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TABLES

2.0 SITE CHARACTERISTICS

The principle purpose of this chapter of the SHINE Medical Technologies, Inc. (SHINE) construction permit safety evaluation report (SER) is to ensure that the site selection is suitable for constructing and operating the SHINE facility. In siting the SHINE facility, considerations are given such that there are: no geographic and demographic features, operations and potential accidents at nearby manmade facilities that pose significant risks, weather-related events of credible frequency and consequences, credible predicted hydrologic events or conditions, hydrologic events or conditions, or seismic characteristics that would render the site unsuitable for operation or safe shutdown of the SHINE facility, as designed.

This chapter of the SHINE construction permit SER describes the review and evaluation of the U.S. Nuclear Regulatory Commission (NRC) staff (the staff) of the preliminary design of the SHINE irradiation facility (IF) and radioisotope production facility (RPF) site characteristics as presented in Chapter 2, "Site Characteristics," of the SHINE Preliminary Safety Analysis Report (PSAR), as supplemented by the applicant's responses to requests for additional information (RAIs).

SER Chapter 2 provides an evaluation of SHINE's site selection as presented in SHINE PSAR Sections 2.1, "Geography and Demography"; 2.2, "Nearby Industrial, Transportation, and Military Facilities"; 2.3, "Meteorology";," 2.4, "Hydrology"; 2.5, "Geology, Seismology, and Geotechnical Engineering"; and 2.6, "References."

2.1 Areas of Review

SHINE PSAR Sections 2.1 through 2.6 provide the bases for the site selection and describe the applicable site characteristics, including geography, demography, meteorology, hydrology, geology, seismology, and interaction with nearby installations and facilities. The SHINE site comprises two major facilities, the IF and the RPF. Both facilities are collocated on a single site.

The staff reviewed SHINE PSAR Sections 2.1 through 2.6 against applicable regulatory requirements using appropriate regulatory guidance and standards to assess the sufficiency of the site selection for the SHINE facility. As part of this review, the staff reviewed and evaluated descriptions and discussions of SHINE's bases for the site selection.

Areas of review for this section included the following:

- The geography and demography descriptions of the site area and facility location used to assess the acceptability of the SHINE site.
- The description of locations and routes referring to potential external hazards or hazardous materials present or may reasonably be expected to be present during the projected lifetime of the SHINE site.
- The description of averages and extremes of climatic conditions and regional meteorological phenomena that could affect the safe design and siting of the SHINE site.
- The description of the SHINE site and safety-related elevations, structures, and systems from the standpoint of hydrologic considerations and topographic map showing the proposed changes to grading and to natural drainage features.

2.2 Summary of Application

As stated above, the SHINE site comprises two major facilities, the IF and the RPF. Both facilities are collocated on a single site.

The SHINE facility will be located on agricultural property in the City of Janesville, Rock County, Wisconsin. The SHINE site will be located on the south side of the City of Janesville corporate boundaries, and the densely populated parts of the city are more than 1 mile (mi) (1.6 kilometers [km]) to the north. Approximately 3.7 mi (6.0 km) to the south of the SHINE facility is the northern city limits of the City of Beloit, Wisconsin, and approximately 60 mi (96.6 km) east of the SHINE facility is Lake Michigan. The SHINE facility is centered at 42° 37' 26.9" north latitude, and 89° 1' 29.5" west longitude. The City of Janesville is shown in Figure 2.1-1.

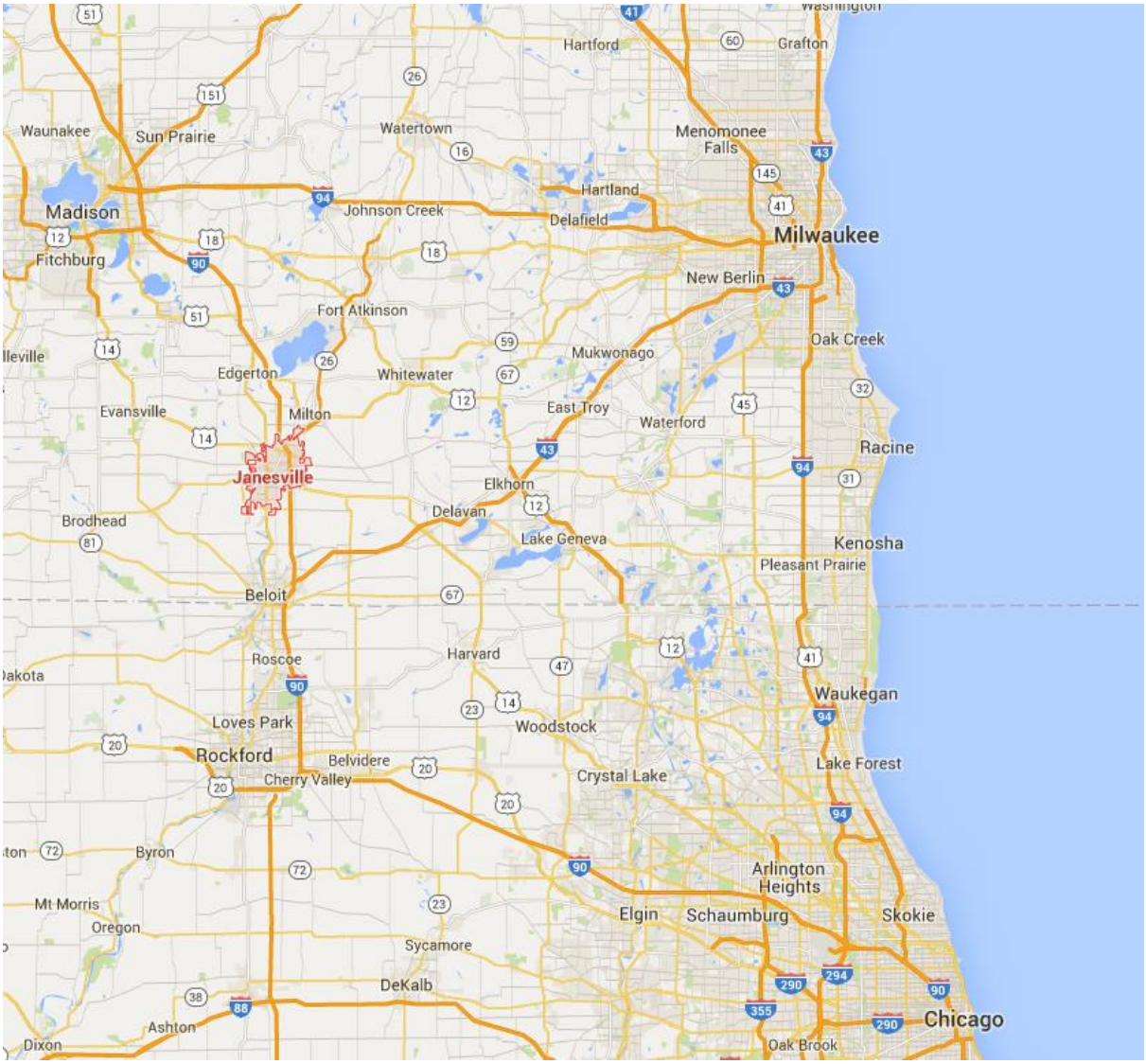


Figure 2.1-1 City of Janesville

The site boundaries encompass approximately 91 acres (36.8 hectares) of land. The finished site grade elevation is approximately 827 feet (ft) (252 meters [m]) per the North American Vertical Datum of 1988. The SHINE facility and adjacent ground within a radius of approximately 1 mi (1.6 km) is generally flat. The area surrounding the site is rural, with most land used for agriculture (about 83 percent of Rock County is farmland). The general site location is shown in Figure 2.1-2.

