Initial Site-Specific De-Inventory Report for Crystal River

RPT-3022488-001

Prepared by: Orano Federal Services LLC

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
000	8/19/19	N/A	Initial Issue
001	5/2/23	Disclaimer	Updated disclaimer per DOE GC recommendations
		Acronyms	Added Florida Gulf & Atlantic Railroad and Atomic Energy Act acronyms
		Executive Summary	• Deleted first paragraph • Clarified some text • Updated here and throughout the report to "Security Plan" • Updated throughout the report "Emergency Response Plan"
		Section 1	• Editorial changes made to clarify text

Rev.	Date	Affected Pages	Revision Description
			• Added "Possible" to Figure 1-2 caption
		Section 2	• Corrected figure citation & added site area information • Added transfer of CR3 to D&D company (ADP CR3) and change from SAFSTOR to DECON plant status. • Updated Figure 2-7 to show to clarify change to the on-site rail spur • Updated train receipt activity and railroad • Identified new extension of on-site rail spur. • Added Figure 2-11 • Updated number of HSM-Hs utilized at the site and planned canisters • Update of MP197HB cask license and update to its availability • Added further information on GTCC LLW
		Section 3	• Update on sale and ownership of rail • Update on receipt of number of coal shipments to site • Update on track spur length • Impact on transit time as a result of change in rail ownership
		Section 4	• New introductory text has been added to identify the temporal nature of the information in this chapter • Two new paragraphs provided by the Department of Energy's General Counsel have been added • Clarified entities and persons in bulleted list
		Section 5	Minor grammatical updates
		Section 6	• Updated number of GTCC canisters • Clarified areas involved with this activity • Minor grammatical updates • Added new footnote to clarify NRC route approval is not typically required for DOE shipments • Deleted text related to the superceded DOE Manual 460.2 • Deleted paragraph related to NRC oversight • Deleted material in section 6.6 related to the QAP
		Section 7	Minor grammatical updates made
		Section 8	• Revised section title (removed ""Safety") • Clarifications made to the text • Removed GCUS from this section • Clarified protection of Safeguards Information • Renamed sections 8.4, 8.11, 8.12, 8.13 • Deleted text related to the superseded DOE Manual 460.2 and DOE Order 460.2A

Rev.	Date	Affected Pages	Revision Description
			and associated bullets in Sections 8.11, 8.12 & 8.13 • Added new bullets to Sections 8.11, 8.12 & 8.13 covering in-transit protection
		Section 9	• Modified section and sub-section titles • Minor grammatical updates made • Section 9.1 revised to reflect requirements associated with emergency response information that is commonly incorporated into an Emergency Response Plan • Updated information required for an emergency contact telephone number • Provided some clarifying remarks on the example index of an ERP and corrected some items in the index
		Section 10	Updated items 2, 3 & 4
		Section 11	Updated references and added 2 new references

DISCLAIMER

This is a technical report that does not take into account contractual limitations or obligations under the Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste (Standard Contract) (10 CFR Part 961).

To the extent discussions or recommendations in this report conflict with the provisions of the Standard Contract, the Standard Contract governs the obligations of the parties, and this report in no manner supersedes, overrides, or amends the Standard Contract.

This report reflects technical work which could support future decision making by the Department of Energy (DOE or Department). No inferences should be drawn from this report regarding future actions by DOE, which are limited both by the terms of the Standard Contract and Congressional appropriations for the Department to fulfill its obligations under the Nuclear Waste Policy Act including licensing and construction of a spent nuclear fuel repository. To the extent costs are discussed in this report, this report does not specify the party or parties responsible for the costs estimated herein.

TABLE OF CONTENTS

Executive Summary ..... **xii**

1.0 Introduction **1-1**

2.0 Pertinent Site Information **2-1**
- 2.1 Description of Site/Characteristics 2-1
- 2.2 Characteristics of SNF and GTCC LLW to be Shipped 2-27
- 2.3 Description of Canisters/Overpacks to be Shipped 2-37

3.0 Transportation Route Analysis **3-1**
- 3.1 Heavy-Haul Trucking Routes 3-1
- 3.2 Rail Routes 3-6
- 3.3 Finalized Sale of Class I Track & Alternate Route 3-11
- 3.4 Barge Routes 3-13
- 3.5 Barge Unloading Locations 3-18
- 3.6 Down-Selected Transportation Routes 3-20

4.0 Participating Entities **4-1**

5.0 Multi-Attribute Utility Analysis **5-1**
- 5.1 Description of MUA Applied to the CR-3 ISFSI 5-1
- 5.2 Description of Evaluated Routes 5-3
- 5.3 Evaluation of Routes 5-5
  - *5.3.1 Identification of Attributes and Metrics 5-5*
  - *5.3.2 Evaluation of Individual Metrics 5-9*
  - *5.3.3 Route Assessments 5-16*
- 5.4 Route Recommendations 5-25
- 5.5 Additional Sensitivity Analyses 5-43
  - *5.5.1 Suppression of Evaluation Span for Select Metrics 5-43*
  - *5.5.3 Details of Select Sensitivity Results 5-47*

6.0 Concept of Operations for Recommended Approach **6-1**
- 6.1 Overview of Operations and Assumptions for TN Americas MP197HB System 6-1
  - *6.1.1 Pre-Mobilization/Mobilization 6-3*
  - *6.1.2 Operational Readiness 6-4*
  - *6.1.3 Site Operations 6-8*
  - *6.1.4 Transport Operations 6-13*
  - *6.1.5 Demobilization 6-22*
- 6.2 Resource Requirements / Staffing 6-22
- 6.3 List of Ancillary Equipment 6-23
- 6.4 Sequence of Operations / Schedule 6-25
- 6.5 As Low As Reasonably Achievable (ALARA) Planning 6-27
- 6.6 Quality Assurance Requirements 6-28

7.0 Budget and Spending Plan **7-1**
- 7.1 Fees and Permits 7-2
- 7.2 Campaign Operation Management 7-2
- 7.3 Equipment for the Loading Operations 7-2
- 7.4 Site modifications 7-2
- 7.5 In-Transit Security 7-2
- 7.6 Cask Transportation Services at Transshipment Site 7-3
- 7.7 On-site Operations 7-3

7.8 Breakdown of the Costs by Activity 7-3
7.9 Additional Cost Estimates to Support De-Inventory Activities 7-3
7.9.1 Estimate of Transportation Costs 7-4
7.9.2 Estimate of Emergency Response Center Operation Costs 7-4
7.9.3 Estimate of Railcar Maintenance Services Costs 7-5
7.9.4 Estimate of Transportation Cask Maintenance and Compliance Costs 7-6

8.0 Security Plan and Procedures 8-1
8.1 Security Plan Requirements 8-2
8.2 Scope 8-3
8.3 Identifying and Selecting the Principal Parties (Administrative Team) 8-3
8.4 Selecting the Rail/Truck Transload Site to be Used 8-4
8.5 Identifying and Selecting the Risk and Security Assessment Team 8-4
8.6 Evaluating the Security and Risk Assessment 8-5
8.7 Developing a Hazardous Materials Security Plan 8-5
8.8 Developing Security and Communication Protocols 8-5
8.9 Developing a Security Plan and Protocols for Marine Facilities 8-5
8.10 Railroad Security Requirements 8-6
8.11 Provisions for Protection of In-Transit Road Shipments 8-7
8.12 Provisions for Protection of In-Transit Rail Shipments 8-8
8.13 Provisions for Protection of In-Transit Barge Shipments 8-9

9.0 Emergency Response Plan and Preparedness 9-1
9.1 General Guidance for an Emergency Response Plan 9-1
9.2 CR-3 Site-Specific Considerations for the Emergency Response Plan 9-3

10.0 Recommended Next Steps 10-1

11.0 References 11-1

Attachment A: Full Pairwise Comparison for the Tangible Metrics A-1

Attachment B: Results from the Twelve Individual's Pairwise Comparison for the Tangible Metrics B-1

Attachment C: Full Pairwise Comparison for the Routes C-1

Attachment D: Route Information from START for CR-3 D-1

LIST OF FIGURES

FIGURE 1-1: POTENTIAL FLOW OF OPERATIONS FOR VIA MODES OF TRANSPORT FROM CR-3 ISFSI....1-2

FIGURE 1-2: POSSIBLE ROUTES EVALUATED BY THE MUA FOR SHIPMENT OF SNF AND GTCC LLW FROM CR-3 ISFSI....1-4

FIGURE 2-1: CRYSTAL RIVER ENERGY COMPLEX SITE LOCATION[9]....2-2

FIGURE 2-2: CRYSTAL RIVER ENERGY COMPLEX SITE BOUNDARY[9]....2-3

FIGURE 2-3: PROPOSED SITE BOUNDARY/CR3 CONTROLLED AREA[7]....2-4

FIGURE 2-4: CRYSTAL RIVER ENERGY COMPLEX SITE LOCATION[8]....2-5

FIGURE 2-5: TRANSFER CASK BEING USED TO LOAD CANISTER INTO HSM[2]....2-6

FIGURE 2-6: CRYSTAL RIVER INDEPENDENT SPENT FUEL STORAGE INSTALLATION WITH HORIZONTAL STORAGE MODULES INSTALLED[2]....2-7

FIGURE 2-7: AERIAL VIEW OF THE CRYSTAL RIVER ENERGY COMPLEX[8]....2-8

FIGURE 2-8: LOCATION OF CRYSTAL RIVER INDEPENDENT SPENT FUEL STORAGE INSTALLATION[8]....2-9

FIGURE 2-9: ISFSI HAUL PATH TO COAL LOOP TRACK[8]....2-10

FIGURE 2-10: NUCLEAR SPUR[2]....2-11

FIGURE 2-11: BIG TOP TENT AT END OF NUCLEAR SPUR[55]....2-12

FIGURE 2-12: JUNCTION OF ON-SITE INDUSTRIAL SPUR (LEFT) AND NUCLEAR SPUR (RIGHT)[2]....2-12

FIGURE 2-13: ON-SITE INDUSTRIAL RAIL SPUR IN FRONT OF THE ISFSI[2]....2-13

FIGURE 2-14: ON-SITE INDUSTRIAL RAIL SPUR IN FRONT OF THE ISFSI[2]....2-13

FIGURE 2-15: ON-SITE INDUSTRIAL RAIL SPUR AT THE COAL LOOP JUNCTION[2]....2-14

FIGURE 2-16: ON-SITE INDUSTRIAL RAIL SPUR APPROACHING U.S. HIGHWAY 19 FROM WEST[2]....2-14

FIGURE 2-17: AERIAL VIEW OF CRYSTAL RIVER INTAKE AND DISCHARGE CANALS[9]....2-16

FIGURE 2-18: CURRENT BARGE AREA USED FOR UNLOADING COAL BARGES[2]....2-17

FIGURE 2-19: BARGE TURNING BASIN[2]....2-17

FIGURE 2-20: AERIAL VIEW OF CRYSTAL RIVER INDUSTRIAL RAIL SPUR AND FNOR[8]....2-19

FIGURE 2-21: AERIAL VIEW OF THE CRYSTAL RIVER INDUSTRIAL RAIL SPUR, FLORIDA NORTHERN RAILROAD, AND CSXT RAILROAD[8] 2-20

FIGURE 2-22: FNOR NEAR DUNNELLON, FLORIDA[2] 2-21

FIGURE 2-23: HIGHWAY BRIDGE OVER FNOR[2] 2-21

FIGURE 2-24: FNOR GRADE CROSSING[2] 2-22

FIGURE 2-25: FNOR BRIDGE[2] 2-22

FIGURE 2-26: TYPICAL NUHOMS HSM BACK-TO-BACK LAYOUT[11] 2-24

FIGURE 2-27: NUHOMS MODEL HSM-H[11] 2-25

FIGURE 2-28: STAGED NUHOMS TRANSFER EQUIPMENT 2-26

FIGURE 2-29: DOCKED NUHOMS TRANSFER EQUIPMENT 2-27

FIGURE 2-30: NUHOMS 32PTH1 DSC COMPONENTS[11] 2-37

FIGURE 2-31: NUHOMS DSC CONFINEMENT/PRESSURE BOUNDARY[11] 2-38

FIGURE 2-32: NUHOMS MP197HB TRANSPORT CASK[22] 2-39

FIGURE 2-33: NUHOMS MP197HB CASK ON RAILCAR 2-41

FIGURE 3-1: HHT ROUTE FROM CR-3 TO NORTH TALLAHASSEE RD TRANSLOAD SITE[9] 3-3

FIGURE 3-2: NORTH TALLAHASSEE ROAD TRANSLOAD SITE[8] 3-4

FIGURE 3-3: HHT ROUTE TO DUNNELLON, FL TRANSLOAD SITE[8] 3-4

FIGURE 3-4: DUNNELLON, FL TRANSLOAD SITE[8] 3-5

FIGURE 3-5: TRACK AT POTENTIAL LOADING SITE IN WILLISTON[8] 3-6

FIGURE 3-6: EXISTING ON-SITE RAIL TRACKS 3-7

FIGURE 3-7: THE COAL LOOP TRACK 3-8

FIGURE 3-8: THE UREA TRACK 3-9

FIGURE 3-9: THE COAL STAGING TRACK 3-9

FIGURE 3-10: THE NUCLEAR TRACK 3-10

FIGURE 3-11: CSX ANNOUNCED SALE OF PANHANDLE ROUTE[29] 3-12

FIGURE 3-12: CR-3 BARGE SLIP 3-13

FIGURE 3-13: LARGE COMPONENTS ARRIVING AT CR-3 BY BARGE[31] 3-14

FIGURE 3-14: CR-3 BARGE LOCATION AND NOAA DEPTH CHART OF THE VICINITY[31] 3-15

FIGURE 3-15: HOGHAVEN AREA FOR BARGE OFF-LOAD IN THE VICINITY OF GCUS 3-19

FIGURE 3-16: A. HHT TO FNOR RAIL 3-25

FIGURE 3-17: B. HHT TO DUNNELLON TO FNOR RAIL 3-26

FIGURE 3-18: C. RAIL FROM CR-3 TO GCUS VIA FNOR & CSX 3-27

FIGURE 3-19: RAIL FROM CR-3 TO GCUS VIA NEW ORLEANS 3-28

FIGURE 3-20: BARGE VIA ICW TO MOBILE/TOMBIGBEE RIVER TO GCUS 3-29

FIGURE 3-21: BARGE VIA ICW TO NEW ORLEANS/MISSISSIPPI TO GCUS 3-30

FIGURE 5-1: OVERVIEW OF MUA APPLIED TO CR-3 ISFSI 5-3

FIGURE 5-2: WEIGHTING OF THE TANGIBLE METRICS BASED ON PAIRWISE COMPARISONS 5-15

FIGURE 5-3: EXAMPLE OF A PORTION OF A PAIRWISE COMPARISON FOR ROUTES ASSESSMENT 5-27

FIGURE 5-4: RESULTING LIST OF PRIORITIZED ROUTES FROM THE CR-3 ISFSI SITE........5-28

FIGURE 5-5: IMPACT OF EACH TANGIBLE METRIC ON EACH ROUTE'S "SCORE" 5-31

FIGURE 5-6: MINIMUM, AVERAGE, AND MAXIMUM RESULTS FROM SENSITIVITY ANALYSIS FOR MINIMIZATION OF EACH METRIC........5-41

FIGURE 5-7: MINIMUM, AVERAGE, AND MAXIMUM RESULTS FROM SENSITIVITY ANALYSIS FOR MAXIMIZATION OF EACH METRIC 5-42

FIGURE 5-8: EXAMPLE OF SUPPRESSION CUMULATIVE WORKER EXPOSURE RANGE 5-44

FIGURE 5-9: RESULTING LIST OF PRIORITIZED ROUTES FROM THE CR-3 ISFSI FOR THE SUPPRESSION OF SPAN FOR SAFETY AND SECURITY METRICS 5-45

FIGURE 5-10: IMPACT OF EACH TANGIBLE METRIC ON EACH ROUTE'S SCORING FOR THE SUPPRESSION OF SPAN FOR SAFETY AND SECURITY METRICS 5-46

FIGURE 5-11: IMPACT OF REMOVING THE SAFETY METRICS 5-48

FIGURE 5-12: IMPACT OF REMOVING THE SECURITY METRIC........5-49

FIGURE 5-13: IMPACT OF REMOVING THE PUBLIC ACCEPTABILITY METRIC 5-50

FIGURE 5-14: IMPACT OF REMOVING THE PUBLIC ACCEPTABILITY AND SECURITY METRICS........5-51

FIGURE 6-1: MP197HB CASK ASSEMBLY VERIFICATION LEAK TEST FLOW CHART........6-12

FIGURE 6-2: SEQUENCE OF OPERATIONS 6-26

LIST OF TABLES

TABLE 2-1: CR-3 FUEL DESIGN INFORMATION[14] 2-28

TABLE 2-2: CR-3 FUEL DISCHARGE DATA[3] 2-29

TABLE 2-3: CR-3 FUEL BURNUP DATA[2] 2-29

TABLE 2-4: CR-3 NUHOMS ISFSI CONTENTS[16][17][18][19][20][21][22][23][24][25] 2-30

TABLE 2-5: NUHOMS MP197HB WEIGHTS AND DIMENSIONS[22] 2-40

TABLE 3-1: NEAREST RAIL TRACKS OUTSIDE OF CR-3 SITE 3-1

TABLE 3-2: CLASS I AND CLASS II RAILROADS NEAR CR-3 3-6

TABLE 3-3: POTENTIAL RAIL ROUTES TO GCUS 3-11

TABLE 3-4: POTENTIAL BARGE ROUTES 3-17

TABLE 3-5: POSSIBLE TRAIN LOADING LOCATIONS NEAR GCUS BARGE SITE 3-19

TABLE 3-6: ROUTES VERSUS SCREENING CRITERIA 3-22

TABLE 4-1: PARTICIPATING ENTITY FUNCTIONAL IDENTIFICATION 4-2

TABLE 5-1: ATTRIBUTES AND ASSOCIATED METRICS 5-6

TABLE 5-2: EXAMPLE OF A PORTION OF A PAIRWISE COMPARISON FOR METRICS ASSESSMENT 5-12

TABLE 5-3: WEIGHTING OF TANGIBLE METRICS 5-15

TABLE 5-4: ROUTE AVERAGED POPULATION DENSITY ALONG EACH ROUTE 5-21

TABLE 5-5: AVERAGE ACCIDENT FREQUENCY OVER EACH ROUTE[2] 5-22

TABLE 5-6: ROUTE TRANSIT DURATIONS[2] 5-24

TABLE 5-7: PRIORITIZED LIST OF ROUTES FROM CR-3 ISFSI 5-30

TABLE 5-8: WEIGHTING OF ROUTES 5-32

TABLE 5-9: WEIGHTING OF ROUTES AT MINIMUM METRIC VALUE (PART 1 OF 4) 5-33

TABLE 5-10: WEIGHTING OF ROUTES AT MINIMUM METRIC VALUE (PART 2 OF 4) 5-34

TABLE 5-11: WEIGHTING OF ROUTES AT MINIMUM METRIC VALUE (PART 3 OF 4) 5-35

TABLE 5-12: WEIGHTING OF ROUTES AT MINIMUM METRIC VALUE (PART 4 OF 4) 5-36

TABLE 5-13: WEIGHTING OF ROUTES AT MAXIMIZED METRIC VALUE (PART 1 OF 4) 5-37

TABLE 5-14: WEIGHTING OF ROUTES AT MAXIMIZED METRIC VALUE (PART 2 OF 4) 5-38

TABLE 5-15: WEIGHTING OF ROUTES AT MAXIMIZED METRIC VALUE (PART 3 OF 4) 5-39

TABLE 5-16: WEIGHTING OF ROUTES AT MAXIMUM METRIC VALUE (PART 4 OF 4) 5-40

TABLE 5-17: COMPARISON OF ORIGINAL MUA RESULTS TO THE SUPPRESSED SPAN MUA RESULTS ... 5-46

TABLE 5-18: RESULTS FROM THE DELETION OF THE SAFETY METRICS ... 5-48

TABLE 5-19: RESULTS FROM THE DELETION OF THE SECURITY METRIC ... 5-49

TABLE 5-20: RESULTS FROM THE DELETION OF THE PUBLIC ACCEPTABILITY METRIC ... 5-50

TABLE 5-21: RESULTS FROM THE DELETION OF THE PUBLIC ACCEPTABILITY AND SECURITY METRICS ... 5-51

TABLE 6-1: MAINTENANCE PROGRAM SCHEDULE ... 6-2

TABLE 6-2: ACTIVITIES TO PREPARE AND REMOVE SNF AND GTCC WASTE FROM CR-3 ISFSI USING MP197HB SYSTEM ... 6-3

TABLE 6-3: ACTIVITIES TO PREPARE AND REMOVE SNF AND GTCC LLW FROM CR-3 ISFSI ... 6-15

TABLE 6-4: ADDITIONAL EQUIPMENT FOR CR-3 TRANSFER ... 6-23

TABLE 6-5: EQUIPMENT FOR THE TRANSLOAD FACILITY ... 6-24

TABLE 6-6: RAIL EQUIPMENT (PER CONSIST) ... 6-24

TABLE 6-7: OPERATIONS TIMELINE WITH REQUIRED RESOURCES ... 6-27

LIST OF ACRONYMS

AAR	Association of American Railroads
AEA	Atomic Energy Act
AL	Alabama
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
ASNT	American Society for Nondestructive Testing
BNSF	Burlington Northern Santa Fe Railway
BOL	Bill of Lading
CAD	Computer Aided Drawing
CFR	Code of Federal Regulations
CN	Canadian National
CO	Crane Operator
CoC	Certificate of Compliance
COSS	Cask Operations Shift Supervisor
COTP	Captain of the Port
CR-3	Crystal River 3 Nuclear Power Plant
CRCPD	Conference of Radiation Control Program Directors, Inc.
CREC	Crystal River Energy Complex
CSX	Chessie-Seaboard (Merger)
DEF	Duke Energy Florida LLC
DHS	Department of Homeland Security
DOE	Department of Energy
DOT	Department of Transportation
DSC	Dry Shielded Canister
EO	Tractor/JCB Driver and Equipment Operator
ERP	Emergency Response Plan
FA	Fuel Assembly
FDOT	Florida Department of Transportation
FEC	Florida East Coast Railway
FGA	Florida Gulf & Atlantic Railroad
FL	Florida
FNOR	Florida Northern Railroad Company, Inc.
FRA	Federal Railroad Administration
FSAR	Final Safety Analysis Report
FSO	Facility Security Officer
FSP	Facility Security Plan
ft	feet
GA	Georgia
GCUS	Geographical Center of the 48 Contiguous United States
GPS	Global Positioning System
GTCC	Greater Than Class C
GWd	GigaWatt-day
HAZMAT	Hazardous Material
HBU	High Burnup Fuel
HHT	Heavy Haul Truck/Trailer

HLW	High-Level Radioactive Waste
HRCQ	Highway Route Controlled Quantity
HSM	Horizontal Storage Module
HTUA	High Threat Urban Areas
ICW	Intracoastal Waterway
IL	Illinois
in	inch
ISFSI	Independent Spent Fuel Storage Installation
ISR	Independent Safety Review
kW	Kilowatt
LA	Louisiana
lbs	Pounds
LLC	Limited Liability Corporation
LLEA	Local Law Enforcement Agency
LLW	Low-Level Radioactive Waste
MCC	Movement Control Center
mph	miles per hour
MTHM	Metric Tons Heavy Metal
MTSA	Maritime Transportation Security Act
MUA	Multi-Attribute Utility Analysis
NOAA	National Oceanic and Atmospheric Administration
NOPB	New Orleans Public Belt Railroad
NRC	U.S. Nuclear Regulatory Commission
NRHM	Non-Radioactive Hazardous Materials
NS	Norfolk Southern
NUHOMS	NUTECH Horizontal Modular Storage System
NUTECH	Nuclear Technology Inc.
NWPA	Nuclear Waste Policy Act
OJT	On the Job Training
OM	Operations Manager
OSHA	Occupational Safety and Health Administration
PAL	Paducah & Louisville Railway
PHMSA	Pipeline and Hazardous Materials Safety Administration
PI	Paducah & Illinois Railway
PIH	Poisonous Inhalation Hazard
PPE	Personal Protective Equipment
PW	Procedure Writer
PWR	Pressurized Water Reactor
QA	Quality Assurance
QAP	Quality Assurance Program
QC	Quality Control
QS	QA/QC Specialist
RAM	Radioactive Material
RCT	Radiation Control Technician
RM	Rigger/Cask Operations Technician/Mechanic
RP	Radiation Protection
RSAT	Risk and Security Assessment Team

RSSM	Rail Security Sensitive Materials
RWC	Radioactive Waste Container
RWP	Radiation Work Permit
SAR	Safety Analysis Report
SC	South Carolina
SG	Steam Generator
SME	Subject Matter Expert
SNF	Spent Nuclear Fuel
SP	Security Personnel
START	Stakeholder Tool for Assessing Radioactive Transportation
STB	Surface Transportation Board
TC	Transport and Waste Management Coordinator
TIH	Toxic Inhalation Hazards
TN	Tennessee
TN	TransNuclear
TPE	Training Program Evaluation
TS	Technical Specification
TS	Training Specialist
TSA	Transportation Safety Administration
TWIC	Transportation Worker Identification Credential
UP	Union Pacific
U.S.	United States
USCG	U.S. Coast Guard
USG	U.S. Gypsum Corp. railroad
VDS	Vacuum Drying System
VSP	Vessel Security Plan

EXECUTIVE SUMMARY

The purpose of this report is to assist the United States (U.S.) Department of Energy (DOE) in laying the groundwork for implementing an integrated nuclear waste management system. This includes preparing for future large-scale transport of Spent Nuclear Fuel (SNF), High-Level Radioactive Waste (HLW), and Greater Than Class C (GTCC) Low-Level Radioactive Waste (LLW). This report addresses the tasks, equipment, and interfaces necessary for the complete de-inventory of the Crystal River 3 Nuclear Power Plant (CR-3) independent spent fuel storage installation (ISFSI) site. It is located in the village of Crystal River, FL, approximately 80 miles northwest of Orlando, FL and 70 miles north of Tampa, FL. As such, this report is intended to provide information useful for planning options within an integrated nuclear waste management system.

Multiple modes of transport of the existing SNF and GTCC LLW were considered as part of this report (i.e., heavy haul truck [HHT], rail, and barge). Barge-to-rail, HHT-to-rail, and direct rail access were evaluated as viable modes of transport by this assessment. To further rank the identified routes and modes, a Multi-Attribute Utility Analysis (MUA) was performed. In addition to subject matter expert (SME) input, data from the DOE's Stakeholder Tool for Assessing Radioactive Transportation (START) program was utilized to support the evaluation of the routes in the MUA. The MUA identified a favored route and mode(s) of transport for shipping the existing SNF and GTCC LLW from CR-3 to a Class I railroad and then to the hypothetical destination near the geographical center of the 48 contiguous United States (GCUS).

The MUA results identified a ranking of six possible routes from the CR-3 site, listed here in order of decreasing favorability as analyzed by the MUA:

1) An all-rail route with the Florida Northern Railroad (FNOR) and CSX through Montgomery, AL and Nashville, TN;
2) A rail route along multiple train lines, through New Orleans, LA and Memphis, TN;
3) A barge route along the intracoastal waterway (ICW) to Mobile, AL, continuing up the Tombigbee River;
4) An HHT of about 6 miles to a loading site for the Florida Northern Railroad Company, Inc (FNOR) and the remainder of option 1);
5) An HHT of about 18 miles to a loading site for the FNOR in Dunnellon, FL and the remainder of option 1); and
6) A barge route along the ICW to New Orleans, LA, continuing up the Mississippi River to GCUS.

Sensitivity analyses were performed on the MUA results to examine the impact on the rankings of the routes created by changes in the weighting of metrics used to evaluate those routes (e.g., cost of rental equipment, ease of permitting, etc.) and by suppressing the evaluation range of some specific metrics (e.g., cumulative worker exposure). The sensitivity analyses showed fairly consistent rankings: while the two highest ranked routes always remained unchanged, changes occurred to the ranking of the last four ranked routes depending on the sensitivity analyzed. For example, if the security, safety, and public acceptability metrics were removed from consideration,

then the two HHT routes scored more favorably than the barge routes, with the direct rail routes remaining the highest ranked routes.

Using the primary MUA result, a concept of operations and a recommended budget and spending plan are detailed for the removal of existing SNF and GTCC LLW from the CR-3 site using the most attractive shipment route: by rail on the FNOR and CSX through Montgomery, AL and Nashville, TN, to the GCUS. The total estimated budget for the entire CR-3 campaign organized over 39 calendar weeks is $14.3M (2022). Also documented in this assessment are aspects of a Security Plan and associated procedures and an Emergency Response Plan and associated preparedness for the prospective shipments. Finally, a set of actions to be taken before initiating the removal of the existing SNF and GTCC LLW from the CR-3 site are proposed.

1.0 INTRODUCTION

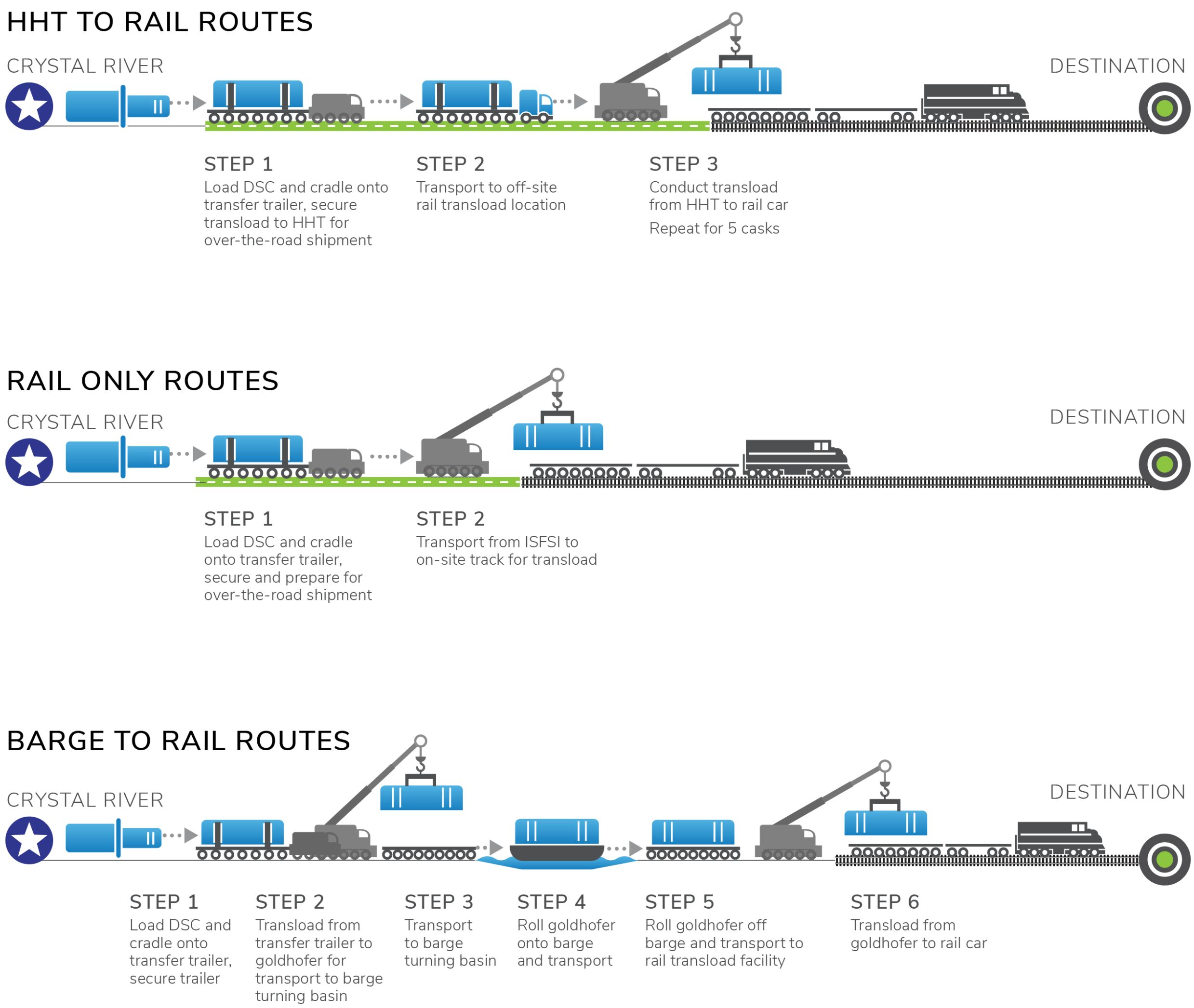
This report provides an assessment of the tasks, equipment, and interfaces that would be necessary to remove the SNF and GTCC LLW from the CR-3 ISFSI located in the village of Crystal River, FL, approximately 80 miles northwest of Orlando, FL and 70 miles north of Tampa, FL. The objective of this removal activity would be to transport the existing SNF and GTCC LLW to a Class I railroad, where it could then be transported to a future consolidated interim storage facility or geological repository. A railroad hub in the central U.S. with connections to all other major rail carriers was used as the route endpoint for the purposes of this study, because it could serve as a connection point to storage or disposal facilities located in any region of the U.S. The use of GCUS as a hypothetical destination does not imply that this location is being considered for a future consolidated interim storage facility, geological repository, or a transportation hub but was used, for purposes of this report, as a basis for scheduling and costing estimates assessed in this report.

In performing this assessment, the results are expected to support the laying of groundwork for implementing an integrated nuclear waste management system for the U.S. DOE. This includes preparing for future large-scale transport of SNF, HLW, and GTCC LLW. This assessment specifically examines the removal of the existing SNF and GTCC LLW contained within the CR-3 ISFSI using Orano's and our teaming partners' experiences in the shipping of like and similar materials. For the purposes of this assessment, it is assumed that DOE would be responsible for a federal consolidated interim storage facility or geological repository to which the material would be shipped and would be the shipper of record; it is also assumed that the shipments would be regulated by the U.S. Nuclear Regulatory Commission (NRC) and the Department of Transportation (DOT) like comparable commercial shipments.

To lay the foundation of the assessment, the report begins by examining the pertinent site information in **Section 2.0**, including a description of the site and its characteristics; the characteristics of the existing SNF and the GTCC LLW to be shipped from the site; and a description of the TransNuclear (TN) Americas, LLC Standardized NUHOMS System used to store this material on-site and the associated transportation packaging system, the TN MP197HB cask. The site information is vital to establishing if sufficient space exists to perform transfer activities and assessing and identifying the potential need for site infrastructure modifications (e.g., fence line modifications to optimize/streamline transfer operations and/or loading activities) and/or hardware requirements (e.g., need for a transfer cask) to facilitate the shipment of these MP197HB casks from the CR-3 ISFSI. Although accessing the site was not within the scope of this activity, sufficient sources of information existed for an informed assessment of the site to be performed. Ultimately a formal inspection would be necessary to verify assumed site criteria. The characteristics of the existing SNF and GTCC LLW at the CR-3 ISFSI was reviewed against the requirements found in the NRC Certificate of Compliance (CoC) for the transportation packaging system. Similarly, the information of the TN dry storage canisters to be shipped was also reviewed against the associated requirements in the CoCs. Finally, the information about the storage system in use was reviewed along with the characteristics of the transportation packaging system to identify any challenges to the ability to transfer the canisters into the transportation packaging system. If any potential issues were identified during these three reviews, the problems were documented along with any needed or recommended corrective actions, including the possible need to revise the CoC or request an exemption from the regulator.

After the pertinent site information was assessed and a transportation route analysis was performed, as described in **Section 3.0**, transportation routes from the CR-3 ISFSI to a Class I railroad were identified, which would be used for subsequent shipment to a repository or interim storage facility. Multiple modes of transport of the existing SNF and GTCC LLW were considered (i.e., HHT, rail, and barge). From the CR-3 ISFSI site itself, all three modes were evaluated to be viable options for shipment of the existing SNF and GTCC LLW. **Figure 1-1** depicts the major steps of the potential transfer scenarios considered. As shown in this figure, the direct to rail scenario appears to be the least complicated approach, with the minimum number of times a TN MP197HB cask is handled, whereas the barge scenario appears to be more complicated, with additional handling activities. The assessment of the transportation routes resulted in a listing of multiple viable routes with both positive and negative attributes that require evaluation to identify the optimal and/or favored route to transport the existing SNF and GTCC LLW from the CR-3 site.

Figure 1-1: Potential Flow of Operations for Via Modes of Transport from CR-3 ISFSI



An MUA was selected as the means to assess and rank the various routes and modes. Due to the large number of routes and associated modes initially identified, performing the MUA for all possible routes would be burdensome, so initial screening criteria were established to allow for less attractive routes to be screened from further consideration based on attributes associated with a particular mode of transport (i.e., screening is performed only between routes associated with a particular mode of transport). These screening criteria were applied in **Section 3.0** to reduce the number of identified routes from greater than 20 to a more manageable six. After the participating entities were identified in **Section 4.0**, these six routes (using all three common modes from the site: HHT, barge, and direct loading on to rail) were evaluated using the MUA to rank the routes for shipping the existing SNF and GTCC LLW from CR-3 to the hypothetical destination of GCUS by Class I rail in **Section 5.0**. **Figure 1-2** identifies the routes evaluated in the MUA.

Based on the results from the MUA, a concept of operations and recommended budget and spending plan are detailed for the highest ranked shipment route in **Sections 6.0** and **7.0**, respectively. This assessment also includes information on a Security Plan and associated procedures in **Section 8.0** and an Emergency Response Plan and associated preparedness for the prospective shipments in **Section 9.0**. Finally, **Section 10.0** identifies the recommended next steps to initiate removal of existing SNF and GTCC LLW from CR-3.

The routes are described in further detail in **Section 3.0**. These figures were produced using results from START software[2]. The colored lines indicate the routes analyzed by the MUA as explained in **Section 5.0**.

Figure 1-2: Possible Routes Evaluated by the MUA for Shipment of SNF and GTCC LLW from CR-3 ISFSI

2.0 PERTINENT SITE INFORMATION

2.1 Description of Site/Characteristics

The Crystal River Energy Complex (CREC) site, owned and operated by Duke Energy Florida LLC (DEF), is located on the western coast of Florida near the Gulf of Mexico on the Crystal River about 80 miles northwest of Orlando, Florida, and 70 miles north of Tampa, Florida[3] as shown in **Figure 2-1**.

The Crystal River Unit 3 Nuclear Generating Plant (CR-3) is part of the larger 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). In December 2018, the two original coal fired units, CR-1 and CR-2, shut down[4].The CREC is also home to a Mariculture Center (fish hatchery and grower of eelgrass) and the new Citrus combined-cycle natural gas plant construction project[5].

CR-3 was a 2,609 megawatt (thermal), 860 megawatt (electric), Babcock & Wilcox Pressurized Water Reactor (PWR), that was licensed to operate from December of 1976 to February 20, 2013. During a refueling outage that started on September 26, 2009, CR-3 replaced the steam generators (SG), requiring a large hole to be made in the containment structure. When attempting to restore the containment structure following the steam generator replacement, damage to the containment structure was observed. The licensee attempted to repair the damage, but later decided to decommission the reactor[6].

The 4,738-acre site, as shown in **Figure 2-2**, is characterized by a 4,400-foot minimum exclusion radius centered on the Reactor Building; isolation from nearby population centers; sound foundation for structures; an abundant supply of cooling water; an ample supply of emergency power; and favorable conditions of hydrology, geology, seismology, and meteorology. The intake and discharge canals are common between CR-1 and CR-2 and the nuclear unit. Maintenance of the canals is the responsibility of the Crystal River Fossil Operations[6]. The intake canal is dredged on a regular basis, approximately every 5-7 years[2].

On January 22, 2019, DEF issued a partial site release request to remove a portion (3,854 acres of the 4,738 acre site) of the site from the CR3 10 CFR Part 50 license. DEF has decided to keep approximately 884 acres under the 10 CFR Part 50 license as shown in **Figure 2-3** which is comprised of the 27-acre footprint of CR-3, as well as approximately 857 acres of the industrialized portions of the CREC, primarily comprised of the four coal plants, ancillary support structures, parking lots, roadways, land, and water[7]. On January 2, 2020, the NRC approved and issued a Partial Site Release of the 3,854 "non-impacted" areas. The new 884-acre Site is now referred to as the Controlled Area[54].

The CR-3 site is directly rail served and has direct barge access via the intake canal through both a dock, where inbound coal barges are regularly received and unloaded by conveyor, and an area in the turning basin which has repeatedly been used to receive and discharge large components by roll on/roll off method. The plant also has direct truck access via U.S. Highway 98 and state and county roads. The plant access road is called West Power Line Street, which leads into U.S. Highway 98, providing easy road access from either north or south of the plant.

Figure 2-1: Crystal River Energy Complex Site Location[9]

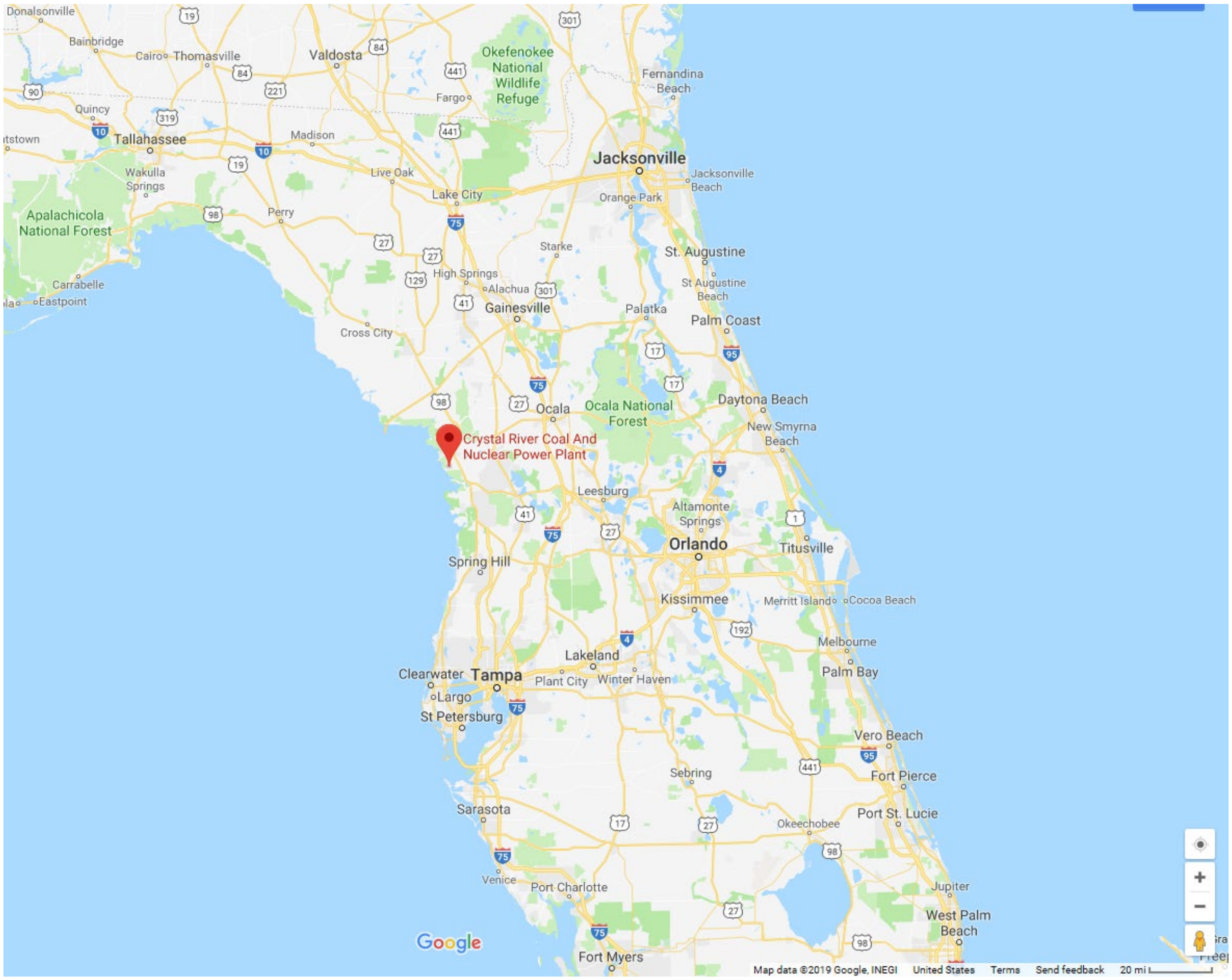


Figure 2-2: Crystal River Energy Complex Site Boundary[9]

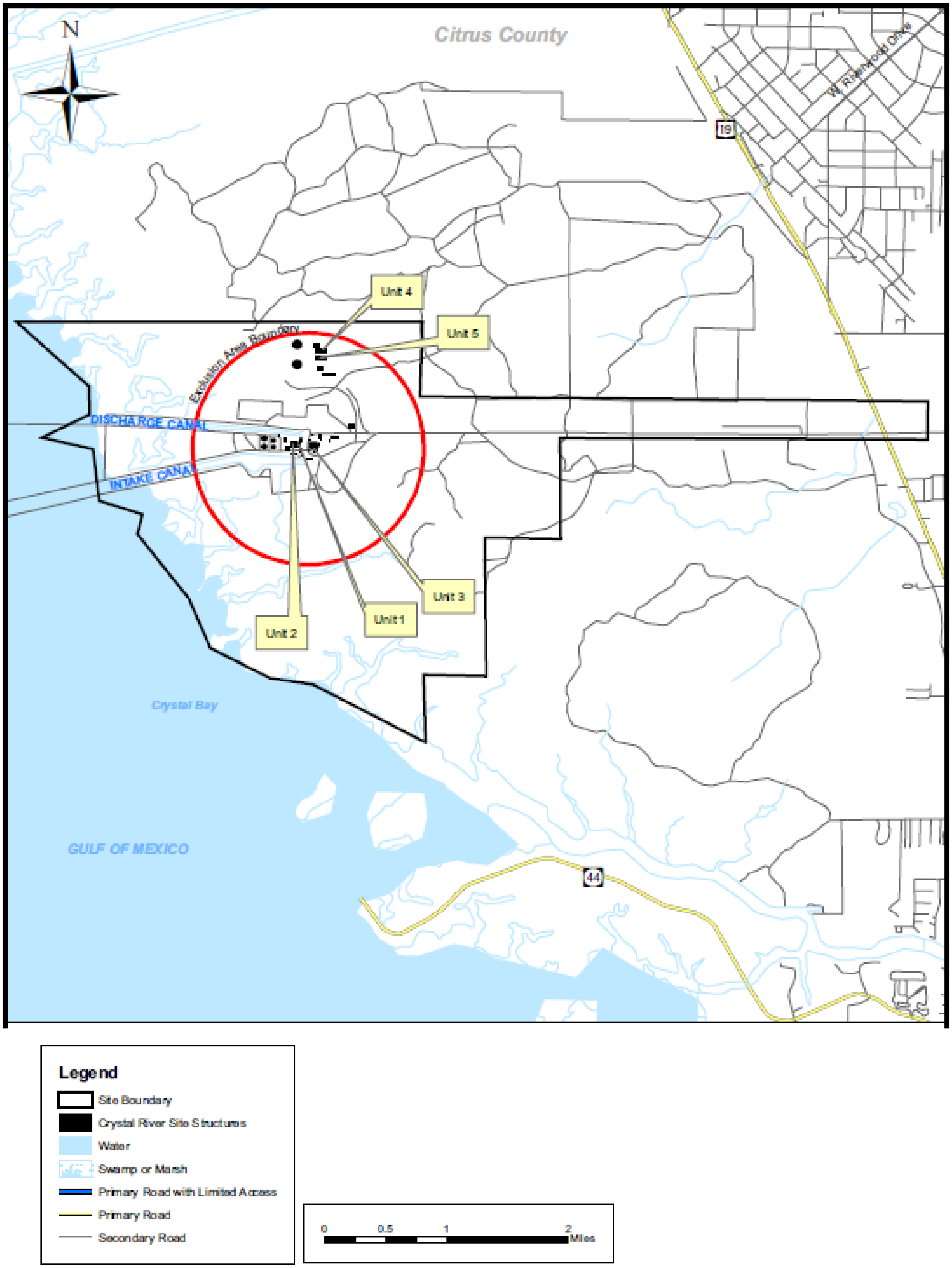
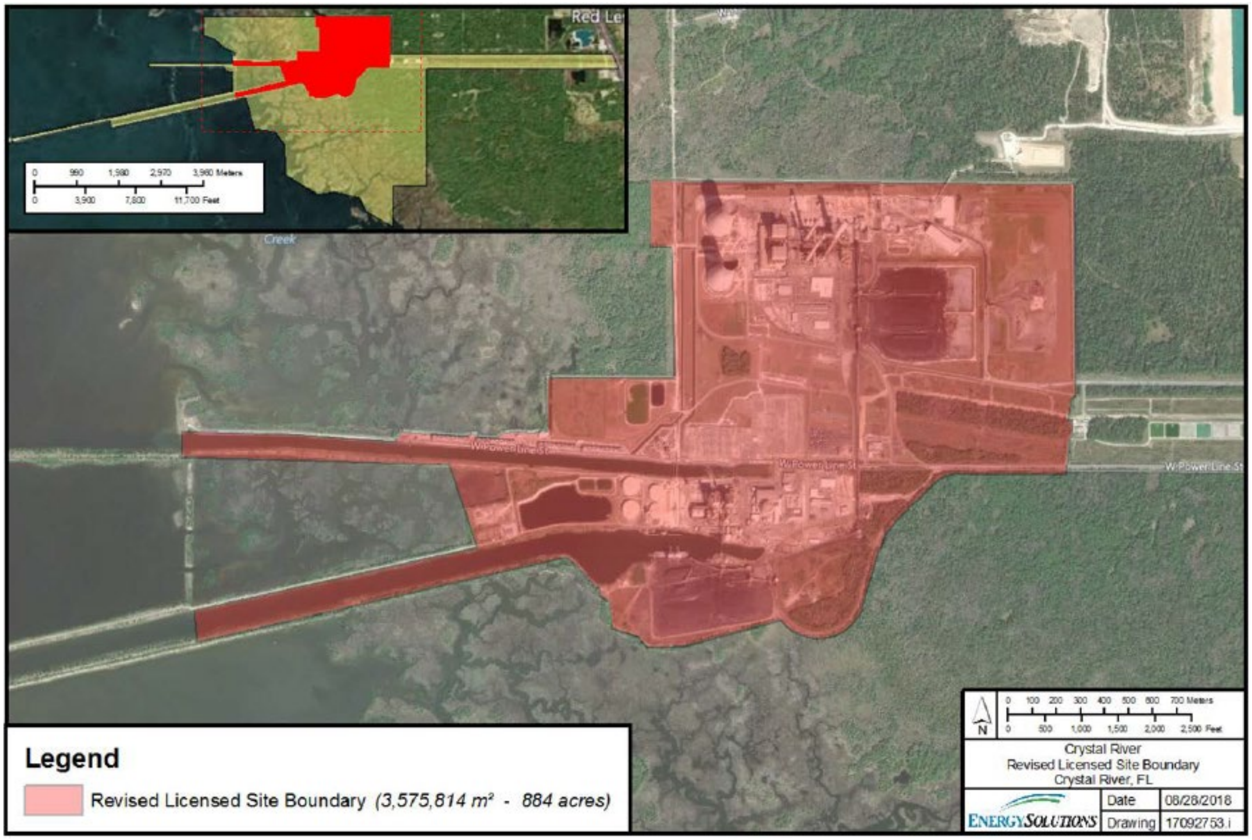


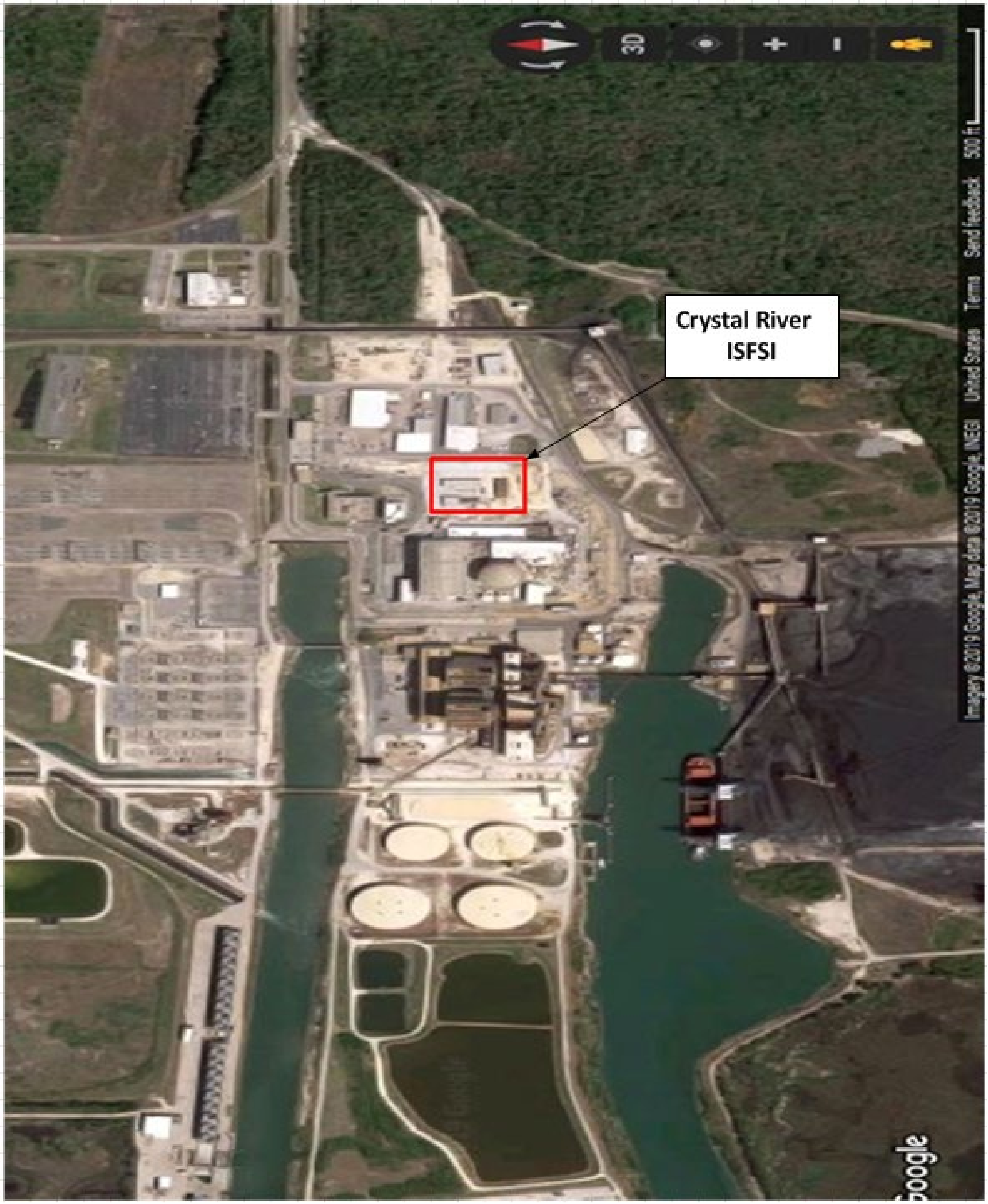
Figure 2-3: Proposed Site Boundary/CR3 Controlled Area[7]



In 2013, DEF chose the 60-year safe storage (SAFSTOR) model and reached its SAFSTOR condition in 2015. In May 2019, DEF announced a plan to decommission CR-3 by 2027 instead of 2074, and to contract with Accelerated Decommissioning Partners (ADP), a joint venture between NorthStar Group Services and Orano USA, to perform the work changing the strategy to the immediate decontamination and dismantlement (DECON) model. On April 1, 2020, the NRC approved the transfer of CR3 from DEF to ADP CR3 to commence decontamination, dismantlement, and demolition (ML20069A023). On October 1, 2020, closing took place and ADP CR3 became the Facility Licensee and the updated Post-Shutdown Decommissioning Activities Report (PSDAR) became effective changing the plant decommissioning strategy from SAFSTOR to DECON[54]. Duke Energy is the Nuclear Regulatory Commission-licensed owner of the nuclear plant, property, and equipment, and retains ownership and control of the trust fund that pays for the decommissioning. ADP CR3 is the Nuclear Regulatory Commission-licensed operator responsible for decommissioning the plant in compliance with all state and federal regulations. ADP CR3 owns the dry cask storage system assets, including the used nuclear fuel assemblies, and operates and maintains the dry cask storage facility[6].

The location of the ISFSI is shown in **Figure 2-4**. The plant began construction of an ISFSI in 2016 and began loading fuel in the summer of 2017. Fuel transfer to the ISFSI was completed in January 2018[6].

Figure 2-4: Crystal River Energy Complex Site Location[8]



CR-3 is using the Standardized NUHOMS System (Docket No. 72-1004) with the 32PTH1 Type 2-W dry shielded canister for dry storage of used nuclear fuel at the Crystal River ISFSI. This system consists of transportable 32PTH1 Type 2-W dry shielded canisters (DSC), reinforced concrete HSM-H horizontal storage modules, and a MP197HB transfer cask (Docket No. 71-9302) to be used for the de-inventory process (See further details in **Section 2.2** and **Section 2.3**). **Figure 2-5** shows a transfer trailer with transfer cask being used to load a canister into a horizontal storage module[3]. For the de-inventory process, only the MP197HB transport cask will be used to unload the DSC from the HSM-H and for the intermodal transport.

Figure 2-5: Transfer Cask being Used to Load Canister into HSM[2]

Figure 2-6 shows the CR-3 ISFSI after installation of the horizontal storage modules. **Figure 2-7** provides an aerial view of the CREC showing the locations of CR-1 through CR-5 and a portion of the extensive on-site rail infrastructure on the plant property, including the nuclear spur where dimensional cargo (e.g., HSMs and transformers) have been unloaded, the coal receiving loop track, 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 2-8 shows the location of the ISFSI at the CR-3 site.

