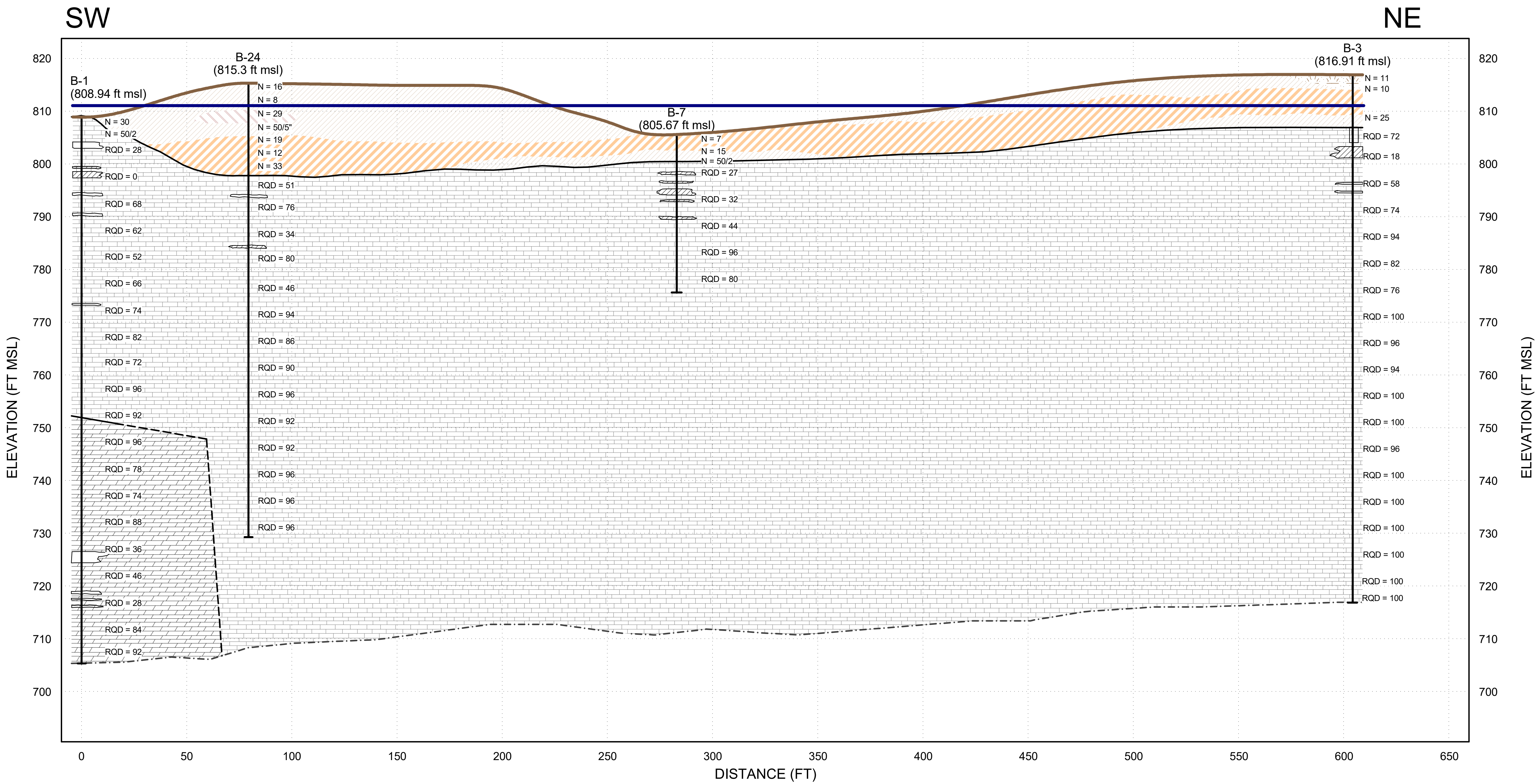
Revised License Figure 1-4: Geologic Cross Section 1




X-energy, Inc.
400 Centrifuge Way
Oak Ridge, TN 37830
By: AAW

Project: 7682215032
Date: 8/8/2022

## Symbol Key

| | |
|---|---|
| B | Geotechnical Boring |
| N | N-Value |
| RQD | Rock Quality Designation |
| (brown line) | Approximate Ground Level |
| (dashed line) | Inferred Lithologic Contact |
| (blue line) | Top of Building Foundation |

## Lithology

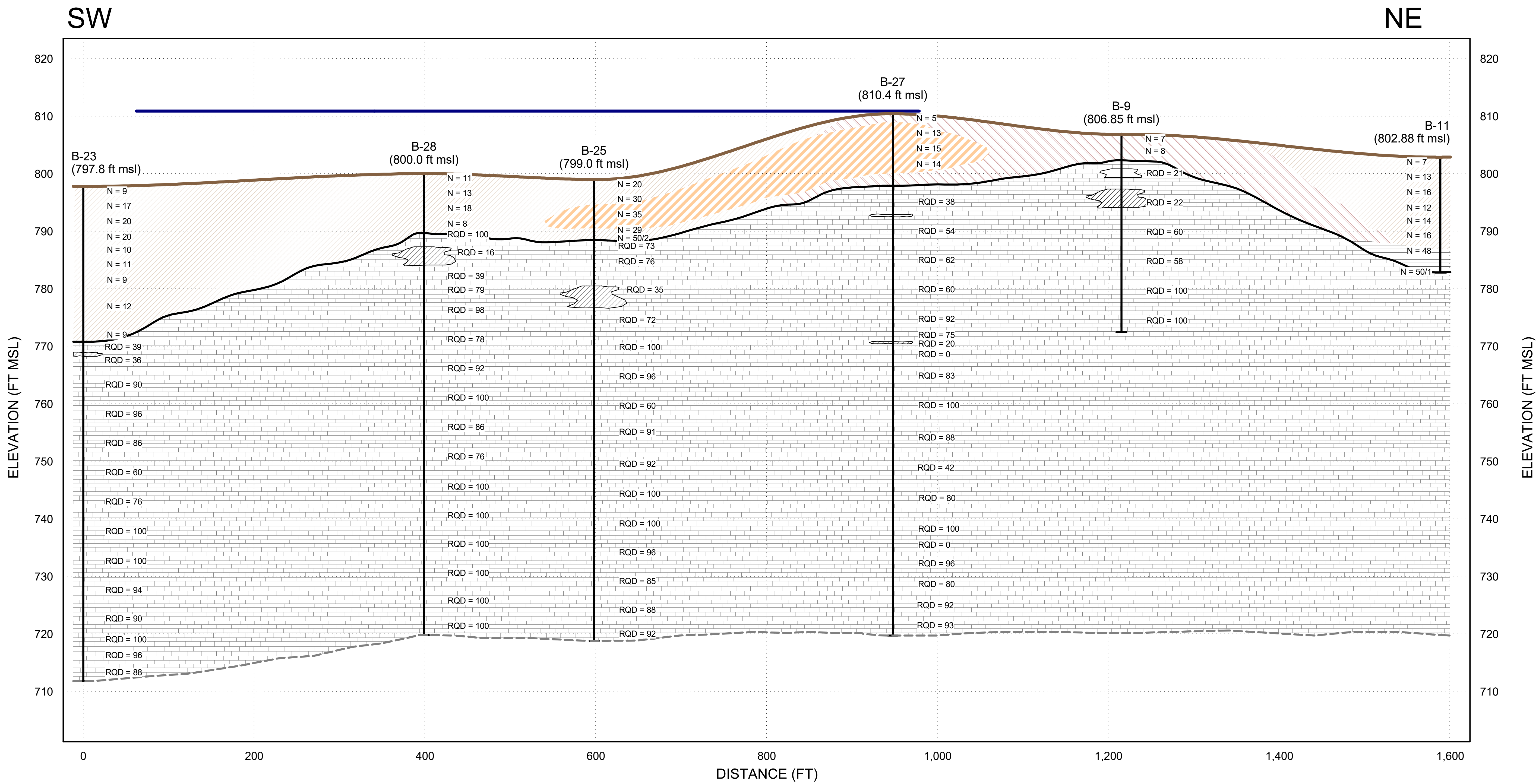
- Limestone (highly weathered to mostly fresh)
- Dolomite (highly weathered to mostly fresh)
- Lean Clay
- Fat Clay
- Lean to Fat Clay
- Topsoil
- Void(s) Encountered
- Clay-Filled Void(s) Encountered

**Cross-Section 1**
**Horizon Center**
**Oak Ridge, Tennessee**

X-energy NRC Licensing Application

Note: Orientation (angle) of inferred lithologic contact(s) between bedrock (e.g., dolomite and limestone) represents approximate apparent dip (angle, 19 degrees E) calculated from dip observed during drilling operations and adjusted based on actual alignment of cross-section illustrated on the 20:50 vertical-to-horizontal exaggerated-profile scale. N-value and rock quality designation displayed approximately at the mid-point of the run.

