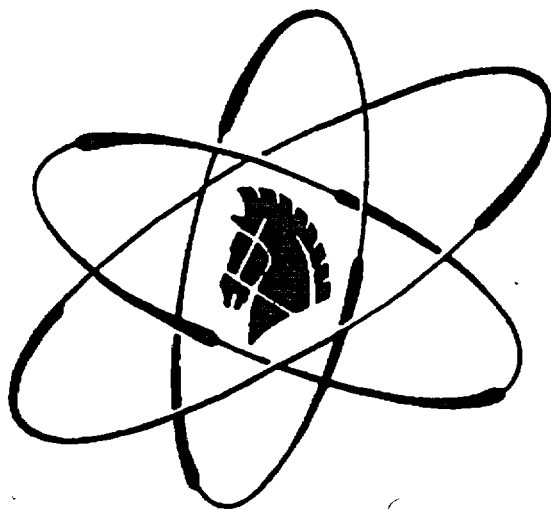


Trojan Independent Spent Fuel Storage Installation

Safety Analysis Report With Holtec MPC

PORTLAND GENERAL ELECTRIC COMPANY



PGE-1069



TABLE OF CONTENTS

1.0 INTRODUCTION AND GENERAL DESCRIPTION OF INSTALLATION 1-1

1.1 INTRODUCTION 1-1

1.2 GENERAL DESCRIPTION OF THE INSTALLATION 1-2

1.3 GENERAL SYSTEMS DESCRIPTION 1-3

 1.3.1 STORAGE SYSTEM CANISTERS 1-3

 1.3.2 STORAGE SYSTEM CONCRETE CASK 1-4

 1.3.3 TRANSFER EQUIPMENT 1-4

 1.3.3.1 Transfer Cask 1-4

 1.3.3.2 Transfer Station 1-4

 1.3.3.3 Air Pad System 1-5

 1.3.4 AUXILIARY EQUIPMENT 1-5

 1.3.4.1 Vacuum Drying and Helium Backfill Systems 1-5

 1.3.4.2 Gap Flushing System 1-5

 1.3.4.3 Automated Welding System 1-5

1.4 IDENTIFICATION OF AGENTS AND CONTRACTORS 1-6

1.5 MATERIAL INCORPORATED BY REFERENCE 1-7

2.0 SITE CHARACTERISTICS 2-1

2.1 GEOGRAPHY AND DEMOGRAPHY 2-1

 2.1.1 SITE LOCATION 2-1

 2.1.2 SITE DESCRIPTION 2-2

 2.1.2.1 Other Activities Within the ISFSI Site Boundary 2-3

 2.1.2.2 Boundaries for Establishing Effluent Release Limits 2-3

 2.1.3 POPULATION DISTRIBUTION AND TRENDS 2-4

 2.1.4 USES OF ADJACENT LANDS AND WATERS 2-5

2.2 NEARBY INDUSTRIAL, TRANSPORTATION AND MILITARY FACILITIES 2-7

 2.2.1 LOCATIONS AND ROUTES 2-7

 2.2.2 DESCRIPTION OF PRODUCTS AND MATERIALS 2-9

 2.2.3 EVALUATION OF POTENTIAL ACCIDENTS 2-10

 2.2.3.1 Explosions 2-10

 2.2.3.2 Toxic Chemicals 2-12

 2.2.3.3 Fires 2-12

 2.2.3.4 Aircraft Impacts 2-13

 2.2.3.5 Cooling Tower Collapse 2-15

 2.2.3.6 Air Pollutants 2-15

2.3 METEOROLOGY 2-16

 2.3.1 REGIONAL CLIMATOLOGY 2-16



2.3.1.1	<u>General Climate</u>	2-16
2.3.1.2	<u>Severe Weather</u>	2-16
2.3.2	LOCAL METEOROLOGY	2-17
2.3.2.1	<u>Normal and Extreme Values of Meteorological Parameters</u>	2-17
2.3.2.2	<u>Potential Influence of the ISFSI on Local Meteorology</u>	2-17
2.3.2.3	<u>Topographic Description</u>	2-18
2.3.3	ONSITE METEOROLOGICAL MEASUREMENTS PROGRAM	2-18
2.3.4	DIFFUSION ESTIMATES	2-19
2.4	<u>HYDROLOGIC ENGINEERING</u>	2-20
2.4.1	HYDROLOGIC DESCRIPTION	2-20
2.4.1.1	<u>Site and Facilities</u>	2-20
2.4.1.2	<u>Hydrosphere</u>	2-21
2.4.1.2.1	Surface Water Use	2-22
2.4.2	FLOODS	2-22
2.4.2.1	<u>Flood History</u>	2-22
2.4.2.2	<u>Flood Design Considerations</u>	2-22
2.4.2.3	<u>Effects of Local Intense Precipitation</u>	2-23
2.4.3	PROBABLE MAXIMUM FLOOD (PMF) OF STREAMS AND RIVERS.....	2-23
2.4.4	POTENTIAL DAM FAILURES	2-24
2.4.4.1	<u>Seismically Induced Dam Failure</u>	2-24
2.4.4.2	<u>Volcanically Induced Dam Failure</u>	2-25
2.4.4.3	<u>Spirit Lake Blockage Failure</u>	2-25
2.4.5	PROBABLE MAXIMUM SURGE FLOODING	2-26
2.4.6	PROBABLE MAXIMUM TSUNAMI FLOODING	2-26
2.4.7	ICE EFFECTS	2-26
2.4.8	FLOODING PROTECTION REQUIREMENTS	2-26
2.4.9	ENVIRONMENTAL ACCEPTANCE OF EFFLUENTS	2-27
2.5	<u>SUBSURFACE HYDROLOGY</u>	2-28
2.5.1	REGIONAL AND SITE CHARACTERISTICS	2-28
2.5.2	CONTAMINANT TRANSPORT ANALYSIS	2-29
2.6	<u>GEOLOGY, SEISMOLOGY AND GEOTECHNICAL ENGINEERING</u>	2-30
2.6.1	BASIC GEOLOGIC AND SEISMIC INFORMATION	2-30
2.6.1.1	<u>Regional Geology</u>	2-31
2.6.1.2	<u>Site Geology</u>	2-32
2.6.2	VIBRATORY GROUND MOTION	2-34
2.6.2.1	<u>Seismicity</u>	2-34
2.6.2.2	<u>Geologic Structures and Tectonic Activity</u>	2-35
2.6.2.3	<u>Maximum Earthquake Potential</u>	2-35
2.6.2.4	<u>Seismic Margin Earthquake</u>	2-37
2.6.3	SURFACE FAULTING	2-38
2.6.4	STABILITY OF SUBSURFACE MATERIALS AND FOUNDATIONS	2-39



2.6.4.1	<u>Geological Foundation Evaluation</u>	2-39
2.6.5	STABILITY OF SLOPES	2-41
2.6.6	VOLCANOLOGY	2-41
2.7	<u>SUMMARY OF SITE CONDITIONS AFFECTING CONSTRUCTION AND OPERATING REQUIREMENTS</u>	2-42
2.8	<u>REFERENCES</u>	2-43
3.0	<u>PRINCIPAL DESIGN CRITERIA</u>	3-1
3.1	<u>PURPOSES OF INSTALLATION</u>	3-1
3.1.1	<u>MATERIALS TO BE STORED</u>	3-1
3.1.1.1	<u>Intact Fuel Assemblies</u>	3-1
3.1.1.2	<u>Damaged and Partial Fuel Assemblies</u>	3-2
3.1.1.3	<u>Fuel Debris</u>	3-2
3.1.2	<u>GENERAL OPERATING FUNCTIONS</u>	3-2
3.2	<u>STRUCTURAL AND MECHANICAL SAFETY CRITERIA</u>	3-2
3.2.1	<u>TORNADO AND WIND LOADINGS</u>	3-3
3.2.1.1	<u>Applicable Design Parameters</u>	3-3
3.2.1.2	<u>Determination of Forces on Structures</u>	3-3
3.2.1.3	<u>Ability of Structures to Perform Despite Failure of Structures Not Designed for Tornado Loads</u>	3-3
3.2.1.4	<u>Tornado Missiles</u>	3-4
3.2.2	<u>WATER LEVEL (FLOOD) DESIGN</u>	3-4
3.2.2.1	<u>Flood Elevations</u>	3-4
3.2.2.2	<u>Flood Protection</u>	3-4
3.2.3	<u>SEISMIC DESIGN</u>	3-5
3.2.3.1	<u>Input Criteria</u>	3-5
3.2.3.1.1	<u>Design Response Spectra</u>	3-5
3.2.3.1.2	<u>Design Response Spectra Derivation</u>	3-5
3.2.3.1.3	<u>Design Time History</u>	3-5
3.2.3.1.4	<u>Use of Equivalent Static Loads</u>	3-5
3.2.3.1.5	<u>Critical Damping Values</u>	3-6
3.2.3.1.6	<u>Bases for Site-Dependent Analysis</u>	3-6
3.2.3.1.7	<u>Soil-Supported Structures</u>	3-6
3.2.3.1.8	<u>Soil-Structure Interaction</u>	3-6
3.2.3.2	<u>Seismic-System Analyses</u>	3-6
3.2.3.2.1	<u>Seismic Analysis Methods</u>	3-6
3.2.3.2.2	<u>Natural Frequencies and Response Loads</u>	3-7
3.2.3.2.3	<u>Procedure Used to Lump Masses</u>	3-7
3.2.3.2.4	<u>Rocking and Translational Response Summary</u>	3-7
3.2.3.2.5	<u>Methods to Determine Overturning Moments</u>	3-7
3.2.3.2.6	<u>Analysis Procedure for Damping</u>	3-8



3.2.3.2.7	Seismic Analysis of Overhead Cranes.....	3-8
3.2.3.2.8	Seismic Analysis of Specific Safety Features.....	3-8
3.2.4	SNOW AND ICE.....	3-8
3.2.5	COMBINED LOAD CRITERIA.....	3-9
3.2.5.1	<u>Load Combinations and Design Strength - Concrete Cask</u>	3-9
3.2.5.2	<u>Load Combinations and Design Strength - MPC</u>	3-10
3.2.5.3	<u>Load Combinations and Design Strength - Transfer Cask</u>	3-10
3.2.5.4	<u>Load Combinations and Design Strength - Failed Fuel Can and Damaged Fuel Container</u>	3-10
3.2.5.5	<u>Load Combinations and Design Strengths - Fuel Debris Process Can Capsule</u>	3-11
3.2.5.6	<u>Load Combinations and Design Strength - Transfer Station</u>	3-11
3.3	<u>SAFETY PROTECTION SYSTEMS</u>	3-12
3.3.1	GENERAL.....	3-12
3.3.2	PROTECTION BY MULTIPLE CONFINEMENT BARRIERS AND SYSTEMS	3-13
3.3.2.1	<u>Confinement Barriers and Systems</u>	3-13
3.3.2.2	<u>MPC Closure Welds</u>	3-14
3.3.2.3	<u>Ventilation Offgas</u>	3-17
3.3.3	PROTECTION BY EQUIPMENT AND INSTRUMENTATION SELECTION.....	3-17
3.3.3.1	<u>Equipment</u>	3-17
3.3.3.2	<u>Instrumentation</u>	3-18
3.3.3.2.1	Temperature Monitoring.....	3-18
3.3.3.2.2	Seismic Monitoring.....	3-18
3.3.4	NUCLEAR CRITICALITY SAFETY	3-18
3.3.4.1	<u>Control Methods for Prevention of Criticality</u>	3-18
3.3.4.2	<u>Error Contingency Criteria</u>	3-19
3.3.4.3	<u>Verification Analyses</u>	3-19
3.3.5	RADIATION PROTECTION	3-19
3.3.5.1	<u>Access Control</u>	3-19
3.3.5.2	<u>Shielding</u>	3-20
3.3.5.3	<u>Radiological Alarm Systems</u>	3-20
3.3.6	FIRE AND EXPLOSION PROTECTION.....	3-20
3.3.7	MATERIALS HANDLING AND STORAGE	3-20
3.3.7.1	<u>Spent Fuel Handling and Storage</u>	3-20
3.3.7.2	<u>Radioactive Waste Treatment</u>	3-21
3.3.7.3	<u>Waste Storage Facilities</u>	3-21
3.3.8	INDUSTRIAL AND CHEMICAL SAFETY	3-21
3.4	<u>CLASSIFICATION OF STRUCTURES, SYSTEMS AND COMPONENTS</u>	3-22
3.5	<u>DECOMMISSIONING CONSIDERATIONS</u>	3-23