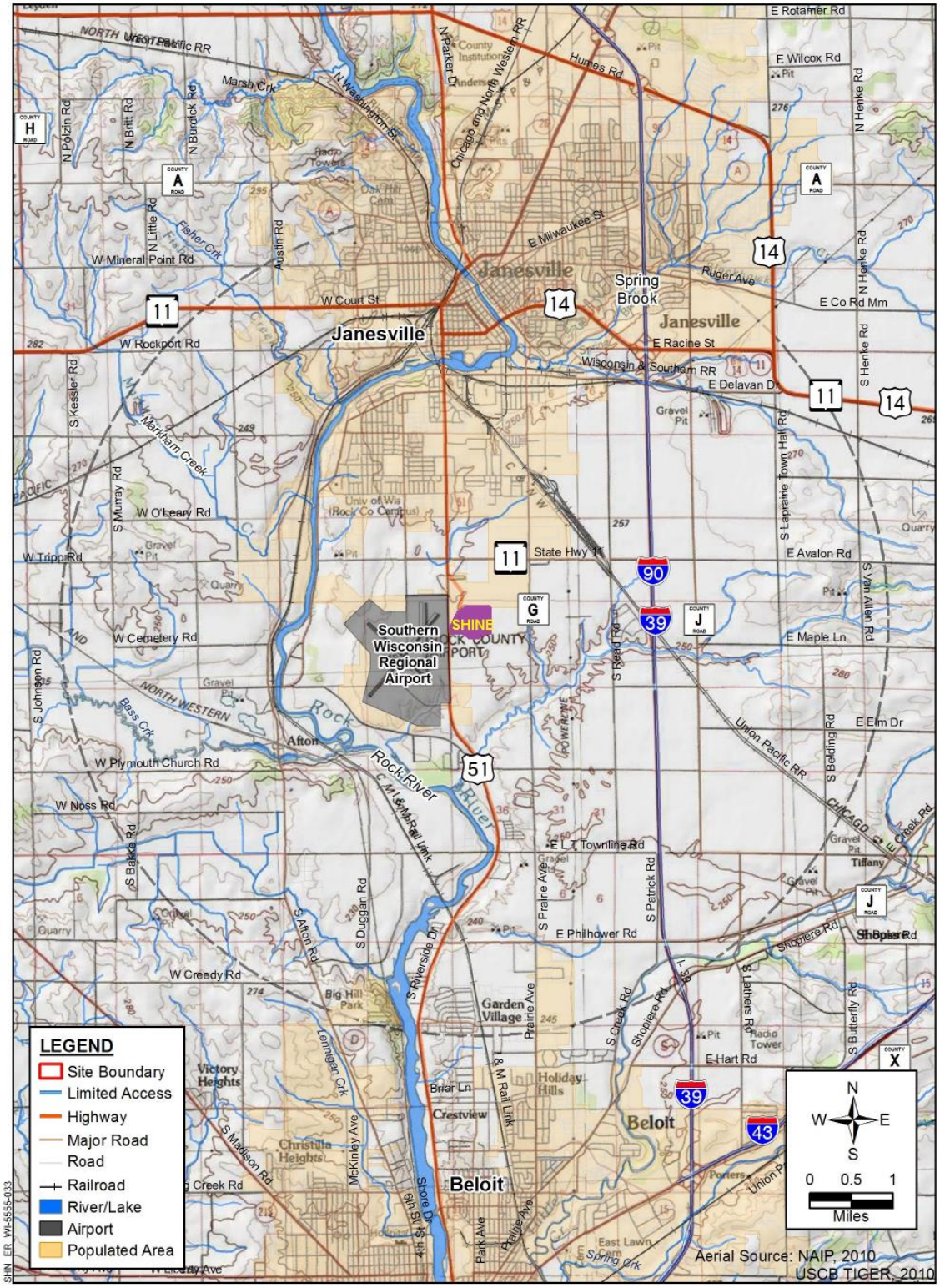
The area within 8 km (5 mi) of the SHINE site supports a population estimated to be about 43,000 people, who mostly live north of the SHINE site in and around the City of Janesville, Wisconsin. Specifically, most of the population is located north-northwest (within 1 km [0.6 mi]) or northwest (1 to 2 km [0.6 to 1.2 mi]) of the SHINE site; while further from the site (4 to 8 km [2.5 to 5 mi]), most of the population is located north of the SHINE site, in and around the City of Janesville.

SHINE estimated the 2050 population surrounding the SHINE site at about 67,000 persons (about a 36-percent increase from the 2010 population), with the largest percentage (at about 70 percent) increases occurring south of the site.

The total 2013 population of the City of Janesville was about 63,600 people, although a portion of that population lives outside of an 8 km (5 mi) radius from the site.

The nearest permanent residence is located approximately 0.80 km (0.50 mi) northwest of the center of the SHINE site. There are permanent residences in two other directions that are only slightly farther away; a house located approximately 0.86 km (0.54 mi) north-northwest of the center point and a house located approximately 0.94 km (0.59 mi) to the south-southwest. In the SHINE PSAR, the joint frequency data indicate that the prevailing wind direction is from the west followed by the south, and that wind is from the north-northeast the least. A resident living downwind of prevailing wind (i.e., east or north of the site) could be most affected by SHINE's operation. The nearest resident in the easterly direction is located 1.2 km (0.73 mi) to the east-northeast, while to the north the nearest resident is also 1.2 km (0.73 mi) from the SHINE site.

In addition to the permanent residents around the SHINE site, there are people who enter this area temporarily for activities such as employment, education, recreation, medical care, and lodging. SHINE estimated a 2010 total transient population of about 27,600 persons. Most of the transient population are either in education (approximately 54 percent) or employment (approximately 36 percent). SHINE also estimated a 2010 total weighted transient population of about 8,100 persons.



Note: North arrow indicates true north.

Figure 2.2-2 SHINE Facility — General Location Map

There are several major industrial and transportation facilities located within 8 km (5 mi) of the SHINE site. These include industrial facilitates, pipelines, highways, railroads, and an airport, which are shown in Figure 2.2-3.

- Industrial Facilities
  - Abitec Corporation
  - Crop Production Services
  - Evonik Goldschmidt Corporation
  - Janesville Jet Center
  - School District of Beloit Turner
  - Seneca Foods Corporation
  - Simmons Manufacturing Co
  - United Parcel Service
- Pipelines
  - Alliant Energy Natural Gas Pipelines
  - ANR Natural Gas Pipeline
- Highways
  - Interstate I-90/39
  - U.S. Highways 14 and 51
  - Wisconsin State Routes 11 and 26
- Railroads
  - Union Pacific Railroad
  - Canadian Pacific Railroad
  - Wisconsin & Southern Railroad
- Airports
  - Southern Wisconsin Regional Airport
  - Mercy Hospital Heliport

There are no major military facilities located within 8 km (5 mi) of the SHINE site, although military aircraft do sometimes utilize the Southern Wisconsin Regional Airport (SWRA).

A small percentage of Rock County is industrial, with the majority of industries in the larger cities of Janesville and Beloit. The only planned industrial growth identified within 8 km (5 mi.) of the SHINE site is expansion of the SWRA. The airport plans to expand runways away from US 51. The airport operations are not expected to grow significantly. The Janesville and Beloit Comprehensive Plans do not provide details of any planned industrial growth.

SHINE PSAR Section 2.2.2, “Air Traffic,” discusses air traffic located within 10 mi (16 km) of the SHINE facility (distance from the center of the SHINE facility to the nearest edge of the airway). SHINE also describes its analysis of aircraft hazards associated with these airways, including approach and holding patterns near its proposed facility. SHINE PSAR Section 2.2.3, “Analysis of Potential Accidents at Facilities,” describes the analysis of postulated accidents and possible effects that could occur at the SHINE facility, including explosions, flammable vapor clouds, toxic chemicals, and fires.