Figure 2-6: Crystal River Independent Spent Fuel Storage Installation with Horizontal Storage Modules Installed[2]

Figure 2-7: Aerial View of the Crystal River Energy Complex[8]

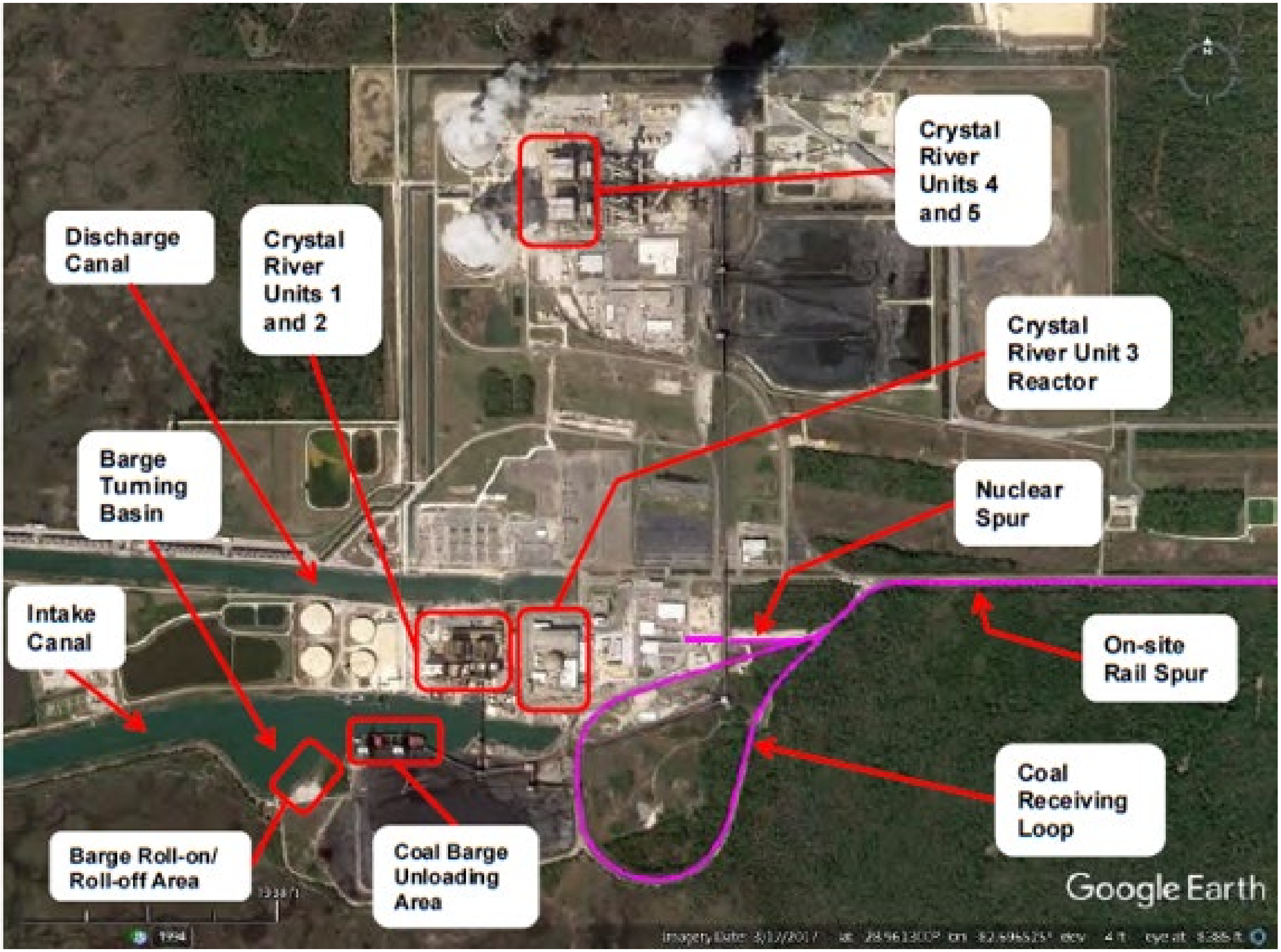
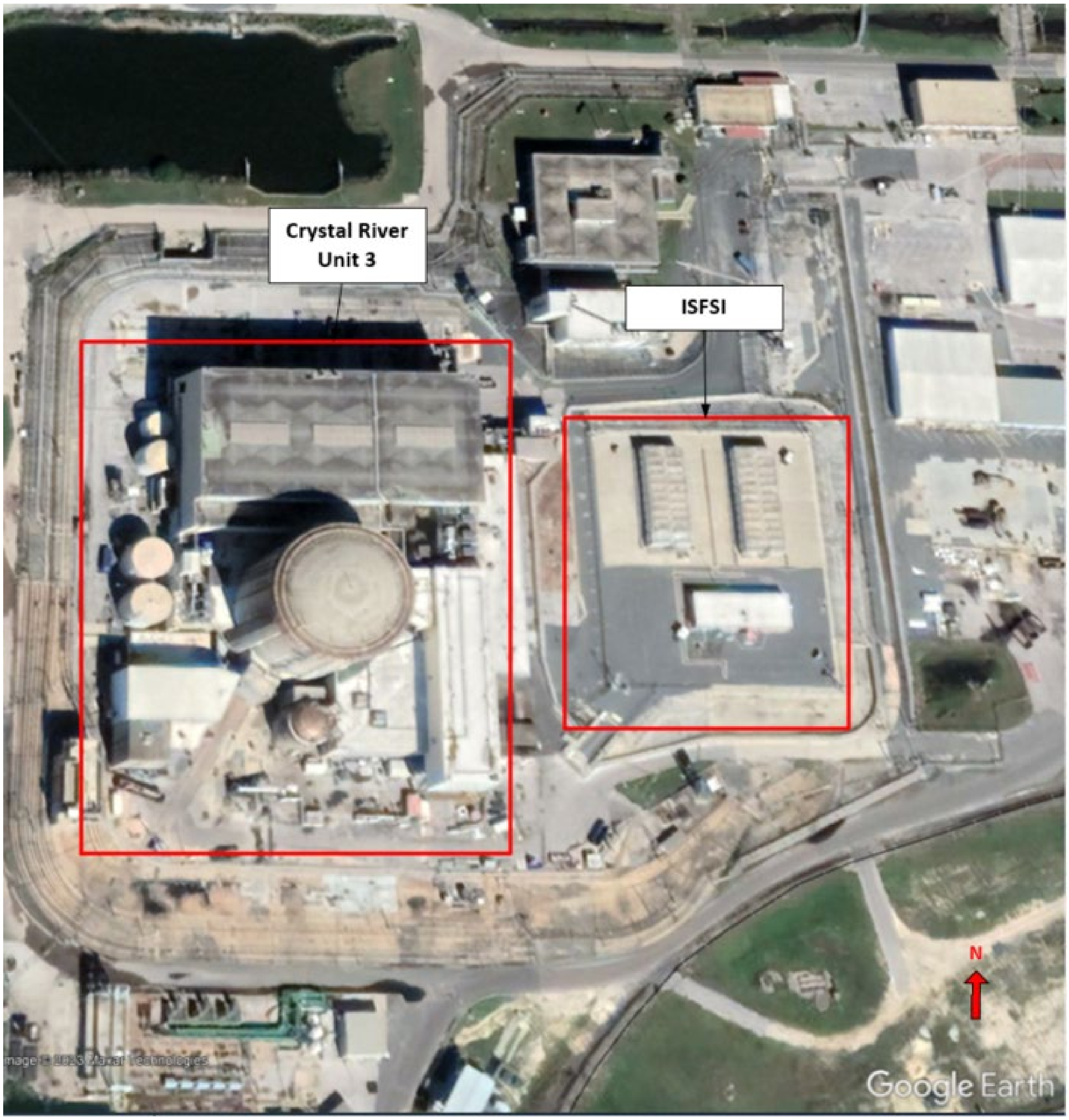


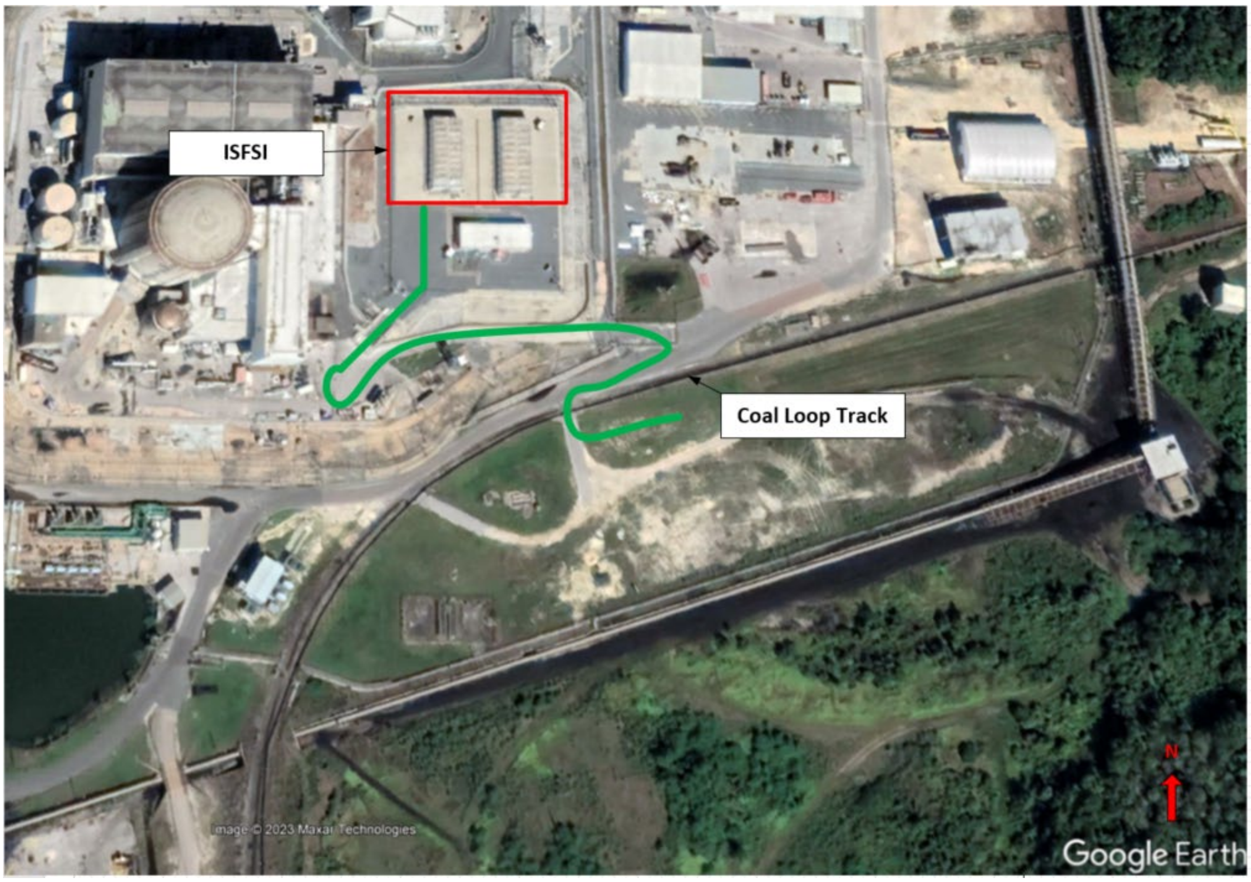
Figure 2-8: Location of Crystal River Independent Spent Fuel Storage Installation[8]



Site Infrastructure

Crystal River has an extensive on-site rail system used for receiving inbound coal trains to the two operating fossil fueled units (CR-4 & CR-5). The plant is served by the Florida Northern Railroad (FNOR). The CREC site did not receive any coal trains in 2019. Previously, in 2008, the plant received 5 coal trains per month, but had previously received as many as 40 trains per month[2]. Currently (2022), the plant is receiving one coal unit train per week. The weight of each coal 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. The coal loop track is comprised of approximately 1.10 miles of continuous track, which is sufficient to hold an entire loaded coal train or 120 cars. Another straight track, referred to as the "nuclear spur", previously extended into the CR-3 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. It is currently 780 feet long, which is not long enough, as a minimum of 1,200 feet is needed to accommodate the intended standard configuration for a cask train composed of 12-axle cars[1]. **Figure 2-9** shows a proposed haul path from the ISFSI pad to the coal loop track which travels down a less than a 7° grade coming off the ISFSI pad. Fence line modifications may be required to include the proposed transload site at the coal loop track. The 884-acre Controlled Area site approved in January 2020 includes the ISFSI and proposed transload site.

Figure 2-9: ISFSI Haul Path to Coal Loop Track[8]



[1] The standard train configuration desired by DOE is buffer car - cask car 1 - cask car 2 - cask car 3 - cask car 4 - cask car 5 – buffer car - security car. It is assumed that the engines will not wait with the consist while it is being loaded. The length of the train x 2 is 1,184', (rounded to 1,200'), so this is the minimum amount of track needed to load the train efficiently, leaving the crane in a stationary position for the loading. Some extra footage is ideal up to 1,500' for operating mobility because the loading crew will be responsible for reassembling and testing the train in preparation for the railroad to pull it from the loading site. Dedicated trains require the shipper to have the train assembled, tested, and ready to go with no intervention by the train crew. If the two engines are required to wait with the loading train, additional room will be required, approximately 137' 8". The goal is to load without any railroad intervention for additional switching from an operations and cost perspective.

Figure 2-10 and **Figure 2-11** show the nuclear spur and the big top tent at the end of the nuclear spur used for rail offloading. **Figure 2-12** show the nuclear spur and the junction (switch) of the on-site industrial spur and the nuclear spur. **Figure 2-13** and **Figure 2-14** show the on-site industrial spur in front of the ISFSI site. **Figure 2-15** and **Figure 2-16** show the on-site industrial spur at the junction with the coal receiving loop track 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 inbound coal shipments for the fossil fueled units.

The plant has additional rail track on the property to allow for holding coal trains (referred to above as the “industrial spur”) and for the receipt of urea tank cars.

Figure 2-10: Nuclear Spur[2]

Figure 2-11: Big Top Tent at end of Nuclear Spur[55]

Figure 2-12: Junction of On-Site Industrial Spur (left) and Nuclear Spur (right)[2]

Figure 2-13: On-Site Industrial Rail Spur in front of the ISFSI[2]

Figure 2-14: On-Site Industrial Rail Spur in front of the ISFSI[2]

Figure 2-15: On-Site Industrial Rail Spur at the Coal Loop Junction[2]

Figure 2-16: On-Site Industrial Rail Spur Approaching U.S. Highway 19 from West[2]

Intake and discharge canals at the CREC site withdraw water from and discharge water to the Gulf of Mexico (see **Figure 2-17**). The CREC site has on-site barge access through the intake canal which is used on a regular basis to receive coal barges that are unloaded by conveyor. It would be impractical and challenging to plan a cask loading campaign at this location because it would require a large crane to place the casks onto the barges while avoiding the conveyer. Due to receiving approximately one inbound coal barge per week and an expected two-week transloading duration for casks to the barge, it would be difficult to coordinate dual use of the dock. The intake canal, which extends into the Gulf of Mexico, is 14 miles long. Based on the most recent National Oceanic and Atmospheric Administration (NOAA) depth charts, the depth at and around the intake canal shows a level of only four to six feet, which is sufficient to conduct barge operations from the site for removal of the loaded casks (See **Figure 3-14**). As soundings are taken or dredging is completed, updated results should be reported to NOAA, but there is no updated information. 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 roughly 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 five to seven years[3].

Figure 2-18 shows the coal barge unloading area at the CREC site. In 2017, the CREC site received about 20 barges per month, each with a capacity of 20,000 tons. **Figure 2-19** shows the barge turning basin. This area has been used to unload roll-on/roll-off barges at the CREC site and has been used to deliver oversized cargo to the plant in the recent past.

Figure 2-17: Aerial View of Crystal River Intake and Discharge Canals[9]

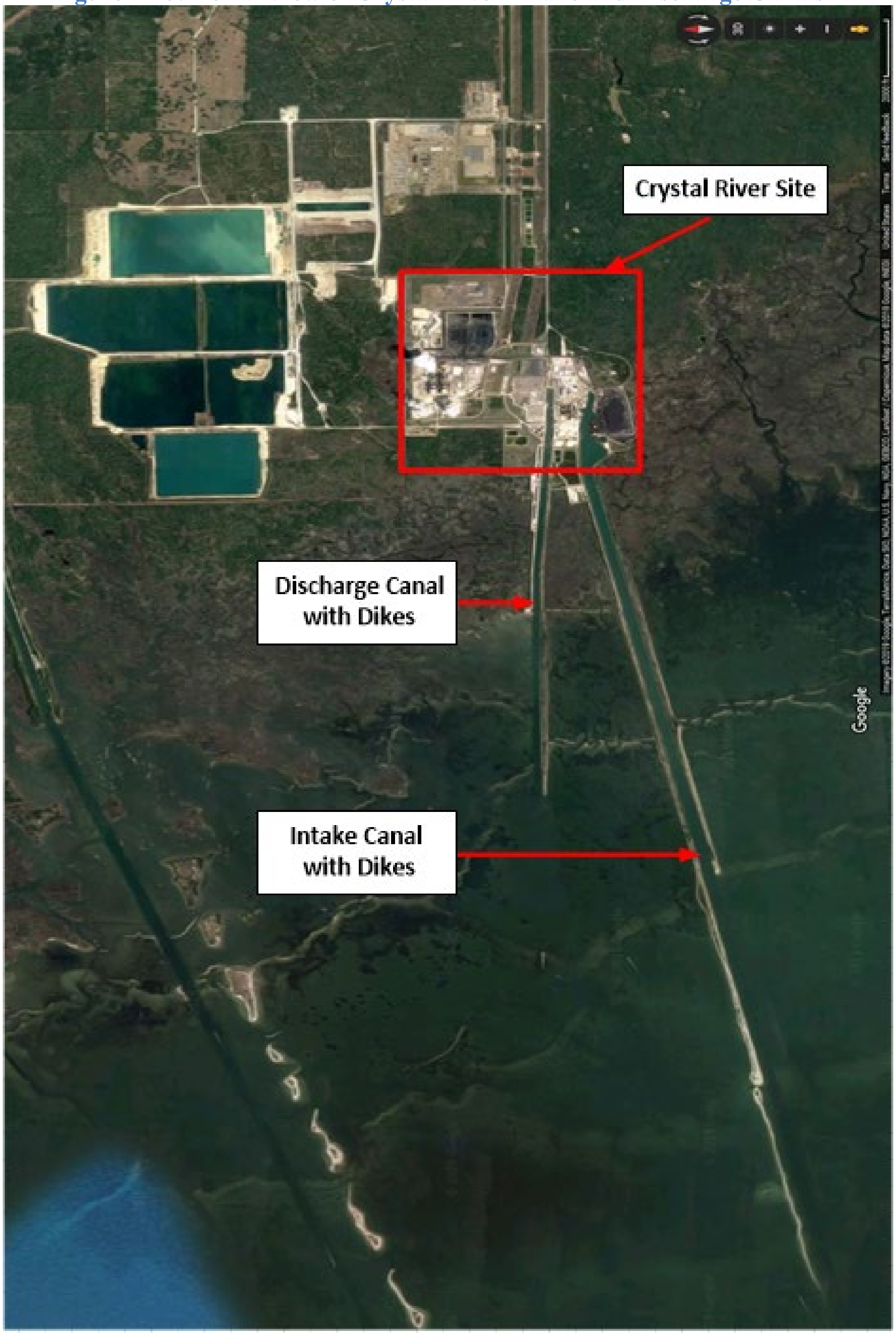


Figure 2-18: Current Barge Area Used for Unloading Coal Barges[2]

Figure 2-19: Barge Turning Basin[2]

Near-Site Transportation Infrastructure

The FNOR is a short line that directly serves the CREC plant. The railhead for this plant is called Red Level Junction (**Figure 2-20**). The plant owns a substantial amount of the rail track depicted in the documented photographs of the site. All of the rail track from the point of switch at Red Level Junction to the plant is owned by DEF. FNOR interchanges with one Class I carrier, the CSX, at Newberry, FL (**Figure 2-21**). FNOR brings loaded coal trains and urea cars from the interchange to the Red Level Junction. The plant industrial lead track runs parallel from Red Level Junction to West Power Line Street. From here, FNOR can reach the various plant tracks using several switches to gain access to the various rail unloading locations. For more specific details on the operations, reference the Shutdown Sites Report[3], which provides a detailed description of the operations including milepost locations.

Figure 2-22, **Figure 2-23**, **Figure 2-24**, and **Figure 2-25** show the FNOR transload track near Dunnellon, Florida; a highway bridge over the FNOR; a grade crossing on the FNOR; and a bridge on the FNOR, respectively. A preliminary assessment finds the highway bridge over the FNOR, shown in **Figure 2-24**, does not present a clearance obstruction for loaded casks exiting the plant on the rail track.

FNOR trains will operate at 10 mph while transporting loaded casks from the CREC site to the CSX junction at Newberry, FL. FNOR track is Track Class 1 and CSX track at interchange is Track Class 3.

As previously mentioned, Crystal River also has barge access to the Gulf of Mexico through the intake canal at the site and has previously received components by both barge and heavy haul truck.

Figure 2-20: Aerial View of Crystal River Industrial Rail Spur and FNOR[8]

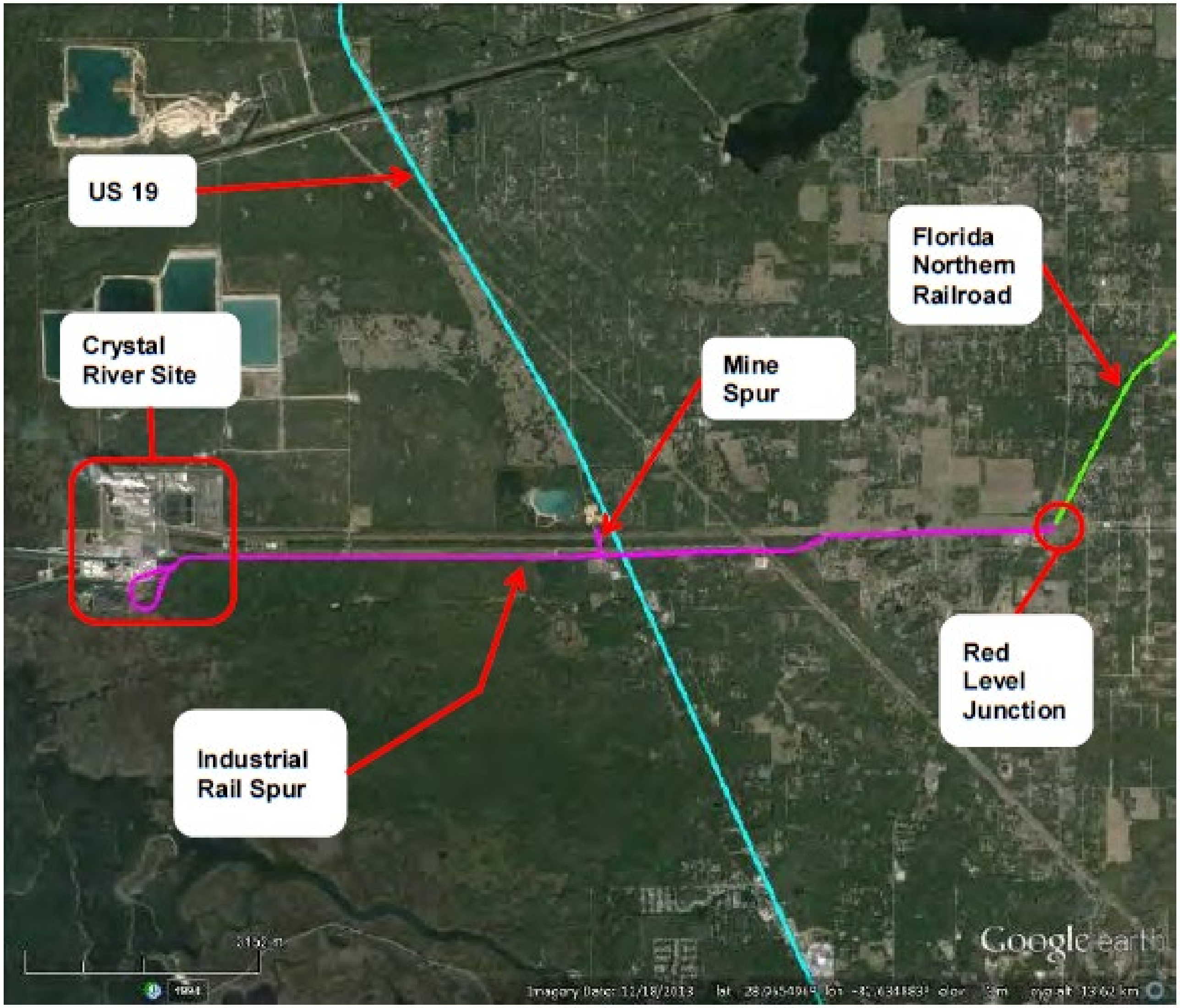


Figure 2-21: Aerial View of the Crystal River Industrial Rail Spur, Florida Northern Railroad, and CSXT Railroad[8]

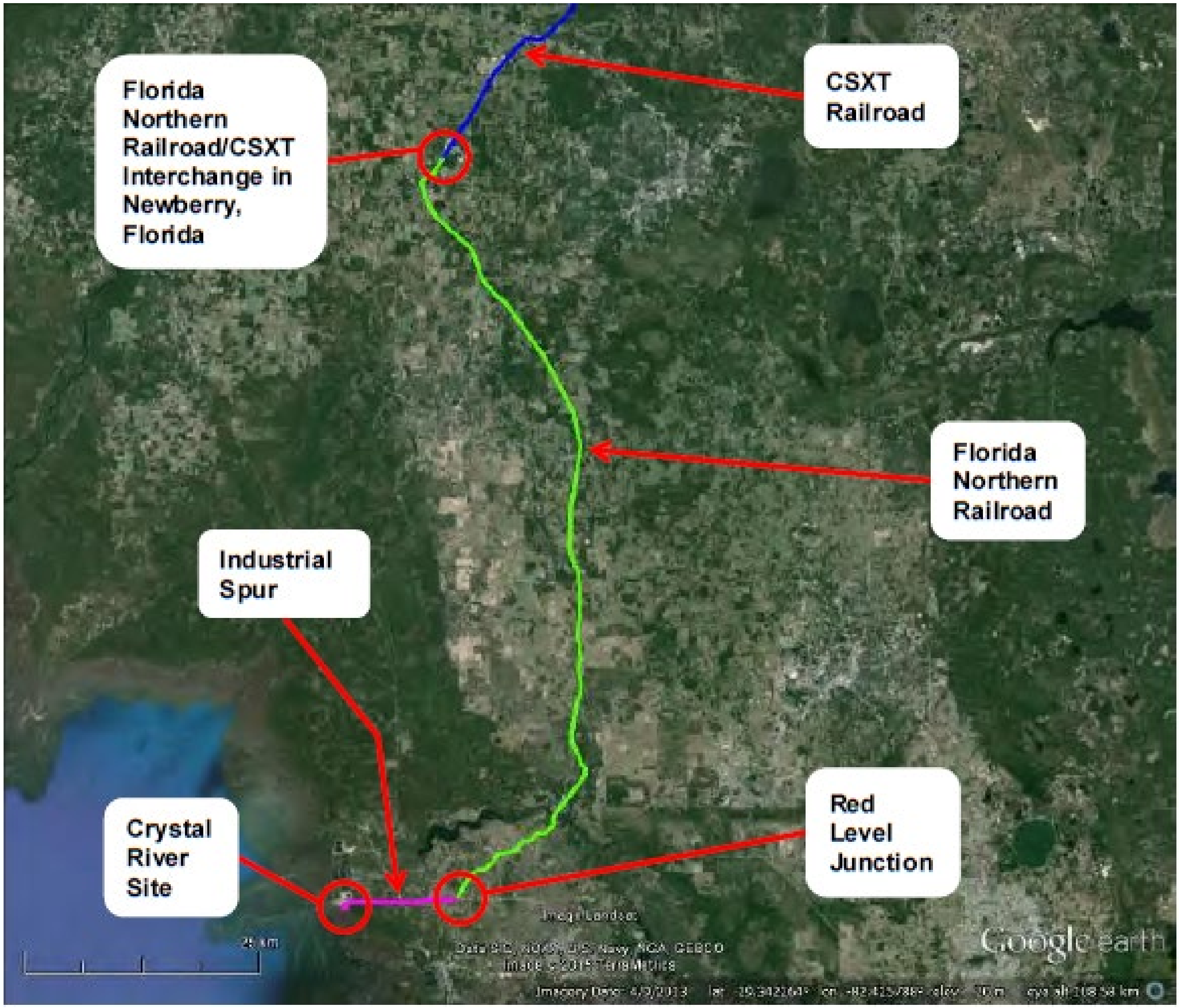


Figure 2-22: FNOR near Dunnellon, Florida[2]

Figure 2-23: Highway Bridge over FNOR[2]

Figure 2-24: FNOR Grade Crossing[2]

Figure 2-25: FNOR Bridge[2]

Regardless of the final transportation mode and route selected to reach the destination site, all the transportation casks will be transported on either an on-site transfer trailer from the ISFSI area to an on-site transload site or on a HHT trailer to off-site transload sites. Equipment staging in support of canister transfer operations from the HSM-H storage to the transport cask will occur in an area of approximately 35 feet x 100 feet in close proximity of the NUHOMS pad. Transfer will occur at the door of each HSM-H with a transfer trailer loaded with a MP197HB transport cask. The prime mover will be attached to the transfer trailer for movement of the transport cask from the ISFSI to the transload site. After reaching the transload site and after the transport cask has been transloaded to the transport conveyance, impact limiters and personnel barriers will be installed.

Refer to **Section 6.1.3** for specific details of the canister transfer and cask preparation operations for the TN system.

NUHOMS Storage System Details

The 39 NUHOMS 32PTH1 DSCs loaded at CR-3, containing a total of 1,243 fuel assemblies, are currently stored in 39 NUHOMS Model HSM-H. The DSCs were loaded and are currently maintained under Amendment 14 of CoC 1004[11].

The HSM-H, measuring 18 feet, 6 inches high x 9 feet, 8 inches wide x 20 feet, 8 inches long, weighing 306,100 lbs. (empty), is built of reinforced concrete and structural steel. Each HSM-H is a self-contained modular unit that is placed next to other HSM-Hs, with sufficient shielding provided to enable hands-on loading and unloading activities. The HSM-H design provides a means of removing spent fuel decay heat through a combination of radiation, conduction, and convection. Ambient air enters the HSM-H through ventilation openings in the lower side walls of the HSM-H and circulates around the DSC. Heated air then exits the HSM-H through outlet openings in the upper side walls of the HSM-H. A heat shield is fitted to the ceiling and walls of the HSM-H to protect the concrete from high canister temperatures[12].

The HSM-H array at CR-3 includes two rows of eleven HSM-Hs, positioned back-to-back, and two rows of ten HSM-Hs, positioned back-to-back: a typical arrangement as shown in **Figure 2-26**. As of January 2018, 39 32PTH1 Type 2-W canisters of used nuclear fuel assemblies have been loaded into 39 HSM-Hs, and there is one empty HSM-H (HSM-40) which is located on the left HSM array on the bottom (south side) of the right column[3]. Two additional HSM-Hs (HSM-41 & 42) were installed on the bottom (south side) of the left HSM array in October 2021. Two canisters containing GTCC low-level radioactive waste generated during decommissioning were loaded into the two new HSMs in January and February 2023. Each HSM-H array is 42’5” wide x 115’2” long. The HSM-H arrays are located on the ISFSI concrete pad which measures 214’10” wide x 142’5” long. The overall dimensions of the ISFSI pad and apron are 214’10” wide x 262’8” long[13]. Adjacent HSM-Hs provide adequate shielding, although modules at the end of an array or not in a back-to-back configuration require a supplemental 24-inch-thick shield wall to minimize personnel dose. As such, the ends of the HSM-H arrays at CR-3 include a separate shield wall.

To access the HSM-H, a shield door is provided on the front surface which consists of reinforced concrete with a steel liner. The shield door is secured to the HSM-H using four 1½-inch bolts and is handled using a door-handling device attached to an overhead crane. Inside of the HSM-H is a steel support frame including a set of rails for the canister to slide on during loading and unloading operations. A removable canister axial retainer fits into the HSM-H and prevents axial movement of the canister during seismic activity[12]. Key features of the HSM-H are shown in **Figure 2-27**.

Figure 2-26: Typical NUHOMS HSM Back-to-Back Layout[11]

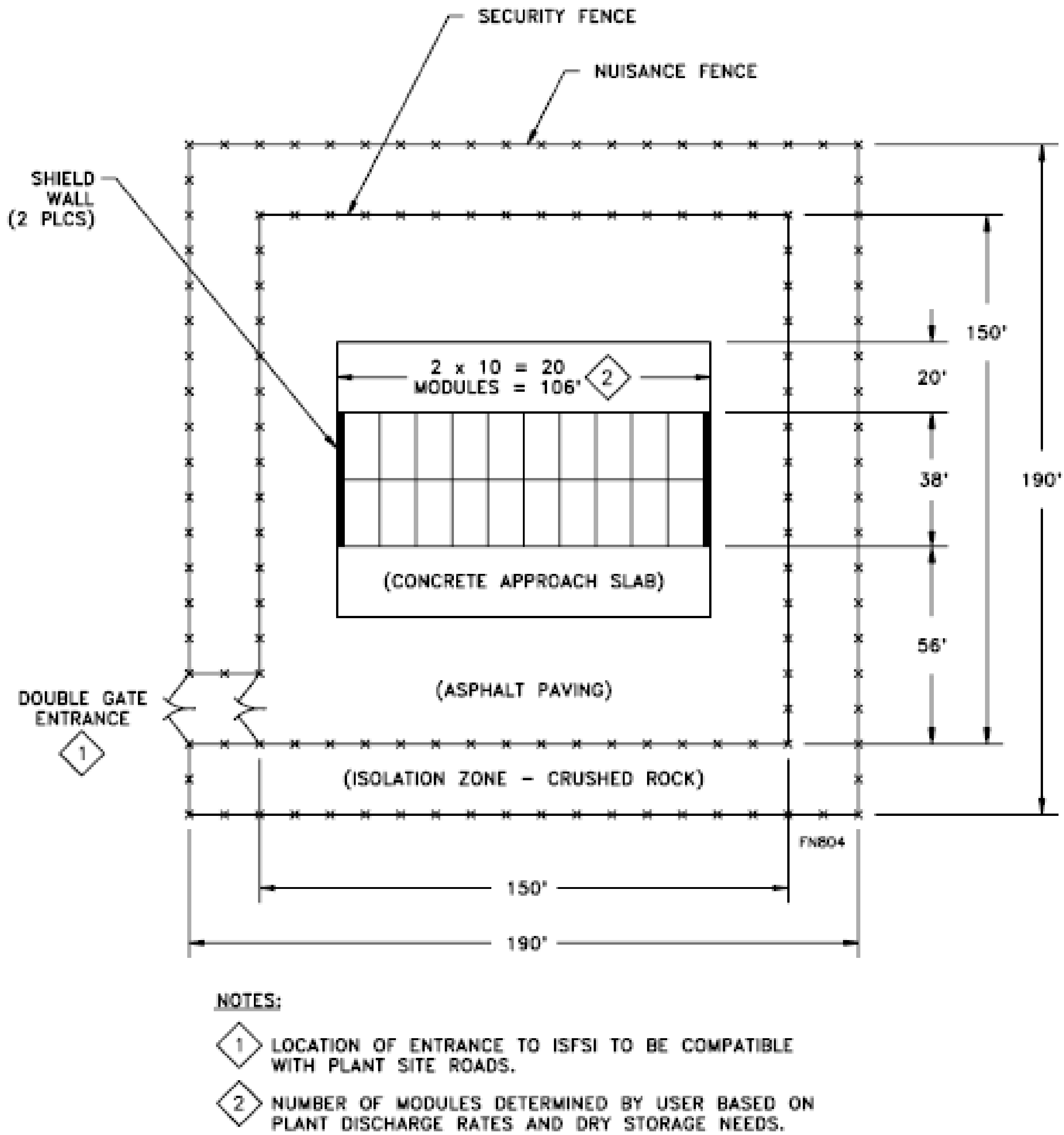
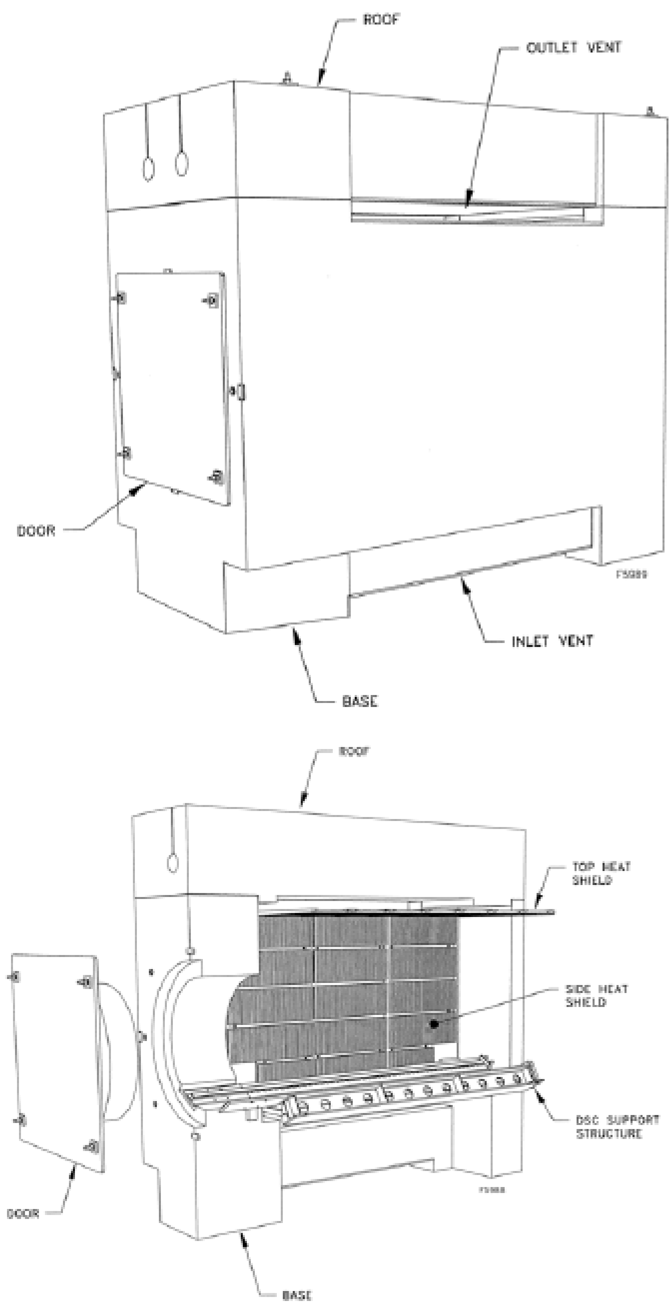


Figure 2-27: NUHOMS Model HSM-H[11]



<u>Transport Equipment</u>

- Currently, CR-3 has no transfer equipment available for the de-inventory process of unloading the 32PTH1 Type 2-W canister from an HSM-H directly into a transport cask. Typical NUHOMS transfer equipment, as depicted in **Figure 2-28** and **Figure 2-29,** will need to be purchased or leased.
- A MP197HB Transport Cask will be needed to transport the 32PTH1 Type 2-W canisters.

- A Transfer Skid will be needed for on-site transport cask handling with the transfer trailer.
- A Transfer Trailer will be needed to position the transport cask against the HSM.
- A Transport Skid will be needed for inter-modal transportation of the transport cask.
- A Prime Mover will be needed to move the transfer trailer.
- A Skid Positioning System will be needed for final alignment of the transport cask to the HSM.
- A Hydraulic Ram System will be needed to pull the 32PTH1 Type 2-W canisters into the transportation cask.
- Cask/HSM Restraints will be needed to secure the transport cask against the HSM.
- A Hydraulic Power Unit will be needed to power the hydraulic cylinders on the transfer trailer, skid positioning system, and the hydraulic ram system.
- An HSM Door-Lifting Device will be needed for handling of the HSM doors.

Figure 2-28: Staged NUHOMS Transfer Equipment

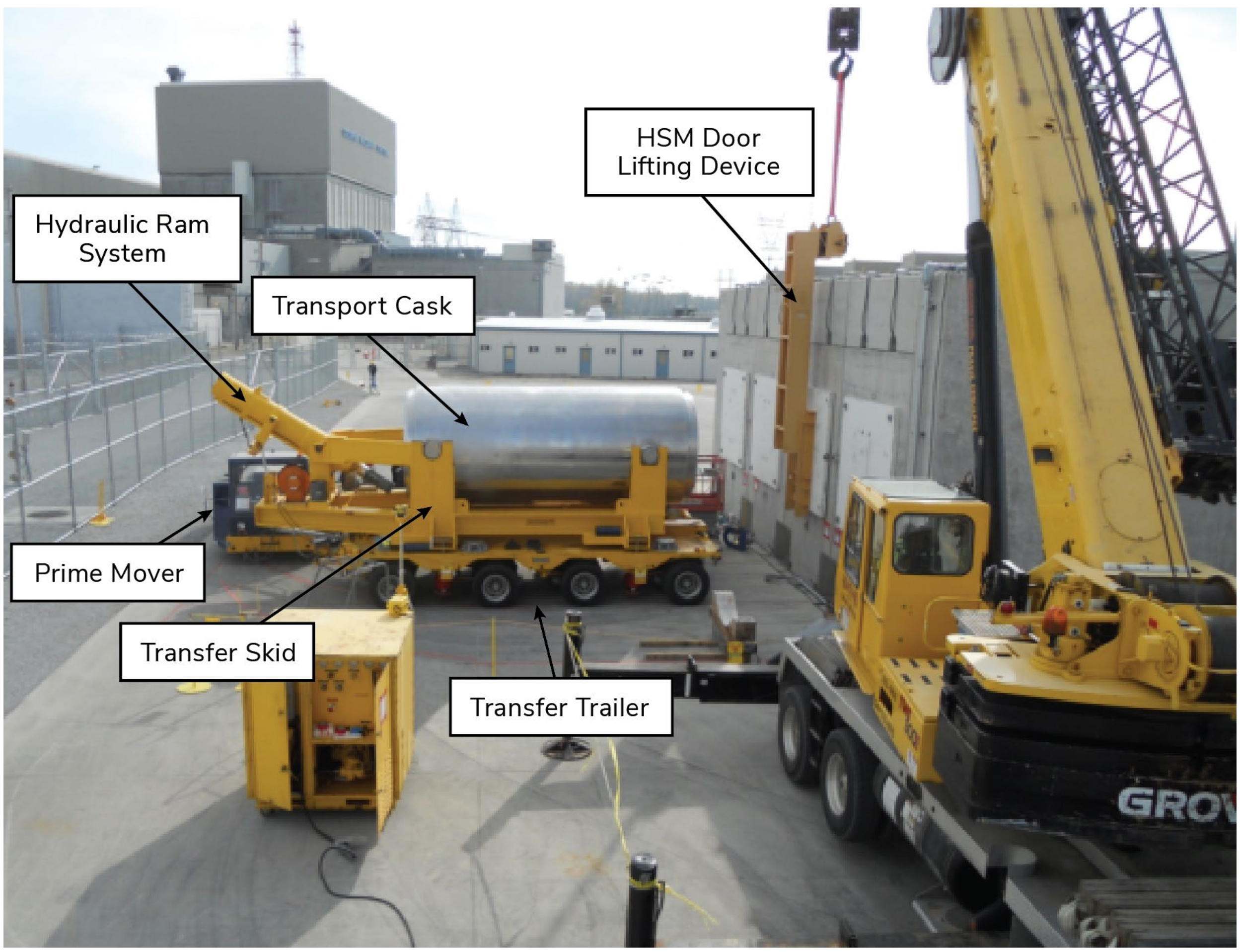
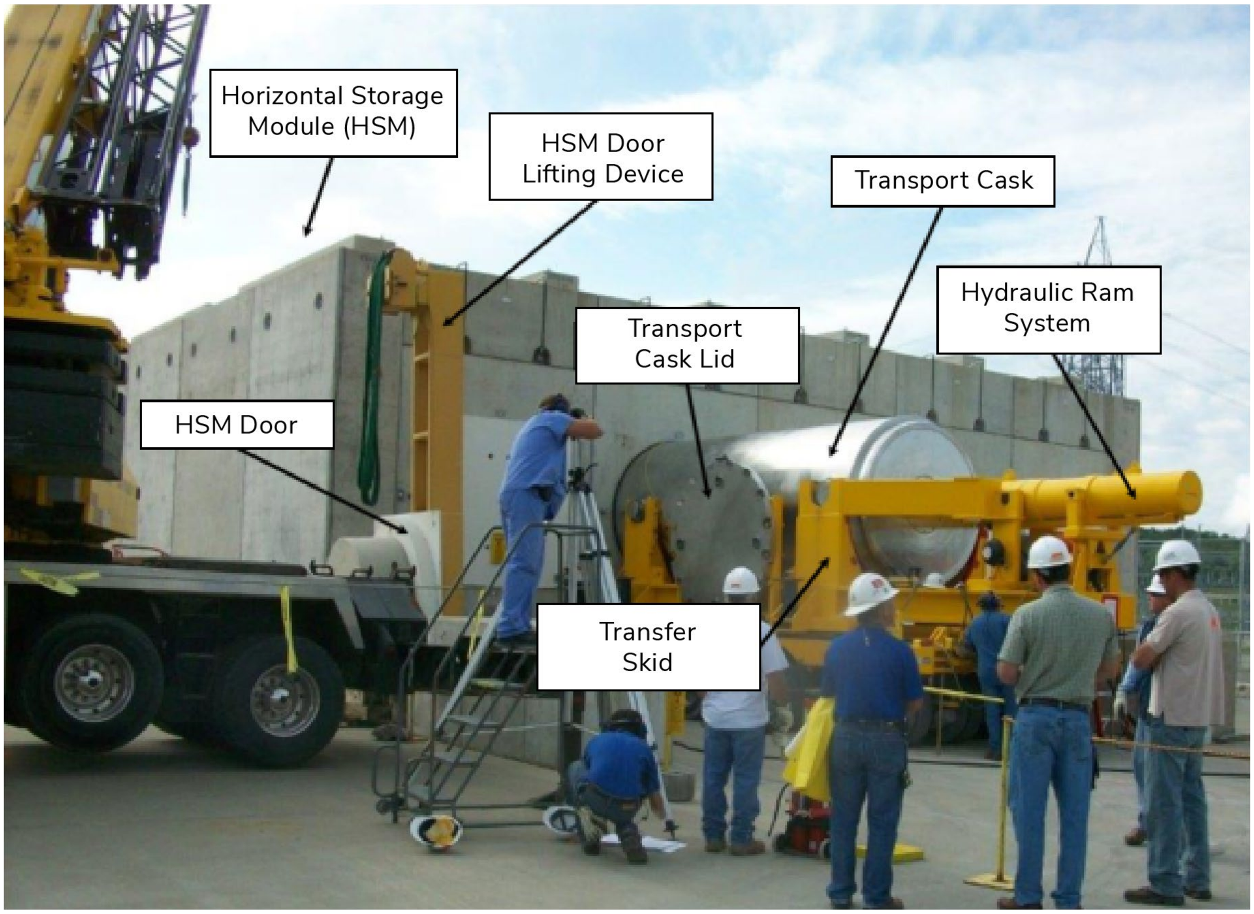


Figure 2-29: Docked NUHOMS Transfer Equipment



2.2 Characteristics of SNF and GTCC LLW to be Shipped

The transfer of the complete inventory of SNF from the fuel pool to the ISFSI started in June 2017 and was completed on January 15, 2018 and is contained in 39 NUHOMS 32PTH1 Type 2-W canisters loaded in 39 HSM-Hs. There is a total of 1,243 SNF assemblies with a total of 582.2 Metric Tons of Heavy Metal (MTHM), which are stored at the CR-3 ISFSI[3].

The CR-3 SNF is a 15x15 Mark B type assembly and was supplied by Babcock & Wilcox, AREVA, and Framatome. In all cases, the fuel assemblies are 165.625 inches long with an assembly cross section of 8.536 inches[7]. **Table 2-1** provides information on the CR-3 fuel designs.

Two canisters (RWCs) containing GTCC LLW generated during decommissioning were loaded in two HSM-Hs. Legacy GTCC LLW (LGTCC) generated during the dry fuel storage campaign and previously stored in a waste liner inside an on-site storage container on the ISFSI pad was inventoried and placed into waste racks inside the top of each RWC.

Table 2-2 and **Table 2-3** provide data associated with the 1,243 fuel assemblies loaded in the CR-3 ISFSI. The fuel was discharged from the reactor vessel between 1978 and 2009. The burnup of the fuel varies between 8.7 and 54.9 GWd/MTHM, with 428 fuel assemblies having a burnup greater than 45 GWd/MTHM (i.e., high burnup)[2]. The high burnup (HBU) fuel is distributed in various configurations within the DSCs. Configurations include the HBU fuel located primarily in the middle portion of the DSC, primarily around the DSC outer edges, and one DSC (CR3-32PTH1-L-2D-W-13) consisting completely of HBU fuel. The initial enrichment (^{235}U weight %) of the fuel varied between 1.93% and 4.71%[13].

Table 2-1: CR-3 Fuel Design Information[14]

Design	No. of Assemblies at CR-3
Mark B10E	24
Mark B10I	192
Mark B10ZL	72
Mark B2	4
Mark B3	177
Mark B4	316
Mark B4Z	152
Mark B9	64
Mark BHTP	242
Total	**1,243**

Table 2-2: CR-3 FUEL Discharge Data[3]

Year[1]	No. of Assemblies Discharged	Year[1]	No. of Assemblies Discharged
1978	2	1994	59
1979	56	1996	73
1980	44	1999	75
1981	69	2001	77
1983	61	2003	85
1985	65	2005	88
1987	89	2007	73
1990	73	2009	177
1992	77	**Total**	**1,243**

1 Year indicates when the assemblies were last critical

Table 2-3: CR-3 Fuel Burnup Data[2]

Burnup (GWd/MTHM)	No. of Assemblies
5-10	2
10 - 15	36
15 - 20	56
20 - 25	163
25 - 30	180
30 - 35	115
35 - 40	163
40 - 45	100
45 – 50 (HBU)	261
50 – 55 (HBU)	167
Total	**1,243**

The 39 32PTH1 Type 2-W canisters of SNF contain a total of 1,243 intact[2] fuel assemblies and 1 failed fuel assembly. The failed fuel assembly was created by combining failed fuel rods from

2 Fuel assemblies with pinhole leaks or hairline cracks may be considered as being intact with regards to the requirements associated with storage under CoC 1004 Amendment 14[12].

other assemblies and was encapsulated into a failed fuel can (FFC) with a welded bottom closure and a removable top closure. The FFC was then placed into a DSC compartment. All fuel assemblies are 15x15 and were supplied by Babcock & Wilcox, AREVA, and Framatome. **Table 2-4** summarizes the contents of each 32PTH1 Type 2-W canister and the identification of the 2 RWCs. There are 105 damaged fuel assemblies of the 1,243 total. The location of each fuel assembly within a particular canister is documented in the canister loading maps[15]. The fuel loading into the NUHOMS system was performed under CoC 1004, Amendment 14[16]. The contents of each RWC consist of core barrel assemblies, surveillance capsule holders and dosimeters, in-core instrument detectors, and the LGTCC waste. The LGTCC waste consists of upper end fittings, empty fuel cages, and fuel assembly parts weighing 1,712 lbs and having a waste volume of 3.61 ft^3 [57]. RWC 1 has a total weight of 35,624 lbs, volume of 71.4 ft^3, and activity of 1.88E+05 Ci. RWC 2 has a total weight of 35,776 lbs, volume of 71.8 ft^3, and activity of 1.88E+05 Ci [58].

Table 2-4: CR-3 NUHOMs ISFSI Contents[16][17][18][19][20][21][22][23][24][25]

Load Seq #	DSC Serial No.	HSM Serial No.	Date of Initial Use	No. of FAs (& Design)	Heat Load (kW)	No. of Damaged Assemblies	No. of Failed Assemblies
1	CR3-32PTH1-L-2C-W-44	HSM-2	6/24/17	(9) Mark B3 (13) Mark B4 (9) Mark B4Z (1) Mark BHTP	13.61	0	0
2	CR3-32PTH1-L-2C-W-38	HSM-4	6/29/17	(1) Mark B10ZL (3) Mark B3 (6) Mark B4 (3) Mark B4Z (12) Mark B9 (7) Mark BHTP	18.56	0	0
3	CR3-32PTH1-L-2C-W-28	HSM-1	7/4/17	(1) Mark B10I (3) Mark B3 (16) Mark B4 (4) Mark B4Z (8) Mark BHTP	13.35	0	0
4	CR3-32PTH1-L-2C-W-26	HSM-3	7/9/17	(9) Mark B10I (8) Mark B10ZL (7) Mark B3 (5) Mark B4 (3) Mark B4Z	18.52	0	0

Load Seq #	DSC Serial No.	HSM Serial No.	Date of Initial Use	No. of FAs (& Design)	Heat Load (kW)	No. of Damaged Assemblies	No. of Failed Assemblies
5	CR3-32PTH1-L-2D-W-11	HSM-5	7/13/17	(4) Mark B10E (7) Mark B10I (1) Mark B3 (10) Mark B4 (1) Mark B4Z (9) Mark BHTP	23.72	0	0
6	CR3-32PTH1-L-2D-W-15	HSM-7	7/17/17	(16) Mark B10I (1) Mark B3 (6) Mark B4 (2) Mark B4Z (3) Mark B9 (4) Mark BHTP	23.60	0	0
7	CR3-32PTH1-L-2D-W-14	HSM-9	7/22/17	(3) Mark B10E (14) Mark B10I (2) Mark B3 (3) Mark B4 (4) Mark B4Z (3) Mark B9 (3) Mark BHTP	25.06	0	0
8	CR3-32PTH1-L-2D-W-16	HSM-11	7/26/17	(5) Mark B10E (11) Mark B10I (9) Mark B4 (3) Mark B9 (4) Mark BHTP	23.60	0	0
9	CR3-32PTH1-L-2D-W-13	HSM-13	7/30/17	(1) Mark B10E (31) Mark B10I	27.75	0	0
10	CR3-32PTH1-L-2D-W-20	HSM-15	8/3/17	(4) Mark B10E (25) Mark B10I (1) Mark B4 (2) Mark B4Z	27.42	7	0

Load Seq #	DSC Serial No.	HSM Serial No.	Date of Initial Use	No. of FAs (& Design)	Heat Load (kW)	No. of Damaged Assemblies	No. of Failed Assemblies
11	CR3-32PTH1-L-2D-W-18	HSM-17	8/7/17	(1) Mark B10E (16) Mark B10I (2) Mark B3 (2) Mark B4 (8) Mark B9 (3) Mark BHTP	24.51	7	0
12	CR3-32PTH1-L-2C-W-24	HSM-19	8/12/17	(7) Mark B10I (3) Mark B10ZL (4) Mark B2 (7) Mark B3 (6) Mark B4 (5) Mark B4Z	15.15	0	0
13	CR3-32PTH1-L-2C-W-29	HSM-21	8/16/17	(2) Mark B10I (12) Mark B10ZL (15) Mark B3 (2) Mark B4 (1) Mark B4Z	15.99	0	0
14	CR3-32PTH1-L-2C-W-27	HSM-6	8/21/17	(1) Mark B10E (5) Mark B10I (8) Mark B10ZL (6) Mark B3 (9) Mark B4 (3) Mark B4Z	17.74	0	0
15	CR3-32PTH1-L-2C-W-25	HSM-8	8/25/17	(11) Mark B10ZL (7) Mark B3 (10) Mark B4 (3) Mark B4Z (1) Mark BHTP	16.35	0	0
16	CR3-32PTH1-L-2C-W-49	HSM-10	8/29/17	(3) Mark B10I (6) Mark B10ZL (16) Mark B3 (2) Mark B4 (4) Mark B4Z (1) Mark B9	15.10	7	0

Load Seq #	DSC Serial No.	HSM Serial No.	Date of Initial Use	No. of FAs (& Design)	Heat Load (kW)	No. of Damaged Assemblies	No. of Failed Assemblies
17	CR3-32PTH1-L-2C-W-39	HSM-12	9/19/17	(12) Mark B10ZL (6) Mark B3 (8) Mark B4 (5) Mark B4Z (1) Mark B9	17.39	0	0
18	CR3-32PTH1-L-2C-W-45	HSM-14	9/23/17	(3) Mark B10I (4) Mark B10ZL (8) Mark B3 (7) Mark B4 (1) Mark B9 (3) Mark B4Z (6) Mark BHTP	18.35	8	0
19	CR3-32PTH1-L-2C-W-33	HSM-16	10/7/17	(1) Mark B3 (18) Mark B4 (3) Mark B4Z (1) Mark B9 (9) Mark BHTP	17.10	8	0
20	CR3-32PTH1-L-2C-W-34	HSM-18	10/11/17	(1) Mark B10I (4) Mark B3 (17) Mark B4 (1) Mark B4Z (9) Mark BHTP	17.26	7	0
21	CR3-32PTH1-L-2C-W-32	HSM-20	10/15/17	(10) Mark B3 (16) Mark B4 (3) Mark B4Z (1) Mark B9 (2) Mark BHTP	13.82	6	0
22	CR3-32PTH1-L-2C-W-46	HSM-22	10/20/17	(1) Mark B10I (9) Mark B3 (12) Mark B4 (5) Mark B4Z (5) Mark BHTP	12.51	7	0

Load Seq #	DSC Serial No.	HSM Serial No.	Date of Initial Use	No. of FAs (& Design)	Heat Load (kW)	No. of Damaged Assemblies	No. of Failed Assemblies
23	CR3-32PTH1-L-2C-W-43	HSM-24	10/24/17	(5) Mark B3 (8) Mark B4 (9) Mark B4Z (4) Mark B9 (6) Mark BHTP	15.50	8	0
24	CR3-32PTH1-L-2C-W-17	HSM-26	10/28/17	(1) Mark B10E (2) Mark B10I (1) Mark B3 (4) Mark B4 (11) Mark B4Z (13) Mark BHTP	18.28	0	0
25	CR3-32PTH1-L-2D-W-22	HSM-28	11/1/17	(1) Mark B10I (2) Mark B3 (10) Mark B4 (19) Mark BHTP	22.15	6	0
26	CR3-32PTH1-L-2D-W-21	HSM-30	11/4/17	(1) Mark B10E (16) Mark B10I (12) Mark B4 (3) Mark BHTP	22.04	12	0
27	CR3-32PTH1-L-2D-W-40	HSM-32	11/8/17	(1) Mark B3 (3) Mark B4 (4) Mark B4Z (8) Mark B9 (16) Mark BHTP	23.00	0	0
28	CR3-32PTH1-L-2D-W-12	HSM-34	11/11/17	(1) Mark B10E (4) Mark B10I (1) Mark B3 (9) Mark B4 (1) Mark B4Z (1) Mark B9 (15) Mark BHTP	24.87	0	0

Load Seq #	DSC Serial No.	HSM Serial No.	Date of Initial Use	No. of FAs (& Design)	Heat Load (kW)	No. of Damaged Assemblies	No. of Failed Assemblies
29	CR3-32PTH1-L-2D-W-19	HSM-36	11/17/17	(1) Mark B10E (11) Mark B10I (6) Mark B4 (6) Mark B4Z (8) Mark BHTP	23.98	1	0
30	CR3-32PTH1-L-2D-W-42	HSM-38	11/20/17	(8) Mark B3 (6) Mark B4 (1) Mark B4Z (8) Mark B9 (9) Mark BHTP	15.17	0	0
31	CR3-32PTH1-L-2D-W-47	HSM-23	11/24/17	(1) Mark B10I (6) Mark B3 (10) Mark B4 (9) Mark B4Z (4) Mark B9 (2) Mark BHTP	14.14	8	0
32	CR3-32PTH1-L-2C-W-48	HSM-25	11/28/17	(1) Mark B10ZL (10) Mark B3 (7) Mark B4 (5) Mark B4Z (9) Mark BHTP	16.49	12	0
33	CR3-32PTH1-L-2C-W-31	HSM-27	12/2/17	(3) Mark B3 (11) Mark B4 (5) Mark B4Z (1) Mark B9 (12) Mark BHTP	17.27	0	0
34	CR3-32PTH1-L-2C-W-36	HSM-29	12/6/17	(1) Mark B10I (2) Mark B10ZL (1) Mark B3 (13) Mark B4 (5) Mark B4Z (10) Mark BHTP	17.74	0	0

Load Seq #	DSC Serial No.	HSM Serial No.	Date of Initial Use	No. of FAs (& Design)	Heat Load (kW)	No. of Damaged Assemblies	No. of Failed Assemblies
35	CR3-32PTH1-L-2D-W-37	HSM-31	12/11/17	(1) Mark B10I (2) Mark B10ZL (2) Mark B3 (8) Mark B4 (4) Mark B4Z (15) Mark BHTP	20.95	0	0
36	CR3-32PTH1-L-2D-W-35	HSM-33	12/15/17	(2) Mark B3 (18) Mark B4 (3) Mark B4Z (1) Mark B9 (8) Mark BHTP	17.04	0	0
37	CR3-32PTH1-L-2D-W-23	HSM-35	12/19/17	(3) Mark B10I (1) Mark B10ZL (5) Mark B3 (5) Mark B4 (6) Mark B4Z (12) Mark BHTP	16.26	1	0
38	CR3-32PTH1-L-2C-W-41	HSM-37	1/6/18	(1) Mark B10E (1) Mark B10ZL (7) Mark B3 (4) Mark B4 (9) Mark B4Z (6) Mark BHTP (4) N/A	12.82	0	0
39	CR3-32PTH1-L-2C-W-30	HSM-39	1/12/18	(6) Mark B3 (8) Mark B4 (6) Mark B4Z (3) Mark B9 (8) Mark BHTP	14.17	0	1
40	RWC-CR3-001	HSM-41	1/19/23	N/A	N/A	N/A	N/A
41	RWC-CR3-002	HSM-42	2/2/23	N/A	N/A	N/A	N/A

2.3 Description of Canisters/Overpacks to be Shipped

The CR-3 ISFSI includes a TN NUHOMS HSM-H storage system. The NUHOMS 32PTH1 Type 2-W canister and the NUHOMS MP197HB transport cask are described below.

The NUHOMS 32PTH1 Type 2-W DSCs, shown in **Figure 2-30** and **Figure 2-31,** are stainless steel and provide confinement of the contents. They are designed to accommodate up to 32 intact (or up to 16 damaged and the balance intact) PWR fuel assemblies with or without control components. The NUHOMS 32PTH1 Type 2-W DSC is a dual purpose (storage & transportation) canister available in three configurations depending on the canister length. CR-3 utilizes the long (198.5 inch) DSC designated as a type "L". The 32PTH1 DSC basket design is provided with two alternate options. CR-3 utilizes the Type 2-W basket design with steel transition rails including aluminum inserts, which is the variant of the Type 2 with larger fuel compartments. In addition, for each neutron absorber material, the NUHOMS 32PTH1 Type 2-W DSC basket is analyzed for five alternate basket configurations, depending on the boron (B-10) content provided, to accommodate the various fuel enrichment levels (designated as Type 2A-W for the lowest B-10 loading to Type 2E-W for the highest B-10 loading)[11]. CR-3 utilizes 26 Type 2C-W baskets and 13 Type 2D-W baskets[14]. Details of this DSC design are as follows[11]:

- The canisters are 198.5 inches long and have an outer diameter of 69.75 inches.
- The maximum nominal loaded weights of the canisters (dry) are 110,000 pounds.
- A basket assembly is located within the canister and includes 32 fuel compartments for PWR fuel assemblies with or without control components.
- To reduce personnel dose, shield plugs are located at each end of the 32PTH1 canister and are located within the sealed confinement boundary of the canister.
- A grapple ring is included on the bottom end of the canister and is used by the NUHOMS transfer equipment to push or pull the canister.
- A top and bottom end cap is installed on each of the 16 fuel compartments which receive a damaged fuel assembly.