3.6	<u>SUMMARY OF DESIGN CRITERIA</u>	3-24
3.7	<u>REFERENCES</u>	3-25
4.0	INSTALLATION DESIGN	4-1
4.1	<u>SUMMARY DESCRIPTION</u>	4-1
4.1.1	<u>LOCATION AND LAYOUT OF INSTALLATION</u>	4-1
4.1.2	<u>PRINCIPAL FEATURES</u>	4-1
4.1.2.1	<u>Site Boundary</u>	4-1
4.1.2.2	<u>Controlled Area</u>	4-1
4.1.2.3	<u>Site Utility Supplies and Systems</u>	4-1
4.1.2.4	<u>Storage Facilities</u>	4-1
4.1.2.5	<u>Stacks</u>	4-2
4.2	<u>STORAGE STRUCTURES</u>	4-3
4.2.1	<u>STRUCTURAL SPECIFICATION</u>	4-3
4.2.2	<u>INSTALLATION LAYOUT</u>	4-4
4.2.2.1	<u>Building Plans and Sections</u>	4-4
4.2.3	<u>CONFINEMENT FEATURES</u>	4-4
4.2.4	<u>INDIVIDUAL UNIT DESCRIPTION</u>	4-5
4.2.4.1	<u>Functional Description</u>	4-5
4.2.4.2	<u>Component Descriptions</u>	4-5
4.2.4.2.1	Description of the MPC	4-5
4.2.4.2.2	This section deleted.....	4-7
4.2.4.2.3	This section deleted.....	4-7
4.2.4.2.4	Description of the Concrete Cask	4-7
4.2.4.2.5	Failed Fuel Can and Damaged Fuel Container	4-8
4.2.4.2.6	Description of Fuel Debris Process Can and Capsule	4-9
4.2.4.2.7	This section deleted.....	4-9
4.2.4.2.8	Component Coatings.....	4-9
4.2.4.3	<u>Design Bases and Safety Assurance</u>	4-10
4.2.5	<u>STRUCTURAL EVALUATION</u>	4-11
4.2.5.1	<u>Weights and Centers of Gravity</u>	4-11
4.2.5.2	<u>Mechanical Properties of Materials</u>	4-12
4.2.5.3	<u>MPC Stress Analysis Under Normal Loads</u>	4-12
4.2.5.3.1	MPC Thermal Stress Analysis.....	4-12
4.2.5.3.2	MPC Dead Weight Load Analyses	4-12
4.2.5.3.3	MPC Pressure Analysis.....	4-12
4.2.5.3.4	MPC Handling Analysis	4-13
4.2.5.3.5	MPC Load Combination	4-13
4.2.5.3.6	MPC Fatigue Evaluation.....	4-13
4.2.5.3.7	MPC Pressure Test.....	4-14
4.2.5.3.8	MPC Fracture Toughness	4-14
4.2.5.4	<u>Concrete Cask Analysis Under Normal Operating Loads</u>	4-14



	4.2.5.4.1	Concrete Cask Dead Load	4-15
	4.2.5.4.2	Concrete Cask Live Load.....	4-15
	4.2.5.4.3	Concrete Cask Thermal Stresses.....	4-15
	4.2.5.4.4	Concrete Cask Load Combination.....	4-16
4.2.6		THERMAL EVALUATION	4-16
	4.2.6.1	<u>Summary of Thermal Properties of Materials</u>	4-17
	4.2.6.2	<u>Thermal Models for Normal Storage Conditions-Overview</u>	4-18
	4.2.6.3	<u>Global Model of the Trojan Storage System</u>	4-20
	4.2.6.3.1	Isotropic Fuel Basket Conductivity	4-21
	4.2.6.3.2	Downcomer Gap Conservatism	4-21
	4.2.6.3.3	Zero (0) Percent Fuel Rods Rupture	4-21
	4.2.6.3.4	Neglect of Flux Trap Gaps.....	4-21
	4.2.6.3.5	Differences Between the Trojan MPC and the Generic Holtec Design.....	4-22
	4.2.6.3.6	Other Assumptions and Parameters.....	4-22
	4.2.6.4	<u>Concrete Cask Body and MPC Exterior Thermal Model</u>	4-24
	4.2.6.5	<u>MPC Thermal Hydraulics</u>	4-24
	4.2.6.6	<u>Maximum Temperatures</u>	4-25
	4.2.6.7	<u>Minimum Temperatures</u>	4-26
	4.2.6.8	<u>Maximum Internal Pressure</u>	4-26
	4.2.6.9	<u>Evaluation of Cask Lifetime Performance Under Normal Conditions of Storage</u>	4-26
4.2.7		CRITICALITY EVALUATION	4-26
	4.2.7.1	<u>Discussion and Results</u>	4-28
	4.2.7.2	<u>Spent Fuel Loading</u>	4-31
	4.2.7.2.1	Assembly Classes in HI-STORM Criticality Evaluation	4-31
	4.2.7.2.2	Spent Fuel Loading at Trojan	4-32
	4.2.7.3	<u>Model Specification</u>	4-33
	4.2.7.3.1	Description of Computational Model.....	4-33
	4.2.7.3.2	Cask Regional Densities	4-33
	4.2.7.4	<u>Criticality Calculations</u>	4-34
	4.2.7.4.1	Criticality Safety Calculations	4-34
	4.2.7.4.2	Fuel Loading or Other Contents Loading Optimization	4-34
	4.2.7.4.3	Criticality Results.....	4-38
	4.2.7.4.4	Damaged Fuel and Fuel Debris.....	4-38
	4.2.7.4.5	Fuel Assemblies with Missing Rods.....	4-41
	4.2.7.4.6	Non-fuel Hardware in PWR Fuel Assemblies	4-41
	4.2.7.4.7	Neutron Sources in Fuel Assemblies	4-41
4.3		<u>AUXILIARY SYSTEMS</u>	4-42
	4.3.1	VENTILATION AND OFF-GAS SYSTEMS	4-42
	4.3.2	ELECTRICAL SYSTEMS	4-42



4.3.3	AIR SUPPLY SYSTEMS.....	4-42
4.3.4	STEAM SUPPLY AND DISTRIBUTION SYSTEM.....	4-42
4.3.5	WATER SUPPLY SYSTEM.....	4-42
4.3.6	SEWAGE TREATMENT SYSTEM.....	4-43
4.3.7	COMMUNICATION AND ALARM SYSTEMS.....	4-43
4.3.8	FIRE PROTECTION SYSTEM.....	4-43
4.3.9	MAINTENANCE SYSTEMS.....	4-43
4.3.10	COLD CHEMICAL SYSTEMS.....	4-43
4.3.11	AIR SAMPLING SYSTEMS.....	4-43
4.3.12	SEISMIC MONITORING INSTRUMENTATION.....	4-44
4.4	<u>DECONTAMINATION SYSTEMS</u>	4-45
4.4.1	EQUIPMENT DECONTAMINATION.....	4-45
4.4.2	PERSONNEL DECONTAMINATION.....	4-45
4.5	<u>TRANSPORT CASK REPAIR AND MAINTENANCE</u>	4-46
4.6	<u>CATHODIC PROTECTION</u>	4-47
4.7	<u>SPENT FUEL AND HIGH-LEVEL RADIOACTIVE WASTE HANDLING OPERATION SYSTEMS</u>	4-48
4.7.1	STRUCTURAL SPECIFICATIONS.....	4-48
4.7.2	INSTALLATION LAYOUT.....	4-49
4.7.2.1	<u>Building Plans and Sections</u>	4-49
4.7.2.2	<u>Confinement Features</u>	4-49
4.7.3	INDIVIDUAL UNIT DESCRIPTION.....	4-49
4.7.3.1	<u>Transfer Cask Description</u>	4-49
4.7.3.2	<u>Transfer Station</u>	4-50
4.7.3.3	<u>Air Pad System</u>	4-51
4.7.3.4	<u>Lifting Yoke</u>	4-51
4.7.3.5	<u>MPC Lift Cleats</u>	4-51
4.7.3.6	<u>Mobile Cranes</u>	4-52
4.7.4	STRUCTURAL ANALYSIS OF THE FUEL HANDLING COMPONENTS.....	4-53
4.7.4.1	<u>Transfer Cask Lift</u>	4-53
4.7.4.1.1	Lifting Trunnions.....	4-53
4.7.4.1.2	Transfer Cask Wall.....	4-54
4.7.4.1.3	Shield Door Rail and Welds.....	4-55
4.7.4.1.4	Welds Attaching the Rails to Transfer Cask Shell.....	4-57
4.7.4.1.5	Top Lid.....	4-57
4.7.4.1.6	Top Lid Bolts.....	4-58
4.7.4.2	<u>Air Pad System</u>	4-59
4.7.4.3	<u>Lifting Yoke</u>	4-59
4.7.4.4	<u>MPC Lift Cleats</u>	4-60
4.7.5	THERMAL EVALUATION DURING FUEL TRANSFER.....	4-60
4.7.5.1	<u>Transfer Cask Heat Transfer Modes</u>	4-60



4.7.5.2	<u>Vacuum Drying</u>	4-61
4.7.5.2.1	<u>MPC In-Plane Resistance</u>	4-61
4.7.5.2.2	<u>Helium Conductivity Under Near Vacuum Conditions</u>	4-62
4.7.5.2.3	<u>Cask Heat Losses to Ambient</u>	4-62
4.8	<u>MATERIALS</u>	4-63
4.9	<u>REFERENCES</u>	4-71
5.0	OPERATIONS	5-1
5.1	<u>GENERAL DESCRIPTION</u>	5-1
5.1.1	<u>OPERATION DESCRIPTION</u>	5-1
5.1.1.1	<u>Damaged Fuel and Fuel Debris Process Can Capsule Loading</u>	5-2
5.1.1.2	<u>MPC Loading and Sealing Operations</u>	5-2
5.1.1.3	<u>MPC Contingency Unloading Operations</u>	5-6
5.1.1.4	<u>Transfer to Storage Area Operations</u>	5-8
5.1.1.5	<u>Maintenance Operations</u>	5-8
5.1.1.6	<u>Off-Normal Event Recovery Operations</u>	5-8
5.1.1.7	<u>Off-Site Transfer Operations</u>	5-8
5.1.2	<u>FLOWCHARTS</u>	5-9
5.1.3	<u>IDENTIFICATION OF SUBJECTS FOR SAFETY ANALYSIS</u>	5-9
5.1.3.1	<u>Criticality Prevention</u>	5-9
5.1.3.2	<u>Chemical Safety</u>	5-9
5.1.3.3	<u>Operation Shutdown Modes</u>	5-9
5.1.3.4	<u>Instrumentation</u>	5-9
5.1.3.5	<u>Maintenance Techniques</u>	5-10
5.1.3.6	<u>Heavy Loads Procedures</u>	5-10
5.2	<u>SPENT FUEL HANDLING OPERATIONS</u>	5-11
5.2.1	<u>SPENT FUEL HANDLING AND TRANSFER</u>	5-11
5.2.1.1	<u>Functional Description</u>	5-11
5.2.1.1.1	<u>Transfer Cask</u>	5-11
5.2.1.1.2	<u>Transfer Cask Lifting Yoke</u>	5-11
5.2.1.1.3	<u>Gap Flushing System</u>	5-12
5.2.1.1.4	<u>Vacuum Drying System</u>	5-12
5.2.1.1.5	<u>Helium Backfill System</u>	5-12
5.2.1.1.6	<u>Automated Welding System</u>	5-12
5.2.1.1.7	<u>Hydraulic System for Operation of Transfer Cask Bottom Doors</u>	5-12
5.2.1.1.8	<u>Air Pad System</u>	5-12
5.2.1.1.9	<u>Transfer Station</u>	5-13
5.2.1.2	<u>Safety Features</u>	5-14
5.2.2	<u>SPENT FUEL STORAGE</u>	5-14
5.2.2.1	<u>Inspection and Surveillance Program</u>	5-14



