Lerch, Robert

From: DOTSON, BARBARA E [bdotson@entergy.com]
Sent: Wednesday, April 28, 2010 11:59 AM
To: Cassidy, John
Cc: ANDREWS, STEVEN M; Shewmaker, Todd E
Subject: GZA 2007 Report
Attachments: GZA hydrogeo rpt 2007.pdf

John,

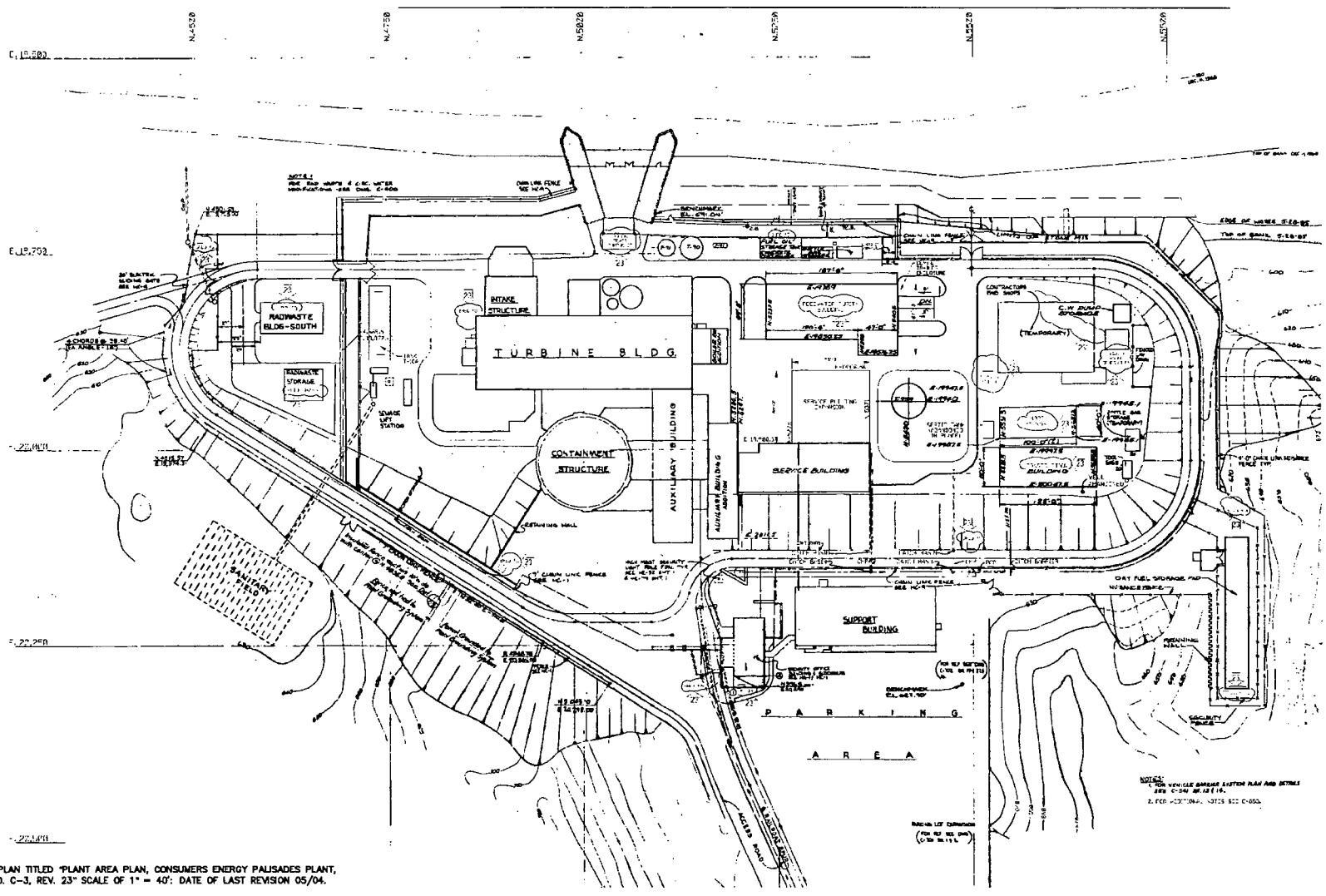
The report you requested is attached. Per our discussion, please note that the report is marked Privileged and Confidential, so please destroy/delete accordingly when you are finished with your review. The figures are being sent by separate email.

Thanks,

Barb

<<GZA hydrogeo rpt 2007.pdf>>

T-6



NOTES:

1. BASED ON PLAN TITLED "PLANT AREA PLAN, CONSUMERS ENERGY PALISADES PLANT, DRAWING NO. C-3, REV. 23" SCALE OF 1" = 40'; DATE OF LAST REVISION 05/04.

REV. NO.	DESCRIPTION	BY	DATE

SCALE 1" = 60'

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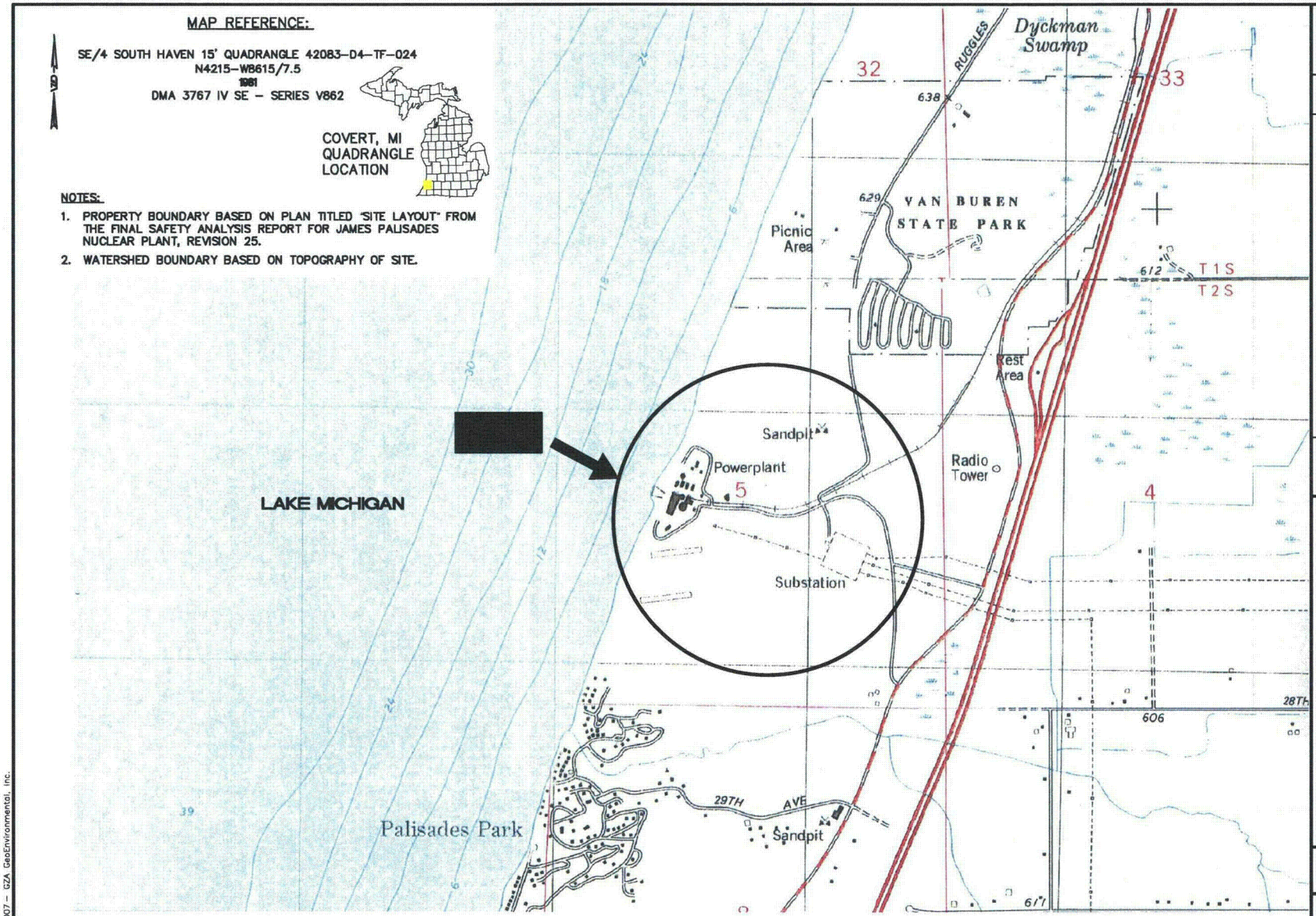
PROJ MGR: LMH
DESIGNED BY: LMH
REVIEWED BY: MAS
OPERATOR: BAC/MS
DATE: AUG. 2007

GROUNDWATER PROTECTION INITIATIVE
ENTERGY NUCLEAR GENERATION COMPANY
PALISADES NUCLEAR POWER PLANT
COVERT, MICHIGAN

SITE PLAN

PROJECT NO.
14.0079316.00

FIGURE NO.
3



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APPROXIMATE
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0 600' 1,200' 2,400'

PROJ MGR: LMN
DESIGNED BY: LMN
REVIEWED BY: MMS

OPERATOR: BJC
CHECKER: JMW
DATE: AUG 2007

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GROUNDWATER PROTECTION INITATIVE
ENTERGY NUCLEAR GENERATION COMPANY
PALISADES NUCLEAR POWER PLANT - COVERT, MICHIGAN

