TERRA INNOVATUM SOLO™

WHITE PAPER

Rock City Admiral Parkway (IL) Site Characteristics Preliminary Analysis

(Non-Proprietary)

Total Pages:55

Document Number: LTR-TINN-25-024
Revision 0

(Enclosure 4)

2025-11-29

Terra Innovatum s.r.l.
Via Matteo Trenta 117, 55100 Lucca (LU), Italy

Notes on revisions, source control and e-attachments:

Revision 0
First release.

Signatures

Role	Person	Signature
Author	Christopher Gosdin	
Reviewer	Cesare Frepoli	
Approver	Alessandro Petruzzi	

Git commit
N/A

Archive Content (e-attachments)
None

Instructions
None.

TABLE OF CONTENTS

1 Introduction 5
1.1 Purpose and Need for the Proposed Action 6
1.2 Objectives 6
1.3 Scope 7
1.4 Applicable Regulations and Regulatory Guidance 9
1.5 Request for NRC 10
1.6 REPORT STRUCTURE 11
2 Site Location and Setting 13
2.1 Site Location and Description 13
2.1.1 Underground Complex (Non-Reactor Functions Only) 13
2.1.2 [[ ]] 14
2.1.3 Surface Facilities (Reactor Location) 14
2.1.4 Surface–Subsurface Relationship 14
2.2 Regional Setting 15
2.3 Land Use and Zoning 15
3 Geography, Climate, and Demography 17
3.1 Geography & Topography 17
3.2 Climate & Meteorology 17
3.2.1 Regional Climate Characteristics 17
3.2.2 Severe Weather Patterns 18
3.2.3 Topographic and Microclimatic Influences 18
3.2.4 Underground Ambient Conditions 18
3.3 Hydrology & Flooding 19
3.3.1 Surface Water and Stormwater Behavior 19
3.3.2 Groundwater and Subsurface Hydrology 20
3.3.3 Regional Hydrologic Context 20
3.3.4 Hydrologic Suitability for Siting 20
3.4 Demography & Population Distribution 22
3.4.1 Population Within the Immediate Vicinity 22
3.4.2 Population Distribution in the 1–10 Mile Region 22
3.4.3 Regional Population Considerations (10–50 Miles) 23
3.4.4 Transient Population 23
3.4.5 Demographic Suitability for Siting 23
3.5 Emergency Planning, Access, and Egress 23
3.5.1 EPZ Strategy and Regulatory Basis 24
3.5.2 Basis for Reduced EPZ 24
3.5.3 Emergency Response Staffing and Coordination 24
3.5.4 Onsite Access and Egress 24
3.5.5 Interaction with Underground Areas 24
3.5.6 Summary 25

4 Geology, Seismology, and Geotechnical Engineering....26
4.1 Regional Geology....26
4.2 Site Geology (Underground)....26
4.3 Site Geology (Above-Ground)....26
4.4 Seismicity & Ground Motion....27
4.5 Surface Faulting & Liquefaction Potential....29
5 Infrastructure and Regional Assets....31
5.1 Transportation & Logistics....31
5.2 Nearby Industrial Facilities....33
5.3 Utilities & Services....33
5.4 Nearby Military & Emergency Services....34
6 Natural and Man-Made Hazards....35
6.1 Severe Weather....35
6.1.1 Wind Rose Data Summary....35
6.2 Flood Hazard Assessment....42
6.3 Critical Habitat Assessment....42
6.4 Industrial & Transportation Hazards....44
7 Environmental Impacts of the Proposed Action....46
7.1 Introduction....46
7.2 Construction Impacts....46
7.3 Operations Impacts....46
7.4 Decommissioning and Cumulative Impacts....47
7.5 Mitigation and Monitoring....47
8 Alternatives....48
8.1 Introduction....48
8.2 No-Action Alternative....48
8.3 Alternative Sites....48
8.4 Alternatives Eliminated from Detailed Study....50
8.5 Comparison of EnvironmentaL Consequences....50
8.6 Preferred Alternative....51
9 Conclusions....52
10 References....53

1 INTRODUCTION

Terra Innovatum is evaluating the suitability of the Rock City Business Complex in Valmeyer, Illinois, as the proposed location for the First-of-a-Kind (FOAK) SOLO Microreactor. The site presents a unique combination of above-ground industrial facilities and an extensive underground limestone complex originally developed through historic quarrying [1]. This dual setting introduces both opportunities and challenges for microreactor siting that are not fully addressed by conventional above-ground nuclear facilities.

This whitepaper provides Terra Innovatum's preliminary siting characteristics evaluation for the Rock City site and is intended to support pre-application engagement with the U.S. Nuclear Regulatory Commission (NRC) before submittal of the Preliminary Safety Analysis Report (PSAR) and Environmental Report (ER).

The information herein reflects the current conceptual design and site characterization approach and identifies the methods, datasets, and regulatory bases that Terra Innovatum intends to use during the PSAR and ER development phases [2].

This document does **not** present final conclusions or licensing positions. Rather, its purpose is to:

1. **Communicate the siting methodology and underlying assumptions** for geology, hydrology, seismology, population distribution, meteorology, and environmental factors [3].
2. **Describe the planned strategy** for integrating above-ground and underground site characteristics into the safety analysis.
3. **Identify data gaps and future investigations** required to support PSAR-level detail.
4. **Request NRC feedback** on the adequacy and completeness of the proposed siting approach.

The Rock City site comprises approximately **137 acres of surface industrial land** and roughly **6 million square feet of subsurface chambers** excavated within Mississippian-age limestone [1]. The above-ground areas provide logistical access, security, and administrative support, while the underground complex offers a stable geologic environment largely shielded from severe weather, temperature extremes, and airborne hazards [4]. This configuration offers potential advantages for microreactor deployment but requires a tailored siting evaluation that considers:

- **Subsurface geologic stability**
- **Groundwater and drainage interactions**
- **Emergency planning and egress** between surface and subsurface areas
- **Surface weather hazards** affecting support infrastructure
- **Integration of industrial co-tenants** within the underground facility

The siting approach described in this white paper aligns with the regulatory framework applicable to non-power reactors and low consequence microreactors, including **10 CFR Parts 50, 51, and 100** [5] [6] [7], **NUREG-1537** [2], **Regulatory Guide (RG) 4.2** [3], **RG 4.7** [8], and relevant seismic, hydrologic, and meteorological guidance. Consistent with recent small modular reactor precedents—such as the NRC's environmental assessments for Kairos Power **Hermes-2** [9] and university-based test reactors such as the Abilene Christian University Molten Salt Research Reactor (ACU) [10] — this document also outlines the applicant's expectations for the environmental review process under the National Environmental Policy Act (NEPA).

The early engagement enabled by this white paper is intended to confirm that Terra Innovatum's siting basis, analytical methods, and planned investigations meet NRC expectations and provide a sound foundation for the forthcoming PSAR and Environmental Report. Terra Innovatum seeks NRC feedback on whether the planned approach is sufficient to support a construction permit application for the SOLO reactor at the Rock City site.

1.1 PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose of the proposed action is for Terra Innovatum to obtain NRC concurrence on the planned siting approach and, ultimately, to support the future construction permit application for the SOLO Microreactor under 10 CFR Part 50 [5]. The Rock City Business Complex in Valmeyer, Illinois, is being evaluated as the proposed First-of-a-Kind (FOAK) deployment site for SOLO, and this white paper documents the preliminary siting analysis that will form the basis for the subsequent Preliminary Safety Analysis Report (PSAR) and Environmental Report (ER).

The need for the proposed action is to enable Terra Innovatum to:

1. Demonstrate the performance and safety characteristics of the SOLO microreactor in a realistic industrial setting [11].
2. Establish a validated siting and licensing basis for a microreactor capable of integration with both surface and underground industrial infrastructure.
3. Collect site-specific data to support safety analysis, environmental impact evaluation, emergency planning, and future standardized deployment.
4. Confirm early NRC alignment with Terra Innovatum's siting methodology, regulatory interpretation, and planned investigations [2].
5. Support long-term commercialization by demonstrating a deployable microreactor model suitable for industrial, defense, and remote applications.

Under 10 CFR Part 51, this white paper also serves as the initial step in providing environmental information necessary for the NRC to perform an Environmental Assessment (EA) or Environmental Impact Statement (EIS), as appropriate. The Rock City site—comprising 137 surface acres and approximately 6 million square feet of subsurface limestone chambers—offers an opportunity to evaluate environmental and safety performance in both surface and protected underground environments.

The proposed action directly supports Terra Innovatum's objective of demonstrating a safe, scalable, and commercially deployable microreactor system and establishing an NRC-accepted framework for siting, environmental analysis, and underground facility integration.

1.2 OBJECTIVES

The objective of this white paper is to outline Terra Innovatum's planned approach for evaluating the suitability of the Rock City Business Complex for siting the First-of-a-Kind (FOAK) SOLO Microreactor [3]. This document provides the preliminary technical bases, regulatory context, and investigative framework that will support development of the future Preliminary Safety Analysis Report (PSAR) and Environmental Report (ER) required for a construction permit under 10 CFR Part 50.

The specific objectives of this siting characteristics evaluation are to:

1. **Establish the baseline environmental and geophysical characteristics of the Rock City site**, including geography, geology, hydrology, seismology, climate, meteorology, and population distribution, consistent with the data needs described in NUREG-1537.
2. **Identify natural and man-made external hazards** that may influence the design or licensing basis of the SOLO reactor, including seismic events, flooding, severe weather, industrial operations within the underground complex, and transportation-related hazards.
3. **Assess the suitability of the dual above-ground and underground facility configuration** for supporting microreactor construction, safe operation, emergency planning, and security functions.

4. **Describe the planned methods, assumptions, and analytical tools** that Terra Innovatum intends to use during PSAR development, including site-specific geotechnical investigations, meteorological data collection, groundwater characterization, and structural evaluations.

5. **Evaluate population distribution and emergency planning considerations** under 10 CFR 100.20(c), including access/egress, coordination with local authorities, and implications of underground facility occupancy.

6. **Define the preliminary environmental review framework** consistent with 10 CFR Part 51, including the approach for evaluating construction, operation, and decommissioning impacts.

7. **Identify data gaps and required future studies** (e.g., boreholes, geophysical surveys, groundwater monitoring, subsurface stability assessments) necessary to support a complete PSAR and ER.

8. **Facilitate early NRC engagement** by providing a clear description of the siting basis and requesting feedback on the adequacy of the proposed scope, methodologies, and regulatory interpretations.

Collectively, these objectives ensure that Terra Innovatum's siting approach is comprehensive, technically defensible, and aligned with NRC expectations for a microreactor construction permit application.

1.3 SCOPE

The scope of this white paper is to present Terra Innovatum's preliminary siting characteristics evaluation for the proposed FOAK deployment of the SOLO Microreactor at the Rock City Business Complex in Valmeyer, Illinois. The document outlines the planned technical approach, supporting data sources, and regulatory framework that Terra Innovatum intends to use during development of the future Preliminary Safety Analysis Report (PSAR) and Environmental Report (ER).

This white paper is not a final safety or environmental analysis; rather, it provides the **conceptual basis** and **methodology** for evaluating the Rock City site in a manner consistent with NRC regulations and guidance for microreactor facilities.

The scope of the evaluation includes the following major elements:

1. Site Characterization

A preliminary assessment of the physical and environmental attributes of the Rock City site, including:

- **Regional and local geology**, stratigraphy, and karst features [12].
- **Seismology**, including regional seismic sources and expected ground motions [13] [14].
- **Hydrology and hydrogeology**, including groundwater behavior, stormwater routing, and flood hazard considerations [15] [16].
- **Meteorology and climatology**, including prevailing winds, severe weather, and dispersion characteristics [17].
- **Geography, topography, and land use** on and around the site [1] [18].
- **Demography** and population distribution relevant to 10 CFR 100.20(c) [19].

2. Facility Interfaces

A description of how SOLO will interface with both the surface and subsurface portions of the Rock City property, addressing:

- Surface logistics areas, utilities, offices, and portal structures.
- Underground chambers, rock-mass stability, drainage systems, HVAC conditions, and environmental controls [20].
- The operational coupling of surface–subsurface systems, including emergency access/egress and utility integration.

3. Hazard and External Event Considerations

Identification of natural and man-made hazards that may influence the design or licensing basis, including:

- Tornadoes, straight-line winds, hail, snow/ice, and temperature extremes [17].
- Seismic events, surface faulting, and potential for liquefaction [13].
- Flooding and stormwater pathways [15] [16].
- Industrial and transportation hazards from co-located tenants or nearby infrastructure [21].
- Fire protection and underground hazard considerations.

4. Regulatory and Siting Criteria

Assessment of the regulatory framework that governs siting and environmental review for a microreactor facility, including:

- **10 CFR Parts 50, 51, and 100**.
- **NUREG-1537 (Parts 1 & 2)** and Interim Staff Guidance.
- **Regulatory Guides 4.2, 4.7, 1.23, 1.165, 1.208**, and other hazard-specific guidance.
- Application of NRC siting criteria for population density, external hazards, exclusion area control, and emergency preparedness.

5. Path Forward for PSAR and ER Development

Identification of additional investigations and data required to complete the licensing submittal, including:

- Geotechnical borings, geophysical surveys, and karst mapping.
- Groundwater monitoring and subsurface drainage characterization.
- Collection of site-specific meteorological data.
- Underground chamber stability and load-bearing evaluations.
- Environmental and ecological surveys required under NEPA and ESA.

- Integration of siting results into the PSAR chapters and Environmental Report structure.

1.4 APPLICABLE REGULATIONS AND REGULATORY GUIDANCE

The siting evaluation for the proposed SOLO Microreactor at the Rock City site will be developed in accordance with the regulatory framework established by the Atomic Energy Act, NRC safety and environmental regulations, and applicable staff guidance for non-power and advanced reactor facilities. This white paper identifies the primary regulations, guidance documents, and methodologies that Terra Innovatum **intends to apply** during preparation of the forthcoming Preliminary Safety Analysis Report (PSAR) and Environmental Report (ER).

The purpose of this section is to confirm with NRC staff that the proposed regulatory basis is appropriate for evaluating both the surface and subsurface components of the Rock City site.

NRC Regulations

The licensing and environmental review for the SOLO Microreactor will be governed by:

- **10 CFR Part 50** – Domestic Licensing of Production and Utilization Facilities (Construction permit and operating license framework)
- **10 CFR Part 51** – Environmental Protection Regulations (Environmental Report requirements for NRC licensing under NEPA)
- **10 CFR Part 100** – Reactor Site Criteria (Population, seismic, and accident-related siting considerations)

These regulations establish the fundamental requirements for siting, construction, environmental analysis, and safety evaluation.

NRC Regulatory Guides and Staff Guidance

Terra Innovatum intends to use the following NRC guidance documents to inform the siting methodology and hazard analyses:

- **Environmental Review Guidance**
- **RG 4.2** – Preparation of Environmental Reports for Nuclear Power Stations
- **RG 4.7** – General Site Suitability Criteria for Nuclear Power Stations

Although originally written for larger reactors, these guides provide useful methodologies for evaluating environmental effects, land use, and meteorology.

Non-Power & Microreactor Licensing Guidance

- **NUREG-1537, Parts 1 and 2** – Guidelines for Preparing and Reviewing Applications for Non-Power Reactors
- **Interim Staff Guidance (ISG) to NUREG-1537, including Chapter 19**

These documents provide the closest process analog for microreactor PSAR and ER preparation.

Meteorology and Dispersion

- **RG 1.23** – Meteorological Monitoring Programs (Supports atmospheric dispersion and χ/Q analyses)

Geology, Seismicity, and Geotechnical Hazards

- **RG 1.165** – Seismic Source Characterization
- **RG 1.208** – Performance-Based Ground Motion Characterization
- **RG 1.132** – Geologic and Geotechnical Site Investigations

- **USGS National Seismic Hazard Maps**
  These provide methods for determining vibratory ground motions, underground stability, and seismic risk.

Hydrology and Flooding

- **RG 1.102** – Flood Protection
- **RG 1.27** – Ultimate Heat Sink (as applicable to water features)
- **RG 1.59** – Design-Basis Floods
  These inform evaluation of site flood risks, groundwater interaction, and stormwater pathways.

Natural Phenomena and External Hazards

- **RG 1.221** – Design-Basis Tornado and Hurricane Loads
  These guide evaluation of above-ground structures and extreme weather hazards.

Transportation, Security, and Nuclear Material Handling

- **49 CFR (DOT Regulations)** – Nuclear and hazardous materials transport
- **10 CFR Part 73** – Physical Protection of Plants and Materials

These requirements will be used in planning logistics for module delivery, fuel handling, and on-site security interfaces.

Purpose of Regulatory Framework in Pre-Application Phase

At this stage, the regulatory framework serves to:

1. Establish the **planned licensing and environmental basis** for the Rock City site.
2. Confirm that **appropriate NRC guidance** is being used for site characterization.
3. Identify where additional data, site investigations, or analyses will be needed for PSAR development.
4. Support NRC alignment on the **scope and adequacy** of Terra Innovatum's planned siting approach.

Terra Innovatum requests NRC feedback on whether the regulations and guidance identified above are sufficient and appropriate for evaluating siting characteristics for the proposed SOLO Microreactor.

1.5 REQUEST FOR NRC

This white paper is submitted to support early, iterative engagement with the U.S. Nuclear Regulatory Commission (NRC) regarding the proposed siting of the SOLO Microreactor at the Rock City Business Complex in Valmeyer, Illinois. Terra Innovatum seeks NRC feedback on the adequacy of the planned siting characterization framework, including the regulatory basis, methodologies, assumptions, and future investigations described in this document.

The objective of this engagement is to establish a shared understanding of the siting and environmental review approach prior to development of the **PSAR** and **Environmental Report (ER)** for a future Construction Permit application.

Terra Innovatum requests NRC staff feedback on the following items:

1. Adequacy of the Siting Evaluation Framework

Confirmation that the overall approach for evaluating geology, seismology, hydrology, meteorology, population distribution, and environmental factors is consistent with NRC expectations for microreactor siting under 10 CFR Parts 50, 51, and 100.

2. Appropriateness of the Regulatory Basis

Agreement that the regulations and guidance documents identified—including NUREG-1537 (Parts 1 & 2), associated Interim Staff Guidance, RG 4.2, RG 4.7, RG 1.23, RG 1.165, RG 1.208, and hazard-specific RGs—are appropriate and sufficient to support PSAR-level siting analyses for the Rock City site.