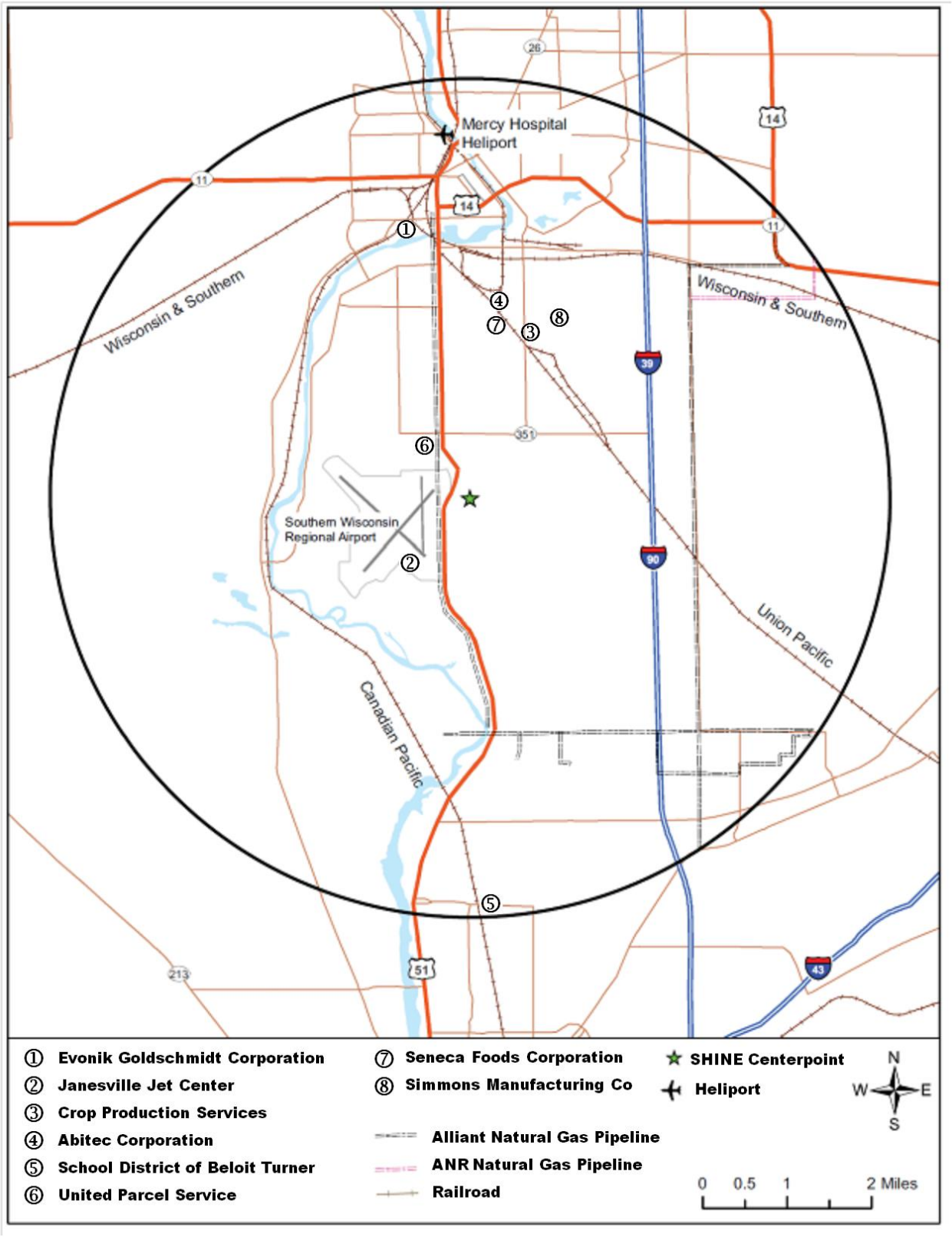


Figure 2.2-3 Nearby Industrial and Transportation Facilities

SHINE PSAR Section 2.3 describes the general and local climate, including historical averages and extremes of climatic conditions and regional metrological phenomena. The SHINE site is located in a region with the Köppen classification “Dfa,” “Daf,” which is a humid continental climate with warm summers, snowy winters, and humid conditions. The climate features a large annual temperature range and frequent short duration temperature changes. Although there are no pronounced dry seasons, most of the annual precipitation falls during the summer. During the autumn, winter, and spring, strong synoptic scale surface cyclones and anticyclones frequently move across the site region. During the summer, synoptic scale cyclones are usually weaker and pass north of the site region. Most air masses that affect the site region are generally of polar origin; however However, air masses occasionally originate from arctic regions, or the Gulf of Mexico. Air masses originating from the Gulf of Mexico generally do not reach the site region during winter months. There are occasional episodes of extreme heat or high humidity in the summer. The windiest months generally occur during the spring and autumn. The annual average number of days with thunderstorms varies from approximately 45 days at the southwest corner of the state of Wisconsin, to approximately 35 days at the northeast corner of the state. Hail is most frequent in the southwestern and west central portions of the state, and is most common during summer months, peaking in late July. Tornadoes are relatively infrequent. Winter storms that affect the region generally follow one of three tracks: Alberta, Panhandle, or Gulf Coast. During an average winter, the ground is covered with snow about 60 percent of the time. In addition, the applicant also discussesdiscussed the potential meteorological effects to the SHINE facility and discusses the dispersion analysis of airborne releases, in both restricted and unrestricted areas, from routine releases during normal operations and from postulated releases resulting from accidents.

SHINE PSAR Section 2.4.1, “Hydrological Description,” identifies the SHINE site surface water, groundwater aquifers, types of on-site groundwater use, sources of recharge, present known withdrawals and likely future withdrawals, flow rates, travel time, gradients, and other properties that affect movement of accidental contaminants in groundwater, groundwater levels beneath the site, seasonal and climatic fluctuations, monitoring and protection requirements, and man-made changes that have the potential to cause long-term changes in local groundwater regime.

In SHINE PSAR Section 2.4.2, “Flood,” the applicant indicates that flooding near the proposed SHINE site is very unlikely to be caused by local intense precipitation or by the Rock River or unnamed tributary overflowing their banks. The applicant describes its analysis of the potential flooding from other natural events, including surges, seiches, tsunami, dam failures, flooding caused by landslides, and effects of ice formation on water bodies. The applicant notes that the Rock River and the unnamed tributary stream are subject to flooding throughout the year. The largest potential for flooding occurs during the spring as a result of precipitation and snow melt. Peak flows occur during the winter and are primarily caused by ice jams.

SHINE PSAR Section 2.5.1, “Regional Geology,” describes the regional geology within about 322 km (200 mi) of the proposed site, including regional physiography and geomorphology; tectonic provinces and structures within the basement rocks; bedrock geology including stratigraphy, lithology, and structure; magnetic and gravity geophysical anomalies; and surficial geology and glacial history. SHINE PSAR Section 2.5.2, “Site Geology,” describes the geology within about 8 km (5 mi) of the proposed site. Specifically, this section describes the stratigraphy and depth to bedrock, structural geology, site soils conditions, and non-seismic geological hazards. SHINE PSAR Section 2.5.3, “Seismicity,” describes the regional geology within about 322 km (200 mi) of the proposed site, including historic earthquakes and felt intensities. SHINE PSAR Section 2.5.4, “Maximum Earthquake Potential,” describes the historical maximum expected moment magnitude from past earthquakes, and frequency of

occurrence. SHINE PSAR Section 2.5.5, "Vibratory Ground Motion," presents an evaluation of the earthquake ground shaking expected at the proposed site. Because most of the regional geological structures are not considered to be seismically capable, the analysis of earthquake ground shaking at the proposed site is based on interpolation of the national seismic hazard model. The development of an earthquake ground motion design response spectrum follows the procedures set out in the structural codes and standards applicable to Wisconsin. SHINE PSAR Section 2.5.6, "Surface Faulting," presents an evaluation of the earthquake ground shaking expected at the proposed site. Because most of the regional geological structures are not considered to be seismically capable, the analysis of earthquake ground shaking at the site is based on interpolation of the national seismic hazard model. The development of an earthquake ground motion design response spectrum follows the procedures set out in the structural codes and standards applicable to Wisconsin. SHINE PSAR Section 2.5.7, "Liquefaction Potential," describes the liquefaction potential within the proposed site.

2.3 Regulatory Basis and Acceptance Criteria

The staff reviewed SHINE PSAR Chapter 2 against applicable regulatory requirements, using appropriate regulatory guidance and standards, to assess the sufficiency of the bases and the information provided by SHINE for the selection of the SHINE site in support of the issuance of a construction permit. In accordance with paragraph (a) of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.35, "Issuance of construction permits," a construction permit authorizing SHINE to proceed with construction may be issued once the following findings have been made:

(1) SHINE has described the proposed design of the facility, including, but not limited to, the principal architectural and engineering criteria for the design, and has identified the major features or components incorporated therein for the protection of the health and safety of the public.

(2) Such further technical or design information as may be required to complete the safety analysis, and which can reasonably be left for later consideration, will be supplied in the final safety analysis report (FSAR).

(3) Safety features or components, if any, which require research and development have been described by SHINE and a research and development program will be conducted that is reasonably designed to resolve any safety questions associated with such features or components.

(4) On the basis of the foregoing, there is reasonable assurance that: (i) such safety questions will be satisfactorily resolved at or before the latest date stated in the application for completion of construction of the proposed facility, and (ii) the proposed facility can be constructed at the proposed location without undue risk to the health and safety of the public.

2.3.1 Applicable Regulatory Requirements

The applicable regulatory requirements for the evaluation of the SHINE site characteristics are as follows:

- 10 CFR 50.34, "Contents of applications; technical information," paragraph (a), "Preliminary safety analysis report."