LOCUS PLAN

PROJECT NO.
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FIGURE NO.
1

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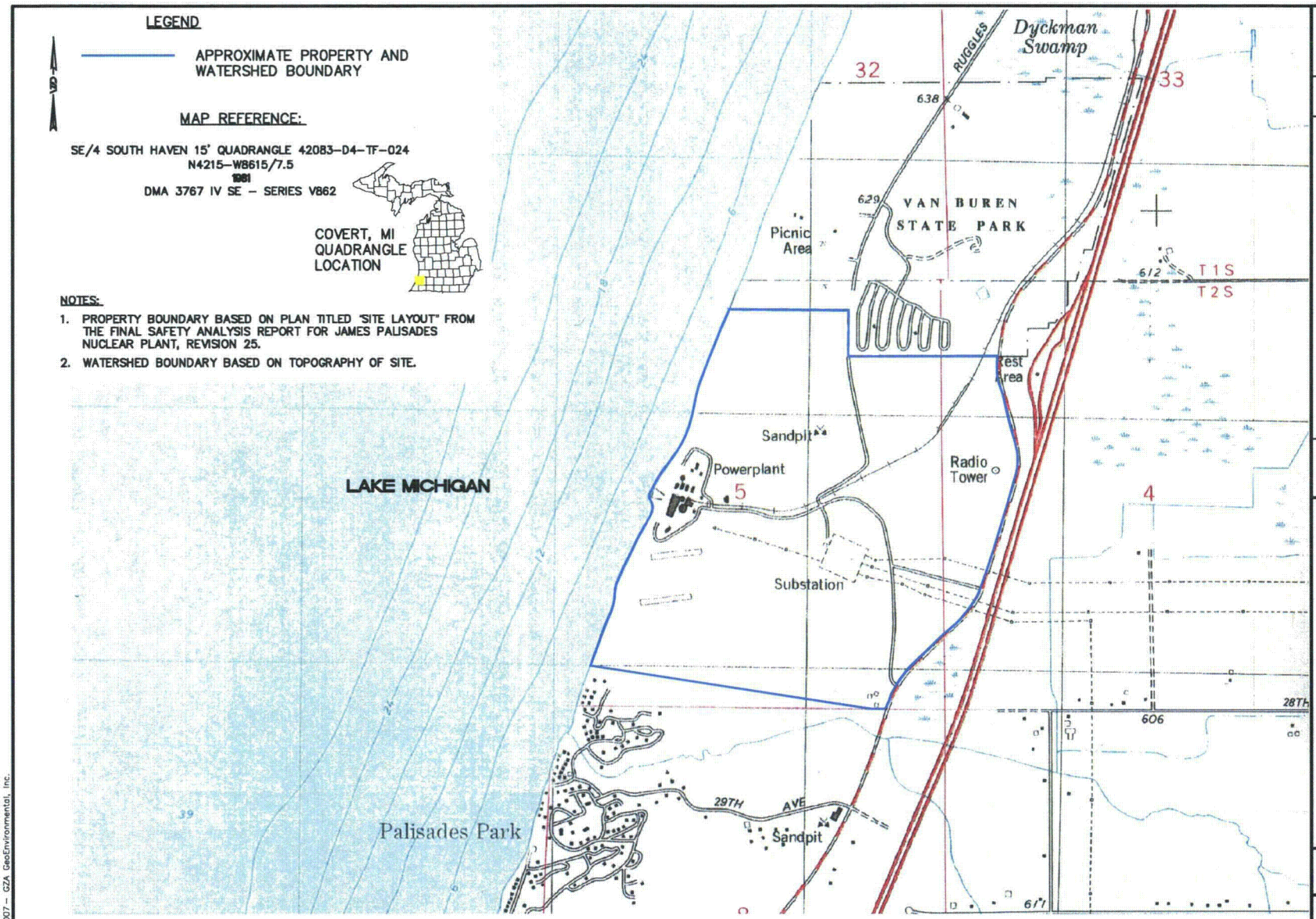

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REVIEWED BY: MMS

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DATE: AUG 2007

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WATERSHED PLAN

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FIGURE NO.
2

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~~Privileged and Confidential Work Product~~

SITE HYDROGEOLOGIC ASSESSMENT IN SUPPORT OF ENTERGY GPI PALISADES NUCLEAR PLANT COVERT, MICHIGAN

PREPARED FOR:
Entergy: Palisades Nuclear Plant
Covert, Michigan

PREPARED BY:
GZA GeoEnvironmental, Inc.
One Edgewater Drive
Norwood, Massachusetts

August 28, 2007
File No. 14.0079316.00

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1.0 EXECUTIVE SUMMARY

This report presents the results of an initial phase of voluntary hydrogeologic investigations underway at the Palisades Nuclear Power Plant (PNP) located in Covert Township, Michigan (the "Site" or "Facility[1]"). The report was prepared for Entergy by GZA GeoEnvironmental Inc. (GZA).

1.1 PROJECT OBJECTIVES

The objectives of this initial phase of study were to:

1. Complete a review of the Facility's own assessment of the systems that are, or could be, impacted with radionuclides, and identify historical events and potential pathways to ground, and thus possibly to groundwater;
2. Complete a hydrogeologic review, characterizing probable groundwater flow patterns and the general hydrogeologic setting in the vicinity of the property;
3. Complete a review of available information concerning known groundwater and surface water uses in the area of the Facility;
4. Identify apparent data gaps in the engineering and hydrogeologic assessments that could impact the design of an appropriate groundwater monitoring program; and,
5. Identify appropriate action items and/or field activities (i.e., options) to address the data gaps and to advance the Facility's groundwater monitoring capabilities, as appropriate. Provide the general location, depth and construction of any proposed wells that may be included as options.

1.2 RESULTS

Based on the activities conducted as part of this initial hydrogeologic assessment, we present the following results:

Systems Review and Pathway Identification: GZA reviewed Entergy's assessment of the various plant systems relative to their potential to release tritium or other radioactive isotopes to the environment (See Table 1). Of the 56 systems identified, 16 have direct pathways to groundwater and 9 have secondary pathways to groundwater. There is one system identified as a monitored (licensed) environmental release point for discharging potentially radioactive liquids from PNP. Outfall 001 is the shoreline discharge structure that is a National Pollutant Discharge Elimination System (NPDES) permitted outfall. This system has calibrated radiation monitoring equipment which continuously monitors the liquids being released. In addition, historical events were identified with potential pathways to groundwater. The systems that have direct or secondary pathways, and the historic events that have direct or potential pathways, are generally located on the south and west sides of the Turbine, Feedwater Purity, and Auxiliary buildings and extending west to Lake Michigan. Additional information is presented in Section 3.0.

[1] The term "Facility" is not being used to reflect the Site status pertaining to the Michigan Department of Environmental Quality Part 201 regulations.

Hydrogeologic Review: Groundwater below the Site is in a regional overburden aquifer first encountered about 7 feet below ground surface (bgs) near the lake to 110 feet bgs on the east side of the property. The primary stratigraphic unit for groundwater transport below the Site consists of dune sands generally located from the ground surface to as deep as 220 ft bgs. Flow direction in the regional groundwater flow system is generally toward the west, with eventual discharge to the Lake Michigan. Additional information is presented in Section 4.0.

Regionally, groundwater flow appears to be generally to the west, toward Lake Michigan. During our review, at least 99 borings and/or monitoring wells were identified as existing or previously existing across the Site. Borings logs were available for 29 of the borings and monitoring wells.

Water Users: According to the PNP Final Safety Analysis Report (FSAR), the nearest drinking water wells are located at least ½ mile east of the Site. Well logs were identified for 182 water supply wells located in Covert Township. PNP gets potable water from the South Haven Municipal Water Authority (SHMWA), located 5 miles north. SHMWA obtains it's water supply from Lake Michigan. PNP gets water for the cooling system from an intake in Lake Michigan. The only reported on-Site groundwater use is from 3 wells used for grounds maintenance. No drinking water wells (private or public) were identified in the presumed downgradient direction.

Data Gaps: Primary data gaps identified during the course of this assessment include: 1) supplemental engineering and systems document review; 2) the construction and usability of existing monitoring wells and supply wells; 3) the impact of foundations or utility-related features and their associated backfill material on local groundwater flow; and, 4) a more complete understanding of current groundwater flow conditions including groundwater velocity and interface with Lake Michigan. A detailed list of data gaps is presented in Section 5.0 and Table 3.

Options to Address Data Gaps and Enhance Our Hydrogeologic Understanding: Options have been identified to address each of the data gaps noted above. Options are presented to provide a basis for further discussion of future Site investigation and are not intended as an exclusive list or as a set of required actions. Among the options presented are: (1) additional engineering and system document review to adequately identify, locate and characterize subsurface site features; (2) the completion of a monitoring well and supply well inventory to assess the status of the wells for use to monitor groundwater at the Site; and, (3) the installation of 5 new monitoring wells along the downgradient property boundary and 5 piezometers at up-gradient and side-gradient locations from the power generating facilities to improve our understanding of groundwater flow across the Site and obtain groundwater samples for water-quality testing. Additional discussion is presented in Section 6.0.

1.3 LIMITATIONS

This executive summary provides a brief overview of our study. Our conclusions were based on information described in subsequent sections of the report. It is important to read the report in its entirety, including the report limitations discussed in Appendix A, to understand how we reached the opinions expressed in this report.