Figure 2-30: NUHOMS 32PTH1 DSC Components[11]

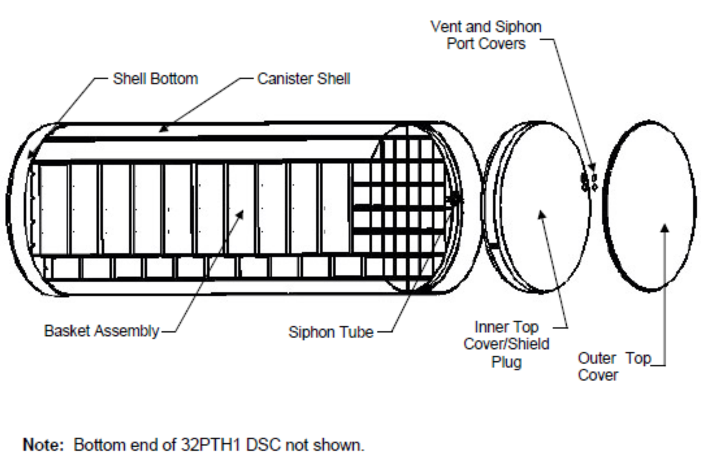
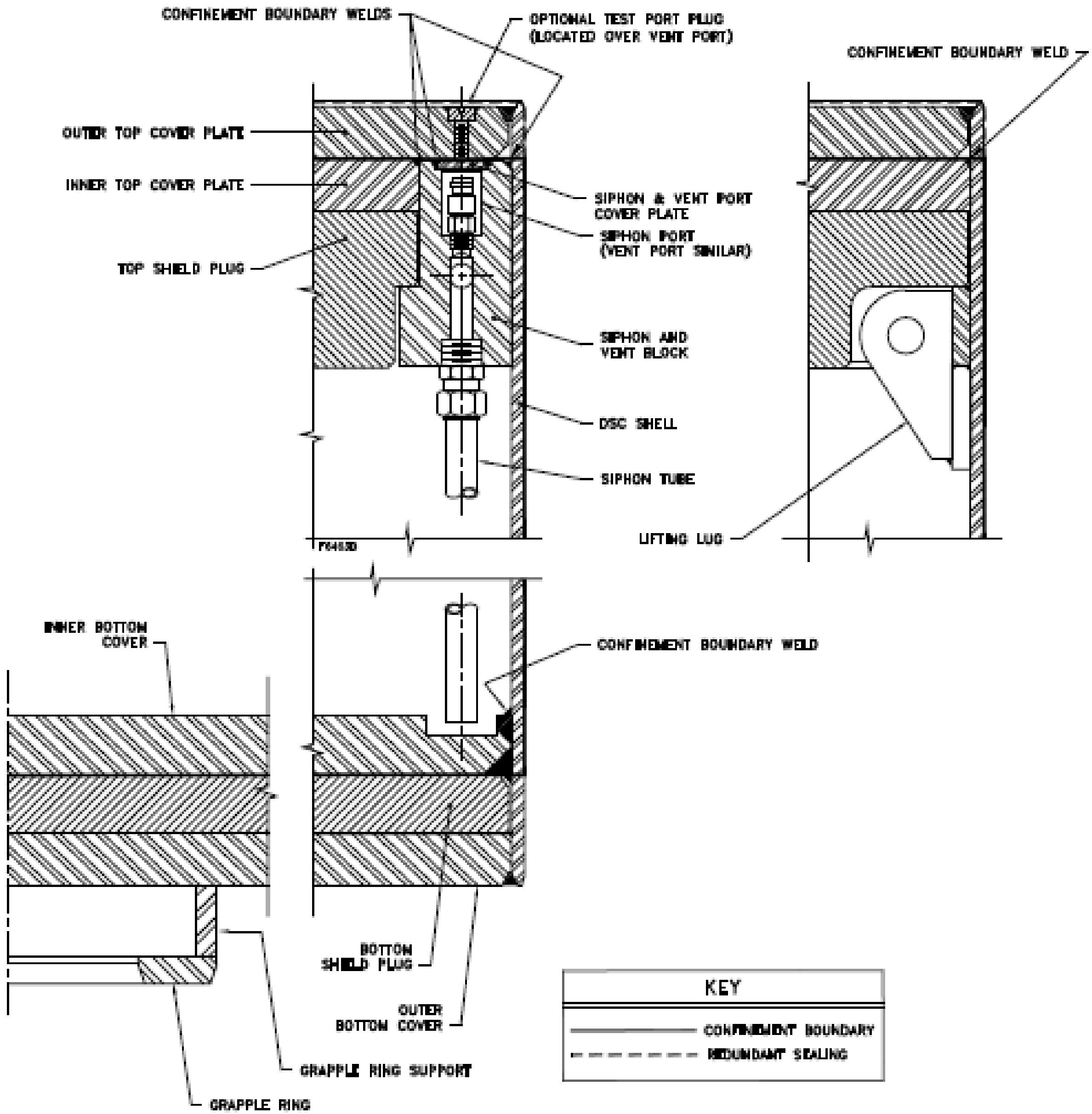


Figure 2-31: NUHOMS DSC Confinement/Pressure Boundary[11]



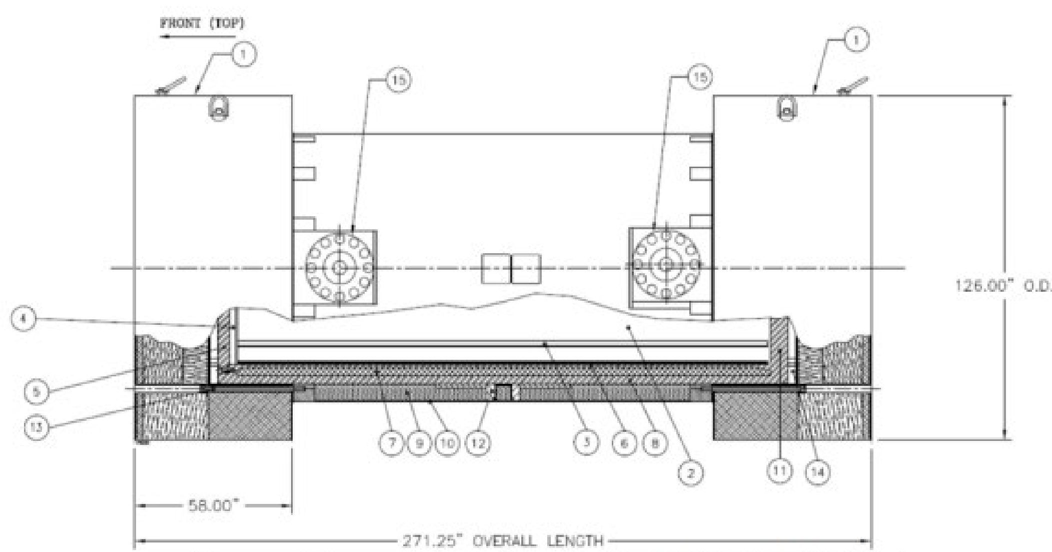
The inventory of 32PTH1 Type 2-W DSCs at the CR-3 ISFSI to be evaluated for shipment includes the 39 canisters listed in **Table 2-4**. The 32PTH1 Type 2-W DSC design is certified by the NRC for transportation of SNF in the NUHOMS MP197HB cask under CoC 71-9302, Revision 11, [27]. The MP197HB cask is also certified for transportation of LLW packaged in a radioactive waste container (RWC), which is similar in design to the NUHOMS DSCs. The RWC could be used for storage and transportation of the GTCC LLW. An evaluation will be required to ensure the RWC and MP197HB cask are designed and licensed for the contents (see **Section 10.0**).

The MP197HB cask is built and available for lease. The first MP197HB cask was placed into service in 2018 and used for LLW shipments in RWCs to the Waste Control Specialists (WCS) facility in Andrews County, Texas. The MP197HB cask is designed with an inner stainless-steel shell, a poured-in-place lead gamma shield, a stainless-steel outer shell, and a solid neutron shield encased in a stainless-steel closure. An outer sleeve with fins is an optional feature that can be installed around the cask body when transporting high burnup fuel. The inner cavity of the cask includes a set of rails for the DSC to slide on during loading and unloading operations. While the main cask lid is located at the top of the cask, a smaller opening is provided in the bottom end to enable the use of a ram for the horizontal loading and unloading of a DSC. The cask body includes four locations to mount trunnions, which are used for lifting and restraint of the cask. For critical lifts, single failure proof trunnions can be installed at all four locations. For other lifts and restraint scenarios, non-single failure proof trunnions are used. During transportation, the trunnions are removed and replaced with trunnion plugs containing neutron shielding. Tie-down of the cask during transportation includes the use of saddles and two metal straps that provide the vertical and lateral restraint, while a shear key that interfaces with the cask body is used for longitudinal restraint.[27]

The MP197HB cask is authorized to transport nine different NUHOMS DSC designs and the RWC, which vary in size. For the 32PTH1 Type 2-W DSC used at CR-3, a spacer, inner sleeve, and unloading flange are not required to be installed in the cask[22].

During transportation of DSCs, the containment boundary of the MP197HB cask (including the inner shell, the cask lid, the bottom ram access closure plate, the vent and drain ports, and the associated seals) is pressurized with helium to preclude air in-leakage and assist in heat removal. The cask lid and the bottom ram access closure plate include dual seals and a test port to perform leak testing between the seals. Leak testing of the vent and drain port seals involve the use of a special test port tool to verify the integrity of those seals[23]. **Figure 2-32** shows the main features of the MP197HB cask.

Figure 2-32: NUHOMS MP197HB Transport Cask[22]



1. Impact Limiter
2. Cask Cavity
3. Canister Slide Rail
4. Sleeve Spacer Ring
5. Cask Lid
6. Cask Inner Shell
7. Cask Gamma (Lead) Shield
8. Cask Outer Shell
9. Cask Neutron (Resin) Shield
10. Cask Shield Shell
11. Cask Bottom
12. Shear Key Receptacle
13. Impact Limiter Attachment Bolt
14. Thermal Shield
15. Trunnion

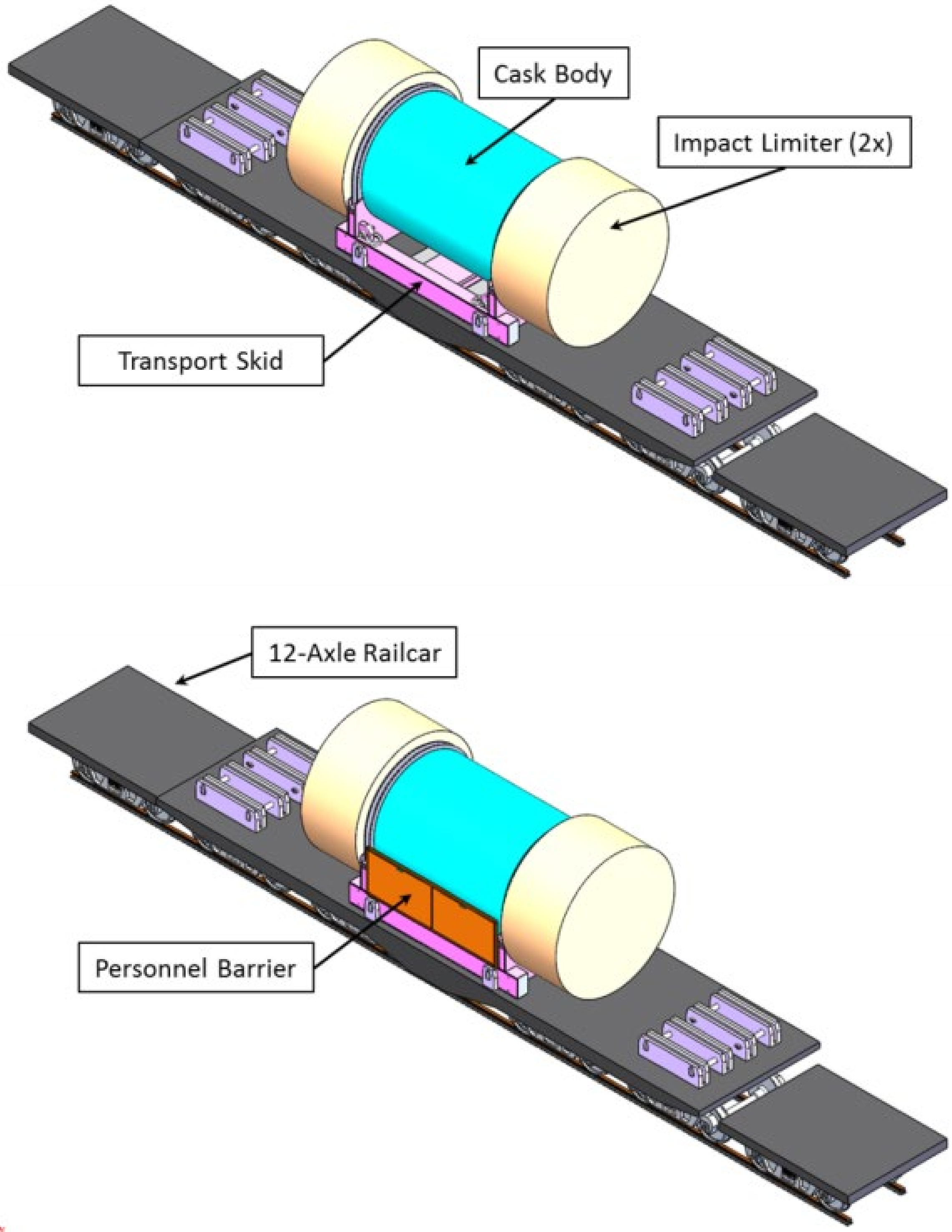
The weights and dimensions of the NUHOMS MP197HB transport packaging are shown in **Table 2-5**.

Table 2-5: NUHOMS MP197HB Weights and Dimensions[22]

Attribute	Value (lbs or in.)	Comments
Empty Cask Weight	157,500	Without impact limiters or lid
Cask Lid Weight	6,000	
Impact Limiter Weights	25,000	Includes both impact limiters
Loaded Cask Weight	303,600	With impact limiters installed
Maximum Transport Load	335,000	Loaded overpack, impact limiters, personnel barrier, cradle, + margin
Overall Overpack Length	271.25	With impact limiters
Overpack Length	210.25	Without impact limiters
Overpack Diameter	97.75	Without impact limiters
Impact Limiter Diameter	126	Overall width and height

Any HHT and barge transport operations are expected to use the same intermodal transport cradle and the same connection methods as used for the railcar transport, although further evaluations would be needed as the transport design loads are specifically designed for rail shipment (see **Section 10.0**). The overall transport weight and dimensions for each NUHOMS MP197HB cask, including margins, is estimated to be: 335,000 pounds, 23 feet long, 10 feet 6 inches wide, and 11 feet high (measured from the cradle base). The 126-inch load width, which is driven by the impact limiters, will not exceed the 128-inch width limit imposed by the Association of American Railroads (AAR) for unrestricted interchange service. **Figure 2-33** shows a representation of a NUHOMS MP197HB cask on an intermodal cradle secured to a 12-axle railcar, where the top and bottom images show the cask with and without the personal barrier installed.

Figure 2-33: NUHOMS MP197HB Cask on Railcar



The transfer of a 32PTH1 Type 2-W DSC from an HSM-H to an NUHOMS MP197HB cask and subsequent preparations for transport will include the following high-level activities (detailed operations are described in **Section 6.1.3**):

- Receive empty MP197HB cask on rail car.
- Verify the integrity of the DSC and that the contents are authorized for the MP197HB[22] cask (see **Section 10.0**).
- Remove the personnel barrier and impact limiters.
- Transfer the empty transport cask from the transport skid on the rail car to the transfer skid on the transfer trailer.
- Remove the front trunnion covers from the cask and install the front trunnions.
- Remove the ram access closure plate.
- Remove the cask lid.
- Position the cask in close proximity to the HSM.
- Remove the HSM door and the DSC seismic restraint assembly.
- Align and dock the cask to the HSM.
- Install the cask/HSM restraints.
- Install the ram, extend through the cask bottom port, and engage the DSC grapple ring.
- Retract the ram, pulling the DSC into the cask.
- Remove the ram cylinder and install the ram access closure plate.
- Remove the cask/HSM restraints and reposition the loaded cask away from the HSM.
- Install the cask lid.
- Remove the cask front trunnions and install the associated trunnion covers.
- Perform the containment boundary leak tests.
- Transfer the loaded transport cask from the transfer skid on the transfer trailer to the transport skid on the rail car.
- Install the impact limiters and then install the personnel barrier.
- Perform pre-shipment inspections and surveys and depart.

To perform the above activities, the below ancillary devices are required[22]. Unless specifically addressed, these components are not considered to be safety-related or important-to-safety.

- Leak Test System: Prior to transport of the loaded MP197HB casks, the containment boundary seals need to be leak tested. This is done after the cask cavity has been evacuated with a vacuum system and then backfilled with helium. Additionally, a helium mass spectrometer along with a test port tool will be required. It is recommended that this equipment be obtained from the cask vendor when the cask is supplied.

- Replacement seals for cask lid and for the vent, drain, and test port plugs: Prior to performing the final containment boundary seal leak tests, new seals need to be installed. This should occur each time the cask is used for a transport, so several seal sets will be required. It is recommended that multiple sets of the seals be obtained from the cask vendor when the cask is supplied. These seals are considered important-to-safety, as they are used to maintain the containment boundary during transport.
- Transport cradle/skid: A cradle (also referred to as a skid) for the MP197HB transport cask will need to be designed and fabricated. The transport skid will be used for the transportation (truck, rail, and/or barge) of the MP197HB transport cask to/from the site. A conceptual design of this transport skid[28], depicted in **Figure 2-33**, includes straps that go over the cask body to secure the cask to the cradle. A shear key is included in the cradle, which interfaces with the shear key pocket in the cask body to resist axial transportation loads. Lifting points on the cradle allow for lifting the cradle with the loaded cask attached and configured for transport (with impact limiters and personnel barrier). The final design and fabrication of this cradle will likely need to be performed by the cask vendor.
- Transfer Skid: A transfer skid will be needed for the MP197HB transport cask and will be used during the on-site DSC transfer operations. The transfer skid will be located on the transfer trailer. The final design and fabrication of this transfer skid will likely need to be performed by the cask vendor.
- Transport Cask Lift Beam: The horizontal intermodal transport cask lift beam is used to lift and move an empty or loaded MP197HB transport cask at the transloading (intermodal transfer) site. This device will need to be fabricated and should be provided by the vendor supplying the transport cask.
- Transfer Trailer: An on-site transfer trailer would be used to position the horizontally oriented MP197HB transport cask at the HSM-H. The cask vendor maintains the design of this equipment and can provide the necessary design and fabrication services.
- Prime Mover: A prime mover will be needed to move the transfer trailer. The cask vendor, who will address any needed trailer modifications, will be able to provide the specifications for this equipment.
- Skid Positioning System: A series of hydraulic cylinders and low-friction contact pads are used between the transfer trailer and transfer skid to allow final alignment of the transport cask to the HSM-H. The cask vendor maintains the design of this equipment and can provide the necessary design and fabrication services.
- Hydraulic Ram and Grapple: A hydraulic ram with a capacity of 80,000 pounds and a minimum stroke of 20 feet, will be required for retracting the DSC from the HSM-H into the cask. A grapple is located at the end of the ram for attaching to the DSC grapple ring. The cask vendor maintains the design of this equipment and can provide the necessary design and fabrication services.
- Hydraulic Power Unit: A hydraulic system, consisting of a pump, control valves, and a control system, is used to power the hydraulic cylinders on the transfer trailer, skid positioning system, and the hydraulic ram.

- Cask/HSM Restraints: A set of adjustable restraints are needed to secure the front trunnions of the MP197HB transport cask to mounting points embedded in the front face of the HSM-H. These are used to prevent movement of the transport cask during DSC transfer operations between the HSM-H and the transport cask. The cask vendor maintains the design of this equipment and can provide the necessary design and fabrication services.
- Cask Lid Handling Device: A below-the-hook lifting device will be required to handle the lid of the MP197HB transport cask, while the cask is oriented horizontally. This device will attach to threaded holes in the lid and will be designed such that the lid will hang vertically when it is being removed or installed. It is recommended that this equipment is obtained from the cask vendor when the cask is supplied.
- HSM-H Door-Handling Device: A second below-the-hook lifting device will be required to handle the door of the HSM-H.
- Cranes: It is expected that two cranes will be required. A single mobile crane is required to handle the ancillary equipment transfer operations at the ISFSI pad, while an additional mobile crane will be needed to load/unload the transport cask at the trans-loading site.
- Impact limiters: The transport cask will arrive with two impact limiters according to the requirements of the Safety Analysis Report (SAR). The impact limiters would be fabricated as part of the transport cask procurement and fabrication. These are considered important-to-safety as they are used to protect the cask during a design basis accident.
- Personnel barrier: As required by the SAR, a personnel barrier would be placed around the loaded transport cask. The barrier, which attaches to the cradle, spans the distance between the impact limiters and matches the outer diameter of the impact limiters. This device does not currently exist, so it would need to be designed and fabricated. There are no unique requirements that would present expected complications with the lead time and cost of obtaining personnel barriers.

3.0 TRANSPORTATION ROUTE ANALYSIS

This section describes the available routes identified as being reasonably able to transport the loaded transportation casks from CR-3 for delivery to the closest Class I railroad and the subsequent movement to GCUS. Although there is vast rail infrastructure at the site, all potential transportation modes were considered for movement of the loaded casks. A number of routes were identified and, as discussed in **Section 3.6,** the options available were down-selected using specified criteria, resulting in a total of six scenarios to consider further using the MUA process, as covered in detail in **Section 5.0,** including two of each mode: HHT to rail, barge to rail, and rail direct.

3.1 Heavy-Haul Trucking Routes

CR-3 is located on West Power Line Street in Crystal River, Florida, approximately 70 miles northwest of Tampa, Florida. The access road leads to U.S. Highway 98. Interstate highways and roads are close to the site. Depending on which loading site is selected, navigation north and south from the site on U.S. Highway 98 is possible. Alternate routes are available using county roads. There are no state designated heavy haul, restricted, Hazardous Materials (HAZMAT), Highway Route Controlled Quantity (HRCQ) of Class 7 radioactive materials (RAM), or non-radioactive hazardous materials (NRHM) truck routes near Crystal River or in the truck path to reach any of the identified potential HHT to rail transload sites.

The roads on the CR-3 site are in good condition and most are paved. When the ISFSI was constructed, the surface was reportedly raised by approximately 20 feet and the road leading from the ISFSI has a grade of slightly less than 7°.

Several potential rail tracks were identified for possible use as off-site transload areas for loading the train consist. **Table 3-1** identifies the rail tracks closest to the plant which could potentially be used as transload sites. Details of these rail sidings were considered in this assessment, including length of track and any associated restrictions or benefits. Three locations have been used in the past for transloading operations for individual or groups of cars, but none of them have been used for a consist with as many cars as are expected for this effort, or for 12-axle cars. The two locations with the most potential were also the two closest rail sidings, at approximately 4.09 miles and 18 miles from the plant. Both are located on the FNOR short line.

Table 3-1: Nearest Rail Tracks Outside of CR-3 Site

Track Location	Siding Length (ft)	HHT Miles to Track	Site Description	Challenges/Considerations
FNOR Track at intersection of W. Power Line St. and N. Tallahassee Rd.	1,445	4.09	FNOR owned track and land. Used for unloading pipe.	This track was used in the past by Crystal River Quarries and its predecessor company. Property and track is available for lease from FNOR for loading. Site has been used in the past to transload cars of pipe and dimensional cargo

Track Location	Siding Length (ft)	HHT Miles to Track	Site Description	Challenges/Considerations
19810 SW 110th St., Dunnellon, FL 34432	1,200	18	FNOR owned track and land used for transloads and car repairs	Shared track located within a portion of an old rail yard used for self-service transloads by multiple shippers. It is available for lease by the short line. There are two 600 ft tracks available but only one track has 400 ft of track which is accessible from both sides of the track - it is located in the interior of the property. Track is non-contiguous which is less attractive for loading trains versus individual cars. Potential tight turning radius for HHT entry into site entrance from East McKinney Street, crossing rail tracks and having to navigate along the railroad access road which is unpaved to reach the interior of the property. Not enough track to load train consist efficiently. Not an ideal location for loading, but it is close to the plant. Track is segregated by trees from neighboring homes. Transload site is not secure.
Williston Pipe Track SE 1st & SE 8th Streets, Williston, FL	750	47	FNOR Property	Limited rail track, cannot load entire consist without multiple switches. The site is not secure and too close to houses and a baseball field.
4000 NW County Road 235, Newberry, FL 32669	5,970	65	Private Industry Track: Argos Cement	This is a private industry with extensive rail infrastructure. It is actively used and would be difficult to load trains there without interfering with normal plant operations.
N Access Rd. Intersection with FNOR (site identified by START[1])	Unk	3	Initial START route	This HHT to rail route was created by START[1]. The HHT short distance provides no advantage and rail route involved multiple rail lines (FNOR, CSXT, NS, BNSF, and UP). Also this route went through Atlanta, GA which was not desirable.
HHT to Newberry, FL and Rail from Newberry (START[1] identified route for minimum distance	Unk	89	Minimum Distance START route	This route was created in START to see minimum mileage route and it suggested highway route to Newberry, FL. Review determined there was no good transload area around Newberry, FL.

START[1] was used to create truck routes to the two closest sites identified above. These routes were considered viable for the transload of 5 transportation casks from HHT to the offsite transload tracks. Routes were configured to follow interstate highways wherever available and to avoid using two-lane country roads, potentially alleviating road congestion during tourist seasons.

Figure 3-1 illustrates the HHT route from CR-3 via the public access road to the closest rail siding located outside the plant property. The most direct route from the plant to the North Tallahassee Road rail site for loading trains involves leaving the ISFSI, exiting the plant onto the access road, West Power Line Street, traveling east for approximately 4.09 miles to North Tallahassee Road, turning left onto North Tallahassee Road, driving north for approximately 319 feet, then taking a slight right onto the unimproved road, and continuing for an additional 300 feet before coming to a stop next to the crane, parallel to the rail track where the transload will take place, as shown in **Figure 3-2**. Once loaded, the train will proceed along the FNOR-Newberry, FL-CSX route to GCUS. START identifies the rail portion transit distance as 1,146 miles with an approximate transit time of 38 hours. This is the best possible transload location, when considering only HHT routes, as it is close to the plant, requiring minimal time for return trips. Additionally, neither the route nor the transload site has any major obstructions. The transload location has sufficient room for an efficient transloading configuration, with enough turning radius for the HHT. It is not secure, but a fence and lighting can be added to create a rail secure site.

Figure 3-1: HHT Route from CR-3 to North Tallahassee Rd Transload Site[9]

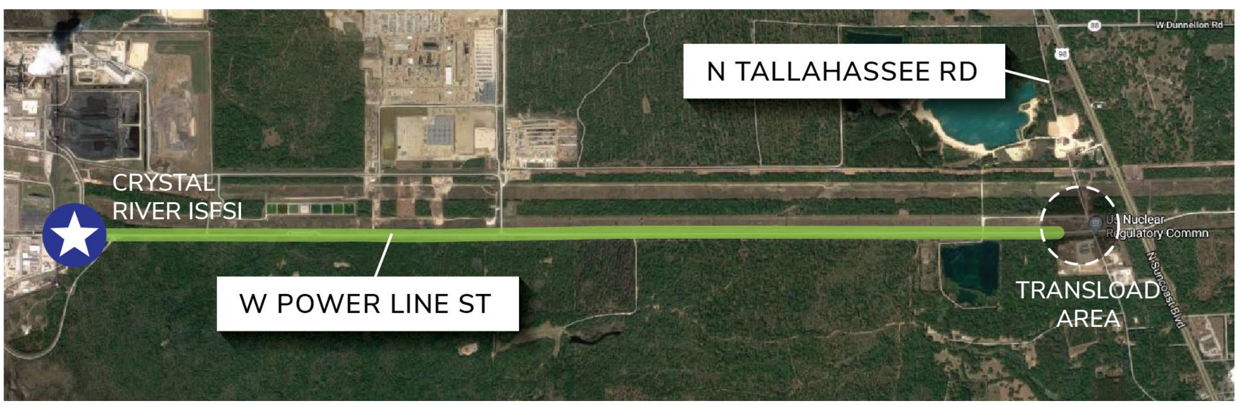


Figure 3-3 illustrates the HHT route from CR-3 via the public access road to the transload location in Dunnellon, FL, approximately 18 miles from the plant. This location is a small rail yard that has been repurposed for transloading and storage as a self-service location. It can be leased from FNOR. The most direct route from the plant to the rail site is for the HHT to leave the ISFSI, to exit the plant onto the access road, West Power Line Street, turn left onto U.S. 19 N/ U.S. 98 for 0.8 mile, turn right onto State Highway 88 (W. Dunnellon Road) continue for 11.8 miles, turn left on US 41 N, for 0.9 miles, traveling east to Route 41 to SR 40, I-75, turn right onto East McKinney Drive proceeding approximately 185 feet. Cross the railroad tracks and make a left onto the unimproved access road and travel parallel to the tracks for approximately 4,450 feet; the transload site is shown in **Figure 3-4**.

Figure 3-2: North Tallahassee Road Transload Site[8]

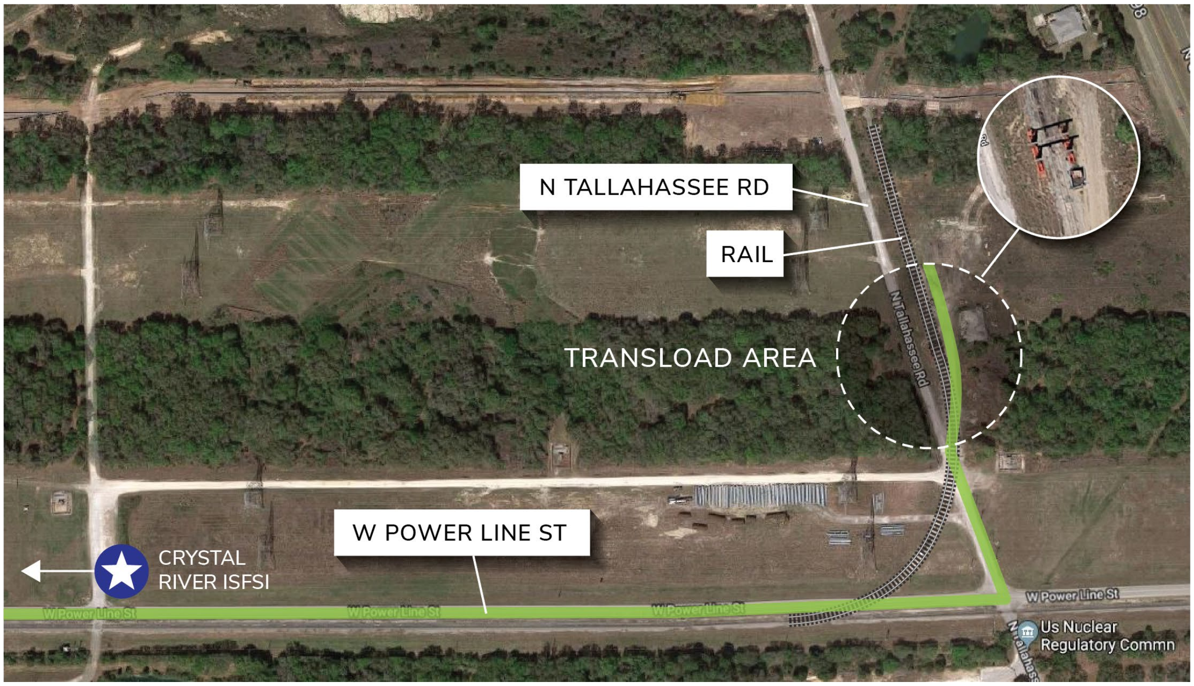


Figure 3-3: HHT Route to Dunnellon, FL Transload Site[8]

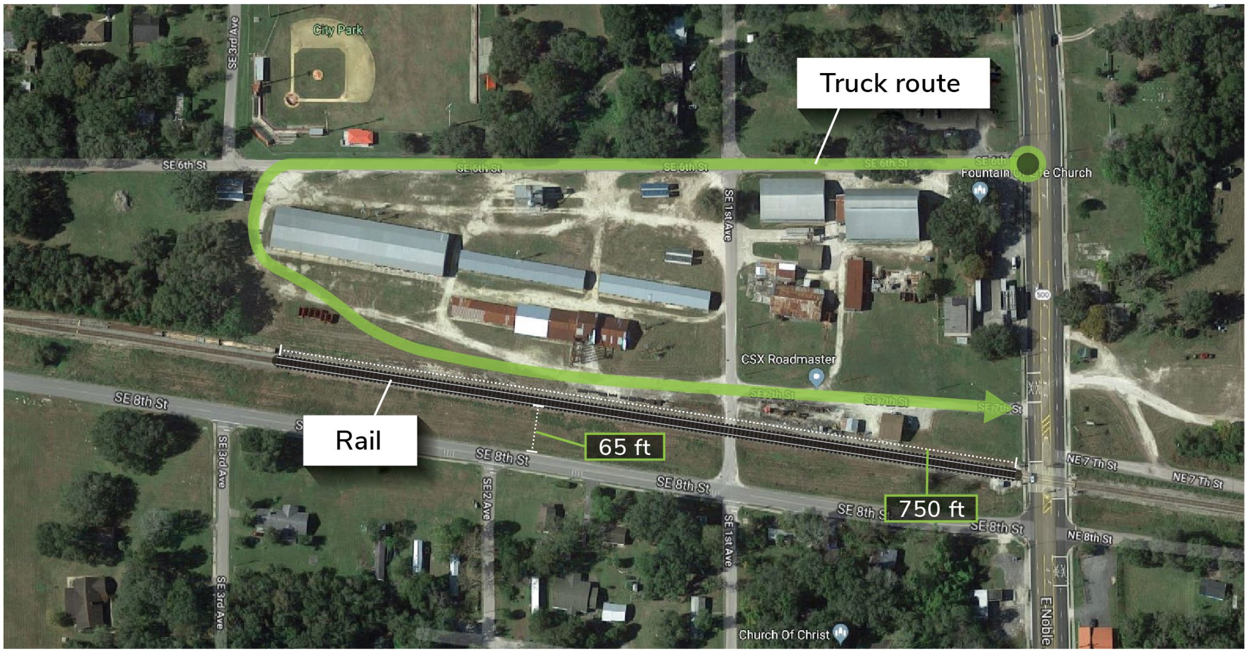
START indicates a 30-minute HHT travel time to reach the transload site. Once loaded, the train will proceed along the FNOR-Newberry, FL-CSX route to GCUS. START identifies the transit distance as 1,130 miles with an approximate transit time of 36.5 hours. This transload site has some restrictions in the configuration of the track, considering that this train consist will be composed of 12-axle cars which have a greater coupled length than shorter 4-axle or 8-axle cars. The limitation of not having access to both sides of the track will factor into operations and additional switching would be necessary to use this non-contiguous track. The site is not secure, but it could be fenced and lighted; though it would take more linear feet of fence to enclose this site than the alternate site on N. Tallahassee Road. The HHT access from E. McKinney Road onto the unimproved access road is of concern and the grade and composition of the road would need to be identified to determine if hazards would be posed to the HHT upon entry to the site.

Figure 3-4: Dunnellon, FL Transload Site[8]

Figure 3-5 shows another off-site option for transload operations near the plant, the Williston site. Unfortunately, this site has limited rail track and cannot load the entire consist without multiple switches. In addition, this site is not secure and too close to residential and public recreational areas.

The largest impediment to an off-site viable HHT truck route to rail transload is that the CR-3 site has ample rail track in excellent condition for loading the entire consist in the most efficient configuration, limiting excessive movement of the rail cars and avoiding additional switching. There are three very good options with ideal track configuration for loading the train on-site.

Figure 3-5: Track at Potential Loading Site in Williston[8]



3.2 Rail Routes

The CREC site is directly rail served by short line FNOR which is a Class II railroad owned and operated by the Pinsly group until November 2019. Pinsly sold the FNOR to Regional Rail LLC which retained the FNOR name. It interchanges with one Class I railroad, CSX Transportation in Newberry, FL, which is approximately 60 rail miles from the site. FNOR serves the CR-3 plant on a regular basis with inbound coal unit trains, loaded urea tank cars, and empty cars leaving from the plant.

The next closest Class I carrier is the Norfolk Southern in Jacksonville, FL, which is approximately 131 miles northeast of CR-3. There is no direct interchange between FNOR and Norfolk Southern (NS); an interchange with CSX would be required if NS were included in a rail route to GCUS. There are no other Class I carriers in the area and no other short lines with access to the plant or with suitable transload locations within close proximity to the plant. The Florida East Coast Railway (FEC) is the next closest short line operating on the east coast of Florida.

Table 3-2 lists the railroads in the geographic area.

Table 3-2: Class I and Class II Railroads Near CR-3

Railroad	Railroad Class	Notes
CSX Transportation	Class I Carrier	This is the only class one carrier that interchanges with the serving short line, FNOR.
Norfolk Southern Railroad	Class I Carrier	Interchanges with CSX in Jacksonville Florida

Railroad	Railroad Class	Notes
FNOR	Class II Carrier	Operates from Newberry to Red Level Junction, FL. Interchanges only with CSX at Newberry
FGA	Class III Carrier	CSX track sold to RailUSA in June 2019, former Panhandle route. Operates from Baldwin to Pensacola, FL.
FEC	Class II Carrier	Operates from Jacksonville to Miami, FL

There is extensive rail infrastructure on the plant site owned by DEF (**Figure 3-6**). In the past, the plant has regularly used the rail track to receive and hold unit trains of coal and loaded urea tank cars. The track has also recently been used to receive dimensional shipments including inbound HSM units and transformers in 2015.

The CREC site did not receive any coal unit trains in 2019. The coal has been coming into the plant by barge and being unloaded by conveyor at the CR-3 barge unloading dock. Since 2019, the plant received three to five carloads of inbound urea cars per month, arriving in blocks of two to three cars at a time. Currently (2022), the plant is receiving one coal unit train per week.

There is over 8,900 feet of private rail track located on the plant property. It is actively used and in good condition. There are multiple switches on site that are also operable and at least three run-around tracks.

Figure 3-6: Existing On-site Rail Tracks

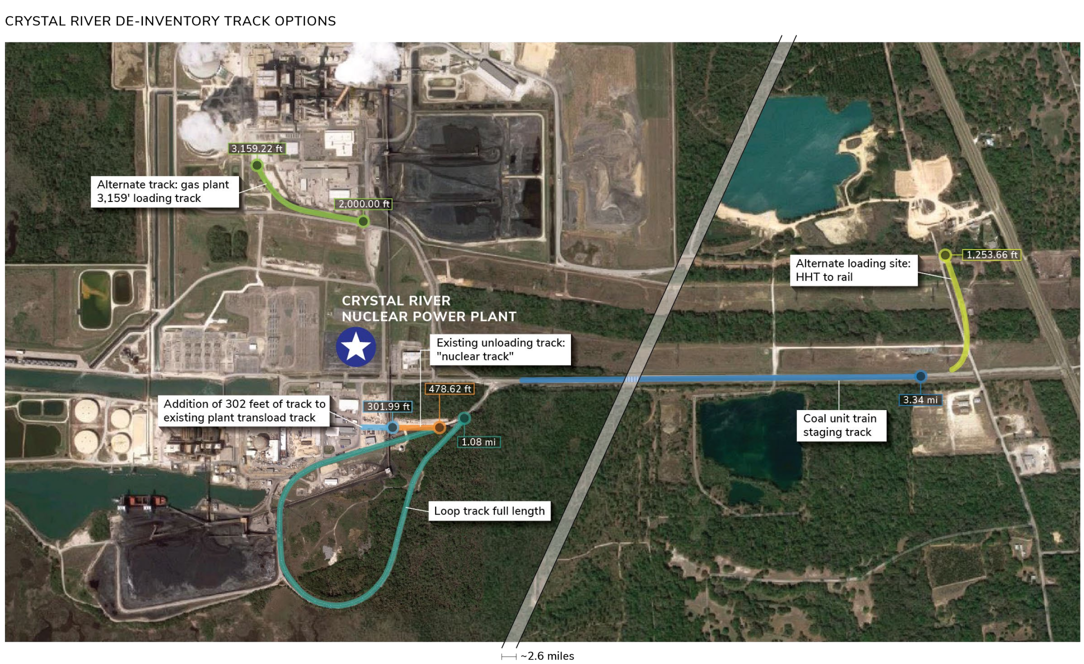
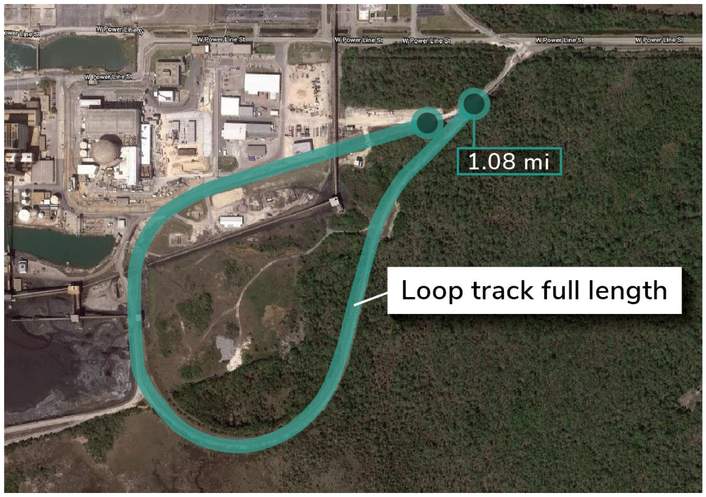


Figure 3-7: The Coal Loop Track



The most viable tracks for loading the train consist on site are listed below in order of preference.

1) <u>The Coal Loop Track (**Figure 3-7**)</u>: This track is the closest in proximity to the ISFSI. The portion of the track at the top of the loop closest to the ISFSI would be ideal for establishing a rail transload operation and is recommended as the best location for loading the train consist. The track is approximately 500 feet from the ISFSI gate. There is ample operating room for the transload operation as only 1,590 feet would be used for loading the train. In addition to having more than enough track to efficiently load the train, there is adequate room for the crane, and the turning radius is sufficient for the transfer trailer, other equipment, and crews. It is close to the ISFSI operation for added security purposes. A fence would need to be added to establish a rail secure site.

2) <u>The Urea Track (**Figure 3-8**)</u>: This track is recommended as the second choice for loading the train consist. It is a double track with 3,159 feet of usable rail track. A portion of the track is bordered by a flat lawn surface suitable for crane and equipment placement. There is easy access for the transfer trailer, although it is located a significant distance from the ISFSI (3,238 feet). The track is not secured by a fence. There is run-around capability.

3) <u>The Coal Staging Track (**Figure 3-9**)</u>: This track runs parallel to the access road leading to/from the plant, W. Power Line St., and encompasses two runaround tracks to allow the plant to hold a unit train (100 coal cars) outside of the plant while unloading another train on the coal loop track. The runarounds allow the short line access to the plant while the empty or loaded coal train is staged. It is approximately 3.35 miles in length. The track is not secured by a fence. This track is referred to in other parts of the report as the “Industrial Lead” and is the rail entrance to the plant.

4) <u>The "Nuclear Track" (**Figure 3-10**)</u>: This track is located perpendicular to the ISFSI and was recently extended from 478 feet long to 780 feet long. It has been used recently to unload dimensional cargo, including HSM components and transformers. The track is not long enough to efficiently load the train consist and would require building not only additional track, but also additional switching and blocking switches for other tracks on site. It may be possible to build track to the ISFSI, however, there is a substantial amount of usable track on site that could be utilized for a more efficient loading operation on the property.

Figure 3-8: The Urea Track

Figure 3-9: The Coal Staging Track

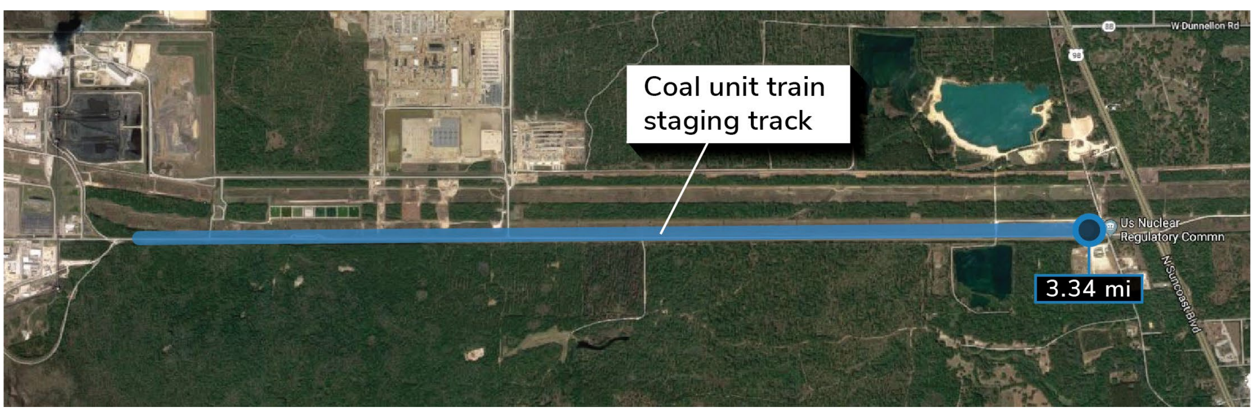


Figure 3-10: The Nuclear Track

Several rail direct routes were considered from the CR-3 site to GCUS as identified in **Table 3-3**. One of these routes is the FNOR-Newberry-CSX to GCUS. This route travels over the CSX Panhandle Route from Baldwin, FL heading west through Tallahassee, Pensacola, north through Montgomery, Birmingham, Nashville, to the GCUS. START identified this route as having a total of 1,147 miles with total rail transit time of 36.42 hours. This is a standard, direct route from the origin to the GCUS and it can accommodate dimensional cargo. The loaded train configuration has been cleared on this route. As a result of the June 2019 sale, this route has changed. It now includes one additional railroad, a Class III carrier, which increases the number of interchanges by two and total railroads in the route to GCUS to four. It also requires the Class I carrier to unnecessarily hand off the traffic to the Class III carrier and then resume handling it at a later point in the route. A more direct route is available that keeps the loaded train on the Class I railroad from Newberry to GCUS, which means only two railroads are in the route from the origin plant to GCUS. Details are described in **Section 3.3**.

An alternative rail direct route involved a route from CR-3 to GCUS via New Orleans, LA. START determined this route was 1,424 miles with a total transit time of approximately 38.76 hours. This route is not as direct as the recommended route and includes multiple rail carriers. START had difficulty keeping the train on the same rail line and it ended up traversing seven carriers. Realistically, the train would move over three carriers along this route to GCUS. This is not a standard route over which HAZMAT or dimensional traffic would move from this origin to GCUS.

Other identified direct rail routes involved additional rail carriers, additional rail miles, a circuitous route, increased transit time, additional interchanges, and additional cost for movement of the train to GCUS. These routes are identified in the **Table 3-3**.

Table 3-3: Potential Rail Routes to GCUS

Route Identification	Total Distance (Miles)	Total Travel Time (min/hrs)	Route Description	Challenges/Considerations
Rail through New Orleans and Memphis	1424	2326 / 39	Developed using START from expert rail route knowledge. Rail lines FNOR, CSX, and Canadian National (CN) only.	Potentially multiple carriers required beyond those identified here (including New Orleans Public Belt Railroad (NOPB), Burlington Northern Santa Fe Railway (BNSF), and Union Pacific (UP))
Rail through New Orleans and Memphis	1424	2326 / 39	Developed using START and Minimum Travel Time forcing to New Orleans as optional rail.	Rail line developed for CSXT to New Orleans, but included additional rail lines NS, NOPB, BNSF, and UP. Expert rail knowledge assessed that rail line CN could actually be used from New Orleans to GCUS and NOPB not utilized.
Rail through Waycross to Montgomery (***Alternate to FL Panhandle Route***)	1230	2068 / 34	Developed using START from expert rail route knowledge for alternate CSXT routes.	This route was developed using START from expert rail knowledge for an alternate CSXT route going from Newberry to Waycross as a result of the CSXT track sale. The sale was completed in June 2019.
Rail through Waycross north to Birmingham (***Alternate to FL Panhandle Route***)	1155	2071 / 35	Developed using START from expert rail route knowledge for alternate CSXT routes.	This route was developed using START from expert rail knowledge for an alternate CSXT route from Newberrry to Waycross to Birmingham as a result of CSXT track sale, which was completed in June 2019.
Rail through Birmingham and Nashville	1257	2186 / 36	START developed route using Minimum Population	This route utilizes multiple rail lines (FNOR, CSXT, NS, US Gypsum (USG), Paducah & Louisville Railway (PAL), Paducah & Illinois Railway (PI))
Rail through Montgomery, Birmingham and Nashville	1147	2185 / 36.42	Developed using START from expert rail route knowledge. Rail lines FNOR to CSXT only.	

3.3 Finalized Sale of Class I Track & Alternate Route

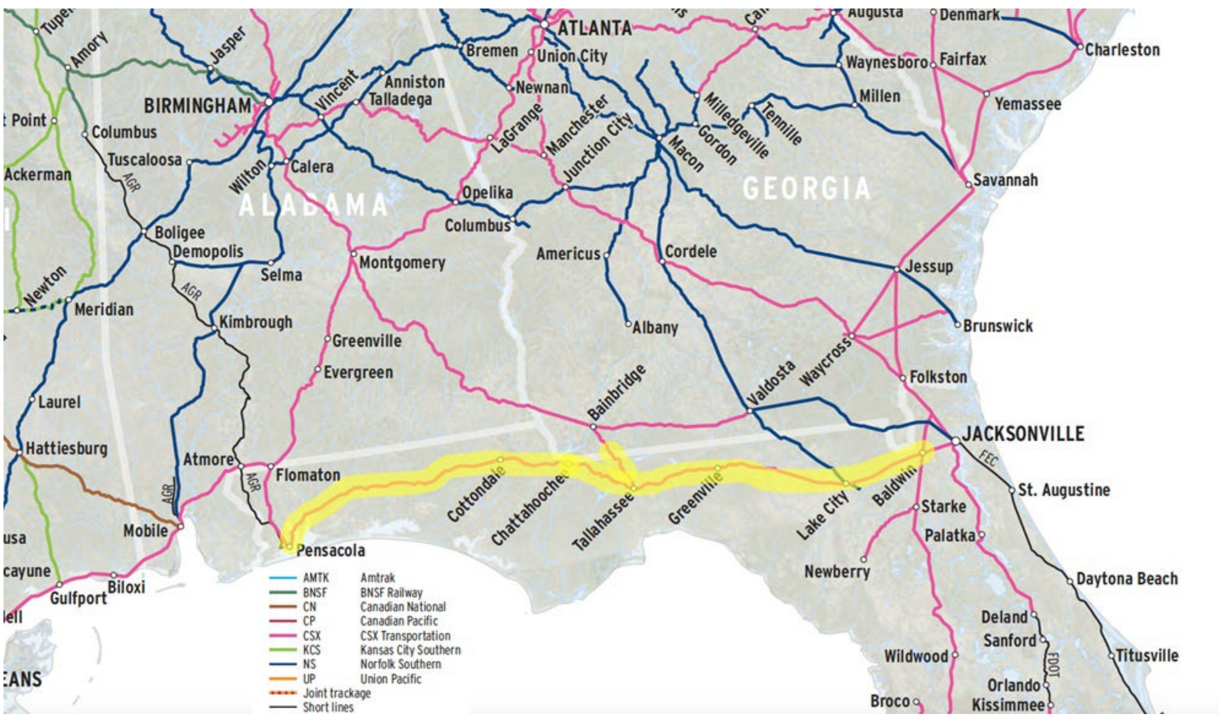
CSX Transportation sold a portion of the MUA identified track from Baldwin to Pensacola, FL formerly known as the Panhandle Route.

In a press release dated June 3, 2019, RailUSA acknowledged the sale had been completed on June 1, 2019. The new railroad is a Class III railroad called Florida Gulf & Atlantic Railroad (FGA). The track being sold includes the portion of track from Baldwin, FL to Pensacola, FL.

Figure 3-11 indicates the portion of the CSX track sold to RailUSA. Since the sale has been completed, the alternate recommended rail direct route to remain on a Class I carrier from CR-3 would still be FNOR-Newberry-CSX. The CSX portion of the route would be from Newberry, FL to Baldwin, FL, through Waycross, GA, Manchester, Birmingham, Nashville, Evansville, Vincennes, and onto GCUS[29].

CSX will maintain trackage rights over FGA for use in emergency situations, such as flooding or track washouts. Based on clearance routes, smaller dimensional traffic will now move via Waycross through Manchester. Wider dimensional loads may be required to move over a more circuitous route to the western interchanges. CR-3 loaded casks would move via Waycross.

Figure 3-11: CSX Announced Sale of Panhandle Route[29]



This adjusted, longer route was created in START so its values could be compared to the original route. The START data did not change substantially from the original Panhandle Route; although, as expected, the mileage increased slightly from 1,147 to 1,155. Despite this, the alternate route showed an estimated transit time of 34 hours, a few hours shorter than the original route.

For unknown reasons, there is a variance between estimated transit times provided by START and individual railroad transit schedules. In some cases, the difference is significant. For example, with the original recommended route of 1,144 miles, the railroad schedule predicts 5 days and 14 hours for the Class I and 10 hours for the short line. START identified the total rail transit time to be 36 hours. Once the sale was completed, additional transit time may be added to this route due to two additional interchanges between the Class I carrier and the FGA.

For purposes of the MUA, START transit times were used. For purposes of schedule development, transit times were based on actual dedicated train movements over the indicated routes.

3.4 Barge Routes

The CREC site has barge access to the Gulf of Mexico through the intake canal, as shown in **Figure 3-12**. There is a dock where coal is routinely received by barge and unloaded by conveyor belt. This location would not be ideal for loading casks because of the configuration of the dock, the conveyor, and the stockpiles of coal next to the dock, which would limit the ability of the transfer trailer to get close to the dock without impediment. In addition, a large crane could be required to lift the casks onto the barge.

Figure 3-12: CR-3 Barge Slip

The Shutdown Sites Report states approximately 20 barges per month, at a capacity of 20,000 tons each, were received and unloaded at this location[2]. In 2019 the plant received an increased number of inbound coal barges while simultaneously reducing the number of inbound unit trains of coal to zero, year-to-date.

Should sharing the dock be required, it would be difficult to design a loading campaign that would not impede and/or delay the receipt and unloading of the frequent inbound coal barges. At a minimum, it would be crucial to coordinate the use of the dock to avoid inference with either operation, which would result in added cost and inefficiencies if the barges were forced to wait, and delays with unloading the coal present a potential risk of shutting down the plant.

Just west of the barge dock is the barge turning basin which has been used frequently in the past to ground barges and roll-on/roll-off dimensional components. In May 2012, two Siemens Low

Pressure rotors and four inner casings were barged from Charleston, SC to CREC; the components were unloaded at this location by grounding the barge and rolling off the components, as shown in **Figure 3-13**. The route was conducted without stops and the barge remained within approximately 20 feet of the coastline for the duration of the trip to CREC until it entered the intake canal and was grounded for offload at the turning basin location[31].

The turning basin is located approximately 20 feet below the ISFSI. An existing paved road runs from the ISFSI to the barge area. The distance from the ISFSI is 4,558 feet. There is an undefined grade to this road. It is estimated that the transfer trailer would be able to traverse this road without incident with a prime mover or pusher. A goldhofer[3], however, would likely be needed to roll the casks onto the barge and set them on stands for transport.

Figure 3-13: Large Components Arriving at CR-3 by Barge[31]

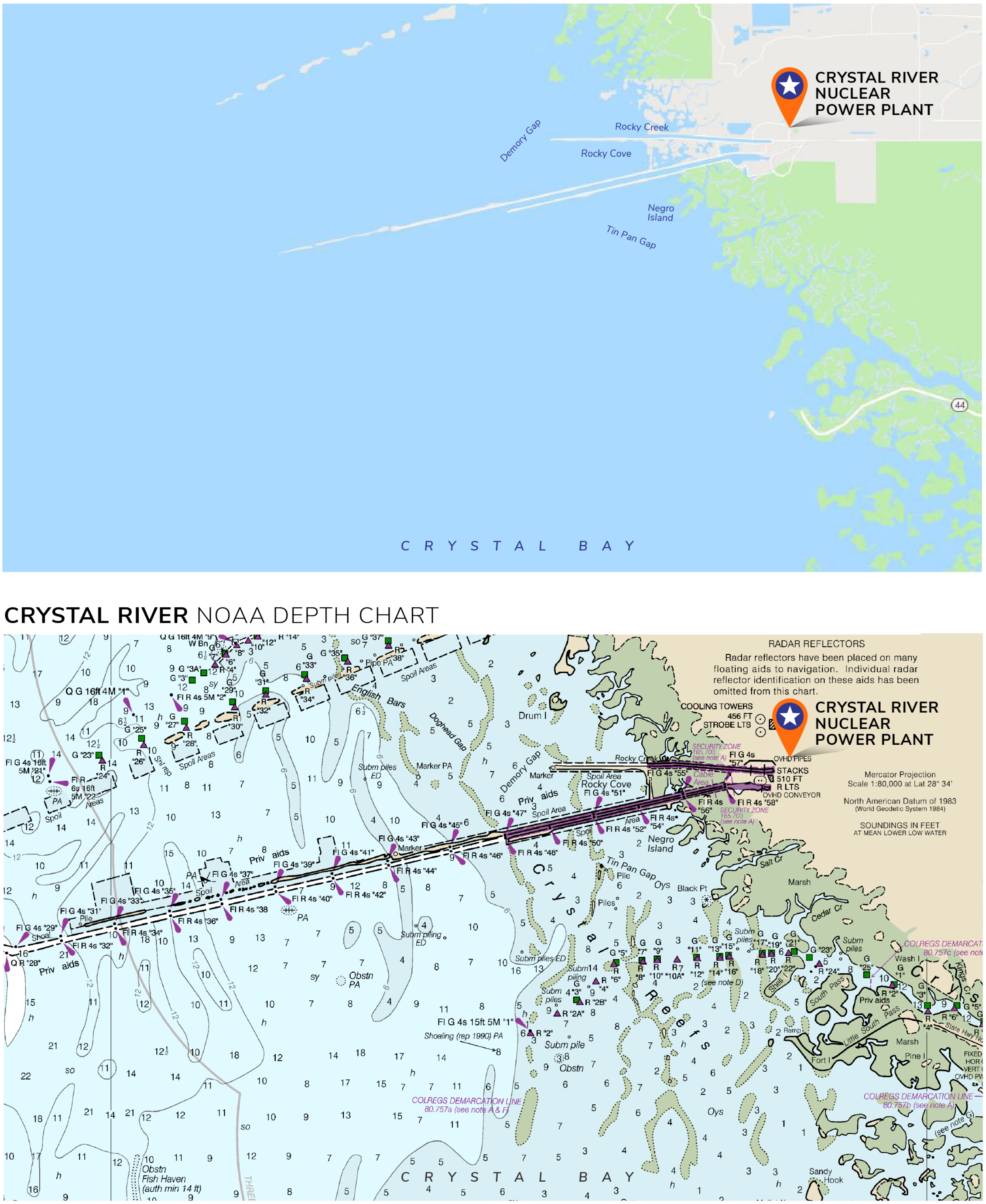
The Shutdown Sites Report indicates a depth of 20 feet is maintained to accommodate barge traffic in the intake canal[2]. However, according to the most recent NOAA depth chart for this area (dated April 19, 2019 and a July 5, 2022 corrected version valid through January 4, 2023), shown in **Figure 3-14**, the depth at and around the intake canal shows a level of only 4 to 6 feet, which is sufficient to conduct barge operations from the site for removal of the loaded casks.

Operations for a cask loading campaign would require grounding the barge, which is a common practice. No submerged barriers are shown on the NOAA maps, but there are sensitive environmental areas surrounding the outside of the intake canal. Although it appears there are no submersed barriers approaching the turning basin or coal dock, a physical site and marine survey must be conducted to ensure there are no submersed barriers approaching the turning basin that would prevent grounding the barge or obstacles on the site to prevent landing the barge.

[3] In this report, a goldhofer equates to a heavy-duty, self-propelled trailer/module.

