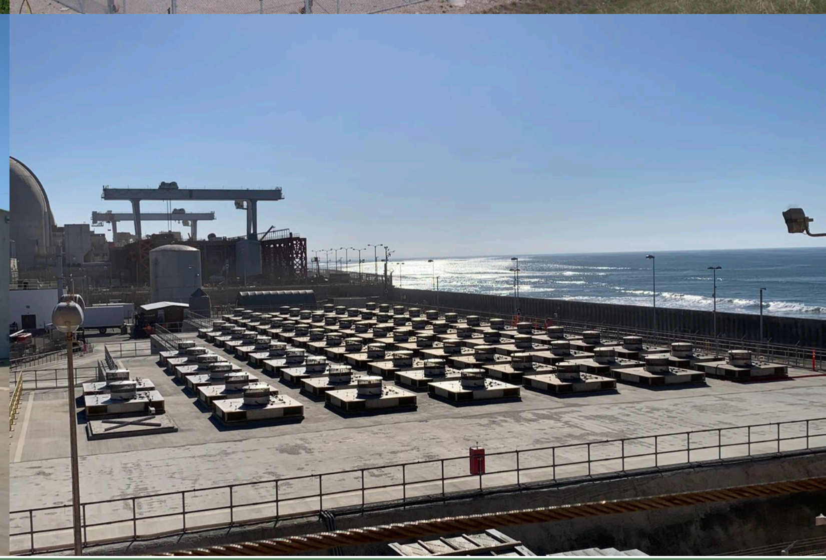
U.S. Department of Energy

NUCLEAR POWER PLANT INFRASTRUCTURE EVALUATIONS FOR REMOVAL OF SPENT NUCLEAR FUEL



U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

February 2024

Sites Evaluated in This Report	
Maine Yankee	Kewaunee
Yankee Rowe	San Onofre
Connecticut Yankee	Vermont Yankee
Humboldt Bay	Fort Calhoun
Big Rock Point	Oyster Creek
Rancho Seco	Pilgrim
Trojan	Dresden
La Crosse	Morris
Zion	Indian Point
Crystal River	Palisades

Cover photos courtesy of the Maine Yankee, Big Rock Point, Kewaunee, and San Onofre Sites.

Nuclear Power Plant Infrastructure Evaluations for Removal of Spent Nuclear Fuel

Spent Fuel and Waste Disposition

Prepared for
U.S. Department of Energy
Office of Integrated
Waste Management
Steven J. Maheras (PNNL)
Lauren S. Rodman (PNNL)
Virgil O. Peoples (INL)
Adam H. Levin (AHL Consulting)
Veronica M. Wilson (PNNL)
Dina Carpenter-Graffy (PNNL)
Ralph E. Best (Consultant)
Jeffrey Moore (FRA)
Kathy Langan (Consultant)

February 29, 2024
M3SF-23PN0203020614
PNNL-34792

EXECUTIVE SUMMARY

This report fulfills the M3 milestone M3SF-23PN0203020614, "Updated NPP Site Evaluation Report (2)." This report is an update of the report *Nuclear Power Plant Infrastructure Evaluations for Removal of Spent Nuclear Fuel* (Maheras et al. 2021) and includes expansion of the site evaluations to include operating nuclear power plant (NPP) sites and to incorporate updated site inventory data. Figures that include the number of spent nuclear fuel (SNF) assemblies and metric tons heavy metal (MTHM) in a single figure have also been added to the report.

This report provides evaluations of the NPP site infrastructure and near-site transportation infrastructure for removing SNF from 19 NPP sites and the Morris Independent Spent Fuel Storage Installation (ISFSI).[1,2] The material to be removed from the NPP sites includes both the SNF and the greater-than-Class C low-level radioactive waste (GTCC waste)[3] that is stored, or will be stored, at the sites.

The evaluation was divided into four components:

- characterization of the SNF and GTCC waste inventory
- a description of the on-site infrastructure and conditions relevant to transportation activities
- an evaluation of the near-site transportation infrastructure and experience relevant to shipping transportation casks containing SNF and GTCC waste from the NPP sites
- identification of future information needs.

As part of conducting the evaluations of the NPP site infrastructure and near-site transportation infrastructure, 20 NPP sites have been visited since 2012: Maine Yankee, Yankee Rowe, Connecticut Yankee, Humboldt Bay, Big Rock Point, Rancho Seco, Trojan, La Crosse, Zion, Crystal River, Kewaunee, San Onofre, Vermont Yankee, Fort Calhoun, Oyster Creek, Pilgrim, Dresden, Morris, Indian Point, and Palisades. The 20 NPP sites use designs from 4 different suppliers, including 11 different (horizontal and vertical) storage systems that would require 10 different transportation cask designs. At the 20 NPP sites, a total of 48,646 SNF assemblies containing a total of 13,484.6 MTHM of SNF are forecast to be stored in 1089 storage canisters (actual plus estimated). In addition, 75 canisters (actual plus estimated) containing GTCC waste are forecast to be stored at these sites. Several issues were identified during the characterization of the SNF and GTCC waste inventory at the NPP sites. The most important of the issues was at the Rancho Seco site, where six damaged fuel assemblies in five of the storage canisters were not placed in failed fuel dry shielded canisters (FF-DSCs). Further evaluation would be needed to

[1] To the extent the discussions or recommendations in this report conflict with the provisions of the Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste, 10 CFR § 961.11, the Standard Contract provisions prevail.

[2] The Morris site is not a nuclear power plant site but stores SNF from nuclear power plants and is included in the 20 sites evaluated in this report.

[3] Removal of GTCC waste at NPP sites was analyzed in this report because the Court of Appeals for the Federal Circuit (Fed. Cir. 2008a, 2008b) has held that because the U.S. Nuclear Regulatory Commission (NRC) has determined by rule that, unless the NRC approves an alternative method, GTCC waste requires disposal in a geologic repository, such waste is considered high-level radioactive waste under the terms of the Standard Contract.

determine if the canisters containing this damaged fuel can be shipped in the MP187 transportation cask without repackaging.

The approved contents in the certificates of compliance for the TS125, HI-STAR 100, HI-STAR 100MB, MP187, and HI-STAR 190 transportation casks do not include GTCC waste. For GTCC waste to be shipped from the Big Rock Point, Rancho Seco, San Onofre, Vermont Yankee, Oyster Creek, Pilgrim, Dresden, Indian Point, and Palisades sites in these transportation casks, changes to the transportation certificates of compliance would be required. Additionally, the certificates of compliance for the TS125 and MP187 transportation casks would need to be updated from a -85 to a -96 designation before the transportation casks or impact limiters could be fabricated or alternative transportation casks with -96 designations used.

Twelve of the sites, Maine Yankee, Zion, Crystal River, Kewaunee, San Onofre, Vermont Yankee, Fort Calhoun, Oyster Creek, Pilgrim, Dresden, Indian Point, and Palisades have high burnup (>45 gigawatt-day per metric ton heavy metal [GWd/MTHM]) SNF assemblies in storage. At Maine Yankee and Zion, these high burnup SNF assemblies are packaged in damaged fuel cans, which eliminates the concern over the transportability of this high burnup fuel. High burnup SNF stored in 32PTH1 canisters at Crystal River, 24PT4 canisters at San Onofre, and 24PTH canisters at Palisades would be transportable in the MP197HB transportation cask. High burnup SNF stored in MPC-37 canisters at San Onofre and Palisades, and MPC-89 canisters at Oyster Creek would be transportable in the HI-STAR 190 transportation cask. High burnup SNF stored in MPC-32, MPC-68, MPC-68M, MPC-68F, and MPC-68FF canisters at the Indian Point, Vermont Yankee, Pilgrim, and Dresden sites would not be transportable without changes to the approved contents in the certificate of compliance for the HI-STAR 100 or HI-STAR 100MB transportation cask.

At the Palisades site, SNF is stored in MSB canisters in VSC-24 dry storage systems. The MSB canisters are not certified for transport by the NRC, and for this SNF stored in these canisters to be transported, they would need to be included in the list of approved contents in the certificate of compliance for a transportation cask.

All sites were found to have at least one off-site transportation mode option for removing their SNF and GTCC waste, and some sites have multiple options. Figure S-1 provides a summary of these transportation mode options for the NPP sites. NPP site experience with shipping large equipment and components to and from the NPP sites provided an important source of information in developing Figure S-1.

With the expansion of the site evaluations to include operating sites, additional site evaluations will be planned of both shutdown sites (Duane Arnold and Three Mile Island) and operating sites based on the oldest-fuel-first acceptance priority ranking contained in DOE (2004).

SITE	TRANSPORTATION MODE OPTIONS	
Maine Yankee	DIRECT RAIL	BARGE to RAIL
Yankee Rowe	HEAVY HAUL TRUCK to RAIL	
Connecticut Yankee	BARGE to RAIL	HEAVY HAUL TRUCK to RAIL
Humboldt Bay	HEAVY HAUL TRUCK to RAIL	HEAVY HAUL TRUCK to BARGE to RAIL
Big Rock Point	HEAVY HAUL TRUCK to RAIL	BARGE to RAIL
Rancho Seco	DIRECT RAIL	
Trojan	DIRECT RAIL	BARGE to RAIL
La Crosse	DIRECT RAIL	BARGE to RAIL
Zion	DIRECT RAIL	BARGE to RAIL
Crystal River	DIRECT RAIL	BARGE to RAIL
Kewaunee	HEAVY HAUL TRUCK to RAIL	HEAVY HAUL TRUCK to BARGE to RAIL
San Onofre	DIRECT RAIL	HEAVY HAUL TRUCK to BARGE to RAIL
Vermont Yankee	DIRECT RAIL	
Fort Calhoun	DIRECT RAIL	BARGE to RAIL
Oyster Creek	BARGE to RAIL	HEAVY HAUL TRUCK to RAIL
Pilgrim	BARGE to RAIL	HEAVY HAUL TRUCK to RAIL
Morris	DIRECT RAIL	HEAVY HAUL TRUCK to BARGE to RAIL
Dresden	DIRECT RAIL	BARGE to RAIL
Indian Point	HEAVY HAUL TRUCK to RAIL	BARGE to RAIL
Palisades	HEAVY HAUL TRUCK to RAIL	BARGE to RAIL

Figure S-1. Summary of Transportation Mode Options for Shipments from Nuclear Power Plant Sites

ACKNOWLEDGMENTS

The authors would like to thank the participants in the NPP site evaluations and the U.S. Department of Energy for sponsoring the NPP site evaluations. The authors would also like to thank the staff at the Maine Yankee, Yankee Rowe, Connecticut Yankee, Humboldt Bay, Big Rock Point, Rancho Seco, Trojan, La Crosse, Zion, Kewaunee, Crystal River, San Onofre, Vermont Yankee, Fort Calhoun, Oyster Creek, Pilgrim, Dresden, Morris, Indian Point, and Palisades sites, who graciously hosted the visits to the NPP sites, and the State and Tribal representatives who participated in the visits to the NPP sites. The authors would also like Pam Turner for coordinating logistics.

Name	Affiliation	Name	Affiliation
Peykan Abbassi	North County Transit District	David Lohman	Kewaunee
Mark D. Abkowitz	Vanderbilt University	Douglas G. Low	New England Central Railroad
Mark Abrahamson	Wisconsin State Patrol	Andrew Ludasi	New Jersey Department of Transportation
Jeanne Alfano	State of Connecticut	Joseph R. Lynch	Vermont Yankee
Mark Allen	Canadian National Railroad	Corinne J. Macaluso	U.S. Department of Energy
Dave Anderson	Pacific Northwest National Laboratory	Ken Mack	Dresden
John Arnold	Maine Yankee	Mark Maday	Federal Railroad Administration
Richard Arnold	Consolidated Group of Tribes and Organizations	James Madigan	San Onofre
Roberto Arroyo	Humboldt Bay	Eric Magnuson	Dresden
Mitch Arvidson	Council of State Governments-Midwest	Ted Maine	Fort Calhoun
James Ashley	Zion	Ziad Malhas	North County Transit District
Paul Ashley	U.S. Coast Guard	Steven Malinski	Indian Point
Mike Bailey	Palisades	Vincent Malkoski	Massachusetts Division of Marine Fisheries
P.J. Bailey	Housatonic Railroad	Matt Mann	Windham Regional Commission
Jennifer Bakker	Indian Point	Caitlin Marmion	Holtec
David Barajas	Canadian National Railroad	Mel Massaro	Federal Railroad Administration
Melissa C. Bates	U.S. Department of Energy	Paul E. McConnell	Sandia National Laboratories
Jaime Becerra	North County Transit District	Tim McDonald	Lacey Township
James Becker	Pacific Northwest National Laboratory	Anthony McFadden	Morris
Don Beckman	Zion	Laura McManniman	International Atomic Energy Agency
Stephanie Bentley	Indian Point	Brian McWilliams	Pilgrim
Bruce Bevard	Oak Ridge National Laboratory	Jeff Mears	Oneida Nation

Name	Affiliation	Name	Affiliation
Erica E. Bickford	U.S. Department of Energy	Christopher Melanson	State of Connecticut
Kevin Block	Palisades	Phillip Meraz	Iowa DOT Rail Transportation
Damon Blythe	North County Transit District	Traven Michaels	Little Traverse Bay Bands of Odawa Indians
Eric Boardman	Housatonic Railroad	Tom Miller	Oyster Creek
Robert Boeri	Massachusetts Office of Coastal Zone Management	Peter Miner	Pilgrim
John Bohac	Dresden	Robert M. Mitchell	Yankee Rowe
Christopher Bohren	Indian Point	Mike Mlynarek	Palisades
Jeff Borah	Palisades	Bob Montgomery	State of New York
Rick Boucher	New England Central Railroad	Bethany Moore	Humboldt Bay
Joe Bowen	Federal Railroad Administration	Jeffrey Moore	Federal Railroad Administration
Nick Boyd	Massachusetts Department of Transportation	Jim Moore	Pacific Sun Railroad
Cameron Bragg	Bragg Crane and Rigging	Tim Morehead	North County Transit District
Don Braman	State of Connecticut	Nigel Mote	Nuclear Waste Technical Review Board
Cornelia Brim	Pacific Northwest National Laboratory	John Moylan	Pilgrim
Maureen Brown	San Onofre	Robert Munger	San Onofre
Tim Brown	San Onofre Community Engagement Panel	Frank Myszewski	Florida Northern Railroad
J.B. Buksa	Bragg Crane and Rigging	Jonathan Nicastro	State of New York
Rich Burroni	Indian Point	Ken Niles	State of Oregon
Nancy Buschman	U.S. Department of Energy	William Nolin	State of New York
Kenneth A. Buxton	Pacific Northwest National Laboratory	Wayne A. Norton	Maine Yankee, Yankee Rowe, Connecticut Yankee
Joe Caccamo	Conrail	David Noyes	Pilgrim
Manuel Camargo	San Onofre	Mark Nutt	Pacific Northwest National Laboratory
Chris Campany	Windham Regional Commission	Patrick O’Brien	Pilgrim and Palisades
Robert Capstick	Maine Yankee, Yankee Rowe, Connecticut Yankee	Mike O'Connell	Oyster Creek
Joe Cascio	Holtec	Kate O’Connor	Vermont Nuclear Decommissioning Citizens Advisory Panel
Kathy Cederberg	Massachusetts Emergency Management Agency	Pat O'Donnell	State of New York
Paul Chadourne	Crystal River	Daniel Ogg	Nuclear Waste Technical Review Board
Mike Chappell	Van Buren County, Michigan	Rob Oglesby	California Energy Commission
Cliff Chapin	State of New York	Michael Olmstead	New England Central Railroad

Name	Affiliation	Name	Affiliation
Martin Cohn	Vermont Yankee	Cheryl Olson	La Crosse
Ryan Coholan	Massachusetts Bay Transportation Authority	Tim Olson	Kewaunee
Tammy Collinson	Fort Calhoun	Kevin O'Reilly	Pilgrim Nuclear Decomissioning Citizens Advisory Panel
Tom Congdon	Indian Point Decommissioning Oversight Board	David Pabst	State of Wisconsin
James Connell	Maine Yankee	Tom Palmisano	San Onofre
Kevin J. Connolly	Oak Ridge National Laboratory	Mike Parker	Pacific Northwest National Laboratory
Daniel Cook	Indian Point	Michelle Panos	Humboldt Bay
Billy Costa	Humboldt Bay	Jay Paquette	State of Michigan
Cynthia Costello	State of New York	Tony Parrish	Florida Northern Railroad
Pamela B. Cowan	Holtec	Bo Partney	Morris
Nick Culp	Palisades	Himanshu Patel	New Jersey Department of Transportation
Mark Cutter	U.S. Coast Guard	Lee Peddicord	Nuclear Waste Technical Review Board
Patrick Daly	Zion	Joseph Perusse	New York State Police
Suzanne D'Ambrosio	Oyster Creek	Alyse Peterson	State of New York
Pete Davin	Humboldt Bay	Kimberly Petry	U.S. Department of Energy
Briana DeBoer	U.S. Nuclear Regulatory Commission	Rodney Pitchford	State of Illinois
Kristi DeBoi	AREVA TN	Paul Plante	Maine Yankee, Yankee Rowe, Connecticut Yankee
Brandon De Graff	Dresden	Chris Podgurski	Massachusetts Coastal Railroad
Adam Deidel	Union Pacific Railroad	Ronald Pontes	San Onofre
Giancarlo Delfini	Indian Point	Mark Porfirio	State of Illinois
Nate DeMaster	Palisades	Lawrence R. Potter	Big Rock Point
Jeffrey Dostal	Oyster Creek	Jené Reese	Fort Calhoun
Scott Douglas	State of New Jersey	Jerry D. Reid	Trojan
Daniel Dove	Pilgrim	John Renda	Oyster Creek
August Dowling	Crystal River	Andrew Richards	Bragg Crane and Rigging
Pine du Bois	Pilgrim Nuclear Decommissioning Citizens Advisory Panel	Bob Richardson	New England Central Railroad
Dan Duggan	Canadian National Railroad	Richard Ridder	Kewaunee
Joseph Dwyer	Oyster Creek	Ralph Ritter	Oyster Creek
Donald G. Egge	La Crosse	Lauren Rodman	Tribal Radioactive Materials Transportation Committee
Steve Elledge	Canadian National Railroad	Parker Rodriguez	Housatonic Railroad
Teri Engelhart	State of Wisconsin	Einar T. Ronningen	Rancho Seco
Jeffery L. England	NAC International	Steven B. Ross	Pacific Northwest National Laboratory
Anthony Farrar	Massachusetts Coastal Railroad	Brian D. Rude	La Crosse

Name	Affiliation	Name	Affiliation
Alan Fata	Crystal River	Joy Russell	Holtec
John Feigl	Dresden	Kathleen Ryan	Indian Point
Matt Feldman	Pacific Northwest National Laboratory	Ben Salo	Union Pacific Railroad
Marc Fialkoff	Oak Ridge National Laboratory	John M. Scaglione	Oak Ridge National Laboratory
Don Filippi	North County Transit District	Julia Schmitt	Nebraska Department of Health and Human Services
Dennis Flores	Dresden	Keith Schultz	Palisades
Mike Firsick	State of Connecticut	Mark Sedevic	Canadian National Railroad
Jay P. Fischer	Trojan	Loren Sharp	Humboldt Bay
Alan Fisher	New Jersey Department of Transportation	Bill Shelton	North County Transit District
Scott Flake	Rancho Seco	Mike Shepard	Oyster Creek
Brayton Ford	U.S. Department of Energy	Mike Shepard	San Onofre
Gary Fowler	Bragg Crane and Rigging	Kailen Shores	Fort Calhoun
James Frank	Oyster Creek	Joshua Sisak	Oyster Creek
Becky Gaines	Rancho Seco	David Slauson	Canadian National Railroad
John Giarrusso	Massachusetts Emergency Management Agency	Brian Smith	Yankee Rowe
Jill Gibson	North County Transit District	Larisa Smith	Pacific Northwest National Laboratory
Wendy Gendron	U.S. Army Corps of Engineers	Mark Smith	Humboldt Bay
Astrid Glynn	Massachusetts Department of Transportation	Paul Smith	Pilgrim Nuclear Decomissioning Citizens Advisory Panel
Randall Granaas	San Onofre	Todd Smith	Maine Yankee, Yankee Rowe, Connecticut Yankee
Glenn Goode	Iowa DOT Motor Vehicle Enforcement	Sarah Snoeyink	Market Van Buren
Greg Gothard	State of Michigan	Gerald Snyder	U.S. Army Corps of Engineers
Veena Gubbi	State of New Jersey	Shane Sousa	Massachusetts Department of Transportation
John Guerci	Dominion	Frank Spagnuolo	Indian Point
Mike Hale	Kewaunee	Dan Sperling	Walker Brothers
James A. Hamilton	The Nuclear Decommissioning Collaborative	Dan Stetson	San Onofre Community Engagement Panel
Michael Hand	Oyster Creek	Brian Strickland	U.S. Army Corps of Engineers
Steve Hart	Conrail	Brian Sullivan	Holtec Decommissioning International
Matt Hassler	Oyster Creek	Greg Sutter	Crystal River
Shae Hemingway	Connecticut Yankee	Kenneth Swanger	Vermont Yankee
Justin Herrera	Crystal River	Peter N. Swift	Sandia National Laboratories

Name	Affiliation	Name	Affiliation
Thomas H. Higinbotham	State of Michigan	Susan Tackett	Pacific Northwest National Laboratory
David Hill	Massachusetts Department of Environmental Protection	Dan Tallman	Rancho Seco
Mike Hnatiuk	West Michigan Railroad	Ken Tavares	Plymouth Board of Selectmen
Kimberly Hobbs	Dresden	Ray Termini	Zion
Kevin Hogan	Michigan State Police	Jason Tharp	Palisades
Sara Hogan	U.S. Department of Energy	George Thomas	Vermont Yankee
Julie Holt	San Onofre	Kathy Treland	Council of State Governments-Midwest
Kelly Horn	State of Illinois	Herb Tritt	Oyster Creek
Robert L. Howard	Pacific Northwest National Laboratory	William J. Trubilowicz	La Crosse
Eric Howes	Maine Yankee	Mark Tursa	Trojan
Alissa Hudson	Argonne National Laboratory	James Unger	North County Transit District
Jerry Humphreys	State of New Jersey	Jim VanLooven	Trojan
Teddy Hutchison	Fort Calhoun	Gerard van Noordennen	Zion
Tracy Ikenberry	Pacific Northwest National Laboratory	Uldis Vanags	Council of State Governments-Eastern Regional Conference
Gerard Jackson	U.S. Department of Energy	Brian Vangor	Indian Point
Mike Jacobs	Pilgrim	Bob VanWagner	Big Rock Point
Sam Jammal	Camp Pendleton	Valarie Velasquez	Pacific Northwest National Laboratory
Lisa Janairo	Council of State Governments-Midwest	Brian Vercruysse	State of Illinois
Joshua J. Jarrell	Idaho National Laboratory	David Victor	San Onofre Community Engagement Panel
Darin Jeanquart	Kewaunee	Dennis Vinson	Savannah River National Laboratory
Philip J. Jensen	Pacific Northwest National Laboratory	John Viveiros	Massachusetts Emergency Management Agency
Ian Johnson	Bragg Crane and Rigging	Jay Vouglitois	State of New Jersey
Matt Johnson	Indian Point	Brad Wagner	Nebraska State Patrol
Ron Johnson	Prairie Island Indian Community	John C. Wagner	Idaho National Laboratory
David Johnston	Massachusetts Department of Environmental Protection	Brian Wakeman	Dominion
Steven Johnston	Oyster Creek	D.J. Walker	Dresden
Jay G. Jones	U.S. Department of Energy	Michael Walsh	U.S. Army Corps of Engineers
Skip Jordan	Kewaunee	Joan Walter	State of California
Tom Kaczmarek	Indian Point Decommissioning Oversight Board	Dillard Waring	New York State Police
Elena Kalinina	Sandia National Laboratories	David Weeden	Mashpee Wampanoag Tribe

Name	Affiliation	Name	Affiliation
Jennifer Kanine	Pokagon Band of Potawatomi Tribe	Christopher Wells	Southern States Energy Board
Greg Kaylor	New Hampshire	Carmen Wells Quigg	University of Michigan
Mike Kempski	Indian Point	Heather Westra	Prairie Island Indian Community
Ellen Kennedy	Pacific Northwest National Laboratory	Bob Weyers	Bragg Heavy Transport
Doug Kimmel	State of Michigan	Jack Wheeler	U.S. Department of Energy
Daniel King	Oneida Nation	Guy Wiggins	Palisades
James Kranik	New York State Police	Frederick N. Williams	Zion
Lee Kshywonis	Fort Calhoun	James M. Williams	Western Interstate Energy Board
Stephen LaJoice	Big Rock Point	Jeffrey R. Williams	U.S. Department of Energy
Martin Langeveld	Vermont Nuclear Decommissioning Citizens Advisory Panel	Ivan Wilson	Crystal River
J. Gary Lanthrum	NAC International	Ryan Wohldmann	Dresden
Valerie Laudeman	Oyster Creek	Mei Wong	State of Connecticut
Lee Laurendeau	Holtec	Brian Wood	Zion
C.J. Lauterbur	Morris	Mary J. Woolen	Consultant
Mark Lawson	Pilgrim	Jan Wyckoff	BNSF (Retired)
Suzanne Leblang	Big Rock Point	Michael Wygant	North County Transit District
Daniel R. Leduc	Savannah River National Laboratory	Ken Yale	State of Michigan
James Lenois	Connecticut Yankee	Dave Yorke	Yankee Rowe
Tony Leshinskie	Vermont	Stewart Yuen	Kewaunee
Tim Lesniak	New England Central Railroad	Brian Zandstra	Indian Point
Eric Levin	Conrail	William Zipp	Kewaunee
Shane Lies	DC Cook	Rick Zuffa	State of Illinois

CONTENTS

FIGURES

TABLES

ACRONYMS

AC&T	American Cranes & Transport
ADAMS	U.S. Nuclear Regulatory Commission Agencywide Documents Access and Management System
BWR	boiling water reactor
CN	Canadian National Railway
CSI	Criticality Safety Index
CY	Connecticut Yankee
DOE	U.S. Department of Energy
DSI	DeskMap Systems, Inc.
EIA	Energy Information Agency
EPRI	Electric Power Research Institute
FC-DSC	fuel with control component dry shielded canister
FF-DSC	failed fuel dry shielded canister
FO-DSC	fuel only dry shielded canister
GTCC	greater-than-Class C
GWd/MTHM	gigawatt-day per metric ton heavy metal
HBHRCD	Humboldt Bay Harbor, Recreation & Conservation District
IAEA	International Atomic Energy Agency
ISFSI	independent spent fuel storage installation
MCBCP	Marine Corps Base Camp Pendleton
MPC	multipurpose canister
MSB	multi-assembly sealed basket
MTC	MSB transfer cask
MTHM	metric tons heavy metal
MWe	megawatt electric
MWt	megawatt thermal
NCTD	North County Transit District
NRC	U.S. Nuclear Regulatory Commission
PG&E	Pacific Gas and Electric Company
PWR	pressurized water reactor
QA	quality assurance
SCRRA	Southern California Regional Rail Authority

SNF	spent nuclear fuel
STB	Surface Transportation Board
STC	storage transport cask
TN	Transnuclear, Inc.
TOM	Transportation Operations Model
TOPO	Transportation Operations Project Office
TSC	Transportable Storage Canister
USACE	U.S. Army Corps of Engineers
UTC	Universal Transport Cask
VCC	ventilated concrete cask or vertical concrete cask

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OFFICE OF INTEGRATED WASTE MANAGEMENT

Nuclear Power Plant Infrastructure Evaluations for Removal of Spent Nuclear Fuel

1. INTRODUCTION

This report provides evaluations of the nuclear power plant (NPP) site infrastructure and near-site transportation infrastructure for removing spent nuclear fuel (SNF) from 19 NPP sites and the Morris ISFSI.[1,2] The locations of the sites are shown in Figure 1-1. The material to be removed from the NPP sites and the Morris ISFSI includes both the SNF and the greater-than-Class C low-level radioactive waste (GTCC waste)[3] that is stored, or will be stored, at the sites.

The evaluation was divided into four components:

- characterization of the SNF and GTCC waste inventory
- a description of the on-site infrastructure and conditions relevant to transportation activities
- an evaluation of the near-site transportation infrastructure and experience relevant to shipping transportation casks containing SNF from the NPP sites
- identification of future information needs.

Section 2 contains the site evaluations and is organized by site. Subsections contain information on the SNF inventory (e.g., discharge date and burnup), damaged fuel, high burnup fuel, dry storage systems, potential transportation casks, and on-site-infrastructure and equipment at the site; information on the near-site transportation infrastructure around the site, such as roads, railroads, barge facilities (e.g., slips or docks), and potential transload locations; information on shipping large equipment to and from the site, such as reactor pressure vessels, steam generators, pressurizers, and transformers; and future information needs, such as transportation cask certificate of compliance revisions, issues associated with the transportation infrastructure near the site, and potential transload locations.

Section 3 identifies transportation mode options for removing SNF from the sites.

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[1] To the extent the discussions or recommendations in this report conflict with the provisions of the Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste, 10 CFR § 961.11, the Standard Contract provisions prevail.

[2] The Morris site is not a nuclear power plant site but stores SNF from nuclear power plants and is included in the 20 sites evaluated in this report.

[3] In the SNF litigation, the Court of Appeals for the Federal Circuit (Fed. Cir. 2008a, 2008b) has held that because the U.S. Nuclear Regulatory Commission (NRC) has determined by rule that, unless the NRC approves an alternative method, GTCC waste requires disposal in a geologic repository, such waste is considered high-level radioactive waste under the terms of the Standard Contract. Accordingly, for purposes of this report, the removal of GTCC waste along with SNF at NPP sites was analyzed.

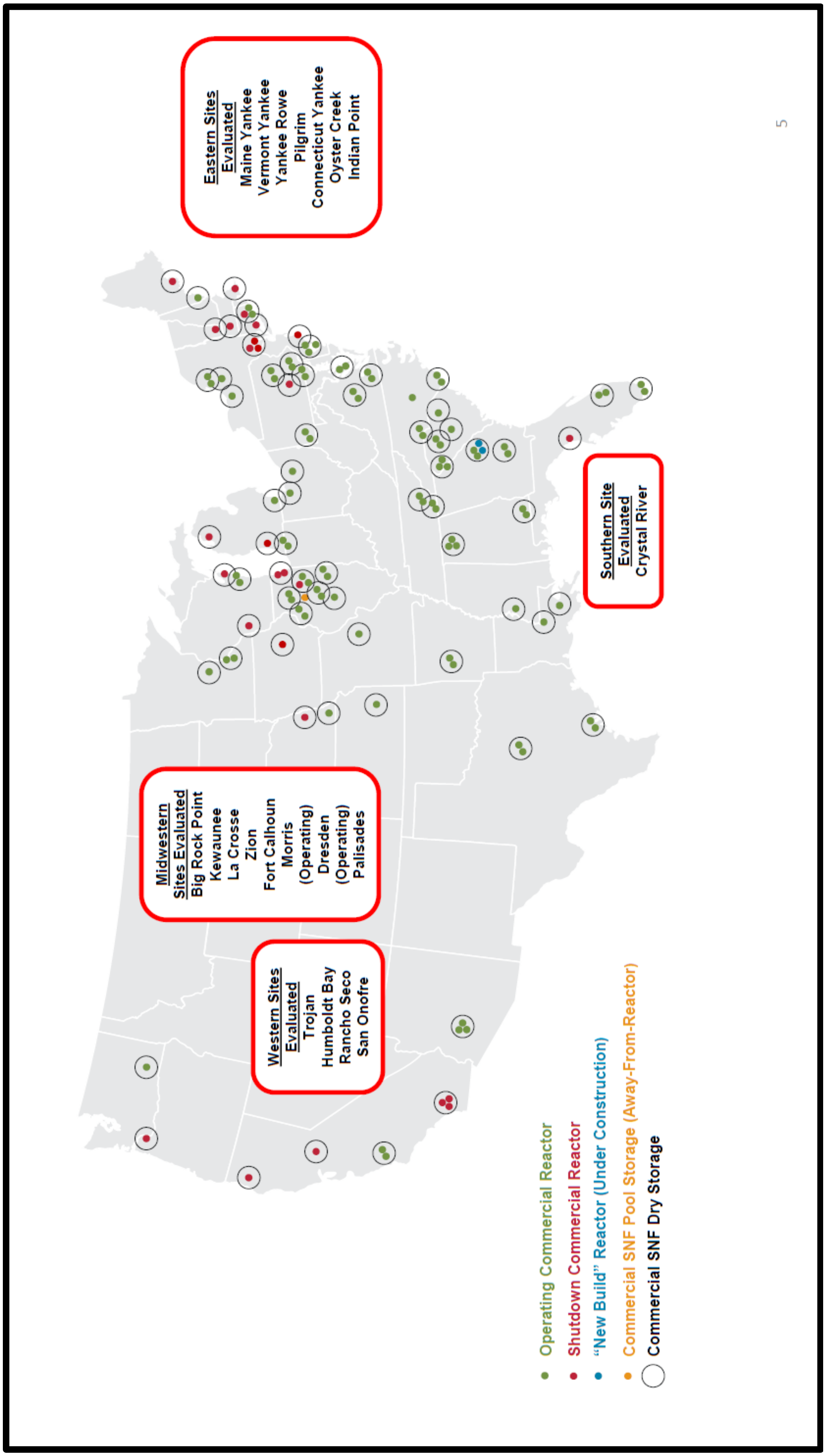

Figure 1-1. Locations of Nuclear Power Plant Sites Evaluated

2. SITE INVENTORY, SITE CONDITIONS, NEAR-SITE TRANSPORTATION INFRASTRUCTURE AND EXPERIENCE, AND FUTURE INFORMATION NEEDS

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the NPP sites. The primary sources for the inventory of SNF and GTCC waste are the GC-859 database (EIA 2018), industry sources such as *StoreFUEL* and *SpentFUEL*, and government sources such as the NRC. The primary sources for the information on the site conditions and near-site transportation infrastructure and experience include site visits to the Maine Yankee, Yankee Rowe, Connecticut Yankee, Humboldt Bay, Big Rock Point, Rancho Seco, Trojan, La Crosse, Zion, Crystal River, Kewaunee, San Onofre, Vermont Yankee, Fort Calhoun, Oyster Creek, Pilgrim, Dresden, Indian Point, and Palisades NPP sites, and the Morris ISFSI; information provided by managers at the NPP sites; Facility Interface Data Sheets compiled for the U.S. Department of Energy (DOE) in 2005 (TriVis Incorporated 2005); Services Planning Documents prepared for DOE in 1993 and 1994; industry publications such as *Radwaste Solutions*; and Google Earth (Google 2022).

Table 2-1 lists the characteristics of the NPPs at the sites. These reactors operated between the years 1960 and 2022. Nine of the reactors (Humboldt Bay, Big Rock Point, La Crosse, Vermont Yankee, Oyster Creek, Pilgrim, and Dresden-1, -2, and -3) were boiling water reactors and 17 of the reactors were pressurized water reactors (Maine Yankee, Yankee Rowe, Connecticut Yankee, Rancho Seco, Trojan, Zion-1 and -2, Crystal River, Kewaunee, San Onofre-1, -2, and -3, Fort Calhoun, Indian Point-1, -2, and -3, and Palisades). The licensed capacities for these reactors ranged from 165 to 3438 MWt (48 to 1095 MWe). The Morris site is not a nuclear power plant site but stores SNF from nuclear power plants.

Figure 2-1 illustrates the number of canisters and type of storage canisters containing SNF and GTCC waste that are stored or will be stored at each of the NPP sites. The number of SNF and GTCC waste canisters stored at Maine Yankee, Yankee Rowe, Connecticut Yankee, Humboldt Bay, Big Rock Point, Rancho Seco, Trojan, La Crosse, Zion, Oyster Creek, and Pilgrim represent actual canisters in storage. The number of SNF canisters at Kewaunee, Crystal River, San Onofre, Vermont Yankee, and Fort Calhoun represents the actual canisters in storage. The number of SNF canisters at Indian Point, Palisades, and Dresden represents an estimate of the number of canisters that will be stored at the conclusion of canister loading and the number of GTCC waste canisters at Crystal River, Kewaunee, San Onofre, Vermont Yankee, Fort Calhoun, Indian Point, and Palisades represents an estimate of the number of canisters generated during decommissioning. There are expected to be a total of 1164 canisters in storage (actual plus estimated). The number of canisters ranges from 5 at La Crosse to an estimated 230 at Dresden. This estimate does not include the SNF stored at the Morris site because the SNF is stored in spent fuel pools and is not in dry storage canisters.

Table 2-1. Characteristics of Nuclear Power Plant Site Reactors

Site Location[a]	Reactor Type[a]	MWt[a]	MWe (net)[b,c]	Operating Period[b,d]
Maine Yankee, Wiscasset, Maine	PWR	2700	860	1972-1996
Yankee Rowe, Rowe, Massachusetts	PWR	600	167	1961-1991
Connecticut Yankee, Haddam Neck, Connecticut	PWR	1825	560	1968-1996
Humboldt Bay, Eureka, California	BWR	200	63	1963-1976
Big Rock Point, Charlevoix, Michigan	BWR	240	67	1963-1997
Rancho Seco, Herald, California	PWR	2772	873	1975-1989
Trojan, Rainier, Oregon	PWR	3411	1095	1976-1992
La Crosse, Genoa, Wisconsin	BWR	165	48	1969-1987
Zion 1, Zion, Illinois	PWR	3250	1040	1973-1997
Zion 2, Zion, Illinois	PWR	3250	1040	1974-1996
Crystal River, Crystal River, Florida	PWR	2609	860	1977-2009
Kewaunee, Carlton, Wisconsin	PWR	1772	566	1974-2013
San Onofre-1, San Clemente, California	PWR	1347	436	1968-1992
San Onofre-2, San Clemente, California	PWR	3438	1070	1983-2013
San Onofre-3, San Clemente, California	PWR	3438	1080	1984-2013
Vermont Yankee, Vernon, Vermont	BWR	1912	605	1972-2014
Fort Calhoun, Fort Calhoun, Nebraska	PWR	1500	482	1973-2016
Oyster Creek, Forked River, New Jersey	BWR	1930	619	1969-2018
Pilgrim, Plymouth, Massachusetts	BWR	2028	677	1972-2019
Dresden-1, Morris, Illinois	BWR	700	197	1960-1978
Dresden-2, Morris, Illinois	BWR	2957	957	1970-Present
Dresden-3, Morris, Illinois	BWR	2957	957	1971-Present
Morris Independent Spent Fuel Storage Installation, Morris, Illinois[e]	PWR and BWR	–	–	1982-Present
Indian Point-1, Buchanan, New York	PWR	615	257	1962-1974
Indian Point-2, Buchanan, New York	PWR	3216	998	1974-2020
Indian Point-3, Buchanan, New York	PWR	3216	1030	1976-2021
Palisades, Covert, Michigan	PWR	2565	805	1971-2022

a. Source: NRC (2021)
b. Source: IAEA (2023)
c. Reference unit power from IAEA (2023).
d. The operating period represents the date of commercial operation to the date of shutdown.
e. The Morris site is not a nuclear power plant site but stores SNF from nuclear power plants.
PWR= pressurized water reactor
BWR= boiling water reactor

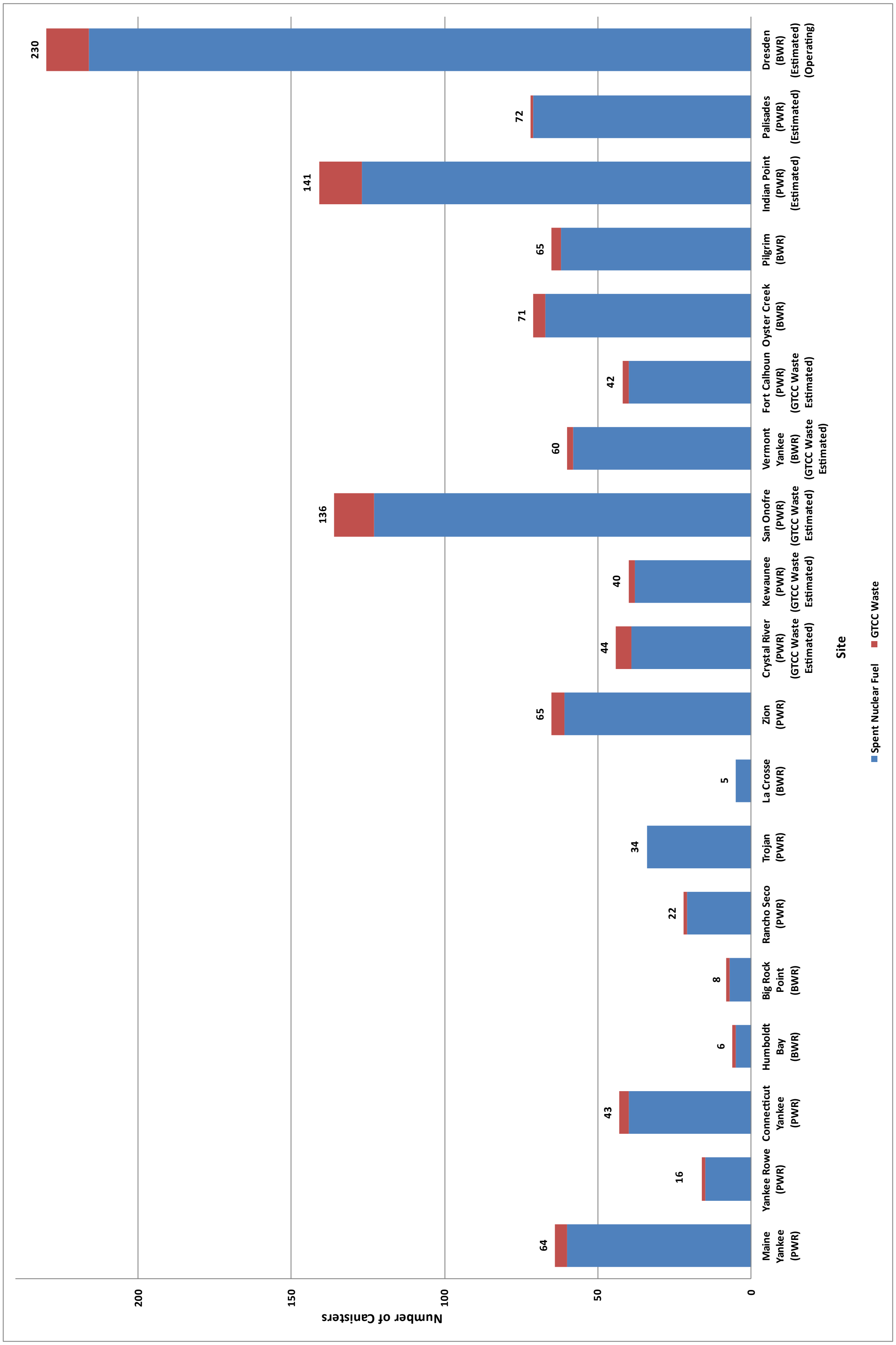

Figure 2-1. Number of Canisters at Nuclear Power Plant Sites

Figure 2-2 illustrates the number of SNF assemblies stored at each site. There are a total of 48,646 SNF assemblies present at the 19 NPP sites and the Morris ISFSI. These assemblies are composed of 20,592 pressurized water reactor assemblies and 28,054 boiling water reactor assemblies. The number of assemblies ranges from 333 at La Crosse to 11,529 at Dresden. The majority (46,476) of the SNF assemblies are zirconium alloy-clad;[4] but Yankee Rowe, Connecticut Yankee, La Crosse, San Onofre-1, Indian Point, and Morris have 2,170 stainless steel-clad SNF assemblies in storage.

Figure 2-2 also illustrates the same information in terms of the metric tons of heavy metal stored at each site. A total of 13484.6 metric tons heavy metal (MTHM) of SNF at the NPP sites and the Morris ISFSI consists of 8623.5 MTHM of pressurized water reactor SNF and 4861.0 MTHM of boiling water reactor SNF. The number of assemblies and MHTM of SNF at each site were obtained from the GC-859 database (EIA 2018), from information provided by the NPP sites, and from projections made using the U.S. Commercial Spent Fuel Projection Tool (Vinson 2015), and may not include material such as fuel debris and failed fuel rods that may also be present in the storage canisters at the NPP sites.

Table 2-2 lists the storage systems used at the NPP sites and the corresponding transportation casks that are certified to ship the storage canisters containing SNF and GTCC waste at each of the sites and Figure 2-3 illustrates the number of canisters that are associated with each transportation cask.[5] Out of the 10 transportation cask designs listed in Table 2-2 and Figure 2-3, only four types have been fabricated for U.S. use: the HI-STAR HB, the MP187, the HI-STAR 100,[6] and the MP197HB. The HI-STAR HB can only be used to ship SNF from the Humboldt Bay site. The MP187 can be used to ship SNF from the Rancho Seco and San Onofre sites. The HI-STAR 100 casks that have been fabricated are already being used as storage casks at the Dresden and Hatch sites (Ux Consulting 2017). For these HI-STAR 100 casks to be used to ship SNF from the Trojan, Vermont Yankee, or Pilgrim sites, they would need to be unloaded, their contents placed in other storage overpacks, and the casks transported to the Trojan, Vermont Yankee, or Pilgrim sites. It would also be necessary to procure impact limiters and spacers for these HI-STAR 100 casks. Six NAC-STC transportation casks have been fabricated for use in China, but not for use in the United States. An MP197HB transportation cask has been fabricated and is in use in the U.S. In addition, the MSB canisters contained in the VSC-24 dry storage systems at Palisades are not certified for transport by the NRC.

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[4] The term zirconium alloy clad encompasses Zircaloy-2, Zircaloy-4, ZIRLO, and M5 clad assemblies.

[5] Appendix A lists the docket number, package identification number, revision number, certificate of compliance expiration date, and the U.S. Nuclear Regulatory Commission Agencywide Documents Access and Management System (ADAMS) accession number for the transportation casks certified to transport SNF from the NPP sites; the docket number, certificate of compliance number issue date, certificate of compliance expiration date, amendment number, amendment effective date, and ADAMS accession number for the general licensed storage systems used at the NPP sites; and the license number, docket number, license issue date, license expiration date, amendment number, amendment date, and ADAMS accession number for the Humboldt Bay, Rancho Seco, and Trojan site-specific licenses. Appendix B presents a summary of state permitting requirements for oversize and overweight truck shipments in California, Connecticut, Florida, Illinois, Maine, Massachusetts, Michigan, Nebraska, New Jersey, New York, Oregon, Pennsylvania, Vermont, and Wisconsin.

[6] Impact limiters have not been fabricated for these transportation casks.

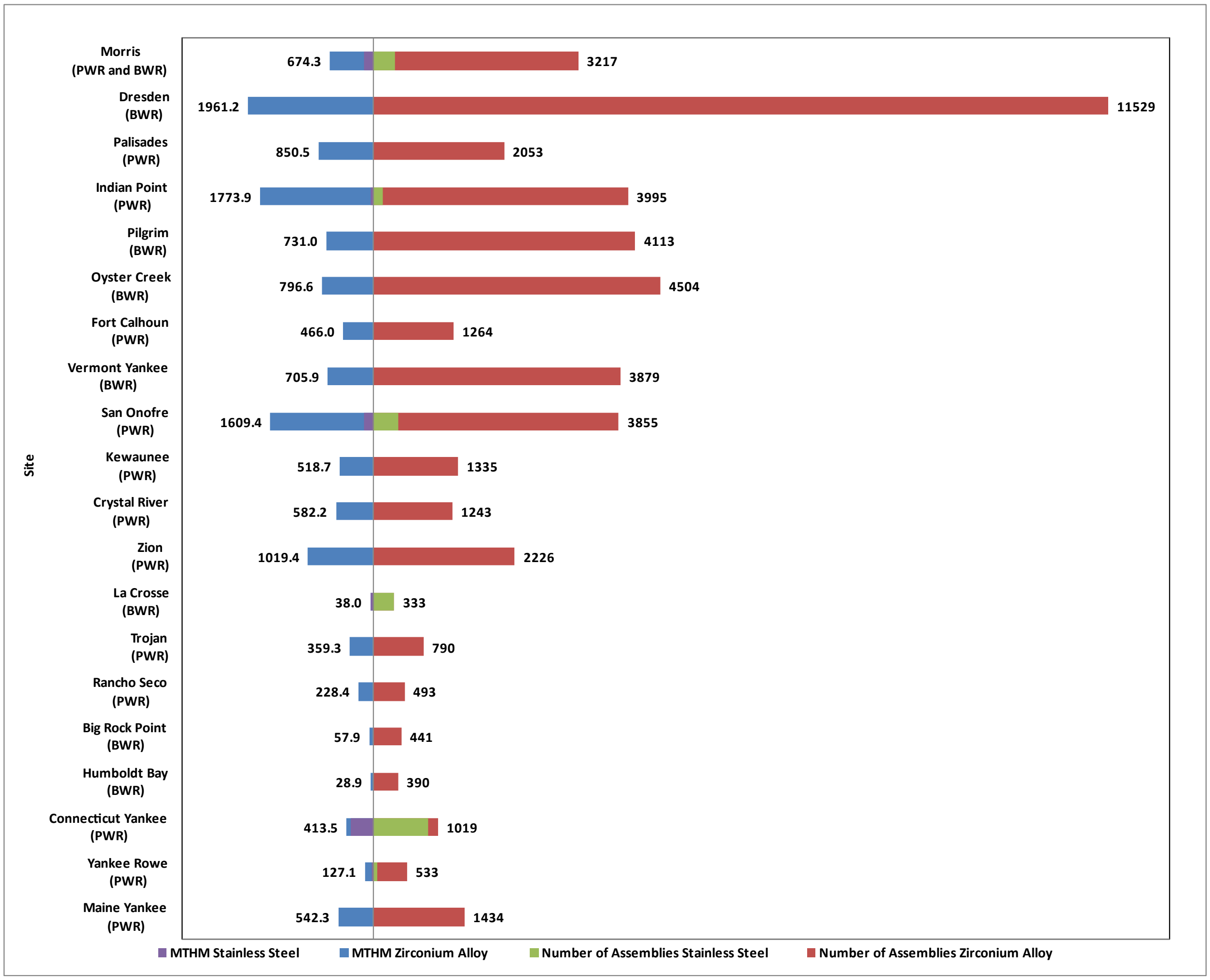

Figure 2-2. Number of Assemblies and MTHM by Cladding Type at Nuclear Power Plant Sites

Table 2-2. Storage Systems and Transportation Casks Used at Nuclear Power Plant Sites

Reactor Site	Type	ISFSI Load Dates[a]	Storage System/Canister(s)	Transportation Cask Status	Canisters SNF/GTCC
Maine Yankee	PWR	2002-2004	NAC-UMS/transportable storage canisters	NAC-UMS UTC (Docket No. 71-9270) None fabricated.	60/4
Yankee Rowe	PWR	2002-2003	NAC-MPC/Yankee-MPC transportable storage canisters	NAC-STC (Docket No. 71-9235) Foreign use versions fabricated.	15/1
Connecticut Yankee	PWR	2004-2005	NAC-MPC/CY-MPC transportable storage canisters	NAC-STC (Docket No. 71-9235) Foreign use versions fabricated.	40/3
Humboldt Bay	BWR	2008-2008	Holtec HI-STAR HB/MPC-HB canisters	HI-STAR HB (Docket No. 71-9261) Fuel in canisters in fabricated casks. No impact limiters.	5/1
Big Rock Point	BWR	2002-2003	Fuel Solutions W150 Storage Overpack/W74 Canisters	TS125 (Docket No. 71-9276) None fabricated.	7/1
Rancho Seco	PWR	2001-2002	TN NUHOMS/FO-DSC, FC-DSC, and FF-DSC canisters	MP187 (Docket No. 71-9255) One cask fabricated. No impact limiters.	21/1
Trojan	PWR	2002-2003	TranStor Storage Overpack/Holtec MPC-24E and MPC-24EF canisters	HI-STAR 100 (Docket No. 71-9261) Units fabricated but dedicated to storage at other sites. No impact limiters or spacers.	34/0
La Crosse	BWR	2012-2012	NAC MPC-LACBWR/MPC-LACBWR transportable storage canisters	NAC-STC (Docket No. 71-9235) Foreign use versions fabricated.	5/0
Zion 1 and 2	PWR	2013-2015	NAC MAGNASTOR/TSC-37 canisters	MAGNATRAN (Docket No. 71-9356) None fabricated.	61/4
Crystal River	PWR	2017-2018	TN Standardized NUHOMS/32PTH1 canisters	MP197HB (Docket No. 71-9302) One cask fabricated.	39/5[b,c]
Kewaunee	PWR	2009-2014	TN Standardized NUHOMS/32PT canisters	MP197HB (Docket No. 71-9302) One cask fabricated.	14/2[b,c]
Kewaunee	PWR	2017-2017	NAC MAGNASTOR/TSC-37 canisters	MAGNATRAN (Docket No. 71-9356) None fabricated.	24/0
Kewaunee Total					38/2

Table 2-2. (contd.)

Reactor Site	Type	ISFSI Load Dates[a]	Storage System/Canister(s)	Transportation Cask Status	Canisters SNF/GTCC
San Onofre-1	PWR	2003-2005	TN Standardized Advanced NUHOMS/24PT1 canisters	MP187(Docket No. 71-9255) One cask fabricated. No impact limiters.	17/1
San Onofre-2 and -3	PWR	2007-2012	TN Standardized Advanced NUHOMS/24PT4 canisters and Radioactive Waste Containers (RWCs)	MP197HB (Docket No. 71-9302) One cask fabricated.	33/12[b,c]
San Onofre-2 and -3	PWR	2018-2020	Holtec HI-STORM UMAX/MPC-37 canisters	HI-STAR 190 (Docket No. 71-9373) None fabricated.	73/0
San Onofre Total					123/13
Vermont Yankee	BWR	2008-2018	Holtec HI-STORM 100S/MPC-68 and MPC-68M canisters	HI-STAR 100 (Docket No. 71-9261) Units fabricated but dedicated to storage at other sites. No impact limiters or spacers.	58/2[b,c]
Fort Calhoun	PWR	2006-2020	TN Standardized NUHOMS/32PT canisters	MP197HB (Docket No. 71-9302) One cask fabricated.	40/2[b,c]
Oyster Creek	BWR	2002-2018	TN Standardized NUHOMS/61BT and 61BTH canisters	MP197HB (Docket No. 71-9302) One cask fabricated.	34/0
Oyster Creek	BWR	2021	Holtec HI-STORM FW/MPC-89 canisters	HI-STAR 190 (Docket No. 71-9373) None fabricated.	33/4[c,d]
Oyster Creek Total					67/4
Pilgrim	BWR	2015-2022	Holtec HI-STORM 100S/MPC-68 and MPC-68M canisters	HI-STAR 100 (Docket No. 71-9261) Units fabricated but dedicated to storage at other sites. No impact limiters or spacers.	62/3[c,d]
Indian Point	PWR	2008-2021	Holtec HI-STORM 100/MPC-32 canisters	HI-STAR 100 (Docket No. 71-9261) Units fabricated but dedicated to storage at other sites. No impact limiters or spacers.	54/14[b]
Indian Point	PWR	2021-Ongoing	Holtec HI-STORM 100/MPC-32M canisters	HI-STAR 100MB (Docket No. 71-9378) None fabricated.	73/0[b]
Indian Point Total					127/14[d]

Table 2-2. (contd.)

Reactor Site	Type	ISFSI Load Dates[a]	Storage System/Canister(s)	Transportation Cask Status	Canisters SNF/GTCC
Palisades	PWR	1993-1999	EnergySolutions VSC-24/MSB canisters	MSB canisters are not certified by the NRC for transport.	18/0
Palisades	PWR	2004-2005 2008-2011	TN Standardized NUHOMS/24PTH and 32PT canisters	MP197HB (Docket No. 71-9302) One cask fabricated.	24/0[b]
Palisades	PWR	2016-Ongoing	Holtec HI-STORM FW/MPC-37 canisters	HI-STAR 190 (Docket No. 71-9373) None fabricated.	29/1[b,d]
Palisades Total					71/1
Dresden	BWR	2000-Ongoing	Holtec HI-STORM 100/MPC-68, MPC-68M, MPC-68F, MPC-68FF canisters Holtec HI-STAR 100/MPC-68 canisters	HI-STAR 100 (Docket 71-9261) Units fabricated but dedicated to storage. No impact limiters or spacers. HI-STAR 100MB (Docket No. 71-9378) None fabricated	216/14[b,c]
Total					1089/75

a. Dates represent the dates that the SNF was transferred to the ISFSI.
b. Estimated.
c. Additional canisters of GTCC waste could be generated during decommissioning.
d. GTCC waste stored in HI-SAFE dry storage systems.
BWR= boiling water reactor
GTCC= greater-than-Class C low-level radioactive waste
ISFSI= independent spent fuel storage installation
PWR= pressurized water reactor
SNF= spent nuclear fuel

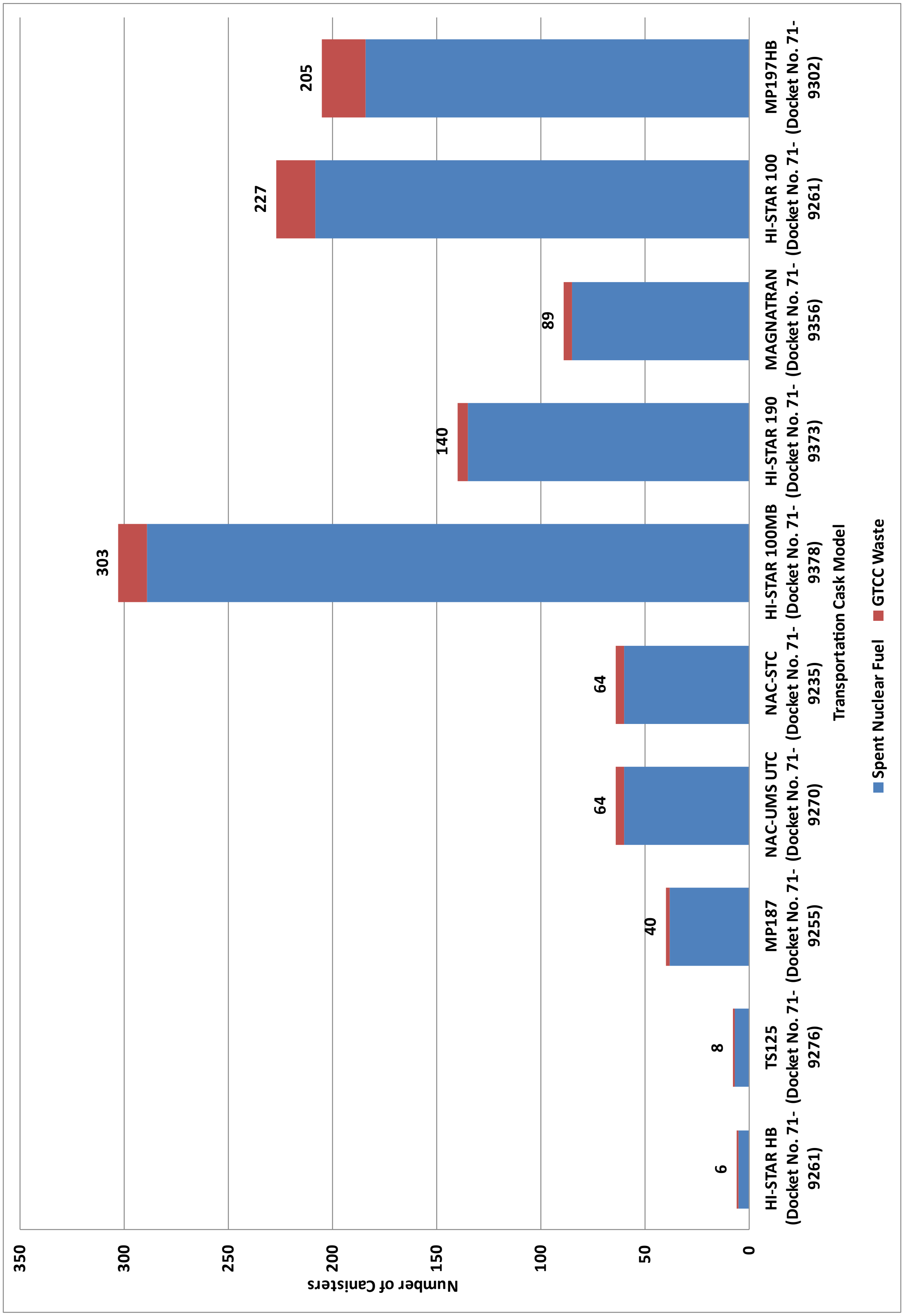

Figure 2-3. Number of Canisters at Nuclear Power Plant Sites Associated with Ten Transportation Cask Models

2.1 Maine Yankee

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the Maine Yankee site. The Maine Yankee site is about 25 miles south of Augusta and about 45 miles north of Portland, Maine (TOPO 1993a).

2.1.1 Site Inventory

Sixty canisters containing 1434 SNF assemblies (542.3 MTHM), 2 consolidated fuel rod containers, and 2 failed fuel rod containers (i.e., damaged fuel cans[7]) and 4 canisters of GTCC waste are stored at the Maine Yankee ISFSI (Docket No. 72-30). Figure 2-4 shows the Maine Yankee ISFSI. The storage system used at Maine Yankee is the NAC-UMS system (Docket No. 72-1015), which consists of a transportable storage canister, a vertical concrete storage cask, and a transfer cask. The transportable storage canister holds 24 pressurized water reactor SNF assemblies. The fuel assemblies from Maine Yankee were loaded into transportable storage canisters from August 2002 through March 2004 (Leduc 2012). The fuel assemblies have zirconium alloy-clad fuel rods. The transportation cask that is certified to transport the canisters containing this SNF or GTCC waste is the NAC-UMS Universal Transport Cask (UTC) Package (Docket No. 71-9270). No NAC-UMS UTC transportation casks have been fabricated.

A failed canister overpack is also present at the Maine Yankee site (see Figure 2-5). The failed canister overpack is a bolted closure overpack that may be used to remediate a postulated canister leak without the need to access a spent fuel pool. The sealed failed canister overpack is capable of providing an additional confinement boundary for a postulated leaking canister inside a vertical concrete storage cask. The failed canister overpack is not licensed for storage in the NAC-UMS storage system and is not certified for transport in the NAC-UMS UTC transportation cask.

Figure 2-6 illustrates the number of SNF assemblies and MTHM at Maine Yankee based on discharge year. The oldest fuel was discharged in 1974 and the last fuel was discharged in 1996. The median discharge year of the fuel is 1984.

Figure 2-7 illustrates the number of SNF assemblies at Maine Yankee and MTHM based on burnup. The lowest burnup is 2.8 gigawatt-day per metric ton heavy metal (GWd/MTHM) and the highest burnup is 49.2 GWd/MTHM. The median burnup is 32.1 GWd/MTHM. SNF with a burnup greater than 45 GWd/MTHM is termed as high burnup SNF by the NRC. There are 90 of these high burnup SNF assemblies (33.9 MTHM) at Maine Yankee. These high burnup SNF assemblies were packaged in Maine Yankee Fuel Cans (i.e., damaged fuel cans, see Figure 2-8 through Figure 2-10) and were loaded in the four basket corner positions in the transportable storage canisters. Twenty-three transportable storage canisters containing high burnup SNF are stored at Maine Yankee. There are also 12 transportable storage canisters containing 43 damaged fuel assemblies in damaged fuel cans stored at Maine Yankee.

[7] A damaged fuel can is a stainless steel container that confines damaged spent nuclear fuel. A damaged fuel can is closed on its end by screened openings. These screened openings allow gaseous and liquid media to escape but minimize the dispersal of gross particulate material.

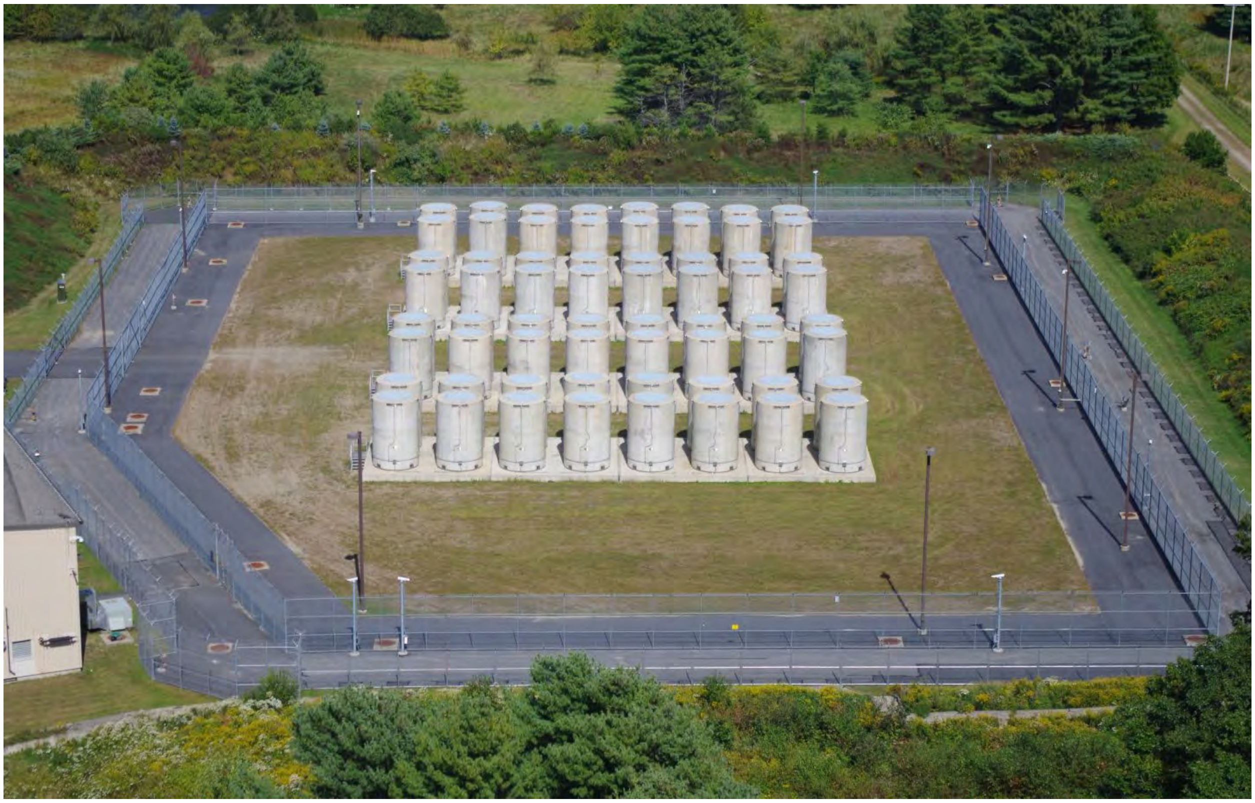

Photo courtesy of Maine Yankee

Figure 2-4. Maine Yankee Independent Spent Fuel Storage Installation (2014)

Photo courtesy of Maine Yankee

Figure 2-5. Failed Canister Overpack at Maine Yankee Site

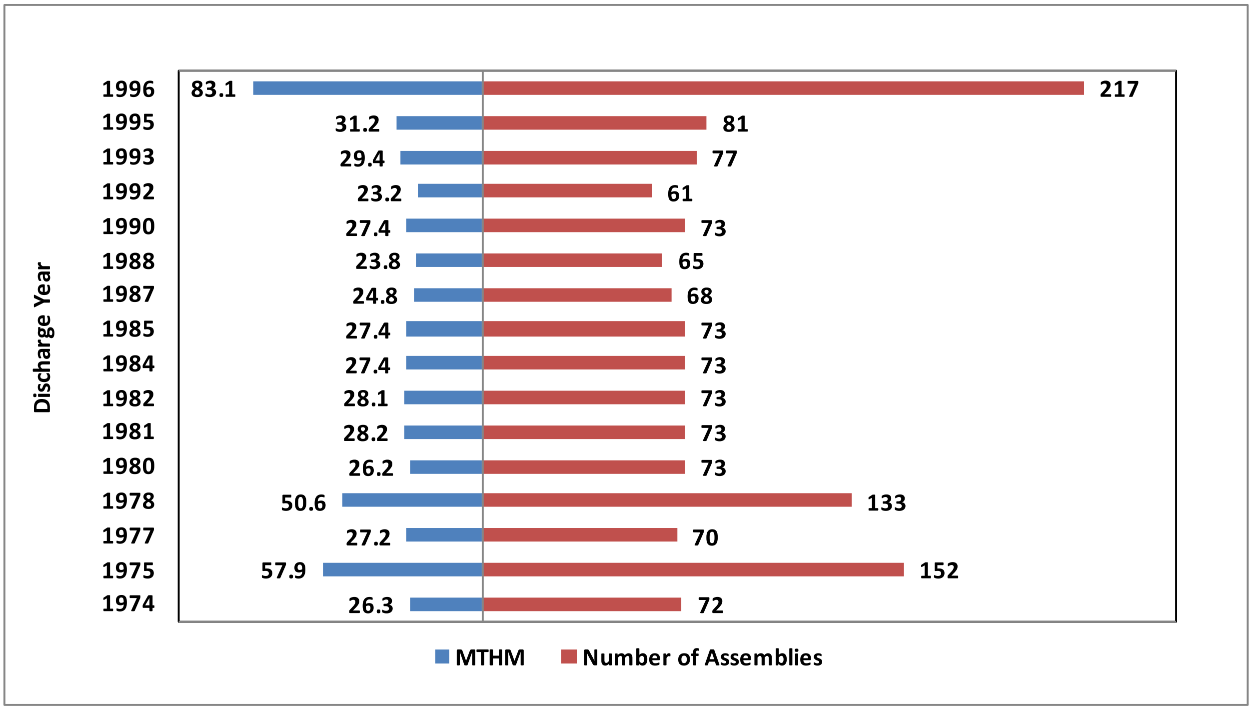

Figure 2-6. Maine Yankee Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

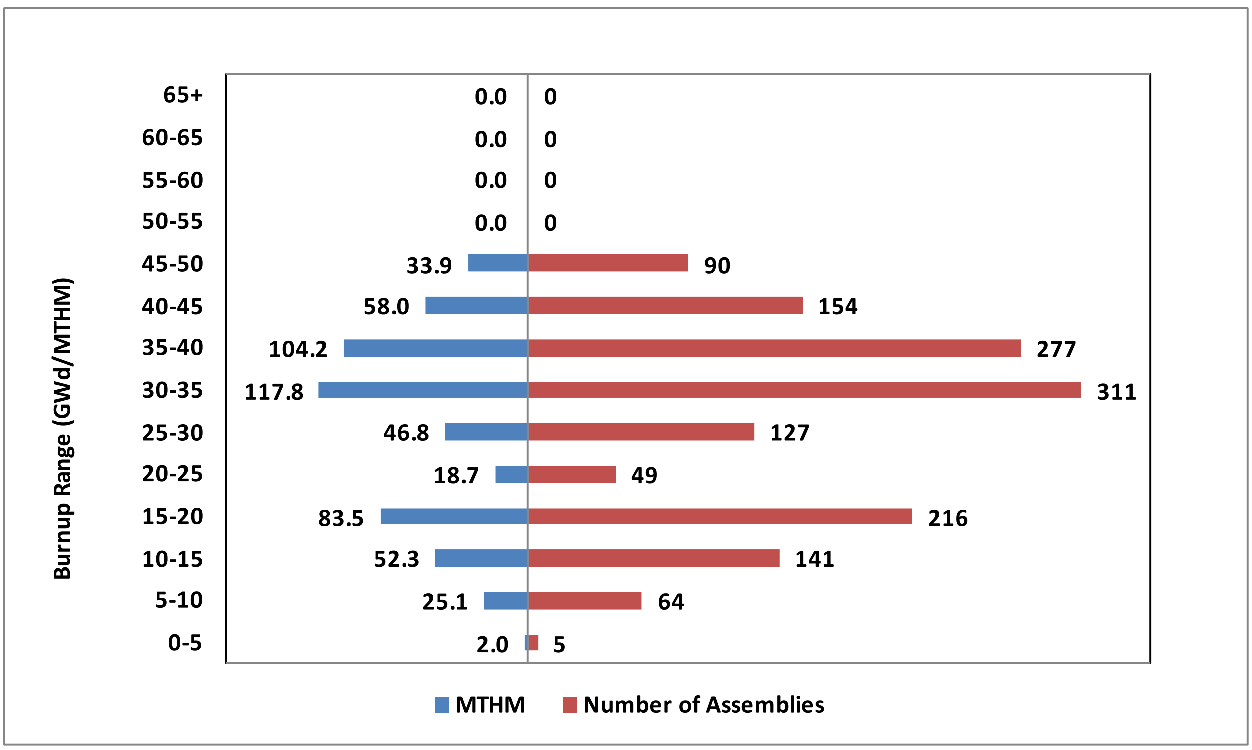

Figure 2-7. Maine Yankee Number of Assemblies and MTHM versus Burnup (EIA 2018)

Photo courtesy of NAC International

Figure 2-8. Damaged Fuel Cans

Photo courtesy of NAC International

Figure 2-9. Ends of Damaged Fuel Cans with Screened Openings

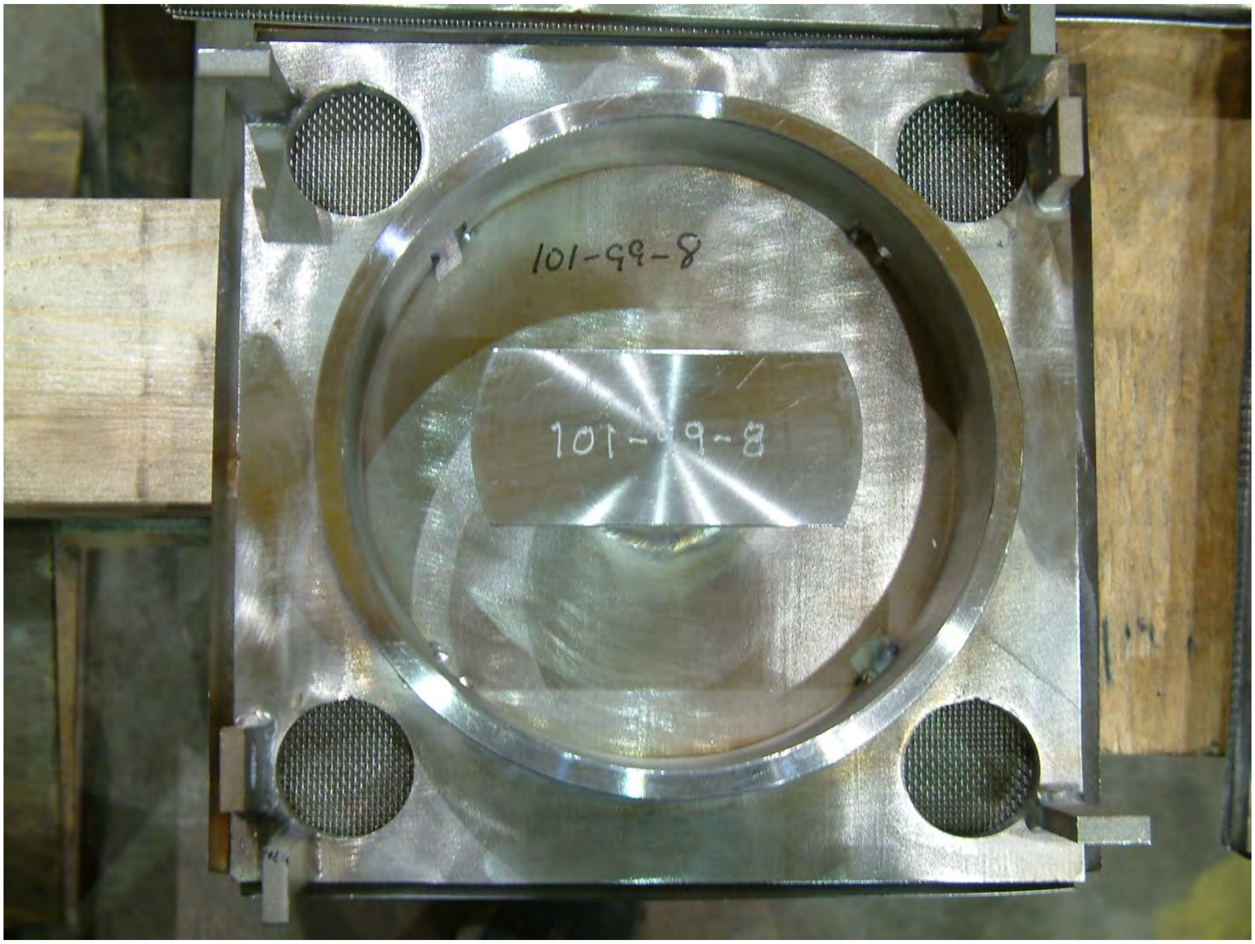

Photo courtesy of NAC International

Figure 2-10. Damaged Fuel Can Lid with Screened Openings

2.1.2 Site Conditions

Figure 2-11 provides an aerial view of the Maine Yankee site, where the Maine Yankee reactor and associated structures have been removed. Electrical power is available at the Maine Yankee ISFSI. However, mobile equipment such as cranes to unload the NAC-UMS vertical concrete storage casks used at Maine Yankee and to load the NAC-UMS UTC transportation cask that is certified to transport the Maine Yankee SNF and GTCC waste, is not present at the site. In addition, a transfer cask, which is used to transfer the transportable storage canister from a NAC-UMS vertical concrete storage cask to a NAC-UMS UTC transportation cask, is not present at the site.

An on-site rail spur exists at Maine Yankee (Figure 2-12). This spur connects to the Rockland branch of the Central Maine and Quebec Railway at milepost 46.66, which is designated as track class 2.[8] The distance from the Maine Yankee ISFSI to the Rockland branch is about 2.2 miles. The Rockland branch connects to the Pan Am Railways in Brunswick, Maine. The distance from

[8] Track class is a measure of track quality. In 49 CFR Part 213, the Federal Railroad Administration has categorized all track into nine classes (1-9), segregated by maximum allowable operating speed.

the Rockland branch to the Pan Am Railways in Brunswick, Maine is about 25 miles. Pan Am Railways is a Class II regional railroad.[9] During decommissioning, 238 radioactive and nonradioactive waste shipments were made over the period 2000 to 2005 using this rail spur (EPRI 2005). There appears to be sufficient room within the Owner Controlled Area to permit staging of railcars. However, the rail spur has been paved over in spots (see Figure 2-13) and is not being maintained.

A barge dock that exists at Maine Yankee (Figure 2-14) would provide access to the Atlantic Ocean. The distance from the Maine Yankee ISFSI to the barge dock is about 0.5 mile. The Maine Yankee steam generators, pressurizer, and reactor pressure vessel were shipped off-site using this barge dock (Wheeler 2002, Feigenbaum 2005). The three steam generators weighed 356 tons each (491 tons each when the shielding and carriage assembly are included) and the pressurizer weighed 100 tons (Radwaste Solutions 2000). These components were transported to Memphis, Tennessee for decontamination (Radwaste Solutions 2000). The reactor pressure vessel package weighed 1175 tons, measured 19 ft. in diameter, was 35 ft. long, and was transported to the Barnwell, South Carolina low-level radioactive waste disposal facility (Feigenbaum 2005). In addition, EPRI (2005) states that the site’s main power transformers were shipped off-site by barge. The barge dock is approximately 10 feet above the water and the depth of the water is about 6 feet at high tide (TOPO 1993a). The barge dock and access road were last used in 2003 (TriVis Incorporated 2005) and are not being maintained.

[9] Railroads are classified by the Surface Transportation Board based on their annual operating revenues. The class to which a carrier belongs is determined by comparing its adjusted operating revenues for three consecutive years to the following scale: Class I – greater than $250 million, Class II – $20 million to $250 million, and Class III – less than $20 million. The following formula is used to adjust a railroad's operating revenues to eliminate the effects of inflation: Current Year's Revenues × (1991 Average Index ÷ Current Year's Average Index). The average index (deflator factor) is based on the annual average Railroad Freight Price Index for all commodities (STB 2012). The U.S. Class I railroads in 2013 are the BNSF Railway, CSX Transportation, Grand Trunk Corporation, Kansas City Southern Railway, Norfolk Southern Combined Railroad Subsidiaries, Soo Line Corporation, and Union Pacific Railroad.

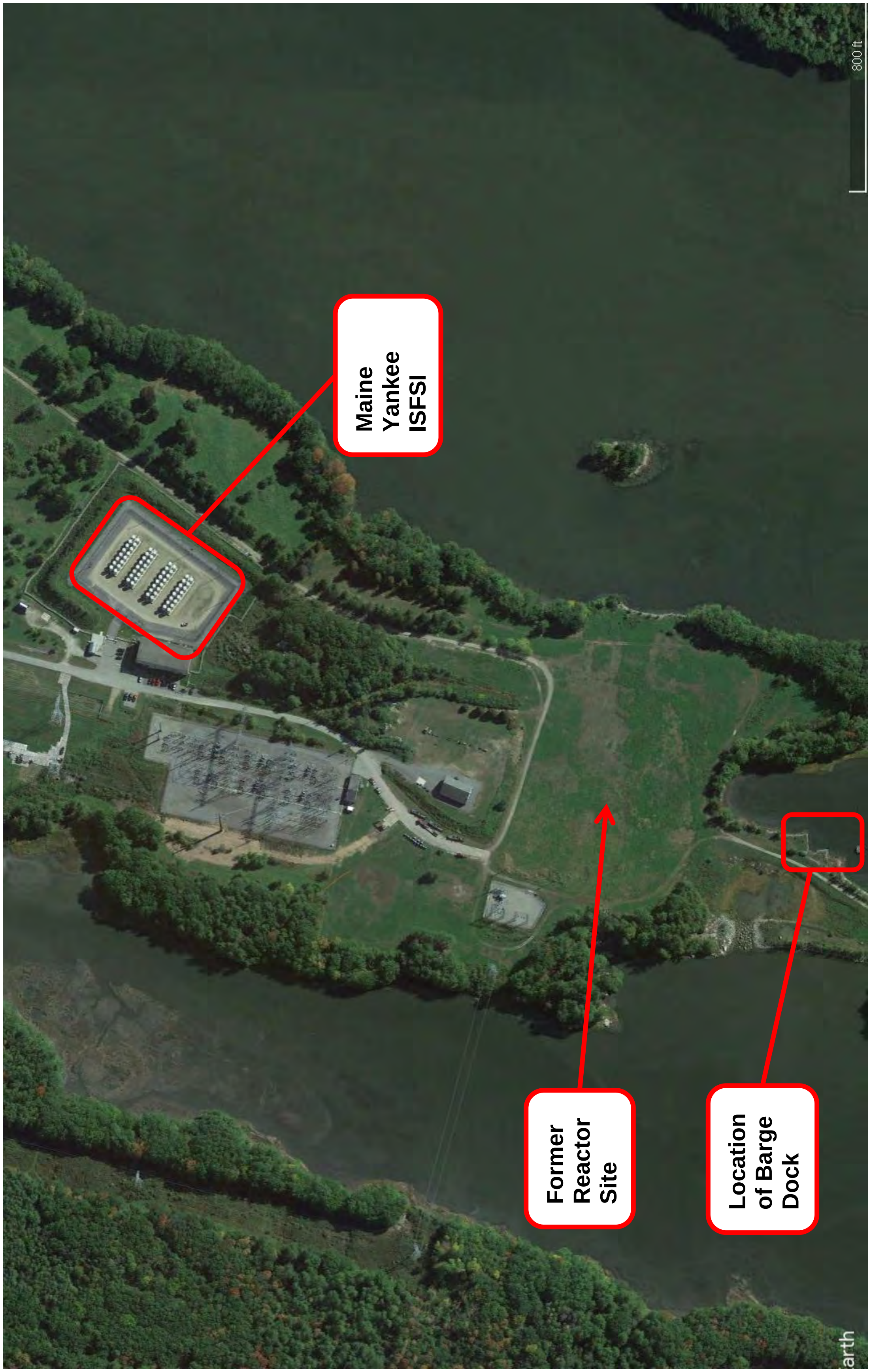

Figure 2-11. Aerial View of the Maine Yankee Site (Google 2022)

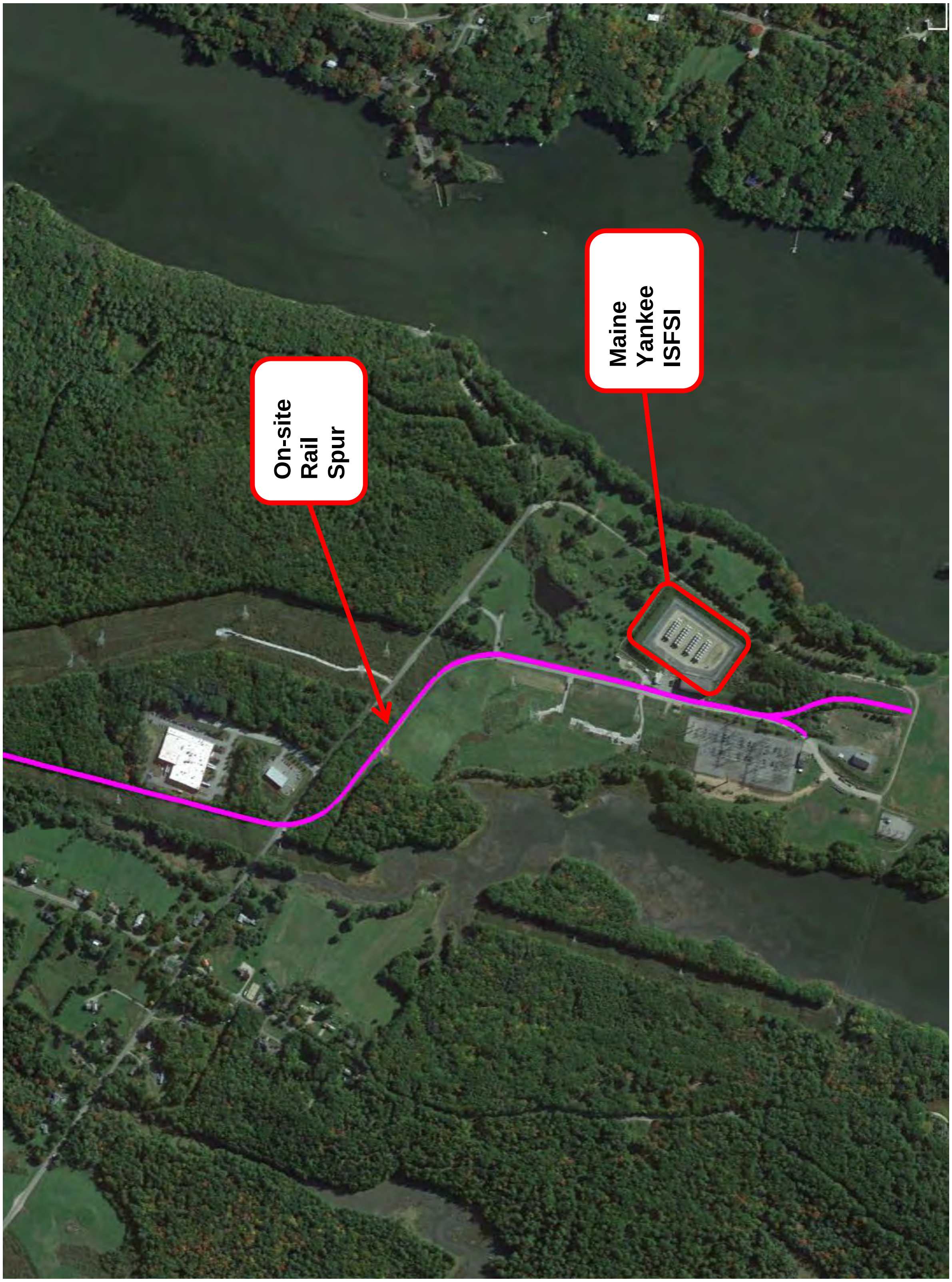

Figure 2-12. On-site Rail Spur at the Maine Yankee Site (Google 2022)

Figure 2-13. Paved-over Railroad Tracks at the Maine Yankee Site (2012)

Figure 2-14. Barge Dock at the Maine Yankee Site (2012)

2.1.3 Near-site Transportation Infrastructure and Experience

As discussed in Section 2.1.2, Maine Yankee has direct rail access to the Central Maine and Quebec Railway via a rail spur (see Figure 2-15). In some off-site locations, the rail spur has been paved over (see Figure 2-16). This rail spur was used for radioactive and nonradioactive waste shipments during decommissioning. There is sufficient room on the Maine Yankee site for a rail spur that should be able to accommodate trains having eight or more railcars (two buffer cars, a security escort car, and five or more cask cars).

The Maine Yankee site is located on Bailey Point on the Back River and has access to the Atlantic Ocean through the Sheepscot River. The Back River and Sheepscot River are navigable waterways and Maine Yankee has an on-site barge dock (see Figure 2-14) and therefore could be accessible by barges that would transport SNF transportation casks to nearby ports served by railroads or to barge-accessible rail sidings or spurs. The nearest port with rail access is in Portland, Maine (DSI 2004).

As discussed in Section 2.1.2, during decommissioning at Maine Yankee, three steam generators, the pressurizer, and reactor pressure vessel were transported off-site using barges. Figure 2-17 and Figure 2-18 show the Maine Yankee reactor pressure vessel being loaded onto a barge and being transported by barge, respectively.

For a site such as Maine Yankee that is directly accessible by barge, transportation casks could be loaded, prepared for off-site transportation, and placed onto transport skids/cradles. Because the location of the Maine Yankee ISFSI is not immediately adjacent to the barge dock, heavy-lift equipment could be used to place the transportation casks and transport skids/cradles onto heavy haul vehicles for transport from the ISFSI to the on-site barge dock. Heavy-lift equipment could then transfer the casks from the heavy haul vehicles onto the deck of the transporting barges. Alternatively, the heavy haul transport vehicles with their transportation casks could roll onto the barge, thereby not requiring heavy-lift capability at the barge dock to move the transportation casks from the heavy haul truck to the barge.

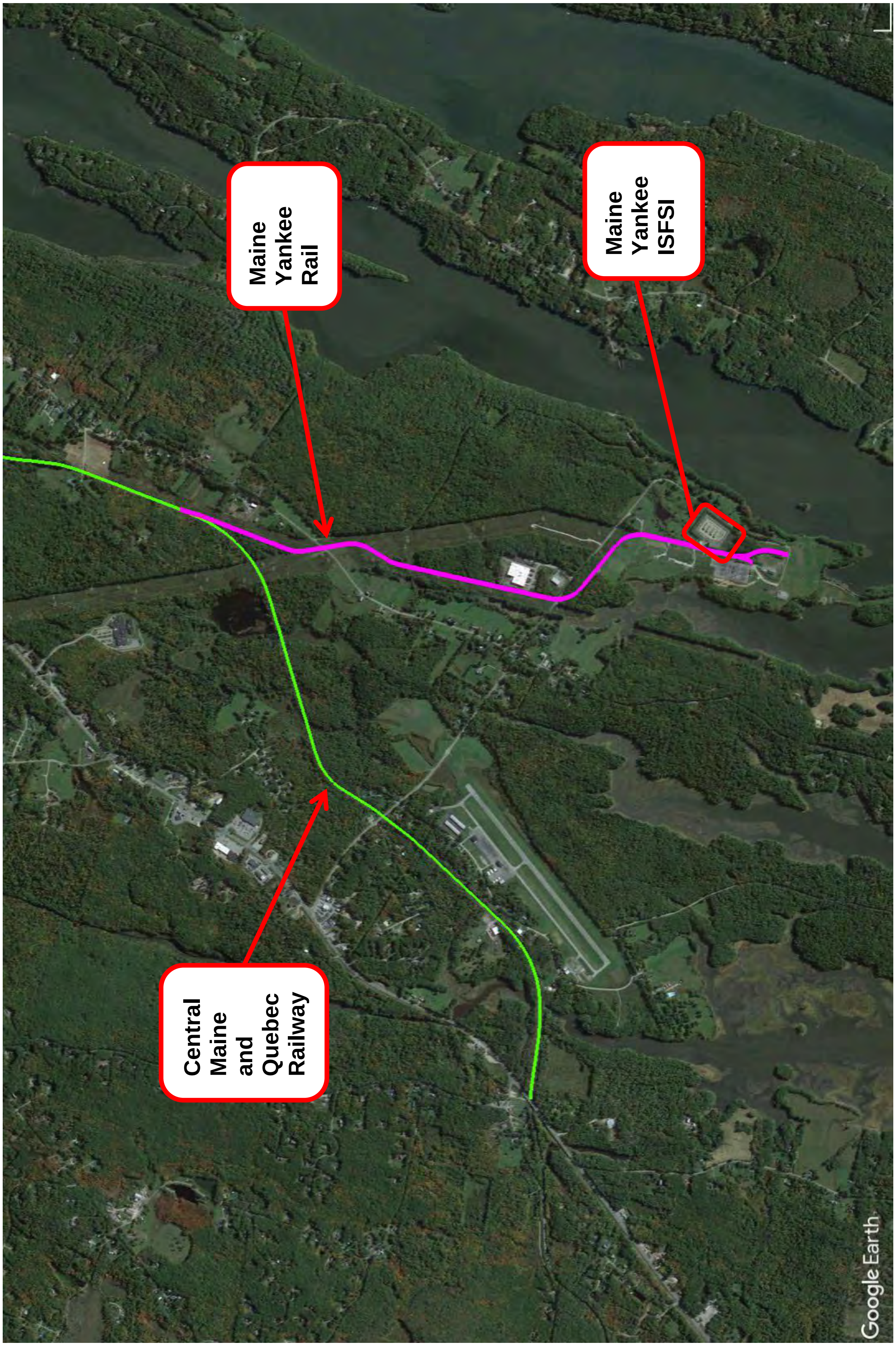

Figure 2-15. Rail Interface at Maine Yankee (Google 2022)

Photo courtesy of Maine Yankee

Figure 2-16. Paved Over Rail Spur at Maine Yankee Site (2017)

Photo courtesy of Maine Yankee

Figure 2-17. Maine Yankee Reactor Pressure Vessel Being Loaded onto Barge (2003)

Photo courtesy of Maine Yankee

Figure 2-18. Maine Yankee Reactor Pressure Vessel Being Transported on Barge (2003)

2.1.4 Future Information Needs

The principal question for the Maine Yankee site regarding the capability of the off-site transportation infrastructure to accommodate shipments of large transportation casks is whether the Central Maine and Quebec Railway is capable of accepting and moving railcars carrying SNF transportation casks. An assessment by the Federal Railroad Administration's track safety engineers and of the Central Maine and Quebec Railway's maintenance-of-way staff would be necessary. If the railroad's infrastructure cannot accommodate the shipments, it would be necessary to ship the SNF transportation casks on barges from the site to a port where they would be transferred to railcars. Because the Maine Yankee reactor pressure vessel was shipped from the site by barge, there is substantial confidence that barges could be used to move SNF transportation casks from the site. Nonetheless, it would be necessary to obtain a marine engineer's assessment of the condition of the channel leading to the Maine Yankee barge siding and to do any dredging and restoration of navigation aids in the channel that may be necessary.

2.2 Yankee Rowe

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the Yankee Rowe site. The Yankee Rowe site is in the northwest corner of Massachusetts, about 0.5 mile south of the Vermont border, 3.5 miles northwest of the town of Rowe, and 48 miles north of Pittsfield, Massachusetts (TOPO 1993b).

2.2.1 Site Inventory

There are 15 canisters containing 533 SNF assemblies (127.1 MTHM) and 1 reconfigured fuel assembly,[10] and 1 canister of GTCC waste stored at the Yankee Rowe ISFSI (Docket No. 72-31). The 15 canisters contain 7 damaged SNF assemblies, which have been placed in damaged fuel cans.

Figure 2-19 shows the Yankee Rowe ISFSI. The storage system used at Yankee Rowe is the NAC Multi-Purpose Canister system (NAC-MPC) (Docket No. 72-1025), which consists of a transportable storage canister, a vertical concrete storage cask, and a transfer cask. The transportable storage canister used for the Yankee Rowe SNF is the Yankee-MPC, which holds 36 Yankee Rowe pressurized water reactor SNF assemblies. The Yankee Rowe fuel assemblies were loaded into NAC-MPC canisters from June 2002 through June 2003 (Leduc 2012). The fuel rods in the fuel assemblies at Yankee Rowe are either zirconium alloy-clad [457 assemblies (106.4 MTHM)] or stainless steel-clad [76 assemblies (20.8 MTHM)]. The NAC-STC transportation cask (Docket No. 71-9235) is certified to transport the Yankee-MPC canisters,

[10] A Yankee Rowe reconfigured fuel assembly is a stainless steel container having approximately the same external dimensions as a spent nuclear fuel assembly that ensures criticality control geometry and permits gaseous and liquid media to escape while preventing the dispersal of gross particulates. A Yankee Rowe reconfigured fuel assembly may contain intact fuel rods, damaged fuel rods, and fuel debris. The Yankee Rowe reconfigured fuel assembly consists of a shell (square tube with end fittings) and a basket assembly that supports 64 tubes in an 8×8 array, which hold the intact fuel rods, damaged fuel rods, or fuel debris. The shell, basket assembly and tubes are stainless steel. The spent fuel rods are confined in the fuel tubes, which are closed with end plugs. The shell is closed with top and bottom end fittings. The tube end plugs and the shell end fittings have drilled holes to permit draining, drying, and helium backfilling (NAC 2006).

including canisters containing GTCC waste. Figure 2-20 illustrates the NAC-STC transportation cask. No NAC-STC transportation casks have been fabricated for use in the United States. Six NAC-STC transportation casks have been fabricated for use in China.

Figure 2-21 illustrates the number of SNF assemblies and MTHM at Yankee Rowe, based on discharge year. The oldest fuel was discharged in 1972 and the last fuel was discharged in 1991. The median discharge year of the fuel is 1984.

Figure 2-22 illustrates the number of SNF assemblies and MTHM at Yankee Rowe based on burnup. The lowest burnup is 4.2 GWd/MTHM and the highest burnup is 36.0 GWd/MTHM. The median burnup is 28.0 GWd/MTHM. There are no high burnup SNF assemblies (burnup greater than 45 GWd/MTHM) stored at Yankee Rowe.

Photo courtesy of Yankee Rowe

Figure 2-19. Yankee Rowe Independent Spent Fuel Storage Installation

Photo courtesy of NAC International

Figure 2-20. NAC-STC Transportation Cask

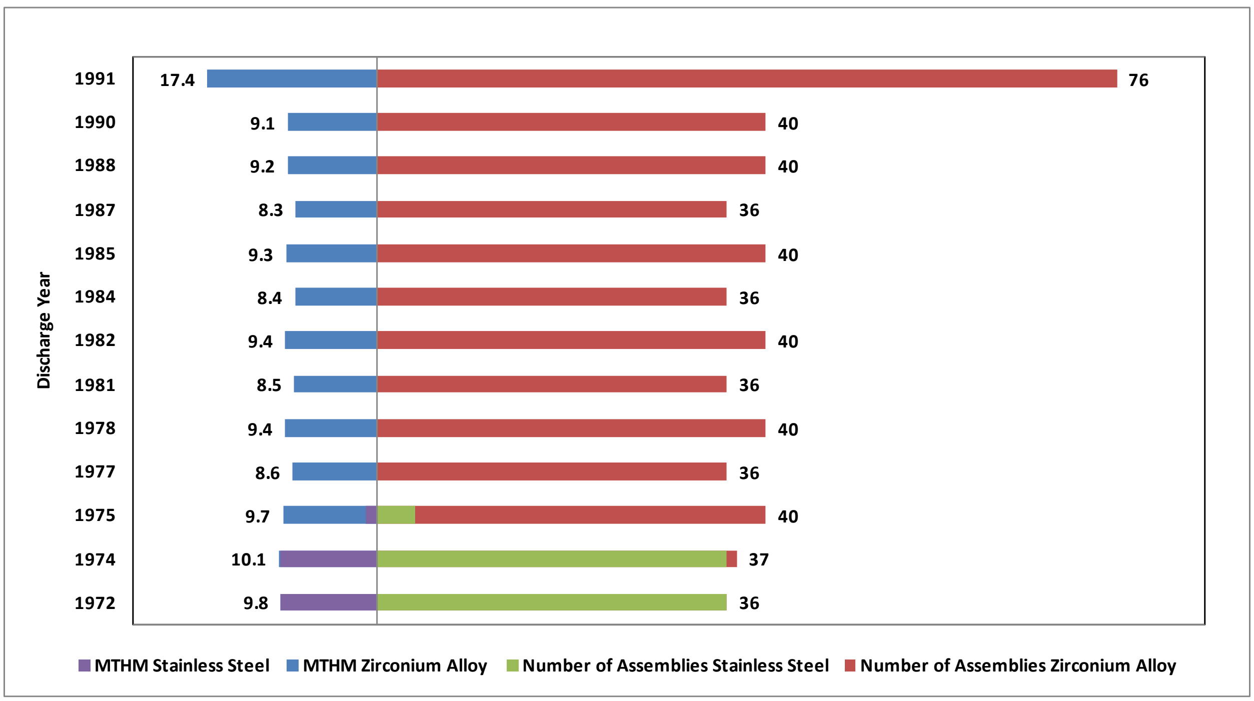

Figure 2-21. Yankee Rowe Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

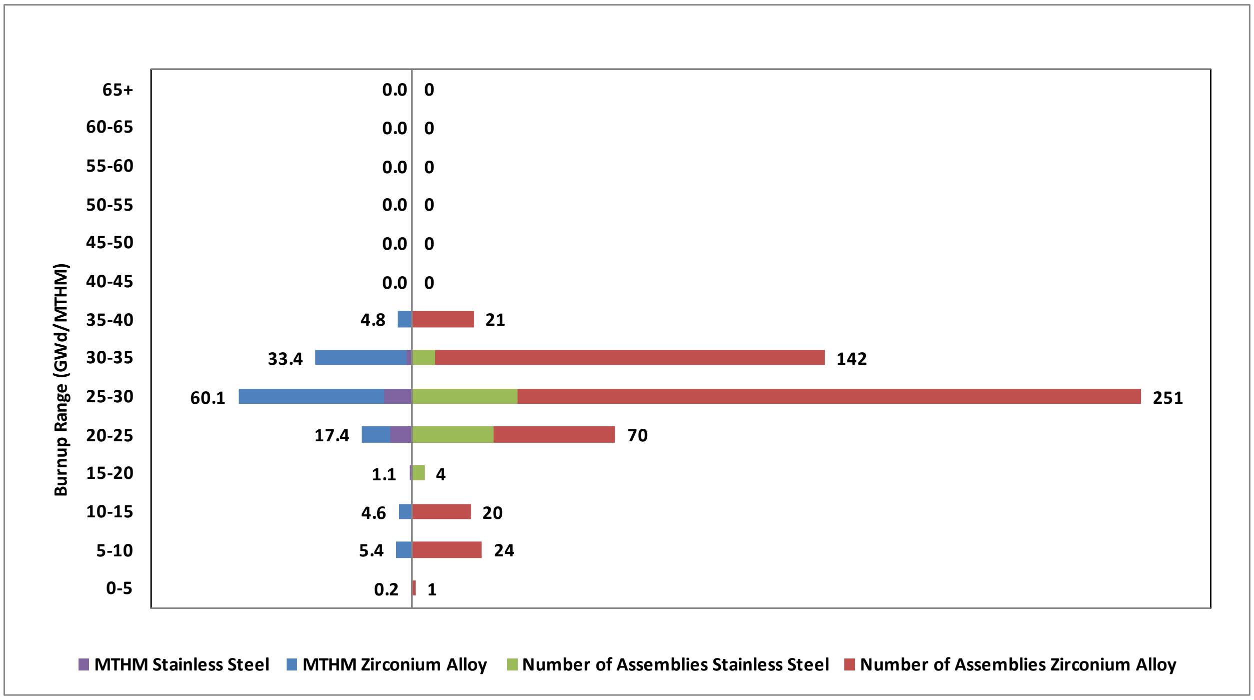

Figure 2-22. Yankee Rowe Number of Assemblies and MTHM versus Burnup (EIA 2018)

2.2.2 Site Conditions

Figure 2-23 provides an aerial view of the Yankee Rowe site, where the reactor and associated structures have been removed. Electrical power is available at the Yankee Rowe ISFSI. However, mobile equipment such as cranes to unload the NAC-MPC vertical concrete storage casks used at Yankee Rowe and to load the NAC-STC transportation cask that is certified to transport the Yankee Rowe SNF and GTCC waste is not currently present at the site. In addition, a transfer cask, which is used to transfer the Yankee-MPC transportable storage canister from a NAC-MPC vertical concrete storage cask to a NAC-STC transportation cask, is not currently present at the site. There are two compatible transfer casks without doors or hydraulic components stored at the Connecticut Yankee site and one compatible transfer cask at the La Crosse site.

There is no barge access or direct rail access at the Yankee Rowe site. The nearest off-site barge facility is located in Albany, New York, a distance of 50 miles from Yankee Rowe (TriVis Incorporated 2005). Yankee Rowe had direct rail service, but the rail spur to the site was removed in the early 1970s and cannot be reinstalled because the construction of the Cockwell (formerly Bear Swamp) Pumped Storage Plant resulted in submersion of the rail line to Yankee Rowe (TOPO 1993b). The nearest rail access is at the east end of the Hoosac Tunnel, a distance of about 7.5 miles from the Yankee Rowe site. Heavy haul truck transport would be required to move NAC-STC transportation casks containing SNF or GTCC waste to this location.

2.2.3 Near-site Transportation Infrastructure and Experience

The Yankee Rowe site does not have an on-site rail spur or a railroad that passes near to the site or along the site boundary. For Yankee Rowe, heavy haul trucks could be used to move transportation casks over public highways to a rail siding or spur that provides access to a railroad that can accommodate the loaded transportation casks.

For shipments of casks containing SNF that require the use of heavy haul trucks, the casks would be prepared for shipment at the Yankee Rowe ISFSI site and loaded onto a transport cradle that would be loaded onto the transport trailer of a heavy haul truck. The truck, led and followed by technical and security escorts, would move over an approved, designated highway route to a nearby rail siding or spur. Heavy lift equipment would be used to transload the cask and its cradle as a unit from the truck to a railcar at the rail siding or spur.

Heavy haul trucks were used to move the reactor pressure vessel and steam generators from the Yankee Rowe site. For example, in 1997, the Yankee Rowe reactor pressure vessel was moved 7.5 miles on an improved county road by a heavy haul truck from the Yankee Rowe site to the rail line at the east portal of the Hoosac Tunnel in western Massachusetts (see Figure 2-24 through Figure 2-26). The rail line is operated by the Pan Am Southern Railroad, a partnership of the Norfolk Southern Railroad and the Pan Am Railroad Company, a northeastern U.S. Class II regional railroad. The Pan Am Southern rail line at the Hoosac Tunnel is designated as track class 3. To reach the east portal of the Hoosac Tunnel, the heavy haul truck and reactor pressure vessel had to cross the Sherman Dam. EPRI (1997a, 1998) states that the spillway bridge on the Sherman Dam was replaced prior to shipping the reactor pressure vessel and the slope stability along the roadway, as well as the roadway culverts, were assessed for the loaded transport conditions. The reactor pressure vessel package weighed 365 tons with saddle and tie downs (EPRI 1997a, 1998), measured 13.5 ft. in diameter, and was 35 ft. long. At the Hoosac Tunnel rail crossing, the reactor pressure vessel package was transloaded from the roadway transporter to a TransAlta CAPX 1001 railcar. The railcar was equipped with a lateral shift mechanism that enabled handlers to move the cargo left or right up to 12 inches (Lessard 2000). The loaded gross weight of the railcar and reactor pressure vessel package was 1,122,700 lb. (EPRI 1997a, 1998). The reactor pressure vessel was then transported to the Barnwell, South Carolina low-level radioactive waste disposal facility (Lessard 2000). During the trip to Barnwell, South Carolina, the lateral shift mechanism had to be used on six separate occasions to maneuver around structures or other railcars along the route (Lessard 2000). These shifts ranged from 3 to 12 inches (Lessard 2000).

Figure 2-27 shows the rail line at the east portal of the Hoosac Tunnel and Figure 2-28 shows the east portal of the Hoosac Tunnel. Figure 2-29 shows the Yankee Rowe reactor pressure vessel on the railcar used to transport it to the Barnwell, South Carolina low-level radioactive waste disposal facility. Figure 2-30 shows the route taken from the Yankee Rowe site to the east portal of the Hoosac Tunnel.

2.2.4 Future Information Needs

The Yankee Rowe site is located inland in the western part of Massachusetts and thus does not have access to a navigable waterway. In addition, the Yankee Rowe site does not have direct rail access.