1.4 ACRONYMS

The acronyms used in this report are as follows.

bgs - below ground surface
CLB - Current Licensing Basis
cm/sec - centimeters per second
EIS - Environmental Impact Statement
FSAR - Final Safety Analysis Report
ft/yr - feet per year
gpd - gallons per day
gpm - gallons per minute
PNP - Palisades Nuclear Plant
mgd - million gallons per day
msl - mean sea level
MWe - megawatts electrical
MWt - megawatts thermal
NPDES - National Pollutant Discharge Elimination System
NRC - Nuclear Regulatory Commission
pCi/L - picocuries per liter
SHMWA - South Haven Municipal Water Authority
USGS - United States Geological Survey

2.0 SCOPE OF WORK

The Scope of Work proposed and executed to address the above objectives included the following major tasks:

Task 1 - Request for Information: This task involved the identification and acquisition of relevant information (i.e., documents, figures, etc.) from Entergy.

Task 2 - Operational Engineering Review: This task involved a review of the Facility's own assessment of plant systems and components (to identify which systems were impacted or potentially could be impacted with radionuclides), historical release files (10CFR 50.75g), and other select relevant documents, and the identification of potential pathways to ground (if apparent) associated with these plant systems and historical release events.

Task 3 - Review of Site Geology and Hydrogeology: This task involved a review of available Site documents related to regional and/or Site-specific geology and hydrogeology. This task included an assessment of local groundwater flow patterns and hydraulic properties, groundwater and surface water uses in the watershed around the plant and potential anthropogenic factors affecting groundwater flow in the plant area. The primary source document for this review was Chapter 2 of the FSAR.

Task 4 - Project Review Meeting and Site Reconnaissance: This task involved a one-day Site visit to review the project objectives and expectations with Site personnel, discuss the availability of additional relevant data that may be locally available, and

observe the physical plant setting, the surrounding area, and relevant plant systems. This task is not specifically documented within this report, but the findings have been incorporated in the various sections as warranted and appropriate. Select photographs are included in Appendix B.

Task 5 - Identification of Data Gaps and Evaluation of Initial Monitoring Well Locations: This task involved the identification of data gaps and potential options for addressing them and the need for and general location, depth, and construction of any initial proposed monitoring wells included within the options.

Task 6 - Summary Report: Following completion of the above tasks, a summary report was to be prepared documenting the work.

2.1 SOURCE DOCUMENTS

A summary of the various documents acquired and reviewed during the course of this effort is presented in Appendix C. Key documents included:

- Final Safety Assessment Report (FSAR) Chapter 2
- Generic Environmental Impact Statement for PNP
- Site-Specific System/Component Assessment
- 10CFR 50.75(g) File
- Select Site Figures and Plans
- Select Available USGS Information for the Site Area

3.0 OPERATIONAL ENGINEERING REVIEW

The following section represents a review of Entergy's prepared evaluations including plant systems and component analysis. Within this report, the terms "impact" and "impacted" are used to refer to systems, structures or components which reportedly or likely contain water with radionuclides. These may be known and monitored conditions, and this designation does not mean that a release to ground or to groundwater has occurred.

Entergy (Eric Dehn) focused on whether systems and components may have the potential to contain radioactive material, and whether direct and/or secondary pathways to ground existed for each system/component. Historical release data from available 10CFR 50.75(g) file information related to the identification of historical releases and potential pathways was similarly reviewed by GZA and is also included in this section.

3.1 GENERIC PLANT DESCRIPTION

Palisades Nuclear Plant consists of approximately 432 acres and is located in Van Buren County in southwestern Michigan at the approximate location shown on Figure No. 1. The plant is located on the east side of Lake Michigan about 40 miles west of Kalamazoo, 4.5 miles south of the town of South Haven and 45 miles north of South Bend, Indiana. Van Buren State Park borders the north side of the Site, and Covert Park is located approximately 1.5 miles south-southwest of the Site. Blue Star Highway borders the Site to the East. The rated gross electric

output of the Facility is approximately 786 MWe when operating at approximately 2,565 MWt. PNP commenced commercial operation in 1971.

The Site consists primarily of heavily wooded, rugged sand dunes. The Site terrain is hilly and rises sharply from Lake Michigan, with elevations of about 580 feet above mean sea level (msl) on the west side, rising to 780 feet above MSL then dropping to approximately 610 feet above msl at the eastern property boundary. Surface drainage over a majority of the Site occurs within one watershed as outlined on Figure No. 2 with surface discharge to Lake Michigan via overland flow. The PNP facilities include: the power block area including the Turbine Building, Containment Building, and Auxiliary Building; two independent spent fuel storage installations for dry storage; steam generator storage; mechanical draft cooling towers; main parking lot; main access road; switchyard; and, power transmission facilities and corridors. The power block is located in the western portion of the Site as shown on Figure No. 1 with some storage facilities located further inland to the east. The developed portion of the Site is approximately 80 acres.

PNP is a pressurized light-water reactor that was designed, fabricated and delivered by Combustion Engineering. The unit produces tritium as a by-product of the reactor design and operation. The plant design has a variety of safety features to control and account for the tritium that is produced. These features were incorporated into the design and licensing phase of the Facility.

3.2 IMPACTED SYSTEMS ASSESSMENT BY ENTERGY

Entergy's review effort conducted at PNP included review of 56 plant system components for their potential to release tritium or other radioactive isotopes to the environment. The information provided by Entergy included a table that defined and outlined various systems and components for consideration. No written evaluation or specific areas of concern identified for additional review or consideration were provided with the table.

The intent of GZA's review was to evaluate whether each item may present either a potential direct or secondary pathway to ground that may not be monitored or otherwise controlled. This review was not intended to verify nor validate the data contained within the Systems Assessment provided by Entergy.

There are a significant number of plant systems that contain radioactive fluids, by design. As such, when the plant was designed and constructed, additional features were included to control these radioactive fluids and thereby minimize or eliminate the potential for inadvertent or unmonitored releases of radioactive fluids from the Facility.

A copy of the systems assessment performed by Entergy is included as Table 1. Of the 56 systems identified, 16 have potential direct pathways to groundwater and 9 have potential secondary pathways to groundwater. There is one system identified as a monitored (licensed) environmental release point for discharging potentially radioactive liquids from PNP. Outfall 001 is the shoreline discharge structure that is a NPDES permitted outfall. This system has calibrated radiation monitoring equipment which continuously monitors the liquids being released. In addition, historical events were identified with potential pathways to groundwater (these are further discussed in Section 3.3). The systems that have potential direct or secondary pathways, and the historic events that had potential direct or secondary pathways, are generally

located on the south and west sides of the Turbine, Feedwater Purity, and Auxiliary buildings and extending west to Lake Michigan. Additional information is presented in Section 3.0.

3.3 REVIEW OF HISTORICAL PLANT EVENTS

Historical events, documented in the 10CFR 50.75g file reviewed by GZA, are described below and summarized in Table 2. The events are categorized below by mechanism or location.

Spent Fuel Pool Overflow
On October 2, 1973, the spent fuel pool overflowed radioactive water, filling the drains and flooding the floor of the Auxiliary Building. The floor of the Auxiliary Building was flooded to a depth of approximately 3 inches. The water was removed and the building was decontaminated. No additional information about this drain system was available during GZA's review.

Waste Transport Spills
Two historic releases related to waste transport were listed in the file.

- On September 13, 1980, a radiological waste liner was being transported to the storage building on a fork lift, which struck a pot hole during transport. The liner slipped from the forks, spilling approximately two gallons of liquid from the liner onto an adjacent "puddle" on the unpaved ground surface. The contaminated "puddle" was pumped into the plant for treatment and monitoring. Once the liquid was removed, the contaminated soil was removed and placed in radiological waste barrels for disposal. The surrounding area was tested after cleanup and confirmed that no radioactivity remained.

- On May 7, 1994, one box of contaminated soil fell off a stake truck during transport when the truck hit a bump. Approximately half the contents of the box spilled on the side of the roadway near the South Radwaste Building. No further information was available in the file regarding whether the area was decontaminated.

Cooling Tower Overflows
A set of releases occurred in 1981, 1985, and 1987 when cooling tower "A" over flowed and water washed through the South Radwaste Storage Building.

- On December 6, 1981, cooling tower "A" overflowed, washing out an embankment near the cooling tower and flooding an area of the plant site south of the Turbine Building, including portions of the Turbine Building, the South Radwaste Building, and the pole barn to a depth of one foot. Approximately 500,000 gallons of water flowed to the plant or Lake Michigan. The water that was released was not contaminated. Samples collected inside the Radwaste Building were contaminated, but the source appeared to be the contaminated material inside the building coming in contact with the water. The impacted material was left in place.

- On July 31, 1985, cooling tower "A" overflowed, washing out the embankment near the cooling tower and flooding the plant area south of the Turbine Building. The South Radwaste Building was flooded to approximately 1.5 feet. The overflow was caused by failure of a computer control panel, which opened the cooling tower bypass valve. Approximately 350,000 gallons of non-contaminated water was released. The South

Radwaste Building had a contaminated area of 400 cubic feet at the time of the flooding. Water and soil samples were collected and indicated impact in and around the South Radwaste Building. Following this release, a survey of the affected area was conducted and approximately 1,568 cubic feet of contaminated soil were removed from the area. The contaminated soil was packaged as radiological waste in 16 98-cubic foot boxes. The final disposal location for the boxes was not included in the 50.75 file. The remaining impact was left in place and the Facility submitted a request for approval to the Nuclear Regulatory Commission (NRC).