5.2.2.2	<u>Safety Features</u>	5-14
5.3	<u>OTHER OPERATING SYSTEMS</u>	5-16
5.3.1	<u>SYSTEM OPERATIONS</u>	5-16
5.3.2	<u>COMPONENT/EQUIPMENT SPARES</u>	5-16
5.4	<u>SUPPORT SYSTEM OPERATION</u>	5-17
5.4.1	<u>INSTRUMENTATION AND CONTROLS</u>	5-17
5.4.2	<u>SPARES</u>	5-17
5.4.3	<u>CONTROL ROOM AND CONTROL AREAS</u>	5-17
5.4.4	<u>ANALYTICAL SAMPLING</u>	5-17
5.5	<u>REFERENCES</u>	5-18
6.0	<u>SITE-GENERATED WASTE CONFINEMENT AND MANAGEMENT</u>	6-1
6.1	<u>ONSITE WASTE SOURCES</u>	6-1
6.2	<u>OFFGAS TREATMENT AND VENTILATION</u>	6-2
6.3	<u>LIQUID WASTE TREATMENT AND RETENTION</u>	6-3
6.4	<u>SOLID WASTES</u>	6-4
6.5	<u>RADIOLOGICAL IMPACT OF NORMAL OPERATIONS - SUMMARY</u>	6-5
7.0	<u>RADIATION PROTECTION</u>	7-1
7.1	<u>ENSURING THAT OCCUPATIONAL RADIATION EXPOSURES ARE AS LOW AS IS REASONABLY ACHIEVABLE (ALARA)</u>	7-1
7.1.1	<u>POLICY CONSIDERATIONS</u>	7-1
7.1.2	<u>DESIGN CONSIDERATIONS</u>	7-1
7.1.3	<u>OPERATIONAL CONSIDERATIONS</u>	7-2
7.2	<u>RADIATION SOURCES</u>	7-4
7.2.1	<u>CHARACTERIZATION OF SOURCES</u>	7-4
7.2.1.1	<u>Fuel Gamma Source</u>	7-5
7.2.1.2	<u>Fuel Neutron Source</u>	7-5
7.2.1.3	<u>Non-Fuel Region Gamma Sources</u>	7-6
7.2.1.3.1	<u>Burnable Poison Rod Assemblies</u>	7-7
7.2.1.3.2	<u>Rod Cluster Control Assemblies</u>	7-7
7.2.1.3.3	<u>Thimble Plug Devices</u>	7-8
7.2.1.4	<u>Fuel Debris</u>	7-9
7.2.1.5	<u>Non-Fuel Bearing Fuel Assembly Components</u>	7-9
7.2.1.6	<u>Primary and Secondary Neutron Sources</u>	7-9
7.2.1.6.1	<u>Primary Sources</u>	7-9
7.2.1.6.2	<u>Secondary Sources</u>	7-9
7.2.1.6.3	<u>Gamma Source from Activation of Neutron Sources</u>	7-10
7.2.2	<u>AIRBORNE RADIOACTIVE MATERIAL SOURCES</u>	7-11



7.2.2.1	<u>MPC Surface Contamination</u>	7-11
7.2.2.2	<u>Confinement Requirements for Normal Conditions</u>	7-12
7.2.2.2.1	Confinement Vessel Releasable Source Term	7-13
7.2.2.2.2	Crud Radionuclides	7-13
7.2.2.2.3	Confinement Boundary Leakage Rate	7-14
7.2.2.2.4	Minimum Free Volume	7-15
7.2.2.2.5	Fraction of Volume Released	7-16
7.2.2.2.6	Release Fraction	7-16
7.2.2.2.7	Radionuclide Release Rate	7-16
7.2.2.2.8	Atmospheric Dispersion Factor	7-16
7.2.2.2.9	Dose Conversion Factors	7-17
7.2.2.2.10	Occupancy Time	7-17
7.2.2.2.11	Breathing Rate	7-17
7.2.2.3	<u>Postulated Doses for Normal Conditions</u>	7-17
7.2.2.3.1	Whole Body Dose	7-17
7.2.2.3.2	Critical Organ Dose	7-18
7.2.2.3.3	Controlled Area Boundary and Nearest Resident	7-19
7.3	<u>RADIATION PROTECTION DESIGN FEATURES</u>	7-20
7.3.1	<u>INSTALLATION DESIGN FEATURES</u>	7-20
7.3.2	<u>SHIELDING</u>	7-21
7.3.2.1	<u>Radial and Axial Shielding Configurations</u>	7-21
7.3.2.2	<u>Shielding Evaluation</u>	7-22
7.3.3	<u>VENTILATION</u>	7-25
7.3.4	<u>AREA RADIATION AND AIRBORNE RADIOACTIVITY MONITORING INSTRUMENTATION</u>	7-25
7.4	<u>ESTIMATED ON-SITE COLLECTIVE DOSE ASSESSMENT</u>	7-26
7.5	<u>RADIATION PROTECTION PROGRAM</u>	7-27
7.5.1	<u>ORGANIZATION</u>	7-27
7.5.2	<u>RADIATION PROTECTION EQUIPMENT, INSTRUMENTATION, AND FACILITIES</u>	7-27
7.5.2.1	<u>Radiation Protection Instrumentation</u>	7-27
7.5.2.2	<u>Area Radiation Monitoring Instrumentation</u>	7-27
7.5.2.3	<u>Radiation Protection Facilities</u>	7-27
7.5.3	<u>RADIATION PROTECTION PROCEDURES</u>	7-28
7.5.3.1	<u>Control of Radiation Exposure to the Public</u>	7-28
7.5.3.2	<u>Control of Personnel Radiation Exposure (Occupational)</u>	7-28
7.5.3.2.1	Shielding	7-28
7.5.3.2.2	Access Control and Area Designations	7-28
7.5.3.2.3	Facility Contamination Control	7-29
7.5.3.2.4	Personnel Contamination Control	7-29
7.5.3.2.5	Area Surveys	7-29



7.5.3.2.6	Personnel Monitoring.....	7-29
7.5.3.2.7	Work Planning	7-30
7.5.3.2.8	Training.....	7-30
7.5.3.2.9	Controls, Practices, and Special Techniques	7-30
7.5.3.3	<u>Records and Reports</u>	7-30
7.6	<u>ESTIMATED OFF-SITE COLLECTIVE DOSE ASSESSMENT</u>	7-31
7.6.1	<u>RADIOACTIVE EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAM</u>	7-31
7.6.2	<u>ANALYSIS OF MULTIPLE CONTRIBUTION</u>	7-31
7.6.3	<u>ESTIMATED DOSE EQUIVALENTS</u>	7-32
7.6.4	<u>LIQUID RELEASE</u>	7-33
7.7	<u>REFERENCES</u>	7-34
8.0	<u>ACCIDENT ANALYSIS</u>	8-1
8.1	<u>NORMAL AND OFF-NORMAL EVENTS</u>	8-2
8.1.1	<u>OFF-NORMAL STRUCTURAL ANALYSIS</u>	8-2
8.1.1.1	<u>MPC Off-Normal Handling Load</u>	8-2
8.1.1.1.1	Postulated Cause of Event	8-2
8.1.1.1.2	Detection of Event	8-3
8.1.1.1.3	Analysis of Effects and Consequences	8-3
8.1.1.1.4	Corrective Actions	8-4
8.1.2	<u>OFF-NORMAL THERMAL ANALYSIS</u>	8-4
8.1.2.1	<u>Severe Environmental Condition</u>	8-4
8.1.2.1.1	Postulated Cause of Event	8-4
8.1.2.1.2	Detection of Event	8-4
8.1.2.1.3	Analysis of Effects and Consequences	8-5
8.1.2.1.4	Corrective Actions	8-5
8.1.2.2	<u>Blockage of One-Half of the Air Inlets</u>	8-5
8.1.2.2.1	Postulated Cause of Event	8-5
8.1.2.2.2	Detection of Event	8-5
8.1.2.2.3	Analysis of Effects and Consequences	8-5
8.1.2.2.4	Corrective Actions	8-6
8.1.3	<u>OFF-NORMAL CONTAMINATION RELEASE</u>	8-6
8.1.3.1	<u>Small Release of Radioactive Particulates from Exterior of MPCs</u> ..	8-6
8.1.3.1.1	Postulated Cause of Event	8-6
8.1.3.1.2	Detection of Event	8-6
8.1.3.1.3	Analysis of Effects and Consequences	8-6
8.1.3.1.4	Corrective Actions	8-8
8.1.3.2	<u>Radiological Impact from Off-Normal Operations</u>	8-8
8.1.4	<u>OFF-NORMAL MPC LEAKAGE</u>	8-9
8.1.4.1	<u>Postulated Leakage of Radioactive Gases, Fuel Fines, and Cladding Surface Contamination</u>	8-9



	8.1.4.1.1	Postulated Cause of Event	8-9
	8.1.4.1.2	Detection of Event	8-9
	8.1.4.1.3	Analysis of Effects and Consequences	8-9
	8.1.4.1.4	Corrective Actions	8-10
	8.1.4.2	<u>Radiological Impact from Off-Normal Operations</u>	8-10
8.2	ACCIDENTS		8-11
	8.2.1	FAILURE OF FUEL PINS WITH SUBSEQUENT BREACH OF MPC CONFINEMENT BOUNDARY	8-11
	8.2.1.1	<u>Cause of Accident</u>	8-11
	8.2.1.2	<u>Accident Analysis</u>	8-11
	8.2.1.3	<u>Accident Dose Calculations</u>	8-12
	8.2.2	MAXIMUM ANTICIPATED HEAT LOAD	8-12
	8.2.2.1	<u>Cause of Accident</u>	8-12
	8.2.2.2	<u>Accident Analysis</u>	8-12
	8.2.2.3	<u>Accident Dose Calculation</u>	8-13
	8.2.3	CONCRETE CASK OVERTURNING EVENT	8-13
	8.2.3.1	<u>Cause of Accident</u>	8-13
	8.2.3.2	<u>Accident Analysis</u>	8-13
	8.2.3.3	<u>Accident Dose Calculation</u>	8-16
	8.2.4	TORNADO	8-16
	8.2.4.1	<u>Cause of Accident</u>	8-16
	8.2.4.2	<u>Accident Analysis</u>	8-16
	8.2.4.2.1	Wind Loads.....	8-17
	8.2.4.2.2	Tornado Missiles.....	8-18
	8.2.4.2.3	Local Damage Prediction - Cask Body.....	8-18
	8.2.4.2.4	Local Damage Prediction - Cask Closure Plate.....	8-19
	8.2.4.2.5	Overall Damage Prediction.....	8-20
	8.2.4.2.6	Combined Tornado Wind and Missile Loading.....	8-23
	8.2.4.2.7	MPC Under Tornado Loadings.....	8-24
	8.2.4.2.8	Transfer Station Tornado Loadings	8-24
	8.2.4.3	<u>Accident Dose Calculations</u>	8-25
	8.2.5	EARTHQUAKE EVENT	8-26
	8.2.5.1	<u>Cause of Accident</u>	8-26
	8.2.5.2	<u>Accident Analysis</u>	8-26
	8.2.5.3	<u>Accident Dose Calculations</u>	8-29
	8.2.6	PRESSURIZATION	8-29
	8.2.6.1	<u>Cause of Accident</u>	8-29
	8.2.6.2	<u>Accident Analysis</u>	8-29
	8.2.6.3	<u>Accident Dose Calculations</u>	8-30
	8.2.7	FULL BLOCKAGE OF AIR INLETS	8-31
	8.2.7.1	<u>Cause of Accident</u>	8-31
	8.2.7.2	<u>Accident Analysis</u>	8-31