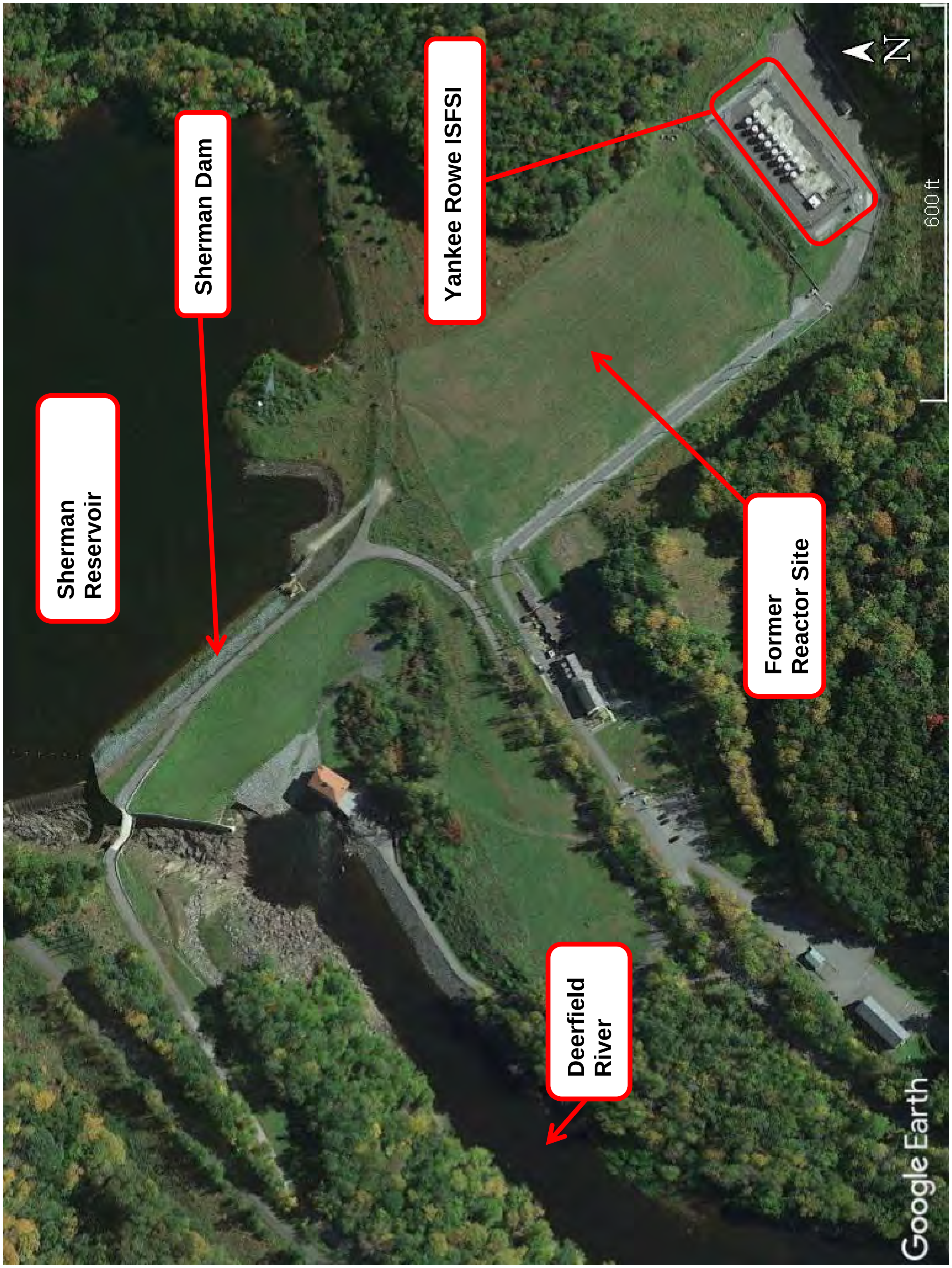

Figure 2-23. Aerial View of the Yankee Rowe Site (Google 2022)

Photo courtesy of AREVA

Figure 2-24. Yankee Rowe Reactor Pressure Vessel Crossing the Sherman Dam (1997)

Photo courtesy of Yankee Rowe

Figure 2-25. Yankee Rowe Reactor Pressure Vessel on Heavy Haul Truck Moving Under Power Lines (1997)

Photo courtesy of AREVA

Figure 2-26. Yankee Rowe Reactor Pressure Vessel on Heavy Haul Truck (1997)

Figure 2-27. Rail Line at East Portal of the Hoosac Tunnel (2012)

Figure 2-28. East Portal of the Hoosac Tunnel (2012)

Photo courtesy of Yankee Rowe

Figure 2-29. Yankee Rowe Reactor Pressure Vessel on Railcar (1997)

Consequently, it would be necessary to use heavy haul trucks to transport casks containing SNF from the site for a distance of about 7.5 miles over a local, improved road to the nearest location for a rail siding at the eastern portal of the Hoosac Tunnel. This would require constructing an on-site access road from the Yankee Rowe ISFSI to the Sherman Dam and obtaining authorization for the heavy haul vehicles to cross the dam. The Sherman Dam is owned and operated by ArcLight Capital Partners, a private equity firm. Based on the experience during decommissioning, ArcLight Capital Partners would need to be notified of the intent to use the roadway and bridge to move heavy loads across the dam; the load evaluation used for the removal of the reactor pressure vessel and steam generators would have to be verified and modified if necessary, and an engineering walk down of the roadway and bridge would be needed to confirm that there had been no changes or deterioration that would invalidate the previous load evaluation.

The heavy haul truck route from Yankee Rowe to the Hoosac Tunnel can be ice covered at times during the winter and could need treatment to prepare it for shipments. A route survey and load evaluation for the heavy haul truck route would also be required. The siding that was installed at the tunnel for the purpose of loading the reactor pressure vessel onto a railcar has been removed and would need to be reinstalled before shipments of casks to this location could take place. Alternative routing for heavy haul trucks that would lead to North Adams, Massachusetts, where casks could be loaded onto railcars, would require travel north over mountainous local roads into Vermont then south to the North Adams area, a distance of about 20 miles.

There is sufficient land in the Hoosac Tunnel area to stage handling equipment. This is based on the use of this area to load the reactor pressure vessel from the transporter to the railcar. However, site preparation work would most likely be required. The available space is limited for a rail siding at the Hoosac Tunnel location, making it likely that only one or two railcars could be placed for loading. It would be necessary to move loaded railcars from the siding to a staging area, possibly in North Adams, where trains with possibly two locomotives, buffer cars, and an escort car could be assembled. A staging location has not been identified.

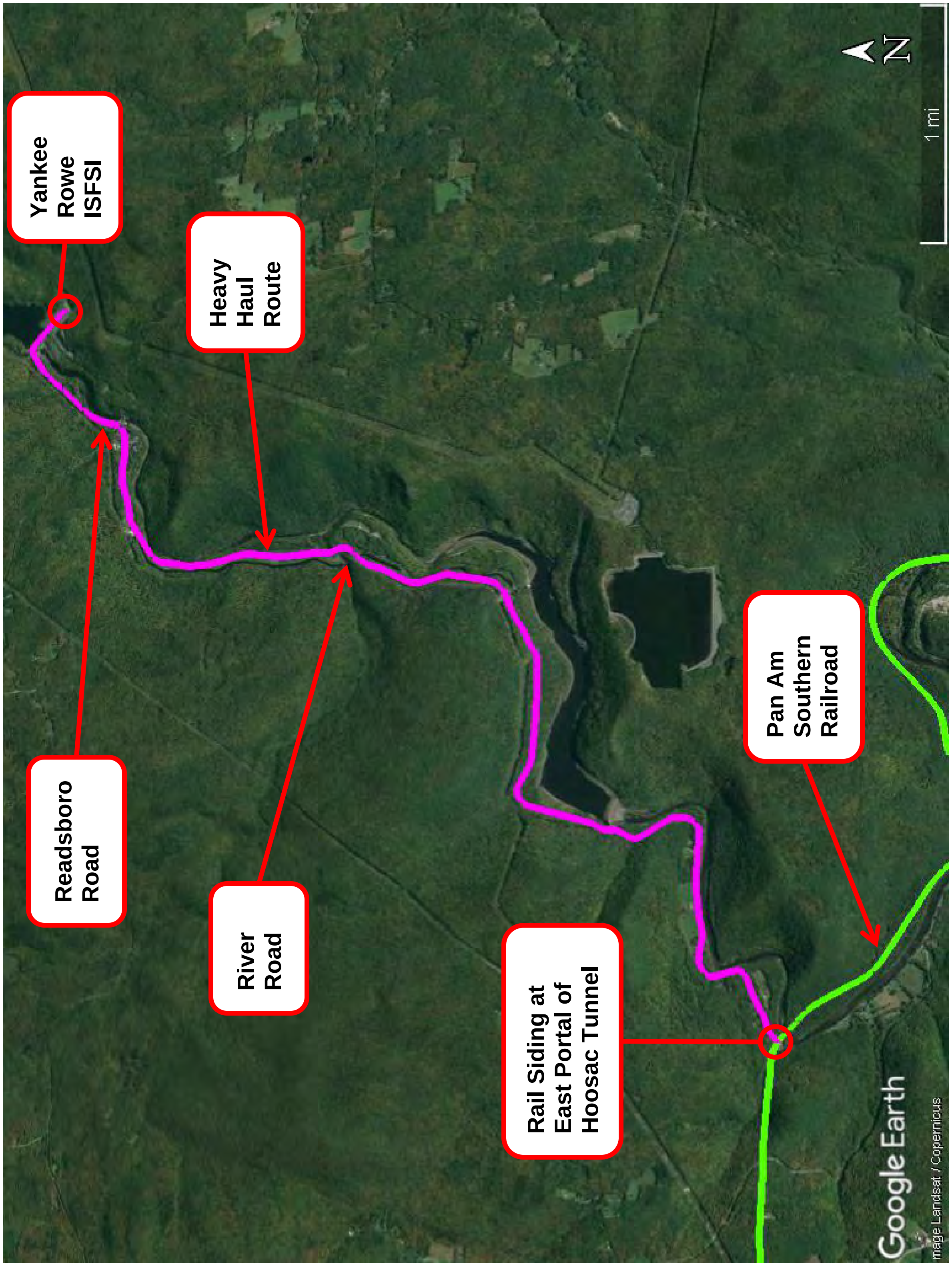

Figure 2-30. Yankee Rowe Reactor Pressure Vessel Heavy Haul Truck Route (Google 2022)

2.3 Connecticut Yankee

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the Connecticut Yankee site. The Connecticut Yankee site is located on the eastern shore of the Connecticut River near Haddam Neck, Connecticut, about 13 miles southeast of Middletown and 25 miles southeast of Hartford, Connecticut (TOPO 1993c).

2.3.1 Site Inventory

Forty canisters containing 1019 SNF assemblies (413.5 MTHM) and 5 fuel rod storage containers, and 3 canisters of GTCC waste are stored at the Connecticut Yankee ISFSI (Docket No. 72-39). The 40 canisters contain 71 damaged fuel cans, which contain 66 damaged SNF assemblies and 5 fuel rod storage containers. There are also an additional 82 stainless steel-clad SNF assemblies (34.5 MTHM) from Connecticut Yankee that are stored at the Morris, Illinois ISFSI (Docket No. 72-1).

Figure 2-31 shows the Connecticut Yankee ISFSI. The storage system used at Connecticut Yankee is the NAC Multi-Purpose Canister system (NAC-MPC) (Docket No. 72-1025), which consists of a transportable storage canister, a vertical concrete storage cask, and a transfer cask. The transportable storage canister used for the Connecticut Yankee (CY) SNF is the CY-MPC. This canister may be configured to hold 24 or 26 pressurized water reactor SNF assemblies. The fuel assemblies from Connecticut Yankee were loaded into CY-MPC canisters from May 2004 through March 2005 (Leduc 2012). The fuel rods in the fuel assemblies at Connecticut Yankee are either zirconium alloy-clad [161 assemblies (59.7 MTHM)] or stainless steel-clad [858 assemblies (353.8 MTHM)]. The NAC-STC transportation cask (Docket No. 71-9235) is certified to transport the CY-MPC canisters, including canisters containing GTCC waste. No NAC-STC transportation casks have been fabricated for use in the United States. Six NAC-STC transportation casks have been fabricated for use in China.

Photo courtesy of Connecticut Yankee

Figure 2-31. Connecticut Yankee Independent Spent Fuel Storage Installation

In addition to the 43 canisters of SNF and GTCC waste stored at the Connecticut Yankee ISFSI, two transfer casks are stored at the Connecticut Yankee ISFSI. These transfer casks could also be used at the Yankee Rowe site.

Figure 2-32 illustrates the number of SNF assemblies and MTHM at Connecticut Yankee, based on discharge year. The oldest fuel was discharged in 1971 and the last fuel was discharged in 1996. The median discharge year of the fuel is 1984.

Figure 2-33 illustrates the number of SNF assemblies and MTHM at Connecticut Yankee, based on burnup. The lowest burnup is 8.2 GWd/MTHM and the highest burnup is 43.0 GWd/MTHM. The median burnup is 33.1 GWd/MTHM. There is no high burnup SNF (burnup greater than 45 GWd/MTHM) stored at Connecticut Yankee.

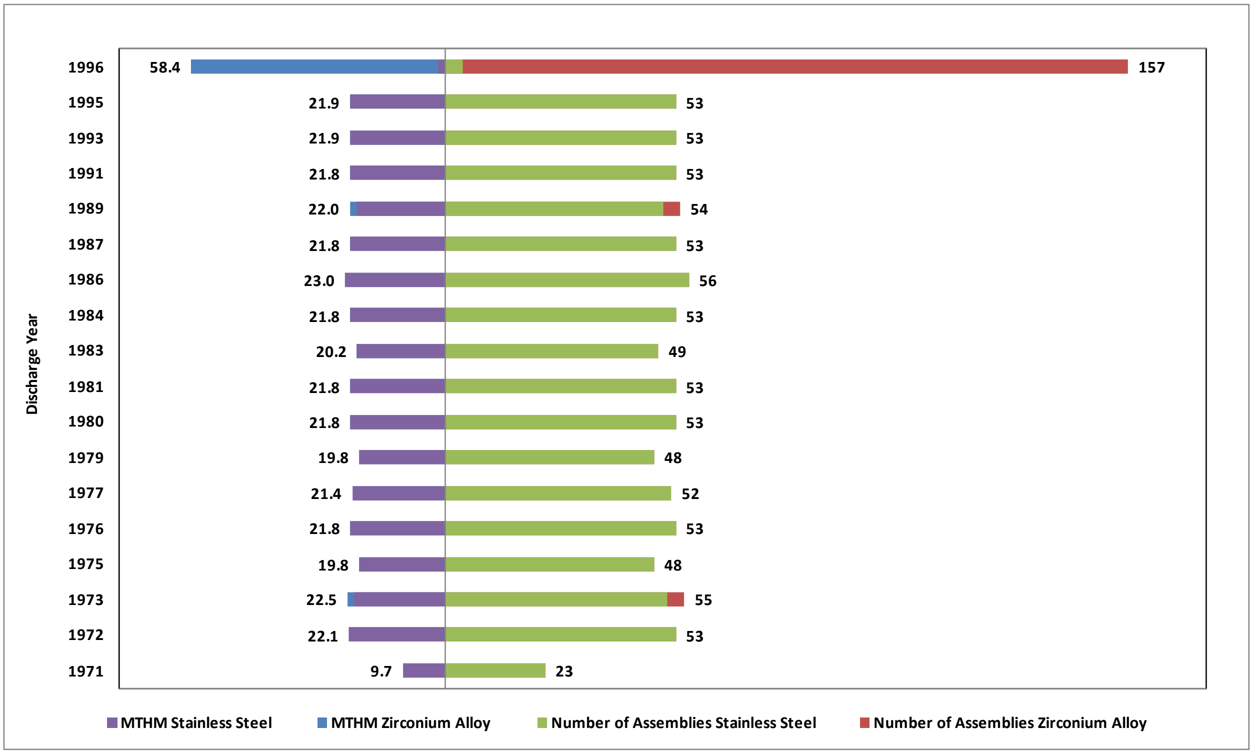

Figure 2-32. Connecticut Yankee Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

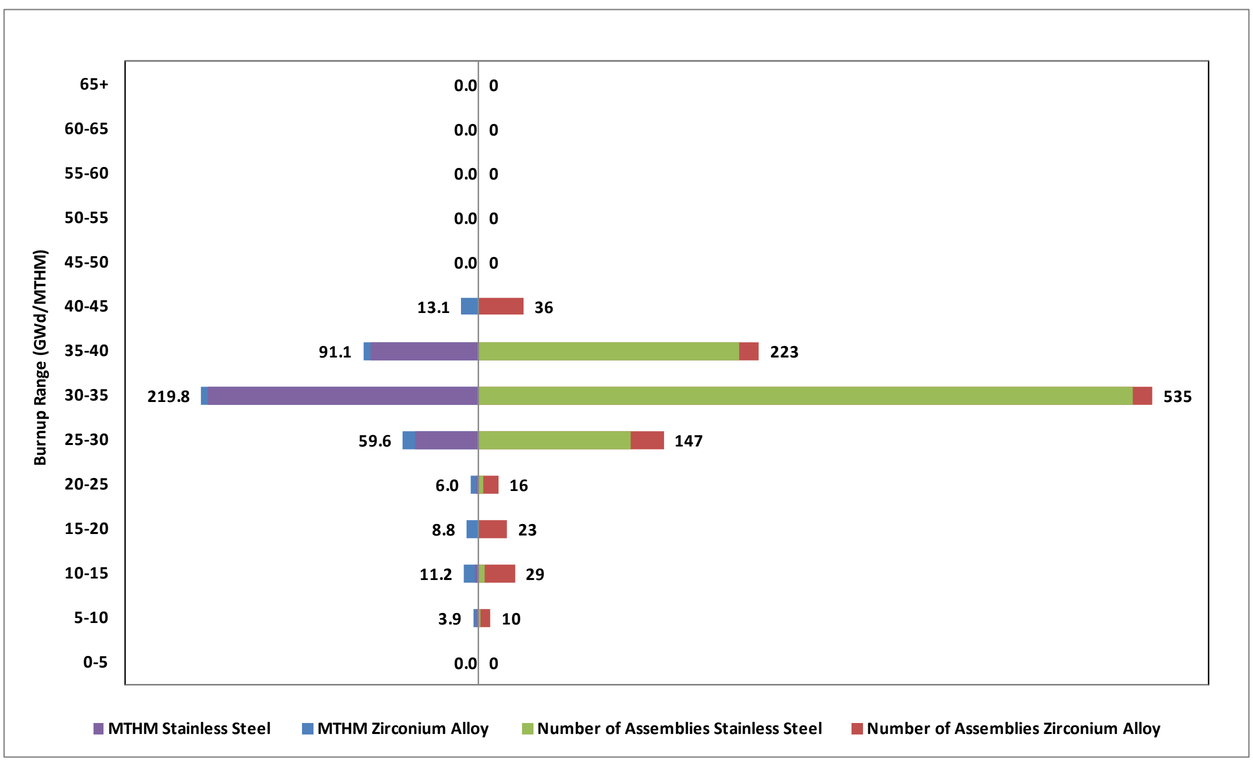

Figure 2-33. Connecticut Yankee Number of Assemblies and MTHM versus Burnup (EIA 2018)

2.3.2 Site Conditions

Figure 2-34 and Figure 2-35 provide aerial views of the Connecticut Yankee site and ISFSI, where the reactor and associated structures have been removed. Electrical power is available at the Connecticut Yankee ISFSI. However, mobile equipment such as cranes to unload the NAC-MPC vertical concrete storage casks used at Connecticut Yankee and to load the NAC-STC transportation cask that is certified to transport the Connecticut Yankee SNF and GTCC waste is not currently present at the site. Two transfer casks without doors or hydraulic components are stored at the Connecticut Yankee ISFSI. These transfer casks could also be used at the Yankee Rowe site.

There is no on-site rail access at Connecticut Yankee. The nearest rail access is in Portland, Connecticut near Middletown, Connecticut, about 12 miles from the Connecticut Yankee ISFSI. To reach this location, heavy haul truck transport would be required. The rail line at Portland is designated as track class 1 and connects to the Providence and Worcester Railroad in Middletown, Connecticut after crossing the Connecticut River. The condition of this bridge is unknown. The Providence and Worcester rail line in Middletown, Connecticut is designated as track class 2.

An on-site barge slip at Connecticut Yankee is located in an area of the shoreline along the northwest end of the cooling water discharge canal (see Figure 2-36 and Figure 2-37) and is about 0.9 miles from the Connecticut Yankee ISFSI. This slip provides access to the Connecticut River and Atlantic Ocean (TOPO 1993c). The barge slip and cooling water discharge canal were used to ship the reactor pressure vessel, steam generators, and transformer off-site (EPRI 2006, Connecticut Yankee 2012). The reactor pressure vessel package weighed 820 tons, measured 18 ft. in diameter, and was 35 ft. long. At the time that the reactor pressure vessel was shipped, the cooling water discharge canal had silted up, and the canal was dredged before the reactor pressure vessel was shipped (EPRI 2006). The on-site barge slip has not been used since decommissioning but remains intact. It is uncertain at this time whether the cooling water discharge canal is deep enough to accommodate barges without dredging.

2.3.3 Near-site Transportation Infrastructure and Experience

Eighty-two stainless steel-clad SNF assemblies from Connecticut Yankee are stored at the Morris, Illinois ISFSI. Eighty assemblies were shipped directly from Connecticut Yankee to Morris (SAIC 1991). Three assemblies (G11, H07, and S004) were shipped from Connecticut Yankee to Battelle West Jefferson for examination (EPRI 1996); two of these assemblies (G11 and H07) were subsequently returned to Connecticut Yankee and then shipped to Morris (EPRI 1996). Assembly S004 was shipped to and is currently stored at the Idaho National Laboratory.

The Connecticut Yankee site does not have an on-site rail spur or a railroad that passes near to the site or along the site boundary. For Connecticut Yankee, heavy haul trucks could be used to move transportation casks over public highways to a rail siding or spur that provides access to a railroad that can accommodate the loaded transportation casks.

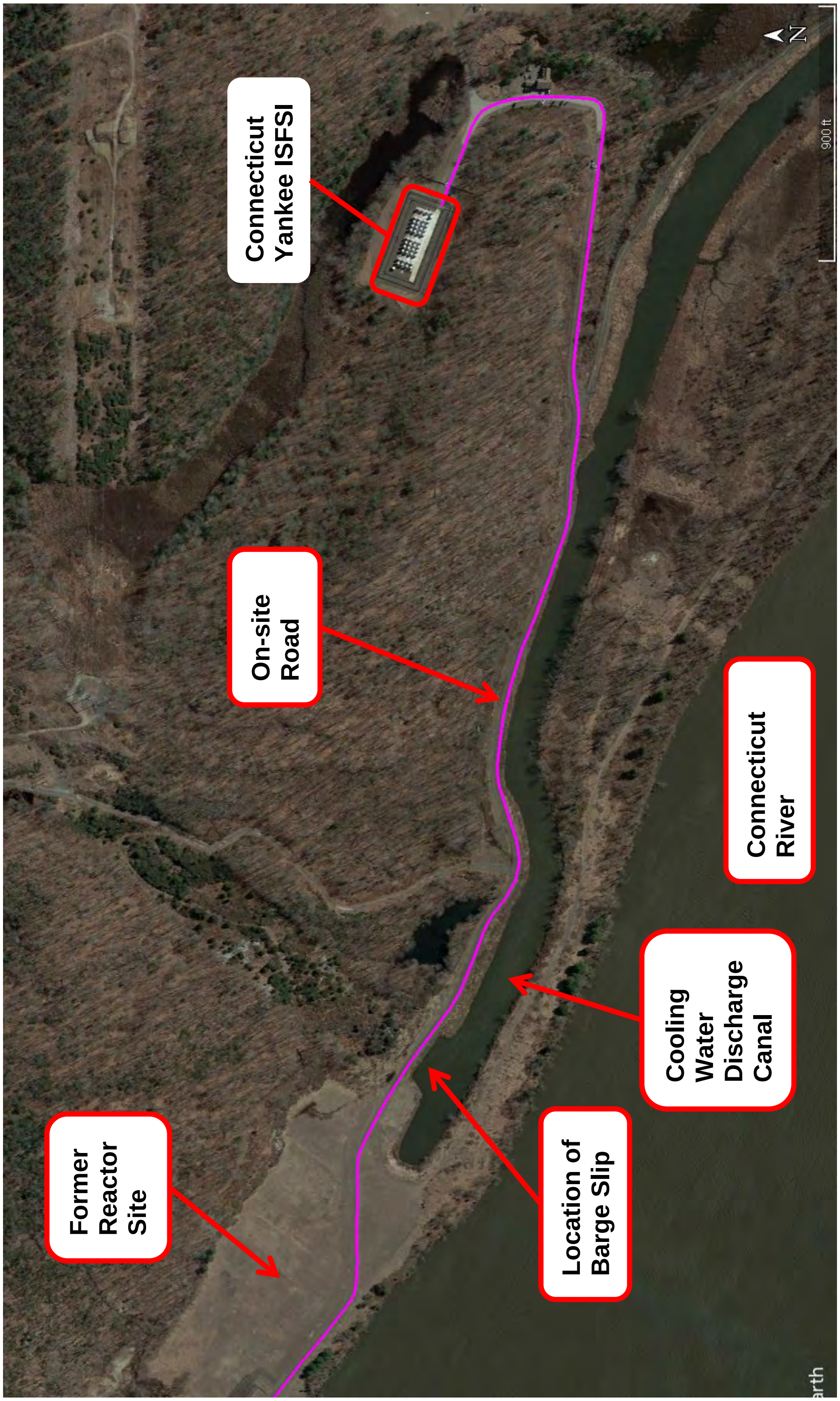

Figure 2-34. Aerial View of the Connecticut Yankee Site (Google 2022)

Photo courtesy of Connecticut Yankee

Figure 2-35. Aerial View of the Connecticut Yankee Independent Spent Fuel Storage Installation (2012)

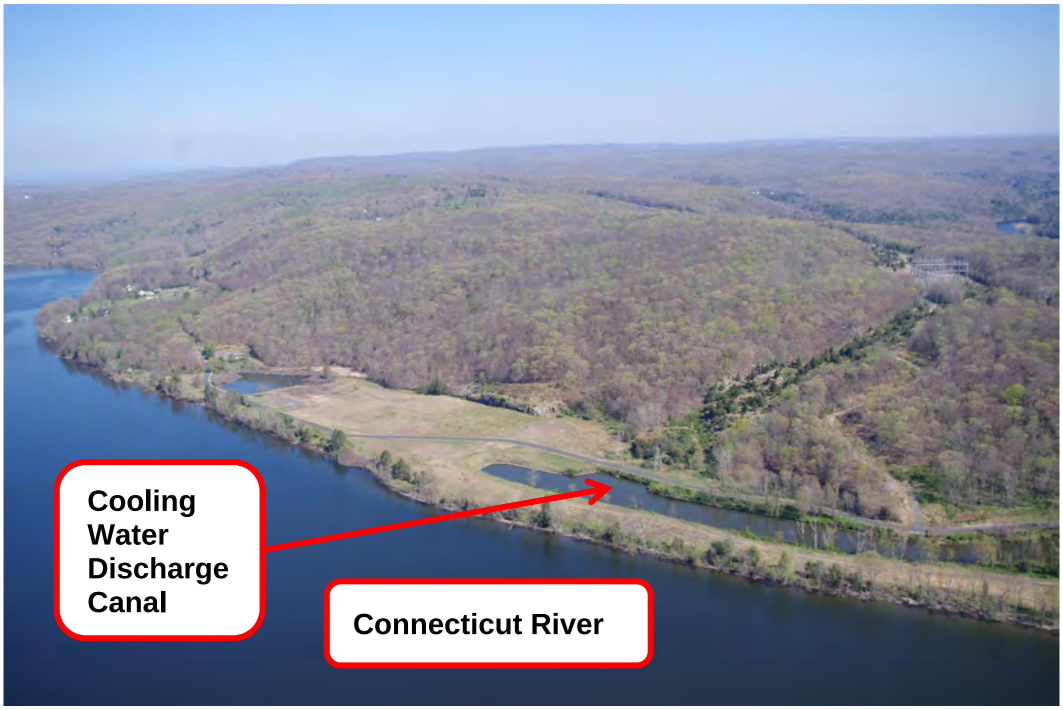

Photo courtesy of Connecticut Yankee

Figure 2-36. Aerial View of the Connecticut Yankee Site and Cooling Water Discharge Canal (2012)

Figure 2-37. Barge Slip at the Connecticut Yankee Site (2012)

For shipments of casks containing SNF that require the use of heavy haul trucks, the casks would be prepared for shipment at the Connecticut Yankee ISFSI site and loaded onto a transport cradle that would then be loaded onto the transport trailer of a heavy haul truck. The truck, led and followed by technical and security escorts, would move over an approved, designated highway route to a nearby rail siding or spur. Heavy lift equipment would be used to transfer the cask and its cradle as a unit from the truck to a railcar at the rail siding or spur.

In 1999 and 2001, the steam domes[11] and pressurizer removed during demolition of the Connecticut Yankee (Haddam Neck) nuclear power plant were moved 12 miles from the plant site over local roads to the Portland rail spur near Middletown, Connecticut, transloaded onto railcars, and transported to the EnergySolutions low-level radioactive waste disposal facility in Clive, Utah (EPRI 2006). A total of five heavy haul truck shipments were made. Figure 2-38 shows the pressurizer on its heavy haul truck transporter and Figure 2-39 shows the route taken from the Connecticut Yankee site to the Portland rail spur. Figure 2-40 shows the pressurizer at the end of the Portland rail spur and Figure 2-41 shows the conditions at the end of the Portland rail spur in 2012.

If heavy haul trucks were used to move casks containing SNF from the Connecticut Yankee site to the Middletown area rail spur, the P&W Railroad, which is a Class II regional railroad, would then haul the shipments to Hartford, Connecticut. In the Hartford area, the shipments would be switched to the Pan Am Southern Railroad, the same railroad that operates the rail line that passes near the Yankee Rowe site.

[11] The steam dome is the upper portion of the steam generator (EPRI 2006).

Photo courtesy of Connecticut Yankee

Figure 2-38. Connecticut Yankee Pressurizer on Heavy Haul Truck Transporter

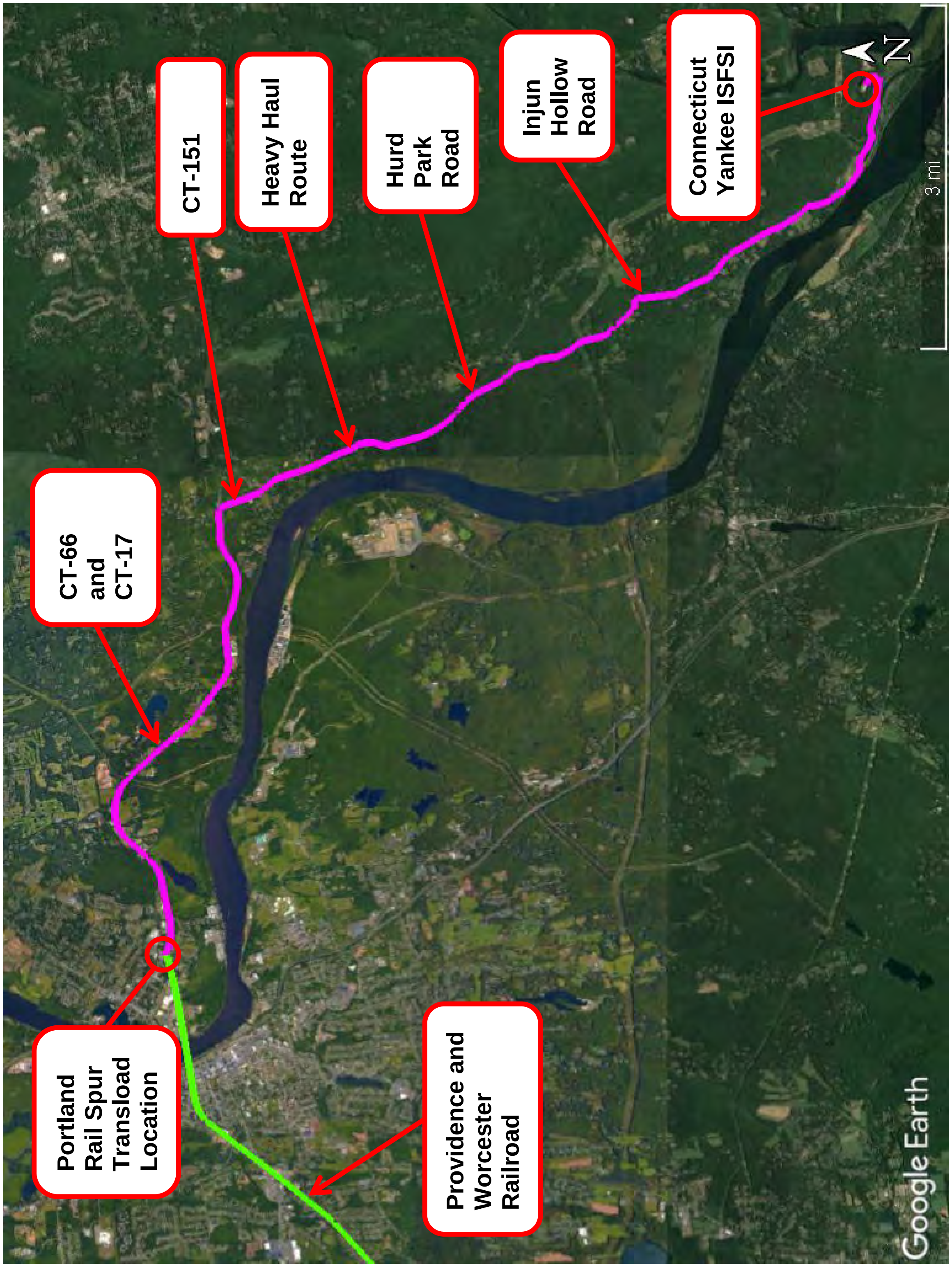

Figure 2-39. Connecticut Yankee Heavy Haul Truck Route (Google 2022)

Photo courtesy of Connecticut Yankee

Figure 2-40. Connecticut Yankee Pressurizer at the End of the Portland Rail Spur

Figure 2-41. Conditions at the End of the Portland Rail Spur (2012)

The Connecticut Yankee site is located on the shores of the Connecticut River and therefore could be accessible by barges that would transport SNF transportation casks to nearby ports served by railroads or to barge-accessible rail sidings or spurs. The Connecticut Yankee barge slip is shown in Figure 2-37. The nearest port with rail access is in New Haven, Connecticut (DSI 2004). As discussed in Section 2.3.2, during decommissioning at Connecticut Yankee, the reactor pressure vessel, steam generators, and transformer were transported off-site using barges. Figure 2-42 through Figure 2-44 show the Connecticut Yankee reactor pressure vessel being loaded onto a barge and being transported by barge.

Photo courtesy of Connecticut Yankee

Figure 2-42. Connecticut Yankee Reactor Pressure Vessel Being Loaded onto Barge

Photo courtesy of Connecticut Yankee

Figure 2-43. Connecticut Yankee Reactor Pressure Vessel Being Transported on Barge

Photo courtesy of Connecticut Yankee

Figure 2-44. Connecticut Yankee Reactor Pressure Vessel Being Transported on Barge in the Connecticut River

2.3.4 Future Information Needs

The Connecticut Yankee site managers suggested that shipments of SNF casks from the site should use barges. The on-site barge slip at Connecticut Yankee is an area of the shoreline along the cooling water discharge canal and has not been used since decommissioning but remains intact. It is uncertain whether the depth of the cooling water discharge canal remains deep enough to accommodate barges. In addition, the cooling water discharge canal and the Connecticut River can freeze in the winter.

Should it be necessary to use heavy haul trucks to move casks from the site, it would be necessary to work with local authorities to determine local routing and heavy haul truck operations procedures and schedules that would minimize disruption of traffic flow and other community activities in the moderately populated area. In addition, the heavy haul truck route from the Connecticut Yankee site to Portland, Connecticut can be ice covered at times during the winter and could need treatment to prepare it for shipments. An engineering review of the heavy haul route would also be required. It would also be necessary to work with the owners of the rail spur to improve track structures from their current degraded condition to allow the transfer of casks from heavy haul trucks to railcars. The condition of the rail bridge over the Connecticut River that is located west of the Portland rail spur would also need to be evaluated.

2.4 Humboldt Bay

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the Humboldt Bay site. The Humboldt Bay site is located on Humboldt Bay near Eureka, California, about 260 miles north of San Francisco (TOPO 1993d).

2.4.1 Site Inventory

The Humboldt Bay ISFSI has a site-specific 10 CFR Part 72 license (License No. SNM-2514). Five canisters containing 390 SNF assemblies (28.9 MTHM) and one canister containing GTCC waste are stored at Humboldt Bay. Figure 2-45 shows the Humboldt Bay ISFSI. In contrast to other ISFSIs, the canisters at Humboldt Bay are stored in HI-STAR HB storage overpacks in a below-grade vault.

The storage system used at Humboldt Bay is the Holtec HI-STAR HB system, which is a variation of the HI-STAR 100 system (Docket No. 72-1008). The system consists of a multipurpose canister inside an overpack designed and certified for both storage and transportation. The MPC-HB canister used at Humboldt Bay can hold up to 80 Humboldt Bay boiling water reactor SNF assemblies. The fuel assemblies from Humboldt Bay were loaded from August through December 2008 (Leduc 2012). The fuel rods in the fuel assemblies are zirconium alloy-clad. The HI-STAR HB storage overpacks used at Humboldt Bay are also transportable (Docket No. 71-9261); however, impact limiters are required and would need to be fabricated. The HI-STAR HB casks would also have to be leak tested and closure bolts inspected prior to shipping and seals replaced for any casks that failed the leak test or required replacement of closure bolts. The HI-STAR HB is certified for the transport of GTCC waste. In addition, the certificate of compliance for the HI-STAR HB has been revised to allow transport of 44 used nuclear fuel assemblies at the Humboldt Bay site with initial enrichments of 2.08 weight percent.

Photo courtesy of Humboldt Bay

Figure 2-45. Humboldt Bay Independent Spent Fuel Storage Installation

Figure 2-46 illustrates the number of SNF assemblies and MTHM at Humboldt Bay based on discharge year. The oldest fuel was discharged in 1971. The fuel was last critical in 1976 and was removed from the reactor vessel in 1984. The median discharge year of the fuel is 1975.

Figure 2-47 illustrates the number of SNF assemblies and MTHM at Humboldt Bay based on burnup. The lowest burnup is 1.3 GWd/MTHM and the highest burnup is 22.9 GWd/MTHM. The median burnup is 16.4 GWd/MTHM. No high burnup SNF (burnup greater than 45 GWd/MTHM) is stored at Humboldt Bay.

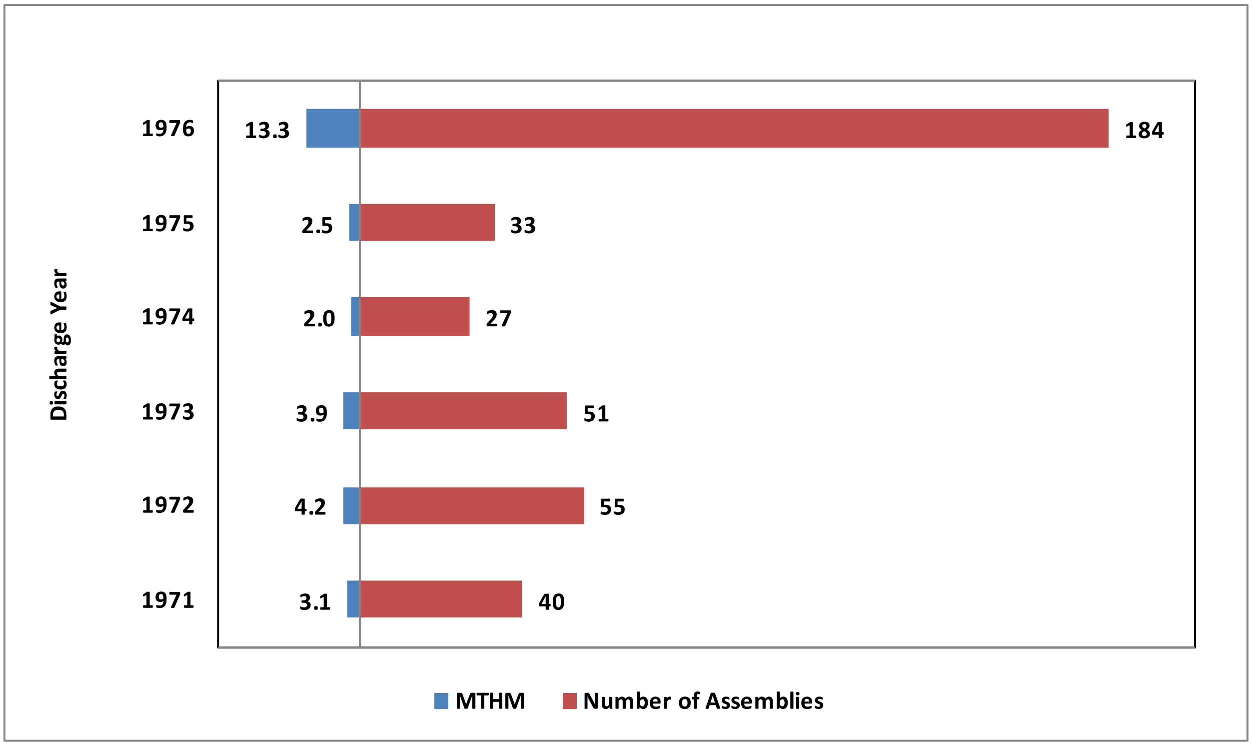

Figure 2-46. Humboldt Bay Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

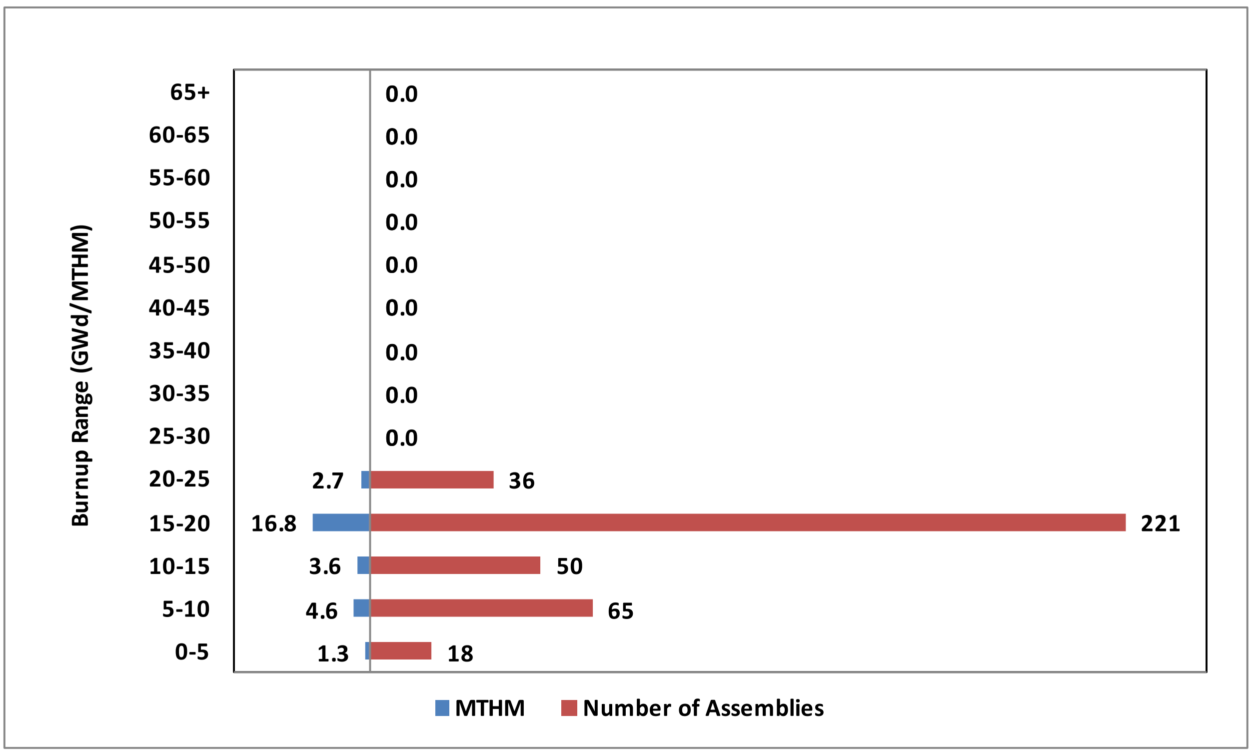

Figure 2-47. Humboldt Bay Number of Assemblies and MTHM versus Burnup (EIA 2018)

2.4.2 Site Conditions

Figure 2-48 provides an aerial view of the Humboldt Bay site, which is being decommissioned, with completion anticipated in 2019. Electrical power is available at the Humboldt Bay ISFSI. The lifting device shown in Figure 2-45 which is used to remove the HI-STAR HB casks containing the Humboldt Bay SNF or GTCC waste from their below-grade vaults is shared with the Diablo Canyon site; however, mobile equipment such as cranes is not on-site. The HI-STAR HB casks are certified for both the storage and transport of the Humboldt Bay SNF. Consequently, a transfer cask is not required at the Humboldt Bay site. The empty HI-STAR HB casks were moved to the Humboldt Bay site using heavy haul trucks (see Figure 2-49).

The Humboldt Bay site has not been served by rail since November 1998, when the Federal Railroad Administration issued Emergency Order 21, which closed the Northwestern Pacific Railroad from Arcata, California (milepost 295.5) to milepost 49.8S (formerly designated milepost 63.4) between Schellville and Napa Junction, California, a distance of 286 miles, for failure to meet federal safety standards (63 FR 67976-67979). In May 2011, the Federal Railroad Administration allowed the Northwestern Pacific Railroad to reopen as far north as milepost 62.9 near Windsor, California (76 FR 27171-27172), about 220 miles south of the Humboldt Bay site. There is also no on-site barge access at the Humboldt Bay site (TriVis Incorporated 2005, TOPO 1993d).

2.4.3 Near-site Transportation Infrastructure and Experience

The Humboldt Bay site does not have an on-site rail spur or an operating railroad that passes near to the site or along the site boundary. For Humboldt Bay, heavy haul trucks could be used to move transportation casks over public highways to a rail siding or spur that provides access to a railroad that can accommodate the loaded transportation casks. Alternatively, heavy haul trucks could be used to move loaded transportation casks from the Humboldt Bay site to a nearby barge facility where the casks would be loaded onto barges.

For shipments of casks containing SNF that require the use of heavy haul trucks, the casks would be prepared for shipment at the Humboldt Bay ISFSI site and loaded onto a transport cradle that would then be loaded onto the transport trailer of a heavy haul truck. The heavy haul truck, led and followed by technical and security escorts, would move over an approved, designated highway route to a rail siding or spur or barge facility. Heavy lift equipment would be used to transfer the cask and its cradle as a unit from the heavy haul truck to a railcar at the rail siding or spur, or onto a barge, or the transport trailer carrying the cask could be rolled onto the barge deck.

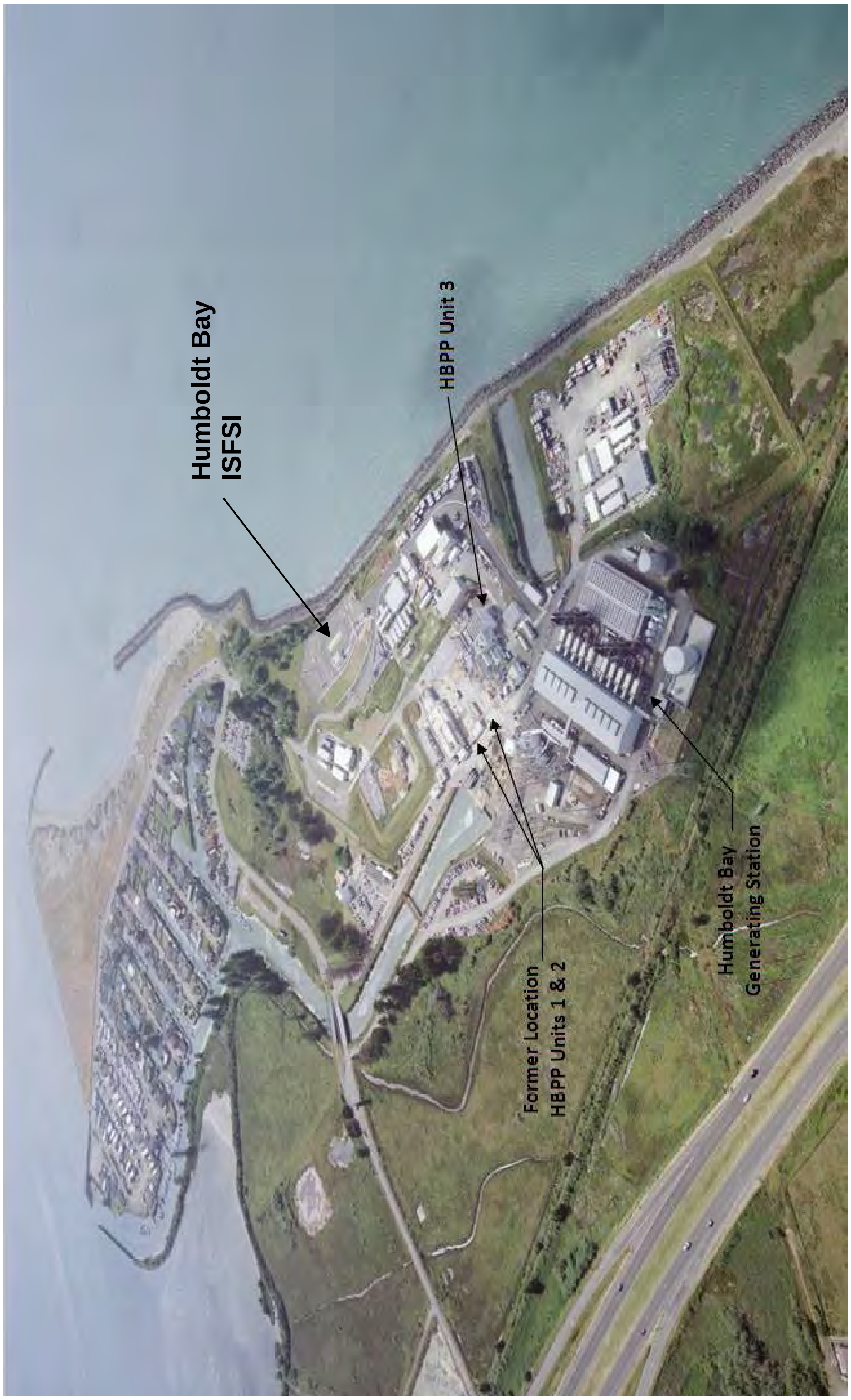

Photo courtesy of Humboldt Bay

Figure 2-48. Aerial View of Humboldt Bay Site

Photo courtesy of Humboldt Bay

Figure 2-49. Empty HI-STAR HB Cask Being Transported by Heavy Haul Truck

The nearest rail access is located in Redding, California, a distance of about 160 miles from Humboldt Bay. To reach this location, heavy haul truck transport would be required on U.S. Highway 101 and State Route 299. The Union Pacific rail line in the vicinity of Redding is designated as track class 4.

During the decommissioning of Humboldt Bay, several truck routes have been used:[12]

- U.S. Highway 101 south to California State Route 20 to Interstate 5
- U.S. Highway 101 north to U.S. Highway 199 to Interstate 5
- U.S. Highway 101 north to California State Route 299 to Interstate 5.

These routes range in length from about 160 to 240 miles.

[12] Williams JR. 2013. Email message from L Sharp (Pacific Gas and Electric Company) to JR Williams (U.S. Department of Energy), "RE: PG&E Comments to DOE Draft Report," February 25, 2013.

The Humboldt Bay site is located on the Port of Humboldt Bay and therefore could be accessible by barges that would transport SNF transportation casks to ports served by railroads or to barge-accessible rail sidings or spurs.

The Port of Humboldt Bay is located on the coast of northern California, approximately 225 nautical miles north of San Francisco, and approximately 156 nautical miles south of Coos Bay, Oregon (USACE 2012). Humboldt Bay is the only harbor between San Francisco and Coos Bay with deep-draft channels large enough to permit the passage of large commercial ocean-going vessels. It is the second largest coastal estuary in California (USACE 2012). Humboldt Bay is reported to have seven shipping terminals: Fairhaven Terminal, Humboldt Bay Forest Products Docks, Redwood Marine Terminal 1 and 2, Schneider Dock, Sierra Pacific Eureka Dock, and the California Redwood Chip Export Dock (HBHRCD 2017). The U.S. Army Corps of Engineers dredges shipping channels in and into Humboldt Bay to depths of 35 to 40 feet. DSI (2004) identifies San Francisco Bay and Coos Bay as the closest ports to Humboldt Bay with rail access.

Although there is no on-site barge access at the Humboldt Bay site, in 2010 barges were used to move 10 Wartsila engines weighing 680,000 lb. each and 10 generators weighing 165,000 lb. each to the Fields Landing Terminal (see Figure 2-50 and Figure 2-51), which is about 2 miles from the Humboldt Bay Generating Station[13] (AC&T 2011). The Fields Landing Channel is 12,000 feet long and 300 feet wide, with an 800-foot-long, 600-foot-wide turning basin (USACE 2012). The engines and generators were loaded onto barges at Schneider Dock in Eureka, California, moved by barge to the Fields Landing Terminal, and offloaded. Heavy haul trucks then moved the engines and generators from the Fields Landing Terminal to the Humboldt Bay Generating Station. Figure 2-50 also shows the heavy haul route taken from the Fields Landing Terminal to the Humboldt Bay Generating Station. Figure 2-52 shows the conditions of the Fields Landing Terminal in 2013. Figure 2-53 through Figure 2-57 show a Wartsila engine being loaded on a barge, a barge and Wartsila engine being towed to the Fields Landing Terminal, a barge and Wartsila engine arriving at the Fields Landing Terminal, a Wartsila engine being unloaded from the barge, and a Wartsila engine being transported by heavy haul truck to the Humboldt Bay Generating Station. Figure 2-58 and Figure 2-59 show the location of the Schneider Dock in relation to the Humboldt Bay site.

[13] Maheras SJ. 2012. Email message from A Richards (Senior Project Manager/Special Projects, Bragg Crane & Rigging) to SJ Maheras (Pacific Northwest National Laboratory), “Andy Richards / Bragg Crane & Rigging,” October 17, 2012.

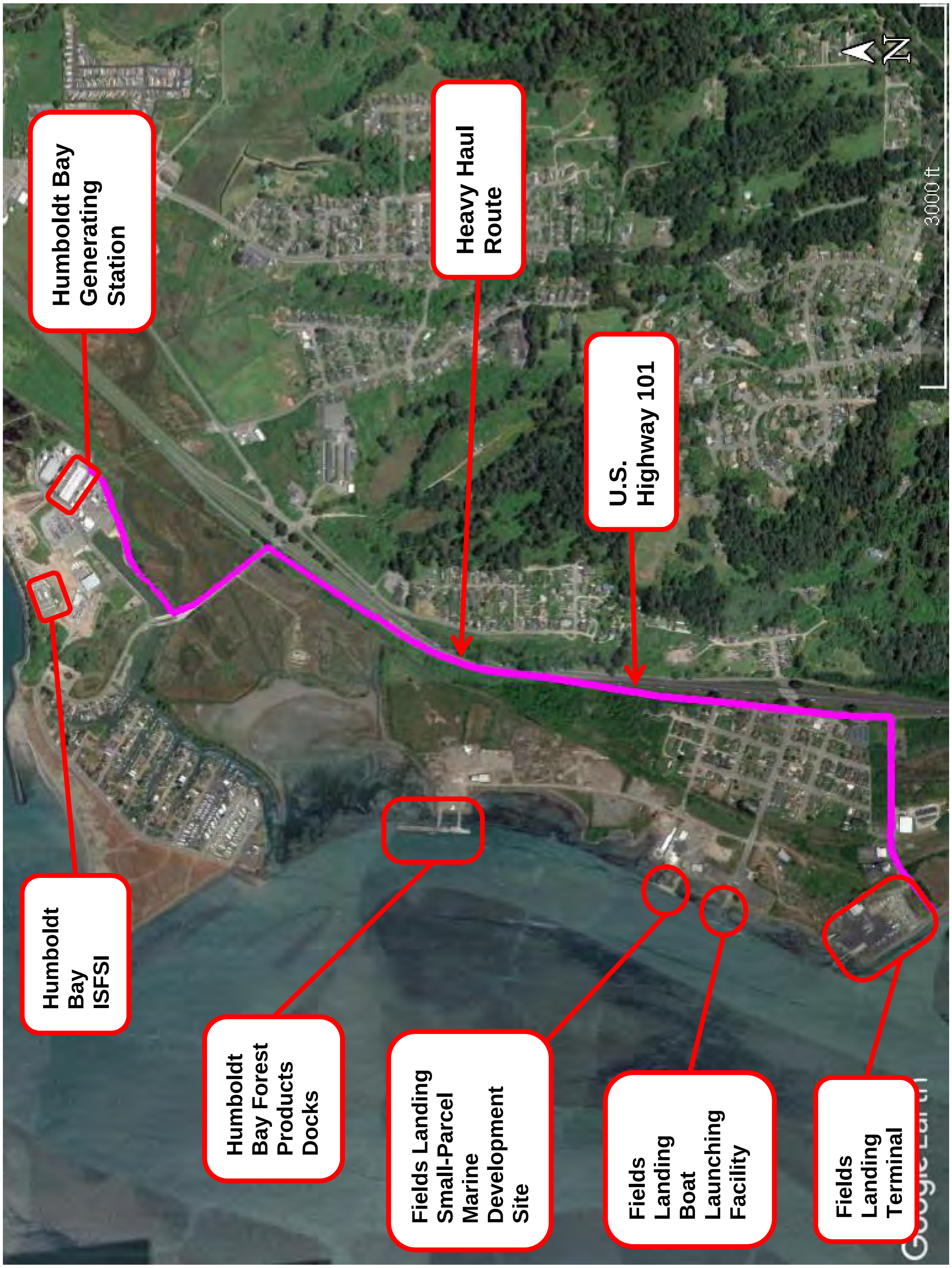

Figure 2-50. Humboldt Bay Independent Spent Fuel Storage Installation and Fields Landing Terminal (Google 2022)

Figure 2-51. Fields Landing Terminal (Google 2022)

Photo courtesy of Federal Railroad Administration

Figure 2-52. Condition of Fields Landing Terminal (2013)

Photo courtesy of Bragg Crane & Rigging Co.

Figure 2-53. Wartsila Engine Being Loaded on a Barge (2010)

Photo courtesy of Bragg Crane & Rigging Co.

Figure 2-54. Wartsila Engine on a Barge Being Towed to Fields Landing Terminal (2010)

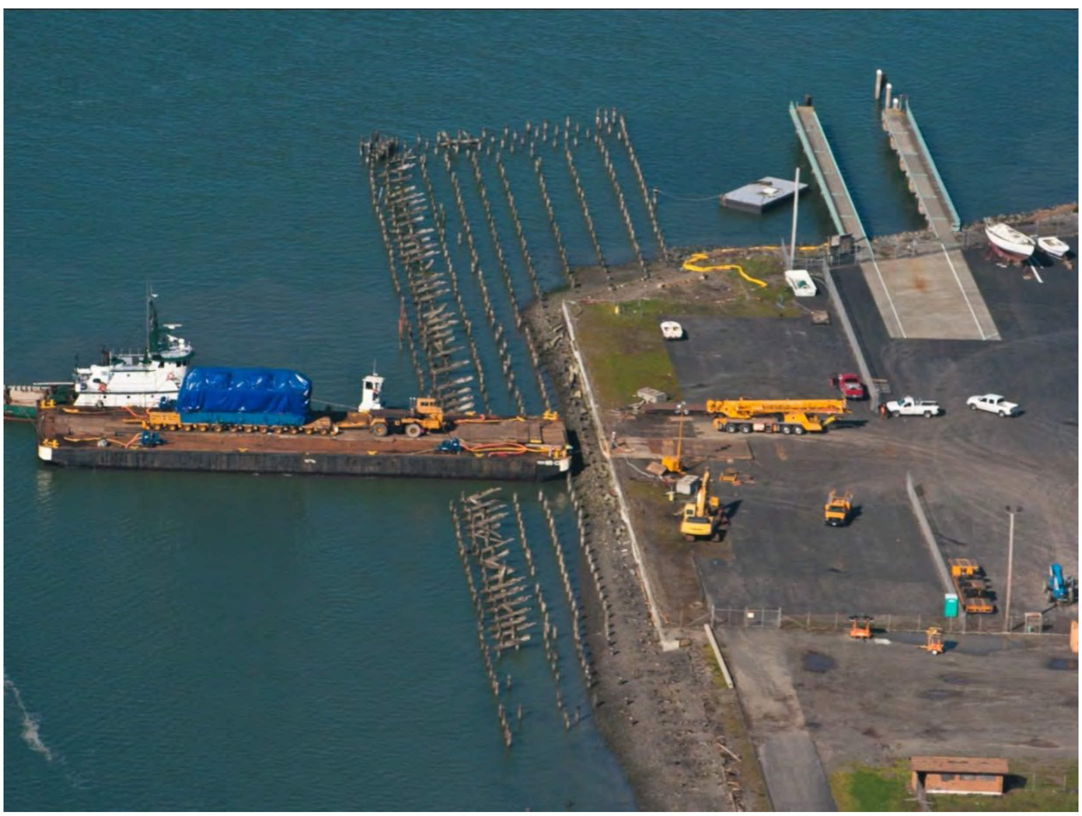

Photo courtesy of Bragg Crane & Rigging Co.

Figure 2-55. Barge with Wartsila Engine Arriving at Fields Landing Terminal (2010)

Photo courtesy of Bragg Crane & Rigging Co.

Figure 2-56. Wartsila Engine Being Unloaded at Fields Landing Terminal (2010)

Photo courtesy of Bragg Crane & Rigging Co.

Figure 2-57. Wartsila Engine Being Transported by Heavy Haul Truck to Humboldt Bay Generating Station (2010)

Figure 2-58. Humboldt Bay Site and Schneider Dock (Google 2022)

Figure 2-59. Schneider Dock (Google 2022)

2.4.4 Future Information Needs

Off-site transportation of HI-STAR HB transportation casks from the Humboldt Bay ISFSI site would require either use of heavy haul trucks for transport over at least 160 miles of mostly two-lane roads that traverse California coastal mountain ranges to a rail siding or spur or use of barges to ship the casks to a port on the western U.S. coast that is served by a railroad.

As discussed in Section 2.4.2, the Humboldt Bay site has not been served by rail since 1998. In 2011, the Northwestern Pacific Railroad reopened as far north as Windsor, California, about 220 miles south of the Humboldt Bay site. The North Coast Railroad Authority hopes to have the rail line open to Willits, California by 2020, which is still about 140 miles south of the Humboldt Bay site. The nearest rail access is located in Redding, California, a distance of about 160 miles from Humboldt Bay (Table 2-3). The 160-mile trip on public highways from the site would entail travel on U.S. Highway 101 through Eureka, connecting to California Highway 299 to travel east across the coastal mountains to Redding, California. This route is illustrated in Figure 2-60. In Redding, heavy-lift equipment would be used to transfer casks from heavy haul trucks onto railcars that would be moved on the Union Pacific mainline that passes through the Redding area. One-way travel time for the heavy haul truck shipments could be greater than one week. It is likely that two of the heavy haul trucks would be moved in convoy in order to limit the overall impact on commuter traffic and business traffic that use the roads. Substantial coordination and planning of the shipments with local and California state officials would be necessary. Prior to the shipments highway engineers would need to survey the roads and road structures (bridges, culverts, and overpasses) to ensure that the shipments could be conducted safely. It is possible that temporary or even permanent improvements, such as adding passing lanes, would need to be made to sections of the roads and structures before the shipments could begin and travel might be limited to late spring through early fall because of weather and frost conditions on roads at higher elevations.

Alternative nearby rail access is located at Grants Pass, Oregon, and Williams, Marysville, and Red Bluff, California. Heavy haul truck routes to these locations are illustrated in Figure 2-60. The distances to these locations range from about 160 to 280 miles (see Table 2-3). Representatives of PG&E have stated that a route using U.S. Highway 101 and State Route 36 would be unacceptable for heavy haul trucks.[14]

Additional heavy haul routes could potentially be used. For example, a heavy haul to Coos Bay, Oregon would be a distance of about 220 miles along U.S. Highway 101, a heavy haul to Windsor, California would be a distance of about 210 miles along U.S. Highway 101, a heavy haul to the San Francisco Bay Area would be a distance of about 240 miles, and a heavy haul to Sacramento, California would be a distance of about 290 miles along U.S. Highway 101, California Highway 20, and Interstate 5. A heavy haul to Willits, California would be a distance of about 130 miles along U.S. Highway 101, but the Northwestern Pacific Railroad is not open to

[14] Williams JR. 2013. Email message from L Sharp (Pacific Gas and Electric Company) to JR Williams (U.S. Department of Energy), "RE: PG&E Comments to DOE Draft Report," February 25, 2013.

Willits. In addition, it is not known if the Northwestern Pacific Railroad will handle hazardous material shipments.[15]

Table 2-3. Alternative Rail Access for Humboldt Bay

Rail Access	Route	Heavy Haul Distance (miles)
Grants Pass, Oregon	U.S. Highway 101 to U.S. Highway 199	180
Redding, California	U.S. Highway 101 to State Route 299	160
Red Bluff, California	U.S. Highway 101 to State Route 36[a]	160
Williams, California	U.S. Highway 101 to State Route 20	240
Marysville, California	U.S. Highway 101 to State Route 20	280

a. Note: Representatives of PG&E have stated that a route using U.S. Highway 101 and State Route 36 would be unacceptable for heavy haul trucks.

Barge transportation of SNF casks from the Humboldt Bay site along the Pacific coast to a port facility that is served by a railroad could be an alternative. However, the site does not have a barge siding or dock, and it is uncertain whether barges could be landed at the shoreline of the site to allow roll-on of heavy haul trucks carrying the six HI-STAR HB casks. A marine survey has not been conducted to determine whether the depth of Humboldt Bay waters that approach the site and the bottom conditions near the shore would permit landing and securing a barge to the shoreline, safely loading it, and backing it back into a navigable channel in the bay. In addition, it is possible that approvals would be needed from California state authorities and from the U.S. Army Corps of Engineers before it would be possible to use a landed barge to load transportation casks containing SNF.

It may be possible to use heavy haul trucks to transport the casks to a nearby shipping terminal in Humboldt Bay. Humboldt Bay is reported to have seven shipping terminals and it would be necessary to determine which, if any, of the reported shipping terminals in Humboldt Bay could be used for shipments of the casks and what routing would be used by heavy haul trucks. Ten large engines and generators were delivered to Schneider Dock in Eureka, California, transported by barge from Schneider Dock to the Fields Landing Terminal, and transported from Fields Landing Terminal to the Humboldt Bay site using heavy haul trucks (AC&T 2011). Moving casks to the Fields Landing Terminal would involve travel over approximately 2 miles of roadways including about 0.5 mile of U.S. Highway 101 and the remainder on local roadways.

[15] Spent nuclear fuel and GTCC waste would be Class 7 hazardous material.

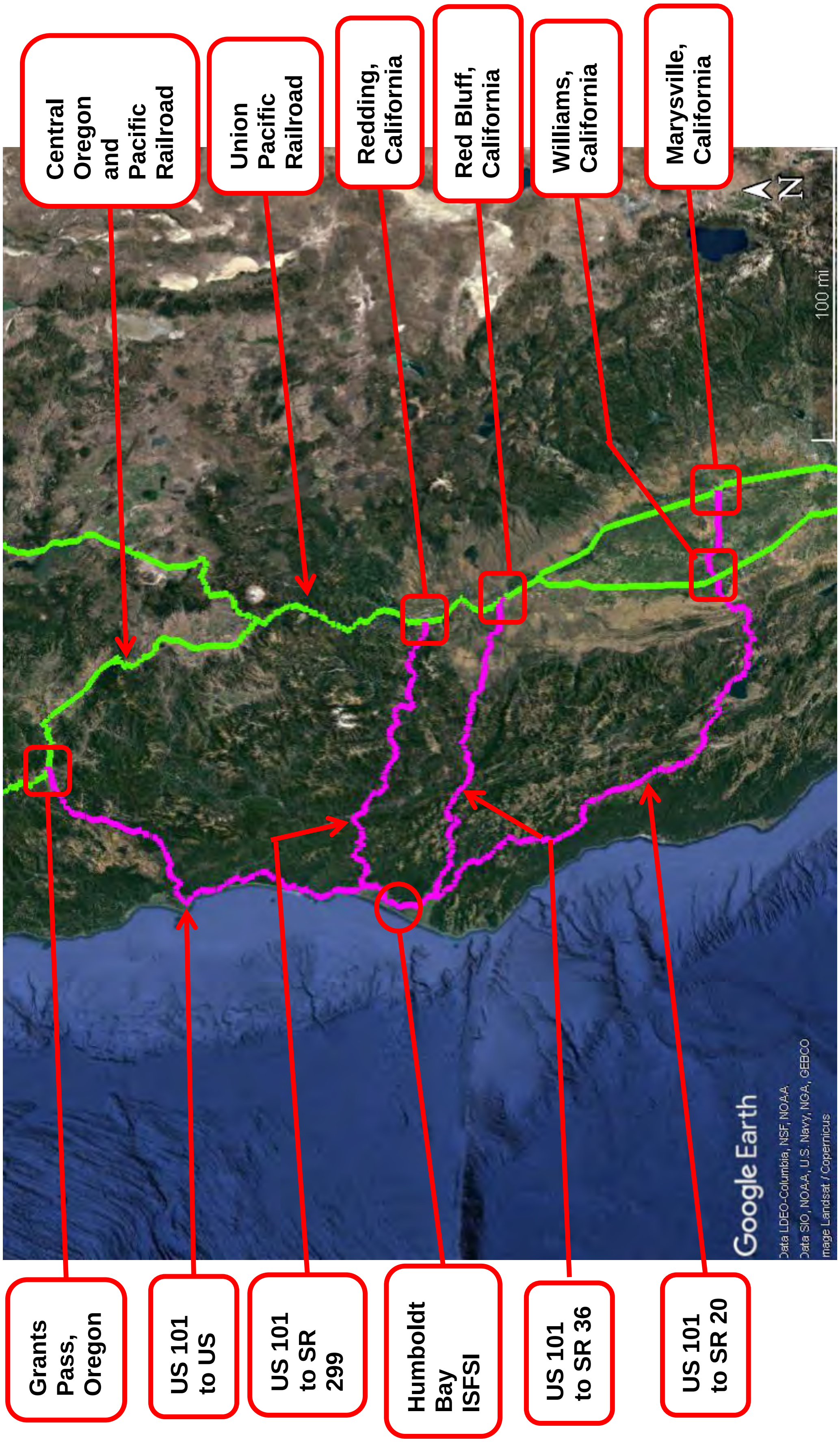

Figure 2-60. Heavy Haul Routes from Humboldt Bay Independent Spent Fuel Storage Installation to Alternative Rail Access Locations (Google 2022)

2.5 Big Rock Point

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the Big Rock Point site. The Big Rock Point site is located on the eastern shore of Lake Michigan about 4 miles north of Charlevoix and 10 miles west of Petoskey, Michigan (TOPO 1994a).

2.5.1 Site Inventory

Seven canisters containing 441 SNF assemblies (57.9 MTHM) and 1 canister of GTCC waste are stored at the Big Rock Point ISFSI (Docket No. 72-43). The seven canisters contain 50 damaged SNF assemblies which have been placed in damaged fuel cans. In addition to uranium dioxide (UO_2) SNF assemblies, there are 36 mixed oxide SNF assemblies stored at Big Rock Point. Table 2-4 lists the assembly identification numbers for these mixed oxide SNF assemblies.

Table 2-4. Assembly Identification Numbers for Mixed Oxide Spent Nuclear Fuel Assemblies at Big Rock Point

Fuel Assembly	Fuel Assembly	Fuel Assembly	Fuel Assembly
D72	G04	G13	G204
D73	G05	G14	G205
DA1	G06	G15	G206
DA2	G07	G16	G207
DA3	G08	G17	G208
DA4	G09	G18	G209
G01	G10	G19	G210
G02	G11	G20	E65
G03	G12	G21	E72

a. Source: Maheras SJ. 2014. Email message from LR Potter (Entergy) to SJ Maheras (Pacific Northwest National Laboratory), "RE: mox fuel assemblies at big rock point," April 2, 2014.

Figure 2-61 shows the Big Rock Point ISFSI. The storage system used at Big Rock Point is the FuelSolutions Storage System which consists of the W74 canister, the W150 storage cask, and the W100 transfer cask (Docket No. 72-1026). The W74 canister holds 64 Big Rock Point boiling water reactor SNF assemblies. The fuel assemblies from Big Rock Point were loaded into W74 canisters from December 2002 through March 2003 (Leduc 2012). The fuel rods in the fuel assemblies are zirconium alloy-clad. The TS125 transportation cask (Docket No. 71-9276) is certified to transport the W74 canister. No TS125 transportation casks have been fabricated. In addition, the TS125 transportation cask is not certified for the transport of GTCC waste.

Photo courtesy of Big Rock Point

Figure 2-61. Big Rock Point Independent Spent Fuel Storage Installation

In October 2012, the NRC issued a renewed certificate of compliance to EnergySolutions for the TS125 transportation cask. The renewed certificate of compliance expires on October 31, 2017 (Waters 2012). The Safety Evaluation Report for the renewal of the certificate of compliance observes that no TS125 transportation casks have been fabricated and states that because the TS125 transportation cask has a -85 designation in its identification number (i.e., USA/9276/B(U)F-85), all fabrication of this package must have been completed by December 31, 2006, as required by 10 CFR 71.19(c). In order to fabricate TS125 transportation casks, EnergySolutions would need to apply for a -96 designation by submitting a revised safety analysis report to demonstrate that the TS125 transportation cask meets the current NRC regulations contained in 10 CFR Part 71. The revisions to the TS125 safety analysis report would include:

- **Revised A_1 and A_2 values.** EnergySolutions would need to update the containment analysis in Chapter 4 of the safety analysis report to incorporate revised A2 values in 10 CFR Part 71, Appendix A, Table A-1. An increase in the maximum allowable leakage rates for the TS125 transportation cask would be expected.
- **Criticality Safety Index (CSI).** EnergySolutions would need to revise Chapters 1, 5, and 6 of the TS125 transportation cask safety analysis report to incorporate the CSI nomenclature and the NRC would need to revise the certificate of compliance to delete references to the Transport Index for criticality control.
- **Expansion of Quality Assurance (QA) Requirements.** EnergySolutions would need to revise the safety analysis report for the TS125 transportation cask to demonstrate how its QA program satisfies the specific requirements of 10 CFR 71.101(a), (b), and (c).

A -96 designation must also be obtained before the TS125 transportation cask is certified for the transport of GTCC waste. The effort to accomplish these changes and to obtain NRC review and approval is estimated to range from one to three years.

Figure 2-62 illustrates the number of SNF assemblies and MTHM at Big Rock Point based on discharge year. The oldest fuel was discharged in 1974 and the last fuel was discharged in 1997. The median discharge year of the fuel is 1988.

Figure 2-63 illustrates the number of SNF assemblies and MTHM at Big Rock Point based on burnup. The lowest burnup is 3.5 GWd/MTHM and the highest burnup is 34.2 GWd/MTHM. The median burnup is 23.7 GWd/MTHM. No high burnup SNF (burnup greater than 45 GWd/MTHM) is stored at Big Rock Point.

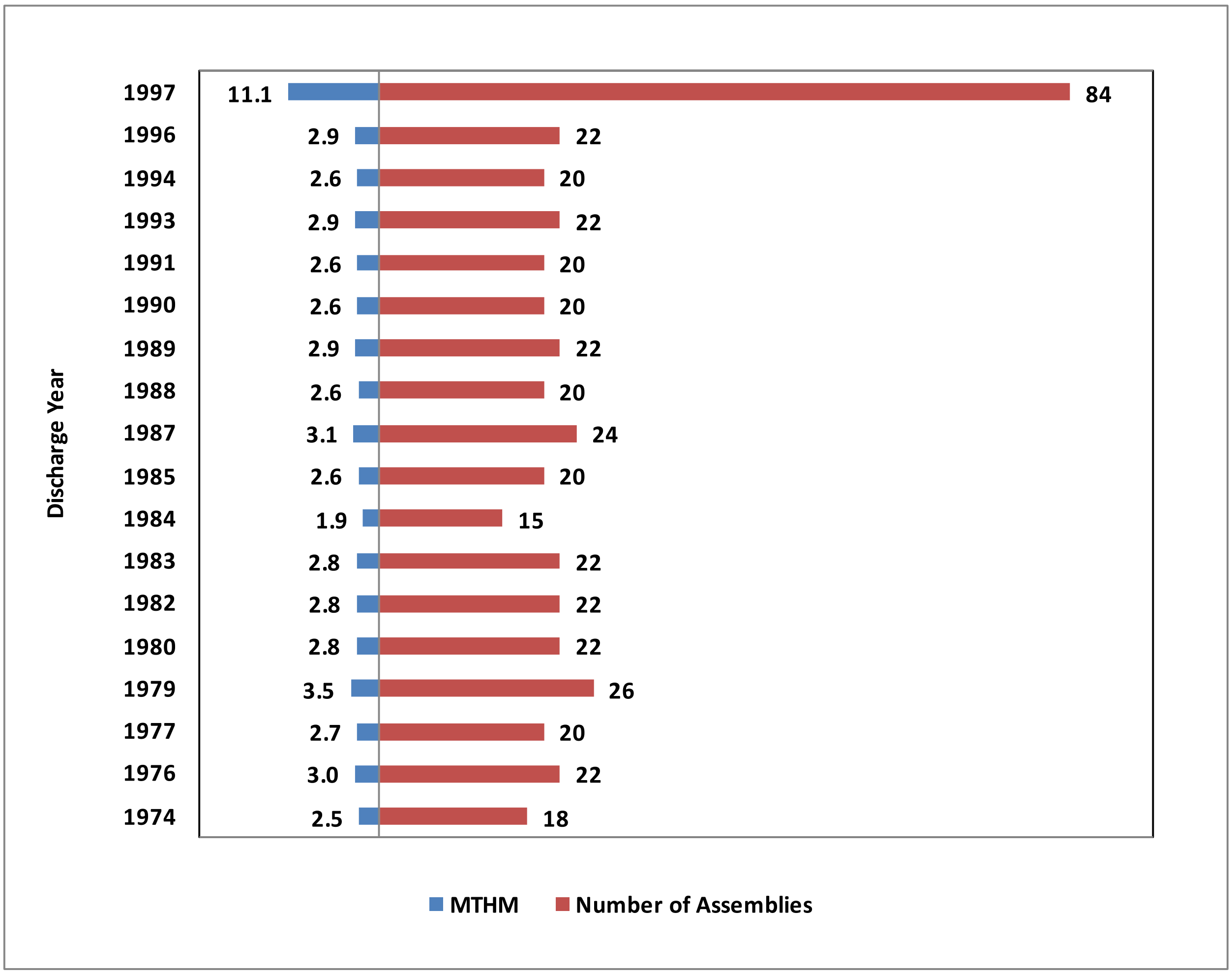

Figure 2-62. Big Rock Point Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

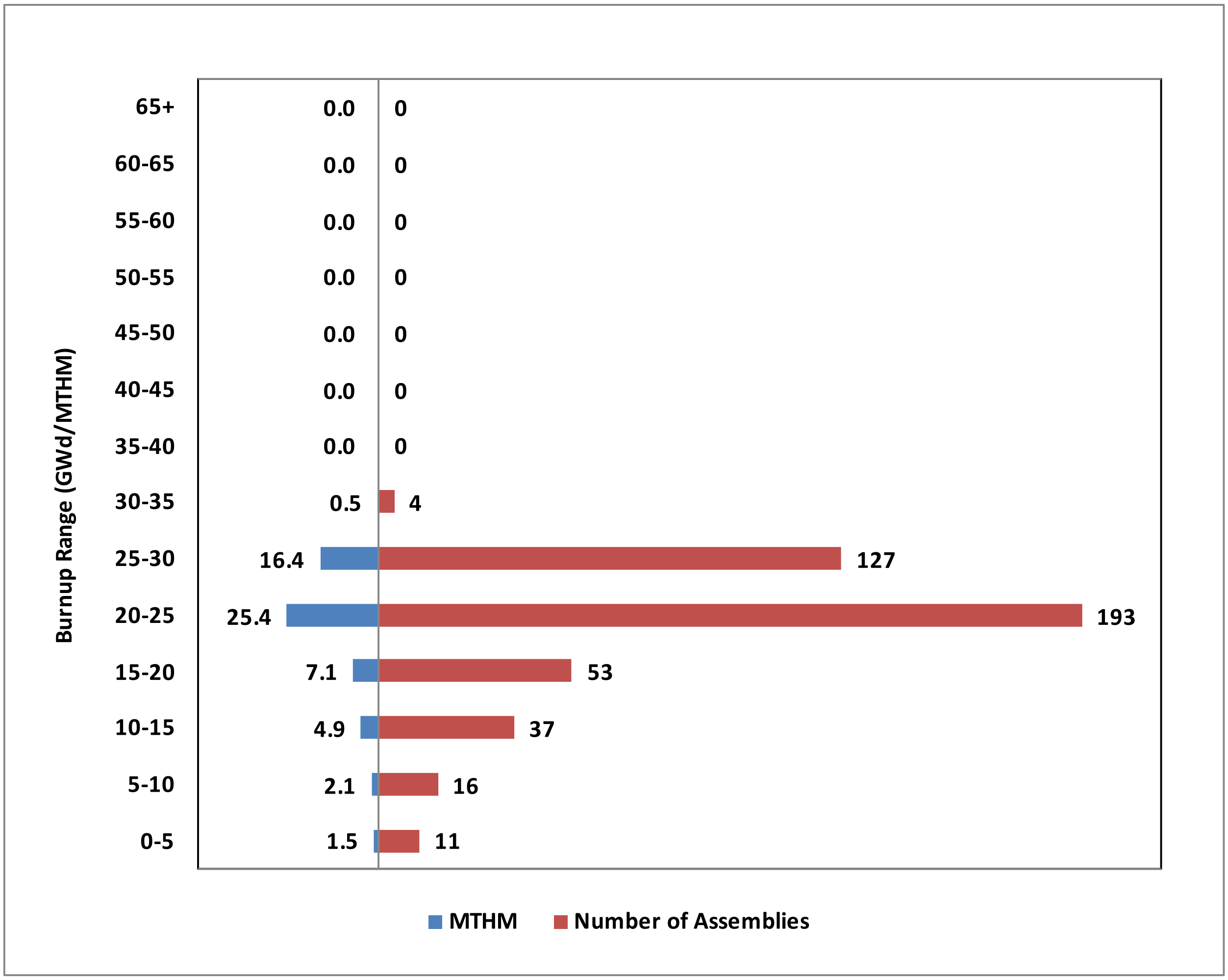

Figure 2-63. Big Rock Point Number of Assemblies and MTHM versus Burnup (EIA 2018)

2.5.2 Site Conditions

Figure 2-64 provides an aerial view of the Big Rock Point site, where the reactor and associated structures have been removed. Electrical power is available at the Big Rock Point ISFSI; a transfer cask, gantry towers, horizontal transfer system, and J-skid[16] are present at the ISFSI. Herron (2010) stated that the equipment needed to transfer SNF and GTCC waste in W74 canisters from the W150 storage casks to the TS125 transportation cask is in place, is tested on a periodic basis, and preventative maintenance is performed. Figure 2-65 shows the transfer cask and J-skid, Figure 2-66 shows the gantry towers, and Figure 2-67 shows the horizontal transfer system at the Big Rock Point site.

A rail spur that served the Big Rock Point site was removed in 1988 (NAC 1990). This spur was used for nine rail shipments of SNF to West Valley, New York between 1970 and 1974 (NAC 1990). There is no on-site rail access at the Big Rock Point site (TriVis Incorporated 2005), and

[16] The J-skid is a built-up welded steel frame of heavy wide flange beams and cross members that is used to capture and engage the W150 storage cask for rotation by the gantry towers. This J-skid is also used to support the W150 storage cask in the horizontal orientation during W74 canister transfer.

heavy haul truck transport would be necessary to reach nearby rail sidings or spurs. For example, a rail spur in Gaylord, Michigan was used for shipping the reactor pressure vessel from Big Rock Point to the Barnwell, South Carolina low-level radioactive waste disposal facility (Petrosky 2004), and a rail siding in Petoskey, Michigan was used for shipping the steam drum to the EnergySolutions low-level radioactive waste disposal facility in Clive, Utah (Tompkins 2006). Herron (2010) states that the heavy haul roadway no longer exists on the site and that the current access road from the ISFSI to the highway was not built to support heavy haul transfers, and may need to be rebuilt or enhanced.

TOPO (1994a) states that an on-site barge facility was used during the construction of Big Rock Point, but its use was discontinued in the early 1960s after Big Rock Point was completed. TOPO (1994a) also identifies a potential barge area at the Big Rock Point site (see Figure 2-64). However, NAC (1990) states that Big Rock Point has never had an on-site barge facility.

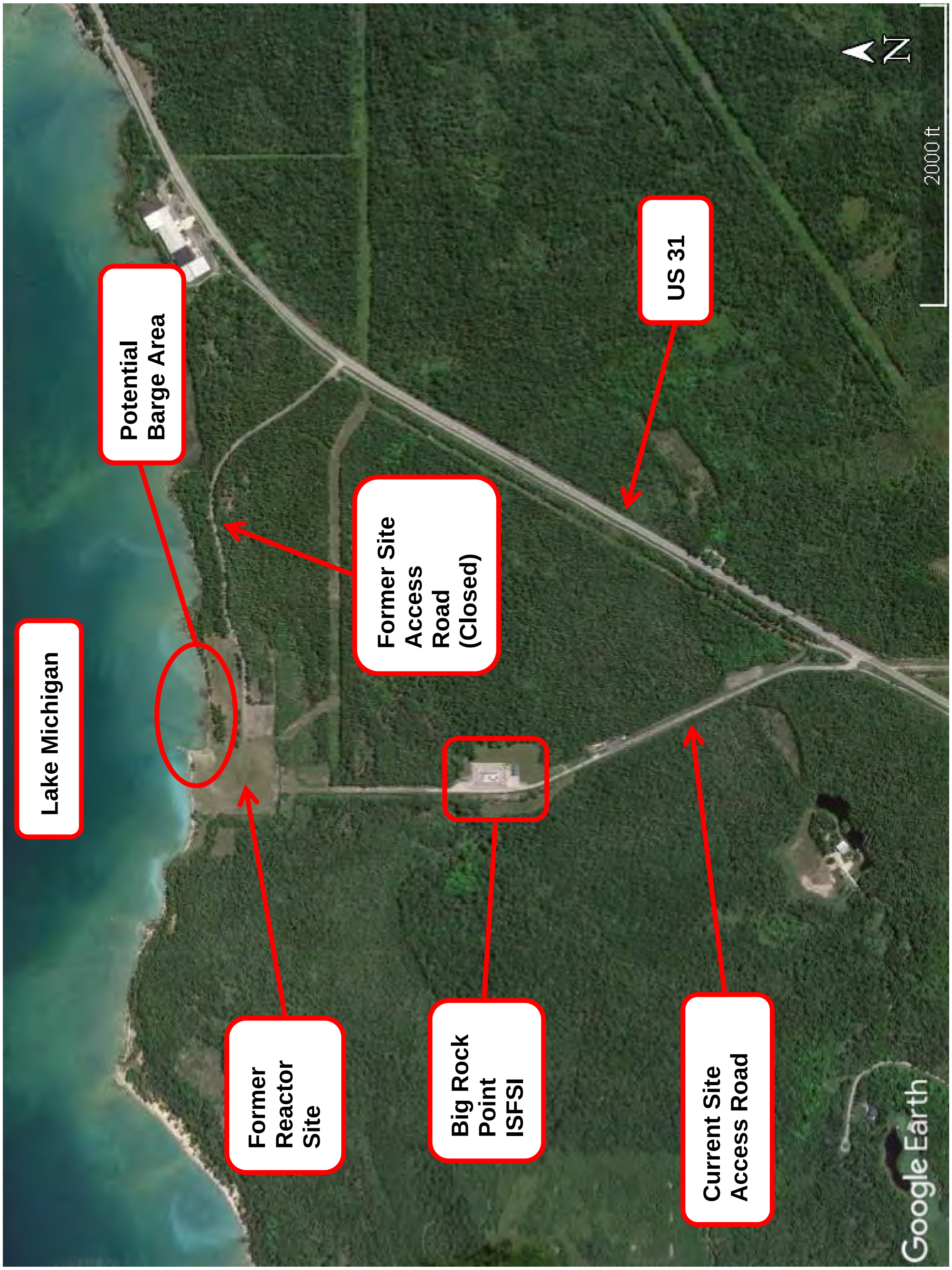

Figure 2-64. Aerial View of Big Rock Point Site (Google 2022)

Photo courtesy of Big Rock Point

Figure 2-65. Transfer Cask and J-Skid at Big Rock Big Rock Point Independent Spent Fuel Storage Installation (2013)

Photo courtesy of Big Rock Point

Figure 2-66. Big Rock Point Gantry Towers (2013)

Photo courtesy of Big Rock Point

Figure 2-67. Big Rock Point Horizontal Transfer System (2013)

2.5.3 Near-site Transportation Infrastructure and Experience

The Big Rock Point site does not have an on-site rail spur or a railroad that passes near to the site or along the site boundary. For Big Rock Point, heavy haul trucks could be used to move transportation casks over public highways to a rail siding or spur that provides access to a railroad that can accommodate the loaded transportation casks. Site representatives from Big Rock Point have also stated that seasonal restrictions would likely exist during January through March because of winter conditions, and during July through September because of the large number of tourists in the Big Rock Point area.

For shipments of casks containing SNF that require the use of heavy haul trucks, the casks would be prepared for shipment at the Big Rock Point ISFSI site and loaded onto a transport cradle that would be loaded onto the transport trailer of a heavy haul truck. The truck, led and followed by technical and security escorts, would move over an approved, designated highway route to a rail siding or spur. Heavy lift equipment would be used to transload the cask and its cradle as a unit from the truck to a railcar at the rail siding or spur.

During the decommissioning of the Big Rock Point reactor, heavy haul trucks were used to move the reactor pressure vessel and steam drum from the Big Rock Point site to nearby rail sidings or spurs. In 2003, the reactor pressure vessel from the Big Rock Point reactor was moved on a Goldhofer trailer with 36 independently controlled axles and 144 tires propelled by two 1000-horsepower engines (Figure 2-68) about 52 miles to a rail spur near Gaylord, Michigan, transloaded onto an ETMX1001 railcar (Figure 2-69 through Figure 2-71), and then transported by rail to the Barnwell, South Carolina low-level radioactive waste disposal facility (Petrosky 2004, Slimp et al. 2014) (Figure 2-72). The Big Rock Point pressure vessel and its shipping package weighed more than 565,000 lb. Figure 2-73 shows the route taken from the Big Rock Point site to Gaylord, Michigan. The Lake State Railway in the vicinity of Gaylord is designated as track class 2. In the vicinity of Big Rock Point, a detour off of U.S. 31 was required to bypass an abandoned overhead rail bridge with inadequate vertical clearance. Figure 2-74 shows this detour and Figure 2-75 shows the bridge. Figure 2-76 shows the route taken by the reactor pressure vessel in the vicinity of Gaylord, Michigan and Figure 2-77 and Figure 2-78 show the condition in 2013 of the rail crossing and spur used for the Big Rock Point reactor pressure vessel transload. The track class at this crossing and spur appears to be “Excepted” and would likely require refurbishment prior to use for SNF shipments.

In 2003, the Big Rock Point steam drum was also moved by heavy haul truck about 13 miles to a rail siding near Petoskey, Michigan, transloaded onto a railcar, and then transported by rail to the EnergySolutions low-level radioactive waste disposal facility in Clive, Utah (Gretzner 2006, Tompkins 2006). The steam drum weighed 200,000 lb. (Figure 2-79 and Figure 2-80). The Great Lakes Central Railroad is designated as track class 1 in the vicinity of Petoskey. The height of the steam drum on its transporter was low enough so that it did not require the same detour as described for the reactor pressure vessel and was able to take U.S. 31 from the Big Rock Point site into Petoskey, Michigan (see Figure 2-73). Figure 2-81 shows the route taken by the reactor pressure vessel in the vicinity of Petoskey, Michigan and Figure 2-82 shows the condition in 2013 of the of rail crossing and siding used for Big Rock Point steam drum transload.

Photo courtesy of Barnhart Crane & Rigging

Figure 2-68. Big Rock Point Reactor Pressure Vessel on Heavy Haul Truck (2003)

Photo courtesy of William J. Trubilowicz

Figure 2-69. ETMX1001 Railcar Staged for Transfer (2003)

Photo courtesy of William J. Trubilowicz

Figure 2-70. Heavy Haul Truck with Reactor Pressure Vessel beside ETMX1001 Railcar (2003)

Photo courtesy of William J. Trubilowicz

Figure 2-71. Transfer of Reactor Pressure Vessel onto ETMX1001 Railcar (2003)

Photo courtesy of Consumers Energy

Figure 2-72. Big Rock Point Reactor Pressure Vessel on ETMX1001 Railcar (2003)

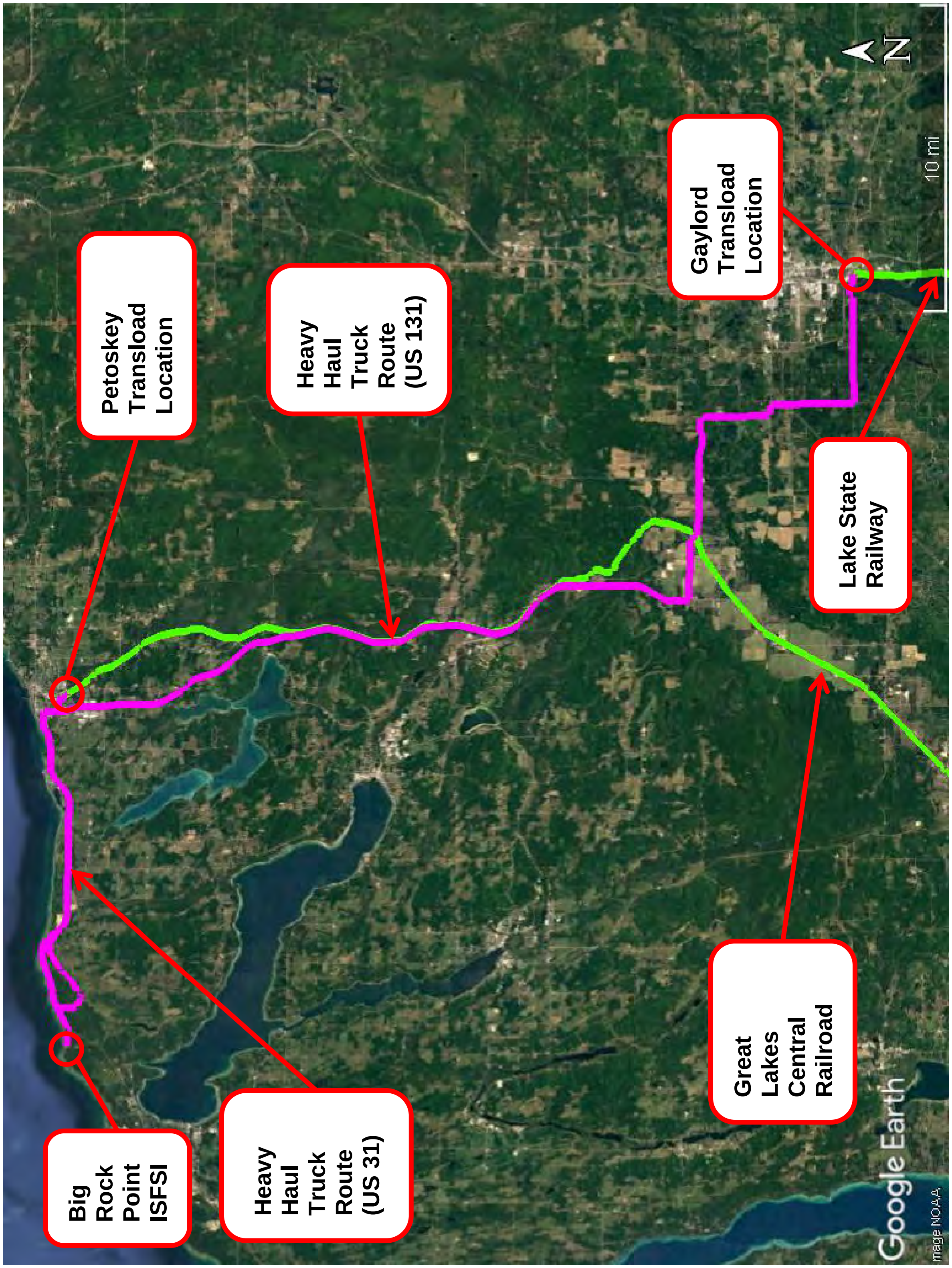

Figure 2-73. Big Rock Point Reactor Pressure Vessel Heavy and Steam Drum Haul Truck Routes (Google 2022)

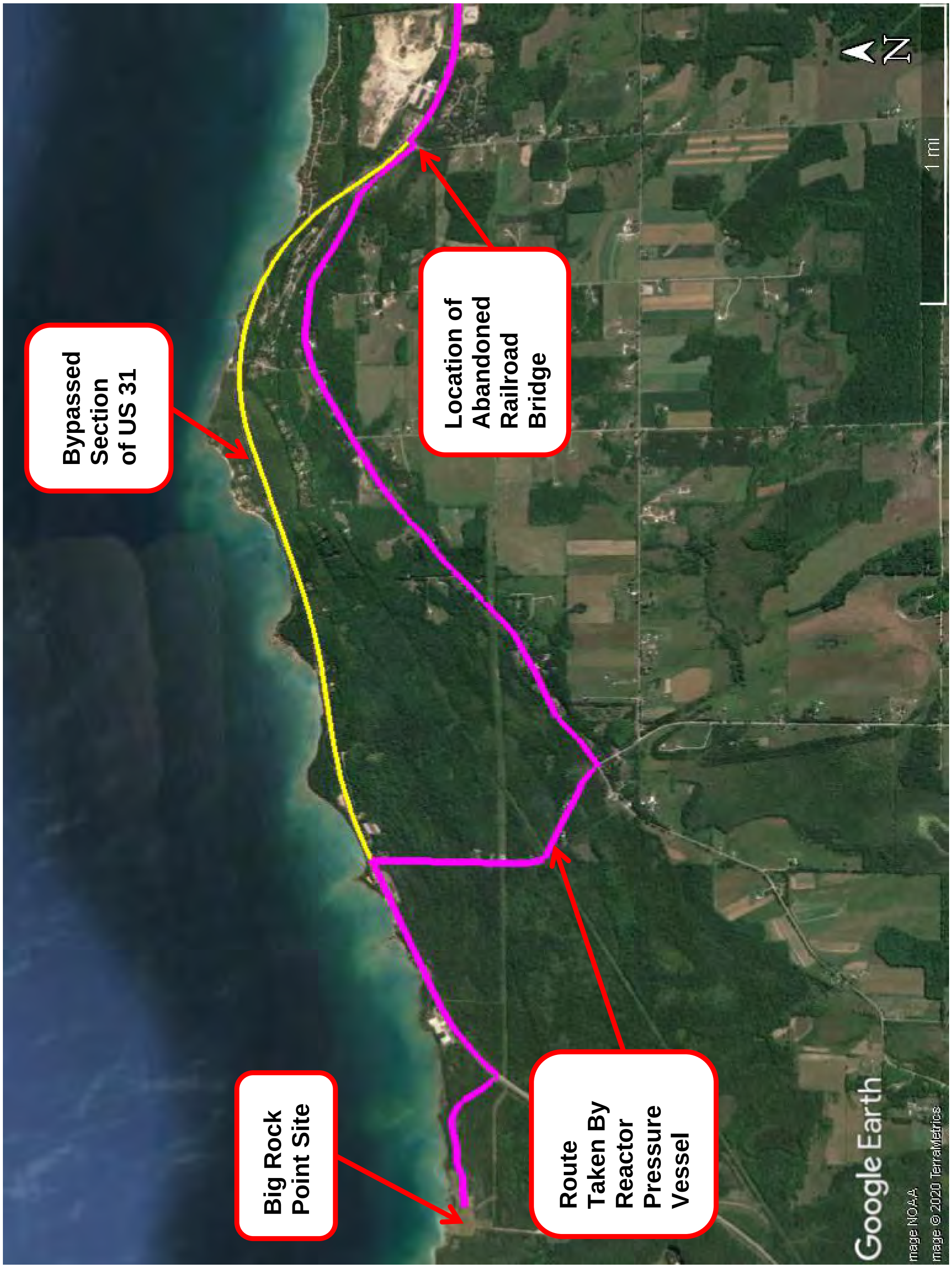

Figure 2-74. Route Taken By Reactor Pressure Vessel to Bypass Low Overhead Clearance Abandoned Railroad Bridge (Google 2022)

Figure 2-75. Low Overhead Clearance Abandoned Railroad Bridge on U.S. 31 (2013)

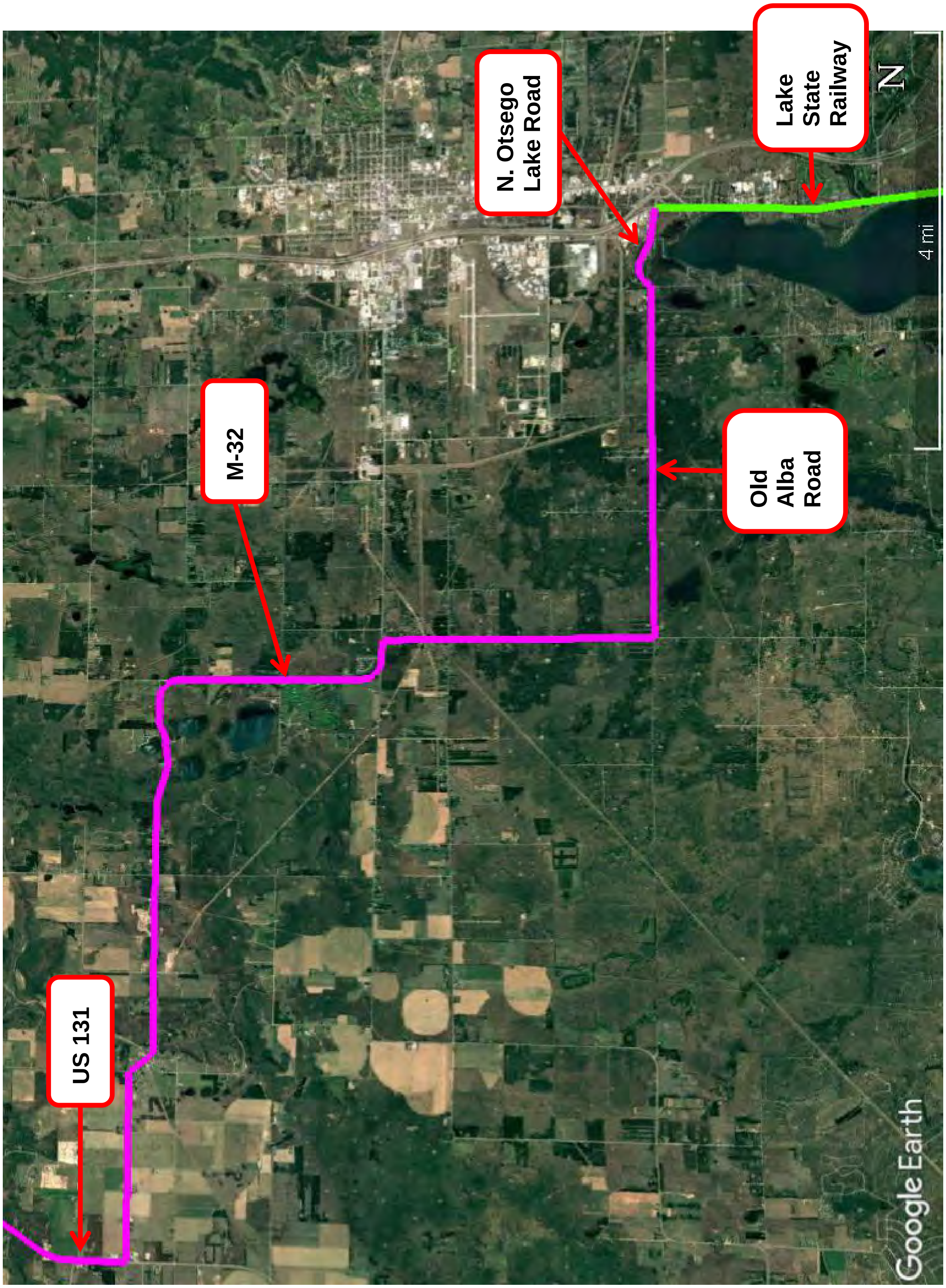

Figure 2-76. Route Taken By Reactor Pressure Vessel in the Vicinity of Gaylord, Michigan (Google 2022)

Figure 2-77. Condition of Rail Crossing Used for Big Rock Point Reactor Pressure Vessel Transload (Looking North) (2013)

Figure 2-78. Condition of Rail Crossing Used for Big Rock Point Reactor Pressure Vessel Transload (Looking South) (2013)

Photo courtesy of Consumers Energy

Figure 2-79. Big Rock Point Steam Drum on Heavy Haul Truck (2003)

Photo courtesy of Consumers Energy

Figure 2-80. Big Rock Point Steam Drum on Railcar (2003)

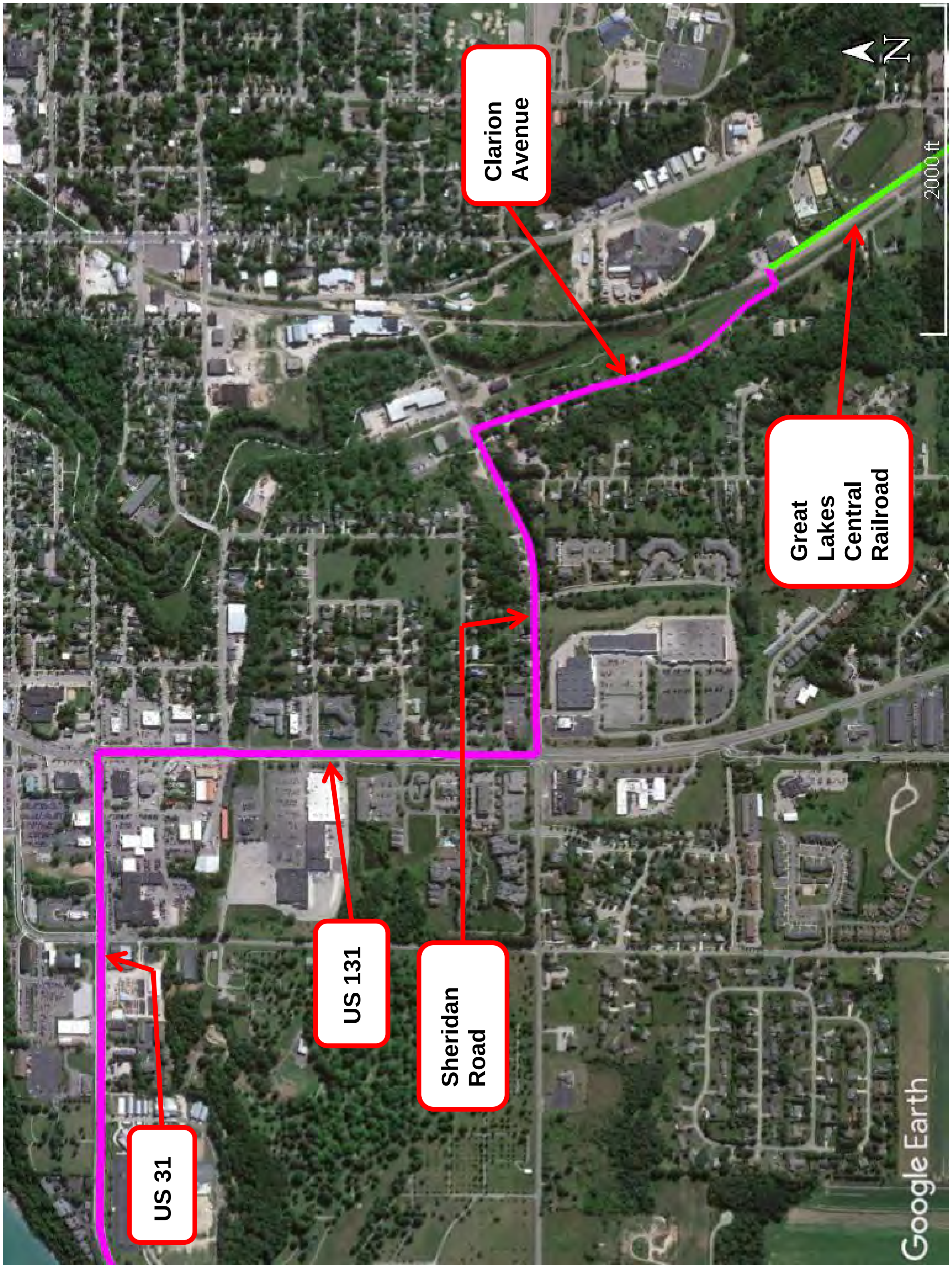

Figure 2-81. Route Taken By Steam Drum in the Vicinity of Petoskey, Michigan (Google 2022)

Photo courtesy of Federal Railroad Administration

Figure 2-82. Condition of Petoskey Rail Siding (2013)

The Big Rock Point site is on the shore of Lake Michigan, and therefore could be accessible by barges that would transport SNF transportation casks to nearby ports served by railroads or to barge-accessible rail sidings or spurs. DSI (2004) identifies the following ports with rail access:

- Traverse City, Manistee, Ludington, Muskegon, and Grand Haven as ports with rail access along the eastern shore of Lake Michigan
- Alpena, Bay City, Port Huron, Saint Clair, and Detroit as ports with rail access along the western shore of Lake Huron
- Inland, Escanaba, Green Bay, and Milwaukee as ports with rail access along the western shore of Lake Michigan
- Chicago, Indiana Harbor, Buffington, and Gary as ports with rail access along the southern shore of Lake Michigan.

