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**PRELIMINARY EVALUATION OF REMOVING USED NUCLEAR FUEL
FROM SHUTDOWN SITES – OYSTER CREEK SITE VISIT**

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ABSTRACT

This is a technical paper that does not take into account contractual limitations under the Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste (10 CFR Part 961). For example, under the provisions of the Standard Contract, DOE does not consider spent fuel in multi-assembly canisters to be an acceptable waste form, absent a mutually agreed to contract amendment. To the extent discussions or recommendations in this paper conflict with the provisions of the Standard Contract, the Standard Contract provisions prevail.

The U.S. Department of Energy Office of Integrated Waste Management (DOE-IWM) continues to conduct evaluations of removing spent nuclear fuel (SNF) from nuclear power plant sites. The 15 sites included in the evaluation to date have nuclear power reactors that have been permanently shut down and the sites have been decommissioned or are undergoing decommissioning. The 15 sites are 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, and Oyster Creek. The Oyster Creek site visit took place May 13-17, 2019. Participants in the site visit included the U.S. Department of Energy, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, the state of New Jersey, the Federal Railroad Administration, the U.S. Coast Guard, the Consolidated Group of Tribes and Organizations (CGTO), the Council of State Governments–Eastern Regional Conference, and the International Atomic Energy Agency. In addition to visiting the Oyster Creek site, truck-to-rail transload locations in Lakehurst and Freehold, New Jersey and the Conrail Railyard in Morrisville, Pennsylvania were evaluated, as well as the area near the Naval Weapons Station Earle pier, which stretches 2.9 miles (4.7 km) into Sandy Hook Bay.

The Oyster Creek site was found to have two transportation mode options, onsite barge access and offsite rail access, which would require heavy haul truck transport to a location where transportation

casks could be transloaded to railcars. Three transload sites were evaluated, Freehold and Lakehurst, New Jersey, and the Conrail Railyard in Morrisville, Pennsylvania.

INTRODUCTION

In order to prepare for the transportation of SNF from nuclear power plant sites, a preliminary evaluation of removing SNF from 15 shutdown sites was conducted. The shutdown sites were 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, and Oyster Creek (see Figure 1). These sites have no other operating nuclear power reactors at their sites and have also notified the U.S. Nuclear Regulatory Commission (NRC) that their reactors have permanently ceased power operations and that nuclear fuel has been permanently removed from their reactor vessels. Shutdown reactors at sites having other operating reactors were not included in this evaluation.