The main weather conditions that may adversely affect outbound barge movements would be hurricanes, which are prominent in the Gulf of Mexico and in Florida, or winds in excess of 25 miles per hour.

Figure 3-14: CR-3 Barge Location and NOAA Depth Chart of the Vicinity[31]



As inbound barge shipments of dimensional components of similar weight and size to the loaded MP197HB cask have successfully been unloaded in the recent past and transported into the plant by goldhofer, there is no reason to assume this would not be a viable option regarding the infrastructure of the barge slip for outbound shipments. CREC has a portable ramp for use in loading the barges. All indications of prior barge shipments delivering dimensional components to CR-3 via the turning basin/barge unloading spot were successful and without incident.

Other barge loading sites were not considered as part of this evaluation because the site has direct barge access along with documented successful inbound shipments involving grounding the barge at the shoreline of the turning basin location. Several barge routes were identified for shipment of the loaded casks from CR-3 to a barge unloading site near GCUS, where the casks would be transloaded onto a train; these routes are given in **Table 3-4**.

Two of these routes involved moving through the Intercoastal Waterway (ICW), which is the practical operational route that a barge would take leaving from the CREC site. These two routes deviated only regarding their approach to the Mississippi River. One route traveled the Tombigbee River to reach the Mississippi River and the other route used the Port of New Orleans as an entry point into the lower Mississippi River. The other routes involved movement of the barge via the ship channel to New Orleans. This is not a practical operational route for barge movements from this origin site, as deep-sea faring vessels likely cannot reach the CREC barge site and hence would require access to the docks, which has already been identified as difficult to perform.

One viable barge route moves from CREC along the ICW to the Port of Mobile and then traveling north via the Tombigbee River to a location in the vicinity of East St. Louis, IL, where the casks could be transloaded onto rail for final movement to the GCUS. An unloading area was identified for barges taking this route with close proximity to GCUS. On this route the barge would maintain a distance of approximately 20 feet from the shoreline to the mouth of the Tombigbee River. Traveling north the barge will encounter 17 locks on the way to the upper Mississippi River. START identified the total water distance to be 1,408 miles and the route duration to be 202.10 hours (8.4 days).

An alternative barge route evaluated movement from CR-3 traveling along the ICW to the Port of New Orleans, LA and traveling north via the lower Mississippi River to the upper Mississippi to a location in the vicinity of East St. Louis, IL, where the casks could be transloaded onto rail for final movement to the GCUS. The barge will encounter 2 locks on the way to the upper Mississippi River. START identified the total water distance of 1,826 miles and 261 hours (10.9 days).

Another barge route traveled through the shipping channel entering Atchafalaya Bay to the Atchafalaya River to the Mississippi River to the Port of Memphis for transload onto train and final delivery to GCUS via rail. START results for the total distance of 1,568 miles going through one lock along the water route. The START transit time is 189 hours (7.9 days). START calculated the rail route to include three Class I railroads for the 300-mile rail portion of the movement, traveling through Tennessee, Arkansas, Missouri, and Illinois.

Table 3-4: Potential Barge Routes

Route Identification	Total Distance (Miles)	Total Travel Time (min/hrs)	Route Description	Challenges/Considerations
Barge from CR-3 ISFSI along the ICW to Mobile River near Port of Mobile	1,408	12126 / 202.1	From CR-3 ISFSI along the ICW to Mobile River near Port of Mobile then up Tombigbee R., Tennessee R., Ohio R., and Mississippi R. to GCUS	17 locks are found along the route.
Barge from CR-3 ISFSI along the ICW to New Orleans	1,826	15660 / 261	From CR-3 ISFSI along the ICW to New Orleans and then up the Mississippi River to GCUS	2 locks are found along the route
Barge to Atchafalaya Bay near Baton Rouge and up waterways to Memphis and Rail to GCUS	1568	11314 / 189	START route Barge to Rail; Minimum Population. Route goes through Deep Water Gulf of Mexico to Atchafalaya Bay / River through multiple waterways including Mississippi River to Memphis and transloads to rail to GCUS	This route is long in length and duration. In addition, questions surrounding depth of water in Florida Power channel that may make it unable to accommodate ocean vessel and transloading questions in Memphis.
Barge to Atchafalaya Bay to transload at Baton Rouge then Rail to GCUS	1130	6811 / 114	START route Barge to Rail; Minimum Distance. Route goes through Deep Water Gulf of Mexico to Atchafalaya Bay / River to Baton Rouge and transloads to rail then rail to GCUS	This route is long in length and duration. In addition, questions surrounding depth of water in Florida Power channel unable to accommodate ocean vessel and transloading questions in Baton Rouge plus multiple rail carriers are utilized.
Barge through Florida Panhandle ICW to Mobile Bay and transloads to Rail at Port of Mobile, then rail to GCUS	1365	5727 / 95	START route Barge to Rail; Minimum Distance. Route goes through Florida Panhandle ICW to Mobile Bay and transloads to Rail at Port of Mobile, then multiple rail lines to GCUS	This route is long in length and duration. In addition, questions surrounding transloads at Port of Mobile, then multiple rail lines to GCUS.

Route Identification	Total Distance (Miles)	Total Travel Time (min/hrs)	Route Description	Challenges/Considerations
Barge Only through Florida Panhandle ICW to Mobile Bay and up the Mississippi River to GCUS	1409	12126 / 202	START route Barge to GCUS; Minimum Travel Time. Route goes through Florida Panhandle ICW to Mobile Bay and up the Mississippi River to GCUS	This route is long in length and duration.

3.5 Barge Unloading Locations

Several options for potential barge unloading locations were identified in the vicinity of GCUS, however the majority of the barge slips in this area are privately owned and are not suitable for unloading breakbulk/dimensional commodities (like the cask). Interference with ongoing operations would need to be coordinated and permission obtained from the owner of the property/slip. Additional lifts will be required with a barge shipment from the site to the identified destination locations for loading onto rail. The additional lifts are critical lifts, add cost and time to the total transit. Only one docking location near the GCUS was found to be practical; it is shown in **Figure 3-15.**

The use of any existing barge slip or dock should be evaluated and a marine survey conducted to determine if there were any submerged conditions that would present complications to the operation. If a pier were used, its condition to hold the combined weight of the cask, cradle, and goldhofer would need to be evaluated. A pier or dock was not considered in either the loading or unloading operations for this barge campaign because of the congestion at CREC with receiving inbound coal barges/vessels and, no desirable piers within close proximity to rail tracks were available. If this barge unloading site were to be used, multiple train transloading locations are in the vicinity, as shown in **Table 3-5**. Note all the rail tracks for transload are within 2.1 miles of the barge receiving area.

Figure 3-15: Hoghaven Area for Barge Off-Load in the Vicinity of GCUS

Table 3-5: Possible Train Loading Locations Near GCUS Barge Site

Rail Transload Facility	Distance from Barge	Comments / Details
Intersection of Hog Haven Road & rail yard Sauget, IL 62201	1,333 ft	Portion of track inside rail yard Not secured by a fence Congested
Gavion 10 Pitzman Ave Sauget, IL 62201	2392 ft	1490' of private track
Lawn & Garden Midwest 3414 Hog Haven Road Sauget, IL 62201	1.09 miles	3,392' of track
Eastman Chemical Plant /Solutia 500 Monsanto Avenue Sauget, IL 62201	2.1 miles	Secure

3.6 Down-Selected Transportation Routes

Considering the large number of potential transportation routes identified in the previous sections, a set of screening criteria was developed and applied to down-select a small group of options considered to be viable for further investigation. This down-selection was based on comparing routes containing the same modes of transport (i.e., truck routes were not screened based on characteristics of barge routes). The result is that one or more routes are identified for each mode of transport to be evaluated by the MUA. The criteria utilized are as follows:

1. The time and/or distance to be traveled by the conveyance/barge would be significantly more than alternate viable routes without significant/substantial benefit.
2. Clearance limits on routes (e.g., through tunnels, around curves, or through heavily forested roads) are not met without significant/substantial upgrading.
3. Sustained travel on routes with steep grades.
4. Bridge(s)/overpass(s) to be used would not sustain weight of conveyance without significant/substantial upgrading.
5. Natural features make barge landings, overpack loading, etc. difficult to perform without significant/substantial upgrading or infrastructure development.
6. No available loading facility or insufficient track for performing loading of a full consist.
7. Transload and/or port facility does not permit receipt of Class 7 materials.
8. Number of interchanges between carriers.
9. Avoidance of high-density transit areas (i.e., regions with significant rail traffic) that would require interruption of traffic if shipment were to transit region.
10. Characteristics of HHT that would require preapproval for Highway Route Controlled Quantity (HRCQ) shipments.[4]

Some of the potential transportation routes had unique characteristics that did not correlate with any of the ten listed criteria above. These characteristics greatly reduced the viability of the transportation route; therefore, an 11th category, "Other", was added to the screening criteria so that the unique criterion could be captured.

The above criteria was applied to a number of potential routes so as to screen out the least desirable before being assessed in the MUA process. After applying the above screening criteria (see **Table 3-6**), a total of six possible routes were identified and are included for further evaluation in the MUA (**Section 5.0**):

1. HHT from CR-3 ISFSI to the FNOR property located at the intersection of W. Power Line St. and N. Tallahassee Rd. in Crystal River, Florida and transload onto rail to GCUS on FNOR and CSX rail lines (i.e., referred to as "A. HHT to FNOR Rail" route in the MUA; see **Figure 3-16**).

[4] For routes where HRCQ applies, screening may occur due to the more restrictive requirements of NRC approval of such a route and its associated requirements for armed security, disabling devices, secure communication, HAZMAT bill of laden, safe haven identification, safe-secure shipments, emergency response planning, etc.

2. HHT from CR-3 ISFSI to 19810 SW 110th St., Dunnellon, Florida and transload onto rail to GCUS on FNOR and CSX rail lines (i.e., referred to as "B. HHT to Dunnellon to FNOR Rail" route in the MUA; see **Figure 3-17**).
3. Rail directly from the CR-3 site on the loop track to GCUS on FNOR and CSX rail lines via Florida (Newberry & Tallahassee), Georgia, Alabama (Montgomery & Birmingham), Tennessee (Nashville), and Kentucky (i.e., referred to as "C. Rail from CR-3 to GCUS via FNOR & CSX" route in the MUA; see **Figure 3-18**).
4. Rail directly from the CR-3 site on the loop track to GCUS on FNOR (to Newberry, Fl.), on CSX (to New Orleans Terminal Back Belt Line) then on Norfolk Southern (NS), Canadian National (CN), and New Orleans Public Belt Railroad (NOPB) (to Memphis) and finally on Burlington Northern Santa Fe Railway (BNSF) and Union Pacific (UP) to GCUS (i.e., referred to as "D. Rail from CR-3 to GCUS via New Orleans" route in the MUA; see **Figure 3-19**).
5. Barge from CR-3 ISFSI along the ICW to Mobile River near Port of Mobile then up the Tombigbee River, Tennessee River, Ohio River, and Mississippi River to GCUS (i.e., referred to as "E. Barge via ICW to Mobile/Tombigbee River to GCUS" route in the MUA; see **Figure 3-20**).
6. Barge from CR-3 ISFSI along the ICW to New Orleans and then up the Mississippi River to GCUS (i.e., referred to as "F. Barge via ICW to New Orleans/Mississippi to GCUS" route in the MUA; see **Figure 3-21**).

Table 3-6: Routes Versus Screening Criteria

Route	1	2	3	4	5	6	7	8	9	10	Other
HHT to FNOR Track at intersection of W. Power Line St. and N. Tallahassee Rd. in Crystal River, Florida											
HHT to 19810 SW 110th St., Dunnellon, Florida											
HHT to Williston Pipe Track SE 1st & SE 8th Streets, Williston, Florida						X					Potentially difficult for HHT to turn into and near houses and baseball field
HHT to 4000 NW County Road 235, Newberry, Florida						X					Interferes with private business
HHT to Access Rd. Intersection with FNOR						X		X			
HHT to Newberry, FL						X					
HHT to sites further East of Newberry, Florida	X										
HHT to sites South of Crystal River Site	X										
HHT to sites North of Crystal River Site	X										
Direct Rail (loading on coal loop track) using FNOR and CSX via Montgomery											
Direct Rail (loading on urea track) using FNOR and CSX via Montgomery											Potentially limiting site access during loading, not within security fence, and further from ISFSI then coal loop

Route	1	2	3	4	5	6	7	8	9	10	Other
Direct Rail (loading on coal staging track) using FNOR and CSX via Montgomery											Potentially limiting site access during loading, not within security fence, and further from ISFSI then coal loop
Direct Rail (loading on the "nuclear track") using FNOR and CSX via Montgomery						X					Potentially limiting site access during loading
Direct Rail (loading on coal loop track) using FNOR, CSX, and CN via New Orleans											
Direct Rail (loading on urea track) using FNOR, CSX, and CN via New Orleans											Potentially limiting site access during loading, not within security fence, and further from ISFSI then coal loop
Direct Rail (loading on coal staging track) using FNOR, CSX, and CN via New Orleans											Potentially limiting site access during loading, not within security fence, and further from ISFSI then coal loop
Direct Rail (loading on the "nuclear track") using FNOR, CSX, and CN via New Orleans						X					Potentially limiting site access during loading
Direct Rail (loading on site track) using FNOR, CSX, CN, NS, NOPB, BNSF, and UP via New Orleans	X					X		X			
Direct Rail (loading on site track) using FNOR and CSX via Waycross to Montgomery	X					X					
Direct Rail (loading on site track) using FNOR and CSX via Waycross to Birmingham	X					X					
Direct Rail (loading on-site track) using FNOR, CSXT, NS, USG, PAL, and PI via Birmingham	X					X		X			
Direct Barge (loading on coal dock) up ICW and up Tombigbee River					X	X					Coal routinely received at this dock and hence will interrupt plant operations and difficult to get truck and trailer to dock

Route	1	2	3	4	5	6	7	8	9	10	Other
Direct Barge (roll-on/roll-off grounding location at turning basin) up ICW and up Tombigbee River											
Direct Barge (roll-on/roll-off grounding location at turning basin) up ICW and up Mississippi River											
Direct Barge (roll-on/roll-off grounding location at turning basin) through the Gulf of Mexico and up Tombigbee River											Barge in Gulf of Mexico was deemed unacceptable due to vulnerability to poor weather
Direct Barge (roll-on/roll-off grounding location at turning basin) through the Gulf of Mexico and up Mississippi River											Barge in Gulf of Mexico was deemed unacceptable due to vulnerability to poor weather
Direct Barge (roll-on/roll-off grounding location at turning basin) up ICW to Mobile Bay and transload to rail at Port of Mobile then rail to GCUS	X							X			
Direct Ship (Ocean going vessel) through the Gulf of Mexico to transload site					X						No direct loading site for ship on CR-3 site and ship cannot go up Tombigbee or Mississippi rivers

Note: The highlighted rows indicate routes that have not been screened out and will be further analyzed in the MUA in **Section 5.0**.

Screening Criteria Legend:

1. The time and/or distance to be traveled by the conveyance/barge will be significantly in excess.
2. Clearance limits on routes.
3. Sustained travel on routes with steep grades.
4. Bridge(s)/overpass(s) weight limitation.
5. Natural features make barge landings, overpack loading, etc., difficult.
6. No available loading facility or insufficient track for performing loading of a full consist.
7. Transloading and/or port facility does not permit receipt of Class 7 materials.
8. Number of interchanges between carriers.
9. Avoidance of high-density transit areas.
10. Characteristics of HHT Requiring Preapproval for HRCQ Shipments.

Figure 3-16: A. HHT to FNOR Rail

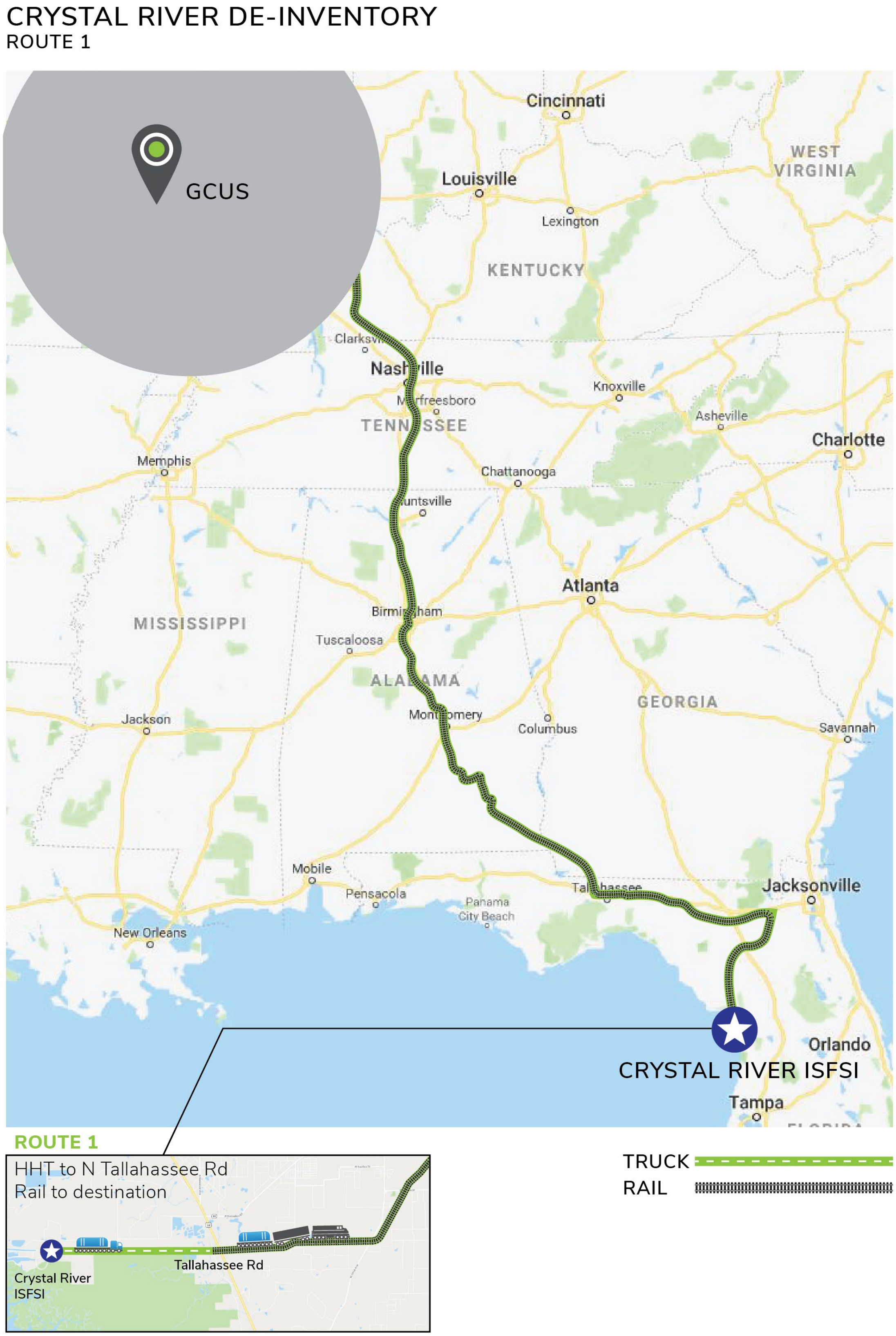


Figure 3-17: B. HHT to Dunnellon to FNOR Rail

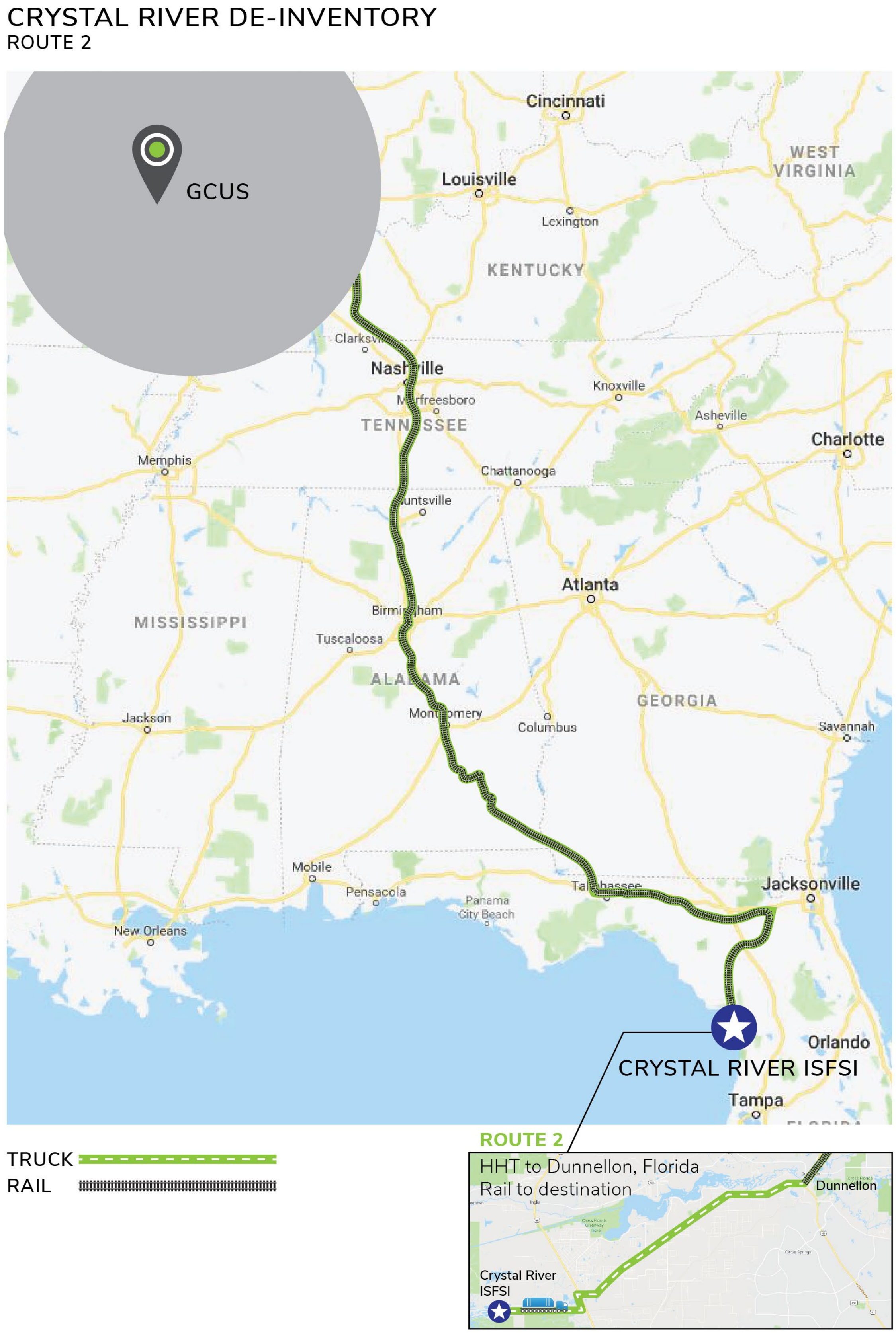


Figure 3-18: C. Rail from CR-3 to GCUS via FNOR & CSX

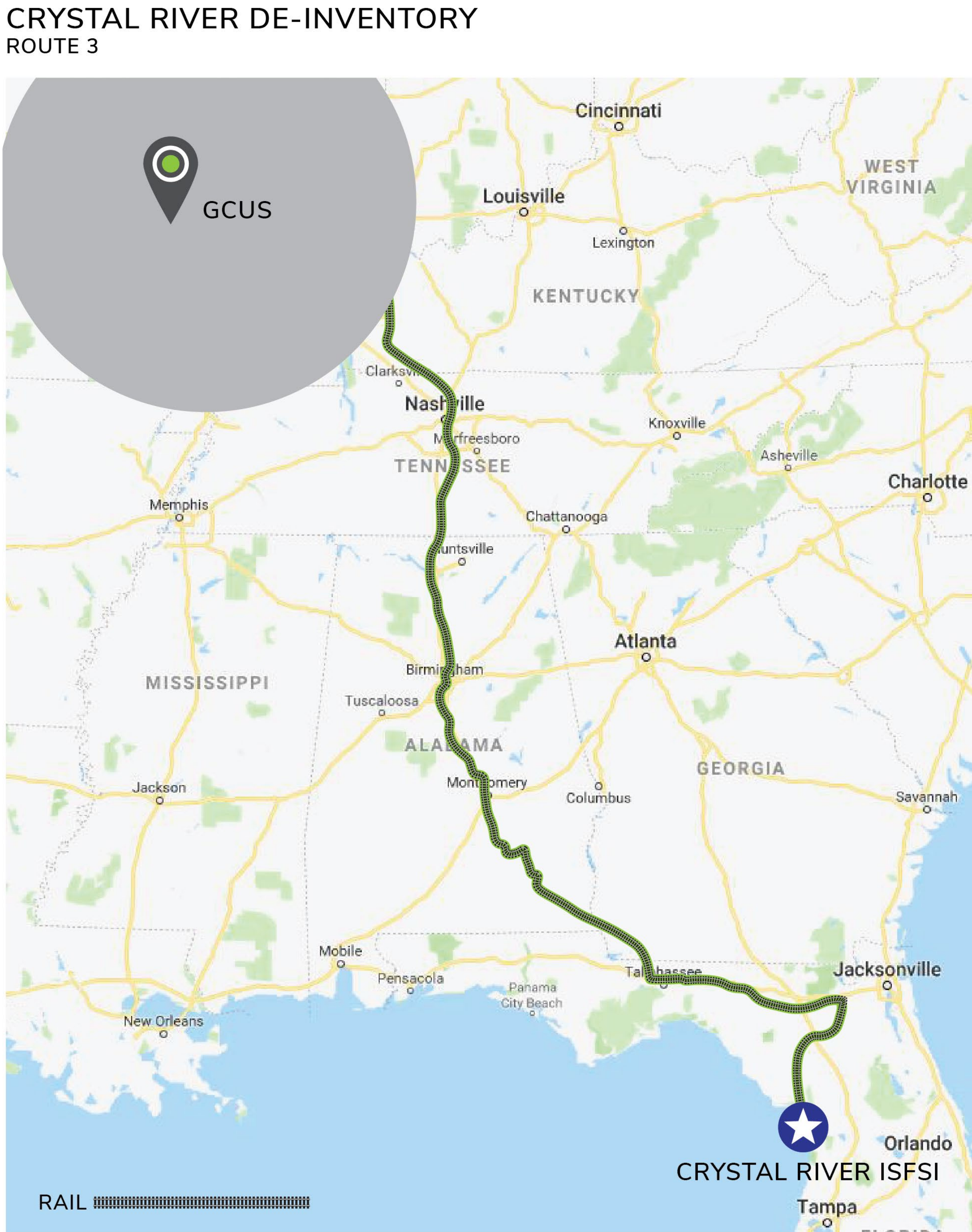


Figure 3-19: Rail from CR-3 to GCUS via New Orleans

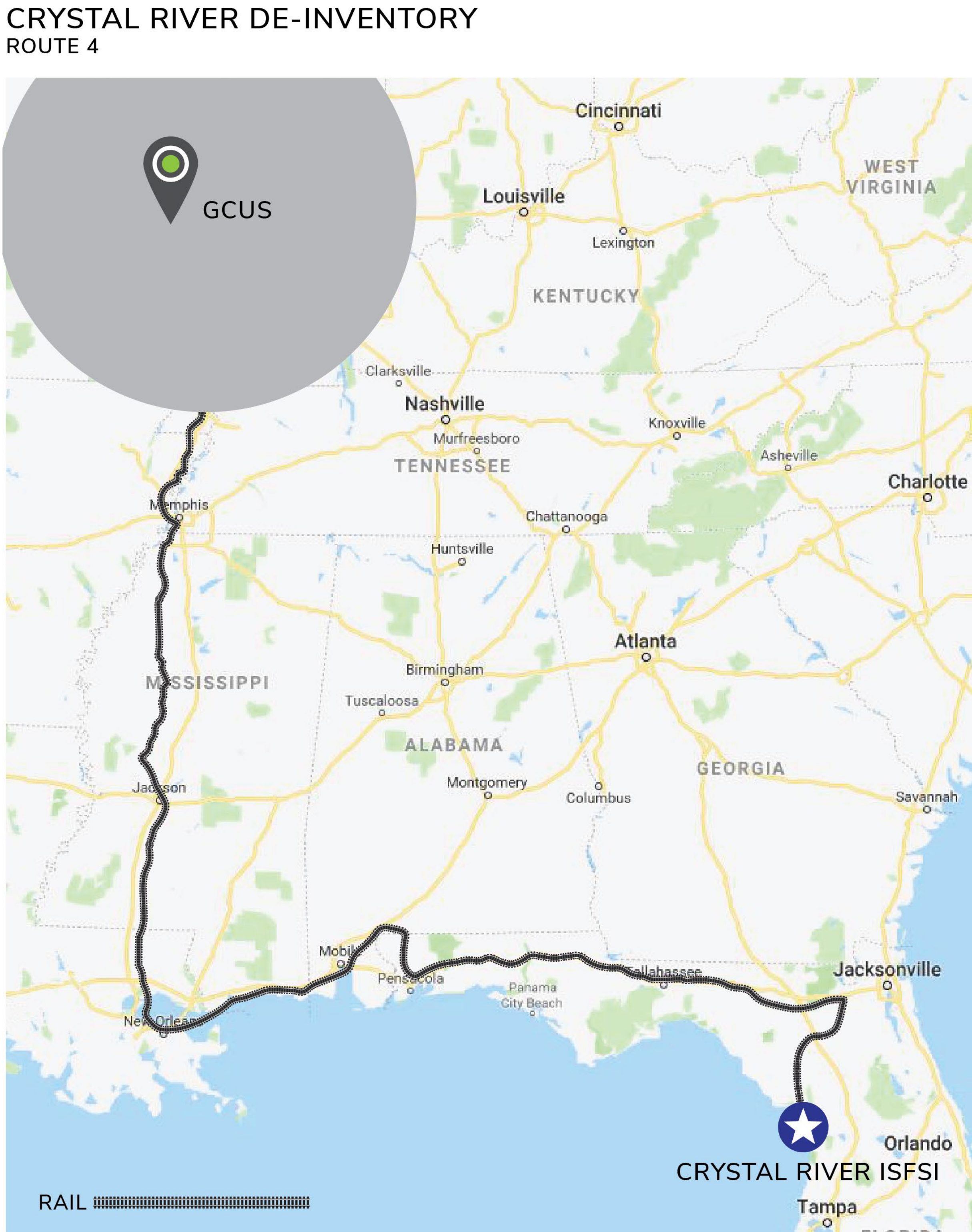


Figure 3-20: Barge via ICW to Mobile/Tombigbee River to GCUS

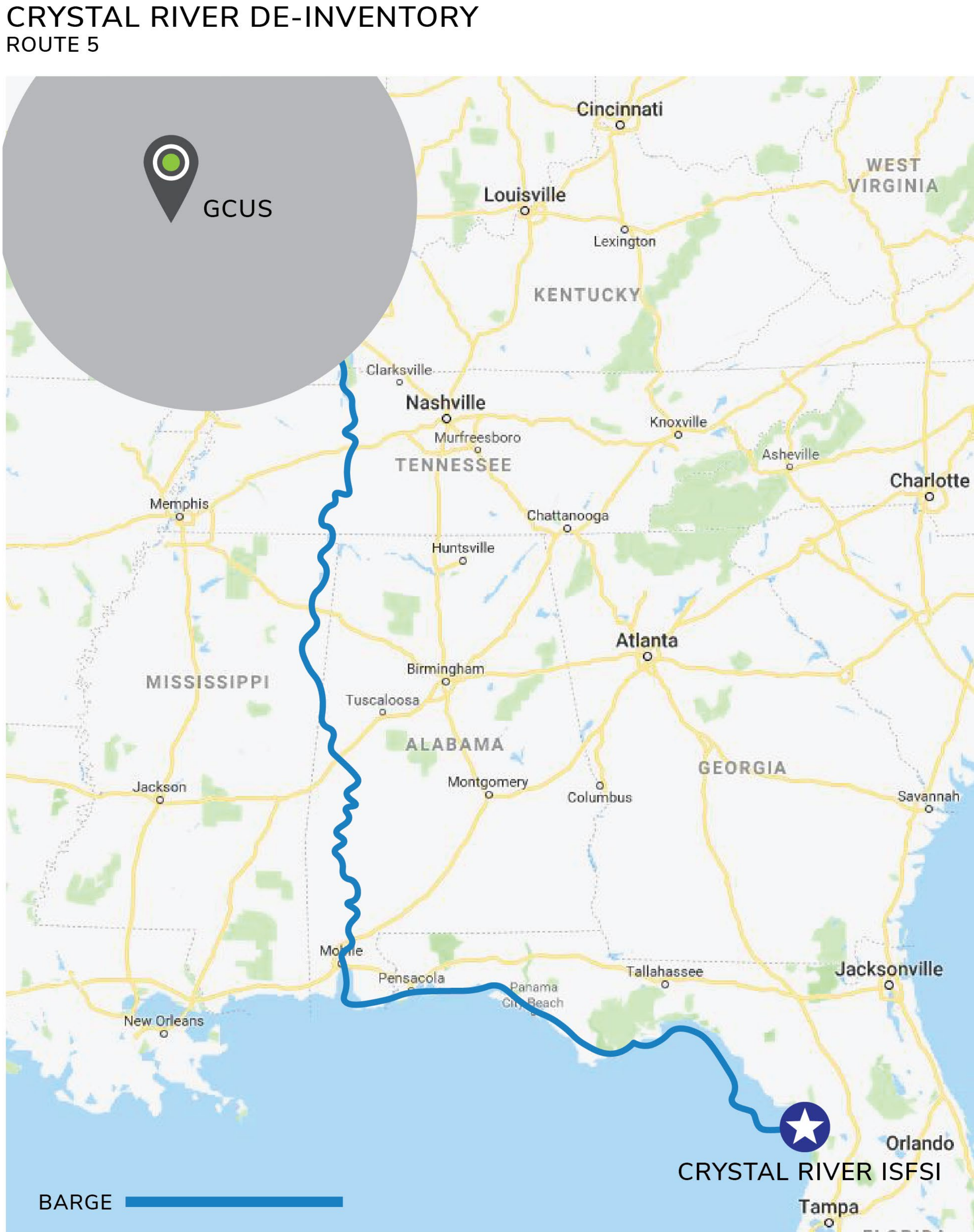
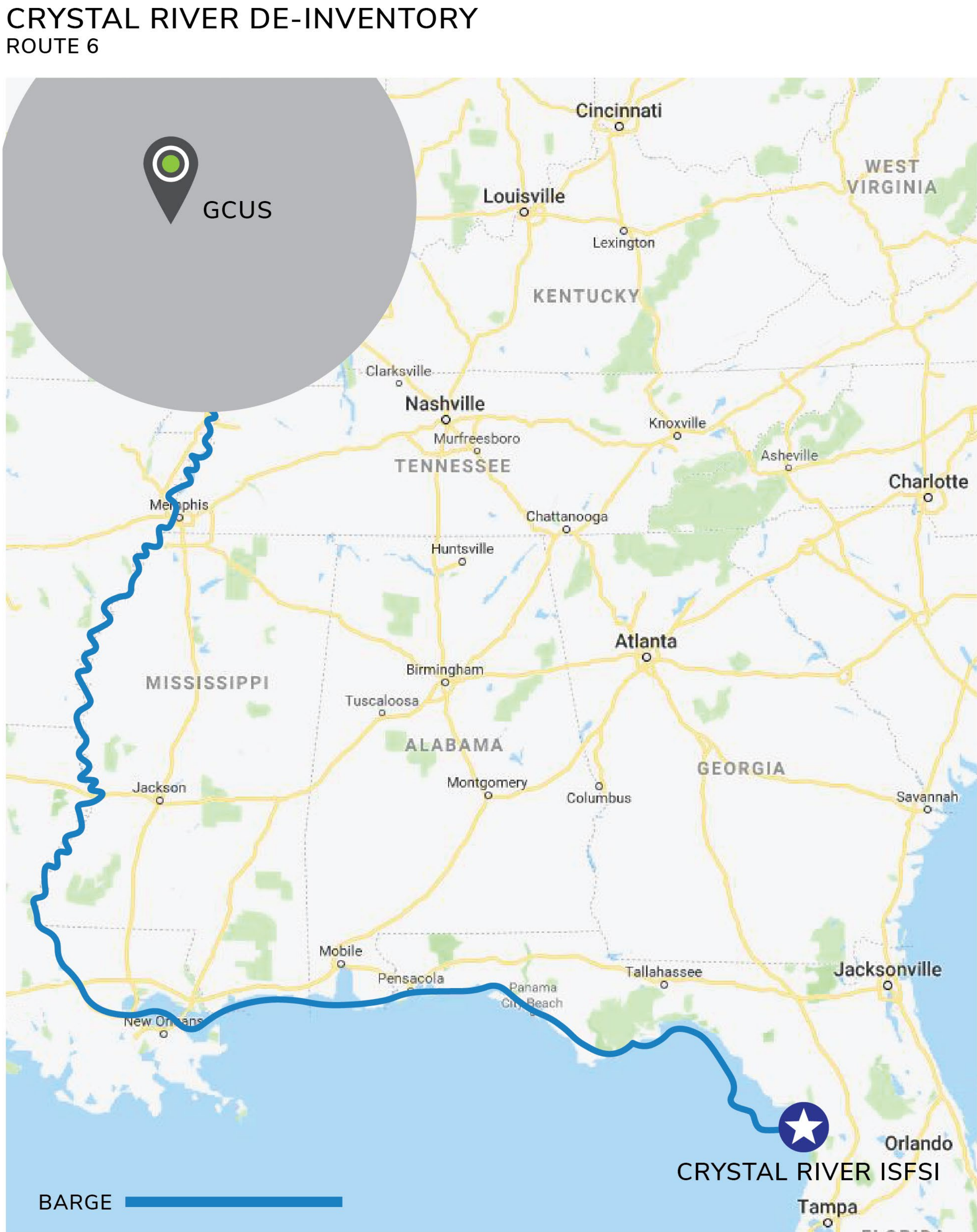


Figure 3-21: Barge via ICW to New Orleans/Mississippi to GCUS



4.0 PARTICIPATING ENTITIES

This section identifies participating entities/persons this report assumed would be involved in the overall de-inventory implementation for the CR-3 ISFSI and summarizes some aspects of their potential roles. By providing this information, which is current as of the date of this report but can be out of date with new events (e.g., elections), an initial means for identifying these entities/persons in the future is considered to be provided.

Various federal agencies would have regulatory authority over the types of shipments of SNF and GTCC contemplated by this report. This report assumes that DOE would be responsible for a federal consolidated interim storage facility or geological repository to which the material would be shipped from the nuclear power plant site and that DOE would be the shipper. DOE has broad authority under the Atomic Energy Act of 1954, as amended (AEA), to regulate activities involving radioactive materials undertaken by DOE or on its behalf, including transportation of radioactive materials. However, in most cases not involving national security, DOE typically uses commercial carriers for its shipments and does not exercise its AEA authority. The DOT and the NRC jointly regulate commercial transportation of radioactive materials in the United States. Most DOE radioactive materials shipments are typically transported by commercial carriers and are subject to regulation by DOT and NRC, as appropriate.

Assuming DOE would use commercial carriers to conduct the shipments, regulatory authority over the shipments can be summarized as follows. In general, DOT would regulate the areas identified in the Memorandum of Understanding between the NRC and the DOT,[5] including package and conveyance radiological controls, routing, hazard communication, and carrier training. Assuming DOE takes custody of the material at the nuclear power plant site, DOE would have authority to regulate other aspects of the shipments (e.g., physical security), except as otherwise required by law.[6] Even where DOE does exercise its AEA authority over its shipments, DOE's general policy is that all DOE shipments must be conducted in a manner that achieves an equivalent level of safety and security to that required by DOT and NRC for comparable commercial shipments. For purposes of this report, it is assumed that the shipments to de-inventory the site would be conducted like typical commercial shipments in accordance with DOT and NRC regulatory requirements.[7]

In addition to the federal agencies described above, participating entities and persons expected to be involved in the de-inventory of the site would include:

- Utility employees;

---

[5] Memorandum of Understanding, Transportation of Radioactive Materials, 44 Fed. Reg. 38690 (July 2, 1979).

[6] For example, one such exception is the requirement in Section 180(a) of the Nuclear Waste Policy Act of 1982, as amended (NWPA), which requires DOE to use casks certified by the NRC for NWPA shipments. In addition, Section 180(b) of the NWPA requires DOE to follow the NRC regulations on providing advance notification of shipments to jurisdictions through which the shipments will be transported. For further discussion, see letter from Chairman Richard A. Meserve, Nuclear Regulatory Commission, to Senator Richard J. Durbin (May 10, 2002), https://www.nrc.gov/docs/ML0210/ML021060662.pdf.

[7] Although this report assumes that DOE would be the responsible entity for a consolidated interim storage facility or geological repository, this report also recognizes that if a separate management and disposal organization were to be responsible for such a facility some aspects of the regulatory regime for the shipments could differ from that which would apply if DOE were the responsible entity.

- Subcontractors: crane suppliers, riggers, etc.;
- Transportation personnel: truck operator, rail carrier, barge transportation operator, private escorts for dimensional loads, State Police or Local Law Enforcement Agency (LLEA);
- Cask suppliers;
- U.S. Coast Guard (USCG) (if a marine mode of transport is used, or if the rail transload facility is located on or adjacent to water);
- Security personnel;
- Communication personnel associated with participating entities (e.g., local authorities, escorts, etc.) needed for advance notification of shipments as required by 10 CFR 73.37, 10 CFR 71.97, and as recommended in NUREG-0561 Revision 2[32];
- TRANSCOM or similar satellite and associated continuous in-transit communication service provider(s); and
- Transportation emergency responders.

The participating entities/persons can be categorized into the functional groups identified in **Table 4-1**. An evaluation of tribal entities that might be impacted during de-inventory operations was performed, and none were identified within the transportation routes analyzed for this report. The Seminole Nation of Florida's Reservation is located near the city of Tampa, but it would not be affected by either the rail route or a HHT route to any of the identified transload sites outside of the CR-3 plant site.

Table 4-1: Participating Entity Functional Identification

Function Group	Entity/Persons
Site	Site Management
	Safety
	Quality
	Document Control
	Security
	Craft support
	Support functions
Transportation	Transportation Supervision
	Equipment Operator (driver)
	Security

Function Group	Entity/Persons
	Shipment Response/Tracking
	Support Functions
Rail Transload Facility	Operations Supervisor
	Security
	Craft Support
	Shipment Response/Tracking
	Quality
Authorities	DOE
	State
	Local
	Federal Railroad Administration (FRA)
	U.S. Coast Guard (USCG)
	U.S. Transportation Security Administration (TSA)
	NRC
	DOT
	Pipeline and Hazardous Materials Safety Administration (PHMSA)

Per NRC's regulation 10 CFR 71.97 "Advance notification of shipment of irradiated reactor fuel and nuclear waste," the following would be required:

> (a)(1) As specified in paragraphs (b), (c), and (d) of this section, each licensee shall provide advance notification to the governor of a State, or the governor's designee, of the shipment of licensed material, within or across the boundary of the State, before the transport, or delivery to a carrier, for transport, of licensed material outside the confines of the licensee's plant or other place of use or storage.

(2) As specified in paragraphs (b), (c), and (d) of this section, after June 11, 2013, each licensee shall provide advance notification to the Tribal official of participating Tribes referenced in paragraph (c)(3)(iii) of this section, or the official's designee, of the shipment of licensed material, within or across the boundary of the Tribe's reservation, before the transport, or delivery to a carrier, for transport, of licensed material outside the confines of the licensee's plant or other place of use or storage.

Similarly, NRC regulations in 10 CFR 73.37 and guidance in NUREG-0561 address the provision of advance notification of shipments to States and Tribes as well as other aspects of shipment coordination and communication with participating entities. Therefore, notification of governing authorities is required to coordinate transport in an actual de-inventory campaign. For transport of radioactive material[32], the government agencies listed in **Table 4-1** ("Authorities") issue regulations concerning the packaging and transport of radioactive materials.

Listed below is contact information for some of the relevant state (Florida) government authorities, a U.S. Coast Guard point of contact for the area, and transportation services for the various modes of transport anticipated. During the development of this report, most information was obtained through public domain. In preparation for an actual de-inventory campaign, this contact information would need to be updated with current information closer to the time of shipments, as coordination and communication with appropriate participating entities would be instrumental in the execution of the shipments.

Florida - Office of the Governor

Listed below is the contact information for the Florida Governor's Office:

https://www.flgov.com
Florida Governor Ron DeSantis

400 S Monroe St

Tallahassee, FL 32399

(850) 488-7146

Florida - Governor's Designee for Notification of SNF Shipments

Listed below is the contact information for the Florida Governor's designee for notification of SNF shipments:

John A. Williamson

Environmental Administrator Bureau of Radiation Control Environmental Radiation Program Department of Health

P.O. Box 680069 Orlando, FL 32868-0069

Phone: (407) 297-2096 x212

Mobile phone: (850) 528-4151

24-hour phone: (407) 297-2095

Fax: (407) 297-2085

E-mail: John.Williamson@flhealth.gov

Florida - Department of Transportation (FDOT)

Listed below is the contact information for the Florida DOT:

Kevin J. Thibault, P.E. (Secretary)

Florida Department of Transportation

605 Suwannee Street

Tallahassee, Florida 32399-0450

Telephone: 850-414-4100

https://www.fdot.gov/home

The Oversize-Overweight Permits Unit issues permits for oversize/overweight loads to travel on state and federal highways. If transportation is to occur on public roadways, outside of the site, more information, contact:

Florida Department of Transportation

Commercial Vehicle Operations Manager

605 Suwannee Street

Tallahassee, FL 32399

Phone: 850-410-5555

Fax: 850-410-5601

United States Coast Guard

CR-3 and the selected transload site are both located along Crystal River. The Double Barrel Creek, Rocky Creek, Crystal River and Crystal Bay are adjacent to the CR-3 plant and transload site. These bodies of water provide potential access to the plant and are under the supervision of the Seventh District Command Center Number: (305) 415-6800 of the USCG.

Captain Nicholas R. Simmons

155 Columbia Dr, Tampa, FL 33606

Phone: (757) 483-8710

Site Management Provider

Phyllis Dixon

ISFSI Manager

Orano NPS

352-224-1200 x2953

Phyllis.Dixon@orano.group

Holly Van Sicklen

ISFSI Licensing Manager

Orano NPS

352-224-1200 x2989

Holly.Van-Sicklen@orano.group

Craig Miller

ISFSI Operation and Maintenance Manager

Orano NPS

352-224-1200 x2969

Craig.Miller@orano.group

Heavy-Haul Transportation Service Providers

Sims Crane & Rental

1604 NW 38th Avenue

Ocala, FL 34482

352-247-7882

M-F 6 AM to 6 PM

Florida Division of Emergency Management

2555 Shumard Oak Boulevard

Tallahassee, Florida 32399-2100

850-815-4000

Email: FDEM.STO@em.myflorida.com

Railroad Transportation Contacts

FNOR

Mark Meyer, Director of Marketing & Sales

Florida Central Railroad
O: 407.880.8500 x 1102
M: 407.340.9509
Email: mmeyer@fcrr.com

Railroad Operations

Matt Schwerin, General Manager
O: 407-880-8500
Email: mschwerin@fcrr.com

Barge Operators

Although barge is not recommended for this project; if used, refer to the contact below:

Bos Smith

Stevens Towing Company

4170 Highway 165
Yonges Island
SC 29449 | USA

Phone: (843) 889-2254

Cask Supplier

Listed below is the contact information for suppliers of the transport casks and related equipment discussed in this report.

TN Americas LLC

https://www.orano.group/en/expertise/facilities/service-and-engineering-activities/nuclear-packages-and-services-sites

Roger Maggi

Sales & Marketing

Orano TN

410-910-6872

Roger.Maggi@orano.group

5.0 MULTI-ATTRIBUTE UTILITY ANALYSIS

As noted in **Section 3.0**, there are several potential routes for shipping the NUHOMS 32PTH1s from the CR-3 ISFSI to a railcar on a Class I railroad that can take these NUHOMS 32PTH1s to their penultimate or ultimate destination (i.e., a consolidated interim storage site or a repository, respectively). The diversity of these routes reflects the multiple viable approaches to shipping the NUHOMS 32PTH1s (i.e., by direct rail, HHT, or barge), and the access of CR-3 to these modes of transport. Furthermore, these routes potentially have both positive attributes (e.g., safe and secure transport) and negative attributes (e.g., expense) meriting an assessment approach that can evaluate these attributes in a combined manner that may distinguish one route from another and/or rank and prioritize routes.

The MUA is a structured methodology designed to handle the trade-offs among multiple objectives (e.g., attributes). The MUA provides a transparent, rational, and defensible analysis that is easy to communicate. MUA methods have been used for decades to provide logically consistent analyses of options (i.e., modes and routes) that are intended to achieve more than one objective, where no single option dominates the others on all objectives. Utility theory is a systematic approach for quantifying an individual's or team of individuals' ratings/preferences (*note: when "preference" is used together with "route" there is a specific connotation not intended to be covered in this analysis, thus "rating," "ranking," or "priority" will be used in its stead when associated with a route*). It is used to assign a numerical value on some measure of interest (e.g., metric of an attribute) and rescale it onto a normalized (0 to 1) scale with 0 representing the worst rating/option and 1 the best rating/option. This allows the direct comparison of many diverse objectives. The result is a rank-ordered evaluation of options that reflects the decision makers' preferences.

The MUA has been selected as the assessment approach for purposes of this report to evaluate the viable modes and routes (options) for moving the NUHOMS 32PTH1s containing SNF and GTCC LLW from the CR-3 ISFSI. In this section, an MUA using a value model, which identifies preferences of attributes, relative importance of meeting an attribute, and/or tradeoffs between attributes, will be used to establish a prioritized list of modes and routes from the CR-3 ISFSI.

5.1 Description of MUA Applied to the CR-3 ISFSI

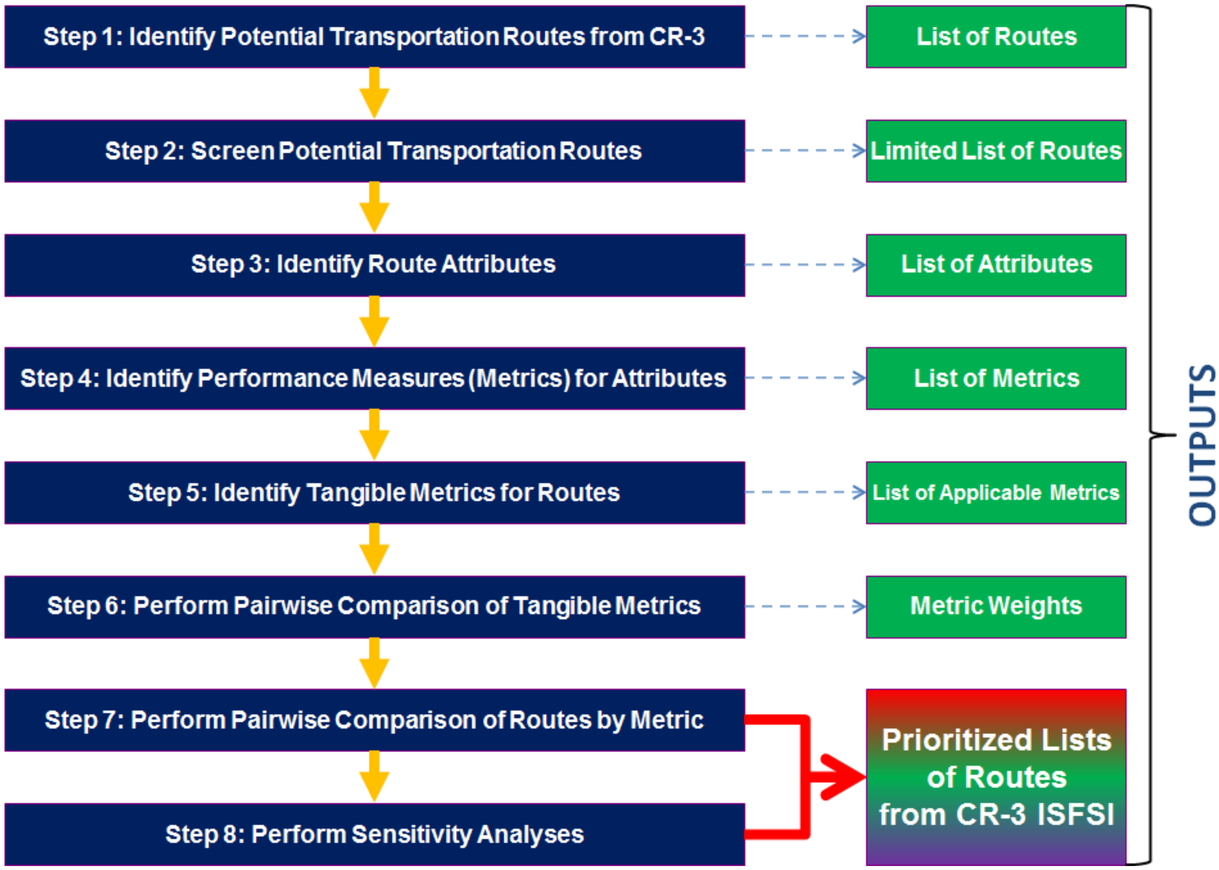
The three primary steps of MUA used to frame the analysis are: (1) identify a set of objectives/attributes that an 'ideal' option will achieve; (2) define a set of performance measures (i.e., metrics) that provide a clear definition of each objective/attribute; and (3) identify or define alternative options to be considered. Once alternative options (routes and modes), objectives (attributes), and performance measures (metrics) have been clearly defined, the preferences for the performance measures are subsequently established from a pairwise comparison between one another to establish a relative weight for each performance measure. The rating for each route per metric is established by performing another pairwise comparison among the performance measures for each route. The rating of each route can then be established by using a value model to create a single metric that can be used to compare each route against one another and provide a ranking of the routes.

The main steps of the MUA applied to the routes from the CR-3 ISFSI are identified in **Figure 5-1** and are as follows:

1) Identify the potential modes and routes for transporting the NUHOMS 32PTH1s from the CR-3 ISFSI; see **Section 3.0**.
2) Due to the large number of potential routes from the CR-3 ISFSI identified in Step 1, a set of screening criteria is developed and applied to reduce the number of routes per mode to a limited group for further evaluation; see **Section 3.6** (if this step were not performed, then the pairwise evaluations of the routes by metric would be too cumbersome to be practical due to the number of evaluations that would need to be performed).
3) Identify the general attributes associated with the routes and the activity of shipping the NUHOMS 32PTH1s from the CR-3 ISFSI; see **Section 5.3.1**.
4) For each identified attribute, identify the metrics that describe performance measures, which could contrast one mode and route from another; see **Section 5.3.1**.
5) Considering the limited list of routes to be evaluated, examine each attribute's metrics, and identify the ones that could tangibly differ between two or more of these modes and routes; see **Section 5.3.1**.
6) Each team member performs a pairwise comparison between each of the tangible metrics, which are subsequently quantified, resulting in a relative ranking of the metrics based on individual ratings and are also combined to establish a weight for each of the tangible metrics based on an equivalent team rating; see **Section 5.3.2** (the individual rankings also provided the basis for the sensitivity analyses).
7) The team collectively performs another pairwise comparison between the tangible metrics for each route (to ensure the SMEs' preferences are incorporated and not diluted by the ratings of other individuals), and the results are quantified and evaluated to establish a relative ranking of each of the routes based on SME ratings; see **Section 5.3.3**.
8) Finally, sensitivity analyses are performed to examine the sensitivity of the ranking to different weighting of the tangible metrics; this includes evaluating the metric weights at the minimum and maximum values identified by the individual members of the team; see **Section 5.5**.

Details of the analyses and the results produced from each of these steps are described in the following portion of this section.

Figure 5-1: Overview of MUA Applied to CR-3 ISFSI



5.2 Description of Evaluated Routes

As noted in **Section 3.0**, there are numerous possible routes from the CR-3 ISFSI (Step 1). The general sequences of the transportation operations for these routes fall into the following categories:

- Transfer directly to on-site rail siding (on-site rail),
- Transport by HHT to an existing rail transload facility (HHT-to-rail), and
- Transport by barge to a port, and transfer to a railcar (barge to rail).

Due to the numerous possible routes identified in **Section 3.0**, a set of screening criteria was used to reduce these routes to a number that can be reasonably evaluated by the MUA (Step 2). If the routes were not reduced by performing this screening activity, then the MUA could take an inordinate amount of time to perform and the pairwise comparison may not be able to distinguish between many of the routes due to the compression of results between the favored routes relative to the evaluated metrics. That is, if the difference between a favored route and another route that clearly has some disadvantages is identified at an extremity of the evaluation range, then the MUA will show a distinct difference between these two routes. However, if there are other favored routes with only slight differences between one another, these differences may be difficult to distinguish from one another as the large differences will have compressed the slight differences identified between two or more favored routes and thereby prevent distinguishing between them in the overall evaluation.

The following screening criteria were used per mode of transport (i.e., routes having the same mode of transport were only contrasted against one another for screening purposes) to reduce the routes to the six routes identified in **Section 3.6**[8]:

1) The time and/or distance to be traveled by the conveyance/barge would be significantly more than alternate viable routes without significant/substantial benefit.
2) Clearance limits on routes (e.g., through tunnels, around curves, or through heavily forested roads) are not met without significant/substantial upgrading.
3) Sustained travel on routes with steep grades.
4) Bridge(s)/overpass(s) to be utilized would not sustain weight of conveyance without significant/substantial upgrading.
5) Natural features make barge landings, overpack loading, etc. difficult to perform without significant/substantial upgrading or infrastructure development.
6) No available loading facility or insufficient track for performing loading of a full consist.
7) Transloading and/or port facility does not permit receipt of Class 7 materials.
8) Number of interchanges between carriers.
9) Avoidance of high-density transit areas (i.e., regions with significant rail traffic) that would require interruption of traffic if shipment were to transit region.
10) Characteristics of HHT that would require preapproval for HRCQ shipments.
11) Other.

The reasons for the screening of potential routes identified in **Section 3.0** are documented in **Table 3-6**. The routes unscreened and remaining to be evaluated by the MUA are as follows:

1) HHT from CR-3 ISFSI to the FNOR property located at the intersection of W. Power Line St. and N. Tallahassee Rd. in Crystal River, Florida and transload onto rail to GCUS on FNOR and CSX rail lines (i.e., referred to as “A. HHT to FNOR Rail” route in the MUA).
2) HHT from CR-3 ISFSI to 19810 SW 110th St., Dunnellon, Florida and transload onto rail to GCUS on FNOR and CSX rail lines (i.e., referred to as “B. HHT to Dunnellon to FNOR Rail” route in the MUA).
3) Rail directly from the CR-3 site on the loop track to GCUS on FNOR and CSX rail lines via Florida (Newberry & Tallahassee), Georgia, Alabama (Montgomery & Birmingham), Tennessee (Nashville), and Kentucky (i.e., referred to as “C. Rail from CR-3 to GCUS via FNOR & CSX” route in the MUA).

[8] Several of these screening criteria use the term “significant.” This term is frequently justified through a relative comparison between identified routes (e.g., one route may be identified as requiring a single bridge to be upgraded, whereas another route may require several bridges to be upgraded). In a few cases, the opinions of the SMEs were used to screen a route using this term or not to screen a route based on, for example, historical experiences.

4) Rail directly from the CR-3 site on the loop track to GCUS on FNOR (to Newberry, Fl.), on CSX (to New Orleans Terminal Back Belt Line) then on Norfolk Southern (NS), CN, and NOPB (to Memphis) and finally on BNSF and UP to GCUS (i.e., referred to as "D. Rail from CR-3 to GCUS via New Orleans" route in the MUA).
5) Barge from CR-3 ISFSI along the ICW to Mobile River near Port of Mobile then up the Tombigbee River, Tennessee River, Ohio River, and Mississippi River to GCUS (i.e., referred to as "E. Barge via ICW to Mobile/Tombigbee River to GCUS" route in the MUA).
6) Barge from CR-3 ISFSI along the ICW to New Orleans and then up the Mississippi River to GCUS (i.e., referred to as "F. Barge via ICW to New Orleans/Mississippi to GCUS" route in the MUA).

5.3 Evaluation of Routes

To evaluate each of these six routes, attributes used to define an 'ideal' route and associated shipping activities were identified, and for each attribute, metrics were identified that describe the performance measures and allow for the quantification of the assessment through pairwise comparisons. With these six routes in mind, the metrics were evaluated to identify those that are tangibly different between two or more routes. These tangibly different metrics were then pairwise compared against one another to identify a level of importance for each metric (i.e., a metric hierarchy) and provide a range of values against which sensitivity analyses were performed. An additional pairwise comparison was performed between the tangible metrics for each route, and using the metric hierarchy, a hierarchy for the routes was established. Finally, sensitivity analyses were performed to examine the impact of changes to the weighting of the metrics on the route hierarchy.