Revised License Figure 1-5: Geologic Cross Section 2




X-energy, Inc.
400 Centrifuge Way
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By: AAW

Project: 7652215032
Date: 8/10/2022

## Symbol Key

| | |
|---|---|
| B | Geotechnical Boring |
| N | N-Value |
| RQD | Rock Quality Designation |
| | Approximate Ground Level |
| | Inferred Lithologic Contact |
| | Top of Building Foundation |

## Lithology

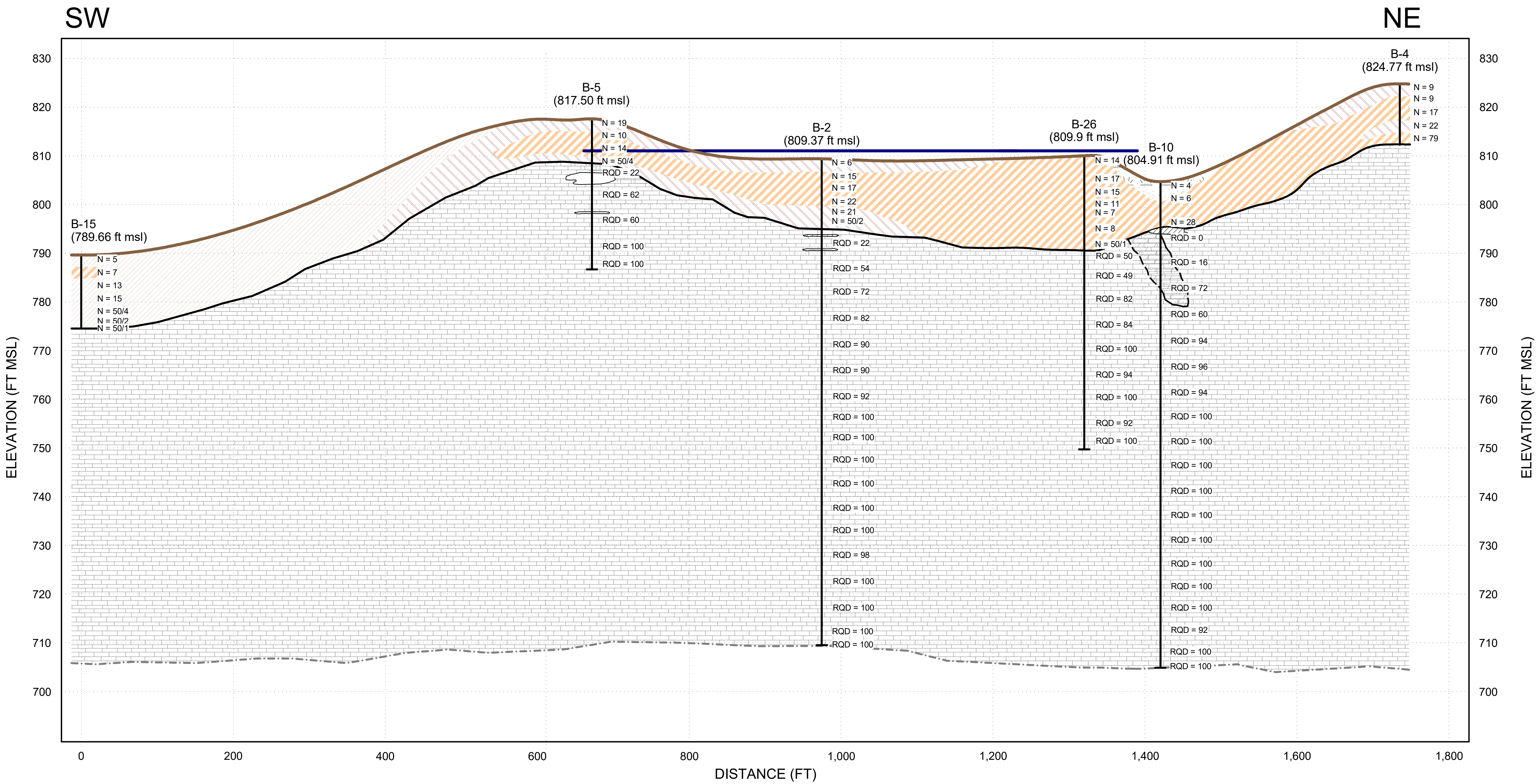
- Limestone (highly weathered to fresh)
- Shale (decomposed)
- Lean Clay
- Fat Clay
- Lean to Fat Clay
- Void(s) Encountered
- Clay-Filled Void(s) Encountered

**Cross-Section 2**
**Horizon Center**
**Oak Ridge, Tennessee**

X-energy NRC Licensing Application

Note: N-value and rock quality designation displayed approximately at the mid-point of the run.