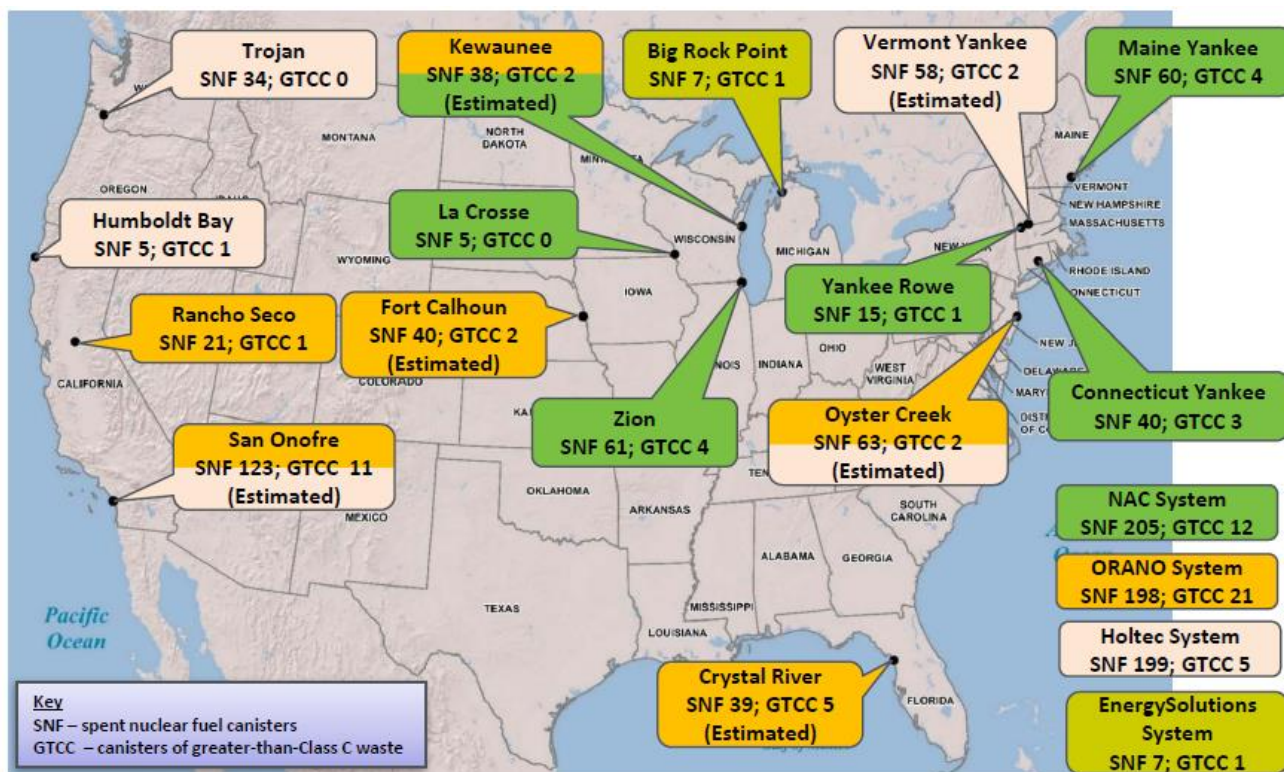


Figure 1 Locations of shutdown sites

EVALUATION OF THE NUCLEAR POWER PLANT SITES

The evaluation was divided into four components:

- Characterization of the SNF and greater-than-Class C low-level radioactive waste (GTCC waste) inventory
- A description of the on-site infrastructure at the shutdown sites
- An evaluation of the near-site transportation infrastructure and transportation experience at the

shutdown sites

- An evaluation of the actions necessary to prepare for and remove SNF and GTCC waste.

Maheras et al. [1] summarizes the wide variety of sources that were used to complete the components of the evaluations listed above. The primary source for the inventory of SNF is the U.S. Department of Energy (DOE) GC-859 spent nuclear fuel inventory database. The primary sources for information on the conditions of on-site and near-site transportation infrastructure and experience included observations and information collected during site visits to the 15 shutdown sites, information provided by managers and staff at the shutdown sites, and Google Earth imagery. State, State Regional Group, Tribal, and Federal Railroad Administration representatives have participated in 12 of these shutdown site visits.

RESULTS

As illustrated in Figure 1, there are predicted to be a total of 648 canisters in storage at the 15 sites (actual plus estimated). The number of canisters ranges from 5 at La Crosse to 134 at San Onofre. The 15 shutdown sites use designs from 4 different suppliers, including 12 different (horizontal and vertical) storage systems that would require 10 different transportation cask designs.

Table 1 provides a summary of the transportation mode options for each of 15 the shutdown sites. All sites were found to have at least one transportation mode option for removing their SNF and GTCC waste, and most sites have multiple options. Experience with transporting large equipment to and from the sites provided an important source of information in developing Table 1.

OYSTER CREEK SITE VISIT

The Oyster Creek site is located in Lacey Township in eastern New Jersey adjacent to Barnegat Bay, approximately 14 km south of Toms River, New Jersey, 97 km south of Newark, New Jersey, 56 km north of Atlantic City, New Jersey, and 97 km east of Philadelphia, Pennsylvania. Oyster Creek was a 1930 MW thermal/619 MW electric boiling water reactor 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. Figure 2 provides an aerial view of the Oyster Creek site.