2.3.2 Regulatory Guidance and Acceptance Criteria

The NRC staff evaluated SHINE's site characteristics against the applicable regulatory requirements listed above, primarily using the guidance and acceptance criteria contained in Chapter 2, "Site Characteristics," of NUREG-1537 Part 1, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Format and Content," issued February 1996 (Reference 4), and NUREG-1537 Part 2, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria," issued February 1996 (Reference 5), as well as the "Final Interim Staff Guidance [ISG] Augmenting NUREG-1537, Part 1, 'Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content,' for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors," dated October 17, 2012 (Reference 6), and "Final Interim Staff Guidance Augmenting NUREG-1537, Part 2, 'Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Standard Review Plan and Acceptance Criteria,' for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors," dated October 17, 2012 (Reference 7).

As appropriate, additional guidance (e.g., NRC regulatory guides, Institute of Electrical and Electronics Engineers [IEEE] standards, American National Standards Institute/American Nuclear Society [ANSI/ANS] standards) has been utilized in the review of SHINE's site characteristics. The use of additional guidance is based on the technical judgment of the reviewer, as well as references in NUREG-1537, Parts 1 and 2; the ISG Augmenting NUREG-1537, Parts 1 and 2; and the SHINE PSAR.

Specific acceptance criteria are provided in the section-by-section technical evaluation in Section 2.4, "Review Procedures and Technical Evaluation," of this SER. Additional guidance documents used to evaluate SHINE's site characteristics are provided as references at the end of this chapter.

2.4 Review Procedures, Technical Evaluation, and Evaluation Findings

SHINE PSAR Chapter 2 discusses the SHINE site characteristics including the geographical, geological, seismological, hydrological, and meteorological characteristics of the site and the vicinity in conjunction with present and projected population distributions, industrial facilities and land use, and site activities and controls. The staff's review of the SHINE site considers the site characteristics as described for use, as well as in the design and analyses associated with the design of structures, systems, and components; radiation protection and program and waste management; and accident analyses.

The staff performed an evaluation of the technical information presented in SHINE PSAR Chapter 2, as supplemented by the applicant's responses to RAIs, to assess the sufficiency of SHINE's site characteristics in support of the issuance of a construction permit, in accordance with 10 CFR 50.35(a). The sufficiency of the SHINE facility's site characteristics are demonstrated by compliance with applicable regulatory requirements, guidance, and acceptance criteria, as discussed in Section 2.3, "Regulatory Basis and Acceptance Criteria," of this SER. The results of this section-by-section technical evaluation are described in SER Section 2.5, "Summary and Conclusions."

2.4.1 Geography and Demography

The staff evaluated the sufficiency of SHINE's site characteristic geography and demography description, as described in SHINE PSAR Section 2.1 using the guidance and acceptance criteria from Section 2.1, "Geography and Demography," of NUREG-1537, Parts 1 and 2, and Section 2.1, "Geography and Demography," of the ISG Augmenting NUREG-1537, Parts 1 and 2.

In accordance with the review procedures of the ISG Augmenting NUREG-1537, Part 2, Section 2.1, the staff compared and verified the SHINE site characteristics geography and demography with the bases for the site selection, as presented in SHINE PSAR Section 2.1.

NUREG-1537, Part 1, Section 2.1, states, in part, that the applicant should provide the descriptions of the site area and facility location" to assess the acceptability of the SHINE site. The applicant should provide the following information: (1) specification of the location with respect to latitude and longitude, political subdivisions, and prominent natural and manmade features of the area; (2) site area map to determine the distance from the facility to the boundary lines of the exclusion area, including consideration of the location, distance, and orientation of plant structures with respect to highways, railroads, and waterways that traverse or lie adjacent to the exclusion area; and (3) a description of population distributions that address population in the site vicinity, including transient populations.

NUREG-1537, Part 1, Section 2.3.2, "Site Meteorology," states that sufficient information should be provided "to support the dispersion analyses of airborne releases from the facility." Also, NUREG-1537, Part 2, Section 2.1, states that the reviewer should determine that "land use in the area of the facility is sufficiently stable or well enough planned that likely potential radiological risks to the public can be analyzed and evaluated with reasonable confidence." Therefore, the staff requested, in RAI 2.1-1 (Reference 14), that the applicant provide a tabulation of the distance from the center of the site and/or the expected airborne release point to the site boundary in each of the 16 compass directions. This information is necessary to determine if land use in the area of the facility is sufficiently stable or well enough planned that likely potential radiological risks to the public can be analyzed and evaluated with reasonable confidence to satisfy the acceptance criteria of the ISG Augmenting NUREG-1537, Parts 1 and 2.

In response to RAI 2.1-1 (Reference 20), SHINE provided the distances from a release point to the site boundary in each of the 16 compass directions. The staff finds the applicant's response satisfies the acceptance criteria of the ISG Augmenting NUREG-1537, Parts 1 and 2.

NUREG-1537, Part 2, Section 2.1, states that the PSAR should contain sufficient demographic information to allow accurate assessments of the potential radiological impact on the public resulting from the siting and operation of the proposed facility. In SHINE PSAR Section 2.1.2.1,

"Resident Population," the applicant provides the distance to the three nearest residence directions in its assessments of potential radiological impact on the public resulting from the siting and operation of the proposed facility. Therefore, in RAI 2.1-2 (Reference 14), the staff requested information regarding the distances to the nearest residences in the remaining 13 directions. In response to RAI 2.1-2 (Reference 20), the applicant provided the approximate distance between the SHINE site center and the nearest residence in each of the 13 remaining compass directions. Based on its review of the distances provided in the SHINE response to RAI 2.1-2 and the PSAR meteorological data, the staff confirmed that the nearest resident in the northwest direction is also the critical resident. The staff finds the applicant's response satisfies the acceptance criteria of the ISG Augmenting NUREG-1537, Part 2.

The staff reviewed the information provided in SHINE PSAR Section 2.1 and concluded that this section of the SHINE PSAR forms the basis for evaluations performed in other chapters. The distance-direction relationships specified in the PSAR to area boundaries, roads, railways, waterways, prevailing winds, and other significant features of the area were independently verified using a third-party-supplied map.

On the basis of its review, the staff finds that the level of detail provided on SHINE's geography and demography demonstrates an adequate design basis and satisfies the applicable acceptance criteria of NUREG-1537, Part 2, Section 2.1, allowing the staff to make the following relevant findings: (1) the information is sufficiently detailed to provide an accurate description of the geography surrounding the facility; (2) the demographic information is sufficient to allow accurate assessments of the potential radiological impact on the public resulting from the siting and operation of the proposed facility; and (3) there is reasonable assurance that no geographic or demographic features render the site unsuitable for operation of the proposed facility.

Therefore, the staff finds that the SHINE facility's geography and demography, as described in SHINE PSAR Section 2.2 and supplemented by the applicant's responses to RAIs, is sufficient and meets the applicable regulatory requirements and guidance in support of the issuance of a construction permit in accordance with 10 CFR 50.35.

2.4.2 Nearby Industrial, Transportation, and Military Facilities

The staff evaluated the sufficiency of the SHINE site characteristics regarding nearby industrial, transportation, and military facility descriptions, as described in SHINE PSAR Section 2.2, using the guidance and acceptance criteria from Section 2.2, "Nearby Industrial, Transportation, and Military Facilities," of NUREG-1537, Parts 1 and 2, and Section 2.2, "Nearby Industrial, Transportation, and Military Facilities," of the ISG Augmenting NUREG-1537, Parts 1 and 2.

In accordance with the review procedures of the ISG Augmenting NUREG-1537, Part 2, Section 2.2, the staff confirmed that any hazards to the SHINE facility posed by normal operation and potential malfunctions and accidents at the nearby manmade stationary facilities and those related to transportation have been described and analyzed to the extent necessary to evaluate the potential radiological risks to the facility staff, the public, and the environment.

The ISG Augmenting NUREG-1537, Part 1, Section 2.2, states, in part, that "the applicant should establish whether the effects of potential accidents in the vicinity of the facility from present and projected industrial, transportation, and military installations and operations should be used in the safety analyses and should establish the facility design parameters related to accidents selected. The applicant should consider all facilities and activities within 8 km of the

facility. Facilities and activities at greater distances should be included as appropriate to their significance of accident impact on the facility."

In SHINE PSAR Section 2.2.1, "Locations and Routes," the applicant provides maps showing locations and distance of nearby industrial facilities, pipelines, waterways, highways, railroads, airports, and airways from the SHINE site. The staff confirmed that any hazards to the facility posed by normal operation and potential malfunctions and accidents at the nearby manmade stationary facilities and those related to transportation have been described and analyzed to the extent necessary to evaluate the potential radiological risks to the facility staff, the public, and the environment.