Revised License Figure 1-6: Geologic Cross Section 3




X energy

X-energy, Inc.
400 Centrifuge Way
Oak Ridge, TN 37830
By: AAW

Project: 7682215032
Date: 8/10/2022

**Symbol Key**

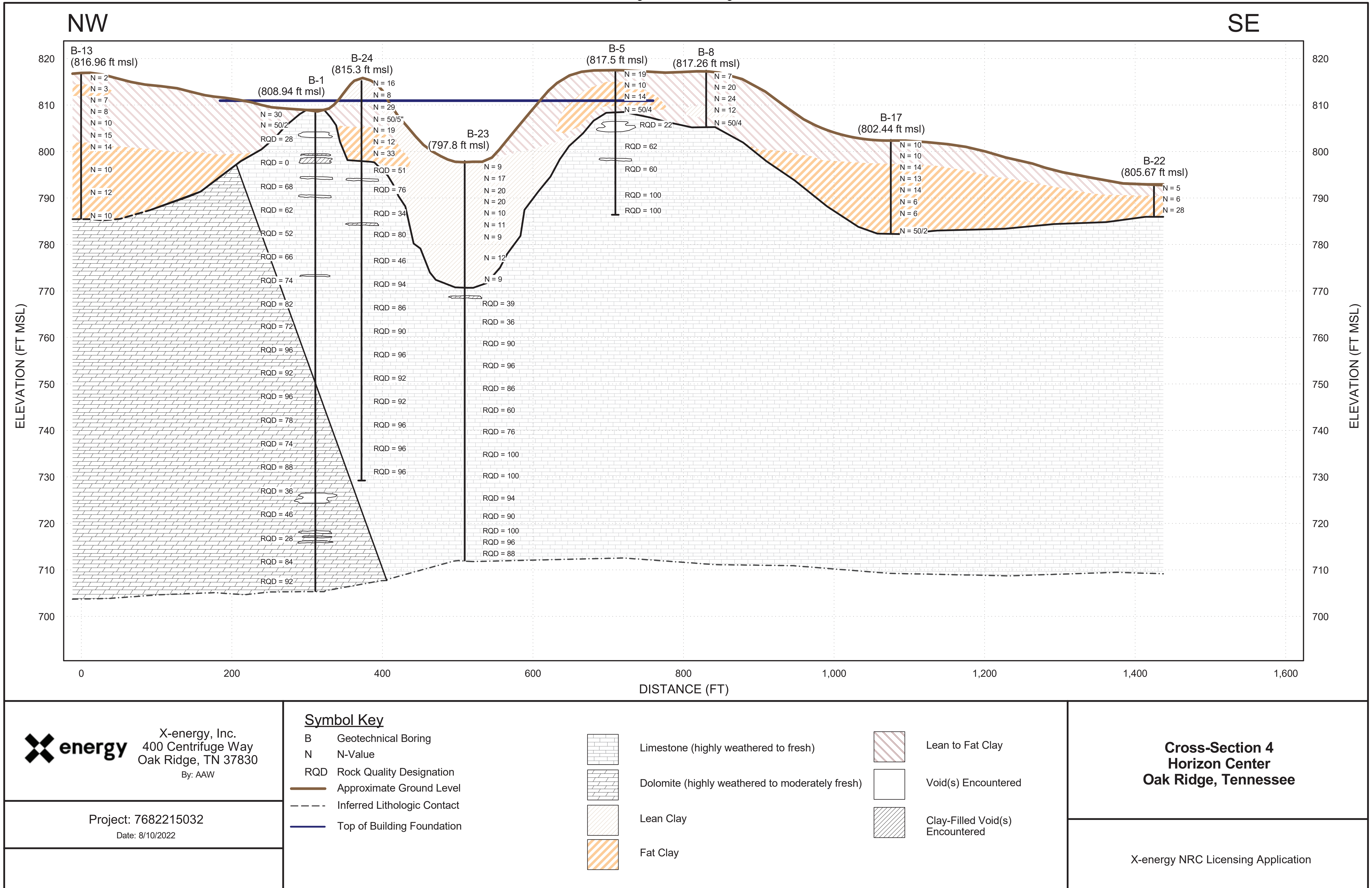
| | |
|---|---|
| B | Geotechnical Boring |
| N | N-Value |
| RQD | Rock Quality Designation |
| | Approximate Ground Level |
| | Inferred Lithologic Contact |
| | Top of Building Foundation |

- Limestone (slightly weathered to fresh)
- Dolomite (moderately to highly weathered)
- Lean Clay
- Fat Clay
- Lean to Fat Clay
- Topsoil (>1ft)
- Void(s) Encountered
- Clay-Filled Void(s) Encountered

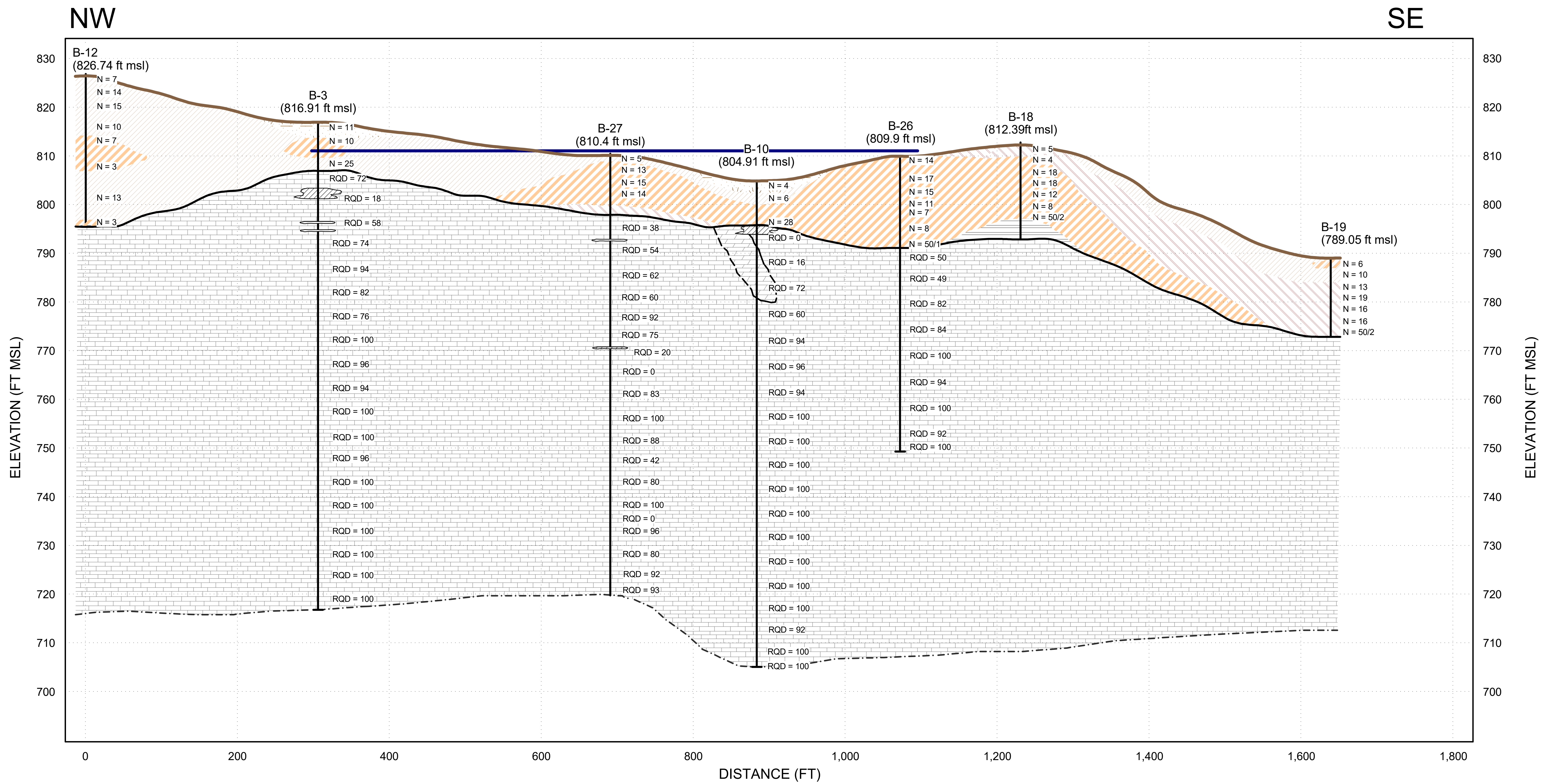
**Cross-Section 3**
**Horizon Center**
**Oak Ridge, Tennessee**

X-energy NRC Licensing Application

Note: Orientation (angle) of inferred lithologic contact(s) between bedrock (e.g., dolomite and limestone) represents approximate apparent dip (angle, 13.5 degrees SE) calculated from dip observed during drilling operations and adjusted based on actual alignment of cross-section illustrated on the 30:200 vertical-to-horizontal exaggerated-profile scale. N-value and rock quality designation displayed approximately at the mid-point of the run.




Note: Orientation (angle) of inferred lithologic contact(s) between bedrock (e.g., dolomite and limestone) represents approximate apparent dip (angle, 13.5 degrees SE) calculated from dip observed during drilling operations and adjusted based on actual alignment of cross-section illustrated on the 34:200 vertical-to-horizontal exaggerated-profile scale. N-value and rock quality designation displayed approximately at the mid-point of the run.

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Project: 7682215032
Date: 8/20/2022

## Symbol Key

| | |
|---|---|
| B | Geotechnical Boring |
| N | N-Value |
| RQD | Rock Quality Designation |
| | Inferred Lithologic Contact |
| | Top of Building Foundation |

- Limestone (highly weathered to fresh)
- Dolomite (moderately to highly weathered)
- Lean Clay
- Fat Clay
- Decomposed Shale
- Lean to Fat Clay
- Void(s) Encountered
- Clay-Filled Void(s) Encountered
- Topsoil (>1 ft)

**Cross-Section 5**
**Horizon Center**
**Oak Ridge, Tennessee**

X-energy NRC Licensing Application

Note: Orientation (angle) of inferred lithologic contact(s) between bedrock (e.g., dolomite and limestone) represents approximate apparent dip (angle, 13.5 degrees SE) calculated from dip observed during drilling operations and adjusted based on actual alignment of cross-section illustrated on the 40:200 vertical-to-horizontal exaggerated-profile scale. N-value and rock quality designation displayed approximately at the mid-point of the run.