8.2.7.3	<u>Accident Dose Calculations</u>	8-31
8.2.8	EXPLOSIONS OF CHEMICALS, FLAMMABLE GASES, AND MUNITIONS	8-32
8.2.8.1	<u>Cause of Accident</u>	8-32
8.2.8.2	<u>Accident Analysis</u>	8-32
8.2.8.3	<u>Accident Dose Calculations</u>	8-33
8.2.9	FIRES	8-33
8.2.10	COOLING TOWER COLLAPSE	8-34
8.2.11	VOLCANISM.....	8-34
8.2.11.1	<u>Cause of Accident</u>	8-34
8.2.11.2	<u>Accident Analysis</u>	8-34
8.2.11.3	<u>Accident Dose Calculations</u>	8-35
8.2.12	LIGHTNING.....	8-35
8.2.12.1	<u>Cause of Accident</u>	8-35
8.2.12.2	<u>Accident Analysis</u>	8-35
8.2.12.3	<u>Accident Dose Calculations</u>	8-35
8.2.13	OFF-SITE SHIPPING EVENTS	8-35
8.2.13.1	<u>Interference During Raising or Lowering the MPC</u>	8-36
8.2.13.1.1	<u>Cause of Accident</u>	8-36
8.2.13.1.2	<u>Accident Analysis</u>	8-36
8.2.13.1.3	<u>Accident Dose Calculation</u>	8-36
8.2.13.2	<u>Interference During MPC Lowering into a Concrete Cask or Transport Cask</u>	8-36
8.2.13.2.1	<u>Cause of Accident</u>	8-37
8.2.13.2.2	<u>Accident Analysis</u>	8-37
8.2.13.2.3	<u>Accident Dose Calculation</u>	8-37
8.2.13.3	<u>MPC Drop into Concrete Cask or Transport Cask</u>	8-37
8.2.13.3.1	<u>Cause of Accident</u>	8-37
8.2.13.3.2	<u>Accident Analysis</u>	8-37
8.2.13.3.3	<u>MPC Drop Analysis</u>	8-39
8.2.13.3.4	<u>Accident Dose Calculation</u>	8-41
8.2.13.4	<u>Loaded Transport Cask Drop</u>	8-41
8.2.14	NATURAL GAS TURBINE COMBINED CYCLE POWER PLANT EVENTS	8-41
8.2.14.1	<u>Cause of Accident</u>	8-42
8.2.14.2	<u>Accident Analysis</u>	8-42
8.2.14.2.1	<u>Turbine Missiles</u>	8-42
8.2.14.2.2	<u>Fire/Heat Flux Effects</u>	8-43
8.2.14.2.3	<u>Partially Confined Explosion at the ISFSI</u>	8-43
8.2.14.2.4	<u>Confined Explosions Inside Plant Structures</u>	8-44
8.2.14.2.5	<u>Seismic Event or Tornado</u>	8-44
8.2.14.3	<u>Accident Dose Calculations</u>	8-45



8.3	<u>SITE CHARACTERISTICS AFFECTING SAFETY ANALYSIS</u>	8-46
8.4	<u>REFERENCES</u>	8-47
9.0	<u>CONDUCT OF OPERATIONS</u>	9-1
9.1	<u>ORGANIZATIONAL STRUCTURE</u>	9-2
9.1.1	<u>ISFSI CONSTRUCTION AND FUEL LOADING ORGANIZATION</u>	9-2
9.1.1.1	<u>Corporate Organization</u>	9-2
9.1.1.1.1	Nuclear Oversight	9-2
9.1.1.1.2	Independent Review and Audit Committee.....	9-2
9.1.1.2	<u>Site Organization</u>	9-3
9.1.1.2.1	General Manager, Trojan	9-3
9.1.1.2.2	Engineering	9-3
9.1.1.2.3	Decommissioning Projects.....	9-3
9.1.1.2.4	Plant Support.....	9-3
9.1.1.2.5	Operations	9-3
9.1.1.2.6	Personnel/Radiation Protection.....	9-3
9.1.1.2.7	Maintenance	9-4
9.1.1.3	<u>Interrelationships with Contractors and Suppliers</u>	9-4
9.1.1.4	<u>Technical Staff</u>	9-4
9.1.2	<u>ISFSI OPERATION ORGANIZATION</u>	9-4
9.1.2.1	<u>Corporate Organization</u>	9-5
9.1.2.1.1	Corporate Support.....	9-5
9.1.2.1.2	ISFSI Safety Review Committee	9-5
9.1.2.2	<u>Operating Organization</u>	9-5
9.1.2.3	<u>Succession of Authority</u>	9-5
9.1.3	<u>PERSONNEL QUALIFICATION REQUIREMENTS</u>	9-6
9.1.4	<u>LIAISON WITH OUTSIDE ORGANIZATIONS</u>	9-6
9.2	<u>PRE-OPERATIONAL AND STARTUP TESTING</u>	9-7
9.2.1	<u>ADMINISTRATIVE PROCEDURES FOR CONDUCTING TEST PROGRAM</u>	9-7
9.2.2	<u>TEST PROGRAM DESCRIPTION</u>	9-8
9.2.3	<u>TEST DISCUSSION</u>	9-8
9.2.3.1	<u>Physical Facilities</u>	9-8
9.2.3.1.1	MPC and Associated Equipment	9-8
9.2.3.1.2	Transfer Cask and Associated Equipment	9-9
9.2.3.1.3	Concrete Cask	9-10
9.2.3.1.4	Air Pad System	9-10
9.2.3.1.5	Transfer Station.....	9-10
9.2.3.2	<u>Operations</u>	9-10
9.2.3.3	<u>Test Response</u>	9-10
9.2.3.4	<u>Corrective Action</u>	9-11



9.3	<u>TRAINING PROGRAMS</u>	9-12
	9.3.1 TRAINING PROGRAM DESCRIPTION	9-12
9.4	<u>NORMAL OPERATIONS</u>	9-13
	9.4.1 PROCEDURES	9-13
	9.4.2 RECORDS	9-13
9.5	<u>EMERGENCY PLANNING</u>	9-15
9.6	<u>REVIEWS AND AUDITS</u>	9-16
	9.6.1 INDEPENDENT SAFETY REVIEWS	9-16
	9.6.2 ISFSI SAFETY REVIEW COMMITTEE	9-16
	9.6.3 RECORDS	9-19
9.7	<u>PROGRAMS</u>	9-20
	9.7.1 THIS SECTION DELETED	9-20
	9.7.2 FIRE PROTECTION PROGRAM	9-20
	9.7.3 TRAINING PROGRAM	9-20
	9.7.4 TROJAN ISFSI EMERGENCY PLAN	9-20
	9.7.5 TROJAN ISFSI SECURITY PLAN	9-20
	9.7.6 TRANSFER CASK AND CONCRETE CASK HANDLING AND STORAGE PROGRAM	9-20
	9.7.7 STRUCTURAL INSPECTION PROGRAM	9-21
	9.7.8 CONCRETE CASK INTERIOR INSPECTION PROGRAM	9-21
9.8	<u>ISFSI DECOMMISSIONING PLAN</u>	9-22
	9.8.1 DECOMMISSIONING PROGRAM	9-22
	9.8.2 COST OF DECOMMISSIONING	9-22
	9.8.3 DECOMMISSIONING FACILITATION	9-22
	9.8.4 RECORD KEEPING FOR DECOMMISSIONING	9-22
10.0	OPERATING CONTROLS AND LIMITS	10-1
11.0	QUALITY ASSURANCE	11-1



LIST OF TABLES

TABLE	TITLE
2.1-1	Public Facilities and Institutions
2.1-2	1994 Land Use Census Nearest Location to Trojan Within a Five-Mile Radius
2.2-1	Nearby Industrial Facilities
2.7-1	Summary of Site Conditions Affecting Construction and Operating Requirements
3.1-1	Fuel Characteristics
3.1-2	Design Maximum Radiological Characteristics of Stored Material
3.1-3	Design Maximum Thermal Characteristics of Stored Material
3.1-4	Physical Parameters of Fuel Assembly Inserts
3.2-1	Wind and Tornado Design Specifications
3.2-2	Design Basis Tornado Generated Missiles
3.2-3	Design Load Combinations for Concrete Cask
3.2-4	Summary of Load Combinations for MPC
3.2-5	MPC Design Criteria
3.2-6	Design Load Combinations for Transfer Station
3.6-1	Summary of Concrete Cask Design Criteria
3.6-2	Summary of Transfer Cask Design Criteria
4.2-1	Fabrication Specification Summary Multi-Purpose Canister (MPC)
4.2-1a	ASME Code Alternatives
4.2-2	Concrete Cask Fabrication Summary
4.2-2a	Concrete Cask Code Alternatives
4.2-3	Conformity to Requirements
4.2-4	Nominal Weights and Centers of Gravity
4.2-5	Mechanical Properties of Steels Used in the Storage System



LIST OF TABLES

TABLE	TITLE
4.2-6	Mechanical Properties of Concrete Used in Concrete Cask
4.2-7	Summary of Maximum MPC Thermal Stresses (ksi)
4.2-8	Maximum Stress Evaluation MPC
4.2-9	Summary of MPC Pressure Analysis
4.2-10	Concrete Cask Structural Load Combination Summary
4.2-11	Summary of Bounding Concrete Cask Thermal Stresses 75°F Ambient Air, Normal Operation
4.2-12	Summary of Cask Thermal Evaluation
4.2-13	Thermal Properties
4.2-14	Summary of Storage System Cooling Air Flow Analysis for Normal Storage Conditions
4.2-15	Bounding Maximum K_{eff} Values in the Trojan MPC-24E/EF
4.2-16	Fuel Composition Used in the Criticality Evaluation of the Trojan Storage System
4.7-1	Transfer Station Fabrication Specification Summary
4.7-2	Transfer Cask Lift Components
4.8-1	Trojan Storage System Material Compatibility with Operating Environments
7.2-1	Isotopic Inventory (Curies per assembly)
7.2-2	Fuel Region Gamma Source Strength
7.2-3	Fuel Region Neutron Source Strengths
7.2-4	Relative Burnup Level and Source Strengths for PWR Assembly Axial Sub-Sections
7.2-5	Mass of Non-Fuel Material in the Westinghouse 17X17 Fuel Assembly
7.2-6	Scaling Factors Used in Calculating the Co-60 Source
7.2-7	Co-60 Gamma Source Strengths (curies Co-60/assembly)