In SHINE PSAR Section 2.2.2, the applicant describes the air traffic, including airports, airways, and military airports and training, approach and holding patterns near the proposed SHINE site, and the evaluation and result of its analyses of the aircraft hazards associated with this air traffic. In PSAR Section 2.2.2, the applicant also calculated the aircraft crash probabilities due to operations at the SWRA. The staff reviewed and finds acceptable the methodologies utilized by the applicant to calculate air craft accident probabilities. The staff also confirmed the applicant's calculations.

NUREG-1537, Part 2, Section 2.2, states in part, "[t]he reviewer should focus on facilities, activities, and materials that may reasonably be expected to be present during the projected lifetime…" The staff noted that from 2003 to 2012, the Southern Wisconsin AirFest was an activity held at the SWRA. Therefore, in RAI 2.2-2(a) (Reference 14), the staff requested additional information regarding the Southern Wisconsin AirFest.

In response to RAI 2.2-2(a) (Reference 20), SHINE provided an evaluation of the accident probability due to the increased number of takeoffs and landings should the Southern Wisconsin AirFest return to the SWRA. That evaluation showed that the accident probability due to the addition of a future air show at the SWRA is bounded by the current analysis provided in PSAR Section 2.2. RAI 2.2-4(a) requested information regarding a potential accident during an AirFest performance (or rehearsal) would not adversely affect the SHINE facility. In response, SHINE indicated that the site exists entirely within the lateral boundaries of the SWRA Class E airspace, and that 14 CFR 91.303(c) prohibits aerobatic flight in Class E airspace. Furthermore, according to Department of Transportation Order 8900.1, "Flight Standards Information Management System," (Reference 38), in order to not detract from safety or create a hazard to any non-participants or spectators, the location of the SHINE facility would need to be taken into consideration by the Federal Aviation Administration (FAA) when authorizing any future aviation events at the SWRA.,Reference 39) (Reference 40).

In RAI 2.2-2(b), the staff requested that the applicant provide justification for utilizing International Atomic Energy Agency (IAEA)-TECDOC-1347, "Consideration of external events in the design of nuclear facilities other than nuclear power plants, with emphasis on earthquakes" (Reference 41), as opposed to NUREG-0800, "Review of Safety Analysis Reports for Nuclear Power Plants," Section 3.5.1.6 acceptance criteria for aircraft accidents. In its response, the applicant stated that IAEA-TECDOC-1347 applies specifically to nuclear installations that are not nuclear power plants, such as research reactors and facilities for fuel conversion, fabrication and reprocessing. The SHINE facility is not a power reactor, and therefore is considered in the scope of IAEA-TECDOC-1347. The use of the acceptance criteria contained in IAEA-TECDOC-1347 is appropriate for the design of the SHINE facility. RAI 2.2-4(b) requested information to justify use of the IAEA's aircraft accident probability of 10^{-5} yr^{-1}, as opposed to utilizing an

aircraft accident threshold probability of 10^{-6} yr^{-1} as supported by NRC precedent and DOE standards on aircraft crashes (DOE-STD-3014-96).

In response to RAI 2.2-4(b), SHINE provided an updated evaluation of the aircraft hazard using an aircraft accident threshold probability of 10^{-6} per yearReference 39. (Reference 40). The updated evaluation made use of updated aircraft operation data from FAA, which indicated fewer operations than were used in the PSAR evaluation. The total crash probabilities calculated by the updated SHINE evaluation are provided in SER Table 2.2-1.

Table 2.2-1 Total Crash Probability

	Large Non-Military Aircraft	Small Non-Military Aircraft	Military Aircraft
Airport	2.9E-07	2.6E-04	1.5E-07
Airways	1.5E-08	1.9E-06	1.6E-07
Total	3.0E-07	2.6E-04	3.1E-07

As Table 2.2-1 indicates, the calculated crash probability (2.6×10^{-4} yr^{-1}) for small non-military aircraft exceeds the threshold probability of 10^{-6} yr^{-1}, while the combined probability of all other aircraft crashes (6.1×10^{-7} yr^{-1}) does not exceed the threshold probability. Thus, the safety-related structures of the SHINE facility must be designed to withstand the impact of a small non-military aircraft.

The staff finds that the applicant's responses to RAI 2.2-2(a and b) and RAI 2.2-4(a and b) satisfysatisfy the acceptance criteria of the ISG Augmenting NUREG-1537, Part 2, Section 2.2.

In SHINE PSAR Section 2.2.3, the applicant identifies and describes its analysis of potential accidents to be considered as design-basis events and the potential effects of those accidents on the facility, in terms of design parameters (e.g., overpressure, missile energies) or physical phenomena (e.g., impact, flammable or toxic clouds). Design-basis events, internal and external to the SHINE facility, are defined as those accidents that have a probability of radiological release to the public on the order of magnitude of 1E-07 per year, or greater, with the potential consequences serious enough to affect the safety of the facility to the extent that the guidelines in 10 CFR 50.34 could be exceeded. The following accident categories were considered in selecting design-basis events: explosions, flammable vapor clouds (delayed ignition), toxic chemicals, and fires. The staff reviewed and finds acceptable the methodologies utilized by the applicant to calculate the effects of potential accidents involving hazardous materials or activities on site and in the vicinity of the SHINE site. The staff also confirmed the applicant's calculations.

NUREG-1537, Part 2, Section 2.2, states that the information contained in this section should be "complete enough to support evaluations of potential risks posed by these facilities to the safe operation and shutdown of the reactor during its projected lifetime."

SHINE PSAR Section 2.2.3.1.3, "Toxic Chemicals," states, "[t]he control room is not safety-related. The control room operators are not required to operate safety-related equipment to ensure the safety of the public. Therefore, a toxic gas release is not a hazard to the facility." Therefore, in RAIs 2.2-1 and 2.2-3 (Reference 14), the staff requested that SHINE provide a description of why an onsite or offsite toxic gas release during normal operations would not initiate an accident that could endanger the public and/or cause damage to the facility condition, should the control room operators become incapacitated. In response to these RAIs, the

applicant evaluated the potential for an offsite toxic gas release within 55 mi of the site. Both stationary and mobile sources of hazardous chemicals were analyzed. Sources were identified, screened, or evaluated based on Regulatory Guide 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," guidance (Reference 42) and criteria. The evaluation was performed using Version 5.4.4 of the ALOHA (Areal Locations of Hazardous Atmospheres) computer program from the National Oceanic and Atmospheric Administration (Reference 43). In NUREG-1851, "Safety Evaluation Report for the American Centrifuge Plant in Piketon, Ohio," (Reference 44), the staff previously determined that the "ALOHA code is well-known … and acceptable." Approximately 12 different potentially hazardous chemical were evaluated. Of the chemicals evaluated, it was determined that only an ammonia release could have a greater than 10^{-6} per year potential to result in an uninhabitable control room; however, it was also determined that following such an ammonia release, the control room operators would have sufficient time (i.e., at least 22 minutes as per Regulatory Guide 1.78) to take protective measures (e.g., shut down the facility).

The staff finds that the applicant's response to RAI 2.2-1 and RAI 2.2-3 satisfies the acceptance criteria of the ISG Augmenting NUREG-1537, Part 2, Section 2.2.

On the basis of its review, the staff finds that the level of detail and analyses provided in SHINE PSAR Section 2.2 demonstrates an adequate design basis and satisfies the applicable acceptance criteria of NUREG-1537, Part 2, Section 2.2, allowing the staff to make the following relevant findings: (1) the applicant discusses all nearby manmade facilities and activities that could pose a hazard to reactor operations. There is reasonable assurance that normal operations of such facilities would not affect SHINE operations; and (2) the analyses in PSAR Chapter 13, "Accident Analysis," of potential malfunctions or accidents at nearby manmade facilities and consideration of normal activities at those facilities show that safe shutdown would not be prevented, and no undue radiological risk to the public, the environment, or the operating staff is predicted. The potential consequences of these events at nearby facilities are considered or bounded by applicable accidents analyzed in Chapter 13 of SHINE PSAR.

Therefore, the staff finds that the operation of nearby manmade facilities and activities (i.e., industrial, transportation, and military), as described in SHINE PSAR Section 2.2 and supplemented by the applicant's responses to RAIs, is sufficient and meets the applicable regulatory requirements and guidance in support of the issuance of a construction permit in accordance with 10 CFR 50.35.

2.4.3 Meteorology

The staff evaluated the sufficiency of SHINE's site characteristic regarding meteorology, as described in SHINE PSAR Section 2.3 using the guidance and acceptance criteria from Section 2.3, "Meteorology," of NUREG-1537, Parts 1 and 2, and Section 2.3, "Meteorology," of the ISG Augmenting NUREG-1537, Parts 1 and 2.