**RAI-1 Karst Features:**

**Regulatory Basis:**
The information below is necessary to demonstrate compliance with the regulations in Title 10 to the *Code of Federal Regulations* (10 CFR) 10 CFR 70.64(a), which states in part that for the "Baseline design criteria. Each prospective applicant or licensee shall address the following baseline design criteria in the design of new facilities…." These include subsection 10 CFR 70.64(a)(4) which states that for, "(4) Environmental and dynamic effects. The design must provide for adequate protection from environmental conditions and dynamic effects associated with normal operations, maintenance, testing, and postulated accidents that could lead to loss of safety functions." The information below is also necessary to demonstrate compliance with the regulations in 10 CFR 70.65, "Additional content of applications," subsection (b)(1), which states, that the integrated safety analysis summary must contain "A general description of the site with emphasis on those factors that could affect safety (i.e., meteorology, seismology)."

**Guidance:**
Guidance on one acceptable approach for demonstrating compliance with these regulations is provided in NUREG-1520, Revision 2, "Standard Review Plan for Fuel Cycle Facilities License Applications" (NUREG-1520) in subsection 1.3.4, criterion 4, "The application includes a summary description of the hydrology and geology (including seismicity) for the area and cites the design-basis flood event for which the facility may be safely shut down," and in subsection 1.3.4, criterion 5, "The applicant's descriptions are consistent with the more detailed information presented in the integrated safety analysis (ISA) summary, the environmental report (Agencywide Documents Access and Management System (ADAMS) ML22266A272), and the emergency plan, if these are applicable," which provides one acceptable approach for demonstrating compliance with the regulations.

**Describe Issue:**
The term "karst feature" as used in the application is not capturing all features related to karst that are present at the site. The geology and hydrology sections submitted with the environmental report and the LA (e.g., section 1.1.1.3, "Hydrology", and section 1.1.1.4, "Geology") do not acknowledge the karst features present on the Horizon Center site (HCS).

Revision 2 to Chapter 1 of the TRIOS-X License Application (LA) (ML22308A254) (page 1-7) states that, "Based on the topography of the site, several shallow draws and depressions exist which may reveal karst features beneath the surface. Karst features are caused by dissolution of carbonate rocks and deep weathering along prevailing fractures and strike-oriented bedding, creating conduits and voids (open and/or clay-filled). Voids within the dolomite and limestone bedrock were encountered on the site during the geotechnical drilling program to support facility design." These voids encountered on the site are karst features caused by dissolution of carbonate rock.

Section 14-505 (5)(f) of the Oak Ridge Stormwater Ordinance also acknowledges that karst features may exist in the subsurface, "All exposed karst features exposed by cutting of overburden must be examined by a qualified licensed professional for appropriate mitigation procedures and the erosion and control and stormwater management plan shall be amended accordingly," and Enclosure 7, "TRISO-X Fuel Fabrication Facility Integrated Safety Analysis Summary," (ML22308A251), states that "Based on the topography of the site, several shallow draws and depressions exist which may reveal karst features beneath the surface."

Section 3.3.3.2, "Site Geology," in the environmental report for the TRISO-X Fuel Fabrication Facility (ML22266A272) describes some of the voids penetrate by geotechnical boring B-01. It states that, "The largest void, estimated at 4.1 ft. (1.2 m) thick in the vertical, was encountered in the relatively shallow limestone at 9.4 ft. (2.9 m) below ground surface (bgs) in boring B-09. This large void was found beneath a shallower void (1.5 ft. [0.5 m], vertical) encountered in the same boring at 6 ft. (1.8 m) bgs."

The response to Requests for Additional Information (RAI) in the TRISO-X, LLC, Environmental Report for the Proposed Fuel Fabrication Facility dated April 14, 2023 (ML23104A419), is an example of subsurface voids not being identified as karst features. TRISO-X Response to RAI ER-SW-1 states that, "These investigations, which included deep rock coring at multiple locations, did not find large voids within the bedrock formation or in the subsurface overburden profiles. Therefore, because there is no reported incidence of sinkholes on the site and the geotechnical investigations did not find any sinkholes or karst features, the cited ordinance does not apply." However, the geotechnical soil boring investigations did find voids (i.e., karst features), and the investigations did find at least one large void.

**Information Needed:**
The LA section 1.1.1.3, "Hydrology", and section 1.1.1.4, "Geology," contain information on the hydrology and the hydrogeology of the site. The following information is needed to proceed with the formal review:

- Revise the geology and hydrology sections submitted with the LA and the environmental report to acknowledge that the karst features are present at the site.

**TRISO-X Response to RAI-1:**
The following changes will be made to the License and Environmental Report (changes in red).

**License and Environmental Report Changes:**
License Chapter 1, Section 1.1.1.4, *Geology*

**Potential for Karst Features**
According to the United States Geological Survey (USGS), the region containing the site may contain carbonate rocks that can become karstified. These folded and faulted carbonate rocks are Paleozoic in age and are subject to dissolution that may produce a range of features that include solution, collapse, cover-collapse sinkholes and caves. Karst features previously reported on lands adjacent to the site have included springs and sinkholes of various sizes. While sinkholes are known to occur adjacent to the site, no sinkholes were reported to occur directly on the site. Based on the topography of the site, several shallow draws and depressions exist on the site which may reveal karst features beneath the surface. Karst features are caused by dissolution of carbonate rocks and deep weathering along prevailing fractures and strike-oriented bedding, creating conduits and voids (open and/or clay-filled). Voids within the dolomite and limestone bedrock were encountered on the site during the geotechnical drilling program to support facility design. Bedrock was encountered during drilling at a minimum depth of 3.6 feet and a maximum depth of 50.0 feet.

In early 2022, a subsurface investigation was performed to support the facility design, which involved 22 geotechnical soil borings and a surface geophysical investigation. There were 6 borings located within the PB footprint with total boring depths ranging from 30 feet to 100 feet below ground surface (b.g.s.) and rock core total lengths ranging from 22 feet to 100 feet. Voids were encountered during rock coring in most borings within the PB footprint with the vertical dimensions from as thin as 0.2 feet to approximately 2.6 feet. The 2.6 feet opening was at 82 feet deep b.g.s. at one corner of the PB, while the majority of voids were filled with stiff clay and encountered within the upper 25 feet b.g.s.

The surface geophysical investigation performed shear wave seismic refraction tomography (SWSRT) and electrical resistivity tomography (ERT) to map the subsurface bedrock conditions, including possible major void (empty or soil-filled) anomalies ~~that may be~~ associated with karst features. The tomography survey lines were over 700 feet long each and spaced at 50 feet to cover the entire PB area. The geophysical findings indicated the same general subsurface profiles as discovered by soil borings, which contained shallow residual stiff overburden underlain by weathered bedrock with higher weathering at upper rock formation and very hard competent rock at greater depths. The geophysical report also identified some anomalies where the ERT results showed high resistivity at deep zones compared to the surrounding rock data, although the shear wave velocity at those deep zones did not show abnormal results.