3. Reasonableness of Preliminary Assumptions

Feedback on the conservative siting assumptions proposed for:

- Seismic ground motion and geotechnical conditions
- Flood hazard and groundwater interactions
- Severe weather (tornadoes, straight-line winds, snow/ice)
- Atmospheric dispersion and meteorological data needs
- Population distribution and emergency planning considerations
- Integration of surface and subsurface facility characteristics

4. Treatment of Dual Surface–Subsurface Siting

Confirmation that the planned approach for incorporating both **above-ground** and **underground** characteristics—unique to the Rock City configuration—is acceptable for early siting evaluation and can be expanded into a licensing-basis analysis in the PSAR.

5. Identification of Additional Data Needs

NRC input on whether additional investigations, surveys, modeling, monitoring programs, or data collection activities should be considered to ensure the PSAR and ER will meet NRC expectations.

1.6 REPORT STRUCTURE

This white paper is organized to present Terra Innovatum's preliminary siting evaluation for the proposed SOLO Microreactor at the Rock City Business Complex. The document provides the planned technical basis, siting methodology, and regulatory framework that will inform preparation of the future Preliminary Safety Analysis Report (PSAR) and Environmental Report (ER).

The report is structured as follows:

- **Chapter 1 – Introduction** (this section)
  Describes the purpose and need for the proposed action, the objectives of the siting evaluation, the scope of planned analyses, applicable regulatory requirements, and the specific areas where Terra Innovatum is seeking NRC feedback.

- **Chapter 2 – Site Location and Setting**
  Provides a preliminary description of the Rock City site and surrounding region, including geography, land use, zoning, and local setting relevant to siting considerations.

- **Chapter 3 – Geography, Climate, and Demography**
  Summarizes regional topography, climate and meteorological conditions, hydrology, population distribution, and atmospheric features that influence site suitability and environmental pathways.

- **Chapter 4 – Geology, Seismology, and Geotechnical Engineering**
  Describes the geologic and seismic characteristics of the region and the Rock City underground complex, including karst features, rock stability, vibratory ground motions, and subsurface hazards.

- **Chapter 5 – Infrastructure and Regional Assets**
  Identifies transportation networks, utilities, industrial tenants, emergency services, and regional assets that support construction, operation, and emergency planning for the SOLO Microreactor.

- **Chapter 6 – Natural and Man-Made Hazards**
  Provides an initial assessment of external hazards—including seismic events, severe weather, flooding, industrial hazards, and transportation-related risks—relevant to reactor siting.

- **Chapter 7 – Environmental Impacts and Alternatives**
  Presents a preliminary evaluation of potential environmental impacts during construction, operation, and decommissioning, and discusses the consideration of alternatives consistent with 10 CFR Part 51 and NEPA.

- **Chapter 8 – Conclusions**
  Summarizes key siting insights, identifies areas requiring further investigation, and outlines how NRC feedback will be incorporated into PSAR and ER development.

DISCLAIMER: *Chapters 2 through 7 were structured to conform as much as possible to an 'Environmental Report' which will support Chapter 2 of the PSAR. At this stage data was gathered primarily from public sources. Detailed references are provided for Chapter 2, while for the other Chapters a more cursory analysis was performed. Terra Innovatum will complete the investigation once comments on this Whitepaper are received and some level of concurrence is received from the NRC Staff on the level of depth and breath required for such analysis.*

2 SITE LOCATION AND SETTING

The proposed SOLO Microreactor site is located within the Rock City Business Complex in Valmeyer, Illinois, an industrial redevelopment situated along the Mississippi River bluffs in Monroe County. The site includes both surface land—approximately 137 acres used for logistics, access, and support facilities—and an extensive underground complex comprising roughly 6 million square feet of former limestone quarry workings [1] [22]. This dual-domain configuration presents a unique siting environment that integrates above-ground industrial infrastructure with stable, climate-moderated subsurface chambers [23].

The regional setting is characterized by elevated limestone [24]terrain overlooking the Mississippi River floodplain, providing natural protection against inundation [25] while maintaining proximity to major transportation corridors, utilities, and workforce centers within the St. Louis metropolitan region. Surrounding land use consists primarily of agricultural fields and low-density rural development [26] [27], with the nearest populated areas being the village of Valmeyer and the cities of Columbia and Waterloo [28].

This chapter provides a preliminary description of the physical location, regional context, land-use patterns, and zoning designations of the Rock City site. These factors form the foundation for evaluating environmental conditions, external hazards, and siting considerations addressed in subsequent chapters. The information presented reflects available data at the time of this white paper and will be supplemented with site-specific investigations as part of the PSAR and Environmental Report development [11].

2.1 SITE LOCATION AND DESCRIPTION

The proposed site for the SOLO Microreactor is located within the Rock City Business Complex at 1429 Boulder Boulevard, Valmeyer, Illinois, in Monroe County. The complex includes approximately 137 acres of surface land [4] [20], which will accommodate all reactor structures, safety-related systems, and operational facilities, consistent with NRC siting and licensing requirements.

In addition to the surface property, the Rock City complex contains roughly 6 million square feet of subsurface industrial space created through historical limestone quarrying [26]. While this underground complex forms part of the broader property footprint, the SOLO reactor itself will be sited entirely on the surface. No reactor systems, safety-related components, or credited safety functions will be located below grade.

2.1.1 Underground Complex (Non-Reactor Functions Only)

The underground portion of Rock City consists of interconnected chambers excavated within Mississippian-age **St. Louis Limestone**, historically used for mining and now repurposed for industrial tenants including archival storage, cold storage, and warehousing [29]. Key characteristics include:

- Approx. **6 million sq ft** of subsurface area [26]
- Excavated within competent limestone supported by rock pillars
- Stable ambient temperature (~58 °F) and moderated humidity
- Fully developed access roads, lighting, and utility service
- **No reactor or safety-related use**

The underground complex is relevant only as part of the industrial setting and potential host to **optional, non-safety-related operational functions** described below [11].

2.1.2 [[ ]]

[[

.]]

2.1.3 Surface Facilities (Reactor Location)

The SOLO reactor and associated support structures will be located **entirely on the surface**, within areas designated for:

- administrative and support buildings
- security boundaries and exclusion zone control
- laydown and staging
- electrical and utility interfaces
- emergency access and evacuation routes

The surface property is situated above the Mississippi River floodplain [25], supported by engineered drainage and grading, and offers sufficient space for exclusion area controls consistent with 10 CFR Part 100. Drainage and grading systems are documented in the FEMA FIRMette and the Village of Valmeyer Stormwater Master Plan (2020 update) [25].

2.1.4 Surface–Subsurface Relationship

While the Rock City site uniquely offers both surface and underground industrial environments, their roles in the SOLO project are **functionally distinct**:

- **Surface areas**: host all reactor systems, safety-related SSCs, and nuclear operational infrastructure.
- **Underground areas**: may support future **non-safety operational functions**, subject to NRC review, but are **not part of the reactor facility**.

This configuration will be evaluated further in the PSAR to ensure full compliance with NRC siting, safety, and emergency-planning requirements.

2.2 REGIONAL SETTING

The Rock City Business Complex is located in Monroe County, Illinois, approximately 25 miles south of St. Louis, Missouri, within the elevated limestone bluffs that overlook the Mississippi River floodplain. The regional geography is defined by this transition between high-relief uplands and the broad alluvial plain of the Mississippi River Basin. The elevated bluff-top position of the site provides natural separation from flood-prone areas while maintaining proximity to the transportation, labor, and emergency-response infrastructure of the greater St. Louis metropolitan region.

Land use in the surrounding region is predominantly agricultural, with row-crop farming, pastureland, and scattered woodlots [26]. Small rural communities, including Valmeyer, Columbia, and Waterloo, form the primary population centers within several miles of the site [28]. These municipalities offer access to local services, while the broader St. Louis region provides specialized labor, industrial support, advanced medical facilities, and multimodal transportation networks important for construction and operational logistics [30].

The regional climate is characteristic of the humid continental zone, with hot summers, cold winters, and year-round precipitation [31]. Severe weather—including thunderstorms, tornadoes, hail, and winter ice events—is a recurring feature of the Midwest [32] and will be addressed in the site's external hazards evaluation. The underlying geology consists of Mississippian-age carbonate formations and Paleozoic sedimentary sequences typical of the Illinois Basin, with seismicity influenced primarily by the New Madrid and Wabash Valley seismic zones [33].

The region benefits from strong multimodal transportation networks, including IL-3, I-255, rail terminals, and barge access along the Mississippi and Kaskaskia Rivers [30]. Two commercial airports—St. Louis Lambert (STL) and MidAmerica St. Louis Airport (BLV)—support passenger and cargo movement.

Overall, the regional setting combines favorable elevation, stable geology, low surrounding population density, and robust transportation and emergency infrastructure, making it appropriate for further siting evaluation consistent with Regulatory Guide 4.7 and NUREG-1537.

2.3 LAND USE AND ZONING

The Rock City Business Complex at **1429 Boulder Boulevard, Valmeyer, Illinois**, is located on property zoned for **industrial and commercial use** by the Village of Valmeyer and Monroe County. The site is part of a long-standing industrial redevelopment initiative that converted former limestone quarry operations into a mixed-use industrial park, including both surface and subsurface facilities. This established zoning framework provides a compatible foundation for siting the SOLO Microreactor, which will be located entirely on the surface portion of the property.

The underground complex hosts existing industrial tenants such as archival storage, cold-storage operations, and light manufacturing [29]. These activities are consistent with the site's industrial designation and demonstrate the property's capacity to support commercial uses without conflicting with residential or agricultural land uses. Coordination of utilities and construction planning will be addressed during PSAR development.

Surrounding land use is predominantly **agricultural**, with scattered low-density residential parcels located in the nearby communities of Valmeyer and Waterloo [28]. No residential areas lie immediately adjacent to the Rock City property, and the site benefits from **natural buffering** provided by topography, land use patterns, and controlled access [25] [29]. These conditions support compliance with **10 CFR Part 100** considerations for population density, exclusion area control, and minimization of public exposure.

The surface acreage—approximately **137 acres**—provides adequate space for establishing the **exclusion area boundary**, controlled access points, security infrastructure, staging and laydown zones, and support buildings. The property is not subject to active municipal redevelopment pressures,

and local long-term planning documents indicate continued support for industrial use of the Rock City area [34].

Taken together, the existing zoning, surrounding land use patterns, and availability of controlled industrial land at Rock City demonstrate strong compatibility with NRC siting and environmental review expectations under **10 CFR Part 51**, **10 CFR Part 100**, and the guidance of **RG 4.7**.

3 GEOGRAPHY, CLIMATE, AND DEMOGRAPHY

3.1 GEOGRAPHY & TOPOGRAPHY

The Rock City Business Complex is located along the Mississippi River bluffs in Monroe County, Illinois, near the incorporated village of Valmeyer [28]. The site occupies elevated terrain at approximately 400–500 feet above mean sea level, positioned well above the Mississippi River floodplain. This bluff-top setting provides a naturally advantageous topographic condition for nuclear facility siting by minimizing the potential for riverine flooding and supporting stable access routes during regional hydrologic events.

The broader regional landscape includes the Valmeyer bluffs to the east and the expansive Mississippi River alluvial plain to the west. The transition from upland limestone bluffs to the low-lying floodplain creates localized wind channeling through valleys and breaks in the terrain, producing microclimatic variations that will be considered in the site's meteorological characterization. These terrain-induced effects are relevant to dispersion modeling, severe weather assessment, and the placement of meteorological monitoring equipment.

The Rock City property itself consists of reclaimed quarry lands and surrounding agricultural fields. Surface grades are generally flat to gently sloped, with engineered drainage features used to direct stormwater away from access roads, portal entrances, and operational areas. Surficial soils in the region are relatively thin, characteristic of pre-glacial karst terrain, with bedrock often occurring close to the ground surface. This condition, along with the presence of karst-prone Mississippian limestone, necessitates targeted geotechnical investigations to evaluate foundation stability, surface settlement potential, and the structural integrity of portal infrastructure.

From a siting perspective, the elevated bluff-top terrain provides natural protection from flooding hazards documented in the region's history—including the catastrophic 1993 Mississippi River flood, which led to the relocation of the original Valmeyer townsite to higher ground. The site's topography, elevation, and underlying competent limestone bedrock collectively support long-term stability, operational resilience, and alignment with NRC siting guidance related to geologic and hydrologic hazards (e.g., Regulatory Guide 4.7).

Beneath the property, the underground industrial complex comprises approximately 6 million square feet of excavated chambers supported by limestone rock pillars. These chambers, supported by a grid of rock pillars, feature interior clear heights of approximately 25–40 feet [20], reflecting the geometry of the former mining operations. Although this subsurface environment is part of the broader industrial setting, all reactor and safety-related systems will be located entirely on the surface.

Overall, the site's geography and topographic setting offer favorable characteristics for the siting of the SOLO Microreactor, with natural advantages related to elevation, stability, access, and hazard resilience.

3.2 CLIMATE & METEOROLOGY

The Rock City site is located within the humid continental climate zone (Köppen Dfa) typical of the central Midwest, characterized by hot, humid summers; cold winters; and year-round precipitation. Climate normals from the 1991–2020 NOAA dataset for the nearby Waterloo [31], Illinois station (approximately 7 miles from Valmeyer) indicate a mean annual temperature of ~56°F, with seasonal extremes ranging from summer highs near 89°F to winter lows near 20°F. Annual precipitation averages roughly 42 inches, and annual snowfall ranges from 11–16 inches, depending on year-to-year variability.

3.2.1 Regional Climate Characteristics

- **Summers** are warm and humid due to Gulf of Mexico air masses, with frequent convective thunderstorms.

- **Winters** feature periodic Arctic air intrusions producing freezing conditions, snow, and ice storms.
- **Precipitation** is distributed throughout the year, with late-spring and early-summer peaks.
- **Temperature variability** is moderate to high, typical of continental U.S. interior climates.

These conditions will inform design considerations for cooling systems, HVAC performance, equipment qualification, and seasonal construction planning.

3.2.2 Severe Weather Patterns

Monroe County and the greater St. Louis region experience a range of severe weather hazards important for reactor siting, including:

- **Thunderstorms and lightning**
- **Hail events**
- **Straight-line windstorms**
- **Tornadoes**, peaking from April through June
- **Freezing rain and ice accumulation** in winter

These phenomena are consistent with Illinois statewide climatology and will be incorporated into the site-specific external hazards evaluation and design-basis meteorological loads following **Regulatory Guide 1.221** (tornado and hurricane loads).

3.2.3 Topographic and Microclimatic Influences

The bluff-top position of the site introduces **localized microclimatic effects** due to the sharp transition between the elevated limestone uplands and the Mississippi River floodplain below. These include:

- **Wind channeling** along valleys and breaks in the bluff line, influencing wind-direction frequencies.
- **Enhanced gustiness** near bluff edges under certain synoptic conditions.
- **Thermal differentials** between elevated and lowland areas during summer and winter temperature inversions.

These topographic influences will be evaluated during the development of a site-specific meteorological monitoring program, consistent with Regulatory Guide 1.23, to support atmospheric dispersion modeling (χ/Q) and safety analysis.

3.2.4 Underground Ambient Conditions

Although the SOLO reactor will be sited on the surface, the broader Rock City industrial setting includes a large underground complex with **stable ambient temperatures near 58°F** and moderated humidity levels. While not relevant to reactor safety systems, these conditions may influence **ancillary non-safety functions**, such as control room or monitoring center placement, and will be characterized accordingly in the PSAR.

Relevance to Siting and Safety Analysis

Meteorological characteristics—including wind roses, turbulence intensity, precipitation frequency (NOAA Atlas 14), and seasonal severe weather—will be used to:

- Establish design-basis values for severe weather impacts.
- Develop atmospheric dispersion inputs for off-site dose calculations.
- Inform location and height of future **on-site meteorological towers**.

- Support emergency planning, including warning systems and protective actions.

Overall, the regional climate and local meteorology of the Rock City site (Table 1) are representative of midcontinental conditions and provide a well-defined basis for environmental and safety-related atmospheric analyses consistent with NRC siting guidance.

Table 1: Representative Climate Parameters for Valmeyer, IL (1991–2020 Normals)

Attribute	Value (Waterloo/Regional Data) [31], [35]
Mean Annual Temperature	~56 °F
July Mean High / Low	89 °F / 70 °F
January Mean High / Low	40 °F / 20 °F
Annual Precipitation	~42 inches
Annual Snowfall	11–16 inches
Underground Ambient Temp	~58 °F (stable)
Severe Weather Season Peak	April–June

3.3 HYDROLOGY & FLOODING

The Rock City site is located along the Mississippi River bluffs near Valmeyer, Illinois, well above the elevation of the surrounding floodplain. Following the catastrophic 1993 Mississippi River flood, the Village of Valmeyer was relocated from the lowlands to its current bluff-top location. As a result, the Rock City Business Complex lies outside both the 100-year and 500-year FEMA flood hazard zones [36], classified as Zone X (Area of Minimal Flood Hazard). This elevated topographic position provides a strong natural safeguard against riverine flooding and supports compliance with NRC siting guidance for hydrologic hazards.

3.3.1 Surface Water and Stormwater Behavior

Although the site is not subject to riverine flooding, surface runoff remains an important design and operational consideration. The Rock City property includes reclaimed quarry lands and engineered surface grades intended to direct stormwater away from:

- access roads
- surface laydown areas
- portal entrances
- utility and support infrastructure

Seasonal convective storms common to the Midwest can produce short-duration, high-intensity rainfall capable of causing **temporary ponding** near access routes or low points on the property. These effects will be addressed through engineered drainage systems such as:

- lined ditches
- culverts
- reinforced portal aprons

- controlled surface infiltration zones

Design-basis precipitation will rely on **NOAA Atlas 14 Volume 10** frequency curves for Monroe County, providing bounding rainfall intensities needed for evaluating site drainage, sump design, and spill management under **RG 1.102** and **RG 1.59**.

3.3.2 Groundwater and Subsurface Hydrology

The underlying Mississippian St. Louis Limestone is known for karstic characteristics, including solution conduits, fractures, and irregular drainage pathways. These features can influence groundwater behavior, especially during periods of rapid infiltration following heavy rainfall.

Key subsurface hydrologic considerations include:

- potential for rapid groundwater inflow through karst conduits
- hydraulic communication between surface infiltration points and underground voids
- variability in groundwater levels in response to seasonal precipitation
- presence of in-cavern water bodies and drainage channels within the underground complex

The Rock City underground facility currently manages groundwater using **redundant sump pumps and drainage infrastructure**, reflecting long-standing industrial experience with subsurface water control in the complex. While the underground complex is **not part of the safety-related reactor facility**, its hydrologic characteristics are relevant to the broader site setting and will be evaluated to ensure no interactions affect surface structures, access routes, or use of underground space for non-safety-related operational functions.