In accordance with the review procedures of the ISG Augmenting NUREG-1537, Part 2, Section 2.3, the staff verified that sufficient documented and referenced historical information is provided to support the necessary analyses of meteorological effects at the proposed site. The data provided address both short-term conditions applicable to accidental releases of radioactive material and long-term averages applicable to releases during normal reactor operation. The staff also verified that the predicted frequencies of recurrence and intensities of severe weather conditions are documented.

The ISG Augmenting NUREG-1537, Part 1, Section 2.3, states, in part, that "the applicant should describe the meteorology of the site and its surrounding areas. Sufficient data on average and extreme conditions should be included to permit an independent evaluation."

In SHINE PSAR Section 2.3.1, "General and Local Climate," the applicant provides general and local climate analysis, with respect to historical and annual frequencies of severe weather for the proposed site, including the

- identification of region with climate representative of the project site;
- regional data sources;
- identification and selection for analysis of weather monitoring stations located within the site climate region;
- extreme wind;
- tornadoes and waterspouts;
- water equivalent precipitation extremes;
- hail, snowstorms and ice storms, thunderstorms and lightning;
- snowpack and probable maximum precipitation;
- design dry bulb and wet bulb temperatures;
- extreme dry bulb temperatures;
- restrictive dispersion conditions;
- air quality; and
- climate change.

The staff notes that in response to RAI 3.2-1, the applicant explained that the snowpack load data presented in PSAR Sections 2.3.1.2.9, "Snowpack and Probable Maximum Precipitation (PMP)," and 3.2.3, "Snow, Ice, and Rain Loading," are equivalent, since both utilize American Society of Civil Engineers Standard ASCE 7-05, "Minimum Design Loads for Buildings and Other Structures," Figure 7-1. (Note, the SHINE response to RAI 3.2-1 pointed out that PSAR Sections 2.3.1.2.9 and 19.3.2.3.6 each contain an administrative error stating the units for the snowpacks are inches, when in actuality the ASCE 7-05, Figure 7-1 snowpack units are in pounds per square foot (lbs/ft^2). SHINE has initiated an Issue Management Report [IMR] to correct this error. The staff's evaluation of the response to RAI 3.2-1 is in Chapter 3, "Design of Structures, Systems, and Components," of this SER.

In SHINE PSAR Section 2.3.2, "Site Meteorology," the applicant provides its local climate analysis for the dispersion conditions in the vicinity of the proposed site. The applicant provides the meteorological information to be used in Chapters 11 and 13 for both long-term and short-term dispersion calculations. The applicant also provides several alternative sources of meteorological information and plans for access to meteorological information during the proposed license period.

On the basis of its review, the staff finds that the level of detail and analyses provided in SHINE PSAR Section 2.3 demonstrates an adequate design basis and satisfies the applicable acceptance criteria of NUREG-1537, Part 2, Section 2.3, allowing the staff to make the following relevant findings: (1) The meteorological history and projections for the proposed site have been prepared in an acceptable form. These projections have been factored into the choice of facility location and design sufficiently to provide assurance that no weather-related event is likely to cause damage to the facility during its lifetime that could release uncontrolled radioactive material to the unrestricted area; and (2) the meteorological information is sufficient

to support analyses applicable to and commensurate with the risks of the dispersion of airborne releases of radioactive material in the unrestricted environment at the proposed site. The methods and assumptions are applied to releases from both normal operations and postulated accidents at the facility.

Therefore, the staff finds that the general, local, and site meteorology, as described in SHINE PSAR Section 2.3 and supplemented by the applicant's responses to RAIs, is sufficient and meets the applicable regulatory requirements and guidance in support of the issuance of a construction permit in accordance with 10 CFR 50.35.

2.4.4 Hydrology

The staff evaluated the sufficiency of SHINE's site characteristic regarding hydrology, as described in SHINE PSAR Section 2.4 using the guidance and acceptance criteria from Section 2.4, "Hydrology," of NUREG-1537, Parts 1 and 2, and Section 2.4, "Hydrology," of the ISG Augmenting NUREG-1537, Parts 1 and 2.

In accordance with the review procedures of the ISG Augmenting NUREG-1537, Part 2, Section 2.4, the staff verified that the proposed site was selected with due consideration of potential hydrologic events and consequences, including any that could be initiated by either local or distant seismic disturbances. In addition, the staff confirmed that the design bases were incorporated into the facility design to address predicted hydrologic events, accidental release or leakage of primary coolant, and radioactive contamination of ground or surface waters.

The ISG Augmenting NUREG-1537, Part 1, Section 2.4 states, in part, that:

> …the applicant should give sufficient information to allow an independent hydrologic engineering review to be made of all hydrologically related design bases, performance requirements, and bases for operation of structures, systems, and components important to safety. Sufficient information should also be provided about the water table, groundwater, and surface water features at the proposed site to support analyses and evaluations in Chapters 11 and 13 of consequences of uncontrolled release of radioactive material from pool leakage or failure, neutron activation of soils in the vicinity of the proposed [site], or deposition and migration of airborne radioactive material released to the unrestricted area.

In SHINE PSAR Section 2.4, the applicant provides a detailed description of hydrological characteristics for its proposed site, including floods, probable maximum flood on streams and rivers, potential dam failures, probable maximum surge and seiche flooding, probable maximum tsunami hazards, ice effects, cooling water canals and reservoirs, channel diversions, groundwater contamination considerations, and accidental releases of radioactive liquid effluents in ground and surface water.

SHINE PSAR, Section 2.4.11.2, "Pathways," provides a particle flow analysis that only considers advective groundwater flow and predicts groundwater travel times and flow directions. Although the text does mention dispersivity (Section 2.4.11.3), the plume-spreading effects were not considered in the transport analysis. Without an understanding of the potential width of the contaminant plume, however, the analysis is inadequate in providing sufficient information to design a groundwater monitoring network (PSAR Chapter 11) or to evaluate the potential

consequences of uncontrolled releases (PSAR Chapter 13). For instance, the potentiometric surfaces presented in SHINE PSAR Figure 2.4-4, "Simplified Groundwater Table Contours Based on Measured Groundwater Elevations in Monitoring Wells," (Reference 45), suggests that any releases at the facility would flow undetected between Monitoring Wells SG-GW4A and SM-GW2A. Furthermore, the depth to bedrock may be as deep as 300 feet. Therefore, ample information must be presented regarding probable transport depths in order to allow the wells to be screened at the interval(s) most likely to detect potential releases. Therefore, in RAI 2.4-1 (Reference 14), the staff asked that the applicant provide additional information and analysis on the spreading effects and transport depth of the contaminant plume to support the design of the groundwater monitoring network presented in PSAR Chapter 11, and ensure that the requirements of 10 CFR 20.1302(b) have been met.

In response to RAI 2.4-1 (Reference 20), the applicant provided information on the test wells and referred to the preliminary analysis of advective travel times in groundwater, as described in PSAR Section 2.4.11.2 and PSAR Table 2.4-13, "Summary of Parameters Used for Advective Travel Time Estimations." The applicant indicated that there are no plausible liquid release pathways from the facility based on their analysis and, therefore, no liquid monitoring is required to meet the requirements of 10 CFR 20.1302. The applicant further provides that while no requirement for liquid monitoring, groundwater monitoring will be conducted as a voluntary effort by SHINE as part of the Community Environmental Monitoring Program to provide the public greater confidence in the operation of the plant. Additionally, the applicant stated that the requirements of 10 CFR 20.1302 will be met as described in PSAR Section 11.1.7, "Environmental Monitoring." The staff finds that the applicant's response to RAI 2.4-1 provides the requested information and, therefore, is acceptable.
SHINE PSAR Table 2.4-13 (Section 2.4.11.2) presents the results of the travel time analysis. The effective porosity for the expected case is 30 percent. The reference cited in the table for the porosity (Gaffield et al., 2002), indicates that a porosity of 20 percent is most representative of Rock county conditions. A porosity of 20 percent would result in a travel time of 6 years as opposed to 9 years presented in the table.

Therefore, in RAI 2.4-2 (Reference 14), the staff requested clarification regarding the porosity values used in the calculations. In response to RAI 2.4-2 (Reference 21), the applicant stated that the PSAR provides a range of porosity values from 10 percent to 30 percent. The 10 percent porosity value would provide the shortest groundwater travel time, while the 30 percent porosity value would provide the longest groundwater travel time. The applicant used the 10 percent porosity value to calculate the conservative advective travel times provided in PSAR Table 2.4-13. The applicant's response went on to state that, as described in PSAR, Section 2.5.2.3, 20 percent effective porosity is not consistent with SHINE site conditions. Thus, the applicant used 30 percent effective porosity for the expected advective travel time. The staff finds that the applicant's response to RAIThe staff finds the response to RAI 2.4-2 sufficiently clarified the information in PSAR Table 2.4-13 and, therefore, is acceptable.