- On November 13, 1987, cooling tower "A" overflowed again, flooding the South Radwaste Building and surrounding area. Further sampling was conducted, and the Facility opted to leave the contaminated material in place, with the NRC's approval.

Releases Near T-90/T-91

There have been several releases near tanks T-90 and T-91, listed below.

- On May 10, 1982, the four valves on the T-90 tank were found with plugs removed and valves open. Water leaking from the valves onto the unpaved ground was potentially contaminated and unmonitored. The valves were bagged and soil samples collected under the valves. The released water was determined not to be contaminated.

- On August 9, 1994, an unknown volume of radioactive liquid was released from T-91 into the valve pit shared with T-90. Once noted, the leakage was stopped. Soil remediation was conducted and over 450 cubic feet of contaminated sand was removed down to five feet below grade. However, radiological impact remained below the pipe run. Upon further evaluation, it was determined that there was a crack in the valve pit that was leaking to the surrounding soil. It was determined that the additional impact would be left in place to avoid undermining the tanks and associated piping.

- On July 26, 1996, while filling tank T-90 with demineralized water, a leak developed at the hose connections near the top of the tank and dripped water onto the top and outside a tent constructed for T-90 recoating activities. The leaking water was sampled and found to be radiologically clean, but the wet sand was contaminated. It was determined that this was a pre-existing condition based on the levels present in the soil in previous evaluations.

- On June 15, 2005, the T-91 utility water storage tank east side manway was found to be leaking at approximately 100 drops per minute to the unpaved ground surface. The leak was slowed, and a catch basin was placed beneath the leak. No further action was noted.

Resin Sluicing Releases

There have been several releases during resin sluicing activities, as summarized below.

- On January 6, 1984, during sluicing of the resin from T-104 to an unused resin bin, it was discovered that there was no plug in the storm drain and resin was spilling over the paved ground surface. Sluicing was stopped and the drain hole was plugged. Approximately 10 gallons spilled and a small amount may have entered the storm drain. The resin on the ground surface was removed, but the material released to the storm drain was not.

- On March 28, 1991, resins from T-104B were being pumped into the resin storage cask. The sluice hose clogged, and the hose broke upstream of the clogged section. Approximately 20 cubic feet of resin mixed with water was spilled in the Turbine Building and just outside the southwest door on the paved surface. The resins were found to be radioactive. The entire area within and adjacent to the Turbine Building was decontaminated.

- On March 24, 2002, while sluicing the Steam Generator blowdown demin T-104A, resins were spilled on the paved ground surface surrounding the cask. Approximately half a barrel (30 to 40 gallons) was spilled. The resins and water were sampled and no significant levels of radiation were found. The nearby storm drain was covered prior to beginning the sluicing, but approximately one gallon of water may have been discharged to the drain. The water and resins were cleaned up.

3.4 POTENTIAL RELEASE AREAS AND TRANSPORT PATHWAYS

Based upon the system and component assessment provided by Entergy and through a review of information available at the time of this report, several potential sources, and transport pathways were identified as issues affecting the development of a Site-wide groundwater monitoring program. These areas are identified in Table 1, noted on Figure 4, and briefly described as follows:

- The liquid Radwaste system contains buried components, external tanks, and lines in or under building floors (see potential intrusion areas 2 and 3). Radwaste systems process impacted water from various sources including Auxiliary Building sumps, Containment Building sumps, Turbine Building sumps, and condensate demineralizer backwash effluent. The Radwaste system reportedly contains tritium. Although there have been no reported problems associated with the underground sections of pipe, there are also no identified inspection or maintenance requirements for this pipe. Since this piping transports radioactive liquids, including tritium, in piping that is buried, it may be prudent to consider some form of periodic inspection or testing to ensure the integrity of this piping is maintained. In addition, this system includes tank T-91, which has had historical releases both to the ground surface and to the adjacent valve pit.

- The Secondary Condensate System contains buried piping which could potentially develop piping/joint leakage that would normally be undetectable (see potential intrusion areas 1 and 4). Since this piping transports radioactive liquids in piping that is buried, it is a potential pathway.

In addition to the potential direct pathways to ground described above, there are several systems with potential secondary pathways, including:

- Demineralized Water
- Plant Heating
- Cooling Towers (overflow)
- Storm Water Drains

Other more generic potential pathways include:

- Buried piping and underground components associated with a number of systems that contain radioactive fluids (representing a potential direct pathway to ground).
- Components in pipe trenches and valve pits containing radioactive liquids have differing leakage collection methods. The collection systems pipe trenches can return leakage to the liquid Radwaste system but could potentially drain to the storm drain system. The integrity of the pipe trenches and Storm Drains is unknown. The storm drain system discharges to Lake Michigan.
- External tanks containing radioactive liquids such as the Primary System Makeup Storage tank and Utility Water Storage tank.
- Low Level Radioactive Material Storage Area located near the South Radwaste Building. Low level radioactive soil disposal by burial has been performed in this area (see Figure 4).
- Subsurface Sanitary Disposal system located outside the secured area to the southeast. Historically there was a cross-connect of a drain from the laboratory that ran to the septic field. No radionuclides were known to be released from the lab, but the area was not sampled for radioactivity.
- Solid waste storage areas including the old steam generator storage and the radwaste buildings do not have potential direct pathways but could flood and result in a release.

3.5 CURRENT LICENSING BASIS REVIEW

Section 2.1 above outlines a number of documents reviewed as part of our effort to assess and characterize Site hydrology specifically in regard to available written descriptions, data tables, reports, and drawings. This information, along with applicable chapters and sections of the Final Safety Analysis Report (FSAR) formed the foundation for a generic review of the Site's Current Licensing Basis (CLB). To the best of our knowledge, review of this information revealed no apparent impact to the CLB. Plant configuration, operations, conditions, and/or events since construction that may have changed as a result of information not specifically evaluated in this cursory review should be analyzed in further detail. License renewal documentation should likewise be reviewed to assure document continuity and consistency with conclusions contained herein.

4.0 HYDROGEOLOGIC ASSESSMENT

Documents provided by Entergy were reviewed and a Site visit was performed on June 29, 2007 to develop an understanding of Site hydrogeologic conditions. Additionally, review of some select published information regarding hydrogeology and water use in the Site vicinity was performed to supplement information provided by Entergy. Subsurface explorations were not performed as part of the assessment summarized herein. Please refer to Appendix C for a list of documents provided by Entergy and reviewed by GZA. This section describes the Site hydrogeology and is organized in sections regarding Geology (Section 4.1), Hydrogeologic Setting (Section 4.2) and Watershed Use (Section 4.3).

4.1 GEOLOGY

Information regarding the regional geologic setting was obtained from various United States Geological Survey (USGS) documents (as referenced herein), the PNP FSAR (Chapter 2), the NRC's Generic Environmental Impact Statement (EIS) Supplement 27 for PNP dated February 2006, and "Geologic and Ground Water Investigations" report by Bechtel Company dated September 1966.

4.1.1 Regional Geology

This subsection provides a summary of general information regarding the geologic history and physical setting of the general area in which the Site is located to provide an understanding of the hydrogeologic conditions that may be present at and around the Facility.

The Site is located within the Eastern Lake Section of the Central Lowlands Physiographic Province which extends from Wisconsin to Tennessee and encompasses all of Michigan. The Central Lowlands Province consists of low-relief surfaces formed by glacial till, outwash plains, and glacial-lake plains. Common features include long, low arcuate ridges formed by recessional moraines that are concave in the north, including the Michigan Basin. The Site is located near the middle of the Michigan basin, where bedrock is at approximately 450 feet above msl. There is approximately 300 feet of overburden overlying the bedrock in the Site vicinity.

The bedrock in the area is the Coldwater shale of Mississippian age. This is the last phase of marine deposition in the Paleozoic Michigan Basin. During the Mesozoic and Cenozoic eras, the Great Lakes region appears to have remained above sea level.

Based on information included in Section 2.3.3 (Faults) of the PNP FSAR, the nearest faults are the Tekonsha and Albion-Scipio Trends located 50 to 60 miles east of the Site. These faults strike north northwest and affect Ordovician rocks.

The Great Lakes region exhibits four distinct glacial ages within the North American Pleistocene record. Each glacial age is represented by extensive till or boulder clay deposits. A low morainal ridge (Covert Ridge) is located east of the Site and contained several lake stages (Glenwood Lake stages I, II, and III). The lake stages occurred during successive advances and retreats of the Wisconsin glacier. The deposits from these lakes generally consist of low permeability silty and clayey sand beds.

Sand dunes are the prevailing surface feature in the vicinity of the plant. The dunes were formed as a result of wind and water erosion. They are relatively stable when covered with vegetation, but strong wind events can cause modifications. Historical modifications appear as conical hills and ridges.

4.1.2 Site Data

This sub-section summarizes hydrogeologic information based on subsurface sampling and testing at the Facility. The information provided by the on-Site explorations

summarized in this section refines the general understanding of hydrogeologic conditions that may be present at the Facility as summarized above.