3.3.3 Regional Hydrologic Context

The **Mississippi River** remains the dominant hydrologic feature in the region, although its direct influence on the site is limited by elevation. Hydrologic evaluations by the **U.S. Army Corps of Engineers (USACE)** show that seasonal navigation operations, releases from upstream structures, and high-water events can affect transportation routes in the floodplain below the bluffs—but **not the site itself**.

Potential impacts include:

- **temporary high-water closures** along Illinois Route 3 or other floodplain roads
- **logistics delays** for equipment arriving via barge
- **changes in groundwater gradients** near the base of the bluffs during sustained high river stages

These factors will be considered in evaluating construction-phase logistics, emergency-planning access, and operational resilience.

3.3.4 Hydrologic Suitability for Siting

Overall, the hydrologic and flood conditions at the Rock City site offer a favorable basis for microreactor deployment. The property's **elevation**, **distance from flood-prone areas**, and **lack of mapped flood hazards** provide a strong margin against riverine flooding consistent with NRC siting expectations. Hydrologic considerations for the PSAR will focus on:

- site drainage and stormwater management
- groundwater behavior in karstic limestone
- potential interactions between surface and subsurface hydrologic systems

- access route reliability under regional flood conditions
- design-basis precipitation and runoff assumptions

Collectively, these factors demonstrate that the Rock City site can be evaluated using established NRC hydrologic guidance and is well positioned to meet regulatory requirements related to flood protection and water-related external hazards. Information can be found in [36], [37], [38], [22], [39], [40]. Key factors are shown in Table 2.

Table 2: Summary of Hydrologic & Flooding Considerations for Rock City

Attribute	Description / Value
Site Elevation	~400–500 ft above mean sea level
Floodplain Risk	Outside mapped 100- and 500-year FEMA flood zones
Major Water Influence	Mississippi River, Kaskaskia River
Drainage Controls	Engineered fill, lined ditches, culverts
Precipitation Design Basis	NOAA Atlas 14 (regional frequency curves)
Groundwater Setting	Karstic limestone, conduit-driven flow
Subsurface Features	In-cavern lakes, sump systems, redundant pumping
Road Access Vulnerability	IL-3 and rural approaches subject to high-water risk

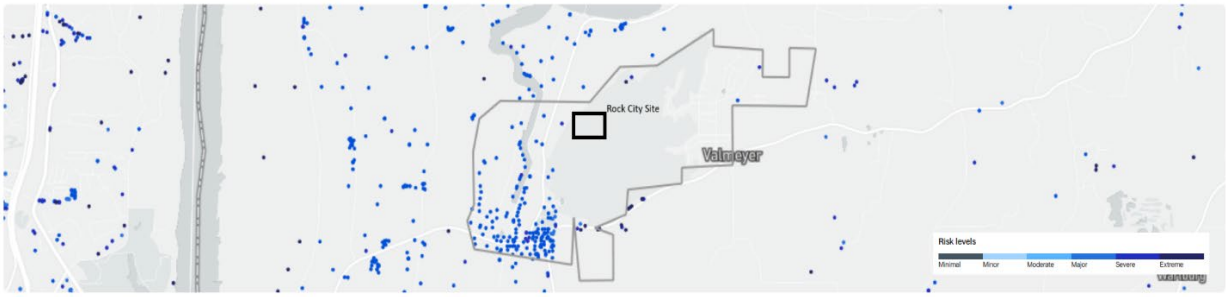


Figure 1: Rock City Site Flood Plain [41]

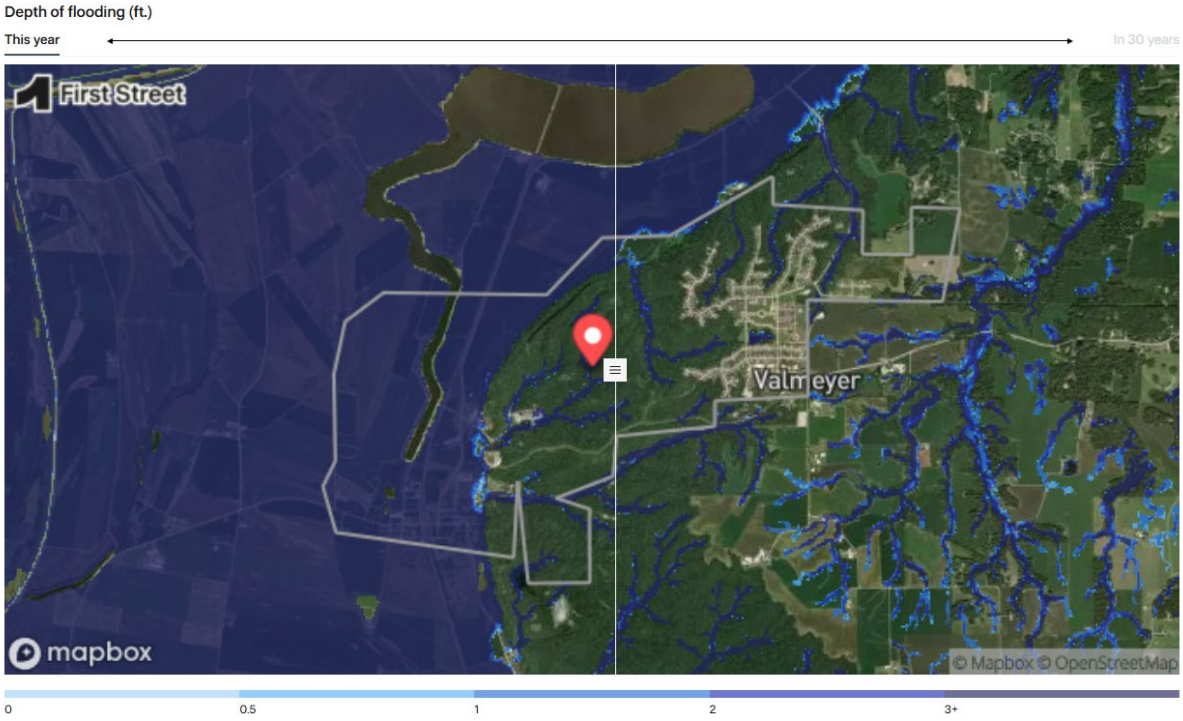


Figure 2: Rock City Site Flooding Risk [41]

3.4 DEMOGRAPHY & POPULATION DISTRIBUTION

The Rock City Business Complex is located in a predominantly rural portion of Monroe County, Illinois, characterized by low population density and dispersed residential development. The nearest population centers include the Village of Valmeyer, the City of Columbia, and the City of Waterloo, each located several miles from the proposed SOLO site. This demographic setting supports compliance with the siting considerations of 10 CFR 100.20(c), which emphasize the importance of low surrounding population densities and adequate separation from densely populated centers for reactor facilities.

3.4.1 Population Within the Immediate Vicinity

Within a 1-mile radius of the site, land use is almost entirely agricultural with scattered farmsteads and no concentrated residential clusters. No schools, hospitals, correctional institutions, or other sensitive receptors are located within this radius.

Terra Innovatum's objective is to limit the Exclusion Area Boundary (EAB) to the operational boundary of the reactor. Pending NRC confirmation of this approach, it is noted that the Rock City surface acreage (~137 acres) provides ample applicant-controlled land to accommodate an EAB fully within the site, consistent with 10 CFR 100.3 and NUREG-1537 guidance. The final EAB configuration will be established in the PSAR.

3.4.2 Population Distribution in the 1–10 Mile Region

Population density increases modestly with distance but remains low. The nearest communities are:

- Valmeyer (~1.5 miles east) — population <1,500
- Columbia (~8 miles northeast) — population ~10,000
- Waterloo (~10 miles southeast) — population ~11,000

These communities exhibit rural-suburban growth patterns consistent with **Regulatory Guide 4.7**, which identifies low surrounding population density as a favorable siting attribute. The distribution of residential, agricultural, and municipal areas supports effective emergency preparedness and protective action planning, if that would be required.

3.4.3 Regional Population Considerations (10–50 Miles)

The 50-mile region includes parts of the St. Louis metropolitan area. While St. Louis represents a large population center, the distance from the urban core, combined with rural topographic surroundings, ensures:

- radiological dose consequences remain bounded by conservative dispersion analysis,
- emergency planning zones (EPZs) can be defined consistent with **NUREG-1537** microreactor guidance, and
- the microreactor's inherently low source term limits public exposure pathways.

Microreactors like SOLO have significantly smaller inventories and release fractions than large LWRs, and the NRC has acknowledged in recent non-power reactor approvals (e.g., ACU MSRR) that population-related siting constraints differ accordingly [10].

3.4.4 Transient Population

Transient population near the site is low and primarily associated with underground industrial tenants, agricultural operations, and light commercial activity in rural corridors. There are no major venues, schools, or seasonal attractions in the immediate vicinity. This stability supports consistent emergency planning inputs.

3.4.5 Demographic Suitability for Siting

The demographic characteristics of the Rock City region are favorable for microreactor siting because they provide:

- low population density around the site,
- sufficient applicant-controlled land for EAB and LPZ (Low Population Zone) establishment even if those would be required for the FOAK,
- absence of large transient populations,
- adequate infrastructure for emergency response, and
- distance from high-density urban centers .

These factors align with NRC expectations outlined in **10 CFR 100.20**, **Regulatory Guide 4.7**, **NUREG-1537**, and siting precedents from the **ACU MSRR PSAR** [10].

3.5 EMERGENCY PLANNING, ACCESS, AND EGRESS

Terra Innovatum intends to implement an emergency planning framework consistent with the size, hazard profile, and licensing basis of the SOLO Microreactor. In accordance with 10 CFR 50.47(a)(1) and the performance-based, risk-informed emergency planning flexibility allowed for advanced and non-power reactors, Terra Innovatum plans to request an Emergency Planning Zone (EPZ) limited to the operational boundary of the reactor, corresponding to the 10 m × 10 m Monolith footprint. This approach reflects the microreactor's inherently small radionuclide inventory, passive safety characteristics, and lack of high-energy accident progression mechanisms.

The proposed EPZ strategy aligns with NRC precedent for low-hazard research and test reactors—such as the ACU Molten Salt Research Reactor (MSRR) and Kairos Hermes test reactor—where the staff accepted reduced EPZs based on mechanistic source term, low potential offsite dose, and limited

accident progression. The SOLO Microreactor shares similar or lower consequence characteristics, supporting a commensurately scaled emergency planning basis.

3.5.1 EPZ Strategy and Regulatory Basis

Under 10 CFR 100.20(c), reactor siting must ensure that individuals beyond the Exclusion Area Boundary (EAB) are protected from radiation doses exceeding the limits defined for hypothetical accidents. Terra Innovatum intends to define the EAB at the edge of the 10×10 m reactor operational footprint, consistent with the proposed EPZ.

This strategy is grounded in:

- the reactor's very low source term,
- slow accident response times,
- absence of high-pressure coolant systems,
- passive decay heat removal,
- robust confinement within the Monolith, and
- lack of energetic failure modes.

Consistent with NUREG-1537, emergency planning requirements for microreactors may be scaled based on radiological hazard, provided the applicant demonstrates that offsite consequences remain below EPA Protective Action Guide (PAG) thresholds at the EAB. Terra Innovatum will provide this dose-based justification in the PSAR.

3.5.2 Basis for Reduced EPZ

The EPZ reduction is presented in a separate document presented to the USNRC (SOLO-TR-2025-10).

3.5.3 Emergency Response Staffing and Coordination

Given the reduced hazard profile, emergency planning for SOLO FOAK will primarily rely on onsite trained operators. Facility-specific Emergency Operating Procedures (EOPs), Coordination with Monroe County Emergency Management Agency, and use of existing countywide notification and communication systems is discussed in a separate report (SOLO-TR-2025-10).

3.5.4 Onsite Access and Egress

The SOLO reactor will be located on the surface within the 137-acre Rock City property, which provides several advantages for emergency response:

- Multiple surface access points connecting directly to Illinois Route 3 and regional emergency services.
- Elevated topography eliminating flood-related access risk.
- Wide turning radii and industrial-grade access roads that can support emergency vehicles.
- Clear separation between surface reactor facilities and underground industrial areas, simplifying emergency isolation.

Egress routes for onsite personnel are direct, unobstructed, and independent of any subsurface access.

3.5.5 Interaction with Underground Areas

While the underground complex may support non-safety-related operational functions (e.g., control room or future fleet monitoring center), these facilities are not part of the EPZ, EAB, or safety-related infrastructure. Emergency planning for the underground complex will be independent of reactor safety functions and consistent with standard industrial protocols.

The underground areas do not provide credited safety functions, influence accident progression, affect emergency planning conclusions, or modify the EPZ or EAB definition.

3.5.6 Summary

The demographic, topographic, and safety characteristics of the Rock City site, combined with the inherent safety features of the SOLO Microreactor, support an EPZ limited to the 10×10 m operational boundary of the reactor. This strategy is consistent with 10 CFR 50.47, 10 CFR 100.20(c), NUREG-1537, Regulatory Guide 1.233, and precedent NRC approvals for low-source-term reactors. A complete dose-based justification for the reduced EPZ and EAB will be submitted in the PSAR.

4 GEOLOGY, SEISMOLOGY, AND GEOTECHNICAL ENGINEERING

4.1 REGIONAL GEOLOGY

The Rock City site is within the Illinois Basin, which contains up to 15,000 ft of Cambrian–Pennsylvanian sediments. Local stratigraphy is dominated by Mississippian-age Valmeyeran Series carbonate formations, including the Salem, St. Louis, and Ste. Genevieve Limestones interbedded with silty and shaly intervals. Illinois State Geological Survey (ISGS) quadrangle mapping provides lithologic resolution for excavation and foundation planning [22], [38].

The St. Louis Limestone is characterized by karst development, including sinkholes, solution-enlarged fractures, and conduit networks. Regional analogs include Illinois Caverns near Valmeyer, with stable passageways up to 20 ft in height and temperatures near 58 °F [20]. Such features present potential voids and irregular drainage pathways requiring detection during excavation.

The Rock City area lies within the Driftless Area of southwestern Illinois, which was not glaciated during the Wisconsin Episode. As a result, surficial materials are limited to thin and discontinuous glacial till deposits in upland areas and alluvium in valley bottoms. Surficial geology mapping provides data on soil cover distribution, alluvial extent, and thickness to bedrock—important parameters for excavation, grading, and slope stability evaluations [38].

Regional structural features include northwest–southeast–trending anticlines, synclines, and fracture systems, which influence both karst development and groundwater flow patterns. Mineral resources in the Carboniferous strata include calcite, dolomite, niter, and sphalerite, indicating a history of hydrothermal fluid migration and localized mineralization. These geologic characteristics may locally affect rock strength, fracture permeability, and long-term stability of underground excavations [36].

4.2 SITE GEOLOGY (UNDERGROUND)

At the Rock City site, the karst and cavern hazard is both real and spatially variable. The St. Louis Limestone and adjacent carbonate units are known to contain extensive solution features, with subsidence and sinkhole risk increasing in areas of thin surficial cover. Although the mapped underground caverns reduce uncertainty in known zones, adjacent unmapped areas may contain voids that have not been documented [22], [36], [38].

Cavern geometry imposes physical constraints on heavy-lift operations and equipment movement. The underground pillar grid, typical clear heights of approximately 25–40 feet in developed areas, and internal road layouts limit the maneuverability of self-propelled modular transporters (SPMTs) and cranes. Planning for large module installation must confirm portal geometry, turning radii, and interior pillar spacing [20].

Groundwater flow in karst conduits can be rapid and unpredictable. Dewatering systems must include redundancy, telemetry, and capacity for variable inflows. Optimal siting favors thicker overburden and absence of mapped karst; verification requires borehole drilling, ground-penetrating radar (GPR), and subsurface mapping [22], [36]. For optimal stability, facility siting should favor locations where overburden thickness is greater and mapped karst features are absent. Conceptual preferred zones have been identified using plan-view schematics, but final decisions require verification through targeted borehole drilling, ground-penetrating radar (GPR), and other subsurface investigations.

4.3 SITE GEOLOGY (ABOVE-GROUND)

The above-ground portion of the Rock City site is situated on surficial soils underlain by the St. Louis Limestone. The primary geologic concern is karst-related settlement, which manifests at the surface as sinkhole development and differential foundation movement. Historic records from Monroe County confirm localized sinkhole activity in areas with thin overburden [36].

Surface foundations must therefore be sited on zones of verified competence, with subsurface investigations (borings, geophysical surveys) required to characterize void potential. Bluff faces adjacent to the facility pose additional slope stability considerations; design solutions should include erosion control, setback distances, and stabilization where necessary.

Surface hydrology is a related concern, as stormwater infiltration into karst conduits can accelerate subsidence. Site drainage design must minimize concentrated infiltration and route surface runoff away from identified karst depressions. These measures ensure structural reliability of above-ground support facilities and prevent surface-induced hazards from propagating into underground chambers [38].

4.4 SEISMICITY & GROUND MOTION

The Rock City site, located near Valmeyer in Monroe County, Illinois, lies in a region of moderate to low seismic hazard as depicted in the U.S. Geological Survey (USGS) National Seismic Hazard Maps [33]. While southern Illinois is influenced by proximity to significant intraplate seismic zones, Valmeyer itself is situated outside the highest hazard bands.