The capabilities of these ports have not been investigated.

Figure 2-83 shows the condition of the shoreline in 2013 in the vicinity of the potential barge area identified in Figure 2-64.

Photo courtesy of Big Rock Point

Figure 2-83. Condition of Potential Barge Area at Big Rock Point (2013)

2.5.4 Future Information Needs

As discussed in Section 2.5.3, shipments of large reactor components have been made from the Big Rock Point site using heavy haul trucks to carry the components to rail sidings for loading onto railcars. The weight limits associated with the Great Lakes Central Railway and the Lake State Railway track that would be used would need to be evaluated, as well as the current condition of rail sidings or spurs that would be used.

It may also be possible to use barges to transport casks containing SNF directly from the Big Rock Point site to a port that is served by a railroad. There is not a barge slip, dock, or landing area on the site's Lake Michigan shoreline. Also, it is unknown whether the depth of water approaching the shore at the site and the bottom conditions near the shore would permit safe operations for barges, and whether extensive grading and spreading of gravel would be required. Barge operations could use either heavy lift equipment to move casks from heavy haul transporters onto barges or the heavy haul transporters might be rolled directly onto barges. Lake Michigan is subject to freezing in the Big Rock Point area (TOPO 1994a), and barge operations would not be conducted on Lake Michigan during winter months.

2.6 Rancho Seco

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the Rancho Seco site. The Rancho Seco site is located about 25 miles southeast of Sacramento, California (NAC 1991a).

2.6.1 Site Inventory

The Rancho Seco ISFSI has a site-specific 10 CFR Part 72 license (License No. SNM-2510). Twenty-one canisters containing 493 SNF assemblies (228.4 MTHM) and 1 canister of GTCC waste are stored at Rancho Seco. Figure 2-84 shows the Rancho Seco ISFSI. The storage system used at Rancho Seco is a site-specific model of the Standardized NUHOMS-24P system (Docket No. 72-1004), which consists of transportable canisters, reinforced concrete horizontal storage modules, and a transfer cask. The canisters used at Rancho Seco are the fuel-only dry shielded canister (FO-DSC) (2 canisters), fuel with control component dry shielded canister (FC-DSC) (18 canisters), and failed fuel dry shielded canister (FF-DSC) (1 canister). The FO-DSC and FC-DSC hold 24 pressurized water reactor SNF assemblies and the FF-DSC holds 13 pressurized water reactor SNF assemblies. There are 48 assemblies contained in FO-DSCs, 432 assemblies contained in FC-DSCs, and 13 assemblies contained in FF-DSCs. The fuel assemblies from Rancho Seco were loaded from April 2001 through August 2002 (Leduc 2012). The fuel rods in the fuel assemblies are zirconium alloy-clad. The transfer cask used at Rancho Seco is the MP187 transportation cask (Docket No. 71-9255), which is also certified for off-site transportation of the FO-DSC, FC-DSC, and FF-DSC. The MP187 transportation cask that was used to load the Rancho Seco ISFSI is stored at the Rancho Seco site (see Figure 2-85). The hydraulic ram used to emplace and withdraw canisters from the horizontal storage modules is also stored at the Rancho Seco site (see Figure 2-86). Figure 2-87 shows the MP187 transportation cask and hydraulic ram being used to load a canister into a horizontal storage module. Impact limiters are required for off-site transport of the MP187 transportation cask and would need to be fabricated. The MP187 transportation cask is also not certified for the transport of GTCC waste.

Photo courtesy of Rancho Seco

Figure 2-84. Rancho Seco Independent Spent Fuel Storage Installation

Figure 2-85. MP187 Transportation Cask at Rancho Seco (2013)

Figure 2-86. Hydraulic Ram Used to Emplace and Withdraw Canisters from Horizontal Storage Modules at Rancho Seco (2013)

Photo courtesy of Rancho Seco

Figure 2-87. MP187 Transportation Cask and Hydraulic Ram Being Used to Load a Canister into a Horizontal Storage Module at Rancho Seco

In August 2013, the NRC issued a renewed certificate of compliance to Transnuclear for the MP187 transportation cask (Sampson 2013).[17] The Safety Evaluation Report for the renewal of the certificate of compliance states that because the MP187 transportation cask has a -85 designation in its identification number (i.e., USA/9255/B(U)F-85), all fabrication of this package must have been completed by December 31, 2006, as required by 10 CFR 71.19(c). To date, one MP187 transportation cask without impact limiters has been fabricated, and before additional MP187 transportation casks are fabricated, Transnuclear/AREVA would need to apply for a -96 designation by submitting a revised safety analysis report to demonstrate that the MP187 transportation cask meets the current NRC regulations contained in 10 CFR Part 71. The revisions to the MP187 safety analysis report would include:

- **Revised A_1 and A_2 values.** Transnuclear would need to update the containment analysis in Chapter 4 of the safety analysis report to incorporate revised A2 values in 10 CFR Part 71, Appendix A, Table A-1. An increase in the maximum allowable leakage rates for the MP187 transportation cask would be expected.

[17] A subsequent update to the MP187 certificate of compliance changed the name of the entity to which the certificate of compliance was issued to from Transnuclear, Inc. to AREVA, Inc. (Sampson 2014).

- **Criticality Safety Index.** Transnuclear would need to revise Chapters 1, 5, and 6 of the MP187 transportation cask safety analysis report to incorporate the CSI nomenclature and the NRC would need to revise the certificate of compliance to delete references to the Transport Index for criticality control.
- **Expansion of QA Requirements.** Transnuclear would need to revise the safety analysis report for the MP187 transportation cask to demonstrate how its QA program satisfies the specific requirements of 10 CFR 71.101(a), (b), and (c).

Representatives of Transnuclear/AREVA have also stated that the -96 designation must be obtained before impact limiters are fabricated for the existing MP187 transportation cask.[18] A -96 designation must also be obtained before the MP187 transportation cask is certified for the transport of GTCC waste. The effort to accomplish these changes and to obtain NRC review and approval is estimated to range from one to three years.

There are six damaged fuel assemblies stored in five FC-DSCs at Rancho Seco. Table 2-5 lists the details of these damaged fuel assemblies. When this fuel was originally packaged in canisters, the fuel was visually inspected and classified as damaged if cladding failures with breaches greater than 25 percent of the circumference of the fuel pin and at least the length of a fuel pellet were present (Redeker 2006). This equates to a cladding failure that is 0.34 inches across the cladding and 0.7 inches along the cladding. Fuel assemblies not classified as damaged using this definition were classified as intact. The current definition of intact fuel is more restrictive, where fuel assemblies are classified as intact if they contain no cladding breaches (NRC 2007a). Assemblies are classified as undamaged if they have no defects greater than hairline cracks or pinhole leaks (NRC 2007a). This change in the definition of damaged and intact fuel resulted in the six fuel assemblies formerly classified as intact being reclassified as damaged, using the new definition. The Rancho Seco storage license was amended to recognize this situation; however, the certificate of compliance for the MP187 transportation cask requires that damaged fuel assemblies are shipped in FF-DSCs, not in FC-DSCs, so the requirements for transporting the five FC-DSCs containing the six damaged fuel assemblies would need to be determined. In addition, the Safety Evaluation Report for the Rancho Seco ISFSI (NRC 2009) noted that visual examination alone is no longer a sufficient method for classifying assemblies as damaged or intact. NRC (2009) also stated that prior to transporting the SNF stored at Rancho Seco, fuel classification may need to be revisited, and the damaged fuel assemblies (and potentially some fuel assemblies currently classified as intact) may need to be placed into damaged fuel cans to be transportable.

[18] Best RE. 2013. Email message from P Murray (AREVA) to RE Best (PNNL Consultant), “MP187 Question,” April 2, 2013.

Table 2-5. Details of Damaged Fuel Assemblies at Rancho Seco

Fuel Assembly	Estimated Flaw Size	Canister Number
2G6	0.25 in. × 0.04 in.	FC24P-P16
OEL	0.75 in. long with 0.2 in. hole	FC24P-P10
ODY	0.2 in. hole	FC24P-P10
17G	Unknown	FC24P-P17
1C34	1 in. × 0.1 in.	FC24P-P18
1C04	0.3 in. holes (two)	FC24P-P03

Source: Transnuclear (2008)

Figure 2-88 illustrates the number of SNF assemblies and MTHM at Rancho Seco based on discharge year. The oldest fuel was discharged in 1977 and the last fuel was discharged in 1989. The median discharge year of the fuel is 1983.

Figure 2-89 illustrates the number of SNF assemblies and MTHM at Rancho Seco based on burnup. The lowest burnup is 10.0 GWd/MTHM and the highest burnup is 38.2 GWd/MTHM. The median burnup is 28.0 GWd/MTHM. No high burnup SNF (burnup greater than 45 GWd/MTHM) is stored at Rancho Seco.

2.6.2 Site Conditions

Figure 2-90 provides an aerial view of the Rancho Seco site. The reactor building equipment and SNF pool have been decommissioned and removed, but the cooling towers, reactor containment building, and other associated structures remain on-site. In 2014, the remaining low-level radioactive waste that was stored on-site after decommissioning was shipped to Andrews, Texas for disposal. Electrical power is available at the Rancho Seco ISFSI. Also available on-site is the hydraulic ram used to unload the canisters from the NUHOMS reinforced concrete horizontal storage modules and to load the MP187 transportation cask that is certified to transport the Rancho Seco SNF. The MP187 transportation cask (without impact limiters) is also stored on-site. The MP187 transportation cask is not certified for the transport of GTCC waste.

There is no on-site barge access at the Rancho Seco site (TriVis Incorporated 2005). A 1-mile-long on-site rail spur exists at Rancho Seco. A short length of track runs adjacent to the ISFSI and a longer length of track runs into the Rancho Seco reactor site (see Figure 2-90). Figure 2-91 shows the junction of the short track running adjacent to the ISFSI and the longer track running into the Rancho Seco site. Figure 2-92 shows the longer track running into the Rancho Seco site.

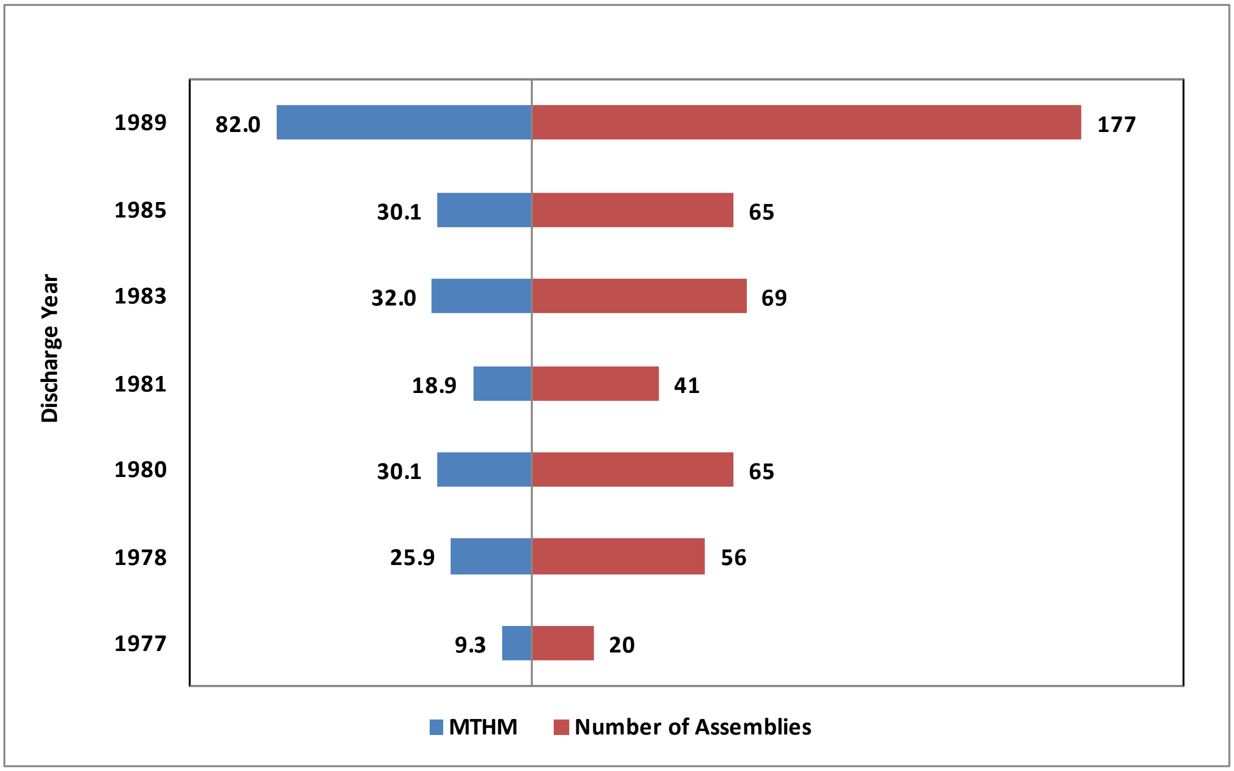

Figure 2-88. Rancho Seco Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

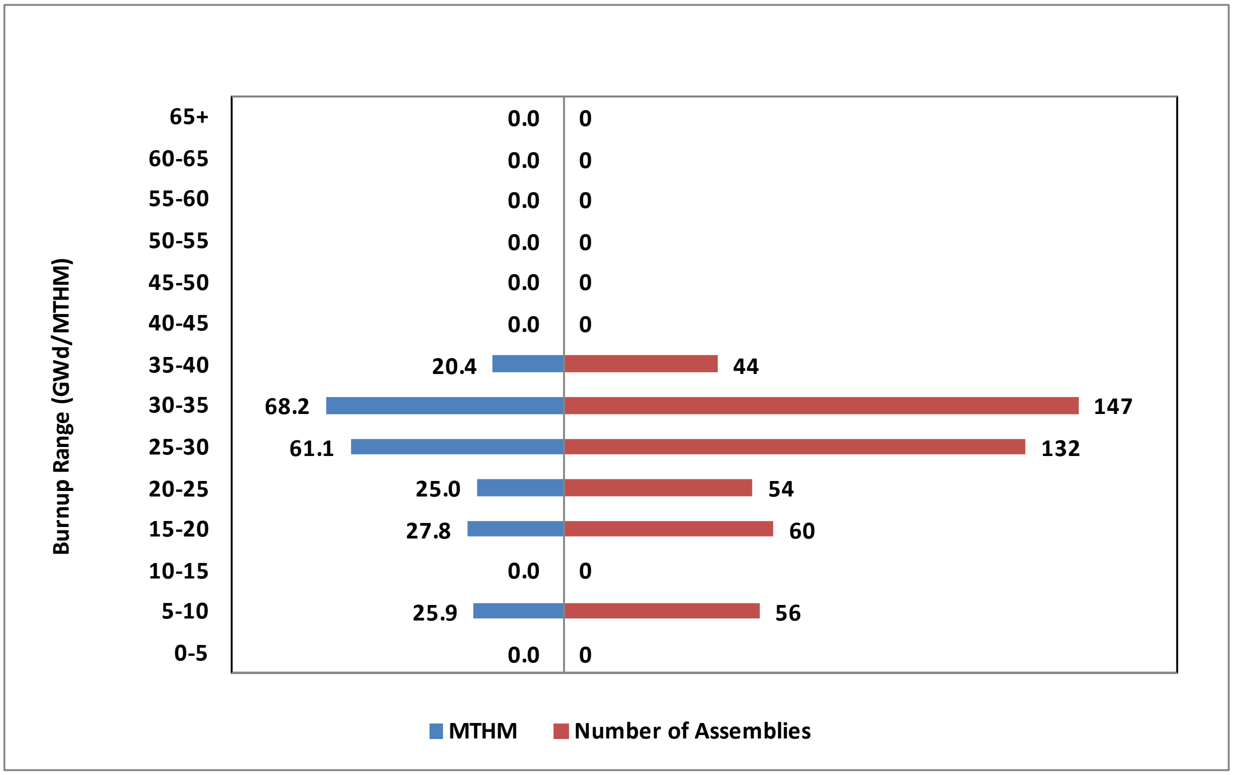

Figure 2-89. Rancho Seco Number of Assemblies and MTHM versus Burnup (EIA 2018)

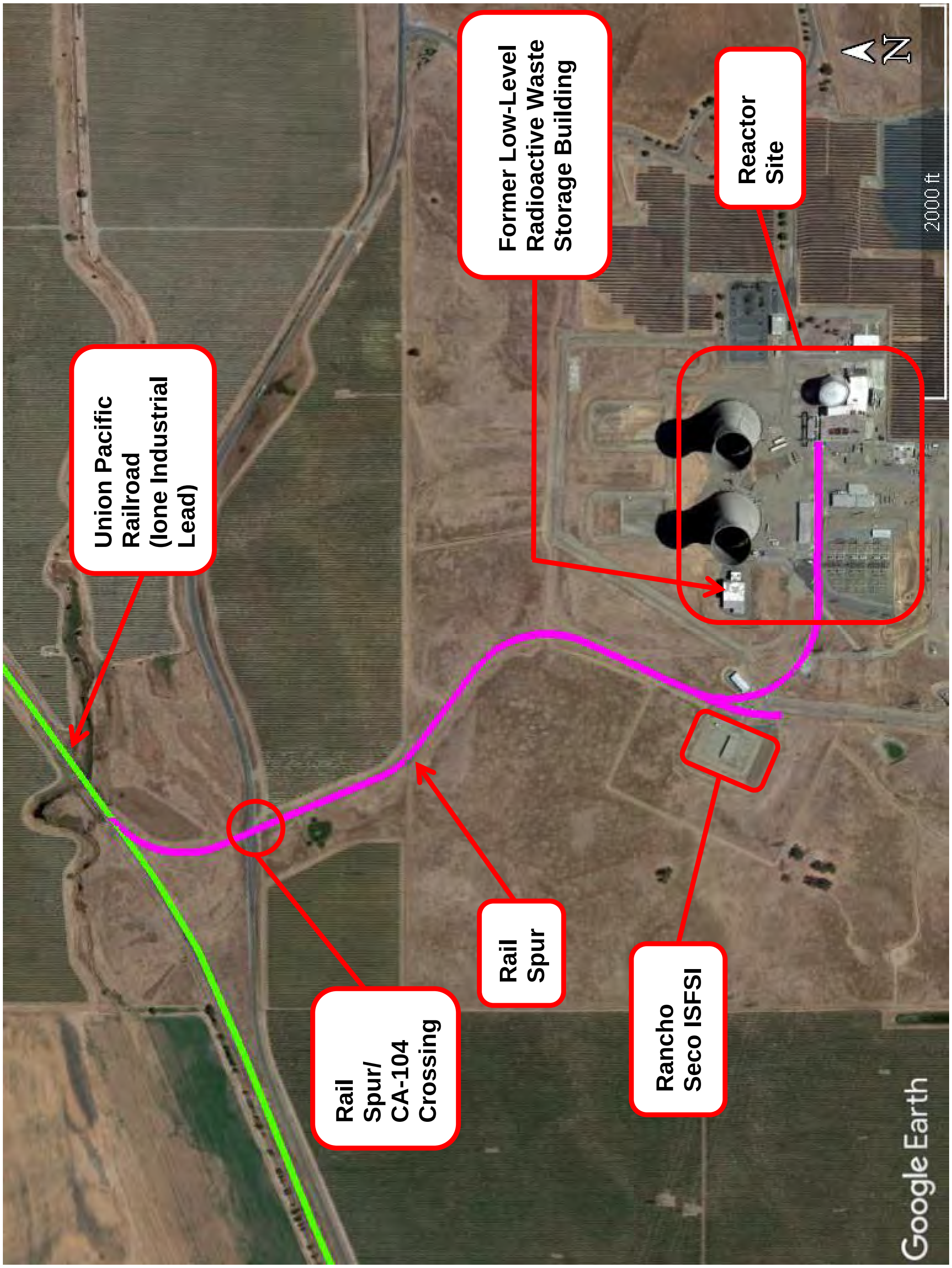

Figure 2-90. Aerial View of Rancho Seco Site (Google 2022)

Figure 2-91. Junction of the On-site Track Spur Running Adjacent to the Independent Spent Fuel Storage Installation (Right) and the Longer Track Running into the Rancho Seco Site (Left) (2013)

Figure 2-92. On-site Rail Spur Running into Rancho Seco Site (2013)

2.6.3 Near-site Transportation Infrastructure and Experience

Rancho Seco owns the rail spur that provides access to the Union Pacific's Ione Industrial Lead, which runs west from the Rancho Seco site to the Union Pacific mainline in Galt, California (see Figure 2-93), a distance of about 15 miles. The distance from Galt to Sacramento, California is about 33 miles and the distance from Galt to Stockton, California is about 28 miles. The Union Pacific mainline is designated as track class 5 and the Ione Industrial Lead is designated as track class 2. The maximum gross weight of railcars on the Ione Industrial Lead between Rancho Seco and Galt is 158 tons, and 6-axle locomotives are prohibited. A loaded MP187 transportation cask would weigh 133 to 136 tons and a cask-carrying railcar would weigh at least 43 tons, so the weight limit of 158 tons is likely to be exceeded, requiring either route clearance or a track upgrade. California State Route 104 crosses the rail spur (see Figure 2-90). The rail spur was not maintained after shutdown in 1989 but was restored to operating condition in the early 2000s to support decommissioning. During decommissioning, this rail spur was used to transport four reactor coolant pumps (50 tons each), the pressurizer (150 tons), and two steam generators (550 tons each) to the EnergySolutions low-level radioactive waste disposal facility in Clive, Utah (Johnson 2006). The two steam generators were approximately 80 feet in length and 12 feet in diameter and were too large to ship in their intact state because of the inability to obtain rail route clearances due to their length (Dempsey and Snyder 2005). Therefore, the steam generators were cut latitudinally into four segments (Dempsey and Snyder 2005) and were transported on 12-axle QTTX railcars. Figure 2-94 and Figure 2-95 show the pressurizer and steam generator segments on railcars prior to shipping, respectively. The segmented Rancho Seco reactor pressure vessel was also shipped by rail to the EnergySolutions low-level radioactive waste disposal facility in Clive, Utah (EPRI 2007, 2008a).

The rail spur was last maintained and certified in 2008; but is not being maintained. Past restoration of the rail spur to pass inspection was a relatively inexpensive, straightforward project.[19]

Although Rancho Seco is not located on a waterway, commercial inland ports suitable for barge traffic are located at the Port of Sacramento, California, about 40 miles from Rancho Seco, and the Port of Stockton, California, about 45 miles from Rancho Seco (NAC 1991a). During decommissioning, a 520-ton generator was transported by heavy haul truck from Rancho Seco to the Port of Stockton, California (see Figure 2-96). At the Port of Stockton, the generator was transloaded onto an ocean-going barge and transported to the Surry Nuclear Power Plant in Virginia for re-use.

Heavy haul trucks have also been used to ship materials to and from the Rancho Seco site. For example, in 2000, Transnuclear, Inc. contracted with a heavy haul truck operator to ship the 100-ton (empty and without impact limiters) MP187 transportation cask from the eastern United States to the Rancho Seco site (see Figure 2-97).

[19] Ross SB. 2012. E-mail from ET Ronningen (Superintendent, Rancho Seco Assets Power Generation, Sacramento Municipal Utility District) to SB Ross (Pacific Northwest National Laboratory), "Re:Request for Info," September 17, 2012.

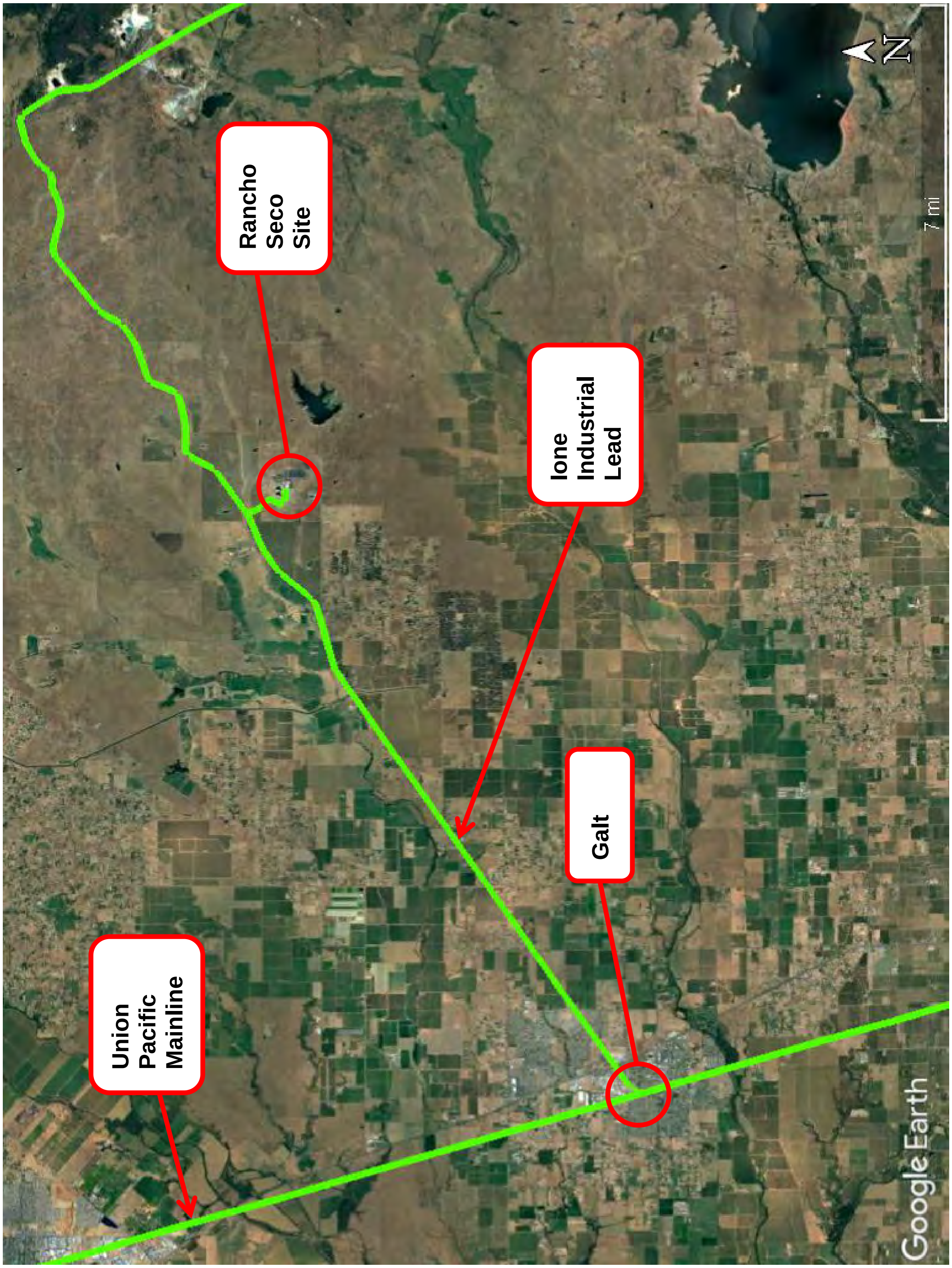

Figure 2-93. Aerial View of Ione Industrial Lead and Union Pacific Mainline (Google 2022)

Photo courtesy of Rancho Seco

Figure 2-94. Rancho Seco Pressurizer on Railcar (2004)

Photo courtesy of Rancho Seco

Figure 2-95. Rancho Seco Steam Generator Segments on Railcars

Photo courtesy of Rancho Seco

Figure 2-96. Rancho Seco Generator on Heavy Haul Truck Being Transported to the Port of Stockton, California (2002)

Photo courtesy of Rancho Seco

Figure 2-97. MP187 Cask Transported by Heavy Haul Truck

2.6.4 Future Information Needs

The principal question for the Rancho Seco site regarding the capability of the off-site transportation infrastructure to accommodate shipments of large transportation casks is the weight limit (158 tons) associated with the Ione Industrial Lead. This weight limit would make it necessary to obtain route clearance from the Union Pacific Railroad or to upgrade the track to allow its use for rail shipments of the MP187 transportation cask. As discussed in Section 2.6.3, during decommissioning loads larger than 158 tons were transported on the Ione Industrial Lead. In addition, it would be necessary to obtain NRC authorization to transport non-failed-fuel canisters containing damaged fuel assemblies in the MP187 transportation cask.

2.7 Trojan

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the Trojan site. The Trojan site is located in northwestern Oregon on the Columbia River about 40 miles northwest of Portland, Oregon (NAC 1991b).

2.7.1 Site Inventory

The Trojan ISFSI has a site-specific 10 CFR Part 72 license (License No. SNM-2509). Thirty-four canisters containing 790 SNF assemblies (359.3 MTHM) and no canisters of GTCC waste are stored at the Trojan site. The 34 canisters contain 780 intact assemblies, 10 partial assemblies, 8 process can capsules, 1 failed fuel can containing 8 bottom nozzles and 2 process cans, 1 fuel rod storage rack containing 23 ruptured or damaged fuel rods, and 1 assembly skeleton.

Figure 2-98 shows the Trojan ISFSI. The storage system used at Trojan is a hybrid of two storage systems (EPRI 2010), and consists of TranStor concrete storage overpacks and Holtec MPC-24E and MPC-24EF canisters. The MPC-24E and the MPC-24EF canisters hold 24 pressurized water reactor SNF assemblies. The fuel assemblies from Trojan were loaded into Holtec canisters from December 2002 through September 2003 (Leduc 2012). The fuel rods in the fuel assemblies are zirconium alloy-clad. The HI-STAR 100 transportation cask (Docket No. 71-9261) is certified to transport the MPC-24E and the MPC-24EF canisters.

Photo courtesy of Trojan

Figure 2-98. Trojan Independent Spent Fuel Storage Installation

Figure 2-99 illustrates the number of SNF assemblies and MTHM at Trojan based on discharge year. The oldest fuel was discharged in 1978 and the last fuel was discharged in 1992. The median discharge year of the fuel is 1988.

Figure 2-100 illustrates the number of SNF assemblies and MTHM at Trojan based on burnup. The lowest burnup is 5.1 GWd/MTHM and the highest burnup is 41.9 GWd/MTHM. The median burnup is 33.4 GWd/MTHM. No high burnup SNF (burnup greater than 45 GWd/MTHM) is stored at Trojan.

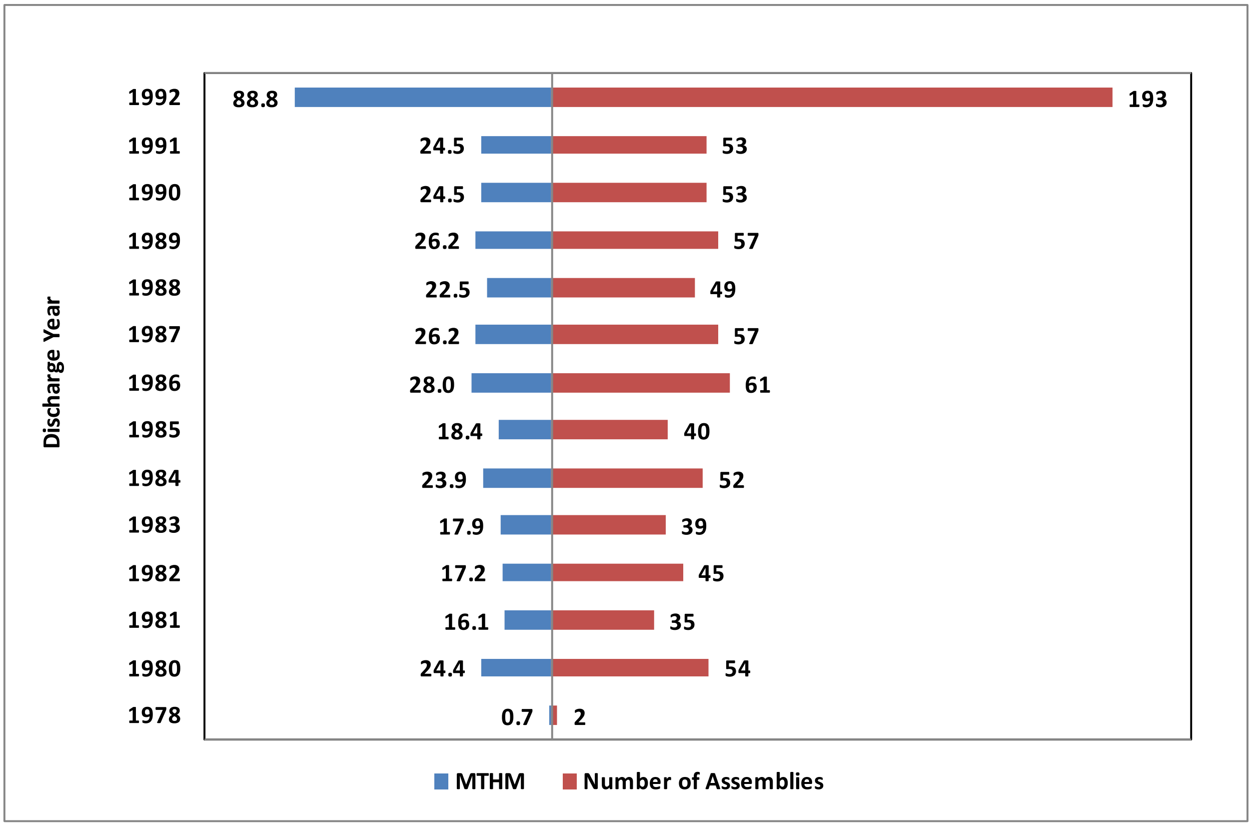

Figure 2-99. Trojan Number of Assemblies and MMTHM versus Discharge Year (EIA 2018)

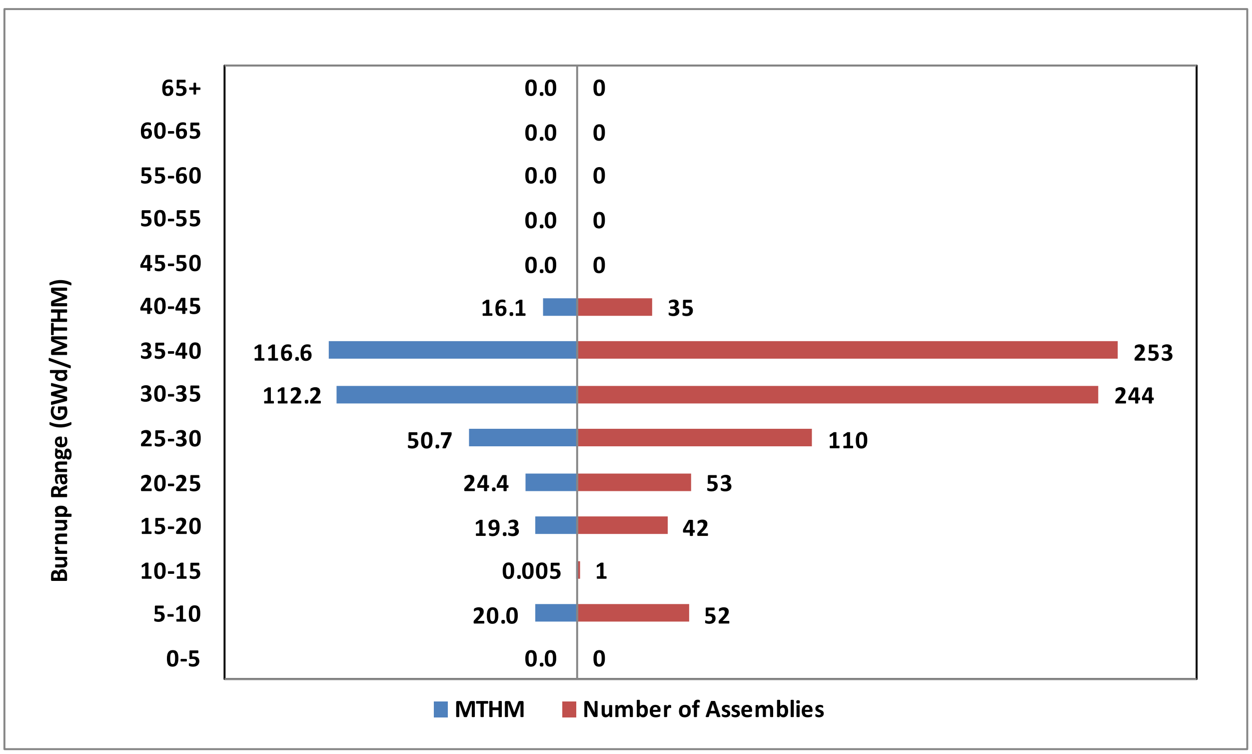

Figure 2-100. Trojan Number of Assemblies and MTHM versus Burnup (EIA 2018)

2.7.2 Site Conditions

Figure 2-101 provides an aerial view of the Trojan site, where the reactor and associated structures have been removed. Electrical power is available at the Trojan ISFSI. However, mobile equipment such as cranes to unload the TranStor vertical concrete storage overpacks containing the Holtec multipurpose canisters used at Trojan, and to load the HI-STAR 100 transportation casks is not present at the site. The HI-STAR 100 transportation cask is certified to transport the Trojan SNF contained in the MPC-24E and the MPC-24EF canisters. A transfer cask, transfer station, and air pad system are also located at the Trojan ISFSI. Figure 2-102 shows the transfer cask, Figure 2-103 shows the transfer station, Figure 2-104 shows the transfer station with the transfer cask and mobile crane, and Figure 2-105 shows the transfer station with the transfer cask and a TranStor vertical concrete storage overpack.

The Portland and Western Railroad rail line passes through the Trojan site approximately 700 feet from the Trojan ISFSI (TriVis Incorporated 2005). This rail line is designated as track class 2 and connects to the Union Pacific and BNSF Railroads near Portland, Oregon, a distance of about 60 miles. A rail spur formerly entered the protected area (NAC 1991b). This spur has been removed, but could be rebuilt in preparation for shipping SNF.[20]

A barge slip is located on the Trojan site about 3000 feet south of the Trojan ISFSI. The barge slip is located at Columbia River Mile 72.5 and provides for roll-on/roll-off capability. The barge slip is not being maintained and dredging is usually required prior to use. There is no crane or other permanently installed handling or lifting equipment at the barge slip.

2.7.3 Near-site Transportation Infrastructure and Experience

At the Trojan site, a rail spur used to run from the Portland and Western Railroad to the site (see Figure 2-106). The rail spur was located at milepost 40.8 on the Astoria District of the Portland and Western Railroad and has been removed. In addition, during decommissioning a short spur was installed for rail shipments of waste from the site. This spur has also been removed.

Figure 2-107 shows the Portland and Western Railroad in the vicinity of the Trojan site, Figure 2-108 shows the location of the former junction of the rail spur with the Portland and Western Railroad, and Figure 2-109 shows the railbed of the former rail spur. Remnants of this spur exist on-site (see Figure 2-110). There appears to be sufficient room at the Trojan site for additional track to accommodate trains having eight or more railcars (two buffer cars, a security escort car, and five or more cask cars).

As discussed in Section 2.7.2, a barge slip is also present at the Trojan site and provides access to the Columbia River. Figure 2-101 shows the location of the barge slip. Figure 2-111 shows the access road to the barge slip, and Figure 2-112 shows the condition of the barge slip in 2013.

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[20] Ross SB. 2012. Email message from JP Fischer (Trojan ISFSI Manager, Portland General Electric Company) to SB Ross (Pacific Northwest National Laboratory), “Re: Request for Info,” September 17, 2012.

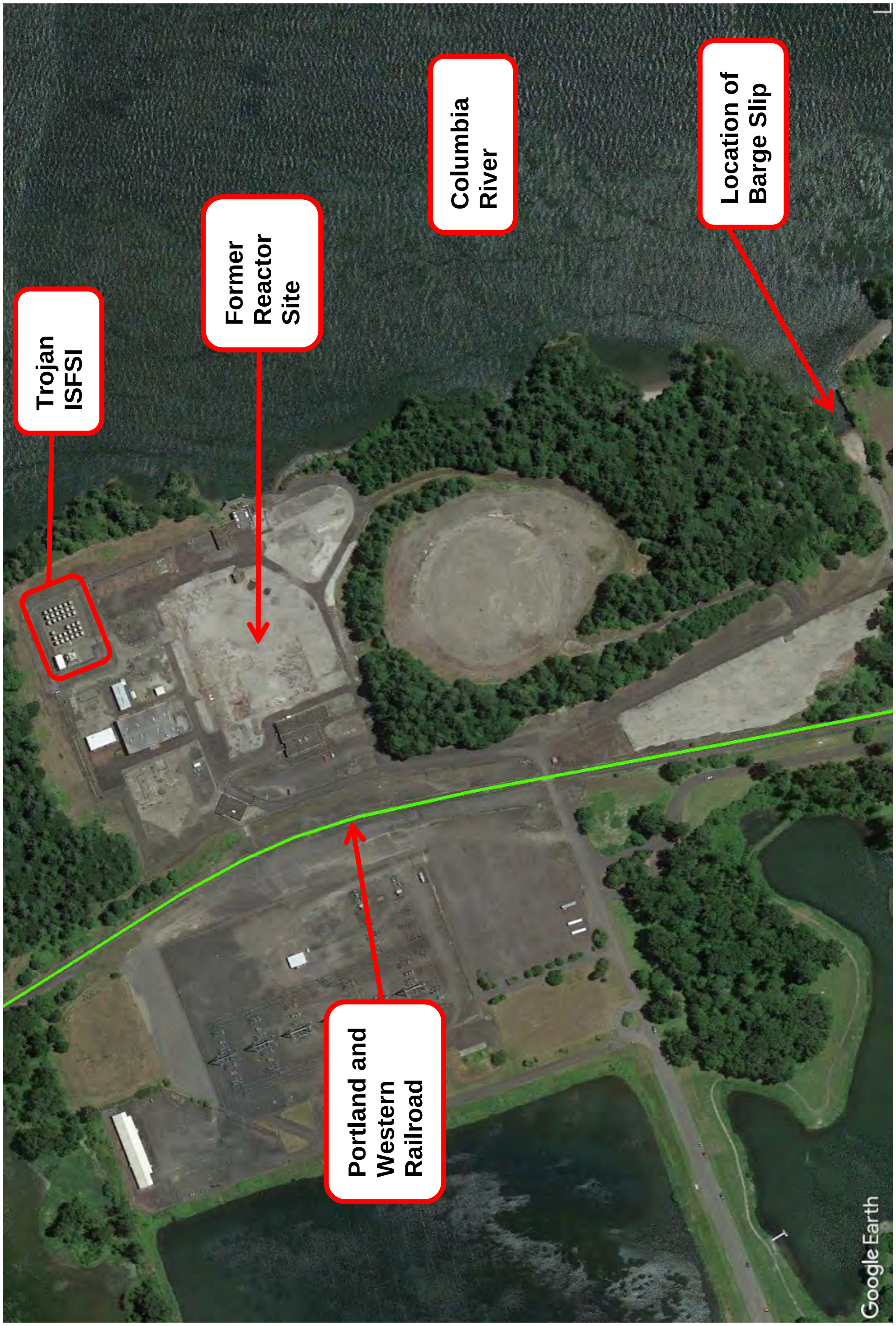


Figure 2-101. Aerial View of Trojan Site (Google 2022)

Photo courtesy of Trojan

Figure 2-102. Trojan Transfer Cask

Photo courtesy of Trojan

Figure 2-103. Trojan Transfer Station

Photo courtesy of Trojan

Figure 2-104. Trojan Transfer Station with Transfer Cask and Mobile Crane

Photo courtesy of Oregon Department of Energy

Figure 2-105. Trojan Transfer Station with Transfer Cask and TranStor Vertical Concrete Storage Overpack

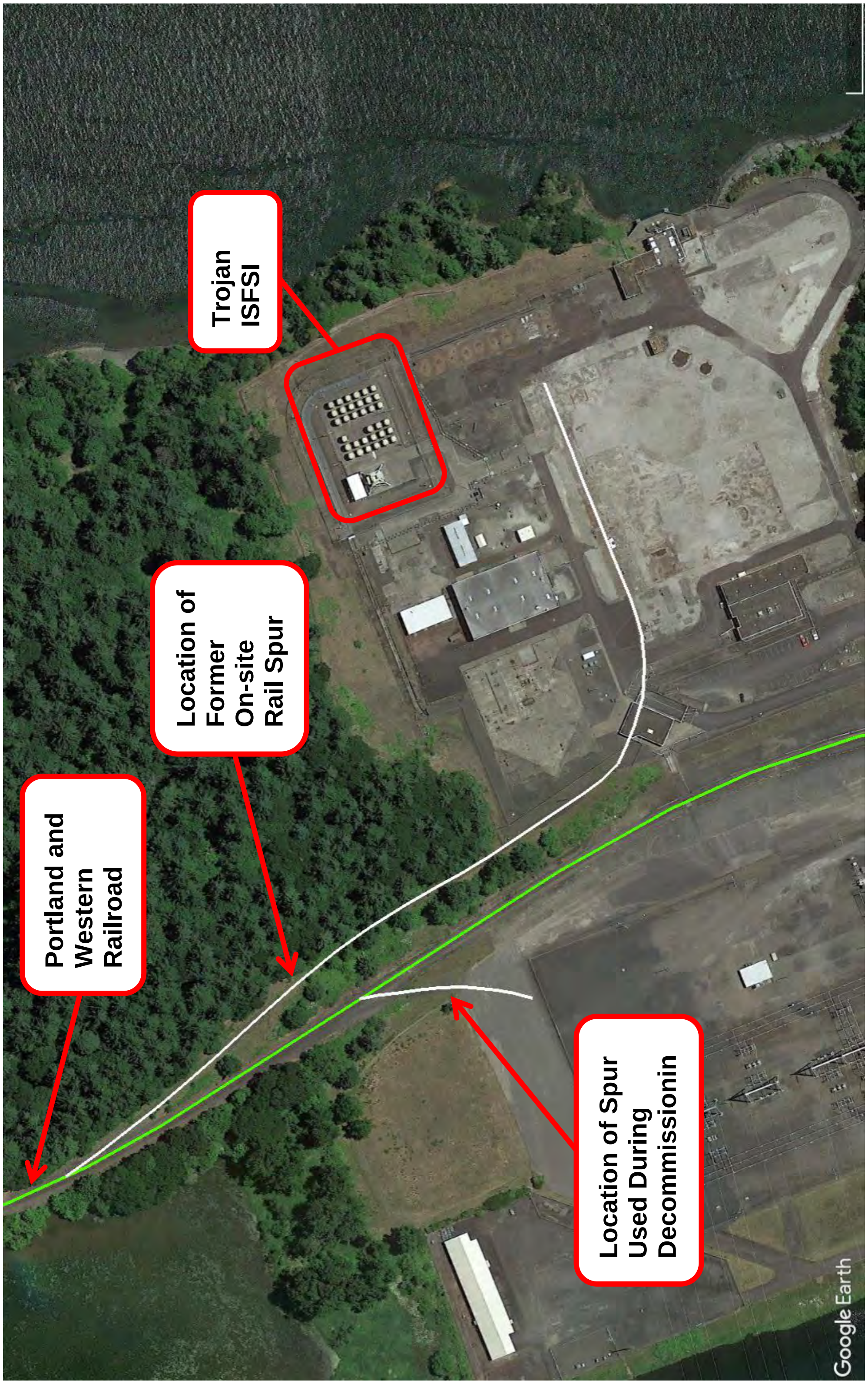


Figure 2-106. Rail Interface at Trojan (Google 2022)

Figure 2-107. Portland and Western Railroad in the Vicinity of the Trojan Site (2013)

Figure 2-108. Location of Former Junction of Portland and Western Railroad and Trojan Rail Spur (2013)

Figure 2-109. Former Trojan Rail Spur Railbed (2013)

Figure 2-110. Remnants of On-site Rail Spur at Trojan (2013)

Photo courtesy of Federal Railroad Administration

Figure 2-111. Trojan Barge Slip Access Road (2013)

Photo courtesy of Federal Railroad Administration

Figure 2-112. Trojan Barge Slip (2013)

During decommissioning, Trojan shipped four steam generators, the pressurizer, and the reactor pressure vessel from this barge slip to the US Ecology low-level radioactive waste disposal facility near Richland, Washington. The steam generator packages weighed 450 tons each and the pressurizer package weighed 125 tons (Lackey and Kelly 1996, 1997). The four steam generators had diameters of 14.5 feet and a length of 68 feet. The pressurizer had a diameter of 8.5 feet and a length of 53 feet. The four steam generators and pressurizer were transported from the Trojan site to the barge slip using a hydraulically-leveled 16-line Goldhofer transporter. The transporter was also used to support the four steam generators and pressurizer while on the barge, and to move the four steam generators and pressurizer from the barge slip at the Port of Benton, Washington (Columbia River Mile 342.8), to the US Ecology low-level radioactive waste disposal facility. A total of five barge shipments were made (EPRI 1997b).

The barge was 180 feet long, 50 feet wide, and 14 feet deep. Prior to transporting the four steam generators and pressurizer, the Trojan barge slip was dredged. The sediments in the barge slip were analyzed to assure that there were no contaminants that would require special handling. Approximately 2750 cubic yards of material were removed from the barge slip. After dredging, the barge slip was graded. Because the barge was grounded for loading and unloading, the barge slip bottoms at the Trojan site and at the Port of Benton were leveled and inspected by divers, who removed any large objects and debris and corrected any out-of-specification unevenness. After the barge was loaded, the barge was deballasted. Inspections were performed prior to ballasting and after deballasting to ensure that no damage was done during loading. The Trojan barge slip is also significantly affected by tides, so departure had to take place during high tide to have sufficient water depth to float the loaded barge (EPRI 1997b).

The reactor pressure vessel package weighed 1000 tons (Radwaste Magazine 1999), had a diameter of 28 feet, and was 42.5 feet long (EPRI 2000). The reactor pressure vessel was transported from the Trojan site to the barge slip using a hydraulically-leveled 4-file, 20-line Scheuerle transport trailer. Each line consisted of 16 tires, which resulted in a total of 320 tires. The transporter was also used to support the reactor pressure vessel package while on the barge, and to move the reactor pressure vessel package from the barge slip at the Port of Benton, Washington (Columbia River Mile 342.8), to the US Ecology low-level radioactive waste disposal facility (EPRI 2000).

The barge was specifically designed and built to transport the reactor pressure vessel package, and was 240 feet long, 55 feet wide, and 15 feet deep. Because the barge was grounded for loading and unloading, the barge slip bottoms at the Trojan site and at the Port of Benton were leveled and inspected by divers, who removed any large objects and debris and corrected any out-of-specification unevenness. After the barge was loaded, the barge was deballasted. Inspections were performed prior to ballasting and after deballasting to ensure that no damage was done during loading. The Trojan barge slip is also significantly affected by tides, so departure had to take place during high tide to have sufficient water depth to float the loaded barge (EPRI 2000).

Figure 2-113 through Figure 2-117 show a steam generator being loaded at the Trojan barge slip, and the Trojan reactor pressure vessel in its transport cradle, the reactor pressure vessel being transported by barge, passing through locks on the Columbia River, and being transported by heavy haul truck to the US Ecology low-level radioactive waste disposal facility.

Photo courtesy of Trojan

Figure 2-113. Trojan Steam Generator Being Loaded at Barge Slip (1995)

Photo courtesy of Oregon Department of Energy

Figure 2-114. Trojan Reactor Pressure Vessel on Transport Cradle (1999)

Photo courtesy of Trojan

Figure 2-115. Trojan Reactor Pressure Vessel Being Transported by Barge (1999)

Photo courtesy of Trojan

Figure 2-116. Trojan Reactor Pressure Vessel Passing Through Locks on the Columbia River (1999)

Photo courtesy of Trojan

Figure 2-117. Trojan Reactor Pressure Vessel Being Transported by Heavy Haul Truck (1999)

2.7.4 Future Information Needs

Both rail and barge modes are feasible for transporting SNF from the Trojan site. The Portland and Western Railroad rail line passes through the Trojan site approximately 700 feet from the Trojan ISFSI. In the past, a rail spur entered the protected area. The spur was disconnected, but according to site representatives, could be rebuilt in preparation for shipping SNF. The Portland and Western Railroad is a Class II regional railroad whose track is expected to be capable of accommodating shipments of HI-STAR 100 casks from the Trojan site. The Trojan site also has an on-site barge slip, and it is likely the barge slip could be used for shipping SNF transportation casks on barges.

2.8 La Crosse

This section describes the inventory of SNF, site conditions, near-site transportation infrastructure and experience, and future information needs for the La Crosse site. The La Crosse site is located in western Wisconsin on the east bank of the Mississippi River, about 1 mile south of Genoa and 17 miles south of La Crosse, Wisconsin (TOPO 1993e).

2.8.1 Site Inventory

Five canisters containing 333 SNF assemblies (38.0 MTHM) are stored at the La Crosse ISFSI (Docket No. 72-46). The five canisters contain 176 intact SNF assemblies, 157 damaged SNF assemblies, and 1 fuel debris can. The 157 damaged assemblies have been placed in damaged fuel cans. La Crosse is undergoing decommissioning; however, because the La Crosse reactor pressure vessel with its internal components has been shipped off-site for disposal (Radwaste Solutions 2007), GTCC waste would not be generated.

Figure 2-118 shows the La Crosse ISFSI. The storage system used at La Crosse is the NAC Multi-Purpose Canister system (NAC-MPC) (Docket No. 72-1025), which consists of a transportable storage canister, a vertical concrete storage cask, and a transfer cask. The transportable storage canister used for the La Crosse SNF is the MPC-LACBWR. This canister holds 68 La Crosse boiling water reactor SNF assemblies. The fuel assemblies from La Crosse were loaded into MPC-LACBWR canisters from July through September 2012. The fuel rods in the fuel assemblies are stainless steel-clad. The NAC-STC transportation cask (Docket No. 71-9235) is certified to transport the MPC-LACBWR canister. No NAC-STC transportation casks have been fabricated for use in the United States. Six NAC-STC transportation casks have been fabricated for use in China.

Figure 2-119 illustrates the number of SNF assemblies and MTHM at La Crosse, based on discharge year. The oldest fuel was discharged in 1972 and the last fuel was discharged in 1987. The median discharge year of the fuel is 1982.

Figure 2-120 illustrates the number of SNF assemblies and MTHM at La Crosse based on burnup. The lowest burnup is 4.7 GWd/MTHM and the highest burnup is 21.5 GWd/MTHM. The median burnup is 15.7 GWd/MTHM. No high burnup SNF (burnup greater than 45 GWd/MTHM) is stored at La Crosse.

Photo courtesy of La Crosse

Figure 2-118. La Crosse Independent Spent Fuel Storage Installation

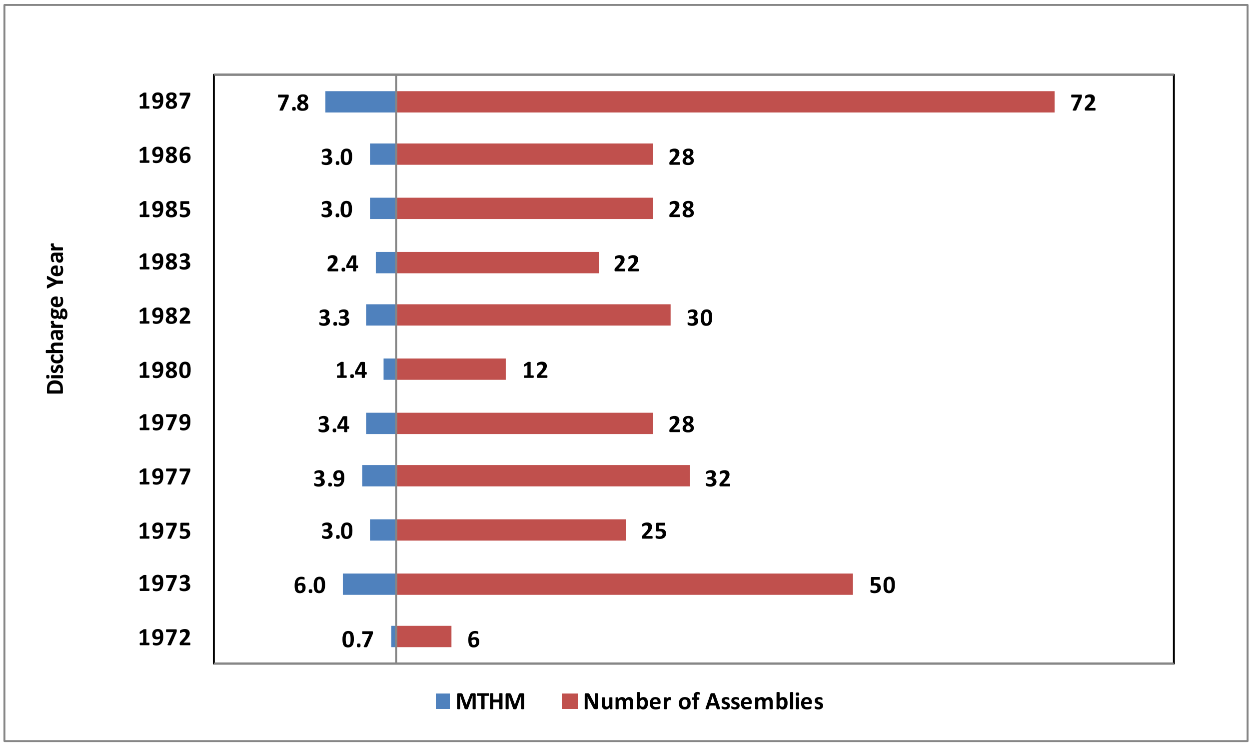


Figure 2-119. La Crosse Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

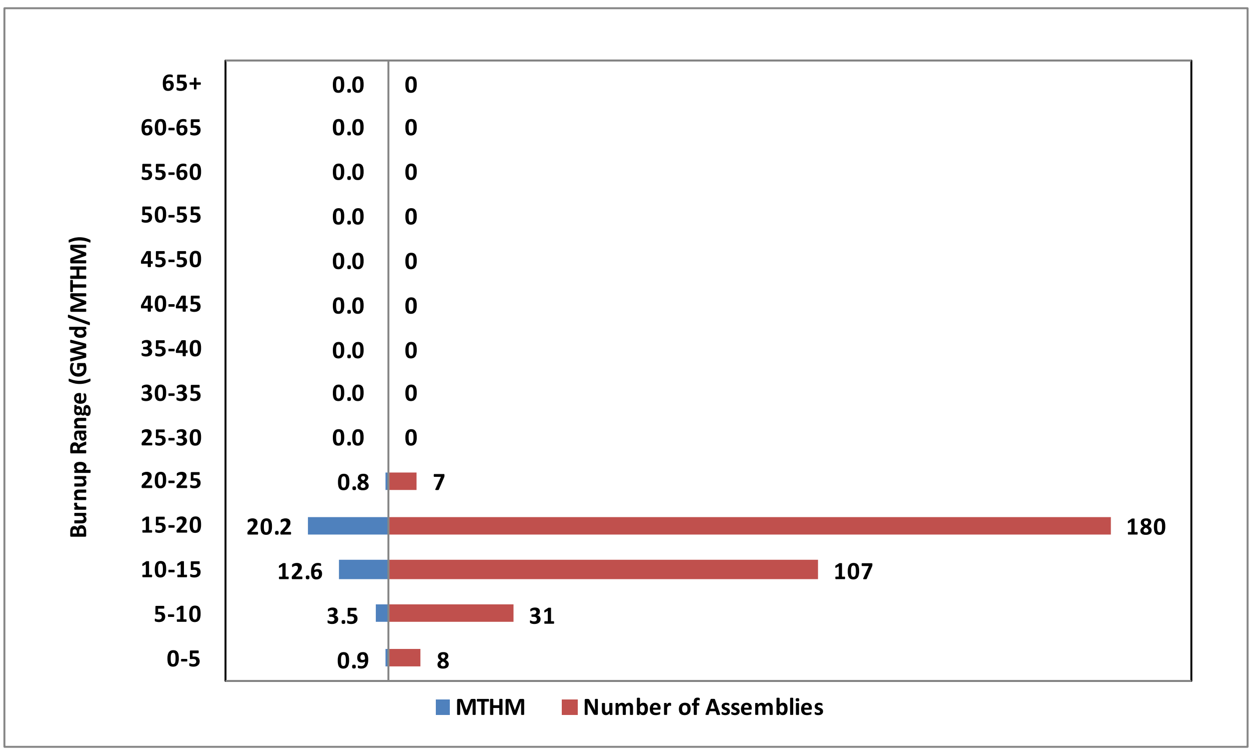


Figure 2-120. La Crosse Number of Assemblies and MTHM versus Burnup (EIA 2018)

2.8.2 Site Conditions

Figure 2-121 through Figure 2-123 provide aerial views of the La Crosse site, barge facility and on-site rail spur, and ISFSI and boat ramp. As seen in Figure 2-121, the La Crosse ISFSI is located south of the La Crosse reactor site and the Genoa #3 coal-fired power plant. Electrical power is available at the La Crosse ISFSI. However, mobile equipment such as cranes or a gantry system to unload the NAC-MPC vertical concrete storage casks used at La Crosse and to load the NAC-STC transportation cask that is certified to transport the La Crosse SNF is not present at the site. A transfer cask is available on-site and is owned by the Dairyland Power Cooperative. This transfer cask could also be used at the Yankee Rowe and Connecticut Yankee sites.

Rail service to the La Crosse site is provided by the BNSF Railroad. The BNSF rail line runs along the eastern boundary of the site about 800 feet from the La Crosse ISFSI. About 86 trains per day use this mainline and the rail line is designated as track class 4. La Crosse does not have an active on-site rail system;[21] however, remnants of an on-site rail system exist at the site (see Figure 2-124). There is a short on-site spur at the north end of the La Crosse site (see Figure 2-125). Figure 2-126 shows the junction of the on-site rail spur with the BNSF Railroad. In 2007, this on-site rail spur was used during the transport of the La Crosse reactor pressure vessel to the Barnwell, South Carolina low-level radioactive waste disposal facility (Radwaste Solutions 2007). The reactor pressure vessel was transported on a specially designed 20-axle railcar and the shipment weighed 310 tons.

The La Crosse site is located on the Upper Mississippi River at Mississippi River Mile 678.7, 0.5 miles south of Lock and Dam 8 (located at Mississippi River Mile 679.2) and 30.8 miles north of Lock and Dam 9 (located at Mississippi River Mile 647.9). On-site barge access is available about 0.2 miles north of the La Crosse reactor site (see Figure 2-127). The dock area is approximately 500 feet long by 100 feet wide with a minimum 9-foot water depth (TOPO 1993e). The barge facility has direct access to the shipping channel and receives between 450 and 500 barges annually. The barge facility is routinely used for the removal of covers from coal barges using a portable crane and for cleaning out the empty barges after the coal has been unloaded. The coal is unloaded several hundred yards downstream adjacent to the Genoa #3 coal-fired power plant. A large number of barge mooring/securing posts are available. Since the Upper Mississippi River usually freezes in the winter, the typical barge delivery season is from March through October, 30 to 35 weeks. Mobile rental cranes of the required capacity are available (TriVis Incorporated 2005). TOPO (1993e) reports that dredging or other dock area refurbishment is likely to be required.

[21] Ross SB. 2012. Email message from DG Egge (Plant Manager, LACBWR, Dairyland Power Cooperative) to SB Ross (Pacific Northwest National Laboratory), "Re: La Crosse Information," October 17, 2012.

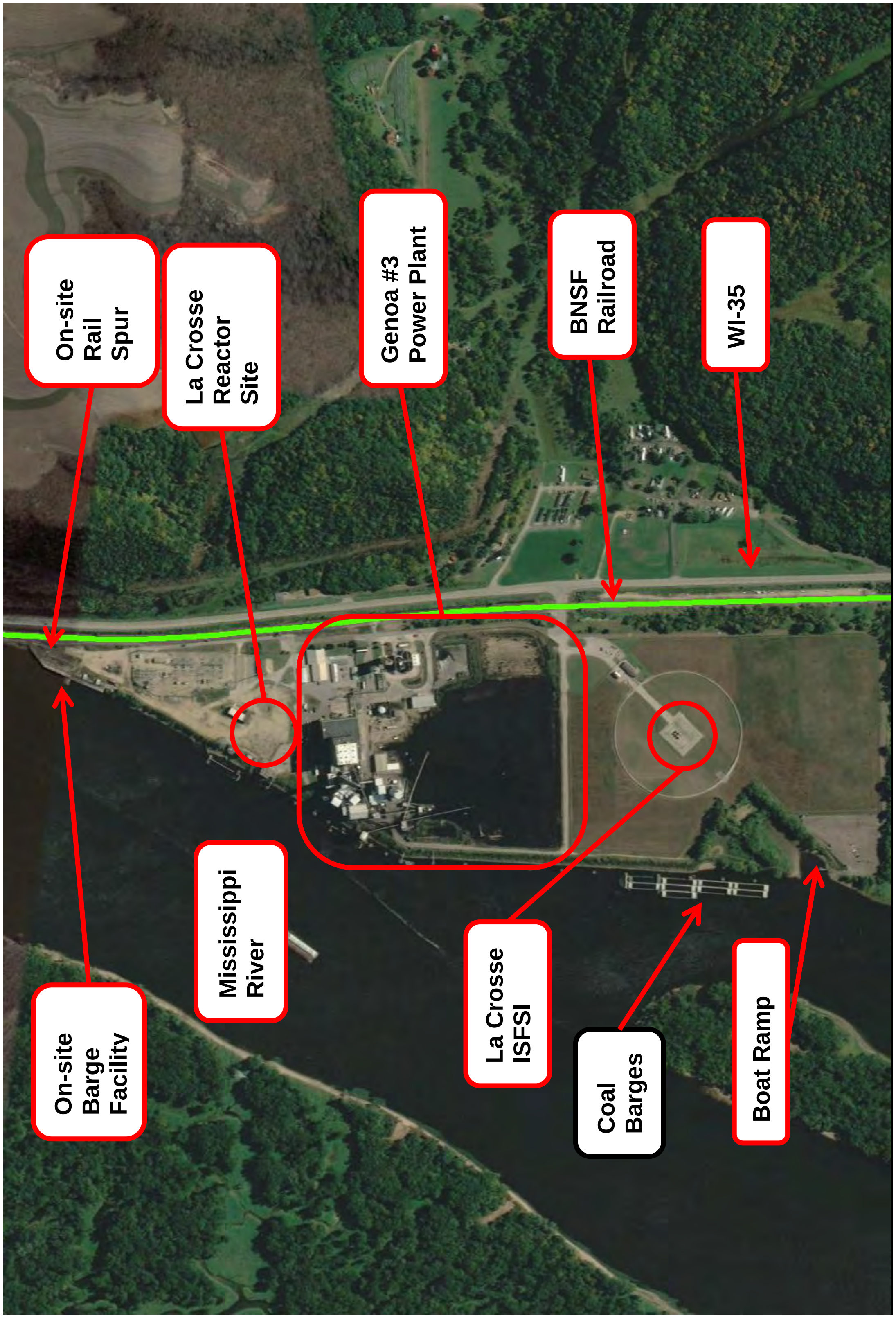


Figure 2-121. Aerial View of La Crosse Site (Google 2022)

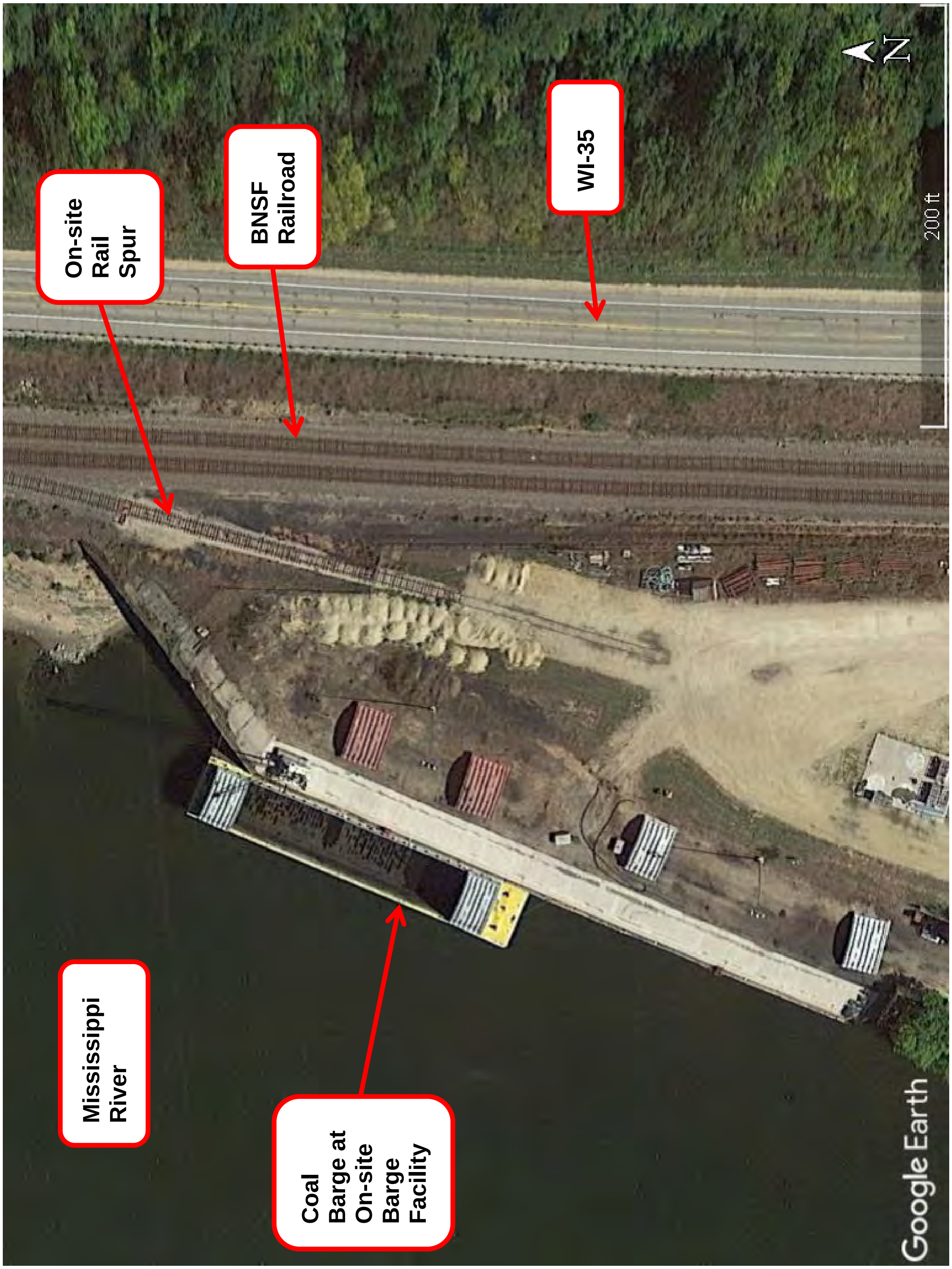


Figure 2-122. Aerial View of La Crosse Barge Facility and On-site Rail Spur (Google 2022)

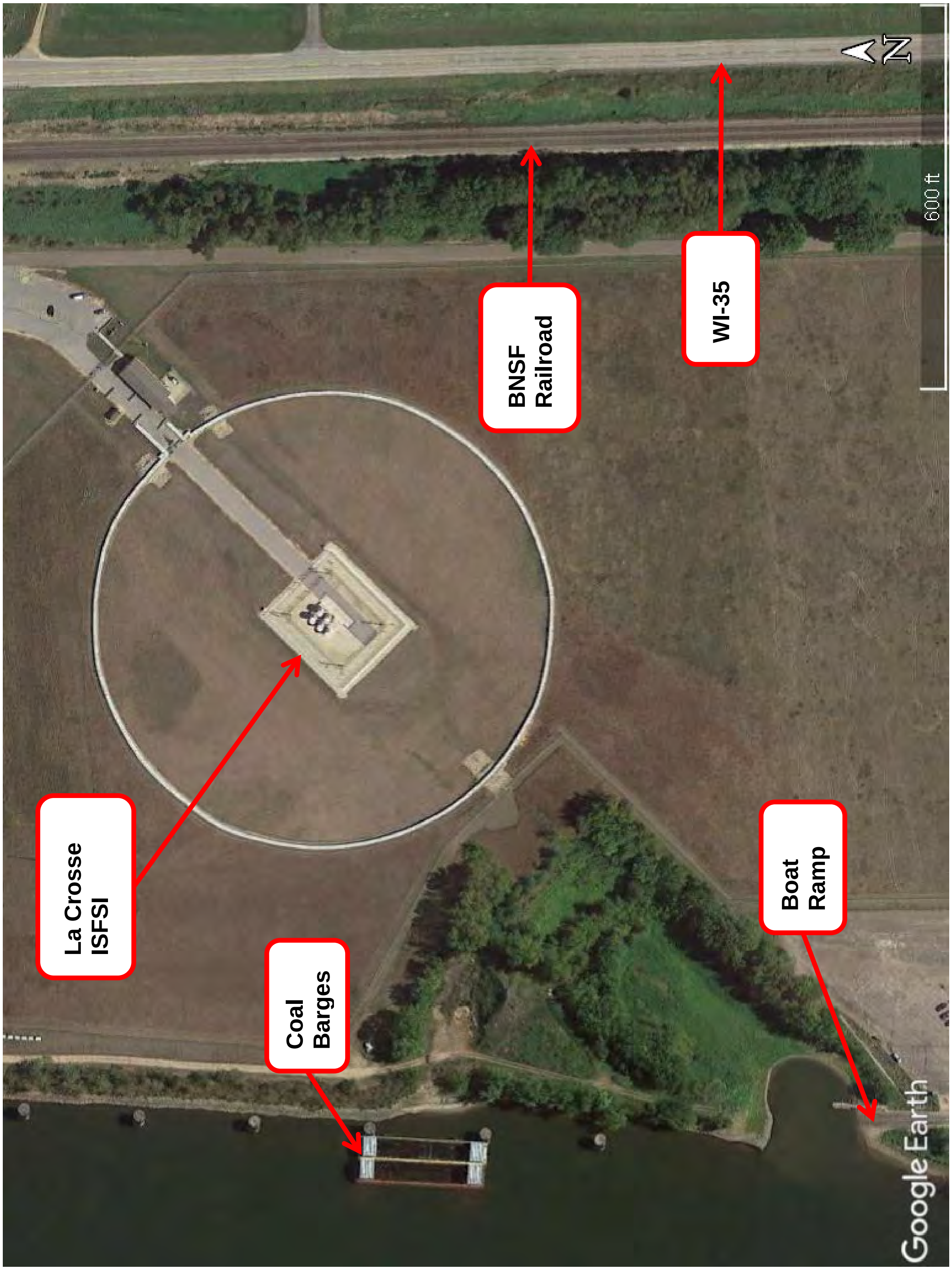


Figure 2-123. Aerial View of La Crosse Independent Spent Fuel Storage Installation and Boat Ramp (Google 2022)

Photo courtesy of La Crosse

Figure 2-124. Remnants of the On-site Rail System at La Crosse Site (2013)

Photo courtesy of La Crosse

Figure 2-125. On-site Rail Spur at Northern End of La Crosse Site (2013)

Photo courtesy of La Crosse

Figure 2-126. Junction of On-site Rail Spur with BNSF Railroad at La Crosse Site (2013)

Figure 2-127. Coal Barge at Barge Dock Area at La Crosse Site (2013)

2.8.3 Near-site Transportation Infrastructure and Experience

At the La Crosse site, a short on-site rail spur exists that provides direct rail access to the BNSF Railroad. There appears to be adequate room at the La Crosse site to extend this spur to accommodate trains having eight or more railcars (two buffer cars, a security escort car, and five or more cask cars). As discussed in Section 2.8.2, in 2007, this on-site rail spur was used to transport the La Crosse reactor pressure vessel to the Barnwell, South Carolina low-level radioactive waste disposal facility. Figure 2-128 and Figure 2-129 show the La Crosse reactor pressure vessel on the on-site spur and on the BNSF Railroad. The La Crosse site is also on the Mississippi River and has on-site barge access. However, barges have not been used for radioactive waste shipments from La Crosse.

Lacrosse Solutions[22] has been transporting low-level radioactive waste in an estimated 1100 intermodal containers approximately 50 miles by truck to the Seven Rivers Intermodal Terminal in Winona, Minnesota. This is being done to avoid blockage of the BNSF mainline which runs along the eastern boundary of the La Crosse site. The intermodal containers will be transferred to approximately 200 flat cars and transported by rail to Clive, Utah for disposal.

2.8.4 Future Information Needs

Rail service to the La Crosse site is provided by the BNSF Railroad that is east of the La Crosse ISFSI using a short on-site rail spur and there appears to be adequate room at the La Crosse site to extend this spur to accommodate trains having eight or more railcars (two buffer cars, a security escort car, and five or more cask cars). The location and method for loading the transportation cask and moving the transportation cask to a rail spur is uncertain.

On-site barge access is available about 0.2 miles north of the La Crosse reactor site. It is uncertain whether the on-site barge facility could accommodate SNF transportation casks.

Assuming that the on-site rail spur into the La Crosse site is maintained or refurbished as may be needed, it is unlikely that heavy haul trucks would be used to remove transportation casks containing SNF from the site.

[22] Lacrosse Solutions is the decommissioning contractor for the La Crosse site.

Photo courtesy of La Crosse

Figure 2-128. La Crosse Reactor Pressure Vessel on Rail Spur (2007)

Photo courtesy of La Crosse

Figure 2-129. La Crosse Reactor Pressure Vessel on BNSF Railroad (2007)

2.9 Zion

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the Zion site. The Zion site is located in the northeastern corner of Illinois on the western shore of Lake Michigan, about 40 miles north of Chicago (TOPO 1994b).

2.9.1 Site Inventory

Sixty-one canisters containing SNF assemblies and four canisters of GTCC waste are stored at the Zion ISFSI (Docket No. 72-1037). The 61 canisters contain 2226 SNF assemblies (1019.4 MTHM) that were discharged from the Zion 1 and Zion 2 reactors. Figure 2-130 shows the Zion ISFSI. The storage system used at Zion is the MAGNASTOR system (Docket No. 72-1031), which consists of a transportable storage canister (see Figure 2-131), a vertical concrete storage cask, and a transfer cask (see Figure 2-132). At Zion, the TSC-37[23] transportable storage canister is being used, which holds 37 pressurized water reactor SNF assemblies. Figure 2-133 shows the TSC-37 canister inside the transfer cask and Figure 2-134 shows a damaged fuel can being installed inside a TSC-37 canister. The fuel rods in the fuel assemblies at Zion are all zirconium alloy-clad. The transportation cask certified to transport the SNF and GTCC waste at the Zion site is the MAGNATRAN (Docket No. 71-9356).

Photo courtesy of EnergySolutions

Figure 2-130. Zion Independent Spent Fuel Storage Installation

[23] The TSC-37 canister is also referred to as the TSC or TSCDF. The TSCDF may contain damaged fuel.

Figure 2-135 illustrates the number of SNF assemblies and MTHM at Zion, based on discharge year. The oldest fuel was discharged in 1976 and the last fuel was discharged in 1997. The median discharge year of the fuel is 1987.

Figure 2-136 illustrates the number of SNF assemblies and MTHM at Zion based on burnup. The lowest burnup is 14.2 GWd/MTHM and the highest burnup is 55.4 GWd/MTHM. The median burnup is 33.1 GWd/MTHM. There are 36 SNF assemblies (16.5 MTHM) at Zion with burnups greater than 45 GWd/MTHM. These 36 fuel assemblies are classified by the NRC as high burnup SNF. At the Zion site, all fuel with a burnup greater than 45 GWd/MTHM was placed in damaged fuel cans. Each TSCDF canister can accommodate up to four damaged fuel cans. An additional assembly (J47B) with a burnup of 44.945 GWd/MTHM was also treated as high burnup SNF and was placed in a damaged fuel can.

In addition to the 37 SNF assemblies discussed above, 57 SNF assemblies identified as damaged, 2 loose fuel rod storage containers (ZFRSB1 and Y48B) holding 28 fuel rods, and 1 SNF assembly (C15R) containing a stainless steel fuel rod of unconfirmed dimensions were placed in damaged fuel cans. Assembly N47B was also canned to meet MAGNATRAN burnup credit requirements. In total, 98 assemblies/fuel rod storage containers are contained in damaged fuel cans. A total of 25 TSCDF canisters contain a combination of high burnup fuel (12 canisters), damaged fuel (20 canisters), or fuel debris (2 canisters).

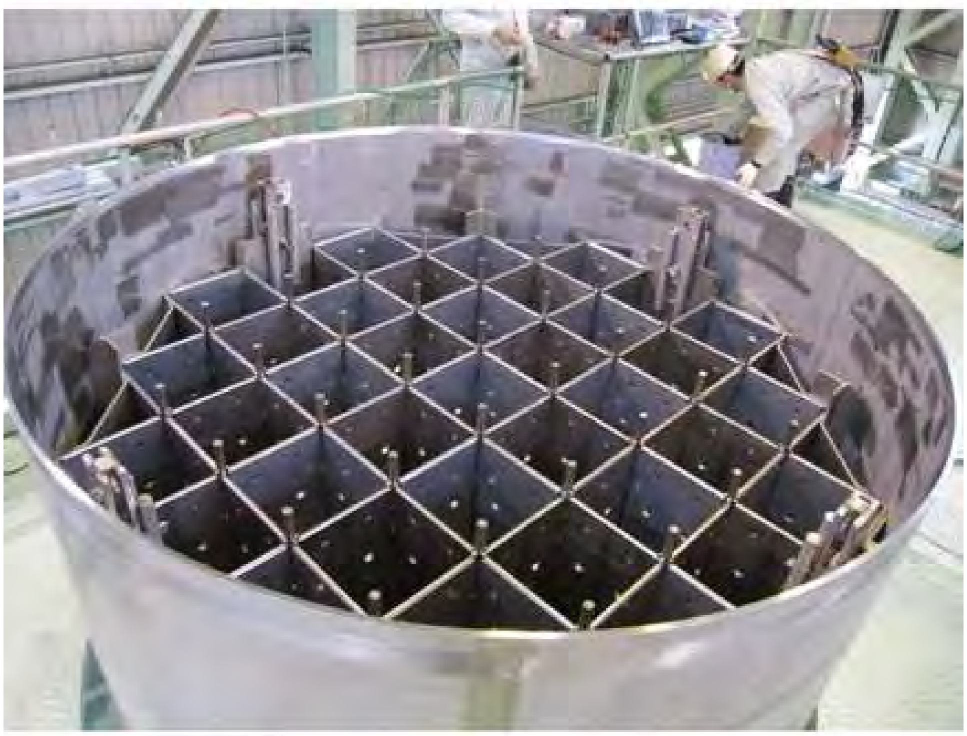


Photo courtesy of NAC International

Figure 2-131. TSC-37 Canister Showing Internal Baskets Which Hold Spent Nuclear Fuel Assemblies

Photo courtesy of ZionSolutions

Figure 2-132. Transfer Cask

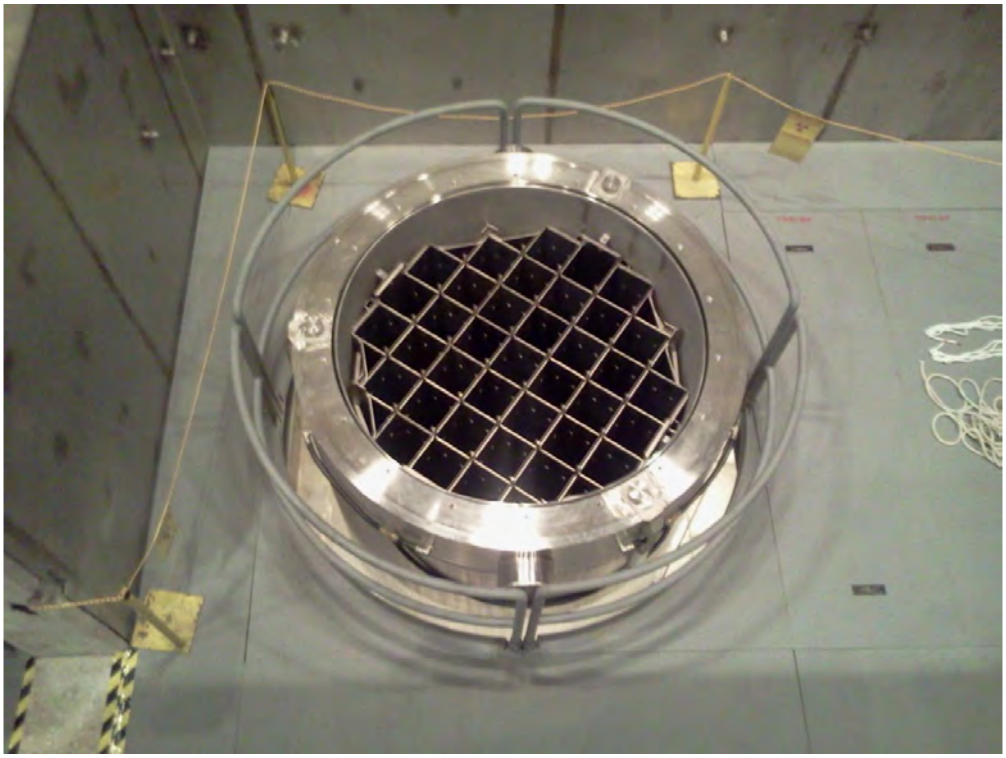


Photo courtesy of ZionSolutions

Figure 2-133. TSC-37 Canister Inside Transfer Cask

Photo courtesy of ZionSolutions

Figure 2-134. Damaged Fuel Can Being Installed in TSC-37 Canister

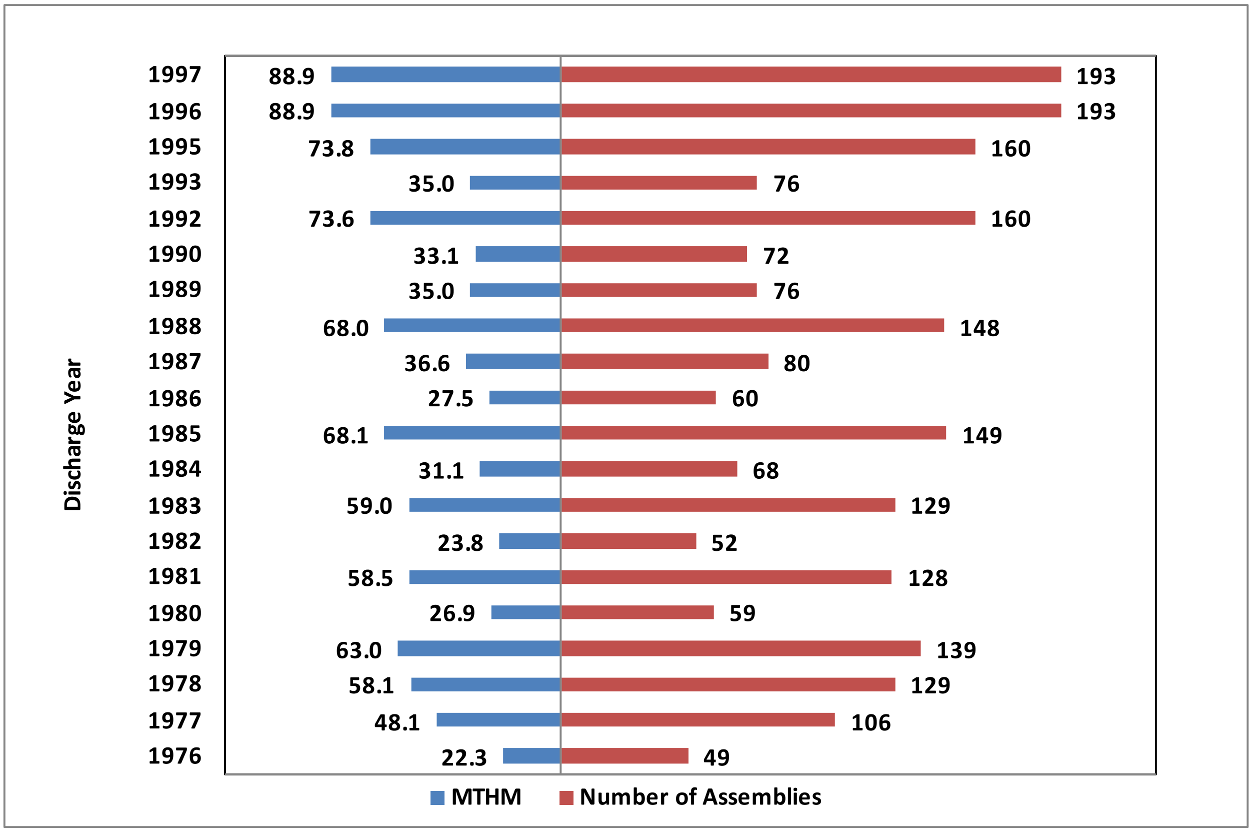


Figure 2-135. Zion Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

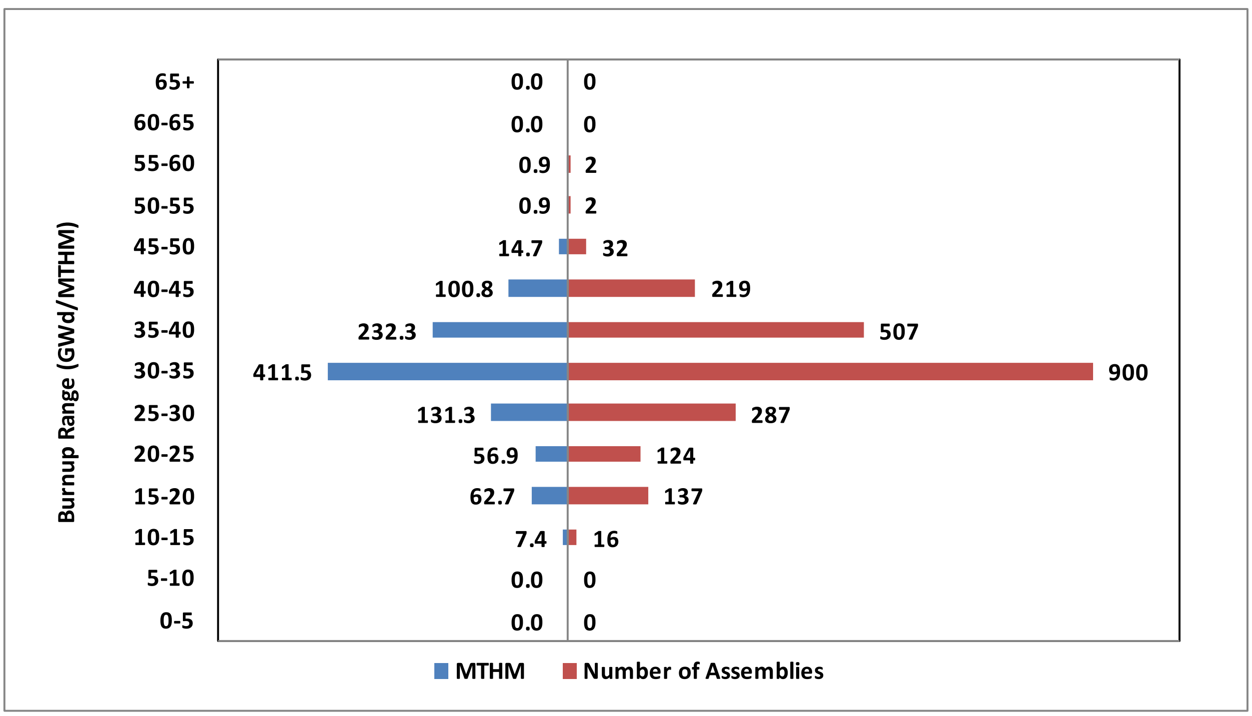


Figure 2-136. Zion Number of Assemblies and MTHM versus Burnup (EIA 2018)

2.9.2 Site Conditions

Figure 2-137 provides an aerial view of the Zion site, which is being decommissioned. The Zion ISFSI is located at the southern end of the Zion site (see Figure 2-138). At the northern end of the Zion site, 65 vertical concrete storage casks were staged prior to being loaded. Figure 2-139 provides a close-up view of these vertical concrete storage casks. Figure 2-140 shows the TSC-37 transportable storage canisters into which the SNF was placed. These canisters were then placed inside vertical concrete storage casks and moved to the Zion ISFSI. Figure 2-141 shows the transporter used to move the loaded vertical concrete storage casks to the ISFSI.

Figure 2-137 also shows the Zion on-site rail spur which was recently refurbished, and which is being used for low-level radioactive waste shipments from the site. This refurbishment included installing concrete ties with Pandrol clips on the curves. A 4-inch ballast lift was also performed over the length of the spur and on the east-west portion of the spur every other wooden tie was replaced. This rail spur provides access to the Union Pacific Railroad. The Union Pacific rail line in the vicinity of the Zion site is designated as track class 4.

During construction of the Zion site, barges were used to move materials and components to the site (see Figure 2-142). The barge facility was located at the northern end of the Zion site and has been abandoned, and the land on which it was located was donated to the Illinois Beach State Park (TOPO 1994b). However, the barge pilings (see Figure 2-143) remain and could be reused to refurbish the barge facility.

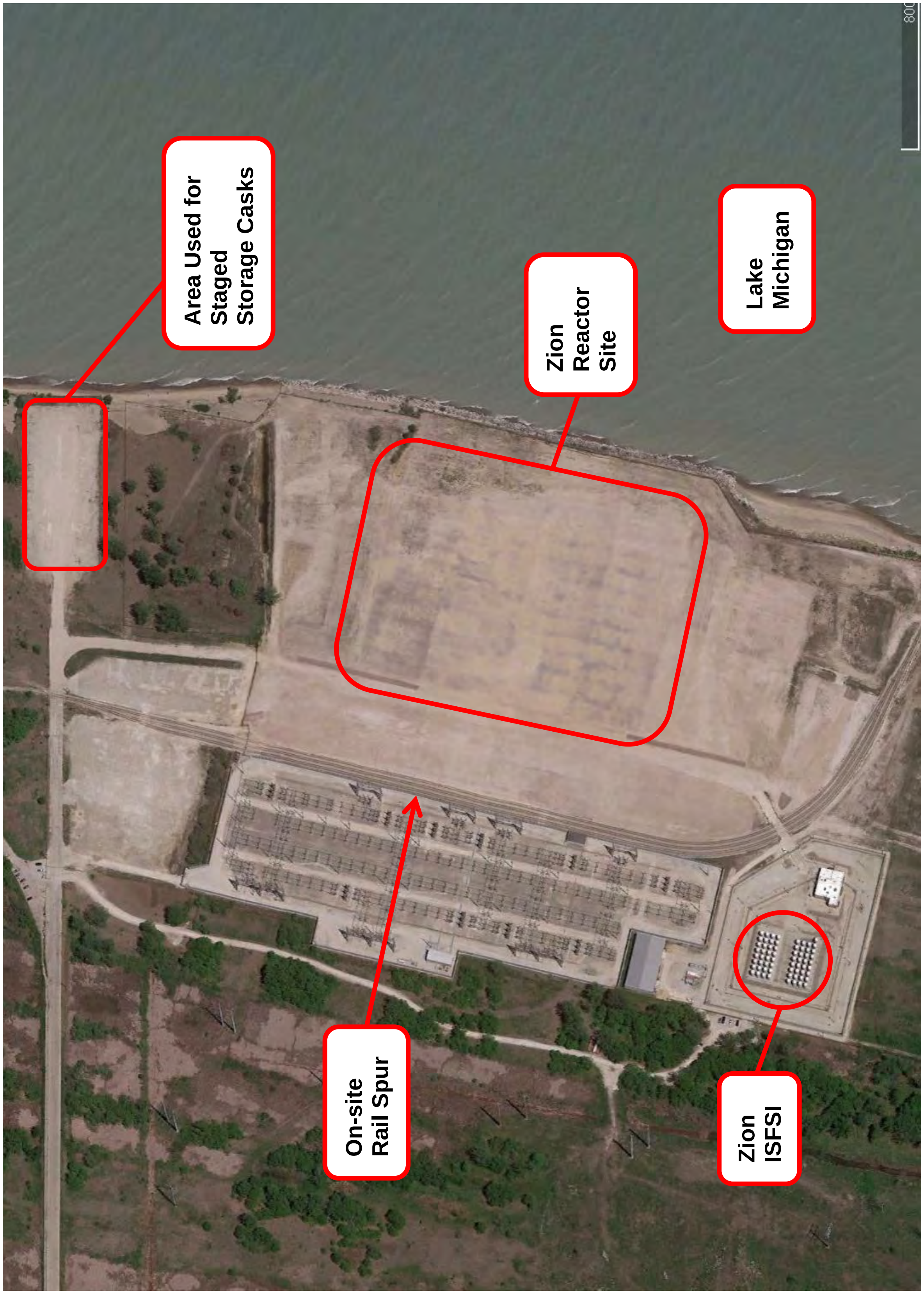


Figure 2-137. Aerial View of Zion Site (Google 2022)

Figure 2-138. Aerial View of Zion Independent Spent Fuel Storage Installation (Google 2022)

Figure 2-139. Vertical Concrete Storage Casks Staged at Zion (2013)

Figure 2-140. Spent Nuclear Fuel Transportable Storage Canisters Staged at Zion (2013)

Figure 2-141. Transporter Used to Move Vertical Concrete Storage Casks (2013)

Photo courtesy of ZionSolutions

Figure 2-142. Steam Generators Being Delivered to Zion Site by Barge during Construction

Figure 2-143. Barge Pilings at the North End of the Zion Site (Google 2022)

2.9.3 Near-site Transportation Infrastructure and Experience

At the Zion site, an on-site rail spur provides direct rail access to the Union Pacific Railroad (see Figure 2-144). The Northeast Illinois Regional Commuter Rail Corporation operates commuter service over this same track and there is a commuter rail stop located approximately 4,000 feet from the Zion site entrance, at the junction of the Union Pacific mainline and the Zion site access road.

There is currently enough room on the Zion site to accommodate trains having eight or more railcars (two buffer cars, a security escort car, and five or more cask cars). Figure 2-145 shows the Trackmobile that is being used to move railcars on-site. Figure 2-146 shows the rail spur entering the Zion site and Figure 2-147 shows the junction of the Zion on-site rail spur with the Union Pacific Railroad. Figure 2-147 also shows the concrete rail ties that were used in the reconstructing the curves of the on-site rail spur.

In 2016, eight steam generators were shipped by rail from the Zion site to Clive, Utah for disposal. The steam generators ranged in weight from 444,000 to 462,200 lb. and were shipped on 360-ton, 53-foot deck, 12-axle QTTX flat cars. Figure 2-148 shows a steam generator being prepared for shipping and Figure 2-149 shows two steam generators awaiting departure from the Zion site.

As mentioned in Section 2.9.2, the Zion site was served by barges during construction. The barge facility was abandoned; however, the barge pilings remain and could be reused to refurbish the barge facility.

In addition to rail, Zion has used heavy haul trucks to ship radioactive waste off-site for disposal. For example, in 2011, ZionSolutions, which is decommissioning the Zion reactors, shipped the Zion Unit 2 reactor head from the Zion site to Clive, Utah for disposal. The reactor head was approximately 17 feet in diameter and weighed 225,000 lb. (Troher 2011). A heavy haul truck was used for this shipment because the Zion Unit 2 reactor head was too large for shipment by rail. The heavy haul truck travelled 1,500 miles from the Zion site north of Chicago, Illinois to the EnergySolutions low-level radioactive waste disposal facility in Clive, Utah. Figure 2-150 shows the Zion reactor head on its heavy haul truck transporter.

2.9.4 Future Information Needs

At the Zion site, a rail spur connects to the Union Pacific Railroad mainline that runs between Milwaukee, Wisconsin, and Chicago, Illinois. The Union Pacific Railroad is a Class I railroad that is expected to have the capability to move shipments of SNF in MAGNATRAN transportation casks. However, the status and maintaining of this rail spur after decommissioning of the Zion site has been completed has not been determined.

The Zion barge facility used during plant construction was abandoned and the land on which it was located was donated to the Illinois Beach State Park. However, the barge pilings remain and could be reused to refurbish the barge facility.

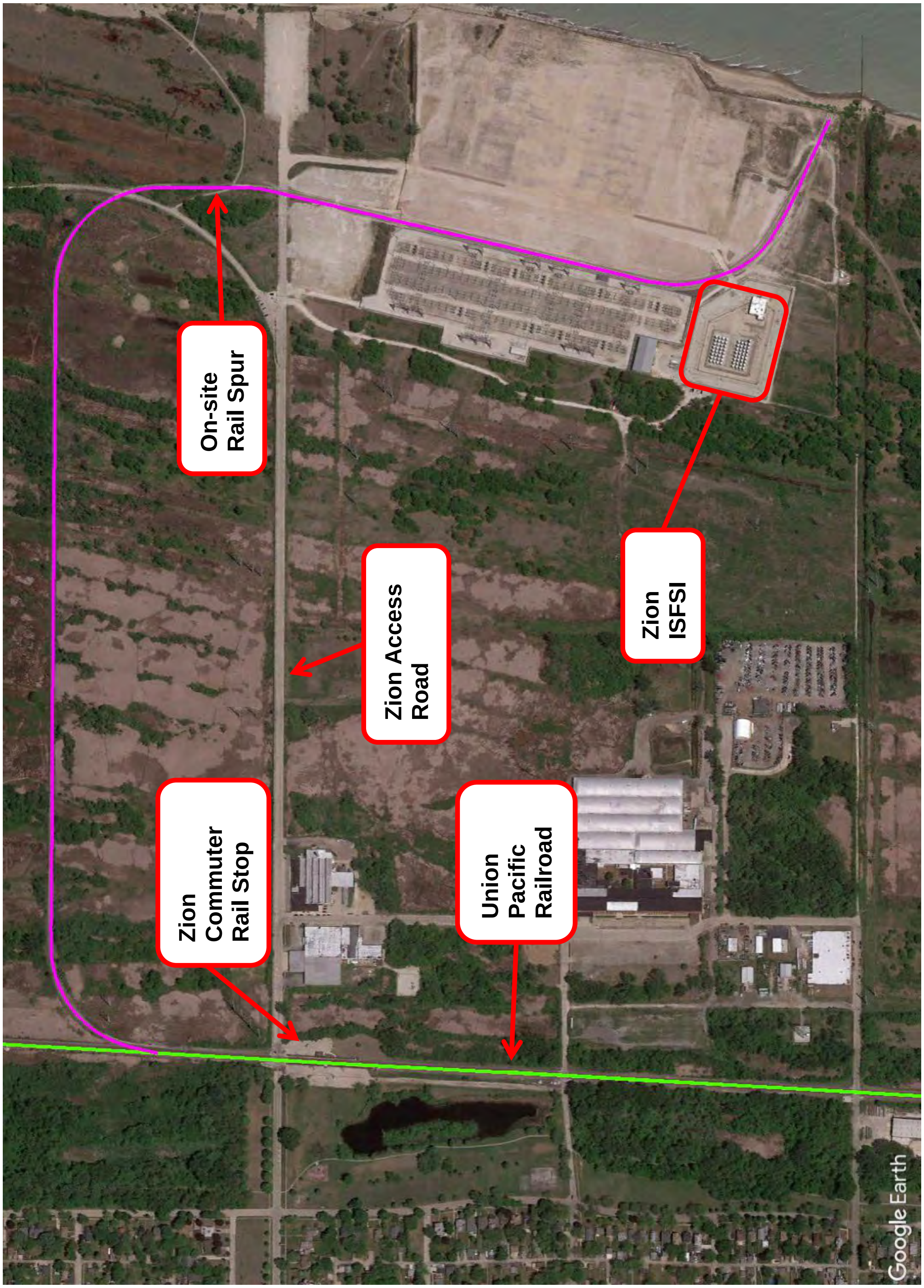


Figure 2-144. Rail Interface at Zion (Google 2022)

Figure 2-145. Trackmobile Used to Move Railcars On-site (2013)

Photo courtesy of Federal Railroad Administration

Figure 2-146. On-site Rail Spur Entering Zion Site (2013)

Figure 2-147. Junction of Zion On-site Rail Spur with Union Pacific Railroad Showing Concrete Rail Ties (2013)

Photo courtesy of ZionSolutions

Figure 2-148. Steam Generator Being Prepared for Shipping (2016)

Photo courtesy of ZionSolutions

Figure 2-149. Two Steam Generators Awaiting Departure from the Zion Site (2016)

Photo courtesy of ZionSolutions

Figure 2-150. Zion Reactor Head on Heavy Haul Truck Transporter (2011)

2.10 Crystal River

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the Crystal River site. The Crystal River site is located in northwestern Florida near the Gulf of Mexico on the Crystal River about 46 miles south-southwest of Gainesville, Florida, and 70 miles north of Tampa, Florida (TOPO 1994c).

2.10.1 Site Inventory

The Crystal River Unit 3 Nuclear Generating Plant (CR-3) has been shut down since September 26, 2009 and the final removal of SNF from the reactor vessel was completed on May 28, 2011 (Franke 2013). Removal of SNF from the Crystal River spent fuel pool was completed on January 15, 2018 (Hobbs 2018). There are 1243 pressurized water reactor SNF assemblies (582.2 MTHM) stored at the Crystal River site.[24] In addition, there is a failed fuel rod canister

[24] Fata A. 2014. Email message from A Fata (Duke Energy Corporation) to SJ Maheras (Pacific Northwest National Laboratory), "Re: CR3 input to DOE report," September 30, 2014.

containing 45 fuel rods (0.103 MTHM) stored at the site. This does not include 76 assemblies that were loaded into the reactor for restart but not brought to critical. These assemblies were sold for reuse.

The fuel rods in the fuel assemblies are zirconium alloy-clad. Crystal River is using the Standardized NUHOMS System (Docket No. 72-1004) with the 32PTH1 dry shielded canister for dry storage of SNF at the Crystal River ISFSI (Docket No. 72-1035). This system consists of transportable 32PTH1 dry shielded canisters, reinforced concrete horizontal storage modules, and a transfer cask. Figure 2-151 shows a transfer cask being used to load a canister into a horizontal storage module.

The 32PTH1 dry shielded canister holds 32 pressurized water reactor SNF assemblies. Thirty-nine 32PTH1 canisters were required to store the 1243 SNF assemblies and failed fuel rod canister at Crystal River. Elnitsky (2013) estimated that 5 canisters containing GTCC waste would be generated during decommissioning.

The MP197HB transportation cask (Docket No. 71-9302) is certified to transport the 32PTH1 canister and also canisters containing GTCC waste. In addition, the MP197HB transportation cask is certified to transport high burnup (> 45 GWd/MTHM) SNF in the 32PTH1 canister. An MP197HB transportation cask has been fabricated and is in use in the U.S.

Figure 2-152 illustrates the number of SNF assemblies and MTHM at Crystal River, based on discharge year. The oldest fuel was discharged in 1978 and the last fuel was discharged in 2009. The median discharge year of the fuel is 1996.

Figure 2-153 illustrates the number of SNF assemblies and MTHM at Crystal River based on burnup. The lowest burnup is 8.7 GWd/MTHM and the highest burnup is 54.9 GWd/MTHM. The median burnup is 38.2 GWd/MTHM. There are 428 SNF assemblies (200.8 MTHM) at Crystal River that have burnups greater than 45 GWd/MTHM. These 428 fuel assemblies are classified by the NRC as high burnup SNF.