Site geologic data are based primarily on geotechnical explorations including borings and geophysical explorations conducted to support design of the Facility. Some information associated with subsequent environmental sampling-related explorations was also reviewed and summarized in this section as referenced below:

DATE	EXPLORATION TYPE	NUMBER OF EXPLORATIONS	EXPLORATION NUMBERS	COMMENTS
1965	Borings	18	1 – 18	Initial exploration of property
	Seismic refraction survey			
1966	Borings	13	21-33	Evaluation of hydraulic properties of overburden, one boring went into bedrock
	Pumping test	1	Test well	
1987	Monitoring Wells	3	OW-1 – OW-3	Installed to monitor potential release to the septic drain field
1989	Borings	21	B-1 – B-7, B2A, B3A, B4A, B5A	Borings drilled due to a non-radioactive environmental release, not to bedrock; monitoring wells installed to monitor groundwater impact
	Soil Gas Survey	17	G-1 – G-17	
	Monitoring Wells	10	MW-2A, MW-2B, MW-3A, MW-3B, MW-4A, MW-4B, MW-4C, MW-5A, MW-7A, MW-7B	
1998	Borings	16	SB-1 – SB-16	Sampling to confirm cleanup of non-radioactive environmental release

Based on the geologic results from the 99 borings listed in the table above and drilled at the Site to depths up to 285 feet bgs as reported in the FSAR and subsequent reports, subsurface deposits are reported to consist of four distinct layers. They include the following in order from ground surface down:

- 22 to 220 feet of dune sand;
- 25 to 40 feet of dense to very dense gray silty sand or sandy silt;
- 2 to 5 feet of stiff gray clay; and,
- 78 to 90 feet of stiff to hard gray gravelly clay (glacial till).

The boring locations conducted in 1965 and 1966 are shown on Figure 2-3 (Site Topography, Boring Locations, and Seismic Profiles) of the FSAR[2]. Boring locations for the other events are shown in the documentation generated for those events (listed in Appendix C). Boring logs and data were available for 26 of the subsurface explorations. However, information for other borings was not available at the time of GZA's review.

[2] Revision 24.

Overburden: Overburden beneath the Site consists of dune sand, silt, clay and gravelly clay (glacial till). Layers appear to be fairly continuous across the Site, with only the dune sand layer varying significantly in thickness. This is consistent with the general description of overburden in Van Buren County[3].

The excavation conducted during installation of the Facility appears to have been approximately 15 feet deep (near Lake Michigan) to 115 feet deep (under the Reactor Building)[4]. There is no long-term dewatering reportedly being conducted at the Facility. Details about the backfill material were not available, but the backfill likely has comparable hydraulic properties to the native soil.

Bedrock: Bedrock beneath the Site has been classified as part of the Coldwater shale group based on borings conducted at the Site. Based on the results of the explorations, bedrock was described as massive, unjointed black shale encountered at 248 feet bgs in drill hole 21. Rock quality designation values (RQDs) were not provided for bedrock cores collected from drill hole 21.

4.2 HYDROGEOLOGIC SETTING

One major regional aquifer exists at the Site that corresponds to the geologic units described in Section 4.1.1 as dune sand (also referred to as the glacial drift aquifer). There is limited presence of water in the Coldwater Shale due to low permeability and minimal pore space. The bedrock aquifer, when encountered, is over 200 feet bgs and cannot be used for water supply due to the presence of brackish groundwater quality. The glacial drift aquifer provides water for domestic supply wells, but is not sufficient for larger (non-domestic) water supply volumes which are locally withdrawn from Lake Michigan.

4.2.1 Regional Watershed and Aerial Recharge

The Site is not encompassed by a large watershed. It is located within a small watershed with an area of approximately 37 square miles. The local watershed includes small streams, the nearest being Brandywine Creek, that discharge to Lake Michigan. The Black River Watershed is located north of the Site and the Paw Paw River Watershed is located south of the Site. The Site is surrounded to the north, east, and south sides by sand dunes. As such, surface runoff runs directly to the lake and the runoff percolating to groundwater also discharges to the lake as shown on Figure No. 2.

Precipitation in the vicinity of the Site is on the order of 34 inches per year and Michigan Geological Survey Division reports runoff for the vicinity of the Site of approximately 4 inches per year. The difference between these two values, 30 inches per year, is the amount of water available for infiltration, a large portion of which will not recharge the groundwater system due to losses from evapotranspiration. It is estimated that approximately 10 inches per year infiltrates into the groundwater.

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[3] "The Glacial Geology and Groundwater Resources of Van Buren County, Michigan" F. Wells Terwilliger, State of Michigan Department of Conservation Geological Survey Division, 1954.

[4] Plate 2, "Cross Sections in Power Plant Area" from the report Evaluation of Geologic and Ground Water Investigations, Bechtel, September 1966.

4.2.2 Hydraulic Properties

Based on information included in the FSAR, only one hydraulic conductivity test was performed for the glacial drift aquifer present beneath the Site. The evaluation of aquifer properties was conducted in 1966 (pre-construction) and is based on the results of a 24-hour step drawdown test. The pumping well was located near the Switchyard (center of the property) and was 8 inches in diameter and 46 feet deep. The step draw-down test included four steps (flow rates) including of the pump test were 80 gpm, 96 gpm, 100 gpm, and 110 gpm. The groundwater elevation in the well was approximately 580 feet above msl at the time of the test. The average hydraulic conductivity estimated from the test was 6.3 feet per day (range of 3.8 to 8.2 feet per day). The regional hydraulic gradient of the water table surface was noted as 0.002 feet per foot. The groundwater velocity was estimated to be 1.8 feet per day[5].

An investigation conducted in 1987 near the septic drain field involved installation of 3 monitoring wells. Groundwater data from these wells indicated a groundwater velocity of 23 feet per year, for this localized area.

4.2.3 Groundwater Flow Patterns

There is one distinct aquifer reported for the Site, identified as the glacial drift (or regional) aquifer. The groundwater elevation across the Site has been reported in the 580 to 604-foot msl elevation range with groundwater flow generally westward toward Lake Michigan. The higher elevations are on the eastern portion of the Site, beneath the Palisades Substation. The groundwater gradient toward Lake Michigan does not appear to reverse based on available data. The surface water elevation of Lake Michigan ranges from a low of 576.9 feet msl in 1974 to a high of 583.5 feet msl in 1886.

Based on the relatively high hydraulic conductivity values, the regional groundwater flow patterns are not likely influenced by the three water wells on Site that have a total pumping capacity of 24 gpm. However, without knowledge of the locations of these wells, it is difficult to estimate their influence. The water wells are used for irrigation purposes at the Site.

4.3 WATERSHED USE

A description of recent surface and groundwater use was obtained primarily from the PNP EIS. Water in the Site vicinity satisfies a variety of purposes including municipal, domestic and agricultural uses with groundwater withdrawn from the regional aquifer and surface water withdrawn from Lake Michigan.

4.3.1 Surface Water

Surface water withdrawals in Van Buren County are predominantly for public supply and power plant use, with no surface water usage reported for domestic self-supplied systems, mining, hydroelectric power, industrial or commercial uses. The Facility draws water from Lake Michigan for cooling processes through the intake structure located 3,300 feet

[5] "Evaluation of Geologic and Groundwater Investigations", Bechtel Company, September, 1966.

off-shore at a rate of approximately 98,000 gpm during normal operation. The Facility discharges approximately 86,000 gpm back into Lake Michigan, with the other 12,000 gpm lost to evaporation from the Cooling Towers.

There are two other surface water supply intakes near PNP. The nearest supply intake is for the Covert Generating Plant. The plant intake is located about 1 mile north of PNP and uses approximately 8 mgd. The second supply intake is for the City of South Haven Municipal Water Authority, located 5 miles north of the Site. The SHMWA withdraws approximately 1.64 mgd. According to the FSAR, the current along the Lake Michigan shoreline flows northward approximately 33% of the time, and southward 23% of the time.

4.3.2 Groundwater

On-Site Groundwater Use: There are three on-Site groundwater wells that are used for grounds maintenance. Their combined pumping capacity is 24 gpm. Logs and locations for these wells were not available during GZA's review. The potable water supply for the Facility comes from the SHMWA.

Public Groundwater Supply Use: There are no nearby public groundwater supply wells.

Domestic Groundwater Supply Use: The nearest domestic wells are located one half mile to the east and south of the Site. Given their anticipated pumping rates (low capacity sufficient for domestic use estimated at less than 100 gallons per capita per day), domestic wells are not expected to influence the groundwater flow direction at the Site. There are no production wells, including domestic wells, down gradient of the power block based on the westerly groundwater flow direction identified at the Site.

On-Site Groundwater Data: The current PNP monitoring program does not include monitoring for tritium in groundwater.

5.0 DATA GAP ANALYSIS

5.1 ENGINEERING

Additional information is needed to understand the underground components and buried piping associated with the potentially contaminated systems or systems that may become cross contaminated through a variety of scenarios. It should also be noted that these underground components (e.g., buried piping) have been in place for many years. At this time, we do not have a clear understanding of the condition of these items, nor any real means to predict their integrity over time.

5.2 HYDROGEOLOGIC/ENVIRONMENTAL

The potential unmonitored release areas as identified on Figure No. 4 exist primarily in the power block area. If an unmonitored release occurred, radioactive liquids would most likely flow downward to the aquifer and migrate to the west, toward Lake Michigan. At this time, however,

there is little to no information documenting local, post-construction groundwater flow conditions around the facility, including seasonal variations in flow and the impact of foundations or utility-related features and their associated backfill material. Also, the construction and usability of existing monitoring wells and supply wells need to be evaluated.