Table 1 Summary of transportation mode options at shutdown sites

Site	Transportation Mode Options		Comments
Maine Yankee	Direct rail	Barge to rail	The on-site rail spur is not being maintained. The condition of the Central Maine and Quebec Railway would need to be verified.
Yankee Rowe	Heavy haul truck to rail	–	Potential transload location at the east portal of the Hoosac Tunnel (12 km from site).
Connecticut Yankee	Barge to rail	Heavy haul truck to rail	The on-site barge slip has not been used since decommissioning but remains intact. It is uncertain whether the cooling water discharge canal is deep enough to accommodate barges without dredging. The shortest heavy haul would be about 20 km to the end of the Portland rail spur. The rail infrastructure at the end of the Portland rail spur would need to be evaluated.
Humboldt Bay	Heavy haul truck to rail	Heavy haul truck to barge to rail	The heavy haul distance to a rail siding or spur would be in the range of 260 to 450 km. The condition of the Fields Landing Terminal located 3.2 km from the Humboldt Bay site would need to be verified for barge transport.
Big Rock Point	Heavy haul truck to rail	Barge to rail	Potential transload locations in Gaylord, Michigan (84 km from site) and Petoskey, Michigan (21 km from site). The rail infrastructure at these locations would need to be evaluated.
Rancho Seco	Direct rail	–	The rail spur is not being maintained. Weight restrictions on the lone Industrial Lead would require route clearance by the railroad or a track upgrade.
Trojan	Direct rail	Barge to rail	The on-site rail spur was removed.
La Crosse	Direct rail	Barge to rail	An on-site rail spur was used to ship the reactor pressure vessel.
Zion	Direct rail	Barge to rail	The rail spur was recently refurbished to support reactor decommissioning waste shipments.
Crystal River	Direct rail	Barge to rail	Extensive on-site rail system serves co-located fossil fuel plants.
Kewaunee	Heavy haul truck to rail	Heavy haul truck to barge to rail	Potential rail transload locations in Bellevue, Luxemburg, Denmark, and Manitowoc. Potential barge transload location in city of Kewaunee.
San Onofre	Direct rail	Heavy haul truck to barge to rail	The rail spur was recently refurbished to support reactor decommissioning.
Vermont Yankee	Direct rail	–	The on-site rail spur was reactivated to support decommissioning.
Fort Calhoun	Direct rail	Barge to rail	Onsite rail spur could be reinstalled or onsite transload performed. Barge used to ship steam generators, pressurizer, and reactor vessel head.
Oyster Creek	Barge to rail	Heavy haul truck to rail	Onsite barge access. Potential transload locations in Morrisville, Pennsylvania, and Freehold and Lakehurst, New Jersey.