Environmental Report, Section 3.3.2, *Karst Features*

Karst features previously reported on lands adjacent to the HCS have included springs and sinkholes of various sizes (DOE, 2013). While sinkholes are known to occur adjacent to the HCS, no sinkholes were reported to occur directly on the HCS (see Figure 2.1-1). Based on the topography of the HCS, several shallow draws and depressions exist on the HCS which may reveal karst features beneath the surface. One such feature is represented by a sinking stream within the western portion of the HCS that had been mapped by USGS as an intermittent stream but was not identified to be present in conjunction with the delineation of surface waters on the HCS (see Section 3.4.2). As discussed in Section 3.4.1.2, this USGS intermittent stream is perhaps best referred to as a swale. Within the HCS, this broad swale has characteristics similar to a "karst swale. Karst features are caused by dissolution of carbonate rocks and deep weathering along prevailing fractures and strike-oriented bedding, creating conduits and voids (open and/or clay-filled). Voids within the dolomite and limestone bedrock were encountered during the geotechnical drilling program. Voids ranged from as thin as 0.2 ft. (0.1 m) to as much as 4.1 ft. (1.2 m) within all seven of the borings that penetrated and cored rock. A total of 21 voids were encountered. Occurrence of voids were primarily (15 of the 21 voids encountered) limited to the upper 25 ft. (7.6 m) below ground surface. These voids were found within limestone, limestone interbedded with shale, and dolomite. Additional investigation was performed to better characterize subsurface conditions within the TRISO-X FFF building footprints. An additional six borings were advanced. Voids ranged from as thin as 0.3 ft. (0.1 m) to as much as 3.8 ft. (1.2 m) within four of the six borings. Occurrence of voids were limited to the upper 40 ft. (12.2 m) below ground surface. More details regarding these findings are provided in Section 3.3.3.

Environmental Report, Section 3.3.3.2, *Site Geology*

As stated in Section 3.3.2, karst features are caused by dissolution of carbonate rocks and deep weathering along prevailing fractures and strike-oriented bedding, creating conduits and voids (open and/or clay-filled). The potential for sinkhole formation and karst features on the HCS has been evaluated by two phases of a geotechnical soil boring investigation program in conjunction with a geophysical investigation. ~~As noted previously (Section 3.3.2), voids caused by dissolution of carbonate rocks and deep weathering along~~

~~prevailing fractures and strike-oriented bedding can form conduits within the dolomite and limestone.~~ A number of voids were encountered during the geotechnical drilling program. Voids (open and/or clay-filled) ranged from as thin as 0.2 ft. (0.1 m) to as much as 4.1 ft. (1.2 m) within all seven of the borings that penetrated and cored rock (B-01, B-02, B-03, B-05, B-07, B-09, and B-10). Voids primarily (15 of the 21 voids encountered) occur within the upper 25 ft. (7.6 m) bgs. These voids were found within limestone, limestone interbedded with shale, and dolomite. The majority of these voids were filled with stiff clay.

Geotechnical boring B-01 penetrated the most voids (11). Six of these voids were encountered at depths to up to 36 ft. (11.0 m) within the overlying limestone. The remaining five were encountered much deeper, within the underlying dolomite, beginning at approximately 82.2 ft (25 m) bgs with the largest estimated to be 2.6 ft. (0.8 m) vertical opening and the other four much smaller with each void forming 0.2 to 0.5 ft (0.06 to 0.15 m) openings. The largest void at B-01 (82.2) bgs was encountered 25 ft. (7.6 m) below the transition from limestone to dolomite. The largest void, estimated at 4.1 ft. (1.2 m) thick in the vertical, was encountered in the relatively shallow limestone at 9.4 ft. (2.9 m) bgs in boring B-09. This large void was found beneath a shallower void (1.5 ft. [0.5 m], vertical) encountered in the same boring at 6 ft. (1.8 m) bgs.

A surface geophysical investigation conducted at the HCS identified the potential for the presence of voids not encountered in the geotechnical subsurface exploration. Therefore, to further characterize the subsurface conditions an additional six borings were advanced at predetermined locations representing the area where the TRISO-X FFF buildings (including the Process Building) would be located on the HCS. Voids within the limestone bedrock were encountered during the supplemental geotechnical drilling program. Voids ranged from as thin as 0.3 ft. (0.1 m) to as much as 3.8 ft. (1.2 m) within four of the six borings. The occurrence of voids was limited to the upper 40 ft. (12.2 m) below ground surface. These voids were found within limestone and limestone interbedded with shale. No large voids were encountered around the target depths of anomalies reported in the surface geophysical investigation. However, although there is no evidence of sinkholes on the surface of the HCS, the presence of the voids reveals the presence of karst features beneath the surface.

Environmental Report, Section 3.4.1.2.1, *Site Hydrogeology*

Karst features previously reported on lands adjacent to the HCS have included springs and sinkholes of various sizes. Geologic logging during drilling and installation of monitoring wells and geotechnical drilling resulted in identification of karst features ~~at the site~~ beneath the surface of the site including a number of voids (See Section 3.3.2, Karst Features).

**RAI-2 Lambert's Quarry:**

**Regulatory Basis:**
This RAI has the same regulatory basis as RAI 1.

**Describe Issue:**
The LA section 1.1.1.3, "Hydrology", and section 1.1.1.4, "Geology," do not include potentially risk-significant insights obtained from a detailed description of the characteristics of the Lambert's Quarry. The nearest flowing water body is the East Fork Poplar Creek; however, there is a body of still or standing water relatively close to the HCS for which no information was provided. It is identified as Lambert's Quarry in Figure 3 (northeast of Development Area 7) in the "Implementation of Mitigation Action Plan for

Parcel ED-1 on the Oak Ridge Reservation, Oak Ridge, Tennessee," dated May 21, 2013 (DOE, 2013). Information about this body of water may provide insights on the prevalence of karst features in the Pond Springs formation, the same geological unit on which the Process Building will be constructed. Although the name of the water body indicates that it was once a quarry, it may have been a natural sinkhole before quarrying started. Information on the relationship between the water body's water surface with that of the water table of the groundwater may provide needed additional information on the hydrogeologic regime of the area.

**Information Needed:**
The LA section 1.1.1.3, "Hydrology", and section 1.1.1.4, "Geology," contain information on the hydrology and the hydrogeology of the site. The following information is needed to proceed with the formal review:

- Provide a detailed description of the hydrological and hydrogeological characteristics and origin of Lambert's Quarry located in the Pond Springs formation.

**TRISO-X Response to RAI-2:**
TRISO-X reviewed existing data to obtain information related to the origin of Lambert's Quarry. Page 7 of the DOE document, "Review of Parcel ED-1, Under Section 120 (h) of the Comprehensive Environmental Response, Compensation, and Liability Act and Section XLIII of the Federal Facility Agreement" (DOE, 1995), states the quarry is believed to have been used by the U.S. Government from 1942 to 1953 to provide stone for building purposes. No specific hydrological or hydrogeological information was identified that is relevant to the Lambert's Quarry. However, there is an aerial photograph in the above referenced document dated September 25, 1942. Review of that photograph does not indicate that there was a sinkhole on the site prior to development of the quarry.

Therefore, there is no information available to indicate that the quarry was a natural sinkhole at one time.

**License Changes:**
None.

**RAI-3 Volumetric Runoff Rate:**

**Regulatory Basis:**
This RAI has the same regulatory basis as RAI 1.

**Describe Issue:**
Section 2.4, "Stormwater Calculations," in the Stormwater Pollution Prevention Plan (SWPPP) states that, "The resulting increase in overall impermeability produces an increase in runoff volume;" however, it does not provide overall volumetric runoff rate values from the site after development although peak flow rates are provided in Appendix D of the SWPPP. Current plan includes stormwater runoff from parking lots and other impervious areas to flow to a detention basin in the southwest corner.
Although flow from this detention basin is to the depression labeled as a sinkhole in the adjacent area (Development Area 5 in Figure 3 in DOE (2013)) and then most likely flows to the groundwater water table, Table 2 of the SWPPP incorrectly states that receiving waterbody would be an unnamed tributary of East Fork Poplar Creek. The unnamed tributary does exist; however, it terminates at the above-mentioned sinkhole.

The LA section 1.1.1.3, "Hydrology" does not compare and discuss calculated post-development volumetric runoff rates with the pre-development annual discharges. Table 4.4.2-1 in the TRISO-X Environmental Report (ML22266A273) provides results for post-developed flows from runoff to the outlet area at the western edge of the HCS for surface drainage area-1, or SD#1. Estimated maximum, or peak, discharge rates and detention system storage volumes for a 1-inch storm and for the 10-, 25-, 50-, and 100- year, 24-hour duration storm events were presented in the table. However, a total discharge or volume within a given time period, e.g., an annual volumetric runoff rate, is not provided. An annual discharge could be calculated using acquired metrological data from the surrounding area and would include historical storm events greater than 1-inch storms as discussed in sections 3.6.1.4.5 and 3.6.1.4.6 in the TRISO-X Environmental Report.