Two major tectonic sources influence the regional seismic profile:

- New Madrid Seismic Zone (NMSZ): Extends into southern Illinois and is historically significant for producing the large 1811–1812 earthquakes, estimated at magnitude (M) 8 or greater. Although centered farther south, this zone represents a long-term risk source due to its recurrence potential
- Wabash Valley Seismic Zone (WVSZ): Located closer to Valmeyer, extending between southeastern Illinois and southwestern Indiana. Historical events in this zone have reached up to M 5.4 and are capable of producing larger intraplate earthquakes

The region has experienced both notable and minor seismic events, including:

- 1917 Fults Earthquake: Approximately M 5.1, located near Monroe County, producing felt shaking in St. Louis.
- 2008 Mt. Carmel Earthquake (WVSZ): Magnitude 5.2, producing moderate shaking across the region and recorded at the Rock City area.
- Recent Minor Activity: Events such as a M 3.3 earthquake in southeastern Illinois in May 2025, and several M 2.8–3.0 tremors in southern Illinois, demonstrate ongoing low-magnitude seismicity

Illinois statewide seismic hazard analysis estimates a 25–40% probability over 50 years for an M 6.0 or greater earthquake within major seismic zones (NMSZ/WVSZ). At Valmeyer specifically, hazard levels are lower due to the site's distance from the zone cores, but still require engineering consideration. Figure 3 is a probabilistic seismic hazard map showing the peak ground acceleration (PGA) levels with a 2% chance of exceedance in 50 years across Illinois and the surrounding region. It illustrates how seismic hazard increases toward the New Madrid Seismic Zone, with Valmeyer located in an area of low-to-moderate expected PGA compared to the much higher hazard levels farther south. Figure 4 adds blue rectangles which outline the USGS-designated New Madrid Seismic Zone (NMSZ) fault source regions, marking the areas where the major fault segments used in seismic hazard modeling are located. These polygons represent the seismogenic source zones incorporated into the National Seismic Hazard Model, defining where large-magnitude earthquakes are most likely to originate for probabilistic hazard calculations .

The region's geology—dominated by hard, continuous bedrock—results in low attenuation of seismic waves, meaning that strong ground motions from distant events can still be transmitted over large areas. Consequently, seismic design should consider both local and regional event scenarios, including ground motion amplification in any unconsolidated surficial deposits present near the site.

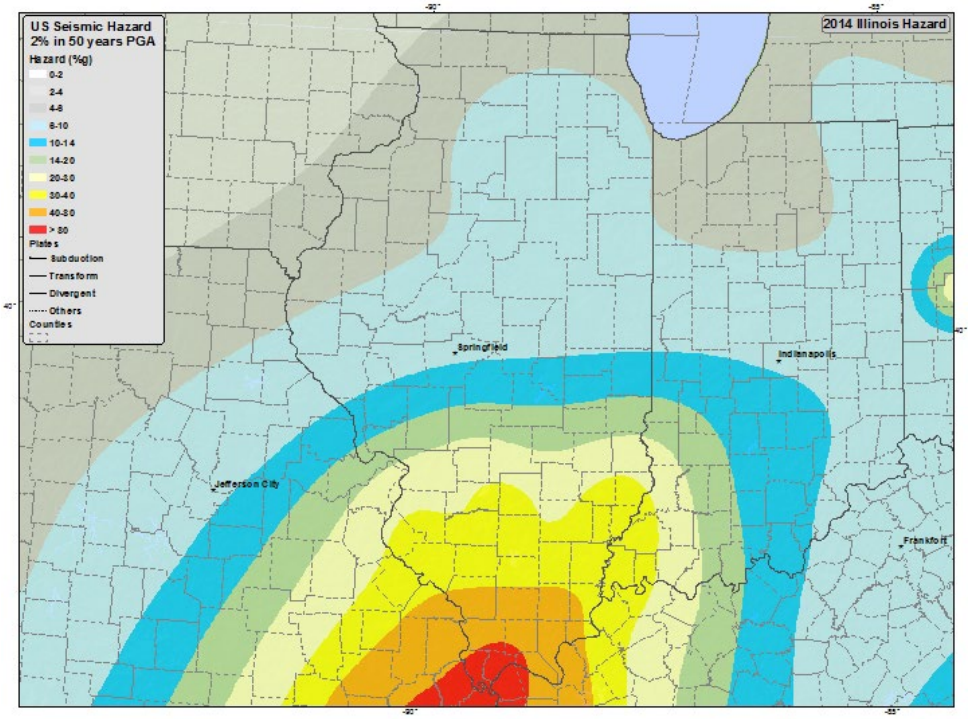


Figure 3: Regional PGA Levels for Valmeyer (Rock City)

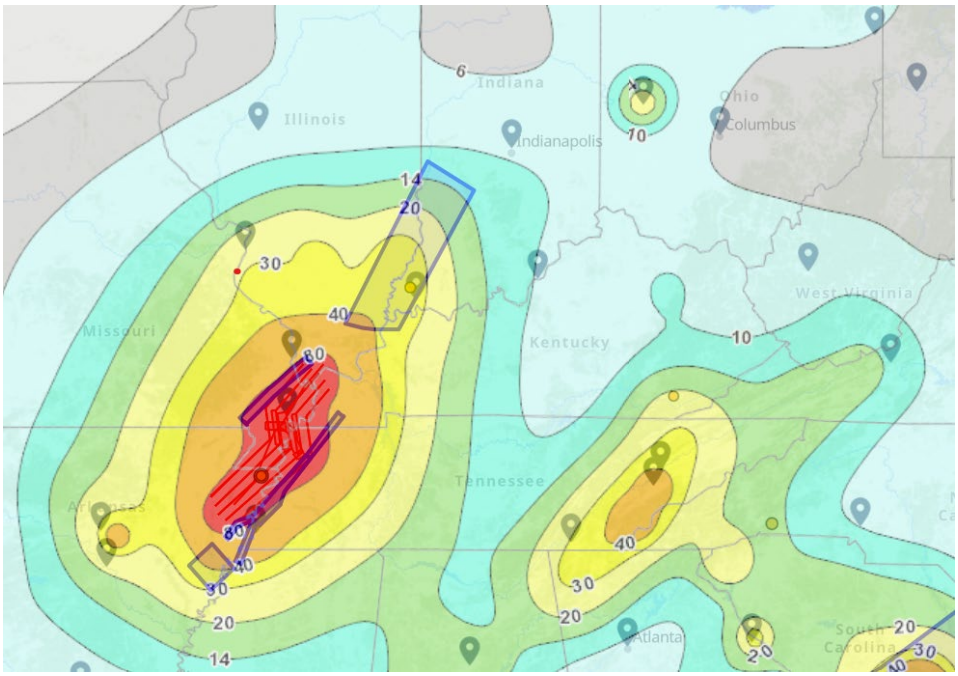


Figure 4: National Seismic Hazard Map (USGS) [33]

Seismotectonic investigations of the central United States confirm that the New Madrid Seismic Zone (NMSZ) is capable of producing upper-bound intraplate earthquakes in the magnitude (M) 7.5–8.0 range. The historic 1811–1812 earthquake sequence is interpreted to have included at least three principal events exceeding M 7.5, generating widespread geomorphic change, liquefaction, and

structural damage across the Mississippi Embayment. Probabilistic hazard assessments by the U.S. Geological Survey (USGS) estimate a recurrence probability of approximately 7–10% for such an event within the next 50 years, and a 25–40% probability for an M 6.0 or greater event during the same interval . The Wabash Valley Seismic Zone (WVSZ), located closer to Monroe County, has documented potential for M 7.0–7.5 earthquakes. Paleo-seismic trenching confirms prehistoric fault displacements of sufficient scale to support high-magnitude intraplate events. Although recurrence frequency is lower than that of the NMSZ, the proximity of the WVSZ increases its design relevance for the Rock City site [33].

Although the Rock City site lies outside the highest hazard zones depicted on national seismic hazard maps, the low attenuation characteristics of the region's bedrock mean that strong ground motions from large, distant events can be transmitted over great distances. Modeling of a hypothetical M 7.7 NMSZ rupture indicates that long-duration, long-period shaking would propagate along the Reelfoot Rift, with potential amplification in sediment-filled embayment and valleys. Historical precedent for long-range shaking includes the 1968 Illinois earthquake (M 5.3), which produced noticeable shaking across a broad multistate area, underscoring the sensitivity of regional infrastructure to even moderate-magnitude events. While site-specific hazard levels are moderate, engineering designs for Rock City should incorporate seismic load cases consistent with the maximum credible earthquake scenarios from both the NMSZ and WVSZ [33].

U.S. Geological Survey (USGS) seismic hazard mapping indicates that the Rock City site in Monroe County, Illinois, lies within a PGA band of approximately 0.10 g to 0.15 g for a 0.2-second spectral period. These values are associated with a 2% probability of exceedance in 50 years, equivalent to a 2,475-year return period. Under the International Building Code (IBC) and ASCE/SEI 7 seismic provisions, these PGA levels would generally place the site within Seismic Design Category B, or low Category C, depending on final site class determination from geotechnical investigations [35].

Two primary seismic sources contribute to the vibratory ground motion hazard at Rock City:

- New Madrid Seismic Zone (NMSZ): Although more distant, the NMSZ is capable of producing high-magnitude (M 7.5–8.0) events that generate long-period ground motions. Due to the high rigidity of the region's Paleozoic bedrock, seismic energy from the NMSZ attenuates slowly, enabling moderate shaking intensities to propagate hundreds of kilometers from the source.
- Wabash Valley Seismic Zone (WVSZ): Located closer to the site, the WVSZ has the potential to produce M 7.0–7.5 events and more frequent moderate-magnitude earthquakes. Its proximity increases the potential for higher-frequency vibratory energy inputs to the site.

Historical seismic events illustrate the efficiency of seismic wave transmission within the Illinois Basin:

- 1968 Illinois Earthquake (M 5.3): Generated Modified Mercalli Intensity (MMI) VI–VII shaking in the region, causing structural damage as far north as Illinois River towns. Felt in 23 states, the event demonstrated significant rock-based amplification effects.
- 2008 Mt. Carmel Earthquake (M 5.2): Produced perceptible shaking throughout the Midwest, highlighting the capability of even moderate intraplate earthquakes to transmit energy over long distances within the basin.

The combination of low attenuation, basin-scale amplification, and multiple contributing seismic sources necessitates that seismic design at Rock City incorporates both near- to mid-range WVSZ scenarios and long-period, high-magnitude NMSZ scenarios in its vibratory ground motion characterization.

4.5 SURFACE FAULTING & LIQUEFACTION POTENTIAL

Surface faulting within the central and eastern United States is generally characterized by blind faults—structures that do not extend to the ground surface or produce visible fault scarps. In regions

such as the New Madrid and Wabash Valley Seismic Zones, these features are frequently concealed beneath layers of glacial till, alluvium, or loess. In such environments, paleoseismic indicators—including sand blows, fissures, and other liquefaction-related structures—serve as indirect evidence for past surface rupture in the absence of clear geomorphic expressions.

The New Madrid Seismic Zone (NMSZ) is situated along deep-seated basement faults associated with the Reelfoot Rift system. Fault planes are typically resolved at depths of 4–14 km, with most lacking persistent surface trace expression. The historical 1811–1812 earthquake sequence produced surface phenomena such as fissuring, subsidence, and liquefaction, but modern erosion and sediment cover obscure continuous fault scarps. Similarly, the Wabash Valley Seismic Zone (WVSZ) consists primarily of high-angle normal faults that are deeply buried and terminate within bedrock, producing no visible surface rupture in modern times. Paleoseismic investigations, however, have documented prehistoric events approaching M 7.1 within the WVSZ, evidenced by sand blows and subsurface deformation features.

At the regional scale, southern Illinois hosts several ancient structural zones—such as the Ste. Genevieve Fault Zone and the Cottage Grove Fault—which experienced activity during the Paleozoic and Mesozoic eras. No contemporary seismicity has been linked to active surface faulting within the immediate Valmeyer vicinity, and no continuous surface rupture features have been mapped at or near the Rock City site [33], [36]. Liquefaction evidence from central and southwestern Illinois indicates that strong prehistoric earthquakes have induced liquefaction well beyond the immediate epicentral regions. Holocene-aged features—such as sand blows and clastic dikes—have been documented near Shoal Creek (~65 km east-southeast of St. Louis) and near Springfield (~35 km distant), events thought to be associated with earthquakes exceeding M 6.0. Historical records from the 1811–1812 NMSZ earthquake sequence show that liquefaction effects extended as far as White County, Illinois, demonstrating the capacity for large-magnitude events to trigger liquefaction over great distances [33].

The Rock City site's subsurface geology—consisting of competent Mississippian limestone—provides a stable foundation largely resistant to bulk liquefaction effects. The underground caverns are excavated entirely in bedrock, eliminating the loose, saturated granular soil conditions necessary for large-scale liquefaction. However, thin surficial soil and loess deposits may be present at portal entrances, surface laydown areas, and drainage paths. If such deposits are loose and water-saturated during a strong seismic event, localized liquefaction or loss of bearing capacity could occur in these limited areas. Regional susceptibility mapping indicates moderate liquefaction vulnerability along floodplain and valley-fill zones within the broader Illinois Basin, but not at the elevated bluff-top position of the Rock City facility. As such, liquefaction hazard at Rock City is classified as low for underground structures, with localized moderate concern in surficial zones subject to saturation [33], [36], [38].

5 INFRASTRUCTURE AND REGIONAL ASSETS

5.1 TRANSPORTATION & LOGISTICS

The site lies within the Kaskaskia Regional Port District (KRPD), one of Illinois's highest-throughput inland port systems. Barge delivery capacity offers a pathway for heavy-lift and oversized cargo. Highway connectivity includes IL-3 (~10 miles) and I-255 (~12 miles), with I-55, I-64, I-70, and I-270 accessible through the St. Louis metro network. These routes support one-day trucking to 29 states. Rail service is provided regionally through the Union Pacific Dupo Intermodal Terminal and the Terminal Railroad Association of St. Louis (TRRA), which operates key Mississippi River rail bridges. The Rock City site is designated "rail accessible" but lacks a spur; direct service would require construction of a new rail connection [42], [43].

Air logistics are supported by four airports:

- MidAmerica St. Louis Airport (BLV), ~29 miles, freight focused.
- St. Louis Lambert International (STL), ~30 miles, major passenger/cargo hub.
- St. Louis Downtown Airport (CPS), ~14 miles, business/general aviation.
- Sullivan Field (27LL), ~4 miles, local general aviation.

Public transit is provided by the Monroe-Randolph Transit District (MRTD), with countywide demand-response and express routes linking to the St. Clair County Metro system.

The Rock City Business Complex is located at **1429 Boulder Blvd., Valmeyer, Illinois**, with approximately 137 surface acres designated for laydown and staging. Multiple underground portals provide entry to the cavern system. Surface access is anchored by Illinois Route 3 (~10 miles) and Interstate 255 (~12 miles), both of which connect to regional interstate corridors including I-55, I-64, and I-70. These routes form the backbone of heavy trucking and logistics for the St. Louis metropolitan area [43].

Rail access is provided regionally through the Union Pacific Dupo Intermodal Terminal, the nearest container-on-flatcar hub. While marketing literature identifies Rock City as "rail accessible," no physical spur exists at present; direct service would require rights acquisition, grading, and track installation [42].

Barge delivery is feasible through the **Kaskaskia Regional Port District (KRPD)**, which provides access to the Mississippi River system. The KRPD supports heavy-lift and oversize cargo handling, subject to seasonal navigation schedules managed by the U.S. Army Corps of Engineers (USACE) and safety oversight by the U.S. Coast Guard (USCG).

Air logistics are supported by St. Louis Lambert International Airport (~30–40 mi), MidAmerica St. Louis Airport (~29–46 mi), and Sullivan Field (27LL), which provides general aviation service for small aircraft.

Trucking is expected to remain the primary mode of transportation for construction and operational logistics. IL-3 and I-255 provide direct connectivity to regional suppliers, vendors, and staging yards.

- Oversize/Overweight (OSOW) permitting is required for large modules and reactor components. Coordination with IDOT and Monroe County is necessary to address rural bridge, culvert, and roadway geometry limitations.
- Seasonal weight limits ("frost laws") during spring thaw may restrict axle loads on secondary roads, narrowing delivery windows for the heaviest items.
- Local road upgrades—including portal apron reinforcement, pavement thickening, and turning radius modifications—may be needed to support specialized transporters.

- On-site geometry limits from ramp grades, pillar spacing, and internal road layouts must be factored into SPMT and crane lift planning.

While trucking remains the primary transport mode, heavy-lift planning must incorporate route validation, seasonal scheduling, structural load analysis, and internal clearance mapping.

Barge shipment offers reduced highway mileage, lower bulk costs, and the ability to handle very heavy reactor components.

- Terminal capabilities vary—crane capacities may range from 50-ton to 200-ton lifts, with some facilities lacking direct rail connections.
- Seasonal navigation factors such as low water, ice, or lock closures can cause delays; USACE navigation schedules and USCG coordination are mandatory.
- Last-mile connection still requires heavy-truck moves from port to site, including OSOW permits.

Barge delivery is ideal for the largest reactor modules but requires port facility vetting, seasonal planning, and synchronized last-mile trucking. Union Pacific's Dupo Intermodal Terminal provides rapid shipment capability for containers, skids, and mid-sized assemblies across the UP system [42].

- No on-site spur—installation would require rights acquisition, grading, FRA permitting, and track construction.
- Railcar and crane compatibility at the terminal must be confirmed against module lift and handling requirements.

Rail is most effective for medium/heavy components and supply replenishment, with a near-term truck plus intermodal hybrid as the practical solution pending spur construction.

Air cargo is suited for critical spares, instrumentation, and sensitive electronic systems. MidAmerica (BLV) and St. Louis Lambert (STL) airports provide national reach for such shipments. Heavy reactor modules are impractical for commercial air transport; any such activity would necessitate military coordination with Scott Air Force Base, Temporary Flight Restrictions (TFRs), and Federal Aviation Administration (FAA) approvals.

Operational logistics will include fuel delivery and waste shipment under DOT and NRC transport regulations (49 CFR), requiring route approvals, community notification, and emergency coordination with IEMA and local law enforcement. Maintenance activities will rely on truck and intermodal for spares, with periodic OSOW deliveries for major component replacements. Workforce commuting patterns indicate primary reliance on IL-3/I-255 corridors, requiring parking capacity and portal access management. Key agencies and stakeholders include:

- IDOT & County — OSOW permitting, bridge/culvert clearance, and seasonal road restrictions.
- USCG / USACE — River routing, lock scheduling, and navigation safety for barge moves.
- Union Pacific / Terminal Operators — Intermodal access, yard coordination, and crane handling procedures.
- FAA / Scott AFB — Airspace coordination for airlift or military transport operations.
- DOT / NRC / IEMA — Nuclear material routing, notification, and emergency response planning.

5.2 NEARBY INDUSTRIAL FACILITIES

The Rock City Business Complex itself hosts several active industrial and commercial tenants, making it one of the most significant underground industrial parks in the Midwest. Documented occupants include:

- National Archives and Records Administration (NARA) – NPRC Valmeyer Annex, which occupies approximately 400,000–474,000 square feet of archival storage space.
- Blue Line Foodservice / Little Caesars, operating ~39,000 square feet of cold storage.
- Additional tenants in warehousing, logistics, and cold storage sectors, supported by subdividable bays, paved interior roads, and utilities.