6.0 OPTIONS FOR MOVING FORWARD

Proposed options for moving forward are discussed below and are summarized in Table 3. Section 6.1 and Table 3 section A summarize potential options for addressing the data gaps presented in Section 5.0, including options to enhance overall hydrogeologic understanding of the Facility and surrounding area. Table 3 section B provides additional information concerning the monitoring wells and piezometers included within the data gap options, including general construction information. The proposed monitoring well locations are generally positioned downgradient of the active Facility area and are intended to not only aid in providing additional stratigraphic, groundwater elevation and flow direction information, but also to serve as initial groundwater monitoring points. The proposed piezometers are generally positioned up-gradient and side-gradient of the active Facility area and are intended to provide additional stratigraphic and groundwater flow direction information.

Consistent with good investigatory practices, we recommend continuing with a phased approach. We also recommend making full use of existing information, and enhancing that information, before undertaking additional intrusive studies.

6.1 OPTIONS TO ADDRESS DATA GAPS AND ENHANCE OUR HYDROGEOLOGIC UNDERSTANDING

Options to address the various system engineering and hydrogeologic data gaps presented in Section 5.0 have been developed and are summarized in Table 3 section A. In general, the purpose behind these potential action items is to improve our understanding of potential release areas, local hydrogeologic conditions and/or potential regional receptors. Additional discussion of the benefits of each option are presented in the table noted above.

Included within the options summarized in Table 3 section A is the installation of 5 monitoring wells and 5 piezometers. Information related to their location, depth, construction, and purpose is presented in Table 3 section B. The tentative location of each point is shown on Figure No. 4 (Note: These locations still need to be cleared for utilities). The monitoring wells and piezometers listed in this table are intended to serve as initial points only. Consistent with the philosophy of a phased approach (and the observational method[6]), following execution of the above potential options to address data gaps, additional monitoring wells and/or piezometers may be considered to further enhance hydrogeologic understanding and/or to serve as additional water quality monitoring points. The borings for the monitoring wells and piezometers will also be used to collect hydrostratigraphic information and hydraulic property data.

[6] Barvenik, M.J., Powers, M.A. and Thompson V., "Use of the Observational Method in the Investigation and Monitoring of a Spent Fuel Pool Release", EPRI / NEI Technical Information Workshop, Nuclear Plant Groundwater Monitoring, September 13, 2006.

In general, non-intrusive options that can further our understanding of local hydrogeologic conditions and associated issues should be conducted first – prior to the installation of the above noted wells. In particular, options involving subsurface utility location and construction, the depth and composition of the backfill materials placed around the Facility during construction, and the surveying and gauging of the existing monitoring wells should generally be conducted prior to the installation of new subsurface monitoring points. Understanding where subsurface utilities are located is important in the safe siting and execution of proposed subsurface work. Understanding the depth and construction of the utilities and the depth and composition of backfill materials placed around the facility provides insight into potential groundwater flow patterns and preferential pathways around the Facility which could impact the location and number of new wells proposed. Finally, knowledge about the location, depth, screen interval and local geologic conditions associated with the existing site monitoring wells and supply wells may influence both the number and location of new wells being proposed. The existing wells can be used to obtain valuable information (at limited additional cost) regarding local groundwater flow patterns, which in turn can be used to further fine-tune the siting of the proposed new locations. If such activities are performed first, changes can be made to the final location of each new well (as well as potentially the number of points), if warranted, based on the results of these initial non-intrusive data gap activities.

TABLES

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Table 1

Impacted Systems Assessment

Palisades Nuclear Plant

Covert, Michigan

System #	System Description	Type of System	Potential Direct Pathway to Ground	Potential Secondary Pathway to Ground	Comments
T-2	Secondary Side Condensate Storage Tank	Water	Yes		This system is located outdoors with buried piping connections. It contains secondary side condensate (1 to 100 piCi's/L H3).
T-81	Primary System Makeup Water Tank	Water	No	No	This is normally a non-radioactive system. The tank has been designed to preclude the entry of potentially radioactive water into the system. Demineralized water in this tank comes from T-939. This system could only be impacted by backflow and the system has been designed to prevent backflow.
T-939	Demineralized Water Storage Tank	Water	No	No	This is normally a non-radioactive system. It contains demineralized water and could only be impacted by backflow. The system is designed to prevent backflow.
T-90	Primary System Makeup Storage Tank	Water	Yes		This is a radioactive system that has had historical leakage. The system is located outdoors with buried piping and contains 1,000 to 8,000 piCi's/L H3.
T-91	Utility Water Storage Tank	Water	Yes		Liquid radioactive waste after process is stored in this tank. The system had a historical leak to the vault between T-91 and T-90. The system is located outdoors with buried piping connections and contains 1,650,000 to 4,000,000 piCi's/L H3.
T-41	Turbine Building Drain Tank	Water	Yes		This system is radioactive and located outdoors with buried piping connections. Concentrations of 1-100 piCi's/L H3. It is also NPDES outfall 00F.
M-18	Turbine Building Oil/Water Separator	Water	Yes		The system is contained in the Turbine Building, within secondary containment. However, there is buried piping associated with the system and any overflow from the secondary containment could flow out the building doors.
M-8	Plant Heating Boiler	Water	No	Yes	System is contained in the Turbine Building but does not have secondary containment. It has been impacted by radiological material from historical use, but does not have associated buried piping. Release would go to the floor and eventually out of the building doors if it remained undetected.

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Table 1

Impacted Systems Assessment

Palisades Nuclear Plant

Covert, Michigan

System #	System Description	Type of System	Potential Direct Pathway to Ground	Potential Secondary Pathway to Ground	Comments
T-20	M-8 Condensate Receiver Tank	Water	No	Yes	System is located inside the Turbine Building and contains secondary condensate (1-200 piCi's/L H3). Release would flow out the doors of the building if it remained undetected.
M-61	Evaporation Heating Boiler	Water	No	No	This system was used as a heating boiler and radioactive waste evaporator. It has been retired and removed from service but is still located inside the turbine building. It contains secondary condensate (1-200 piCi's/L H3).
T-38	Evaporator Boiler Condensate Receiver Tank	Water	No	Yes	This system is located in the Turbine Building and contains secondary condensate (1-200 piCi's/L H3). There is no secondary containment for this system, so leaks would go to the nearby floor drains.
M-901	Feedwater Purity Boiler	Water	Yes		This system is located inside the Feedwater Purity Building and contains secondary condensate (1-200 piCi's/L H3). It has associated underground piping, and does not have secondary containment.
T-927	M-901 Condensate Receiver Tank	Water	No	No	This system is contained in the Feedwater Purity Building and contains secondary condensate (1-200 piCi's/L H3). It does not have secondary containment, but all piping is above grade.
T-58	Safety Injection Refueling Water Tank	Water	Yes		This system is a radiological system located outdoors on the Auxiliary Building roof and has a 270,000 gallon capacity. A release from this tank would go either to the roof drains and then the storm drains, or over the edge of the roof.
E-10	Secondary - Main Condenser	Water	No	No	Circulating water and secondary condensate run through this system. However, the secondary condensate is under vacuum and runs in a tube through the circulating water. If the tube were compromised, circulating water would go into the secondary condensate, not vice versa. There is no buried piping associated with the secondary condensate.
E-8	Air Ejector – Main Condenser	Air/Gas	No	No	This system is monitored and gas released from it is routed through the main stack.

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Table 1

Impacted Systems Assessment

Palisades Nuclear Plant

Covert, Michigan

System #	System Description	Type of System	Potential Direct Pathway to Ground	Potential Secondary Pathway to Ground	Comments
E-19	Gland Steam Condenser	Water/ Steam	No	Yes	This system contains secondary condensate (1-200 piCi's/L H3) and is contained in the Turbine Building. The system is located within the condensate pump pit, with no buried piping. Release would go to the turbine sump, discussed later in this table.
E-53	Spent Fuel Pool	Water	No	Yes	System is elevated and completely contained in the Auxiliary Building and can be visually inspected. There is a leak collection system (floor drains) if any release were to occur, that goes into the radwaste system.
T-78A	East Engineered Safeguards Pump Room Sump Tank	Water	Yes		This system is located below ground and could contain radionuclides. It is designed to be water tight.
T-78B	West Engineered Safeguards Pump Room Sump Tank	Water	Yes		This system is located below ground and could contain radionuclides. It is designed to be water tight.
T-26A	Feedwater Turbine Gland Seal Drain Tank	Water	No	Yes	Located within the Turbine building, this system is elevated with no buried piping. It is part of the main condenser system. Any leaks from this tank would go to the floor drain and eventually to the storm drains.
T-26B	Feedwater Turbine Gland Seal Drain Tank	Water	No	Yes	Located within the Turbine building, this system is elevated with no buried piping. It is part of the main condenser system. Any leaks from this tank would go to the floor drain and eventually to the storm drains.
ALPS	Liquid Radwaste Processing System	Water	No	No	This system is located in Track Alley. It is skid mounted with no buried piping and has secondary containment.
Track Alley	Resin Sluicing/Rad material handling, ALPS processing	Water, resins, solid radiological material	No	Yes	This system is elevated and has multiple safety features to prevent release. There is no buried piping associated with this system. Note: historical releases associated with resin sluicing have occurred outside the building and are not associated with this system.
Turbine Building. Sump	Turbine Building Floor Drainage Collection Sump	Water	Yes		System is contained in the Turbine building and has no associated underground piping. It is located in the condensate pump pit (below grade) and does not have any integrity testing.