SHINE PSAR Table 2.4-13 (Section 2.4.11.2) presents the results of the travel time analysis. An arithmetic average of the hydraulic conductivities was used in the expected case calculations. Typically, hydraulic conductivities are represented in a log-normal distribution and geometric means are used to represent typical values. Therefore, in RAI 2.4-3 (Reference 14), the staff asked for clarification regarding how hydraulic conductivity values were used and requested that the applicant provide the Advanced Aquifer Test Analysis Software (AQTESOLV) graphical output for the hydraulic conductivity calculations from the slug tests. In response to RAI 2.4-3, the applicant indicated that since the calculated arithmetic mean of the hydraulic conductivity values was found to be more conservative than the calculated geometric mean of the hydraulic

conductivity values, "SHINE used the arithmetic mean of the hydraulic conductivity values to calculate the expected advective travel times provided in Table 2.4-13." The applicant also clarified that the AQTESOLV graphical outputs for the hydraulic conductivity calculations from on-site slug tests were previously provided to the NRC as Appendix F of the Preliminary Hydrological Analyses for the Janesville, Wisconsin site, provided as Attachment 23 to the SHINE Response to Environmental Requests for Additional Information (Reference 31). The staff finds that the applicant's response to RAI 2.4-3 sufficiently clarified the information in PSAR Table 2.4-13 and, therefore, is acceptable.

SHINE PSAR Section 2.4.11.2 indicates that travel times through the unsaturated zone had not been considered due to the limited information available. An estimation of potential lag times through the unsaturated zone, following a release, is important with respect to evaluating accident scenarios and designing monitoring frequencies and remedial options. Therefore, in RAI 2.4-4 (Reference 14), the staff requested that the applicant provide additional information on the bounding estimates for travel time through the unsaturated zone. In its response (Reference 21), the applicant stated that it determined bounding estimates for travel time through the unsaturated zone, or vadose zone, based on the estimated travel distance (thickness) of the vadose zone and the estimated velocity of groundwater travel through the vadose zone. For vertical flow, the travel distance is calculated as the thickness of the vadose zone (provided in RAI 2.4-4, Table 2.4-4-1). The applicant used a representative vadose zone thickness of 50 feet (15 meters). A lower bound vadose zone thickness was estimated as 44 ft. (13 m), while an upper bound vadose zone thickness was estimated as 71 feet (21 meters). Bounding estimates for travel time through the vadose zone are provided in the response to RAI 2.4-4, Table 2.4-4-2. The staff finds that the applicant's response to RAI 2.4-4 provides the requested information and, therefore, is acceptable.

NUREG-1537, Part 1, Chapter 2 states, in part, "the applicant should discuss and describe the …hydrological… characteristics of the site and vicinity in conjunction with present and projected population distributions, industrial facilities and land use, and site activities and controls." SHINE PSAR Section 2.4.1.2, "General Setting – Groundwater," mentions that there are irrigation wells operated on properties in the vicinity that have the potential to influence groundwater levels. These irrigation wells could also act as pathways for bringing any groundwater contamination released by the facility to the surface. The pumping of irrigation wells can also have a significant effect on groundwater flow directions.

Therefore, in RAI 2.4-5 (Reference 14), the staff requested that SHINE provide additional information on irrigation well location(s) and its construction and operating parameters. In response to RAI 2.4-5 (Reference 21), the applicant provided a list of well construction reports and groundwater flow direction for both pumped and non-pumped conditions. Consequently, it is not anticipated that withdrawals from wells within an 8-km (5-mi) radius would change the flow direction of groundwater on the proposed SHINE site. The applicant determined the well with the lowest pumping head closest to the proposed site. The applicant calculated the advective travel times for this well to be 0.1 years (expected permeability and porosity assumptions) and 0.01 years (conservative permeability and porosity assumptions).

On the basis of its review, the staff finds that the level of detail and analyses provided in SHINE PSAR Section 2.4 demonstrates an adequate design basis and satisfies the applicable acceptance criteria of NUREG-1537, Part 2, Section 2.4, allowing the staff to make the following relevant findings:

(1) the applicant considered hydrologic events of credible frequency and consequence in selecting the facility site. The site is not located where catastrophic hydrologic events are credible;

(2) the applicant considered credible hydrologic events in developing the design bases for the facility, to mitigate or avoid significant damage so that safe operation and shutdown of the facility would not be precluded by a hydrologic event;

(3) the applicant selected combinations of site characteristics and facility design bases to provide reasonable assurance that uncontrolled release of radioactive material in the event of a credible hydrologic occurrence would be bounded by accidents analyzed in PSAR Chapter 13; and

(4) the facility design bases give reasonable assurance that contamination of ground and surface waters at the site from inadvertent release or leakage of primary coolant, neutron activation, or airborne releases would not exceed applicable limits of 10 CFR Part 20, "Standards for Protection Against Radiation."

Therefore, the staff finds that the general, local, and site hydrology as described in SHINE PSAR Section 2.4, and supplemented by the applicant's responses to RAIs, is sufficient and meets the applicable regulatory requirements and guidance in support of the issuance of a construction permit in accordance with 10 CFR 50.35.

2.4.5 Geology, Seismology, and Geotechnical Engineering

The staff evaluated the sufficiency of SHINE's geology, seismology, and geotechnical characteristics for its proposed site, as described in SHINE PSAR Section 2.5 using the guidance and acceptance criteria from Section 2.5, "Geology, Seismology, and Geotechnical Engineering," of NUREG-1537, Parts 1 and 2, and Section 2.5, "Geology, Seismology, and Geotechnical Engineering," of the ISG Augmenting NUREG-1537, Parts 1 and 2.

In accordance with the review procedures of the ISG Augmenting NUREG-1537, Part 2, Section 2.5, the staff confirmed that the information presented in the SHINE PSAR was obtained from sources of adequate credibility and is consistent with other available data, such as data from the U.S.United States Geological Survey (USGS) or in the FSAR of a nearby nuclear power plant. There is reasonable assurance that the seismic characteristics of the site are considered in the design bases of structures, systems, and other facility features discussed in PSAR Chapter 3, "Design of Structures, Systems, and Components."

The ISG Augmenting NUREG-1537, Part 1, Section 2.5 states, in part, that the applicant should detailing the seismic and geologic characteristics of the [proposed] site and the region surrounding the site. The degree of detail and extent of the considerations should be commensurate with the potential consequences of seismological disturbance, both to the … facility and to the public from radioactive releases."

In SHINE PSAR Section 2.5, the applicant providesprovided descriptions on the regional geologic features, the site-specific geologic features, the historical seismic information, the maximum earthquake potential, how vibratory ground motion was addressed, the surface faults

in the region, and the liquefaction potential in a form to be integrated acceptably into design bases for structures, systems, and operating characteristics of the proposed facility.

SHINE PSAR Section 2.5.1.4, "Structural Geology," provides a discussion of the major faults and folds and concludes that many of the faults are not capable of generating large earthquakes based on lack of evidence for Pleistocene or post-Pleistocene displacement. As noted in SHINE PSAR Section 2.5.1, "10 CFR Part 100, "Reactor Site Criteria," Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," defines a capable fault as a fault with "[m]ovement at or near the ground surface at least once within the past 35,000 years or movement of a recurring nature within the past 500,000 years." Therefore, in RAI 2.5-1 (Reference 14), the staff requested that the applicant provide additional information explaining the basis for the determination that there are no capable faults, and provide additional information with respect to the recurring nature of the faults. In response to RAI 2.5-1 (Reference 21), the applicant clarified the determination that, with the exception of the Wabash Valley features, the faults within 322 km (200 mi) show no evidence of being capable faults and provided published scientific information to justify this claim. The staff finds that the applicant's response to RAI 2.5-1 provides the information requested and, therefore, is acceptable.