There are also additional manufacturing and mining facilities nearby too but they are farther outside a 10 mile radius of the proposed SOLO facility and may have minimal impact [44].

These facilities demonstrate the adaptability of the underground complex to high-reliability and controlled-climate operations, while also highlighting the need for construction phasing and dust/noise mitigation to avoid disruptions to existing tenants [4].

5.3 UTILITIES & SERVICES

The Rock City Business Complex currently has an installed electrical capacity of approximately 50 MW, sufficient to support medium industrial tenants and potential phased development of high-demand users [43], [1]. The facility's marketing documentation highlights that redundant electrical feeds can be established within 24–36 months, improving resilience for critical infrastructure. This electrical capacity is adequate to support initial microreactor siting studies, though long-term nuclear operations will require evaluation of redundancy, load growth, and integration with regional transmission operators.

At present, large-scale potable water and industrial process water infrastructure is not established at Rock City. Only sewer taps and limited water service points exist within the underground complex, supporting existing tenant operations [1]. This limitation is critical for nuclear siting, as construction, hydrostatic testing, and reactor auxiliary systems may require dedicated water supplies. Site-specific solutions may include well development, connection to municipal water service, or modular packaged treatment plants staged above ground. Wastewater management must ensure compliance with Illinois Environmental Protection Agency (IEPA) standards and avoid discharge into karst-influenced drainage systems.

No natural gas service currently exists at the Rock City site. Industrial tenants requiring heating or fuel supply utilize propane or other standalone systems. For nuclear microreactor operations, this limitation may not be a primary barrier; however, auxiliary systems (such as HVAC, emergency boilers, or hydrogen production) may necessitate project-specific gas solutions. Coordination with regional gas utility providers would be required if pipeline access were to be established.

The facility has installed fiber-optic communications, telephone lines, and cellular relay capacity, supporting tenants such as the National Archives (NARA) [4]. This telecommunications backbone offers an advantage for nuclear siting, enabling reliable control system networking, security monitoring, and emergency communication pathways.

Underground areas are equipped with zoned fire suppression systems, including sprinklers and hydrants, though these require evaluation for nuclear safety compatibility. A historical sprinkler leak at the NARA facility demonstrates the need for redundant drainage and water-management planning [45]. Local emergency services are provided through Monroe County and regional fire departments, with supplementary support possible from the Illinois National Guard and nearby Scott Air Force Base.

5.4 NEARBY MILITARY & EMERGENCY SERVICES

The Rock City site benefits from proximity to Scott Air Force Base (AFB), located approximately 20–35 miles northeast in St. Clair County. Scott AFB is home to Air Mobility Command (AMC) and U.S. Transportation Command (USTRANSCOM), which operate critical global logistics and airlift missions [46], [44]. The joint-use airfield, shared with MidAmerica St. Louis Airport (BLV), provides access to military cargo handling, airlift capacity, and security support during national or regional emergencies. The base maintains rapid response capabilities and could serve as a strategic partner for airlift operations, medical evacuation support, and interagency emergency coordination for the microreactor project.

In addition, the Illinois Army National Guard maintains regional armories and operational units throughout Monroe and St. Clair Counties [44]. These forces can be mobilized under state authority to support disaster response, perimeter security, or logistics operations during construction or operation of the reactor.

The Rock City site falls within the jurisdiction of the U.S. Coast Guard (USCG) Sector Upper Mississippi River, headquartered in St. Louis. The Sector oversees navigation safety, hazardous cargo routing, and spill response along the Mississippi and Kaskaskia Rivers [47]. Coordination with USCG will be required for any barge-based shipments of heavy reactor modules or fuel packages. In addition, the USCG provides a rapid-response capability for waterborne incidents that may affect site logistics or environmental safety.

Emergency planning for the Rock City site is supported by Monroe County and neighboring municipalities, including Valmeyer, Columbia, and Waterloo. Regional fire and EMS services provide first response capability, with county-level coordination through the Monroe County Emergency Management Agency. Given the underground complex's unique hazards (e.g., fire, water intrusion, confined-space rescue), site-specific response pre-plans will need to be developed in partnership with these agencies. Scott AFB medical facilities and St. Louis–area trauma centers provide regional capacity for emergency medical response. Additionally, the Illinois National Guard maintains logistical and medical units that can support large-scale incident scenarios if activated.

Table 3: Summary of Military & Emergency Services Proximity

Service / Installation	Location / Distance	Capabilities Relevant to Site
Scott AFB / USTRANSCOM	~20–35 mi NE (St. Clair Co.)	Air mobility, logistics, medevac, DoD coordination
MidAmerica St. Louis Airport (BLV)	Joint-use with Scott AFB	Cargo handling, military-civil coordination
Illinois Army National Guard	Regional armories (Metro East)	Emergency response, logistics, perimeter security
USCG Sector Upper Mississippi River	HQ in St. Louis	River navigation, hazardous cargo routing, spill response
Monroe County EMA / Fire / EMS	Local & regional	First response, confined-space rescue planning
St. Louis Trauma Centers	~25–30 mi	Emergency medical treatment for severe injuries

6 NATURAL AND MAN-MADE HAZARDS

The primary climatological baseline for the Rock City site is derived from the National Weather Service (NWS) climate records and published climate data for nearby Waterloo, Illinois, which represents conditions for Monroe County and the surrounding Mississippi River Valley. Supplemental climate data from the U.S. Climate Data service corroborate mean annual conditions and seasonal averages for temperature and precipitation [48].

- Mean Annual Temperature (1991–2020): ~57.4 °F.
- Typical Summer Conditions (July): Mean high ~89.6 °F; mean low ~71.1 °F; monthly mean ~80.4 °F.
- Typical Winter Conditions (January): Mean high ~40.4 °F; mean low ~23.8 °F; monthly mean ~32.1 °F.
- Annual Precipitation: ~41.7 inches/year.
- Annual Snowfall: ~16.6 inches/year (primarily December–March).

6.1 SEVERE WEATHER

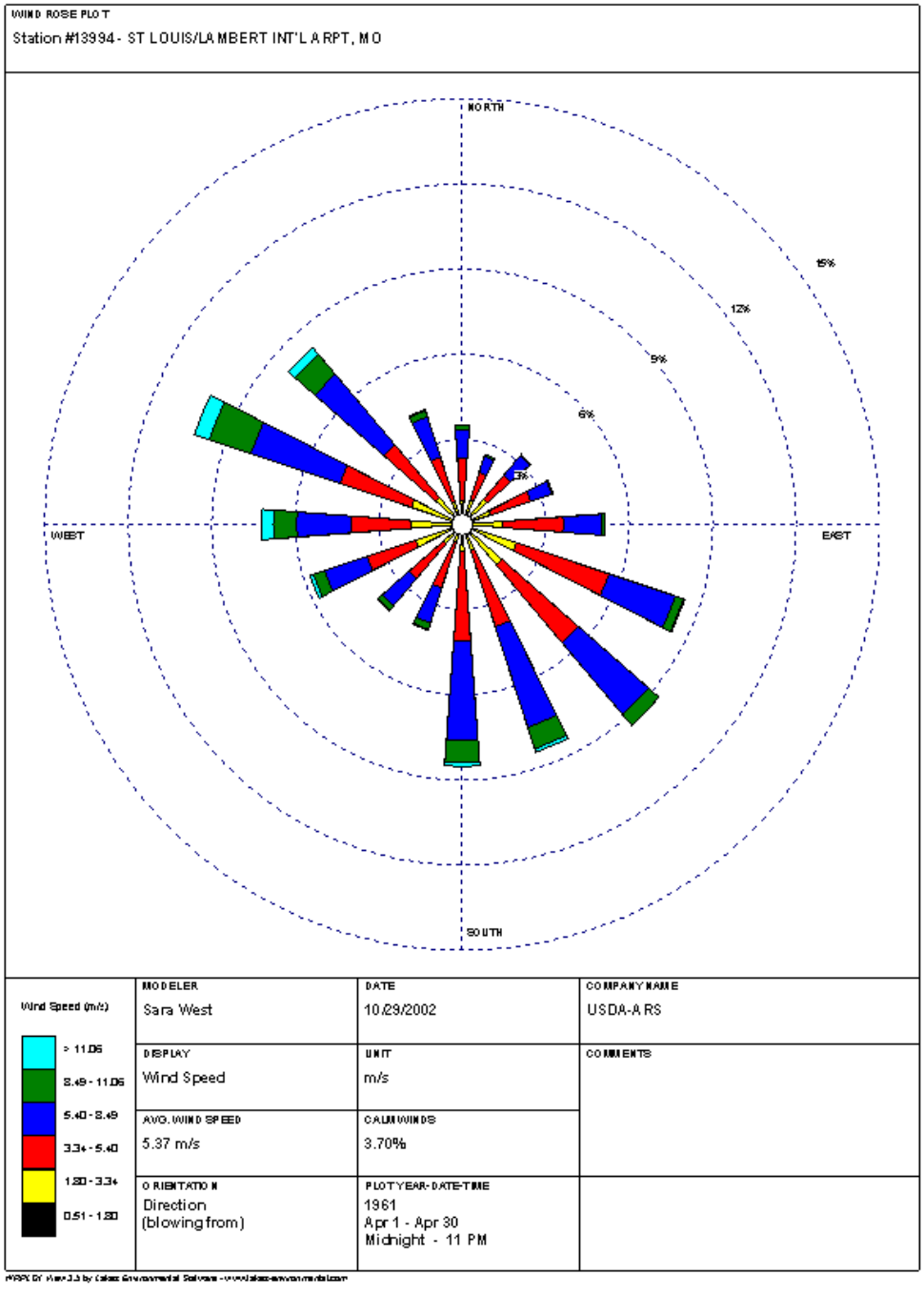
Historical analyses of Illinois tornado climatology demonstrate recurring severe weather risk across Monroe County. Regional climatology shows that tornadoes and severe storms are not limited to spring and early summer but can occur throughout the year, albeit with reduced frequency. In alignment with NRC precedent, design requirements will incorporate tornado wind speed exceedance probabilities for structural and safety-related features. Sheltering and worker protection will be provided through hardened subsurface facilities, while surface areas will maintain tornado refuge points consistent with Occupational Safety and Health Administration (OSHA) severe weather guidance [48], [32].

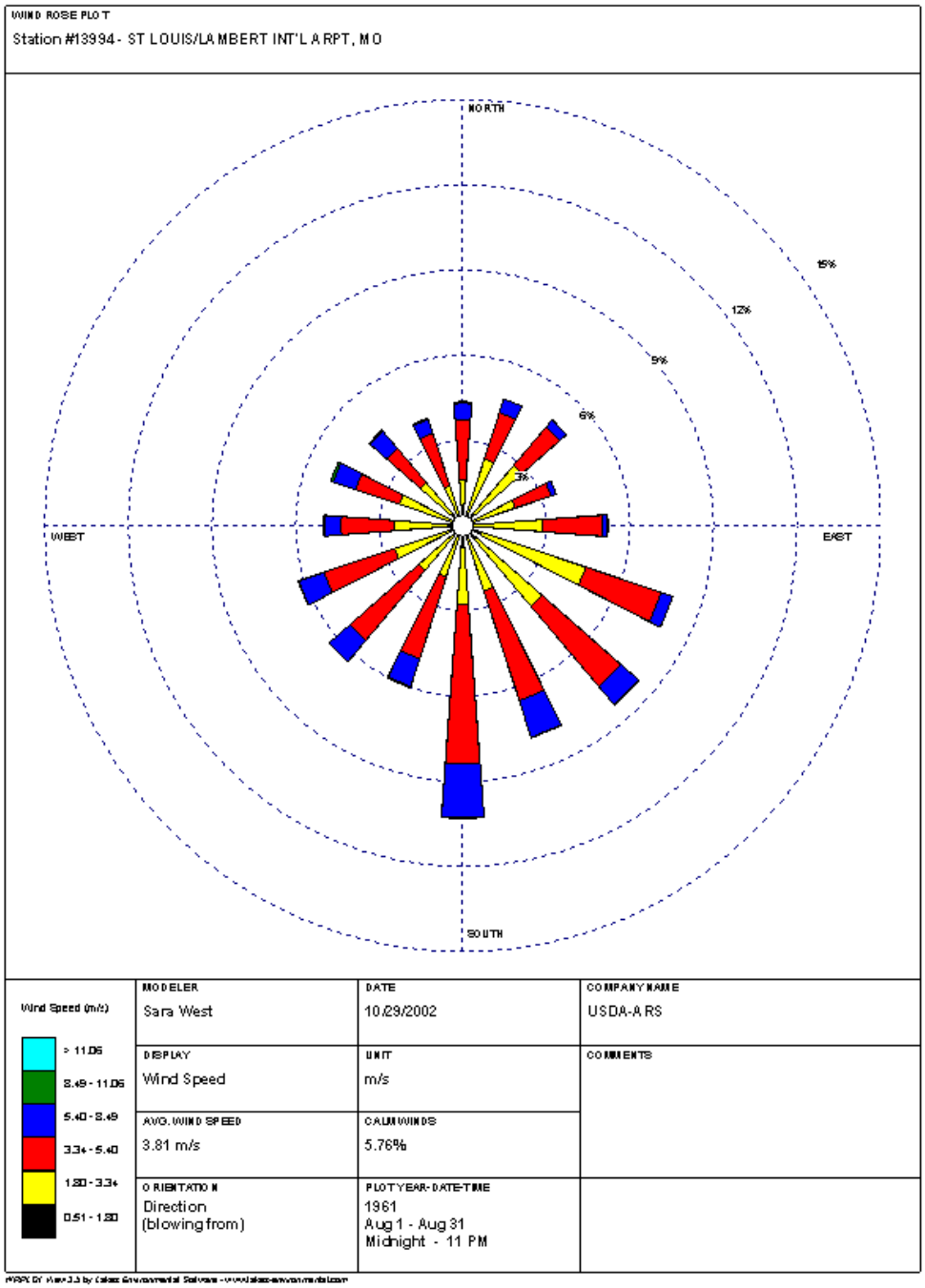
6.1.1 Wind Rose Data Summary

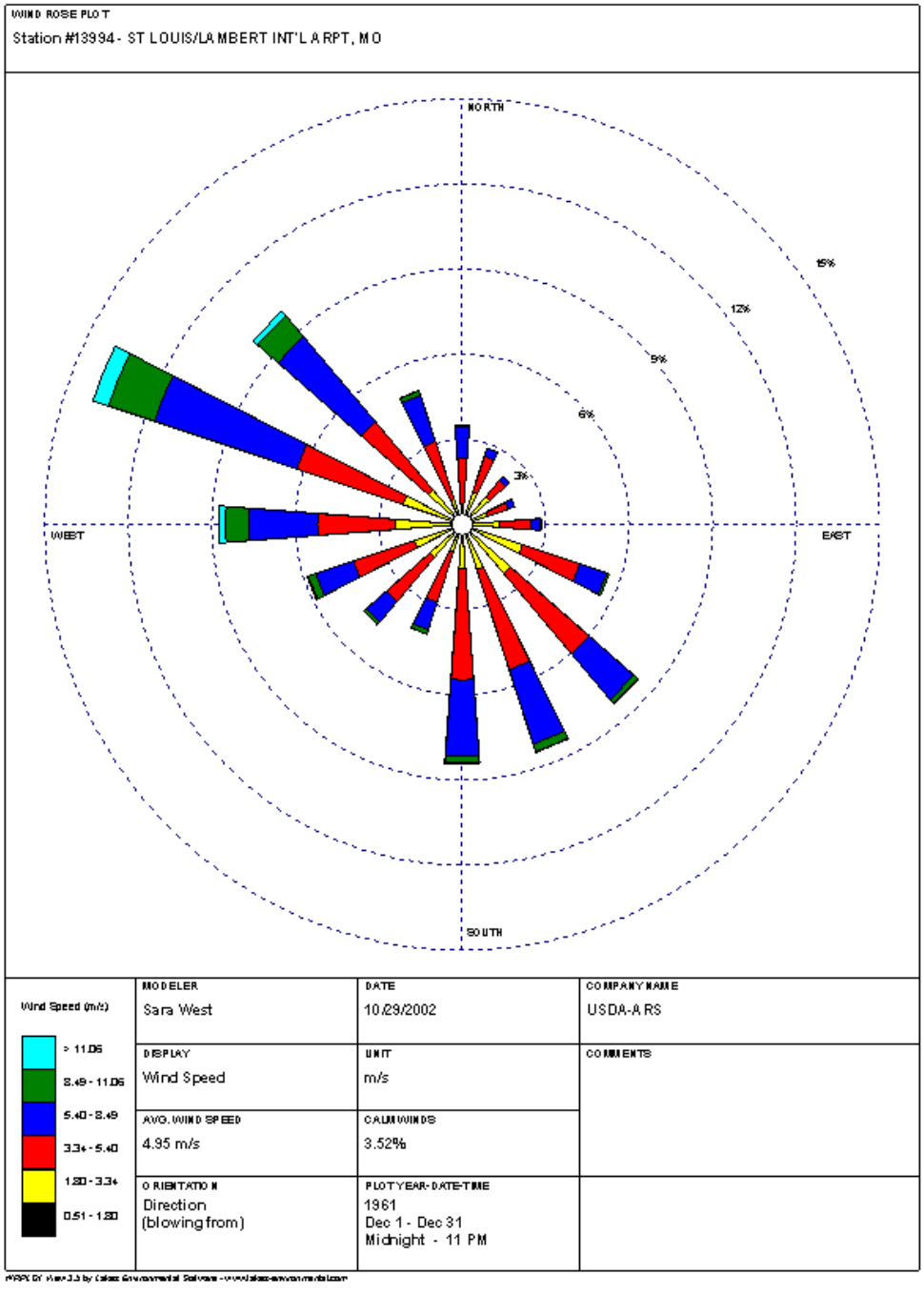
The polar wind rose illustrates that the majority of winds are from the south quadrant, with a concentration between SSE and SSW (see Figures 5). This concentration is significant from a safety analysis perspective, as it allows the atmospheric dispersion factor (χ/Q) calculations in the PSAR to focus on northward and northeastward receptor points for bounding analyses. The lack of substantial contribution from other quadrants simplifies worst-case meteorological scenario selection but should still be validated against seasonal and diurnal variability datasets.