The difference between the runoff volume and peak flow rate is not clearly described and runoff volume and peak flow rates are inconsistently applied in the response to RAIs in the TRISO-X, LLC, Environmental Report for the Proposed Fuel Fabrication Facility dated April 14, 2023 (ML23104A419). For example, TRISO-X Response to RAI ER-SW- 4 states that, "In Tennessee, this definition would also include directing increased stormwater runoff volumes into an existing sinkhole from new upland development. As stated above, the stormwater runoff volume will not increase in the post-development condition; therefore, a Class V UIC permit is not required." However, both the SWPPP and TRISO-X Response to RAI ER-GW-2 state that the resulting increase in overall impermeability produces an increase in runoff volume. The response to RAI ER-GW-2 also contains another example of a misinterpretation between runoff volume and runoff flow rate. The response states that, "The referenced manual states that, as part of a detailed site investigation, if karst features are expected to receive additional runoff after land development, it is advisable to conduct dye tracing to determine the flow direction of water entering the subsurface." The response's rational for not performing a dye test is that "the rate of discharge at the outfall locations are below the pre-developed site condition." However, the adjacent depression or sinkhole will receive more runoff on average per year due to the increase in overall impermeability of the site even if peak discharge rates will be reduced for precipitation events of one inch or less.

**Information Needed:**

Section 1.1.1.3, "Hydrology," of the TRISO-X LA contains information on the hydrology, but very little information on overall volumetric runoff, of the site. The following information is needed to proceed with the formal review:

- Revise the SWPPP's Table 2, "Outfall Details," for the West Outlet (SD#1, SD#2, & SD#7) and state that the unnamed tributary flows to the depression, or sinkhole, in the adjacent area and not to the East Fork Poplar Creek.
- Revise the LA section 1.1.1.3, "Hydrology," to include a subsection comparing and discussing calculated pre-development and post-development volumetric runoff, e.g., an annual volumetric rate.

**TRISO-X Response to RAI-3:**

The existing stormwater discharge from the West Outlet drains to the natural drainage course (i.e., intermittent stream) toward a sinkhole depression located approximately 400 feet away in the DOE green belt reservation area to the west. TRISO-X followed the screening criteria for a UIC Class V Injection Well Program per the Tennessee Division of Water Resources (DWR) guidance document G-DWR-UIC-01-120817 "Regulation of karst features used for stormwater management under the UIC Class V injection well program." The discharge point for the west detention basin is the same point as the existing natural drainage course. The stormwater collection system does not discharge directly to the subsurface. Therefore, stormwater management practices are not subject to Class V injection well requirements.

The post-developed runoff from the facility is routed through a detention basin and the basin effluent is discharged from the West Outlet at a controlled rate following the same natural drainage course. Depending on the condition of the depressed sinkhole area, during some storm events if the sinkhole depression is full, water will overflow to an unnamed tributary of East Fork Poplar Creek.

The pre- and post-developed peak discharge rates and the volumes are calculated following the guidance in “Tennessee Permanent Stormwater Management and Design Guidance Manual”, 1st Edition, Appendix B, Section B.5.4 (Recommended Procedures for Conveying Runoff from Larger Storms). The following acceptance criteria are from Appendix B, Section B.5.4:

1. “…reducing the allowable peak flow rate resulting from the 1.5-, 2-, and 10-year, 24-hour storms to a level that is less than or equal to the peak flow rate from the site assuming the site was in a good forested condition.”
2. “The total post development runoff volume may not exceed the pre development volume for the 2-year storm or more frequent storms. Storms in excess of the 2-year storm may discharge a larger volume.”

An analysis was performed for the 2-year and 10-year, 24-hour storm events to determine the pre and post development discharge rates and volumes for the West Outlet. The 1.5-year event is considered bounded by the results of the 2-year and 10-year analysis. A summary of the results is shown in Table 1.

Table 1: Comparison of Pre- and Post-developed Condition Results

| Storm Event | 2-Year, 24-hour Storm | | 10-Year, 24-hour Storm | |
|---|---|---|---|---|
| Parameter | Allowable Pre-Developed Discharge | Post-Developed Discharge | Allowable Pre-Developed Discharge | Post-Developed Discharge |
| Peak discharge rate to the sinkhole (cubic feet / second) | 28.20 | 3.20 | 124.62 | 28.99 |
| Runoff volume (acre-feet) | 5.877 | 2.231 | 15.015 | 11.200 |

Based on the results shown in Table 1, the post developed runoff is less than the allowable limits of Section B.5.4 for the pre-developed runoff volume and discharge rate for the rainfall frequency of 2-year and 10-year, 24-hour storm events.

Note that the stormwater drainage system is designed to keep 25-year and 100-year, 24-hour storm event post development discharge rates less than the pre development discharge rates. Per acceptance criteria #2 above, “Storms in excess of the 2-year storm may discharge a larger volume.” The stormwater drainage system post development volumes for the 2-year and 10-year, 24-hour storm evens are both less than the pre development conditions. Post development larger magnitude storm event volumes may be greater than pre development conditions.

**License Changes:**
None.

**RAI-4 Hydrology – Runoff Water Quality:**

**Regulatory Basis:**
This RAI has the same regulatory basis as RAI 1.

**Describe Issue:**
The LA provides no information of the potential changes to groundwater quality after development. The application describes stormwater runoff from parking lots and other impervious areas will flow to a detention basin in the southwest corner. Flow from this detention basin is to the depression labeled as a sinkhole in the adjacent area (Development Area 5 in Figure 3 in DOE (2013)) which then likely quickly flows to the water table. Changes to the groundwater quality may affect future users of this groundwater. Section 4.4.2.2.3.2 from the environmental report document ML22266A273 states that, "Therefore, no degradation of water quality is expected in the downstream receiving waters or surface-oriented water users." The same section also states that, "Small amounts of oil and grease, metals, and other constituents associated with vehicular activity are expected to be carried in runoff from the roads and parking areas within the site. All constituents within stormwater runoff are expected to be at or below the allowable limits set by TDEC." The LA section 1.1.1.3, "Hydrology" does not describe water quality or provide a technical basis as to why all constituents within stormwater runoff are expected to be at or below the allowable limits.

**Information Needed:**
Section 1.1.1.3, "Hydrology," of the TRISO-X LA contains information on the hydrology, but very little information on water quality, of the site. The following information is needed to proceed with the formal review:

- Revise LA section 1.1.1.3, "Hydrology," to include a subsection on water quality in addition to providing a technical basis as to why all constituents within stormwater runoff are expected to be at or below the allowable limits.

**TRISO-X Response to RAI-4:**
The License and Environmental Report will be revised as follows (changes in red) to further clarify the statement that all constituents within stormwater runoff are expected to be at or below the allowable limits.

**License and Environmental Report Changes:**
License Chapter 1, Section 1.1.1.3, *Hydrology*

[New paragraph added at end of Section]
Water quality of stormwater runoff is maintained through the use of detention ponds. Stormwater generated is collected in peripheral ditches and the interior stormwater system before being discharged to the stormwater detention basin. The detention basin is divided into two separate sections, the forebay section and the main detention basin section. The forebay section collects the runoff from the entire permanent site areas and provides storage for a portion of the runoff for water quality treatment that allows sediment and site generated total suspended solids (TSS) to settle at the bottom of the forebay. The main detention basin section receives stormwater overflow from the forebay section and provides additional storage for the remaining stormwater volume to allow for TSS to settle at the bottom of the detention basin section. Treated water effluent is discharged via the NW Outlet into an existing drainage swale to an observed sinkhole feature in the adjacent parcel. As such, all constituents within stormwater runoff are expected to be at or below the allowable limits set by TDEC. Any stormwater runoff from electrical transformers,

mechanical yards and above ground tank containments is collected separately and disposed of after adequate treatment.