LIST OF TABLES

TABLE	TITLE
7.2-8	Mass of Material in the Burnable Poison Rod Assemblies and Thimble Plug Devices
7.2-9	Burnable Poison Rod Assembly and Thimble Plug Device Co-60 Gamma Source Strengths (curies Co-60/device)
7.2-10	Parameters for Test and Normal Conditions
7.2-11	Bounding χ/Q Values for the Controlled Area Boundary and Nearest Residence for Normal Conditions
7.2-12	Release Fractions
7.2-13	Description of Rod Cluster Control Assembly Configurations for Source Term Calculations
7.2-14	Source Terms for Rod Cluster Control Assembly Configurations
7.3-1	Elemental Densities of Shielding Materials Used in Calculational Models (gm/cc)
7.3-2	Axial Configuration of the Modeled Fuel Assembly
7.3-3	Neutron Energy Group Flux-to-Dose Conversion Factors (mrem/hr per neutron/cm ² -sec)
7.3-4	Gamma Flux-to-Dose Conversion Factors (mrem/hr per γ /cm ² -sec)
7.3-5	Burnup and Cooling Times Used for Casks in the ISFSI Analysis
7.3-6	Dose Versus Distance from Radiation Emanating off the Side of a Single Concrete Cask 42,000 MWD/MTU and 9 Years Cooling
7.3-7	Dose Versus Distance from Radiation Emanating off the Top of a Single Concrete Cask 42,000 MWD/MTU and 9 Years Cooling
7.3-8	Dose Versus Distance from Radiation Emanating off the Sides of the Concrete Casks in the ISFSI with Uniform Burnup and Cooling Time of 42,000 MWD/MTU and 9 Years Cooling
7.3-9	Dose Versus Distance from Radiation Emanating from the ISFSI with Uniform Burnup and Cooling Time of 42,000 MWD/MTU and 9 Years Cooling



LIST OF TABLES

TABLE	TITLE
7.3-10	Deleted
7.4-1	Maximum Expected Dose Rates for the Storage Cask System (42,000 MWD/MTU and 9-Year Cooling)
7.4-2	Normal Condition Effluent Dose Calculation Results for the Fully Loaded Trojan ISFSI
7.4-3	Estimated Personnel Doses while Operating the Cask System (42,000 MWD/MTU and 9-Year Cooling)
7.4-4	Dose Rates at the Controlled Area Boundary and Nearest Resident from Effluent and Direct Radiation During Normal and Off-Normal Conditions
8.0-1	Design Basis Normal and Off-Normal Events
8.0-2	Design Basis and Beyond Design Basis Infrequent (Accident) Events
8.1-1	MPC Stresses (ksi) Resulting From Off-Normal Handling Event
8.1-2	Deleted
8.1-3	Summary of Impact from Off-Normal Operations
8.1-4	Release Fractions for Confinement Evaluation of Off-Normal and Accident Conditions
8.2-1	MPC Stresses/Loads Resulting from Accident Pressurization
8.2-2	Off-Normal and Hypothetical Accident Confinement Dose Calculations (Single Cask)
8.2-3	Regulatory Guide 1.76 Design Basis Comparison
8.2-4	Tornado Missile Probability Data
8.2-5	Parameters for Accident Conditions
8.2-6	Bounding χ/Q Values for the Controlled Area Boundary and Nearest Residence for Accident Conditions
8.3-1	Summary of Site Characteristics Affecting the Safety Analysis
9.1-1	ISFSI Staffing Qualifications



LIST OF TABLES

TABLE	TITLE
9.2-1	Pre-Operational, Startup, and Other Tests
9.8-1	ISFSI Decommissioning Costs



LIST OF FIGURES

Figure Number	Title
1.1-1	Location of Trojan Nuclear Plant
1.1-2	Location of ISFSI at TNP Site
1.3-1	Storage System
Appendix 1.A	Licensing Drawings
3969	Trojan MPC-24E/EF Enclosure Vessel General Arrangement
3970	Trojan MPC-24E/EF Fuel Basket Layout and Weld Details
PGE-002	Trojan Concrete Cask
3971	Trojan Transfer Cask Assembly
3967	Trojan Transfer Cask Lifting Yoke
2.1-1	Site Location
2.1-2	PGE Property, ISFSI Site, and Controlled Area Boundary
2.1-3	ISFSI Layout
2.1-4	1990 Population Distribution within 10 miles
2.1-5	2000 Projected Population Distribution within 10 miles
2.1-6	2010 Projected Population Distribution within 10 miles
2.2-1	Nearby Industrial Activity
2.2-2	Longview Area Industrial Activity
2.3-1	Topographical Cross Sections (Maximum Elevations) SSE, S, SSW
2.3-2	Topographical Cross Sections (Maximum Elevations) SW, NW, WNW
2.3-3	Topographical Cross Sections (Maximum Elevations) W, WSW, NNW
2.3-4	Topographical Cross Sections (Maximum Elevations) N, NNE, NE
2.3-5	Topographical Cross Sections (Maximum Elevations) ENE, E



LIST OF FIGURES

Figure Number	Title
2.3-6	Topographical Cross Sections (Maximum Elevations) ESE, SE
2.4-1	ISFSI Topography
2.4-2	ISFSI Site Drainage
4.2-1a	Multi-Purpose Canister Elevation View
4.2-1b	MPC-24E/EF Cross Section
4.2-2	Deleted
4.2-3	Deleted
4.2-4	Concrete Cask
4.2-5	Failed Fuel Can
4.2-5a	Damaged Fuel Container
4.2-6a	Fuel Debris Process Can
4.2-6b	Fuel Debris Process Can Capsule
4.2-7	Deleted
4.2-8	Nominal Weights and Centers of Gravity
4.2-9	Concrete Cask Thermal Model
4.2-10	MPC Heat Transfer Model
4.2-11	Homogenization of the Storage Cross Section
4.2-12	MPC Cross Section Replaced with an Equivalent Two Zone Axisymmetric Body
4.2-13	MPC Temperature Distribution (75 Degrees F Ambient Air)
4.2-14	MPC Temperature Distribution (100 Degrees F Ambient Air)
4.2-15	MPC Temperature Distribution (125 Degrees F Ambient Air)
4.2-16	Damaged Fuel and Fuel Debris Model with 16X16 Bare Fuel Rod Array in MPC-24E/EF Corner Cell
4.7-1	Transfer Cask
4.7-2	Transfer Cask Lifting Trunnion Design



LIST OF FIGURES

Figure Number	Title
4.7-3	Transfer Station
4.7-4	Lifting Yoke
4.7-5	Deleted
4.7-6	Transfer Cask Shield Door Rail Design
4.7-7	Deleted
4.7-8	HI-TRAC Transfer Cask FLUENT Model
4.7-9	MPC Temperature Distribution in Transfer Cask (75 Degrees F Ambient Air)
4.7-10	MPC Temperature Distribution in Transfer Cask (100 Degrees F Ambient Air)
4.7-11	Transfer Cask Through Wall Temperature Distribution (75 Degrees F Ambient Air Temperature)
4.7-12	Vacuum Transient Peak Cladding Temperature (Design Maximum Heat Load $Q = 17.4\text{kW}$)
4.7-13	Vacuum Transient Peak Cladding Temperature (Bounding Heat Load Analysis $Q = 15\text{kW}$)
5.1-1	Operations Sequence (Typical)
5.1-2	Deleted
5.1-3	Transport Cask Operation Sequence (Typical)
5.1-4	MPC Contingency Unloading Sequence (Typical)
7.2-1	PWR Fuel Assembly Axial Burnup Profile
7.3-1	ISFSI Pad Configuration
7.3-2	Summary of Dose Rates for Concrete Cask
7.3-3	Summary of Dose Rates for Transfer Cask
7.3-4	Cross Sectional Elevation View of the Concrete Cask with As-Modeled Dimensions



LIST OF FIGURES

Figure Number	Title
7.3-5	View A of the Concrete Cask with As-Modeled Dimensions
7.3-6	View B of the Concrete Cask with As-Modeled Dimensions
7.3-7	View C of the Concrete Cask with As-Modeled Dimensions
7.3-8	View D of the Concrete Cask with As-Modeled Dimensions
7.3-9	Transfer Cask Cross Sectional Elevation View with As-Modeled Dimensions
7.3-10	Cross Sectional View of the Transfer Cask with As-Modeled Dimensions
7.3-11	Cross Sectional View of an MPC-24E Fuel Cell with As-Modeled Dimensions
8.1-1	Concrete Cask Temperature Distribution (100°F Day)
8.1-2	Concrete Cask Temperature Distribution (-40°F Day)
8.1-3	Deleted
8.1-4	Deleted
8.2-1	Concrete Cask Temperature Distribution (125°F Short Term)
8.2-2	Missile/Cask Impact Geometry
8.2-3	Cask Tip-Over Geometry
8.2-4	Inner Concrete Temperature All Inlets Blocked
8.2-5	Deleted
8.2-6	MPC Lift Cleats and Rigging
9.1-1	ISFSI Organization – Construction and Fuel Loading
9.1-2	ISFSI Organization – Operation



LIST OF EFFECTIVE PAGES

<u>Page Number</u>	<u>Revision</u>
Table of Contents i through xxiv	2
List of Effective Pages xxv through xxx	2
1-1 through 1-7	2
Figure 1.1-1	0
Figure 1.1-2	2
Figure 1.3-1	2
Appendix 1.A	2
Drawing 3969	2
Drawing 3970	2
PGE-002	2
Drawing 3971	2
Drawing 3967	2
2-1 through 2-47	2
Table 2.1-1	0
Table 2.1-2	0
Table 2.2-1	2
Table 2.7-1	2
Figure 2.1-1	0
Figure 2.1-2	2
Figure 2.1-3	0
Figure 2.1-4	0
Figure 2.1-5	0
Figure 2.1-6	0
Figure 2.2-1	0
Figure 2.2-2	0
Figure 2.3-1	0
Figure 2.3-2	0
Figure 2.3-3	0
Figure 2.3-4	0
Figure 2.3-5	0
Figure 2.3-6	0
Figure 2.4-1	0
Figure 2.4-2	0
3-1 through 3-25	2



LIST OF EFFECTIVE PAGES

<u>Page Number</u>	<u>Revision</u>
Table 3.1-1	0
Table 3.1-2	2
Table 3.1-3	2
Table 3.1-4	0
Table 3.2-1	0
Table 3.2-2	0
Table 3.2-3	0
Table 3.2-4	2
Table 3.2-5	2
Table 3.2-6	0
Table 3.6-1	2
Table 3.6-2	2
4-1 through 4-72	2
Table 4.2-1	2
Table 4.2-1a	2
Table 4.2-2	2
Table 4.2-2a	2
Table 4.2-3	2
Table 4.2-4	2
Table 4.2-5	2
Table 4.2-6	0
Table 4.2-7	2
Table 4.2-8	2
Table 4.2-9	2
Table 4.2-10	0
Table 4.2-11	2
Table 4.2-12	2
Table 4.2-13	2
Table 4.2-14	2
Table 4.2-15	2
Table 4.2-16	2
Table 4.7-1	0
Table 4.7-2	2
Table 4.8-1	2
Figure 4.2-1a	2
Figure 4.2-1b	2