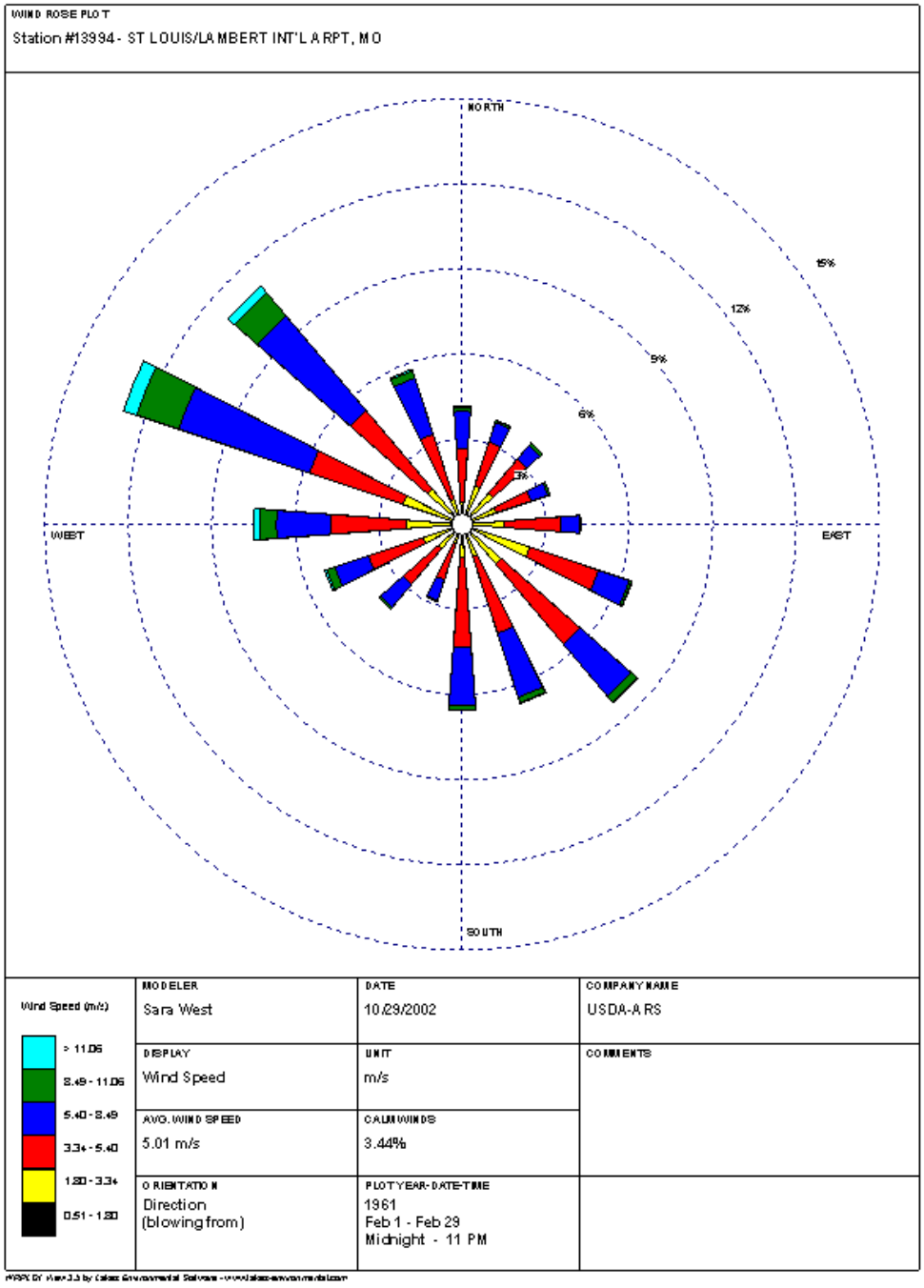
For physical design, the dominance of southern sector winds can influence snow drifting patterns in winter and dust transport during construction phases, potentially impacting operational access routes and HVAC intake cleanliness. This also provides a predictable input for evaluating thermal plume rise and the resultant influence on sensitive equipment.

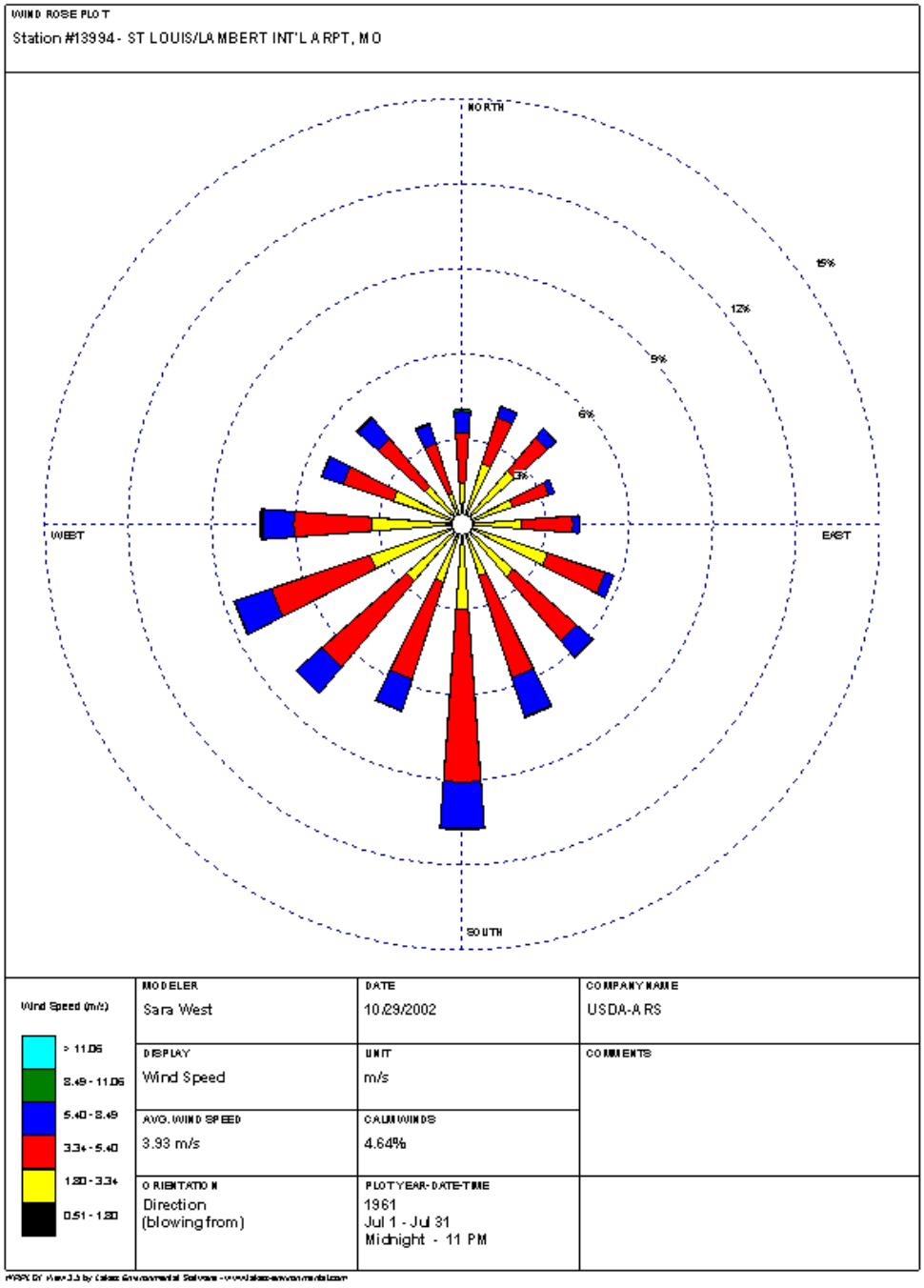
The turbulence intensity decreases as wind speed increases, a typical behavior in open terrain where mechanical turbulence from surface roughness becomes less significant at higher wind regimes. At lower wind speeds (<5 m/s), TI values are relatively elevated, which may have implications for early morning stable atmospheric conditions when plume meandering is more likely. At higher wind speeds (>10 m/s), TI values stabilize below 0.15, indicating more laminar flow patterns conducive to consistent dispersion and lower wake effects. This relationship should be used in the PSAR's meteorological monitoring program section to establish sensor siting requirements and data quality objectives. It also informs input parameter selection for the NRC's XOQDOQ dispersion modeling framework.

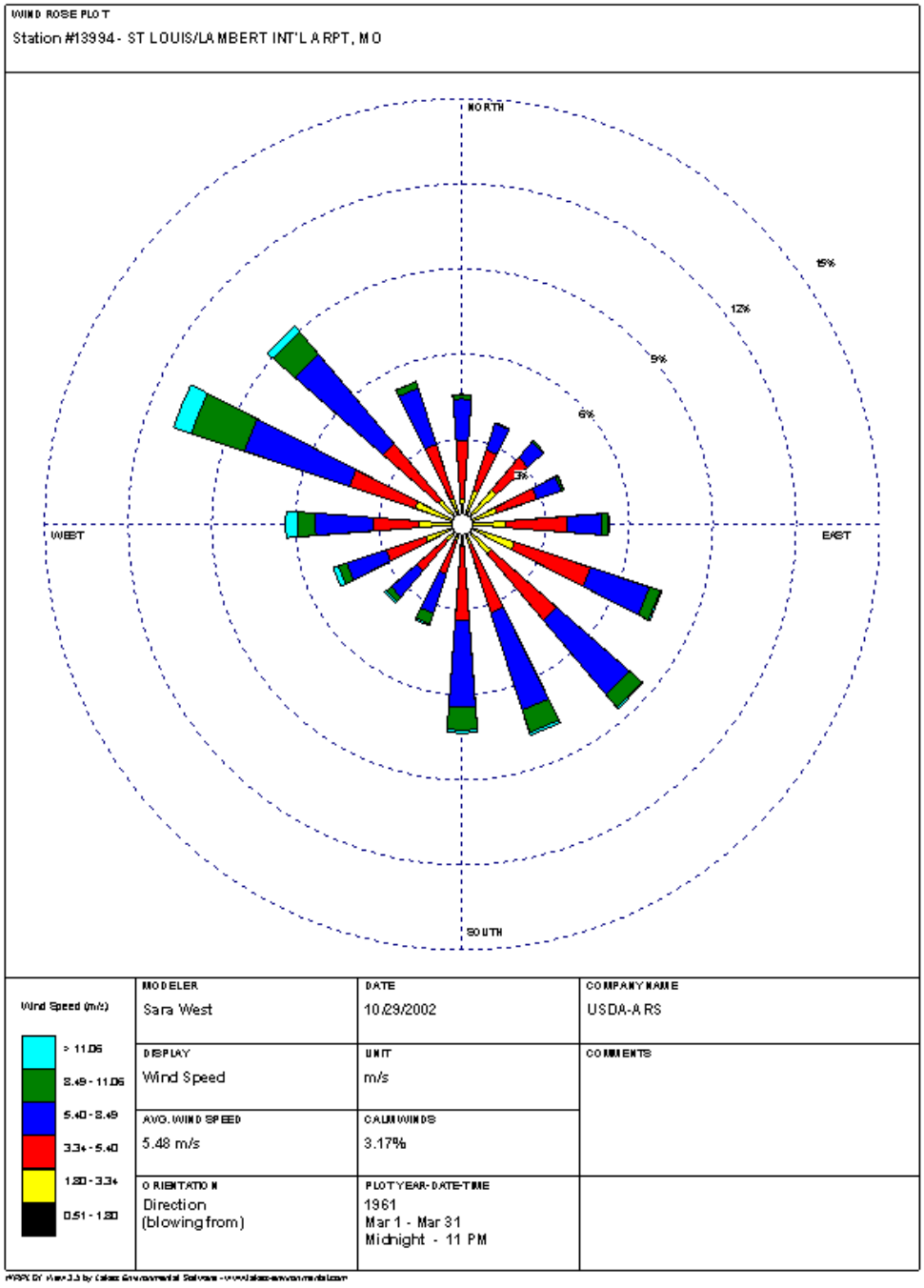

WIND ROSE PLOT
Station #13994 - ST LOUIS/LAMBERT INT'L ARPT, MO
NORTH
EAST
SOUTH
WEST
15%
12%
9%
6%
3%
Wind Speed (m/s)
> 11.06
8.49 - 11.06
5.40 - 8.49
3.34 - 5.40
1.80 - 3.34
0.51 - 1.80
MODELER
Sara West
DATE
10/29/2002
COMPANY NAME
USDA-ARS
DISPLAY
Wind Speed
UNIT
m/s
COMMENTS
AVG. WIND SPEED
5.37 m/s
CALM WINDS
3.70%
ORIENTATION
Direction
(blowing from)
PLOT YEAR-DATE-TIME
1961
Apr 1 - Apr 30
Midnight - 11 PM


WIND ROSE PLOT
Station #13994 - ST LOUIS/LAMBERT INT'L ARPT, MO
NORTH
EAST
SOUTH
WEST
15%
12%
9%
6%
3%
Wind Speed (m/s)
> 11.06
8.49 - 11.06
5.40 - 8.49
3.34 - 5.40
1.80 - 3.34
0.51 - 1.80
MODELER
Sara West
DATE
10/29/2002
COMPANY NAME
USDA-ARS
DISPLAY
Wind Speed
UNIT
m/s
COMMENTS
AVG. WIND SPEED
3.81 m/s
CALM WINDS
5.76%
ORIENTATION
Direction
(blowing from)
PLOT YEAR-DATE-TIME
1961
Aug 1 - Aug 31
Midnight - 11 PM


WIND ROSE PLOT
Station #13994 - ST LOUIS/LAMBERT INT'L ARPT, MO
NORTH
EAST
SOUTH
WEST
3%
6%
9%
12%
15%
Wind Speed (m/s)
> 11.06
8.49 - 11.06
5.40 - 8.49
3.34 - 5.40
1.80 - 3.34
0.51 - 1.80
MODELER
Sara West
DATE
10/29/2002
COMPANY NAME
USDA-ARS
DISPLAY
Wind Speed
UNIT
m/s
COMMENTS
AVG. WIND SPEED
4.95 m/s
CALM WINDS
3.52%
ORIENTATION
Direction
(blowing from)
PLOT YEAR-DATE-TIME
1961
Dec 1 - Dec 31
Midnight - 11 PM


WIND ROSE PLOT
Station #13994 - ST LOUIS/LAMBERT INT'L ARPT, MO
NORTH
EAST
SOUTH
WEST
15%
12%
9%
6%
3%
Wind Speed (m/s)
> 11.06
8.49 - 11.06
5.40 - 8.49
3.34 - 5.40
1.80 - 3.34
0.51 - 1.80
MODELER
Sara West
DATE
10/29/2002
COMPANY NAME
USDA-ARS
DISPLAY
Wind Speed
UNIT
m/s
COMMENTS
AVG. WIND SPEED
5.01 m/s
CALM WINDS
3.44%
ORIENTATION
Direction
(blowing from)
PLOT YEAR-DATE-TIME
1961
Feb 1 - Feb 29
Midnight - 11 PM


WIND ROSE PLOT
Station #13994 - ST LOUIS/LAMBERT INT'L ARPT, MO
NORTH
EAST
SOUTH
WEST
15%
12%
9%
6%
3%
Wind Speed (m/s)
> 11.06
8.49 - 11.06
5.40 - 8.49
3.34 - 5.40
1.80 - 3.34
0.51 - 1.80
MODELER
Sara West
DATE
10/29/2002
COMPANY NAME
USDA-ARS
DISPLAY
Wind Speed
UNIT
m/s
COMMENTS
AVG. WIND SPEED
3.93 m/s
CALM WINDS
4.64%
ORIENTATION
Direction
(blowing from)
PLOT YEAR-DATE-TIME
1961
Jul 1 - Jul 31
Midnight - 11 PM



Figures 5 (a, b, c, d, e, f) Wind Rose Data (St. Louis)

6.2 FLOOD HAZARD ASSESSMENT

The Rock City site is mapped within FEMA Flood Insurance Rate Map (FIRM) Zone X, defined as an *Area of Minimal Flood Hazard*. This designation indicates a less than 0.2% annual chance of flooding, placing the site outside both the 100-year (1% annual chance) and 500-year (0.2% annual chance) floodplains. The site is situated on the Mississippi River bluffs, at an elevation significantly higher than the surrounding floodplain. This natural topographic relief provides inherent protection against riverine flooding. FEMA-designated Zone AE areas (100-year flood hazard) are confined to the lowlands west of the bluff, well below the elevation of the proposed development (Figure 6). As such, no mapped flood hazard zones directly intersect the Rock City property.

Because the site is located within Zone X, no special floodplain development permits would normally be required for construction activities under FEMA or Illinois floodplain management regulations. From an NRC perspective, documenting this designation in the Environmental Report (ER) and Safety Analysis provides strong evidence that flooding risk is negligible for the SOLO microreactor facility [25].

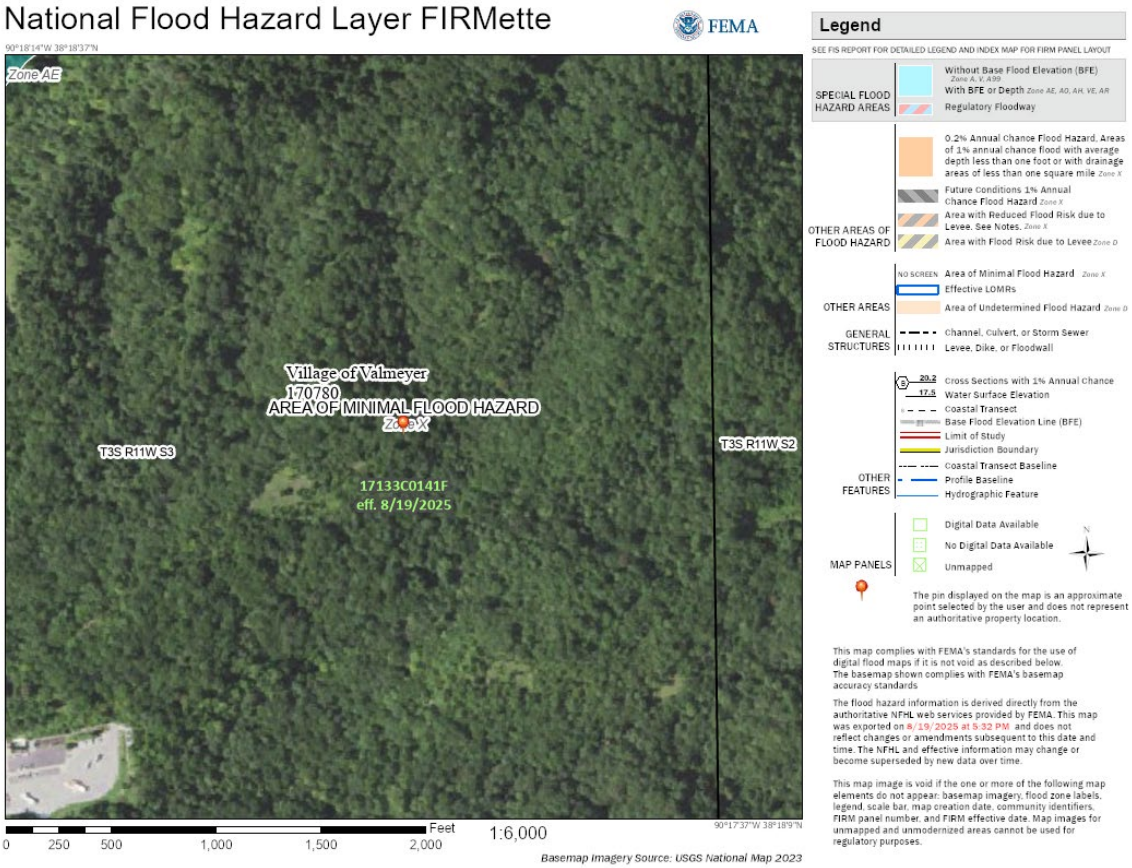


Figure 6: Flood Hazard Zones for Rock City Site

6.3 CRITICAL HABITAT ASSESSMENT

Review of U.S. Fish & Wildlife Service (USFWS) critical habitat maps indicates that the nearest designated critical habitat lies several miles southwest of the Rock City site, primarily associated with large, contiguous floodplain ecosystems along the Mississippi River corridor in southern Illinois and Missouri (Figure 7). These shaded areas (designated in dark red on the official habitat overlays)

encompass habitats for federally listed threatened and endangered species, including bottomland forest and wetland-dependent species.