Environmental Report, Section 4.4.2.2.3.2, *Operation*

Stormwater collected during normal operations would contain pollutants typically associated with runoff collected from public streets and parking areas. Small amounts of oil and grease, metals, and other constituents associated with vehicular activity are expected to be carried in runoff from the roads and parking areas within the site. Water quality of the stormwater runoff is maintained through the use of detention ponds. Stormwater generated is collected in peripheral ditches and the interior stormwater system before being discharged to the stormwater detention basin. The detention basin is divided into two separate sections, the forebay section and the main detention basin section. The forebay section collects the runoff from the entire permanent site areas and provides storage for a portion of the runoff for water quality treatment that allows sediment and site generated total suspended solids (TSS) to settle at the bottom of the forebay. The main detention basin section receives stormwater overflow from the forebay section and provides additional storage for the remaining stormwater volume to allow for TSS to settle at the bottom of the detention basin section. Treated water effluent is discharged via the NW Outlet into an existing drainage swale to an observed sinkhole feature in the adjacent parcel. As such, ~~A~~ all constituents within stormwater runoff are expected to be at or below the allowable limits set by TDEC. Any stormwater runoff from electrical transformers, mechanical yards and above ground tank containments is collected separately and disposed of after adequate treatment.

**RAI-5 Contaminated Water Resulting from Fire Suppression:**

**Regulatory Basis:**
This RAI has the same regulatory basis as RAI 1.

**Describe Issue:**
It is not clear as to where liquids and foams used to suppress potential fires will flow to during and after a fire event, and what safeguards will exist to prevent contaminants originating during a fire event (i.e., contaminates emanating from a severely fire- damaged building or potential chemical contaminants used to suppress fires) from flowing outside the site boundaries in an uncontrolled manner. Section 2.6.6 in the ISA Summary discusses liquids flowing to equipment drains and floor drains and subsequently routed to a common sump for collection, and section 5.10.1 in the NFPA 801 describes how drainage or containment shall be provided and accomplished by the use of floor drains and trenches, open doorways or other wall openings, curbs for containing or directing drainage, equipment pedestals, and pits, sumps, and sump pumps. However, in case of a serious fire, considerable water may be used during efforts to douse fires, that water may likely end up around the impacted building and on the surrounding impervious parking lots. Current plans include water runoff from parking lots and other impervious areas to flow to a detention basin in the southwest corner. Flow from this detention basin is to the depression labeled as a sinkhole in the adjacent area (Development Area 5 in Figure 3 in DOE (2013)), which then likely quickly flows to the groundwater. Changes to the groundwater quality may affect future users of this groundwater. It is not clear if the water used to suppress the fire is not expected to flow from the impacted area, and if so, what design features limit the flow of water.

**Information Needed:**
It is not clear to the NRC staff how contaminated water that may originate during fire events will be disposed of, and information is needed on plans to manage contaminated

water for such a fire scenario. The following information is needed to proceed with the formal review:

- Provide information on the plans to manage contaminated water for a fire scenario as discussed in the “Description of Issue” above.

**TRISO-X Response to RAI-5:**
There are no floor drains in the uranium processing area. The equipment drains and floor drains referenced in ISA Summary Section 2.6.6 are specific to the non-radiological areas of the facility. One-inch thresholds located at the exterior doors of the TRISO-X FFF prevent discharge of water or liquids from the facility. Section 5.10 of National Fire Protection Association (NFPA) 801 states that the maximum flow from fire sprinklers to consider in areas handling radioactive materials is 500 gallons per minute for a duration of 30 minutes. This is a total volume of 15,000 gallons. The total floor area within the uranium processing area of the TRISO-X FFF is well over 100,000 $ft^2$. At a depth of 1-inch, 100,000 $ft^2$ equates to a volume of approximately 62,200 gallons. The floor within the uranium processing area is designed for flatness and level which allows water to spread out between interior rooms and hallways. Based on the expected flow rate, firefighting time, floor area, and exterior door thresholds, no water or liquids used during firefighting are expected to leave the facility.

Water used during a firefighting event will be processed through recovery and waste operations at the facility.

**License Changes:**
None.

**RAI-6 Groundwater Flow Direction:**

**Regulatory Basis:**
This RAI has the same regulatory basis as RAI 1.

**Describe Issue:**
Section 1.1.1.3, “Hydrology,” in Revision 2 to Chapter 1 of the TRIOS-X LA states that, “Groundwater elevation measurements and modeling indicate that groundwater generally flows in a southwest direction toward East Fork Poplar Creek. There are no known household, public, or industrial users of groundwater downgradient of the site.” However, both statements on flow direction and users of groundwater lack supporting evidence. While Figures 3.4.1-5 and 3.4.1-6 in the same LA document show a general flow direction towards the southeast, not the southwest, it is not clear where the terminus for the groundwater movement is. It is uncertain if the groundwater from HCS discharges to East Fork Poplar Creek or flows underneath since there are no groundwater monitoring wells on the other side of the creek. Therefore, it is unknow if there are household, public, or industrial users of groundwater downgradient of the site. This is especially true if the contour lines drawn in Figure 3.4.1-5 and 3.4.1-6 are correct. The contour lines between the groundwater monitoring wells GW-5 and GW-6 show a flow that is not discharging into the creek, but rather flowing parallel to it. However, the southwest corner of the figures, which includes the depression labeled as a sinkhole (see Development Area 5 in Figure 3 in DOE (2013)), suffers from a lack of data and any contour lines drawn in this area would be associated with a large uncertainty. For example, the flow direction from GW-5 shows a flow direction to the southwest in both figures; however, an inferred hydraulic gradient could show groundwater flowing to the northeast since the both figures show a 755-foot contour line to the northeast that is five feet below that of the measured head for GW-5

(circa 760 feet). Section 1.1.1.3 in Revision 2 to Chapter 1 of the TRIOS-X LA does not include groundwater data from the areas south of the HCS. The hydrogeology downgradient of the site is uncertain and appears to be not well understood, which makes predictions of groundwater flow and transport difficult to make with any certainty. Data from additional sources south of the site are needed, especially from areas consistent with Development Area 2 and Development Area 5 (see Figure 3 from DOE, 2013) from Parcel ED-1.

**Information Needed:**
Section 1.1.1.3, "Hydrology," of the TRISO-X LA contains information on the hydrogeology of the site, but the hydrogeology downgradient of the site is unknown. This includes water table elevations or groundwater flow direction information from the south side of East Fork Poplar Creek in addition to groundwater flow direction information from the adjacent depression towards which the future detention basin will drain. The following information is needed to proceed with the formal review:

- Revise LA section 1.1.1.3, "Hydrology," to include an evaluation and a discussion pertaining to this new hydrologic data.

**Reference:**
DOE, 2013. Implementation of Mitigation Action Plan for Parcel ED-1 on the Oak Ridge Reservation, Oak Ridge, Tennessee. May 21, 2013.

**TRISO-X Response to RAI-6:**
No wells were identified for data to support flow south of East Fork Poplar Creek. However, existing data was used to update the interpretation of groundwater flow and to provide supporting evidence of flow paths. Environmental Report Figures 3.4.1-5 and 3.4.1-6 will be revised (included in the Attachment to Enclosure 2) to show surface water elevations with respect to groundwater elevations, supporting groundwater discharge to East Fork Poplar Creek and not shallow groundwater flow beyond the creek. Environmental Report Figures 3.4.1-5 and 3.4.1-6 will also be revised to show that a groundwater divide exists during both drier and wetter periods near GW-5. Flow at the groundwater divide can occur from the south to the north, turning to the east locally near GW-5 and ultimately indicating discharge to East Fork Poplar Creek. Additionally, Figures 3.4.1-5 and 3.4.1-6 will be expanded to show the East Fork Poplar Creek turns to the north just south and west of GW-6 and that flow from south and west of GW-5 is toward East Fork Poplar Creek.