5.3.1 Identification of Attributes and Metrics

The attributes identified to characterize the 'ideal' route are given in **Table 5-1** (Step 3). These attributes were established based on solicitation of the members of the de-inventory team, past de-inventory studies[33][34][35][36][37][38] and on the large body of past MUA activities performed on nuclear waste management evaluations.[39][40][41][42].

For each attribute, one or more performance measures (metrics) was established (Step 4). These metrics provide a means for estimating how well each route performs against each attribute, defined in terms that can be evaluated by technical experts and compared meaningfully by decision makers. **Table 5-1** also lists the identified metrics per attribute.

To minimize the number of evaluations performed in the next set of MUA activities, the team was surveyed to establish which metrics identify a potentially tangible difference between one or more of the remaining five routes (Step 5). **Table 5-1** shows the results of this survey and some subsequent team discussions. Those metrics identified as having the potential to differentiate between one or more of the routes are identified in **Table 5-1** with a "Y" (yes). Comments are provided in the last column of the table to indicate how the "applicable metric" assessment was performed/concluded. The results of this assessment identified at least one metric for each attribute, with the exception of the Permitting, Resource Requirements, and Waste Generation attributes, for which no tangible differences in the permitting needs, resources and waste production were identified between the routes (e.g., the waste generated during the de-inventory activities, such as personnel protection equipment, is considered to essentially result in the same quantity and type of waste and hence, will not identify a tangible difference between the evaluated routes). A total of 17 metrics will be evaluated for each route and contrasted against the other routes.

Table 5-1: Attributes and Associated Metrics

Attribute	Metric	Y/N	Comments
Cost[9]	On-Site Rental Equipment Costs (e.g., mobile cranes)	Y	Mobile cranes may be required for barge but could instead use Goldhofer and stands. Mobile cranes needed for loading on to railcar and HHT trailer for direct rail and HHT routes.
	Hardware Procurement Costs (e.g., transfer cask)	N	Hardware is expected to be relatively the same for all routes, with stands for barging being a negligible exception.
	Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)	Y	Improvements, such as preparing a barge transfer site, upgrading of on-site heavy haul paths to the rail line loop and barge loading site may be necessary and may pose measurable differences.
	Labor and Permitting Costs	Y	Labor and permitting costs are expected to vary by route, as on-site transfer to rail is expected to be minimal, off-site transfer by HHT to be more burdensome, and barge somewhere in-between.
	Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)	Y	Different modes of transport from the site of HHT or barge will result in different shipment and transload costs
	Cost of Rail Transport (e.g., costs associated with use of multiple railroads in route)	Y	Rail routes take different length routes and will have different numbers of interchanges.
	Total Overall Costs	N	The above broken-down elements of the total cost are expected to cover this metric and hence, this metric is not expected to provide any significance to this assessment.
Environmental Impact	Gaseous Effluent Release	N	Although vehicle and barge emissions will vary among the routes, there are no radiological releases associated with the routes and hence, this metric will not provide a tangible difference between the routes.
	Liquid Effluent Release	N	No liquid effluent release is associated with any route from this site.
	Route Aesthetic Changes Needed (e.g., tree trimming)	N	Aesthetic changes not needed to support the routes to be evaluated.
	Route Impact to or Proximity to Historical, Archaeological, and/or Cultural Features	N	Evaluated routes are not expected to impact historical, archaeological, or cultural features.

[9] Casks, railcars, and associated equipment are assumed to be government furnished equipment and therefore the cost of this equipment is not included in this assessment.

Attribute	Metric	Y/N	Comments
	Route Environment Characteristics (e.g., terrain, grade, tunnels, etc.)	N	Evaluated routes are not expected to traverse steep grades and/or utilize tunnels that may pose a challenge to the shipments of the material from the CR-3 site.
	Impact of Weather to Route (e.g., limited availability of route or instability of weather)	Y	Weather (e.g., hurricanes) may impact shipments from CR-3.
	Number of Water Areas Nearby Route (e.g., number of bridges crossed)	N	Mileage over water (non-barge routes) shows negligible differences.
	Number of Sensitive Environmental Areas Nearby Route (e.g., endangered species habitats)	Y	START[1] identified distinguishable differences for number of environmentally sensitive areas traversed between the evaluated routes.
Institutional Considerations	Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churches)	Y	Based on results from START[1], the routes show significant differences between the number of these mass gathering places along the routes.
	Number of Tribal Lands Crossed	Y	Based on results from START[1], the routes show significant differences between the number of tribal lands crossed by the routes.
	Public Acceptability of Route	Y	This subjective metric will be evaluated as done in the previous evaluations based on our experts' opinions and will consider nearby features of the routes.
Permitting	Ease of Permit Procurement	N	All permit pulling is expected to be difficult to perform and hence, no real means for distinguishing between the routes, especially since all the routes have some precedence for making prior shipments.
	Number of Permits	N	Number of permits for each route are considered to be relatively equal, since very short HHT routes are being utilized.
	Insurability of Route	N	All routes to be indemnified by DOE (Price Anderson Act).
Resource Requirements	Number of Personnel involved in Transfer	N	Impact considered to be covered by cost and safety metrics.
	Quantity of Hardware Needed	N	Hardware is expected to be relatively the same for all routes, with stands for barging being negligible exception.
	Availability of Specialty Equipment (e.g., rigging, transfer cask)	N	Specialty equipment such as a transfer cask, rigging, and a heavy haul truck (Goldhofer) will be required for each route. Barges and tugs will only be needed for barge routes, but their inclusion will be captured in the transport to rail costs identified above.

Attribute	Metric	Y/N	Comments
Safety	Cumulative Worker Exposure (α handling time & number of workers)	Y	Some routes will involve greater cumulative worker exposure as a result of an additional transload activity (for barge routes) and/or the longer transient duration associated with some routes.
	Cumulative Population Dose along Route (α population density)	Y	According to START[1], the population exposed along a route may vary significantly between various routes (noting all exposures will meet regulatory limits and be negligibly small).
	Risks Associated with Number of Lifting Activities	Y	Risks associated with lifting activities will vary between modes of transportation.
	Average Accident Frequency on Route	Y	According to START[1], the average accident frequency along a route may vary significantly between various routes (noting the frequencies are very small overall).
	Hazards (Occupational Safety and Health Administration (OSHA) & Radiological) associated with Route Duration	N	The OSHA risks are expected to be negligible and comparable for each of the routes and any difference will be covered by the worker exposure and transit duration metrics.
	Number of Fire Stations & Trained Personnel Nearby Route	N	The number of fire stations and trained personnel nearby the route will be proportional to the population density and hence the population density metric will account for this metric.
Schedule	Transit Duration per Conveyance and Consist	Y	START[1] identified distinguishable duration differences between the evaluated routes.
	Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)	Y	Potential differences may be expected between, for example, improving the heavy haul path to the rail loop vs. to the barge.
	Ease of Access to Transload Site (e.g., consider usage of existing site)	N	Based on current usage, the transload sites for HHT and barge are not expected to pose a constraint to operations.
	Immediacy of Ability to Perform Transfer (e.g., ability to train crew)	N	The team decided there was no tangible difference between the routes as all routes were deemed equally immediately ready for performing a transfer with some potential requirements to coordinate with other site activities, such as train or barge arrival with a load of coal.
	Size of conveyance (# of casks per shipment)	N	Although HHT routes will be limited to one cask per shipment versus the 5 per shipment for barge and rail, the combination of the shortness of the HHT routes and the potential for having more than one HHT utilized at one time is expected to result in no significant scheduling penalty.

Attribute	Metric	Y/N	Comments
Security/ Vulnerability	Security Vulnerability of Route	Y	Some routes may transit urban areas viewed as a higher risk, where as other routes may remain in mostly lower risk rural areas.
	Availability of Security Escort for Route	N	Security escort is assumed to always be available.
	Number of Police Stations Nearby Route	N	The number of police stations nearby the route will be proportional to the population density and hence the population density metric will account for this metric.
Waste Generation	Quantity of Radiological Waste Produced from Normal Ops	N	A minimum amount of rad waste is expected and will likely be nearly the same for all routes.
	Quantity of Non-Radiological Waste Produced from Normal Ops	N	A minimum amount of non-rad waste is expected and will likely be nearly the same for all routes.

5.3.2 Evaluation of Individual Metrics

With the tangible metrics established in **Section 5.3.1**, a pairwise comparison among these metrics was performed by each of the 12 members of the Orano-led team to establish a relative weighting of the metrics and a range for the metric weight over which a sensitivity analyses was performed (Step 6). In a pairwise comparison, each metric is evaluated for its favorability against the other metrics. This exercise was performed by each of the 12 individuals of the Orano-led team to ensure a reasonable cross-section of preference samples was taken from the collective team, which allowed for an average metric weighting to be established and a prioritized list of metrics identified.

An example of the pairwise comparison performed by an individual is shown in **Table 5-2**. In this example, the "Transport to Rail Class I Costs" metric (e.g., costs associated with transload activities and rental costs for a HHT, trailer, and/or barge) is pairwise compared against the other metrics on a favorability scale. For example, the "Transport to Rail Class I Costs" metric is rated mildly favorable against the "Transit Duration per Conveyance and Consist," but is rated strongly unfavorable against "Cumulative Worker Exposure." These ratings are interpreted to mean that there is a slight benefit seen to reducing the monies spent on the transport to rail at the expense of increasing the duration of the transit per conveyance and consist (e.g., renting a tug that may operate at a lower speed but costs less than a tug operating at a higher speed, then this evaluator would slightly favor utilizing the slower tug even though that may increase the transit duration). However, if there were an improvement to the transport to Rail Class I that resulted in an increased cost but could be performed to improve (reduce) the cumulative worker exposure along the route (e.g., utilization of a goldhofer trailer to eliminate some worker operations for barge activities), and then this will be a strongly favored/encouraged outcome.

With 17 tangible metrics to be evaluated, 136 pairwise evaluations had to be performed by each individual. **Attachment A** shows the entire pairwise evaluation for these metrics. If the original 40 metrics were evaluated, then 780 pairwise evaluations will have had to have been performed to establish the weight for the metrics, which would have been very burdensome.

The favorability scale, shown in **Table 5-2** (e.g., "Strongly Favorable"), allows for quantification of the comparison when weights are assigned to the scale. In this MUA, the relative weighting is assessed as follows:

- Strongly favorable as 11 (+5),
- More favorable as 9 (+3),
- Mildly favorable as 7 (+1),
- Neutral is rated as 6 (0),
- Mildly unfavorable as 5 (-1),
- More unfavorable as 3 (-3), and
- Strongly unfavorable as 1 (-5).

Using this weight scheme, **Figure 5-2** shows the results for the relative weighting of the tangible metrics as established from the evaluation of twelve individual pairwise comparisons. **Table 5-3** shows the numerical values associated with these tangible metrics. Three sets of data are shown in this figure and four sets of data are shown in this table:

1) The "Minimum" value as established from the twelve individual assessments.
2) The "Average Weight" value, which is an average of normalized results from each of the individual assessments (i.e., each individual's assessment is equally weighted, and the results combined).

$$\bar{R}_m = \sum_{p=1}^{P} \left\{ \frac{\sum_{i=1}^{7} N_{m,p}^{i}\, W_i}{\sum_{m=1}^{M} \left[\sum_{i=1}^{7} N_{m,p}^{i}\, W_i\right]} \right\} / \mathrm{P}$$

where R = average relative weight, N = number of times rank selected, W = weight of rank (see above), M = number of metrics to be evaluated, P = number of evaluators, m. = metric, i = rank (e.g., "strongly favorable"), p = person evaluating metrics.

3) The "Biased Weight" value, which is an average of the unnormalized results from each of the individual assessments (i.e., the raw scores are used to establish overall average values, so if an individual scored significant differences between the metrics, then these results could skew the overall average in favor of this individual's assessment).

$$\bar{B}_m = \left\{ \frac{\sum_{p=1}^{P} \left(\sum_{i=1}^{7} N_{m,p}^{i}\, W_i \right)}{P} \right\} \Bigg/ \sum_{m=1}^{M} \left\{ \frac{\sum_{p=1}^{P} \left(\sum_{i=1}^{7} N_{m,p}^{i}\, W_i \right)}{P} \right\}$$

where B = averaged biased relative weight.

4) The "Maximum" value as established from the twelve individual assessments.

Results from all twelve of the individual assessments are shown in **Attachment B**.

As shown in **Figure 5-2** and **Table 5-3**, the tangible metrics with the highest preferences (based on average weighting method) are Security Vulnerability of Route, Cumulative Population Dose, and Cumulative Worker Exposure, which rated at about 8.1%, 8.0%, and 7.9% of the total weight, respectively. The tangible metrics with the least preferences (based on average weighting method) are On-Site Rental Equipment Costs, Labor and Permitting Costs, and Infrastructure Improvement Costs, which rated at about 4.3%, 4.3%, and 4.7% of the total weight, respectively. The preferences/ranking and weights of all the tangible metrics in descending order (based on average weighting method) are shown **Table 5-3.**

Table 5-2: Example of a Portion of a Pairwise Comparison for Metrics Assessment

Column A Metrics	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Metrics
Transport to Rail Class I Costs				X				Cost of Rail Transport (e.g., costs associated with interchange activities)
Transport to Rail Class I Costs			X					Impact of Weather to Route (e.g., limited availability of route or instability of weather)
Transport to Rail Class I Costs			X					Number of Sensitive Environmental Areas Nearby Route (e.g., endangered species habitats)
Transport to Rail Class I Costs			X					Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churches)
Transport to Rail Class I Costs					X			Number of Tribal Lands Crossed
Transport to Rail Class I Costs					X			Public Acceptability of Route
Transport to Rail Class I Costs							X	Cumulative Worker Exposure (proportional to handling time & # of workers)
Transport to Rail Class I Costs						X		Cumulative Population Dose along Route (proportional to population density)
Transport to Rail Class I Costs					X			Risks Associated with Number of Lifting Activities

Column A Metrics	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Metrics
Transport to Rail Class I Costs					X			Average Accident Frequency on Route
Transport to Rail Class I Costs			X					Transit Duration per Conveyance and Consist
Transport to Rail Class I Costs				X				Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Transport to Rail Class I Costs						X		Security Vulnerability of Route

These results also show negligible differences between the average weighting method and the biased weighting method, which indicates a fairly uniform assessment by the twelve individuals. However, at the extremities of the individual assessments (i.e., the minimum and maximum values), there are some significant findings including:

- The Transit Duration per Conveyance and Consist metric, which ranked 8th overall, was ranked 2nd highest overall by an individual at 9.6% (as clearly seen in **Figure 5-2**) indicating a wide range of importance levels for this metric between the individual evaluators. This metric also was ranked fairly low by another individual at 4.2% giving it the largest range between maximum and minimum.
- The Cumulative Worker Exposure metric, which ranked 3rd overall, had the second highest favorable ranking by an individual at 10.3%, but was also ranked fairly low by another individual at 5.2% (having the second highest range between the minimum and maximum).
- Overall, the safety and security metrics ranked near the top in preference for everyone's assessment.
- The metrics with the least difference between minimum and maximum values were the Transport to Rail Class I Costs metric and the Infrastructure Improvement metric, which ranked near the bottom of importance of all the metrics and hence, showing a fairly robust rating.

Finally, the minimum and maximum values listed in **Table 5-3** provide ranges of values to be used in the sensitivity analyses performed in **Section 5.5**.

Figure 5-2: Weighting of the Tangible Metrics Based on Pairwise Comparisons

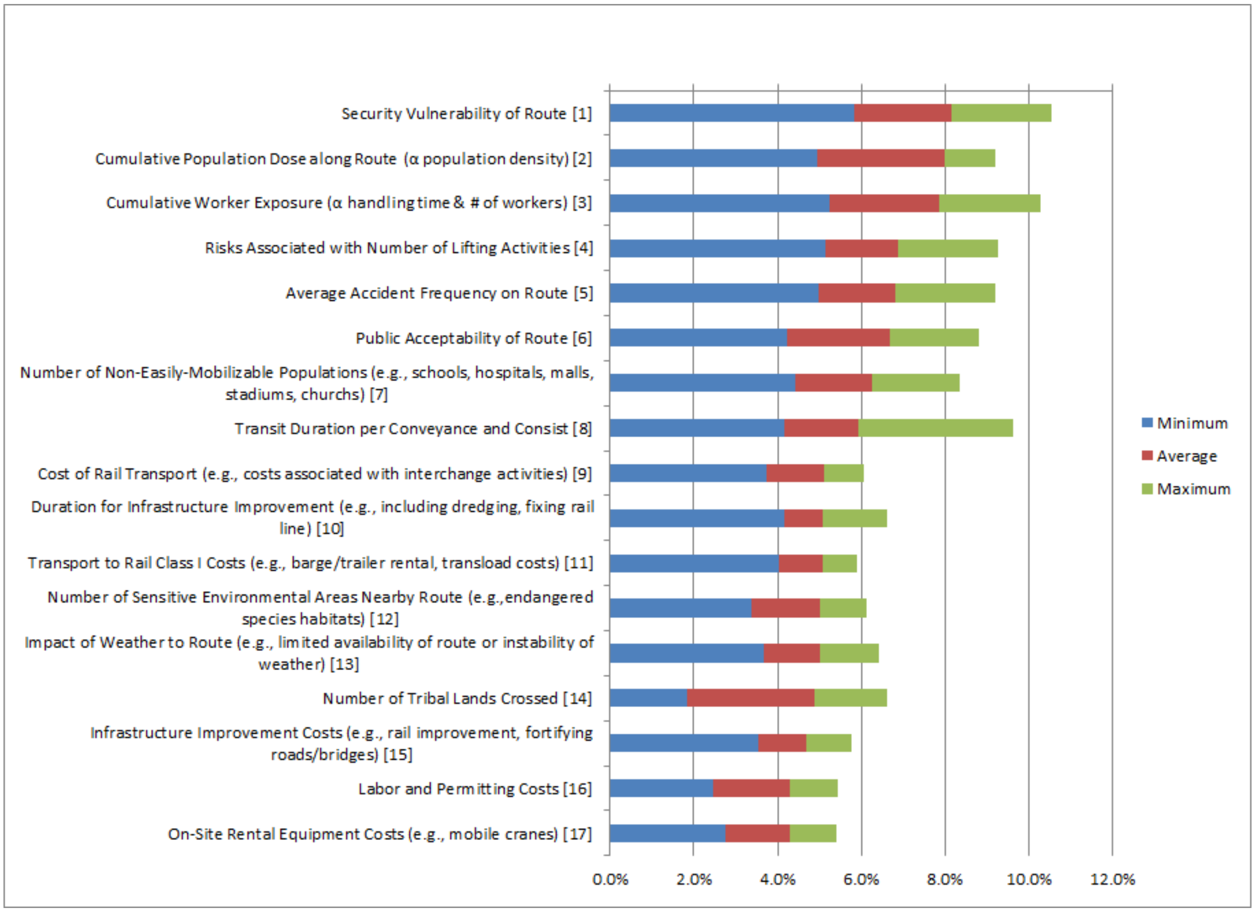


Table 5-3: Weighting of Tangible Metrics

Rank	Minimum	Average Weight	Biased Weight	Maximum	Metric
1	5.8%	8.15%	8.15%	10.5%	Security Vulnerability of Route
2	4.9%	7.97%	7.97%	9.2%	Cumulative Population Dose along Route
3	5.2%	7.85%	7.85%	10.3%	Cumulative Worker Exposure
4	5.1%	6.87%	6.88%	9.3%	Risks Associated with Number of Lifting Activities
5	5.0%	6.82%	6.81%	9.2%	Average Accident Frequency on Route
6	4.2%	6.67%	6.67%	8.8%	Public Acceptability of Route
7	4.4%	6.26%	6.27%	8.3%	Number of Non-Easily-Mobilizable Populations

Rank	Minimum	Average Weight	Biased Weight	Maximum	Metric
8	4.2%	5.93%	5.93%	9.6%	Transit Duration per Conveyance and Consist
9	3.7%	5.10%	5.10%	6.0%	Cost of Rail Transport
10	4.2%	5.09%	5.09%	6.6%	Duration for Infrastructure Improvement
11	4.0%	5.07%	5.06%	5.9%	Transport to Rail Class I Costs
12	3.4%	5.02%	5.02%	6.1%	Number of Sensitive Environmental Areas Nearby Route
13	3.7%	5.02%	5.02%	6.4%	Impact of Weather to Route
14	1.8%	4.89%	4.90%	6.6%	Number of Tribal Lands Crossed
15	3.6%	4.70%	4.70%	5.8%	Infrastructure Improvement Costs
16	2.5%	4.30%	4.30%	5.4%	Labor and Permitting Costs
17	2.8%	4.28%	4.28%	5.4%	On-Site Rental Equipment Costs

5.3.3 Route Assessments

With the ranking/preference of the tangible metrics calculated, another pairwise comparison was performed to compare the tangible metrics for a route against those of each of the other routes (Step 7). Unlike the pairwise comparison performed for the tangible metrics, which were performed by multiple individuals, this pairwise comparison was performed by the collective team to ensure the responses from SMEs were properly weighted against responses from the other team members when a metric(s) (e.g., cost) was addressed in that SME's discipline(s). In this manner, for example, in the ranking of a safety-related metric, the safety SME's preference was afforded greater influence than were the preferences of the other individuals on the team if there was a difference.

An alternative approach would be to let each SME separately perform a pairwise comparison on only the metrics within the SME's discipline(s). However, by having a team assessment, productive discussions can take place on each metric, which may change, challenge, concur, etc., on the evaluation of the metric. Furthermore, by acting as a team, the rationale for the pairwise comparisons preferences can be established which will ensure a fairly consistent basis in the selection of the preferences (e.g., this may temper extreme assessments in cases where differences in rankings of a metric may not be that significant on a relative basis).

Before performing this pairwise comparison between the tangible metrics for a route against those of each of the other routes, some cursory data is required for each of the routes to inform this assessment. **Section 3.0** contains some of this information, but a summary of the cursory data used to perform this comparison by metric is provided here.

5.3.3.1 On-Site Rental Equipment Costs

The majority of the rental costs for on-site equipment are expected to be the same for each route (e.g., mobile crane and trailer), however for the barge routes, goldhofers are recommended. The goldhofers would be able to transport the 32PTH1 canister loaded in a transportation cask to the barge from the ISFSI. The goldhofers would then drive on to the deck of the barge and be aligned with stands designed to hold the transportation casks during the barging portion of the trip. Once aligned, the goldhofers would lower their deck in a manner that would leave the transportation casks sitting in their stands (with their weight no longer supported by the goldhofers) and then drive off the barge. The use of goldhofers would eliminate the need for mobile cranes at the barge landing site; however, the rental rate of goldhofers is considered to be higher than mobile cranes, depending on the availability of the units. Thus, the barge routes are considered to have the higher on-site rental equipment costs relative to the other routes.

5.3.3.2 Infrastructure Improvement Costs

During the initial evaluation of this metric there was a concern the haul paths to the rail and barge loading sites were in need of improvement. However, upon further investigation, the haul paths were deemed to be adequate for the movement of the transport casks to the rail and barge loading sites as-is and hence, no improvements to the infrastructure for a specific route was deemed necessary (i.e., any improvements would be useful to each route). Other infrastructure improvements considered for the CR-3 site included: the need to dredge the barge site, extension/improvement of the rail spur, improvement of the rail loop, development of transload sites, and improvements of the HHT routes. However, the barge site was deemed adequately dredged as it is an off-shoot of the heavily utilized channel for coal barges brought to the CREC site. The rail spur was deemed too expensive to modify compared to the rail loop and was screened in Chapter 3. The rail loop is actively utilized for bringing in shipments of coal for the CREC site and hence, also required no improvements. The transload sites to be utilized for each route were identified to each be in need of development/improvement and hence, no discernable differences in the costs were identified. Finally, each of the HHT and rail routes will require clearance assessments of the off-site routes prior to their use to verify this assessment, considering this assessment is temporal. The team’s assessment determined there is no difference in the infrastructure improvement costs among the routes evaluated here.

5.3.3.3 Labor and Permitting Costs

The HHT routes are expected to have higher costs relative to the on-site rail and on-site barge costs. The HHT routes are expected to have higher permitting costs relative to the evaluated rail and barge routes, as local permits for the HHT are required whereas no local permits are necessarily needed for the rail and barge routes. Furthermore, labor costs for the HHT routes are expected to be higher due to the off-site transload activities the rail and barge routes will not have. Thus, the HHT routes would be unfavorable compared to the rail and barge routes.

5.3.3.4 Transport to Rail Class I Costs

For the transport to rail costs (not including on-site costs), each of the six routes were evaluated by the team to have a cost benefit or cost penalty relative to the other routes based primarily on composite costs associated with rental of barges, tugs, and HHTs and number of transload activities. For rail routes, no transport to rail costs were identified beyond those already covered by the on-site rental costs. For barge routes, the costs are associated with: (1) the rental of a barge and tugs to ship five transportation casks at a time placed on specialty racks on the barge or left on the trailer (rolled on) and (2) the rental of a crane(s) to move the transportation cask from the trailer onto a stand on a barge (if applicable) or to move the transportation cask from the barge or trailer (rolled off) to a railcar. For HHT routes, the costs are associated with: (1) an HHT to move one transportation cask from the ISFSI to the rail transload facility and (2) the rental of a crane to move the transportation cask from the HHT to railcar at the transload site. In addition to these rental costs, costs associated with the distance required to be covered for each route and the number of shipments required to be performed for each route will impact this assessment. The barge route to New Orleans, LA and up the Mississippi River, followed by the barge route to Mobile, AL and up the Tombigbee River, were deemed to be the most expensive routes due to the equipment rental costs, distances traveled, locks traversed, and the need to perform a transload activity. The HHT route to FNOR followed by the HHT route to Dunnellon, FL were the next two most expensive routes due to the equipment rental costs, distances traveled, and the need to perform a transload activity. The rail routes were deemed to have equivalent (negligible) costs and were favored over the other routes for this metric.

5.3.3.5 Cost of Rail Transport

The barge routes with no rail (directly off-loaded to rail in GCUS) are strongly favored over both the HHT and rail routes. Since the HHT and rail route via FNOR and CSX essentially follow the same rail routes, these routes all evaluate neutrally against one another. Finally, the rail route via FNOR and CSX is shorter than the rail route via New Orleans, LA and hence is more favorable.

5.3.3.6 Impact of Weather to Route

The impact of weather and tides/seiches in this area of the country is considered to be either directly impacting on the routes (e.g., rough waters) or indirectly impacting on the routes (e.g., vacationer traffic in the fall, winter, and spring on the roads and waterways). For example, the barge routes traversing significant distances on the ICW along the Gulf Coast will be more impacted by vacationer boat traffic during the fall, winter, and spring than the HHT routes traveling relatively lightly populated portions of Florida near the CR-3 site. In addition, the barge routes traverse significant distances on rivers that may be heavily utilized (e.g., the Mississippi River by commercial traffic and the Tombigbee River by both commercial and recreational traffic). Furthermore, the barge routes are more susceptible to interruptions by tides and weather, including hurricanes, than the HHT and rail routes. Hence, the barge routes are at a distinct disadvantage over the rail and HHT routes and the barge route using the Tombigbee River has a slight advantage over the barge route using the Mississippi River due to the longer distance in the ICW and up the commercially busy Mississippi River, even though the Tombigbee route requires navigating ~17 locks.

5.3.3.7 Number of Sensitive Environmental Areas Nearby Route

Using data produced from the START program[1], each route could be evaluated for the quantity (square miles) of environmentally sensitive areas crossed. Based on these results (see **Attachment D**), the quantity of environmentally sensitive areas crossed by each route ranged from 33 to 146 square miles[10] which is small compared to the total land crossed by the entire route. Nevertheless, according to START[1], some routes do have advantages over others: the HHT routes, the rail route using the same CSX rail line as these HHT routes, and the barge route to New Orleans, LA all impact the least amount of environmentally sensitive areas (33 - 37 mi^2). The rail route via New Orleans, LA has the next least impact (90 mi^2), and the barge route up the Tombigbee River has the highest impact (146 mi^2).

5.3.3.8 Number of Non-Easily-Mobilizable Populations

Using data produced from the START program[1], each route could be evaluated for the number of non-easily-mobilizable populations, such as those found at schools, hospitals, malls, stadiums, churches, and retirement homes along the routes. Based on these results (see **Attachment D**), the number of non-easily-mobilizable populations along each route was lowest for the barge route using the Tombigbee River, followed by the barge route using the Mississippi River, and then the HHT routes and the rail route using CSX had the next highest number. The rail route via New Orleans, LA produced the highest number.

5.3.3.9 Number of Tribal Lands Crossed

Using data produced from the START program[1], each route could be evaluated for the quantity (square miles) of tribal land crossed. Based on these results (see **Attachment D**), the quantity of tribal land crossed by each route was small (i.e., less than 26 square miles[11]) relative to the total land crossed by an entire route. Nevertheless, according to START, the routes did have some mild differences over one another: the barge routes and the rail route via New Orleans did not cross any tribal lands and the other three routes crossed 26 square miles of tribal land.

5.3.3.10 Public Acceptability of Route

Public acceptability varied among each of the routes. The rail routes were judged to be most favorable over all the other routes due to the lack of off-site activities (e.g., HHT and transloading), utilizing rail lines with regular commercial service, and not utilizing public waterways and their associated environmentally sensitive areas. The HHT routes were judged to be mildly favorable over the barge routes as they utilize rail lines with regular commercial service, and do not utilize public waterways and their associated environmentally sensitive areas. The rail route using the CSX rail lines was favored over the rail route to New Orleans, LA due to principally to the shorter route and the avoidance of New Orleans. The HHT route to FNOR was favored over the HHT

---

[10] START establishes the square miles of tribal land crossed by determining the number of miles a route crosses through tribal land, assuming 800 meters on either side of the route, as a buffer region, then multiplying these values together to establish the number of square miles of tribal land crossed.

[11] START establishes the square miles of tribal land crossed by determining the number of miles a route crosses through tribal land, assuming 800 meters on either side of the route, as a buffer region, then multiplying these values together to establish the number of square miles of tribal land crossed.

route to Dunnellon, FL as it is a shorter HHT route. No advantage of one barge route over another was established during this evaluation. However, unlike the evaluations for the other metrics, this metric did result in some disagreements between the team members, specifically between public acceptance of rail versus barge shipments. The focus of the disagreements centered on the proximity of the public to the actual shipments (i.e., rail routes result in closer proximities of the public to the shipments relative to barge) and the ability of protestors to stop a shipment (i.e., barge considered more difficult to stop than rail). So, the results for this metric represent an average of the opinions shared during the evaluation of this metric.

5.3.3.11 Cumulative Worker Exposure

The cumulative worker exposure metric assessment relies heavily on the number of handling events (e.g., transloads) involving the transportation casks and, to a lesser degree, on the distance traveled for each route. These handling events are outlined below and result in the rail routes (equivalent of two on-site transload activities) having an advantage over both the HHT routes (equivalent of one on-site transload activity and one off-site transload activity) and the barge routes (equivalent of two on-site transload activities and one off-site transload activity). Worker exposure levels would not approach regulatory limits as the shielding afforded by the transportation casks and the remote operations involved with these handling activities would result in low exposure levels. Furthermore, a significant fraction of the cumulative worker exposure would occur at the CR-3 ISFSI, where the transfer operations to move the canisters to the transportation casks take place and apply to each route.

- Transfer to HHT then to rail (two lifts):
    - Lift of the MP197HB cask (loaded with the NUHOMS 32PTH1) in its cradle onto the HHT trailer.
    - Lift of transportation cask and cradle from HHT trailer to cask railcar at transload site (*Note: a single lift is assumed at the HHT-to-rail transload site*).
- Transfer to on-site rail (two lifts):
    - Lift of the MP197HB cask (loaded with the NUHOMS 32PTH1) in its cradle onto the on-site trailer
    - Lift of the MP197HB cask from on-site trailer to cask railcar
- Transfer to on-site barge to rail (two to three lifts):
    - Lift of the MP197HB cask (loaded with the NUHOMS 32PTH1) in its cradle onto the on-site trailer/goldhofer
    - Two options for loading onto barge:
        - Lowering of goldhofer that has been rolled onto barge to allow beams holding transportation cask and cradle to rest on stands and subsequently roll off goldhofer from barge (*Note: this lowering activity may not be necessary if the goldhofer is to be left loaded with the transportation cask and cradle on the barge)*
        - Use a crane to lift the transportation cask from the on-site trailer/goldhofer and place it onto the stands on the barge.

- Lift of transportation cask and cradle located on beams off stand/goldhofer onto cask railcar (*Note: a direct transfer from barge to rail is assumed available*).

Based on these assessments and the duration of transport on each of the individual routes, the rail routes are more favored over the HHT routes, the barge routes are mildly favored over the HHT routes, the rail routes are more favored over the barge routes, and the rail route using the CSX rail lines is mildly favored over the other rail route via New Orleans, LA due to the shorter distance traveled.

5.3.3.12 Cumulative Population Dose Along Route

The cumulative population dose along each route is expected to be negligible (comparable to background) due to the significant amount of shielding afforded by the transportation casks and their canisters, the age of the SNF, and the minimal duration of exposure during each transport operation. Furthermore, doses to individual members of the public during normal transportation activities are expected to be below background levels. Nevertheless, the relative differences in preferences established for the assessment of this metric are based primarily on the total exposed population established from data provided by START[1] along each route as shown in **Table 5-4**. Those routes with the lowest total exposed populations are favored over the other routes, as they would result in the lowest cumulative dose to the population.

Table 5-4: Route Averaged Population Density Along Each Route

ID	Route Description	Average Population Density (Persons/Square Mile)1	Total Exposed Population Estimate2 (Thousands)
A	HHT to FNOR Rail	278	337
B	HHT to Dunnellon to FNOR Rail	314	338
C	Rail from CR-3 to GCUS via FNOR & CSX	505	337
D	Rail from CR-3 to GCUS via New Orleans	433	421
E	Barge via ICW to Mobile/Tombigbee River to GCUS	176	21
F	Barge via ICW to New Orleans/Mississippi to GCUS	305	47

1 Data established by START[1] and established by totaling the population located within an 800-m buffer of either side of the route and dividing by the area of the buffer.

2 Established by multiplying the cumulative population density by the route distance and the buffer width (1,600 m).

5.3.3.13 Risks Associated with Number of Lifting Activities

Risks associated with lifting activities are dependent on the number of lifts made of a transportation cask, which have been identified in **Section 5.3.3.11**. Based on this assessment, the rail routes are deemed strongly favorable over the barge routes, the HHT routes are mildly favorable over the barge routes, and the rail routes are more favorable over the HHT routes due to the transload operation taking place off-site with different equipment and personnel. These risks are minimized by the protection afforded the transportation casks by the impact limiters, the design of the lifting equipment (includes multiple safety factors and avoidance of single-failure points), and the robustness of the transportation cask systems. Hence, although this parameter provides some preference to rail routes, the overall risk associated with a lifting device is deemed negligible.

5.3.3.14 Average Accident Frequency on Route

Using data produced from START[2], each route could be evaluated for the annual frequency of the average accident rate (accidents per mile per year) on each route by mode of transport or cumulatively for all of the modes of transport used on a route. Based on these results (see **Table 5-5**), the average cumulative accident frequency for each route was very small, but there are differences in the cumulative frequencies, which provided the information necessary to perform the pairwise comparison. **Table 5-5** provides the average accident rate by mode of transport on the route and the cumulative accident rate for the entire route, which was used to perform this evaluation.

Table 5-5: Average Accident Frequency Over Each Route[2]

Accident Rate (per mi per yr)	Route					
	HHT to FNOR Rail	HHT to Dunnellon to FNOR Rail	Rail from CR-3 to GCUS via FNOR & CSX	Rail from CR-3 to GCUS via New Orleans	Barge via ICW to Mobile/Tombigbee River to GCUS	Barge via ICW to New Orleans/Mississippi to GCUS
Average Accident Rate	0.14	0.72	0.000001	0.000001	0.08	0.14
Factor Increase Over Lowest Rate	140,000 x	720,000 x	1 x	1 x	80,000 x	140,000 x

5.3.3.15 Transit Duration per Conveyance and Consist

The transit duration for each route was roughly estimated during the team meeting and arrived at the following estimates:

1) HHT to FNOR Rail and CSX Rail to GCUS:
   a) Loading Cask: load NUHOMS 32PTH1 canister into MP197HB cask, load MP197HB cask on to HHT trailer/goldhofer and attach HHT to HHT trailer/ goldhofer (2 to 4 days per cask).
   b) Transportation: transport by HHT to FNOR Rail Transload Site (< 1 day per cask).

c) Transload: prepare and load MP197HB cask onto cask railcar, secure, and prepare cask for shipment (1 day per cask).

d) Complete Rail Consist (e.g., add buffer cars, locomotives, and escort car) (~1 day).

e) Thus, approximately **21 to 31 days** for 5 MP197HB casks to load onto a full consist.

f) Total HHT and Rail Transit Duration from START[1]: 38 hours.

2) HHT to Dunnellon to FNOR Rail and CSX Rail to GCUS:

a) Same as previous HHT route: thus, approximately **21 to 31 days** for 5 MP197HB casks to load onto a full consist.

b) Total HHT and Rail Transit Duration from START[1]: 37 hours.

3) Rail from CR-3 to GCUS via FNOR & CSX:

a) Loading Cask: load NUHOMS 32PTH1 canister into MP197HB cask, load MP197HB cask on to on-site trailer/goldhofer and attach truck/tug to on-site trailer/goldhofer (1 to 3 days per cask).

b) Transload: prepare and load MP197HB cask onto cask railcar, secure, and prepare cask for shipment (1 day per cask).

c) Complete Rail Consist (e.g., add buffer cars, locomotives, and escort car) (~1 day).

d) Thus, approximately **11 to 21 days** for 5 MP197HB casks to load onto a full consist.

e) Total HHT and Rail Transit Duration from START[1]: 38 hours.

4) Rail from CR-3 to GCUS via New Orleans:

a) Same as previous rail route: thus, approximately **11 to 21 days** for 5 MP197HB casks to load onto a full consist.

b) Total HHT and Rail Transit Duration from START[1]: 39 hours.

5) Barge via ICW to Mobile/Tombigbee River to GCUS:

a) Loading Cask: load NUHOMS 32PTH1 canister into MP197HB cask, load MP197HB cask on to on-site trailer/goldhofer and attach truck/tug to on-site trailer/ goldhofer (2 to 4 days per cask).

b) Transload: transport to barge and either roll-on on-site trailer/goldhofer or lift MP197HB cask onto stands and then secure and prepare cask for shipment (1 day per cask).

c) Barge Preparation: pre-barge briefings for procedures, quality, and safety reviews; assemble crew (1 to 2 days for 5 casks).

d) Barging: transport 1,408 miles to GCUS (202 hrs per START[1] or 8 ½ days for 5 casks).

e) Unloading Barge: transload operations from barge to rail (2½ days for 5 casks).

f) Thus, approximately **27 to 38 days** for 5 casks to load onto cask railcar.

g) Total Barge Transit Duration from START[1]: 202 hours (accounted for above).

6) Barge via ICW to New Orleans/Mississippi to GCUS:

a) Loading Cask: load NUHOMS 32PTH1 canister into MP197HB cask, load MP197HB cask on to on-site trailer/goldhofer and attach truck/tug to on-site trailer/goldhofer (2 to 4 days per cask).

b) Transload: transport to barge and either roll-on on-site trailer/goldhofer or lift MP197HB cask onto stands and then secure and prepare cask for shipment (1 day per cask).

c) Barge Preparation: pre-barge briefings for procedures, quality, and safety reviews; assemble crew (1 to 2 days for 5 casks).

d) Barging: transport 1,826 miles to GCUS (261 hrs per START[1] or ~11 days for 5 casks).

e) Unloading Barge: transload operations from barge to rail (2½ days for 5 casks).

f) Thus, approximately **<u>29 ½ to 40 ½ days</u>** for 5 casks to load onto cask railcar.

g) Total Barge Transit Duration from START[1]: 261 hours (accounted for above).

As noted in these handling times, there are also the total route transit durations on the HHTs, barges, and rails. START[1] provides these distances and total transit times and **Table 5-6** provides a breakdown by route.

Table 5-6: Route Transit Durations[2]

Distance (miles)	Route					
	HHT to FNOR Rail	HHT to Dunnellon to FNOR Rail	Rail from CR-3 to GCUS via FNOR & CSX	Rail from CR-3 to GCUS via New Orleans	Barge via ICW to Mobile/Tombigbee River to GCUS	Barge via ICW to New Orleans/Mississippi to GCUS
HHT	6	18	0	0	0	0
Barge	0	0	0	0	1408	1826
Rail	1146	1129	1147	1423	0	0
Total Duration (hrs)	38	37	38	39	202	261

Note: the times provided are based on one, one-way trip and assume travel at posted speed limits, which is not realistic, but expected speeds will still result in HHT transport durations of less than 1 day since the distances are fairly short. The values shown above do not account for the multiple trips that will be required by HHT to and from the site and do not account for time spent in locks.

Using the data in **Table 5-6** from START[2] (note some of these times seem counter intuitive and hence were not solely used to establish the comparisons) and the above handling times, the pairwise comparisons were performed between the various routes.

5.3.3.16 Duration for Infrastructure Improvement

Since no infrastructure improvements were identified as necessary for any of the evaluated routes, as identified in **Section 5.3.3.2**, this metric did not identify any differences among the evaluated routes.

5.3.3.17 Security Vulnerability of Route

For the metric on security vulnerability of the route, all routes were capable of being secured; however, some minor advantages of one route over another were identified and these advantages are related to a combination of duration of the shipment, distance traversing urban versus rural regions, number of high threat urban areas on the route, number of transload activities, and the lower vulnerability associated with barge routes over HHT routes. The shortest rail route direct from the site with no off-site transload activities was judged to be the most favored security route over the other routes (but only mildly favored). Similarly, the shorter distance and duration HHT routes evaluated in this comparison were mildly favored over the longer distance and duration barge routes.

5.4 Route Recommendations

Using the metric information identified for the routes listed in the previous section, the Orano-led team held conference calls to perform a pairwise comparison of all the tangible metrics each route identified in **Section 5.2** (Step 7). This team evaluation, unlike the individual assessments performed for the tangible metrics, ensured SMEs' preferences and knowledge could appropriately influence the results for the SMEs' metrics used to compare the routes, while allowing those knowledgeable of the routes to provide beneficial inputs and all team members the opportunity to provide feedback to the discussion

Figure 5-3 provides an example of the pairwise comparison performed by the de-inventory team for the metric related to the Transport to Rail Class I Costs (as denoted on the far-left column). "Column A Routes" (2nd column on left) are subsequently compared against "Column B Routes" (last column on right) for the Transport to Rail Class I Costs metric. The favorability scale listed in this figure is the same as identified for the pairwise comparison of the tangible metrics (see **Figure 5-3**). As an example, the fourth row of the evaluation (excluding the header row) shows that the A. HHT to FNOR Rail route is more favorable when compared to the E. Barge via ICW to Mobile/Tombigbee River to GCUS route for the metric related to the Transport to Rail Class I Costs, which is reflective of the information provided in **Section 5.3.3.4**.

With 17 tangible metrics and 6 routes to be evaluated, the team performed 255 pairwise evaluations. **Attachment C** shows the entire pairwise evaluation for these metrics.

Using the same weighting scheme as described in **Section 5.3.2** and the relative weighting of the tangible metrics identified in **Table 5-3**, **Figure 5-4** shows the resulting relative weighting of the routes in order of the highest rated (C. Rail from CR-3 to GCUS via FNOR & CSX) to the least rated (F. Barge via ICW to New Orleans/Mississippi to GCUS). **Table 5-8** shows the numerical values associated with each of the routes for multiple different weighting schemes:

1) The "Unweighted" results, which are based on each metric having an equal weight.
2) The "Average Weight" results, which are based on the metric weights associated with the "Average Weights" from **Table 5-3**.

3) The “Biased Weight” results, which are based on the metric weights associated with the “Biased Weights” from **Table 5-3**.
4) The “No Safety or Security Metric” results, which are based on zeroing out the weights associated with the safety and security metrics and re-normalizing the “Average Weights” from **Table 5-3**.
5) The “No Public Acceptability Metric” results, which are based on zeroing out the weight for the Public Acceptability of Route metric and re-normalizing the “Average Weights” from **Table 5-3**.
6) The “No Safety, Security, or Public Acceptability Metric” results, which are based on zeroing out the weights for the safety, security, and public acceptability metrics and re-normalizing the “Average Weights” from **Table 5-3**.

Figure 5-3: Example of a Portion of a Pairwise Comparison for Routes Assessment

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)	A. HHT to FNOR Rail			X					B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail						X		C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail						X		D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail						X		C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail						X		D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX				X				D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX	X							E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX	X							F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans	X							E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans	X							F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS			X					F. Barge via ICW to New Orleans/Mississippi to GCUS

As shown in **Figure 5-4** and **Table 5-7**, the routes with the highest ratings (based on average weighting method) are: Rail from CR-3 to GCUS via FNOR & CSX and Rail from CR-3 to GCUS via New Orleans. The route with the least favored rating (based on average weighting method) is the Barge via ICW to New Orleans/Mississippi to GCUS. The difference between the second and third routes is almost 3% favored over the last four routes, indicating some definitive preference of the first two routes with direct loading of rail on the CR-3 site. However, the bottom four routes are separated by less than 1%, indicating no definitive distinction between these alternatives.

Figure 5-4: Resulting List of Prioritized Routes from the CR-3 ISFSI Site

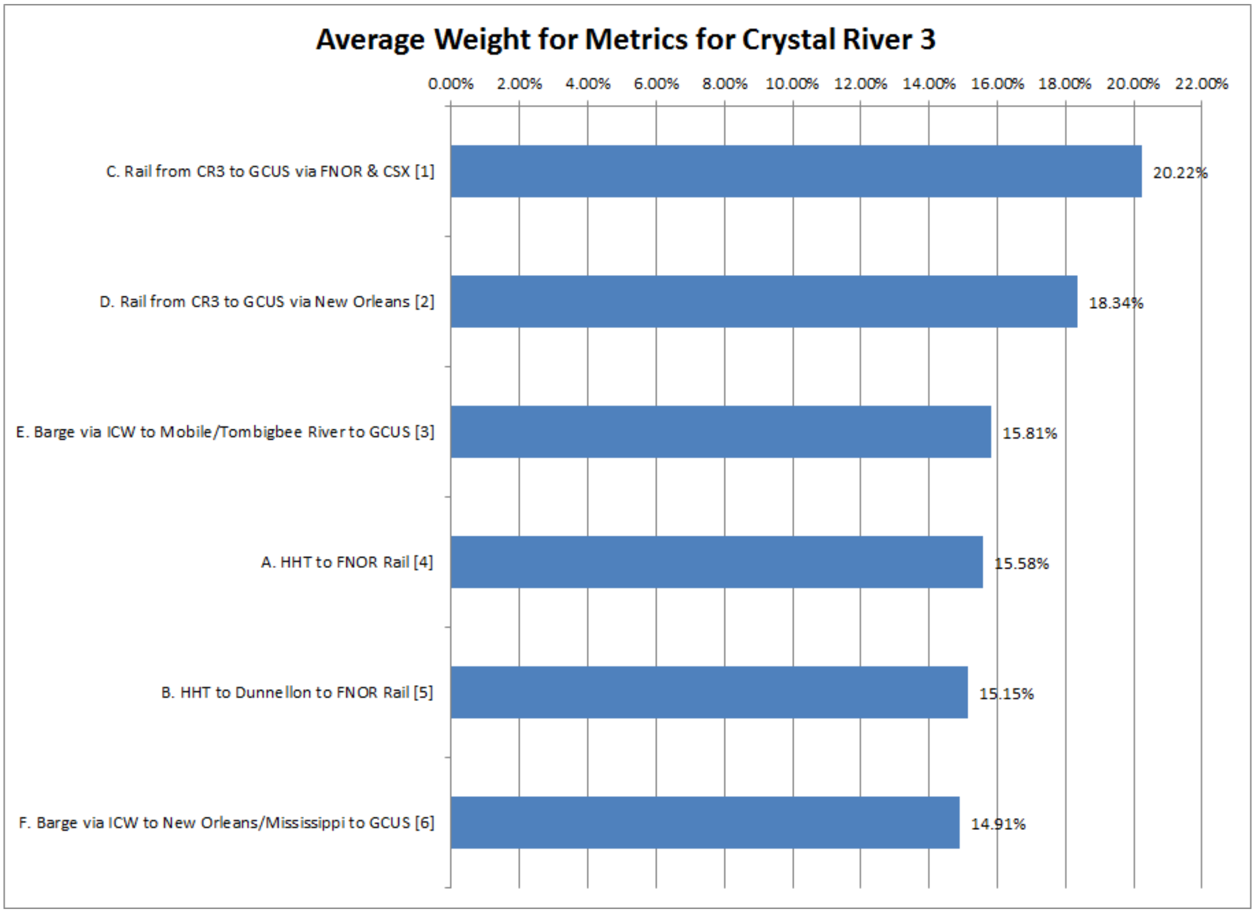


Figure 5-5 shows the impact each tangible metric had on the overall scoring of each route. There is no single dominant metric identified in this figure. However, this figure does show the two most favored routes (direct rail from the site) received significantly greater contributions from the following tangible metrics: average accident frequency on route, public acceptability of routes, cumulative worker exposure, and risks associated with number of lifting activities. Whereas the barge from the site routes received significant contributions from the following tangible metrics: cumulative population dose along route, number of non-easily mobilizable populations, cost of rail transport, and security vulnerability of route. The HHT routes received significant contributions from the following tangible metrics: transit duration per conveyance and consist, cumulative population dose along route, and security vulnerability of route.

Since the safety and security metrics will be established by regulation acceptability, these metrics may not be needed to distinguish routes; hence, an alternative weighting scheme was examined to establish the impact of using no security or safety metrics. As shown in **Table 5-8**, the highest-scored routes do not change regardless of which metric is removed from the assessment, with only the 3rd, 4th and 5th ranked routes switching positions. Similarly, the removal of only the public acceptability metric results in no change to the top two routes but does result in the last two routes changing order. The removal of the public acceptability, security, and safety metrics also results in no change to the top two routes, but does result in changes to the 3rd, 4th, and 5th ranked routes. Additional analyses and sensitivity results were performed on these metrics to examine their impact on the rankings in **Section 5.5**.

Table 5-8 shows the sensitivity of the rankings, in general, to the alternative weighting schemes. To further examine the impact to the ranking/scores of the routes to changes in the weighting of the metrics, a sensitivity analysis was performed using the range of the metrics identified in **Table 5-3** (Step 8).

Table 5-9, **Table 5-10, Table 5-11**, and **Table 5-12** present the results of the sensitivity of the route rankings to the minimization of the weighting of a metric, using the minimum metric weights from **Table 5-3**. For example, under the metric column labeled “Transit Duration per Conveyance and Consist” in **Table 5-11**, results are presented using a weight of 4.2% for the “Transit Duration per Conveyance and Consist” (instead of the 5.93% in **Table 5-3**) with the other metrics proportionally re-normalized. The results indicate that only the 5th and 6th ranked routes change positions in the overall ranking. **Figure 5-6** summarizes the minimum, average, and maximum results presented in **Table 5-9**, **Table 5-10, Table 5-11**, and **Table 5-12** for the minimization of individual metrics. As can be seen from these results, the rail from CR-3 to GCUS via FNOR & CSX route remains robustly ranked as the most favored route for the removal of the SNF from the CR-3 ISFSI (at this time).

Table 5-13, **Table 5-14**, **Table 5-15**, and **Table 5-16** present the results of the sensitivity of the route rankings to the maximization of the weighting of a metric, using the maximum metric weights from **Table 5-3**, For example, under the metric column labeled “Public Acceptability of Route” in **Table 5-14**, results are presented using a weight of 8.8% for the “Public Acceptability of Route” (instead of the 6.67%), with the other metrics proportionally re-normalized. The results indicate that there is no change in the ranking of the routes. **Figure 5-7** summarizes the minimum, average, and maximum results presented in **Table 5-13**, **Table 5-14**, **Table 5-15**, and **Table 5-16** for the maximization of individual metrics. As can be seen from these results, the top ranked routes remain robustly ranked as the most favored routes for the removal of the SNF and GTCC LLW from the CR-3 ISFSI.

A final assessment of the results was performed by using the results for each individual from the pairwise comparison on the metrics to establish a route ranking per individual. These results also established, for each individual, the two rail routes with direct shipment from the CR-3 ISFSI as the favored routes for the removal of the SNF and GTCC LLW from the CR-3 ISFSI.

As a result of the MUA and its sensitivity analyses, the prioritized list of routes from the CR-3 ISFSI is found in **Table 5-7**.