LIST OF EFFECTIVE PAGES

<u>Page Number</u>	<u>Revision</u>
Figure 4.2-2	Deleted
Figure 4.2-3	Deleted
Figure 4.2-4	0
Figure 4.2-5	2
Figure 4.2-5a	2
Figure 4.2-6a	0
Figure 4.2-6b	0
Figure 4.2-7	Deleted
Figure 4.2-8	2
Figure 4.2-9	2
Figure 4.2-10	2
Figure 4.2-11	2
Figure 4.2-12	2
Figure 4.2-13	2
Figure 4.2-14	2
Figure 4.2-15	2
Figure 4.2-16	2
Figure 4.7-1	2
Figure 4.7-2	2
Figure 4.7-3	0
Figure 4.7-4	2
Figure 4.7-5	Deleted
Figure 4.7-6	2
Figure 4.7-7	Deleted
Figure 4.7-8	2
Figure 4.7-9	2
Figure 4.7-10	2
Figure 4.7-11	2
Figure 4.7-12	2
Figure 4.7-13	2
5-1 through 5-18	2
Figure 5.1-1	2
Figure 5.1-2	Deleted
Figure 5.1-3	2
Figure 5.1-4	2
6-1 through 6-5	2



LIST OF EFFECTIVE PAGES

<u>Page Number</u>	<u>Revision</u>
7-1 through 7-35	2
Table 7.2-1	2
Table 7.2-2	2
Table 7.2-3	2
Table 7.2-4	0
Table 7.2-5	2
Table 7.2-6	2
Table 7.2-7	2
Table 7.2-8	2
Table 7.2-9	2
Table 7.2-10	2
Table 7.2-11	2
Table 7.2-12	2
Table 7.2-13	2
Table 7.2-14	2
Table 7.3-1	2
Table 7.3-2	2
Table 7.3-3	2
Table 7.3-4	2
Table 7.3-5	2
Table 7.3-6	2
Table 7.3-7	2
Table 7.3-8	2
Table 7.3-9	2
Table 7.3-10	Deleted
Table 7.4-1	2
Table 7.4-2	2
Table 7.4-3	2
Table 7.4-4	2
Figure 7.2-1	0
Figure 7.3-1	2
Figure 7.3-2	2
Figure 7.3-3	2
Figure 7.3-4	2
Figure 7.3-5	2
Figure 7.3-6	2



LIST OF EFFECTIVE PAGES

<u>Page Number</u>	<u>Revision</u>
Figure 7.3-7	2
Figure 7.3-8	2
Figure 7.3-9	2
Figure 7.3-10	2
Figure 7.3-11	2
Appendix 7A, 7A-1 through 7A-2	2
Appendix 7B, 7B-1 through 7B-47	2
Appendix 7C, 7C-1 through 7C-36	2
8-1 through 8-48	2
Table 8.0-1	2
Table 8.0-2	2
Table 8.1-1	2
Table 8.1-2	Deleted
Table 8.1-3	2
Table 8.1-4	2
Table 8.2-1	2
Table 8.2-2	2
Table 8.2-3	0
Table 8.2-4	0
Table 8.2-5	2
Table 8.2-6	2
Table 8.3-1	2
Figure 8.1-1	2
Figure 8.1-2	2
Figure 8.1-3	Deleted
Figure 8.1-4	Deleted
Figure 8.2-1	2
Figure 8.2-2	2
Figure 8.2-3	2
Figure 8.2-4	2
Figure 8.2-5	Deleted
Figure 8.2-6	2
9-1 through 9-22	2
Table 9.1-1	2
Table 9.2-1	2
Table 9.8-1	0



LIST OF EFFECTIVE PAGES

<u>Page Number</u>	<u>Revision</u>
Figure 9.1-1	2
Figure 9.1-2	2
10-1	2
11-1	2



1.0 INTRODUCTION AND GENERAL DESCRIPTION OF INSTALLATION

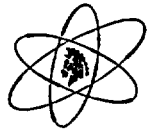
1.1 INTRODUCTION

The Trojan Nuclear Plant (TNP) was operated for approximately 17 years and was shut down for the last time on November 9, 1992. The plant is jointly owned by Portland General Electric Company (PGE), the City of Eugene through the Eugene Water and Electric Board (EWEB), and Pacific Power and Light/PacifiCorp. PGE is the principal owner and has responsibility for maintaining TNP.

PGE's plans to decommission TNP include prompt decontamination and dismantlement of contaminated structures, systems and components. In order to facilitate decontamination and dismantlement, the contents of the Spent Fuel Pool will be relocated to an Independent Spent Fuel Storage Installation (ISFSI). Use of an ISFSI was determined to be the most economical method for the temporary storage of the TNP spent fuel until a Department of Energy (DOE) or other offsite facility is available. Relocation of the spent fuel and associated radioactive material stored in the pool to the ISFSI would allow decontamination and dismantlement of structures, systems, and components throughout TNP to proceed without impacting the safe storage of the spent fuel.

Activities involving loading of the spent nuclear fuel assemblies into the Holtec International Multi-Purpose Canister (MPC-24E or MPC-24EF; hereafter referred to simply as "MPC" when specification of the particular canister type is unnecessary), closure of the MPC, and placement of the MPC into a Concrete Cask are considered licensed activities per PGE's 10 CFR Part 50 license and are not described in detail in this Safety Analysis Report (SAR). This SAR is primarily focused on ISFSI operations, including ultimate transfer to a Transport Cask. However, certain restrictions related to the MPC loading and sealing operations are included in the ISFSI Technical Specifications.

TNP is located in Columbia County, Oregon, along the west bank of the Columbia River, approximately 42 miles north of Portland, Oregon. Figure 1.1-1 shows the location of TNP. The ISFSI will be located in the northeast portion of the TNP site, as shown in Figure 1.1-2.



1.2 GENERAL DESCRIPTION OF THE INSTALLATION

PGE will use BNFL Fuel Solutions TranStor™ Concrete Casks loaded with Holtec International MPC-24Es or MPC-24EFs at the Trojan ISFSI. The MPC-24E is designed to accommodate up to 24 pressurized water reactor (PWR) fuel assemblies. Up to four of the fuel assemblies in any one MPC-24E may be classified as damaged fuel and the balance must be intact fuel. The MPC-24EF is also designed to accommodate up to 24 PWR fuel assemblies. Up to four of the fuel assemblies in any one MPC-24EF may be classified as damaged fuel or fuel debris, and the balance must be intact fuel.

This storage system is a vertical dry storage system that utilizes a ventilated Concrete Cask and a seal-welded stainless steel MPC to safely store spent nuclear fuel assemblies and fuel debris. Hereafter in this SAR, this storage system will be referred to as the Trojan Storage System.

The ISFSI consists of a reinforced concrete Storage Pad, supporting 34 Trojan Storage Systems designed to safely store intact spent fuel assemblies, fuel assembly inserts and metal fragments (e.g., portions of fuel rods and grid assemblies, bottom nozzles, etc.), assemblies containing damaged fuel, or fuel debris. The storage system is passive and requires minimal surveillances. Significant radioactive waste generation is not anticipated as a result of ISFSI operation.

The system is designed to permit transfer of the MPC to a Holtec HI-STAR 100 System Transport Cask (CoC 71-9261) once a repository or other facility is available. The system is also designed to accommodate recovery from postulated off-normal events without reliance on the Spent Fuel Pool.

The principal design criteria are discussed in Chapter 3. Chapter 4 discusses the design of the ISFSI.



1.3 GENERAL SYSTEMS DESCRIPTION

The storage system consists of the MPCs, Concrete Casks, Storage and Service Pads, Transfer Station, and associated transfer equipment necessary for safe placement of spent nuclear fuel assemblies, fuel assembly inserts, and fuel debris into dry storage. The following sections provide an overview of the primary components used during storage. Figure 1.3-1 provides an overview of the MPC and Concrete Cask.

1.3.1 STORAGE SYSTEM CANISTERS

MPCs are metal fuel storage containers that are seal-welded closed and serve as the confinement boundary for the materials stored within the MPCs. The MPC is designed to provide safe storage of intact spent fuel, damaged fuel, fuel assembly inserts, and fuel debris. The MPC consists of a honeycomb fuel basket, a baseplate, an outer shell, a lid, vent and drain port cover plates, and a closure ring. A detailed drawing of the MPC is provided in Appendix 1.A.

The MPC fuel basket is fabricated from stainless steel plates formed into an array of 24 square fuel storage locations (cells), each holding one PWR spent fuel assembly. The cells are sized to accommodate storage of control components and other fuel assembly inserts within the fuel assembly. The MPC relies on geometry (including flux traps) for subcriticality during storage. In addition, credit was taken for the boral (neutron poison) plates in the dry storage criticality analysis, consistent with the analysis for the flooded condition. However, the effect of these plates on reactivity under dry conditions is small. Section 1.2.1.1 of the HI-STORM FSAR provides a complete description of the generally certified Holtec MPC design. Unique features of the Trojan-specific MPC-24E/EF, implemented to customize the generic design for site-specific use, are described in Chapter 4.

Four specially designated cells in each MPC can accommodate Failed Fuel Cans or Damaged Fuel Containers as well as spent fuel assemblies. Failed Fuel Cans may be loaded with:

- Assemblies containing damaged fuel,
- Process Can Capsules containing fuel debris (MPC-24EF only),
- Fuel assembly metal fragments (e.g., portions of fuel rods and grid assemblies, bottom nozzles, etc.),
- Process Cans containing fuel debris (whole and partial pellets) and fuel assembly hardware (MPC-24EF only), or
- A fuel rod storage container (MPC-24EF only).



Fuel debris mixed with organic filter material was placed in Process Cans, processed to remove the organic material, and sealed in Process Can Capsules, which will be placed in the Failed Fuel Can in the MPC-24EF. Damaged Fuel Containers may be loaded with fuel assemblies containing damaged fuel or fuel debris.

1.3.2 STORAGE SYSTEM CONCRETE CASK

The Concrete Cask provides structural support, shielding, and natural circulation cooling for the MPC. The MPC is stored in the central steel lined cavity of the Concrete Cask. The Concrete Cask is ventilated by internal air flow paths which allow the decay heat to be removed by natural circulation around the metal MPC wall. Air flow paths are formed by the skid channels at the bottom (air entrance), the air inlet ducts, the gap between the MPC exterior and the Concrete Cask interior, and the air outlet ducts. A temperature monitoring device located in each of the four air outlets in each Concrete Cask provides indication of proper decay heat removal. A detailed drawing of the Concrete Cask is provided in Appendix 1.A.

The air inlet and outlet vents are steel lined penetrations that take non-planar paths to minimize radiation streaming. Side surface radiation dose rates are limited by the thick steel and concrete walls of the Concrete Cask.

1.3.3 TRANSFER EQUIPMENT

1.3.3.1 Transfer Cask

The Transfer Cask is used in conjunction with the Transfer Cask Lifting Yoke to move the loaded MPC from the Spent Fuel Pool to the Concrete Cask. The Transfer Cask is also utilized with the Transfer Station to transfer an MPC to a HI-STAR 100 Transport Cask for transportation off site. Drawings of the Transfer Cask and Transfer Cask Lifting Yoke are provided in Appendix 1.A.

In preparation for use at the ISFSI, the Transfer Cask is first positioned in the Transfer Station. A Concrete Cask is positioned below the Transfer Cask, the retractable doors at the bottom of the Transfer Cask are opened, and a loaded MPC is hoisted into the Transfer Cask. The Transfer Cask bottom doors are then closed, mechanical stops are installed, and the empty Concrete Cask is moved out of the Transfer Station. The destination HI-STAR 100 Transport Cask is moved into the Transfer Station and positioned beneath the Transfer Cask. The MPC is lowered in a process reverse to that described above.

1.3.3.2 Transfer Station

The Transfer Station is utilized for MPC transfer operations at the ISFSI site. The Transfer Station provides lateral and vertical support that prevents the loaded Transfer Cask from falling or overturning during transfer operations. During transfer to a Transport Cask, the Transfer Cask



is locked into the Transfer Station, while the destination casks are moved under the Transfer Cask. All MPC transfers are accomplished by vertical lifts, with the Transfer Cask secured and stationary within the Transfer Station.