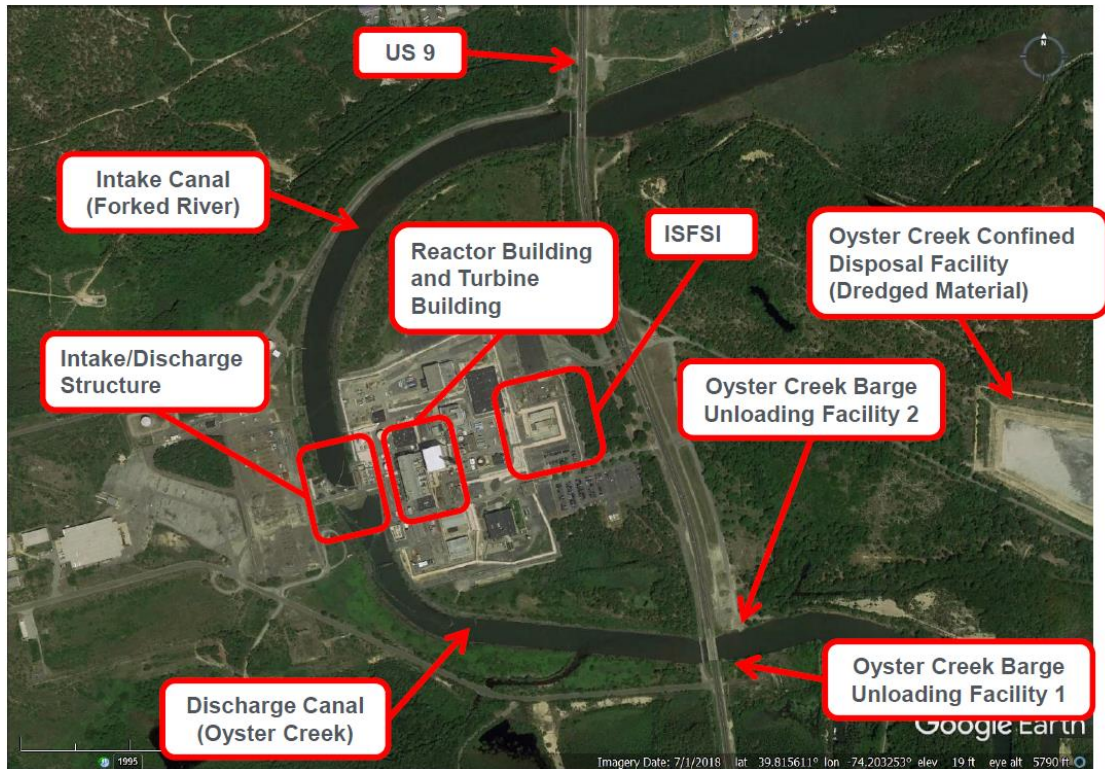


Figure 2 Aerial view of Oyster Creek site

The Oyster Creek Independent Spent Fuel Storage Installation (ISFSI) is located at the eastern edge of the Oyster Creek site (Figure 3). At the ISFSI, 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). In addition to the SNF in dry storage, 2430 fuel assemblies and 17 individual fuel pins are stored in the spent fuel pool. The 2430 fuel assemblies and 17 fuel pins currently stored in the spent fuel pool will be stored in 29 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).

The site visit to Oyster Creek was conducted May 13-17, 2019. Participants in the site visit included the U.S. Department of Energy, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, the U.S. Coast Guard, the Federal Railroad Administration, the Consolidated Group of Tribes and Organizations (CGTO), the New Jersey Bureau of Nuclear Engineering, the New Jersey Department of Transportation Office of Maritime Resources, New Jersey Department of Transportation Division of Multimodal Services, the New Jersey Department of Transportation Office of Superload Oversize/Overweight (OS/OW) Truck Permits, the Council of State Governments–Eastern Regional Conference, and the International Atomic Energy Agency. During the site visit, the site visit team met with Conrail, Oyster Creek staff, the Mayor of Lacey Township, the U.S. Nuclear Regulatory Commission, Holtec, and Comprehensive Decommissioning International (CDI).



Figure 3 Oyster Creek Independent Spent Fuel Storage Installation (ISFSI)

Oyster Creek does not currently have rail service. During construction, rail service was provided from Toms River, New Jersey. The Oyster Creek site has used locations in Freehold and Lakehurst, New Jersey for truck-to-rail transloads (see Figure 4). Freehold is about 113 km from Oyster Creek and Lakehurst is about 48 km 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.