The Rock City Business Complex itself is located outside any mapped critical habitat boundaries, positioned on elevated limestone bluffs above the Mississippi River floodplain. The bluff topography and separation from lowland ecosystems provide a natural buffer zone, further reducing potential direct impacts to critical habitat.

Because the Rock City site is not within designated critical habitat, it is not subject to the most restrictive prohibitions under the Endangered Species Act (ESA), Section 9. However, ESA Section 7 consultation will still be required as part of the NRC's 10 CFR Part 51 environmental review, to ensure that construction and operation of the SOLO microreactor do not result in indirect impacts. Key considerations include:

- Water Discharges: Ensuring stormwater or wastewater releases do not degrade downstream aquatic habitats connected to the Mississippi River.
- Habitat Fragmentation: Avoiding unnecessary disturbance to bluff-edge woodland areas that may provide movement corridors for migratory birds or listed species.
- Transmission & Access Corridors: Evaluating potential new right-of-way clearances or utility extensions that could alter edge habitats or increase fragmentation.

The Zone X flood hazard designation and bluff-top position reinforce the suitability of the Rock City site from an ecological perspective, as it avoids direct interaction with sensitive riverine habitats. While formal ESA consultation is anticipated, the combination of site elevation, existing industrial use, and separation from mapped habitat strongly supports a finding of no adverse effect with appropriate mitigation measures [26].

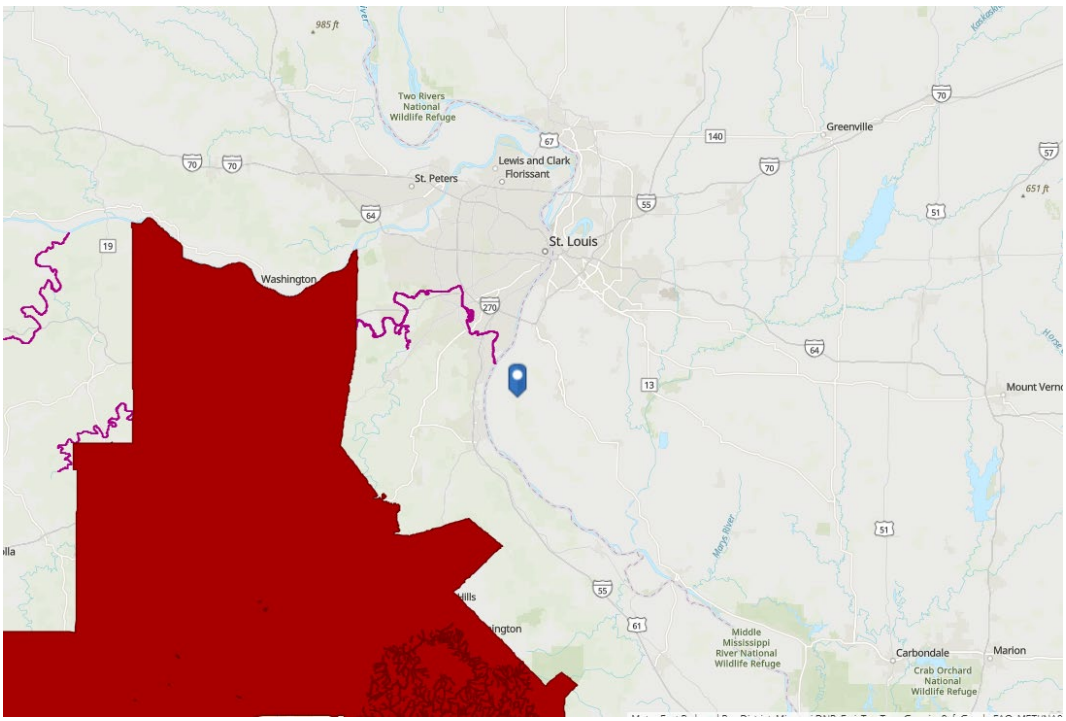


Figure 7: Critical Habitat Area for Rock City

6.4 INDUSTRIAL & TRANSPORTATION HAZARDS

The Rock City Business Complex is located in an active industrial setting with existing tenants such as the National Archives Valmeyer Annex and commercial cold-storage operations. While these facilities are generally low-risk, potential hazards include fire, ammonia releases, and vehicle/equipment accidents. For example, the U.S. Government Accountability Office documented a sprinkler system failure and subsequent water intrusion at the NARA facility, underscoring the importance of utility protection and water-management plans [45]. Cold storage operations may involve anhydrous ammonia refrigeration systems, which represent a toxic chemical release hazard requiring Tier II/EPCRA reporting and coordination with local emergency planners.

The Rock City site is highly connected to multimodal transport networks (Figure 8). Its proximity to Interstate 255, I-270, I-55, and I-64 provides regional trucking access , while the Kaskaskia Regional Port District (KRPD) enables barge shipments along the Mississippi and Kaskaskia Rivers. The Union Pacific Dupo Intermodal Terminal provides nearby rail access for hazardous freight. These corridors regularly support the transport of hazardous materials (HAZMAT), which poses credible risks to site operations. Potential scenarios include highway HAZMAT spills, railcar derailments involving chemicals or fuels, or barge collisions resulting in petroleum or cargo release [44].

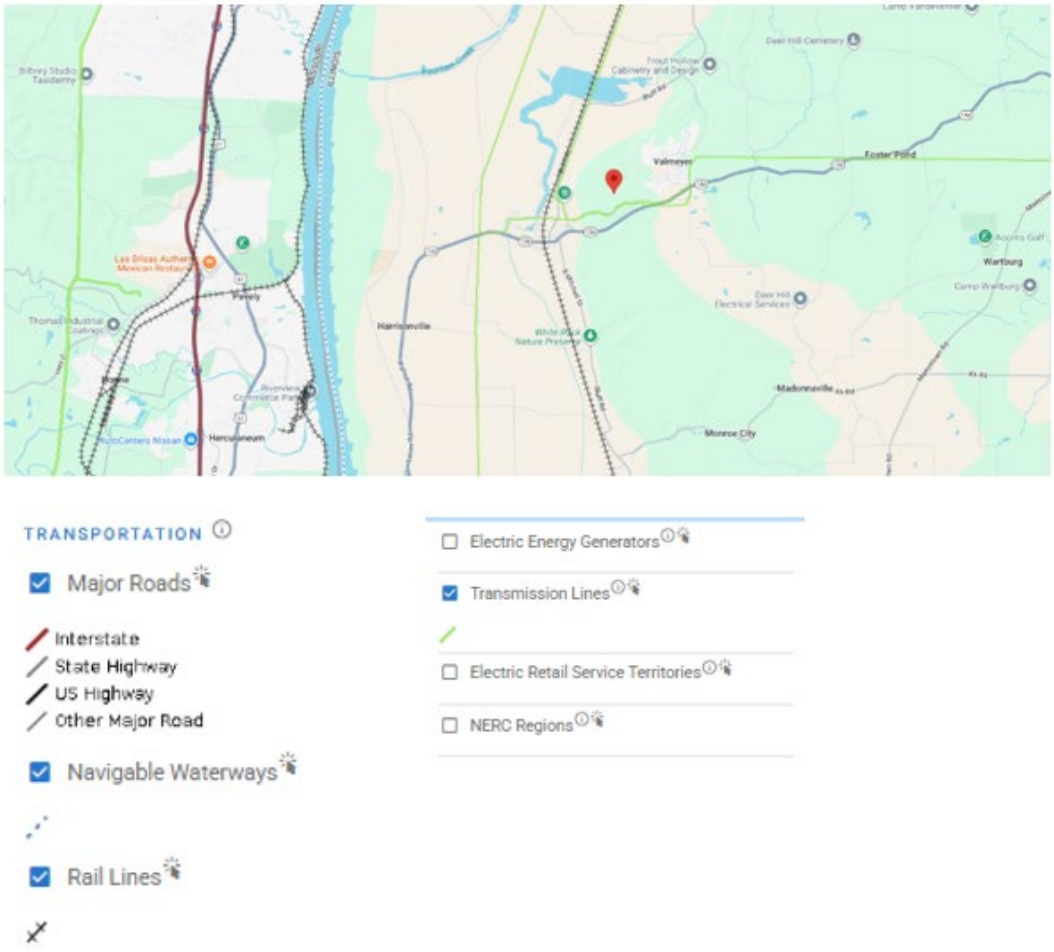


Figure 8: Rock City Site Transportation Routes [44]

The site is also influenced by nearby air traffic from MidAmerica St. Louis Airport (BLV), Scott Air Force Base, and Lambert–St. Louis International Airport (STL). These facilities increase the probability of overflight and cargo aircraft operations in the vicinity. Although the Rock City site is outside controlled airport property, air hazards must be considered for siting. FAA airspace

restrictions, including Temporary Flight Restrictions (TFRs), may be imposed during military surge operations or large regional events.

7 ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

7.1 INTRODUCTION

This chapter evaluates the potential environmental effects associated with the construction, operation, decommissioning, and cumulative activities of the proposed SOLO Microreactor at the Rock City Business Complex in Valmeyer, Illinois. The assessment follows the framework established in 10 CFR Part 51, NUREG-1537, and NUREG-1748, which require that environmental consequences be characterized in terms of SMALL, MODERATE, or LARGE significance levels. A SMALL impact denotes effects not discernible or well below regulatory concern; MODERATE indicates measurable but not destabilizing impacts; and LARGE represents clearly significant degradation of environmental quality. Based on site conditions and the implementation of standard best-management practices, all environmental effects of the proposed action are anticipated to be **SMALL**.

7.2 CONSTRUCTION IMPACTS

Construction of the SOLO facility will occur entirely within the existing industrial footprint of the Rock City complex. Activities will include site preparation, limited grading of surface laydown areas, installation of portal access improvements, and assembly of above-ground support structures. Because the site is already developed and zoned for industrial use, no land-use conversion or displacement of existing communities will occur. Visual effects will be minor and consistent with ongoing industrial operations.

Temporary air emissions will result from construction equipment, vehicle traffic, and minor dust generation; these will be mitigated through dust suppression, equipment maintenance, and adherence to Illinois EPA air-quality standards. Construction noise will be transient and confined to daytime hours, with the nearest receptors located more than half a mile away and screened by natural topography.

Stormwater runoff will be managed through existing drainage infrastructure and temporary controls such as silt fencing and sediment traps. The site lies on elevated limestone bluffs outside FEMA-mapped flood hazard areas; no encroachment upon wetlands or surface waters will occur. Because the area is already disturbed, no significant ecological or habitat impacts are expected. Solid and sanitary wastes will be collected by local services and disposed of in licensed facilities.

Socioeconomic effects will be limited to short-term increases in construction employment and local spending, yielding a modest beneficial impact. Overall, construction-phase effects on land use, air and water quality, ecology, and socioeconomic conditions are expected to be **SMALL**.

7.3 OPERATIONS IMPACTS

During operation, the SOLO Microreactor will function as a low-power, test-scale facility providing research and performance data for advanced microreactor systems. The reactor will be located within reinforced underground chambers that provide natural containment and thermal stability, while above-ground areas will support control, administrative, and utility functions.

Operational impacts on land use and visual resources will remain minimal because the facility will occupy an existing industrial site. Air emissions will be limited to conventional HVAC systems and standby generators; no continuous or process emissions are expected. The underground configuration effectively contains noise, resulting in negligible off-site sound propagation.

Water usage will be restricted to domestic supply and minor cooling or humidification functions. No process water discharges are anticipated, and groundwater quality will be protected through secondary containment and monitoring of portal drainage. The site’s elevation above the Mississippi River floodplain ensures protection from inundation events.

Ecological impacts during operations will be negligible due to the absence of open discharges and the highly developed nature of the site. Radiological releases, if any, will remain well below regulatory

limits established in **10 CFR Part 20** and will comply with ALARA principles. Low-level radioactive wastes will be packaged and shipped to licensed disposal facilities in accordance with **10 CFR 61**. Routine operations will generate limited quantities of non-radiological waste, managed under local and state programs.

Traffic and socioeconomic effects will be minor, associated with a small operating workforce and periodic material shipments. The project will provide incremental economic benefit through skilled employment and supply-chain participation. No disproportionate or adverse effects on minority or low-income populations are expected. Overall, operational impacts are expected to be **SMALL** across all resource areas.

7.4 DECOMMISSIONING AND CUMULATIVE IMPACTS

At the conclusion of its service life, the SOLO facility will be decommissioned in accordance with **10 CFR 50.82** and NRC guidance for non-power reactors. Decommissioning activities will involve defueling, decontamination, removal of equipment, and site restoration to unrestricted use or continued industrial service. All radiological and non-radiological wastes will be managed under applicable NRC and state requirements, with off-site transport to licensed facilities.

Because decommissioning will occur within the same developed footprint as the operational facility, no new land disturbance or permanent environmental change is anticipated. Short-term air emissions and noise from dismantlement equipment will be temporary and minor. Water and ecological resources will remain protected through existing drainage and waste-handling controls. Following site restoration, residual impacts are expected to be **SMALL**.

Cumulative effects consider the combined influence of the proposed action with other past, present, or reasonably foreseeable projects in Monroe County and the surrounding region. Nearby industrial and transportation activities are limited, and no major developments are planned that would overlap spatially or temporally with the SOLO project. Given the localized and minimal nature of construction and operational impacts, the cumulative contribution of the SOLO project to regional environmental change is expected to be **SMALL**.

7.5 MITIGATION AND MONITORING

Although no significant impacts have been identified, Terra Innovatum will implement standard mitigation and monitoring measures to ensure continued environmental protection. These include compliance with the Illinois EPA construction stormwater permit, adherence to dust and noise control practices, and waste minimization consistent with state and federal regulations.

During operation, the facility will maintain an environmental monitoring program that verifies radiological effluent control, assesses stormwater quality, and ensures compliance with applicable NRC, EPA, and state standards. The underground configuration provides inherent mitigation of meteorological, seismic, and radiological risks. Decommissioning activities will follow NRC-approved procedures to verify site release criteria and prevent long-term contamination.

Collectively, these measures ensure that the SOLO project will maintain **SMALL** environmental impacts throughout its life cycle and remain protective of public health, safety, and the environment.

8 ALTERNATIVES

8.1 INTRODUCTION

In accordance with the National Environmental Policy Act (NEPA) and the NRC's implementing regulations in 10 CFR Part 51, an Environmental Report (ER) must discuss alternatives to the proposed action. The purpose of the alternatives analysis is to ensure that the NRC and the applicant consider reasonable options that could accomplish the same objectives as the proposed action while potentially reducing environmental impacts.

The scope of this alternative's evaluation is limited to the siting of the SOLO Microreactor. Because the Purpose and Need for the proposed action is to obtain a construction permit for the SOLO design at the Rock City site in Valmeyer, Illinois, alternatives are restricted to those that could achieve the same siting and licensing objectives. Other reactor technologies or non-nuclear energy sources would not satisfy this purpose and need and therefore were not evaluated in detail.

This chapter considers the following:

- The No-Action Alternative, in which NRC would not issue a construction permit for the SOLO reactor.
- Alternative site locations that could, in principle, host a similar facility.
- Alternatives that were considered but eliminated from further study.

8.2 NO-ACTION ALTERNATIVE

Under the No-Action Alternative, the NRC would not issue a construction permit, and the SOLO Microreactor would not be constructed or operated at Rock City or elsewhere. The existing Rock City Business Complex would continue in its current industrial and storage use, and the local environment would remain largely unchanged. This alternative would avoid construction-related impacts such as temporary noise, minor land disturbance, and incremental traffic. However, it would also prevent realization of the project's objectives: collection of site-specific data, demonstration of microreactor performance, and advancement of licensing readiness for future deployments. The Rock City site would require an alternative solution for providing efficient electricity for its tenants. Consequently, while the No-Action Alternative would result in no new environmental impacts, it would not satisfy the need for the proposed action.

8.3 ALTERNATIVE SITES

Terra Innovatum conducted a comparative site evaluation using the STAND decision analysis framework, assessing potential alternative locations for microreactor deployment against the proposed Rock City site. The evaluation applied normalized performance metrics across three primary objectives: Safety, Proximity, and Economic factors to produce a composite site suitability score. Candidate sites were screened using criteria consistent with Regulatory Guide 4.7 and NUREG-1537, Part 1, Ch. 19, including:

- Availability of existing industrial or brownfield infrastructure.
- Geological and seismic stability.
- Minimal population density and compatible land use.
- Access to transportation, utilities, and emergency services.
- Ability to accommodate required exclusion zones and security controls.

The sites evaluated were:

- **Rock City**– Valmeyer, Illinois

- **Seadrift**– Texas
- **Heritage Center**– Tennessee
- **Kemmerer**– Wyoming

Figure 9 and Figure 10 summarize the results of this comparative analysis. Rock City ranked highest overall, with a composite value of 74.35, reflecting balanced performance across all three objectives. Safety and economic indicators were particularly favorable, owing to the site's isolation, stable geology, and existing industrial zoning.