Table 5-7: Prioritized list of routes from CR-3 ISFSI

Rank	Prioritized Route
1	C. Rail from CR-3 to GCUS via FNOR & CSX
2	D. Rail from CR-3 to GCUS via New Orleans
3	E. Barge via ICW to Mobile/Tombigbee River to GCUS
4	A. HHT to FNOR Rail
5	B. HHT to Dunnellon to FNOR Rail
6	F. Barge via ICW to New Orleans/Mississippi to GCUS

Figure 5-5: Impact of Each Tangible Metric on Each Route's "Score"

Table 5-8: Weighting of Routes

Nominal Results:	Unweighted		Average Weight		Biased Weight		No Safety or Security Metric		No Public Acceptability Metric		No Safety, Security, or Public Acceptability Metric	
Route	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**
A. HHT to FNOR Rail	3	15.72%	4	15.58%	4	15.58%	3	16.48%	4	15.46%	3	16.39%
B. HHT to Dunnellon to FNOR Rail	5	15.33%	5	15.15%	5	15.14%	4	16.15%	6	15.16%	4	16.29%
C. Rail from CR-3 to GCUS via FNOR & CSX	1	20.00%	1	20.22%	1	20.22%	1	19.26%	1	19.80%	1	18.44%
D. Rail from CR-3 to GCUS via New Orleans	2	18.30%	2	18.34%	2	18.34%	2	17.09%	2	18.38%	2	17.01%
E. Barge via ICW to Mobile/Tombigbee River to GCUS	4	15.69%	3	15.81%	3	15.81%	5	15.90%	3	16.02%	5	16.28%
F. Barge via ICW to New Orleans/ Mississippi to GCUS	6	14.97%	6	14.91%	6	14.91%	6	15.11%	5	15.18%	6	15.59%

Table 5-9: Weighting of Routes at Minimum Metric Value (Part 1 of 4)

Metric Minimized:	On-Site Rental Equipment Costs		Infrastructure Improvement Costs		Labor and Permitting Costs		Transport to Rail Class I Costs		Cost of Rail Transport	
Route	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**
A. HHT to FNOR Rail	4	15.51%	4	15.56%	4	15.68%	4	15.56%	4	15.63%
B. HHT to Dunnellon to FNOR Rail	5	15.07%	5	15.13%	5	15.24%	5	15.14%	5	15.19%
C. Rail from CR-3 to GCUS via FNOR & CSX	1	20.23%	1	20.26%	1	20.23%	1	20.17%	1	20.33%
D. Rail from CR-3 to GCUS via New Orleans	2	18.31%	2	18.36%	2	18.31%	2	18.26%	2	18.48%
E. Barge via ICW to Mobile/Tombigbee River to GCUS	3	15.90%	3	15.80%	3	15.73%	3	15.89%	3	15.64%
F. Barge via ICW to New Orleans/ Mississippi to GCUS	6	14.99%	6	14.89%	6	14.81%	6	14.99%	6	14.73%

Table 5-10: Weighting of Routes at Minimum Metric Value (Part 2 of 4)

Metric Minimized:	Impact of Weather to Route		Number of Sensitive Environmental Areas Nearby Route		Number of Non-Easily-Mobilizable Populations		Number of Tribal Lands Crossed		Public Acceptability of Route	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. HHT to FNOR Rail	4	15.52%	4	15.52%	3	15.63%	4	15.60%	4	15.54%
B. HHT to Dunnellon to FNOR Rail	5	15.08%	5	15.08%	5	15.19%	5	15.15%	5	15.15%
C. Rail from CR-3 to GCUS via FNOR & CSX	1	20.23%	1	20.25%	1	20.36%	1	20.39%	1	20.08%
D. Rail from CR-3 to GCUS via New Orleans	2	18.31%	2	18.39%	2	18.48%	2	18.34%	2	18.35%
E. Barge via ICW to Mobile/Tombigbee River to GCUS	3	15.88%	3	15.92%	4	15.57%	3	15.73%	3	15.88%
F. Barge via ICW to New Orleans/ Mississippi to GCUS	6	14.98%	6	14.84%	6	14.76%	6	14.80%	6	15.00%

Table 5-11: Weighting of Routes at Minimum Metric Value (Part 3 of 4)

Metric Minimized:	Cumulative Worker Exposure		Cumulative Population Dose along Route		Risks Associated with Number of Lifting Activities		Average Accident Frequency on Route		Transit Duration per Conveyance and Consist	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. HHT to FNOR Rail	4	15.67%	3	15.63%	4	15.60%	4	15.65%	4	15.48%
B. HHT to Dunnellon to FNOR Rail	5	15.22%	5	15.18%	5	15.16%	5	15.27%	6	15.04%
C. Rail from CR-3 to GCUS via FNOR & CSX	1	20.13%	1	20.42%	1	20.13%	1	20.08%	1	20.14%
D. Rail from CR-3 to GCUS via New Orleans	2	18.22%	2	18.55%	2	18.21%	2	18.16%	2	18.34%
E. Barge via ICW to Mobile/Tombigbee River to GCUS	3	15.84%	4	15.56%	3	15.91%	3	15.84%	3	15.90%
F. Barge via ICW to New Orleans/ Mississippi to GCUS	6	14.92%	6	14.66%	6	15.00%	6	14.99%	5	15.11%

Table 5-12: Weighting of Routes at Minimum Metric Value (Part 4 of 4)

Metric Minimized:	Duration for Infrastructure Improvement		Security Vulnerability of Route	
Route	Rank	Result	Rank	Result
A. HHT to FNOR Rail	4	15.57%	4	15.52%
B. HHT to Dunnellon to FNOR Rail	5	15.13%	5	15.08%
C. Rail from CR-3 to GCUS via FNOR & CSX	1	20.26%	1	20.24%
D. Rail from CR-3 to GCUS via New Orleans	2	18.35%	2	18.39%
E. Barge via ICW to Mobile/Tombigbee River to GCUS	3	15.80%	3	15.83%
F. Barge via ICW to New Orleans/ Mississippi to GCUS	6	14.89%	6	14.93%

Table 5-13: Weighting of Routes at Maximized Metric Value (Part 1 of 4)

Metric Minimized:	On-Site Rental Equipment Costs		Infrastructure Improvement Costs		Labor and Permitting Costs		Transport to Rail Class I Costs		Cost of Rail Transport	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. HHT to FNOR Rail	4	15.63%	4	15.59%	4	15.51%	4	15.59%	4	15.54%
B. HHT to Dunnellon to FNOR Rail	5	15.20%	5	15.16%	5	15.09%	5	15.15%	5	15.11%
C. Rail from CR-3 to GCUS via FNOR & CSX	1	20.22%	1	20.19%	1	20.22%	1	20.27%	1	20.15%
D. Rail from CR-3 to GCUS via New Orleans	2	18.36%	2	18.32%	2	18.36%	2	18.40%	2	18.24%
E. Barge via ICW to Mobile/Tombigbee River to GCUS	3	15.74%	3	15.82%	3	15.85%	3	15.75%	3	15.92%
F. Barge via ICW to New Orleans/ Mississippi to GCUS	6	14.86%	6	14.93%	6	14.97%	6	14.85%	6	15.03%

Table 5-14: Weighting of Routes at Maximized Metric Value (Part 2 of 4)

Metric Minimized:	Impact of Weather to Route		Number of Sensitive Environmental Areas Nearby Route		Number of Non-Easily-Mobilizable Populations		Number of Tribal Lands Crossed		Public Acceptability of Route	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. HHT to FNOR Rail	4	15.64%	4	15.61%	4	15.52%	4	15.57%	4	15.61%
B. HHT to Dunnellon to FNOR Rail	5	15.21%	5	15.19%	5	15.10%	5	15.14%	5	15.14%
C. Rail from CR-3 to GCUS via FNOR & CSX	1	20.22%	1	20.21%	1	20.07%	1	20.13%	1	20.35%
D. Rail from CR-3 to GCUS via New Orleans	2	18.36%	2	18.30%	2	18.18%	2	18.34%	2	18.33%
E. Barge via ICW to Mobile/Tombigbee River to GCUS	3	15.74%	3	15.74%	3	16.06%	3	15.85%	3	15.74%
F. Barge via ICW to New Orleans/ Mississippi to GCUS	6	14.83%	6	14.95%	6	15.07%	6	14.97%	6	14.83%

Table 5-15: Weighting of Routes at Maximized Metric Value (Part 3 of 4)

Metric Minimized:	Cumulative Worker Exposure		Cumulative Population Dose along Route		Risks Associated with Number of Lifting Activities		Average Accident Frequency on Route		Transit Duration per Conveyance and Consist	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. HHT to FNOR Rail	4	15.50%	4	15.56%	4	15.55%	4	15.49%	3	15.77%
B. HHT to Dunnellon to FNOR Rail	5	15.08%	5	15.13%	5	15.13%	5	14.99%	5	15.36%
C. Rail from CR-3 to GCUS via FNOR & CSX	1	20.31%	1	20.15%	1	20.35%	1	20.40%	1	20.39%
D. Rail from CR-3 to GCUS via New Orleans	2	18.44%	2	18.26%	2	18.50%	2	18.56%	2	18.34%
E. Barge via ICW to Mobile/Tombigbee River to GCUS	3	15.78%	3	15.91%	3	15.67%	3	15.76%	4	15.62%
F. Barge via ICW to New Orleans/ Mississippi to GCUS	6	14.90%	6	15.00%	6	14.80%	6	14.81%	6	14.52%

Table 5-16: Weighting of Routes at Maximum Metric Value (Part 4 of 4)

Metric Minimized:	Duration for Infrastructure Improvement		Security Vulnerability of Route	
Route	Rank	Result	Rank	Result
A. HHT to FNOR Rail	4	15.59%	4	15.63%
B. HHT to Dunnellon to FNOR Rail	5	15.17%	5	15.21%
C. Rail from CR-3 to GCUS via FNOR & CSX	1	20.17%	1	20.20%
D. Rail from CR-3 to GCUS via New Orleans	2	18.31%	2	18.29%
E. Barge via ICW to Mobile/Tombigbee River to GCUS	3	15.82%	3	15.79%
F. Barge via ICW to New Orleans/ Mississippi to GCUS	6	14.94%	6	14.89%

Figure 5-6: Minimum, Average, and Maximum Results from Sensitivity Analysis for Minimization of Each Metric

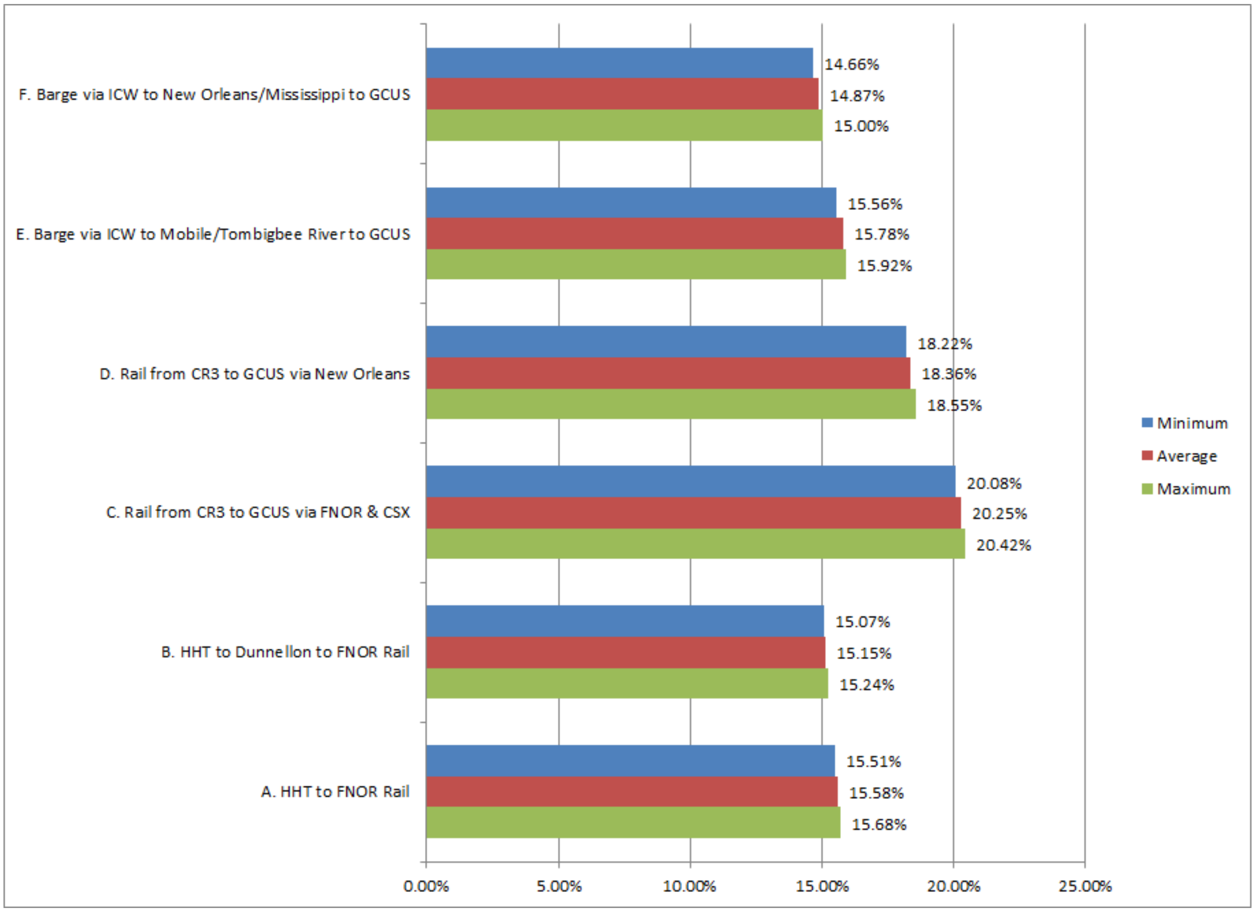
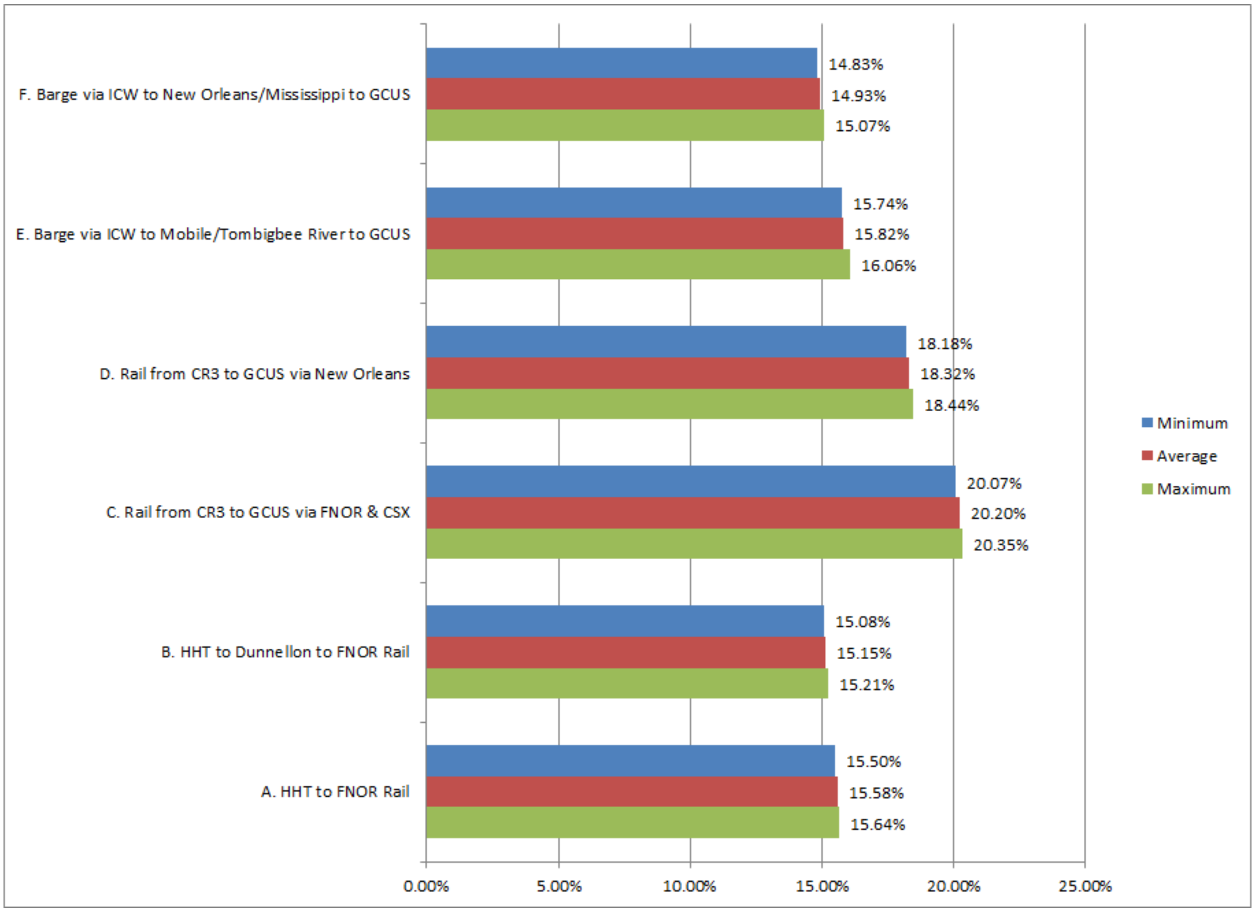


Figure 5-7: Minimum, Average, and Maximum Results from Sensitivity Analysis for Maximization of Each Metric



5.5 Additional Sensitivity Analyses

Additional sensitivity analyses have been performed to examine in more detail the impact of the results of some of the sensitivity analyses performed in **Table 5-8**. The purpose of the MUA is to use objective input backed by numerical data generated from START[1] and evidence from other sources of information (e.g., pictures) to provide a quantitative ranking of the favorability of route scenarios. However, occasionally the subjective opinions of team members can span a larger range than may be necessary to distinguish between routes and may over emphasize the difference between routes. For example, as noted in **Section 5.3.3.12**, the dose along the route to individuals is expected to be below background levels (i.e., essentially negligible). Nevertheless, cumulative population doses along the routes were still ranked from being neutral to more favorable against one another, when in fact they should have at most spanned from neutral to mildly favorable over one another. Additional sensitivity analyses were performed, which examined the impact of suppressing the range of assessments for metrics whose material results are acceptable (e.g., through regulatory requirements). Additionally, more detailed analyses of the sensitivity results presented in **Table 5-8** are provided in this section for additional assessment.

5.5.1 Suppression of Evaluation Span for Select Metrics

As noted in **Section 5.3.3**, there are several metrics used in the MUA that realistically only vary slightly between each route, as the results will always be acceptable for regulatory reasons. The purpose of this sensitivity analyses is to examine the impact to the route rankings as a result of limiting the span by which select metrics are evaluated. These select metrics include:

- Cumulative Worker Exposure,
- Cumulative Population Dose along Route,
- Risks Associated with Number of Lifting Activities,
- Average Accident Frequency on Route, and
- Security Vulnerability of Route.

These specific safety and security metrics were selected for evaluation of span suppression as a result of each of them being regulated (e.g., by the NRC) to an acceptable level. Regardless of the route selected, these identified metrics should only vary marginally, so suppressing the span of the pairwise comparison by route from between mildly favorable to mildly unfavorable, as shown in **Figure 5-8**, was examined. Since these five metrics were ranked by average in the top six metrics from the pairwise comparison by individual team members, the suppression of the span of the pairwise comparison could impact the route rankings.

Figure 5-8: Example of Suppression Cumulative Worker Exposure Range

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Cumulative Population Dose along Route (α population density)	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail					X			E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail					X			F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail					X			E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail					X			F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX			X					D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX					X			E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX					X			F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans					X			E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans					X			F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS			X					F. Barge via ICW to New Orleans/Mississippi to GCUS

In **Figure 5-8**, assessments originally identified as "Strongly Favorable" or "More Favorable" were suppressed to "Mildly Favorable" and those originally identified as "Mildly Favorable" were moved to "Neither Favorable (neutral)" to examine the impact of suppressing the span of the pairwise comparison by route for metrics whose parameters are regulated to acceptable levels.

Figure 5-9 shows the modified rankings with the security and safety metrics evaluation range suppressed. **Figure 5-10** shows the contribution each tangible metric makes to the scoring for each route.

Table 5-17 compares the results from the original assessment and the modified results using the suppressed span. These results show little overall change, with the exception of the HHT to FNOR Rail moving up to 3rd, and the barge route via ICW to Mobile/Tombigbee River moved down to 4th in the rankings. Hence, the rail routes from the CR-3 site remain the highest ranked routes, which is consistent with the results identified by the other sensitivity analyses included in this report.

Figure 5-9: Resulting List of Prioritized Routes from the CR-3 ISFSI for the Suppression of Span for Safety and Security Metrics

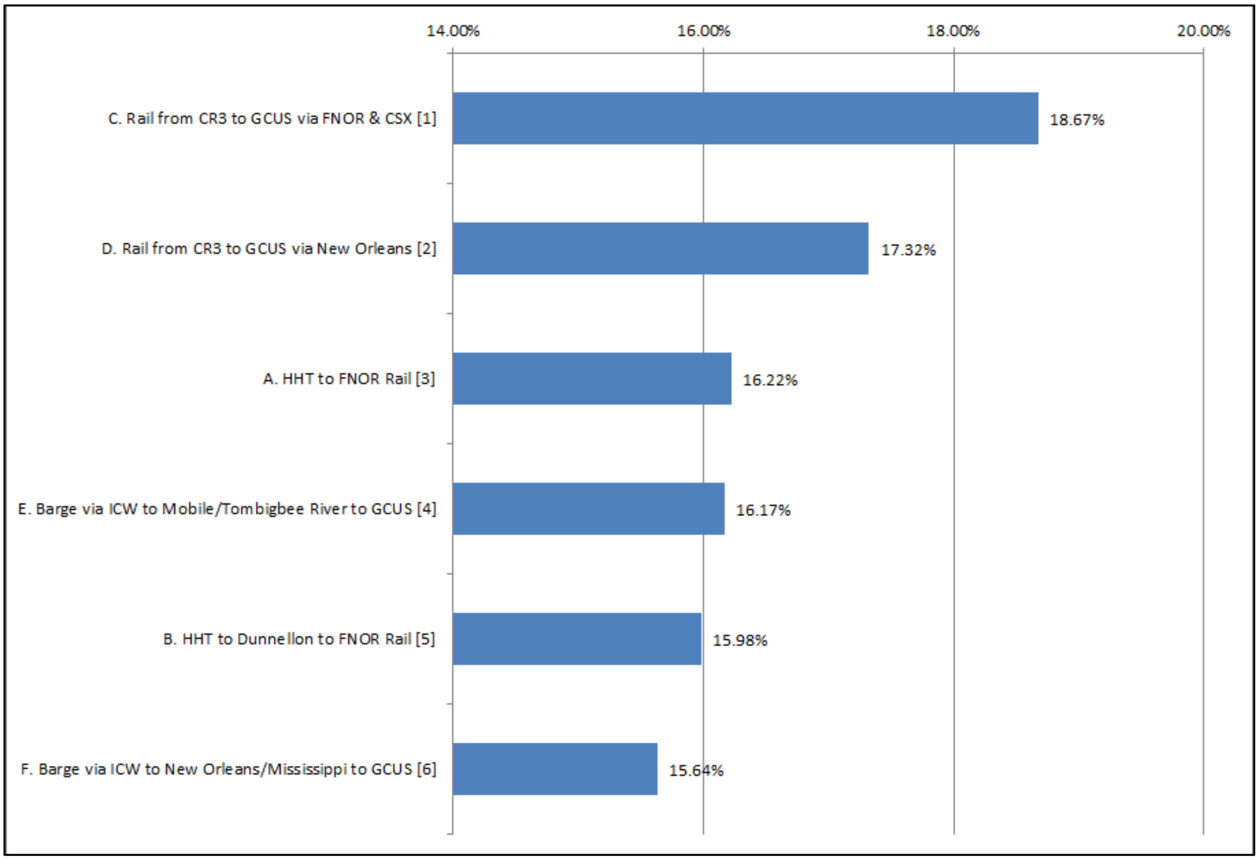


Figure 5-10: Impact of Each Tangible Metric on each Route's Scoring for the Suppression of Span for Safety and Security Metrics

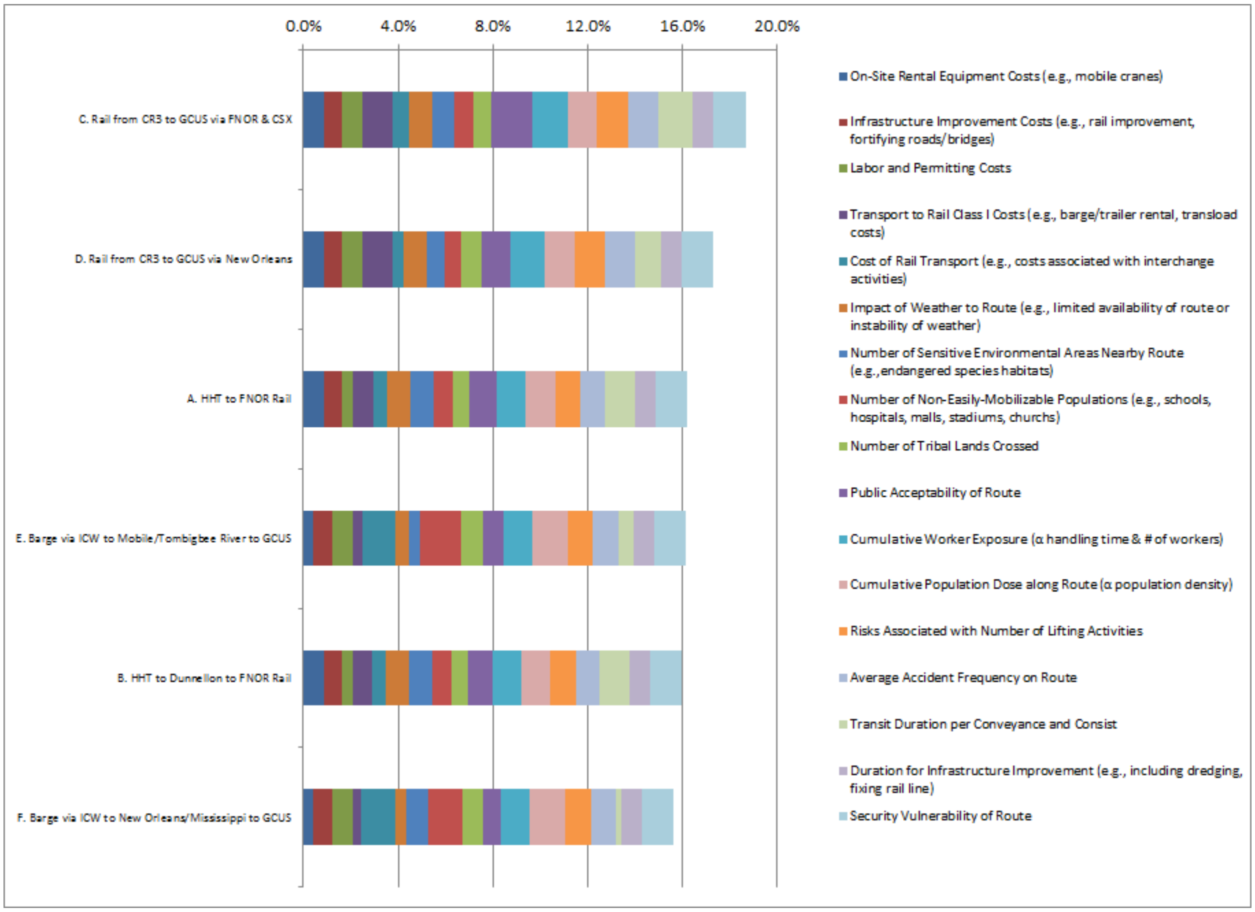


Table 5-17: Comparison of Original MUA Results to the Suppressed Span MUA Results

Suppression Results		Route	Original Results	
Rank	Avg		Rank	Avg
1	18.67%	C. Rail from CR-3 to GCUS via FNOR & CSX	1	20.22%
2	17.32%	D. Rail from CR-3 to GCUS via New Orleans	2	18.34%
3	16.22%	A. HHT to FNOR Rail	4	15.58%
4	16.17%	E. Barge via ICW to Mobile/Tombigbee River to GCUS	3	15.81%
5	15.98%	B. HHT to Dunnellon to FNOR Rail	5	15.15%
6	15.64%	F. Barge via ICW to New Orleans/Mississippi to GCUS	6	14.91%

5.5.3 Details of Select Sensitivity Results

Additional details of some select sensitivity results shown in **Section 5.4** are presented in this section to allow for additional assessment of the results. The specific sensitivity analyses for which additional details are provided include the impact of the removal of:

- The safety metrics including:
    - The cumulative worker exposure metric,
    - The cumulative population dose along route metric,
    - The risks associated with the number of lifting activities metric, and
    - The average accident frequency on route metric.
- The security metric;
- The public acceptability metric; and
- The public acceptability and security metrics at the same time.

Results shown in **Figure 5-11** and **Table 5-18** for the removal of the safety metrics show the rankings for the top two routes remain intact. Although the resulting rankings indicate the rail from CR-3 to GCUS via FNOR & CSX remains the top ranked route, the other 5 routes become closer together and separated by approximately 2%, indicating just a minor difference between the routes. Results shown in **Figure 5-12** and **Table 5-19** for the removal of the security metric show a slight change from the original rankings, with only the last two ranked routes changing positions. Results shown in **Figure 5-13** and **Table 5-20** for the removal of the public acceptability metric show a slight change from the original rankings, with only the last two ranked routes changing positions, similar to the results of removing the security metric results. The final sensitivity analysis performed involved removing both the public acceptability and security metrics at the same time. **Figure 5-14** and **Table 5-21** show the results of this assessment with only the 4^{th}, 5^{th}, and 6^{th} ranked routes exchanging positions relative to the original ranking.

Overall, the Rail from CR-3 to GCUS via FNOR & CSX is consistently the highest-ranked route for transloading the transportation casks onto a Class I railroad. However, this route does require additional assessment prior to final selection, and some of the particular issues requiring resolution include but are not limited to the rail line at the on-site transload site remaining viable for use and the rail routes meeting the required clearances.

Figure 5-11: Impact of Removing the Safety Metrics

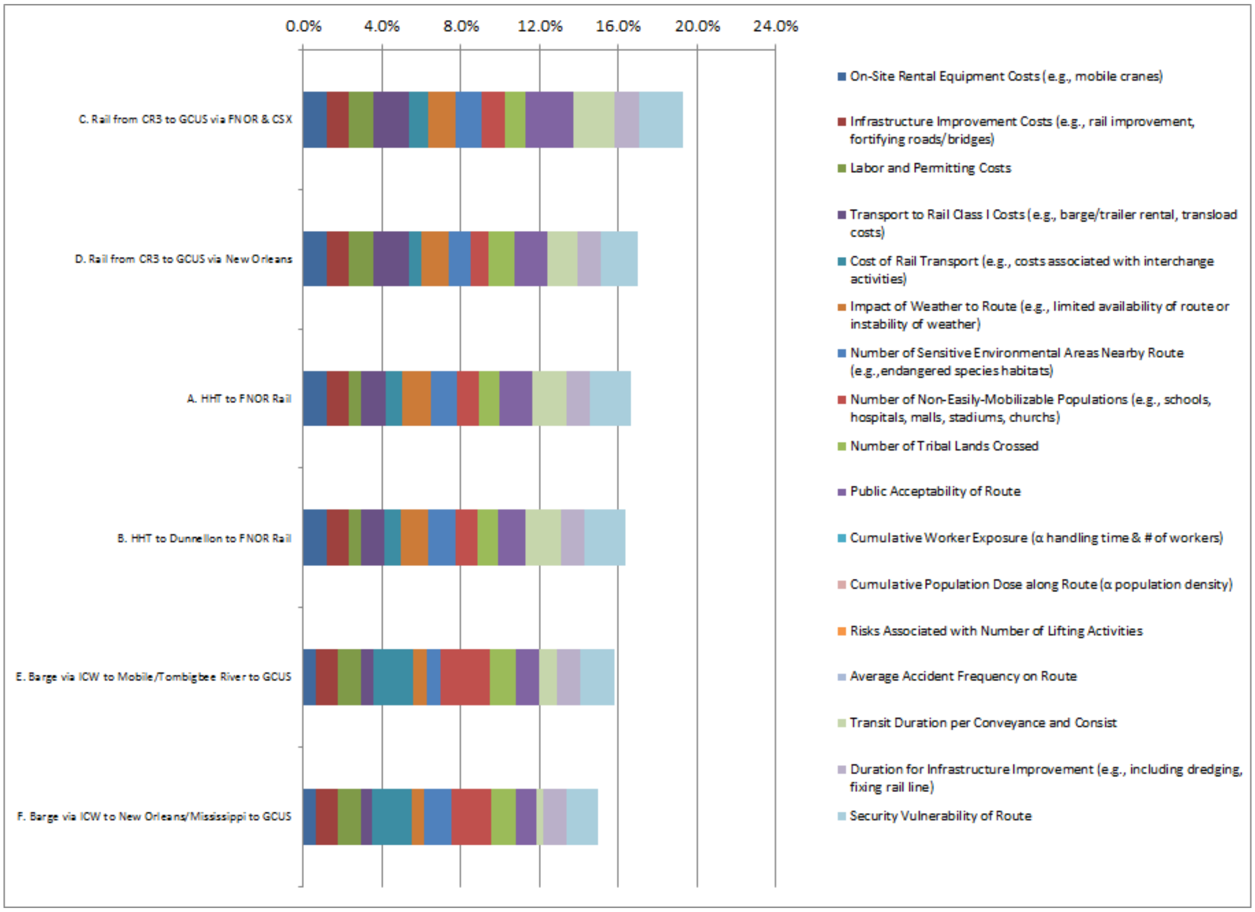


Table 5-18: Results from the Deletion of the Safety Metrics

Rank	Norm Points	Results
1	19.28%	C. Rail from CR-3 to GCUS via FNOR & CSX
2	16.98%	D. Rail from CR-3 to GCUS via New Orleans
3	16.63%	A. HHT to FNOR Rail
4	16.34%	B. HHT to Dunnellon to FNOR Rail
5	15.80%	E. Barge via ICW to Mobile/Tombigbee River to GCUS
6	14.97%	F. Barge via ICW to New Orleans/Mississippi to GCUS

Figure 5-12: Impact of Removing the Security Metric

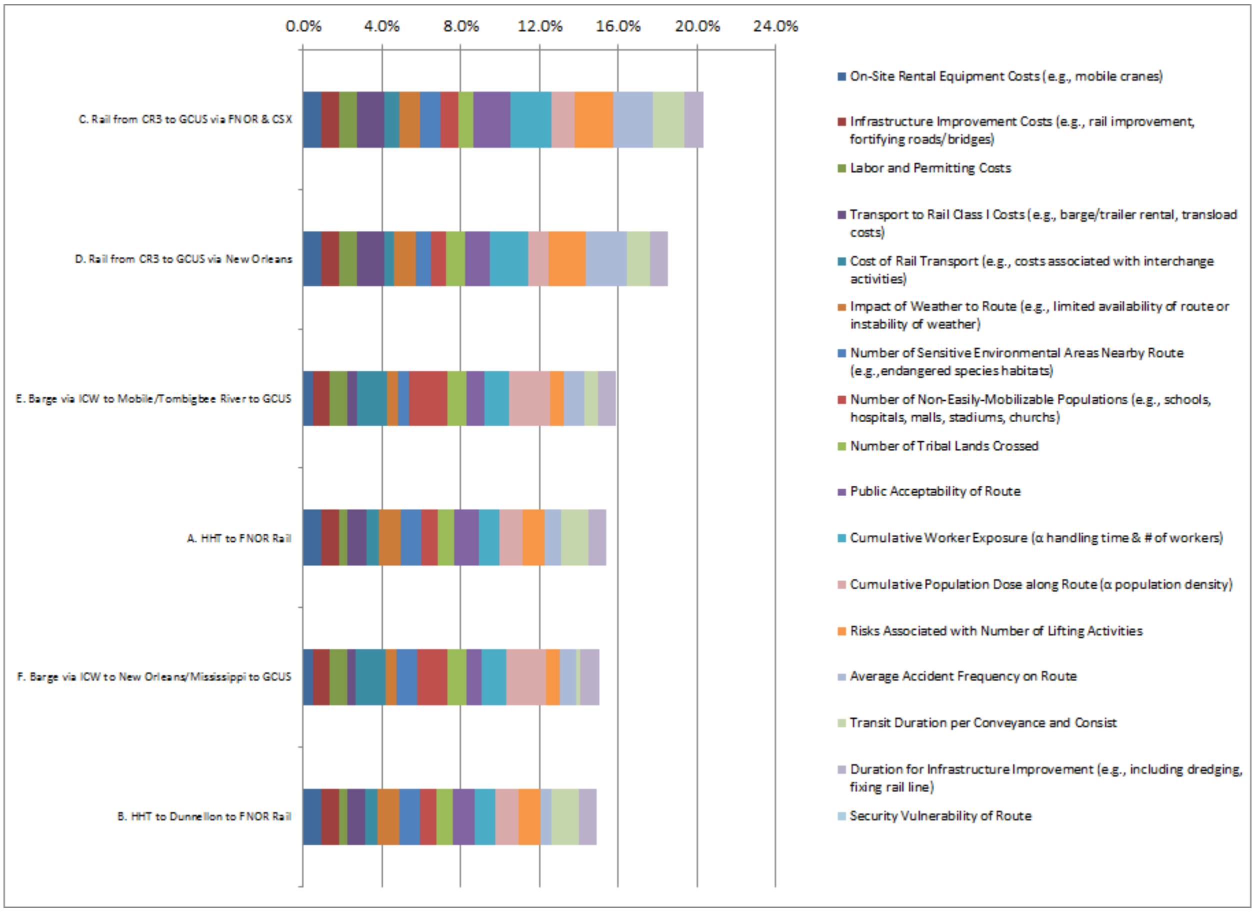


Table 5-19: Results from the Deletion of the Security Metric

Rank	Norm Points	Results
1	20.29%	C. Rail from CR-3 to GCUS via FNOR & CSX
2	18.53%	D. Rail from CR-3 to GCUS via New Orleans
3	15.88%	E. Barge via ICW to Mobile/Tombigbee River to GCUS
4	15.38%	A. HHT to FNOR Rail
5	15.00%	F. Barge via ICW to New Orleans/Mississippi to GCUS
6	14.91%	B. HHT to Dunnellon to FNOR Rail

Figure 5-13: Impact of Removing the Public Acceptability Metric

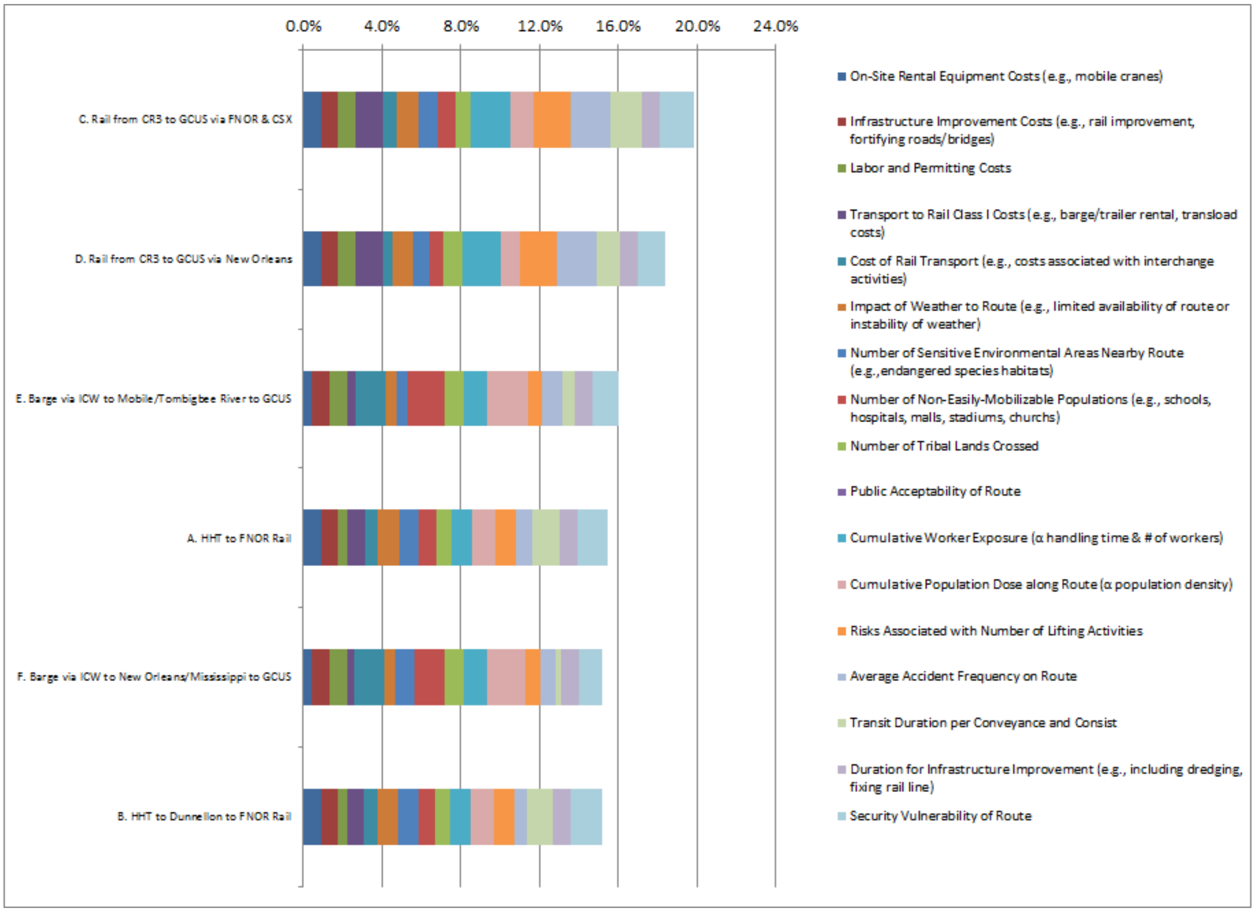


Table 5-20: Results from the Deletion of the Public Acceptability Metric

Rank	Norm Points	Results
1	19.80%	C. Rail from CR-3 to GCUS via FNOR & CSX
2	18.38%	D. Rail from CR-3 to GCUS via New Orleans
3	16.02%	E. Barge via ICW to Mobile/Tombigbee River to GCUS
4	15.46%	A. HHT to FNOR Rail
5	15.18%	F. Barge via ICW to New Orleans/Mississippi to GCUS
6	15.16%	B. HHT to Dunnellon to FNOR Rail

Figure 5-14: Impact of Removing the Public Acceptability and Security Metrics

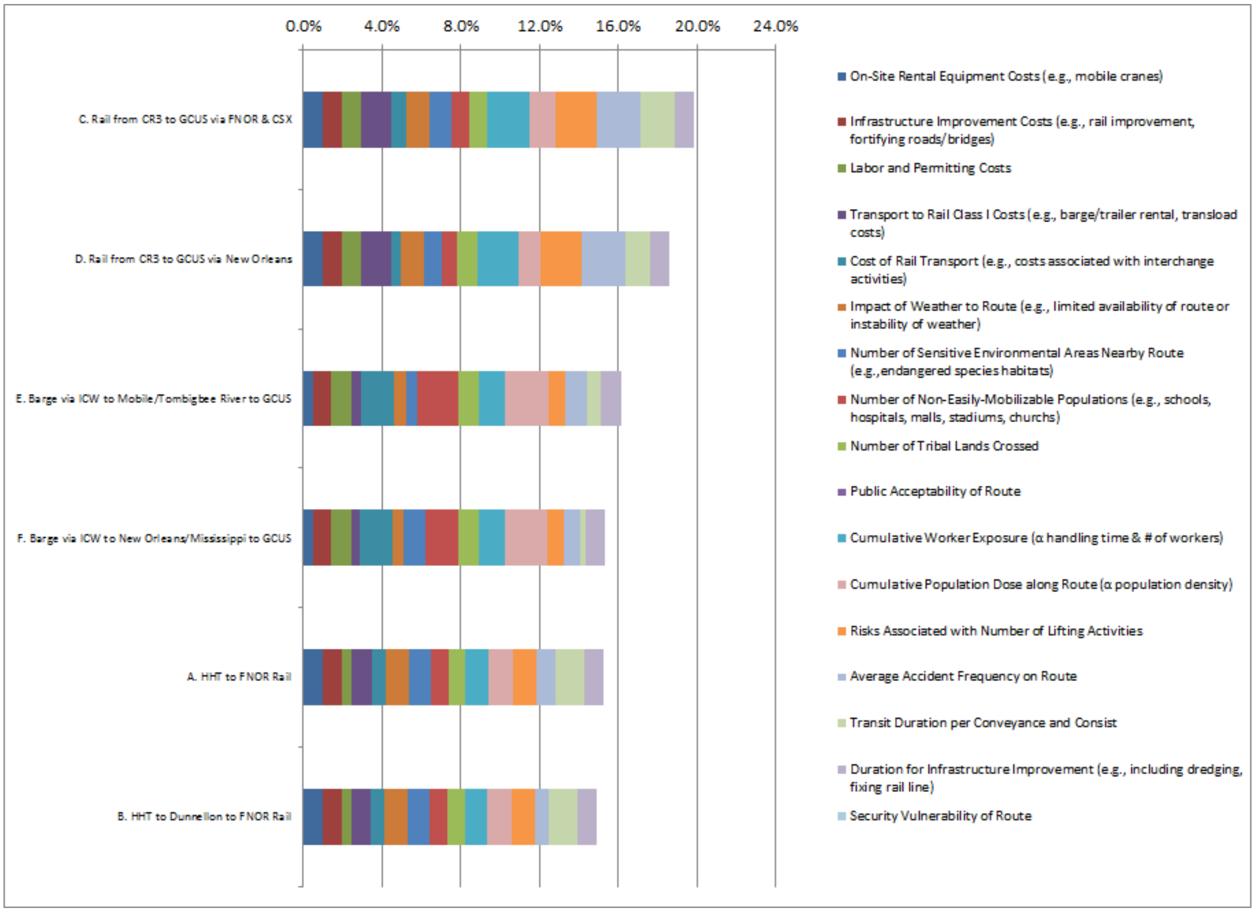


Table 5-21: Results from the Deletion of the Public Acceptability and Security Metrics

Rank	Norm Points	Results
1	19.84%	C. Rail from CR-3 to GCUS via FNOR & CSX
2	18.59%	D. Rail from CR-3 to GCUS via New Orleans
3	16.12%	E. Barge via ICW to Mobile/Tombigbee River to GCUS
4	15.30%	F. Barge via ICW to New Orleans/Mississippi to GCUS
5	15.24%	A. HHT to FNOR Rail
6	14.90%	B. HHT to Dunnellon to FNOR Rail

6.0 CONCEPT OF OPERATIONS FOR RECOMMENDED APPROACH

6.1 Overview of Operations and Assumptions for TN Americas MP197HB System

The operations associated with the de-inventory of CR-3 fuel stored in NUHOMS systems will require leasing or purchasing transportation casks, on-site transfer equipment, auxiliary equipment, ancillary systems including mobile crane(s) and lifting equipment, development/confirmation of training program materials, training of operating personnel and supervisors, preparation and approval of site operating procedures, facility operational readiness review, dry run operations, de-inventory activities, and transportation operations, and demobilization of equipment from the site. Due to the complexity of these operations, the sequence of activities is divided into five groups:

1) Mobilization operations: procurement/lease and delivery of required equipment to the site;
2) Operational readiness: operating procedure preparation and approval, training program development, operator training, equipment checkouts, dry run(s), and operational readiness review(s);
3) ISFSI Site operations: performance of canister transfer operations from the NUHOMS HSM to the MP197HB transport casks respectively, for offsite transports;
4) Rail transport operations; and
5) Demobilization of equipment and personnel from the CR-3 site.

Based on the number of canisters to be loaded and shipped from the CR-3 ISFSI (i.e., 39 canisters with SNF and two GTCC waste canisters), it is recommended to load and ship five transport casks for each offsite transport campaign by rail transport with a total of ten transport cask systems each committed to the de-inventory shipping campaign. Shipment of the empty casks from GCUS will be transported on a dedicated train.

The following assumptions were used in planning this NUHOMS 32PTH1 canister transfer, loading, and off-site shipment campaign:

- Ten MP197HB casks, including impact limiters (to allow for simultaneous shipments) and intermodal transport cradle with integral tie-downs and personnel barrier are all available;
- Two transfer trailers with transfer skids will be used for transfer operations at the CR-3 site;
- Impact limiters will be removed and installed onto the cask while the cask is positioned on the rail car;
- The maintenance activities required to be performed in Chapter 8 of the SAR will be completed and up-to date (see **Table 6-1**):
  - Trunnions (as applicable),
  - The MP197HB cask lid bolts are within the 250 shipments requirement or have been replaced,

   - The five-year test of the impact limiter to ensure that water has not entered the impact limiters is current, and
   - Cask annual containment boundary leakage test.
- Canister and contents have been evaluated and are compliant with the cask SAR;
- Fuel/canister is assumed transportable for these activities (e.g., 10 CFR Part 71 dose and thermal limits are met);
- All areas used for transfer operations, including the ISFSI, haul path, and transloading site, will be encompassed inside of the boundary and be covered by the safety basis associated with the relevant 10 CFR Part 50 or 10 CFR Part 72 license; and
- The cask intermodal skid used to transport the cask on railcars will be permanently attached and secured to the railcars in accordance with the AAR Open Top Rules. Specifically, all restraint values meet the requirements of 7.5G x 2G x 2G[43][44], the requirement from the DOT and what is required for load securement in the transportation cask SAR.

Table 6-1: Maintenance Program Schedule

Maintenance Program Schedule MP197HB Cask	
Task/Activity	**Frequency**
Visual inspection of cavity	Prior to loading
Visual inspection of O-rings	Prior to loading
Visual inspection of neutron shield shell segments for structural or penetration damage	Prior to loading
Visual inspection of cask lid bolts and lid port coverplate bolts	Prior to installation (each use)
Visual and Proper Function Inspection of Cask	Prior to and during each use
Visual inspection of lifting trunnions and rotation trunnions	Prior to and during each use
Periodic leakage rate test of cask lid and lid port coverplate containment O-rings	Annually during use
Pre-shipment leakage rate test of cask lid and lid port coverplate containment O-rings	Prior to each loaded transport
Maintenance leakage rate test of containment system	After replacement or repair of containment boundary components
Replacement of lid and lid port coverplate metallic O-rings	Prior to each loaded transport
Visual inspection of impact limiters for structural or penetration damage	Prior to each loaded transport
Impact Limiters Leak Test	Once every five years

6.1.1 Pre-Mobilization/Mobilization

Table 6-2 lists the activities required to prepare for and remove SNF and GTCC waste from the CR-3 ISFSI.

Table 6-2: Activities to Prepare and Remove SNF and GTCC waste from CR-3 ISFSI using MP197HB System

Task		Task Activity Description
Programmatic Activities to Prepare for Transport Operations from the CR-3 Site		
1	Assemble Project Organization	Assemble management teams; identify decommissioned site existing infrastructure, constraints, and transportation resource needs; and develop interface procedures.
2	Acquire Transportation Cask, Hardware, Railcars, Off-Site HHT, and Transport Services	Develop specifications, solicit bids, issue contracts, and initiate preparations for shipping campaigns; includes procurement of transport packagings including impact limiters, personnel barriers, intermodal transport cradles, if required; procurement of AAR Standard S-2043 railcars; and procurement of off-site transportation services including rail and HHT as applicable.
3	Acquire/Lease Required Auxiliary Equipment Prime Mover, on-site Transfer Trailer and Remaining Required Auxiliary Equipment	Equipment will need to be leased and shipped to site for setup and checkout prior to start of the training program and performance of the dry run(s). In addition, there is limited staffing at the CR-3 ISFSI site, so outside contractor crews will need to be assembled, trained, and evaluated to perform all transfer operations.
4	Prepare Transfer Area and Equipment in accordance with the requirements of the CR-3 FSAR	There is area of approximately 35 feet x 100 feet on the south end of the NUHOMS pad allowing sufficient room for equipment staging in support of canister transfer operations. Transfer will occur at the door of each HSM with a transfer trailer loaded with a MP197HB cask aligned to make the transfer and transport the transfer trailer to the rail car.
5	Conduct Preliminary Logistics Analysis and Planning	Determine fleet size, transport requirements, and modes of transport.
6	Coordinate with Stakeholders	Coordinates with carriers and makes notifications to federal, state, and applicable tribal nations.

Task		Task Activity Description
7	Develop Campaign Plans/Procedures (e.g., prepare, review, and approve all required site operating procedures for the DSC unloading from the HSMs and transfer/loading into the MP197HB casks, preparation and testing of the casks, and procedures for all the major and auxiliary components and systems)	Develop plans, policies, and procedures for on-site operational interfaces and acceptance, support operations, and in-transit security operations. Initial drafts of DSC unloading operations can be prepared from procedures initially prepared during the original loading campaign. Similar procedures will be required for the auxiliary equipment including transfer operations. New site procedures will be required for the handling of the transport casks, transfer operations, transfer trailer operations, proper tie-down and securing of the cask's packages to the railcar/intermodal transport cradle, evacuation and backfilling of the cask cavity with helium, helium leakage testing of the cask containment boundary seals, etc. All approved procedures will require review and approval by CR-3 Independent Safety Review (ISR).
Operational Activities to Prepare, Accept, and Transport from CR-3		
8	Conduct Readiness Activities (e.g., In-Processing, Badging, Training, and Dry Run(s) of All Personnel, Procedures, and Operations)	Assemble and train on-site operations interface team including readiness reviews, tabletop exercises, and dry-run operations. All new de-inventory project personnel including supervisors, riggers/cask technicians, radiation protection (RP), and Quality Assurance (QA)/Quality Control (QC) personnel would need to be trained and qualified to perform the operating procedures in accordance with CR-3's Systemic Approach to Training Programs. Training would require classroom, on-the-job training (OJT) (operating required equipment), and formal Training Program Evaluation (TPE) effectiveness. All de-inventory project personnel would require training commensurate with their responsibilities and work scope on the project.
9	Transmit DSC load reports and transportation related documents	Assemble DSC load reports and the applicable transportation documents and transmit to the un-loading facility.
10	Load for Off-Site (ISFSI) Transport	Unload storage systems and transfer DSCs to transport casks, install loaded casks onto intermodal transport cradles, installing impact limiters and personnel barrier.
11	Accept for Off-Site (ISFSI) Transport	Accept loaded casks onto transfer trailer for offsite ISFSI transportation and shipment to the designated destination.

6.1.2 Operational Readiness

6.1.2.1 Site-related Operational Readiness Items

Prior to the performance of an Operational Readiness Review and Assessment, the assembled de-inventory project team would be required to be trained and competence confirmed in all required planned site operations and contingencies. All equipment would need to be delivered, assembled, and proper operation verified. Required procedures and project instructions would need to be approved and issued. When all preliminary activities have been completed, the Operational

Readiness Review and Assessment would be performed. This is a process used to verify facility, equipment, processes, procedures, and other critical activities have been planned and executed safely. It also ensures that the project team and procedures comply with the applicable regulations, permits, authorizations, and agreements that are in effect for the shipment to meet regulatory, contract, and stakeholder requirements prior to commencing operations as part of a de-inventory of the CR-3 ISFSI. The following subsection will discuss the operational readiness required to ensure operations at CR-3 are ready to commence and can be performed in a safe and regulatory compliant manner.

A review of the NUHOMS FSAR, the transportation cask's SARs, and the applicable CoCs will need to be performed to verify that the contents of the NUHOMS DSCs meet the required content conditions and quantities listed in the storage and transportation CoCs and Approved Contents. The contents (form and quantity) of the NUHOMS DSCs would require verification for compliance with the current revision of the CoC for the transport cask systems at the time of shipment.

Operations management would ensure quality, safety, and operational readiness. This assessment shall include verification of the roles and responsibilities among the different organizations involved with and performing the work. Communication among the stakeholders, review and approval of procedures, and interfacing with regulators must occur to ensure the processes to execute work have been reviewed are ready to start work. Based on the assumption in this report that DOE shipments would follow the same requirements as a commercial shipper of SNF, NRC is assumed to be involved in the initial routing approval, and those approved routes will be valid for five to seven years as indicated and described below.[12] Once route approval is granted, advanced notification would be provided prior to each shipment, as the campaign is longer in duration than one train movement.

6.1.2.2 Personnel-related Operational Readiness Items

As required by the NUHOMS technical specifications (TS), a training program is required to be implemented for all project personnel as specified in the TSs. The training program would require a qualified trainer to oversee and conduct the training on the NUHOMS systems with operationally qualified personnel to perform the OJT and TPE portions of the training program. The training program shall include the following requirements and elements:

Classroom Training:

- Module 1 – NUHOMS HSM and MP197HB Systems Overview,
- Module 2 – On-site ISFSI Transport (transfer trailer) Operations including Prime Mover,
- Module 3 – Canister Unloading Operations from NUHOMS HSM,
- Module 4 – MP197HB Transport Cask Handling and Loading Operations,
- Module 5 – MP197HB Transport Cask Intermodal Transport Cradle Tie-Down and Transloading Operations,

[12] NRC route approval is not typically required for DOE shipments; however, for purposes of this report, it is assumed that the shipments would be conducted like comparable commercial shipments.

- Module 6 – Preparation of MP197HB Transport Cask for Transport,
- Module 7 – MP197HB Transport Cask Containment O-Ring Helium Leakage Testing,
- Module 8 – Use of Measuring and Test Equipment,
- Module 9 – Radiological Concerns and as low as reasonably achievable (ALARA) Planning,
- Module 10 – Regulatory Requirements,
- Module 11 – Supervisor Training, and
- Module 12 – Contingency CR-3 Procedures.

On the Job Training:

- OJT-1 – Perform Pre-Use Inspections MP197HB casks, Lift Yoke, Chain Hoist, and other support equipment,
- OJT-2 – Prepare an HSM for Canister Transfer,
- OJT-3 – Off-Load Empty MP197HB Transport Cask from Intermodal Transport Cradle,
- OJT-4 – Perform MP197HB Cask Setup for Canister Transfer from HSM,
- OJT-5 – DSC Loading into MP197HB Transport Cask,
- OJT-6 – Movement of MP197HB transfer trailer to/from ISFSI/HSM,
- OJT-7 – MP197HB Transport Cask Lid Installation and Torquing, and Cavity Evacuation, Backfill, and Helium Leakage Testing,
- OJT-8 – On-site and Off-site ISFSI Operations, and
- OJT-9 – On-site and Off-site ISFSI Intermodal Transport Cradle Handling Operations.

At the completion of the classroom training and OJT elements, operations supervisors would perform TPE for each applicable project personnel to confirm the adequate knowledge and effectiveness of the training prior to final training certification.

Operational dry runs with a DSC mock-up to perform the transport cask loading operation will be conducted at CR-3 for the MP197HB cask and support equipment. This includes preparation of the HSM for DSC transfer, transfer of the DSC into the MP197HB cask, testing, and transfer of the cask onto the transport skid.

Communication and interfacing with the applicable stakeholders will be needed to ensure readiness. Including, but not limited to, CR-3, DOE, State, Tribal, and local authorities. In addition, the NRC on-site and Region III inspectors would observe and provide regulatory oversight throughout the entire preparation, construction, operating procedure and approval process, and training/dry run program. Some entities should be involved in all aspects of the project, i.e., planning, development of concepts, training, readiness approval, and performing oversight on any dry run operations. This includes reviewing procedures and possibly performing audits/assessments to ensure operational readiness. As additional readiness verification, an independent team of dry cask storage and transport experts should review applicable operational procedures and equipment design/function prior to initiation of the transfer program. As a last step prior to start of operations, a final dry run would be performed as specified in the NUHOMS training program and witnessed by DOE, NRC, and stakeholders. Additionally, and as applicable, these entities would be involved in event response planning and mitigation, including contingency CR-3 emergency event training, to ensure that any event is well managed and mitigated prior to the first shipment of the campaign. This would encompass approvals to start work, training, and interaction with State and local authorities. It is assumed that CR-3, NRC, and DOE would participate as observer/regulator/participant for each shipment.

6.1.2.3 Transportation-related Operational Readiness Items

Equipment Readiness Determined through Review of the Following:

- Document insurance requirements of the contract are in place,
- Transportation equipment certifications are current and would be for the duration of the CR-3 transportation cycle,
- All vehicles have required registrations (as applicable),
- All vehicles have current inspections,
- Radiological packaging meets all current requirements,
- Packages are correctly identified (i.e., all required markings and placards are displayed properly, and are available at the site prior to beginning the operation),
- Copies of inspections are provided for equipment to be used to handle and transport the transport casks,
- Copies of all procedures associated with the transportation of the transport casks are provided, and
- Proper documentation that the required Security Plan is in place and has been approved.

Transportation Personnel Readiness:

- Key personnel and their qualifications are identified,
- Required background checks are current and requirements of coverage of drug and alcohol programs are met,
- Copies of the training materials are provided and required trainings are current for all employees involved,
- All personnel are in possession of and working from the correct procedures and Radiation Work Permits (RWPs) and copies are provided,
- All private security personnel have required weapons certifications to cover the CR-3 transportation cycle,
- Transportation personnel would be monitored for radiological exposure, if required, and
- Proper equipment and personnel are available to monitor workers and equipment for contamination, if required.

Transportation Readiness Notifications:

- Proper notifications have been made to the Tribes, State and local governments, DOT, USCG, NRC, and DOE, as applicable, and copies are provided. Any water served or adjacent facility is required to have an active and updated Security Plan, which must be reviewed and approved by the USCG. If a plan exists, it should be confirmed by the shipper and updated as to the actual operations designed to take place on the site during the campaign;
- All required permits to transport SNF are prepared and/or in place;
- Proper notification requirements are being met for the receiving facility; and
- Scheduled meetings and briefings that would be conducted for all phases of the shipments are identified.

6.1.3 Site Operations

Each NUHOMS canister transfer sequence and loading into the MP197HB cask will encompass multiple major elements.

6.1.3.1 Receiving the Cask and Preparation for Canister Loading

An inspection of the empty cask system and intermodal skid will be performed to verify no damage has occurred to the cask and intermodal skid during transport. Additionally, radiation and contamination surveys will be performed to the cask system to verify acceptable levels.

Once the inspections and surveys have been completed and verification that all equipment needed to perform the cask loading is in place, operations will remove the personnel barrier and impact limiters from the cask. The bolts that secure the personnel barrier to the cask intermodal skid will be removed. The personnel barrier will be removed from the intermodal skid/cask and positioned at a location for storage. The personnel barrier and associated hardware will be inspected for damage and additional surveys of the exposed cask surfaces will be performed to verify levels are acceptable.

The three impact limiter hoist rings will be inspected, the impact limiter hoist ring plugs/bolts removed, and the hoist rings installed to the front impact limiter. The tamper indicator will be removed. The crane operator will apply a slight load to the impact limiter to aid in removal of the 12 impact limiter bolts. Operations will remove the impact limiter bolts from the cask and store them. Each bolt will be inspected for damage and surveys of the bolts will be performed as needed.

Once all the bolts have been removed from the impact limiter, the crane operator, with support from riggers, will swing the front impact limiter from the cask body and store. Once this is completed, the cask tie-downs to the intermodal skid will be removed. The on-site transfer trailer will be positioned at a location for loading the empty cask onto the transfer trailer. The impact limiter and cask lid area exposed surfaces will be surveyed for contamination. Additional inspections will be performed on the impact limiter shell for any dents or penetrations or any evidence of weld cracking or other damage which could result in water in-leakage.

Once the front impact limiter has been removed, the crane operator and riggers will attach to the rear impact limiter. This operation for removal of the rear impact limiter is the same process as discussed above for the front impact limiter.

Once both impact limiters have been removed, the cask has been surveyed for contamination, and levels are acceptable, operations, with support from a radiological control technician (RCT), will obtain a sample of the atmosphere on the inside of the cask cavity. During removal of the vent plug and bolt, RCT coverage will be needed to verify that contamination levels are within the acceptable levels. If contamination levels are not acceptable, operations will be stopped, the cask will be placed in a safe configuration, and management notified.

The crane will be attached to the cask and slowly lift the cask from the rail car and swing the cask into position over the on-site transfer trailer with the cask lid facing to the back of the transfer trailer. At this point, the crane operator will slowly lower the cask onto the on-site transfer trailer and into the skid positioning system. The crane will be disconnected from the cask and the skid tie-downs will be attached to secure the cask to the transfer skid.

Once the cask surveys have been completed and levels confirmed, operations will remove the front cradle tie down strap and the front trunnion covers from the cask and perform an inspection of the two front cask trunnions including bolts and thread area, seals, mounting blocks, bolt holes on the cask body, and trunnion lifting surfaces for damage that would cause an unsafe condition during docking and transfer operations. Once the inspections are completed, the front trunnions will be installed onto the cask body and the trunnion bolts torqued as required in the cask SAR.

It should be noted that only the front cask trunnions will be installed on the cask body to allow an anchor point to secure the cask to the HSM for docking purposes and loading of a canister into the cask.

Loading of the second transfer trailer will start and be completed concurrently while loading a DSC into the first cask.

6.1.3.2 Canister Loading into the Cask

In preparation for canister loading, the port plugs and port plug bolts will be removed from the vent, drain, and test ports. RCT will survey the plugs and port areas for contamination. Plugs and bolts will be inspected for damage and new O-ring seals installed.

Concurrently, the cask ram access closure plate will be removed by first removing the 12 cover bolts. RCT will survey bolts as needed. As the cover is removed, RCT coverage would be needed during the cover plate removal. Using the crane, the cover is removed. Once the cover is removed and surveyed, the metal seal will be removed and inspected for damage performed on the cover plate, cask body seal surface area, and the cover plate bolts. Operations staff will install a new seal on the cover plate and store.

A cask lid-handling device will be attached to the cask lid and a slight load will be applied to the rigging to aid in the removal of the cask lid bolts. Operations staff will loosen all bolts and then remove the bolts and store, and RCT will survey bolts as needed. Once the bolts are all removed and with support from RCT, the cask lid will be removed, surveyed, and stored in a location for inspection.

Operations staff will remove and discard the cask lid seals and perform an inspection on the cask lid, the lid/body seal surfaces for damage, cask lid bolts, and the cask body bolt holes for any damage. Once the inspection is completed, new lid seals will be installed onto the cask lid. The cask lid will be placed in a storage location.

RCT will perform a survey of the internal cask cavity for contamination and direct any decontamination if required.

Using the target aligning system on the cask, trailer, HSM, and using a transit, the transfer trailer will be positioned in front of the HSM to be discharged.

The HSM door-lift fixture will be positioned to the HSM door and the fixture mounting bolts and torque installed. Operations staff will raise the crane slightly to preload the door to aid in the HSM door bolt removal. With support from RCTs, the HSM door bolts will be removed. Operations staff will continue to remove the HSM door while RCT continues radiation and contamination monitoring during the operation. At any time, if the radiation or contamination levels exceed the approved limits, the operation will be stopped, equipment placed in a safe configuration, and management notified. Once the HSM door is removed, it will be placed in a storage location.

RCT will conduct additional surveys and monitoring of the canister and verify the levels are acceptable. Operations will inspect the canister and canister grapple for any signs of degradation from storage and remove the seismic restraints. Once the inspection has been completed, the transfer trailer and cask will be positioned, aligned, leveled, and docked to the HSM using the cradle positioning system.

Once the cask is docked with the HSM and the alignment verified, the cask will be connected to HSM restraints and secured to the HSM. Concurrently, the hydraulic ram will be installed and aligned for connecting the grapple to the canister.

Using the ram system hydraulics, the ram will be connected to the canister via the canister grapple. The canister will be pulled into the cask. Operations staff will monitor the progress to ensure the alignment and canister transfer into the cask is achieved. RCT will continue to monitor the radiation as this operation is conducted. In the event the canister becomes wedged or is not able to be transferred into the cask, operations staff will stop and place the equipment in a safe configuration and notify management.

Once the canister is fully inserted into the cask, operations will disconnect the grapple from the canister and position the ram for the installation of the cask ram closure plate. RCT will continue to monitor radiation/contamination levels. Operations will rig to the ram access closure plate and install it onto the cask. The 12 bolts will be installed and torqued as required by the cask SAR.

Concurrently, operations will remove the cask-to-HSM restraints and prepare the transfer trailer to un-dock from the HSM. Operations staff will rig the cask lid and position the lid for installation onto the cask. The transfer trailer will be moved away from the HSM far enough for the installation of the cask lid. RCT will monitor radiation and contamination during this operation to verify the levels are acceptable. Once the trailer is in position and surveys completed, the canister unloading flange will be removed from the cask and the canister sleeve spacer ring will be installed in the cask opening. The cask lid will then be positioned and installed onto the cask. The cask lid bolts will be installed and torqued between 950 and 1,040 ft-lbs. The crane will disconnect from the lid and operations will torque the lid bolts as required in the cask SAR.