1.3.3.3 Air Pad System

To move a loaded Concrete Cask from one location to another, an air pad system is used. Air pads are inserted under the Concrete Cask and energized with one or more standard air compressor(s). A forklift or other small truck can then be used to move the Concrete Cask.

1.3.4 AUXILIARY EQUIPMENT

1.3.4.1 Vacuum Drying and Helium Backfill Systems

A vacuum drying system is used to dry the MPC cavity following fuel loading. A helium backfill system is used to backfill the MPC cavity with helium. The vacuum drying system is designed to evacuate the MPC cavity. During evacuation, the decay heat from the fuel further helps remove residual moisture from the MPC cavity.

1.3.4.2 Gap Flushing System

A flushing system is used to pump Spent Fuel Pool water through the gap between the Transfer Cask and MPC. The system is designed to remove Spent Fuel Pool contaminants by filtering water through a demineralizer using resin to minimize contamination of the exterior of the MPCs while they are in the Cask Loading Pit.

1.3.4.3 Automated Welding System

The MPCs are seal-welded using an automated welding system as the preferred method.



1.4 IDENTIFICATION OF AGENTS AND CONTRACTORS

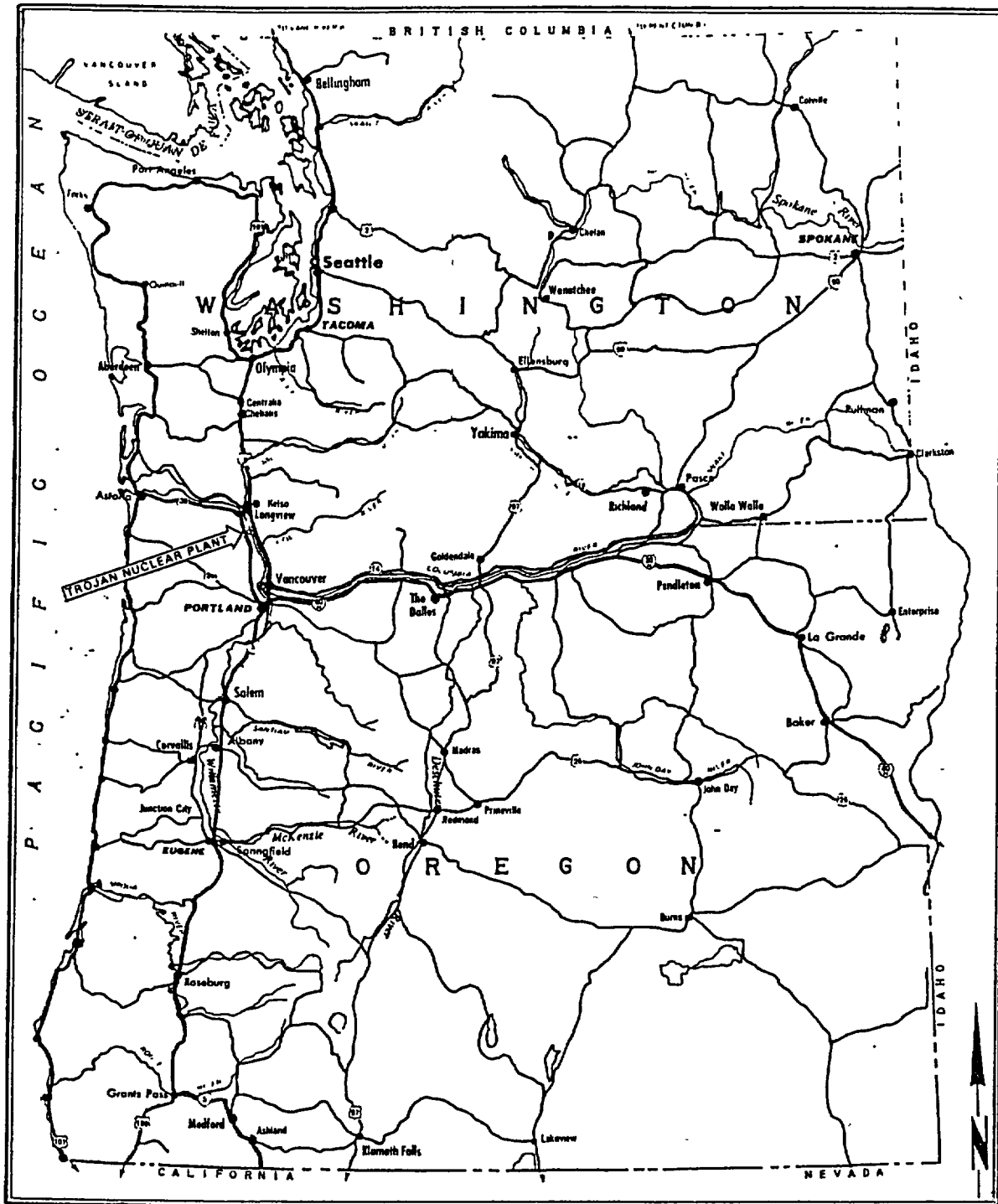
PGE is the principal owner of the Trojan ISFSI and is responsible for fabrication, construction, operation, maintenance and surveillance of the ISFSI. PGE is also responsible for overall project management.

BNFL Fuel Solutions is responsible for the design and fabrication of the Concrete Casks and Failed Fuel Cans, and for some auxiliary equipment fabrication activities including related quality assurance services. Holtec International is responsible for design and fabrication of the MPC, Damaged Fuel Containers, and Transfer Cask, and for some of the related auxiliary equipment design and fabrication, including associated quality assurance services.



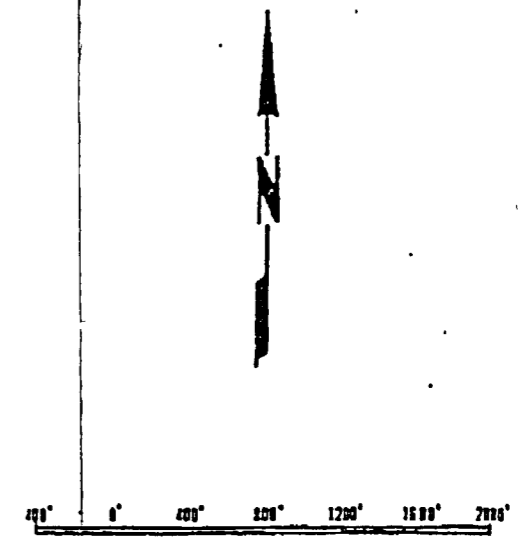
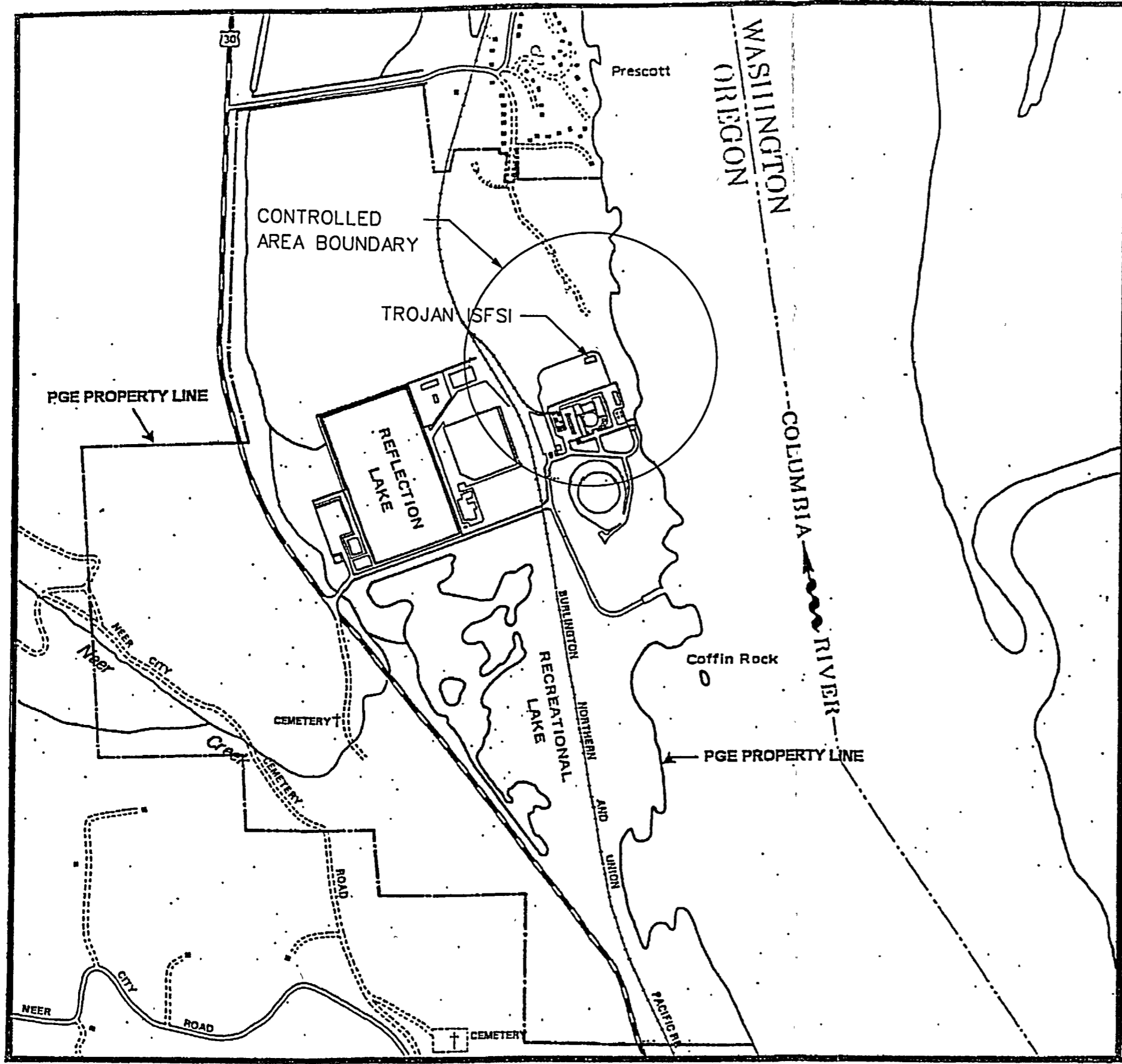
1.5 MATERIAL INCORPORATED BY REFERENCE

The Trojan ISFSI MPC and Transfer Cask are based on the same design as components described in the HI-STORM 100 Final Safety Analysis Report (Docket 72-1014) and in the HI-STAR 100 System Transportation Safety Analysis Report (Docket 71-9261). PGE intends to register as a user of the HI-STAR 100 Transport Cask prior to first use of the cask for transporting Trojan spent nuclear fuel off site.