Photo courtesy of AREVA TN

Figure 2-151. Transfer Cask Being Used to Load Canister into Horizontal Storage Module

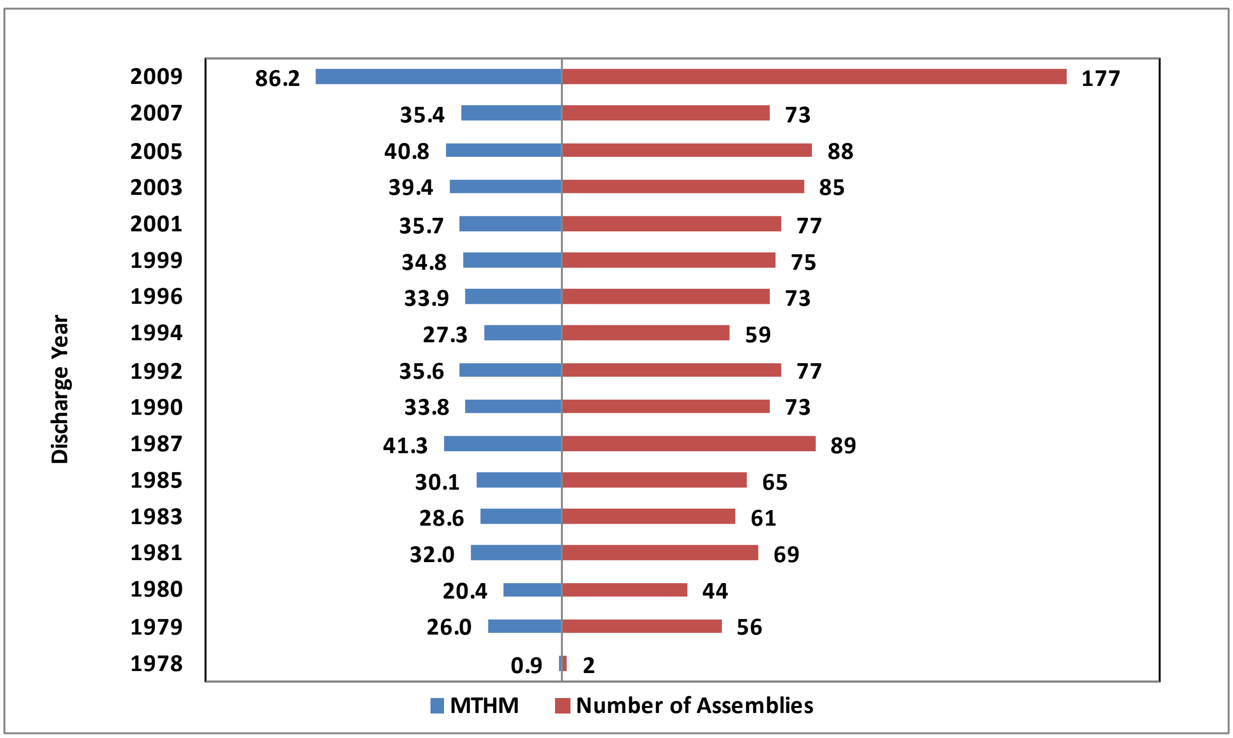


Figure 2-152. Crystal River Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

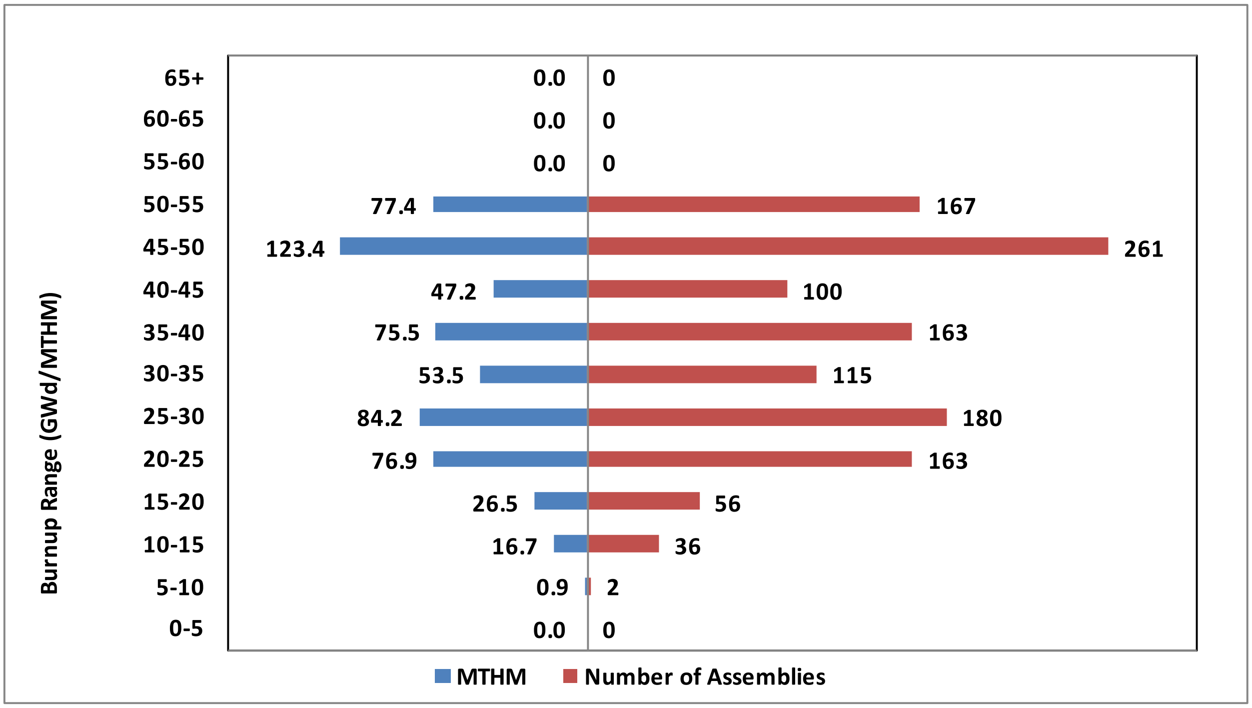


Figure 2-153. Crystal River Number of Assemblies and MTHM versus Burnup (EIA 2018)

2.10.2 Site Conditions

The Crystal River Unit 3 Nuclear Generating Plant (CR-3) is part of the larger Crystal River Energy Complex (CREC), which includes the single nuclear unit and four fossil fueled units, Crystal River Units 1, 2, 4, and 5 (CR-1, CR-2, CR-4, and CR-5). Figure 2-154 shows the site of the Crystal River ISFSI before construction. This area was built up approximately 20 feet to be above flood level. Figure 2-155 shows the Crystal River ISFSI after installation of the horizontal storage modules. Figure 2-156 provides an aerial view of the Crystal River Energy Complex showing the location of CR-1 through CR-5, the on-site rail system including the nuclear spur and coal receiving loop, the coal barge unloading area, the barge turning basin, an area used to unload roll-on/roll-off barges, and the intake and discharge canals. Figure 2-157 shows the location of the ISFSI at the Crystal River site discussed in Section 2.10.1.

Crystal River has an extensive on-site rail system used for coal shipments to the 4 fossil fueled units with service provided by the Florida Northern Railroad. The Crystal River site currently receives 5 coal trains per month but has received 30 to 40 trains per month. The weight of each car is in the range of 100 to 110 tons and coal trains weigh about 11,000 tons. In general, the on-site rail system is built using 132 to 136 lb. rail. A nuclear spur previously extended into the Crystal River reactor cask receiving area; the nuclear spur now terminates about 0.22 miles east of the cask receiving area and does not extend into the ISFSI.

Figure 2-158 and Figure 2-159 show the nuclear spur and the junction of the on-site industrial spur and the nuclear spur. Figure 2-160 and Figure 2-161 show the on-site industrial spur in front of the ISFSI site. Figure 2-162 and Figure 2-163 show the on-site industrial spur at the junction with the coal receiving loop and approaching U.S. Highway 19 from the west. There is sufficient track outside of the Crystal River protected area to assemble or store more than 20 railcars, but use of the on-site track would not be allowed to interfere with coal shipments for the fossil fueled units.

Intake and discharge canals at the Crystal River site withdraw water from and discharge water to the Gulf of Mexico (see Figure 2-164). The Crystal River site has on-site barge access through the intake canal but loading a transportation cask onto a barge would require a crane to boom out over 30 feet to avoid a coal conveyer. The intake canal, which extends into the Gulf of Mexico, is 14 miles long. It has a minimum depth of 20 feet to accommodate barge traffic used to deliver coal for the fossil fuel units. Southern and northern dikes parallel the intake canal for about 3.4 miles offshore. The southern dike terminates at this point, while the northern dike extends an additional 5.3 miles into the Gulf of Mexico. The dikes are about 50 to 100 feet wide on top and are elevated about 10 feet above the water surface at mean low tide. Starting at the east end, the intake canal is 150 feet wide for 2.8 miles; 225 feet wide for the next 6.3 miles; and 300 feet wide for the last 4.9 miles. Dredging occurs in the intake canal every 5 to 7 years (NRC 2011).

Figure 2-165 shows the coal barge unloading area at the Crystal River site. The Crystal River site currently receives about 20 barges per month and each barge has a capacity of 20,000 tons. Figure 2-166 shows the barge turning basin. This area has been used to unload roll-on/roll-off barges at the Crystal River site.

Photo courtesy of Crystal River

Figure 2-154. Site of the Crystal River Independent Spent Fuel Storage Installation Before Construction (2015)

Photo courtesy of Crystal River

Figure 2-155. Crystal River Independent Spent Fuel Storage Installation with Horizontal Storage Modules Installed (2017)

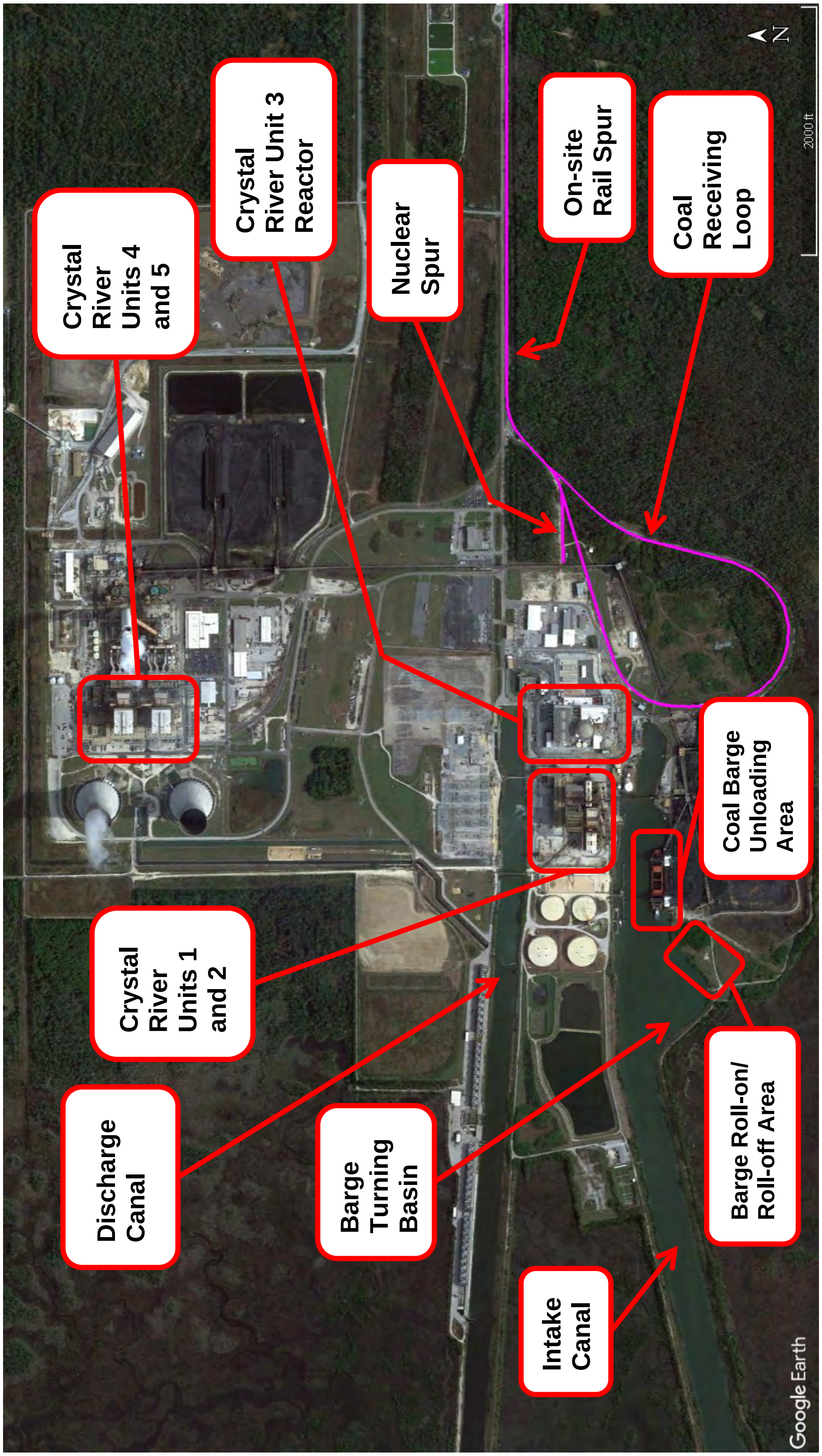


Figure 2-156. Aerial View of the Crystal River Energy Complex (Google 2022)

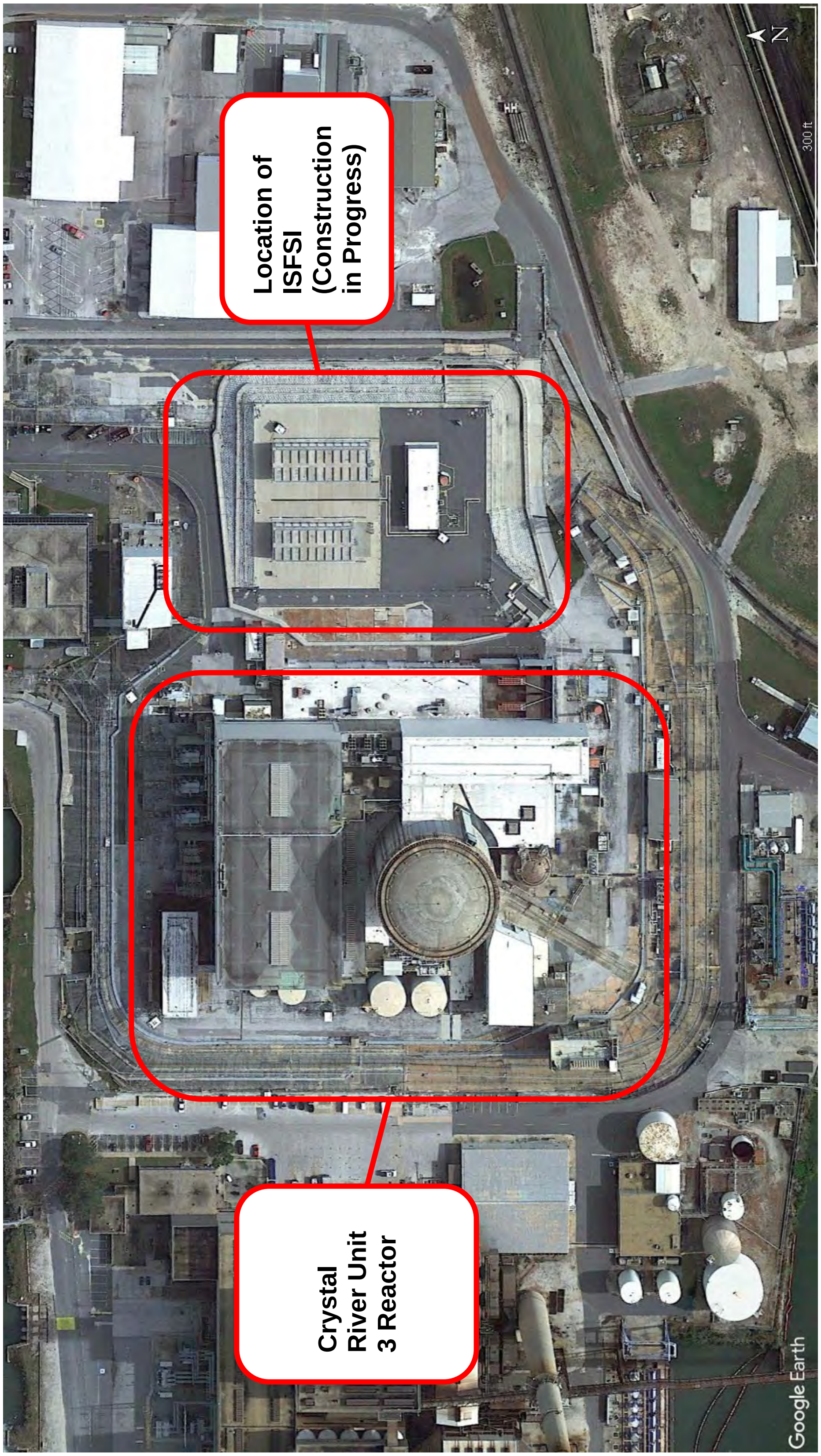


Figure 2-157. Location of Crystal River Independent Spent Fuel Storage Installation (Google 2022)

Figure 2-158. Nuclear Spur (2015)

Figure 2-159. Junction of On-site Industrial Spur (Left) and Nuclear Spur (Right) (2015)

Figure 2-160. On-site Industrial Rail Spur in Front of the Independent Spent Fuel Storage Installation Site (Looking East) (2015)

Figure 2-161. On-site Industrial Rail Spur in Front of the Independent Spent Fuel Storage Installation Site (Looking West) (2015)

Figure 2-162. On-site Industrial Rail Spur at the Coal Loop Junction (2015)

Figure 2-163. On-site Industrial Rail Spur Approaching U.S. Highway 19 from the West (2015)

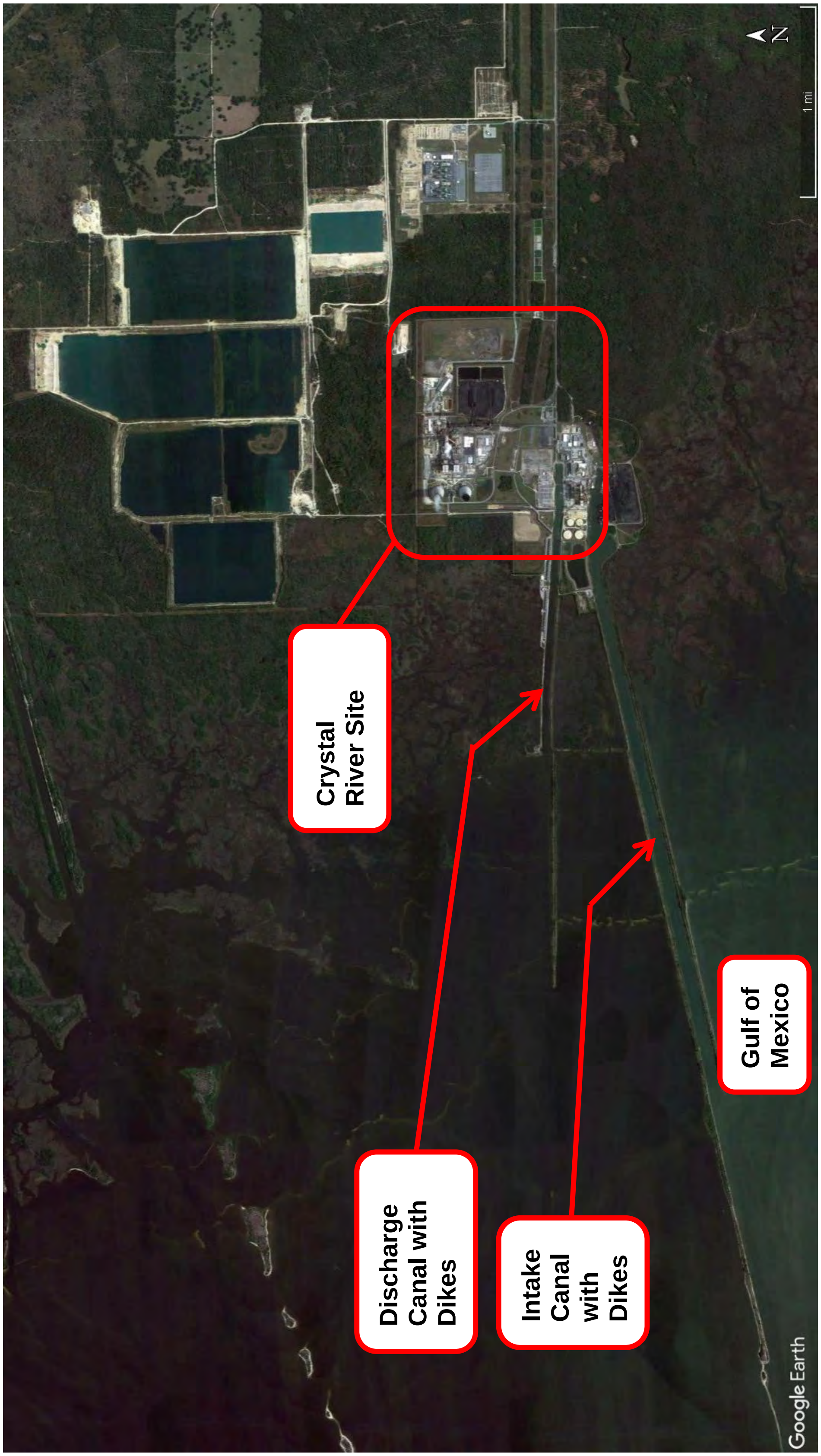


Figure 2-164. Aerial View of the Crystal River Intake and Discharge Canals (Google 2022)

Figure 2-165. Current Barge Area Used for Unloading Coal Barges (2015)

Figure 2-166. Barge Turning Basin (2015)

2.10.3 Near-site Transportation Infrastructure and Experience

At the Crystal River site, a 7-mile industrial rail spur provides direct rail access to the Florida Northern Railroad at Red Level Junction (see Figure 2-167). This spur is used to receive coal shipments for CR-1, CR-2, CR-4, and CR-5. The track south of Red Level Junction has been abandoned. In Newberry, Florida, about 60 miles from the Crystal River site, the Florida Northern Railroad interchanges with the CSXT Railroad at the Newberry wye (see Figure 2-168 and Figure 2-169). The Crystal River industrial spur (milepost 793.1 to 785.7) has a speed limit of 10 mph and is designated as track class 1. The Florida Northern Railroad speed limit from milepost 785.7 and 732.0 is 25 mph and is designated as track class 2. At milepost 789.27, the Florida Northern Railroad crosses U.S. Highway 19. At the Newberry wye (milepost 732.0 to 729.9), the speed limit is 10 mph and the track is designated as track class 1. To the northeast of the Newberry wye (milepost 718.7 to 717.0), the speed limit is also 10 mph and the track is designated as track class 1. At milepost 718.34, the Florida Northern Railroad crosses U.S. Highway 41/Main Street. In general, the Florida Northern Railroad is built using 115 lb. rail.

The CSXT track begins at milepost 717.0 and is track class 3. The CSXT also has trackage rights over the Florida Northern Railroad between milepost 718.7 and 717.0, enabling the CSXT to interchange with the Florida Northern Railroad at the Newberry wye, and between milepost 730.0 and 732.0, which is where inbound and outbound trains are staged. Figure 2-170 through Figure 2-173 show the Florida Northern Railroad near Dunnellon, Florida, a highway bridge over the Florida Northern Railroad, a grade crossing on the Florida Northern Railroad, and a bridge on the Florida Northern Railroad, respectively. Figure 2-174 through Figure 2-176 show wheel detectors, a hot bearing detector, and a dragging equipment detector on the Florida Northern Railroad at milepost 759.6. Figure 2-177 shows track maintenance equipment staged at the mine spur, just off the industrial spur, and Figure 2-178 shows a Florida Northern Railroad Hi-Rail vehicle used for track inspections.

In 2009, four moisture separator reheaters and a generator rotor were shipped to the Crystal River site by rail. The moisture separator reheaters weighed 300,000 lb. each, and had a length of 51 feet and a diameter of 14 feet (see Figure 2-179 and Figure 2-180). The generator rotor weighed 395,000 lb., and had a length of 50 feet and a diameter of 8 feet (see Figure 2-181 and Figure 2-182). The moisture separator reheaters and a generator rotor were unloaded at the Crystal River site nuclear spur. The old moisture separator reheaters were also loaded at the nuclear spur and shipped off-site by rail (see Figure 2-183 and Figure 2-184).

In 2015, twelve horizontal storage modules were shipped to the Crystal River site by rail. The horizontal storage modules were transported using 230-ton, 27-foot deck, 8-axle QTTX depressed center cars. Each horizontal storage module weighed 189,000 lb., and had a length of 20.7 feet, a width of 9.7 feet, and a height of 14.8 feet. As with the moisture separator reheaters and the generator rotor, the horizontal storage modules were unloaded at the nuclear spur. Figure 2-185 shows two horizontal storage modules loaded on railcars, Figure 2-186 shows a horizontal storage module staged for unloading, Figure 2-187 shows a horizontal storage module being unloaded from a railcar, and Figure 2-188 shows the twelve horizontal storage modules at the nuclear spur after unloading.

As discussed in Section 2.10.2, Crystal River also has barge access to the Gulf of Mexico through the intake canal at the site. In 2012, the Crystal River site received low pressure turbine components by barge. These components consisted of two low pressure rotors (353,000 lb. each), two low pressure upper casings (117,000 lb. each), and two low pressure lower casings (200,000 lb. each). The components were unloaded at an area adjacent to the coal barge unloading area (see Figure 2-189), which also shows the barge turning basin. A ramp was constructed in the bank of the barge turning basin, the barge grounded, and the components rolled off the barge. Figure 2-190 through Figure 2-197 show the sequence of operations used to offload the components from the barge.

The Crystal River site has also received components by heavy haul truck. For example, in 2011, a high pressure turbine rotor was received by the Crystal River site (see Figure 2-198). The high pressure turbine weighed 150,000 lb., and had a length of 28 feet and a diameter of 7 feet.

2.10.4 Future Information Needs

At the Crystal River site, an on-site rail spur provides direct access to the Florida Northern Railroad which interchanges with the CSXT Railroad and consequently, barge or heavy haul truck transport of SNF and GTCC waste would be unlikely from the Crystal River site.

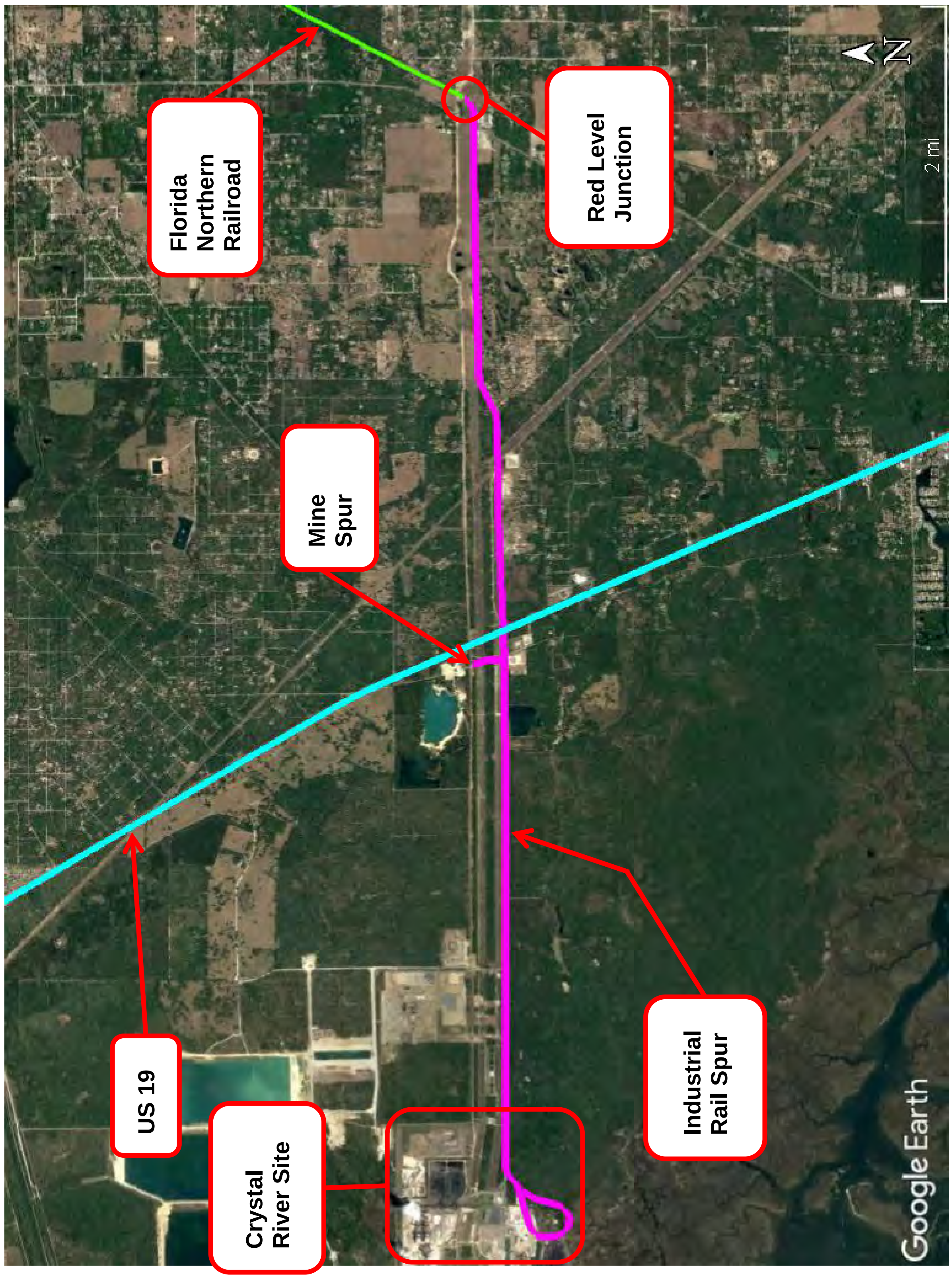


Figure 2-167. Aerial View of the Crystal River Industrial Rail Spur and Florida Northern Railroad (Google 2022)

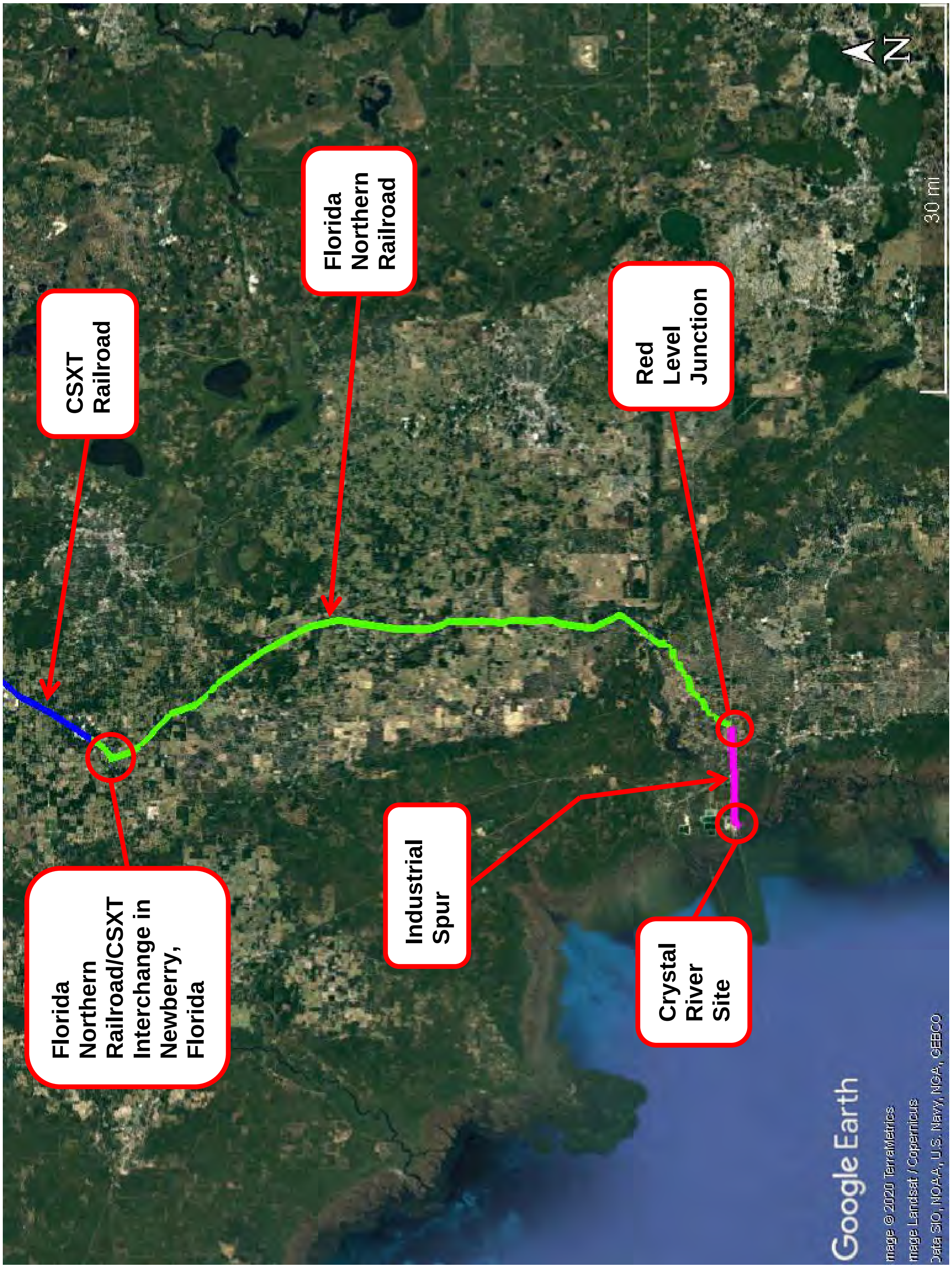


Figure 2-168. Aerial View of the Crystal River Industrial Rail Spur, Florida Northern Railroad, and CSXT Railroad (Google 2022)

Figure 2-169. Newberry Wye (Google 2022)

Figure 2-170. Florida Northern Railroad near Dunnellon, Florida (2015)

Figure 2-171. Highway Bridge over Florida Northern Railroad (2015)

Figure 2-172. Florida Northern Railroad Grade Crossing (2015)

Figure 2-173. Florida Northern Railroad Bridge (2015)

Figure 2-174. Wheel Detectors on Florida Northern Railroad (2015)

Figure 2-175. Hot Bearing Detector on Florida Northern Railroad (2015)

Figure 2-176. Dragging Equipment Detector on Florida Northern Railroad (2015)

Figure 2-177. Track Maintenance Equipment Staged at the Mine Spur (2015)

Figure 2-178. Hi-Rail Vehicle Used for Track Inspections (2015)

Photo courtesy of Crystal River

Figure 2-179. Moisture Separator Reheaters Being Shipped by Rail to the Crystal River Site (2009)

Photo courtesy of Crystal River

Figure 2-180. Moisture Separator Reheaters Being Unloaded at the Crystal River Site (2009)

Photo courtesy of Crystal River

Figure 2-181. Generator Rotor Being Shipped by Rail to the Crystal River Site (2009)

Photo courtesy of Crystal River

Figure 2-182. Generator Rotor Being Unloaded at the Crystal River Site (2009)

Photo courtesy of Crystal River

Figure 2-183. Old Moisture Separator Reheaters Being Shipped Off-site by Rail (2009)

Photo courtesy of Crystal River

Figure 2-184. Locomotive Picking Up Old Moisture Separator Reheaters (2009)

Photo courtesy of Crystal River

Figure 2-185. Two Horizontal Storage Modules Loaded on Railcars (2015)

Photo courtesy of Crystal River

Figure 2-186. Horizontal Storage Module Staged for Unloading (2015)

Photo courtesy of Crystal River

Figure 2-187. Horizontal Storage Module Being Unloaded from Railcar (2015)

Photo courtesy of Crystal River

Figure 2-188. Horizontal Storage Modules at Nuclear Spur after Unloading (2015)

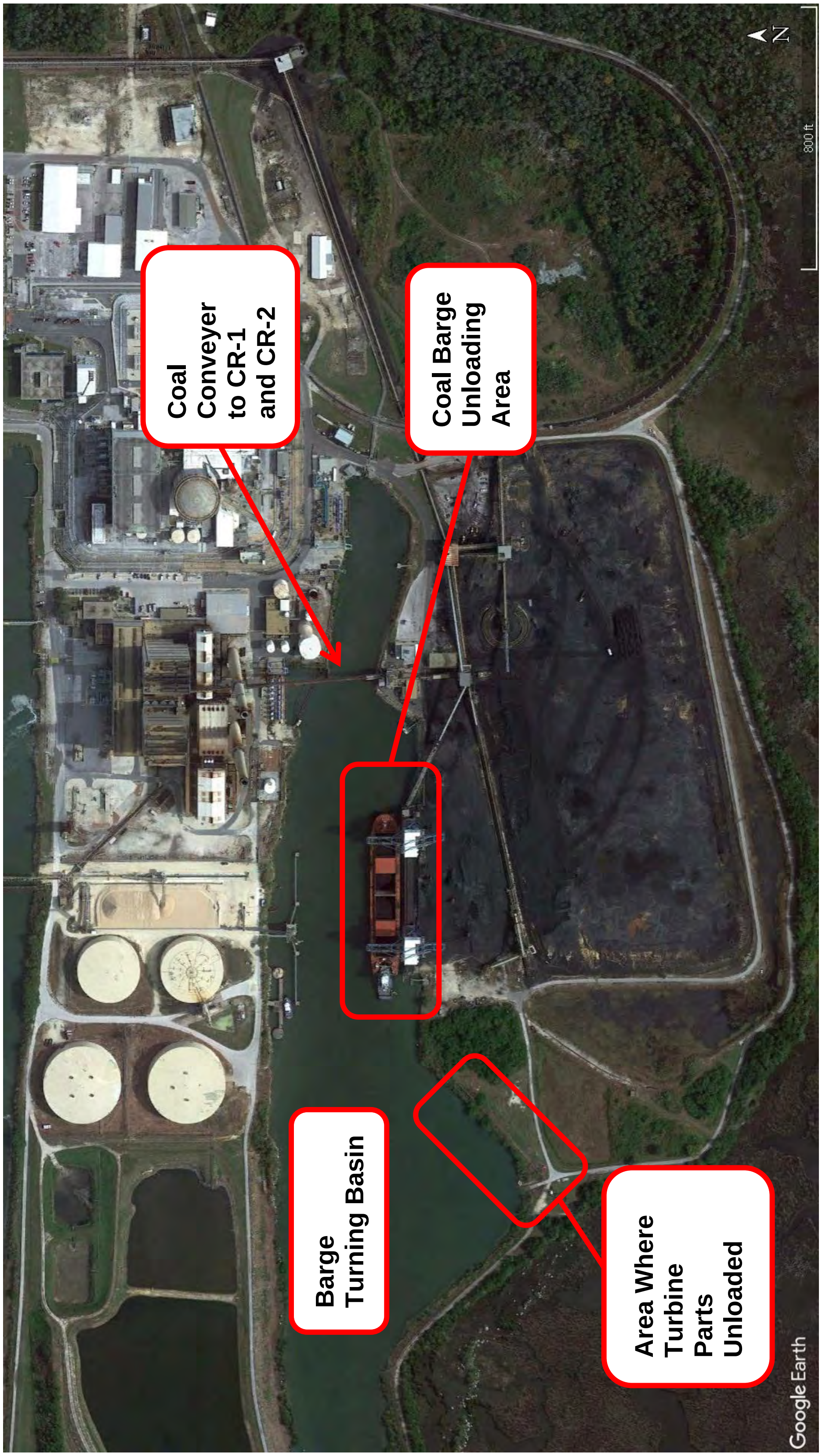


Figure 2-189. Crystal River Site Barge Area (Google 2022)

Photo courtesy of Crystal River

Figure 2-190. Crystal River Turbine Components on Barge (2012)

Photo courtesy of Argonautics Marine Engineering, Inc.

Figure 2-191. Barge with Turbine Components Approaching Ramp (2012)

Photo courtesy of Crystal River

Figure 2-192. Barge with Turbine Components Just Before Grounding at Ramp (2012)

Photo courtesy of Argonautics Marine Engineering, Inc.

Figure 2-193. Barge with Turbine Components Grounded at Ramp (2012)

Photo courtesy of Argonautics Marine Engineering, Inc.

Figure 2-194. Turbine Components Being Unloaded Using Self-Propelled Modular Transporter (2012)

Photo courtesy of Argonautics Marine Engineering, Inc.

Figure 2-195. Turbine Components Driving Off of Unloading Ramp (2012)

Photo courtesy of Argonautics Marine Engineering, Inc.

Figure 2-196. Turbine Components Fully Unloaded from Barge (2012)

Photo courtesy of Argonautics Marine Engineering, Inc.

Figure 2-197. Self-Propelled Modular Transporter Turning with Turbine Components (2012)

Photo courtesy of Crystal River

Figure 2-198. High Pressure Turbine Rotor Delivered to Crystal River Site by Heavy Haul Truck (2011)

2.11 Kewaunee

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the Kewaunee site. The Kewaunee site is located on the western shore of Lake Michigan between the towns of Manitowoc and Kewaunee about 30 miles southeast of Green Bay and 98 miles north of Milwaukee, Wisconsin (TOPO 1994d).

2.11.1 Site Inventory

Kewaunee has been shut down since May 7, 2013 and final removal of SNF from the reactor vessel was completed on May 14, 2013 (Stoddard 2013a, 2013b). Removal of SNF from the Kewaunee spent fuel pool was completed on June 15, 2017. A total of 1335 SNF assemblies (518.7 MTHM) are stored at Kewaunee (Sartain 2014a). The fuel rods in the fuel assemblies are zirconium alloy-clad.

Kewaunee uses the Standardized NUHOMS System (Docket No. 72-1004) and the MAGNASTOR System (Docket No. 72-1031) for dry storage of SNF. The Standardized NUHOMS System consists of transportable dry shielded canisters, reinforced concrete horizontal storage modules, and a transfer cask. There are 448 pressurized water reactor SNF assemblies

(170.3 MTHM) stored in 14 32PT dry shielded canisters at the Kewaunee ISFSI (Docket No. 72-64) in Standardized NUHOMS Systems. The 32PT dry shielded canister holds 32 pressurized water reactor SNF assemblies.

There are a total of 16 horizontal storage modules at the Kewaunee ISFSI. The two horizontal storage modules that are not being used for storing SNF are currently empty. These horizontal storage modules will be used for storing GTCC waste.

The MP197HB transportation cask (Docket No. 71-9302) is certified to transport the 32PT canister and also canisters containing GTCC waste. An MP197HB transportation cask has been fabricated and is in use in the U.S.

The MAGNASTOR System consists of transportable storage canisters, vertical concrete storage casks, and a transfer cask. There are 887 pressurized water reactor SNF assemblies (348.4 MTHM) stored in 24 TSC-37 transportable storage canisters. The TSC-37 transportable storage canister holds 37 pressurized water reactor SNF assemblies. The transportation cask certified to transport the TSC-37 canister is the MAGNATRAN (Docket No. 71-9356).

Three damaged fuel assemblies (A15, C02, and N11) have been identified at the Kewaunee site. These assemblies were placed in damaged fuel cans (Ridder 2016). In addition, 241 assemblies were identified as susceptible to bulge joint corrosion of the top nozzle sleeves and were repaired to allow inspection and movement into dry storage (Ridder 2016).

At the Kewaunee site, a total of 38 canisters containing SNF and an estimated 2 canisters containing GTCC waste will be stored. Sartain (2014b) states that GTCC waste would not be packaged until 2070.

Figure 2-199 illustrates the number of SNF assemblies and MTHM at Kewaunee based on discharge year. The oldest fuel was discharged in 1976 and the last fuel was discharged in 2013. The median discharge year of the fuel is 1994.

Figure 2-200 illustrates the number of SNF assemblies and MTHM at Kewaunee based on burnup. The lowest burnup is 14.7 GWd/MTHM and the highest burnup is 56.3 GWd/MTHM. The median burnup is 37.2 GWd/MTHM. There are 264 SNF assemblies (104.4 MTHM) at Kewaunee that have burnups greater than 45 GWd/MTHM. These 264 fuel assemblies are classified by the NRC as high burnup SNF.

As mentioned previously, Kewaunee has 448 SNF assemblies (170.3 MTHM) stored in 14 32PT dry storage canisters. Figure 2-201 and Figure 2-202 illustrate the number of these fuel assemblies and MTHM based on discharge year and burnup. The oldest fuel was discharged in 1982 and the last fuel was discharged in 2004. The median discharge year of the fuel is 1992. The lowest burnup is 25.0 GWd/MTHM and the highest burnup is 43.1 GWd/MTHM. The median burnup is 36.9 GWd/MTHM. There are no fuel assemblies at Kewaunee stored in 32PT canisters that have burnups greater than 45 GWd/MTHM.

Figure 2-203 and Figure 2-204 illustrate the number of fuel assemblies and MTHM based on discharge year and burnup for the 887 fuel assemblies (348.4 MTHM) that are stored in TSC-37 dry storage canisters. The oldest fuel was discharged in 1976 and the last fuel was discharged in

2013. The median discharge year of the fuel is 2001. The lowest burnup is 14.7 GWd/MTHM and the highest burnup is 56.3 GWd/MTHM. The median burnup is 37.6 GWd/MTHM. There are 264 fuel assemblies (104.4 MTHM) at Kewaunee that are stored in TSC-37 canisters that have burnups greater than 45 GWd/MTHM. These assemblies were not placed in damaged fuel cans (Ridder 2016).

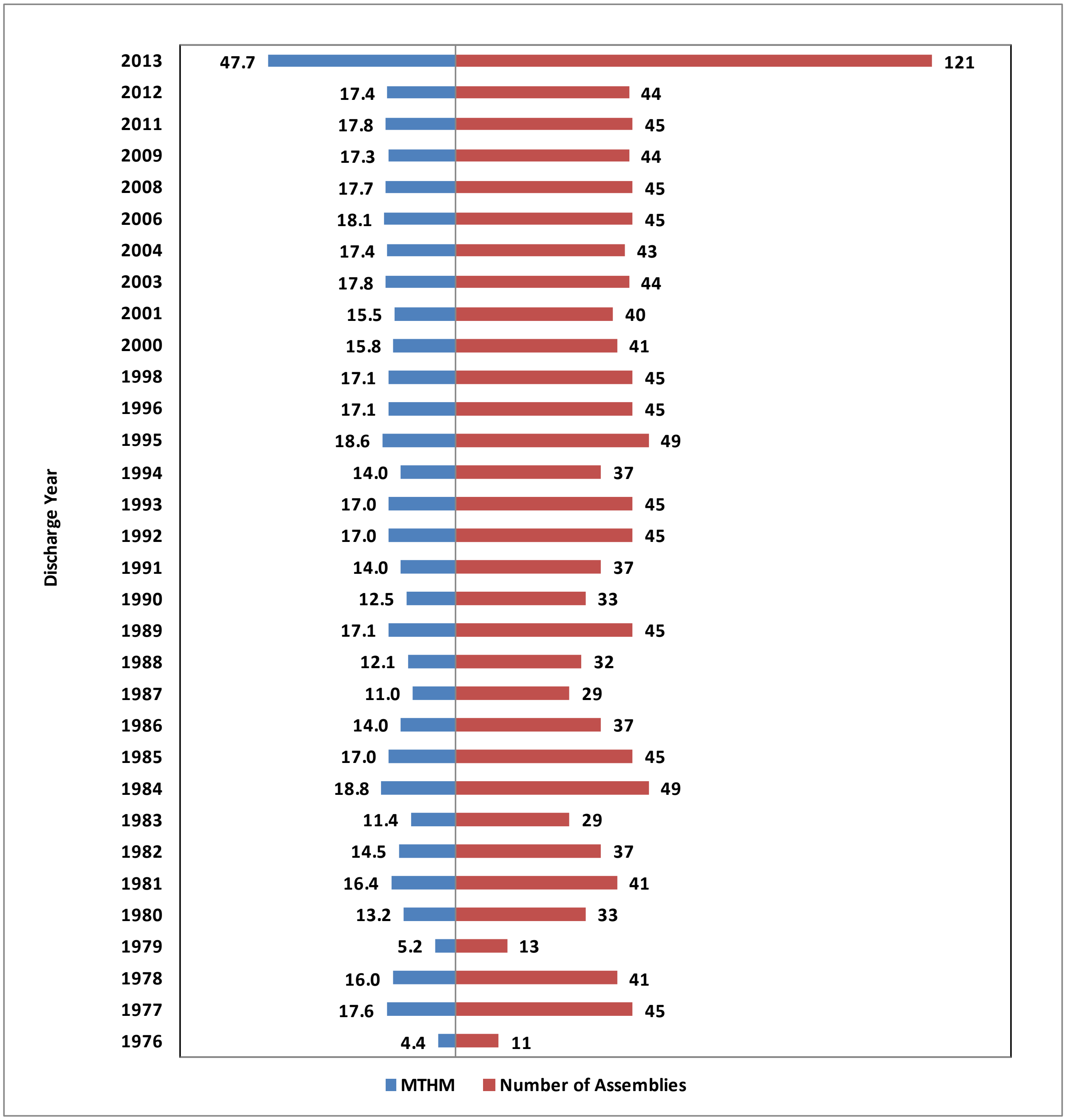


Figure 2-199. Kewaunee Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

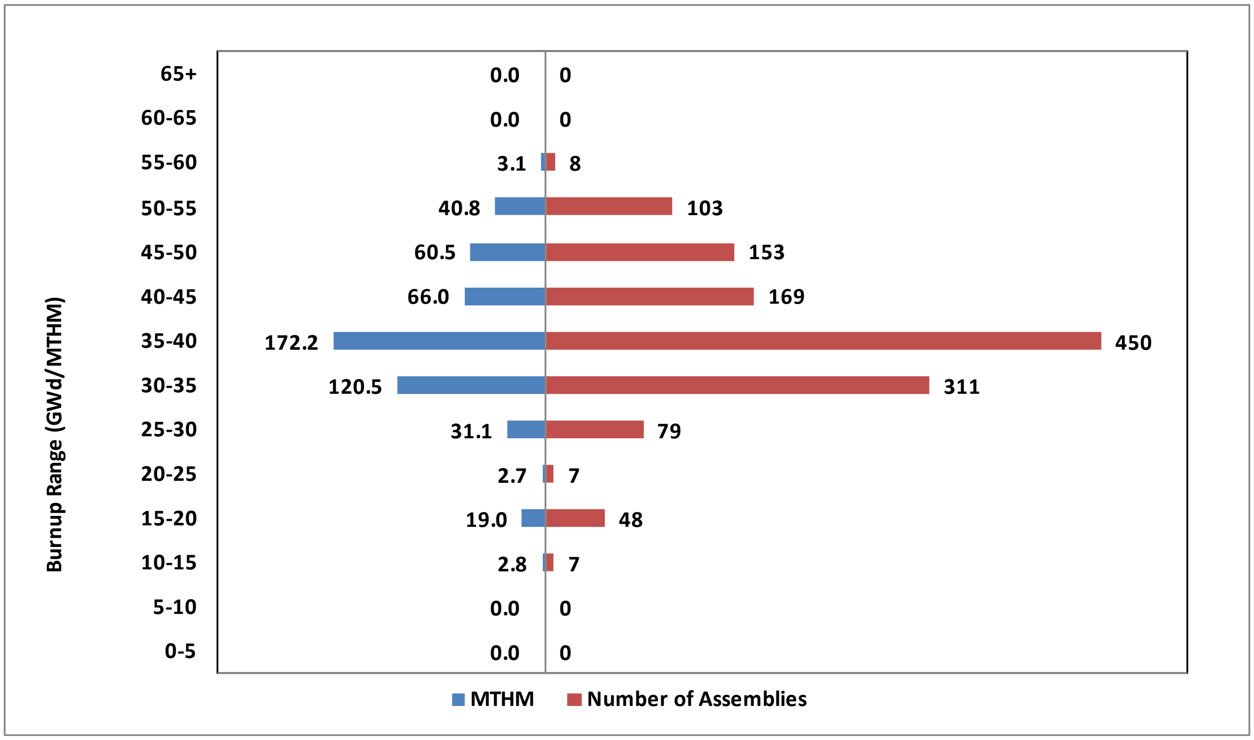


Figure 2-200. Kewaunee Number of Assemblies and MTHM versus Burnup (EIA 2018)

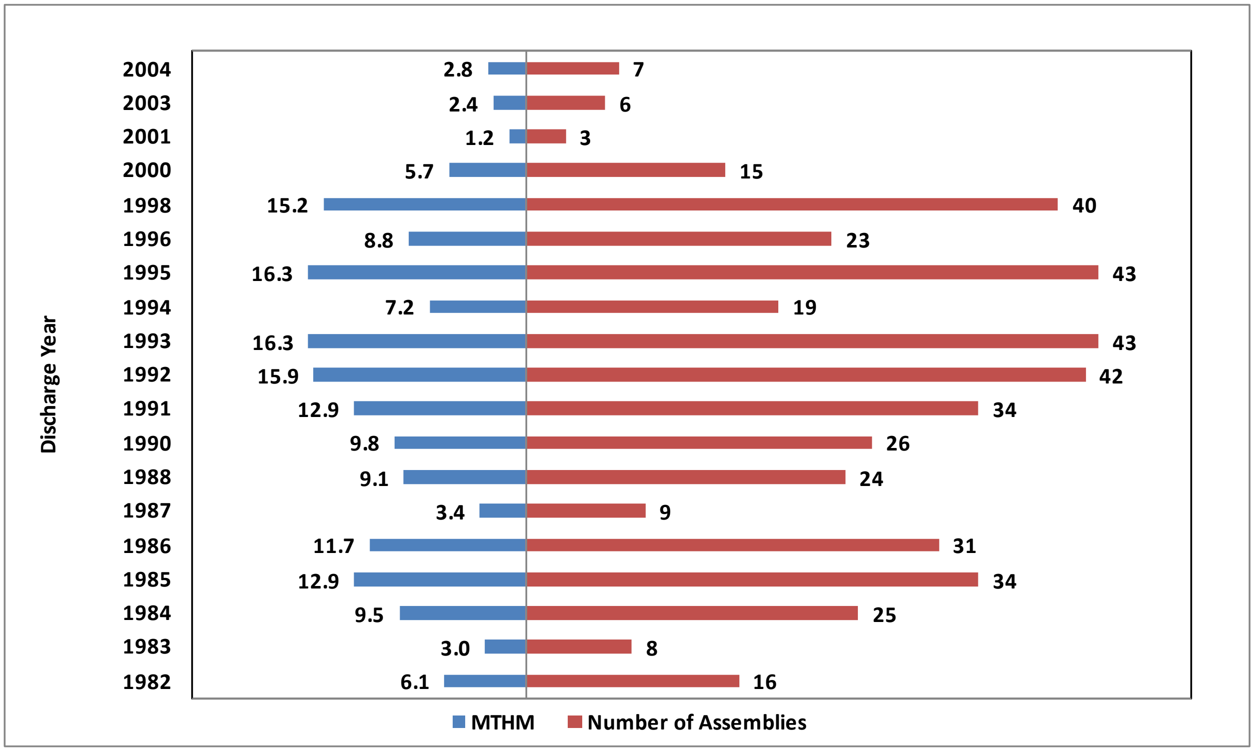


Figure 2-201. Kewaunee Number of Assemblies and MTHM Stored in 32PT Canisters versus Discharge Year (EIA 2018)

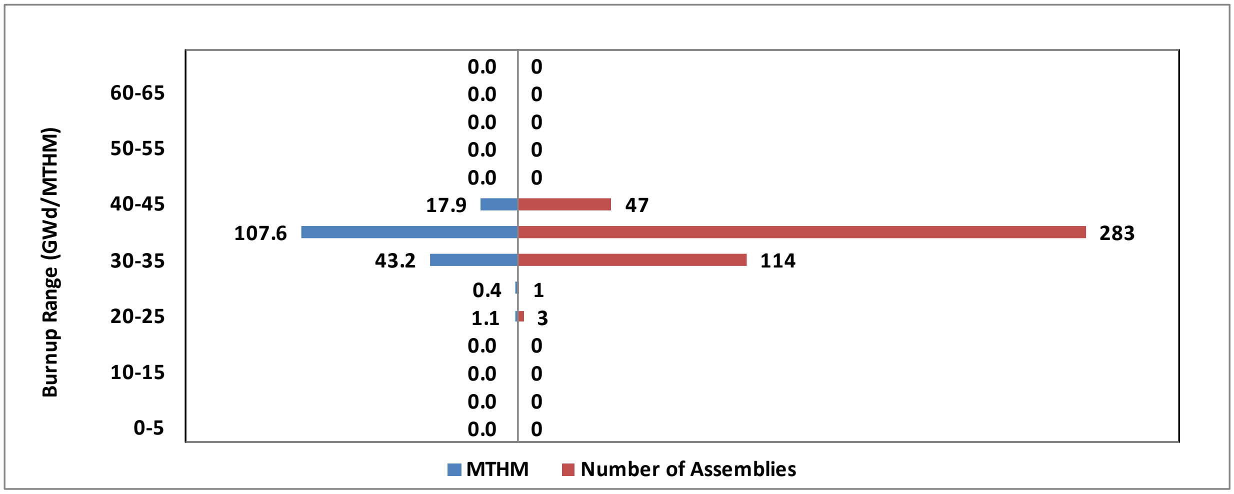


Figure 2-202. Kewaunee Number of Assemblies and MTHM Stored in 32PT Canisters versus Burnup (EIA 2018)

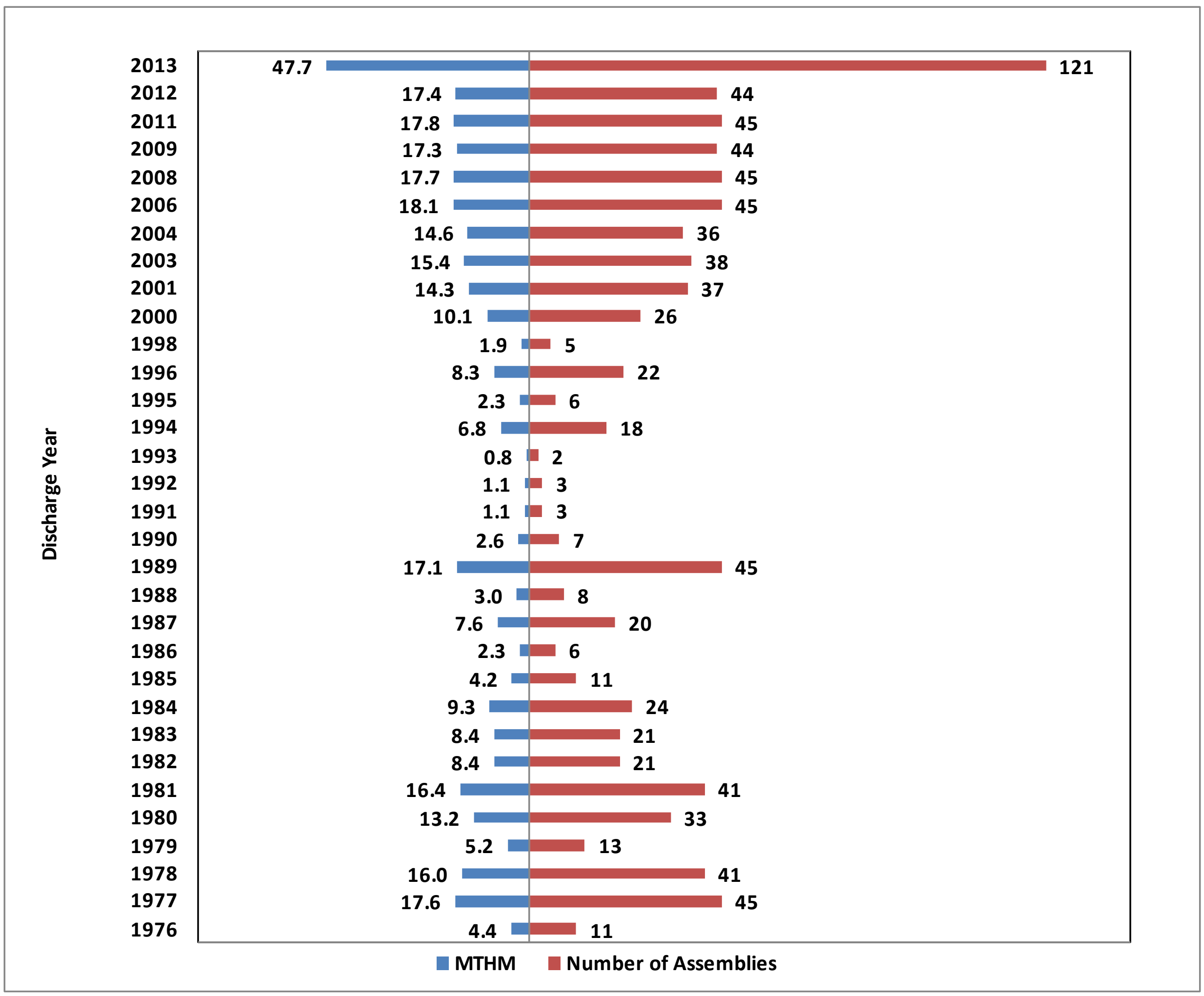


Figure 2-203. Kewaunee Number of Assemblies and MTHM Stored in TSC-37 Canisters versus Discharge Year (EIA 2018)

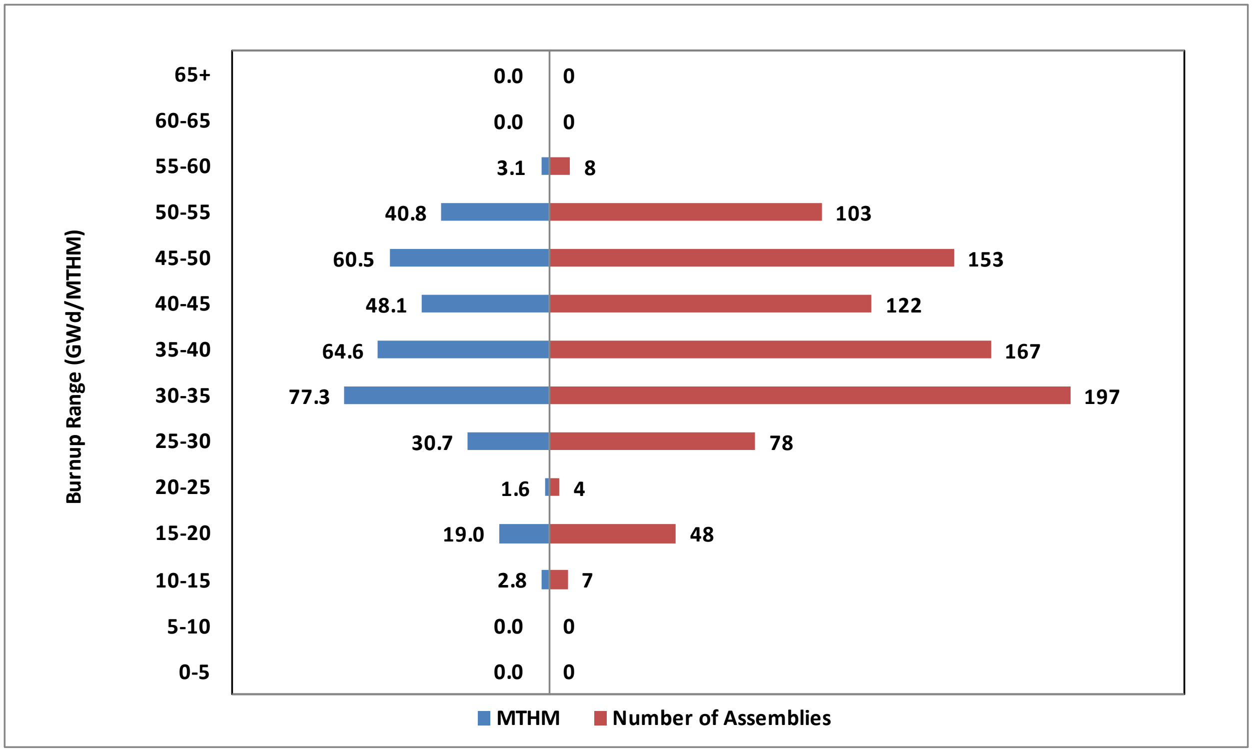


Figure 2-204. Kewaunee Number of Assemblies and MTHM Stored in TSC-37 Canisters versus Burnup (EIA 2018)

2.11.2 Site Conditions

The Kewaunee site is located on the western shore of Lake Michigan and the Kewaunee ISFSI (see Figure 2-205) is located at the northern end of the site (see Figure 2-206). There is no direct rail or barge service to the site (TOPO 1994d). The nearest rail access is in Denmark, Wisconsin, about 16 miles from the site, and the nearest barge terminal is in Kewaunee, Wisconsin, about 10 miles from the site. There was an on-site barge facility during plant construction, but it was disassembled, and reestablishment would require a major restoration (TriVis Incorporated 2005).

Photo courtesy of Kewaunee

Figure 2-205. Kewaunee Independent Spent Fuel Storage Installation

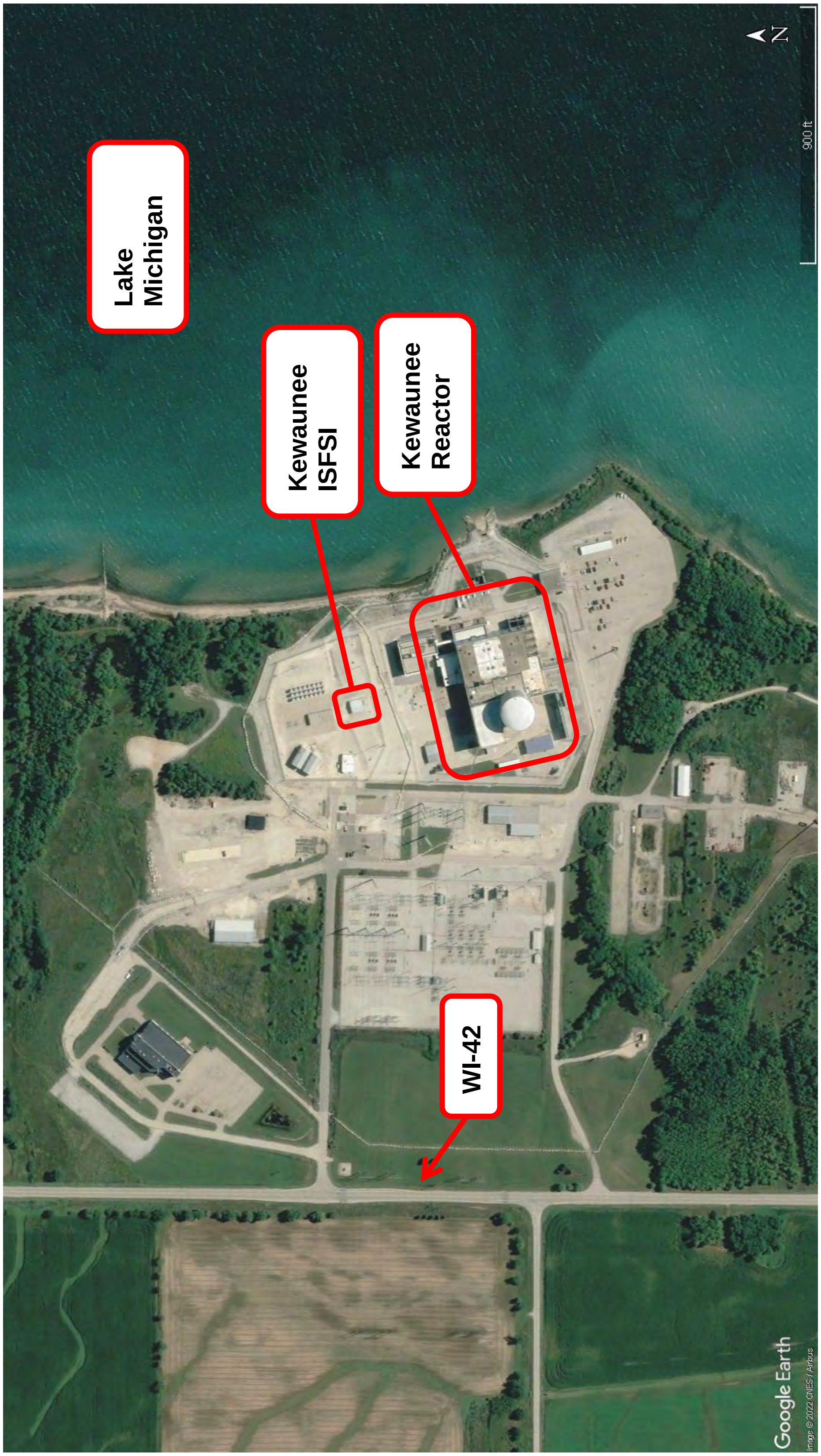


Figure 2-206. Aerial View of Kewaunee Site (Google 2022)

2.11.3 Near-site Transportation Infrastructure and Experience

The Kewaunee site does not have an on-site rail spur or a railroad that passes near to the site or along the site boundary. For Kewaunee, heavy haul trucks could be used to move transportation casks over public highways to a rail siding or spur that provides access to a railroad that can accommodate the loaded transportation casks.

For shipments of casks containing SNF that require the use of heavy haul trucks, the casks would be prepared for shipment at the Kewaunee ISFSI site and loaded onto a transport cradle that would be loaded onto the transport trailer of a heavy haul truck. The truck, led and followed by technical and security escorts, would move over an approved, designated highway route to a nearby rail siding or spur. Heavy lift equipment would be used to transload the cask and its cradle as a unit from the truck to a railcar at the rail siding or spur.

Table 2-6 lists distances from the Kewaunee site to potential transload locations at Luxemburg, Bellevue, Denmark, Rockwood, and Manitowoc, Wisconsin (see Figure 2-207). Figure 2-207 also shows the location of the Point Beach Nuclear Plant, which is about 4.5 miles south of the Kewaunee site. The rail lines in the vicinity of Luxemburg, Bellevue, and Denmark are designated as track class 1. These rail lines connect to the Fox River Subdivision of the Canadian National Railroad which is designated as track class 2. The rail line in the vicinity of Rockwood is designated as track class 1. After merging with the mainline at Manitowoc, the rail line is designated as track class 2.

Table 2-6 also provides potential routes that heavy haul trucks might use to get to the rail transload locations. These routes have not been evaluated for attributes such as weight limitations, bridge and tunnel limitations, turning radii, vertical or horizontal clearances, seasonal restrictions, presence of culverts, etc.

Table 2-6. Potential Kewaunee Rail Transload Locations

Rail Transload Location	Distance From Kewaunee Site (mile)	Potential Route
Luxemburg	23.5	WI-42 North to County Road C North to WI-29 West to County Road AB North
Bellevue	27.9	WI-42 North to County Road C North to WI-29 West
Denmark	16.7–17.4	WI-42 South to County Road BB West to County Road R North WI-42 South to County Road BB West to County Road R North to County Road T North
Rockwood Spur at WI-310	21.0–22.7	WI-42 South to WI-310 West WI-42 South to County Road BB West to County Road Q South to WI-310 West
Rockwood Spur at Manitowoc Airport	21.5	WI-42 South to WI-42 West
Manitowoc (waterfront area)	21.3	WI-42 South

Figure 2-208 shows an aerial view of a potential transload location at Luxemburg, Wisconsin, and Figure 2-209 shows a potential heavy haul truck route from the Kewaunee site to the Luxemburg transload location. Figure 2-210 through Figure 2-212 show the current condition of the potential Luxemburg transload location. In 2008, the Luxemburg transload location was used to transload four 160-ton transformers from railcars to 15-axle Goldhofer trailers using a gantry system, which were then moved to the Kewaunee site. Figure 2-213 shows the gantry system used to transfer the transformers from the railcars to Goldhofer trailer and Figure 2-214 shows a transformer on a heavy haul truck being moved from Luxemburg to the Kewaunee site.

Figure 2-215 shows an aerial view of a potential transload location at Bellevue, Wisconsin, and Figure 2-216 shows a potential heavy haul truck route from the Kewaunee site to the Bellevue transload location. Figure 2-217 through Figure 2-220 show the current condition of the potential Bellevue transload location. In 2008, the Bellevue transload location was used to transload ten 82-ton NUHOMS horizontal storage modules from railcars to 6-axle Goldhofer trailers using a 550-ton crane. Figure 2-221 shows horizontal storage modules on railcars and Figure 2-222 shows a horizontal storage module on a heavy haul truck being moved from Bellevue to the Kewaunee site.

Figure 2-223 shows an aerial view of a potential transload location at Denmark, Wisconsin, and Figure 2-224 shows a potential heavy haul truck route from the Kewaunee site to the potential Denmark transload location. Figure 2-225 through Figure 2-228 show the current condition of the potential Denmark transload location.

Figure 2-229 shows an aerial view of a potential transload location at the junction of the Rockwood Spur and WI-310, located near Manitowoc, Wisconsin, and Figure 2-230 shows potential heavy haul truck routes from the Kewaunee site to the potential Rockwood Spur and WI-310 transload location. Figure 2-231 through Figure 2-234 show the current condition of the potential Rockwood Spur and WI-310 transload location. Figure 2-235 shows a traffic circle on WI-310 that a transportation cask would have to pass through to approach the potential transload location from the east.

Figure 2-236 shows an aerial view of a potential transload location on the Rockwood Spur near the Manitowoc, Wisconsin airport, and Figure 2-237 shows a potential heavy haul truck route from the Kewaunee site to the Rockwood Spur near the Manitowoc, Wisconsin airport. Figure 2-238 through Figure 2-240 show the current condition of this potential transload location.

Figure 2-241 shows an aerial view of a potential transload location in Manitowoc, Wisconsin, and Figure 2-242 shows potential heavy haul truck routes from the Kewaunee site to the potential Manitowoc transload location. Figure 2-243 through Figure 2-245 show the current condition of the potential Manitowoc transload location.

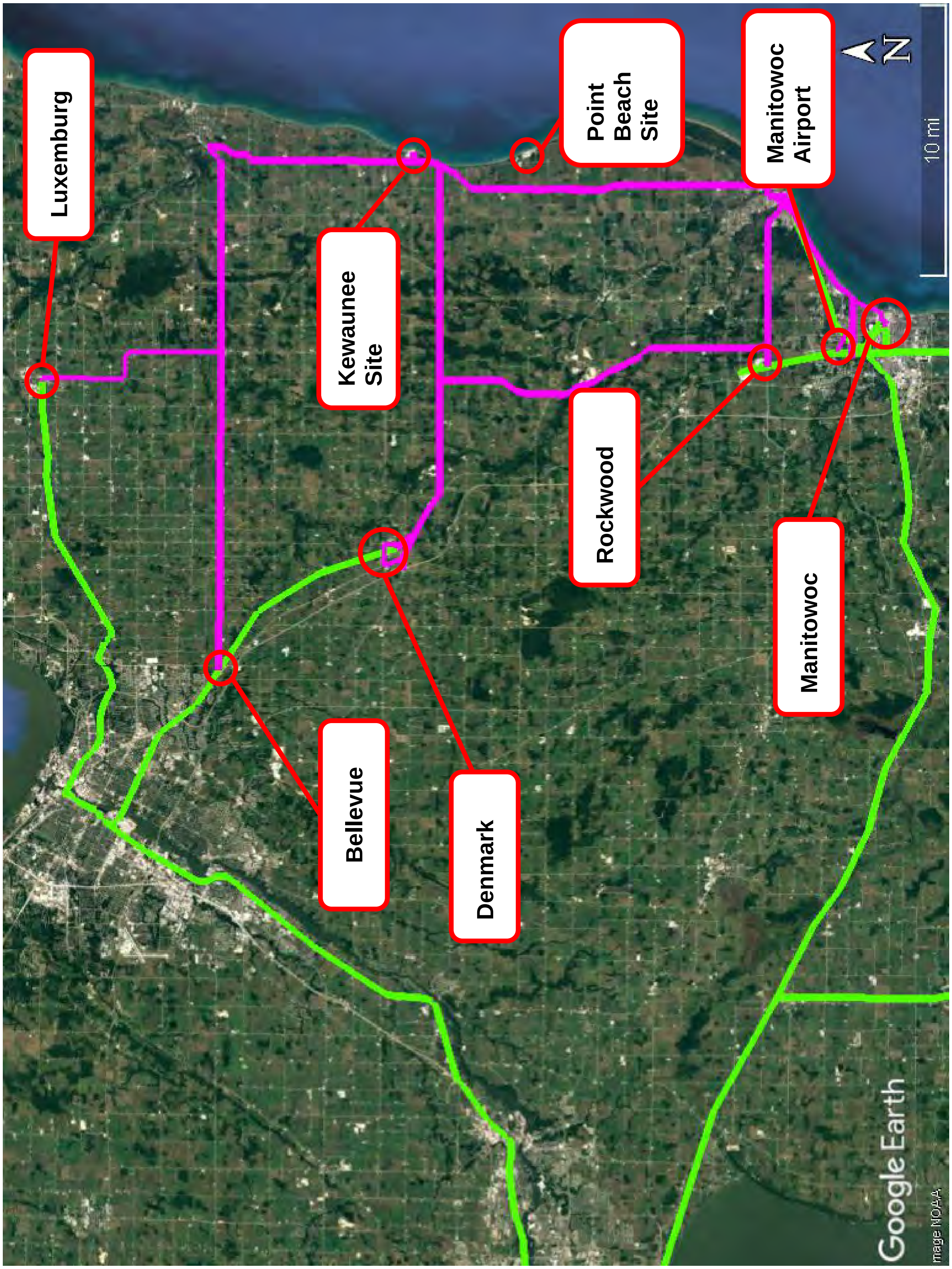


Figure 2-207. Potential Rail Transload Locations and Heavy Haul Truck Routes for the Kewaunee Site (Google 2022)

Figure 2-208. Potential Luxemburg Transload Location (Google 2022)

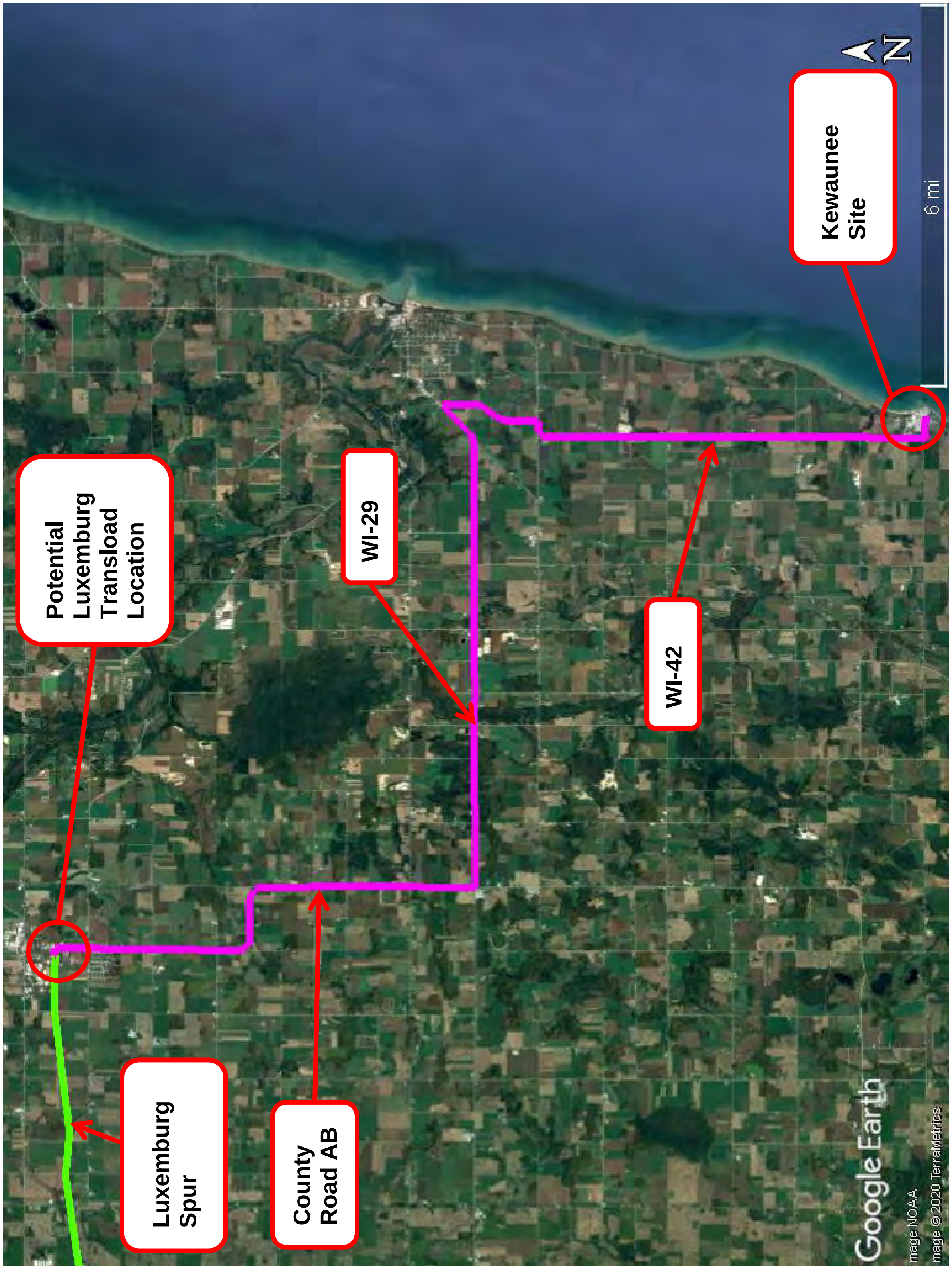


Figure 2-209. Potential Luxemburg Heavy Haul Route (Google 2022)

Figure 2-210. Potential Luxemburg Transload Location (Looking West) (2014)

Figure 2-211. Potential Luxemburg Transload Location Further Down Track (Looking West) (2014)

Figure 2-212. Potential Luxemburg Transload Location (Looking East) (2014)

Photo courtesy of Kewaunee

Figure 2-213. Gantry System Used to Transfer Transformers from Railcars to Goldhofer Trailers (2008)

Photo courtesy of Kewaunee

Figure 2-214. Transformer on 15-axle Goldhofer Trailer (2008)

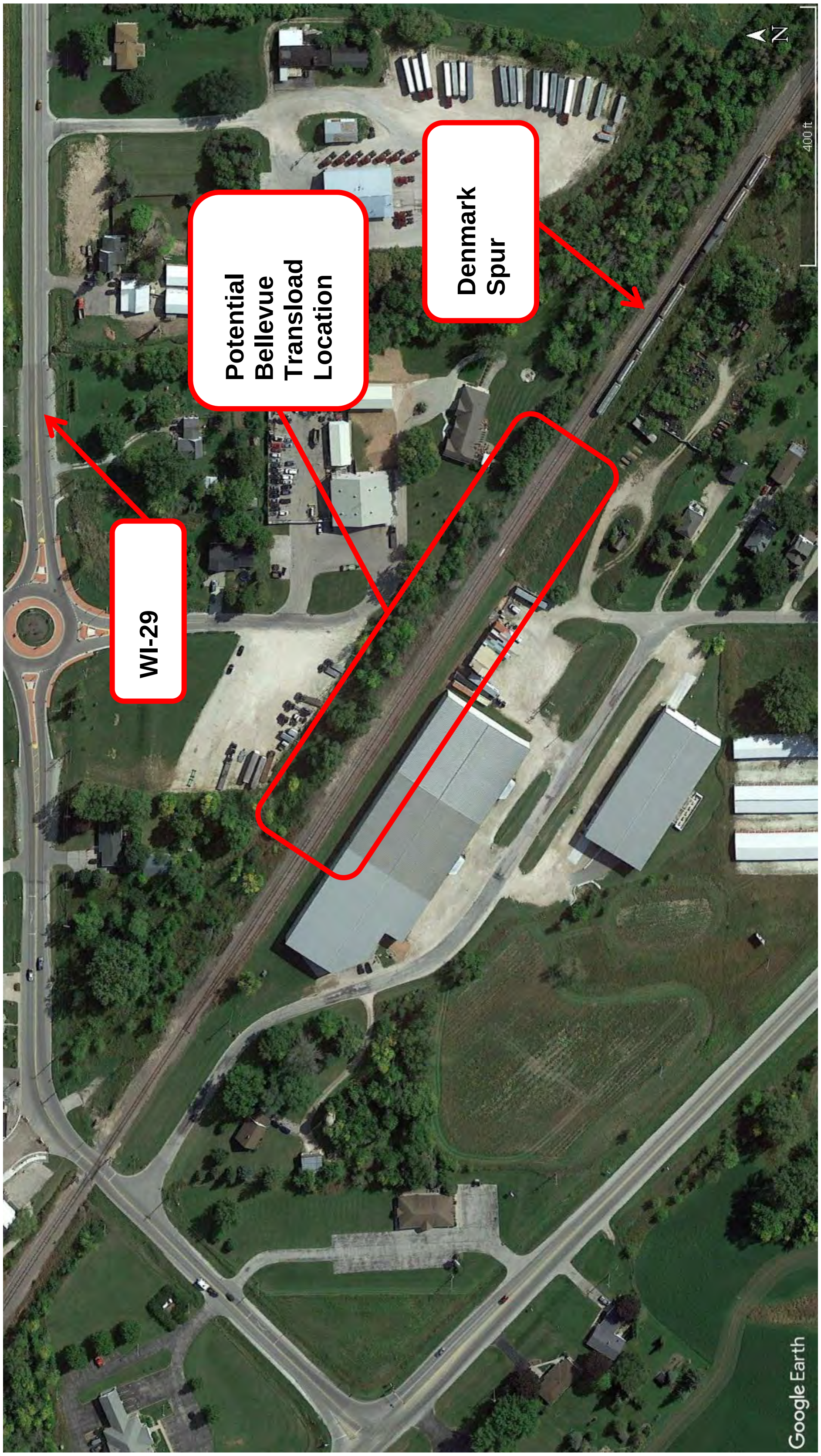


Figure 2-215. Potential Bellevue Transload Location (Google 2022)

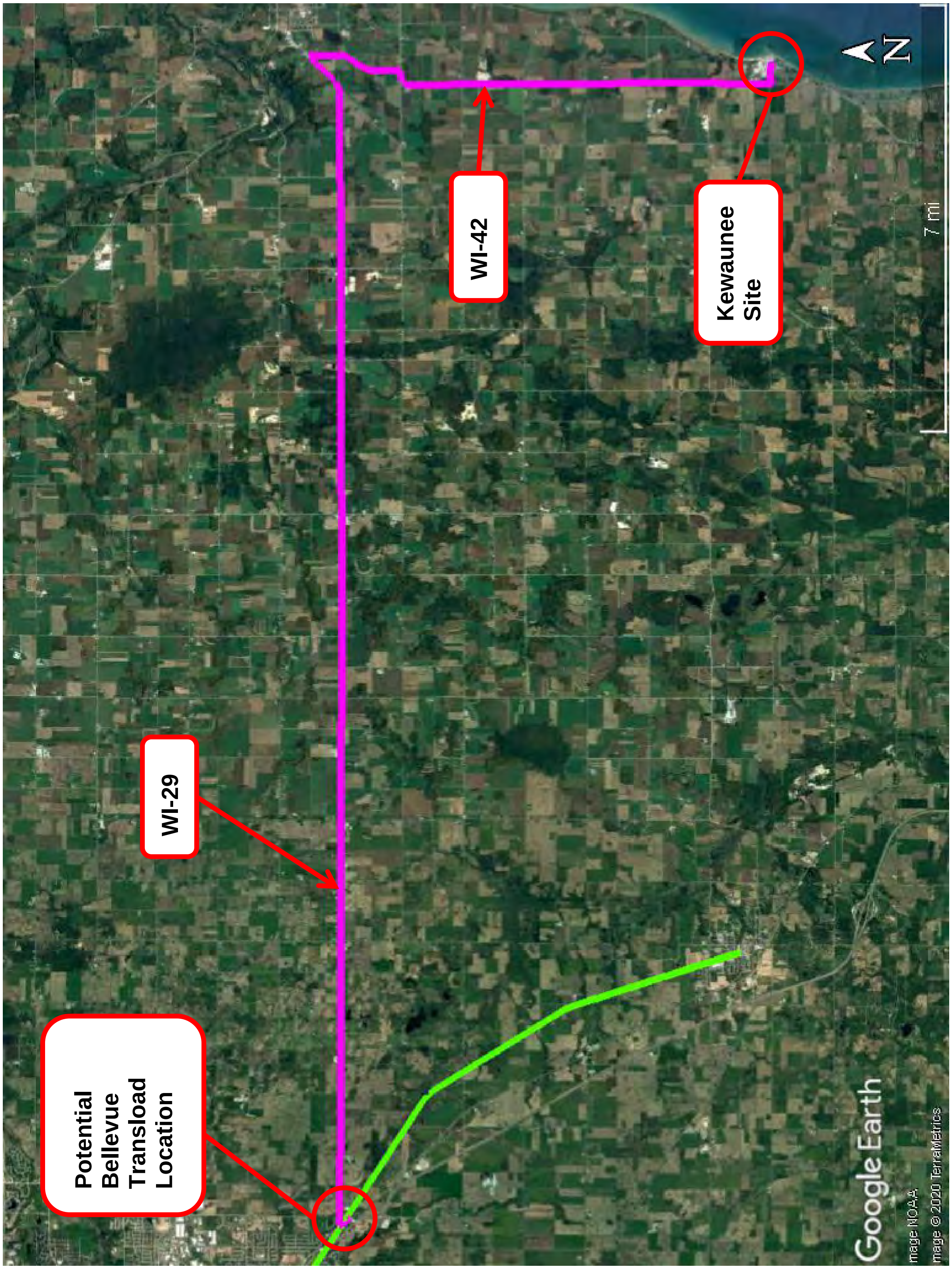


Figure 2-216. Potential Bellevue Heavy Haul Route (Google 2022)

Figure 2-217. Potential Bellevue Transload Location (Looking North) (2014)

Figure 2-218. Potential Bellevue Transload Location (Looking South) (2014)

Figure 2-219. Potential Bellevue Transload Location at WI-29 (2014)

Figure 2-220. Approaching Potential Bellevue Transload Location on WI-29 (Looking West) (2014)

Photo courtesy of Kewaunee

Figure 2-221. Horizontal Storage Module Transloading at Bellevue Location (2008)

Photo courtesy of Kewaunee

Figure 2-222. Horizontal Storage Module on 6-axle Goldhofer Trailer (2008)

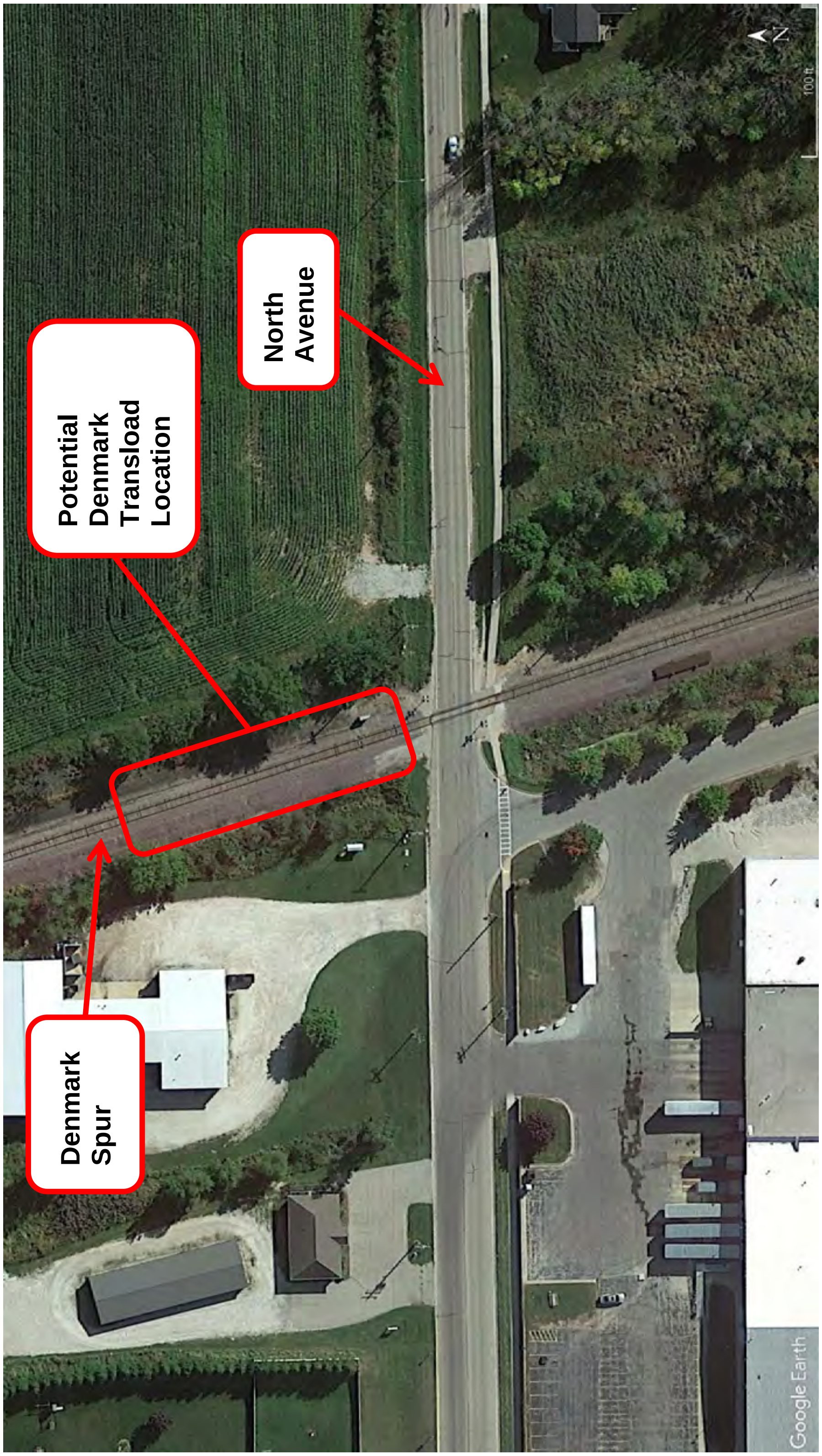


Figure 2-223. Potential Denmark Transload Location (Google 2022)

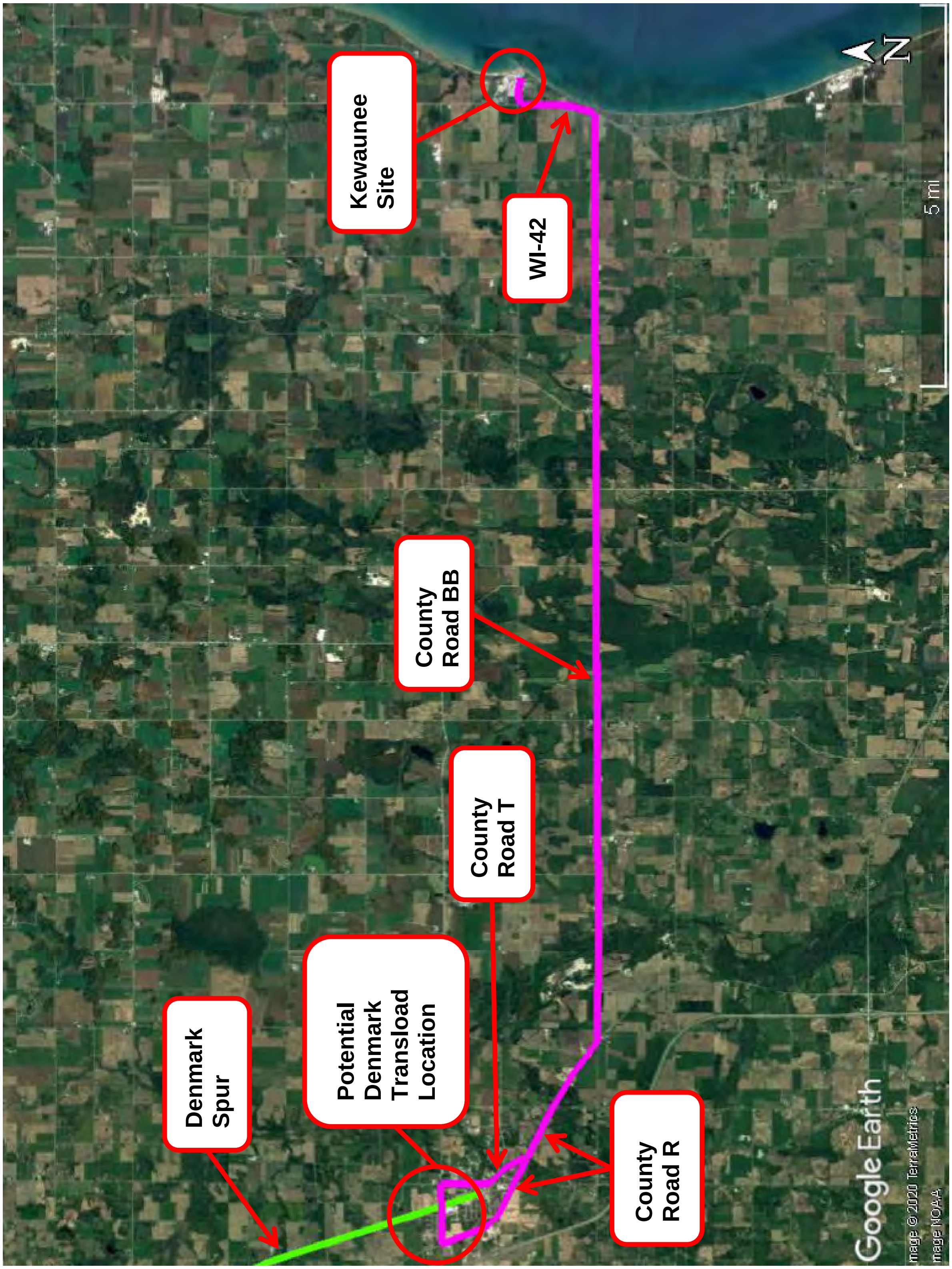


Figure 2-224. Potential Denmark Heavy Haul Route (Google 2022)

Figure 2-225. Potential Denmark Transload Location (Looking South) (2014)

Figure 2-226. Potential Denmark Transload Location (Looking North) (2014)

Figure 2-227. Potential Denmark Transload Location (Looking West) (2014)

Figure 2-228. Potential Denmark Transload Location (Looking East) (2014)

Figure 2-229. Potential Rockwood Spur at WI-310 Transload Location (Google 2022)

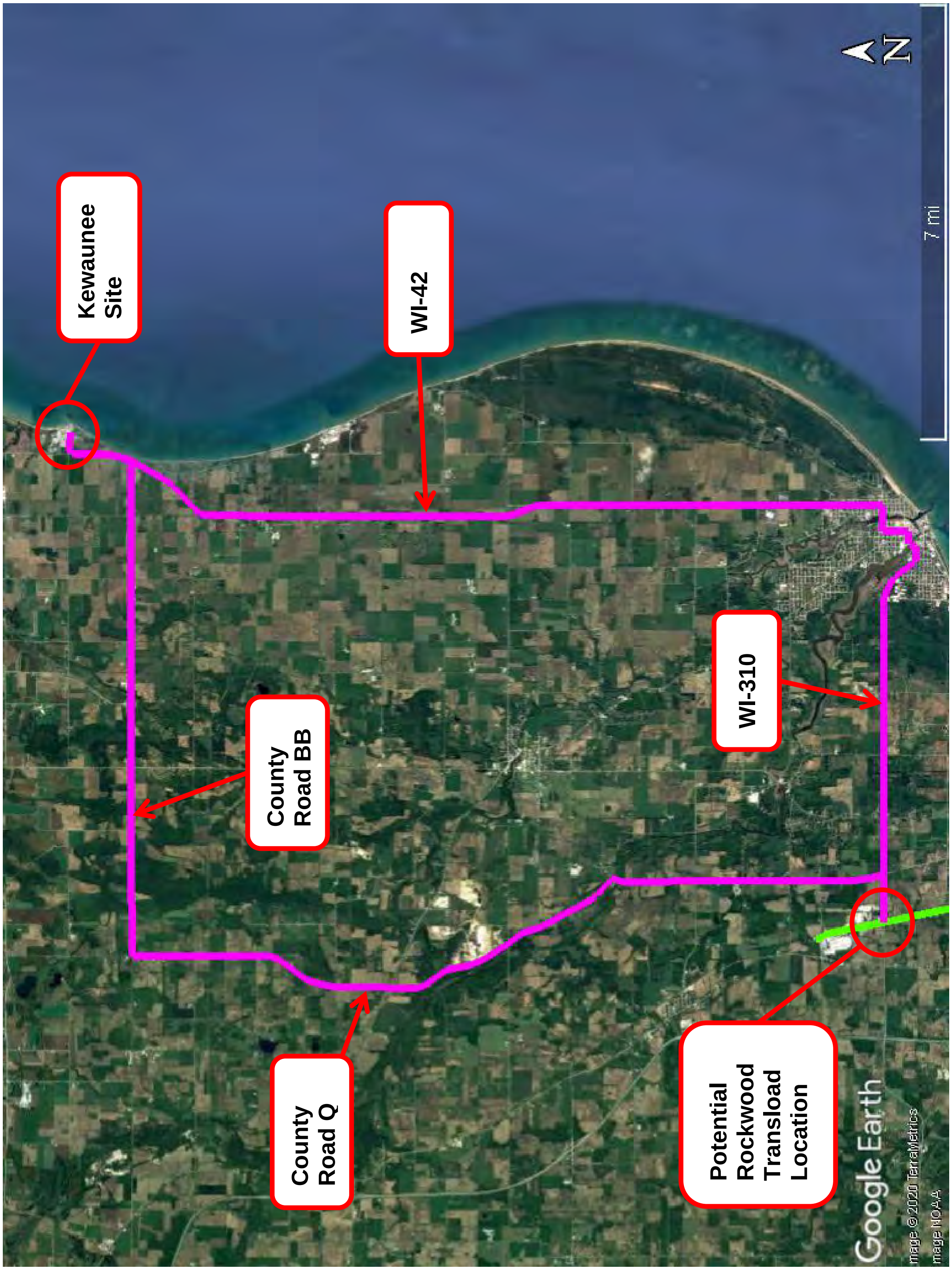


Figure 2-230. Potential Rockwood Spur at WI-310 Heavy Haul Routes (Google 2022)

Figure 2-231. Potential Rockwood Spur at WI-310 Transload Location (Looking North) (2014)

Figure 2-232. Potential Rockwood Spur at WI-310 Transload Location (Looking South) (2014)

Figure 2-233. Approaching Rockwood Spur at WI-310 from the East (2014)

Figure 2-234. Turning into Parking Lot at Rockwood Spur at WI-310 (2014)

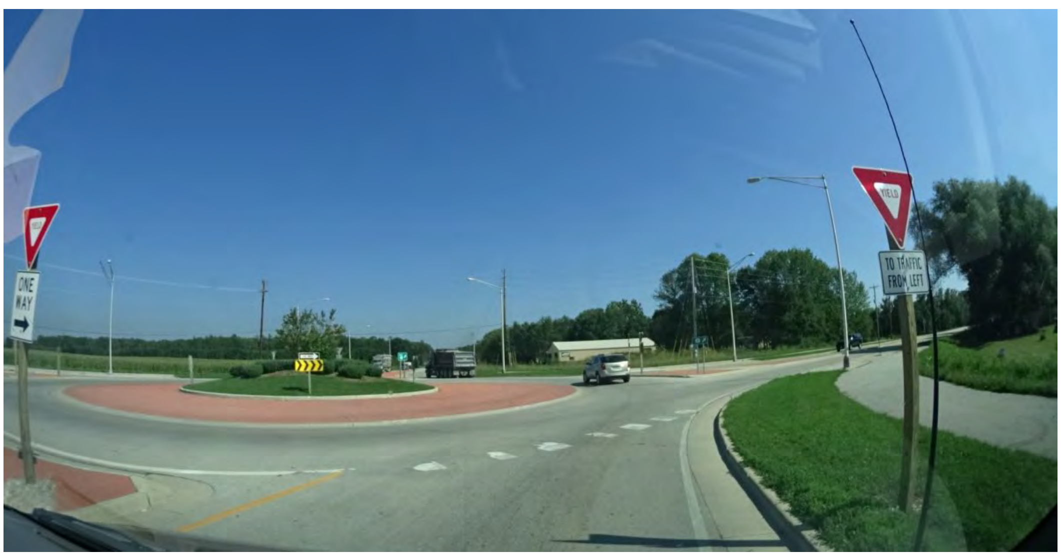


Figure 2-235. Traffic Circle on WI-310 (Looking East) (2014)

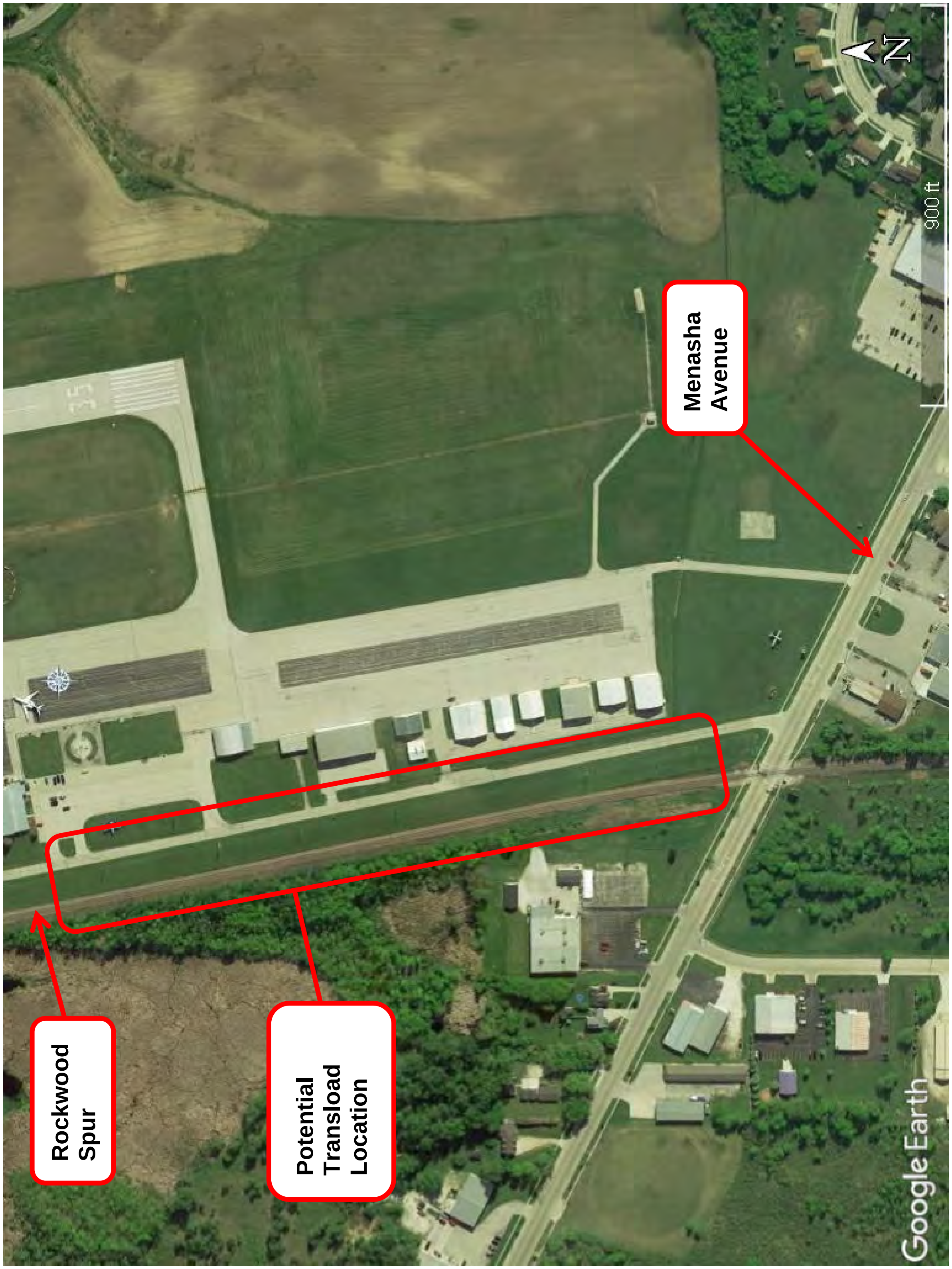


Figure 2-236. Potential Rockwood Spur at the Manitowoc Airport Transload Location (Google 2022)

Figure 2-237. Potential Rockwood Spur at the Manitowoc Airport Heavy Haul Route (Google 2022)

Figure 2-238. Potential Rockwood Spur at the Manitowoc Airport Transload Location (Looking North) (2014)

Figure 2-239. Potential Rockwood Spur at the Manitowoc Airport Transload Location (Looking South) (2014)

Figure 2-240. Access Road at Potential Rockwood Spur at the Manitowoc Airport Transload Location (Looking North) (2014)

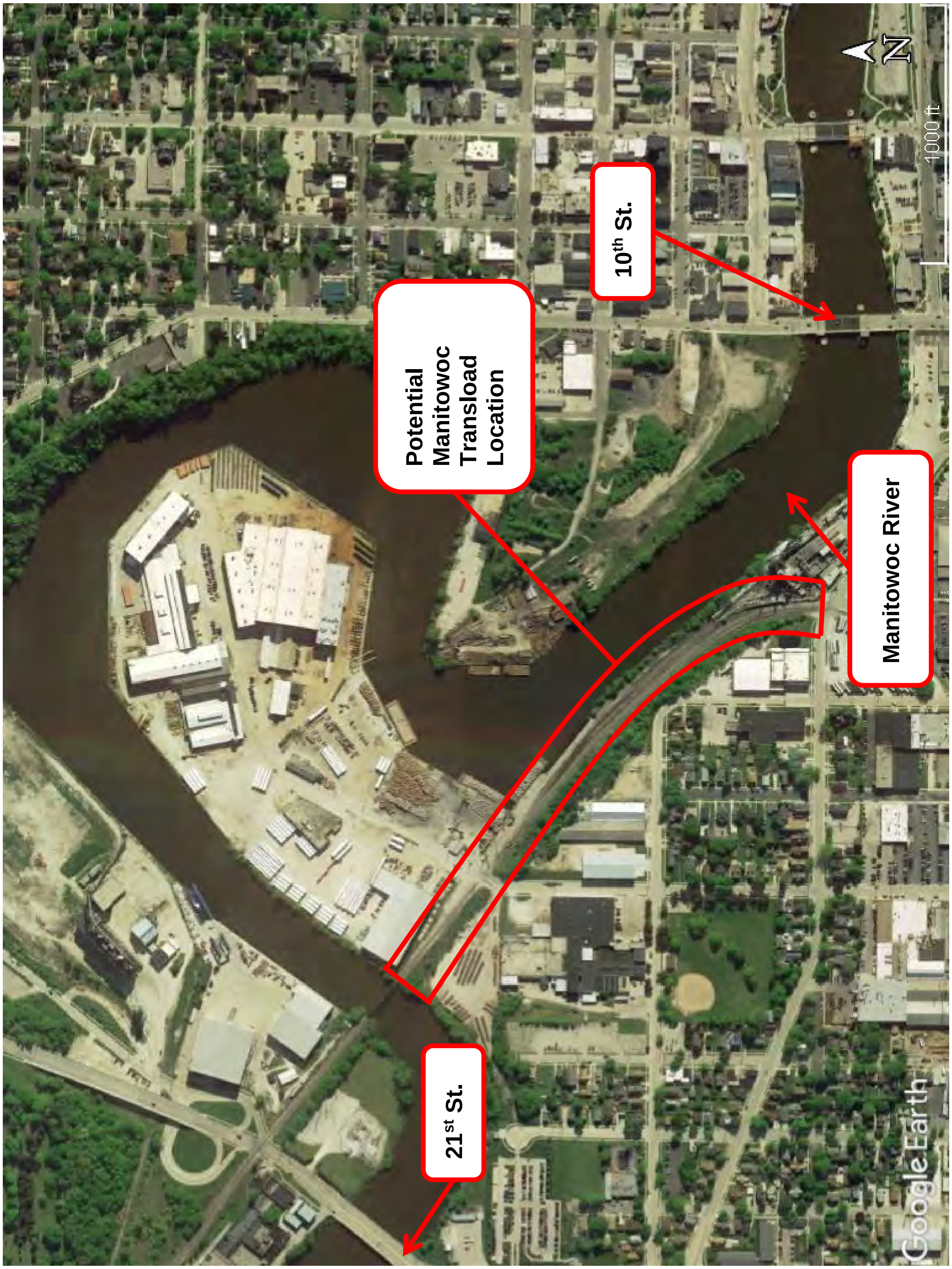


Figure 2-241. Potential Manitowoc Transload Location (Google 2022)

Figure 2-242. Potential Manitowoc Heavy Haul Routes (Google 2022)

Figure 2-243. Potential Manitowoc Transload Location (Looking Northwest) (2014)

Figure 2-244. Potential Manitowoc Transload Location (Looking Southeast) (2014)

Figure 2-245. Potential Manitowoc Transload Location (Looking South) (2014)

The closest barge terminal to the Kewaunee site is located in the city of Kewaunee, about 10 miles from the Kewaunee site. The city of Kewaunee is located on the west shore of Lake Michigan about 105 miles north of Milwaukee, Wisconsin and about 32 miles east of Green Bay. Kewaunee Harbor is a commercial harbor that currently serves primarily recreational boat traffic. The harbor also supports transitory barge traffic. There are approximately 6,500 feet of breakwater and pier structures and approximately 5,500 feet of maintained channel (USACE 2014).