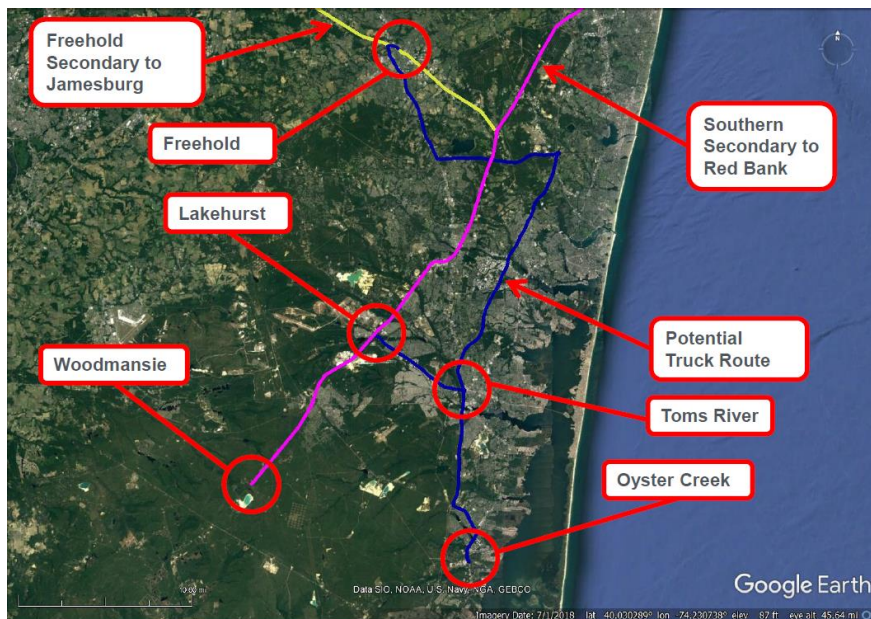


Figure 4 Regional rail infrastructure at Oyster Creek

Figures 5 and 6 show the current condition of the rail infrastructure at Freehold and Lakehurst. During meetings with Conrail, Conrail staff stated that the Freehold and Lakehurst locations were no longer viable transload locations. They recommended evaluating the Conrail Railyard in Morrisville, Pennsylvania as an alternative transload location. This location is approximately 92 to 111 km from the Oyster Creek site. Figure 7 provides an aerial view of the Morrisville railyard and Figure 8 shows the conditions at an industrial spur at the railyard.



Figure 5 Rail at Lakehurst New Jersey looking northeast

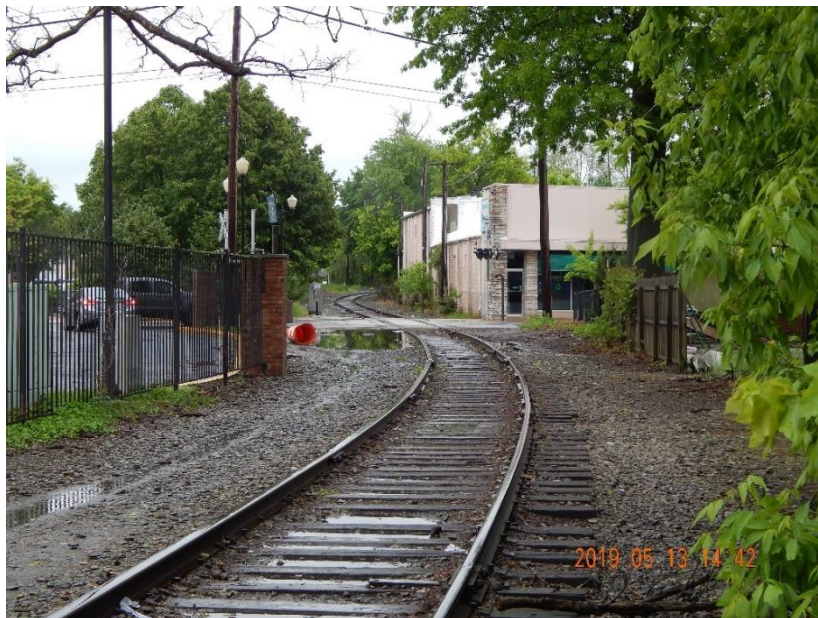


Figure 6 Rail at Freehold New Jersey looking southeast (West Main and Throckmorton Street)