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Table 1

Impacted Systems Assessment

Palisades Nuclear Plant

Covert, Michigan

System #	System Description	Type of System	Potential Direct Pathway to Ground	Potential Secondary Pathway to Ground	Comments
Aux Building Elevator	Auxiliary Building Elevator Shaft	None	No	No	Not a radiological system. However, a historical overflow of the Spent Fuel Pool reached this system (it was decontaminated) so it is theoretically a potential secondary pathway.
P-2A, B Pit	Secondary Side Condensate Pumps	Water	Yes		This system is contained in the Turbine Building and handles secondary condensate. It is located below grade in the same room as the turbine sump.
P-10 A, B	Heater Drain Pump Pit	Water	Yes		This system is located within the Turbine building below grade. It contains secondary condensate. Cracks in the floor have been noted in this area.
M-61 Sump	Sump	Water	Yes		This system is located below grade in the M-61 boiler room within the Turbine Building. It contains secondary condensate and releases go to the turbine sump.
M-8 Sump	Sump	Water	Yes		This system is located below grade in the M-8 boiler room within the Turbine Building. It contains secondary condensate and releases go to the turbine sump.
M-901 Sump	Sump	Water	Yes		This system is located in the Feedwater Purity Building in the M-901 boiler room. It is below grade and contains secondary condensate.
E10 E/W Pit	Feedwater Turbine Gland Seal Drain Tank	Water	No	Yes	This system is located above grade within the Feed Water Purity Building with no buried piping. Leaks from this system would go to the floor drain.
V-12A	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-12B	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-12C	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-12D	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-12E	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.

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Table 1

Impacted Systems Assessment

Palisades Nuclear Plant

Covert, Michigan

System #	System Description	Type of System	Potential Direct Pathway to Ground	Potential Secondary Pathway to Ground	Comments
V-12F	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-12G	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-12H	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-12I	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-12J	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-12K	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-12L	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-21R	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-21S	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-21T	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-22A	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-22B	Turbine Building Roof Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-29A	Boiler Room Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-29B	Boiler Room Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.

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Table 1

Impacted Systems Assessment

Palisades Nuclear Plant

Covert, Michigan

System #	System Description	Type of System	Potential Direct Pathway to Ground	Potential Secondary Pathway to Ground	Comments
V-71A	Boiler Room Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-71B	Boiler Room Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
V-912	Boiler Room Exhaust	Steam	No	No	This system provides secondary side ventilation. Steam releases could reach the ground surface and the storm drains.
Buried Piping	Storm Water Drains	Water	Yes		No indication of failure in any of the buried piping for the storm drain system to date, but it carries radiological material.
Vaults	T-90/T-91 Recirculation Pumps Pit	Water	Yes		This system is located outdoors, below grade. Leakage from the piping or pumps in this system could reach soil or groundwater.

Notes:

1. Need additional information and analysis pertaining to system interfaces and underground piping for determination of potential groundwater intrusion paths.
2. Potential Direct Pathway to Ground - Indicates whether the system has the potential to introduce radiological constituents by means of immediate proximity of site system components in direct contact with the ground. For example, an external condensate storage tank containing radioactive liquid and associated buried underground piping has the potential to introduce it's content directly into the ground through an inadvertent or otherwise uncontrolled release when and if any unseen portion develops a leak.
3. Potential Secondary Pathway to Ground - Indicates that the system has the ability to introduce constituents to ground via an indirect or alternative pathway. For example, for a release of radiological constituents within a building or structure, its secondary pathway may be a sump pit or floor drain system that has direct contact to ground through buried piping or other external components.
4. Vents from both the Auxiliary Building and Turbine Building were categorized as neither direct pathways nor secondary pathways. Any discharge from a vent would be as steam rising. Ultimately, this could be a non-point source of radiological impact, but it is not a direct or secondary pathway.

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Table 2

KNOWN EVENTS

Palisades Nuclear Plant

Covert, Michigan

Date	Event / Ref. Report No.	Discussion	Potential Direct Pathway to Ground	Potential Secondary Pathway to Ground
October 2, 1973	Palisades Incident 73-58	The spent fuel pool overflowed radioactive water, filling the drains and flooding the floor. The floor of the Auxiliary Building was flooded to a depth of approximately 3 inches.	No	Yes
September 13, 1980	D-PAL-80-187 Radiological waste spill during transport	A radiological waste liner was being transported to the storage building. The liner was on a fork lift, which struck a pot hole during transport. The liner slipped from the forks, spilling approximately two gallons of liquid from the liner onto an adjacent "puddle" on unpaved ground surface.	Yes	Yes
December 6, 1981	Cooling tower "A" overflow	Cooling tower "A" overflowed, washing out an embankment near the cooling tower and flooding an area of the plant site south of the Turbine Building, including portions of the Turbine Building, the South Radwaste Building, and the pole barn to a depth of one foot.	Yes	
May 10, 1982	D-PAL-82-066 Spill in an uncontrolled area	The four valves on the T-90 tank were found with the plugs removed and the valves open. The water leaking from the valves onto the unpaved ground surface was potentially contaminated and unmonitored. The released water was later determined not to be contaminated.	NA	NA
January 6, 1984	D-PAL-84-008 Resin spill	During sluicing of the #3 demin resin from T-104 to an unused resin bin, it was discovered that there was no plug in the storm drain and the resin was spilling over the paved ground surface. Sluicing was stopped and the drain hole was plugged. Approximately 10 gallons spilled and a small amount may have entered the storm drain.	Yes	
July 31, 1985	Cooling tower "A" overflow	Cooling tower "A" overflowed, washing out the embankment near the cooling tower and flooding the plant area south of the Turbine Building. The South Radwaste Building was flooded to approximately 1.5 feet. The overflow was caused by failure of a computer control panel, which opened the cooling tower bypass valve. Approximately 350,000 gallons of water was released.	Yes	
November 13, 1987	Cooling tower "A" overflow	Cooling tower "A" overflowed into the South Radwaste Building and surrounding areas.	Yes	

Table 2
KNOWN EVENTS
Palisades Nuclear Plant
Covert, Michigan

March 28, 1991	D-PAL-91-071 Resin spill during resin sluice	Resins from T-104B were being pumped into the resin storage cask. The sluice hose appeared to clog, and before the demin outlet valve could be closed, the hose broke upstream of the clogged section.	No	Yes
May 7, 1994	Spill of radioactive material	One box of contaminated soil fell off a stake truck during transport when the truck hit a bump. Approximately half the contents of the box spilled on the side of the roadway near the South Radwaste Building.	No	No
August 9, 1994	C-PAL-94-0653 T-91 Sump Leakage	An unknown volume of radioactive liquid was released from T-91 into the valve pit shared with T-90. Once noted, the leakage was stopped. Upon further examination, it was also noted that the valve pit had cracks, allowing radioactive liquid to be released to the surrounding soil.	Yes	
July 26, 1996	C-PAL-96-0832 Contaminated soil near tank T-90	While filling tank T-90 with demineralized water, a leak developed at the hose connections near the top of the tank and dripped water onto the top and outside the tent constructed for T-90 recoating activities. The leaking water was sampled and found to be radiologically clean, but the wet sand was contaminated. It was determined that this was a pre-existing condition based on the levels present in the soil in previous evaluations.	No	No
March 24, 2002	Resin Spill	While sluicing the Steam Generator blowdown demin T-104A resins were spilled on the ground surrounding the cask. After roughly half the resin had been sluiced, the lid onto which the resin hose was attached lifted and resins began flowing onto the paved ground surface around the cask. Approximately half a barrel (30 to 40 gallons) was spilled.	Yes	
June 15, 2005	T-91 Manway Leak	The T-91 utility water storage tank east side manway was found to be leaking to the unpaved ground surface at approximately 100 drops per minute to the unpaved ground surface.	Yes	

Notes:

1. This table was prepared based on the Facility's 50.75(g) files or summaries thereof provided by Entergy.
2. Potential Direct Pathway to Ground - Indicates whether the event has the potential to introduce radiological constituents by means of immediate proximity of site system components in direct contact with the ground. For example, an external condensate storage tank containing radioactive liquid and associated buried underground piping has the potential to introduce it's content directly into the ground through an inadvertent or otherwise uncontrolled release when and if any unseen portion develops a leak.

Table 2
KNOWN EVENTS
Palisades Nuclear Plant
Covert, Michigan

3. Potential Secondary Pathway to Ground - Indicates that the event has the ability to introduce constituents to ground via an indirect or alternative pathway. For example, for a release of radiological constituents within a building or structure, its secondary pathway may be a sump pit or floor drain system that has direct contact to ground through buried piping or other external components.