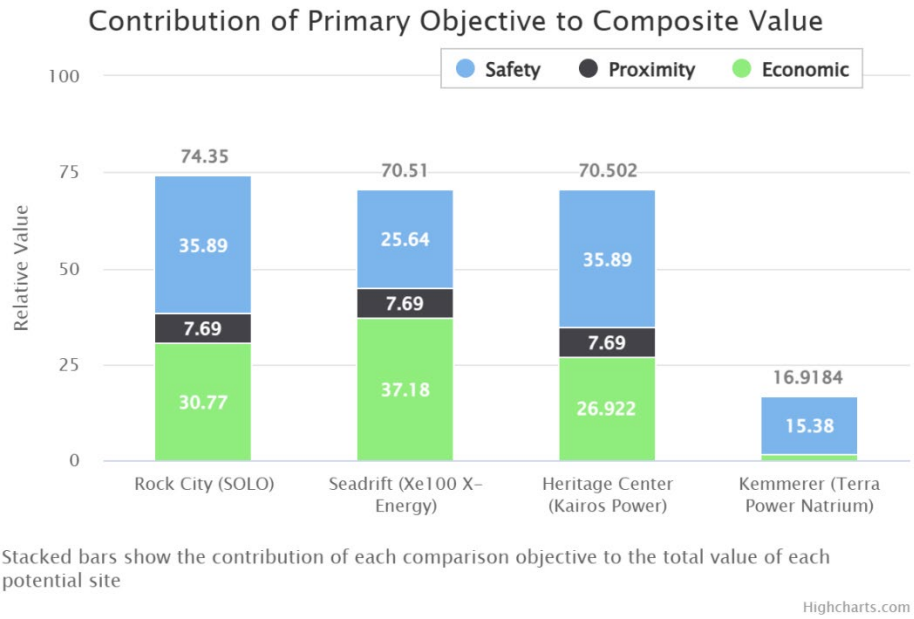


Figure 9: STAND Bar Summary [44]

Site Attributes

Rank	Site Name	Energy Price	Nuclear Sentiment	Landslide Hazard	Hazardous Facilities	One Hundred Year Flood	Streamflow	Federal Incentive
1	Rock City (SOLO)	12.501 cents/kWh	40.8 percent	Yes	1 count	No	Yes	Yes
2	Seadrift (Xe100 X-Energy)	10.107 cents/kWh	47.3 percent	No	3 count	No	Yes	Yes
3	Heritage Center (Kairos Power)	10.976 cents/kWh	44.2 percent	Yes	2 count	No	Yes	No
4	Kemmerer (Terra Power Natrium)	9.295 cents/kWh	41.1 percent	Yes	0 count	Yes	No	No

Rows per page: 5 1-4 of 4

The actual values used to calculate normalized values for each site

Figure 10: STAND Analysis Summary

The STAND study demonstrated that the Rock City site provided the highest composite suitability among evaluated alternatives. It offers a strong balance of safety, accessibility, and economic feasibility. Other sites either lacked comparable subsurface infrastructure (Seadrift, Heritage Center) or presented higher environmental or logistical risk (Kemmerer). Therefore, Rock City remains the environmentally and operationally preferred alternative for the proposed SOLO Microreactor installation.

8.4 ALTERNATIVES ELIMINATED FROM DETAILED STUDY

Several classes of alternatives were considered but dismissed from detailed evaluation for the reasons below:

Table 4: Eliminated Alternatives

Alternative Type	Basis for Elimination
Alternative reactor technologies (e.g., light-water or molten-salt systems)	Do not meet the purpose and need, which is to demonstrate the specific SOLO microreactor design.
Alternative energy sources (e.g., solar, natural gas, or other non-nuclear options)	Do not satisfy the need to collect reactor-specific licensing and performance data.
Alternative cooling or fuel systems	Outside the scope of this siting-focused action; would alter design certification rather than site selection.
Alternative configurations within Rock City (e.g., different portal locations or orientation)	Minor layout differences would have negligible environmental impact; will be optimized during detailed design.

8.5 COMPARISON OF ENVIRONMENTAL CONSEQUENCES

Both the No-Action Alternative and alternative-site options were compared qualitatively against the proposed action using NEPA's impact significance framework (SMALL, MODERATE, LARGE) is shown by Table 5. All environmental effects from the Proposed Action (construction, operation, decommissioning, and cumulative) are classified as SMALL, consistent with NRC definitions in *NUREG-1748*. The No-Action Alternative would avoid all construction or operational impacts but would also forgo the potential benefits of demonstrating safe, low-impact microreactor deployment at an existing industrial site.

Table 5: Comparison of Environmental Impacts

Resource Area	Construction Impacts	Operations Impacts	Decommissioning Impacts	Cumulative Impacts	No-Action Alternative
Land Use & Visual	Work limited to existing industrial footprint; visually compatible with current land use. Impact Level: SMALL	Facility within industrial zone; consistent with surroundings. SMALL	Activities remain within same footprint; minor visual change. SMALL	No additive land use effects. SMALL	No disturbance; existing industrial use continues unchanged.
Air Quality & Noise	Temporary emissions and construction noise controlled by BMPs. SMALL	Routine HVAC/equipment noise; no significant emissions. SMALL	Short-term emissions from dismantlement equipment. SMALL	No cumulative degradation of air quality. SMALL	No new emissions or noise sources introduced.
Water Resources	No direct discharges; runoff managed via stormwater BMPs; site outside FEMA flood zones. SMALL	Minimal domestic water use; no process discharges; groundwater unaffected. SMALL	Controlled runoff and wastewater under permits. SMALL	No overlapping withdrawals or discharges. SMALL	No change in hydrology or floodplain; existing drainage maintained.
Ecological Resources	Previously disturbed site; no wetlands or critical habitats affected. SMALL	No interaction with sensitive habitats; compliance monitoring. SMALL	Temporary localized disturbance; site restored after completion. SMALL	No regional cumulative habitat effects. SMALL	No additional disturbance; existing habitat conditions persist.
Radiological Impacts	None—no radioactive materials during construction. SMALL	Controlled releases below limits (10 CFR Part 20, ALARA). SMALL	Decommissioning managed under 10 CFR 50.82; post-closure surveys verify compliance. SMALL	No cumulative radiological effects. SMALL	No radioactive materials introduced.
Waste Management	Solid/sanitary wastes handled by local facilities. SMALL	LLRW disposed through licensed sites; conventional waste	Waste handled under NRC/state requirements. SMALL	Regional waste infrastructure adequate. SMALL	No new waste generation; existing waste practices unchanged.

Resource Area	Construction Impacts	Operations Impacts	Decommissioning Impacts	Cumulative Impacts	No-Action Alternative
		managed locally. SMALL			
Traffic & Socioeconomics	Temporary workforce and traffic increase; minor local benefit. SMALL	Permanent staffing yields modest positive economic effect. SMALL	Temporary workforce effects only. SMALL	No combined infrastructure strain. SMALL	No employment or traffic change; no local economic stimulus.
Environmental Justice	No disproportionate effects identified. SMALL	No EJ populations adversely affected. SMALL	No EJ impacts expected. SMALL	None cumulatively. SMALL	No new effects; baseline community conditions remain unchanged.

8.6 PREFERRED ALTERNATIVE

Terra Innovatum has identified the Rock City Business Complex in Valmeyer, Illinois, as the preferred alternative for siting the SOLO Microreactor. The location provides a combination of environmental, technical, and logistical advantages that make it particularly suitable for this first-of-a-kind deployment. The site offers minimal incremental environmental impacts, supported by existing industrial infrastructure and zoning that are compatible with nuclear energy applications. Its geologic and topographic conditions underlain by competent Mississippian limestone and situated above the Mississippi River floodplain, further enhance site safety and reduce construction and operational risk. All potential environmental effects associated with the proposed action are expected to be SMALL, consistent with the impact significance definitions established by the NRC in NUREG-1748 and NUREG-1537.

Summary

The evaluation of reasonable alternatives demonstrates that the No-Action Alternative would not meet the project's purpose and need, as it would preclude the development and demonstration of the SOLO Microreactor technology. Among the alternative locations evaluated, none provided the same combination of low environmental impact, strong existing infrastructure, and regulatory compatibility as the Rock City site. Other technologies or energy sources were not considered reasonable because they do not meet the objectives of demonstrating a safe, scalable, and site-flexible nuclear microreactor system. Accordingly, siting the SOLO Microreactor at the Rock City Business Complex represents the most reasonable and environmentally preferable course of action.

9 CONCLUSIONS

The environmental review of the proposed SOLO Microreactor at the Rock City Business Complex in Valmeyer, Illinois, demonstrates that the project can be constructed, operated, and decommissioned with SMALL environmental impacts across all evaluated resource areas. The assessment, performed in accordance with 10 CFR Part 51, NUREG-1537 (Parts 1 and 2), and NUREG-1748, concludes that the proposed action would not result in any significant adverse effects on land use, air or water quality, ecological resources, or the health and safety of the public. The Rock City site's location within an existing industrial complex, its elevated topography above the Mississippi River floodplain, and its stable limestone geology collectively minimize environmental sensitivity and enhance long-term facility resilience.

All construction and operational activities are confined to previously developed property and will employ established best-management practices for erosion control, waste handling, and stormwater management. No wetlands, critical habitats, or environmentally sensitive areas will be affected. Radiological impacts during operation and decommissioning will remain well below the regulatory limits of 10 CFR Part 20, and the project will comply with all NRC, EPA, and Illinois environmental protection standards. Cumulative effects of the proposed action, when considered with other regional industrial and infrastructure projects, are expected to remain SMALL.

Based on the analyses presented in this Environmental Report, the Rock City site represents the preferred and environmentally acceptable alternative for the siting of the SOLO Microreactor. The proposed action fulfills the project's purpose and need to demonstrate a safe, secure, and scalable microreactor design, while maintaining environmental protection and regulatory compliance. Terra Innovatum concludes that the proposed action will not have a significant effect on the quality of the human environment and provides sufficient technical and environmental basis for NRC's preparation of an Environmental Impact Statement under NEPA and 10 CFR Part 51.

10 REFERENCES

[1] I. Illinois, "Rock City Business Complex - Vetted Site Profile," [Online]. Available: https://www.intersectillinois.org/vetted-site/rock-city-business-complex/.

[2] United States Nuclear Regulatory Commission, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors Standard Review Plan and Acceptance Criteria, NUREG-1537, Parts 1 and 2," U.S. NRC, Washington, DC, 1996.

[3] "Preparation of Environmental Reports for Nuclear Power Stations, Regulatory Guide 4.2," Commission, United States Nuclear Regulatory, 2018.

[4] R.C. Development, "History - Rock City Business Complex," [Online]. Available: https://www.rockcitydevelopment.com/about-us/history/.

[5] United States Nuclear Regulatory Commission, "PART 50—DOMESTIC LICENSING OF PRODUCTION AND UTILIZATION FACILITIES," U.S. NRC, Washington, DC, 2025.

[6] United States Nuclear Regulatory Commission, "PART 51—ENVIRONMENTAL PROTECTION REGULATIONS FOR DOMESTIC LICENSING AND RELATED REGULATORY FUNCTIONS," U.S. NRC, Washington, DC, 2025.

[7] United States Nuclear Regulatory Commission, "PART 100—REACTOR SITE CRITERIA," 2025.

[8] "General Site Suitability Criteria for Nuclear Power Stations, Regulatory Guide 4.7," United States Nuclear Regulatory Commission, 2023.

[9] U.S. Nuclear Regulatory Commission, "Kairos Power, LLC; Hermes 2; Environmental Assessment, Finding of No Significant Impact, and Exemptions; Federal Register Vol. 89, No. 172 (5 September 2024): 72433-72438.," 2024.

[10] Abilene Christian University (ACU), "Molten Salt Research Reactor (MSRR): Preliminary Safety Analysis Report (PSAR) and Environmental Report - ACU NEXT Laboratory. Submitted to the U.S. Nuclear Regulatory Commission under Docket 50-610," 2022.

[11] Terra innovatum, "Principal Design Criteria for the SOLO Microreactor, ADAMS Accession No. ML25159A013," 2025.

[12] U.S. NUCLEAR REGULATORY COMMISSION, "Regulatort Guide 1.132, Revision 3, Geologic and Geotechnical Site Characterization Investigations for Nuclear Power Plants," 2021.

[13] United States Nuclear Regulatory Commission, "RG 1.165 - IDENTIFICATION AND CHARACTERIZATION OF SEISMIC SOURCES AND DETERMINATION OF SAFE SHUTDOWN EARTHQUAKE GROUND MOTION," U.S. NRC, 1997.

[14] United States Nuclear Regulatory Commission, "RG 1.208 - A PERFORMANCE-BASED APPROACH TO DEFINE THE SITE-SPECIFIC EARTHQUAKE GROUND MOTION," 2007.

[15] U.S. NUCLEAR REGULATORY COMMISSION, "DG-1290 (Proposed Revision 3 of RG 1.59) - DESIGN-BASIS FLOODS FOR NUCLEAR POWER PLANTS," 2022.

[16] United States Nuclear Regulatory Commission, "RG 1.27 - ULTIMATE HEAT SINK FOR NUCLEAR POWER PLANTS," 2015.

[17] National Weather Service / NOAA, "Waterloo Station Climate Normals and Severe Weather Data 1991–2020".

[18] Valmeyer Village Planning Department, "Zoning Map and Land Use Ordinances," 2024.

[19] U.S. Census Bureau, "Valmeyer, IL Profile, 2020 Census & ACS Updates".

[20] T. Freightway, "Rock City - Underground Industrial Complex Pamphlet," 2018. [Online]. Available: https://www.thefreightway.com/wp-content/uploads/2018/07/RockCity-Pamphlet-Web.pdf.

[21] Illinois Department of Transportation, "Kaskaskia Regional Port District Profile, IDOT Marine System Report," 2025.

[22] I.S.G.S. (Illinois State Geological Survey), "Bedrock Geology of the Velmeyer Quadrangle, Monroe County, Illinois," 2019.

[23] "Rock City Website," [Online]. Available: https://www.rockcitydevelopment.com/.

[24] [Online].

[25] FEMA, "FEMA Flood Map Service Center," [Online]. Available: https://msc.fema.gov/portal/home.

[26] ArcGIS, "ESRI Map Viewer," 2025. [Online]. Available: https://www.arcgis.com.

[27] "Monroe County, IL," [Online]. Available: https://monroecountyil.maps.arcgis.com/home/index.html.

[28] Census Reporter, "Valmeyer, IL Profile," [Online]. Available: https://censusreporter.org/profiles/16000US1777265-valmeyer-il/.

[29] "Rock City Site Storage Options," [Online]. Available: https://www.rockcitydevelopment.com/storage-options/future-expansion/.

[30] "Illinois Department of Transportation," [Online]. Available: https://idot.illinois.gov/transportation-system.html.

[31] I.S.C. NOAA, "Waterloo Station Climate Data," [Online]. Available: https://stateclimatologist.web.illinois.edu/data/climate-data/waterloo/.

[32] "NOAA Storm Prediction Center, Severe Weather Climatology," [Online]. Available: https://www.spc.noaa.gov/wcm/#climo.

[33] "USGS Site," [Online]. Available: https://www.usgs.gov/programs/earthquake-hazards.

[34] "Monroe County Zoning Office, Industrial/Commercial Zoning Districts," [Online]. Available: https://monroecountyil.gov/departments/zoning-and-building/.

[35] N.N.W.S - HDSC, "NOAA Atlas 14, Volume 10," [Online]. Available: https://noaa-mirror.org/www.weather.gov/media/owp/oh/hdsc/docs/Atlas14_Volume10.pdf.

[36] I.P.C.B. (PCB), "Geological and Hydrogeological Setting in Southwestern Illinois," 2014. [Online]. Available: https://pcb.illinois.gov/documents/dsweb/GetRendition/Document-13666/html.

[37] I.D of Transportation, "Kaskaskia Regional Port District Profile," [Online]. Available: https://idot.illinois.gov/content/dam/soi/en/web/idot/documents/transportation-system/reports/opp/marine/kaskaskia_regional_port_district_profile.pdf.

[38] I.S.G.S., "Surficial Geology of the Ames and Monro Quadrangles, Illinois," [Online].

[39] I.E.P.A, "Pecatonica River Watershed Final Stage 3 Report," [Online]. Available: https://epa.illinois.gov/content/dam/soi/en/web/epa/topics/water-quality/watershed-management/tmdls/documents/pecatonica-river/final-pecatonica-stage3-08-01-2018.pdf.

[40] I.A.F.S.M., "Recatonica River Flooding - Freeport, Illinois," 2019. [Online]. Available: https://www.illinoisfloods.org/content/documents/5b_-_freeport_pecatonica_flooding_brief.pdf.

[41] First Street, "Valmeyer Flooding Risk," 2025. [Online]. Available: https://firststreet.org/city/valmeyer-il/1777265_fsid/flood.

[42] T. Freightway, "Kaskaskia Regional Port District Profile," [Online]. Available: https://www.thefreightway.com/why-stl-region/kaskaskia-regional-port-district/.

[43] T. Freightway, "Rock City LOIS Fact Sheet," [Online]. Available: https://www.thefreightway.com/wp-content/uploads/2019/01/Rock-City-LOIS-Fact-Sheet.pdf.

[44] NRIC, "NRIC Stand," 2025. [Online]. Available: https://fptz.org/stand/exploration/.

[45] U.S.G.A.O., "National Archives - Valmeyer Sprinkler Incident (GAO-13-668)," [Online]. Available: https://www.gao.gov/assets/gao-13-668.pdf.

[46] M. OneSource, "Scott AFB Overview," [Online]. Available: https://installations.militaryonesource.mil/in-depth-overview/scott-air-force-base.

[47] U.S.C.G., "Sector Upper Mississippi River - Welcome Aboard," [Online]. Available: https://www.atlanticarea.uscg.mil/Our-Organization/District-8/District-Units/Sector-Upper-Mississippi-River/Welcome-Aboard/.

[48] U.S.C. Data, "Waterloo, IL Climate Statistics," [Online]. Available: https://www.usclimatedata.com/climate/waterloo/illinois/united-states/usil1232.

[49] U.S.A.C of Engineers, "Upper Mississippi River Navigation Charts - Introduction," [Online]. Available: https://www.mvr.usace.army.mil/Portals/48/docs/Nav/NavigationCharts/UMR_new/02_Introduction.pdf.