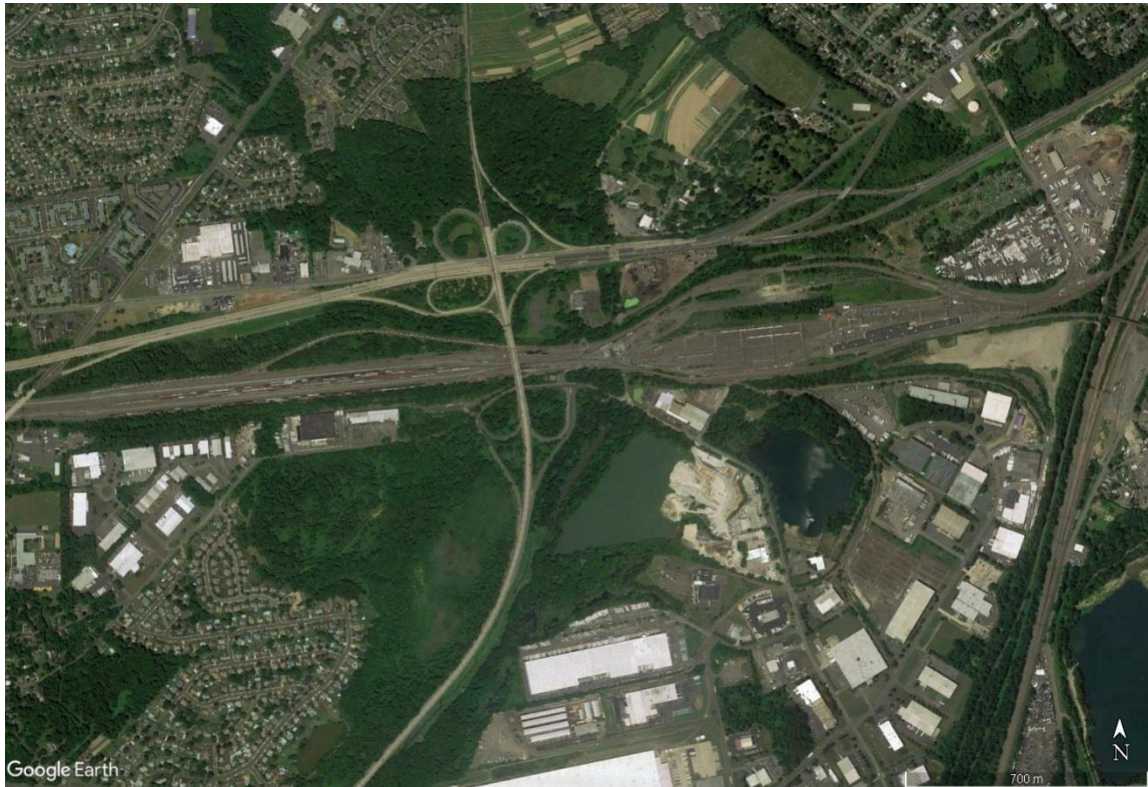


Figure 7 Aerial view of Morrisville Railyard



Figure 8 Spur at Morrisville Railyard looking west

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). 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. Figure 9 provides an aerial view of the Oyster Creek state and federal channels, the Intracoastal Waterway, and the Barnegat Bay inlet. Figures 10 and 11 show the conditions at the barge access locations.