RCT will perform additional contamination surveys on the cask and area to verify acceptable levels.

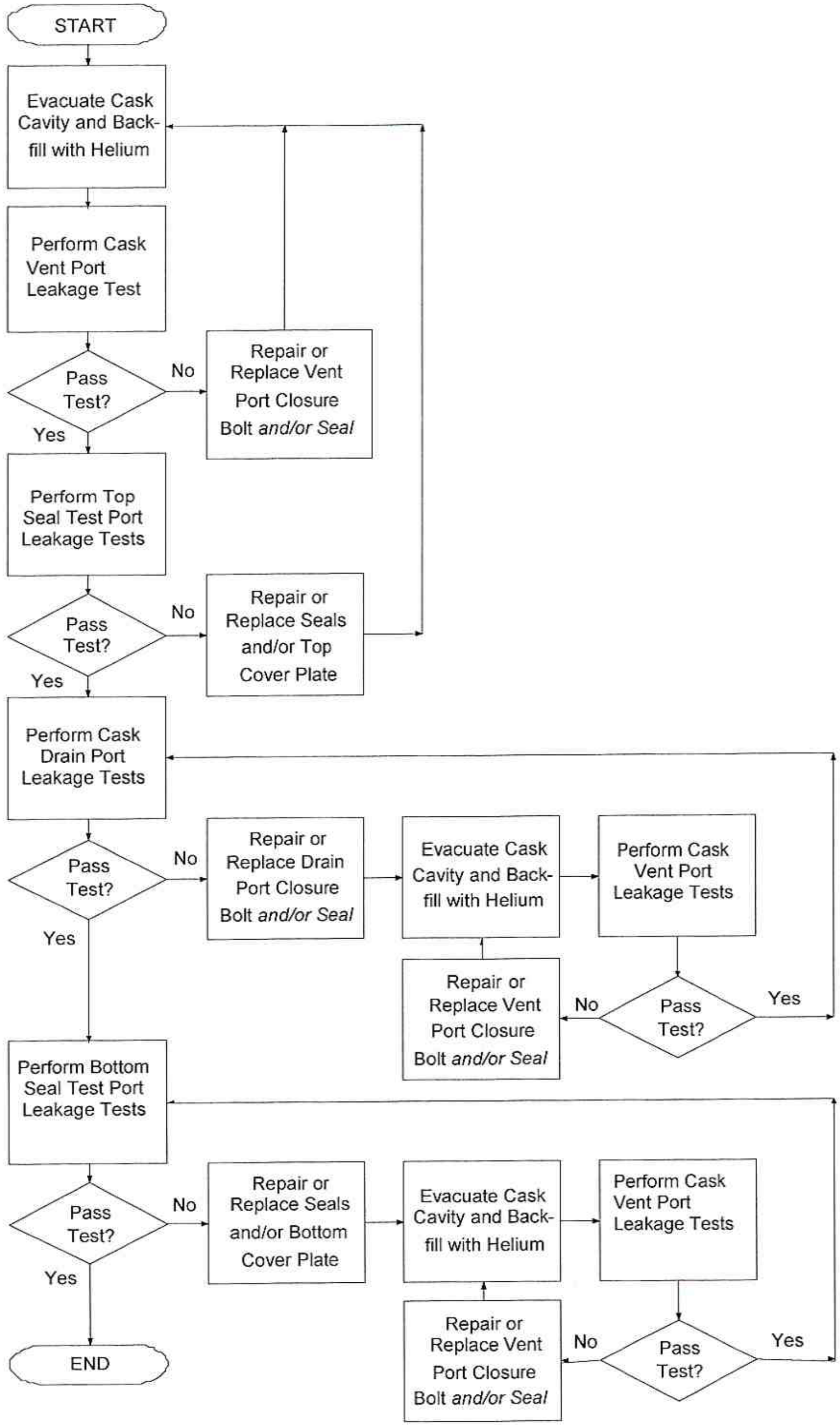
The transfer trailer will be positioned as required for leak testing of the cask. Concurrently, the HSM door will be reinstalled, if required, and DSC loading of the second cask would start.

Operations staff will remove the vent port plug and connect the leak test system to the vent port. The cask cavity will be evacuated and then backfilled with helium. Helium leak tests will then be performed to verify the containment boundary seals are acceptable. These tests include checking the port plug bolt seals of the vent and drain ports and the interspace between the lid and ram access cover seals. **Figure 6-1** depicts the process flow for cask assembly leak testing verification. Then, the cask front trunnions will be removed from the cask and the cask trunnion covers installed. After installation of the front trunnion covers, the front tie-down strap will be reinstalled over the cask and secured to the intermodal skid.

6.1.3.3 Cask Final Assembly and Preparation for Shipment

Once the cask leak test has been completed, the loaded transfer trailer will be moved to the on-site transloading site and leak testing on the second cask will start.

Figure 6-1: MP197HB Cask Assembly Verification Leak Test Flow Chart



6.1.4 Transport Operations

6.1.4.1 Special Permit Requirements

The following permits for transporting the loaded transportation casks from the CR-3 ISFSI would have to be obtained by the shipper:

- A formal clearance submission would be made to the originating Class I rail carrier. For the purposes of this project, the goal is to deliver the overpacks from the CR-3 site to the Class I rail carrier, CSX Transportation, which would clear the entire route with all participating railroads and
- For the purposes of this report, it is assumed that DOE would be the shipper and that the shipments would be conducted by commercial carriers like comparable commercial shipments. Although typically not required for DOE shipments, for the purposes of this report, it is assumed that DOE would file an application with the NRC for an approved rail and transfer trailer truck route from CR-3 to the identified destination. DOE Order 460.2B[50] provides information on the management of DOE materials transportation and packaging.

Note: A formal clearance submission is required for all dimensional shipments on all railroads involved in the full route. With loading at the recommended track location within the CR-3, the clearance will be submitted to CSX Transportation for the rail movement, and it will clear the entire route to the final destination, in this case to the GCUS, including the short line FNOR, which serves the CR-3.

Each Class I rail carrier has a formal procedure for clearance submissions, and all are electronically filed. Some require a fee to accompany clearance submissions, and some do not. At this time, CSX Transportation does not require a fee for conducting the clearance evaluation. The following components must be present in each clearance submission:

1) Identification of the origin, the destination, the standard transportation commodity code, the shipper, receiver, and associated serving carriers, and the route (including interchange locations for the requested route);
2) Identification of the specific railcar to be used for the shipment;
3) All dimensions of the loaded unit on the railcar, which depict a profile of the loaded unit and car together. These should also include:
   a) A diagram of offsets, ballasts, or any other loading configuration specifics important to the railcar.,
   b) Center of gravity measurements and total weight of the unit plus the railcar, and
4) A diagram of the unit with actual placement on the selected railcar.

The more specific the information provided in the clearance submission, the better the chance of clearance acceptance. The above submission requirements are considered a minimum. Some railroads require additional information for clearance acceptance. The AAR Open Top Loading Rules delineate what must be submitted for acceptance at interchange between carriers.

Note: Requirements may be relaxed if movement is restricted to only one railroad and is not subject to interchange with another carrier. This also applies to loading and securement configurations.

However, with HAZMAT, the relaxation of these requirements is not expected nor anticipated principally for safety reasons.

Furthermore, it is recommended that more than six months are allotted for the railroad clearance submission process in the event the intended routes have not been approved for previous shipments and the approval process takes longer than anticipated. This recommendation is based on extensive experience in obtaining super-load permits for movements of similar weight and dimensions and HAZMAT (Class 7) shipments. Once the railroad-cleared route is approved by NRC, it would be valid and effective for seven years for rail routes. The NRC would approve routes for a period of five years for combination routes (truck-to-rail siding, transloading, and rail to final destination). The minimum amount of time to submit cleared routes to the NRC for approval is 90 days; however, six months is preferred.

Once the rail route is cleared by all involved railroads, the clearance is valid for six months for railroad purposes; should the campaign take longer than six months, the clearance must be resubmitted. The clearance ensures that the loaded dimensions and weights of the transportation cask and railcar (in this case the train) would traverse the railroad route without any impediment. It would need to be resubmitted after six months to ensure no changes have taken place on the rail route that would affect the ability for the dimensional load to pass the route safely without striking anything (tunnels, bridges, trestles, signals, silos, or any structure that may be close to the track), including other dimensional traffic moving in the same lane.

Any time a route condition changes or needs to be altered on an approved route, the shipper must notify the NRC and submit an amendment.

Road permits would be required for movement of the cranes and other equipment to CR-3 to be used for lifting or transloading the transportation casks onto the rail cars. The permits will also dictate the requirement for private escorts (not the security team) and State Police escorts for both the mobilization and demobilization efforts of the equipment to be used in the on-site operations. These escorts are separate than those required by the regulations for LLEA for safety and security purposes.

6.1.4.2 Coordination with Mode of Transport

This section provides a description of activities necessary to coordinate with the site owners in preparation for the transport activities. The actions necessary to prepare for and remove the SNF from CR-3 are listed as tasks in **Table 6-3**. These identified actions are based on the assumption that DOE or another management and disposal organization would be responsible for shipping to and operating the consolidated interim storage facility or repository. Based on these tasks, the characteristics of the site’s inventories of SNF, the on-site conditions, the near-site transportation infrastructure and experience, time sequences of activities, and time durations were developed to prepare for and remove the loaded transportation casks.

Table 6-3: Activities to Prepare and Remove SNF and GTCC LLW from CR-3 ISFSI

Task		Task Activity Description
Programmatic Activities to Prepare for Transport Operations from a Shutdown Site		
1	Assemble Project Organization	Assemble management teams, identify shutdown site existing infrastructure, constraints, and transportation resource needs and develop interface procedures.
2	Acquire Casks, Railcars, Ancillary Equipment and Transport Services	Develop specifications, solicit bids, issue contracts, and initiate preparations for shipping campaigns. Includes procurement of transportation casks and revisions to CoC as may be needed, procurement of AAR Standard S-2043 railcars, and procurement of off-site transportation services.
3	Conduct Preliminary Logistics Analysis and Planning	Determine fleet size, transport requirements, and modes of transport for shutdown site.
4	Coordinate with Stakeholders	Assess and select routes and modes of transport and support training of transportation emergency response personnel.
5	Develop Campaign Plans	Develop plans, policies, and procedures for at-site operational interfaces and acceptance, support operations, and in-transit security operations.
Operational Activities to Prepare, Accept, and Transport from a Shutdown Site		
6	Conduct Readiness Activities	Assemble and train on-site operations interface team and shutdown site workers. Includes readiness reviews, tabletop exercises and dry run operations.
7	Load for Transport from ISFSI to on-site Transload Track for Loading Rail Cars	Load and prepare casks and place on CR-3 Transfer Trailer for the on-site transportation to the on-site rail siding.
8	Transmit DSC load reports and transportation related documents	Assemble DSC load reports and the applicable transportation documents and transmit to the un-loading facility.
9	Accept for On-site Transport	Accept loaded casks on Transfer Trailer for on-site transportation to rail siding.
10	Transport	Ship shutdown site casks.

6.1.4.3 Additional Coordination Efforts

Description of Activities Necessary to Coordinate with Crane Company and Rigging Providers:

- All diagrams including dimensions, center of gravity, and weights must be collected (preferably in CAD format) to be provided to the crane company for use in planning the proper lift plan. This includes crane selection for the job based on the conditions of the site and rigging plans and configurations;

- Any manufacturing lift and transport diagrams, especially regarding restrictions on pick points or special rigging required for lifts, should be collected and distributed to the crane company. This information will be used for plan development, including crane selection;
- Crane company/riggers would physically survey the items to be lifted, ground conditions, and other requirements (e.g., turn radius for crane and ancillary equipment) in addition to any specialized rigging provided by the site specific to the transportation casks being lifted. This is a joint effort between the crane company experts/engineers and transload operator/licensee/shipper. Coordination within the parties would ensure all aspects of the lift and securement plan are considered and planned; and
- A timeline would be established for mobilization of all required equipment including all standard rigging tools, forklifts, etc., to make sure all equipment is in place and tested prior to the start of the operation and test lift.

Description of Activities Necessary to Coordinate with Transload Site:

The private rail siding at the recommended loading location is on-site, inside the Crystal River plant. It is served by the FNOR short line. This is an operating plant with active and regular rail service today. Coordination will be required between the operating plant and the on-site Rail Transload Area to ensure cask loading operations will not interfere with normal plant operations. Meeting with the railroad six months prior to beginning the loading operation would allow for coordinating and planning with the railroad to set expectations for service level requirements and crew staffing for the additional rail service required to meet the desired shipping schedule and to plan coordination activities to avoid congestion with any planned inbound coal trains or loaded urea cars being delivered to the site. This will include pulling empty cars from the site. Special considerations and possibly budget concerns would need to be addressed by the railroad to ensure it has the available crews to run a dedicated train and is willing to do so. It is important to know the number and frequency of trains to be handled. Other items to discuss would be security requirements for the crew entering the site, describing the intended loading operations, and loading site at the loop track, planning for the placement of the empty train, inspection of the loaded train to ensure compliance with the approved clearance, and all other operations including establishing the mechanics for pulling the released train from the site and obtaining the transit schedule for delivery to the GCUS:

- Develop a Security Plan for the rail transload site and notify the serving rail carrier, FNOR, of the plan in place and provide a contact name and number for the site;
- Provide proper notification that the transload site will be designated as a “rail secure area”, which is based on the HAZMAT category of the commodity being loaded. The railroad does not need to approve the plan, but it must be notified it is in place and there is an identified contact available at the transload site;
    - The recommended on-site loading location is a portion of the existing loop track currently used for unloading inbound coal trains. The plant likely has not been designated as a rail secure site with the railroad due to the commodities unloaded at the plant as a course of its normal activities receiving inbound commodities for operation of the plants, so this must be established and
    - Although not required, plan to institute the same precautions and planning as is used in Toxic Inhalation Hazards (TIH)/Poisonous Inhalation Hazards (PIH)

handling and reporting for added measure of security at the rail transload site. This provides notice to the railroad of the level of preparation and operations planning for the campaign.

- Determine if railroad police will be present during the manned interchanges and any other stops along the entire route on the way to the destination. They can provide extra observation in rail yards to deter rail fans, which typically "chase" dimensional shipments along the rail route and other trespassers in the yards. At this time, the FNOR does not have a railroad police force. Railroad management personnel and the Class I railroad police will be present during the manned interchange between FNOR and CSX at Newberry;
- Hold initial meetings with the Class I carrier, CSX Transportation, to explain the movement, provide estimated number of trains to ship, discuss the dedicated train requirement, manned interchange requirement and begin rate negotiations for the trains; and
- Mention current safety and security measures for the site to FNOR to ensure the railroad is aware of special considerations and operating procedures in case it has no familiarity with these requirements as it does not currently serve other customers where these procedures are in place:
  - Note and discuss safety features that will be added to the site: fence, lights, defined perimeter, etc.,
  - Discuss requirements of crew entry into the site (Transportation Worker Identification Credential (TWIC) cards, training, etc.),
  - Discuss manned interchanges with the railroad and record keeping requirements,
  - Discuss normal times of operation for the established plant and any extensions in hours the plant has granted to the shipper for the transload campaign. Coordinating operations hours and access to the plant is important for planning release of the loaded train and consideration of the current rail operations on the division and normal operating parameters at the plant,
  - Open communication with all rail carriers in the route to ensure a smooth transition at any interchange point. In this case, only one Class I railroad is involved in the route to the GCUS,
  - Hold initial meetings with the local trainmaster and safety manager to discuss intended operations and parameters for operations, even though the transload is taking place inside a private and secure site, and
  - Communicate that all requirements have been exceeded for the intended site and operations.

6.1.4.4 Transportation-related Operational Readiness Items

Equipment Readiness is Determined through Review of the Following:

- Insurance requirements of the contract are in place;
- Transportation equipment certifications are current and would be for the duration of the transportation cycle;

- All vehicles have required registrations (as applicable);
- All vehicles have current inspections;
- Radiological packaging meets all current requirements;
- Packages are correctly identified: All required markings and placards are properly displayed and are available at the site prior to beginning the operation;
- Inspections for equipment to be utilized to handle and transport the loaded transportation casks to the on-site rail siding have been conducted and copies provided;
- Proper documentation is provided to demonstrate the required Security Plan is in place and has been approved by the USCG for the rail transload site, as the site is located along/adjacent to Double Barrel Creek, Rocky Creek, Crystal River, and Crystal Bay;
- As the transload site is located on a private facility with water access, potentially providing easy access to the loaded train, the CR-3/shipper will inform the USCG when rail operations will commence, so it will be aware of the ISFSI transfer trailer transport and train loading activity on the site and possibly evoke a Marine Safety Zone during active operations if required or deemed appropriate by the Captain of the Port (COTP); and
- If CR-3 has an existing Maritime Transportation Security Act (MTSA) plan in effect for the plant site, adopt that plan and make necessary changes to include the on-site transfer trailer transport from the ISFSI to the rail transload site activities and submit the revision to the USCG for approval.

Transportation Personnel Readiness:

- Identify key personnel and their qualifications,
- Ensure required background checks are current and requirements of coverage of drug and alcohol programs are met,
- Provide copies of the training materials and ensure required trainings are current for all employees involved,
- Provide copies and ensure that all personnel are in possession of and working from the correct procedures and RWP,
- Ensure all private security personnel have required weapons certifications to cover the transportation cycle,
- Ensure the transportation personnel would be monitored for radiological exposure, if required, and
- Ensure proper equipment and personnel are available to monitor workers for contamination, if required.

Transportation Readiness Notifications:

- Provide copies and ensure proper notifications have been made to the Tribes, NRC, State and local governments, DOT, USCG, and DOE as applicable. The USCG would need to be notified because the transload site is located immediately on a navigable waterway, at the water’s edge, and it should be aware of the transportation activities taking place on site;

- It is recommended that any water-served or adjacent facility should have an active Security Plan in place while campaign activities are taking place, and in compliance with the regulations, the security team must be on the site once the transportation casks begin to arrive. This includes the CR-3 plant since transload activities are to take place on the loop track which is in close proximity to the barge slip and vessel/barge dock where unloading operations occur on a regular basis;
- The USCG must review and approve the MTSA plan or altered plan if one already exists for the transload site;
- Provide copies of and ensure all required permits to transport SNF are prepared and/or in place;
- Ensure proper notification requirements are being met for the disposal/storage facility; and
- Identify scheduled meetings and briefings that would be conducted for all phases of the shipments.

6.1.4.5 Transport Operations

On-Site Movement to the Transload Facility

Once the transportation cask is loaded onto the transfer trailer at the CR-3 ISFSI and the cask leak testing completed, it should be secured by the site operations personnel. No Florida State DOT inspection is required for on-site movements. No permits or State Police escorts are required for on-site movements remaining exclusively on the private plant property. The transfer trailer would proceed to move the transport trailer the 500 ft. from the ISFSI into position at the designated portion of the loop rail track for loading.

Normally, hours of operation for the transport would be in accordance with the issued truck permits, which dictate the number of casks that may travel in one day. Since no truck permits are required for this transport, for purposes of this report, it is assumed that one cask every three days will move from the ISFSI to the rail transload site. Local law enforcement personnel or the private security team would provide physical protection of the load during the 500 ft. transport and rail loading, as applicable. No private escorts are required by state DOT since the movement is solely on private property.

Prior to any transportation operation from the ISFSI to the Transloading Site, a pre-job briefing with the operations staff would be provided. This briefing will be conducted to review procedures, discuss any safety/quality-related concerns and practices, and verify availability of adequate resources to support the activity, including verification that prerequisite conditions are met. Once the briefings have been completed, the transportation team would be assembled and staged as directed by the transportation supervisor.

The transfer trailer will exit the CR-3 ISFSI gates and proceed along the access road toward the rail loop following the road from the ISFSI to the loop and moving into place parallel to the crane which will already be in place next to the rail track. No stops are anticipated during the short 500 ft. transit.

Shipment speed, route, and duration would be monitored and controlled by procedure and managed by the transportation supervisor.

6.1.4.6 Performing the On-Site Transload from Transfer Trailer to the Railcars

The loaded transfer trailer would meet the crane at the rail transloading track, where the train is already staged. The intermodal skid would already have been secured to the railcar decks in preparation for loading. This enhances the accuracy of the loading, as the fixture placement on the railcars will be carefully measured to ensure the center of gravity of the unit rests exactly on the centerline of the railcar for maximum stability and to confirm with the approved clearance window for the rail shipment.

The transfer trailer will park parallel to the crane, which is positioned along the rail track. The crane will lift the transportation cask, move it 180 degrees, and place it onto the positioned railcar. The crane will be attached to the front impact limiter and the impact limiter positioned onto the cask body. Once the impact limiter is fully engaged onto the cask body, the 12 bolts are snugged (hand tight). Once all the bolts have been snugged, the bolts will be continually torqued as required in the SAR. This same evolution will be used to position the rear impact limiter to the cask. The hoisting rings will be removed, and the impact limiter hoist ring plugs/bolts installed on both impact limiters. Operations staff will install the required security seal to the cask front impact limiter.

The transfer trailer will then be loaded with an empty cask from a rail car and return to the CR-3 ISFSI and the cycle will be repeated until all five casks are delivered to the rail siding. For purposes of this study, a second transfer trailer will be planned for the campaign and will be loaded at the CR-3 ISFSI while the first transportation cask is being unloaded at the transload site.

If needed, RCT will perform additional surveys of the cask prior to installation of the personnel barrier. Once the surveys have been completed, the personnel barrier will be rigged, loaded, and the frame secured to the intermodal skid.

Operations staff will verify that the temperature on all accessible surfaces is less than 185°F.

The RCT will perform the additional survey required to release the cask system for transport. Final radiation surveys are then performed with dose rates taken at the cask surface, 1 meter from the cask surface and 2 meters from the vertical plane of the transport conveyance. The maximum dose rate at 1 meter from the cask is defined as the transportation index. All dose rates and contamination surveys must comply with applicable DOT and NRC regulations. The appropriate criticality safety index assigned to the package contents should be determined in accordance with the CoC and indicated on the Fissile Material labels applied to the package. Appropriate placards are applied to the railcar(s) in accordance with DOT regulations. The final shipping documentation is then completed by the transport specialist including instructions to the carrier regarding the required Exclusive Use Shipment.

Performance of a visual inspection of the installed transportation casks, intermodal skid, impact limiters, and personnel barrier assures that it is assembled correctly and in an unimpaired physical condition. The visual inspection includes checking for cracks on the intermodal skid main beam web-to-flange-welds, the beam webs, plus checking the tie-down structure for any signs of distortion or failure.

Once the transportation cask is secured to the railcar and internal inspections of the transportation cask and the loaded train are completed, the Rail Transload Facility Supervisor will request the railroad inspection. Once the inspector measures and approves the cars for shipment, the Rail Transload crew shall air test the train if air brakes are on the train (as with some existing

Department of Defense shipments) and perform a visual inspection of the train's safety devices. The appropriate party should issue the electronic bill of lading (BOL) to the serving railroad, the FNOR.

The crew will then attach the Global Positioning System (GPS)/Impact Recorders (or other telemetric units or similar approved devices) to the loaded train to provide 24/7 on-demand GPS location information using the most current monitoring sensor technology available at the time. The device will also record any impacts (from switching, etc.) that occur at more than 4 mph. Impact recorders are not required by regulation or the railroads but are commonly used by dimensional shippers for high-value and sensitive machinery to record any impacts (switching) and forces exerted on the loaded cars during transportation. Simultaneously, the Transload Facility Supervisor electronically releases the loaded train to the railroad.

Once all of these steps have been completed, the shipment is considered ready for transport. Additional steps to be performed prior to release of the shipment include but are not limited to preparation of transportation-related documentation BOLs, permits, and other transportation-related documents to ensure compliance with regulations, notifications of States and Tribes and regulatory agencies as required, and communication with the Movement Control Center (MCC) and security team.

Once the serving railroad, FNOR notifies the rail transload facility of the intended switch time and the train will be prepared for movement from the private loading track. Upon arrival of the FNOR train crew at the rail transload facility, the Rail Transload Supervisor will unlock the gate and allow entry of the train crew into the site. This will be a documented and manned release of the loaded train from the transload facility to the FNOR train crew. The chocks should be removed, and the locomotive attached to the loaded train and pulled from the facility once the Rail Transload Supervisor unlocks the gate to allow the train to exit the transload facility property with the Rail Transload Security Team (armed security escorts) in the escort car.

The railroad and Transload Facility Manager will document the manned interchange in writing.

The FNOR train will leave the facility and proceed to the interchange point with the Class I carrier, (located in Newberry, FL) where the CSX Transportation crew and railroad police will await the arrival of the FNOR train. The anticipated travel time from the CR-3 to the interchange point is 10 hours. No stops will take place from the time the train leaves the CR-3 until it reaches the interchange with the Class I carrier. Upon arrival at the interchange, the FNOR crew will document arrival and the physical manned interchange with the Class I crew, deliver the loaded train to the designated track and then disengage its locomotive. The Class I carrier will provide advance notification to the GCUS location to coordinate the arrival and manned delivery to the GCUS. It would then proceed to the GCUS with no other interchanges taking place until arrival. Any stops along the route for refueling and changing the crew would result in the train being stopped only at interim rail yards and it would be guarded by railroad police during the minimal stops. An estimated transit schedule will be provided to the shipper for the entire train movement. The ability to monitor and trace the train would be limited to need-to-know personnel.

Upon arrival at the GCUS, the CSX Transportation train crew would document the manned interchange, deliver the loaded train to the designated track, and then disengage its locomotive.

6.1.5 Demobilization

Once the de-inventory project (campaign) operations have been completed, demobilization will commence. This is the process of removing all the equipment and materials used during the operation at the CR-3 ISFSI and returning it to its proper owner in accordance with rental / lease agreements. This includes returning any leased property to the proper owner in the agreed upon condition in accordance with the lease, which may include leaving added pads, fences, and lighting in place.

As the DSC exterior surfaces are potentially contaminated, as discussed earlier, large components, such as the transfer trailer, lift yokes, chain hoists, etc. would be decontaminated as needed, approved for free release, and returned to the owner(s) for storage. Specialized equipment (e.g., the vacuum drying system [VDS] and leak test systems) would be decontaminated as feasible and returned to the owner.

Railcars would be shipped directly from the disposal or storage site at the completion of the project in accordance with the release criteria established by DOE. The train would be returned to its storage track until it is needed for the next shipment. The transport packaging, transport intermodal skids, lift yokes, and the like would be decontaminated, placed in an assembled condition, and returned to DOE for storage and maintenance.

Demobilization of ancillary equipment from each site would be accomplished in the same manner as it was mobilized. Forklifts, man lifts, diesel air compressor(s) and any large pieces of equipment would be surveyed and loaded onto flat beds and drop deck trailers for transport back to origin. It is customary for the leasing company to pick up the equipment once it is formally released by the contractor. Rigging, tools, and smaller articles would be surveyed and loaded into containers and flatbed trailers for transport back to the owner. Security-associated equipment, such as fences and lighting, would be broken down, surveyed, and returned to the suppliers, as appropriate. If personnel trailers, porta-johns, and storage trailers are utilized, utilities would be disconnected, and the units returned to the leasing companies. Cranes would need to be broken down and transported, as required, by the road permits to reach their next destination or be returned to the owner's storage yard. Any standard rigging rented with the crane would also be inspected for condition, documented, properly packaged to prevent damage, and returned to the owner or leaser.

The empty HSMs would remain on-site for disposition by CR-3 as potentially contaminated and activated materials. In addition, the ISFSI site, after all removal of all TN storage systems, would be decommissioned in accordance with NRC and site regulatory requirements.

In the event any of this equipment is purchased, it would be surveyed and loaded onto trailers or containers for movement by truck to its storage facility. This process takes approximately one week to complete. The train would be returned intact to its storage location and would likely move in regular train service, which may take a few weeks depending on the distance and route dictated for the movement.

6.2 Resource Requirements / Staffing

At the CR-3 site:

- Operations Manager;
- Cask Operations Shift Supervisor;

- Training Specialist;
- Procedure Writers;
- RP Specialist– in charge of the radiation monitoring and surveys;
- Transport and Waste Management Coordinator (TC) provides supervision of the waste management aspects of the program and of the transport. The TC is in charge of the preparation of the shipping papers, verification of the proper labeling and placarding of the transport and tracking and response coordination. Position may be seconded by a Transport Analyst;
- Crane Operators;
- Riggers;
- Rail Transload Supervisor;
- Rail Transload Security Team (as applicable);
- Cask Operations Technicians/Mechanics;
- Tractor Driver and Equipment Operators;
- QA/QC Specialist; and
- Security Personnel.

6.3 List of Ancillary Equipment

Additional equipment needed is listed in **Table 6-4**, **Table 6-5**, and **Table 6-6**.

Table 6-4: Additional Equipment for CR-3 Transfer

Additional Equipment for CR-3 Transfer	
Secondary Mobile Crane (150-ton)	Required for lifting ancillary items, such as, HSM door, transfer adapters, transport cask lids, transport impact limiters, and personnel barriers.
Lifting Rigs	See **Section 2.3** for details.
Standard rigging and supplies	See **Section 2.3** for details.
Diesel-Powered Air Compressor	See **Section 2.3** for details.
Standard tools	These include personal protective equipment (PPE), communications equipment, wrenches, etc.
2 Transfer Trailers	Used to load and transfer the cask from the ISFSI to the rail car loading area
2 Prime Movers	Used to move the transfer trailers on site

Table 6-5: Equipment for the Transload Facility

Equipment for the On-site Rail Transload Area	
Crane: 375-ton mobile crane	Crane would be used to conduct lift operations removing the MP197HB cask package onto and off of the railcar.
Large forklift	Used to move heavy equipment on-site, pick up and relocate heavy objects, and reposition train if required.
Man basket	Used to inspect and measure the loaded railcars to ensure compliance with the clearance window and to safely extend reach of humans for any required reason.
Welding machines	Use for welding and securement.
Standard rigging and supplies	For use in lifting the over-pack and intermodal skid combination.
Specialty rigging – spreader bar or other rigging specific to the overpack or intermodal skid	To be provided by the site for use in lifts at the rail transload facility.
Standard tools	These include personal protective equipment (PPE), communications equipment, wrenches, etc.

Table 6-6: Rail Equipment (per consist)

Rail Equipment (per consist)	
Locomotive(s)	Dedicated for the train movement and at least two required per AAR S-2043.
Buffer cars	Used to provide buffer between loaded over-pack cars and all other cars, per clearances.
Load (cask) cars	Heavy duty flat cars.
Escort car	Houses the armed security team and will meet the portion of AAR S-2043 applicable to escort cars.
Redundant radio equipment	Used for communication between the security team and the monitoring control center, LLEA, and other required parties. This communication system is in addition to the normal radio communication of the railroad crew with dispatch.
GPS/impact recorder units	One per loaded over-pack car. While GPS (telemetric devices) are required for SNF movements, combination units are commonly used by shippers on sensitive and high-value dimensional shipments to indicate both locations of the cars/train and to document all forces exerted on the load car while moving. These are not required by regulation or the railroad but are an additional means of ensuring safety and security in the handling of the units during transportation.

6.4 Sequence of Operations / Schedule

The operations would be sequenced as described in **Section 6.1**.

The sequence of operation timeline, **Figure 6-2**, outlines the operations associated with loading, shipping, and return of the trains removing the CR-3 canisters from the ISFSI. The cask loading operations include loading a transfer trailer, preparing the casks for transport (e.g., evacuation, helium backfill, leakage testing), moving the casks from the ISFSI to the rail loading site, conducting the transload from the transfer trailer to the railcars, securing the cask/intermodal transport intermodal skids, and preparing the railcars for shipment. As some cask loading operations can be done concurrently (equipment staging and some inspections) to reduce time, it is assumed that two transfer trailers will be in operation at a time. In this case, transfer of the canisters from the storage units to the railcars is estimated to take approximately three 8-hour days for each set of two casks; a full rail consist of five canisters will take approximately seven days.

The transit times listed in **Figure 6-2 (top)** are provisional and may change as route details and operations are better defined. The total round-trip transit time, from the initial transfer of a canister from a HSM to the return of the empty casks is approximately 24 days.

For a campaign where two train consists are available and can loaded and shipped in sequence, the timeline for complete removal of all canisters would require nine round trip shipments (of five MP197HB packages per shipment) over a period of 40 weeks, as shown in **Figure 6-2 (middle)**. A one-week contingency is given for each shipment.

If only one train consist is available, and shipments need to be done sequentially, the timeline for removal of the canisters would require substantially longer, as shown in **Figure 6-2 (bottom)**.

If only one transfer trailer is available, the on-site loading sequence is estimated to take three 8-hour days per loading. Therefore, for a 5-cask train, approximately two weeks (15 days) will be required. This case is not considered.

Table 6-7 estimates the resource requirements needed to support this de-inventory campaign. An additional eight weeks of planning and preparation is added before the start of the first campaign. The level of detail is the week.

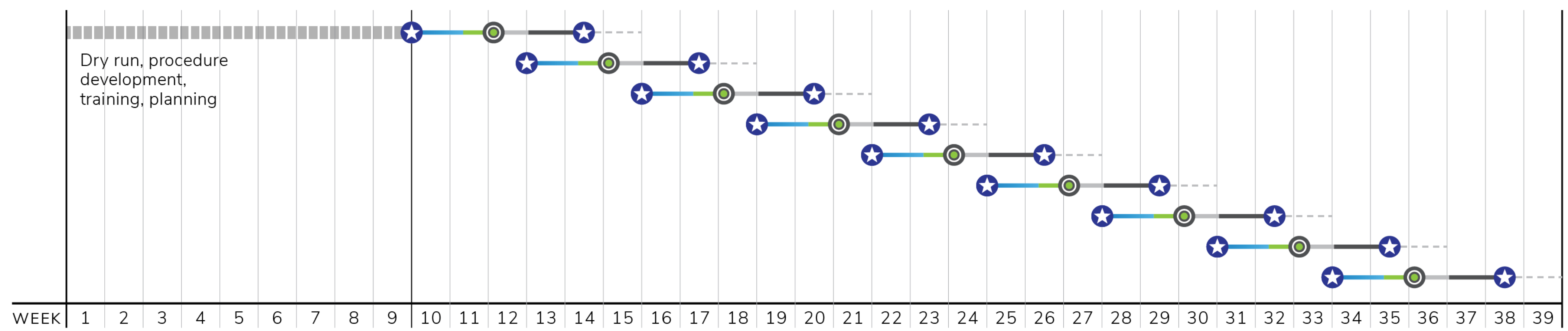
Figure 6-2: Sequence of Operations

CRYSTAL RIVER DE-INVENTORY
SEQUENCE OF OPERATIONS FOR ONE BATCH OF CASKS

ASSUMPTIONS:

1. Will use 10 MP197HB transport casks: 5 casks per train
2. Will use 2 on-site transfer trailers
3. All transfer operations will be considered "on-site work"
4. Two crews will be used for on-site transfer operations: one at the ISFSI and one at the transloading site at CR-3

COMPLETE SEQUENCE TIMELINE



ALTERNATE COMPLETE SEQUENCE TIMELINE

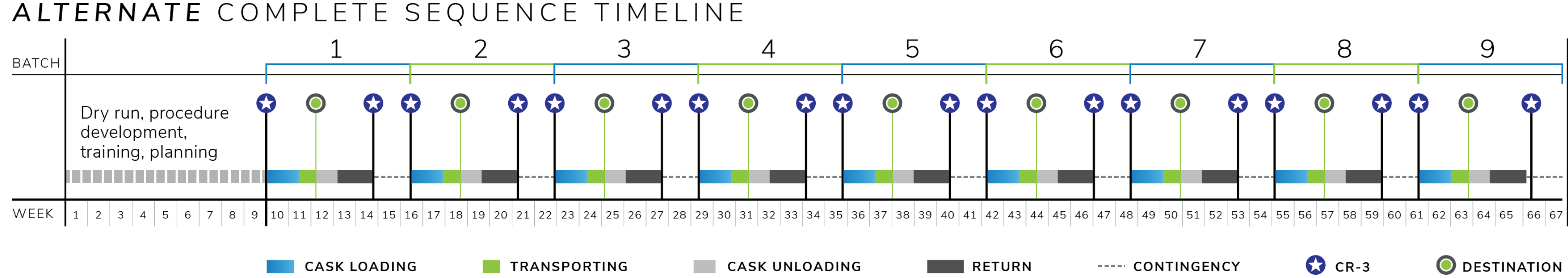


Table 6-7: Operations Timeline with Required Resources

	Major steps for a 38 TSC campaign	Resources required [in full-time equivalent]*											Estimated Duration (work weeks)
		OM	COSS	TS	PW	RP	TC	CO	RM	EO	QS	SP	
1	Detailed operations planning, campaign preparation, equipment mobilization, procedure preparation and approval, training program, pre-loading review(s) and dry run(s)	1	2	1	2	2	1	2	6	2	1	3	9 weeks prior to 1st campaign
2	On-site transfer of the SNF and GTCC canisters and preparation of 5 packages	1	2	1	1	2	1	2	6	2	1	3	7 days per 5-cask campaign
3	Shipment to destination by rail	0.5			1		2						4 days per 5-cask campaign
4	Unloading	0.5	1		1	1	2						5 days per 5-cask campaign
5	Return transport of empty casks	0.5			1		2						8 days per 5-cask campaign

***Key:**

OM: Operations Manager
COSS: Cask Operations Shift Supervisor
TS: Training Specialist
PW: Procedure Writer
RP: Radiation Protection
CO: Crane Operator
TC: Transport and Waste Management Coordinator
RM: Rigger/Cask Operations Technician/Mechanic
EO: Tractor/JCB Driver and Equipment Operator
QS: QA/QC Specialist
SP: Security Personnel

6.5 As Low As Reasonably Achievable (ALARA) Planning

Specific requirements are provided in 10 CFR 72.126, "Criteria for radiological protection," that address radiological control measures for work with dry cask storage of SNF. Infrastructure requirements that would be required for transitioning from essentially a static, monitoring condition of the storage of SNF to an active worksite that involves handling and loading operations would be considerable. Stranded sites that are no longer staffed with trained and qualified health physics personnel would be dependent upon either loaned labor from the utility, if those resources are still available, and/or contract health physics staff. In addition, portable survey instruments, portable Continuous Air Monitors, and area radiation monitors must be provided along with the means to maintain them, calibrate, and response check for usage. Infrastructure must also be provided to facilitate safe operations at the site. Temporary offices, electric power for lights, equipment and instrumentation, potable water, and limited decontamination facilities must be in place prior to start of operations at the ISFSI. Considerations must be made to provide for the following:

- Effluent monitoring and control;
- Airborne and direct radiation monitoring capabilities;
- Personnel and equipment access control;
- Radioactive material control;
- Decontamination capabilities for personnel and equipment; and
- ALARA equipment such as temporary shielding for low exposure waiting areas, video surveillance equipment, and other remote or robotic equipment may be appropriate

In accordance with the requirements stated in 10 CFR Part 20 and 10 CFR Part 72, sufficient controls must be in place to protect the workers and the public from radiation. Therefore, at a minimum, the following requirements must be satisfied prior to commencement of radiological work activities at the site:

- Approved radiological control procedures in place;
- A sufficient number of trained and qualified RCTs are mobilized and ready to support operations at the pad (estimated at one supervisor and three RCTs per shift);
- Sufficient quantity of radiation control equipment and consumable supplies on hand to support the planned work activities (PPE, signage for posting, radioactive waste controls, etc.);
- Qualified RP/ALARA supervision assigned for oversight of radiological work activities;
- Personnel dosimetry for monitoring worker doses including Thermoluminescent Dosimeters and electronic dosimeters available for issue;
- A bioassay program in place for worker monitoring (in vivo and in vitro as necessary);
- Health Physics instrumentation calibrated and suited for the types of surveys and measurements required in place;
- Detailed work plans developed that would be used for RWP preparation and ALARA evaluation; and
- In addition to the RCTs, workers that are supporting operation have been trained and qualified to the applicable Rad Worker Program requirements

6.6 Quality Assurance Requirements

All quality-affecting activities associated with cask handling operations including transportation would be controlled under an NRC-approved Quality Assurance Plan (QAP) meeting the requirements of 10 CFR Part 50, Appendix B (within owner-controlled area); 10 CFR Part 71, Subpart H (as related to transportation); and 10 CFR Part 72, Subpart G (within the ISFSI site), as applicable to the scope of work.

Fabrication of important safety components and support equipment for the TN NUHOMS and MP197HB Systems would be controlled under the licensee's QAP or by a qualified supplier's

QAP that has been approved for this scope of work. Component classification guidance is taken from Regulatory Guide 7.10[45] and NUREG/CR-6407[46] to establish a graded approach to QA. These QAPs are used to establish the quality category of components, subassemblies, and piece parts according to each item's relative importance to safety.

7.0 BUDGET AND SPENDING PLAN

The total estimated budget for the entire CR-3 campaign organized over 39 calendar weeks is $14.3M. This amount is based on the assumptions and estimates listed below. The estimates provided are centerline estimates based on the current knowledge of the sites and of the operations needed. They are based on operations being performed at the time the data was gathered for this report (2022). This section provides a breakdown of the estimated campaign costs for the de-inventory of the CR-3 site, by activity, to the extent cost information is currently available. This report does not specify the party or parties responsible for the costs estimated herein.

The following assumptions were made to assess the costs in this report:

1) Two sets each of five MP197HB transport casks, five pairs of impact limiters, five personnel barriers, five transport cradles for loading and unloading a canister into the cask, etc. are provided by the cask vendor. Ancillary equipment to prepare the transport cask for transportation (tooling, lifting yoke, spreader bar, leak test equipment, VDS, etc.) will be supplied by the cask vendor. No estimate is provided herein;
2) The cask railcar, escort car, buffer cars, locomotives, etc. are provided by DOE. No estimate is provided herein;
3) The site-specific physical road survey and the complete de-inventory study which includes communication with the site and official stakeholders are not included herein;
4) It is assumed that no covered building would be used at the designed transload location. No cost for a new building construction is considered herein;
5) Only the rail cost of the loaded casks transport to the Class I railroad is included. Train delivery to the final destination and return shipment of the empties by train are not included. For scheduling purpose, the destination is considered to be GCUS;
6) Assumptions are made based on the current status of the origin site and current understanding of the operation. Some pieces of equipment are not designed yet and no reasonable assumption can be made at this point;
7) No additional on-site fencing and lighting is considered;
8) A total of nine iterations of six working weeks each will be necessary to complete the de-inventory. If sufficient resources are available, these iterations can be processed concurrently. In addition, another iteration of nine weeks is added and will happen before the first shipment for campaign readiness, procedure writing, dry run, testing and training purpose. One week of contingency per iteration is included in the six weeks duration;
9) Pre-loading canisters inspection activities are not included in the cost estimates; and
10) This does not account for potential impact of additional specific local regulatory requirements, if applicable, and labor is assumed to be performed by vendor-approved specialists.

7.1 Fees and Permits

No truck permit is expected to be necessary for these moves other than the one that may be required for the mobilization of the transfer equipment (that are already included in the mobilization cost) as there is no highway transport of the casks.

No physical road survey would be expected.

An estimated amount of $50,000 for the NRC route approval processing, preparation of the Security Plan, route survey and the clearance are to be expected. In addition to these costs, States may require the payment of fees for the transport of SNF or HLW through the States. These costs are currently unknown.

7.2 Campaign Operation Management

The Campaign Operation Management would require a crew to be dedicated to the preparation, planning, and supervision of the operation, as described in **Section 6.0**. The Operation Management Team would be composed of a Project Manager, Plant Manager/Coordinator supported by a Scheduler and some engineering staff.

The estimated cost for the Management crew for the 39-week campaign is $1.3 million. In addition to the physical road survey, the management crew would also oversee the planning phase leading to a complete de-inventory study including communication with the site and official stakeholders. This is not captured here.

7.3 Equipment for the Loading Operations

The estimated costs for the mobilization of the equipment on site, the lease of one 375-ton crane, a 150-ton crane and operators, one large forklift, two man baskets, three welding machines, miscellaneous supplies, a telescopic handler, and the mobilization/demobilization of the equipment would be approximately $1.8 million for the duration of the CR-3 campaign.

Additional equipment is also necessary for the transfer of the TN NUHOMS system, including the NUHOMS HSM lid handling system, hydraulic ram and hydraulic power unit system, transfer trailer, transfer skid, and skid positioning system. The lease cost including the mobilization and demobilization costs of this equipment is estimated to be $4 million.

No cost for a new building is considered herein.

7.4 Site modifications

No significant modification of the site is required to support the operation as described in **Section 6.0**.

7.5 In-Transit Security

The security at the shipping and receiving sites would be ensured by the crew already in place at the site and is therefore not included in this estimate. The security in transit on the train to the final destination is not included in this cost estimate

The in-transit security composed of the security crew is estimated to be $250,000 for the movement to the Class I railroad for the campaign. These costs will be included in the overall security costs for the entire movement to the final destination as it is reasonable to assume the same security crew will be responsible for the security over the entire shipment.

7.6 Cask Transportation Services at Transshipment Site

The Cask Transportation Services team would consist of a Transport Coordinator located on site who would coordinate the transport operations with the railroad, support the shipper in the preparation of shipping documentation; and marking, labeling, and placarding. The Transport Coordinator would also notify the required regulatory body in accordance with the applicable regulation. The Transport Coordinator will be supported by a Transport Analyst. They will consolidate the communication between the shipper site, consignee site, railroad, and different stakeholders involved during the transportation phases. The team will also oversee the coordination for the return of the empty casks (detailed in **Section 6.0**).

The transportation costs include the rail transport of the casks loaded on railcars from the origin site to the location where the short line meets the Class I railroad.

The estimated costs for the cask transportation services are $3.3 million for the entire campaign.

7.7 On-site Operations

The shipping site operations would be composed of the crew listed in **Section 6.4**. The estimate for the whole crew for the on-site operation is $3.9 million for the entire campaign.

7.8 Breakdown of the Costs by Activity

This section provides a breakdown of the estimated $14.3 million cost to de-inventory the CR-3 site, by activity, and to the extent cost information is currently available:

- Equipment (e.g., transportation casks, railcars, cranes, movers, etc.): >$5.8 million (cost of casks and railcars is currently unknown);
- Transportation services and security: $3.3 million;
- Management and labor: $5.2 million; and
- Infrastructure: $0

7.9 Additional Cost Estimates to Support De-Inventory Activities

Additional costs estimated in this section that are associated with some of the activities involving the shipment of the casks from the transload site to GCUS include: consist transportation services (loaded and unloaded) costs; emergency response center operation costs; railcar maintenance services costs; and transportation cask maintenance and compliance costs. Estimates for these costs are provided in the following sub-sections; however, these costs have several significant conditions associated with them including:

- The shipment of the consist occurs in the current quarter of the calendar year (2^{nd} quarter of 2022), as rates are temporal;
- The transportation casks meet the 10 CFR Part 71 regulatory limits (e.g., thermal, structural, and radiological) at the time of shipment;

- The maintenance and compliance activities assumed in the cost estimate for the transportation casks are representative of the yet to be built casks systems utilized in this report (i.e., the MP197HB cask) and are similar to one another;
- The maintenance activities projected for the railcars are representative of DOE's in-progress railcar design of the ATLAS cask car and will be built to ship the transportation casks identified in this report;
- The transportation cask systems and railcars are assumed to be leased to DOE and maintained at vendor operated facilities; and
- The emergency response center is assumed to have been designed for the handling of multiple near-simultaneous rail shipments of SNF and estimated costs are for personal assigned full time to the monitoring of shipments only from the CR-3 ISFSI and the portion of the facility and communication equipment needed to support the shipments from the CR-3 ISFSI.

Due to the potential significant impact of these stated conditions on the following identified costs, the values are presented in ranges that provide a rough order of magnitude for the associated costs. Development of more precise values requires resolution to the above conditions, consideration of economies of scale and synergies associated with the de-inventory of multiple sites at the same or nearly same time, understanding of ownership of equipment (e.g., railcars and casks), and a comprehensive breakdown of activities.

7.9.1 Estimate of Transportation Costs

For the CSX movement of a single rail consist from the Newberry, FL transload site to the GCUS site, which is a point-to-point distance of approximately 1,074 railroad miles, the costs would be comparable to the current market rates for radioactive materials rail shipments and would be broken down into the following categories:

- Freight Costs per Consist,
- Special Train Movement Costs (Empty casks return shipment done on merchandise train),
- Current Fuel Surcharge Costs (this surcharge adjusts on a monthly basis), and
- For clarification, the transport (rail) costs from CR-3 to Newberry, FL are included in **Section 7.6**.

7.9.2 Estimate of Emergency Response Center Operation Costs

The operating costs for an Emergency Response Center are based on the following additional assumptions:

- A team of five transport analysts to ensure a constant on-duty presence and to allow an individual to attend the required periodic trainings;
- One manager with the dual role of resource manager and technical expert on emergency response;

- The crew will support the emergency response and will provide the resources to support the day-to-day transport operations with the support of a transport coordinator located on site;
- The crew will be in charge of the coordination and necessary notifications. They will coordinate with the transport vendors (railroads, trucking companies, etc.), the DOE, and the shipping and receiving sites. They will also act as the interface with the first responders and their contact information will be indicated on the shipping documentations; and
- The entire crew will be trained to the DOT, NRC, DOE, and shipper's requirements. The crew will have the necessary DOE clearances, access to the safeguards information, and appropriate training. Additional emergency training such as Federal Emergency Management Agency training would also be useful.

The costs for an Emergency Response Center should be considered independent of the number of shipments and includes the costs for an office and associated communication equipment.

7.9.3 Estimate of Railcar Maintenance Services Costs

To develop an estimate for railcar maintenance services costs, a combination of experience from an existing fleet of railcars used to ship low level waste in the U.S. and activities involving the design and potential building of AAR S-2043 compliant cask and buffer railcars for SNF shipment was utilized. For the purpose of estimating these costs, they are assumed for a single consist, made up of the aforementioned two buffer cars, five cask cars, and one escort car and dedicated to the de-inventory of the CR-3 ISFSI, as opposed to costs associated with maintaining a fleet of rail cars for the de-inventory of multiple sites. No maintenance costs associated with locomotives are included in this assessment. In addition:

- Routine railcar maintenance is assumed provided by the handling railroads and, depending on the costs, will be invoiced to the car owner (major and emergency maintenance) or covered by the shipping rate (minor/regular maintenance),
- Buffer car (4 axles) maintenance costs,
- Cask car (12 axles) maintenance costs,
- Escort car (4 axles) maintenance costs, and
- Costs associated with administering a fleet maintenance program.

The above costs associated with the maintenance of a fleet of rail cars encompass activities associated with the physical inspection, periodic regular servicing, and minor routine maintenance and repair activities. In addition, administrative costs for maintaining the program and covering taxes and insurance included in the above costs. However, these costs are estimated to only cover the cars in use for the de-inventory of the CR-3 ISFSI, rather than the costs associated with establishing and maintaining a facility and fleet for the larger inventory of rail cars needed for a national campaign. A separate assessment would need to be performed to establish if it is more prudent to lease the needed support services from an existing qualified supplier rather than establishing a dedicated facility to service, maintain, and store this fleet of rail cars considering:

- Administrative costs for such a support facility;

- Taxes can vary significantly by site for such a support facility, which could be placed in a large number of jurisdictions due to the number of potential de-inventory sites;
- Similarly, construction and maintenance costs for such a facility can vary widely depending on the suitable site selected; and
- Staffing costs for such a facility would also vary by site selected.

As noted above, routine maintenance activities for railcars are generally provided by the railroad and a portion is covered in freight rates.

7.9.4 Estimate of Transportation Cask Maintenance and Compliance Costs

To estimate the costs associated with the maintenance of a transportation cask, the following additional assumptions were made:

- One single shop is assumed to be used to perform the maintenance for all the transport casks (including those from different cask vendors if applicable);
- Costs associated with the transport to or from this shop are not included, as its location has not yet been established (although an economic argument could be made to locate this facility near the receiver site to minimize the transport costs);
- The shop where maintenance activities are to take place must have approval from the State to perform radiological work and dispose of the radioactive wastes potentially generated by the maintenance activities, noting the shop will need to open potentially contaminated transportation casks that may result in the release of some contamination;
- The shop must provide facilities for the storage of transportation casks, potentially for long periods of time;
- The shop must also allow for the training of personnel on cask maintenance operations;
- The shop must provide a covered building to allow maintenance operations to occur under any weather conditions and at any time of the year;
- The shop must be able to receive and store railcars (preferred) and/or HHT and ideally be connected by a rail spur to a major railroad;
- The shop must be equipped with a crane capable of lifting a transportation cask and the associated cradle/skid from a railcar or HHT,
    - Conservatively, the lifting capacity of this crane would need to be approximately 375 tons, although the transportation casks brought to this facility will be empty (i.e., will not include a canister with SNF),
    - From a nuclear safety standpoint, no critical load lift is necessary and hence, the crane does not need to be designed as single failure-proof,
    - The crane hook and height of the crane must be compatible with the lifting of yokes and associated rigging supplied by cask vendors;
- Some details of the transportation cask maintenance program will be different between cask vendors; however, the bulk of the maintenance costs are assumed to involve the following larger scale common activities:

  - External decontamination of the casks,
  - Internal decontamination of the casks,
  - Replacement of sealing gaskets,
  - Periodic maintenance and leak testing of the containment boundary,
  - Load tests,
  - Maintenance of spare parts,
  - Maintenance of the leak testing tools,
  - Maintenance of cask leak testing equipment,
  - Maintenance of the vacuum drying systems, and
  - Maintenance of lifting and support equipment (yokes, trunnions, skids, etc.).
- Leak testing will be performed according to American National Standards Institute (ANSI) N14.5-2014, unless specified otherwise in a Safety Analysis Report, by an American Society for Nondestructive Testing (ASNT) Level II cask operator;
- The maintenance program will be approved by an ASNT Level III reviewer and performed in accordance to the specifications identified in each transportation cask's Safety Analysis Report;
- The single shop will require a radiation protection plan that will be implemented and maintained;
- The size of the facility and the staff are assumed to limit maintenance to only one cask at a time; and
- The staff at this single shop will be composed of 2 trained operators, some engineering support, a half-time ASNT Level II cask operator, and a part-time ASNT level III procedure writer/reviewer.

8.0 SECURITY PLAN AND PROCEDURES

A Security Plan would encompass strategies and procedures in compliance with 49 CFR Part 172 to ensure the safety and the security of the material, employees, and the public during loading, transloading activities, and movement associated with the transportation of the SNF and GTCC LLW from the CR-3 ISFSI to the final destination.

The transportation activities covered by the plan would include all aspects of the shipment from loading the transportation casks at the CR-3 ISFSI, preparing them for movement on the transport trailer to the on-site rail transload track to the train movement to the hypothetical destination of the GCUS.

Multiple entities have jurisdiction over commercial shipments of SNF in the U.S. including the NRC, USCG, and the DOT. The DOT's PHMSA issues the Hazardous Materials Regulations in 49 CFR Parts 171-180 and represents the DOT in international organizations. The relevant regulations addressing the security of SNF during transportation include 49 CFR Parts 172-177; 10 CFR 73.20, 73.37 and 73.72 (advance notification); and 49 CFR Part 172, Subpart I.

The basic statute regulating HAZMAT transportation in commerce in the U.S. is 49 U.S. Code 5101 et seq., which identifies "hazardous materials" by commodity, or a group of commodities. It identifies regulations for the safe movement of HAZMAT, including safety and security for movements within the U.S. Several agencies have jurisdiction over different aspects of commercial transportation of HAZMAT depending on the mode of transport and other circumstances of the shipment. These agencies include the PHMSA, Federal Motor Carrier Safety Administration, FRA, Federal Aviation Administration, and USCG. Together these entities cover all aspects of commercial transportation of HAZMAT, which includes the movement of SNF, by road, rail, air, or water with an emphasis on safely moving this material.

Given the geographic proximity of both the ISFSI and transload site to navigable waters, the MTSA is assumed to apply to the CREC water-served site, even though the recommended mode of transportation is direct rail. Any site, whether private or public, that is on or adjacent to water and handling or storing HAZMAT will be governed by the USCG regulations, in coordination with other agency regulations. It is assumed and recommended that MTSA provisions apply to both the ISFSI and transload site. As such, additional security precautions should be implemented, including development, in consultation with the USCG, of a facility security plan if one does not already exist for the site. Likewise, when movement of SNF is occurring on-site, the USCG should be notified to monitor and patrol the navigable waters adjacent to the facility to provide a secure maritime area and limit access to the site by water. The COTP has the authority to establish the area as either a Safety Zone or Security Zone during loading operations, regardless of the mode of transportation.

In addition to the maritime security measures for the rail-served transload site, the railroad will be notified the site is being declared a "rail secure area" (due to the transload operation), as required by regulation. This means all provisions of the Security Plan will be adhered to and enforced and effectively, a layered security approach will be established to govern the sites for ISFSI transload operation, the HHT-to-rail movement, and the rail transload operations.

While maintaining security protocols relevant to the control of sensitive information regarding the movement of the SNF and its associated procedures, all relevant parties to the transportation activity will receive a copy of the Security Plan, and complete applicable training. All personnel will be required to return a signed copy of the Security Plan review signature sheet to the designated site administrator as part of documentation control.

8.1 Security Plan Requirements

Security plans for the transportation of hazardous materials in commerce are addressed in 49 CFR Part 172, Subpart I, which mandates a Security Plan must be in writing and contain an assessment of security risks for transportation of hazardous materials identified in 49 CFR 172.800, which includes highway route controlled quantities (HRCQ) of radioactive materials, and must address the identified risks including security while the material is en route. The Security Plan must also provide protection of the ISFSI facility and transload activities incidental to the transportation, including loading and unloading operations. This document assumes the provisions of the MTSA of 2002 are applicable. No formal determination has yet been made by the USCG or the NRC as to its applicability.

As delineated in 49 CFR 172.802, a Security Plan must also include the following elements addressing:

- Personnel security: Measures to confirm information provided by job applicants hired for positions that involve access to, and handling of, the HAZMAT covered by the Security Plan;
- Unauthorized access: Measures to address the assessed risk that unauthorized persons may gain access to the HAZMAT or transport conveyances being prepared for transportation of the HAZMAT;
- En-route security: Measures to address the assessed security risks of shipments of HAZMAT covered by the Security Plan en route from origin to destination, including shipments stored incidental to movement;
- Security Plan Owner: Identification, by job title, of the senior management official responsible for overall development and implementation of the Security Plan;
- Security duties: Duties and responsibilities for each position or department tasked with implementing any portion of the plan and the process of notifying employees when specific elements must be implemented;
- Training: Description of the training required by HAZMAT employees in accordance with 49 CFR 172.704 (a)(4) and (a)(5); and
- Risk Assessment with details addressing:
    - An assessment of transportation security risks for shipments of the specific HAZMAT listed in 49 CFR 172.800 (includes radioactive materials),
    - Site-specific or location-specific risks associated with facilities at which the HAZMAT is prepared for transportation, stored, or unloaded incidental to movement (e.g., rail transload facility), and
    - Appropriate measures to address the assessed risks.

The Security Plan, including the transportation security risk assessment, must be in writing and retained for as long as it remains in effect. It must be reviewed, at a minimum, on an annual basis and updated as necessary to reflect changing circumstances. Each person required to develop or implement a portion of the Security Plan must maintain a copy of the plan (written or electronic) that is accessible at their principal place of business and must make the plan available upon request, at a reasonable time and location, to an authorized official of the DOT or the Department of Homeland Security (DHS). The most recent version of the Security Plan, or portions thereof, must be available to the employees who are responsible for implementing it, consistent with personnel security clearance, or background investigation restrictions and a demonstrated need to know. When the Security Plan is updated or revised, all employees responsible for implementing it must be notified and all copies of the plan must be maintained as of the date of the most recent revision.

8.2 Scope

Key transportation, security, and Federal and State agency officials involved in the transport will need to be identified. The truck and rail transfer sites where the SNF will be loaded or unloaded will also need to be identified. Security professionals will conduct the security and risk analysis from point of origin (CREC site) to the final destination. In addition, a physical route analysis will be conducted to determine any potential logistical issues that may exist or that could pose a risk to security during all phases of the operation. Security professionals involved will identify requirements for compliance as part of the action plan and define and establish procedures for the operation, including contingency plans.