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Table 3

OPTIONS FOR MOVING FORWARD

Palisades Nuclear Plant

Covert, Michigan

A. Options for Addressing Data Gaps

No.	Description of Data Gap	Potential Options to Address Data Gap	Rationale for Action
1	Supplemental Engineering and System Document Review	Review of some system information that was not available or could not be completed within the time frame of this report. Note: Current physical conditions of underground components or buried piping is incomplete. Programmed inspection and evaluation of underground components and buried piping with corrective actions (maintenance, repair, or replace) could be completed to mitigate potential risks.	Identification of inter-system connections, underground system components, and buried piping to complete the evaluation of potential release points. Known Impacted systems with components in direct contact with the ground may be monitored and controlled to prevent or limit potential releases.
2	Knowledge of the conditions of the existing groundwater monitoring and irrigation water supply wells and the geologic conditions adjacent to the screened sections of existing wells.	Inventory the four existing monitoring wells and three existing supply wells; evaluate their condition for use as water level measurement locations and horizontal and vertical locations of each by survey. Obtain well construction reports for each well, if available, to verify/ evaluate the geologic unit being monitored and the screen location.	Provide an understanding of the condition of the existing monitoring wells to minimize the need for new well construction while maximizing the value of future monitoring wells that are constructed.
3	Understanding of lithologic variations in the area of the power block, including the location, depth and composition of backfill materials placed around the power block and associated Site utilities.	Obtain boring logs prepared for borings drilled prior to and after construction of the Facility. Obtain and review other construction related information associated with building foundations and Site utilities. (See also response for item 4 below)	Aid in evaluating migration pathways and groundwater flow patterns in the glacial drift aquifer and potential release areas.

Table 3
OPTIONS FOR MOVING FORWARD
Palisades Nuclear Plant
Covert, Michigan

No.	Description of Data Gap	Potential Options to Address Data Gap	Rationale for Action
4	Understanding of current groundwater flow conditions including groundwater velocity and relationship with Lake Michigan.	Install strategically located monitoring wells and piezometers (see Table 3 B below). Survey new points and collect groundwater elevation data over multiple seasons.	If an unmonitored release of radioactive water were to occur, the fate of the radioactive water needs to be understood.

Table 3

OPTIONS FOR MOVING FORWARD

Palisades Nuclear Plant

Covert, Michigan

B. Summary of Monitoring Wells Included within the Options in Table 3 (A)

Exploration ID	Type	Location	Total Depth (Target Strata)	Proposed Construction (Diameter, Screen Int,)	Rationale
MW-100 through MW-104	Monitoring Well	West of the power generating facilities along the shore of Lake Michigan	15 feet Dune Sand	2-inch PVC, 5-15 ft bgs	Assess groundwater elevations, flow direction and potentially groundwater quality in this presumed down-gradient portion of the Site
PZ-100	Piezometer	North of the power generating facilities along the north edge of the secured area	15 feet Dune Sand	2-inch PVC, 5-15 ft bgs	Assess groundwater elevations, flow direction and potentially groundwater quality in this presumed side-gradient portion of the Site
PZ-101	Piezometer	Northeast of the power generating facilities along the outside of the secured area	40 feet Dune Sand	2-inch PVC, 30-40 ft bgs	Assess groundwater elevations, flow direction and potentially groundwater quality in this presumed up-gradient portion of the Site
PZ-102	Piezometer	East of the power generating facilities along the access road adjacent to the parking area	50 feet Dune Sand	2-inch PVC, 40-50 ft bgs	Assess groundwater elevations, flow direction and potentially groundwater quality in this presumed up -gradient portion of the Site
PZ-103	Piezometer	East of the power generating facilities and north of the sanitary field	50 feet Dune Sand	2-inch PVC, 40-50 ft bgs	Assess groundwater elevations, flow direction and potentially groundwater quality in this presumed up-gradient portion of the Site
PZ-104	Piezometer	South of the power generating facilities along the border of the secured area	15 feet Dune Sand	2-inch PVC, 5-15 ft bgs	Assess groundwater elevations, flow direction and groundwater quality in this presumed side-gradient portion of the Site

1. Refer to **Figure No. 4** for the location of potential monitoring wells relative to site features

2. Potential monitoring well locations are presented herein for consideration and are subject to change based on a variety of factors including: the results of subsequent investigation and data review, evolving industry guidance, site access conditions, and/or review of subsurface utility locations.

3. Depths shown indicate approximate depth of screen section. Actual depths to be based on conditions encountered while drilling.

FIGURES

APPENDIX A

LIMITATIONS

APPENDIX A

PROJECT LIMITATIONS

1. This focused report was prepared for use by the Client at the subject Facility, for the limited technical and legal purposes stated in the report. We take no responsibility for other uses of this report, or for use by other parties.

2. By agreement with the Client, we relied on information provided by the Facility to develop our opinions. We also relied upon public sources of information to help develop our understanding of the Facility's hydrogeologic setting. Local subsurface conditions or soil heterogeneities may exist and may subsequently be shown to have an unanticipated effect on groundwater flow patterns. These were initial reviews; we did not attempt to verify or validate information, oral or written.

3. Unidentified and/or unanticipated conditions may exist. Should such conditions become obvious, it may be necessary for us to reevaluate the opinions expressed in this report.

4. Our findings and conclusions are provided as professional opinions, and not as statements of fact.

5. Our services were provided with the degree of skill and care ordinarily used by qualified professionals performing the same or similar services, at the same time, under similar circumstances, in the same or similar locations. No other warranty expressed or implied is made.

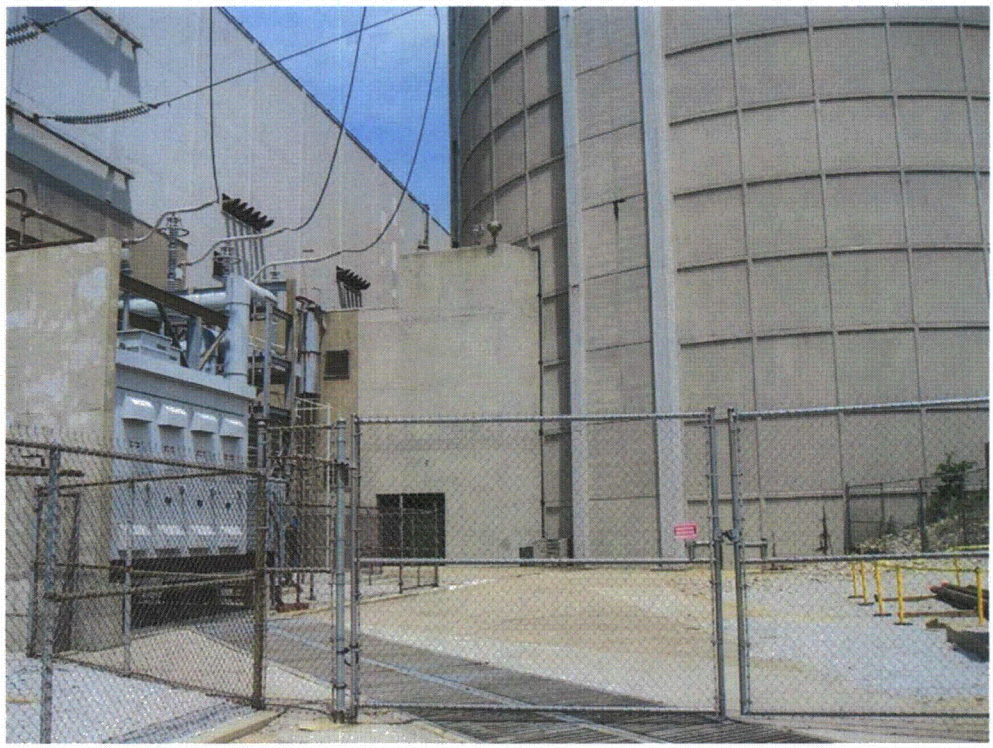
APPENDIX B

PHOTOGRAPHS

PHOTOGRAPH NO. 1 - Looking north from the discharge point at the sand dunes surrounding the Site.

PHOTOGRAPH NO. 2 - Looking southeast toward the septic drain field with cooling towers to the south. Illustrates elevation change.

PHOTOGRAPH NO. 3 - General Site conditions looking north along the Turbine Building and the Feedwater Purity Building.



PHOTOGRAPH NO. 4 - Looking north at the Containment Structure.

PHOTOGRAPH NO. 5 - Looking southwest at the Radwaste Storage and South Radwaste buildings.

PHOTOGRAPH NO. 6 - Vault located between T-90 and T-91.

APPENDIX C

DOCUMENT LIST

Palisades Nuclear Plant
Covert, Michigan

The following documents provided by Entergy and other cited sources were reviewed as part of this assessment:31

Entergy Nuclear, 10CFR 50.75(g) File

Entergy Nuclear, Palisades Nuclear Plant Final Safety Analysis Report, Chapter 2.

Western Michigan University, Department of Geology, 1981, Hydrogeologic Atlas of Michigan,.

Bechtel Company, September 1966, Palisades Nuclear Power Plant Evaluation of Geologic and Groundwater Investigations.

Dames & Moore, January 12, 1990, Soil and Groundwater Investigation, Consumers Power Company, Palisades Nuclear Plant.

STS Consultants, Ltd., September 16, 1987, Palisades Nuclear Power Plant Hydrogeologic Study.

U.S. Nuclear Regulatory Commission, February 2006, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 27 Regarding Palisades Nuclear Plant, Chapter 2.

State of Michigan Geological Survey Division, 1954, Publication 49/Part 1 The Glacial Geology and Groundwater Resources of Van Buren County, Michigan.

State of Michigan Geological Survey Division, 1964, Water Resources of Van Buren County, Michigan.

"Soil Borings at Former Fuel Depot", Consumer's Energy Memorandum, September 4, 1998.

U.S. Geological Survey, 1981, Covert, Michigan 7.5-Minute Topographic Quadrangle Map.

APPENDIX D

INTERVIEWS

Interviews

Eric Dehn - Entergy