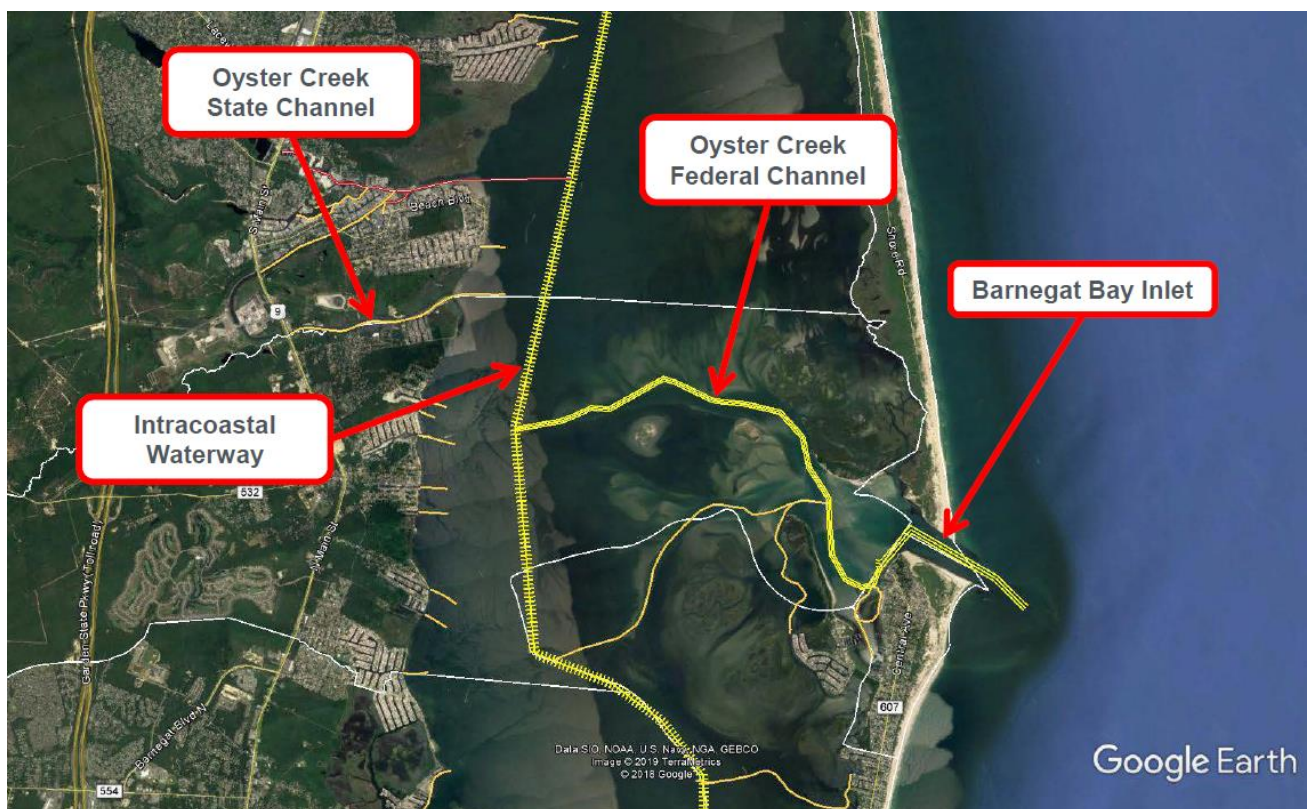


Figure 9 Aerial view of Oyster Creek channels, Intracoastal Waterway, and Barnegat Bay



Figure 10 Oyster Creek barge access (north bank of Oyster Creek)



Figure 11 Oyster Creek barge access road looking north



Figure 12 Oyster Creek barge access (south bank of Oyster Creek)

CONCLUSIONS

DOE-NE continues to update its evaluation of removing SNF and GTCC waste from nuclear power plant sites. The major update in 2019 will include adding Oyster Creek to the evaluation. Observations from the Oyster Creek site visit include:

- Two transportation cask models, the MP-197HB and HI-STAR 190, will be required to remove the SNF and GTCC waste from the Oyster Creek site.
- Direct rail access to the Oyster Creek site is not available. The use of rail as a transport mode for SNF and GTCC waste would require heavy haul truck transport to a transload location. Three potential transload locations were evaluated, Freehold and Lakehurst, New Jersey, and the Conrail Railyard in Morrisville, Pennsylvania.
- Onsite barge access to the Oyster Creek site is available and has been used in the past to ship large equipment to and from Oyster Creek.

Over the period 2019-2025, nine additional sites have announced they will be shutting down (see Figure 13). As these sites shut down, they will be added to the evaluation.