Figure 2-246 shows an aerial view of a potential barge transload location in the city of Kewaunee. Figure 2-247 shows a potential heavy haul truck route from the Kewaunee site to the barge transload location. As with the routes to the rail access locations, this route has not been evaluated for attributes such as weight limitations, bridge or tunnel limitations, turning radii, vertical or horizontal clearances, seasonal restrictions, presence of culverts, etc. Figure 2-248 and Figure 2-249 show the current condition of the transload location.

In 2013, the Kewaunee barge transload location was used to transload ten 82-ton NUHOMS horizontal storage modules from railcars to 6-axle Goldhofer trailers using a 550-ton crane. Figure 2-250 shows horizontal storage modules being unloaded from a barge and Figure 2-251 shows a horizontal storage module on a 6-axle Goldhofer trailer.

In 2000, replacement steam generators were shipped from Milan, Italy to the Kewaunee barge transload location via the Atlantic Ocean, Saint Lawrence Seaway, and the Great Lakes. At the Kewaunee transload location, the replacement steam generators were transloaded from barge to a

14-axle transporter and moved to the Kewaunee site by road. In 2001, the old steam generators were moved from the Kewaunee site to the Kewaunee barge transload location using a 14-axle transporter, transloaded to barge and shipped to Memphis, Tennessee for decontamination via Lake Michigan, the Illinois Waterway System, and the Mississippi River. Speeds during barge transport were limited to 10 knots.

In 2014, four old steam generators from the Point Beach Nuclear Power Plant (located about 4 miles south of the Kewaunee site) were shipped to the Waste Control Specialists low-level radioactive waste disposal facility located in Andrews, Texas (Posivak 2016). The steam generators were transported from the Point Beach site using Goldhofer trailers (see Figure 2-252) and transloaded onto a barge at the Kewaunee barge transload location (see Figure 2-253 through Figure 2-256). The steam generators were transported on Lake Michigan, through Chicago, Illinois to the Mississippi River to the Intracoastal Waterway to Houston, Texas, where the steam generators were transloaded to railcars (see Figure 2-257) and transported through Texas to the Waste Control Specialists low-level radioactive waste disposal facility in Andrews, Texas (see Figure 2-258).

Heavy haul truck transport has been used to move large components to and from the Kewaunee site. For example, in 2004, the replacement Kewaunee site reactor pressure vessel head was shipped from Houston, Texas to the Kewaunee site using a heavy haul truck (see Figure 2-259), and the old Kewaunee site reactor pressure vessel head was shipped to Clive, Utah for disposal using a heavy haul truck (see Figure 2-260).

Figure 2-246. Aerial View of Potential Kewaunee Barge Transload Location (Google 2022)

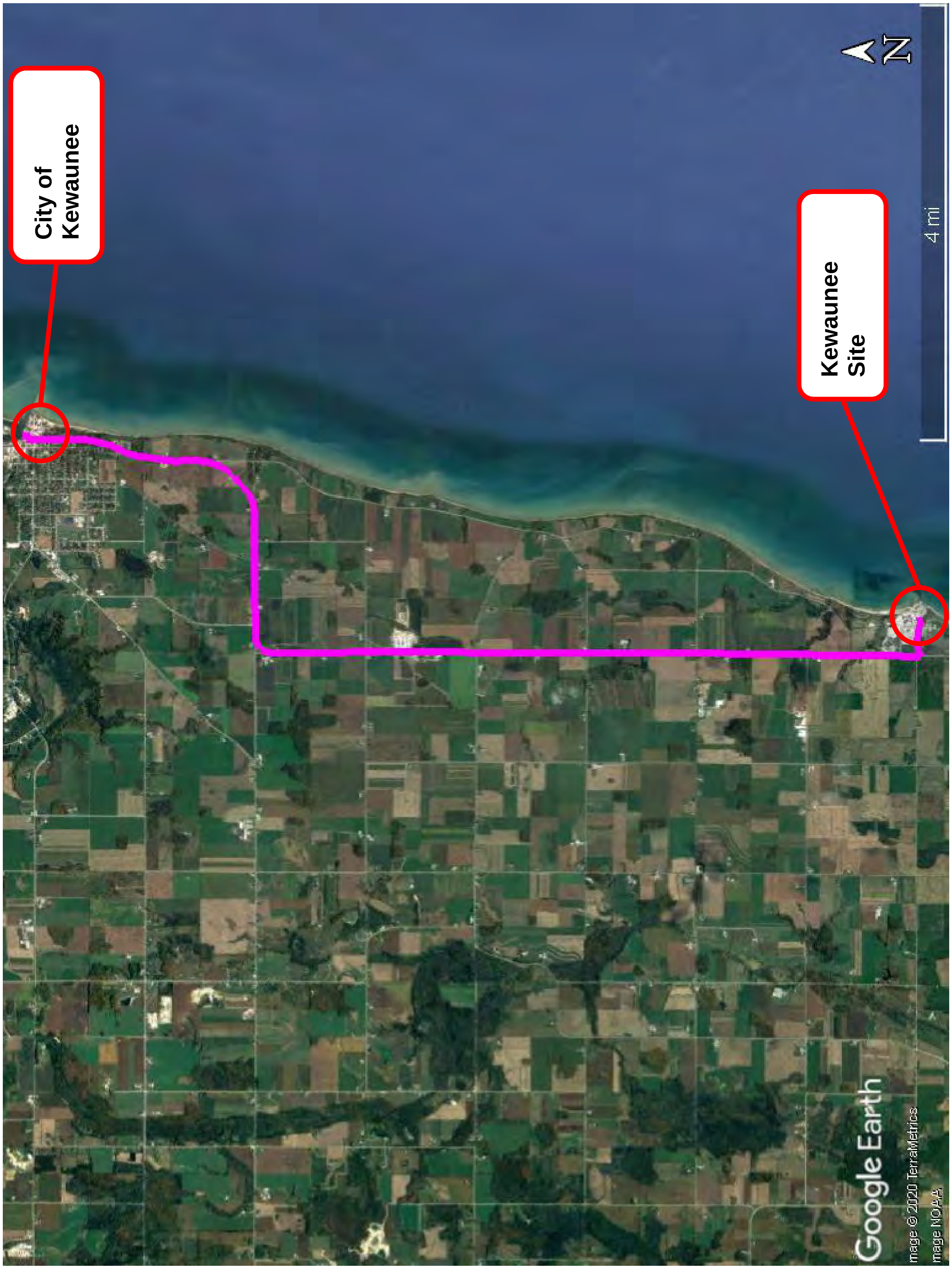


Figure 2-247. Potential Heavy Haul Truck Route to City Of Kewaunee Dock Facilities (Google 2022)

Figure 2-248. Potential Kewaunee Barge Transload Location Parking Lot (2014)

Figure 2-249. Potential Kewaunee Barge Transload Location Water Front (2014)

Photo courtesy of Kewaunee

Figure 2-250. Horizontal Storage Modules Being Unloaded from a Barge (2013)

Photo courtesy of Kewaunee

Figure 2-251. Horizontal Storage Module on 6-axle Goldhofer Trailer (2013)

Photo courtesy of Point Beach

Figure 2-252. Steam Generator on Goldhofer Trailer (2014)

Photo courtesy of Point Beach

Figure 2-253. First Steam Generator on Goldhofer Trailer Moving onto Barge (2014)

Photo courtesy of Point Beach

Figure 2-254. Barge with Two Steam Generators at Kewaunee Barge Transload Location (2014)

Photo courtesy of Point Beach

Figure 2-255. Fourth Steam Generator Moving onto Barge (2014)

Photo courtesy of Point Beach

Figure 2-256. Barge with Four Steam Generators at Kewaunee Barge Transload Location (2014)

Photo courtesy of Point Beach

Figure 2-257. Transloading of Steam Generator from Barge to Railcar in Houston, Texas (2014)

Photo courtesy of Point Beach

Figure 2-258. Steam Generators Arriving at Waste Control Specialists Low-Level Radioactive Waste Disposal Facility (2014)

Photo courtesy of Kewaunee

Figure 2-259. Replacement Reactor Pressure Vessel Head on Heavy Haul Truck (2004)

Photo courtesy of Kewaunee

Figure 2-260. Old Reactor Pressure Vessel Head on Heavy Haul Truck (2004)

2.11.4 Future Information Needs

The Kewaunee site does not have direct rail access or an on-site barge facility. Off-site shipment of transportation casks from the Kewaunee site would require either the use of heavy haul trucks for transport of casks to nearby rail sidings or spurs, or the use of heavy haul trucks for transport of casks to a nearby barge facility, likely followed by barge transport to a port on the Great Lakes that is served by a railroad. Potential nearby rail transload locations include Luxemburg, Bellevue, Denmark, Rockwood, and Manitowoc, Wisconsin; these locations are 16.7 to 27.9 miles from the Kewaunee site. At Luxemburg, the track is built using 80 lb. rail, while at Bellevue, Denmark, and Rockwood, the track is built using 110 to 115 lb. rail. The track at these locations is track class 1. Canadian National Railroad staff stated that to rehabilitate the track to track class 2 would require replacing every third or fourth tie at a cost of about $90,000 per mile. At Manitowoc, the track is track class 2.

The city of Kewaunee dock facilities are located 10 miles from the Kewaunee site. The roads to these rail or barge locations have not been evaluated for attributes such as weight limitations, bridge or tunnel limitations, turning radii, vertical or horizontal clearances, seasonal restrictions, presence of culverts, etc.

High burnup (> 45 GWd/MTHM) SNF is not stored in 32PT canisters so the certificate of compliance for the MP197HB transportation cask would not have to be revised before transport of 32PT canisters. The certificate of compliance for the MAGNATRAN transportation cask allows for transport of high burnup SNF in damaged fuel cans; however, the undamaged high burnup SNF stored in TSC-37 canisters at Kewaunee is not contained in damaged fuel cans and a revision to the certificate of compliance would be required for this SNF to be transportable.

2.12 San Onofre

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the San Onofre site. The San Onofre site is located on California's Pacific coast, about 70 miles southeast of Los Angeles and about 60 miles northwest of San Diego, near the town of San Clemente, California (TOPO 1993f, 1994e; Google 2022).

2.12.1 Site Inventory

San Onofre Unit 1 (San Onofre-1) ceased operation in 1992 and San Onofre Units 2 and 3 (San Onofre-2 and -3) ceased operation on June 7, 2013 (Dietrich 2013a), although the reactors did not operate after January 2012. The final removal of SNF from the San Onofre-2 reactor vessel was completed on July 18, 2013 (Dietrich 2013b). Final removal of SNF from the San Onofre-3 reactor vessel was completed on October 5, 2012 (Dietrich 2013c). Removal of SNF from the San Onofre-2 and -3 spent fuel pools was completed on August 7, 2020 (Bauder 2020).

There are 3855 SNF assemblies (1609.4 MTHM) stored at the San Onofre site. Figure 2-261 illustrates the number of SNF assemblies and MTHM stored at the San Onofre site, based on discharge year and Figure 2-262 illustrates the number of SNF assemblies and MTHM based on burnup. The oldest fuel was discharged in 1971 and the last fuel was discharged in 2012. The median discharge year of the fuel is 1997. The lowest burnup is 6.8 GWd/MTHM and the highest burnup is 55.1 GWd/MTHM. The median burnup is 38.4 GWd/MTHM.

San Onofre uses the Standardized Advanced NUHOMS System (Docket No. 72-1029) and the HI-STORM UMAX System (Docket No. 72-1040) for dry storage of SNF. The Standardized Advanced NUHOMS System consists of transportable dry shielded canisters, reinforced concrete horizontal storage modules, and a transfer cask. The specific dry shielded canisters that have been used at San Onofre are the 24PT1 and 24PT4, which each hold 24 pressurized water reactor SNF assemblies. The MP187 transportation cask (Docket No. 71-9255) is certified to transport the 24PT1 canister and the MP197HB transportation cask (Docket No. 71-9302) is certified to transport the 24PT4 canister.

HI-STORM UMAX System consists of transportable multipurpose canisters, which contain the fuel; underground vertical ventilated modules, which contain the multipurpose canisters during storage; and a transfer cask (HI-TRAC VW), which contains the multipurpose canister during loading, unloading and transfer operations. The multipurpose canister (MPC-37) stores up to 37 pressurized water reactor SNF assemblies. The HI-STAR 190 transportation cask (Docket No. 71-9373) is certified to transport the MPC-37 canister. Figure 2-263 shows a cutaway view of the HI-STORM UMAX dry storage system.

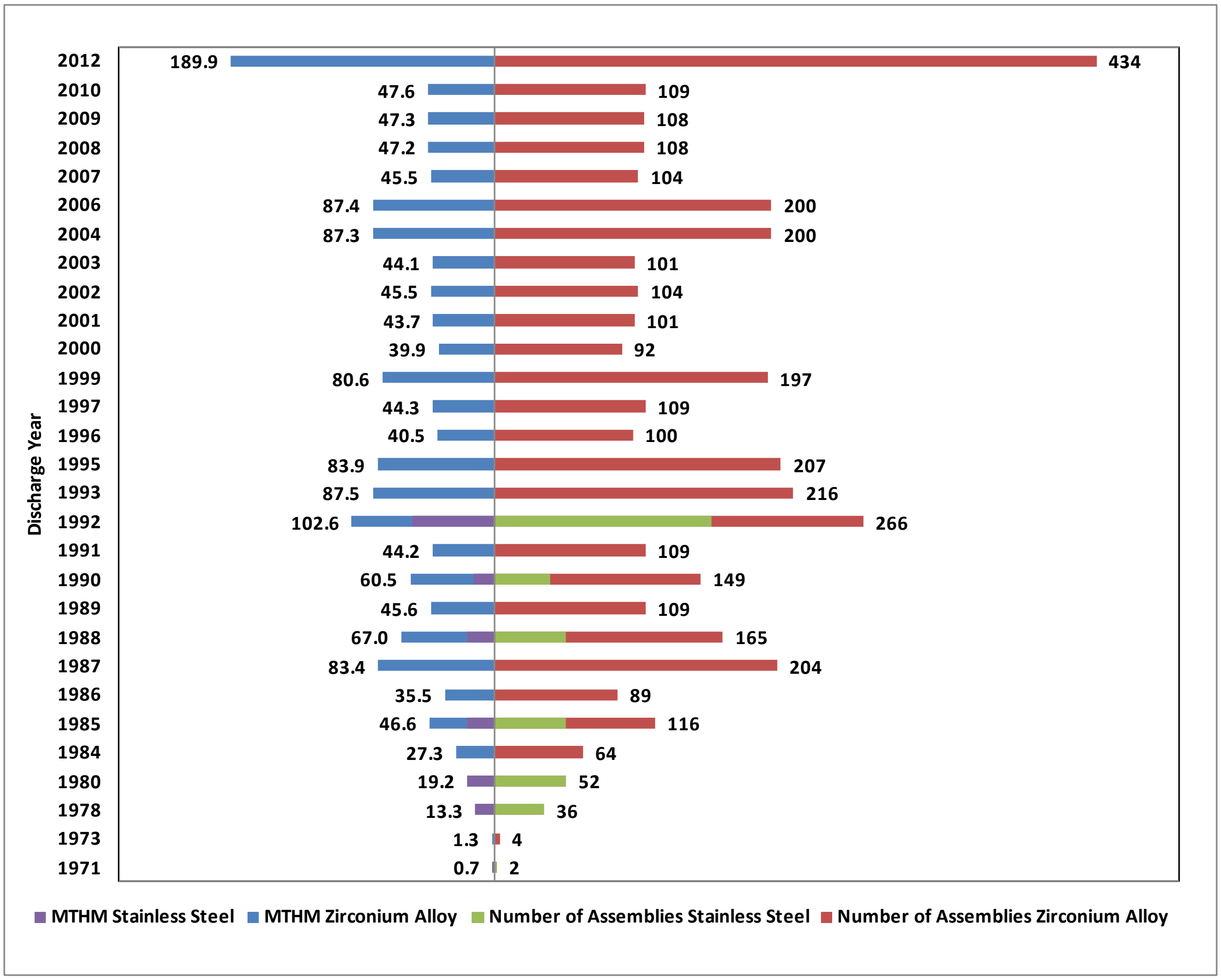


Figure 2-261. San Onofre Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

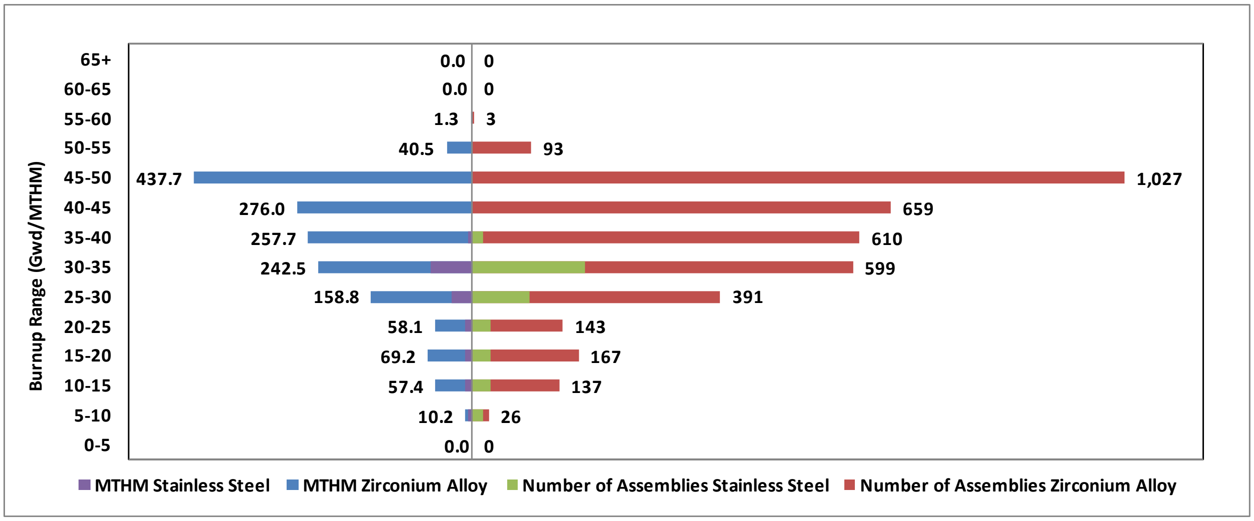


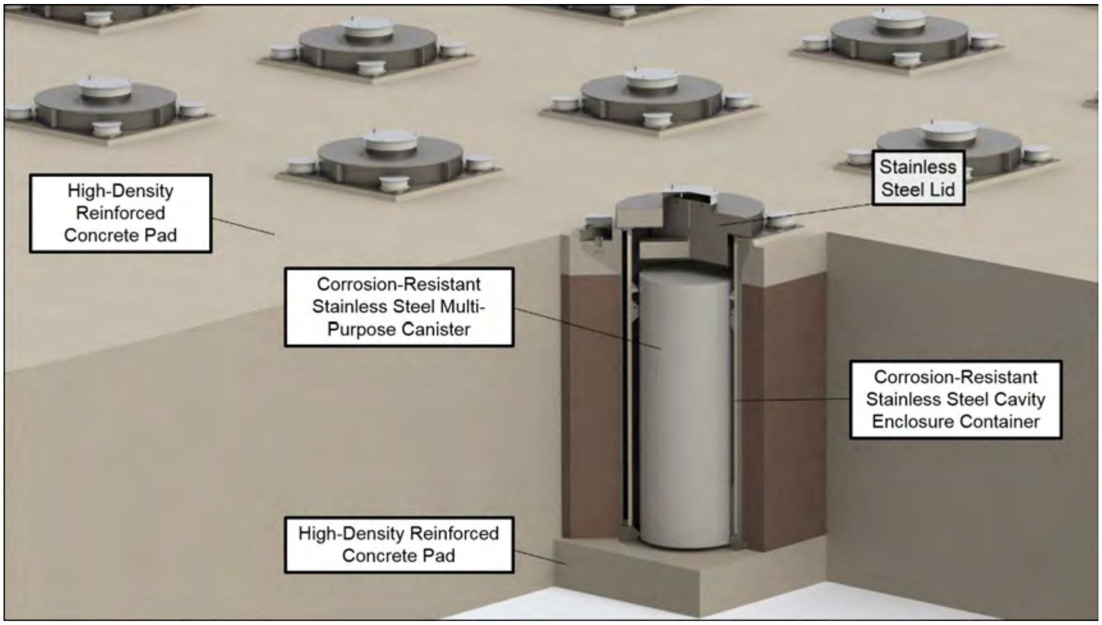
Figure 2-262. San Onofre Number of Assemblies and MTHM versus Burnup (EIA 2018)

There are also 12 additional unused 24PT4 dry shielded canisters, nine of which have been shipped off-site, and 12 unused NUHOMS reinforced concrete horizontal storage modules on the ISFSI pad, and eight additional reinforced concrete horizontal storage modules stored at the site.

There were six 32PTH2 dry shielded canisters at the San Onofre site; however, these canisters have been shipped off-site. Figure 2-264 through Figure 2-267 show 24PT4 and 32PTH2 dry storage canisters, a transfer cask, and horizontal storage modules, respectively. Two of the 24PT4 dry storage canisters will be used for GTCC waste and one of the 24PT4 dry storage canisters will be used in San Onofre's Aging Management Program. Ten Radioactive Waste Containers (RWC) are being designed and fabricated to store GTCC waste from San Onofre-2 and -3 reactor vessel segmentation. The RWCs are designed to be processed similarly to a 24PT4 dry shielded canister, and will be stored in unused NUHOMS horizontal storage modules.

There are 395 pressurized water reactor SNF assemblies (146.3 MTHM) in 17 24PT1 dry shielded canisters from San Onofre-1 in dry storage at the San Onofre site. Four of these assemblies (D049, D050, D051, and D052) are mixed oxide SNF assemblies. There is also one 24PT1 dry shielded canister containing GTCC waste from the segmentation of reactor vessel internals during the decommissioning of San Onofre-1 stored at the San Onofre site. It was initially estimated that two canisters would be required; however, due to packaging efficiencies, only one canister was required (EPRI 2005, 2008b).

The MP187 transportation cask is certified to ship SNF in the 24PT1 canister. However, the MP187 transportation cask is not certified for the transport of GTCC waste. As discussed in Section 2.6.1, a single MP187 transportation cask is stored at the Rancho Seco site, but impact limiters would need to be fabricated before this MP187 transportation cask could be used to ship SNF or GTCC waste. A -96 designation must be obtained before impact limiters are fabricated for the existing MP187 transportation cask. A -96 designation must also be obtained before the MP187 transportation cask is certified for the transport of GTCC waste. The effort to accomplish these changes and to obtain NRC review and approval is estimated to range from one to three years. It may also be possible to transport the 24PT1 canister containing GTCC waste using the MP197HB transportation cask.



Graphic courtesy of San Onofre

Figure 2-263. Cutaway View of the HI-STORM UMAX Dry Storage System

Photo courtesy of San Onofre

Figure 2-264. 24PT4 Dry Storage Canisters

Figure 2-265. 32PTH2 Dry Storage Canisters (On Left) (2015)

Figure 2-266. Transfer Cask for 32PTH2 Canisters (2015)

Figure 2-267. Horizontal Storage Modules (2015)

There are also 792 pressurized water reactor SNF assemblies (330.9 MTHM) in 33 24PT4 dry shielded canisters from San Onofre-2 and -3 stored at the San Onofre site. The MP197HB transportation cask is certified to ship SNF in the 24PT4 canister. The MP197HB is also certified to ship GTCC waste. An MP197HB transportation cask has been fabricated and is in use in the U.S.

The fuel rods in 391 (145.0 MTHM) of the 395 SNF assemblies (146.3 MTHM) from San Onofre-1 stored at the San Onofre site are stainless steel-clad. The four mixed oxide SNF assemblies from San Onofre-1 (D049, D050, D051, and D052) are zirconium alloy-clad. There are also an additional 270 stainless steel-clad SNF assemblies (98.4 MTHM) from San Onofre-1 that are stored at the Morris, Illinois ISFSI. Figure 2-268 illustrates the number of SNF assemblies and MTHM from San Onofre-1 stored at the San Onofre site, based on discharge year. The oldest fuel was discharged in 1971 and the last fuel was discharged in 1992. The median discharge year of the fuel is 1988.

Figure 2-269 illustrates the number of SNF assemblies and MTHM from San Onofre-1 stored at the San Onofre site based on burnup. The lowest burnup is 6.8 GWd/MTHM and the highest burnup is 39.3 GWd/MTHM. The median burnup is 30.0 GWd/MTHM. No high burnup SNF (burnup greater than 45 GWd/MTHM) from San Onofre-1 is stored at the San Onofre site.

There are a total of 3460 SNF assemblies (1463.2 MTHM) from San Onofre-2 and -3 stored at the San Onofre site. This total includes the 792 assemblies (330.9 MTHM) in dry storage in Standardized Advanced NUHOMS Systems and 2668 assemblies (1132.2 MTHM) in dry storage in HI-STORM UMAX Systems. The fuel rods in these fuel assemblies are zirconium alloy-clad. There are also two rod storage baskets containing rods from reconstituted fuel assemblies from San Onofre -2 and -3 in dry storage. The 2668 SNF assemblies do not include 108 fuel assemblies that were inserted into the San Onofre-2 reactor but that were not made critical. These assemblies were transported off-site to a fuel fabricator for uranium recovery.

All SNF at San Onofre has been moved to dry storage. All of the 395 San Onofre-1 fuel assemblies are stored in 24PT1 dry shielded canisters, and 792 of the San Onofre-2 and -3 fuel assemblies are stored in 24PT4 dry shielded canisters. The remaining 2668 San Onofre-2 and -3 fuel assemblies are stored in 73 MPC-37 canisters. The San Onofre site also estimates that 12 canisters would be required to store the GTCC waste from decommissioning of San Onofre-2 and -3. At the San Onofre site, a total of 123 canisters contain SNF from San Onofre-1, -2, and -3. The San Onofre site estimates that 13 canisters would be required to store GTCC waste generated during decommissioning.

High burnup SNF stored in 24PT4 canisters and MPC-37 canisters at San Onofre would be transportable in the MP197HB and HI-STAR 190 transportation casks, respectively.

There are 94 damaged SNF assemblies from San Onofre-1, -2, and -3 stored in 24PT1 and 24PT4 dry storage canisters. There are 27 damaged assemblies from San Onofre-1 stored in 9 canisters, 46 damaged assemblies from San Onofre-2 stored in 4 canisters, and 21 damaged assemblies from San Onofre-3 stored in 2 canisters. These assemblies are packaged in damaged fuel cans. There are 34 damaged assemblies from San Onofre-2 and 29 damaged assemblies from San Onofre-3 stored in MPC-37 canisters. These assemblies are packaged in damaged fuel cans. Two rods storage baskets (one each from San Onofre-2 and -3) and two fuel debris containers (one each from San Onofre-2 and -3) are stored in damaged fuel cans. An additional two fuel assemblies (one each from San Onofre-2 and -3) are stored in damaged fuel cans due to the presence of foreign material, for a total of 69 damaged fuel cans within 28 MPC-37 canisters.

Figure 2-270 illustrates the number of SNF assemblies and MTHM from San Onofre-2 and -3, based on discharge year. The oldest fuel was discharged in 1984 and the last fuel was discharged in 2012. The median discharge year of the fuel is 1999.

Figure 2-271 illustrates the number of SNF assemblies and MTHM from San Onofre-2 and -3 based on burnup. The lowest burnup is 9.3 GWd/MTHM and the highest burnup is 55.1 GWd/MTHM. The median burnup is 40.7 GWd/MTHM. There are 1123 SNF assemblies (479.4 MTHM) from San Onofre-2 and -3 that have burnups greater than 45 GWd/MTHM. These 1123 fuel assemblies are classified by the NRC as high burnup SNF.

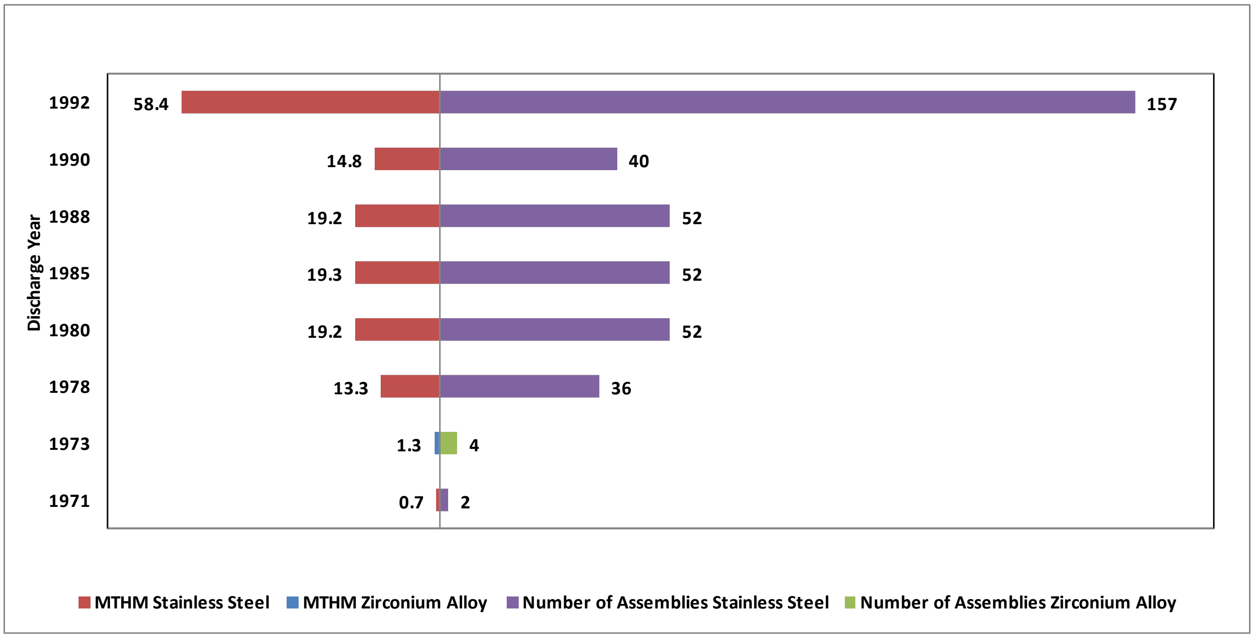


Figure 2-268. San Onofre-1 Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

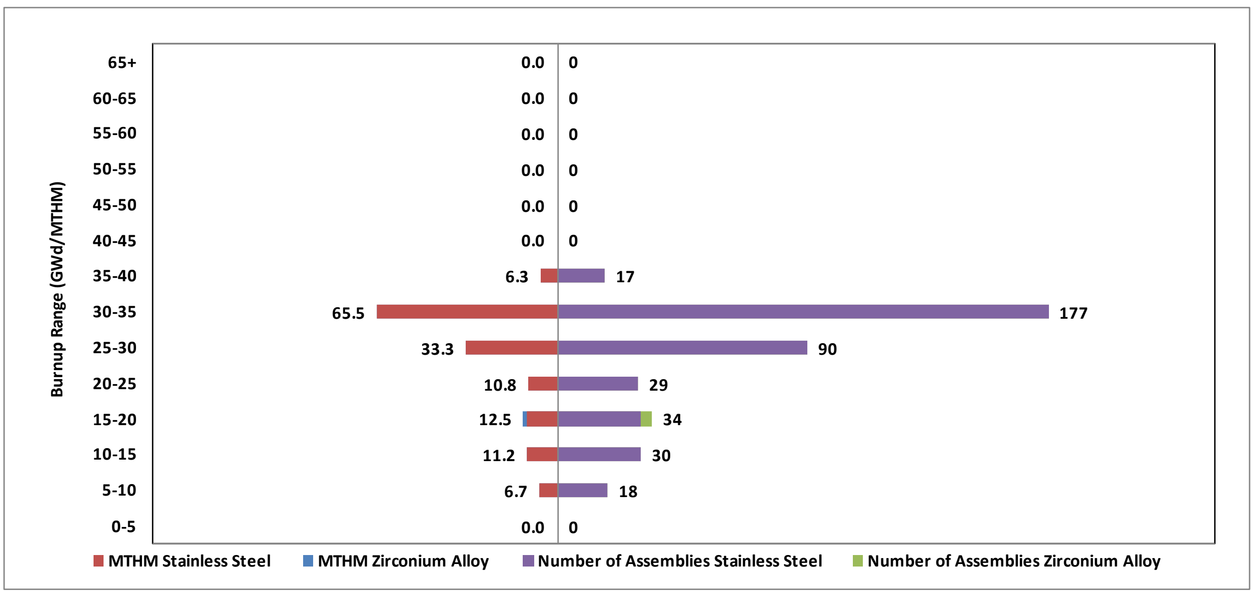


Figure 2-269. San Onofre-1 Number of Assemblies and MTHM versus Burnup (EIA 2018)

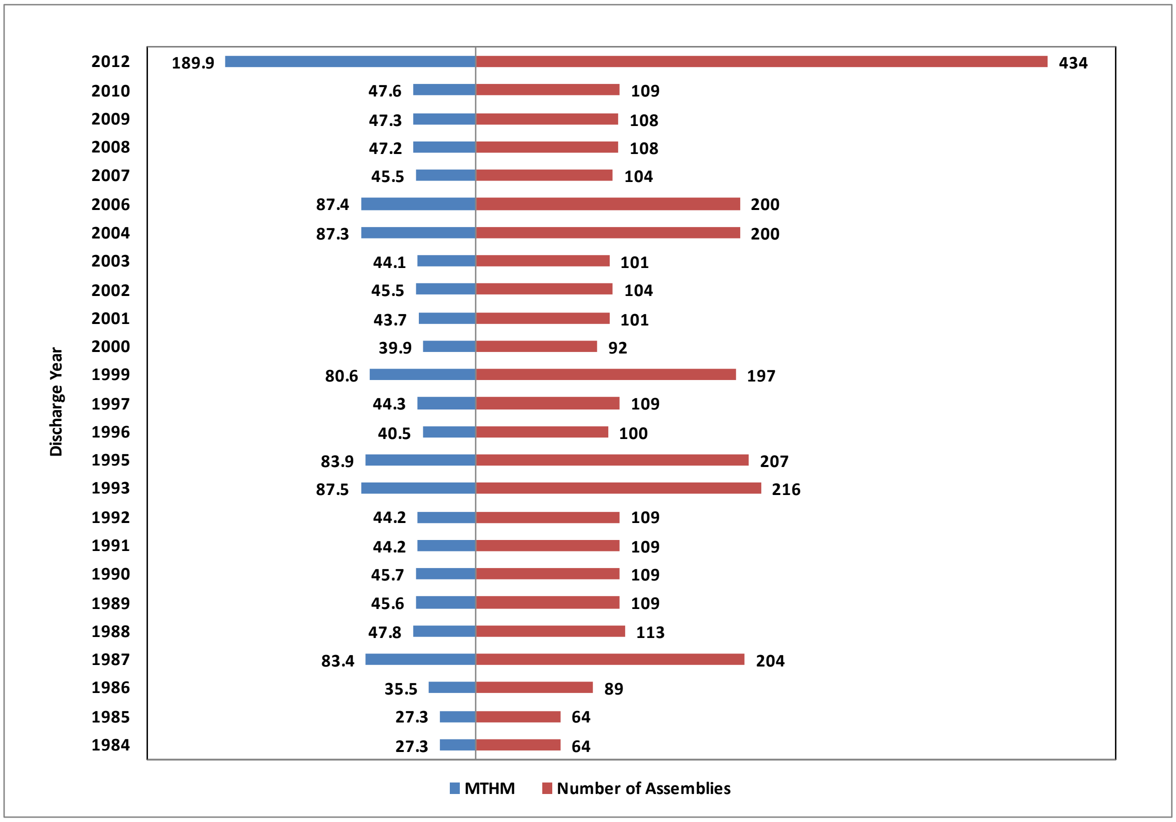


Figure 2-270. San Onofre-2 and -3 Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

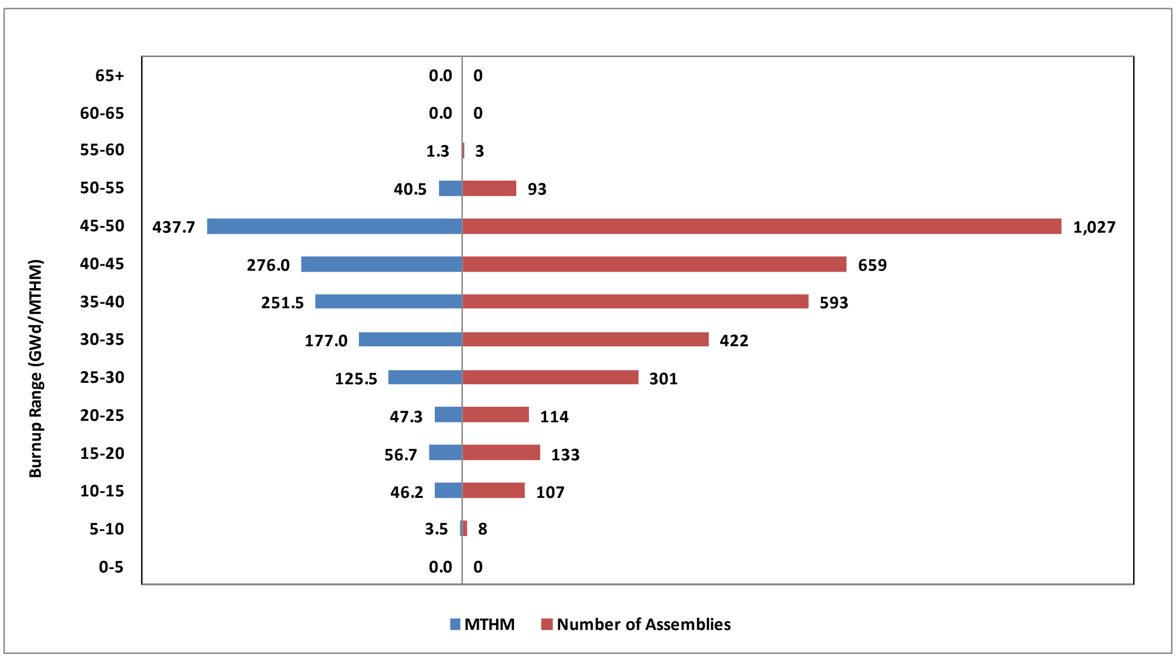


Figure 2-271. San Onofre-2 and -3 Number of Assemblies and MTHM versus Burnup (EIA 2018)

As mentioned previously, there are 792 SNF assemblies from San Onofre-2 and -3 stored in 33 24PT4 dry storage canisters. Figure 2-272 and Figure 2-273 illustrate the number of fuel assemblies and MTHM stored in 24PT4 canisters based on discharge year and burnup. The oldest fuel was discharged in 1984 and the last fuel was discharged in 2004. The median discharge year of the fuel is 1993. The lowest burnup is 11.1 GWd/MTHM and the highest burnup is 48.0 GWd/MTHM. The median burnup is 34.2 GWd/MTHM. There are 8 fuel assemblies (3.4 MTHM) from San Onofre-2 and -3 stored in 24PT4 canisters that have burnups greater than 45 GWd/MTHM. These 8 assemblies are not packaged in damaged fuel cans.

Figure 2-274 and Figure 2-275 illustrate the number of fuel assemblies and MTHM based on discharge year and burnup for the 2668 fuel assemblies from San Onofre-2 and -3 that are stored in MPC-37 dry storage canisters. The oldest fuel was discharged in 1984 and the last fuel was discharged in 2012. The median discharge year of the fuel is 2002. The lowest burnup is 9.3 GWd/MTHM and the highest burnup is 55.1 GWd/MTHM. The median burnup is 43.1 GWd/MTHM. There are 1115 fuel assemblies (476.0 MTHM) from San Onofre-2 and -3 that have burnups greater than 45 GWd/MTHM. These 1115 assemblies are not packaged in damaged fuel cans.

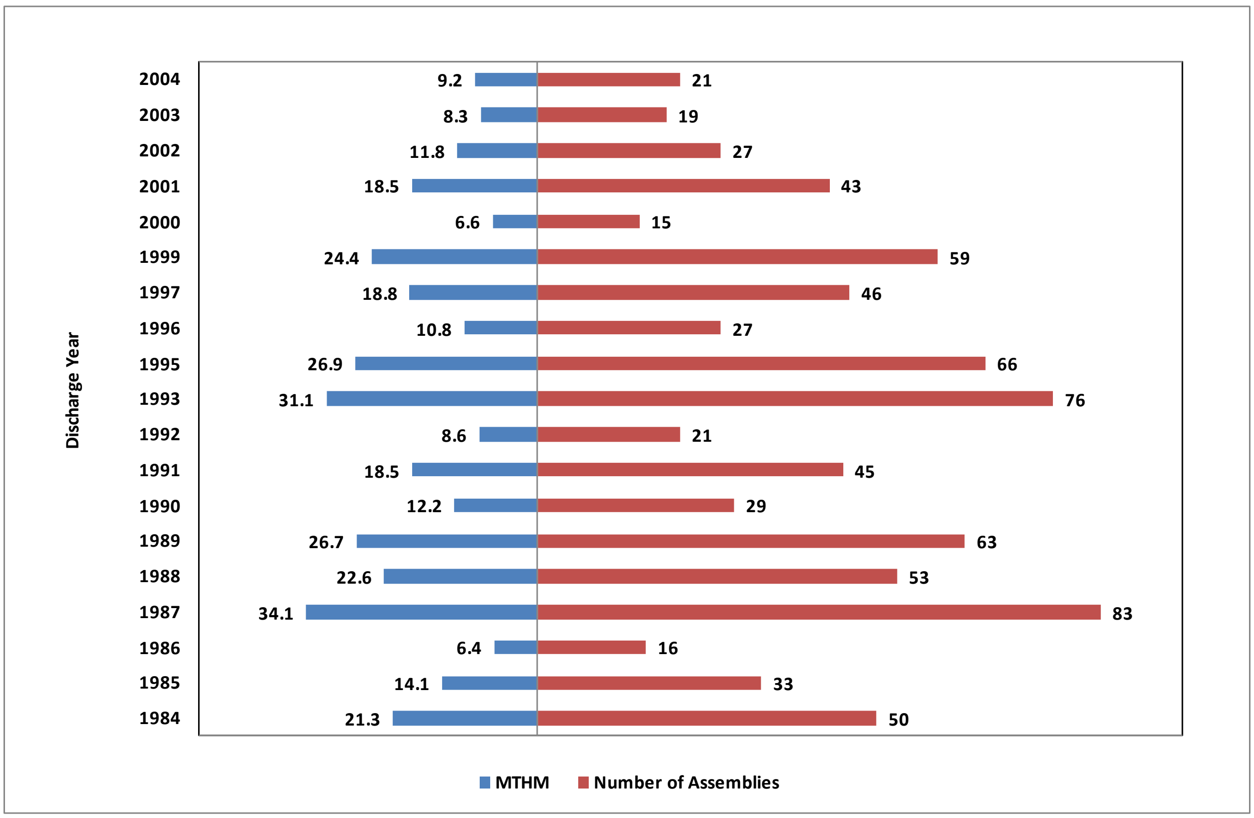


Figure 2-272. San Onofre-2 and -3 Number of Assemblies and MTHM Stored in 24PT4 Canisters versus Discharge Year (EIA 2018)

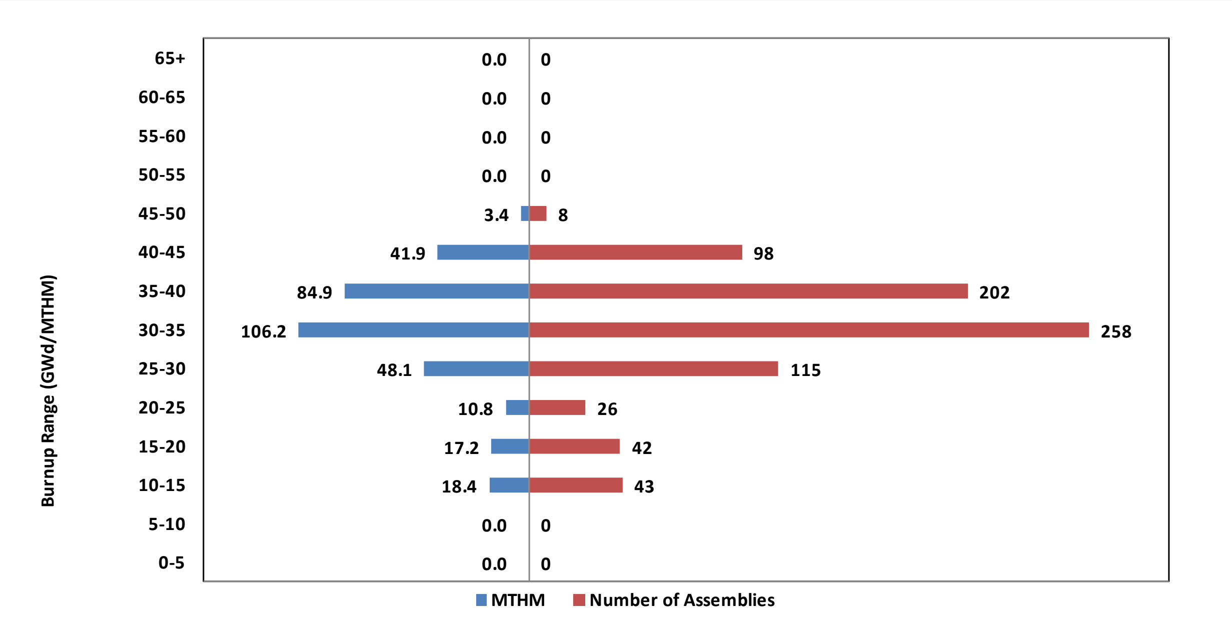


Figure 2-273. San Onofre-2 and -3 Number of Assemblies and MTHM Stored in 24PT4 Canisters versus Burnup (EIA 2018)

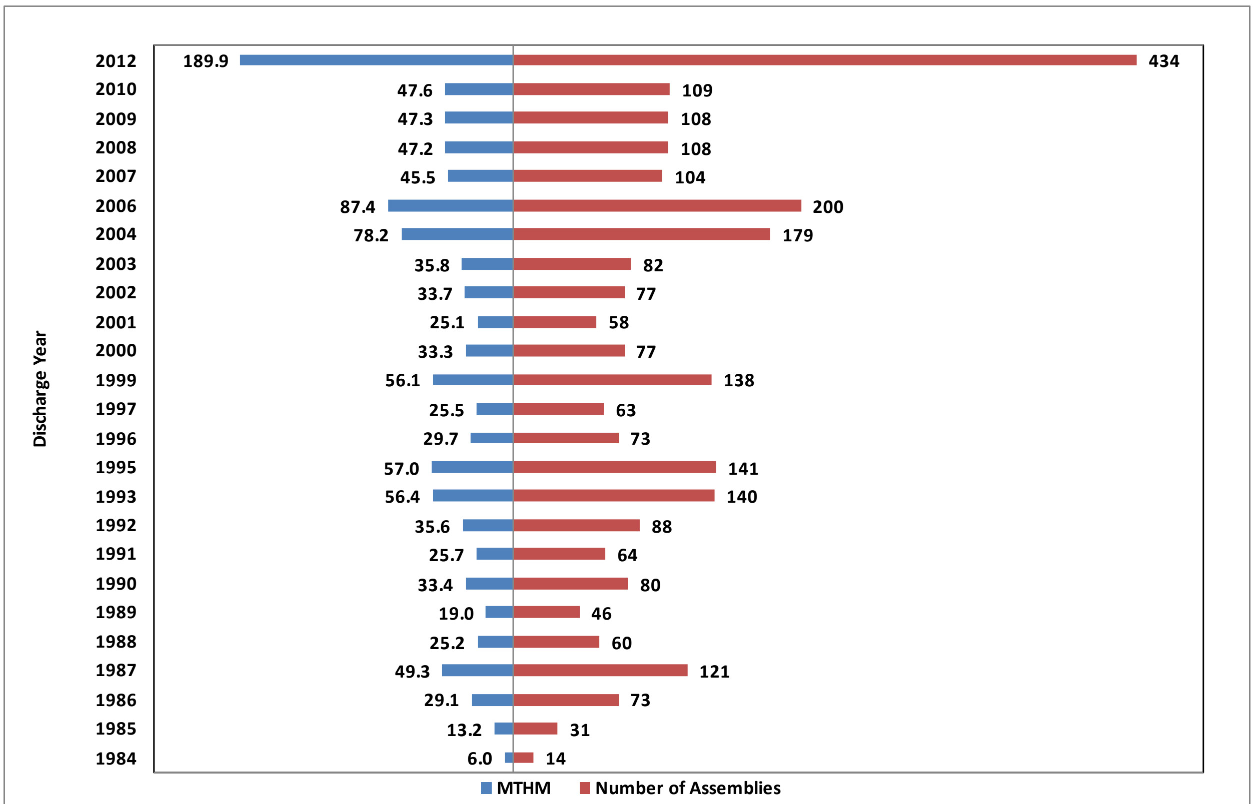


Figure 2-274. San Onofre-2 and -3 Number of Assemblies and MTHM Stored in MPC-37 Canisters versus Discharge Year (EIA 2018)

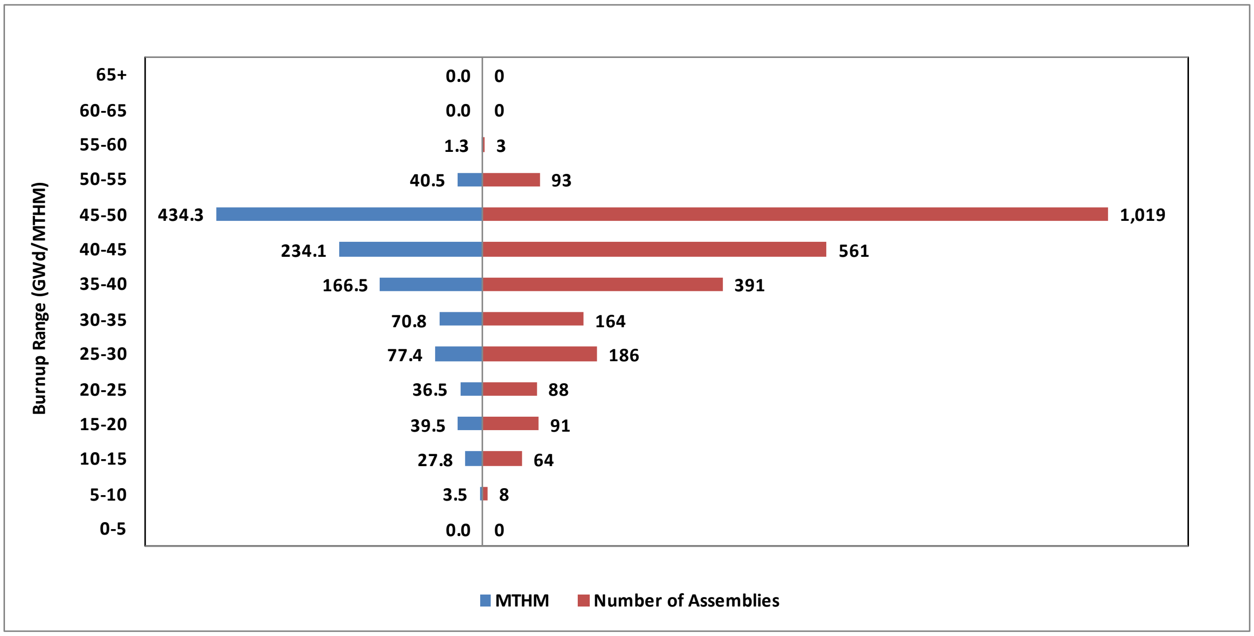


Figure 2-275. San Onofre-2 and -3 Number of Assemblies and MTHM Stored in MPC-37 Canisters versus Burnup (EIA 2018)

2.12.2 Site Conditions

The San Onofre site is located on the Pacific coast in southern California. The San Onofre ISFSI (Docket No. 72-41) is located at the northwestern end of the site. San Onofre uses two systems to store SNF. The original ISFSI uses the Standardized Advanced NUHOMS System and expanded ISFSI uses the HI-STORM UMAX System. Figure 2-276 and Figure 2-277 show the original ISFSI and Figure 2-278 shows the expanded ISFSI. Figure 2-279 and Figure 2-280 show an open reinforced concrete horizontal storage module that will be used to store GTCC waste.

Figure 2-281 provides an aerial view of the San Onofre site and Figure 2-282 provides an aerial view of the original ISFSI and the expanded ISFSI. The expansion was required to accommodate additional dry storage in HI-STORM UMAX underground vertical storage modules. The expanded ISFSI is located in an area adjacent to the original ISFSI (see Figure 2-282). Figure 2-283 shows this area before the expansion of the ISFSI. This area was excavated to a depth of approximately 12 feet to install the underground vertical storage modules. Following installation of the modules, the area was built up approximately 12 feet from the current ground level.

The San Onofre site is served by the BNSF Railroad and has an on-site rail spur (TOPO 1993f, 1994e; TriVis Incorporated 2005). The rail spur is about 0.8 mile long and was originally built in the 1960s to support construction of San Onofre-1 and was subsequently used to support construction of San Onofre-2 and -3 in the 1970s (Gilson 2005, Gilson and Blythe 2005). The rail spur connects with the BNSF mainline about 0.6 mile northwest of the site. The rail spur was reactivated in 2000 to support the decommissioning of San Onofre-1 (Gilson 2005, Gilson and Blythe 2005). The on-site rail spur was refurbished to support shipping of the San Onofre-1 reactor pressure vessel in 2020. The rail spur is being modified to support decommissioning. Figure 2-284 through Figure 2-294 show the on-site rail spur and the junction of the rail spur with the BNSF mainline:

- Figure 2-284 – Expansion of on-site rail spur looking west
- Figure 2-285 – Expansion of on-site rail spur looking south
- Figure 2-286 – Expansion of on-site rail spur looking north
- Figure 2-287 – End of on-site rail spur looking south
- Figure 2-288 – End of on-site rail spur looking south
- Figure 2-289 – Potential on-site transload location
- Figure 2-290 – BOSS MX7 railcar mover
- Figure 2-291 – On-site rail spur at San Onofre site looking north
- Figure 2-292 – Derailer on on-site rail spur
- Figure 2-293 – Junction of on-site rail spur with BNSF mainline at San Onofre site
- Figure 2-294 – BNSF mainline looking south.

The San Onofre site has no on-site barge facilities (TOPO 1993f, 1994e; TriVis Incorporated 2005). Construction of an on-site barge facility was attempted during construction of the San Onofre site, but this effort was unsuccessful because of currents and wave activity.

Figure 2-276. Original San Onofre Independent Spent Fuel Storage Installation (2022)

Figure 2-277. Close-up View of Original San Onofre Independent Spent Fuel Storage Installation (2018)

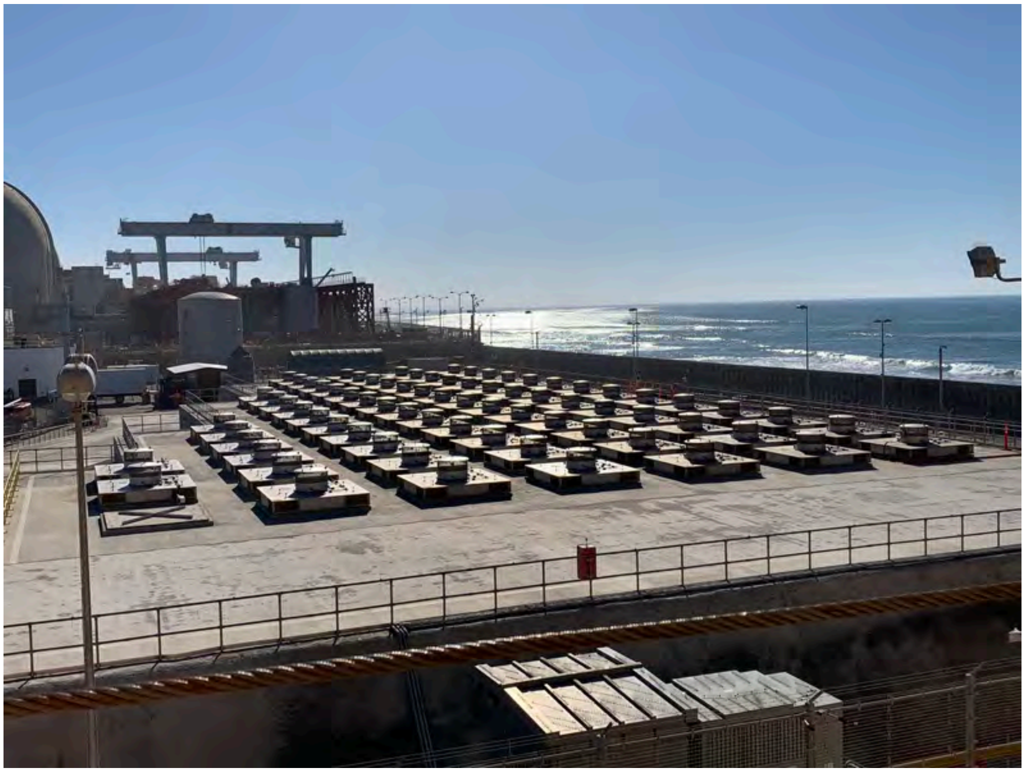


Figure 2-278. Expanded San Onofre Independent Spent Fuel Storage Installation (2022)

Figure 2-279. Open Reinforced Concrete Horizontal Storage Module and Shielded Access Door (2022)

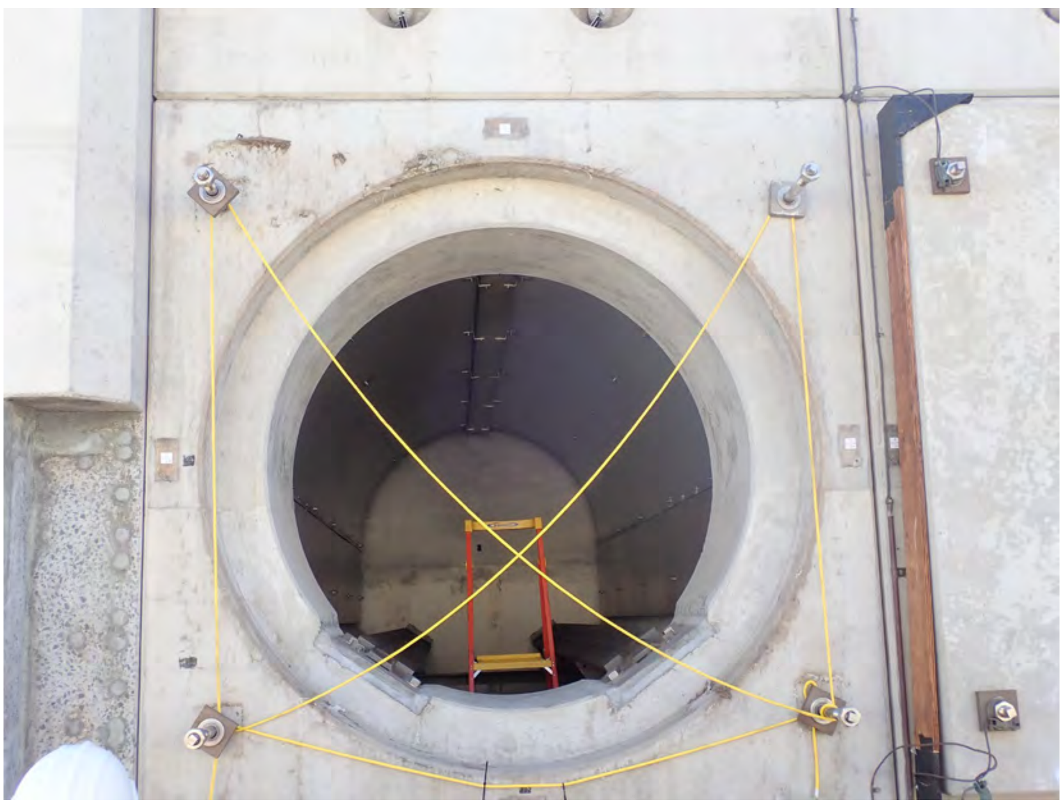


Figure 2-280. Interior of Open Reinforced Concrete Horizontal Storage Module (2022)

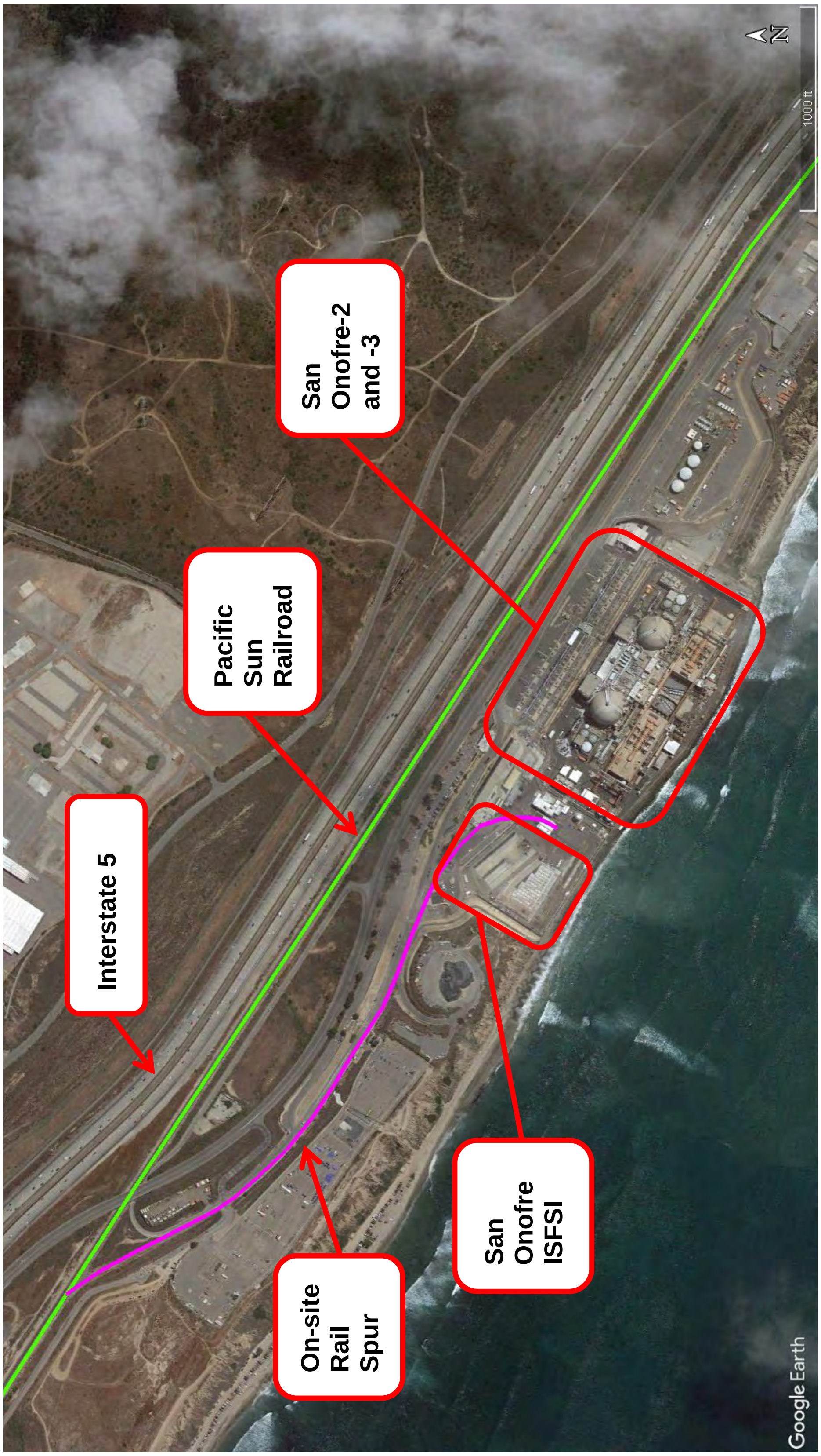


Figure 2-281. Aerial View of San Onofre Site (Google 2022)

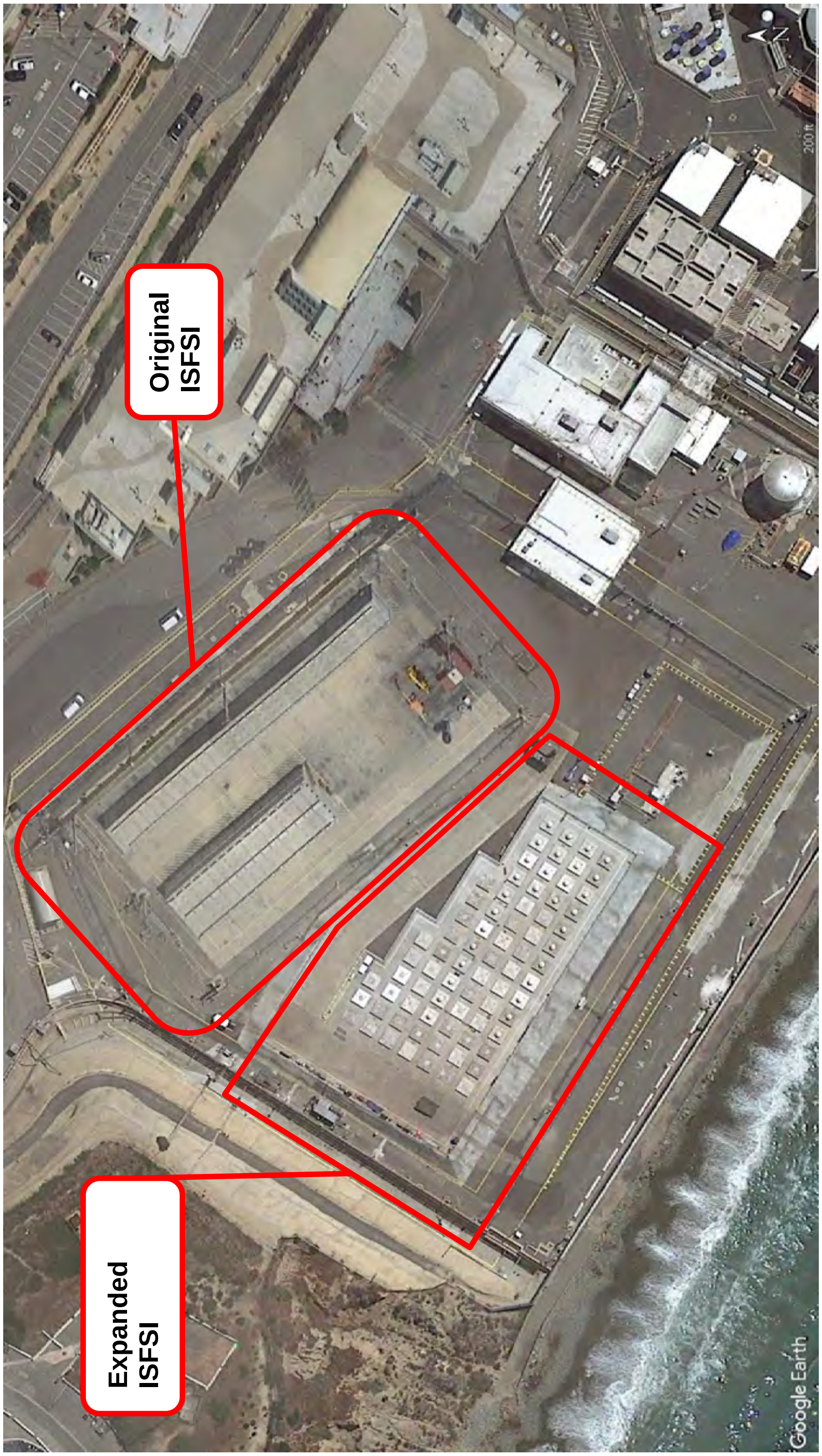


Figure 2-282. Aerial View of the San Onofre Original and Expanded Independent Spent Fuel Storage Installation (Google 2022)

Figure 2-283. Expanded San Onofre Independent Spent Fuel Storage Installation Location Prior to Construction (2015)

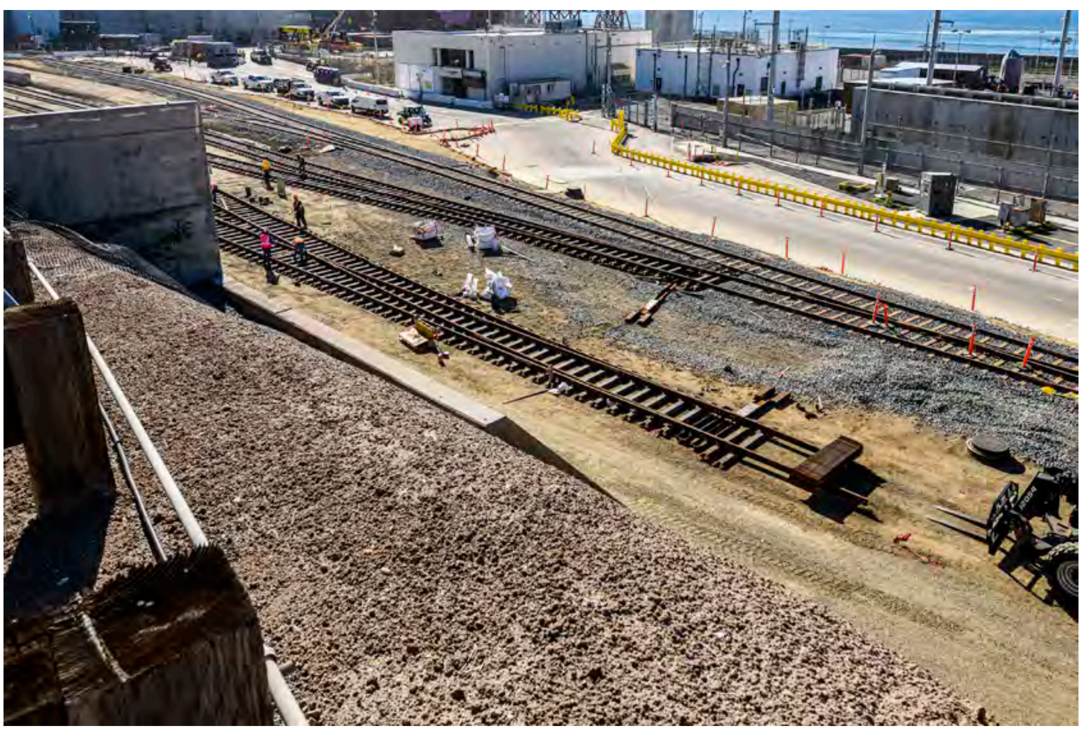


Figure 2-284. Expansion of On-site Rail Spur (Looking West) (2022)

Figure 2-285. Expansion of On-site Rail Spur (Looking South) (2022)

Figure 2-286. Expansion of On-site Rail Spur (Looking North) (2022)

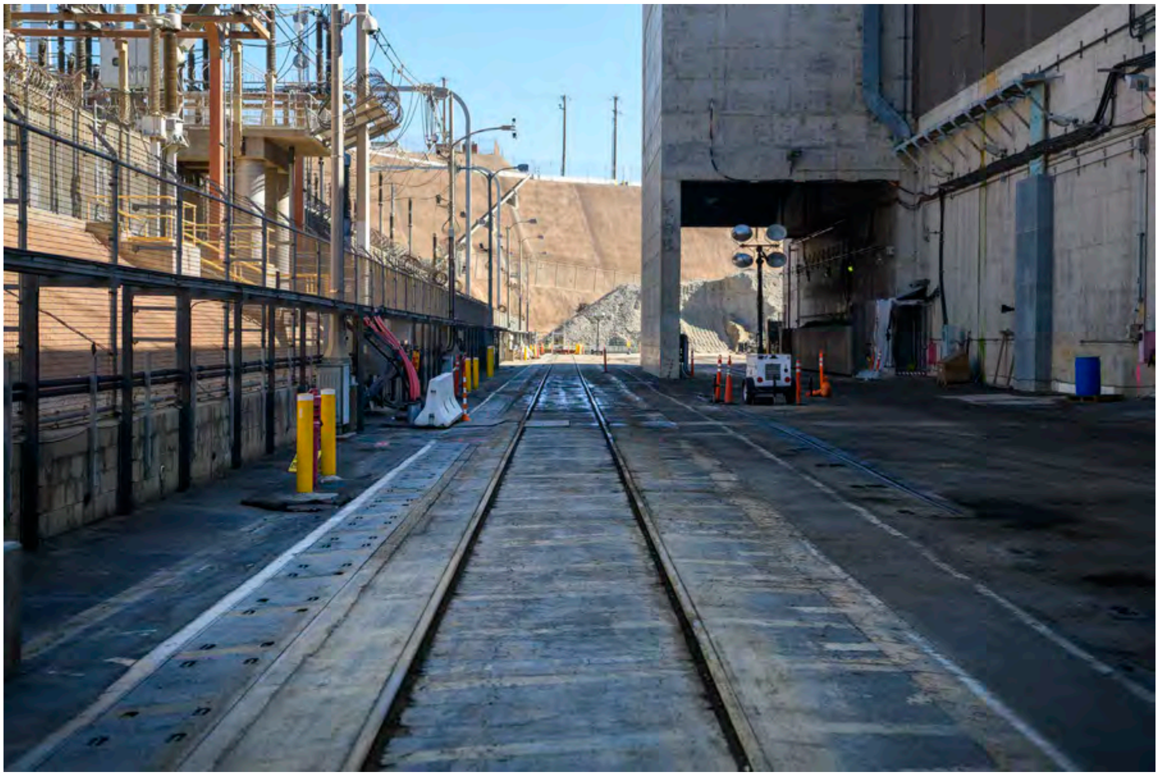


Figure 2-287. End of On-site Rail Spur (Looking South) (2022)

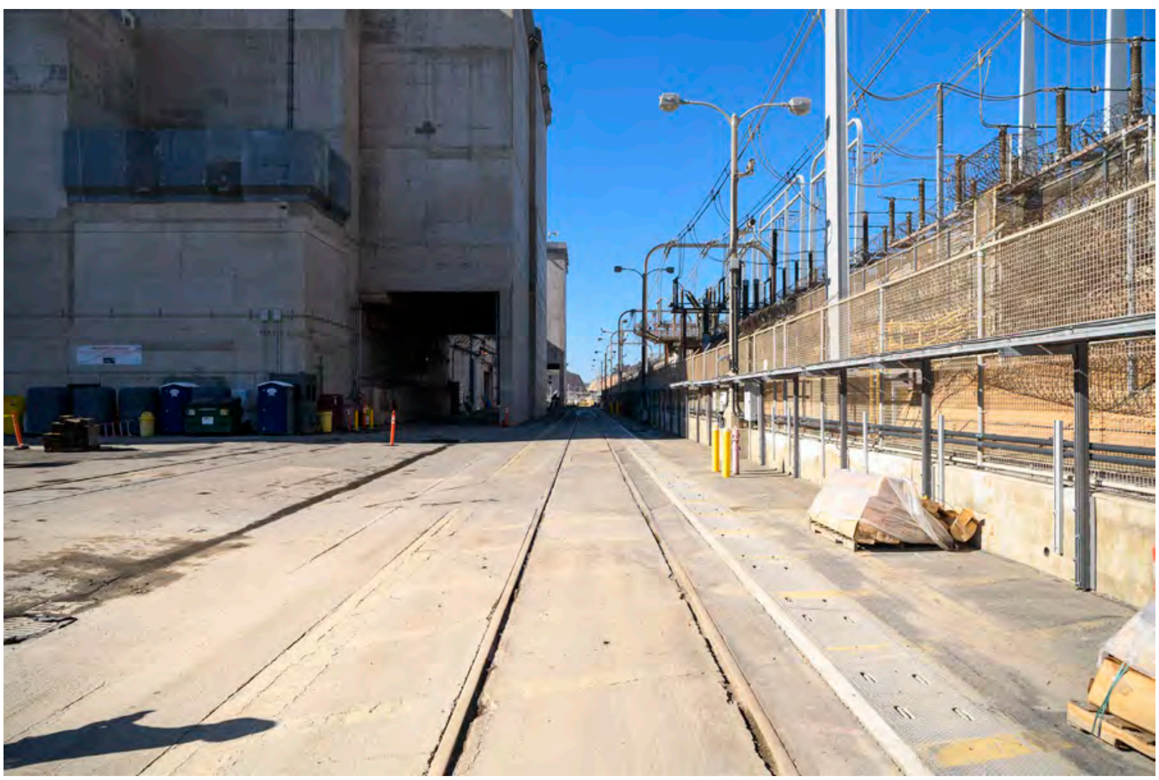


Figure 2-288. End of On-site Rail Spur (Looking South) (2022)

Figure 2-289. Potential On-site Transload Location (2022)

Figure 2-290. BOSS MX7 Railcar Mover (2022)

Figure 2-291. On-site Rail Spur at San Onofre Site (Looking North) (2022)

Figure 2-292. Derailer on On-site Rail Spur (2022)

Figure 2-293. Junction of On-site Rail Spur with BNSF Mainline at San Onofre Site (Looking North) (2022)

Figure 2-294. BNSF Mainline Looking South (2022)

2.12.3 Near-site Transportation Infrastructure and Experience

As discussed in Section 2.12.2, the San Onofre site has direct rail access to the BNSF Railroad through an on-site rail spur, and the rail spur has been used to ship several large turbine shells, turbine rotors, three steam generators, and a pressurizer during the decommissioning of San Onofre-1 (Gilson 2005, Gilson and Blythe 2005). Each steam generator weighed approximately 209 tons, was cylindrical with spherical ends, measured approximately 11 ft. 4.5 in. in diameter at the upper dome and was approximately 45 ft. long (EPRI 2008b). Lifting trunnions were attached to the exterior of the steam generators and increased the maximum width of the steam generators to approximately 14 ft. 5 in. (EPRI 2008b). The pressurizer weighed approximately 105 tons, was cylindrical with spherical ends, measured approximately 7 ft. 6.5 in. in diameter, and was about 42 ft. 7 in. long (EPRI 2008b). Low-level radioactive waste was also shipped by rail using gondola cars (Figure 2-295) and intermodal containers loaded onto rail cars (Figure 2-296) (EPRI 2008b).

In October 2015, a main generator rotor was shipped by rail from the San Onofre site to a location near Richmond, Virginia for refurbishment, after which it was shipped by rail to a storage location near the Fermi Nuclear Power Plant near Monroe, Michigan. The rotor weighed slightly over 400,000 lb., was just over 50 ft. long, and was shipped on a 370-ton, 45-foot deck, 12-axle QTTX flat car (see Figure 2-297).

In 2020, the San Onofre-1 reactor pressure vessel was shipped by rail and heavy haul truck to the EnergySolutions low-level radioactive waste disposal facility in Clive, Utah. The reactor pressure vessel package weighed approximately 670 tons, was 15.5 ft. in diameter, and was 38.5 ft. long (Radwaste Solutions 2020). The reactor pressure vessel was moved by Goldhofer trailer (Figure 2-298) to the rail spur, transloaded onto a 36-axle Schnabel railcar (KRL 3600) (Figure 2-299) and moved by rail to Apex, Nevada where it was transloaded to a platform trailer (Figure 2-300), and moved by truck to Clive, Utah. The reactor pressure vessel departed San Onofre on May 25, 2020 and arrived in Clive, Utah July 14, 2020.

Truck shipments of 270 SNF assemblies were also made from San Onofre-1 to Morris, Illinois from 1972 through 1980 (SAIC 1991). Ninety-five shipments were made using the IF-100 truck transportation cask and 175 shipments were made using the NAC-1 truck transportation cask (SAIC 1991). Southern California Edison does not intend to return these assemblies to the San Onofre site (EPRI 2008b).

The mainline track in the vicinity of the San Onofre site is designated as track class 5 and is built with 115 lb. rail; the on-site spur is built with 90 lb. rail. Figure 2-301 and Figure 2-302 show the mainline. The mainline is owned by the North County Transit District. Amtrak Pacific Surfliner and Metrolink commuter rail service operate over the same track between Orange County and Oceanside, California, which limits freight service to 12:00 a.m. to 5:00 a.m. The North County Transit District also provides Coaster and Sprinter commuter rail service between Oceanside and San Diego, and Oceanside and Escondido, California. The Pacific Sun Railroad interchanges with the BNSF Railroad at the Stuart Mesa rail yard, which is located about 13 miles south of the San Onofre site (see Figure 2-303 and Figure 2-304).

Photo courtesy of San Onofre

Figure 2-295. Gondola Railcar Used to Transport Large Non-Containerized Components

Photo courtesy of San Onofre

Figure 2-296. Articulating Intermodal Railcar Transporting Low-Level Radioactive Waste

Photo courtesy of San Onofre

Figure 2-297. Main Generator Rotor on QTTX Railcar (2015)

Photo courtesy of San Onofre

Figure 2-298. San Onofre-1 Reactor Pressure Vessel on Goldhofer Trailer

Photo courtesy of TheNavigator at Trainorders.com

Figure 2-299. San Onofre-1 Reactor Pressure Vessel on Schnabel Railcar

Photo courtesy of Nevada Department of Transportation

Figure 2-300. San Onofre-1 Reactor Pressure Vessel on Heavy Haul Truck Platform Trailer

Figure 2-301. Mainline at San Onofre Site (Looking North) (2015)

Figure 2-302. Mainline at San Onofre Site (Looking South) (2015)

Figure 2-303. Aerial View of Stuart Mesa Rail Yard (Google 2022)

Figure 2-304. Stuart Mesa Rail Yard (Looking South) (2016)

In addition to rail shipments of large components, ship, barge, platform trailer, tracked vehicle, and heavy haul truck transport were used to transport four replacement steam generators from Mitsubishi Heavy Industries in Kobe, Japan to the San Onofre site. The steam generators weighed approximately 650 tons each. The two replacement steam generators for San Onofre-2 were transported from Kobe, Japan by the heavy lift cargo ship Happy Ranger to the Port of Long Beach in 2008; the two replacement steam generators for San Onofre-3 were transported from Kobe, Japan by the heavy lift cargo ship Enchanter to the Port of Los Angeles in 2010. At the ports, the steam generators were transloaded to an ocean-going barge (see Figure 2-305) and transported to the Del Mar Boat Basin (see Figure 2-306) which is located at Marine Corps Base Camp Pendleton (MCBCP). At a pre-existing bulkhead at the Del Mar Boat Basin, each steam generator was then transloaded onto a Goldhofer trailer that had been rolled from the bulkhead onto the barge under the steam generator (see Figure 2-307). The Goldhofer trailer with its steam generator was then rolled off of the barge.

After being rolled off of its barge at the Del Mar Boat Basin, each steam generator was then transloaded onto a tracked vehicle (see Figure 2-308). The tracked vehicle then traveled north on military roads. From the paved road behind the Camp Del Mar recreational vehicle park at the north end of Camp Pendleton's Camp Del Mar Beach and Recreational Area, the tracked vehicle followed the Amphibious Tracked Vehicle access road and proceeded to the beach and past the Santa Margarita Estuary.

During travel on the beach, several natural drainages were crossed, the most important of which was the Santa Margarita River. North of the Santa Margarita Estuary, the tracked vehicle traveled along military transit routes on the beach for approximately 8 miles. Travel on the beach was below the high tide line; layovers were above the high tide line. The tracked vehicle then followed a military transport dirt road that heads east and northeast from Red Beach at the MCBCP Uniform Training Area to the MCBCP Las Pulgas gate. At the Las Pulgas Gate, each steam generator was transloaded from its tracked vehicle onto a Goldhofer trailer (see Figure 2-309). From the Las Pulgas gate, the Goldhofer trailer turned north onto a MCBCP road that parallels Interstate-5 for 0.2 miles.

The Goldhofer trailer then moved to the south bound lanes of Interstate-5 through a temporary opening made in the fencing along Interstate-5. The transfer to the south bound lanes of Interstate-5 was necessary to avoid the environmentally sensitive Skull Canyon area of the Southern California Coast. The Goldhofer trailer traveled north on the south bound lanes of Interstate-5 for approximately 0.2 miles, and then transitioned back to a MCBCP dirt road through another temporary opening made in the fencing along Interstate-5.

Travel north on south-bound Interstate-5 necessitated the closure of three of the four south-bound lanes of Interstate-5 for approximately 1 hour, and no special grading was necessary to transfer to and from Interstate-5. The transporter then traveled north on the MCBCP dirt road for approximately 1 mile and transitioned onto Old Highway 101, which is paved. The distance traveled along Old Highway 101 was approximately 5.5 miles, and transitioned from MCBCP property to State of California State Park property. Travel on Old Highway 101 required the reinforcement of drainage culverts and underground utilities which were protected with steel plates or mats. Old Highway 101 is also the main access road into the San Onofre State Beach and required the use of flaggers to direct traffic around the steam generators. From

Old Highway 101, the Goldhofer trailer moved to the San Onofre site where each steam generator was offloaded. The overall length of the route from the Del Mar Boat Basin to the San Onofre site was about 15 miles (see Figure 2-310). Figure 2-311 shows the condition of the Del Mar Boat Basin bulkhead in 2016.

Heavy haul truck transport was also used to ship the four old steam generators from San Onofre to Clive, Utah for disposal; a distance of about 830 miles. Each steam generator weighed 760,335 lb., and was 15.5 ft. wide, 15.5 ft. tall, and 43 ft. long (Morgan 2015). The gross vehicle weight of each shipment was 1,561,050 lb. and each shipment required 14 days of travel time (Morgan 2015). Figure 2-312 shows a steam generator (without its steam dome) on its heavy haul truck transporter.

Photo courtesy of California Public Utilities Commission

Figure 2-305. San Onofre Steam Generators on Barge Arriving at Del Mar Boat Basin (2009)

Figure 2-306. Del Mar Boat Basin (Google 2022)

Photo courtesy of California Public Utilities Commission

Figure 2-307. Offloading of Steam Generator on Goldhofer Trailer at Del Mar Boat Basin Bulkhead (2009)

Photo courtesy of California Public Utilities Commission

Figure 2-308. Steam Generator on Tracked Vehicle on Beach (2009)

Photo courtesy of San Diego Union-Tribune

Figure 2-309. Steam Generator on Goldhofer Trailer (2009)

Figure 2-310. Steam Generator Route from the Del Mar Boat Basin to the San Onofre Site (Google 2022)

Figure 2-311. Del Mar Boat Basin Bulkhead (2016)

Photo courtesy of San Diego Union-Tribune

Figure 2-312. Old Steam Generator on Heavy Haul Truck Transporter (2011)

2.12.4 Future Information Needs

At the San Onofre site, an on-site rail spur provides direct access to the BNSF Railroad and consequently, barge or heavy haul truck transport of SNF and GTCC waste would be unlikely from the San Onofre site.

There are 1123 SNF assemblies at San Onofre-2 and -3 that have burnups greater than 45 GWd/MTHM. The certificate of compliance for the MP197HB transportation cask authorizes the transport of high burnup fuel in the 24PT4 canister; therefore, the 8 high burnup fuel assemblies stored in 24PT4 canisters would be transportable. The certificate of compliance for the HI-STAR 190 transportation cask authorizes the transport of high burnup fuel in the MPC-37 canister; therefore, the additional 1115 high burnup fuel assemblies would also be transportable.

In addition to transportation infrastructure information needs, the dry storage canister SNF contents would need to be evaluated to verify that they meet the conditions in the 10 CFR Part 71 transportation certificate of compliance. Any changes made to dry storage canisters through the 10 CFR 72.48 process would also need to be evaluated to determine if they need to be propagated to the 10 CFR Part 71 transportation certificate of compliance.

2.13 Vermont Yankee

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the Vermont Yankee site. The site is located at the southeast corner of Vermont in the town of Vernon, Vermont in Windham County on the western shore of the Connecticut River (TOPO 1994f).

2.13.1 Site Inventory

Vermont Yankee ceased operation on December 29, 2014 and all SNF has been removed from the Vermont Yankee reactor vessel (Wamser 2015). Removal of SNF from the Vermont Yankee spent fuel pool was completed on August 1, 2018 (Chappell 2018). A total of 3879 SNF boiling water reactor assemblies and one fuel debris canister are in dry storage at the Vermont Yankee ISFSI (Docket No. 72-59). The fuel rods in the fuel assemblies are zirconium alloy-clad. The 3879 fuel assemblies (705.9 MTHM) are stored in 58 MPC-68 and MPC-68M multipurpose canisters. The MPC-68 and MPC-68M multipurpose canisters hold 68 boiling water reactor SNF assemblies and are part of the HI-STORM 100S System (Docket No. 72-1014). This system consists of a multipurpose canister, which contains the fuel; a vertical concrete storage overpack (HI-STORM), which contains the multipurpose canister during storage; and a transfer cask (HI-TRAC), which contains the multipurpose canister during loading, unloading and transfer operations. The HI-STORM 100S is a variation of the HI-STORM 100 overpack design that includes a modified lid which incorporates the air outlet ducts into the lid, allowing the overpack body to be shortened. Two additional canisters containing GTCC waste could also be generated at the Vermont Yankee site (Wamser 2014).

The HI-STAR 100 transportation cask (Docket No. 71-9261) is certified to ship MPC-68 canisters. Transport of MPC-68M canisters, high burnup (> 45 GWd/MTHM) SNF, or GTCC waste is not authorized in the certificate of compliance for the HI-STAR 100. The certificate of compliance for either the HI-STAR 100MB (Docket No. 71-9378) or HI-STAR 100 could be revised to include these contents.

Figure 2-313 illustrates the number of SNF assemblies and MTHM at Vermont Yankee, based on discharge year. The oldest fuel was discharged in 1973 and the last fuel was discharged in 2014. The median discharge year of the fuel is 1993.

Figure 2-314 illustrates the number of SNF assemblies and MTHM at Vermont Yankee, based on burnup. The lowest burnup is estimated to be 0.96 GWd/MTHM and the highest burnup is 52.9 GWd/MTHM. The median burnup is estimated to be 30.6 GWd/MTHM. There are 260 SNF assemblies (46.0 MTHM) at Vermont Yankee that have burnups greater than 45 GWd/MTHM. These 260 fuel assemblies are classified by the NRC as high burnup SNF.

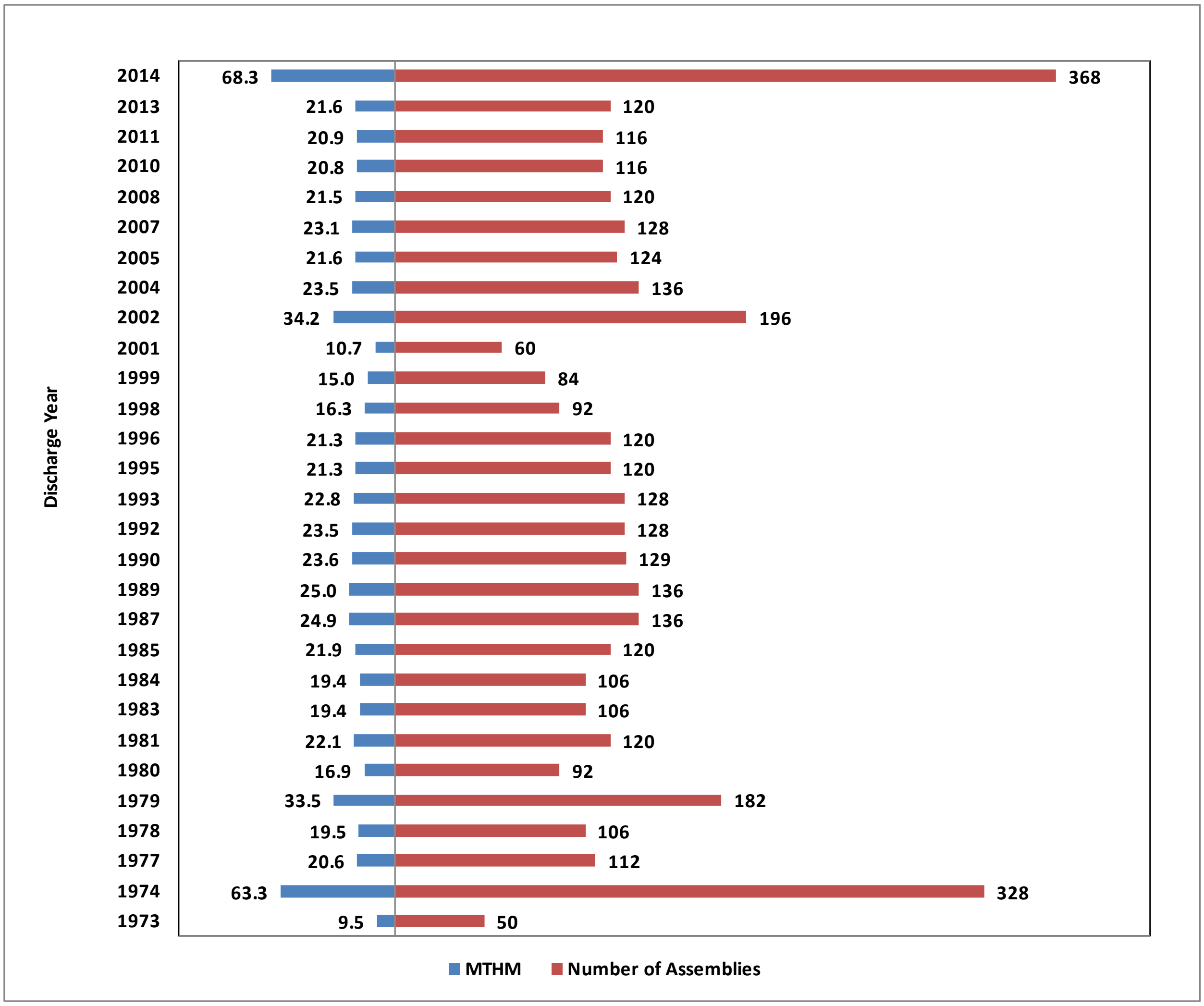


Figure 2-313. Vermont Yankee Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

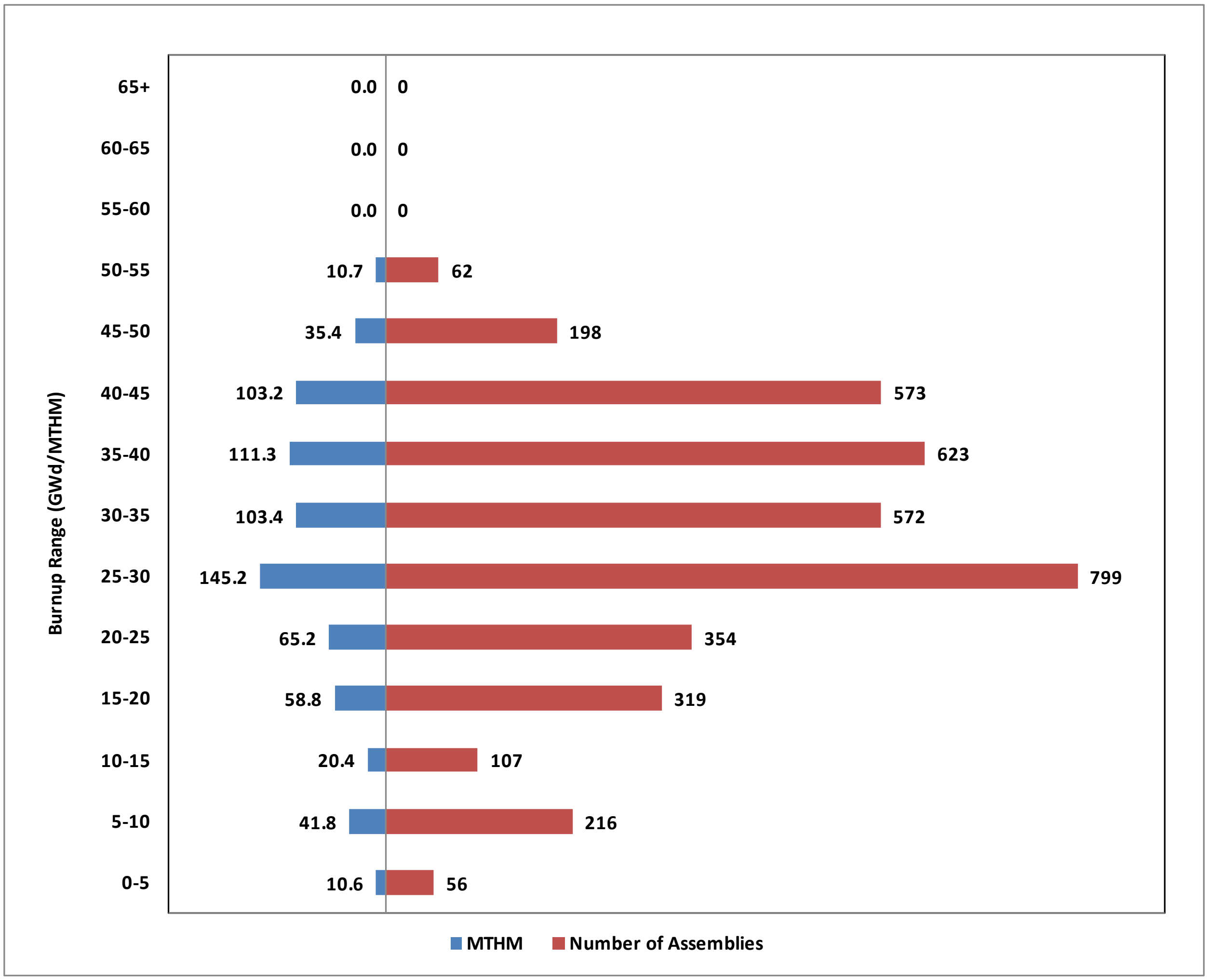


Figure 2-314. Vermont Yankee Number of Assemblies and MTHM versus Burnup (EIA 2018)

2.13.2 Site Conditions

The Vermont Yankee site is located on the western shore of the Connecticut River, across from Hinsdale, New Hampshire, which is located on the eastern side of the Connecticut River. The site is about 5 miles southeast of Brattleboro, Vermont, and about 45 miles north of Springfield, Massachusetts. The site is located on Vernon Pond, formed by Vernon Dam and Hydroelectric Station located immediately downstream 0.75 miles from the site (NRC 2007b). Figure 2-315 provides an aerial view of the Vermont Yankee site. Figure 2-316 shows the Vernon Dam and Hydroelectric Station.

The Vermont Yankee ISFSI (see Figure 2-317) is located at the northern end of the Vermont Yankee site (see Figure 2-318). There are two ISFSI pads at the site, one with a capacity of 40 dry storage casks in an eight by five arrangement and a second pad with a capacity of 25 casks in a five by five arrangement. The second pad is approximately 30 feet immediately to the west of the existing ISFSI pad. A transfer cask, the platform used to move the vertical concrete casks from the reactor building to the containment access building, and the transporter used to move the vertical concrete storage casks from the containment access building to the ISFSI are available at the Vermont Yankee site.

Rail service to the Vermont Yankee site is provided by the New England Central Railroad. In the past, the Vermont Yankee on-site rail system had two branches, one spur that ran to the containment access building and a second spur that ran to the south end of the turbine building (TOPO 1994f). The spur that ran to the containment access building has largely been removed. The spur that runs to the south end of turbine building has been refurbished and an additional spur has been added that runs to the southeast corner of the former protected area. The location of the second spur allows the concrete pad from the Construction Office Building (demolished in 2019) to be used for staging scrap material that will be shipped offsite via railcar. To facilitate railcar loading during poor weather conditions, a prefabricated metal-frame and plastic wall “big-top” structure has been erected over the southeastern end of the new rail spur. A short rail siding has also been added near the north end of the existing rail spur to facilitate on-site railcar storage (VTNDCAP 2020). The spur that runs to the turbine building is shown in Figure 2-319 through Figure 2-324. Figure 2-325 shows the locations of the on-site rail spurs.

Dams on the Connecticut River to the north and south of the Vermont Yankee site preclude barge access and consequently there is no on-site barge facility at Vermont Yankee (TOPO 1994f).

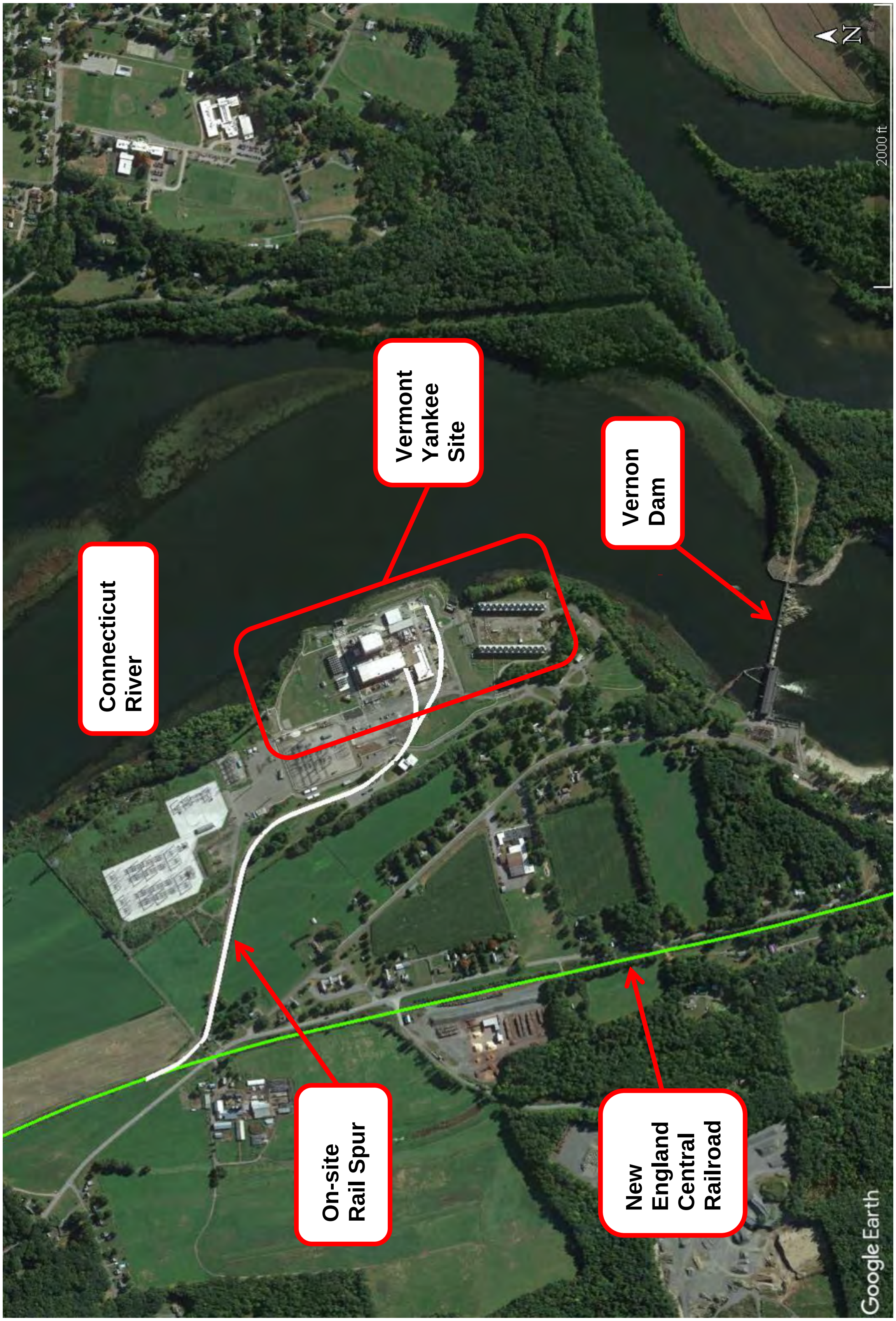


Figure 2-315. Aerial View of Vermont Yankee Site (Google 2022)

Figure 2-316. Vernon Dam and Hydroelectric Station (2016)

Photo courtesy of Vermont Yankee

Figure 2-317. Vermont Yankee Independent Spent Fuel Storage Installation (2016)

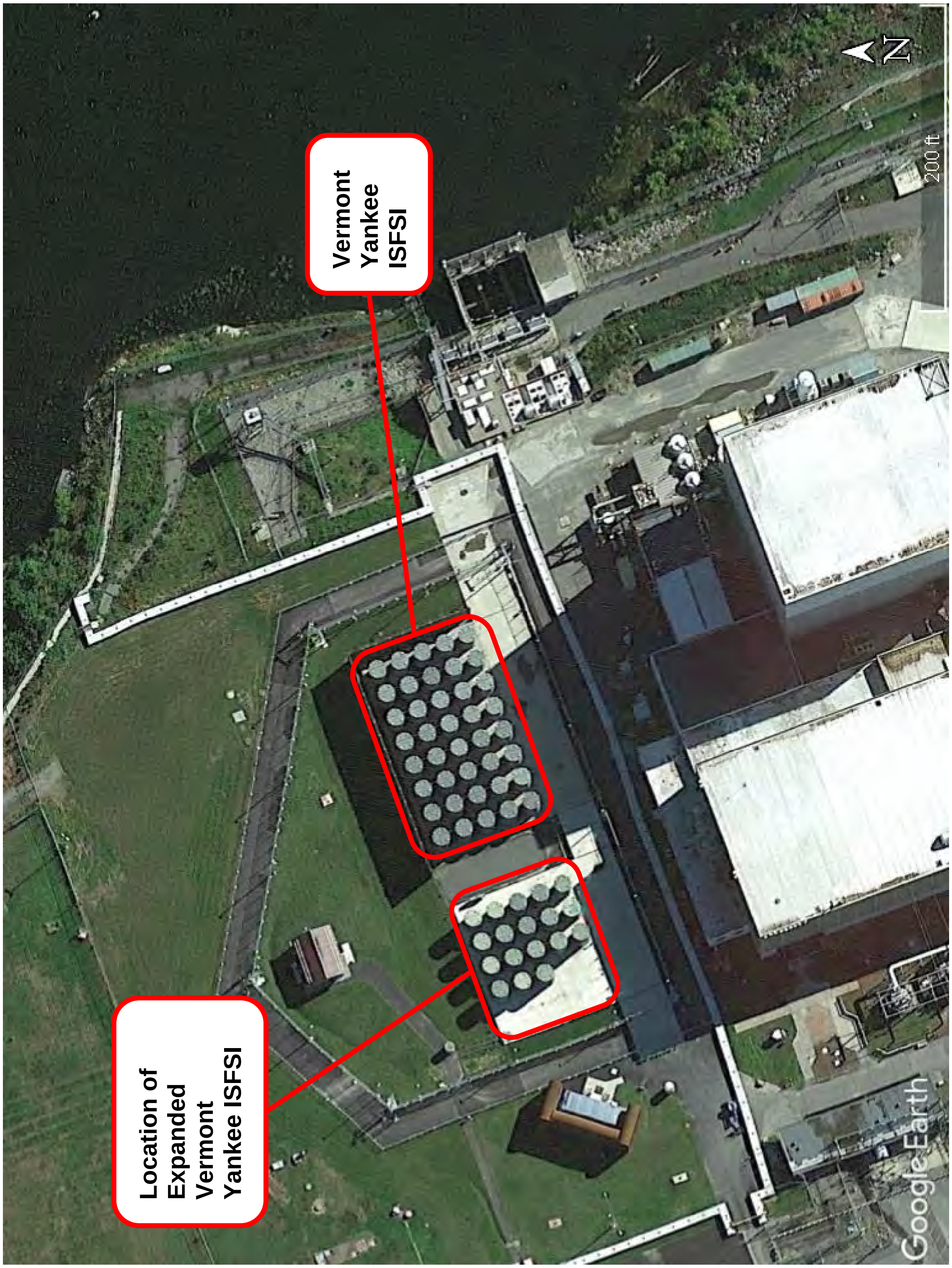


Figure 2-318. Aerial View of Vermont Yankee Independent Spent Fuel Storage Installation (Google 2022)

Photo courtesy of Vermont Yankee

Figure 2-319. Paved Over Portions on On-Site Rail Spur (2016)

Photo courtesy of Vermont Yankee

Figure 2-320. On-Site Rail Spur Approaching Turbine Building (2018)

Photo courtesy of Anthony Leshinskie

Figure 2-321. On-site Rail Spur Looking North (2017)

Photo courtesy of Anthony Leshinskie

Figure 2-322. On-site Rail Spur Looking South (2017)

Photo courtesy of Anthony Leshinskie

Figure 2-323. On-site Rail Spur Approaching Site Exit (2017)

Photo courtesy of Anthony Leshinskie

Figure 2-324. Rail Spur at Entrance to Vermont Yankee Site (2017)

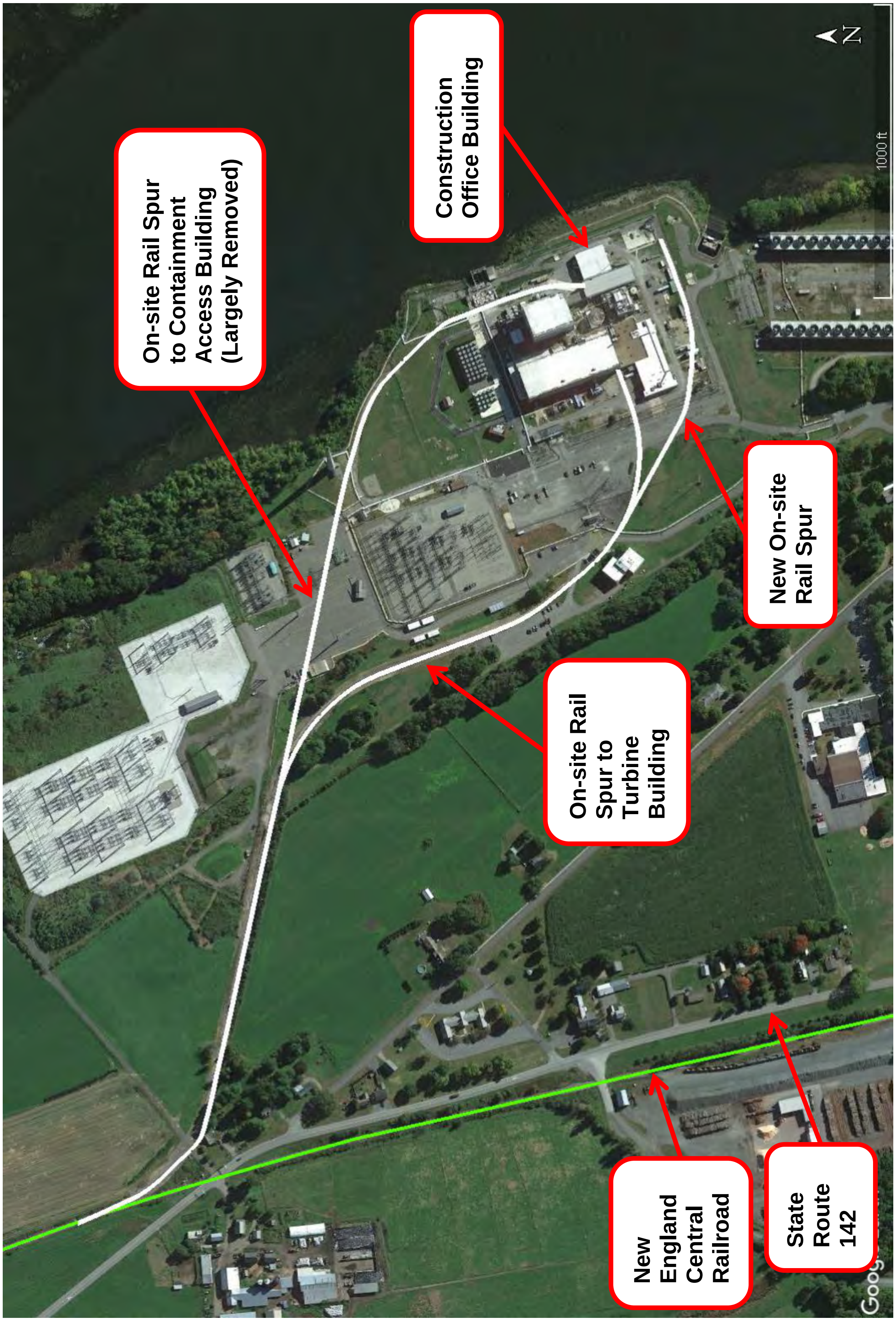


Figure 2-325. Aerial View of On-site Rail Spur (Google 2022)

2.13.3 Near-site Transportation Infrastructure and Experience

As mentioned in Section 2.13.2, rail service to the Vermont Yankee site is provided by the New England Central Railroad. In the vicinity of the Vermont Yankee site, the New England Central Railroad is track class 3. The New England Central Railroad is a Class III railroad and operates 394 miles of track from the Canadian border at East Alburgh, Vermont to New London, Connecticut. The New England Central Railroad interchanges with the Claremont Concord Railroad, the Canadian National, the Canadian Pacific, the CSXT, the Massachusetts Central Railroad, the Norfolk Southern, the Pan Am Southern, the Providence and Worcester Railroad, and the Vermont Railway. The Pan Am Southern also operates trains via trackage rights on the New England Central Railroad between East Northfield, Massachusetts and White River Junction, Vermont. The New England Central Railroad hosts the Amtrak Vermonter passenger service from East Northfield, Massachusetts to St. Albans, Vermont, including over the tracks in the vicinity of the Vermont Yankee site.