The revised Environmental Report Figures 3.4.1-5 and 3.4.1-6 will be added to the license as new License Figures 1-9 and 1-10, respectively.

The statement that there are no known household, public, or industrial users of groundwater downgradient of the site is based upon the groundwater and surface water elevation interpretation and flow paths in combination with a comprehensive well search for an area within a 3-mi (4.8-km) radius from the TRISO-X Fuel Fabrication Facility as discussed in the Environmental Report, Section 3.4.1.1.3.1. The transport of groundwater to any of the identified wells would be highly improbable given that the closest users of groundwater reside north of the HCS site in a separate valley (Poplar Creek Valley) and on the other side of Poplar Creek, separated by Blackoak Ridge, while groundwater flow is to the southeast and/or southwest (Environmental Report Figure 3.4.1-2). Other potential groundwater users identified are in separate valleys. One location is nearly directly east and at a topographically higher elevation and further upstream on the separate valley. The other potential users reside to the southwest across Poplar Creek in valleys upstream of

Poplar Creek which would likely be associated with shallow groundwater flow from west to east.

**License and Environmental Report Changes:**
License Chapter 1, Section 1.1.1.3, *Hydrology*

[New paragraph added at end of Section, following the new paragraph added by response to RAI-4 (changes in red)]
Groundwater hydraulic gradients are based on potentiometric level contours of water levels collected on September 16, 2021 and January 12, 2022, and are shown on Figures 1-9 and 1-10, respectively. These two months were selected for their seasonal influence (summer and winter) on potentiometric levels, as it is apparent that lower evapotranspiration levels during colder shorter days (i.e., decreases naturally as vegetation is dormant, and less need of infiltrating water) influences groundwater availability. The interpreted flow paths, perpendicular to contours, indicate groundwater flows from north of the site in a predominantly southeastern direction toward East Fork Poplar Creek and is consistent in summer and winter. The groundwater flow paths do not indicate flow toward any potential groundwater users.

Environmental Report, Section 3.4.1.2.1.1, *Groundwater Levels and Elevations*

[New paragraphs added at end of section (changes in red)]
The interpreted flow paths, perpendicular to contours, indicate groundwater flows from north of the HCS site in a predominantly southeastern direction toward EFPC and is consistent in summer and winter. All flow paths that cross the HCS site indicate flow to EFPC, and surface water elevation measurements collected during the summer (November 2021) and winter (February to March 2021) sampling events, posted in Figures 3.4.1-5 and 3.4.1-6 respectively, indicate groundwater discharge is occurring at EFPC and shallow groundwater flow past EFPC is unlikely. No flow paths other than to EFPC were identified that would indicate flow from the HCS site to other locations. However, a groundwater divide south of the HCS site is identified near GW-5 that is apparent in both summer and winter as noted in Figures 3.4.1-5 and 3.4.1-6 by the yellow dashed line and arrow. This alternate flow path supports groundwater flow from the south to the north locally near GW-5 and then east to EFPC but does not cross the HCS site and indicates flow from the HCS site discharging at EFPC and not flowing further south.

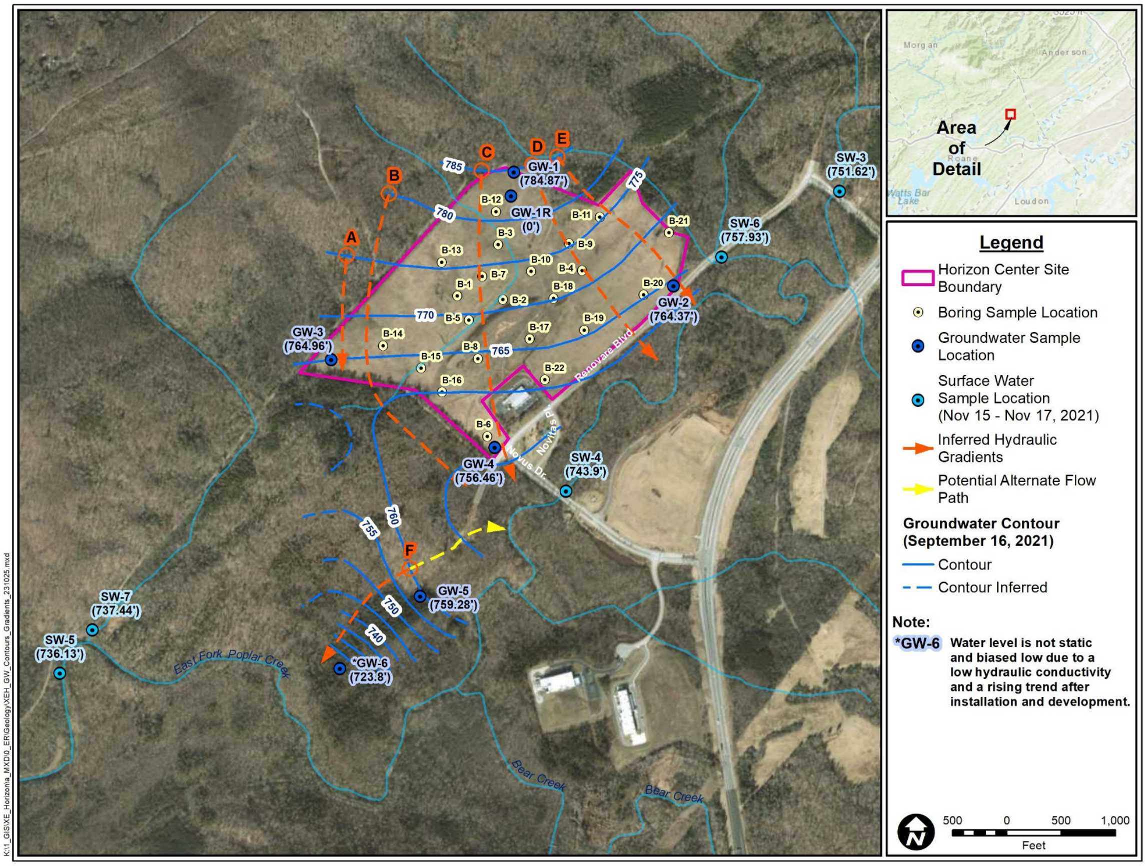
The groundwater elevation noted at GW-6 during the summer in Figure 3.4.1-5 could be interpreted as groundwater flow beneath EFPC. However, the hydrograph for well GW-6 shows that the water level in summer was not static and on a very slow rising limb due to low hydraulic conductivity after installation and development. The groundwater elevation at GW-6 stabilized at an elevation of approximately 741 feet in February 2022 where it remained through the remainder of the monitoring program (Figure 3.4.1-4). A groundwater elevation of 741 feet at GW-6 and estimated EFPC surface water elevation of approximately 740 feet west of GW-6, based on surface water elevations from upstream of GW-6 at SW-4 (743.9 feet) and downstream of GW-6 at SW-5 (736.13 feet) supports discharge of groundwater to EFPC and not beyond.

The groundwater flow paths do not indicate flow toward any of the potential groundwater users identified in Section 3.4.1.1.3.1. The transport of groundwater to any of the identified wells would be highly improbable given that the closest users of groundwater reside north of the HCS site in a separate valley, Poplar Creek Valley and on the other side of Poplar Creek, separated by Blackoak Ridge while groundwater flow is to the southeast, and or southwest (Figure 3.4.1-2). Other potential groundwater users identified are in separate valleys. One location is nearly directly east further upstream in a separate valley. The other potential users reside to the southwest across Poplar Creek in valleys upstream of Poplar Creek which would likely be associated with shallow groundwater flow from west to east.

# New License Figure 1-9

## Revised ER Figure 3.4.1-5

## Groundwater Contours – September 2021



# New License Figure 1-10

# Revised ER Figure 3.4.1-6

# Groundwater Contours – January 2022