SHINE PSAR, Section 2.5.1.4.6, "Saint Charles Lineament (SCL)," states, in part, "[s]ince 1974, seven earthquakes of magnitude 2.5 or less have been recorded in regions surrounding the SCL." Information pertaining to these earthquakes is not provided in the summary tables. Therefore, in RAI 2.5-2, (Reference 14), the staff requested that the applicant provide additional information regarding seven earthquakes that occurred near the Saint Charles Lineament SCL. In response to RAI 2.5-2, the applicant stated that none of these seven earthquakes are listed in the composite earthquake catalog developed for the Central and Eastern United States Seismic Source Characterization for Nuclear Facilities (CEUS-SSC) Project (NRC 2012). Since the seven earthquakes are not in the CEUS-SSC catalog, the applicant considered them not of a large enough magnitude or well enough located to indicate neotectonic activity along the SCL. Additionally, the applicant determined, based on a re-evaluation, thatIn response to RAI 2.5-2 (Reference 21), the applicant determined, based on a re-evaluation, the seven referenced earthquakes do not suggest ongoing activity on the SCL, and should not be listed in PSAR Table 2.5-1, "Historic Earthquake Epicenters Located Within Approximately 200 Miles (322 km) of the SHINE Site." Additionally, because there is no evidence that any of these earthquakes were felt, SHINE did not include them in PSAR Table 2.5-3, "Recorded Earthquake Intensities (Modified Mercalli Intensity – MMI) for Earthquakes Within Approximately 200 Miles (322 km) of the SHINE Site." The staff finds that the applicant's response to RAI 2.5-2 provided the requested additional information and, therefore, is acceptable.

SHINE PSAR Section 2.5.2.2, "Structural Geology," states, in part, "[d]espite the presence of the Arch, cross sections from Mudrey et al. (1982), suggest that the Cambrian and Ordovician sedimentary rock units beneath the SHINE site probably have very shallow to horizontal dips. These observations indicate little or no net deformation beneath the SHINE site over about the last 500 million years." An NRC staff review of the Bedrock Geology of Wisconsin, map referenced in the PSAR (Mudrey et al., 1982), failed to locate the cross-sections being referenced in the text. Therefore, in RAI 2.5-3 (Reference 14), the staff requested additional information on the cross sections associated with Bedrock Geology of Wisconsin in a referenced document in SHINE PSAR Section 2.5.2.2. In its response (Reference 20), the applicant provided the web link referenced in the document (see Reference 46). The staff finds that the applicant's response to RAI 2.5-3 provided a sufficient reference to the requested document and, therefore, is acceptable.

SHINE PSAR Section 2.5.3.1, "Historic Earthquakes," provides a list of databases and references that were used to identify historic earthquakes at the location of the SHINE facility. The most recent historic earthquake located within approximately 200 mi of the SHINE site was in 1985 (PSAR Table 2.5-1, page 2.5-26). Another database that includes six more recent earthquakes is compiled by the USGS at http://earthquake.usgs.gov/earthquakes. Therefore, in RAI 2.5-4 (Reference 14), the staff requested that the applicant provide additional information justifying the exclusion of the earthquake information compiled by the USGS from analysis in the PSAR, or provide a reanalysis that takes this information into consideration in the PSAR. In response to RAI 2.5-4 (Reference 21), the applicant stated that it relied on the analysis of earthquake records used to create the comprehensive earthquake catalog for the CEUS-SSC project. Therefore, while the USGS-hosted database includes six post-1985 earthquake epicenters, SHINE included only those earthquakes that have passed the robust screening process used to prepare the CEUS-SSC catalog in PSAR Table 2.5-1. The staff finds that the applicant's response to RAI 2.5-4 provided a sufficient response and, therefore, is acceptable.

NUREG-1537, Part 1, Section 2.5.1, "Regional Geology," states, in part, "[t]he applicant should discuss all geologic and seismic hazards within the region that could affect the facility…." SHINE PSAR Section 2.5.2.4, "Non-Seismic Geological Hazards," states in part, "Rock County contains carbonate bedrock susceptible to dissolution or karst formation (WGNHS, 2009). The Rock County Hazard Mitigation Plan (Vierbicher, 2010) indicates that no significant sinkholes have been reported in Rock County in recent years. The plan indicates a potential for karst features to form in the county, particularly in the eastern third of the county that lies to the east of the SHINE site." Therefore, in RAI 2.5-5, the NRC staff requested that the applicant provide additional information regarding regional magnetic and gravity geophysical anomalies to include an evaluation of potential karst features at the SHINE site. In response to RAI 2.5-5 (Reference 21), the applicant provided two figures which provide details of the composite aeromagnetic and Bouguer gravity anomalies in southern Wisconsin. The applicant stated that from these figures, the available regional magnetic and Bouguer gravity anomalies in southern Wisconsin are suitable only for identifying the major regional fault structures with large vertical separations. Regarding sink holes, the applicant stated that small sinkholes in parts of Rock County have been reported but not at the proposed site. Because of the near-surface geology, the applicant stated that it is very unlikely that a sinkhole would form near the SHINE site. The SHINE site has little topographic relief and lacks any geomorphic evidence of differential subsidence that may indicate past or ongoing solution of any subsurface carbonate rocks and formation of karst features. The staff finds the applicant's response to RAI 2.5-5 iesto be sufficient and, therefore, is acceptable.

NUREG-1537, Part 1, Section 2.5.7, "Liquefaction Potential," states that the applicant should discuss soil structure. SHINE PSAR Section 2.5.7.1, "Site Soil Conditions," states that geotechnical engineering field investigations were conducted that included standard penetrometer test (SPT) blow counts (N-values) measured in 14 boreholes. However, details and an explanation were not given about how and whether these investigations were used to develop the soil parameters (engineering properties) listed in SHINE PSAR, Chapter 3 (Section 3.4.2.6.3.1). Therefore, in RAI 2.5-6, the staff requested that the applicant provide a report with details and results from the geotechnical investigations. In response, the applicant stated that the Preliminary Geotechnical Engineering Report for the SHINE site was previously provided to the NRC as Attachment 26 to the SHINE Response to Environmental RAI. The applicant went on to state that soil parameters in FSAR Section 3.4.2.6.3.1 will be revised to more accurately reflect the results documented in the Preliminary Geotechnical Engineering Report, and that an IMR has been initiated to track this revision. The staff finds the applicant's response to RAI 2.5-6 to be sufficient, will result in an FSAR that more accurately

and consistently reflects the Preliminary Geotechnical Engineering Report and, therefore, is acceptable.

On the basis of its review, the staff finds that the level of detail and analyses provided in SHINE PSAR Section 2.5 demonstrates an adequate design basis and satisfies the applicable acceptance criteria of NUREG-1537, Part 2, Section 2.5, allowing the staff to make the following relevant findings:

(1) the information on the geologic features and the potential seismic activity at the site has been provided in sufficient detail and in a form to be integrated acceptably into the design bases for structures, systems, and operating characteristics of the facility;

(2) the information in the PSAR indicates that damaging seismic activity at the proposed site during its projected lifetime is very unlikely. Furthermore, if seismic activity were to occur, any radiologic consequences are bounded or analyzed in PSAR Chapter 13; and

(3) the PSAR shows that there is no significant likelihood that the public would be subject to undue radiological risk following seismic activity, therefore, the site is not unsuitable for the proposed facility because of potential earthquakes.

Therefore, the staff finds that the geology, seismology, and geotechnical characteristics as described in SHINE PSAR Section 2.5, and supplemented by the applicant's responses to RAIs, is sufficient and meets the applicable regulatory requirements and guidance in support of the issuance of a construction permit in accordance with 10 CFR 50.35.

2.5 Summary and Conclusions

The staff evaluated the descriptions and discussions of the SHINE facility site characteristics, as described in Chapter 2 of the SHINE PSAR and supplemented by the applicant's responses to RAIs, and finds that the SHINE facility site characteristics: (1) provide reasonable assurance that the final design will conform to the design basis, and (2) meet all applicable regulatory requirements and acceptance criteria in NUREG-1537 and the ISG Augmenting NUREG-1537. Based on these findings, the staff has made the following conclusions to support the issuance of a construction permit in accordance with 10 CFR 50.35:

(1) SHINE has described the proposed design of the facility, including, but not limited to, the principal architectural and engineering criteria for the design, and has identified the major features or components incorporated therein for the protection of the health and safety of the public.

(2) Such further technical or design information as may be required to complete the safety analysis, and which can reasonably be left for later consideration, will be supplied in the FSAR.

(3) Safety features or components, if any, which require research and development have been described by SHINE and a research and development program will be conducted that is reasonably designed to resolve any safety questions associated with such features or components.

(4) On the basis of the foregoing, there is reasonable assurance that: (i) such safety questions will be satisfactorily resolved at or before the latest date stated in the application for completion of construction of the proposed facility, and (ii) the proposed facility can be constructed at the proposed location without undue risk to the health and safety of the public.