Figure 2-326 provides an aerial view of the Vermont Yankee rail spur, Figure 2-327 shows the rail spur at the Vermont Yankee site entrance, Figure 2-328 shows the junction of the Vermont Yankee rail spur and the New England Central Railroad (looking south), Figure 2-329 shows the junction of the Vermont Yankee rail spur and the New England Central Railroad (looking north), Figure 2-330 shows a derailer on the Vermont Yankee rail spur, and Figure 2-331 shows a dragging equipment detector and hot bearing detector located at the junction of the Vermont Yankee rail spur and the New England Central Railroad mainline.

The two major freight railroads that the New England Central Railroad interchanges with in the vicinity of the Vermont Yankee site are the Pan Am Southern and the CSX. The New England Central Railroad interchanges with the Pan Am Southern in Brattleboro, Vermont and with the CSXT in Palmer, Massachusetts. Figure 2-332 and Figure 2-333 show the railyards in these locations. Figure 2-334 shows the junction of New England Central Railroad and Pan Am Southern Railroad in East Northfield, Massachusetts.

In 2008, DOE, the Federal Railroad Administration, and the Council of State Governments – Eastern Regional Conference conducted an assessment of the rail infrastructure at and near the Vermont Yankee site. The assessment was focused on the New England Central Railroad from the Vermont Yankee site to Palmer, Massachusetts, where the New England Central Railroad interchanges with the CSXT, a distance of about 51 miles. The assessment identified one major bridge over the Connecticut River, 13 other bridges, and 17 grade crossings.

Figure 2-335 from this assessment shows the State Route 142 railroad grade crossing at milepost 115.97, Figure 2-336 shows the grade crossing at milepost 112.68, Figure 2-337 shows the railroad bridge over the Connecticut River at milepost 109.15, and Figure 2-338 shows a smaller railroad bridge at milepost 103.33.

The Connecticut River is dammed both upstream and downstream from the Vermont Yankee site. For example, the Vernon Dam is located 0.75 mile downstream of the Vermont Yankee site at river mile 142, and the Bellows Falls Dam is located upstream of the Vermont Yankee site at river mile 174 (NRC 2007b). TOPO (1994f) states that the nearest off-site barge terminal is located 60 miles from the Vermont Yankee site.

Figure 2-326. Aerial View of Vermont Yankee Rail Spur (Google 2022)

Photo courtesy of Anthony Leshinskie

Figure 2-327. Rail Spur at Vermont Yankee Site Entrance (2017)

Figure 2-328. Junction of Vermont Yankee Rail Spur (Left) and New England Central Railroad Mainline (Right) Looking South (2016)

Figure 2-329. Junction of Vermont Yankee Rail Spur and New England Central Railroad Mainline Looking North (2016)

Figure 2-330. Derailer on Vermont Yankee Rail Spur (2016)

Figure 2-331. Dragging Equipment Detector and Hot Bearing Detector on New England Central Railroad Mainline (2016)

Figure 2-332. Brattleboro Railyard (2016)

Figure 2-333. Palmer Railyard (2016)

Figure 2-334. Junction of New England Central Railroad (Left) and Pan Am Southern Railroad (Right) in East Northfield, Massachusetts (2016)

Photo courtesy of Federal Railroad Administration

Figure 2-335. State Route 142 Grade Crossing at Milepost 115.97 (2008)

Photo courtesy of Federal Railroad Administration

Figure 2-336. Grade Crossing at Milepost 112.68 (2008)

Photo courtesy of Federal Railroad Administration

Figure 2-337. Connecticut River Railroad Bridge at Milepost 109.15 (2008)

Photo courtesy of Federal Railroad Administration

Figure 2-338. Railroad Bridge at Milepost 103.33 (2008)

In 2020, Vermont Yankee began shipping segmented reactor internals by rail to the Waste Control Specialists low-level radioactive waste disposal facility located in Andrews, Texas. These segmented reactor internals are being shipped using the MP197HB transportation cask on the KRL 50002 railcar. The KRL 50002 railcar is an 8-axle, 55 ft. flat deck railcar with a load limit of 394,300 lb. Figure 2-339 shows the MP197HB transportation cask without impact limiters on the KRL 50002 railcar prior to shipping, Figure 2-340 shows the MP197HB transportation cask on the KRL 50002 with impact limiters, and Figure 2-341 shows the MP197HB transportation cask arriving at the Waste Control Specialists low-level radioactive waste disposal facility in Andrews, Texas.

Photo courtesy of NorthStar

Figure 2-339. MP197HB Transportation Cask Without Impact Limiters on Railcar (2019)

Photo courtesy of Orano

Figure 2-340. MP197HB Transportation Cask With Impact Limiters on Railcar (2020)

Photo courtesy of Orano

Figure 2-341. MP197HB Transportation Cask Carrying Segmented Reactor Internals from Vermont Yankee Arriving at the Waste Control Specialists Low-Level Radioactive Waste Disposal Facility in Andrews, Texas (2020)

2.13.4 Future Information Needs

The certificate of compliance for the HI-STAR 100 transportation cask does not allow the transport of MPC-68M canisters, high burnup (> 45 GWd/MTHM) SNF, or GTCC waste. Consequently, the certificate of compliance for either the HI-STAR 100MB (Docket No. 71-9378) or the HI-STAR 100 would have to be revised before the SNF stored in MPC-68M canisters, the 248 high burnup SNF assemblies, or the GTCC waste from decommissioning at the Vermont Yankee site could be transported.

2.14 Fort Calhoun

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the Fort Calhoun site. The site is located on the western shore of the Missouri River in Washington County in eastern Nebraska (TOPO 1994g), about 19 miles north of Omaha, Nebraska.

2.14.1 Site Inventory

Fort Calhoun has been shut down since October 24, 2016 and final removal of SNF from the reactor vessel was completed on November 13, 2016 (Burke 2016a, 2016b). Removal of SNF from the Fort Calhoun spent fuel pool was completed on May 13, 2020 (Blome 2020). A total of 1264 SNF assemblies (466.0 MTHM) are stored at Fort Calhoun (Fisher 2017a). These pressurized water reactor SNF assemblies are in dry storage at the Fort Calhoun ISFSI (Docket No. 72-54). The fuel rods in the fuel assemblies are zirconium alloy-clad. The 1264 fuel assemblies are stored in 40 32PT dry shielded canisters. The 32PT dry shielded canister holds 32 pressurized water reactor SNF assemblies and is part of the Standardized NUHOMS System (Docket No. 72-1004). This system consists of transportable dry shielded canisters, reinforced concrete horizontal storage modules, and a transfer cask. Two transfer casks have been used at the Fort Calhoun site, the OS197 and the OS197L. The OS197L transfer cask is lighter and contains less shielding than the OS197 transfer cask. Two additional canisters containing GTCC waste could also be generated at the Fort Calhoun site. Fisher (2017b) states that GTCC waste would not be packaged until 2060-2065.

The MP197HB transportation cask (Docket No. 71-9302) is certified to transport the 32PT canister and also canisters containing GTCC waste. Transport of high burnup (> 45 GWd/MTHM) or damaged SNF in the 32PT canister is not authorized in the certificate of compliance for the MP197HB. An MP197HB transportation cask has been fabricated and is in use in the U.S.

Figure 2-342 illustrates the number of SNF assemblies and MTHM at Fort Calhoun based on discharge year. The oldest fuel was discharged in 1975 and the last fuel was discharged in 2016. The median discharge year of the fuel is 1998.

Figure 2-343 illustrates the number of SNF assemblies and MTHM at Fort Calhoun based on burnup. The lowest burnup is 7.8 GWd/MTHM and the highest burnup is 55.3 GWd/MTHM. The median burnup is 38.5 GWd/MTHM. There are 172 SNF assemblies (63.8 MTHM) at Fort

Calhoun that have burnups greater than 45 GWd/MTHM. These 172 fuel assemblies are classified by the NRC as high burnup SNF.

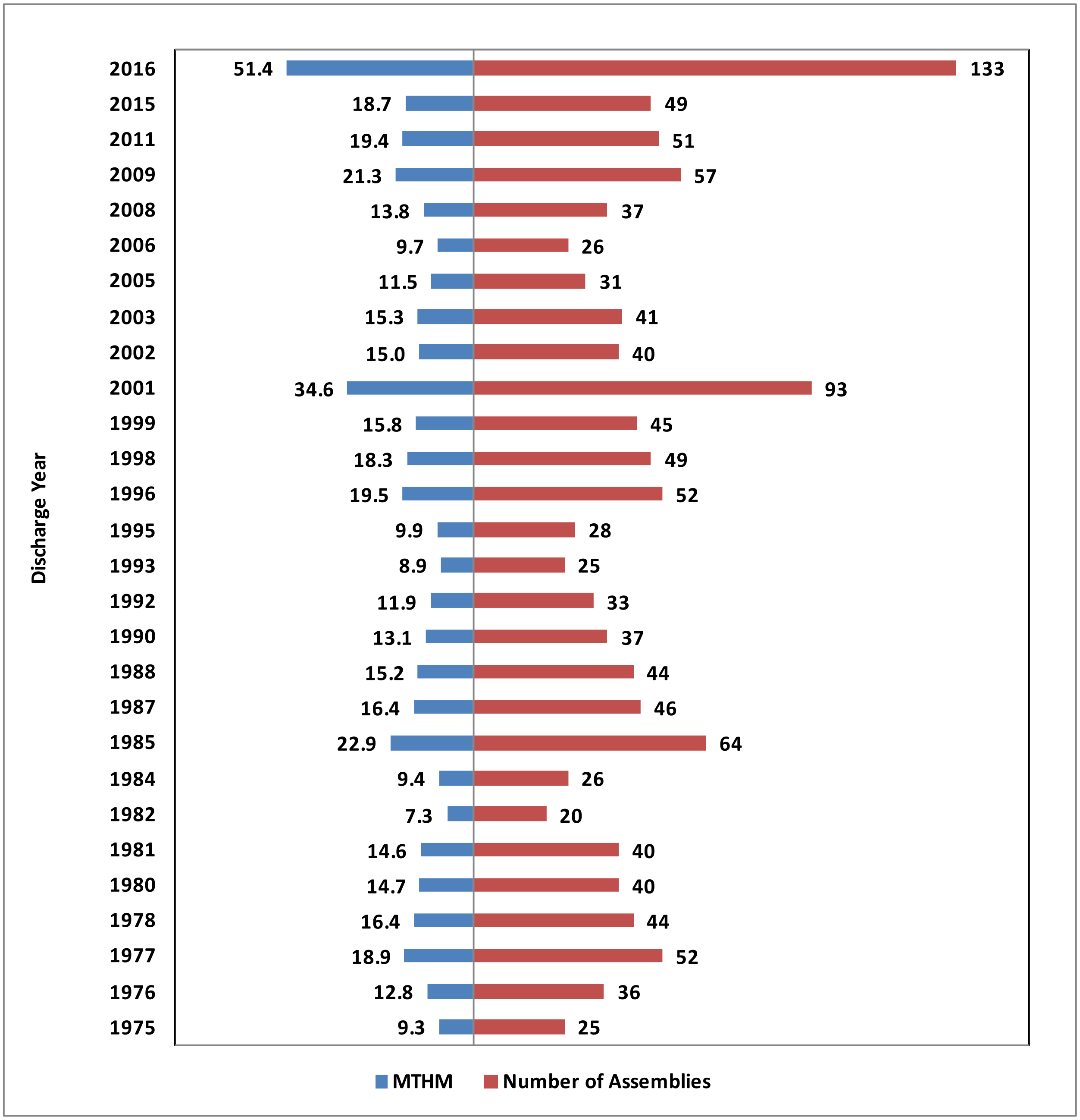


Figure 2-342. Fort Calhoun Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

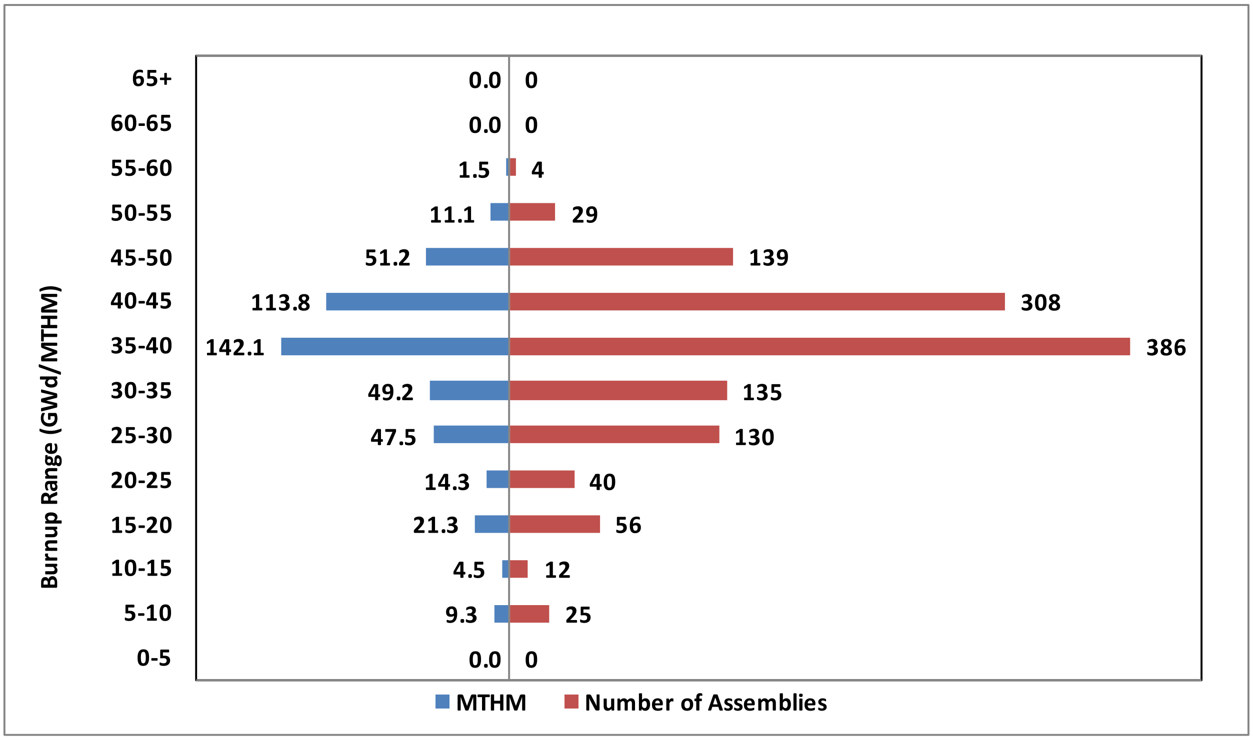


Figure 2-343. Fort Calhoun Number of Assemblies and MTHM versus Burnup (EIA 2018)

2.14.2 Site Conditions

The Fort Calhoun site is located on the western shore of the Missouri River in Washington County, Nebraska and consists of 660 acres of land. The nearest municipalities are Blair, Nebraska, approximately 6 miles to the northwest, and Fort Calhoun, Nebraska, approximately 5 miles to the south of the Fort Calhoun site (NRC 2003). Figure 2-344 provides an aerial view of the Fort Calhoun site.

The Fort Calhoun ISFSI (see Figure 2-345) is located at the northwestern end of the Fort Calhoun site (see Figure 2-346). The ISFSI pad has a capacity of 40 dry storage modules.

Rail service to the Fort Calhoun site is provided by the Union Pacific Railroad through the Cargill Industrial Spur (see Figure 2-347, Figure 2-348, and Figure 2-349). The Cargill Industrial Spur is on a right-of-way easement to the Union Pacific Railroad that follows the base of the bluff across the southern portion of the Fort Calhoun site and continues northwestward to Blair, where it joins the Union Pacific mainline (OPPD 2002). The spur was built in 1994 to serve the neighboring Cargill corn milling and processing facility and is coincident with the Chicago and Northwestern spur used for plant construction, which was subsequently abandoned and removed (OPPD 2002). It should be noted that the bridge over the Cargill Industrial Spur on the Fort Calhoun access road shown in Figure 2-349 has a weight limit of 30 tons (60,000 lb.) and would not support an MP197HB transportation cask, which weighs about 304,000 lb.

The rail spur is 4.33 miles in length and is constructed from 136 lb. rail, concrete ties, and Pandrol clips (see Figure 2-350). The rail spur no longer extends into the site. In the past, the Fort Calhoun on-site rail system had two branches, one branch that ran between the reactor area and the switchyard, and a second branch that ran to the Auxiliary Building (see Figure 2-351). It is possible that the on-site rail spur could be re-established to support decommissioning.

Recent barge access to the Fort Calhoun site has been provided at an area to the northeast of the Fort Calhoun ISFSI (see Figure 2-352).

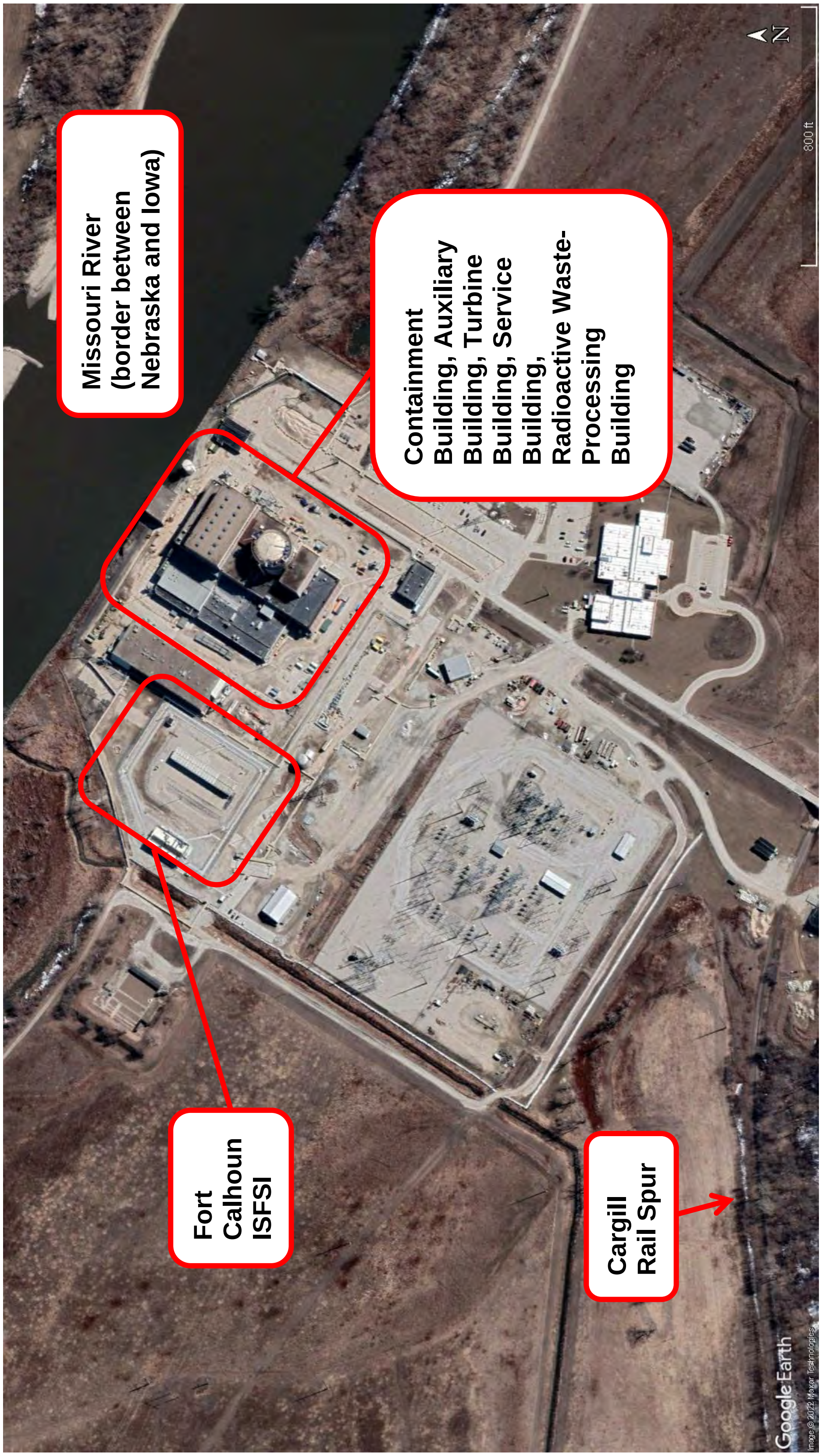


Figure 2-344. Aerial View of Fort Calhoun Site (Google 2022)

Figure 2-345. Fort Calhoun Independent Spent Fuel Storage Installation (2017)

Figure 2-346. Aerial View of Fort Calhoun Independent Spent Fuel Storage Installation (Google 2022)

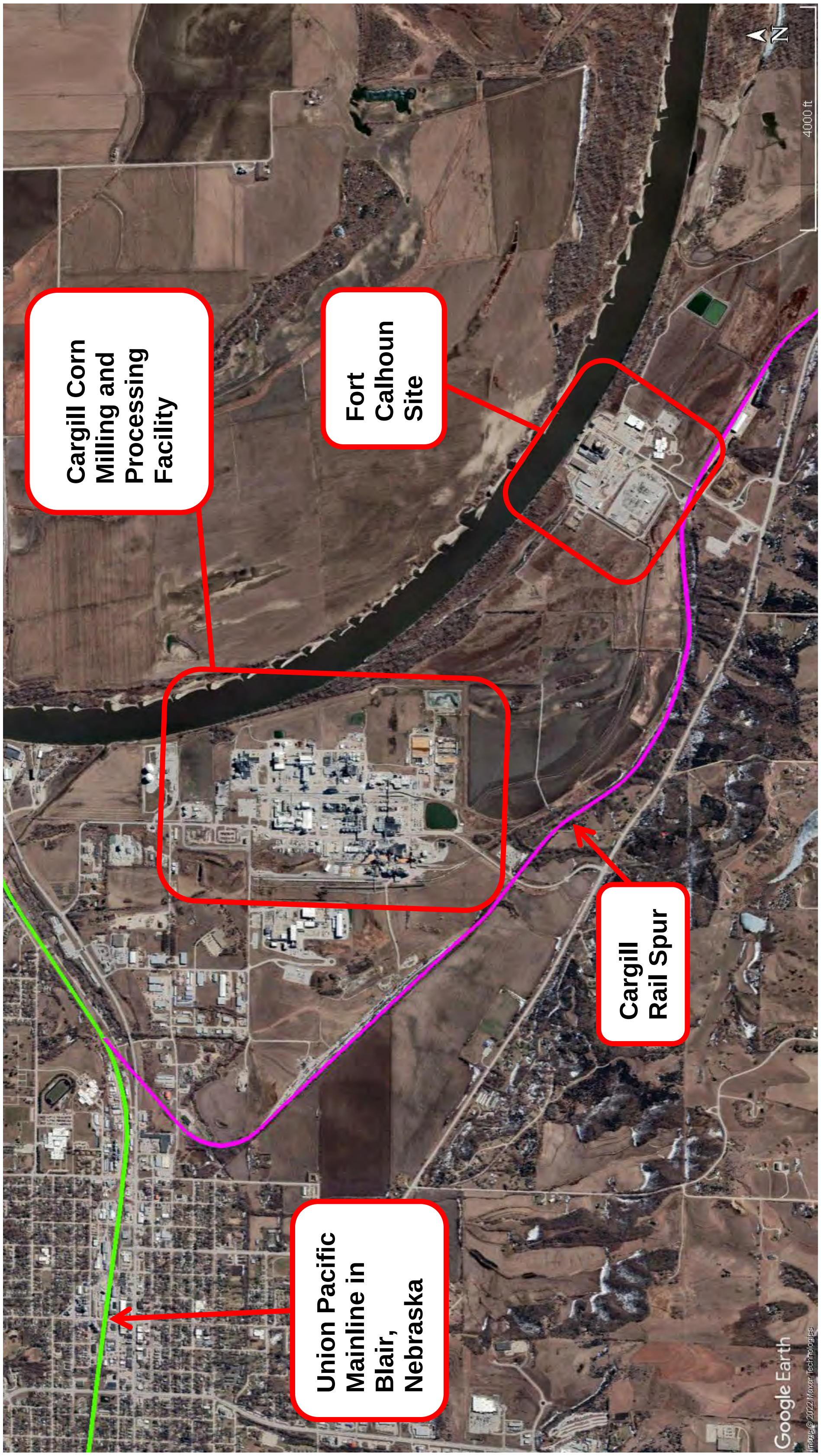


Figure 2-347. Cargill Industrial Spur (Google 2022)

Figure 2-348. Cargill Industrial Spur (Looking Northwest) (2017)

Figure 2-349. Cargill Industrial Spur (Looking Southeast) (2017)

Figure 2-350. Rail, Concrete Ties, and Pandrol Clips on Cargill Industrial Spur (2017)

Figure 2-351. Former On-site Rail Spur at Fort Calhoun (Google 2022)

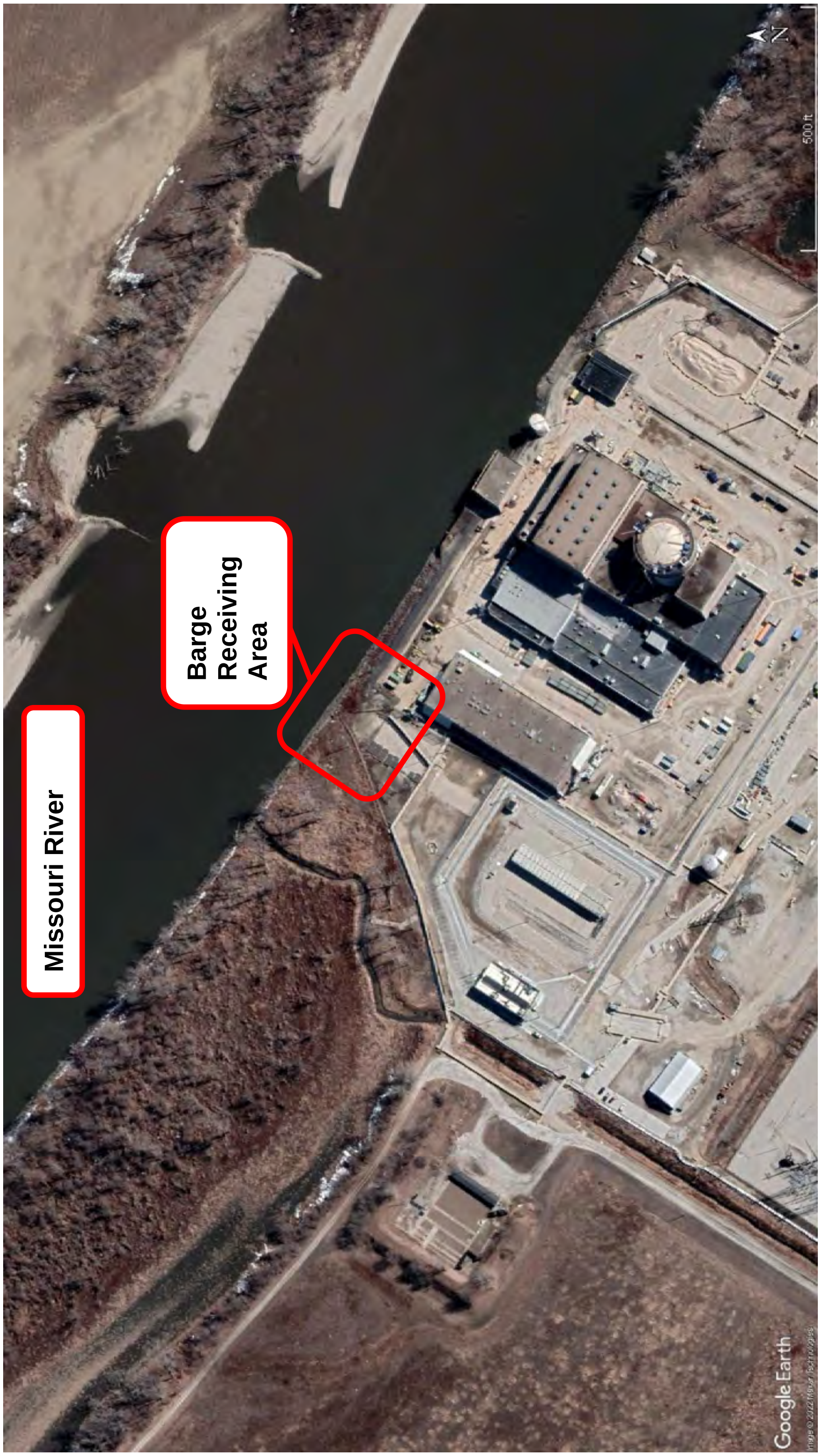


Figure 2-352. Aerial View of Barge Area at Fort Calhoun (Google 2022)

2.14.3 Near-site Transportation Infrastructure and Experience

As mentioned in Section 2.14.2, rail service to the Fort Calhoun site is provided by the Union Pacific Railroad through the Cargill Industrial Spur which connects to the mainline in Blair, Nebraska. In the vicinity of Blair, the Union Pacific Railroad mainline is track class 3. Figure 2-353 and Figure 2-354 show the track at the entrance to the Cargill Industrial Spur (looking south and north, respectively) and Figure 2-355 shows the derailer at the entrance to the spur. At the north end of the spur, Cargill maintains a railyard. North of the Cargill railyard, there is a 7.5-8 degree curve (716-764 ft. radius) (see Figure 2-356). At the entrance to the Cargill yard, there is a derailer and a greaser (see Figure 2-357). Greasers are installed before curves to lubricate the inside of a rail head to reduce wear on the rail and function by dispensing a small amount of grease as the flange of a wheel passes the activator. Figure 2-358 provides a close-up of the greaser and its activators. Figure 2-359 and Figure 2-360 shows the junction of the Cargill Industrial Spur and the Union Pacific Railroad at Blair, Nebraska, looking south and north, respectively.

Figure 2-353. Track at Entrance to Cargill Industrial Spur (Looking South) (2017)

Figure 2-354. Track at Entrance to Cargill Industrial Spur (Looking North) (2017)

Figure 2-355. Derailer at Entrance to Cargill Industrial Spur (2017)

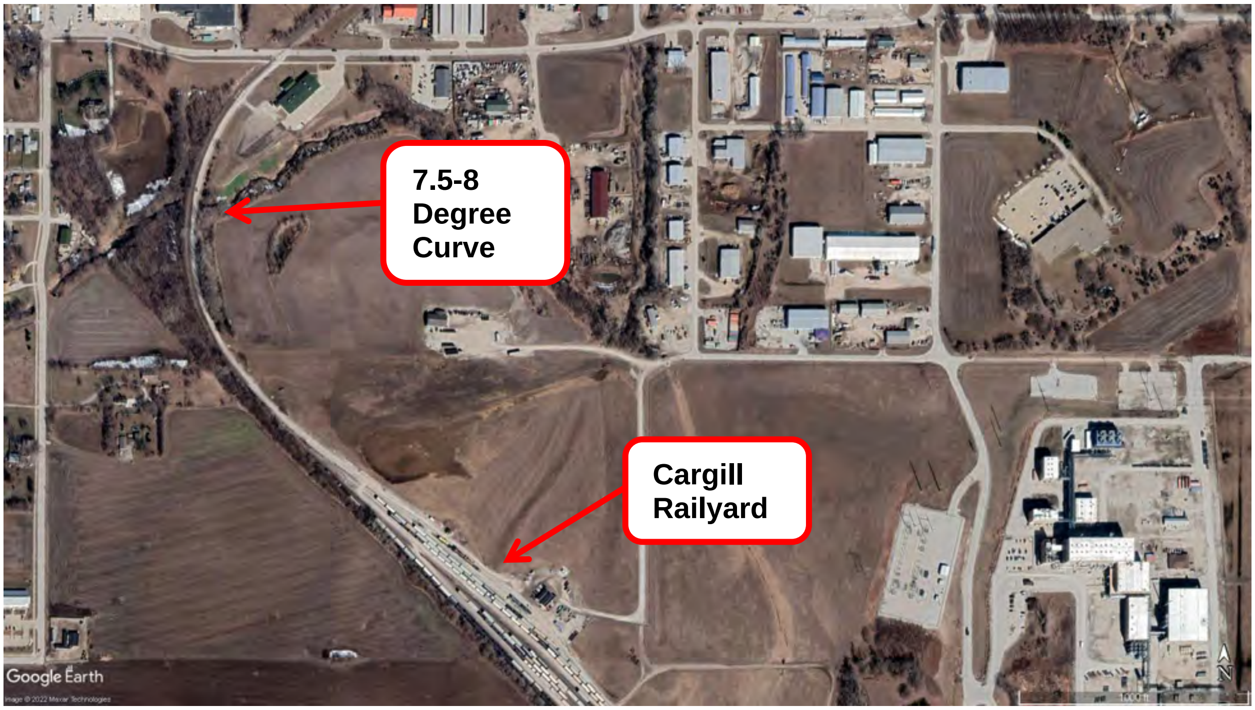


Figure 2-356. Cargill Railyard and 7.5-8 Degree Curve on the Cargill Industrial Spur (Google 2022)

Figure 2-357. Derailer and Greaser on Cargill Industrial Spur (2017)

Figure 2-358. Close-up of Greaser Activators on Cargill Industrial Spur (2017)

Photo courtesy of Federal Railroad Administration

Figure 2-359. Track at Junction of Cargill Industrial Spur and Union Pacific Railroad (Looking South) (2017)

Photo courtesy of Federal Railroad Administration

Figure 2-360. Track at Junction of Cargill Industrial Spur and Union Pacific Railroad (Looking North) (2017)

In 2006, ten horizontal storage modules were shipped to the Fort Calhoun site by rail. The horizontal storage modules were transported using 112-ton, 70-foot deck, 4-axle Kasgro flat cars. Each horizontal storage module weighed 178,000 lb., and had a length of 20.7 feet, a width of 9.7 feet, and a height of 14.8 feet. Figure 2-361 shows the horizontal storage modules being transported by rail; Figure 2-362 shows the horizontal storage modules being delivered; Figure 2-363 provides an aerial view of the transload location and haul road, which was located on the Fort Calhoun site; Figure 2-364 shows a horizontal storage module being transloaded onto a self-propelled modular transporter; Figure 2-365 shows two horizontal storage modules being moved on the haul road to the Fort Calhoun ISFSI; Figure 2-366 shows the horizontal storage modules being installed at the ISFSI; and Figure 2-367 shows the completed ISFSI. Figure 2-368 and Figure 2-369 show the current condition of the transload location and haul road, respectively.

Photo courtesy of Fort Calhoun

Figure 2-361. Horizontal Storage Modules Being Transported by Rail to Fort Calhoun

Photo courtesy of Fort Calhoun

Figure 2-362. Horizontal Storage Modules Being Delivered to Fort Calhoun

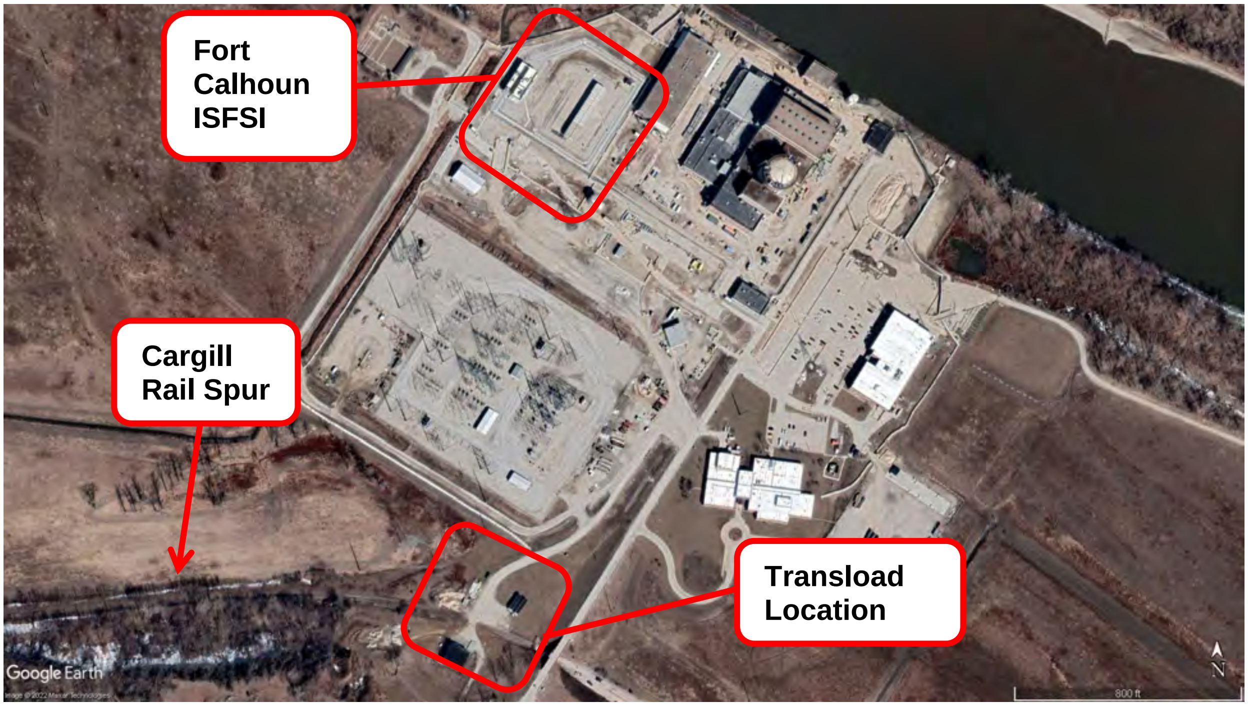


Figure 2-363. Aerial View of Transload Location (Google 2022)

Photo courtesy of Fort Calhoun

Figure 2-364. Horizontal Storage Module Being Transloaded from Railcar to Self-Propelled Modular Transporter

Photo courtesy of Fort Calhoun

Figure 2-365. Horizontal Storage Modules Being Moved on Haul Road to Independent Spent Fuel Storage Installation

Photo courtesy of Fort Calhoun

Figure 2-366. Installation of Horizontal Storage Modules at Independent Spent Fuel Storage Installation

Photo courtesy of Fort Calhoun

Figure 2-367. Completed Fort Calhoun Independent Spent Fuel Storage Installation

Figure 2-368. Current Condition of Transload Location (2017)

Figure 2-369. Current Condition of Haul Road (2017)

The Fort Calhoun site has also received large equipment by barge. On the Missouri River between Fort Calhoun (Missouri River Mile 646) and St. Louis (Missouri River Mile 0), there is a 9-foot-deep and 300-foot-wide navigation channel and no locks or dams. Harsh winter weather and low water levels on the Missouri River in the summer could limit the use of barge transport at the Fort Calhoun site.

During construction, the reactor vessel and steam generators were shipped by barge (see Figure 2-370 and Figure 2-371). In 2006, two steam generators, the pressurizer, and the reactor vessel head were shipped to the Fort Calhoun site by barge. Each steam generator weighed approximately 310 tons and measured approximately 55 ft. x 19.5 ft. x 17.5 ft. The pressurizer weighed approximately 67 tons, and measured approximately 28.5 ft. x 10 ft. x 10 ft. The reactor vessel head weighed approximately 65 tons, and measured approximately 14 ft. x 14 ft. x 12 ft.

The two steam generators, pressurizer, and reactor vessel head were shipped from Japan to New Orleans, loaded onto a barge, and towed from New Orleans to Fort Calhoun on the Mississippi and Missouri Rivers via Memphis, St. Louis, and Omaha.

At Fort Calhoun, two tugboats and two bulldozers stabilized the barge for unloading. Temporary ramps were used to unload the barge. Figure 2-372 shows the two steam generators, pressurizer, and reactor vessel head on the barge. Figure 2-373 and Figure 2-374 show the two tugboats and two bulldozers stabilizing the barge for unloading. Figure 2-375 shows the barge approaching the unloading area, Figure 2-376 shows the installation of the temporary ramps used for unloading, and Figure 2-377 shows a steam generator on a transporter after unloading from the barge.

Photo courtesy of Fort Calhoun

Figure 2-370. Reactor Vessel Being Shipped by Barge During Construction

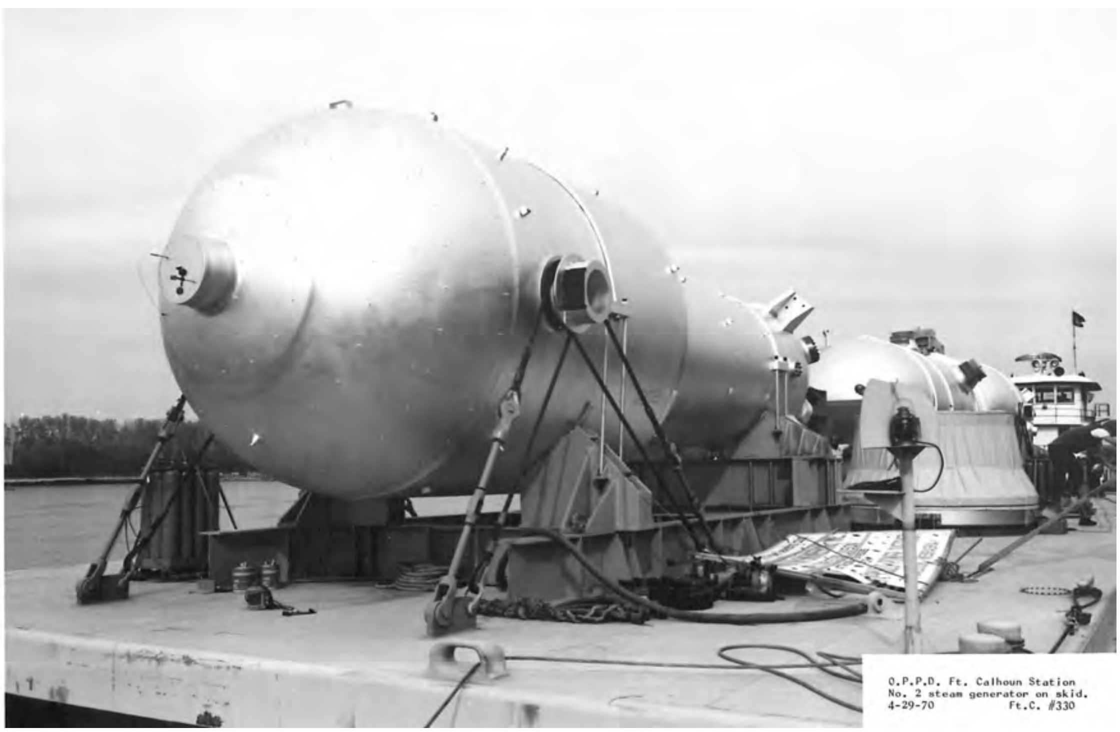


Photo courtesy of Fort Calhoun

Figure 2-371. Steam Generators Being Shipped by Barge During Construction

Photo courtesy of Fort Calhoun

Figure 2-372. Steam Generators, Pressurizer, and Reactor Vessel Head Being Shipped by Barge (2006)

Photo courtesy of Fort Calhoun

Figure 2-373. Tugboats Stabilizing Barge for Unloading (2006)

Photo courtesy of Fort Calhoun

Figure 2-374. Bulldozers Stabilizing Barge for Unloading (2006)

Photo courtesy of Fort Calhoun

Figure 2-375. Preparing to Unload Barge (2006)

Photo courtesy of Fort Calhoun

Figure 2-376. Installation of Temporary Ramps for Unloading (2006)

Photo courtesy of Fort Calhoun

Figure 2-377. Steam Generator on Transporter After Unloading (2006)

2.14.4 Future Information Needs

Direct rail access to the Fort Calhoun site is provided through the Union Pacific Railroad and the Cargill Industrial Spur, so heavy haul truck transport of SNF and GTCC waste to an off-site transload location is unlikely. However, an agreement with Cargill will be necessary to use the rail spur. It is also not known whether an on-site heavy haul and on-site transload would be performed, or if an on-site rail spur would be reinstalled from the Cargill Industrial Spur directly into the Fort Calhoun site. An on-site rail spur could also be used to support shipping of radioactive and nonradioactive waste from decommissioning.

The Fort Calhoun site has recent experience shipping large equipment by barge, and transport of SNF and GTCC waste by barge is also possible; however, the barge area at Fort Calhoun is unimproved.

2.15 Oyster Creek

This section describes the inventory of SNF, site conditions, near-site transportation infrastructure and experience, and future information needs for the Oyster Creek site. The site is located in Lacey Township in eastern New Jersey adjacent to Barnegat Bay, approximately 9 miles south of Toms River, New Jersey, 60 miles south of Newark, New Jersey, 35 miles north of Atlantic City, New Jersey, and 50 miles east of Philadelphia, Pennsylvania (TOPO 1993g, NRC 2007c).

2.15.1 Site Inventory

Oyster Creek was a 1930 MW thermal/619 MW electric boiling water reactor (BWR) and was originally licensed in 1969. The Oyster Creek license was renewed in 2009 for 20 years. The Oyster Creek site permanently ceased power operations on September 17, 2018 and fuel was permanently removed from the Oyster Creek reactor vessel on September 25, 2018 (Gallagher 2018).

There are a total of 4504 BWR SNF assemblies (796.6 MTHM) stored at Oyster Creek, of which 2074 fuel assemblies are stored in 34 Standardized NUHOMS dry storage systems (Docket No. 72 1004) in 61BT and 61BTH dry storage canisters. These canisters can be shipped in the MP197HB transportation cask (Docket No. 71-9302). There are also 2430 fuel assemblies and 17 fuel pins stored in 33 HI-STORM FW dry storage systems (Docket No. 72-1032) in MPC-89 dry storage canisters. These canisters can be shipped in the HI-STAR 190 transportation cask (Docket No. 71-9373). There are 4 canisters containing GTCC waste stored in HI-SAFE dry storage systems at the Oyster Creek site.

Figure 2-378 illustrates the number of SNF assemblies and MTHM at Oyster Creek based on discharge year. The oldest fuel was discharged in 1971 and the last fuel was discharged in 2018. The median discharge year of the fuel is 1998. SNF discharges and assembly burnups for 2018 were estimated using the U.S. Commercial Spent Fuel Projection Tool (Vinson 2015).

Figure 2-379 illustrates the number of SNF assemblies and MTHM at Oyster Creek based on burnup. The lowest burnup is 4.5 GWd/MTHM and the highest burnup is 49.5 GWd/MTHM.

The median burnup is 31.9 GWd/MTHM. There are 241 SNF assemblies (41.5 MTHM) at Oyster Creek that have burnups greater than 45 GWd/MTHM. These 241 fuel assemblies are classified by the NRC as high burnup SNF.

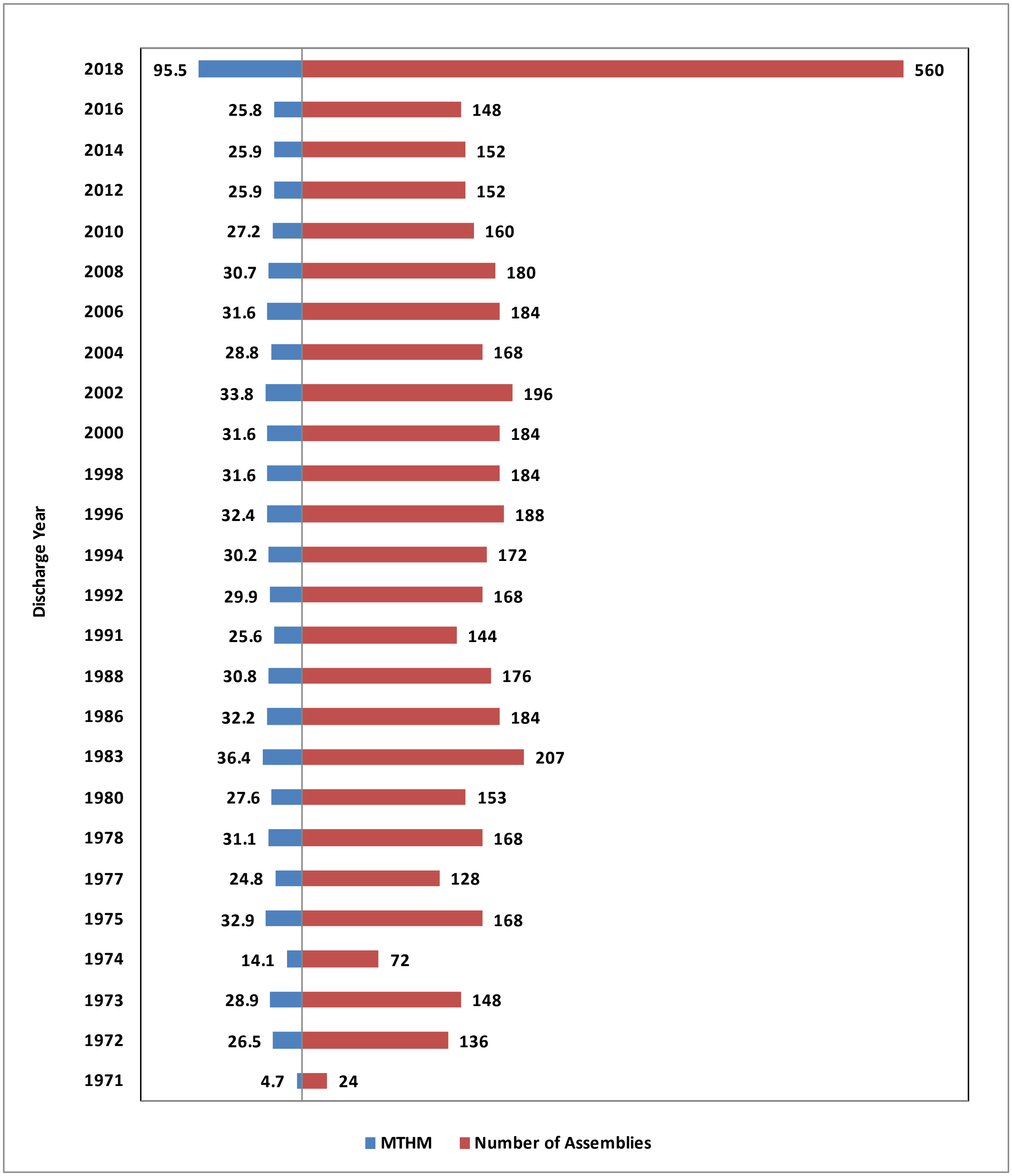


Figure 2-378. Oyster Creek Number of Assemblies and MTHM versus Discharge Year

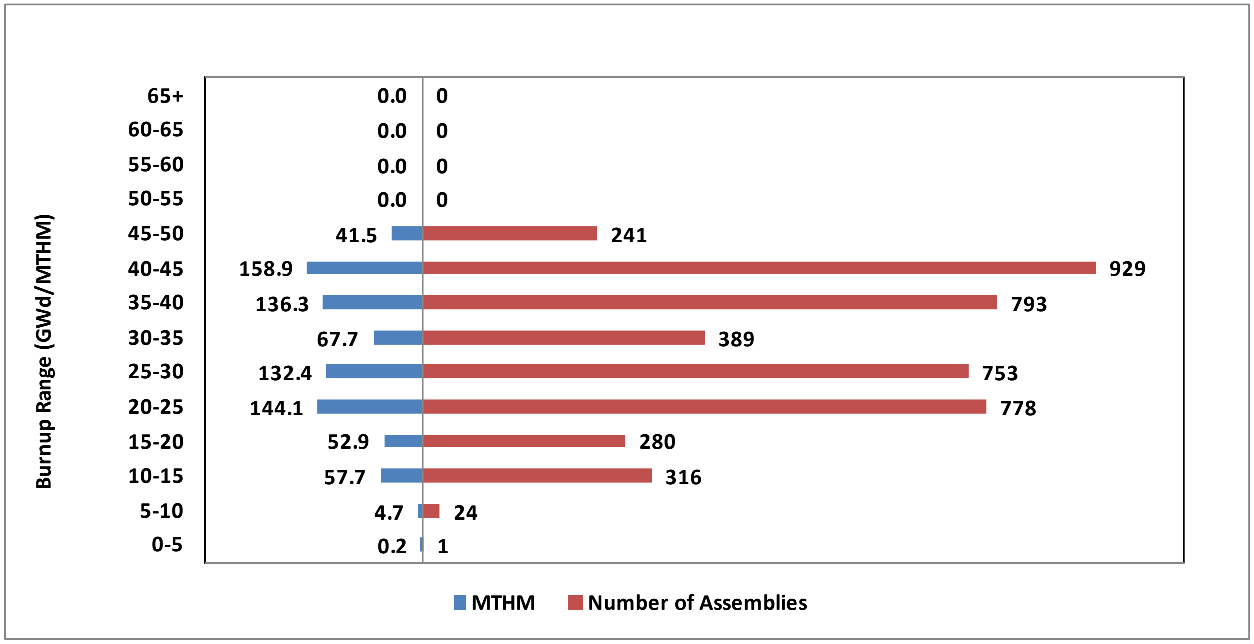


Figure 2-379. Oyster Creek Number of Assemblies and MTHM versus Burnup

2.15.2 Site Conditions

Figure 2-380 provides an aerial view of the Oyster Creek site. The Oyster Creek Independent Spent Fuel Storage Installation (ISFSI) is located at the eastern edge of the Oyster Creek site. Figure 2-381 provides an aerial view of the Oyster Creek ISFSI and Figure 2-382 provides a ground-level view of the ISFSI.

Barge access to the Oyster Creek site is provided at two locations on the site, on the north and south banks of Oyster Creek at the US Route 9 bridge (see Figure 2-380 and Figure 2-383). Figure 2-384 shows the current conditions of the barge access location on the north bank of Oyster Creek, Figure 2-385 shows the barge access road, Figure 2-386 shows the barge access location on the south bank of Oyster Creek and Figure 2-387 shows Oyster Creek looking east from U.S. Route 9 bridge.

These locations were used to ship the 622-ton reactor vessel to Oyster Creek by barge in 1966, a 200-ton transformer to Oyster Creek in 1989, two 200-ton transformers to Oyster Creek in 2010, and one 200-ton transformer from Oyster Creek in 2011. In 1996, a barge carrying ten 100-ton horizontal storage modules to Oyster Creek ran aground in Barnegat Bay.

Oyster Creek is located between U.S. Route 9 and the Garden State Parkway. Figure 2-388 shows a potential heavy haul truck route from the Oyster Creek site to the Garden State Parkway. Figure 2-389 shows the potential heavy haul truck route to the Garden State Parkway looking east and Figure 2-390 shows the potential heavy haul truck route looking west at the Garden State Parkway.

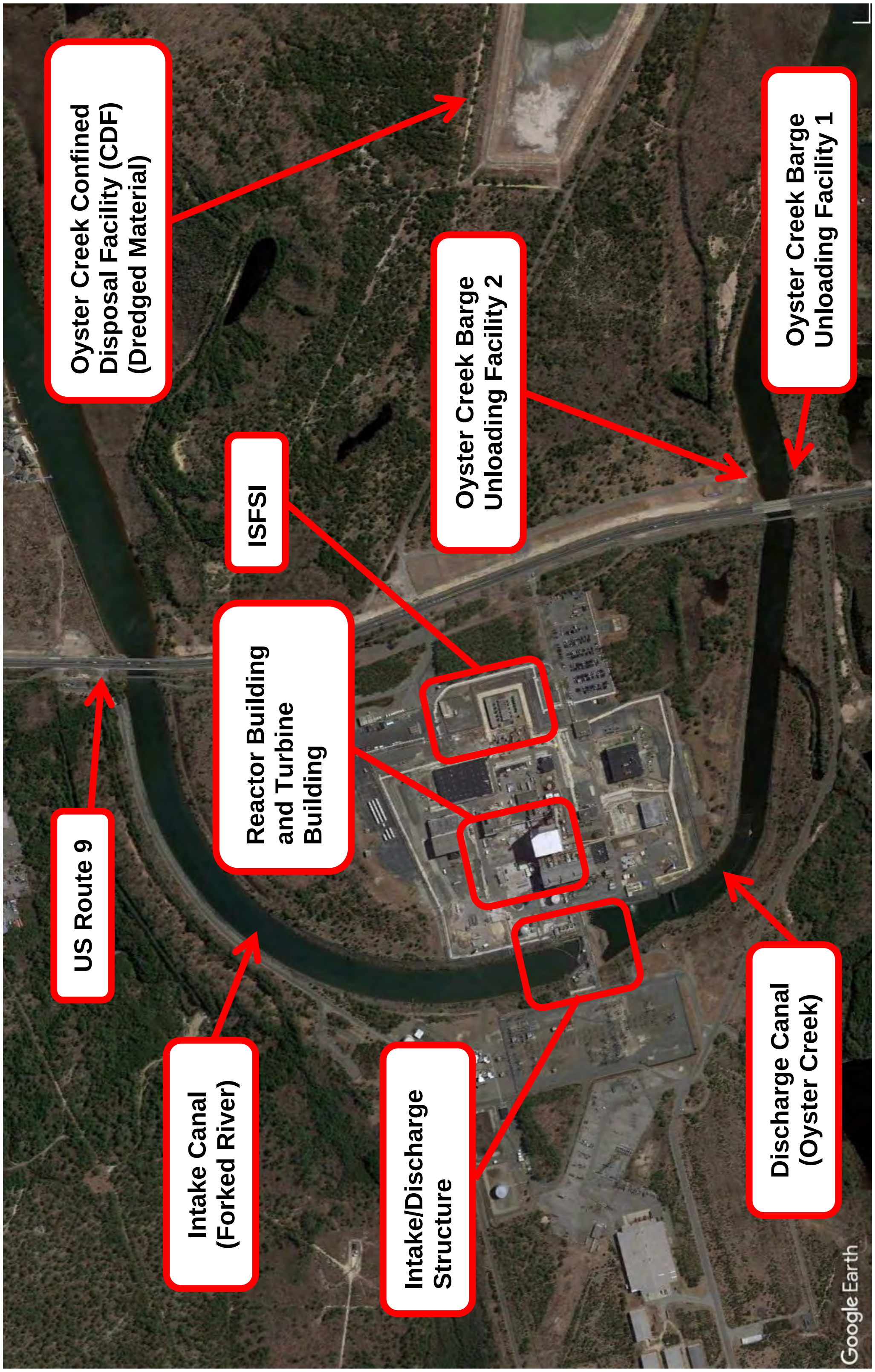


Figure 2-380. Aerial View of Oyster Creek Site (Google 2022)

Figure 2-381. Aerial View of Oyster Creek Independent Spent Fuel Storage Installation (Google 2022)

Figure 2-382. Ground-Level View of Oyster Creek Independent Spent Fuel Storage Installation (2019)

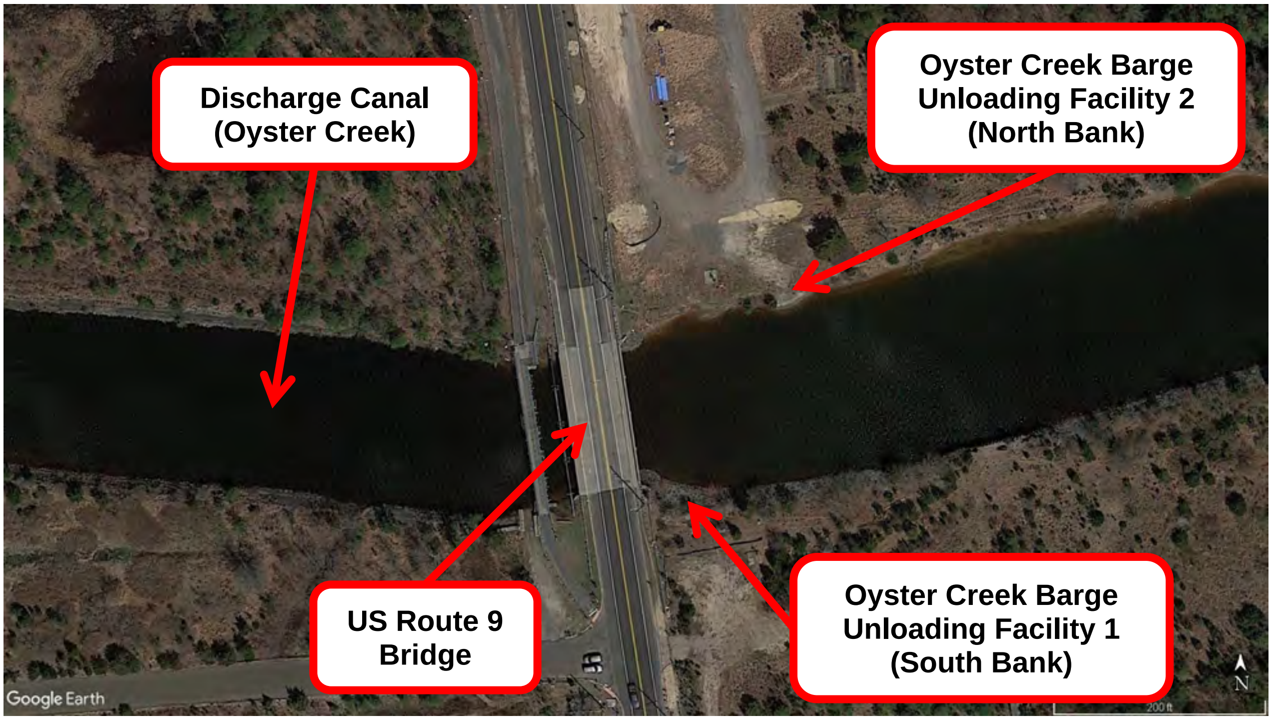


Figure 2-383. Aerial View of Oyster Creek Barge Locations (Google 2022)

Figure 2-384. Oyster Creek Barge Access (North Bank of Oyster Creek) (2019)

Figure 2-385. Oyster Creek Barge Access Road Looking North (2019)

Figure 2-386. Oyster Creek Barge Access Road (South Bank of Oyster Creek) (2019)

Figure 2-387. Oyster Creek Looking East from U.S. Route 9 Bridge (2019)

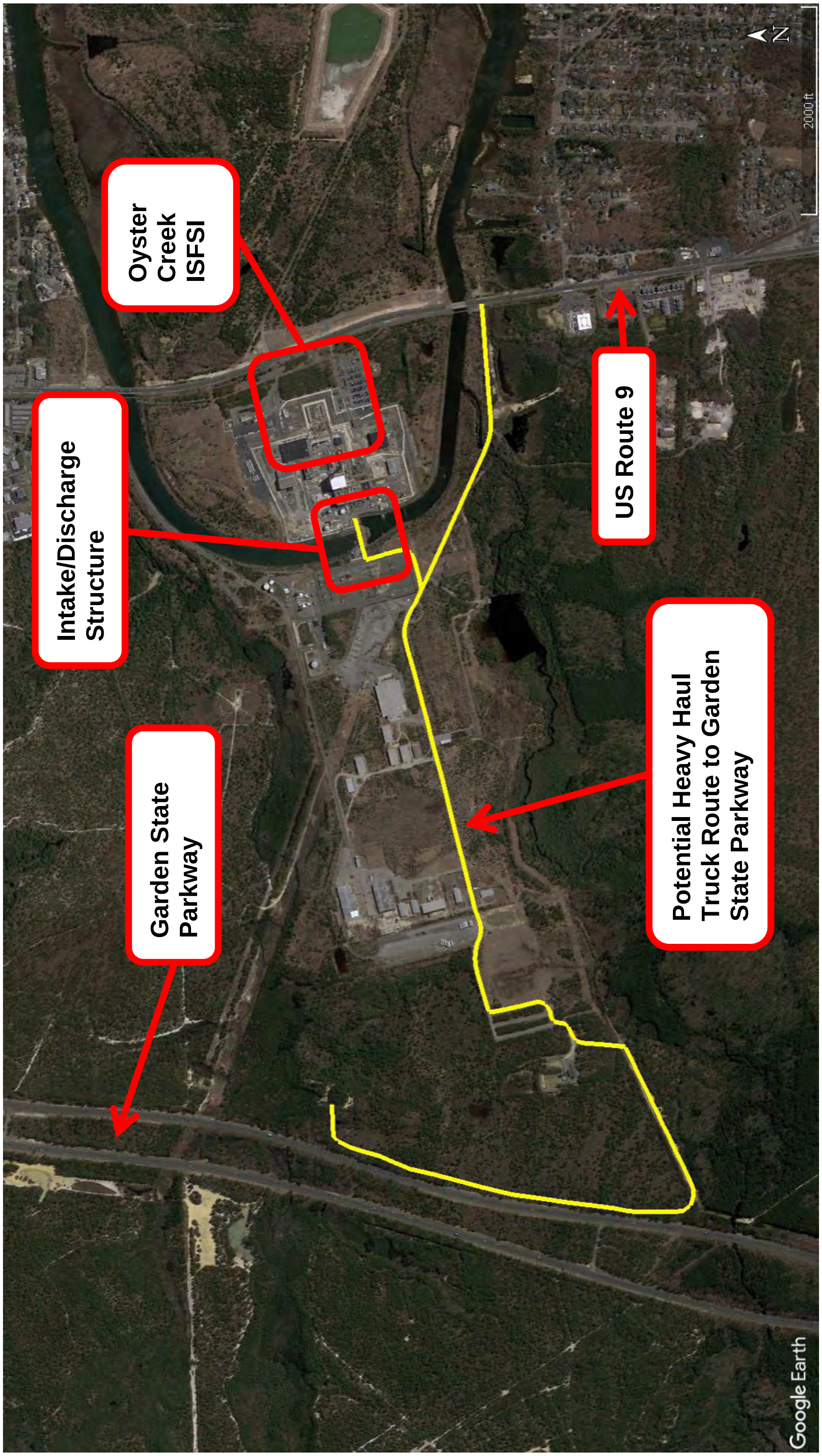


Figure 2-388. Aerial View of Potential Heavy Haul Truck Route to Garden State Parkway (Google 2022)

Figure 2-389. Potential Heavy Haul Truck Route to Garden State Parkway Looking East (2019)

Figure 2-390. Potential Heavy Haul Truck Route Looking West Towards Garden State Parkway (2019)

2.15.3 Near-site Transportation Infrastructure and Experience

Oyster Creek does not currently have rail service. During construction, rail service was provided from Toms River, New Jersey. This rail line is abandoned. The Oyster Creek site has used locations in Freehold and Lakehurst, New Jersey for truck-to-rail transloads (see Figure 2-391). These locations are served by the Conrail Railroad.

Freehold is about 70 miles from Oyster Creek and Lakehurst is about 30 miles from Oyster Creek. Access to these locations was provided via heavy haul truck transport. The Freehold transload location was used to ship two 150-ton transformers by rail to Philadelphia and Bradenton, Florida in 1989 for repair, and to ship one 150-ton transformer by rail from Bradenton, Florida in 1990. The Lakehurst transload location was used to ship a 235-ton transformer by rail in 1989.

Figure 2-392 and Figure 2-393 show the rail line in Lakehurst, New Jersey looking northeast and the end of the rail line in Lakehurst, respectively. Figure 2-394 and Figure 2-395 show the rail line in Freehold, New Jersey looking northwest and southeast, respectively. Figure 2-396 shows the end of the rail line in Freehold, New Jersey.

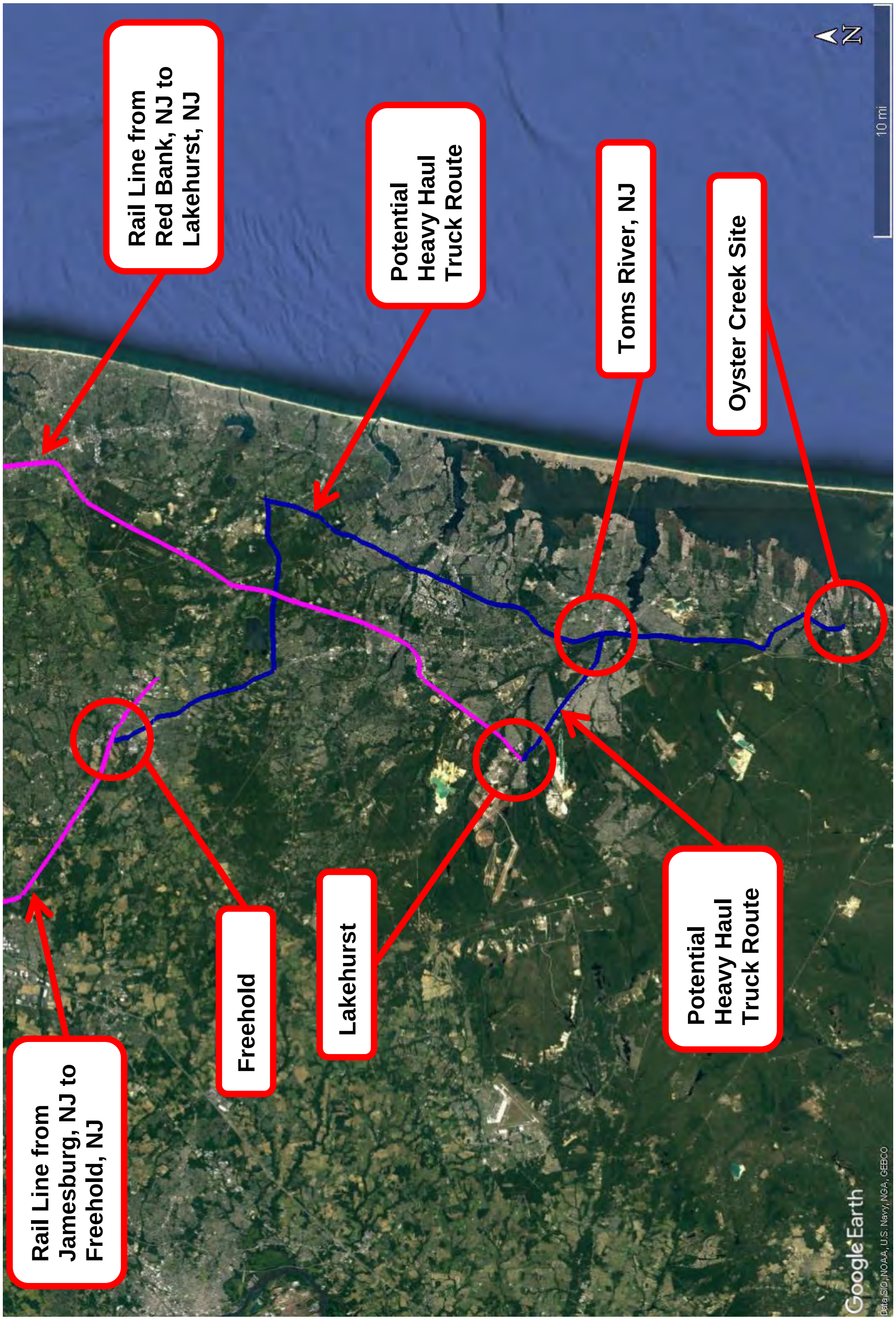


Figure 2-391. Potential Oyster Creek Rail Access Locations (Google 2022)

Figure 2-392. Rail Line in Lakehurst, New Jersey Looking Northeast (2019)

Figure 2-393. End of Rail Line in Lakehurst, New Jersey Looking Northeast (2019)

Figure 2-394. Rail Line in Freehold, New Jersey Looking Northwest (2019)

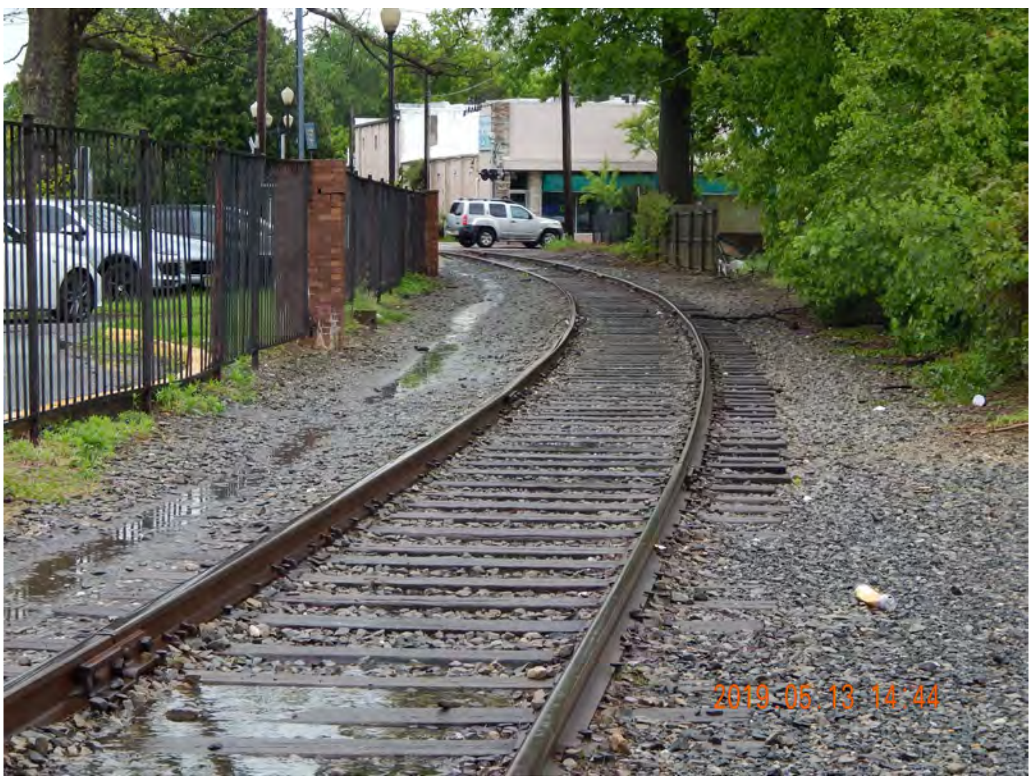


Figure 2-395. Rail Line in Freehold, New Jersey Looking Southeast (2019)

Figure 2-396. End of Rail Line in Freehold, New Jersey Looking Northwest (2019)

Conrail Railroad staff stated that the Freehold and Lakehurst locations were no longer viable transload locations and recommended evaluating the Conrail Railyard in Morrisville, Pennsylvania as an alternative transload location. This location is northwest of and approximately 57 to 69 miles from the Oyster Creek site (see Figure 2-397). A heavy haul truck route to this location would also require crossing the Delaware River, which is the border between New Jersey and Pennsylvania.

Figure 2-398 provides an aerial view of the Morrisville Railyard, Figure 2-399 shows the Morrisville Railyard looking east, Figure 2-400 shows a potential transload location on a rail spur at the Morrisville Railyard, Figure 2-401 shows the 131-lb. rail at the Morrisville Railyard, and Figure 2-402 shows the access road to the Morrisville Railyard.

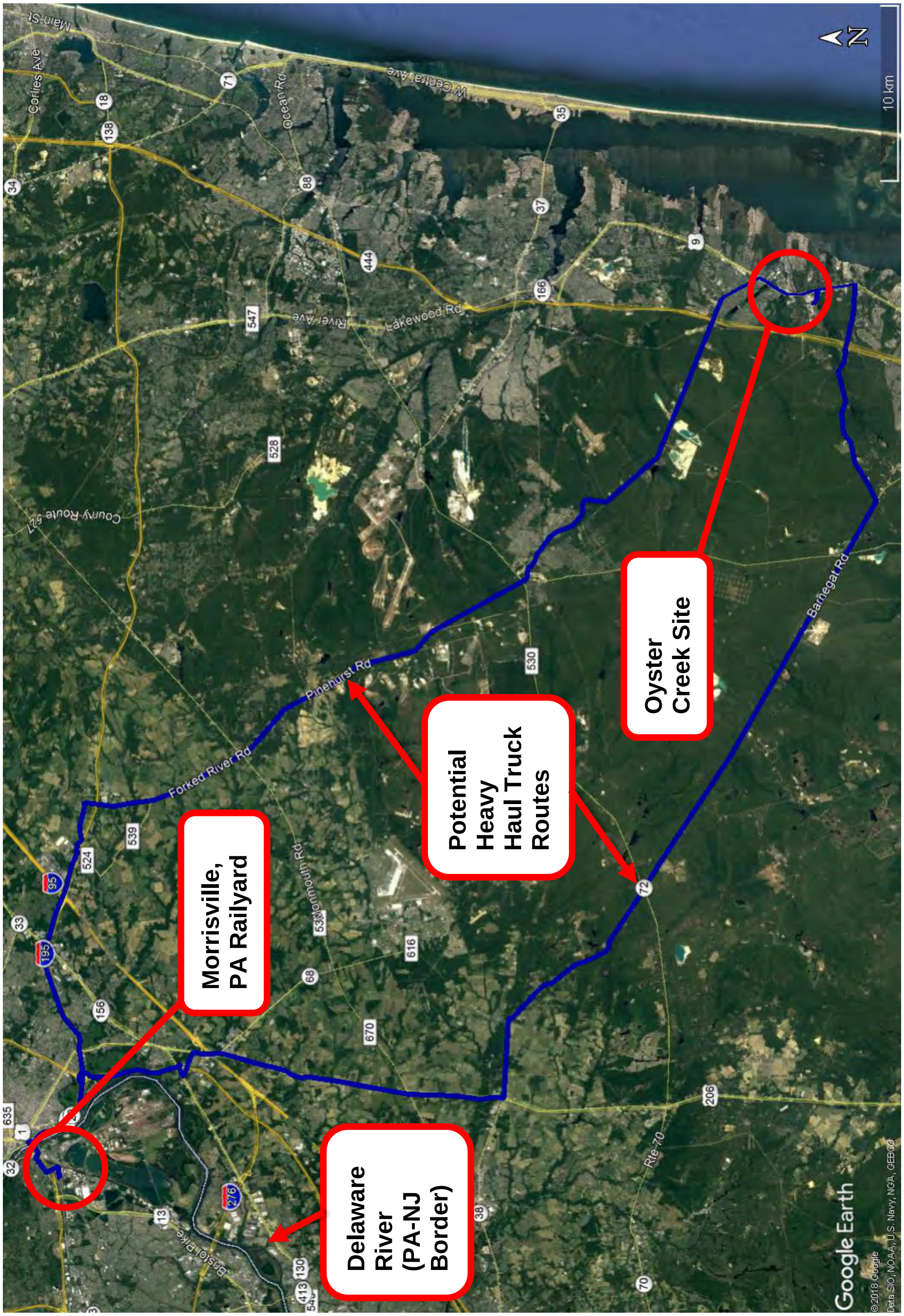


Figure 2-397. Location of Morrisville, Pennsylvania Railyard and Potential Heavy Haul Truck Routes from Oyster Creek (Google 2022)

Figure 2-398. Aerial View of the Morrisville, Pennsylvania Railyard (Google 2022)

Figure 2-399. Morrisville Railyard Looking East (2019)

Figure 2-400. Potential Transload Location at Morrisville Railyard (2019)

Figure 2-401. 131-lb. Rail at Morrisville Railyard (2019)

Figure 2-402. Morrisville Railyard Access Road (2019)

As mentioned previously, Oyster Creek has barge access to the Atlantic Ocean through the Barnegat Bay Inlet. Figure 2-403 provides an aerial view of the Oyster Creek state and federal channels, the Forked River state channel, the Intracoastal Waterway, and the Barnegat Bay inlet channel. Figure 2-404 shows the entrance to Barnegat Bay Inlet. The Oyster Creek channel is maintained at a depth of about 6 feet below mean low water (MLW) by the New Jersey Department of Transportation (NJDOT). Key waterways beyond the immediate boundary of the Oyster Creek site are located within Barnegat Bay and include the Intracoastal Waterway, the Oyster Creek channel, and Barnegat Bay Inlet, all of which are federal navigation channels maintained by the U.S. Army Corps of Engineers (USACE) at approximately 6 feet, 8 feet, and 8 feet, respectively, below MLW. The ocean bar beyond Barnegat Bay Inlet (not depicted in Figure 2-403) is also a federal navigation channel maintained at about 10 feet below MLW by USACE.

The Forked River State navigation channels were dredged in 2017 (Becker et al. 2019) and NJDOT typically conducts depth studies of Oyster Creek every 2 to 3 years. The Oyster Creek (federal) channel is typically dredged every 8 to 10 years, with the condition of the channel determining how often it is dredged. However, the existing depths (and widths) of these and the other State and federal navigation channels noted above are unknown and could be less than the maintained depths (and widths) due to frequent sediment deposition attributed to the geology of the Coastal Plain and to shoaling processes. For example, during severe winter weather, the width of the Oyster Creek channel (federal) may shrink from 75 feet to 30 feet, and depth may be reduced to 3 to 5 feet, with barge transport potentially requiring a 60-foot width and a greater depth (Becker et al. 2019).

In addition to depth and width of the waterways, a variety of conditions may impact potential dredging and barging activities. These include weather conditions, seasonal limitations, barge traffic, and potential restrictions due to seasonal fish spawning activities. Since the Oyster Creek site is no longer operating (absence of heated cooling water discharge), Oyster Creek may freeze over for brief periods during winter. Barnegat Bay and the Forked River have frozen over periodically in winter regardless of the operational status of the Oyster Creek site. Such weather conditions may temporarily curtail dredging activities, restricting dredging to ice-free periods. The most suitable weather for dredging is generally June through August; however, this is also the period of greatest barge traffic in Barnegat Bay. Further, in-water work may need to be done outside time periods established by the National Marine Fisheries Service to protect essential fish habitat for winter flounder (*Pseudopleuronectes americanus*) (January 1–May 31), and summer flounder (*Paralichthys dentatus*) (April 15–October 15) in areas with submerged aquatic vegetation located adjacent to channels. Such restrictions have been applied previously to dredging projects in the vicinity of Barnegat Bay (Becker et al. 2019), and it is noteworthy that NJDOT's dredging of the Oyster Creek channel in 2017 was completed between early October and December 31 (outside the time periods for protecting winter flounder and summer flounder). Additionally, local tides may affect the ability to conduct dredging and barging because tides cause the water level to vary +/- 1 foot, with greater fluctuations occurring during storms.

Maintenance dredging of the Oyster Creek State channel occurred April–May 1970 when 63,467 yd^3 of sediment were removed (Becker et al. 2019). GPU Nuclear, Inc., the former owner and operator of Oyster Creek site until 1999, acquired a Waterfront Development Permit/Water Quality Certification in 1997 for maintenance and new dredging (Becker et al. 2019). The permit was valid until 2002 and authorized the removal of 85,485 yd^3 of sediment from the Forked River. For this permit, dredging in the Forked River was limited to a depth of 5 feet below MLW. Dredged materials generated from dredging activities at the Oyster Creek site were deposited in the Confined Disposal Facility (CDF), located east of the Oyster Creek site (see Figure 2-380). The NJDOT currently owns and operates the CDF; however, dredged materials may be reused or deposited elsewhere, such is the Sedge Islands in Barnegat Bay.

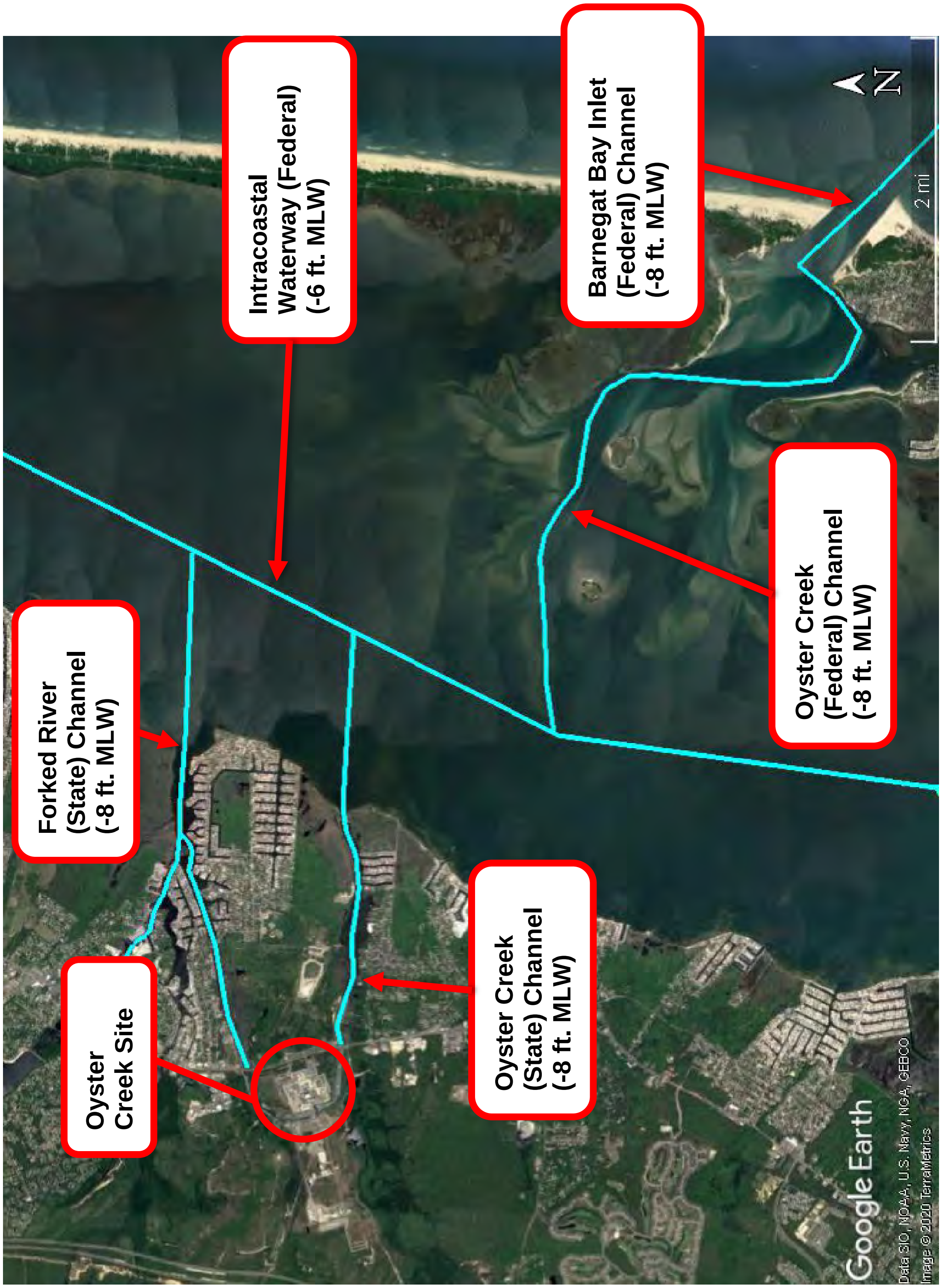


Figure 2-403. Aerial View of the Oyster Creek State and Federal Channels, the Intracoastal Waterway, and the Barnegat Bay Inlet Channel (Google 2022)

Figure 2-404. Entrance to Barnegat Bay Inlet (2019)

2.15.4 Future Information Needs

The Oyster Creek site does not have direct rail access. However, it does have two barge areas located on-site and has experience shipping large components by barge. Dredging of the Oyster Creek state and federal channels, the Intracoastal Waterway, and the Barnegat Bay Inlet federal channel could potentially be required to ship SNF from the Oyster Creek site by barge. Dredged materials generated from dredging activities at the Oyster Creek site could be deposited at the CDF located east of the Oyster Creek site; however, dredged materials may be reused or deposited elsewhere, such as the Sedge Islands in Barnegat Bay.

Three potential off-site heavy haul truck to rail transload locations were evaluated. Although two of the locations, Lakehurst and Freehold, New Jersey, have previously been used to move large equipment to and from the Oyster Creek site, Conrail Railroad staff have stated that the Freehold and Lakehurst locations were no longer viable transload locations. The third transload location, the Conrail Railyard in Morrisville, Pennsylvania, would require moving SNF transportation casks 57 to 69 miles by heavy haul truck to reach the transload location and would also require crossing the Delaware River, which is the border between New Jersey and Pennsylvania.

2.16 Pilgrim

This section describes the inventory of SNF, site conditions, near-site transportation infrastructure and experience, and future information needs for the Pilgrim site. The Pilgrim site is located on the western shore of Cape Cod Bay in the Town of Plymouth, Massachusetts, about 38 miles southeast of Boston and 44 miles east of Providence, Rhode Island (TOPO 1994h, NRC 2007d).

2.16.1 Site Inventory

Pilgrim was a 2028 MW thermal/677 MW electric BWR originally licensed in 1972. The Pilgrim license was renewed in 2012 for 20 years. The Pilgrim site permanently ceased power operations on May 31, 2019 and fuel was permanently removed from the Pilgrim reactor vessel on June 9, 2019 (Sullivan 2019).

There are a total of 4113 BWR SNF assemblies (731.0 MTHM) stored at Pilgrim, of which 1156 fuel assemblies are stored in 17 HI-STORM dry storage systems (Docket No. 72-1014) in MPC-68 dry storage canisters and 2957 fuel assemblies are stored in 45 HI-STORM dry storage systems in MPC-68M dry storage canisters. A total of 62 MPC-68 and MPC-68M canisters will eventually be stored at the Pilgrim site. There are 3 canisters containing GTCC waste stored in HI-SAFE dry storage systems at the Pilgrim site.

The HI-STAR 100 transportation cask (Docket No. 71-9261) is certified to ship MPC-68 canisters. Transport of MPC-68M canisters, high burnup (> 45 GWd/MTHM) SNF, or GTCC waste is not authorized in the certificate of compliance for the HI-STAR 100. The certificate of compliance for either the HI-STAR 100MB (Docket No. 71-9378) or HI-STAR 100 could be revised to include these contents.

Figure 2-405 illustrates the number of SNF assemblies and MTHM at Pilgrim based on discharge year. The oldest fuel was discharged in 1973 and the last fuel was discharged in 2019. The median discharge year of the fuel is 1999. SNF discharges and assembly burnups for 2019 were estimated using the U.S. Commercial Spent Fuel Projection Tool (Vinson 2015).

Figure 2-406 illustrates the number of SNF assemblies and MTHM at Pilgrim based on burnup. The lowest burnup is 2.6 GWd/MTHM and the highest burnup is 53.7 GWd/MTHM. The median burnup is 32.8 GWd/MTHM. There are 1461 SNF assemblies (251.4 MTHM) at Pilgrim that have burnups greater than 45 GWd/MTHM. These 1461 fuel assemblies are classified by the NRC as high burnup SNF.

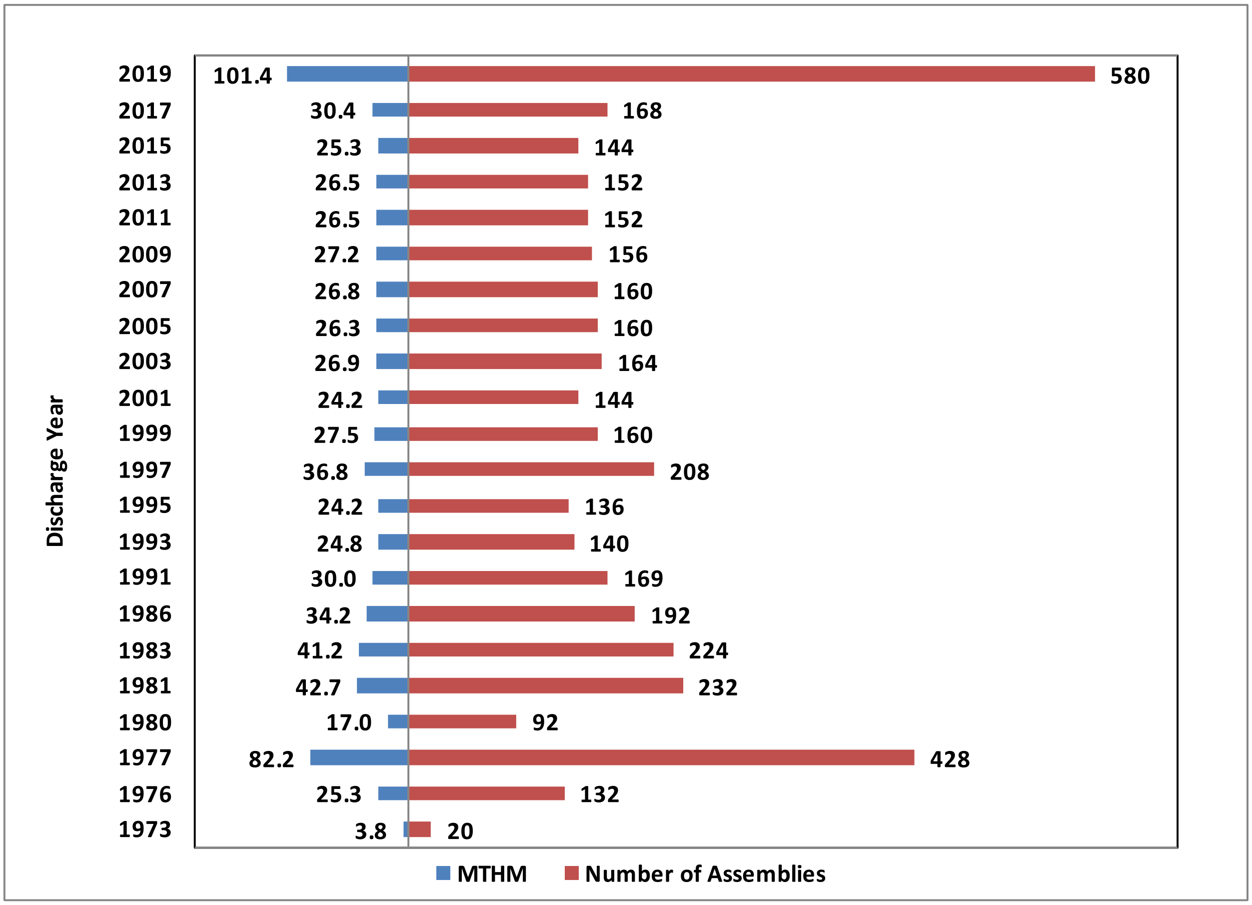


Figure 2-405. Pilgrim Number of Assemblies and MTHM versus Discharge Year

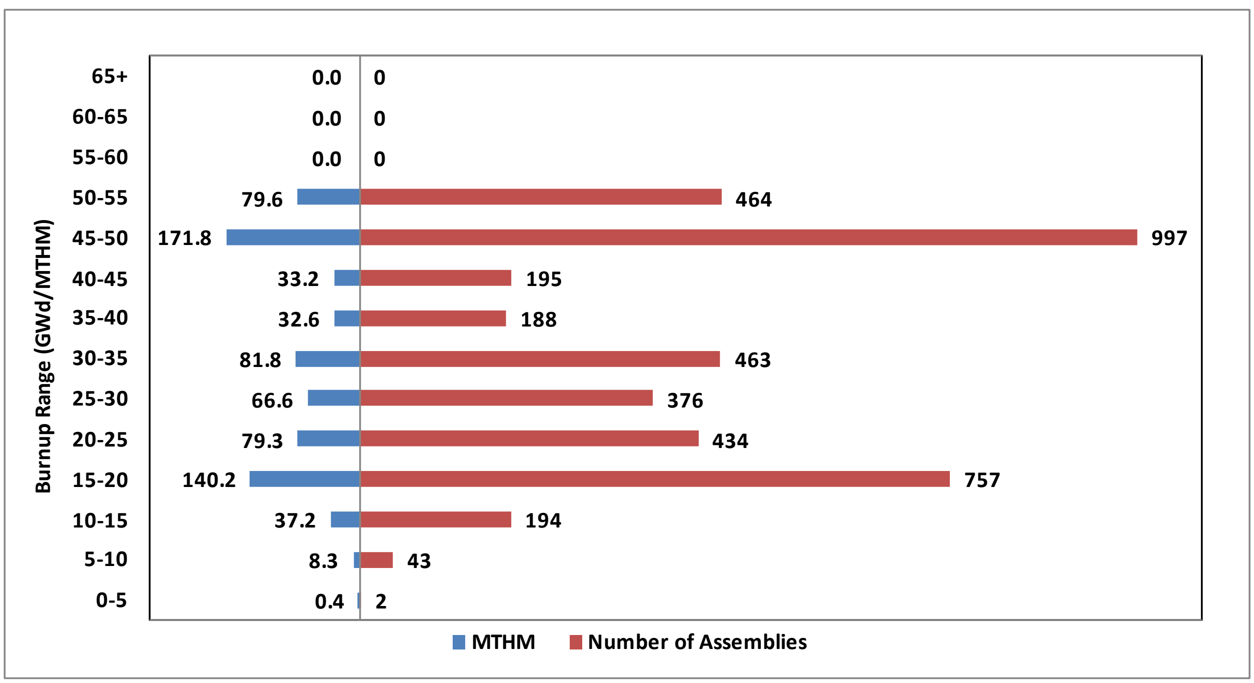


Figure 2-406. Pilgrim Number of Assemblies and MTHM versus Burnup

2.16.2 Site Conditions

Figure 2-407 provides an aerial view of the Pilgrim site. The current Pilgrim ISFSI is located at the northwestern edge of the Pilgrim site (Figure 2-407, Figure 2-408 and Figure 2-409). A new ISFSI is currently being constructed at the Pilgrim site (see Figure 2-407, Figure 2-410, Figure 2-411, and Figure 2-412). The current ISFSI is located 25.5 feet above sea level; the new ISFSI will be located 75 feet above sea level. All dry storage canisters will be moved to this new ISFSI in 2021.

Barge access to the Pilgrim site is at the north end of the site on Cape Cod Bay (see Figure 2-413 and Figure 2-414). During construction, this location was used to receive the Pilgrim reactor pressure vessel. Although dredging of the Pilgrim intake channel was conducted during operations, the barge area was not regularly dredged. Refurbishment would be required to use this location for barge shipments of SNF and could involve dredging which could require multiple permits. There could be time of year restrictions on dredging due to potential impacts on species such as the winter flounder (*Pseudopleuronectes americanus*) and on shipping in Cape Cod Bay due to its use by North Atlantic right whales (*Eubalaena glacialis*). Disposal of dredged material would likely be at the Massachusetts Bay Disposal Site[25] or the Cape Cod Bay Disposal Site.[26]

[25] The Massachusetts Bay Disposal Site is located 12 nautical miles southeast of Gales Point, Massachusetts. Water depths at this location range from 269 to 302 feet.

[26] The Cape Cod Bay Disposal Site is located 8.0 nautical miles southwest of Long Point, Provincetown, Massachusetts. Water depths at this location average 102 feet.

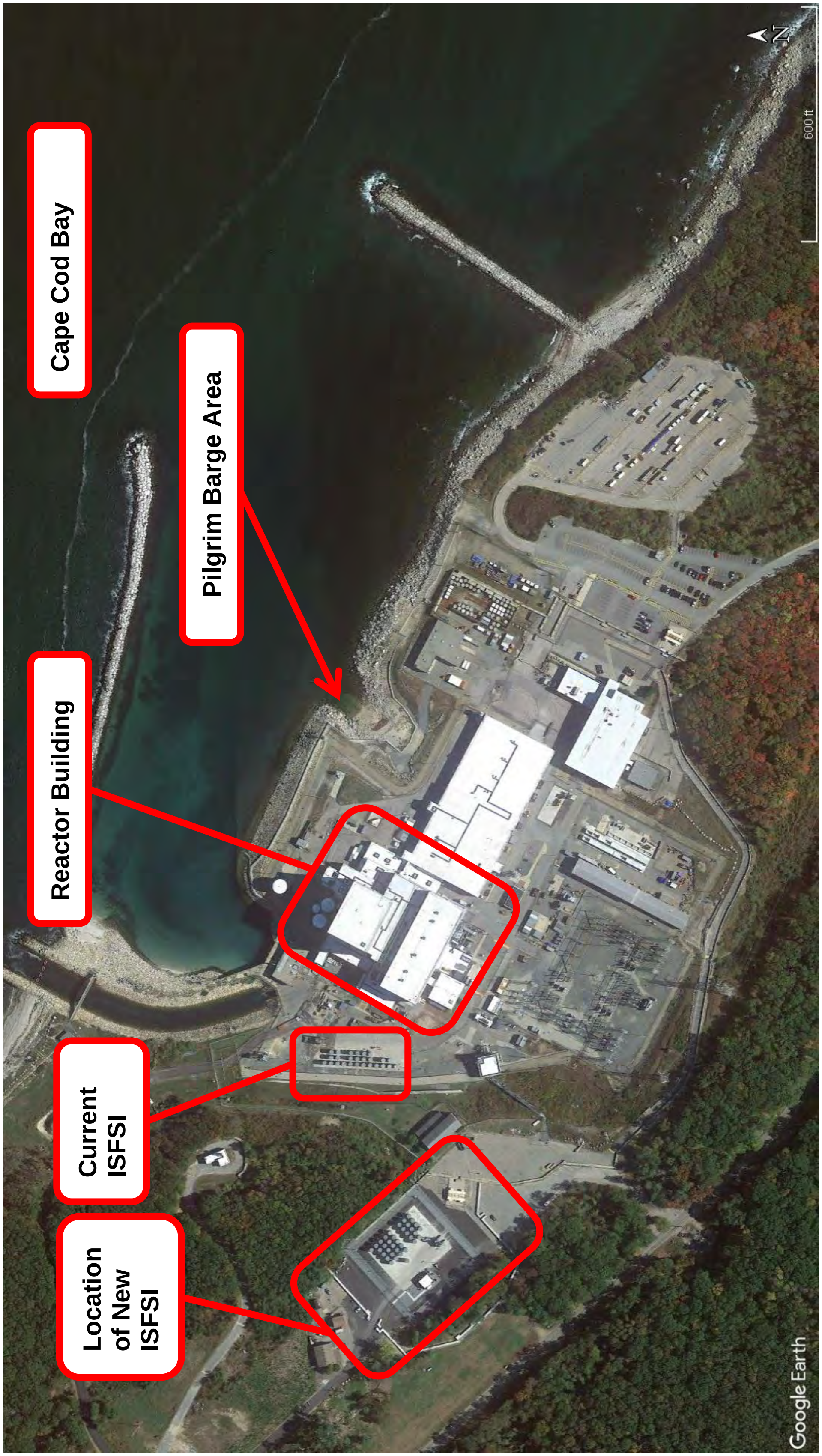


Figure 2-407. Aerial View of Pilgrim Site (Google 2022)

Figure 2-408. Current Pilgrim Independent Spent Fuel Storage Installation (2019)

Figure 2-409. Storage System Mover at Pilgrim Independent Spent Fuel Storage Installation (2019)

Figure 2-410. Location of New Pilgrim Independent Spent Fuel Storage Installation (Google 2022)

Figure 2-411. Construction of New Pilgrim Independent Spent Fuel Storage Installation (2019)

Figure 2-412. Construction of New Pilgrim Independent Spent Fuel Storage Installation (2019)

Figure 2-413. Aerial View of Pilgrim Barge Access Location (Google 2022)

Figure 2-414. Barge Access at Pilgrim Site (2019)

2.16.3 Near-site Transportation Infrastructure and Experience

Pilgrim does not currently have rail service. In the past, Pilgrim used a freight line that terminated in Plymouth, Massachusetts, about 7 miles from the site, for moving heavy equipment such as transformers to the site. This rail line is now a passenger line and is not suitable for shipping large SNF transportation casks because the large SNF transportation casks will not clear the station platforms.

Because Pilgrim does not have direct rail access, two off-site heavy haul truck to rail transload locations were evaluated, one in Middleborough, Massachusetts, about 23-30 miles from the Pilgrim site, and a second location also in Middleborough about 24-28 miles from the Pilgrim site (see Figure 2-415). Both locations are served by the Massachusetts Coastal Railroad.

Figure 2-416 shows an aerial view of the first potential transload location. Figure 2-417 and Figure 2-418 provide views of the transload location looking east and west, respectively. Figure 2-419 shows a derailer, Figure 2-420 shows positive train control sensors, and Figure 2-421 shows 132-lb. rail at the first potential transload location. Access to the first location is provided by I-495; however, the closest exit contains a low overhead (13 feet 11 inches bridge) (see Figure 2-422).

Figure 2-423 shows an aerial view of the second potential transload location. Figure 2-424 and Figure 2-425 show the mainline at the second potential transload location looking southeast and northwest, respectively. Figure 2-426, Figure 2-427, Figure 2-428, and Figure 2-429 show the industrial spur at the second potential transload looking southeast, south, northwest, and east, respectively. Figure 2-430 shows the industrial spur covered with mulch and Figure 2-431 shows the end of the industrial spur. Figure 2-432 shows the 115-lb. rail at the second potential transload location.

Two sites south of the Cape Cod Canal were evaluated as potential barge to heavy haul truck to rail transload locations (see Figure 2-433 and Figure 2-434). Use of these sites would require a short heavy haul and an additional transload from heavy truck to rail. Figure 2-435 shows the west transload location looking east and Figure 2-436 shows the east transload location looking west. Figure 2-437 shows the rail line approaching the transload locations. The Cape Cod Canal Vertical Lift Railroad Bridge would be used to cross the Cape Cod Canal (see Figure 2-438).