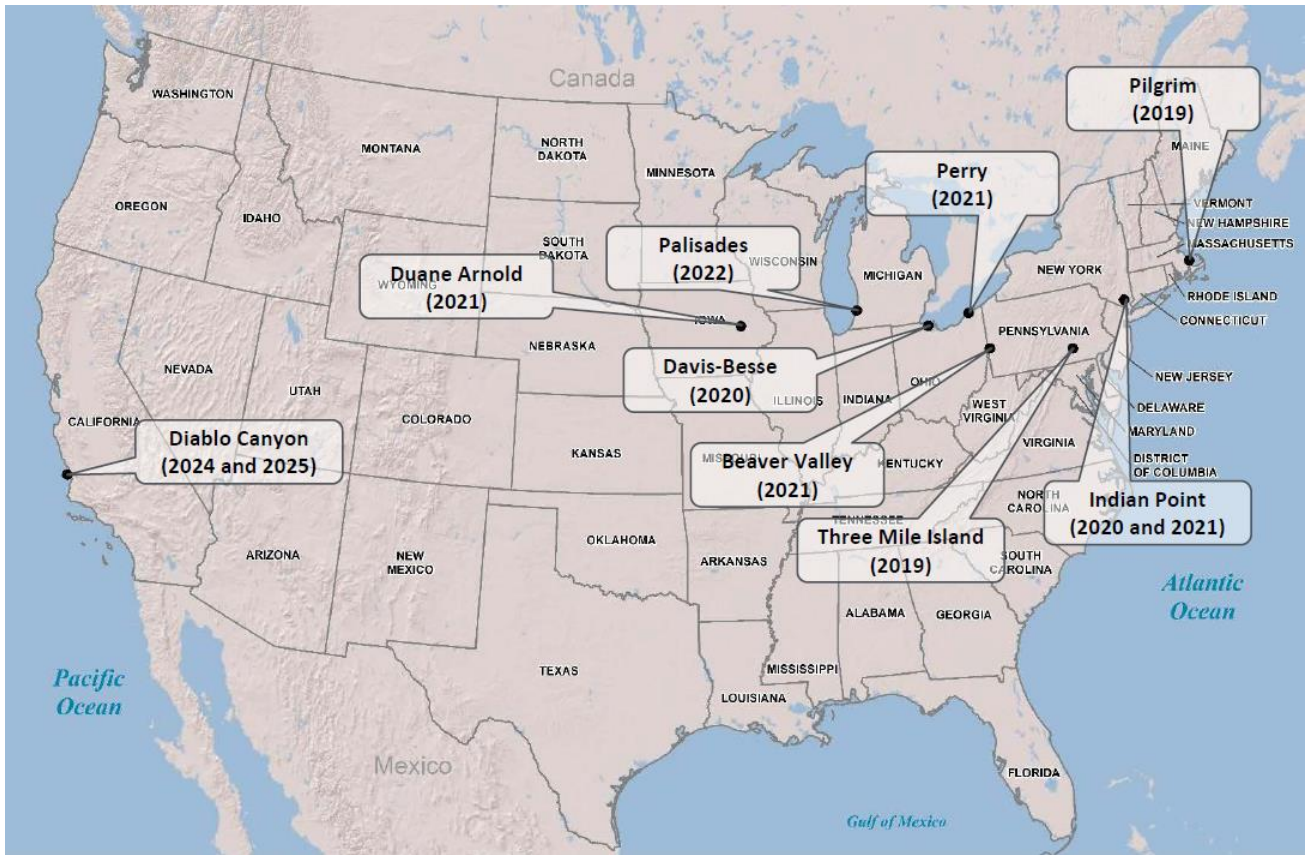


Figure 13 Future shutdown nuclear power plant sites

ACKNOWLEDGMENTS

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REFERENCES

1. S. J. Maheras, R. E. Best, S. B. Ross, K. A. Buxton, J. L. England, P. E. McConnell, L. M. Massaro, and P. J. Jensen. Preliminary Evaluation of Removing Used Nuclear Fuel from Shutdown Sites, Report No. SFWD-IWM-2017-000024, U.S. Department of Energy, Washington, D.C. (2017).