8.3 Identifying and Selecting the Principal Parties (Administrative Team)

The following should be considered for the identification and selection of the principal parties involved in the development of the Security Plan:

- The Security Contractor would chair the Administrative Team for the entire process or until an alternate is determined;
- Once the requirements of each transload site and the destination of the SNF and GTCC LLW is determined, contact should be made with all parties involved in the operation, including the rail and truck operators that will be involved with the transfer;
- Per 10 CFR 73.37 (b)(1)(viii), the initial contact with logistical partners should be made at a high level of the organizations in order to ensure the protection of Safeguards Information;
- Initial meetings should bring together the licensee, security, and risk assessment contractor or designee, high level logistical partners in truck, rail and other vendors (e.g., crane and rigging companies and monitoring partners), DHS, DOT, USCG, NRC, and other Federal and State, and Tribal officials, as needed;
- The meeting should address the concerns of each representative group, identify any groups that may not be present or need to be included, and come away with a framework for managing the project and how communications will be handled at all phases of the operation; and

- The purpose of this meeting is to establish the Administrative Team as a partnership dedicated to working together to ensure the safety and security of the SNF and GTCC LLW in transportation and identify any areas of concern.

8.4 Selecting the Rail/Truck Transload Site to be Used

The following should be considered when selecting and/or using a secure, existing transload site:

- If an existing transload site is identified, it is preferred that it be a fully enclosed and secure commercial installation, or that it can be easily secured. If the site must be established, these measures must be considered to enclose the site in an effort to create a secure perimeter around the loading location. This will include fencing and lighting around the perimeter of the property, installing security cameras and limiting egress and ingress to secure gates with locks at both the rail and truck entrances;
- Establish direct contacts at the site(s) for logistics and security; and
- Ensure that all persons on site with direct knowledge or access to the transfer location have background checks. Security clearances may also be considered but are not required.
- Assuming MTSA jurisdiction over the site and transload locations, TWIC identification cards would be mandatory for workers. TWIC cards are issued by TSA and involve background and fingerprint checks.

8.5 Identifying and Selecting the Risk and Security Assessment Team

Identification and selection of the Risk and Security Assessment Team (RSAT) should consider the following:

- Once the routes are proposed and agreed to by the Administrative Team, a RSAT shall be formed to conduct a security risk assessment of the routes and transfer sites;
- The RSAT will be selected and approved by the Administrative Team; and
- The RSAT will be comprised of security and risk professionals from licensee, security contractor, and any Federal, State, and Tribal agency that wishes to participate.

The RSAT will perform the security risk assessment of the surrounding transportation infrastructure. This includes, but is not limited to, bridges, tunnels, overpasses, proximity to population centers or landmarks, direct route access to the installation, identification of potential bottlenecks, narrow roads, interstate highways, proximity to hospitals, schools, civic centers, shipping channels, and highly populated areas. The assessment should include a 10-mile area on either side of the center of the proposed transportation route. Contingency routes should be identified and assessed throughout the transportation route.

Each step in the proposed route should be geographically divided and the results submitted to the Administrative Team for evaluation. If the RSAT uncovers any major concerns during the Security Risk Assessment, the next portion of the route geographically should be placed on hold until the issue is resolved in the event the transportation route must be changed. If no major concerns are uncovered, the RSAT can continue with the next geographical portion of the trip. During the assessment, agreements need to be made with all state agencies in the state(s) that is included in the assessment before finalizing the assessment.

8.6 Evaluating the Security and Risk Assessment

Upon completion of each geographical portion of the risk assessment, the assessment will be submitted to the Administrative Team for review, evaluation, and approval. All identified risks will be evaluated and resolved, or a contingency developed prior to approval of that portion of the transportation route.

8.7 Developing a Hazardous Materials Security Plan

The following should be considered while developing a HAZMAT Security Plan:

- Existing Security Plans for the site, railroads, trucking companies and transload sites, should be incorporated into the overall plan, especially to develop a concise hand-off of security responsibilities at each transfer;
- The Security Plan hand-off of responsibility at each site will be reviewed by the RSAT and evaluated and approved by the Administrative Team, DHS, DOT, USCG, the licensee, and each individual state authority for each state that will be crossed;
- Strict chain-of-custody protocols will be established and all physical transfers will be "manned" and documented[47]; and
- Any additional Security Plan that will be needed at the rail/truck transfer sites will be developed using the "Risk Management Framework For Hazardous Materials Transportation"[48] and the "Enhancing Security of Hazardous Materials Shipments Against Acts of Terrorism or Sabotage"[47].

8.8 Developing Security and Communication Protocols

Security and communication protocols will be developed as follows by the Administrative Team:

- All personnel identified above will have background checks completed prior to being included in any communications;
- The level of security required for operations personnel such as railroad personnel, truck drivers, riggers, flag men, security personnel, and others once the project is operational;
- What type of communications can and cannot be used during the entire project;
- What level of distribution will be allowed and how that will be administered and monitored; and
- Develop and approve all distribution lists and approved contacts.

8.9 Developing a Security Plan and Protocols for Marine Facilities

The following will be considered in the development of a Security Plan and associated protocols for a marine facility site (CREC and on-site transload track):

When a site handling hazardous materials, including SNF, is located near or on the water, additional maritime security precautions should be considered. While no determination has been made on its applicability, the MTSA describes prudent security measures for maritime facilities.

A Facility Security Plan (FSP) should be developed that identifies procedures and processes for transportation activities on site. The FSP is implemented by a Facility Security Officer (FSO) and submitted to the COTP for the Sector in which the site is located. The RSAT will conduct a security assessment up to the entrance of the marine facility. A review of the FSP in effect inside the marine facility will be conducted with the permission of the USCG COTP.

An Area Maritime Security Plan should be developed that identifies procedures for handling the maritime domain surrounding the facility during a transportation activity. Included in the Area Maritime Security Plan would be buffer zones where commercial or pleasures vessels would not be permitted during a transportation activity at the site. If vessels are to be used to transport SNF, the vessels would need a Vessel Security Plan (VSP). The VSP outlines vessel security and identifies the Vessel Security Officer, who would be delegated the responsibility of implementing the VSP and coordinating with the USCG and the FSO during a transportation activity. This plan should be created in coordination with the COTP.

8.10 Railroad Security Requirements

The following are railroad security-related requirements:

- The TSA published rules regarding the rail transportation of certain HAZMAT, which became effective on December 26, 2008[49] and are still in effect. The materials subject to these rules include explosive, TIH, PIH, and HRCQ. TSA refers to these commodities collectively as Rail Security-Sensitive Materials (RSSM). As a result of these rules, the carrier will only be able to accept or deliver RSSM from Rail Secure Areas;
- There are additional requirements for delivery/acceptance of RSSM in designated High Threat Urban Areas (HTUA), but none of the geographical locations involved in this assessment fall into designated HTUA.
- Shipments of RSSM will be subject to chain-of-custody requirements which apply:
    - To all shippers of these materials and
    - To receivers only located in HTUA;
- Personnel must be physically present for attended hand-offs of the railcars to document the transfer by recording the following information:
    - Each railcar's initial and number,
    - The individual attending the transfer,
    - The location of the transfer, and
    - The date and time of the transfer;
- Additionally, for any location in a HTUA that receives RSSM by rail, security personnel must be present 24 hours a day, 7 days per week. For any location that has notified the railroad that an RSSM railcar is available for shipment (released);
- Security personnel must be present 24 hours a day, 7 days per week from the time notification was provided to the railroad until the transfer has been completed and appropriately documented by both the shipper and railroad;

- A facility that is directly served by a railroad will be required to provide the following information to the carrier:
    - Acknowledgement that the facility has an appropriately designated Rail Secure Area,
    - The facility has designed and implemented procedures to ensure compliance with TSA chain-of-custody requirements effective as of February 15, 2009[49] (the requirements remain the same for rail-served sites handling HAZMAT),
    - If the facility has not established a Rail Secure Area or put chain-of-custody procedures in place, declare when it expects to complete these requirements and what interim measures are in place to ensure compliance in the meantime,
    - Without compliance with these measures, the railroad may refuse to perform switching services at the facility until the requirements are met, and
    - Proper and current contact information must be supplied, including company name, street address, phone number, and primary point of contact,
- There is no requirement to submit the Security Plan to the railroad for review or approval, but the shipper must inform the serving railroad that the plan exists; and
- All of the above will apply to the SNF rail transload facility.

8.11 Provisions for Protection of In-Transit Road Shipments

Specific provisions for protection of in-transit road shipments of SNF are found in 10 CFR 73.37(c):

- Transportation vehicles must be accompanied by at least two individuals
    - One serving as an armed escort
    - A second armed member of the LLEA in a mobile unit or
    - Led by a separate vehicle occupied by at least one armed escort and trailed by a third vehicle occupied by at least one armed escort.
- All armed escort are equipped with a minimum of two weapons (as permitted by law); however, this requirement does not apply to LLEA personnel who are performing escort duties.
- Transport and escort vehicles are equipped with redundant communication abilities that provide 2-way communications between the transport vehicle, the escort vehicle(s), the MCC, LLEA, and one another. To ensure that 2-way communication is possible at all times, alternate communications should not be subject to the same failure modes as the primary communication.
    - Escorts must have the ability to call for assistance when necessary
    - Escorts must be provided with a way to quickly develop new LLEA contacts and obtain new route information when unexpected detours become necessary
    - Escorts must be provided a way to coordinate the movement of transport and escort vehicles when more than one transport vehicle is used in the shipment

  - Escorts must be able to reach the emergency phone number provided on the approved route
- The transport vehicle must be equipped with NRC-approved features that permit immobilization of the cab or cargo-carrying portion of the vehicle with the purpose being to render the vehicle inoperable or incapable of movement under its own power. It must take at least 30 minutes to reverse the immobility once engaged.
- The transport vehicle driver must be trained with, and capable of implementing, the transport vehicle immobilization, communications, and other security procedures.

Shipments must be continuously and actively monitored by a telemetric position monitoring system or an alternate tracking system reporting to a MCC. The MCC shall:

- Provide positive confirmation of the location, status, and control over the shipment,
- Implement preplanned procedures in response to deviations from the authorized routes, or
- Notification of actual, attempted or suspicious activities related to the theft loss or diversion of a shipment.

These procedures must include contact information for the appropriate LLEA along the shipment route.

8.12 Provisions for Protection of In-Transit Rail Shipments

The following provisions are required for protection of in-transit rail shipments in accordance with 10 CFR 73.37(d):

- Loaded cars must be accompanied by two armed escorts;
- At least one escort is stationed on the train, permitting observation of the shipment car while in motion (generally, in an escort or security car).
- Each armed escort shall be equipped with a minimum of two weapons (as permitted by law but does not apply to LLEA personnel performing guard duties).
- The train operator(s) and each escort are equipped with redundant communication capabilities that provide 2-way communications between the transport, the escort vehicle(s), the MCC, local law enforcement agencies, and one another.
- To ensure that 2-way communication is possible at all times, alternate communications should not be subject to the same failure modes as the primary communication device.
- Rail shipments must be monitored by a telemetric position monitoring system or an alternate tracking system reporting to the licensee, third-party, or railroad MCC.
- The MCC shall provide positive confirmation of the location of the shipment and its status.
- The MCC shall implement preplanned procedures in response to deviations from the authorized route or to a notification of actual, attempted, or suspicious activities related to the theft, diversion, or radiological sabotage of a shipment.
- These procedures shall include, but not be limited to, the identification of and contact information for the appropriate LLEA along the shipment route.

8.13 Provisions for Protection of In-Transit Barge Shipments

Specific provisions for protection of in-transit barge shipments are found in 10 CFR 73.37(e) and include:

- A shipment vessel while docked at a U.S. port is protected by:
    - Two armed escorts stationed on board the shipment vessel, or stationed on the dock at a location that will permit observation of the shipment vessel; or
    - A member of a LLEA, equipped with normal local law enforcement agency radio communications, who is stationed on board the shipment vessel, or on the dock at a location that will permit observation of the shipment vessel.
- As permitted by law, all armed escorts are equipped with a minimum of two weapons. This requirement does not apply to LLEA personnel who are performing escort duties.
- A shipment vessel, while within U.S. territorial waters, shall be accompanied by an individual, who may be an officer of the shipment vessel's crew, who will assure that the shipment is unloaded only as authorized by the licensee.
- Each armed escort is equipped with redundant communication abilities that provide 2-way communications between the vessel, the movement control center, local law enforcement agencies, and one another. To ensure that 2-way communication is possible at all times, alternate communications should not be subject to the same failure modes as the primary communication.

Because the on-site loading facility from the CR-3 ISFSI to HHT is located adjacent to the waters of the U.S. waterway (Crystal River, Crystal Bay, Double Barrel Creek, Rocky Creek), the following definitions will apply, even though no transportation on the waterways is expected to occur:

- U.S. waters extend to three nautical miles from the U.S. land territory, with the exception of small offshore islands;
- Security between three and 12 nautical miles from the coast falls under the responsibility of the USCG;
- If a U.S. port is used for transport, the licensee shall coordinate with both the USCG and local port authorities during a transport (or transload) operation to ensure that all parties are appropriately informed and to ensure the physical protection thereof[52]; and
- If an established port facility is used, protocols of that MTSA plan will be enforced to protect the shipment from any threat presented from the rail transfer site being located on water or adjacent to the water and provide protection against theft, diversion, or radiologic sabotage while located adjacent or next to the water.

Items requiring action for protection of transload sites (HHT to rail) near navigable waterways include:

- MTSA plan to be developed and implemented on the rail transfer site or amended to include the transfer if already in place,
- Property to be fenced,

- Property to be lighted,
- Perimeter and fence line to be surveilled by a closed-circuit camera system,
- All personnel on a water-served site must obtain a TWIC,
- All personnel who are on duty will have the capability to delay or impede such acts as listed for the Security Plan and can request assistance promptly from LLEA responses forces and USCG, and
- All provisions applicable to U.S. ports may apply to a private water-served site, including coordinating with USCG and local port authorities.

No HAZMAT vessels will be docked at the CR-3 site barge slip and therefore, the escort requirements in 10 CFR 73.37(e) will not apply to the site.

9.0 EMERGENCY RESPONSE PLAN AND PREPAREDNESS

The purpose of the Emergency Response Plan (ERP) is to establish notification protocols and provide response guidance in the event of a reportable incident involving an HHT or rail shipment transporting HAZMAT. The ERP includes all pertinent contact and contingency information including specific contact names and phone numbers, as well as procedures in the event of an incident. These procedures encompass the requirements for providing and maintaining emergency information during transportation and at facilities where HAZMAT is loaded, stored, or otherwise handled during every phase of transportation[53].

Emergency response information is required to be immediately available for use at all times when HAZMAT is present. It is also required to be immediately available to any Federal, State, or local government agency representative who responds to an incident or is investigating an incident (per 49 CFR 172.600(c)(1)&(2))[56].

9.1 General Guidance for an Emergency Response Plan

As required by 49 CFR 172.602, emergency response information must be provided that can be used in the mitigation of an incident involving hazardous materials and, as a minimum, must contain the following information:

- The basic description and technical name of the hazardous material;
- Immediate hazards to health;
- Risks of fire or explosion;
- Immediate precautions to be taken in the event of an accident or incident;
- Immediate methods for handling fires;
- Initial methods for handling spills or leaks in the absence of fire; and
- Preliminary first aid measures.

This information must be written in English and available for use away from the package and provided in an approved format such as shipping papers or a document containing all the relevant information that will be found in shipping papers[53].

This emergency response information is usually incorporated into an ERP. The ERP will include the emergency contact telephone number (per 49 CFR 172.604) and this number:

- Must be monitored at all times the HAZMAT is in transportation, including storage incidental to transportation;
- Must be monitored by a "person who is either knowledgeable of the hazardous material being shipped and has comprehensive emergency response and incident mitigation information for that material, or has immediate access to a person who possesses such knowledge and information;"
- Must be entered on the shipping paper(s) immediately following the description of the hazardous material;

- Must be entered on the shipping paper(s) in a prominent, readily identifiable, and clearly visible manner; and
- Must be the number of the person offering the hazardous material for transportation when that person is also the emergency response information provider, or the number of an agency or organization capable of, and accepting responsibility for, providing the detailed information.

All HAZMAT rail shippers are registered with CHEMTREC, or a similar company, to provide the above requirements. Shipper must make sure to provide CHEMTREC with current information on the material before it is offered for transportation.

As stated above, the purpose of the ERP is to establish notification and response guidance in the event of a reportable transportation incident involving an HHT or rail shipment that is transporting hazardous material. The plan would include information in compliance with 49 CFR Part 172.600 to 172.606 (i.e., Subpart G) and other Federal, State, Tribal, or local requirements and regulations and is intended to provide direction by identifying immediate measures to contain the situation and ensure safety and security until the LLEA and emergency response professionals arrive on the scene.

The emergency response procedures apply to persons who offer, accept, transfer, or otherwise handle HAZMAT during transportation. In this case, the procedures will apply to site operations at CR-3, on-site HHT transport beginning with all transfer operations conducted at CREC to transfer the overpacks from the ISFSI to the transfer trailer for the on-site transport to the on-site rail siding (loop track). This includes all transload operations to place the overpacks onto the railcars, movement of the dedicated train from the rail transload facility along the entire route from CSEC to the final destination.

The security personnel accompanying the train will remain with the train for the entire train movement.

Each entity involved in each facet of the transportation operation will develop its own emergency response information and procedures commonly included in an ERP. The plan will be disseminated to the appropriate employees and the information will become part of the overall Security Plan for the licensee. Each entity on the project will have separate and individual procedures respective to its role, but they will be coordinated for the project to delineate hand-off procedures (interfaces) to clearly define responsibilities for each phase and participant. Note that the limitations of information dissemination as identified by 10 CFR 71.11 must be considered before sharing information concerning safety, security, and emergency response.

An example of the index for such a plan and the information to be included is listed below. This example index comes from a proprietary ERP (containing safeguards information) from a trucking company that is actively transporting HAZMAT. It is only intended to be an example of the potential contents of an ERP.

Section 1: Purpose & Scope

Section 2: Commitments, Company procedures, Title 49 CFR related-material

Section 3: References – 49 CFR Part 172 (subpart G), Hazardous Material Regulations First Notifications, Emergency Response Guidebook (latest edition issued by DOT), Condition Reports, Assistance with Radioactive Material Transportation Incidents, Conference of Radiation Control Program Directors, Inc. (CRCPD) "CRCPD Notes," current edition

Section 4: General - Definitions of relevant terms: Emergency, Hazardous Material, Minor and Major Incident, Reportable Quantity, Responsibilities identified for the following employees: Manager of Compliance, Director of Radiation Safety, Transload Facility Drivers, Driver Incident packet with checklists, schematics, etc.

Section 5: Notifications – Notification of Transportation Incidents, Minor and Reportable Incident Notification – definitions, Emergency Contact Phone Numbers for all Company (transload, etc.) employees including 24/7 contact numbers, Emergency Response Agencies for the jurisdictions in which the SNF is traveling, with requirements for notification and frequency, Emergency Contact Responsibilities

Section 6: Attachments - Incident Log, Checklist of notifications with internal and external notification contacts and contact numbers, Notifications and conditions for contacting the National Response Center and State Agencies, Blank incident logs indicating identifying incidents and resultant injuries, with room for documenting any damage, mode contact information is listed along with vehicle details and road location (for road), and any resulting drug tests.

9.2 CR-3 Site-Specific Considerations for the Emergency Response Plan

The MUA identified the highest ranked route for transporting the SNF and GTCC LLW from CR-3 to be a direct rail route, starting with a 500 ft. transfer trailer transit from the ISFSI to the on-site rail loop (coal unloading track) where the transportation casks would be loaded onto railcars. Since the CREC site is located on or adjacent to a U.S. waterway (Crystal River, Crystal Bay, Double Barrel Creek, Rocky Creek), it is assumed that MTSA requirements apply, in addition to the Rail Secure Area designation. These two sources of provisions would present a layered security approach for the operations involved in the loading campaign. As a result, some additional fencing would be required to enclose the rail transload area (the portion of the track where the train would be loaded).

The USCG is responsible for reviewing and approving the MTSA plan for operations conducted on any water-served site, including activities at the ISFSI and rail transload site, as it pertains to safety and security of the sites from the coastline. The respective COTPs from the Seventh USCG District would be involved in the assessment of the plan. This may include a request from the site for the USCG to establish a barrier or security zone around CREC while the on-site truck transport and rail transloading operations are conducted. The required notification would be given in writing to the serving railroad, FNOR, stating that the area meets the requirements of a "rail secure area" and contact information will be supplied to the railroad. There is no requirement, as stated earlier, for the railroad to approve the Security Plan.

At this time, no formal determination has been made as to the applicability/jurisdiction of MTSA on the CREC site. Compliance with MTSA is recommended at this time as a conservative approach to a multi-tiered security plan.

The site Security Plan for CR-3, as required by 10 CFR Part 73, is comprehensive and encompasses various protection measures for the vital areas of the site, including the ISFSI. This plan will include compliance with 10 CFR 73.55(e)(ii), which requires the licensee to identify areas from which a waterborne vehicle must be restricted and in coordination with local, State and federal agencies having jurisdiction over waterway approaches, provide periodic surveillance and observation of waterway approaches and adjacent areas. Hence, any MTSA requirements for the site are presumed to become part of the overall Security Plan for the site.

Due to the fact that the CR-3 site is located on the western coast in Florida, precautions should be taken to consider natural disasters prevalent to the area such as tropical storms, hurricanes and resulting flooding. Hurricane season in FL typically lasts from June 1st to November 30th. In the planning stages of the loading campaign, weather conditions should be considered. NOAA (www.noaa.gov) provides forecasting information for hurricanes in conjunction with The National Weather Service (www.spc.noaa.gov) and the National Hurricane Center (www.nhc.gov) provides information on watches and warnings for hurricanes and tropical storms.

10.0 RECOMMENDED NEXT STEPS

Based on the results of this study, the following recommendations are provided to support implementation of a future de-inventory program. These recommendations are listed in approximate order of when to be addressed (earliest to latest):

1. Examine the on-site path from the ISFSI to each loading area and evaluate the need for improvements to ensure acceptable conditions of transport exist. Consider the extent of the concrete roadway needed to be added/upgraded at the site to handle anticipated transportation activities, as well as grading improvements need on steep paths;
2. The TN 32PTH1 DSCs and GTCC RWCs will need to be evaluated prior to transport to ensure 10 CFR Part 71 requirements are met. At a minimum, this will need to involve a comparison of the fabrication records against the CoC requirements and verification that the canister integrity has been maintained. It is recommended to allocate two to three years for this activity, which could involve a need to revise the CoC. In general, a complete transportability study consisting of a comparison of each transport cask and its contents in a transport configuration to the 10 CFR Part 71 CoC at the time the transport will be performed by the NRC licensee with the support of the transport cask CoC holder prior to transportation of each canister to be offered for transport;
3. Establish planned shipment date from the CR-3 ISFSI and verify:
    a. The CoC for the TN MP197HB package is still valid,
    b. The contents, as loaded in the TN canisters are compliant to the applicable CoC requirements (e.g., dose and thermal transport limits are satisfied), and
    c. Ability for permitting the transportation activities along the selected route(s).
4. Establish equipment needs for transportation:
    a. Procurement of the necessary MP197HB casks, associated impact limiters, cavity spacers, transport cradles, personnel barriers, and vertical lifting yoke and horizontal lift beam. As discussed in **Section 2.3**, any road or barge transportation activities may not require the complete cradle assembly necessary for rail transportation and
    b. Investigate the availability and capacity of the existing NUHOMS transfer equipment, previously used at CR-3, to identify what can be reused and what, if any, modifications would be needed due to the additional weight of the MP197HB transportation cask; and
5. Establish CR-3 ISFSI site operations related details:
    a. Establish electrical power requirements for performing operations and verify availability at CR-3 ISFSI,
    b. Determine the maximum height an MP197HB cask can be lifted without impact limiters. While no lifts of the loaded MP197HB cask are proposed, this may drive additional requirements for the transfer trailer regarding cask retention. Currently the trailer and HHT designs are not important to safety, and

c. Consult with appropriate regulatory authorities on the applicability of the MTSA and its requirements for CR-3 ISFSI.

6. Due to the potential significant impacts of the conditions and assumptions identified in **Section 7.9** for the estimated costs associated with activities involving the rail shipment of transportation casks from the transload site to the GCUS site (i.e., cask consist transportation services costs, emergency response center operation costs, railcar maintenance services freight costs, and transportation cask maintenance and compliance costs), the development of more precise costs requires resolution to, or clarification of, the identified conditions and assumptions in **Section 7.9**, as well as consideration of economies of scale and synergies associated with the de-inventory of multiple sites at the same or nearly same time, understanding of equipment (e.g., railcars and casks) ownership impact, and the need for a comprehensive breakdown of activities involved in these costs.

11.0 REFERENCES

[1] Abkowitz, M., “Stakeholder Tool for Assessing Radioactive Transportation (START): Version 3.2 User Manual,” FCRD-NST-2014-000092, Rev. 5, North Wind Services, LLC, June 2017.

[2] Steven J. Maheras, Lauren S. Rodman, Ralph E. Best, Adam Levin, Steven B. Ross, Lawrence M. Massaro, and Philip J. Jensen, “Nuclear Power Plant Infrastructure Evaluations for Removal of Spent Nuclear Fuel,” PNNL-30429, April 30, 2021.

[3] Citrus County Chronicle, “Coal-fired units to retire this month”, December 17, 2018, https://www.chronicleonline.com/news/local/coal-fired-units-to-retire-this-month.

[4] Duke Energy website, https://www.duke-energy.com/our-company/about-us/power-plants/crystal, 04/04/2019.

[5] U.S. Nuclear Regulatory Commission website, https://www.nrc.gov/info-finder/decommissioning/power-reactor/cr3.html, Page Last Reviewed/Updated Thursday, July 19, 2018.

[6] CR-3 DSAR, Crystal River Unit 3 Defueled Safety Analysis Report – Sections 1.1, 1.2, 1.8, Table 1-1, Figure 1-24, Revision 0, August 31, 2017. (ML17251A290)

[7] DEF Letter 3F0119-01, Crystal River Unit 3 – Partial Shutdown Release Request, January 22, 2019. (ML19022A076)

[8] Google Maps, Crystal River Energy Complex area (Crystal River, FL), April, 2019.

[9] Applicant’s Environmental Report – Operating License Renewal Stage, Crystal River Unit 3, Progress Energy, Unit 3, Docket No. 50-302, License DPR-72, Final November 2008.

[10] U.S. Nuclear Regulatory Commission Certificate of Compliance for Standardized NUHOMS Horizontal Modular Storage System No. 1004, Amendment 14 (Docket 72-1004).

[11] TN NUH-003.0103, Updated Final Safety Analysis Report for the Standardized NUHOMS Horizontal Modular Storage System for Irradiated Nuclear Fuel, Revision 15, 2016.

[12] May 29, 2019, Email from Steven Maheras to Sven Bader, additional crystal river information.

[13] May 22, 2019, Email from Steven Maheras to Sven Bader, cr fuel data.

[14] Crystal River ISFSI Fuel Assembly Certification, Loading Maps for 32PTH1 Type 2-W canisters.

[15] U.S. Nuclear Regulatory Commission Certificate of Compliance for Standardized NUHOMS Horizontal Modular Storage System No. 1004, Amendment 14.

[16] DEF Letter 3F0717-02, ISFSI Cask Registration for Spent Fuel Storage, July 19, 2017. (ML17200D093)

[17] Crystal River ISFSI Fuel Assembly Certification, Loading Maps for 32PTH1 Type 2-W canisters.

[18] DEF Letter 3F0817-01, ISFSI Cask Registration for Spent Fuel Storage, August 16, 2017. (ML17228A543)

[19] DEF Letter 3F0917-01, ISFSI Cask Registration for Spent Fuel Storage, September 13, 2017. (ML17256A170)

[20] DEF Letter 3F1017-01, ISFSI Cask Registration for Spent Fuel Storage, October 16, 2017. (ML17289B121)

[21] DEF Letter 3F1117-01, ISFSI Cask Registration for Spent Fuel Storage, November 14, 2017. (ML17318A054)

[22] DEF Letter 3F1217-01, ISFSI Cask Registration for Spent Fuel Storage, December 12, 2017. (ML17346A347)

[23] DEK Drawing A-596, "Site Plan ISFSI Pad Module and Cask Configuration and Identification Numbers", Revision L.

[24] DEF Letter 3F0118-01, ISFSI Cask Registration for Spent Fuel Storage, January 10, 2018. (ML18010A462)

[25] DEF Letter 3F0118-02, ISFSI Cask Registration for Spent Fuel Storage, January 15, 2018. (ML18015A006)

[26] U.S. Nuclear Regulatory Commission Certificate of Compliance for NUHOMS-MP197HB Transport Cask Package No. 9302, Revision 11 (Docket 71-9302).

[27] TN NUHOMS-MP197 Transportation Packaging Safety Analysis Report (SAR), Revision 21, 2022.

[28] AREVA Federal Services LLC Report DE-NE0008390, October 28, 2016, Atlas Railcar Phase 1 Final Report.

[29] RailUSA website; https://www.railusa.net/2019/06/03/railusa-acquires-csxs-430-mile-florida-panhandle-rail-line/, 7/10/19; photo: Bill Stephens, "CSX Florida Panhandle route line-sale deal falls through", http://trn.trains.com/news/news-wire/2019/01/21-csx-florida-panhandle-route-line-sale-deal-falls-through, 1/21/2019.

[30] Argonautics Marine Engineering, Inc.; Argonautics.com/Crystal_River_Turbines.html, 4/3/2019 and Bos Smith, VP Operations, Stevens Towing.

[31] BookletChart, Crystal River to Horseshoe Point, NOAA Chart 11408, page 21. 31st Edition, June 2018. Last Correction: 3/8/2019. Cleared through: LNM: 1519 (4/9/2019), MN: 1719 (4/27/2019).

[32] NUREG-0561, Revision 2, Physical Protection of Shipments of Irradiated Reactor Fuel: Final Report.

[33] AREVA Federal Services LLC Report RPT-3016127-002, March 21, 2017, Initial Site-Specific De-Inventory Report for Maine Yankee.

[34] AREVA Federal Services LLC Report RPT-3014538-002, May 5, 2017, Initial Site-Specific De-Inventory Report for Connecticut Yankee.

[35] AREVA Federal Services LLC Report RPT-3015142-004, June 2, 2017, Initial Site-Specific De-Inventory Report for Humboldt Bay.

[36] AREVA Federal Services LLC Report RPT-3016128-000, September 28, 2016, Trojan De-Inventory Study.

[37] AREVA Federal Services LLC Report RPT-3014537-002, May 10, 2017, Initial Site-Specific De-Inventory Report for Big Rock Point.

[38] AREVA Federal Services LLC Report RPT-3019262-000, August 31, 2017, Initial Site-Specific De-Inventory Report for Kewaunee.

[39] Hardin, Ernest, "Deep Borehole Field Test Specifications," FCRD-UFD-2015-000132 Rev. 1, Sandia National Laboratory, September 2015.

[40] Merkhofer MW, Keeney RL., "A multi-attribute utility analysis of alternative sites for the disposal of nuclear waste," Risk Anal. 1987 Jun;7(2):173-94.

[41] U.S. DOE Office of Civilian Radioactive Waste Management, "A Multi-attribute Utility Analysis of Sites Nominated for Characterization for the First Radioactive Waste Repository - A Decision Aiding Methodology," DOE/RW-0074, May 1986.

[42] Davis, F., et. al., "A Multi-Attribute Utility Decision Analysis for Treatment Alternatives for the DOE/SR Aluminum-Based Spent Nuclear Fuel." Sandia National Laboratories. SAND98-2146. October 1998.

[43] Association of American Railroads, "AAR Open Top Loading Rules Manual," Effective 8/11/17.

[44] Association of American Railroads, AAR Circular OT-55-O (CPC-1312), "Recommended Railroad Operating Practices for Transportation of Hazardous Materials", January 27, 2015.

[45] U.S. NRC, Regulatory Guide 7.10 "Establishing Quality Assurance Programs for Packaging Used in Transport of Radioactive Material," Rev. 2, March 2005.

[46] J. W. McConnell, Jr., A. L. Ayers, Jr., M. J. Tyacke, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety," NUREG/CCR-6407, February 1996.

[47] U.S. Department of Transportation, Research and Special Programs Administration, "Enhancing Security of Hazardous Materials Shipments Against Acts of Terrorism or Sabotage Using RSPA's Risk Management Self-Evaluation Framework (RMSEF), Revision 1", January 2002.

[48] ICF Consulting, U.S. Department of Transportation, Research and Special Programs Administration, "Risk Management Framework for Hazardous Materials Transportation", November 1, 2000.

[49] National Archives and Records Administration, Office of Federal Register, "Code of Federal Regulations 73FR 72173", Title 49 CFR 1580, Title 49 – Transportation, Subtitle B – Other Regulations Relating to Transportation, Chapter X – Surface Transportation Board, Department of Transportation, Subchapter B – Security Rules for All Modes of Transportation, Part 49 CFR 1580 – Rail Transportation Security, November 26, 2008.

[50] Department of Energy, "Departmental Materials Transportation and Packaging Management," DOE Order 460.2B, June 2022.

[51] Not used.

[52] Title 10, Code of Federal Regulations Part 73.37, "Requirements for physical protection of irradiated reactor fuel in transit", December 31, 2015.

[53] Title 49, Code of Federal Regulations Part 172, Subpart G, Section 172.602, "Emergency response information" June 2, 2016.

[54] Crystal River Unit 3 – Safety Analysis Report, Quality Assurance Program and 10 CFR 50.59 – 10 CFR 72.48 Report – May 2022. (ML22138A042)

[55] Orano Photo, Nuclear Spur Big Top Tent, November 2021.

[56] Title 49, Code of Federal Regulations Part 172, Subpart G, Section 172.600, "Emergency response information: Applicability and general requirements" June 2, 2016.

[57] Orano Decommissioning Services EIR-DDOPS.CR3-LWP-00077, Rev. 001, 12/5/2022, Legacy GTCC Waste Segmentation and Packaging.

[58] Orano Decommissioning Services CALC-DDOPS.CR3-LWP-00003, Rev. 004, 2/16/2023, CR3 RVI Waste Characterization and Classification Report.

Attachment A: Full Pairwise Comparison for the Tangible Metrics

Place a single "X" per line where you believe the importance of the metric in column A falls against the metric in column B.

Column A Metrics	Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Strongly Favorable	Column B Metrics
On-Site Rental Equipment Costs (e.g., mobile cranes)								Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)
On-Site Rental Equipment Costs (e.g., mobile cranes)								Labor and Permitting Costs
On-Site Rental Equipment Costs (e.g., mobile cranes)								Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)
On-Site Rental Equipment Costs (e.g., mobile cranes)								Cost of Rail Transport (e.g., costs associated with interchange activities)
On-Site Rental Equipment Costs (e.g., mobile cranes)								Impact of Weather to Route (e.g., limited availability of route or instability of weather)
On-Site Rental Equipment Costs (e.g., mobile cranes)								Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)
On-Site Rental Equipment Costs (e.g., mobile cranes)								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)
On-Site Rental Equipment Costs (e.g., mobile cranes)								Number of Tribal Lands Crossed
On-Site Rental Equipment Costs (e.g., mobile cranes)								Public Acceptability of Route
On-Site Rental Equipment Costs (e.g., mobile cranes)								Cumulative Worker Exposure (α handling time & # of workers)
On-Site Rental Equipment Costs (e.g., mobile cranes)								Cumulative Population Dose along Route (α population density)
On-Site Rental Equipment Costs (e.g., mobile cranes)								Risks Associated with Number of Lifting Activities
On-Site Rental Equipment Costs (e.g., mobile cranes)								Average Accident Frequency on Route
On-Site Rental Equipment Costs (e.g., mobile cranes)								Transit Duration per Conveyance and Consist
On-Site Rental Equipment Costs (e.g., mobile cranes)								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
On-Site Rental Equipment Costs (e.g., mobile cranes)								Security Vulnerability of Route
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Labor and Permitting Costs
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Cost of Rail Transport (e.g., costs associated with interchange activities)
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Impact of Weather to Route (e.g., limited availability of route or instability of weather)
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Number of Tribal Lands Crossed
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Public Acceptability of Route
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Cumulative Worker Exposure (α handling time & # of workers)
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Cumulative Population Dose along Route (α population density)
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Risks Associated with Number of Lifting Activities
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Average Accident Frequency on Route
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Transit Duration per Conveyance and Consist
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Security Vulnerability of Route
Labor and Permitting Costs								Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)
Labor and Permitting Costs								Cost of Rail Transport (e.g., costs associated with interchange activities)
Labor and Permitting Costs								Impact of Weather to Route (e.g., limited availability of route or instability of weather)
Labor and Permitting Costs								Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)
Labor and Permitting Costs								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)
Labor and Permitting Costs								Number of Tribal Lands Crossed
Labor and Permitting Costs								Public Acceptability of Route
Labor and Permitting Costs								Cumulative Worker Exposure (α handling time & # of workers)
Labor and Permitting Costs								Cumulative Population Dose along Route (α population density)
Labor and Permitting Costs								Risks Associated with Number of Lifting Activities
Labor and Permitting Costs								Average Accident Frequency on Route
Labor and Permitting Costs								Transit Duration per Conveyance and Consist
Labor and Permitting Costs								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Labor and Permitting Costs								Security Vulnerability of Route
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Cost of Rail Transport (e.g., costs associated with interchange activities)
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Impact of Weather to Route (e.g., limited availability of route or instability of weather)
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Number of Tribal Lands Crossed
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Public Acceptability of Route
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Cumulative Worker Exposure (α handling time & # of workers)
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Cumulative Population Dose along Route (α population density)
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Risks Associated with Number of Lifting Activities
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Average Accident Frequency on Route
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Transit Duration per Conveyance and Consist
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Security Vulnerability of Route

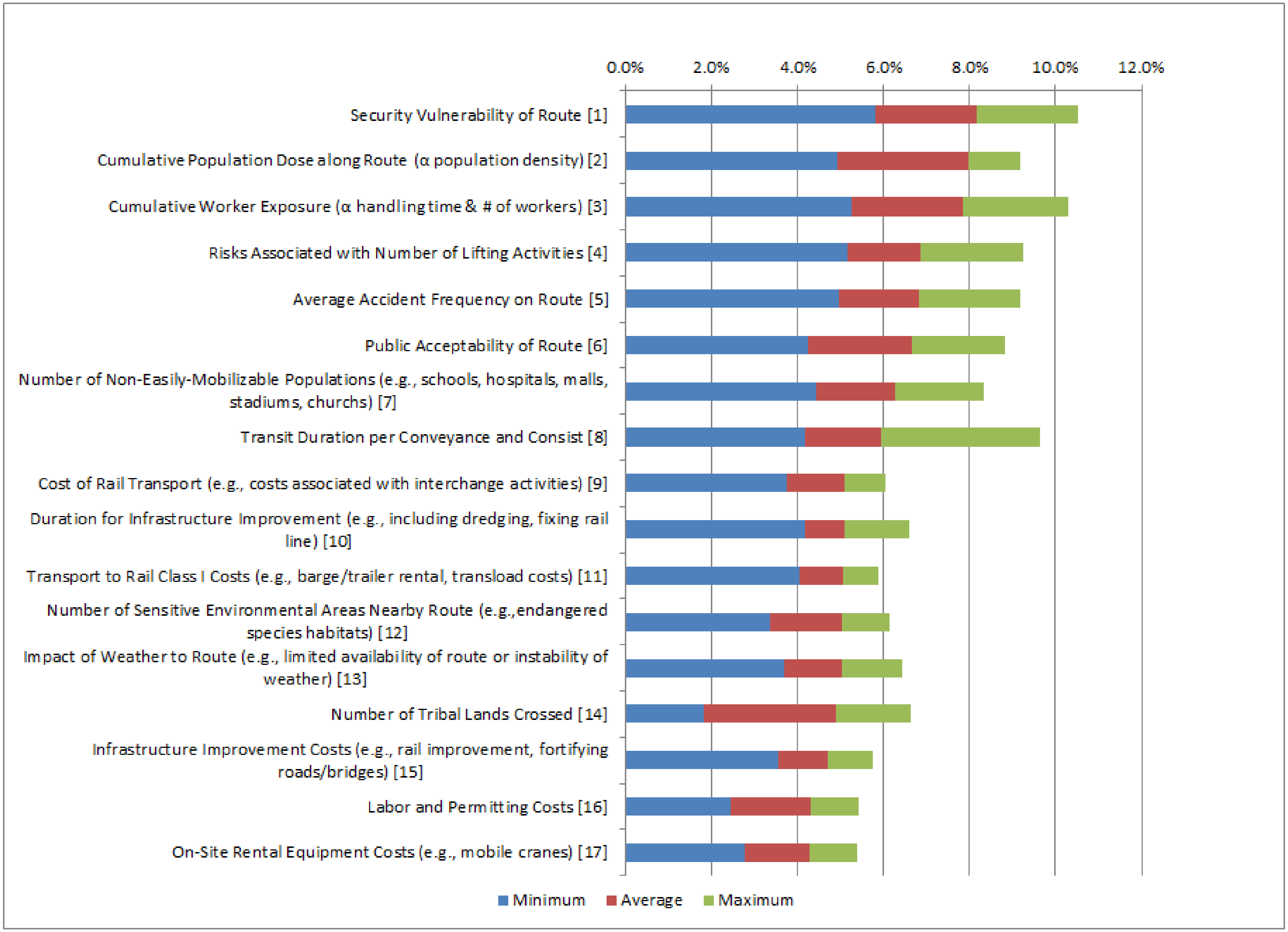
Column A Metrics	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Metrics
Cost of Rail Transport (e.g., costs associated with interchange activities)								Impact of Weather to Route (e.g., limited availability of route or instability of weather)
Cost of Rail Transport (e.g., costs associated with interchange activities)								Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)
Cost of Rail Transport (e.g., costs associated with interchange activities)								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)
Cost of Rail Transport (e.g., costs associated with interchange activities)								Number of Tribal Lands Crossed
Cost of Rail Transport (e.g., costs associated with interchange activities)								Public Acceptability of Route
Cost of Rail Transport (e.g., costs associated with interchange activities)								Cumulative Worker Exposure (α handling time & # of workers)
Cost of Rail Transport (e.g., costs associated with interchange activities)								Cumulative Population Dose along Route (α population density)
Cost of Rail Transport (e.g., costs associated with interchange activities)								Risks Associated with Number of Lifting Activities
Cost of Rail Transport (e.g., costs associated with interchange activities)								Average Accident Frequency on Route
Cost of Rail Transport (e.g., costs associated with interchange activities)								Transit Duration per Conveyance and Consist
Cost of Rail Transport (e.g., costs associated with interchange activities)								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Cost of Rail Transport (e.g., costs associated with interchange activities)								Security Vulnerability of Route
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Number of Tribal Lands Crossed
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Public Acceptability of Route
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Cumulative Worker Exposure (α handling time & # of workers)
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Cumulative Population Dose along Route (α population density)
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Risks Associated with Number of Lifting Activities
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Average Accident Frequency on Route
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Transit Duration per Conveyance and Consist
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Security Vulnerability of Route
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)								Number of Tribal Lands Crossed
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)								Public Acceptability of Route
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)								Cumulative Worker Exposure (α handling time & # of workers)
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)								Cumulative Population Dose along Route (α population density)
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)								Risks Associated with Number of Lifting Activities
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)								Average Accident Frequency on Route
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)								Transit Duration per Conveyance and Consist
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)								Security Vulnerability of Route
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)								Number of Tribal Lands Crossed
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)								Public Acceptability of Route
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)								Cumulative Worker Exposure (α handling time & # of workers)
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)								Cumulative Population Dose along Route (α population density)
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)								Risks Associated with Number of Lifting Activities
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)								Average Accident Frequency on Route
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)								Transit Duration per Conveyance and Consist
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)								Security Vulnerability of Route
Number of Tribal Lands Crossed								Public Acceptability of Route
Number of Tribal Lands Crossed								Cumulative Worker Exposure (α handling time & # of workers)
Number of Tribal Lands Crossed								Cumulative Population Dose along Route (α population density)
Number of Tribal Lands Crossed								Risks Associated with Number of Lifting Activities
Number of Tribal Lands Crossed								Average Accident Frequency on Route
Number of Tribal Lands Crossed								Transit Duration per Conveyance and Consist
Number of Tribal Lands Crossed								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Number of Tribal Lands Crossed								Security Vulnerability of Route

Column A Metrics	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Metrics
Public Acceptability of Route								Cumulative Worker Exposure (α handling time & # of workers)
Public Acceptability of Route								Cumulative Population Dose along Route (α population density)
Public Acceptability of Route								Risks Associated with Number of Lifting Activities
Public Acceptability of Route								Average Accident Frequency on Route
Public Acceptability of Route								Transit Duration per Conveyance and Consist
Public Acceptability of Route								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Public Acceptability of Route								Security Vulnerability of Route
Cumulative Worker Exposure (α handling time & # of workers)								Cumulative Population Dose along Route (α population density)
Cumulative Worker Exposure (α handling time & # of workers)								Risks Associated with Number of Lifting Activities
Cumulative Worker Exposure (α handling time & # of workers)								Average Accident Frequency on Route
Cumulative Worker Exposure (α handling time & # of workers)								Transit Duration per Conveyance and Consist
Cumulative Worker Exposure (α handling time & # of workers)								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Cumulative Worker Exposure (α handling time & # of workers)								Security Vulnerability of Route
Cumulative Population Dose along Route (α population density)								Risks Associated with Number of Lifting Activities
Cumulative Population Dose along Route (α population density)								Average Accident Frequency on Route
Cumulative Population Dose along Route (α population density)								Transit Duration per Conveyance and Consist
Cumulative Population Dose along Route (α population density)								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Cumulative Population Dose along Route (α population density)								Security Vulnerability of Route
Risks Associated with Number of Lifting Activities								Average Accident Frequency on Route
Risks Associated with Number of Lifting Activities								Transit Duration per Conveyance and Consist
Risks Associated with Number of Lifting Activities								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Risks Associated with Number of Lifting Activities								Security Vulnerability of Route
Average Accident Frequency on Route								Transit Duration per Conveyance and Consist
Average Accident Frequency on Route								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Average Accident Frequency on Route								Security Vulnerability of Route
Transit Duration per Conveyance and Consist								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Transit Duration per Conveyance and Consist								Security Vulnerability of Route
Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)								Security Vulnerability of Route

Attachment B: Results from the Twelve Individual's Pairwise Comparison for the Tangible Metrics

	Rater																											
	1		2		3		4		5		6		7		8		9		10		11		12		Average			
Metric	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	Average	Metric
On-Site Rental Equipment Costs (e.g., mobile cranes)	4.04%	15	4.23%	13	4.10%	16	5.39%	7	3.19%	17	3.98%	15	4.26%	16	2.76%	17	4.99%	12	4.35%	16	5.37%	15	4.72%	17	4.2%	17	15.4	On-Site Rental Equipment Costs (e.g., mobile cranes)
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)	4.04%	15	4.23%	13	4.91%	12	5.33%	8	3.55%	16	5.02%	12	4.20%	17	3.86%	14	4.36%	15	5.76%	7	5.62%	10	5.51%	7	4.6%	15	12.5	Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)
Labor and Permitting Costs	4.04%	15	4.84%	12	4.10%	16	2.45%	17	3.86%	15	3.80%	16	4.69%	14	3.74%	15	5.43%	11	5.02%	11	4.38%	17	5.27%	13	4.5%	16	14.1	Labor and Permitting Costs
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)	4.11%	14	5.51%	8	4.60%	14	4.84%	12	4.04%	14	5.51%	10	5.06%	9	4.23%	12	5.87%	9	5.39%	8	5.74%	8	5.88%	5	5.1%	12	10.1	Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)
Cost of Rail Transport (e.g., costs associated with interchange activities)	4.60%	13	4.96%	11	4.98%	11	4.96%	10	4.17%	13	5.27%	11	6.05%	6	3.74%	15	5.81%	10	5.33%	9	5.49%	12	5.88%	5	5.1%	11	10.5	Cost of Rail Transport (e.g., costs associated with interchange activities)
Impact of Weather to Route (e.g., limited availability of route or instability of weather)	6.43%	5	3.68%	17	4.91%	12	3.92%	16	4.23%	12	5.88%	9	5.68%	7	4.17%	13	6.12%	8	4.47%	15	5.49%	12	5.27%	13	5.1%	10	11.2	Impact of Weather to Route (e.g., limited availability of route or instability of weather)
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)	6.13%	9	5.02%	9	5.04%	10	4.53%	14	5.70%	6	3.37%	17	4.69%	14	5.82%	8	4.23%	16	4.29%	17	6.11%	6	5.33%	12	5.1%	13	11.3	Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)	6.37%	6	7.35%	4	8.02%	3	5.45%	6	8.33%	5	6.50%	7	4.75%	12	6.07%	7	4.42%	14	6.07%	6	6.54%	5	5.27%	13	6.3%	7	7.5	Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)
Number of Tribal Lands Crossed	5.27%	12	5.02%	9	5.16%	9	4.78%	13	5.21%	9	4.29%	14	4.94%	10	6.62%	5	1.83%	17	4.72%	14	5.56%	11	5.27%	13	4.9%	14	11.2	Number of Tribal Lands Crossed
Public Acceptability of Route	8.76%	1	4.23%	13	7.77%	5	8.82%	3	5.70%	6	7.78%	3	4.75%	12	5.39%	11	7.45%	4	6.80%	4	7.16%	2	5.45%	9	6.5%	6	6.4	Public Acceptability of Route
Cumulative Worker Exposure (α handling time & # of workers)	6.62%	4	7.23%	5	7.84%	4	8.15%	5	9.19%	2	8.15%	2	5.25%	8	9.44%	1	6.69%	5	10.29%	1	6.67%	3	8.64%	1	7.8%	3	3.3	Cumulative Worker Exposure (α handling time & # of workers)
Cumulative Population Dose along Route (α population density)	6.80%	3	7.90%	3	8.77%	2	8.33%	4	9.19%	2	8.39%	1	4.94%	10	8.76%	2	8.46%	2	8.88%	2	6.60%	4	8.64%	1	7.9%	2	2.9	Cumulative Population Dose along Route (α population density)
Risks Associated with Number of Lifting Activities	6.25%	8	6.86%	6	5.47%	8	9.25%	2	5.15%	10	6.74%	6	7.53%	3	8.76%	2	6.44%	6	6.50%	5	7.35%	1	6.19%	4	6.7%	5	5.4	Risks Associated with Number of Lifting Activities
Average Accident Frequency on Route	6.37%	6	8.58%	2	5.53%	7	5.02%	9	9.19%	2	7.05%	5	6.60%	4	8.76%	2	8.84%	1	4.96%	12	5.49%	12	5.39%	11	7.0%	4	5.8	Average Accident Frequency on Route
Transit Duration per Conveyance and Consist	5.82%	10	5.64%	7	4.17%	15	4.90%	11	5.58%	8	6.13%	8	9.63%	2	6.56%	6	6.31%	7	5.27%	10	5.68%	9	5.45%	9	6.0%	8	8.3	Transit Duration per Conveyance and Consist
Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)	5.76%	11	4.17%	16	5.66%	6	4.17%	15	4.41%	11	4.66%	13	6.60%	4	5.51%	10	4.86%	13	4.90%	13	4.81%	16	5.51%	7	5.2%	9	10.9	Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Security Vulnerability of Route	8.58%	2	10.54%	1	8.96%	1	9.68%	1	9.31%	1	7.48%	4	10.37%	1	5.82%	8	7.89%	3	6.99%	3	5.93%	7	6.31%	3	8.0%	1	3.1	Security Vulnerability of Route

Purple	lowest ranked
Red	highest ranked


0.0%
2.0%
4.0%
6.0%
8.0%
10.0%
12.0%
Security Vulnerability of Route [1]
Cumulative Population Dose along Route (α population density) [2]
Cumulative Worker Exposure (α handling time & # of workers) [3]
Risks Associated with Number of Lifting Activities [4]
Average Accident Frequency on Route [5]
Public Acceptability of Route [6]
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs) [7]
Transit Duration per Conveyance and Consist [8]
Cost of Rail Transport (e.g., costs associated with interchange activities) [9]
Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line) [10]
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs) [11]
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats) [12]
Impact of Weather to Route (e.g., limited availability of route or instability of weather) [13]
Number of Tribal Lands Crossed [14]
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges) [15]
Labor and Permitting Costs [16]
On-Site Rental Equipment Costs (e.g., mobile cranes) [17]
Minimum
Average
Maximum

Attachment C: Full Pairwise Comparison for the Routes

Place a single "X" per line where you believe the importance of the metric for the route in column A falls against the same metric for the route in column B.

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
On-Site Rental Equipment Costs (e.g., mobile cranes)	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail				X				D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail				X				D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX				X				D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail				X				D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail				X				E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail				X				D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail				X				E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX				X				D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX				X				E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans				X				E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
Labor and Permitting Costs	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail						X		C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail						X		D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail						X		E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail						X		F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail						X		C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail						X		D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail						X		E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail						X		F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX				X				D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX				X				E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans				X				E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS				X				F. Barge via ICW to New Orleans/Mississippi to GCUS

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)	A. HHT to FNOR Rail			X					B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail						X		C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail						X		D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail						X		C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail						X		D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX				X				D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX	X							E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX	X							F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans	X							E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans	X							F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS			X					F. Barge via ICW to New Orleans/Mississippi to GCUS
Cost of Rail Transport (e.g., costs associated with interchange activities)	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail							X	E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail							X	F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail							X	E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail							X	F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX		X						D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX							X	E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX							X	F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans							X	E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans							X	F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
Impact of Weather to Route (e.g., limited availability of route or instability of weather)	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail				X				D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail				X				D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX				X				D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS			X					F. Barge via ICW to New Orleans/Mississippi to GCUS

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX			X					D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans			X					E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans					X			F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS						X		F. Barge via ICW to New Orleans/Mississippi to GCUS
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail							X	E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail						X		F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail							X	E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail						X		F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX			X					D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX							X	E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX						X		F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans							X	E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans						X		F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS			X					F. Barge via ICW to New Orleans/Mississippi to GCUS
Number of Tribal Lands Crossed	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail					X			D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail					X			E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail					X			F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail					X			D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail					X			E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail					X			F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX					X			D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX					X			E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX					X			F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans				X				E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS				X				F. Barge via ICW to New Orleans/Mississippi to GCUS

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Public Acceptability of Route	A. HHT to FNOR Rail			X					B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail						X		C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail			X					E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail			X					F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail						X		C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail				X				D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail				X				E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail			X					F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX		X						D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX	X							F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
Cumulative Worker Exposure (α handling time & # of workers)	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail						X		C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail						X		D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail					X			E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail					X			F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail						X		C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail						X		D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail					X			E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail					X			F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX			X					D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans		X						F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
Cumulative Population Dose along Route (α population density)	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail						X		E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail						X		F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail						X		E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail						X		F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX			X					D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX						X		E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX						X		F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans						X		E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans						X		F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS			X					F. Barge via ICW to New Orleans/Mississippi to GCUS

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Risks Associated with Number of Lifting Activities	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail						X		C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail						X		D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail			X					E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail			X					F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail						X		C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail						X		D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail			X					E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail			X					F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX				X				D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX	X							E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX	X							F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans	X							E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans	X							F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
Average Accident Frequency on Route	A. HHT to FNOR Rail			X					B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail							X	C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail							X	D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail					X			E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail			X					F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail							X	C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail							X	D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail						X		E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail					X			F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX				X				D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX	X							E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX	X							F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans	X							E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans	X							F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS			X					F. Barge via ICW to New Orleans/Mississippi to GCUS
Transit Duration per Conveyance and Consist	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail					X			C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail	X							F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail					X			C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail	X							F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX		X						D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX	X							E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX	X							F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans		X						E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans	X							F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS		X						F. Barge via ICW to New Orleans/Mississippi to GCUS

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail				X				D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail				X				E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail				X				C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail				X				D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail				X				E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX				X				D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX				X				E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans				X				E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS				X				F. Barge via ICW to New Orleans/Mississippi to GCUS
Security Vulnerability of Route	A. HHT to FNOR Rail				X				B. HHT to Dunnellon to FNOR Rail
	A. HHT to FNOR Rail					X			C. Rail from CR3 to GCUS via FNOR & CSX
	A. HHT to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	A. HHT to FNOR Rail			X					E. Barge via ICW to Mobile/Tombigbee River to GCUS
	A. HHT to FNOR Rail			X					F. Barge via ICW to New Orleans/Mississippi to GCUS
	B. HHT to Dunnellon to FNOR Rail					X			C. Rail from CR3 to GCUS via FNOR & CSX
	B. HHT to Dunnellon to FNOR Rail			X					D. Rail from CR3 to GCUS via New Orleans
	B. HHT to Dunnellon to FNOR Rail			X					E. Barge via ICW to Mobile/Tombigbee River to GCUS
	B. HHT to Dunnellon to FNOR Rail			X					F. Barge via ICW to New Orleans/Mississippi to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX			X					D. Rail from CR3 to GCUS via New Orleans
	C. Rail from CR3 to GCUS via FNOR & CSX			X					E. Barge via ICW to Mobile/Tombigbee River to GCUS
	C. Rail from CR3 to GCUS via FNOR & CSX			X					F. Barge via ICW to New Orleans/Mississippi to GCUS
	D. Rail from CR3 to GCUS via New Orleans			X					E. Barge via ICW to Mobile/Tombigbee River to GCUS
	D. Rail from CR3 to GCUS via New Orleans			X					F. Barge via ICW to New Orleans/Mississippi to GCUS
	E. Barge via ICW to Mobile/Tombigbee River to GCUS			X					F. Barge via ICW to New Orleans/Mississippi to GCUS

Attachment D: Route Information from START for CR-3

Route	HHT Distance (mi.)	Barge Distance (mi.)	Rail Distance (mi.)
Route B - Heavy Haul Truck (HHT) / CSXT Rail to GCUS	6	0	1146
Route C - HHT to Dunnellon FL Rail through Montgomery and Nashville to GCUS	18	0	1129
Route D - Rail Only (FNOR & CSX) through Montgomery and Nashville to GCUS	0	0	1147
Route E - Rail Only through New Orleans and Memphis to GCUS	0	0	1423
Barge Route along Gulf ICW to Mobile River / Tombigbee River and then up to GCUS	0	1408	0
Route F - Barge Only by Gulf ICW to New Orleans, up Mississippi River to GCUS	0	1826	0

Parameter	**Route > Metric \/**	A: HHT to Rail	B: HHT to rail at Dunnellon	C: Rail (Mont-gomery / Nashville)	D: Rail (NOLA and Memphis)	E: Barge Mobile / Tombigbee	F: Barge ICW NOLA / Mississippi
Total Distance (mi)		1152	1148	1147	1423	1408	1826
Travel Time (min & hr)	Route Duration	2299 min. 38 hrs.	2215 min. 37 hrs.	2290 min. 38 hrs.	2326 min. 39 hrs.	12126 min. 202 hrs.	15656 min. 261 hrs.
Accident Likelihood (Avg/mile/year)	Accidents	0.14	0.72	0.00	0.00	0.08	0.14
Water Crossings	Public Acceptability	117	117	117	110	N/A	N/A
Average Track Class		3.2	3.2	3.2	3.7	N/A	N/A
Average Rail Traffic Density		3.8	3.9	3.8	4.2	N/A	N/A
Average Population Density (person/mi^2)		278	314	505	433	176	305
Total Population (800m buffer)	Cumulative Pop. Dose	336,617 persons	337,923 persons	336,614 persons	420,863 persons	21,491 persons	47,103 persons
Mass Gathering Places	Cumulative Pop. Dose	682	689	682	972	33	143
Tribal Lands (mi^2)	Public Acceptability	26	26	26	0	0	0
Environmentally Sensitive Areas (mi^2)	Public Acceptability	37	37	37	90	146	33
Locks		N/A	N/A	N/A	N/A	17	2
Tunnels		3	3	3	0	0	0
Emergency Response Capability (/mi)		0.25	0.21	0.25	0.20	0.02	0.02

Parameter	**Route > Metric** \/	A: HHT to Rail	B: HHT to rail at Dunnellon	C: Rail (Mont-gomery / Nashville)	D: Rail (NOLA and Memphis)	E: Barge Mobile / Tombigbee	F: Barge ICW NOLA / Mississippi
Fire Departments (/mi)		0.13	.24	0.13	0.10	0.00	0.02
Police (/mi)		0.11	0.16	0.11	0.09	0.01	0.00
Hospitals (/mi)		0.01	0.01	0.01	0.01	0.00	0.00
Educ. Institutions		252	252	252	297	6	20
Grammar Schools		237	237	237	291	6	18
Higher Education		15	15	15	6	0	2
Special Age Groups		304	303	304	388	10	19
Day Care		250	250	250	332	7	12
Nursing Homes		54	53	54	56	3	7
Railroad Crossings (at grade)		1095	1086	1094	1295	0	0
Signs		74	74	74	102	0	0
Signals		52	52	52	250	0	0
No signs or signals		0	0	0	0	0	0
Both signs and signals		0	0	0	0	0	0
Unknown signs or signals		969	960	968	943	0	0