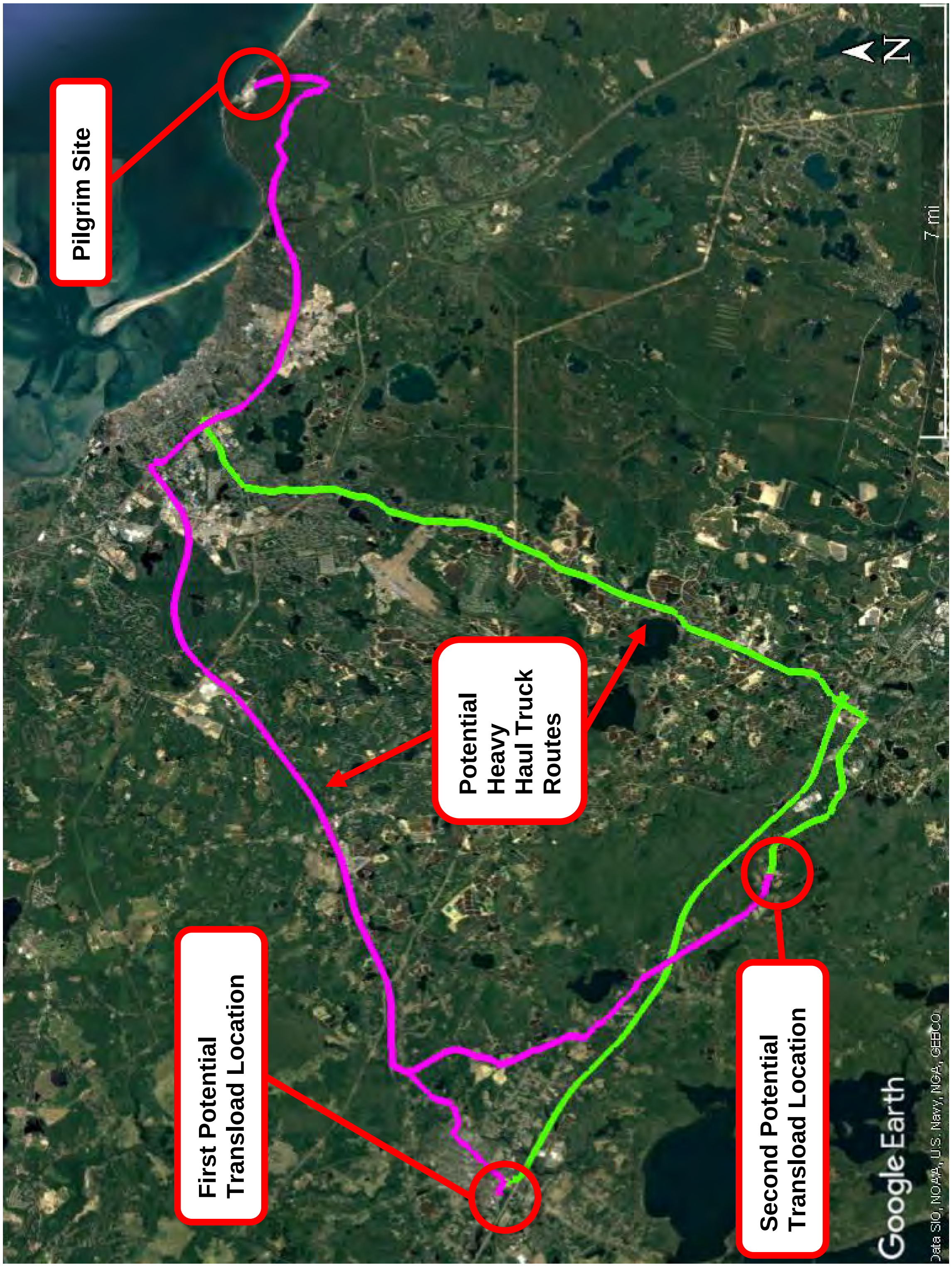


Figure 2-415. Potential Heavy Haul Truck Routes to Rail Transload Locations (Google 2022)

Figure 2-416. Aerial View of First Potential Rail Transload Location in Middleborough, Massachusetts (Google 2022)

Figure 2-417. First Potential Rail Transload Location Looking East (2019)

Figure 2-418. First Potential Rail Transload Location Looking West (2019)

Figure 2-419. Derailer at First Potential Rail Transload Location (2019)

Figure 2-420. Positive Train Control Sensors at First Potential Rail Transload Location (2019)

Figure 2-421. 132-lb. Rail at First Potential Rail Transload Location (2019)

Figure 2-422. Low Overhead Bridges (13’11”) Near First Potential Rail Transload Location (2019)

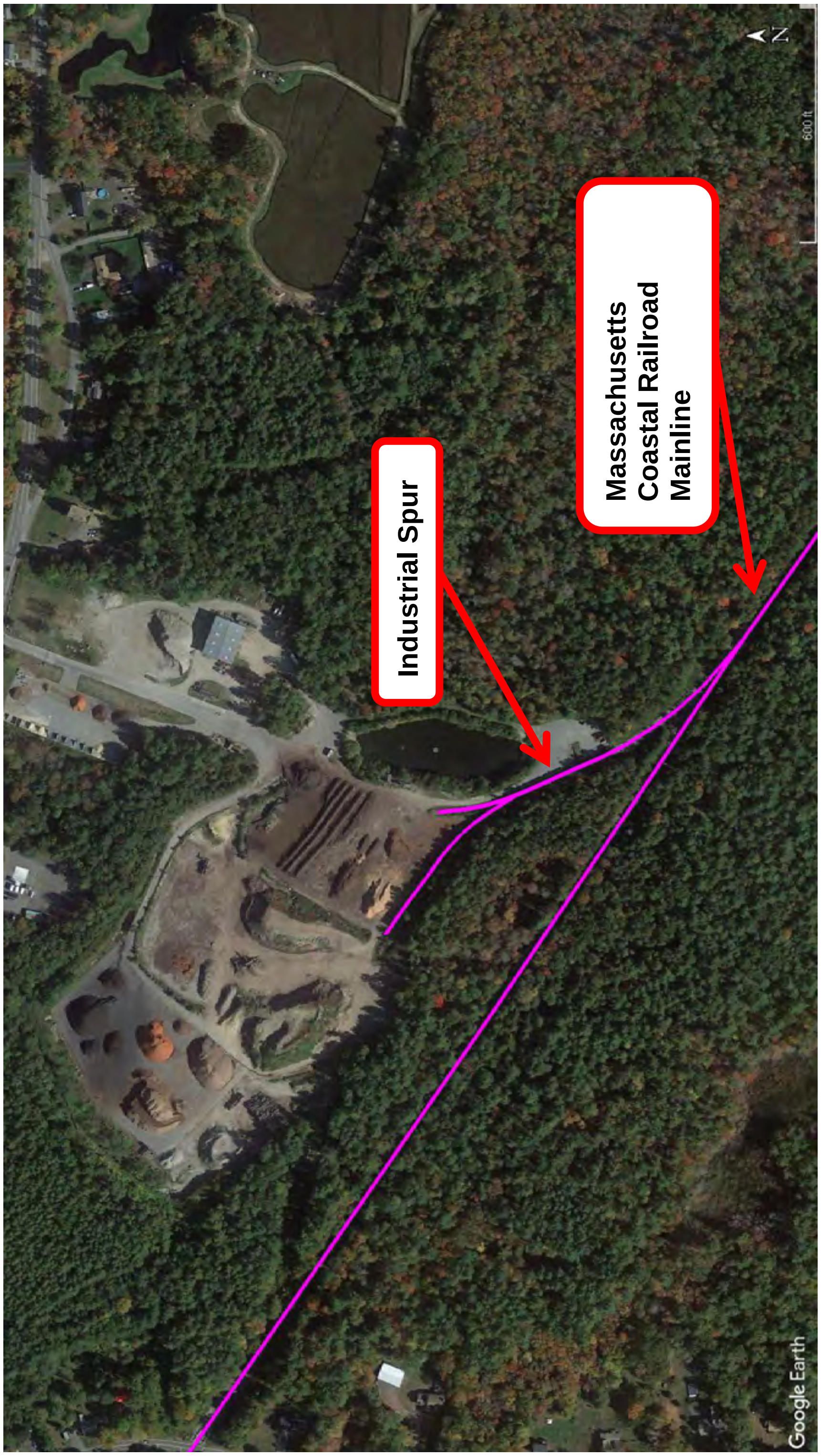


Figure 2-423. Aerial View of Second Potential Rail Transload Location (Google 2022)

Figure 2-424. Mainline at Second Potential Rail Transload Location Looking Southeast (2019)

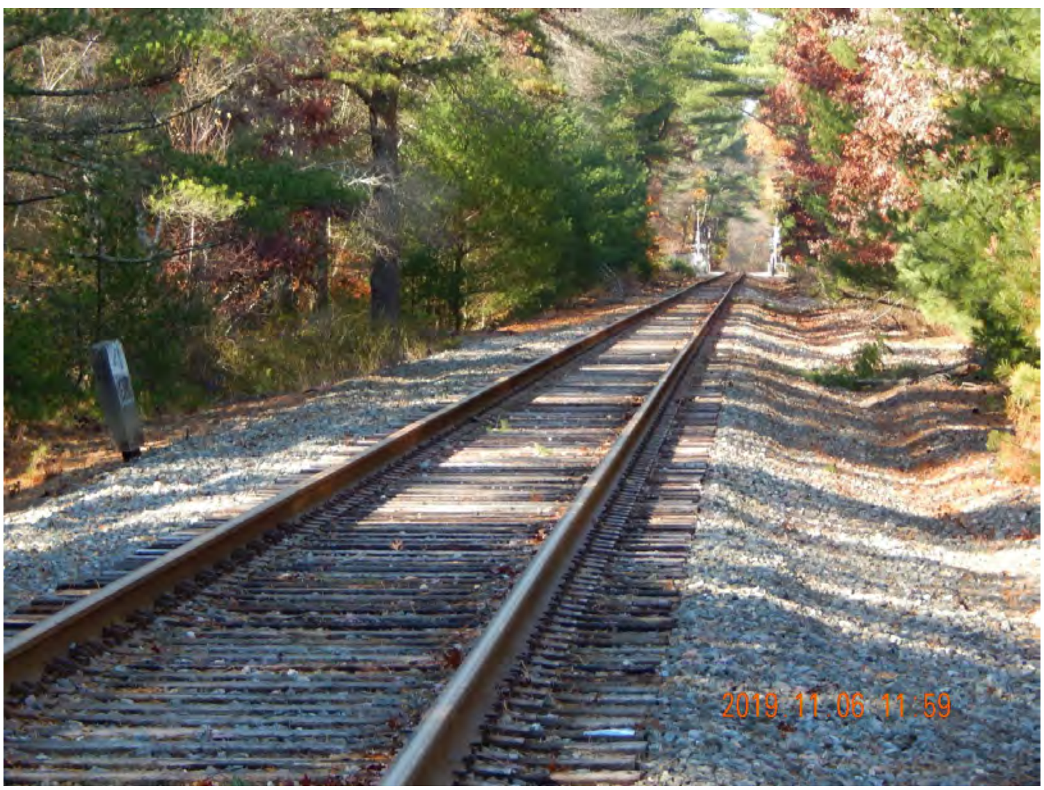


Figure 2-425. Mainline at Second Potential Rail Transload Location Looking Northwest (2019)

Figure 2-426. Industrial Spur at Second Potential Rail Transload Location Looking Southeast (2019)

Figure 2-427. Industrial Spur at Second Potential Rail Transload Location Looking South (2019)

Figure 2-428. Industrial Spur at Second Potential Rail Transload Location Looking Northwest (2019)

Figure 2-429. Industrial Spur at Second Potential Rail Transload Location Looking East (2019)

Figure 2-430. Industrial Spur at Second Potential Rail Transload Location Covered with Mulch (2019)

Figure 2-431. End of Industrial Spur at Second Potential Rail Transload Location (2019)

Figure 2-432. 115-lb. Rail at Industrial Spur at Second Potential Rail Transload Location (2019)

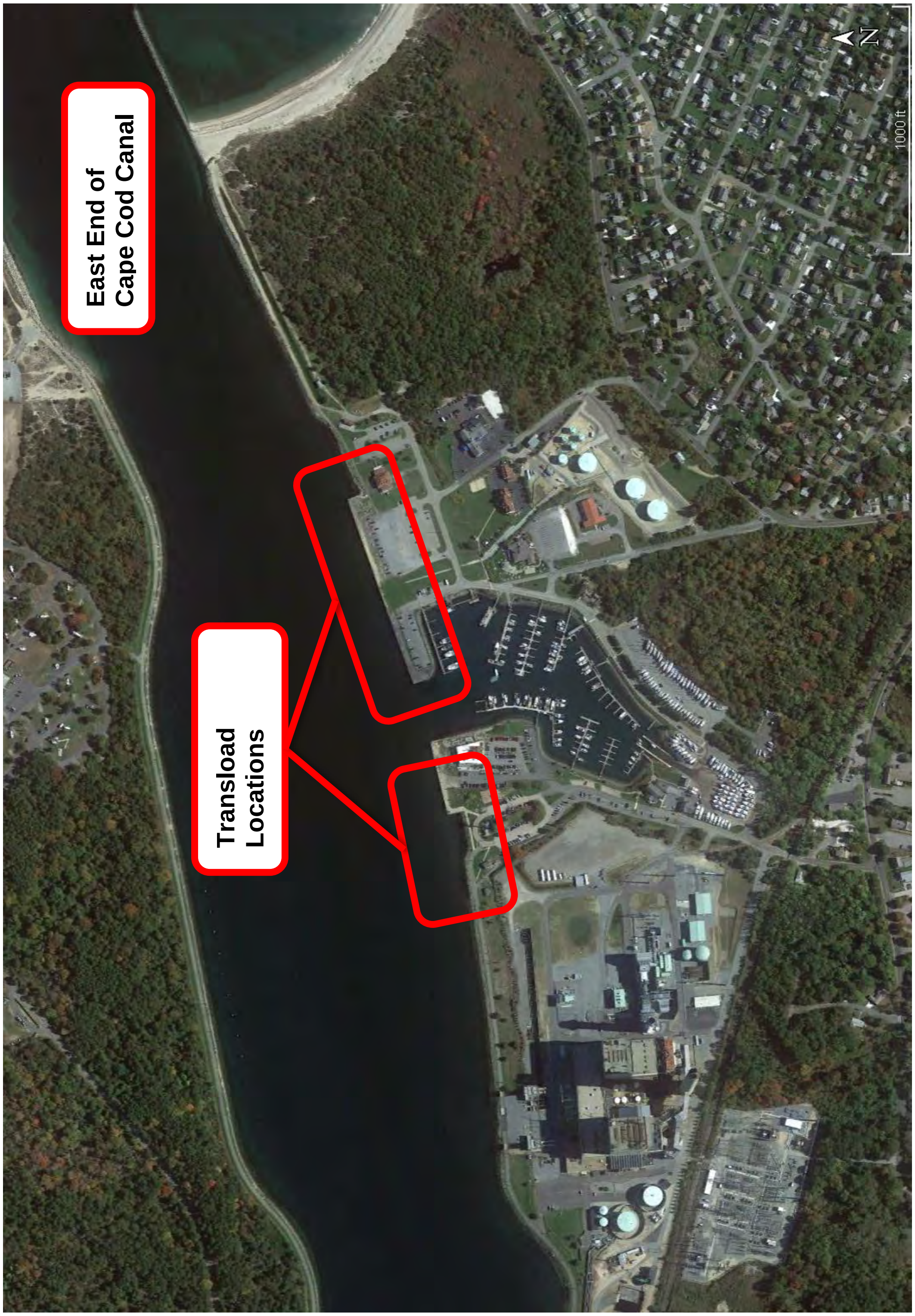


Figure 2-433. Aerial View of Potential Barge to Heavy Haul Truck to Rail Transload Locations on South Bank of South of the Cape Cod Canal (Google 2022)

Figure 2-434. Closeup Aerial View of Potential Barge to Heavy Haul Truck to Rail Transload Locations (Google 2022)

Figure 2-435. West Barge Transload Location Looking East (2019)

Figure 2-436. East Barge Transload Location Looking West (2019)

Figure 2-437. Rail Line Approaching Barge Transload Locations (2019)

Figure 2-438. Cape Cod Canal Railroad Bridge (2019)

2.16.4 Future Information Needs

The Pilgrim site does not have direct rail access. However, it does have a barge area on-site and during construction, this location was used to receive the Pilgrim reactor pressure vessel. Refurbishment would be required to use this location for barge shipments of SNF and could involve dredging which could require multiple permits.

Two potential off-site heavy haul truck to rail transload locations were evaluated. Both locations are served by the Massachusetts Coastal Railroad. The use of these transload locations would require shipping SNF transportation casks by heavy haul truck a distance of 23-30 miles.

The certificate of compliance for the HI-STAR 100 transportation cask does not allow the transport of MPC-68M canisters, high burnup (> 45 GWd/MTHM) SNF, or GTCC waste. Consequently, the certificate of compliance for either the HI-STAR 100MB (Docket No. 71-9378) or the HI-STAR 100 would have to be revised before the SNF stored in MPC-68M canisters, the 248 high burnup SNF assemblies, or the GTCC waste from decommissioning at the Pilgrim site could be transported.

2.17 Dresden

This section describes the inventory of SNF and GTCC waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the Dresden site. The Dresden site is an operating NPP and is located on the banks of the Illinois River in Grundy County, Illinois. Chicago is the largest city within 50 miles of Dresden Nuclear Power Station (NRC 2004).

2.17.1 Site Inventory

There are three units at the Dresden site. Dresden-1 was a 197 MWe (IAEA 2023, Reference Unit Power) BWR that operated between 1960 and 1978 and is currently in SAFSTOR. All SNF from Dresden-1 has been transferred to an on-site ISFSI. Dresden-2 is an operating 957 MWe BWR and Dresden-3 is an operating 957 MWe BWR. Dresden-2 is licensed to operate through 2029 and Dresden-3 is licensed to operate through 2031.

Ninety-two canisters of SNF are stored at the Dresden site at two separate ISFSI pads in HI STORM 100 dry storage systems (Docket No. 72-1014), and 4 canisters of SNF are stored in HI-STAR 100 dry storage systems (Docket No. 72-1008). A total of 11,529 SNF assemblies (1961.2 MTHM) are stored at Dresden, of which 2772 fuel assemblies (486.6 MTHM) are stored in the Dresden-2 spent fuel pool, 2505 fuel assemblies (443.6 MTHM) are stored in the Dresden-3 spent fuel pool, and 6252 fuel assemblies (1031.1 MTHM) are stored in the HI-STORM 100 and HI-STAR 100 dry storage systems in MPC-68, MPC-68M, MPC-68F, and MPC-68FF dry storage canisters. The fuel rods in the assemblies are zirconium-alloy clad.

At the conclusion of operations, the Dresden site estimated that there would be 14,657 SNF assemblies stored at the Dresden site. If these SNF assemblies were stored in MPC-68 dry storage canisters, there would be 216 canisters stored at the Dresden site. In addition, the Dresden site estimated that there would be 14 GTCC waste canisters stored at Dresden after decommissioning of the three reactors at the Dresden site.

The HI-STAR 100 transportation cask (Docket No. 71-9261) is certified to ship MPC-68 and MPC-68F canisters. Transport of MPC-68M, and MP-68FF canisters, high burnup (> 45 GWd/MTHM) SNF, or GTCC waste is not authorized in the certificate of compliance for the HI-STAR 100. The certificate of compliance for either the HI-STAR 100 or HI-STAR 100MB transportation cask (Docket No. 71-9378) could be revised to include these contents.

Over the 1965-1974, 889 SNF assemblies were shipped from Dresden to West Valley, New York for reprocessing; 206 of these assemblies were subsequently returned from West Valley to Dresden (NAC 1986). Approximately 71.5 MTHM (683 assemblies) of Dresden SNF was reprocessed at West Valley (ERJ 1981). In addition, 753 SNF assemblies (145.2 MTHM) from Dresden are stored at the Morris site.

Figure 2-439 illustrates the number of SNF assemblies and MTHM at Dresden based on discharge year. The oldest fuel was discharged in 1969; SNF discharged prior to this date was reprocessed at West Valley, New York. Because Units 2 and 3 are still operating, the latest SNF discharge data contains fuel that was discharged in 2021 through the end of Cycle 27 for Unit 2 and through the end of Cycle 26 for Unit 3. The median discharge year of this data is 1999.

Figure 2-440 illustrates the number of SNF assemblies and MTHM at Dresden based on burnup. The lowest burnup is 3.2 GWd/MTHM and the highest burnup is 52.6 GWd/MTHM. The median burnup is 36.2 GWd/MTHM. There are 2635 (454.7 MTHM) SNF assemblies at Dresden that have burnups greater than 45 GWd/MTHM. These 2635 fuel assemblies are classified by the NRC as high burnup SNF.

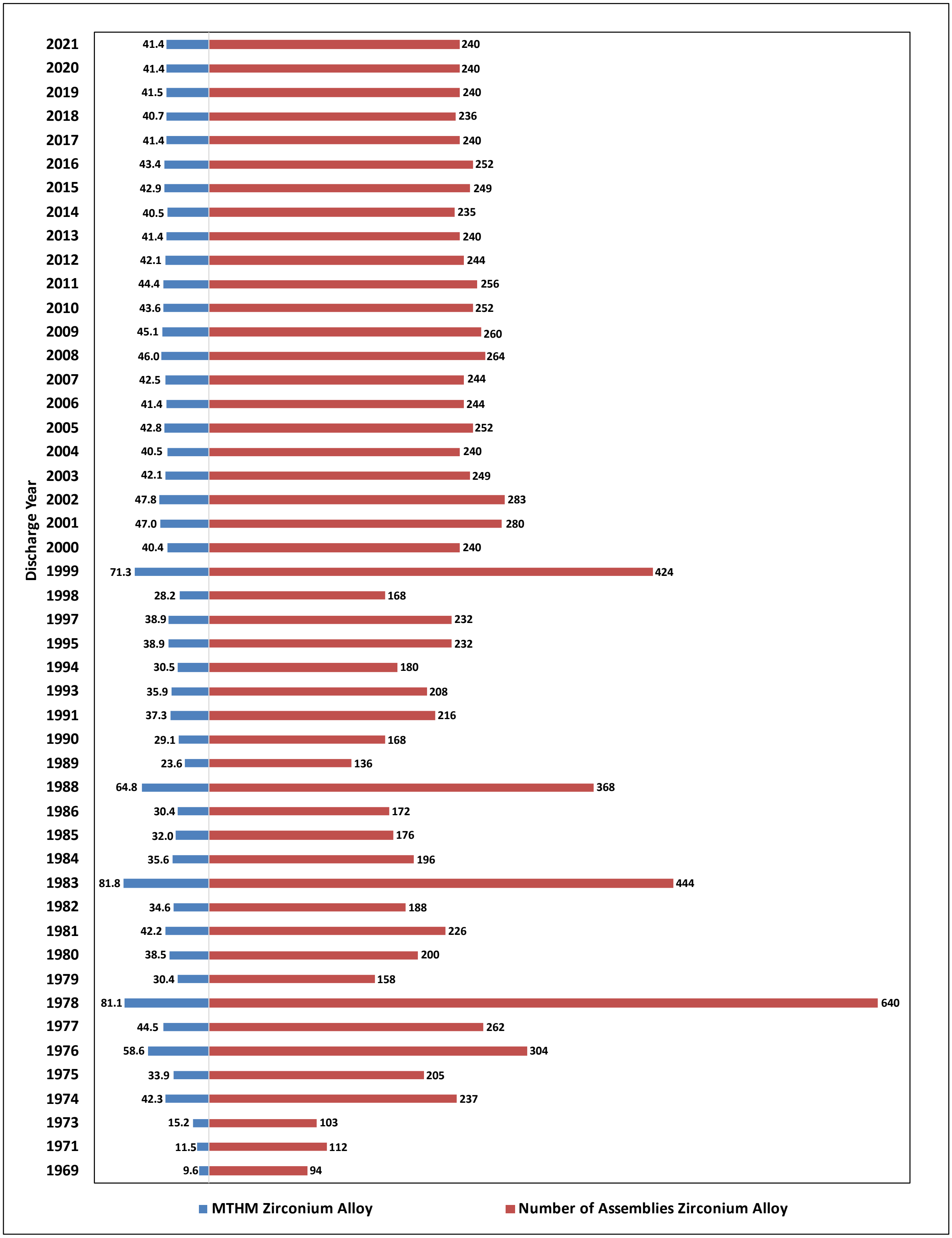


Figure 2-439. Dresden Number of Assemblies and MTHM versus Discharge Year

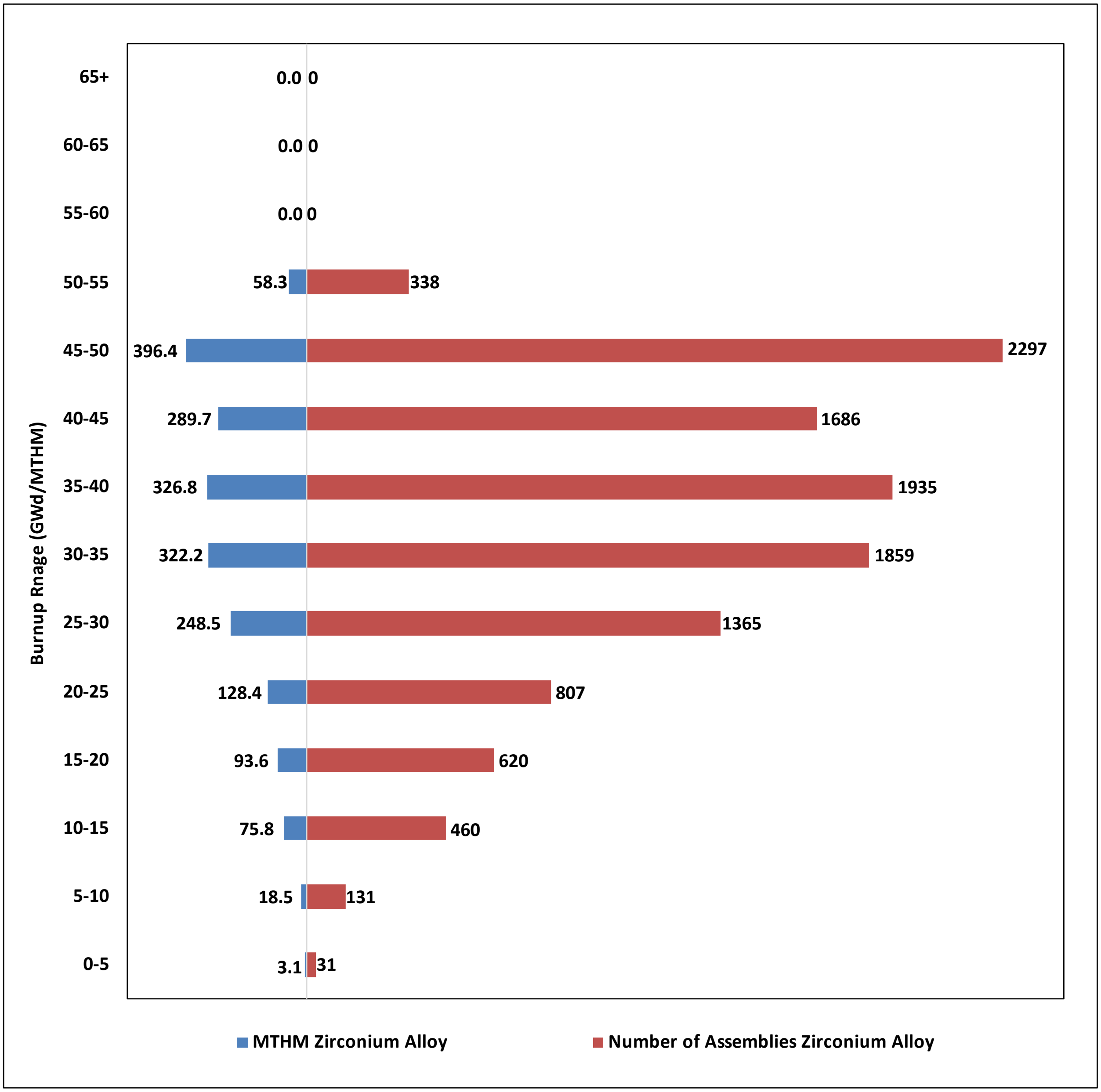


Figure 2-440. Dresden Number of Assemblies and MTHM versus Burnup

2.17.2 Site Conditions

The Dresden site is located approximately 45 miles southwest of Chicago, Illinois, 8 miles east of Morris, Illinois, and 15 miles southwest of Joliet, Illinois. The Dresden site is located at the confluence of the Kankakee River, the Des Plaines River, and the Illinois River (see Figure 2-441). The Dresden Island Lock and Dam is located downstream of the Dresden site.

Figure 2-442 show an aerial view of the Dresden site, including the East ISFSI and the West ISFSI, and the future location of the South ISFSI, which will consolidate the SNF from the East and West ISFSIs at one location. Figure 2-443 and Figure 2-444 show aerial views of the East and West ISFSIs, respectively. Figure 2-445 shows HI-STORM dry storage systems at the East ISFSI, Figure 2-446 shows HI-STAR 100 dry storage systems at the East ISFSI, and Figure 2-447 shows HI-STORM dry storage systems at the West ISFSI. Figure 2-448 shows the cask lifting platform and Figure 2-449 shows the vertical cask transporter at the Dresden site.

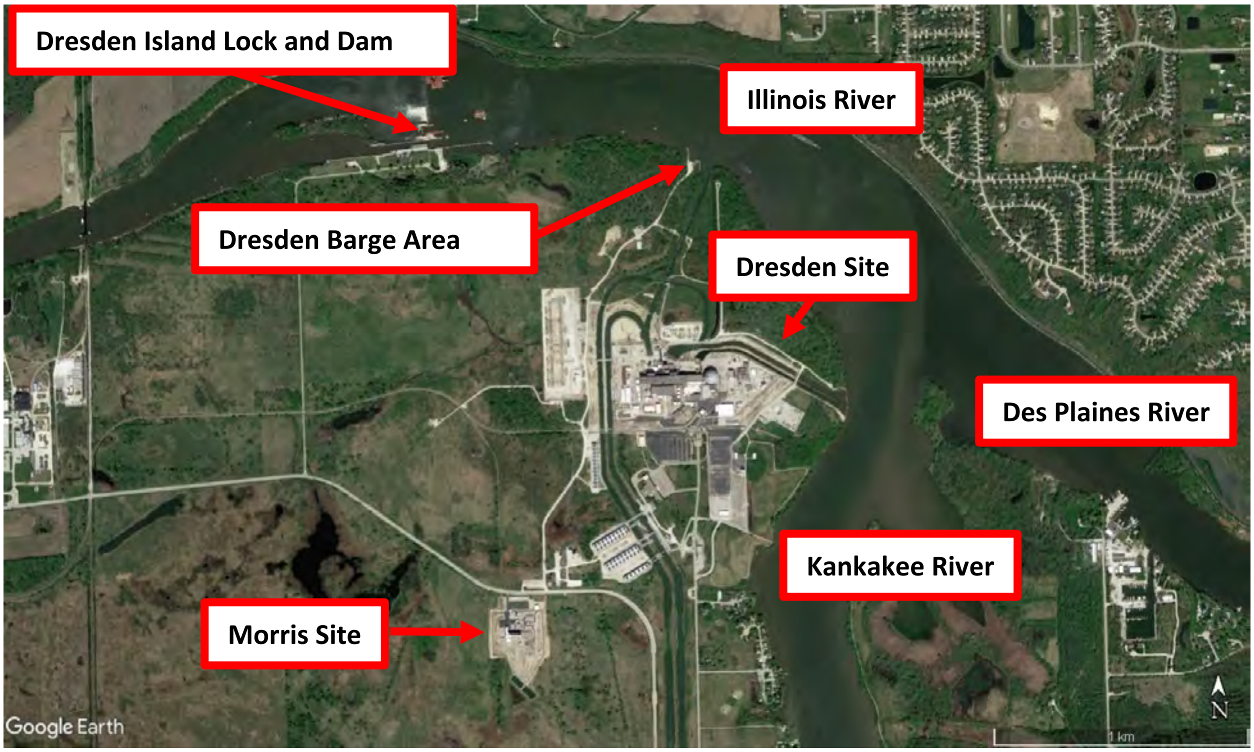


Figure 2-441. Dresden Site Surrounding Area Map (Google 2022)

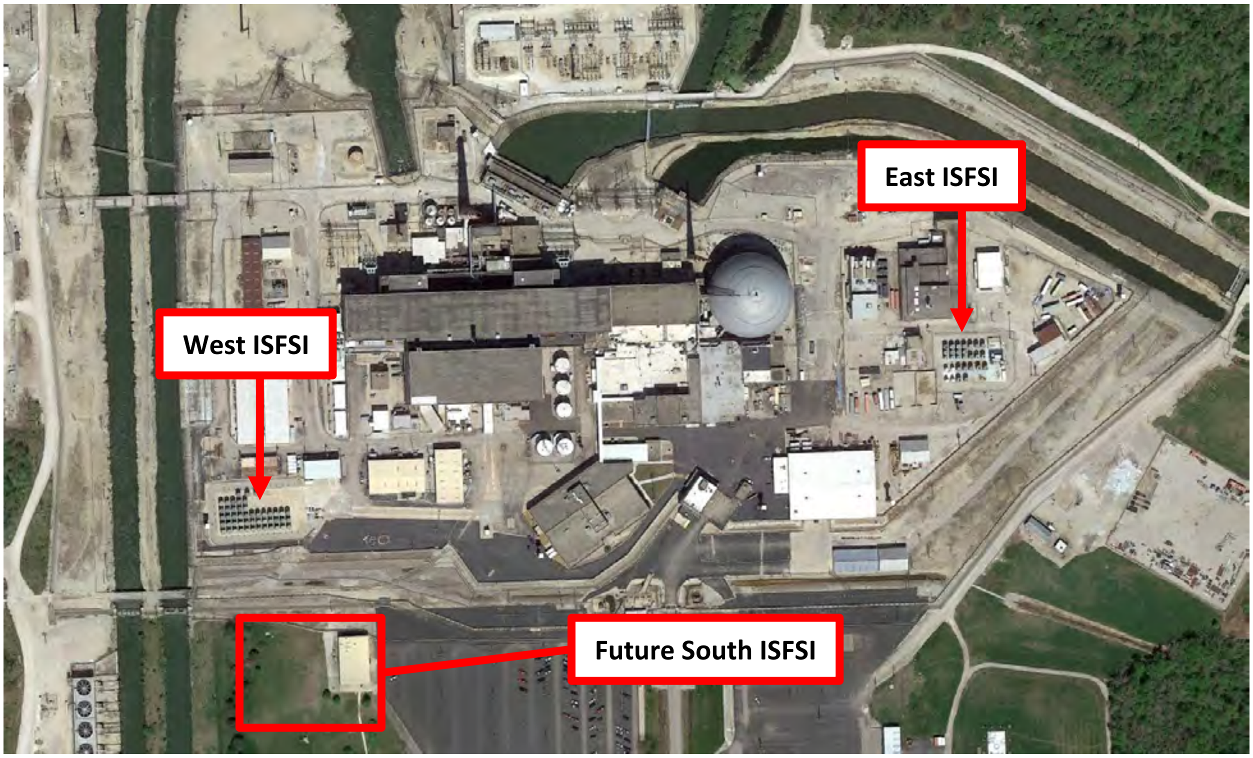


Figure 2-442. Aerial View of Dresden Site (Google 2022)

Photo courtesy of the Dresden Site

Figure 2-443. Aerial View of the East ISFSI (2020)

Photo courtesy of the Dresden Site

Figure 2-444. Aerial View of the West ISFSI (2020)

Figure 2-445. HI-STORM Dry Storage Systems at East ISFSI

Figure 2-446. HI-STAR 100 Dry Storage Systems at East ISFSI

Figure 2-447. HI-STORM Dry Storage Systems at West ISFSI

Figure 2-448. Cask Lifting Platform at Dresden Site

Figure 2-449. Vertical Cask Transporter at Dresden Site

2.17.3 Near-site Transportation Infrastructure and Experience

The Dresden site is located on the south bank of the Illinois River at the confluence of the Des Plaines and the Kankakee Rivers. There is a barge area located at the north end of the site on the Illinois River. The Morris Independent Spent Fuel Storage Installation (Morris site)[27] is located about 0.75 miles southwest of the Dresden site. Three major railroads pass through the area: the BNSF Railroad, the Canadian National (CN) Railroad, and the CSXT. The Dresden and Morris sites have direct rail access and are served by the Illinois River Subdivision of the CN Railroad. Rail access to both the Morris site and Dresden site is provided by a 1.0 mile spur from the Illinois River Subdivision of the CN Railroad. The Morris site spur intersects the spur from the Dresden site about 0.6 miles north of the Morris site (see Figure 2-450). Figure 2-451 and Figure 2-452 show the Dresden rail spur at the Dresden site, Figure 2-453 and Figure 2-454 show the rail spur at Lock Road, Figure 2-455, Figure 2-456, Figure 2-457, and Figure 2-458 show the rail spur at the CN Illinois Subdivision rail line, Figure 2-459, Figure 2-460, Figure 2-461, and Figure 2-462 show various views of the Divine Rail Bridge over the Illinois River on the CN Illinois Subdivision rail line. Figure 2-463 and Figure 2-464 show aerial views of the Dresden rail spur, and the Dresden rail spur at Lock Road and at the Dresden meteorological tower access road. As part of a virtual site evaluation of the Dresden site in 2020, a drone survey was conducted. Figure 2-461 through Figure 2-464 are photographs from this survey.

Highway access to the Dresden site is provided by North Dresden Road. Highway access to the Morris site is provided by East Collins Road, which runs east-west adjacent to the north side of the Morris site. East Collins Road connects to North Dresden Road and North Dresden Road runs north-south and intersects Pine Bluff Road. Pine Bluff Road runs east-west and provides access to I-55 and access to Illinois 47. Illinois 47 provides access to I-80. If the Dresden rail spur was not available, it is possible that heavy haul truck transport to a nearby heavy haul truck to rail transload location would be necessary. Figure 2-465 shows the location of potential transload locations at Murphy Road and Lorenzo Road, Figure 2-466 and Figure 2-467 show a potential transload location at Murphy Road, and Figure 2-468 and Figure 2-469 show a potential transload location at Lorenzo Road.

Barge access to the Illinois River is available north of the Dresden site. Figure 2-470, Figure 2-471, Figure 2-472, Figure 2-473, and Figure 2-474 show views of the Dresden barge area. Figure 2-475 though Figure 2-479 show the Dresden Lock and Dam. Figure 2-470 and Figure 2-475 through Figure 2-479 are photographs from the 2020 drone survey of the Dresden site.

The Dresden site also has experience transporting heavy loads. Figure 2-480 shows the Dresden Unit 1 reactor vessel being shipped to the Dresden site by barge and Figure 2-481 shows a transformer being shipped to the Dresden site by heavy haul truck. This transformer was transloaded from rail to heavy haul truck at Lorenzo Road.

[27] The Morris site is not a nuclear power plant site but stores SNF from nuclear power plants.

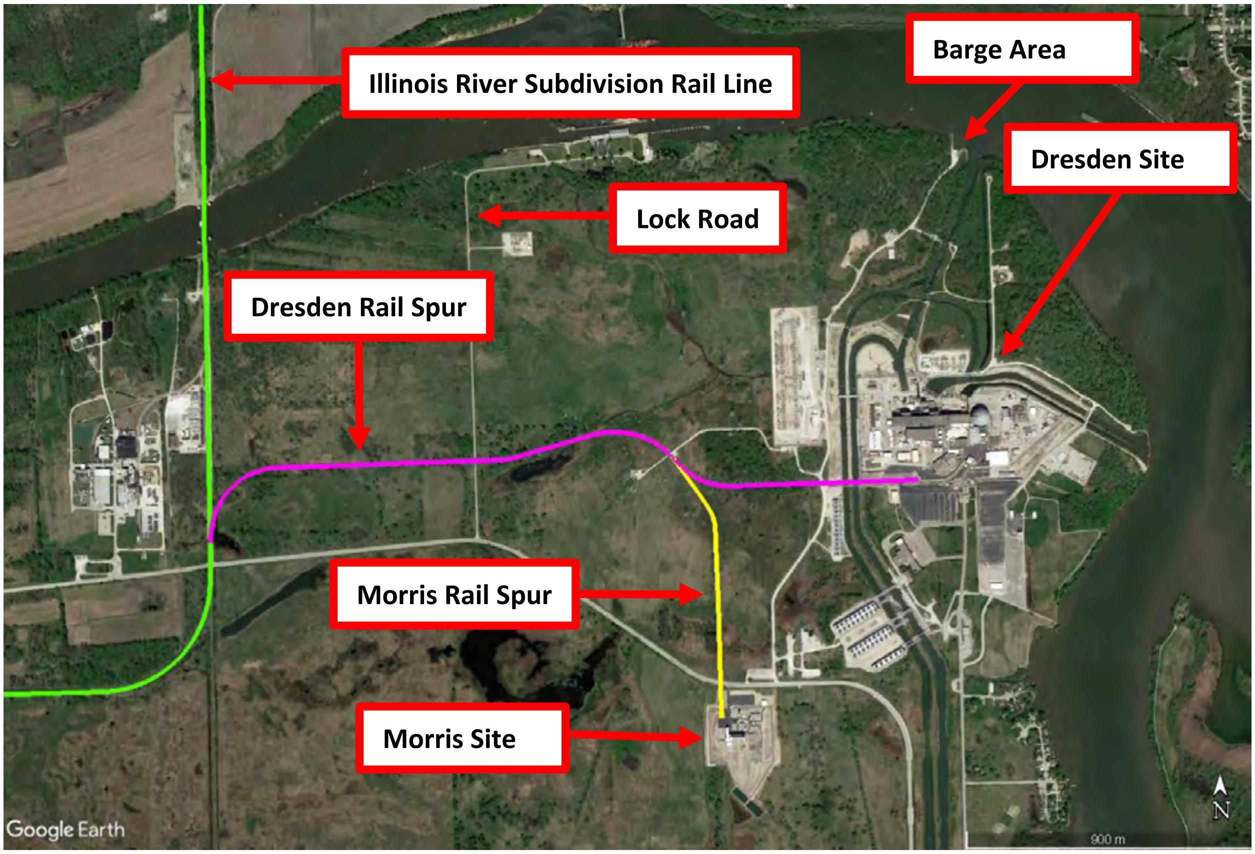


Figure 2-450. Rail Infrastructure Near the Dresden Site (Google 2022)

Figure 2-451. Rail Spur at the Dresden Site Looking West

Figure 2-452. Grade Crossing at the Dresden Site Looking West

Figure 2-453. Rail Spur at Lock Road Looking East

Figure 2-454. Rail Spur at Lock Road Looking West

Figure 2-455. Rail Spur and Canadian National Illinois Subdivision Rail Line (Looking Southwest)

Figure 2-456. Rail Spur and Canadian National Illinois Subdivision Rail Line (Looking South)

Figure 2-457. Rail Spur and Canadian National Illinois Subdivision Rail Line (Looking North)

Figure 2-458. Split Derailer on Illinois Subdivision Rail Line

Figure 2-459. Approach to Divine Railroad Bridge on Illinois River Subdivision Rail Line

Figure 2-460. Divine Railroad Bridge on Illinois River Subdivision Rail Line

Photo courtesy of the Dresden Site

Figure 2-461. Aerial View of Divine Railroad Bridge (2020)

Photo courtesy of the Dresden Site

Figure 2-462. Aerial View of Divine Railroad Bridge (Looking North) (2020)

Photo courtesy of the Dresden Site

Figure 2-463. Aerial Views of Dresden Rail Spur (2020)

Photo courtesy of the Dresden Site

Figure 2-464. Aerial Views of Dresden Rail Spur at Lock Road and at Meteorological Tower Access Road (2020)

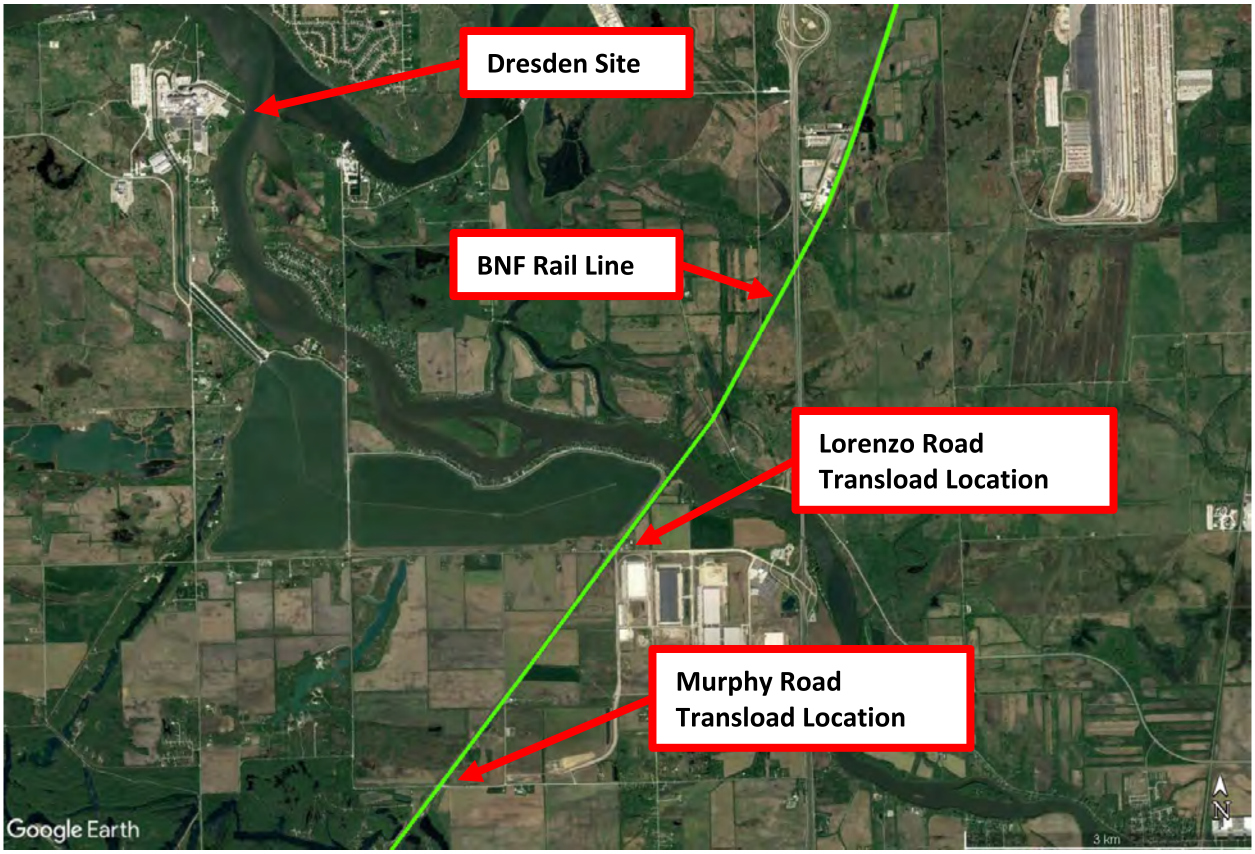


Figure 2-465. Aerial Views of Potential Transload Locations at Murphy Road and Lorenzo Road (Google 2022)

Figure 2-466. Potential Transload Location at Murphy Road (Looking South)

Figure 2-467. Potential Transload Location at Murphy Road (Looking North)

Figure 2-468. Potential Transload Location at Lorenzo Road (Looking South)

Figure 2-469. Potential Transload Location at Murphy Road (Looking North)

Photo courtesy of the Dresden Site

Figure 2-470. Dresden Barge Area Aerial View (2020)

Figure 2-471. Dresden Barge Area Looking North

Figure 2-472. Dresden Barge Area Looking South

Figure 2-473. Dresden Barge Area Looking Northwest

Figure 2-474. Dresden Barge Area Looking Northwest Towards Dresden Lock and Dam

Photo courtesy of the Dresden Site

Figure 2-475. Dresden Barge Area Looking Northwest Towards Dresden Lock and Dam (2020)

Photo courtesy of the Dresden Site

Figure 2-476. Dresden Lock and Dam Showing Tug, Barge, and Downstream Gate on the Illinois River (2020)

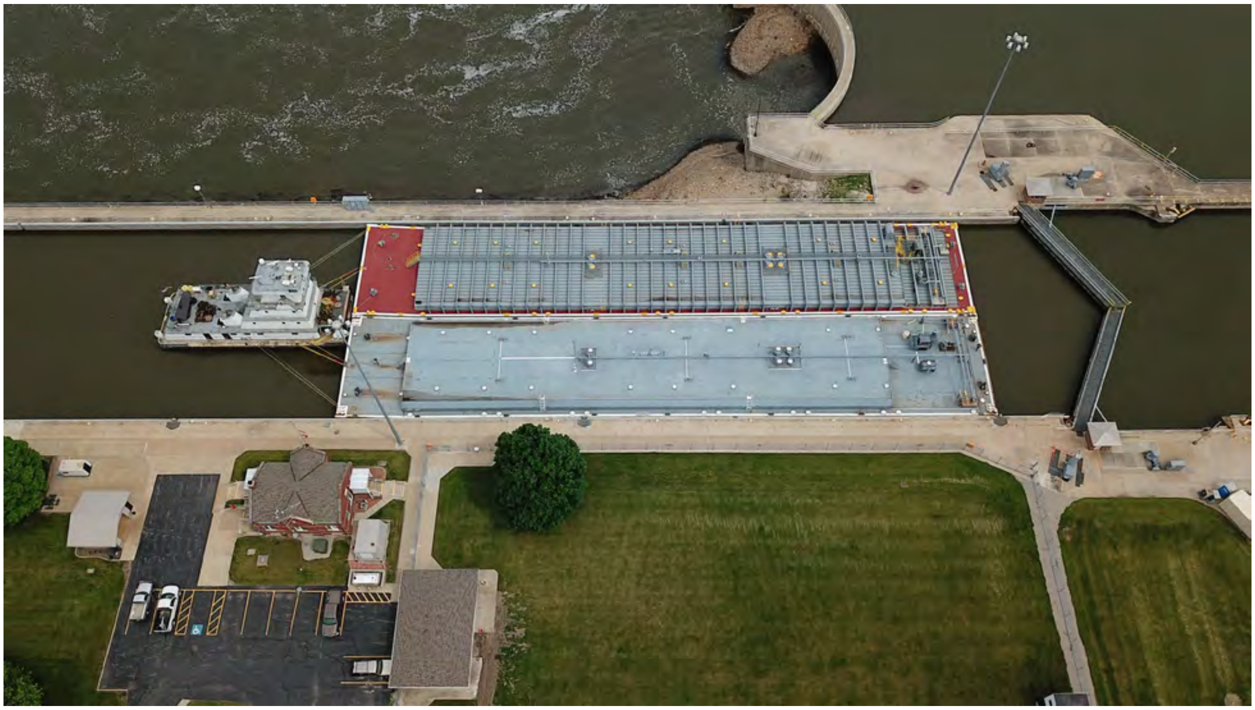


Photo courtesy of the Dresden Site

Figure 2-477. Dresden Lock and Dam Showing Tug, Barge, and Upstream Gate on the Illinois River (2020)

Photo courtesy of the Dresden Site

Figure 2-478. Dresden Lock and Dam Showing Entire Lock with Tug, Barge, and Open Upstream Gate on the Illinois River (2020)

Photo courtesy of the Dresden Site

Figure 2-479. Downstream View from Dresden Lock and Dam Showing Closed Lock and Barrier Island on the Illinois River (2020)

Photo courtesy of the Dresden Site

Figure 2-480. Reactor Vessel Being Shipped to Dresden Site By Barge

Figure 2-481. Transformer Being Shipped to Dresden Site

2.17.4 Future Information Needs

The certificate of compliance for the HI-STAR 100 transportation cask does not allow the transport of MPC-68M or MPC-68FF canisters, high burnup SNF, or GTCC waste. Consequently, the certificate of compliance for either the HI-STAR 100 or HI-STAR 100MB would have to be revised before the SNF stored in MPC-68M or MPC-68FF canisters, high burnup SNF assemblies, or the GTCC waste from decommissioning at the Dresden site could be transported.

The rail infrastructure at the Dresden site has not been maintained and would require refurbishment to be used.

In the future, on-site inspection of the drone survey routes is recommended to confirm and enhance the drone survey findings because inspections of rails, track hardware, railroad ties, roadway pavement, vegetation/overgrowth, overhead surveys for wires and utilities along with other details cannot be determined with a great degree of accuracy from aerial photography. Roads that would be used to facilitate barge transport via heavy-haul trucks appear level and also appear to provide adequate clearance, however; this would have to be confirmed. It is also recommended that the barge area be surveyed to confirm substructure conditions at the barge area for items such as wood pilings, wood planking, seawalls, seawall tie backs, seawall hardware etc. The waterway directly adjacent to the barge area could require a marine survey to confirm adequate draft is available for a barge to dock. Siltation may have occurred over the years in this area which may require dredging to accommodate shipping SNF from the Dresden site by barge.

In addition to transportation infrastructure information needs, the dry storage canister SNF contents would need to be evaluated to verify that they meet the conditions in the 10 CFR Part 71 transportation certificate of compliance. Any changes made to dry storage canisters through the 10 CFR 72.48 process would also need to be evaluated to determine if they need to be propagated to the 10 CFR Part 71 transportation certificate of compliance.

2.18 Morris

This section describes the inventory of SNF waste, site conditions, near-site transportation infrastructure and experience, and future information needs for the Morris Independent Spent Fuel Storage Installation (Morris site). The Morris site is not a nuclear power plant site, but stores SNF from nuclear power plants. The Morris site is located in Grundy County, Illinois, 7 miles from the city of Morris, Illinois and 45 to 50 miles southwest of Chicago. The Des Plaines River and the Kankakee River join to form the Illinois River about 1.2 miles northeast of the Morris site. The Dresden nuclear power plant site is located about 0.7 miles northeast of the Morris site.

2.18.1 Site Inventory

The Morris site was originally designed in 1964 as an SNF reprocessing plant and was known as the Midwest Fuel Recovery Plant (MFRP). The site was licensed for the receipt and storage of SNF in December 1971 and the storage of SNF began in December 1972. The MFRP construction permit was terminated in August 1974 and the site never operated as a reprocessing plant due to technical problems.

The Morris site stores 3217 SNF assemblies (674.3 MTHM) from the Connecticut Yankee, Cooper, Dresden, Monticello, and San Onofre nuclear power plants. This SNF is stored in spent fuel pools; there is no dry storage at the Morris site. The SNF from Dresden is owned by the Morris site; the SNF from the other sites is owned by the respective sites.

The Morris site contains two spent fuel pools measuring 1,150 ft^2 and 1,850 ft^2 (see Figure 2-482). The floors of the spent fuel pools are under 25 feet of water. The spent fuel pools are served by a 7.5 ton capacity basin crane. SNF in the spent fuel pools is stored in baskets containing four PWR assemblies or nine BWR assemblies. The design of the basin crane and fuel basket grapples preclude the lifting of a basket because lifting of a basket with fuel assemblies would result in less than 9 feet of water over the SNF assemblies based on the normal spent fuel pool water level. Consequently, it is not possible to lift a basket over adjacent baskets.

The site also contains a cask unloading basin which is 48 feet deep and contains a shelf where transportation casks are placed using an extension hook for the lowering of the transportation cask to the bottom of the unloading basin (see Figure 2-483). The water depth over the shelf is 18.5 feet. The cask unloading basin is served by the 7.5-ton capacity basin crane and a 5-ton capacity fuel handling crane. A 125-ton capacity bridge crane serves the cask unloading basin, cask decontamination area, and the cask receiving area (see Figure 2-484).

The Morris site has received SNF in six transportation casks: the IF-100, IF-200, IF-300, NFS-4, NAC-1, and NLI 1/2. The IF-100, NFS-4, NAC-1, and NLI-1/2 transportation casks ranged in weight from 22 to 26 tons. The IF-300 weighed 70 tons. These transportation casks are not currently certified by the U.S. Nuclear Regulatory Commission (NRC). The Morris site has also loaded and unloaded the REA 2023 dry storage cask as part of a demonstration project. The REA-2023 cask weighs 100 tons.

The Morris site last received SNF in 1989. The current NRC license (SNM-2500) (Docket No. 72-1) does not permit the receipt or handling of SNF. Transportation of SNF from the Morris site would require relicensing.

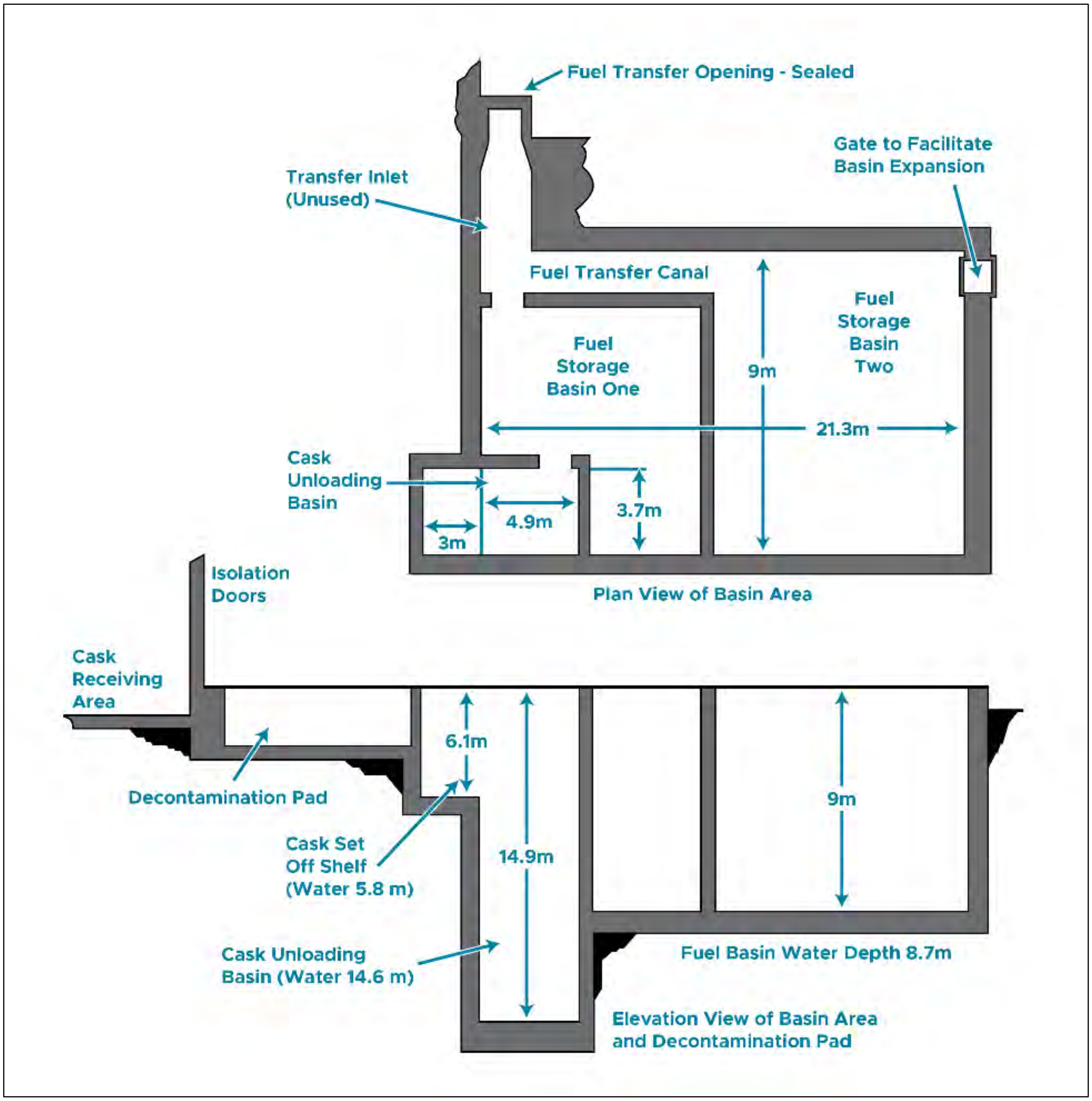


Figure 2-482. Plan and Elevation Views of Basin Area and Decontamination Pad at the Morris Site

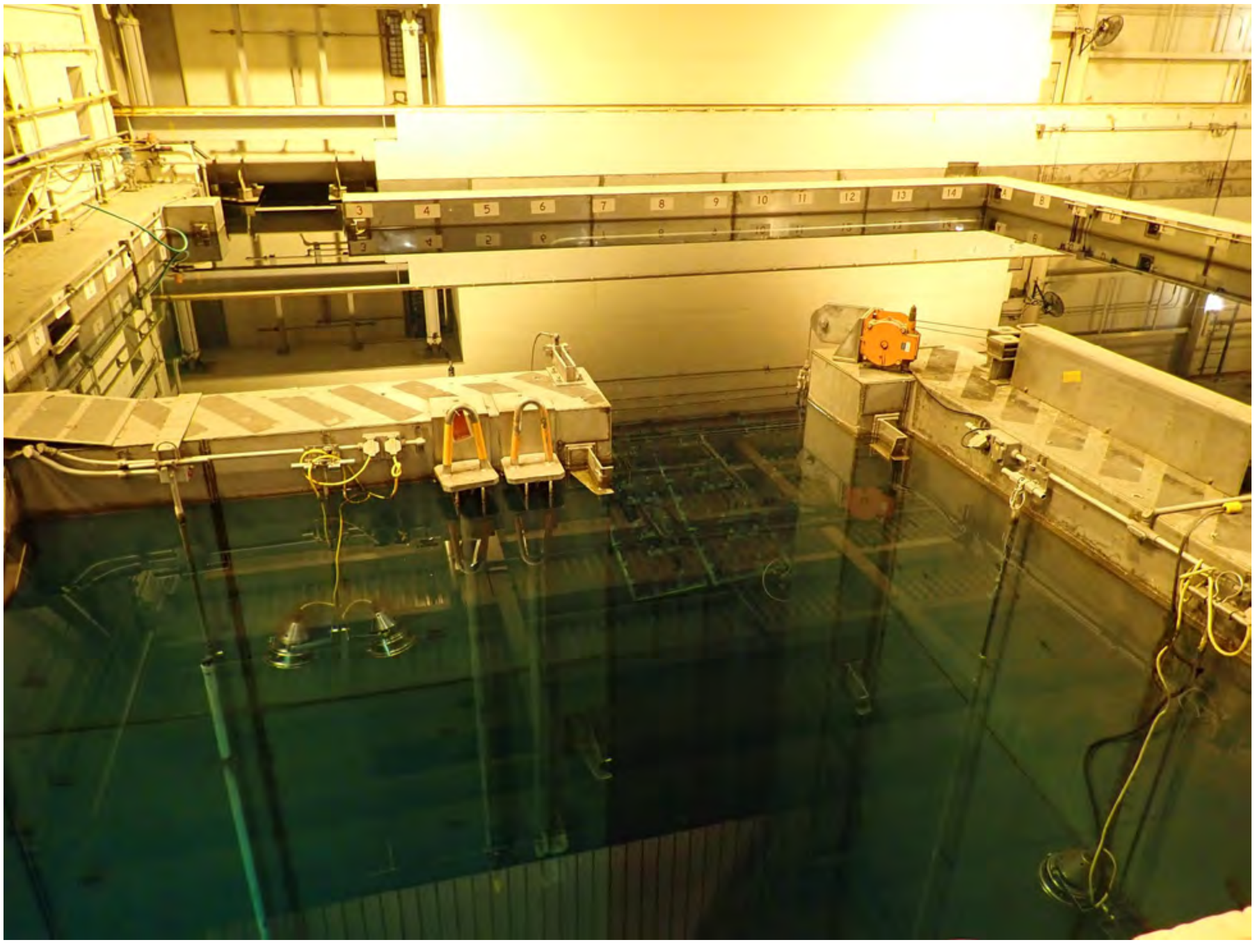


Figure 2-483. Cask Unloading Basin at the Morris Site

Figure 2-484. 125-Ton Crane at the Morris Site

Figure 2-485 illustrates the number of SNF assemblies and MTHM at the Morris site based on discharge year. The oldest fuel was discharged in 1970 and the latest fuel was discharged in 1986. The median discharge year of the fuel is 1976.

Figure 2-486 illustrates the number of SNF assemblies and MTHM at the Morris site based on burnup. The lowest burnup is 0.18 GWd per metric ton heavy metal (MTHM) and the highest burnup is 36.7 GWd/MTHM. The median burnup is 22.1 GWd/MTHM. No high burnup SNF (burnup greater than 45 GWd/MTHM) is stored at Morris.

Figure 2-487 illustrates the assembly types and the MTHM for each assembly type of the spent fuel. There are thirteen assembly types of which 37 percent of them are G2307G2B assemblies.

As mentioned previously, there are assemblies from five nuclear power plants at Morris: Cooper, Monticello, Dresden 3, San Onofre 1, and Connecticut Yankee as shown in Figure 2-488. Both Cooper and Monticello each represent 33 percent of the inventory. Figure 2-488 also illustrates the MTHM for the SNF from each of the five nuclear power plants. Both Cooper and Monticello each contribute 29 percent of the inventory.

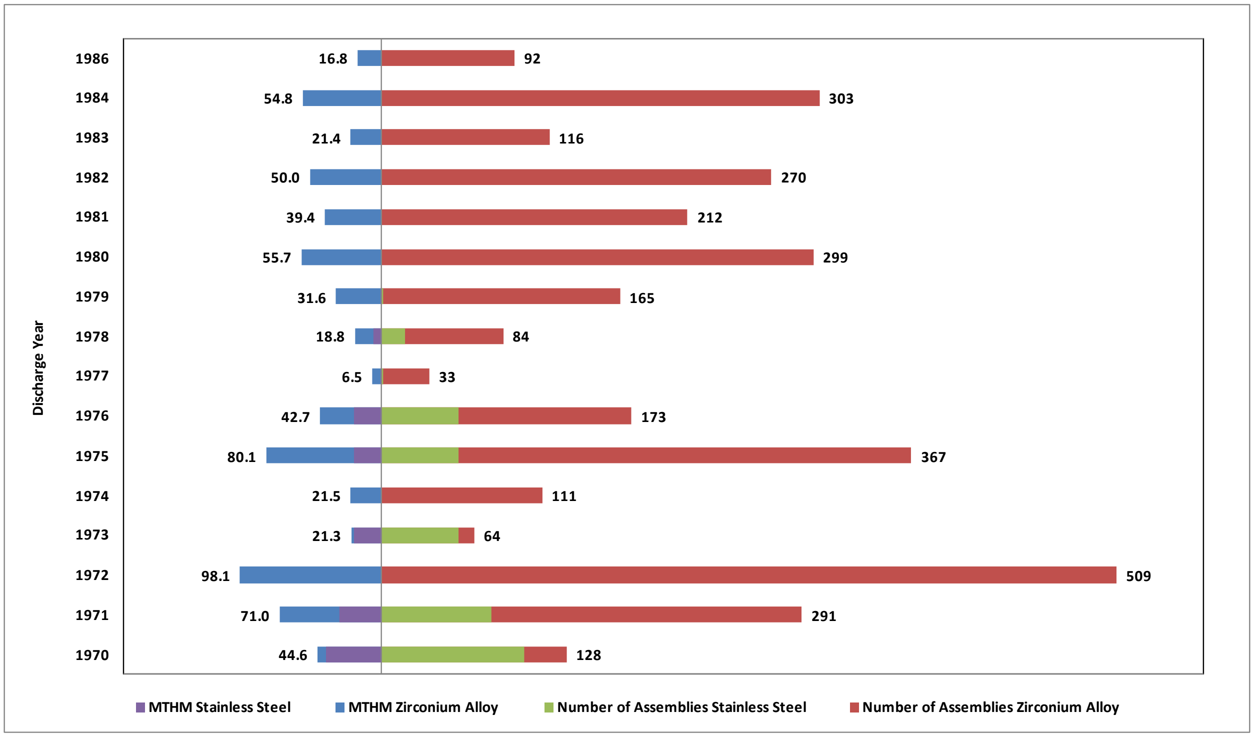


Figure 2-485. Morris Number of Assemblies and MTHM versus Discharge Year (EIA 2018)

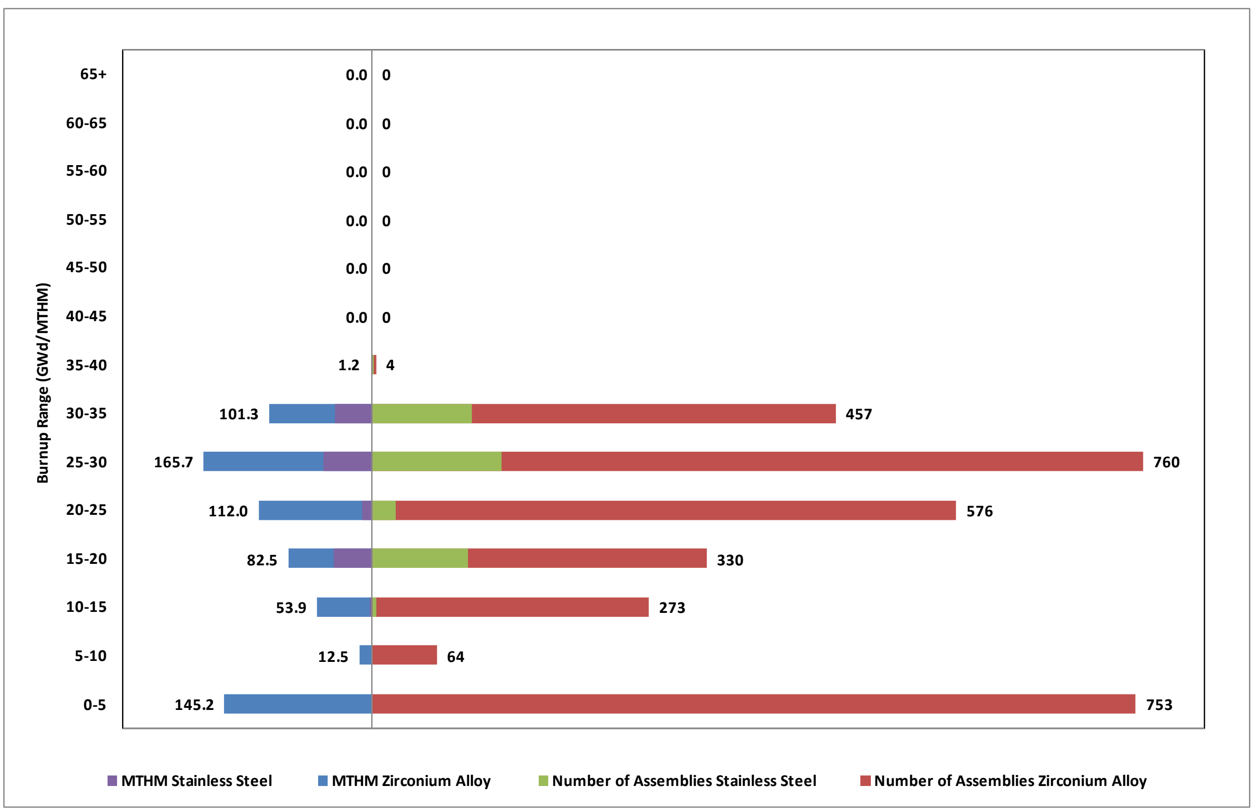


Figure 2-486. Morris Number of Assemblies and MTHM versus Burnup (EIA 2018)

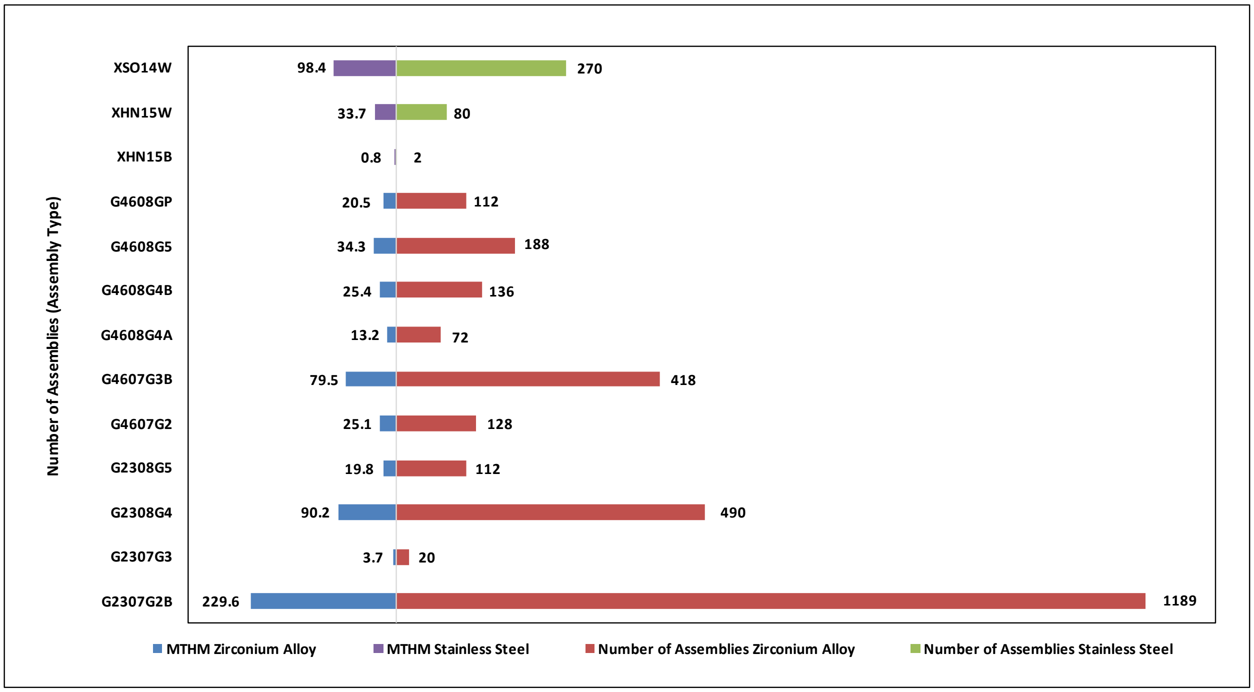


Figure 2-487. Morris Number of Assemblies and MTHM by Assembly Type (EIA 2018)

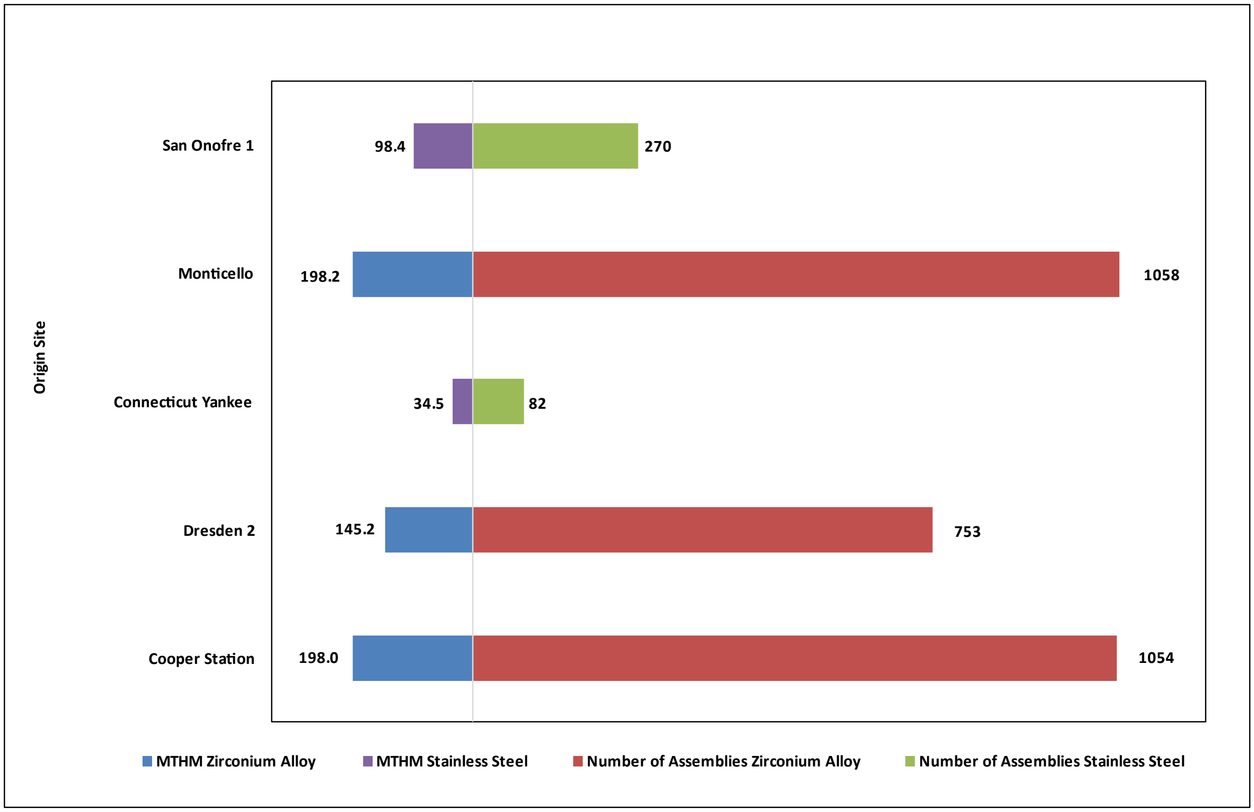


Figure 2-488. Morris Number of Assemblies and MTHM by Nuclear Power Plants Storing Assemblies (EIA 2018)

2.18.2 Site Conditions

The Morris site is located about 0.75 miles southwest of the Dresden Nuclear Power Plant (Dresden site), in Grundy County, about 7.5 miles east-northeast of the small town of Morris, Illinois. Figure 2-489 shows an aerial view of the Morris and Dresden sites.

Figure 2-490 and Figure 2-491 provide aerial views of the Morris site looking to the north and south, respectively. Figure 2-492 provides an aerial view of the rail spurs at the Morris Site. Figure 2-493 and Figure 2-494 show the railroad tracks into the Cask Receiving Area, Figure 2-495 show the railroad tracks into the Cask Service Facility, and Figure 2-496 and Figure 2-497 show the western rail spur looking south and north, respectively.

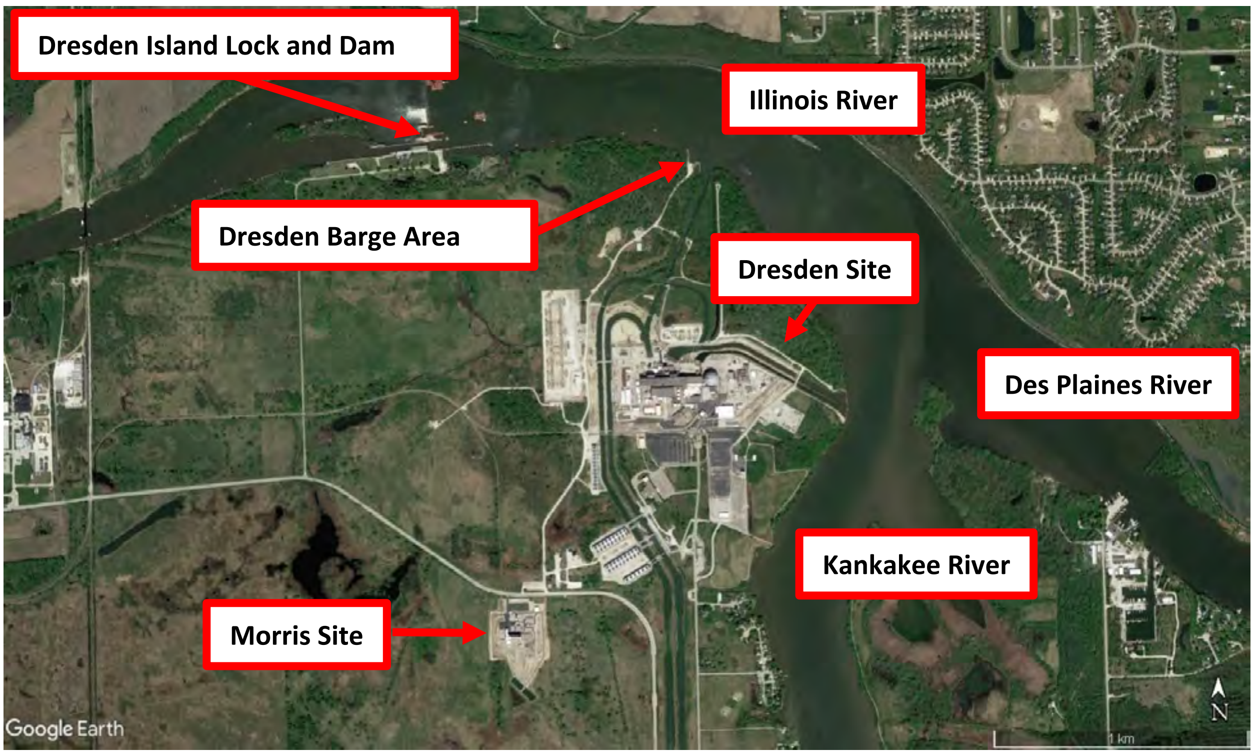


Figure 2-489. Morris Site Surrounding Area Map (Google 2022)

Photo courtesy of the Morris Site

Figure 2-490. Aerial View of Morris Site (Looking North)

Photo courtesy of the Morris Site

Figure 2-491. Aerial View of Morris Site (Looking South)

Photo courtesy of the Dresden Site

Figure 2-492. Aerial View of Morris Site with Rail Spurs (Looking South) (2020)

Figure 2-493. Railroad Tracks into the Cask Receiving Area (Looking South)

Figure 2-494. Railroad Tracks into the Cask Receiving Area (Looking North)

Figure 2-495. Railroad Tracks into the Cask Service Facility

Figure 2-496. Western Rail Spur (Looking South)

Figure 2-497. Western Rail Spur (Looking North)

2.18.3 Near-site Transportation Infrastructure and Experience

The rail infrastructure near the Morris site is shown in Figure 2-498. Rail access to both the Morris site and Dresden site is provided by a 1 mile rail spur from the Illinois River Subdivision of the Canadian National Railroad. This rail spur is discussed in Section 2.17.3. The Morris site rail spur intersects the rail spur from the Dresden site about 0.6 miles north of the Morris site. As the rail spur approaches the Morris site, it divides into three spurs (see Figure 2-499).

The eastern spur (shown on the right in Figure 2-499) enters the cask receiving area. The center spur serves the cask service facility. The western spur (shown on the left in Figure 2-499) is a storage track with capacity to store four railcars. The Morris rail spur has not been maintained and the rail spur is paved over as it crosses East Collins Road. As it enters the Morris site, the rail spur has also been disabled. Figure 2-500 through Figure 2-502 show the condition of the Morris rail spur in the vicinity of the Morris site. Figure 2-503 and Figure 2-504 show aerial views of the Morris rail spur. As part of a virtual site evaluation of the Dresden site in 2020, a drone survey was conducted of the Morris site rail infrastructure. Figure 2-499, Figure 2-501, Figure 2-503, and Figure 2-504 are photographs from this survey.

The Morris site does not have barge access. However, barge access is available at the Dresden site (see Section 2.17.3). The Dresden barge area is located about 1.4 miles from the Morris site and transport would require truck transport from the Morris site to the Dresden barge area (see Figure 2-505).

As mentioned previously, the Morris site has received SNF in six transportation casks: the IF-100, IF-200, IF-300, NFS-4, NAC-1, and NLI 1/2. Figure 2-506 shows the IF-300 transportation cask.

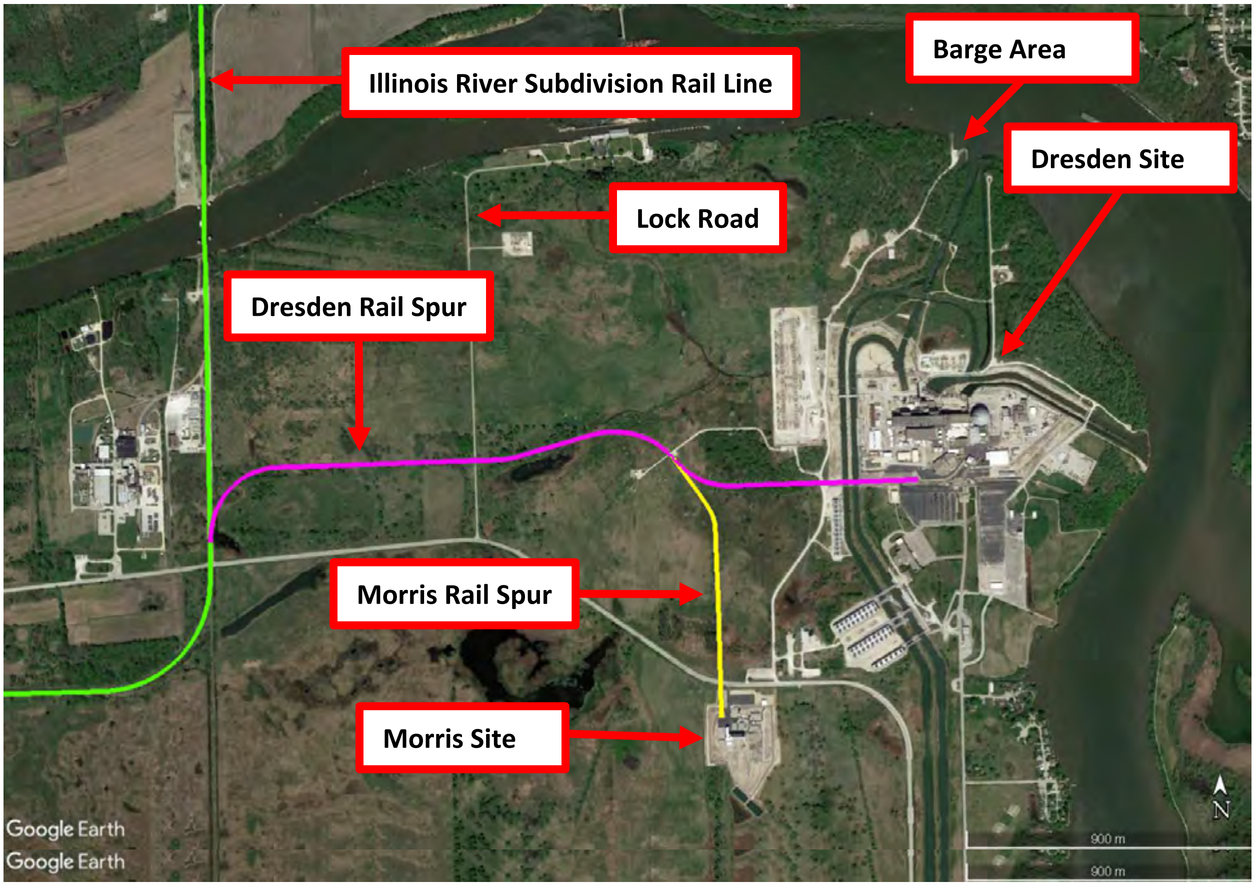


Figure 2-498. Rail Infrastructure Near the Morris Site (Google 2022)

Photo courtesy of the Dresden Site

Figure 2-499. Morris Rail Spur Exiting the Morris Site (2020)

Figure 2-500. Morris Rail Spur Approaching the Morris Site

Photo courtesy of the Dresden Site

Figure 2-501. East Collins Road Crossing the Morris Rail Spur (2020)

Figure 2-502. Morris Rail Spur at East Collins Road Exiting the Morris Site

Photo courtesy of the Dresden Site

Figure 2-503. Aerial Views of Morris Rail Spur (2020)

Photo courtesy of the Dresden Site

Figure 2-504. Morris Rail Spur Approaching the Dresden Rail Spur (2020)

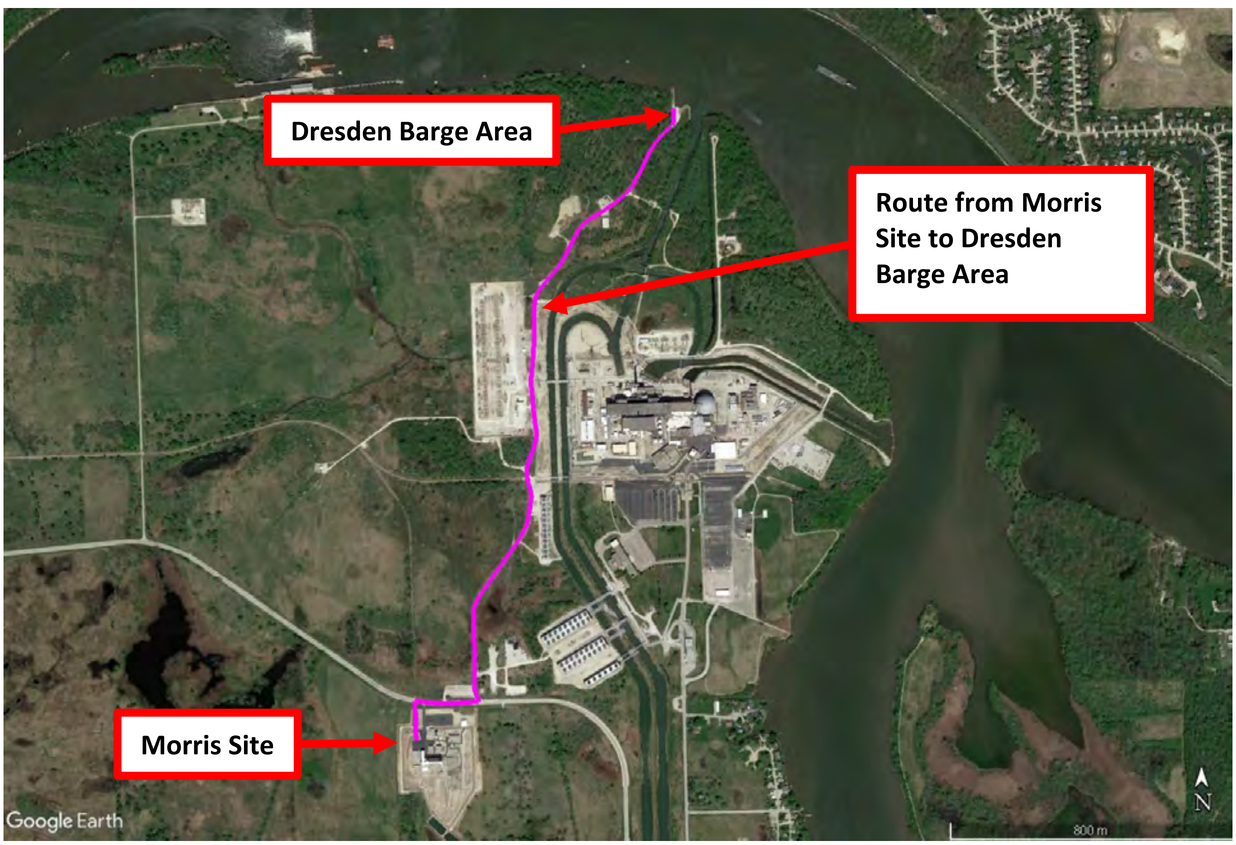


Figure 2-505. Route from Morris Site to Dresden Barge Area (Google 2022)

Photo courtesy of the Morris Site

Figure 2-506. IF-300 Rail Transportation Cask at the Morris Site

2.18.4 Future Information Needs

The primary future information need at the Morris site is identification of which transportation cask would be used to remove SNF from the site. This is because the Morris site stores SNF in a spent fuel pool, in contrast to nuclear power plant sites where dry storage systems have been deployed and where transportation casks have been certified to transport the associated dry storage canisters.

The rail infrastructure at the Morris site has not been maintained and would require refurbishment to be used. The Morris site rail spur has been paved over as it crosses East Collins Road. As it enters the Morris site, the rail spur has also been disabled.

On-site barge access is not available at the Morris site; however, barge access is available at the Dresden site. The Dresden barge area is located about 1.2 miles from the Morris site and transport would require heavy-haul truck transport from the Morris site to the Dresden barge area.

In the future, on-site inspection of the drone survey routes is recommended to confirm and enhance the drone survey findings because inspections of rails, track hardware, railroad ties, roadway pavement, vegetation/overgrowth, overhead surveys for wires and utilities along with other details cannot be determined with a great degree of accuracy from aerial photography. Roads that would be used to facilitate barge transport via heavy-haul trucks appear level and also appear to provide adequate clearance, however; this would have to be confirmed. It is also recommended that the barge area be surveyed to confirm substructure conditions at the barge area for items such as wood pilings, wood planking, seawalls, seawall tie backs, seawall hardware etc. The waterway directly adjacent to the barge area could require a marine survey to confirm adequate draft is available for a barge to dock. Siltation may have occurred over the years in this area which may require dredging to accommodate shipping SNF from the Morris site via the Dresden barge area.

2.19 Indian Point

This section describes the inventory of SNF, site conditions, near-site transportation infrastructure and experience, and future information needs for the Indian Point site. The Indian Point site is located on approximately 239 acres of land in the Village of Buchanan in upper Westchester County, New York. The facility is on the eastern bank of the Hudson River about 2.5 miles southwest of Peekskill, the closest city, and about 24 miles north of New York City (NRC 2018).

2.19.1 Site Inventory

There are three units at the Indian Point site. Indian Point-1 was a 257 MWe PWR (IAEA 2023, Reference Unit Power) that operated from 1962 to 1974. Indian Point-2 was a 998 MWe PWR that operated from 1974 to 2020. Indian Point-3 was a 1030 MWe PWR that operated from 1976 to 2021.

There are a total of 3995 PWR SNF assemblies (1773.9 MTHM) stored at the Indian Point site. All fuel assemblies have been removed from the Indian Point-1 and Indian Point-2 spent fuel pools and Indian Point-3 spent fuel pool is scheduled to be emptied in November 2023. Fuel assemblies are stored in the HI-STORM dry storage systems (Docket No. 72-1014) in MPC-32 and MPC-32M dry storage canisters. SNF assemblies from Indian Point-1 are stainless steel clad and SNF assemblies from Indian Point-2 and -3 are zirconium alloy clad.

Five HI-STORM dry storage systems [160 SNF assemblies (30.6 MTHM)] contain Indian Point-1 stainless steel clad fuel. When all fuel is placed into dry storage, it is expected that there will be 127 dry storage systems at Indian Point. These HI-STORM dry storage systems contain MPC-32 and MPC-32M canisters. One canister containing GTCC waste is also stored at Indian Point at this time. A total of 14 canisters of GTCC waste are currently estimated to be stored at Indian Point from both the Unit 2 and 3 reactors as well as their respective spent fuel pools. A characterization analysis of the Unit 1 reactor is in progress which may result in additional GTCC waste containers.

The HI-STAR 100 transportation cask (Docket No. 71-9261) is certified to ship MPC-32 canisters. Transport of high burnup (> 45 GWd/MTHM) SNF or GTCC waste is not authorized in the certificate of compliance for the HI-STAR 100. The HI-STAR 100MB transportation cask (Docket No. 71-9378) is certified to ship MPC-32M canisters. Transport of high burnup SNF up to 55 GWD/MTHM is allowed but transport of GTCC waste is not allowed in the certificate of compliance for the HI-STAR 100MB.

Figure 2-507 illustrates the number of SNF assemblies and MTHM at Indian Point based on discharge year. The oldest fuel was discharged in 1972 and the last fuel was discharged in 2021. The median discharge year of the fuel is 2002.

Figure 2-508 illustrates the number of SNF assemblies and MTHM at Indian Point based on burnup. The lowest burnup is 3.7 GWd/MTHM and the highest burnup is 59.6 GWd/MTHM. The median burnup is 44.0 GWd/MTHM. There are 1824 SNF assemblies (827.0 MTHM) at Indian Point that have burnups greater than 45 GWd/MTHM. These 1824 fuel assemblies are classified by the NRC as high burnup SNF. Additionally, there are 542 fuel assemblies with burnups greater than 55 GWd/MTHM.

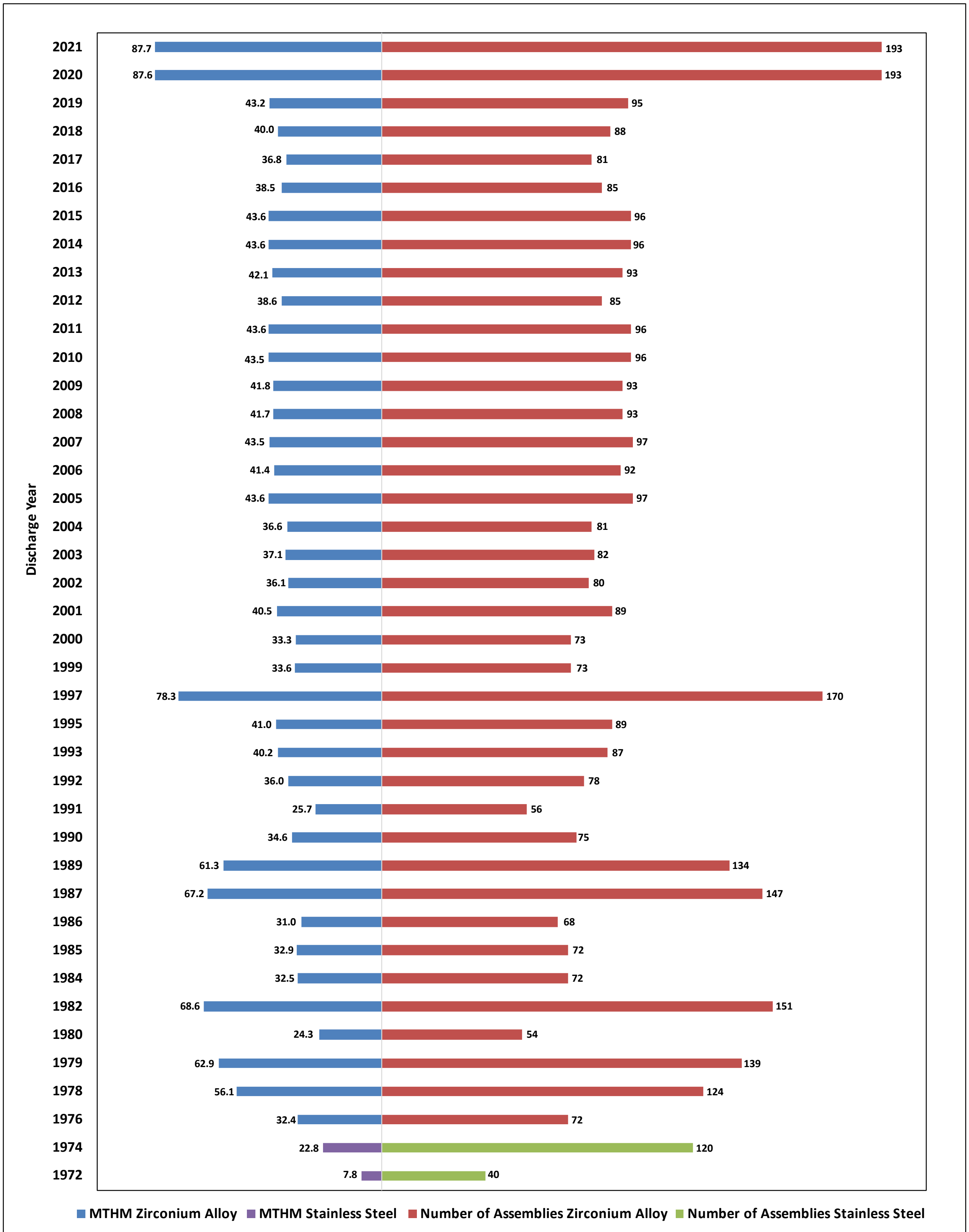


Figure 2-507. Indian Point Number of Assemblies and MTHM versus Discharge Year

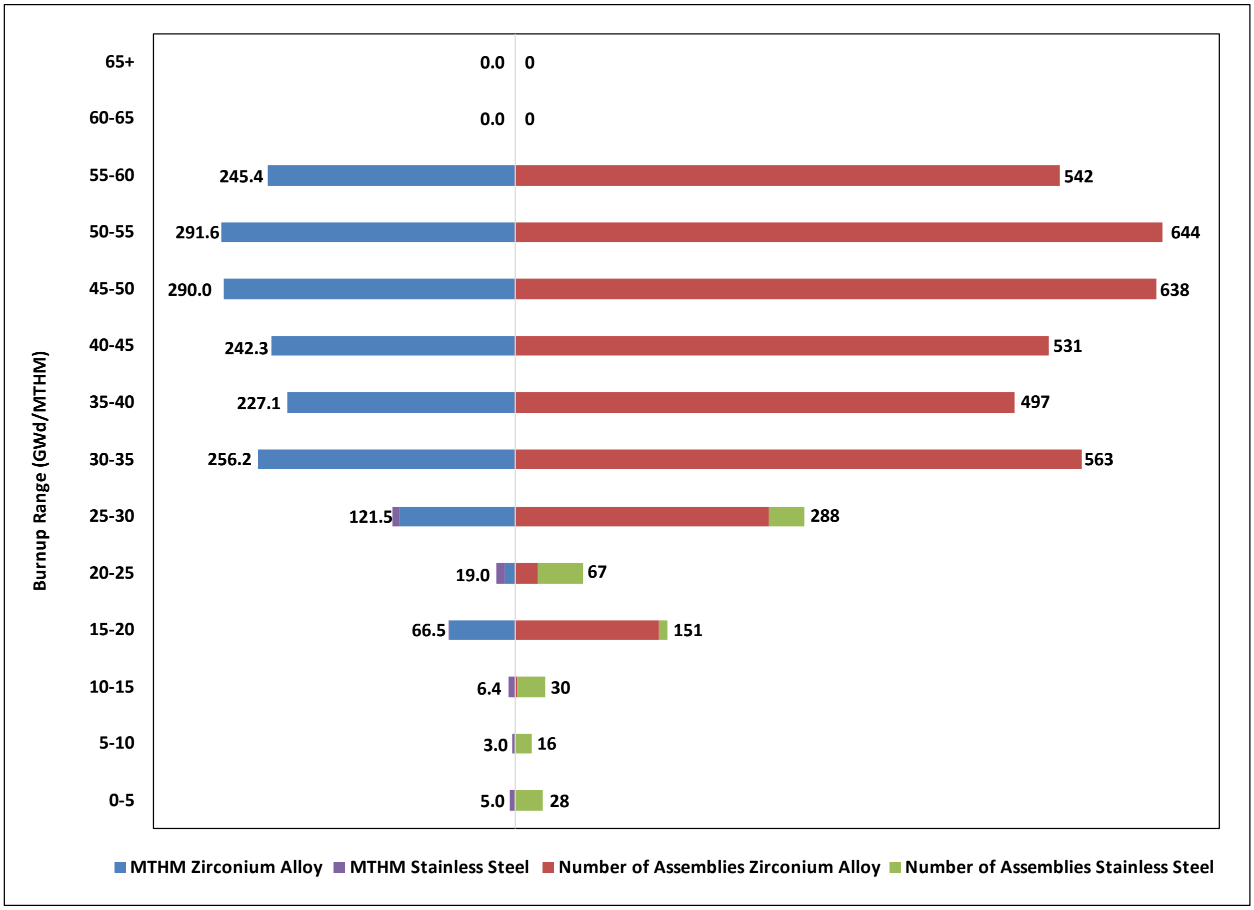


Figure 2-508. Indian Point Number of Assemblies and MTHM versus Burnup

2.19.2 Site Conditions

Figure 2-509 shows an aerial view of the Indian Point site, including potential barge areas, the ISFSI, site entrances, and Indian Point-1, -2, and -3. Figure 2-510 shows an aerial view of the Indian Point ISFSI, and Figure 2-511 and Figure 2-512 show the HI-STORM FW dry storage systems deployed at Indian Point.

Figure 2-513 and Figure 2-514 shows the south entrance to the Indian Point site looking east and west, respectively. Figure 2-515 and Figure 2-516 shows the south entrance to the Indian Point site looking east and west, respectively. Figure 2-517 and Figure 2-518 shows Broadway at the north entrance looking south and north respectively. Figure 2-519 and Figure 2-520 shows the middle entrance to the Indian Point site looking east and north, respectively.

Figure 2-521 shows the vertical cask transporter at the Indian Point site, Figure 2-522 shows the barge area at Indian Point looking north, and Figure 2-523 shows the barge area access road.

The Indian Point site and Broadway is bisected by 2 gas lines, a 26-inch line and a 30-inch line, and a 42-inch gas line runs across the southern end of the Indian Point site (see Figure 2-524). Figure 2-525 and Figure 2-526 show the air bridge over the 26-inch and 30-inch gas lines.

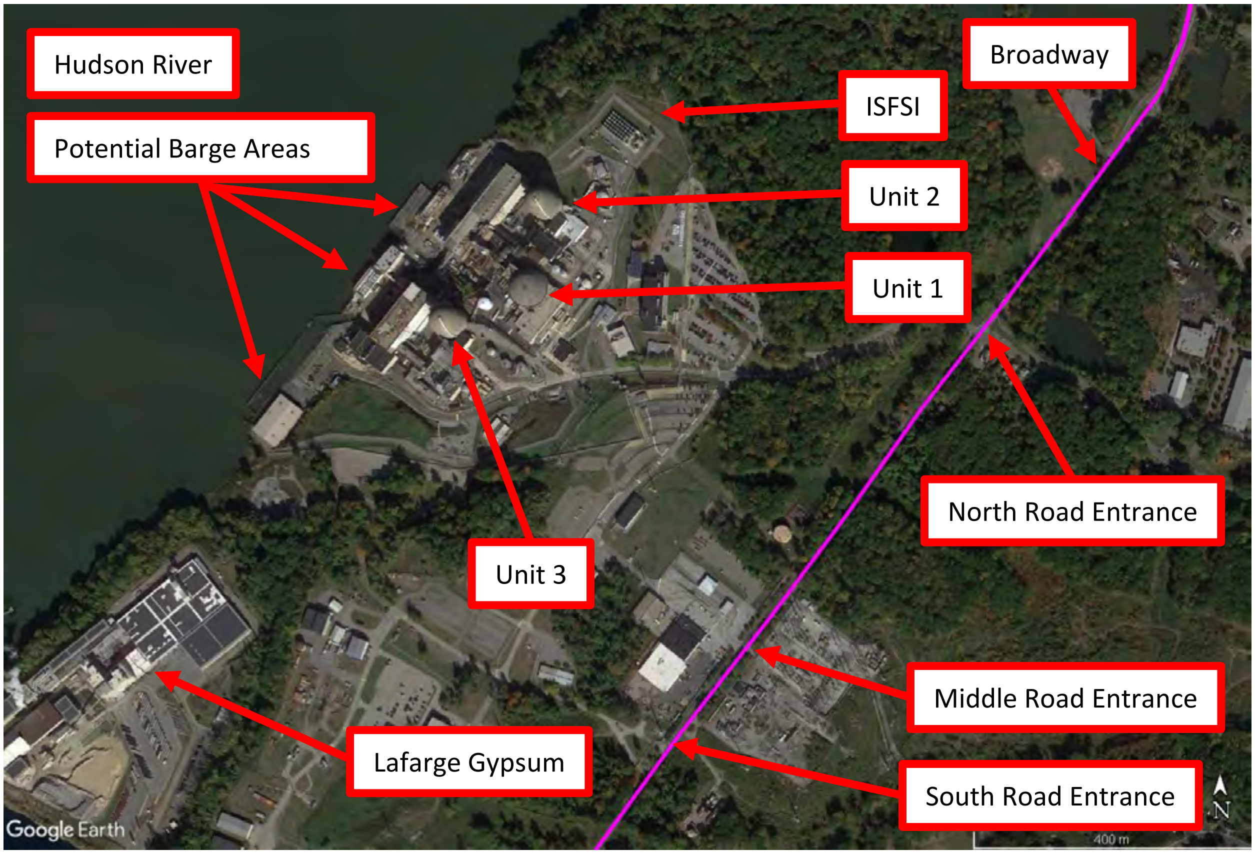


Figure 2-509. Aerial View of the Indian Point Site (Google 2022)

Figure 2-510. Aerial View of the Indian Point ISFSI (Google 2022)

Figure 2-511. HI-STORM FW Dry Storage Systems at the Indian Point ISFSI (Looking West Towards Hudson River)

Figure 2-512. HI-STORM FW Dry Storage Systems at the Indian Point ISFSI (Looking North)

Figure 2-513. Indian Point South Entrance Looking East Towards Broadway

Figure 2-514. Indian Point South Entrance Looking West Towards Hudson River

Figure 2-515. Indian Point North Entrance Looking East Towards Broadway

Figure 2-516. Indian Point North Entrance Looking West Towards Hudson River

Figure 2-517. Broadway at North Entrance Looking South

Figure 2-518. Broadway at North Entrance Looking North Towards Louisa Street

Figure 2-519. Indian Point Middle Entrance Looking East Towards Broadway

Figure 2-520. Indian Point Middle Entrance Looking North

Figure 2-521. Indian Point Vertical Cask Transporter

Figure 2-522. Indian Point Barge Area Looking North

Figure 2-523. Indian Point Barge Area Access Road

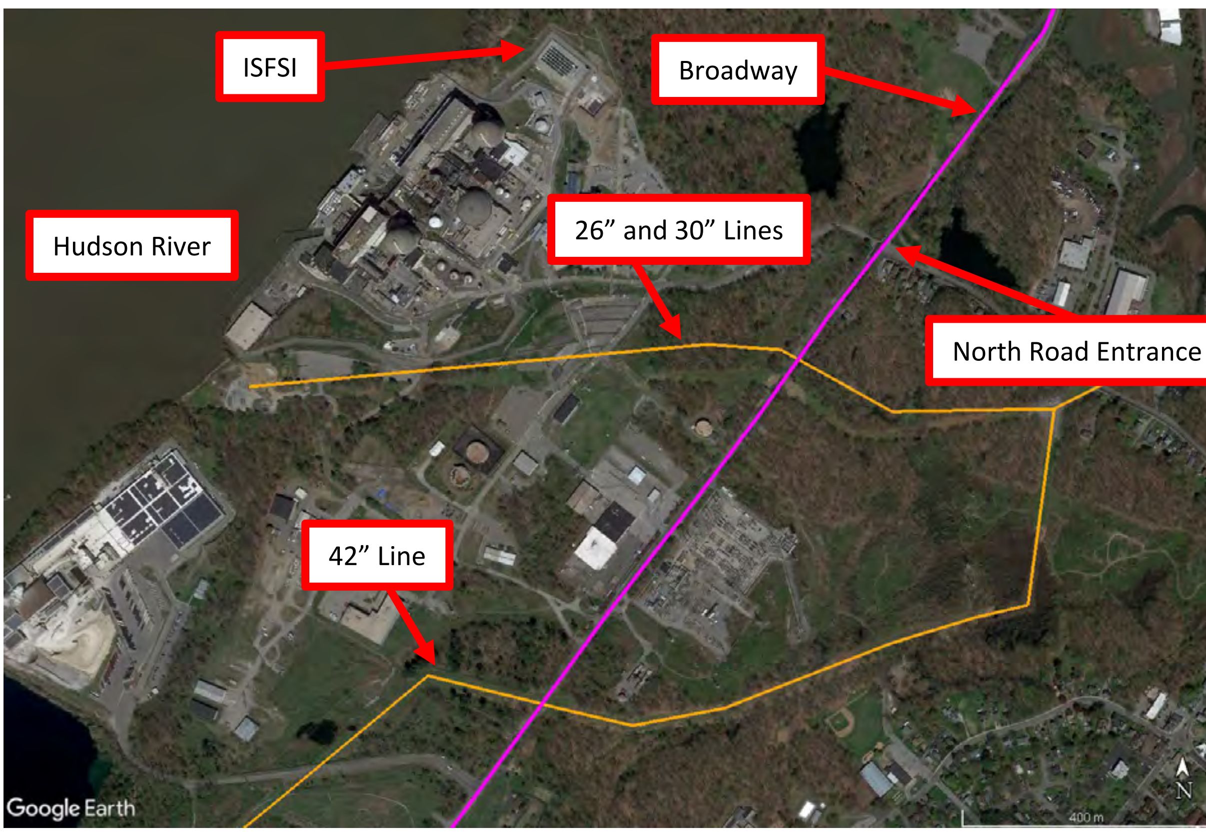


Figure 2-524. Indian Point Gas Lines (Google 2022)

Figure 2-525. Air Bridge Over 26-inch and 30-inch Gas Lines Looking South

Figure 2-526. Air Bridge Over 26-inch and 30-inch Gas Lines Looking North

2.19.3 Near-site Transportation Infrastructure and Experience

The Indian Point site does not have direct rail access. The closest railroads in the vicinity of the Indian Point site are the Metro North Railroad, which operates in New York, the CSX Railroad, which operates on the west bank of the Hudson River, and the Housatonic Railroad (HRRC), which operates in Connecticut and interchanges with the CSX Railroad in Pittsfield, MA.

Eight potential heavy haul truck to rail transload locations were evaluated:

- Hawleyville Road, Newtown, CT – HRRC.
- Segar Street, Danbury, CT – HRRC.
- Agriventures Agway, Danbury, CT – HRRC.
- State Line, Danbury, CT – HRRC.
- Hopewell Railyard, Hopewell Junction, NY – Metro North.
- Croton Railyard – Metro North.
- Lower South Street, Peekskill, NY – Metro North.
- West Bank of Hudson River, Newburgh, NY – CSX Railroad.

Figure 2-527 shows the locations of these potential transload locations. To reach many of these locations, travel on U.S. 9 north would be required. Figure 2-528 shows a potential heavy haul truck route in the vicinity of Louisa Street, which would be used to access U.S. 9. Figure 2-529 shows Louisa Road at the underpass onto U.S. 9. Figure 2-530 shows views of U.S. 9 heading north.

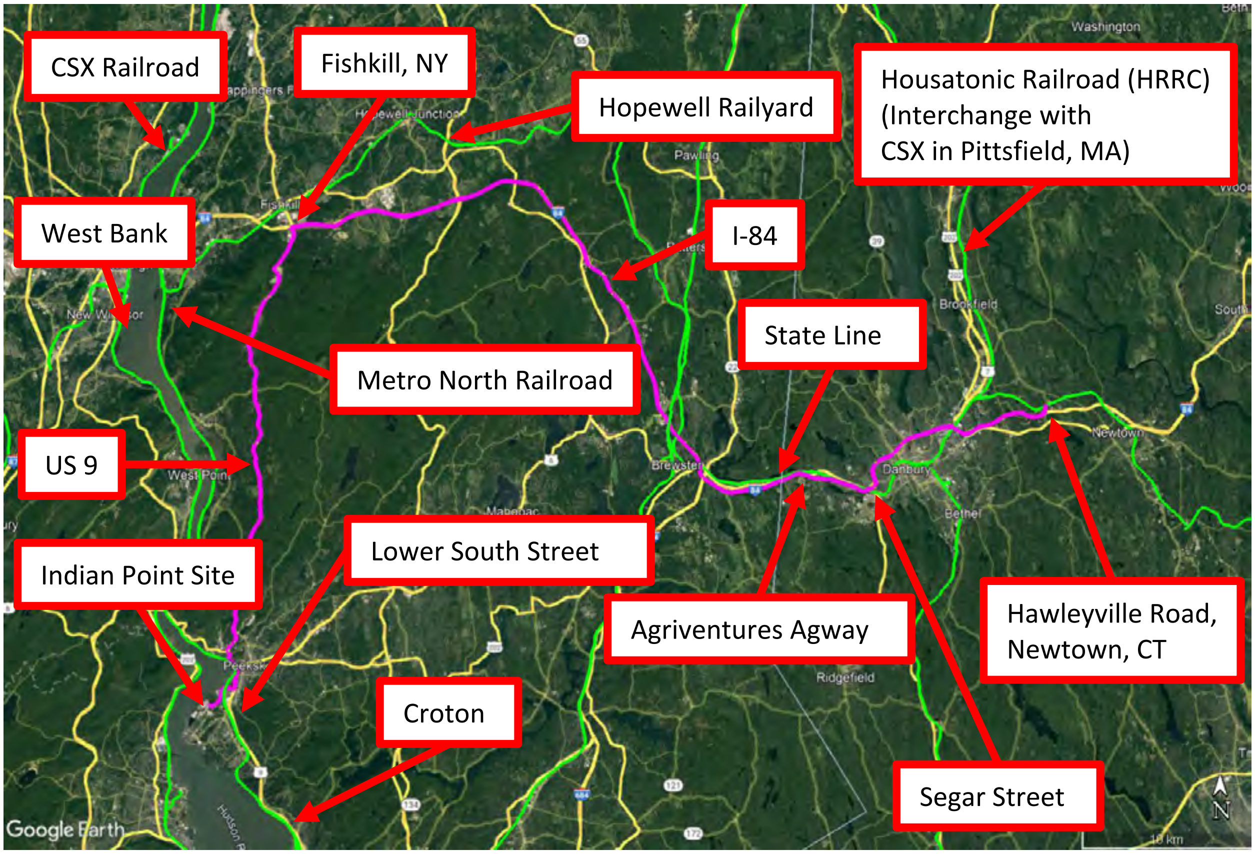


Figure 2-527. Potential Heavy Haul Truck to Rail Transload Locations (Google 2022)

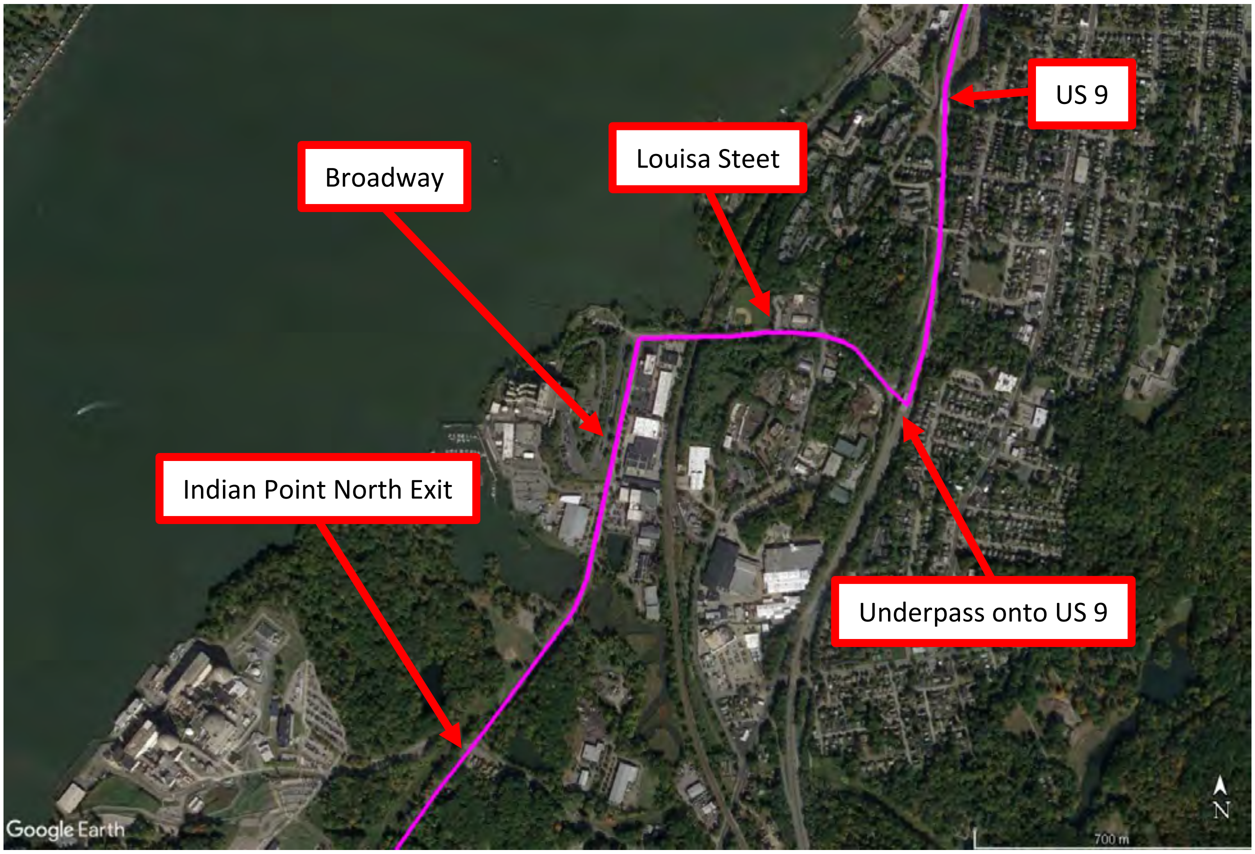


Figure 2-528. Potential Heavy Haul Truck Route in Vicinity of Louisa Street (Google 2022)

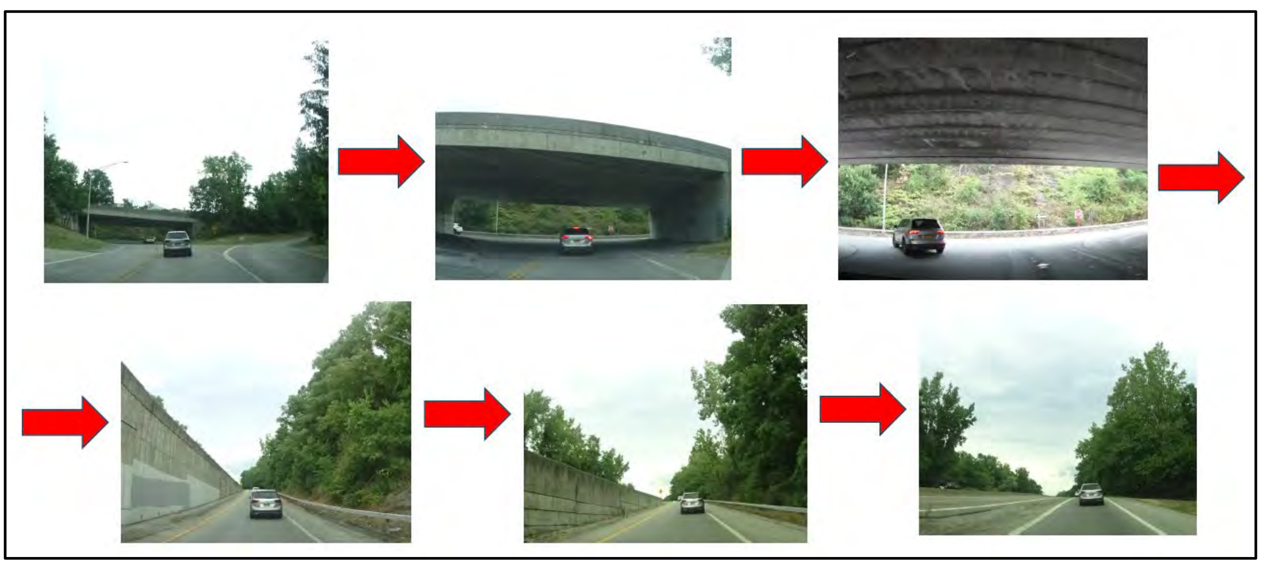


Figure 2-529. Louisa Road at Under Pass Onto U.S. 9

Figure 2-530. Views of U.S. 9 Heading North

2.19.3.1 Hawleyville Road Potential Transload Location

The Hawleyville Road potential heavy haul truck to rail transload location is located in Newtown, CT and is currently being used to transload truck shipments of low-level waste from Indian Point to the HRRC for transport to Andrews, TX. The site is 57 miles from Indian Point.

Figure 2-531 provides an aerial view of the Hawleyville Road location. Other areas of the Hawleyville Road site include:

- Figure 2-532 – Hawleyville Road potential transload location looking southwest
- Figure 2-533 – Hawleyville Road entrance looking southwest
- Figure 2-534 – 131-lb. rail at Hawleyville Road potential transload location
- Figure 2-535 – Hawleyville Road potential transload location looking north.

Figure 2-536 and Figure 2-537 shows the transloading of shipping container onto a railcar at Hawleyville Road and shipping containers on a railcar at Hawleyville Road, respectively.

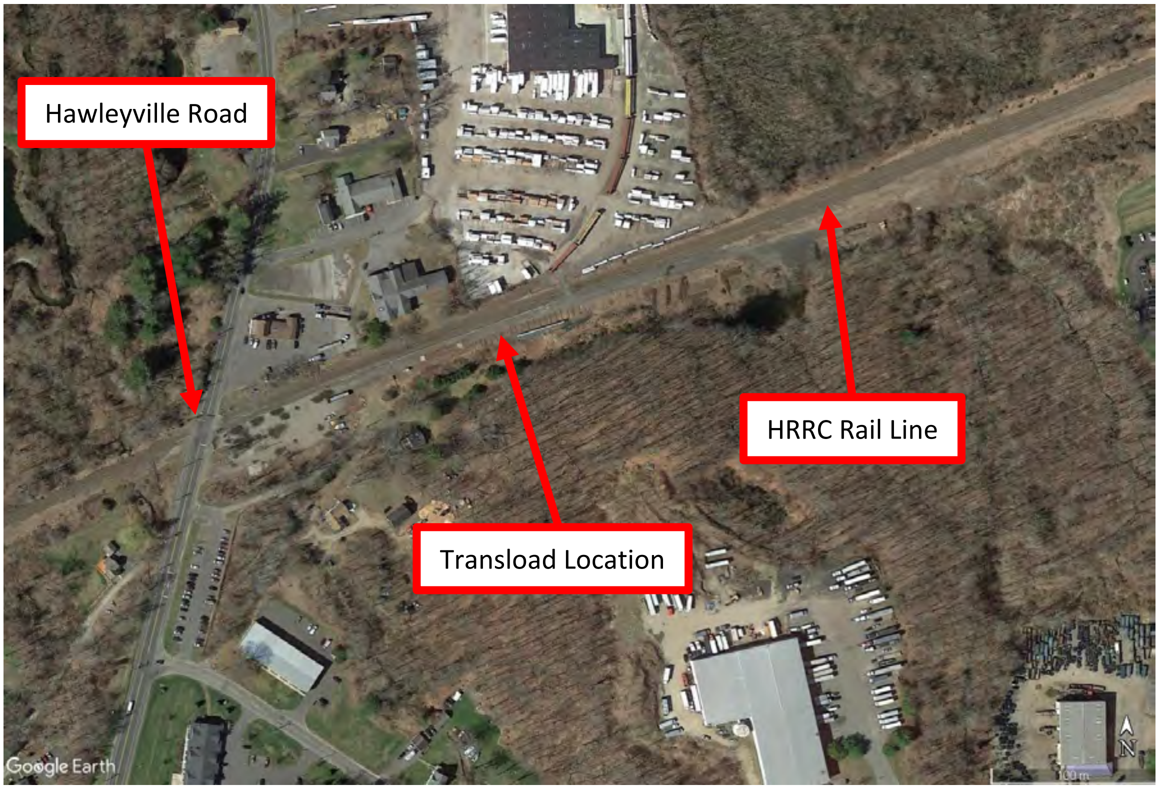


Figure 2-531. Aerial View of Hawleyville Road Potential Transload Location (Google 2022)

Figure 2-532. Hawleyville Road Potential Transload Location Looking Southwest

Figure 2-533. Hawleyville Road Entrance Looking Southwest

Figure 2-534. 131-lb. Rail Hawleyville Road Potential Transload Location

Figure 2-535. Hawleyville Road Potential Transload Location Looking North

Photo courtesy of the Indian Point Site

Figure 2-536. Transloading of Shipping Container onto Railcar at Hawleyville Road

Photo courtesy of the Indian Point Site

Figure 2-537. Shipping Containers on Railcar at Hawleyville Road

2.19.3.2 Segar Street Potential Transload Location

The Segar Street potential heavy haul truck to rail transload location is located in Danbury, CT and is 50 miles from Indian Point. The site is served by the HRRC.

Figure 2-538 provides an aerial view of the Segar Street site. Other areas of the Segar Street site include:

- Figure 2-539 – Segar Street potential transload location looking northwest
- Figure 2-540 – Segar Street potential transload location looking southeast
- Figure 2-541 – 132 lb. to 130 lb. rail joint at Segar Street potential transload location
- Figure 2-542 – Segar Street potential transload location looking northwest
- Figure 2-543 – Segar Street potential transload location looking northwest under U.S. 7 overpass.

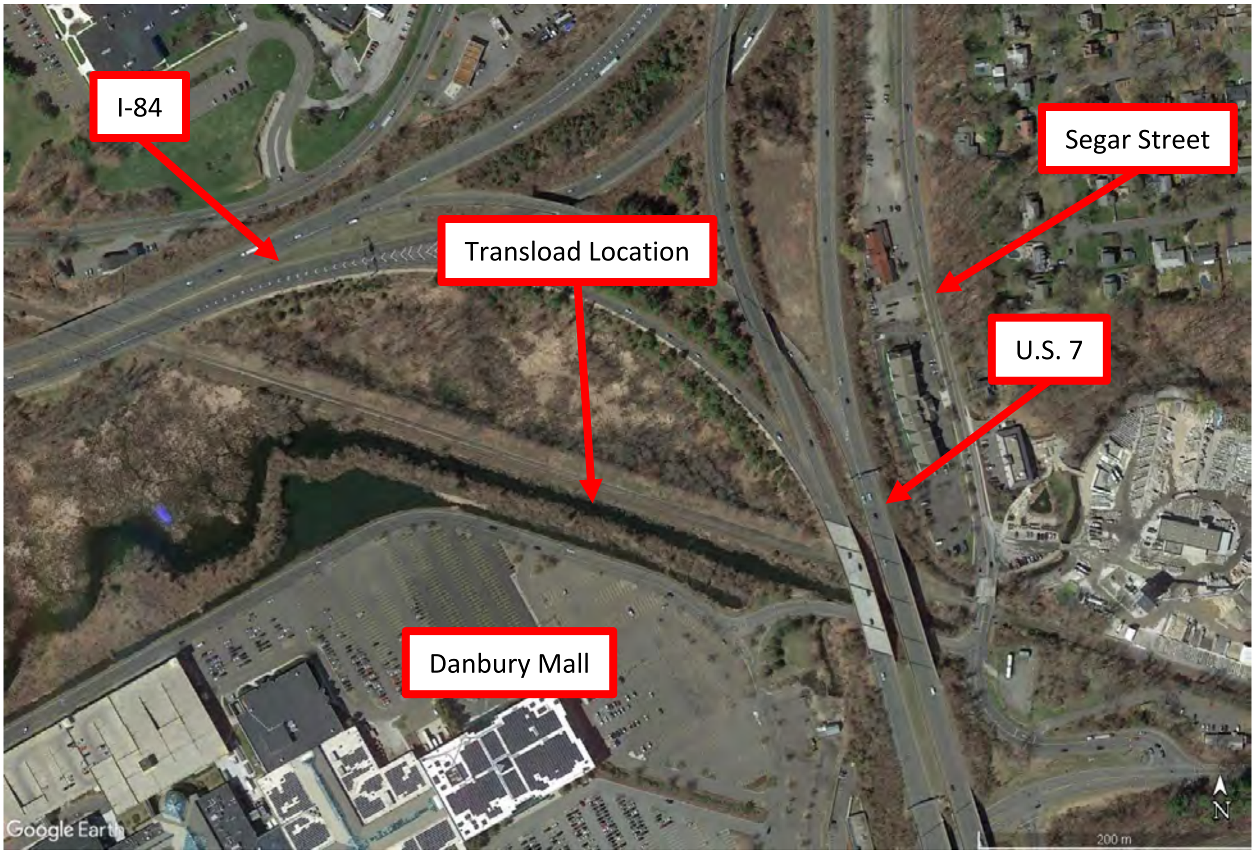


Figure 2-538. Aerial View of Segar Street Potential Transload Location (Google 2022)

Figure 2-539. Segar Street Potential Transload Location Looking Northwest

Figure 2-540. Segar Street Potential Transload Location Looking Southeast

Figure 2-541. 132 lb. to 130 lb. Rail Joint at Segar Street Potential Transload Location

Figure 2-542. Segar Street Potential Transload Location Looking Northwest

Figure 2-543. Segar Street Potential Transload Location Looking Northwest Under U.S. 7 Overpass

2.19.3.3 Agriventures Agway Potential Transload Location

The Agriventures Agway potential heavy haul truck to rail transload location is located in Danbury, CT and is 47 miles from Indian Point. The site is served by the HRRC and was used to transload a transformer from rail to heavy haul truck.

Figure 2-544 provides an aerial view of the Agriventures Agway site. Other areas of the Agriventures Agway site include:

- Figure 2-545 – Agriventures Agway potential transload location looking southeast
- Figure 2-546 – Agriventures Agway potential transload location looking northwest
- Figure 2-547 – 130-lb. rail at Agriventures Agway potential transload location.

Figure 2-544. Aerial View of Agriventures Agway Potential Transload Location (Google 2022)

Figure 2-545. Agriventures Agway Potential Transload Location Looking Southeast

Figure 2-546. Agriventures Agway Potential Transload Location Looking Northwest

Figure 2-547. 130-lb. Rail at Agriventures Agway Potential Transload Location

2.19.3.4 State Line Potential Transload Location

The State Line potential heavy haul truck to rail transload location is located in Danbury, CT at the Connecticut-New York state line and is 46 miles from Indian Point. The site is served by the HRRC.

Figure 2-548 provides an aerial view of the State Line site. Other areas of the State Line site include:

- Figure 2-549 – State Line potential transload location looking northeast towards Connecticut
- Figure 2-550 – State Line potential transload location looking southwest towards New York
- Figure 2-551 – State Line potential transload location looking southwest at cut rail at the Connecticut-New York border
- Figure 2-552 – State Line potential transload location looking southwest at cut rail end of the rail line at the Connecticut-New York border.

Figure 2-548. Aerial View of State Line Potential Transload Location (Google 2022)

Figure 2-549. State Line Potential Transload Location Looking Northeast Towards Connecticut

Figure 2-550. State Line Potential Transload Location Looking Southwest Towards New York

Figure 2-551. State Line Potential Transload Location Looking Southwest at Cut Rail at CT-NY Border

Figure 2-552. State Line Potential Transload Location Looking Southwest at Cut Rail End of the Rail Line at CT-NY Border

2.19.3.5 Hopewell Railyard Potential Transload Location

The Hopewell Railyard potential heavy haul truck to rail transload location is located in Hopewell Junction, NY and is 28 miles from Indian Point. This site is served by the Metro North Railroad but is not connected to the rest of Metro North rail network.

Figure 2-553 provides an aerial view of the State Line site. Figure 2-554 and Figure 2-555 show the Hopewell Railyard location looking northwest and southeast.

Figure 2-553. Aerial View of the Hopewell Railyard Potential Transload Location (Google 2022)

Figure 2-554. Hopewell Railyard Potential Transload Location Looking Northwest at the Northwest End of the Yard

Figure 2-555. Hopewell Railyard Potential Transload Location Looking Southeast at the Center of the Yard

2.19.3.6 Croton Railyard Potential Transload Location

The Croton Railyard potential heavy haul truck to rail transload location is 7 miles from Indian Point on the east bank of the Hudson River in New York. This site is served by the Metro North Railroad.

Figure 2-556 provides an aerial view of the Croton Railyard. Figure 2-557 and Figure 2-558 show the Croton Railyard location looking southeast and northwest.

Figure 2-556. Aerial View of the Croton Railyard Potential Transload Location (Google 2022)

Figure 2-557. Croton Railyard Potential Transload Location Looking Southeast

Figure 2-558. Croton Railyard Potential Transload Location Looking Northwest

2.19.3.7 Lower South Street Potential Transload Location

The Lower South Street potential heavy haul truck to rail transload location is located in Peekskill, NY and is 1.7 miles from Indian Point. This site is served by the Metro North Railroad.

Figure 2-559 provides an aerial view of the Lower South Street site. Figure 2-560 and Figure 2-561 show the Lower South Street location looking north and south.

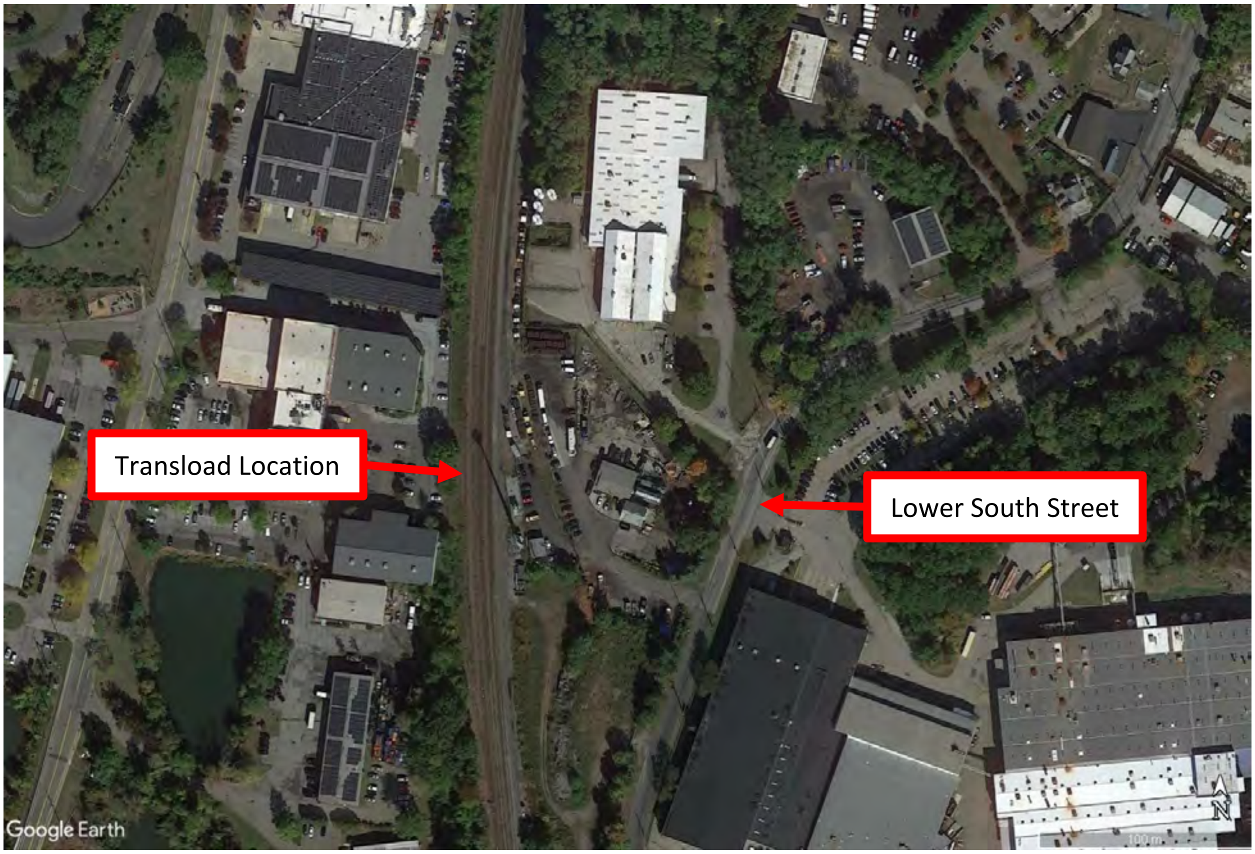


Figure 2-559. Aerial View of the Lower South Street Potential Transload Location (Google 2022)

Figure 2-560. Lower South Street Potential Transload Location Looking North

Figure 2-561. Lower South Street Potential Transload Location Looking South

2.19.3.8 West Bank of the Hudson River Potential Transload Location

This location is on the west bank of the Hudson River, which would be crossed using the I-84 Newburgh-Beacon Bridge. The location is 31 miles from Indian Point and is served by the CSX Railroad.

Figure 2-562 provides an aerial view of the West Bank site. Figure 2-563 and Figure 2-564 show the West Bank location looking north and south.

Figure 2-562. Aerial View of the West Bank of the Hudson River Potential Transload Location (Google 2022)

Figure 2-563. West Bank of the Hudson River Potential Transload Location Looking North

Figure 2-564. West Bank of the Hudson River Potential Transload Location Looking South

2.19.3.9 Local Schools in the Vicinity of the Indian Point Site

During meetings with the Indian Point Decommissioning Oversight Board, concern was expressed over the proximity of local schools to the Indian Point site. The Indian Point ISFSI is located about 0.8 miles from the Buchanan-Verplanck Elementary School and about 1.4 miles from the Hendrick Hudson High School (see Figure 2-565). Figure 2-566and Figure 2-567 show the Buchanan-Verplanck Elementary School and the Hendrick Hudson High School.

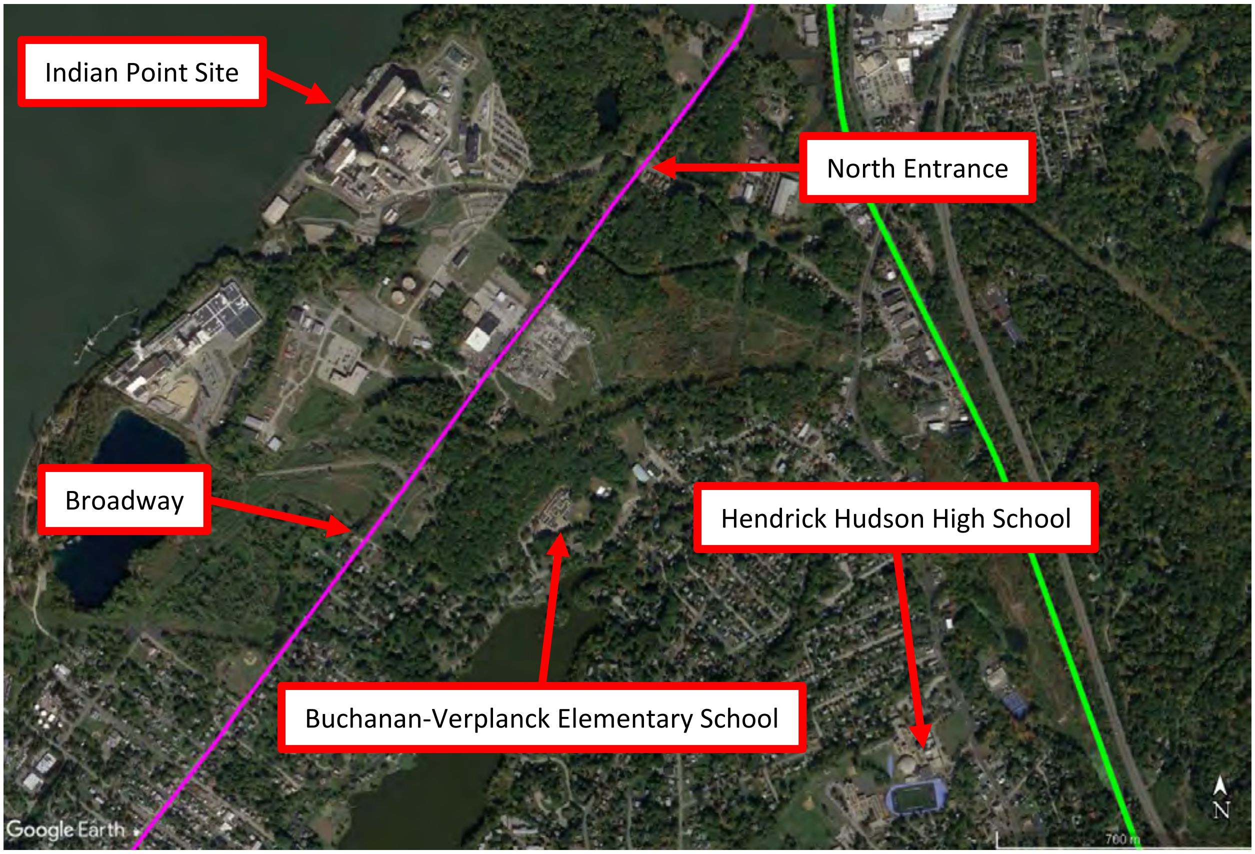


Figure 2-565. Local Schools in the Vicinity of the Indian Point Site (Google 2022)

Figure 2-566. Buchanan-Verplanck Elementary School

Figure 2-567. Hendrick Hudson High School

2.19.3.10 Barge Access at the Indian Point Site

During construction of the reactors at the Indian Point site, the barge area was used to deliver major reactor components to the site (NAC 1991c, 1991d). The Hudson River is approximately 15 feet below the level of the dock at the barge area and the water depth at the barge area is at least 9 feet. The barge dock area is about 150 feet long. Based on the topography of the barge area, roll-on/roll-off transfers of SNF transportation casks may be possible (NAC 1991c, 1991d).

The Hudson River is available for shipments year-round and is generally not subject to winter freeze conditions south of the Indian Point site. The Hudson River is navigable and open to barge traffic from the Atlantic Ocean north to Albany, New York (NAC 1991c, 1991d).

The barge area was last used in 2016 for shipping of transformers to the Indian Point site and would need to be refurbished to accommodate a crane to support loading of the barge. Cost estimates from Indian Point staff were approximately $6.1 million to restore, maintain, and demolish the barge area, or $2 million to restore and maintain the barge area.

2.19.4 Future Information Needs

The certificate of compliance for the HI-STAR 100 transportation cask does not allow for the transport of high burnup SNF or GTCC waste. The certificate of compliance for the HI-STAR 100MB transportation cask does not allow for the transport of SNF with burnups greater than 55 GWd/MTHM or GTCC waste. Consequently, the certificate of compliance for the HI-STAR 100 or the HI-STAR 100MB would have to be revised to transport all SNF and GTCC waste from the Indian Point site.

The Indian Point site does not have direct rail access but does have direct barge access. However, the barge area would need to be refurbished to accommodate a crane to support loading of the barge. For this reason, the principal future information need is the choice of transport mode to be used when removing SNF from the Indian Point site. In addition, the choice of a potential heavy haul truck to rail transload location which would depend on several factors, such as the condition and capacity of the transportation infrastructure, the distance to the transload location, etc. The feasibility of removing SNF from Indian Point using barge transport would also need to be evaluated.

In addition to transportation infrastructure information needs, the dry storage canister SNF contents would need to be evaluated to verify that they meet the conditions in the 10 CFR Part 71 transportation certificate of compliance. Any changes made to dry storage canisters through the 10 CFR 72.48 process would also need to be evaluated to determine if they need to be propagated to the 10 CFR Part 71 transportation certificate of compliance.

2.20 Palisades

The Palisades site is located Covert Township, Van Buren County, Michigan, on the southeastern shoreline of Lake Michigan. The site is bordered by Lake Michigan on the west and the Blue Star Memorial Highway and adjacent Interstate-196 on the east. The nearest town is South Haven, Michigan, which is approximately 4.5 miles north of the plant. The major towns within a 50-miles radius of the plant are Kalamazoo and Portage, Michigan, and Elkhart, Mishawaka, and South Bend, Indiana (NRC 2006).

2.20.1 Site Inventory

Palisades is a 805 MWe PWR (IAEA 2023, Reference Unit Power) that operated from 1971 through 2022. There are 18 VSC-24 dry storage systems (Docket No. 72-1007) containing 432 SNF assemblies at the Palisades site. The VSC-24 dry storage system comprised of three principal components, the canister [i.e., the multi-assembly sealed basket (MSB)], the ventilated concrete cask (VCC), and the transfer cask [i.e., the MSB transfer cask (MTC)]. The MTC is used for canister loading and unloading operations.

There are also 24 Standardized NUHOMS dry storage systems (Docket No. 72-1004) at the Palisades site. SNF is stored in 13 24PTH canisters (312 assemblies) and 11 32PT canisters (352 assemblies). There are also 7 HI-STORM FW dry storage systems (Docket No. 72-1032) containing 259 SNF assemblies stored in MPC-37 canisters. Twenty-two additional HI-STORM FW dry storage systems will be required to store all remaining SNF at Palisades. All SNF assemblies at the Palisades site are zirconium alloy clad.

When all fuel at Palisades is placed into dry storage, there will be 71 dry storage systems at Palisades. An additional 1 canister of GTCC waste is estimated to be stored at Palisades after decommissioning.

The MSB canisters stored in the VSC-24 dry storage systems are not certified for transport by the NRC, and for SNF stored in these canisters to be transported, they would need to be included in the list of approved contents in the certificate of compliance for a transportation cask.

The MP197HB transportation cask (Docket No. 71-9302) is certified to transport the 24PTH and 32PT canisters. The HI-STAR 190 transportation cask (Docket No. 71-9373) is certified to transport the MPC-37 canisters. The HI-STAR 190 is not certified to transport GTCC waste.

Figure 2-568 illustrates the number of SNF assemblies and MTHM at Palisades based on discharge year. There are a total of 2053 SNF assemblies (850.5 MTHM) at the Palisades site. The oldest fuel was discharged in 1973 and the last fuel was discharged in 2022. The median discharge year of the fuel is 2001.

Figure 2-569 illustrates the number of SNF assemblies and MTHM at Palisades based on burnup. The lowest burnup is 3.4 GWd/MTHM and the highest burnup is 55.8 GWd/MTHM. The median burnup is 40.1 GWd/MTHM. There are 635 SNF assemblies (273.3 MTHM) at Palisades that have burnups greater than 45 GWd/MTHM. These 635 fuel assemblies are classified by the NRC as high burnup SNF.

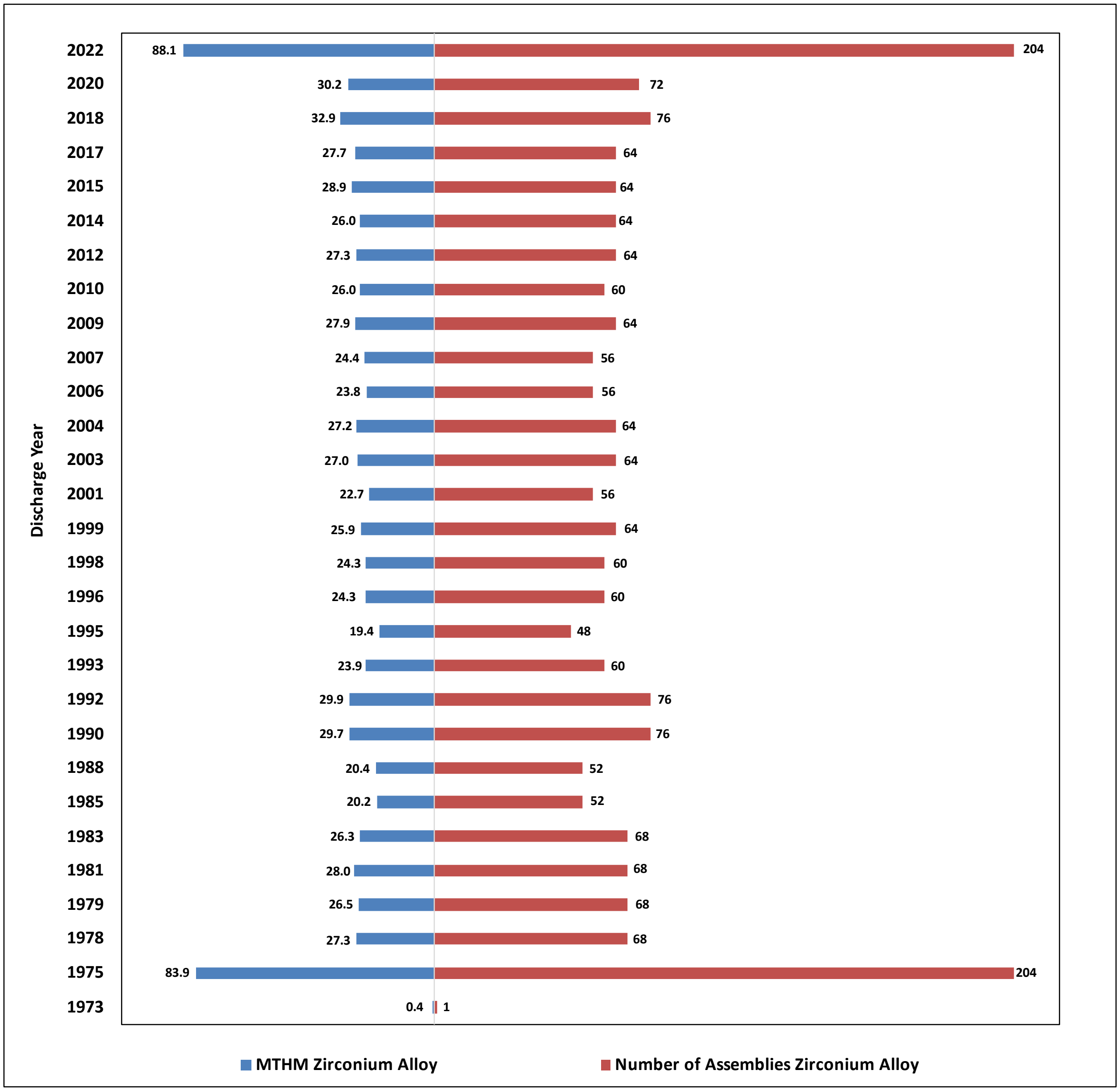


Figure 2-568. Palisades Number of Assemblies and MTHM versus Discharge Year

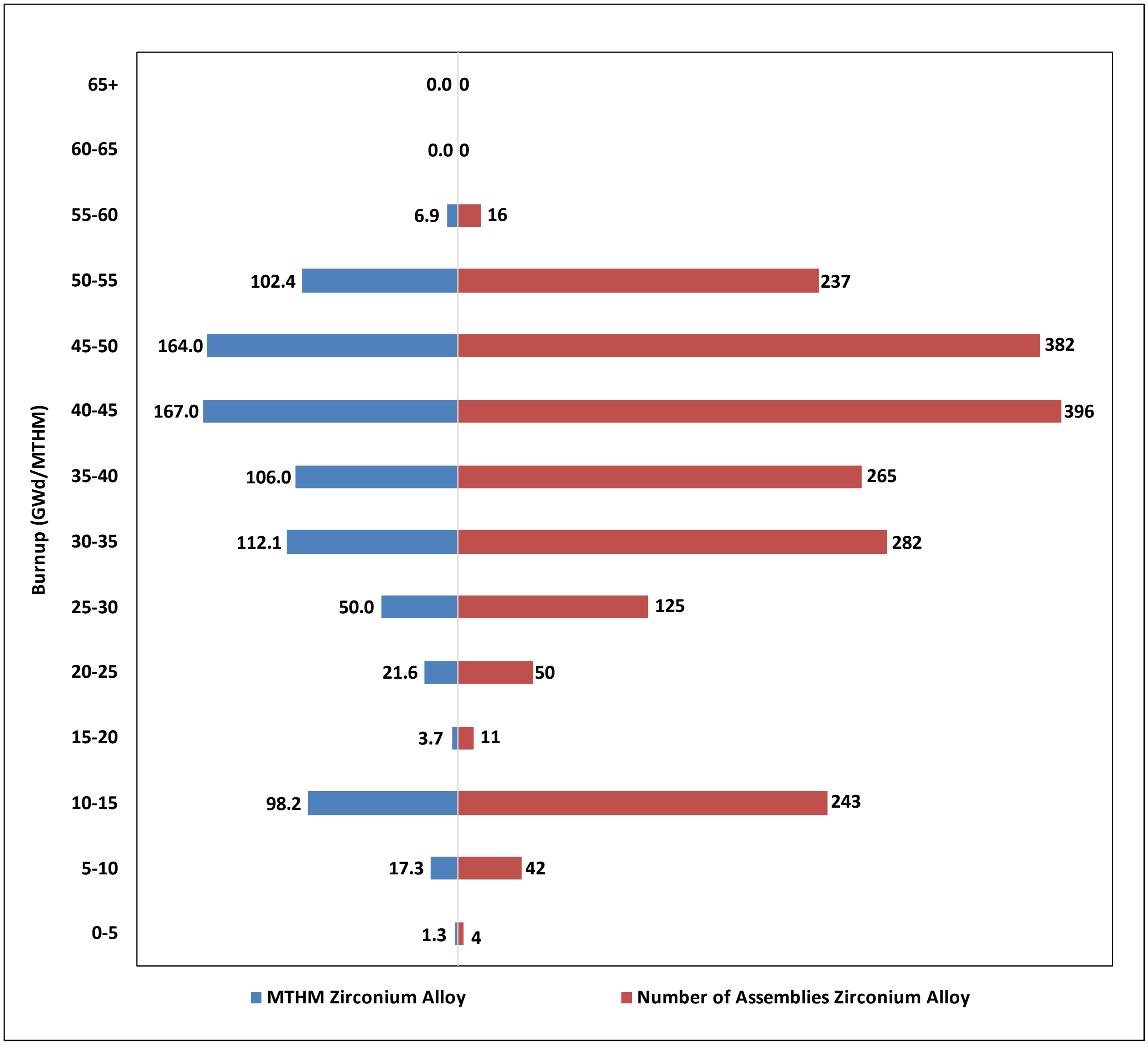


Figure 2-569. Palisades Number of Assemblies and MTHM versus Burnup

2.20.2 Site Conditions

Figure 2-570 shows and aerial view of the Palisades site, including Palisades Unit 1, the original ISFSI, and the east ISFSI. Figure 2-571 shows an aerial view of the original ISFSI at the Palisades site, and Figure 2-572 and Figure 2-573 show the VSC-24 dry storage systems at the original ISFSI.

Figure 2-574 shows an aerial view of the east ISFSI, Figure 2-575 shows the NUHOMS dry storage systems at the east ISFSI, and Figure 2-576 shows the HI-STORM FW dry storage systems at the east ISFSI.

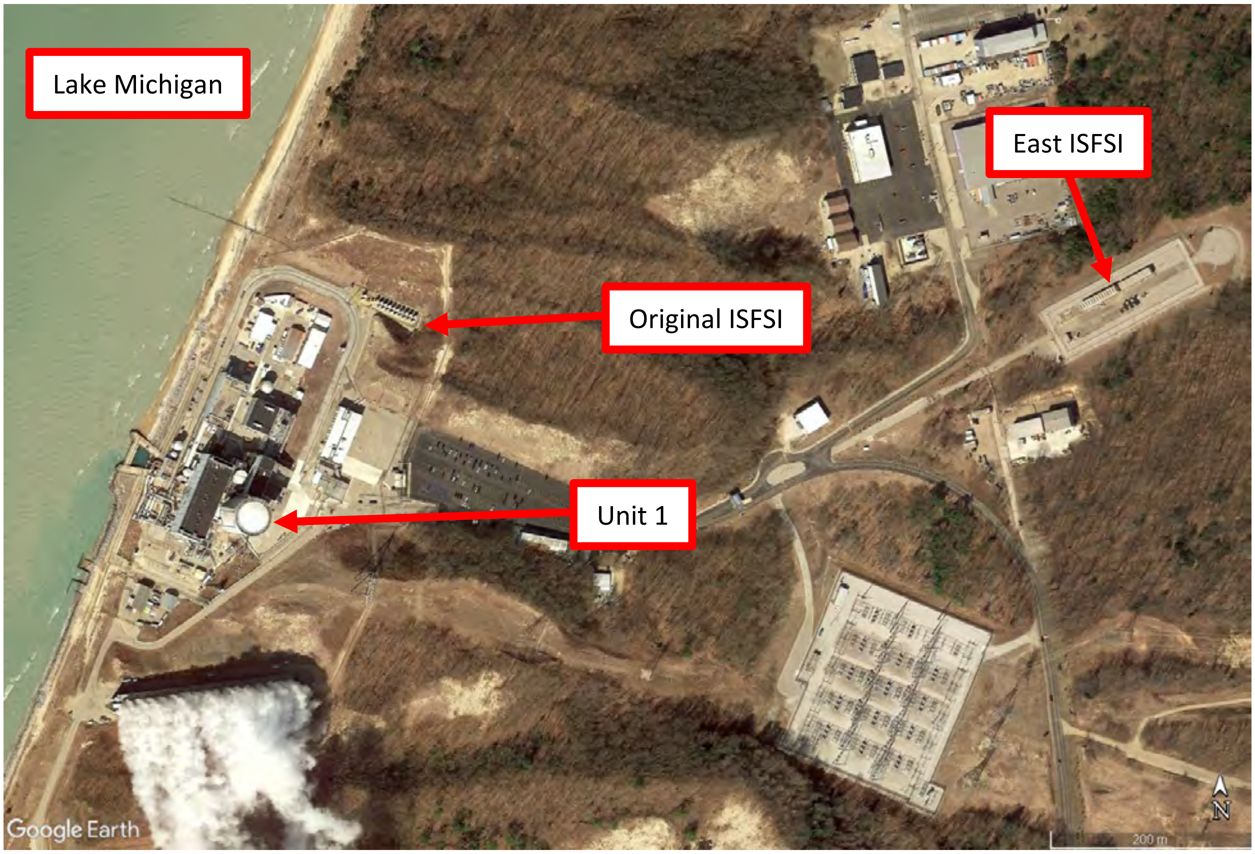


Figure 2-570. Aerial View of the Palisades Site (Google 2022)

Figure 2-571. Aerial View of the Original ISFSI Containing VSC-24 Dry Storage Systems (Google 2022)

Figure 2-572. VSC-24 Dry Storage Systems at the Original ISFSI Looking East

Figure 2-573. VSC-24 Dry Storage Systems at the Original ISFSI Looking West

Figure 2-574. Aerial View of East ISFSI at the Palisades Site (Google 2022)

Figure 2-575. NUHOMS Dry Storage Systems at the East ISFSI at the Palisades Site

Figure 2-576. HI-STORM FW Dry Storage Systems at the East ISFSI at the Palisades Site

2.20.3 Near-site Transportation Infrastructure and Experience

The Palisades site does not have direct rail access. Figure 2-577 shows the rail infrastructure in the vicinity of the Palisades site. The closest railroads in the vicinity of the Palisades site are the CSX Railroad and the Western Michigan Railroad (WMI). The CSX Railroad and the WMI interchange in Hartford, Michigan.

Nine potential heavy haul truck to rail transload locations were evaluated:

- Paw Paw River Produce
- Lineage Logistics
- Rail Spur near NoBo Marijuana Cultivation Facility
- Aludyne
- Quarry
- Abandoned CSX Railyard
- Dicastal Logistics
- Menasha Packaging
- DC Cook Nuclear Power Plant

It may be possible to establish barge access at the Palisades site.

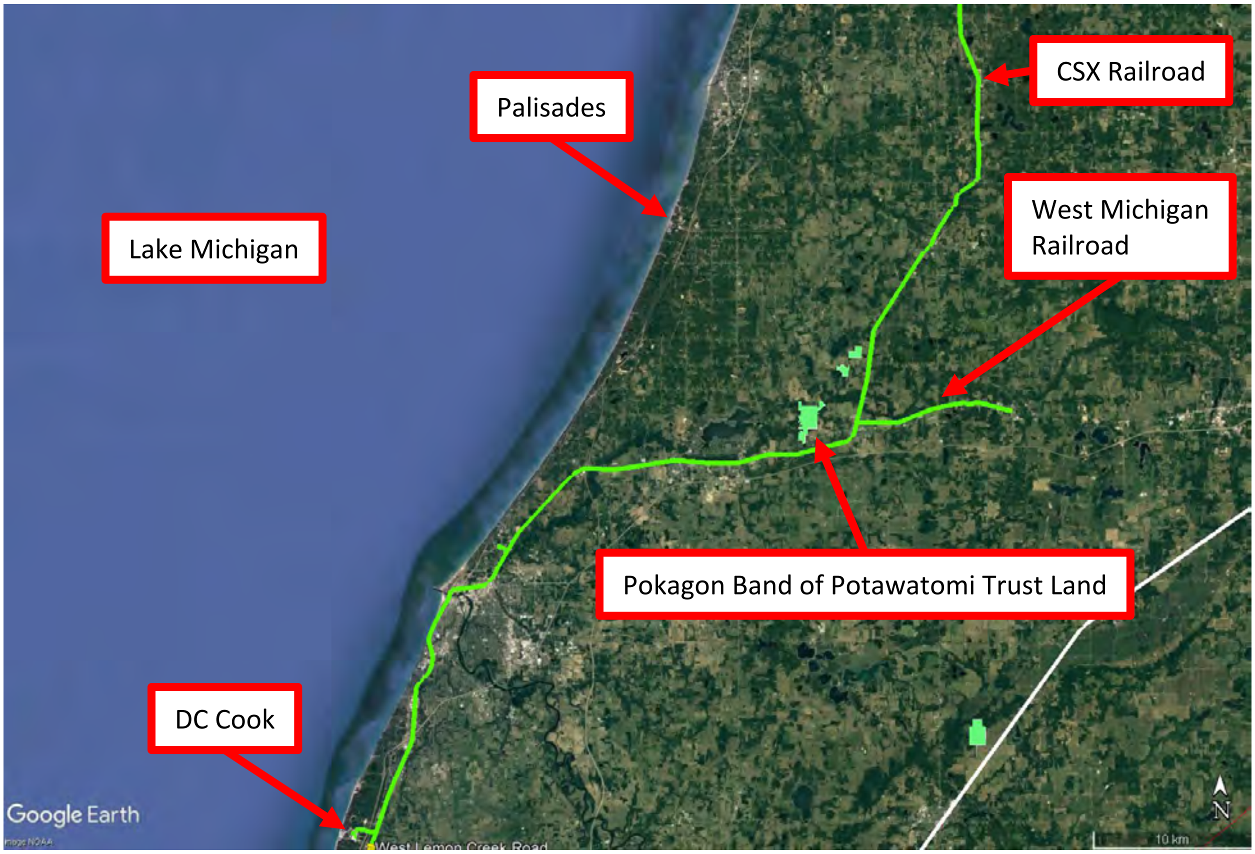


Figure 2-577. Rail Infrastructure in the Vicinity of the Palisades Site (Google 2022)

2.20.3.1 Paw Paw River Produce Potential Transload Location

The Paw Paw River Produce potential heavy haul truck to rail transload location is located in Hartford, Michigan and is about 12 miles from the Palisades site. The location is served by the WMI.

Figure 2-578 shows an aerial view of the Paw Paw River Produce location. Figure 2-579 and Figure 2-580 show the Paw Paw River Produce location looking west and east.

Figure 2-578. Aerial View of Paw Paw River Produce Potential Transload Location (Google 2022)

Figure 2-579. Paw Paw River Produce Potential Transload Location Looking West

Figure 2-580. Paw Paw River Produce Potential Transload Location Looking East

2.20.3.2 Lineage Logistics Potential Transload Location

The Lineage Logistics potential heavy haul truck to rail transload location is located in Hartford, Michigan and is about 12 miles from the Palisades site. The location is served by the WMI.

Figure 2-581 shows an aerial view of the Lineage Logistics location. Figure 2-582 and Figure 2-583 show the Lineage Logistics location looking west and east.

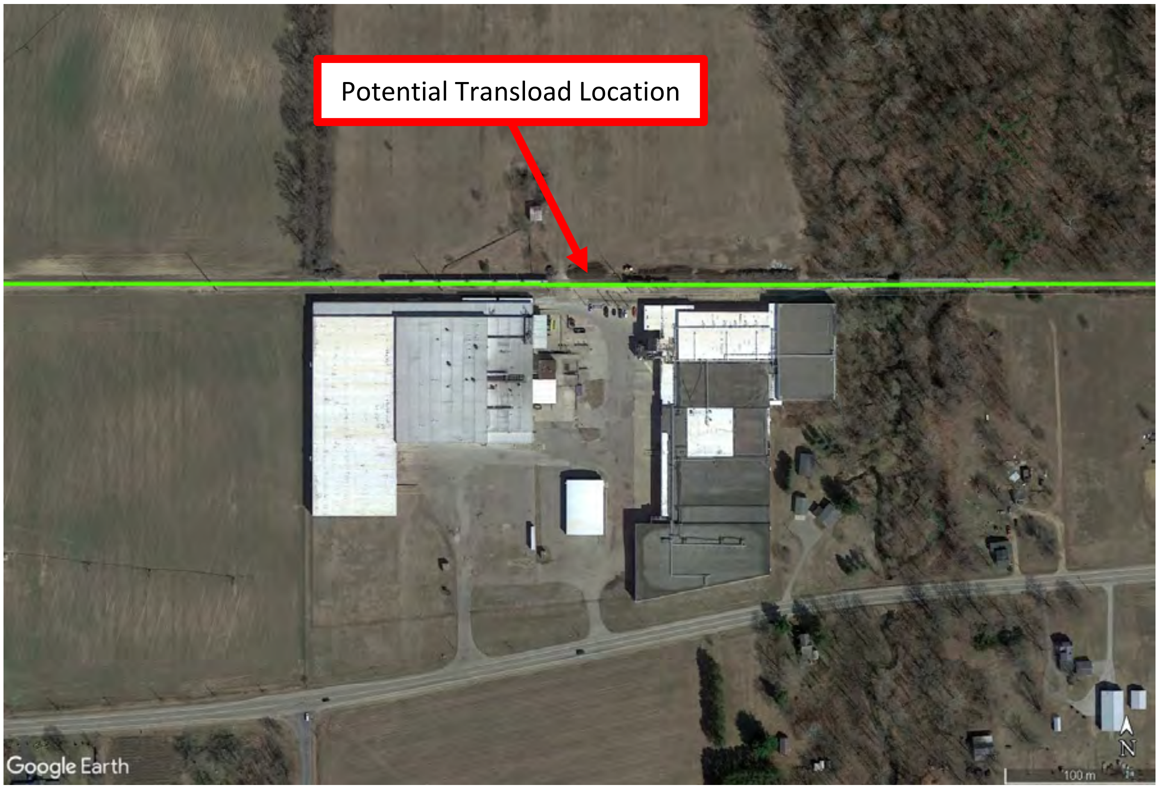


Figure 2-581. Aerial View of Lineage Logistics Potential Transload Location (Google 2022)

Figure 2-582. Lineage Logistics Potential Transload Location Looking West

Figure 2-583. Lineage Logistics Potential Transload Location Looking East

2.20.3.3 CSX Interchange in Hartford, Michigan

The CSX Railroad interchange with the WMI is located in Hartford, Michigan and is about 11 miles from the Palisades site. This location is not considered a potential transload location.

Figure 2-584 shows an aerial view of the CSX–WMI interchange location. Figure 2-585 and Figure 2-586 show the CSX–WMI interchange location looking south and north.

Figure 2-584. Aerial View of CSX Railroad and Western Michigan Railroad Interchange (Google 2022)

Figure 2-585. CSX Interchange Looking South

Figure 2-586. CSX Interchange Looking North

2.20.3.4 Rail Spur Near NoBo Marijuana Cultivation Facility Potential Transload Location

The potential heavy haul truck to rail transload location near the NoBo Marijuana Cultivation Facility is located in Benton Harbor, Michigan and is about 14 miles from the Palisades site. The location is served by the CSX Railroad.

- Figure 2-587 shows an aerial view of the potential transload location. Other areas of the potential transload location include:
- Figure 2-588 – Rail spur near NoBo Marijuana Cultivation Facility potential transload location looking north
- Figure 2-589 – Rail spur near NoBo Marijuana Cultivation Facility potential transload location looking south
- Figure 2-590 – Rail spur near NoBo Marijuana Cultivation Facility potential transload location looking towards CSX mainline
- Figure 2-591 – Rail spur near NoBo Marijuana Cultivation Facility potential transload location further down spur looking towards CSX mainline.

Figure 2-587. Aerial View of Rail Spur Near NoBo Marijuana Cultivation Facility Potential Transload Location (Google 2022)

Figure 2-588. Rail Spur Near NoBo Marijuana Cultivation Facility Potential Transload Location Looking North

Figure 2-589. Rail Spur Near NoBo Marijuana Cultivation Facility Potential Transload Location Looking South

Figure 2-590. Rail Spur Near NoBo Marijuana Cultivation Facility Potential Transload Location Looking Towards CSX Mainline

Figure 2-591. Rail Spur Near NoBo Marijuana Cultivation Facility Potential Transload Location Further Down Spur Looking Towards CSX Mainline

2.20.3.5 Aludyne Potential Transload Location

The potential heavy haul truck to rail Aludyne transload location is located in Benton Harbor, Michigan and is about 14 miles from the Palisades site. The location is served by the CSX Railroad.

Figure 2-592 shows an aerial view of the Aludyne location. Figure 2-593 and Figure 2-594 show the Aludyne location looking north.

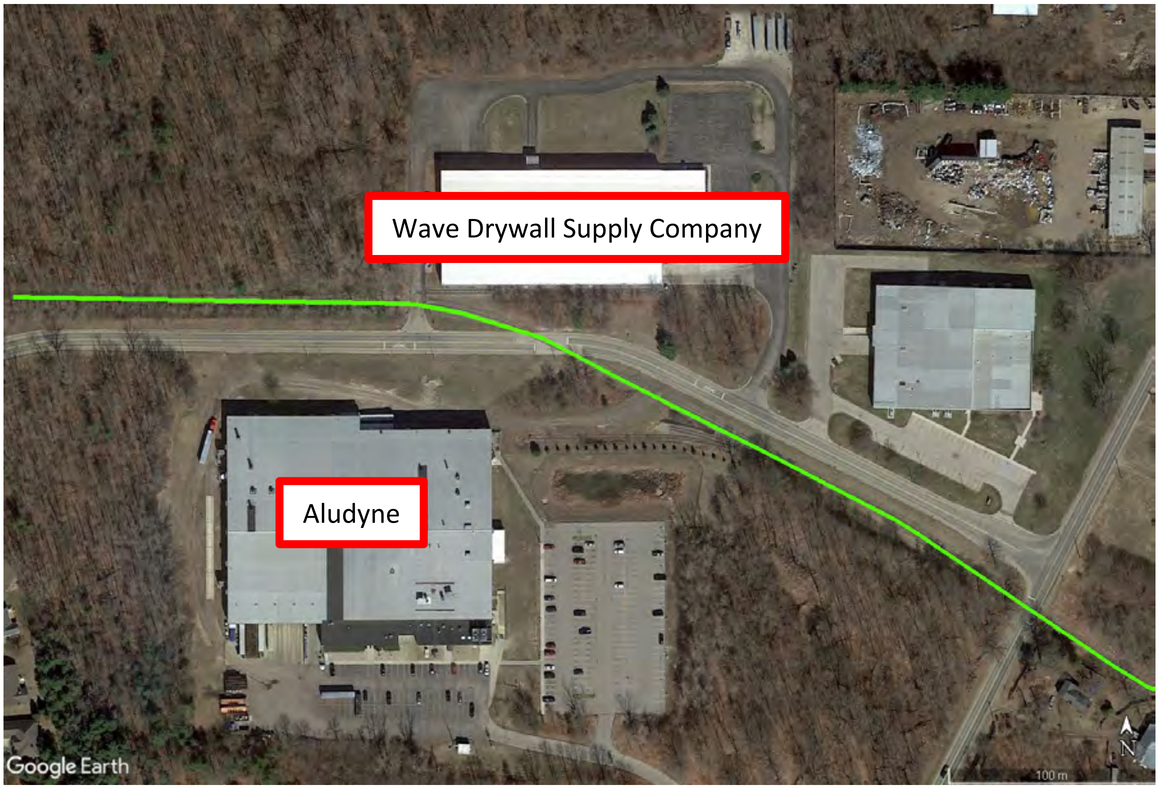


Figure 2-592. Aerial View of Aludyne Potential Transload Location (Google 2022)

Figure 2-593. Aludyne Potential Transload Location Looking North

Figure 2-594. Aludyne Potential Transload Location Looking North Showing Spur

2.20.3.6   Quarry Potential Transload Location

The potential heavy haul truck to rail quarry transload location is located in Benton Harbor, Michigan and is about 14 miles from the Palisades site. The location is served by the CSX Railroad.

Figure 2-595 shows an aerial view of the quarry location. Figure 2-596 and Figure 2-597 show the quarry location looking north and south.

Figure 2-595. Aerial View of Quarry Potential Transload Location (Google 2022)

Figure 2-596. Quarry Potential Transload Location Looking North

Figure 2-597. Aludyne Potential Transload Location Looking South

2.20.3.7 Abandoned CSX Railyard Potential Transload Location

The potential heavy haul truck to rail transload location at the abandoned CSX Railyard in Benton Harbor, Michigan and is located about 16 miles from the Palisades site. The location is served by the CSX Railroad.

Figure 2-598 shows an aerial view of the abandoned CSX Railyard. Figure 2-599 and Figure 2-600 show the abandoned CSX Railyard location looking east and west.

Figure 2-598. Aerial View of Abandoned CSX Railyard Potential Transload Location (Google 2022)

Figure 2-599. Abandoned CSX Railyard Potential Transload Location Looking East

Figure 2-600. Abandoned CSX Railyard Potential Transload Location Looking West

2.20.3.8 Dicastal Logistics Potential Transload Location

The Dicastal Logistics potential heavy haul truck to rail transload location is located in Coloma, Michigan and is about 10 miles from the Palisades site. The location is served by the CSX Railroad.

Figure 2-601 shows an aerial view of the Dicastal Logistics location. Figure 2-602 and Figure 2-603 show the Dicastal Logistics location looking west and east.

Figure 2-601. Aerial View of Dicastal Logistics Potential Transload Location (Google 2022)

Figure 2-602. Dicastal Logistics Potential Transload Location Looking West

Figure 2-603. Dicastal Logistics Potential Transload Location Looking East

2.20.3.9 Menasha Packaging Potential Transload Location

The Menasha Packaging potential heavy haul truck to rail transload location is located in Coloma, Michigan and is about 10 miles from the Palisades site. The location is served by the CSX Railroad.

Figure 2-604 shows an aerial view of the Menasha Packaging location. Figure 2-605 and Figure 2-606 show the Menasha Packaging location looking west and east.

Figure 2-604. Aerial View of Menasha Packaging Potential Transload Location (Google 2022)

Figure 2-605. Menasha Packaging Potential Transload Location Looking West

Figure 2-606. Menasha Packaging Potential Transload Location Looking East

2.20.3.10 DC Cook Nuclear Power Plant Potential Transload Location

DC Cook is an operating two-unit (1030 MWe and 1168 MWe) PWR nuclear power plant site located 31 miles from Palisades in Bridgman, Michigan. The DC Cook site has direct rail access and is served by the CSX Railroad.

Figure 2-607 shows an aerial view of the DC Cook site. Transloading would use the DC Cook rail spur. Figure 2-608 shows a potential heavy haul truck from Palisades to DC Cook. Figure 2-609 shows an aerial view of the DC rail spur. Other areas of the DC Cook site include:

- Figure 2-610 – DC Cook rail spur looking west
- Figure 2-611 – DC Cook rail spur looking east
- Figure 2-612 – Bumping post on DC Cook rail spur
- Figure 2-613 – Rail bridge on DC Cook rail spur looking west
- Figure 2-614 – Grade crossing on DC Cook rail spur looking east
- Figure 2-615 – CSX mainline at DC Cook looking south

- Figure 2-616 – CSX mainline at DC Cook looking north
- Figure 2-617 – DC Cook rail spur at CSX mainline looking north
- Figure 2-618 – DC Cook rail spur at CSX mainline looking south.

Figure 2-607. Aerial View of DC Cook Nuclear Power Plant Site (Google 2022)

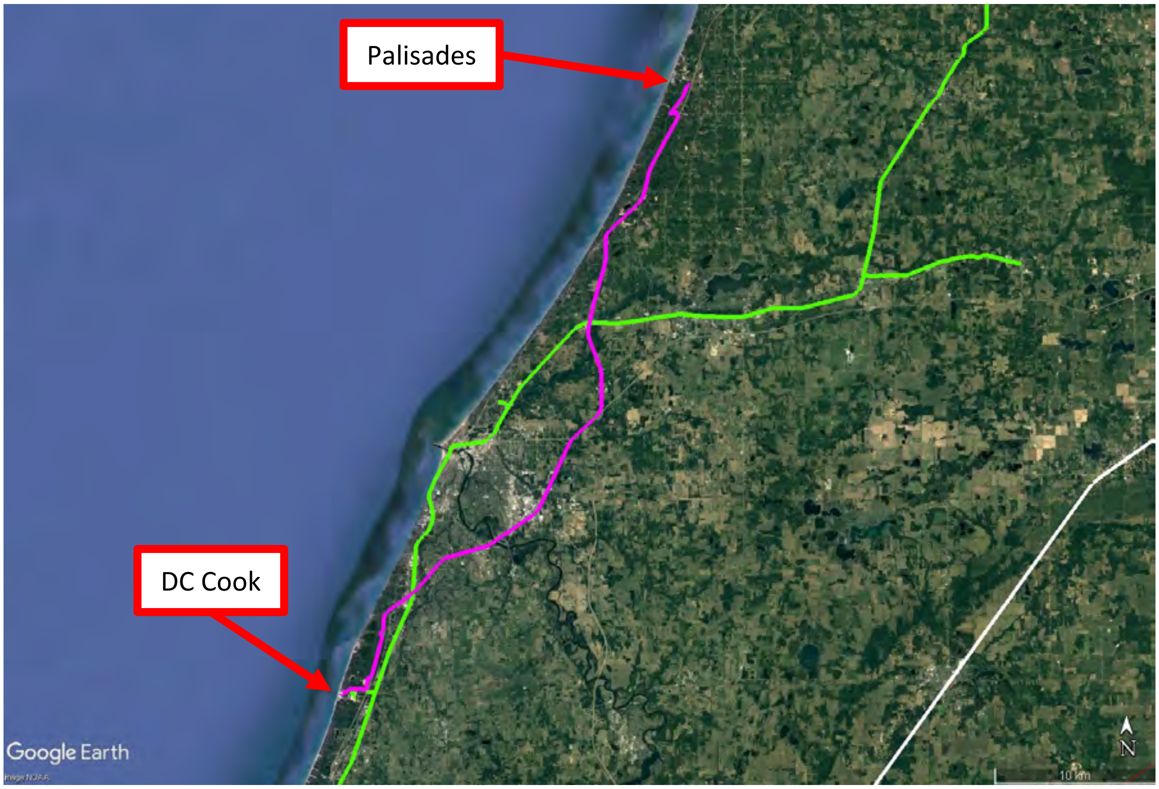


Figure 2-608. Potential Heavy-Haul Route From Palisades to DC Cook (Google 2022)

Figure 2-609. Aerial View of DC Cook Rail Spur (Google 2022)

Figure 2-610. DC Cook Rail Spur Looking West

Figure 2-611. DC Cook Rail Spur Looking East

Figure 2-612. Bumping Post on DC Cook Rail Spur

Figure 2-613. Rail Bridge on DC Cook Rail Spur Looking West

Figure 2-614. Grade Crossing on DC Cook Rail Spur Looking East

Figure 2-615. CSX Mainline at DC Cook Looking South

Figure 2-616. CSX Mainline at DC Cook Looking North

Figure 2-617. DC Cook Rail Spur at CSX Mainline Looking North

Figure 2-618. DC Cook Rail Spur at CSX Mainline Looking South

2.20.3.11 Barge Access at the Palisades Site

The Palisades site is located on Lake Michigan but there is not currently barge access at the Palisades site, although barge transport has been used at the Palisades site in the past (NAC 1991e). NAC (1991e) states that barge transport was used at Palisades to receive the original steam generators and a pair of 450-ton replacement steam generators. Each of these barge facilities were removed after use.

A potential restriction on the use of barge transport of SNF from Palisades is State of Michigan regulations regarding the movement or disturbance of dunes and dune grasses (NAC 1991e). NRC (2006) states that the entire Palisades site is protected under the Coastal Zone Management Act and Michigan's Coastal Zone Management Program. About 80,000 ac of Lake Michigan sand dunes in Michigan, including those within the Palisades site, are classified and protected as Critical Dune Areas under authority of Michigan's Natural Resources and Environmental Protection Act, Part 353. Development activities in designated critical dune areas, including those on the Palisades site, require an environmental impact assessment and permit from the Michigan Department of Environmental Quality (NRC 2006).

2.20.4 Future Information Needs

The MSB canisters stored in the VSC-24 dry storage systems are not certified for transport by the NRC, and for SNF stored in these canisters to be transported, they would need to be included in the list of approved contents in the certificate of compliance for a transportation cask. The certificate of compliance for the HI-STAR 190 transportation cask does not allow for the transport of GTCC waste and would have to be revised before GTCC waste could be transported.

The Palisades site does not have direct rail access. For this reason, the principal future information need is the choice of a potential heavy haul truck to rail transload location which would depend on several factors, such as the condition and capacity of the transportation infrastructure, the distance to the transload location, etc. It may be possible to remove SNF from Palisades by creating barge access, but the feasibility of this would need to be determined.

In addition to transportation infrastructure information needs, the dry storage canister SNF contents would need to be evaluated to verify that they meet the conditions in the 10 CFR Part 71 transportation certificate of compliance. Any changes made to dry storage canisters through the 10 CFR 72.48 process would also need to be evaluated to determine if they need to be propagated to the 10 CFR Part 71 transportation certificate of compliance.

3. CONCLUSIONS AND RECOMMENDATIONS

This report provides evaluations of the NPP site infrastructure and near-site transportation infrastructure for removing SNF from 19 NPP sites and the Morris ISFSI.[28] The evaluations were divided into four components:

- characterization of the SNF and GTCC waste inventory
- a description of the on-site infrastructure and conditions relevant to transportation activities
- an evaluation of the near-site transportation infrastructure and experience relevant to shipping transportation casks containing SNF and GTCC waste from the NPP sites
- identification of future information needs.

As part of conducting the evaluations of the NPP site infrastructure and near-site transportation infrastructure, 20 NPP sites have been visited since 2012: Maine Yankee, Yankee Rowe, Connecticut Yankee, Humboldt Bay, Big Rock Point, Rancho Seco, Trojan, La Crosse, Zion, Crystal River, Kewaunee, San Onofre, Vermont Yankee, Fort Calhoun, Oyster Creek, Pilgrim, Dresden, Morris, Indian Point, and Palisades. The 20 NPP sites use designs from 4 different suppliers, including 11 different (horizontal and vertical) storage systems that would require 10 different transportation cask designs. Transportation cask certificates of compliance are for 5-year periods, so these certificates will need to be renewed on a regular basis. This will require a long-term commitment by the owners of the certificates of compliance to maintain these certificates.

Several issues were identified with the SNF and GTCC waste inventory at the NPP sites. The most important of the issues was that there are six damaged fuel assemblies in five of the storage canisters at Rancho Seco that were not placed in failed fuel dry shielded canisters (FF-DSCs). Further evaluation would be needed to determine if the canisters containing this damaged fuel can be shipped in the MP187 transportation cask without repackaging.

The approved contents in the certificates of compliance for the TS125, HI-STAR 100, HI-STAR 100MB, MP187, and HI-STAR 190 transportation casks do not include GTCC waste. For GTCC waste to be shipped from the Big Rock Point, Rancho Seco, San Onofre, Vermont Yankee, Oyster Creek, Pilgrim, Dresden, Indian Point, and Palisades sites in these transportation casks, changes to the transportation certificates of compliance would be required. Additionally, the certificates of compliance for the TS125 and MP187 transportation casks would also need to be updated from a -85 to a -96 designation before the casks or impact limiters could be fabricated or alternative transportation casks with -96 designations used.

Twelve of the sites, Maine Yankee, Zion, Crystal River, Kewaunee, San Onofre, Vermont Yankee, Fort Calhoun, Oyster Creek, Pilgrim, Dresden, Indian Point, and Palisades, have high burnup SNF in storage. The 90 high burnup SNF assemblies at Maine Yankee are packaged in Maine Yankee Fuel Cans (i.e., damaged fuel cans). This option for transporting high burnup SNF is allowed by the certificate of compliance for the NAC-UMS UTC transportation cask, and

[28] The Morris site is not a nuclear power plant site but stores SNF from nuclear power plants and is included in the 20 sites evaluated in this report.

eliminates the concern over its transportability. For the Zion site, all high burnup fuel was packaged in damaged fuel cans. This also eliminates the concern over transportability of the 36 high burnup SNF assemblies at Zion in the MAGNATRAN transportation cask. High burnup SNF stored in 32PTH1 canisters at Crystal River, 24PT4 canisters at San Onofre, and 24PTH canisters at Palisades would be transportable in the MP197HB transportation cask. High burnup SNF that is stored in MPC-37 canisters at San Onofre and Palisades, and MPC-89 canisters at Oyster Creek would be transportable in the HI-STAR 190 transportation cask. High burnup SNF that is stored in MPC-32, MPC-68, MPC-68M, MPC-68F, and MPC-68FF canisters at Indian Point, Vermont Yankee, Pilgrim, and Dresden would not be transportable without changes to the approved contents in the certificate of compliance for the HI-STAR 100 or HI-STAR 100MB transportation cask.

At the Palisades site, SNF is stored in MSB canisters in VSC-24 dry storage systems. The MSB canisters are not certified for transport by the NRC, and for SNF stored in these canisters to be transported, they would need to be included in the list of approved contents in the certificate of compliance for a transportation cask.

Figure 3-1 summarizes the mode options for transporting SNF and GTCC waste from the 20 NPP sites. The modes listed in Figure 3-1 were based on the evaluations of on-site transportation conditions, the near-site transportation infrastructure, and off-site transportation experience at the NPP sites, particularly during the shipping of large equipment and components to and from the NPP sites. An important observation regarding Figure 3-1 is that all NPP sites have at least one off-site transportation mode option for removing their SNF and GTCC waste, and most NPP sites have multiple options.

With the expansion of the site evaluations to include operating sites, additional site evaluations will be planned of both shutdown sites (Duane Arnold and Three Mile Island) and operating sites based on the oldest-fuel-first acceptance priority ranking contained in DOE (2004).

SITE	TRANSPORTATION MODE OPTIONS	
Maine Yankee	DIRECT RAIL	BARGE to RAIL
Yankee Rowe	HEAVY HAUL TRUCK to RAIL	
Connecticut Yankee	BARGE to RAIL	HEAVY HAUL TRUCK to RAIL
Humboldt Bay	HEAVY HAUL TRUCK to RAIL	HEAVY HAUL TRUCK to BARGE to RAIL
Big Rock Point	HEAVY HAUL TRUCK to RAIL	BARGE to RAIL
Rancho Seco	DIRECT RAIL	
Trojan	DIRECT RAIL	BARGE to RAIL
La Crosse	DIRECT RAIL	BARGE to RAIL
Zion	DIRECT RAIL	BARGE to RAIL
Crystal River	DIRECT RAIL	BARGE to RAIL
Kewaunee	HEAVY HAUL TRUCK to RAIL	HEAVY HAUL TRUCK to BARGE to RAIL
San Onofre	DIRECT RAIL	HEAVY HAUL TRUCK to BARGE to RAIL
Vermont Yankee	DIRECT RAIL	
Fort Calhoun	DIRECT RAIL	BARGE to RAIL
Oyster Creek	BARGE to RAIL	HEAVY HAUL TRUCK to RAIL
Pilgrim	BARGE to RAIL	HEAVY HAUL TRUCK to RAIL
Morris	DIRECT RAIL	HEAVY HAUL TRUCK to BARGE to RAIL
Dresden	DIRECT RAIL	BARGE to RAIL
Indian Point	HEAVY HAUL TRUCK to RAIL	BARGE to RAIL
Palisades	HEAVY HAUL TRUCK to RAIL	BARGE to RAIL

Figure 3-1. Summary of Transportation Mode Options for Shipments from Nuclear Power Plant Sites

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Appendix A:

U.S. Nuclear Regulatory Commission Certificates of Compliance

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Appendix A
U.S. Nuclear Regulatory Commission Certificates of Compliance and Site-Specific Licenses

Table A-1 lists the docket number, package identification number, revision number, certificate of compliance expiration date, and ADAMS accession number for the transportation casks certified to transport SNF from the NPPs. Table A-2 lists the docket number, certificate of compliance number issue date, certificate of compliance expiration date, amendment number, amendment effective date, and ADAMS accession number for the general certified storage systems used at the NPPs. Table A-3 lists the license number, docket number, license issue date, license expiration date, amendment number, amendment date, and ADAMS accession number for the Humboldt Bay, Rancho Seco, and Trojan site-specific licenses.

Table A-1. Transportation Casks Certified to Transport Spent Nuclear Fuel from the Nuclear Power Plant Sites

Transportation Cask	Docket	Package Identification Number	Revision	Certificate of Compliance Expiration Date	ADAMS Accession Number
NAC-STC	71-9235	USA/9235/B(U)F-96	23	05/31/2024	ML19318G674
MP187	71-9255	USA/9255/B(U)F-85	14	11/30/2023	ML18330A247
HI-STAR 100, HI-STAR HB, and HI-STAR HB GTCC	71-9261	USA/9261/B(U)F-96	12	04/30/2024	ML19239A189
NAC-UMS UTC	71-9270	USA/9270/B(U)F-96	6	10/31/2027	ML22290A046
TS125	71-9276	USA/9276/B(U)F-85	7	11/30/2027	ML22290A111
MP197 and MP197HB	71-9302	USA/9302/B(U)F-96	11	01/31/2028	ML23020A933
MAGNATRAN	71-9356	USA/9356/B(U)F-96	4	04/30/2024	ML22306A238
HI-STAR 190	71-9373	USA/9373/B(U)F-96	2	08/31/2027	ML22215A140
HI-STAR 100MB	71-9378	USA/9378/B(U)F-96	1	08/31/2024	ML21133A270 ML21133A271

ADAMS= U.S. Nuclear Regulatory Commission Agencywide Documents Access and Management System (http://www.nrc.gov/reading-rm/adams.html)

Table A-2. General Licensed Storage Systems Used at the Nuclear Power Plant Sites

Storage System	Docket	Certificate of Compliance Issue Date	Certificate of Compliance Expiration Date	Amendment	Amendment Effective Date	ADAMS Accession Number
Standardized NUHOMS	72-1004	01/23/1995 12/11/2017	01/23/2015 01/23/2055	17	06/07/2021	ML21109A325
VSC-24	72-1007	05/07/1993 09/20/2017	05/07/2013 05/07/2053	6	06/05/2006	ML17242A189
HI-STAR 100	72-1008	10/04/1999 12/15/2021	10/04/2019 10/04/2059	3	11/05/2019	ML21316A192
HI-STORM 100	72-1014	05/31/2000	05/31/2020	15	06/14/2021	ML21118A862
NAC-UMS	72-1015	11/20/2000	11/20/2020	8	10/19/2021	ML21253A235
NAC-MPC	72-1025	04/10/2000	04/10/2020	8	03/04/2019	ML19039A088
Fuel Solutions Storage System	72-1026	02/15/2001	02/15/2021	4	07/03/2006	ML061910527
Standardized Advanced NUHOMS	72-1029	02/05/2003 10/27/2021	02/05/2023 02/05/2063	4	03/12/2019	ML21246A086
MAGNASTOR	72-1031	02/04/2009	02/04/2029	9	12/07/2020	ML20307A116
HI-STORM FW	72-1032	06/13/2011	06/12/2031	8	10/11/2022	ML22242A214
HI-STORM UMAX	72-1040	04/06/2015	04/06/2035	4	01/25/2021	ML20349A206

ADAMS= U.S. Nuclear Regulatory Commission Agencywide Documents Access and Management System (http://www.nrc.gov/reading-rm/adams.html)

Table A-3. Site-Specific Licenses at the Nuclear Power Plant Sites

Site	License	Docket	License Issue Date	License Expiration Date	Amendment	Amendment Date	ADAMS Accession Number
Trojan	SNM-2509	72-17	03/31/1999	03/31/2059	7	12/11/2020	ML20280A519 ML20280A520 ML20280A521
Rancho Seco	SNM-2510	72-11	03/09/2020	06/30/2060	4	03/09/2020	ML20065N276
Humboldt Bay	SNM-2514	72-27	11/17/2005	11/17/2065	5	06/10/2020	ML22214A115

ADAMS= U.S. Nuclear Regulatory Commission Agencywide Documents Access and Management System (http://www.nrc.gov/reading-rm/adams.html)

Appendix B:

Summary of Permitting Requirements for Oversize and Overweight Trucks

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Appendix B
Summary of Permitting Requirements for Oversize and Overweight Trucks

This appendix summarizes the permitting requirements for oversize and overweight trucks for states with NPP sites (California, Connecticut, Florida, Illinois, Maine, Massachusetts, Michigan, Nebraska, New Jersey, New York, Oregon, Pennsylvania, Vermont, and Wisconsin). In addition, state super load dimension and weight requirements are also summarized. A vehicle and load is considered oversized when the vehicle and the cargo it carries exceed the legal dimensions of length or width, as defined by federal requirements or length, height, or width as defined by state requirements for the state in which the vehicle will be traveling (GAO 2015). A vehicle and load is considered overweight when the vehicle and the cargo it carries exceed the legal weight limit as defined by federal and state requirements (GAO 2015). A vehicle and load is considered a super load when its dimensions and weight exceed the dimensions and weight established for typical oversized and overweight loads. The dimensions and weights that qualify as a super load are set by the states and a super load is subject to additional state permitting requirements over and above the requirements for typical oversized and overweight vehicles and loads.

The permitting summaries were compiled from information contained in the *Vehicle Sizes and Weights Manual* (J.J. Keller and Associates, Inc. 2013) and the electronic supplement to *Transportation Safety: Federal Highway Administration Should Conduct Research to Determine Best Practices in Permitting Oversize Vehicles* (GAO 2015). The electronic supplement is available at http://www.gao.gov/special.pubs/gao-15-235sp/index.htm.

B.1 California

Table B-1 summarizes the oversize vehicle permitting practices in California.

Table B-1. California Oversize Vehicle Permitting Practices

Permit Issuing Agency	California Department of Transportation – Division of Traffic Operations – Office of Commercial Vehicle Operations
Permit Enforcement Agency	California Highway Patrol – Enforcement and Planning Division – Commercial Vehicle Section
Online Oversize and Overweight Permit System	Yes
Automated Truck Routing Software	No
Number of Different Oversize and Overweight Permit Types Available	6 [Permit types include: single trip (fax), single trip (electronic), variance, annual, repetitive, direct crossing]
Regional Permit Agreement Membership	None
Maximum Legal Width	102 in.
Maximum Legal Height	14 ft. 0 in.
Maximum Legal Length for a Semitrailer	53 ft. 0 in.
Maximum Legal Gross Vehicle Weight	80,000 lb.
Super Load Width Requirement	15 ft. 0 in.
Super Load Height Requirement	17 ft. 0 in.
Super Load Length Requirement	135 ft. 0 in.
Super Load Gross Vehicle Weight Requirement	None specified
Escort Vehicle Requirement for Overheight Permitted Vehicle	No
Pole Car Requirement for Overheight Permitted Vehicle	No
Law Enforcement Escort Requirement for Overheight Permitted Vehicle	Yes (California Highway Patrol escort may be required for anything over 17 ft. 0 in.)
Escort Vehicle Requirement for Overwidth Permitted Vehicle	Yes (over 12 ft.)
Law Enforcement Escort Requirement for Overwidth Permitted Vehicle	Yes (over 15 ft.)
Route Survey Requirement for Overheight Permitted Vehicle	Yes (over 17 ft.)
Certification Requirement for Escort Vehicle Driver	No
Source: GAO (2015)	

B.2 Connecticut

Table B-2 summarizes the oversize vehicle permitting practices in Connecticut.

Table B-2. Connecticut Oversize Vehicle Permitting Practices

Permit Issuing Agency	Connecticut Bureau of Highway Operations – Oversize and Overweight Permits
Permit Enforcement Agency	Connecticut State Police and Department of Motor Vehicles – Commercial Vehicle Safety Division
Online Oversize and Overweight Permit System	Yes
Automated Truck Routing Software	No
Number of Different Oversize and Overweight Permit Types Available	5
Regional Permit Agreement Membership	None
Maximum Legal Width	102 in.
Maximum Legal Height	13 ft. 6 in.
Maximum Legal Length for a Semitrailer	53 ft. 0 in.
Maximum Legal Gross Vehicle Weight	80,000 lb.
Super Load Width Requirement	16 ft. 0 in.
Super Load Height Requirement	15 ft. 4 in.
Super Load Length Requirement	150 ft. 0 in.
Super Load Gross Vehicle Weight Requirement	200,000 lb.
Escort Vehicle Requirement for Overheight Permitted Vehicle	Yes
Pole Car Requirement for Overheight Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overheight Permitted Vehicle	Yes
Escort Vehicle Requirement for Overwidth Permitted Vehicle	Yes (Escorts required for loads over 12 ft. wide, 14 ft. height, and 90 ft. long)
Law Enforcement Escort Requirement for Overwidth Permitted Vehicle	Yes (State Police escorts required for all super loads and loads over 15 ft. 4 in. height)
Route Survey Requirement for Overheight Permitted Vehicle	Yes (Required for loads over 14 ft. height)
Certification Requirement for Escort Vehicle Driver	No
Source: GAO (2015)	

B.3 Florida

Table B-3 summarizes the oversize vehicle permitting practices in Florida.

Table B-3. Florida Oversize Vehicle Permitting Practices

Permit Issuing Agency	Florida Department of Transportation – Permit Office
Permit Enforcement Agency	Florida Department of Transportation – Motor Carrier Size and Weight and Florida Highway Patrol – Commercial Vehicle Enforcement Unit
Online Oversize and Overweight Permit System	Yes
Automated Truck Routing Software	Yes
Number of Different Oversize and Overweight Permit Types Available	3
Regional Permit Agreement Membership	Southern Regional Permit
Maximum Legal Width	102 in.
Maximum Legal Height	13 ft. 6 in.
Maximum Legal Length for a Semitrailer	53 ft. 0 in.
Maximum Legal Gross Vehicle Weight	80,000 lb.
Super Load Width Requirement	16 ft. 0 in.
Super Load Height Requirement	16 ft. 0 in.
Super Load Length Requirement	150 ft. 0 in.
Super Load Gross Vehicle Weight Requirement	199,000 lb.
Escort Vehicle Requirement for Overheight Permitted Vehicle	Yes
Pole Car Requirement for Overheight Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overheight Permitted Vehicle	Yes
Escort Vehicle Requirement for Overwidth Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overwidth Permitted Vehicle	Yes
Route Survey Requirement for Overheight Permitted Vehicle	Yes
Certification Requirement for Escort Vehicle Driver	Yes
Source: GAO (2015)	

B.4 Illinois

Table B-4 summarizes the oversize vehicle permitting practices in Illinois.

Table B-4. Illinois Oversize Vehicle Permitting Practices

Permit Issuing Agency	Illinois Department of Transportation – Bureau of Operations – Permit Unit
Permit Enforcement Agency	Illinois State Police
Online Oversize and Overweight Permit System	Yes
Automated Truck Routing Software	Yes
Number of Different Oversize and Overweight Permit Types Available	11
Regional Permit Agreement Membership	None
Maximum Legal Width	96 in.
Maximum Legal Height	13 ft. 6 in.
Maximum Legal Length for a Semitrailer	65 ft. 0 in.
Maximum Legal Gross Vehicle Weight	80,000 lb.
Super Load Width Requirement	14 ft. 6 in.
Super Load Height Requirement	14 ft. 6 in.
Super Load Length Requirement	145 ft. 0 in.
Super Load Gross Vehicle Weight Requirement	120,000 lb.
Escort Vehicle Requirement for Overheight Permitted Vehicle	Yes
Pole Car Requirement for Overheight Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overheight Permitted Vehicle	Yes
Escort Vehicle Requirement for Overwidth Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overwidth Permitted Vehicle	Yes
Route Survey Requirement for Overheight Permitted Vehicle	No
Certification Requirement for Escort Vehicle Driver	No
Source: GAO (2015)	

B.5 Maine

Table B-5 summarizes the oversize vehicle permitting practices in Maine.

Table B-5. Maine Oversize Vehicle Permitting Practices

Permit Issuing Agency	Maine Bureau of Motor Vehicles – Office of Motor Carrier Services
Permit Enforcement Agency	Maine State Police – Troop K, Commercial Vehicle Enforcement
Online Oversize and Overweight Permit System	Yes
Automated Truck Routing Software	No
Number of Different Oversize and Overweight Permit Types Available	2
Regional Permit Agreement Membership	New England Transportation Consortium
Maximum Legal Width	102 in.
Maximum Legal Height	14 ft. 0 in. (13 ft. 6 in. structural height, additional 6 in. allowed for load)
Maximum Legal Length for a Semitrailer	53 ft. 0 in.
Maximum Legal Gross Vehicle Weight	100,000 lb.
Super Load Width Requirement	16 ft. 0 in.
Super Load Height Requirement	16 ft. 0 in.
Super Load Length Requirement	125 ft. 0 in.
Super Load Gross Vehicle Weight Requirement	130,000 lb.
Escort Vehicle Requirement for Overheight Permitted Vehicle	Yes
Pole Car Requirement for Overheight Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overheight Permitted Vehicle	No
Escort Vehicle Requirement for Overwidth Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overwidth Permitted Vehicle	Yes
Route Survey Requirement for Overheight Permitted Vehicle	No
Certification Requirement for Escort Vehicle Driver	No
Source: GAO (2015)	

B.6 Massachusetts

Table B-6 summarizes the oversize vehicle permitting practices in Massachusetts.

Table B-6. Massachusetts Oversize Vehicle Permitting Practices

Permit Issuing Agency	Massachusetts Department of Transportation – Highway Division
Permit Enforcement Agency	Massachusetts Department of Public Safety
Online Oversize and Overweight Permit System	Yes
Automated Truck Routing Software	No
Number of Different Oversize and Overweight Permit Types Available	9
Regional Permit Agreement Membership	None
Maximum Legal Width	102 in.
Maximum Legal Height	13 ft. 6 in.
Maximum Legal Length for a Semitrailer	53 ft. 0 in.
Maximum Legal Gross Vehicle Weight	80,000 lb.
Super Load Width Requirement	14 ft. 0 in.
Super Load Height Requirement	Varies
Super Load Length Requirement	120 ft. 0 in.
Super Load Gross Vehicle Weight Requirement	130,000 lb.
Escort Vehicle Requirement for Overheight Permitted Vehicle	Yes
Pole Car Requirement for Overheight Permitted Vehicle	No
Law Enforcement Escort Requirement for Overheight Permitted Vehicle	Yes
Escort Vehicle Requirement for Overwidth Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overwidth Permitted Vehicle	Yes
Route Survey Requirement for Overheight Permitted Vehicle	Yes
Certification Requirement for Escort Vehicle Driver	No
Source: GAO (2015)	

B.7 Michigan

Table B-7 summarizes the oversize vehicle permitting practices in Michigan.

Table B-7. Michigan Oversize Vehicle Permitting Practices

Permit Issuing Agency	Michigan Department of Transportation, Michigan Transport Permits Unit – Michigan Transport Routing and Internet Permitting
Permit Enforcement Agency	Michigan State Police – Commercial Vehicle Enforcement Division
Online Oversize and Overweight Permit System	Yes
Automated Truck Routing Software	No
Number of Different Oversize and Overweight Permit Types Available	24
Regional Permit Agreement Membership	None
Maximum Legal Width	102 in.
Maximum Legal Height	13 ft. 6 in.
Maximum Legal Length for a Semitrailer	53 ft. 0 in.
Maximum Legal Gross Vehicle Weight	164,000 lb.
Super Load Width Requirement	16 ft. 0 in.
Super Load Height Requirement	15 ft. 0 in.
Super Load Length Requirement	150 ft. 0 in.
Super Load Gross Vehicle Weight Requirement	None specified
Escort Vehicle Requirement for Overheight Permitted Vehicle	Yes
Pole Car Requirement for Overheight Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overheight Permitted Vehicle	No
Escort Vehicle Requirement for Overwidth Permitted Vehicle	Yes (Over 12 ft. wide)
Law Enforcement Escort Requirement for Overwidth Permitted Vehicle	No
Route Survey Requirement for Overheight Permitted Vehicle	Yes (Prior to movement)
Certification Requirement for Escort Vehicle Driver	No
Source: GAO (2015)	

B.8 Nebraska

Table B-8 summarizes the oversize vehicle permitting practices in Nebraska.

Table B-8. Nebraska Oversize Vehicle Permitting Practices

Permit Issuing Agency	Nebraska Department of Roads
Permit Enforcement Agency	Nebraska State Patrol – Carrier Enforcement Division
Online Oversize and Overweight Permit System	Yes
Automated Truck Routing Software	Yes
Number of Different Oversize and Overweight Permit Types Available	15
Regional Permit Agreement Membership	None
Maximum Legal Width	102 in.
Maximum Legal Height	14 ft. 6 in.
Maximum Legal Length for a Semitrailer	53 ft. 0 in.
Maximum Legal Gross Vehicle Weight	80,000 lb. (Interstate and Defense Highways) 95,000 lb. (secondary highways)
Super Load Width Requirement	16 ft. 0 in.
Super Load Height Requirement	16 ft. 0 in.
Super Load Length Requirement	100 ft. 0 in.
Super Load Gross Vehicle Weight Requirement	160,000 lb.
Escort Vehicle Requirement for Overheight Permitted Vehicle	Yes
Pole Car Requirement for Overheight Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overheight Permitted Vehicle	No
Escort Vehicle Requirement for Overwidth Permitted Vehicle	Yes (vehicle width ≥ 20 ft.)
Law Enforcement Escort Requirement for Overwidth Permitted Vehicle	Yes
Route Survey Requirement for Overheight Permitted Vehicle	Yes
Certification Requirement for Escort Vehicle Driver	No
Source: GAO (2015)	

B.9 New Jersey

Table B-9 summarizes the oversize vehicle permitting practices in New Jersey.

Table B-9. New Jersey Oversize Vehicle Permitting Practices

Permit Issuing Agency	New Jersey Department of Transportation – Bureau of Freight Planning and Services
Permit Enforcement Agency	New Jersey Department of Law and Public Safety – Division of State Police
Online Oversize and Overweight Permit System	Yes
Automated Truck Routing Software	Yes
Number of Different Oversize and Overweight Permit Types Available	4
Regional Permit Agreement Membership	None
Maximum Legal Width	102 in.
Maximum Legal Height	13 ft. 6 in.
Maximum Legal Length for a Semitrailer	53 ft. 0 in.
Maximum Legal Gross Vehicle Weight	80,000 lb.
Super Load Width Requirement	None specified
Super Load Height Requirement	None specified
Super Load Length Requirement	None specified
Super Load Gross Vehicle Weight Requirement	None specified
Escort Vehicle Requirement for Overheight Permitted Vehicle	No
Pole Car Requirement for Overheight Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overheight Permitted Vehicle	No
Escort Vehicle Requirement for Overwidth Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overwidth Permitted Vehicle	No
Route Survey Requirement for Overheight Permitted Vehicle	No
Certification Requirement for Escort Vehicle Driver	No
Source: GAO (2015)	

B.10 New York

Table B-10 summarizes the oversize vehicle permitting practices in New York.

Table B-10. New York Oversize Vehicle Permitting Practices

Permit Issuing Agency	New York Department of Transportation – Permit Section
Permit Enforcement Agency	New York State Police
Online Oversize and Overweight Permit System	Yes
Automated Truck Routing Software	No
Number of Different Oversize and Overweight Permit Types Available	12
Regional Permit Agreement Membership	None
Maximum Legal Width	102 in.
Maximum Legal Height	13 ft. 6 in.
Maximum Legal Length for a Semitrailer	53 ft. 0 in.
Maximum Legal Gross Vehicle Weight	80,000 lb.
Super Load Width Requirement	16 ft. 0 in.
Super Load Height Requirement	16 ft. 0 in.
Super Load Length Requirement	160 ft. 0 in.
Super Load Gross Vehicle Weight Requirement	199,999
Escort Vehicle Requirement for Overheight Permitted Vehicle	Yes
Pole Car Requirement for Overheight Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overheight Permitted Vehicle	Yes
Escort Vehicle Requirement for Overwidth Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overwidth Permitted Vehicle	Yes
Route Survey Requirement for Overheight Permitted Vehicle	Yes
Certification Requirement for Escort Vehicle Driver	Yes
Source: GAO (2015)	

B.11 Oregon

Table B-11 summarizes the oversize vehicle permitting practices in Oregon.

Table B-11. Oregon Oversize Vehicle Permitting Practices

Permit Issuing Agency	Oregon Department of Transportation – Over-Dimensional Permit Unit
Permit Enforcement Agency	Oregon Department of Transportation
Online Oversize and Overweight Permit System	Partial
Automated Truck Routing Software	No
Number of Different Oversize and Overweight Permit Types Available	41
Regional Permit Agreement Membership	Western Regional Permit
Maximum Legal Width	102 in.
Maximum Legal Height	14 ft. 0 in.
Maximum Legal Length for a Semitrailer	53 ft. 0 in.
Maximum Legal Gross Vehicle Weight	80,000 lb.
Super Load Width Requirement	> 16 ft. (interstates and other multilane highways) > 14 ft. (state two-lane highways)
Super Load Height Requirement	17 ft. 0 in.
Super Load Length Requirement	150 ft. 0 in.
Super Load Gross Vehicle Weight Requirement	None specified
Escort Vehicle Requirement for Overheight Permitted Vehicle	Yes
Pole Car Requirement for Overheight Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overheight Permitted Vehicle	No
Escort Vehicle Requirement for Overwidth Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overwidth Permitted Vehicle	No
Route Survey Requirement for Overheight Permitted Vehicle	Route survey may be required.
Certification Requirement for Escort Vehicle Driver	No
Source: GAO (2015)	

B.12 Pennsylvania

Table B-12 summarizes the oversize vehicle permitting practices in Pennsylvania.

Table B-12. Pennsylvania Oversize Vehicle Permitting Practices

Permit Issuing Agency	Pennsylvania Department of Transportation – Central Permit Office
Permit Enforcement Agency	Pennsylvania State Police – Bureau of Patrol
Online Oversize and Overweight Permit System	Yes
Automated Truck Routing Software	Yes
Number of Different Oversize and Overweight Permit Types Available	96
Regional Permit Agreement Membership	None
Maximum Legal Width	102 inches
Maximum Legal Height	13 ft. 6 in.
Maximum Legal Length for a Semitrailer	53 ft. 0 in.
Maximum Legal Gross Vehicle Weight	80,000 lb.
Super Load Width Requirement	16 ft. 0 in.
Super Load Height Requirement	None specified
Super Load Length Requirement	160 ft. 0 in.
Super Load Gross Vehicle Weight Requirement	201,000 lb.
Escort Vehicle Requirement for Overheight Permitted Vehicle	Yes
Pole Car Requirement for Overheight Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overheight Permitted Vehicle	No
Escort Vehicle Requirement for Overwidth Permitted Vehicle	No
Law Enforcement Escort Requirement for Overwidth Permitted Vehicle	Yes
Route Survey Requirement for Overheight Permitted Vehicle	Yes
Certification Requirement for Escort Vehicle Driver	No
Source: GAO (2015)	

B.13 Vermont

Table B-13 summarizes the oversize vehicle permitting practices in Vermont.

Table B-13. Vermont Oversize Vehicle Permitting Practices

Permit Issuing Agency	Vermont Department of Motor Vehicles – Commercial Vehicle Operations Unit
Permit Enforcement Agency	Vermont Department of Motor Vehicles – Commercial Vehicle Enforcement Unit
Online Oversize and Overweight Permit System	No
Automated Truck Routing Software	No
Number of Different Oversize and Overweight Permit Types Available	6
Regional Permit Agreement Membership	None
Maximum Legal Width	102 in.
Maximum Legal Height	13 ft. 6 in.
Maximum Legal Length for a Semitrailer	53 ft. 0 in.
Maximum Legal Gross Vehicle Weight	80,000 lb.
Super Load Width Requirement	15 ft. 0 in.
Super Load Height Requirement	14 ft. 0 in.
Super Load Length Requirement	100 ft. 0 in.
Super Load Gross Vehicle Weight Requirement	150,000 lb.
Escort Vehicle Requirement for Overheight Permitted Vehicle	Yes
Pole Car Requirement for Overheight Permitted Vehicle	No
Law Enforcement Escort Requirement for Overheight Permitted Vehicle	Yes
Escort Vehicle Requirement for Overwidth Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overwidth Permitted Vehicle	Yes
Route Survey Requirement for Overheight Permitted Vehicle	Yes
Certification Requirement for Escort Vehicle Driver	No
Source: GAO (2015)	

B.14 Wisconsin

Table B-14 summarizes the oversize vehicle permitting practices in Wisconsin.

Table B-14. Wisconsin Oversize Vehicle Permitting Practices

Permit Issuing Agency	Wisconsin Department of Transportation – Oversize Overweight Permit Section – Bureau of Highway Maintenance
Permit Enforcement Agency	Wisconsin Department of Transportation – State Patrol Division Headquarters
Online Oversize and Overweight Permit System	Yes
Automated Truck Routing Software	Yes
Number of Different Oversize and Overweight Permit Types Available	28
Regional Permit Agreement Membership	Bilateral Agreement Between Wisconsin and Minnesota
Maximum Legal Width	102 in.
Maximum Legal Height	13 ft. 6 in.
Maximum Legal Length for a Semitrailer	53 ft. 0 in.
Maximum Legal Gross Vehicle Weight	80,000 lb.
Super Load Width Requirement	16 ft. 0 in.
Super Load Height Requirement	None specified
Super Load Length Requirement	160 ft. 0 in.
Super Load Gross Vehicle Weight Requirement	270,000 lb.
Escort Vehicle Requirement for Overheight Permitted Vehicle	Yes
Pole Car Requirement for Overheight Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overheight Permitted Vehicle	No
Escort Vehicle Requirement for Overwidth Permitted Vehicle	Yes
Law Enforcement Escort Requirement for Overwidth Permitted Vehicle	Yes
Route Survey Requirement for Overheight Permitted Vehicle	No
Certification Requirement for Escort Vehicle Driver	No
Source: GAO (2015)	

B.15 Summary of State Super Load Dimension and Weight Requirements

Table B-15 summarizes the super load width, height, length, and gross vehicle weight requirements for California, Connecticut, Florida, Illinois, Maine, Massachusetts, Michigan, Nebraska, New Jersey, New York, Oregon, Pennsylvania, Vermont, and Wisconsin.

Table B-15. Summary of State Super Load Dimension and Weight Requirements

State	Super Load Width Requirement	Super Load Height Requirement	Super Load Length Requirement	Super Load Gross Vehicle Weight Requirement
California	15 ft. 0 in.	17 ft. 0 in.	135 ft. 0 in.	None specified
Connecticut	16 ft. 0 in.	15 ft. 4 in.	150 ft. 0 in.	200,000 lb.
Florida	16 ft. 0 in.	16 ft. 0 in.	150 ft. 0 in.	199,000 lb.
Illinois	14 ft. 6 in.	14 ft. 6 in.	145 ft. 0 in.	120,000 lb.
Maine	16 ft. 0 in.	16 ft. 0 in.	125 ft. 0 in.	130,000 lb.
Massachusetts	14 ft. 0 in.	Varies	120 ft. 0 in.	130,000 lb.
Michigan	16 ft. 0 in.	15 ft. 0 in.	150 ft. 0 in.	None specified
Nebraska	16 ft. 0 in.	16 ft. 0 in.	100 ft. 0 in.	160,000 lb.
New Jersey	None specified	None specified	None specified	None specified
New York	16 ft. 0 in.	16 ft. 0 in.	160 ft. 0 in.	199,999 lb.
Oregon	16 ft. 0 in.[a] 14 ft. 0 in.[b]	17 ft. 0 in.	150 ft. 0 in.	None specified
Pennsylvania	16 ft. 0 in.	None specified	160 ft. 0 in.	201,000 lb.
Vermont	15 ft. 0 in.	14 ft. 0 in.	100 ft. 0 in.	150,000 lb.
Wisconsin	16 ft. 0 in.	None specified	160 ft. 0 in.	270,000 lb.

Source: GAO (2015)
a. Interstates and other multilane highways.
b. State two-lane highways.

B.16 References

GAO (U.S. Government Accountability Office). 2015. *Transportation Safety: Federal Highway Administration Should Conduct Research to Determine Best Practices in Permitting Oversize Vehicles*. GAO-15-236 and electronic supplement GAO-15-235SP. Available at http://www.gao.gov/special.pubs/gao-15-235sp/index.htm.

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