**TROJAN ISFSI
SAFETY ANALYSIS REPORT**

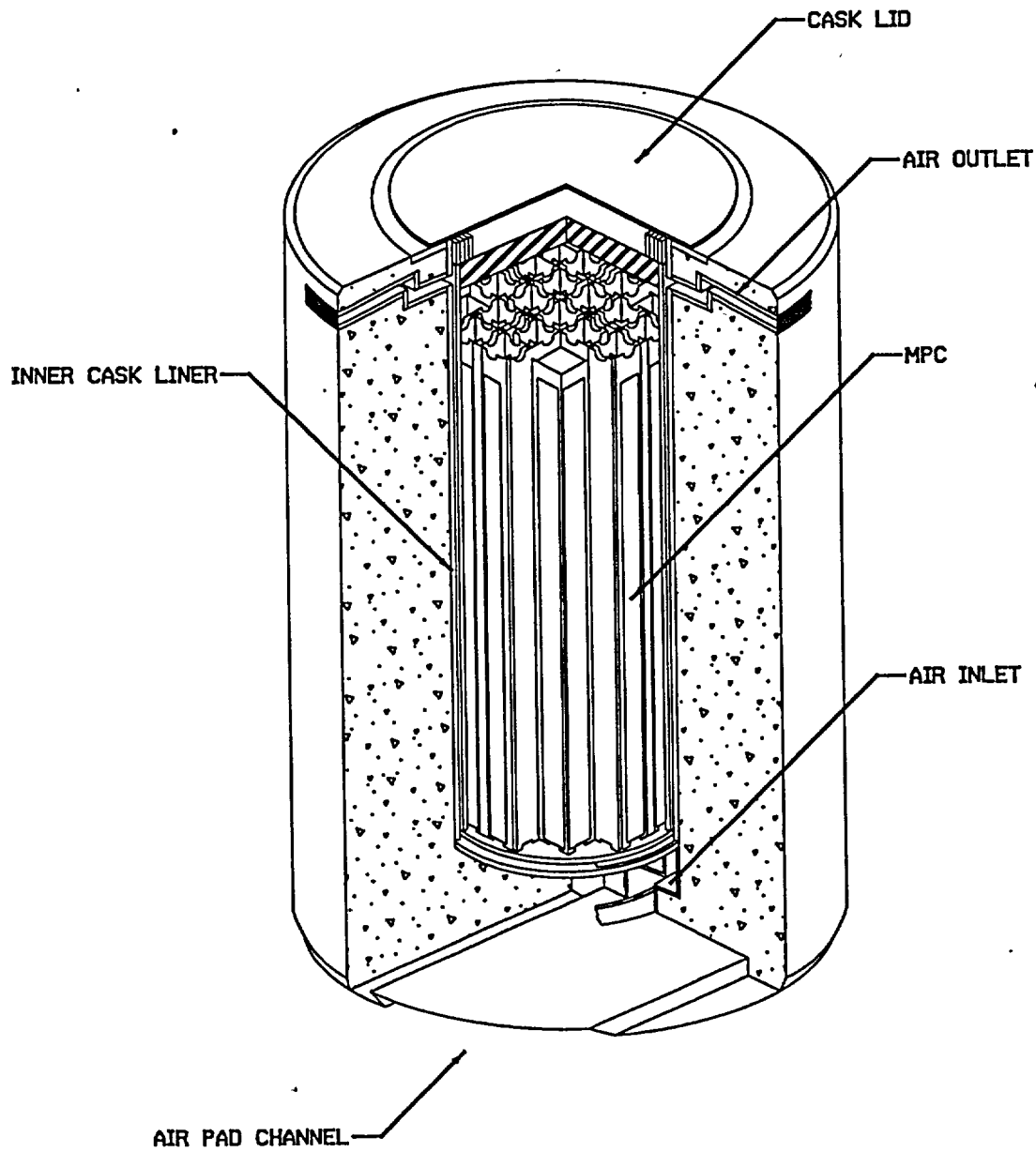
**FIGURE 1.1-1
LOCATION OF
TROJAN NUCLEAR PLANT**



TROJAN ISFSI
SAFETY ANALYSIS REPORT

FIGURE 1.1-2.
LOCATION OF ISFSI AT TNP SITE
 Revision 2

SA:\figures\pge-1989 final\revision 3 figures\1.1-2.02.dgn
 SA:\figures\pge-1989 final\revision 3 figures\1.1-2.02.ctb



<p>TROJAN ISFSI SAFETY ANALYSIS REPORT</p>
<p>FIGURE 1.3-1</p>
<p>STORAGE SYSTEM REVISION 2</p>



Appendix 1.A

Licensing Drawings

CONTENTS

NUMBER	TOTAL SHEETS	TITLE
3969	4	Trojan MPC-24E/EF Enclosure Vessel Assembly
3970	3	Trojan MPC-24E/EF Fuel Basket Assembly
PGE-002	1	Trojan Concrete Cask
3971	14	Trojan Transfer Cask Assembly
3967	2	Trojan Transfer Cask Lifting Yoke

FIGURE WITHHELD UNDER 10 CFR 2.390


 HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053		CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)	
		DESCRIPTION TROJAN MPC-24E/EF ENCLOSURE VESSEL GENERAL ARRANGEMENT	
COMPANION DRAWINGS -	SIZE D	DRAWING NO. 3969	SHEET 2
	SCALE NONE	REV 0	FILE PATH G:\DRAWINGS\1158\3969

FIGURE WITHHELD UNDER 10 CFR 2.390


				CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)	
HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053				DESCRIPTION TROJAN MPC-24E/EF ENCLOSURE VESSEL ELEVATION DETAILS	
COMPANION DRAWINGS	SIZE D	DRAWING NO. 3969	SHEET 3	REV 0	
	SCALE NONE	FILE PATH G:\DRAWING\31139\3969			

FIGURE WITHHELD UNDER 10 CFR 2.390


				CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)			
HOLTEC INTERNATIONAL				DESCRIPTION TROJAN MPC-24E/EF ENCLOSURE VESSEL LID DETAILS			
HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053				SIZE D	DRAWING NO. 3969	SHEET 4	REV 0
COMPANION DRAWINGS				SCALE NONE	FILE PATH G:\DRAWING\31135\3969		

FIGURE WITHHELD UNDER 10 CFR 2.390



				CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)	
HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053				DESCRIPTION TROJAN MPC-24E/EF ENCLOSURE VESSEL LID DETAILS	
COMPANION DRAWINGS	SIZE D	DRAWING NO. 3969	SHEET 4	REV 0	
SCALE NONE		FILE PATH G:\DRAWINGS\1135\3969			

FIGURE WITHHELD UNDER 10 CFR 2.390

				CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)			
HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053				DESCRIPTION TROJAN MPC-24E/EF FUEL BASKET ARRANGEMENT			
COMPARISON DRAWING:		SIZE	DRAWING NO.	SHEET	REV		
-		D	3970	2	0		
		SCALE	FILE PATH				
		NONE	G:\DRAWINGS\11250970				

A

FIGURE WITHHELD UNDER 10 CFR 2.390


 HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053		CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)	
		DESCRIPTION TROJAN MPC-24E/EF FUEL BASKET LAYOUT AND WELD DETAILS	
COMPANION DRAWING -	SIZE D	DRAWING NO. 3970	SHEET 3
	SCALE NONE	REV 0	FILE PATH G:\DRAWING\391139\3970

FIGURE WITHHELD UNDER 10 CFR 2.390

FIGURE WITHHELD UNDER 10 CFR 2.390


 HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053		CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)		
		DESCRIPTION TROJAN MPC-24E/EF FUEL BASKET LAYOUT AND WELD DETAILS		
COMPANION DRAWINGS -	SIZE D	DRAWING NO. 3970	SHEET 3	REV 0
		SCALE NONE	FILE PATH G:\DRAWINGS\11350970	

FIGURE WITHHELD UNDER 10 CFR 2.390


TOLERANCE				CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)	
INCHES MILLIMETERS		ANGULAR		DESCRIPTION	
X ± .1	[2.5]	±1°		TROJAN	
X ± .05	[1.27]			TRANSFER CASK ASSEMBLY	
X ± .010	[.25]			GENERAL ARRANGEMENT	
FRACTIONAL				SIZE	
0 TO LESS THAN 2 IN.	±1/16 IN.			DRAWING NO.	SHEET
2 IN. TO LESS THAN 3 FT.	±1/8 IN.			3971	2
3 FT. AND GREATER	±3/16 IN.				REV
					2
PROJECT NO.	1135	COMPANION DRAWINGS		SCALE	FILE PATH
				NONE	G:\DRAWING\1135\3971
SAR REV. 2					

FIGURE WITHHELD UNDER 10 CFR 2.390


TOLERANCES				CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)			
INCHES	MILLIMETERS	ANGULAR		DESCRIPTION TROJAN TRANSFER CASK OVERALL DIMENSIONS			
X ± .1	(2.5)	± 1°					
X ± .05	(1.27)						
X ± .010	(.25)						
FRACTIONAL							
0 TO LESS THAN 2 IN.		± 1/16 IN.					
2 IN TO LESS THAN 3 FT.		± 1/8 IN.					
3 FT AND GREATER		± 3/16 IN.					
			HOLTEC INTERNATIONAL				
			HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053				
PROJECT NO.	1135	COMPANION DRAWINGS		SIZE	DRAWING NO.	SHEET	REV.
				D	3971	3	2
A SAR REV. 2				SCALE	FILE PATH	Q:\DRAWINGS\1135\971	
				NONE			

FIGURE WITHHELD UNDER 10 CFR 2.390


TOLERANCES <small>INCHES [MILLIMETERS]</small> X ± .1 XX ± .05 XXX ± .010 FRACTIONAL 0 TO LESS THAN 2 IN. ± 1/16 IN. 2 IN. TO LESS THAN 3 FT. ± 1/8 IN. 3 FT. AND GREATER ± 3/16 IN.		ANGLES ± 1°	 HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053	CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)
PROJECT NO. 1135		CONTRACTOR SAR REV. 2	DESCRIPTION TROJAN TRANSFER CASK SHELL DETAILS	SCALE NONE
DATE D		DRAWING NO. 3971	SHEET 4	REV 2
SCALE NONE		FILE PATH /s/	Q:\DRAWING\5113313971	

FIGURE WITHHELD UNDER 10 CFR 2.390


TOLERANCES				CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)			
INCHES	MILLIMETERS	ANGULAR		DESCRIPTION			
X ± .1	(2.5)	± 1°		TROJAN TRANSFER CASK SHELL ASSEMBLY			
XX ± .05	(1.3)						
XXX ± .018	(.45)						
FRACTIONAL							
0 TO LESS THAN 2 IN.	± 1/16 IN.						
2 IN. TO LESS THAN 3 FT.	± 1/8 IN.						
3 FT. AND GREATER	± 3/16 IN.						
PROJECT NO.	1135	COMPANION DRAWING		SIZE	DRAWING NO.	SHEET	REV.
SAR REV. 2				D	3971	5	2
				SCALE	FILE PATH	Q:\DRAWINGS\1135\3971	
				NONE			

FIGURE WITHHELD UNDER 10 CFR 2.390

FIGURE WITHHELD UNDER 10 CFR 2.390


TOLERANCES		 HOLTEC INTERNATIONAL HOLTEC CENTER 353 LINCOLN CENTER MARLTON, NJ 08053	CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)		
INCHES (MILLIMETERS)	ANGLES		DESCRIPTION TROJAN TRANSFER CASK TOP FLANGE ASSEMBLY		
X ± .1 XX ± .05 XXX ± .010	(2.5) (1.27) (.25)				
FRACTIONAL					
0 TO LESS THAN 2 IN. 2 IN. TO LESS THAN 3 FT. 3 FT. AND GREATER	1/16 IN. 1/8 IN. 3/16 IN.				
PROJECT NO. 1135	COMPANION DRAWINGS -	SIZE D	DRAWING NO. 3971	SHEET 7	REV. 2
SAR REV. 2					

FIGURE WITHHELD UNDER 10 CFR 2.390


TOLERANCES		 HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053	CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)				
INCHES, MILLIMETERS	ANGULAR		DESCRIPTION TROJAN TRANSFER CASK INNER AND OUTER ASSEMBLY				
X ± .1 XX ± .05 XXX ± .010	± .01 ± .02 ± .05						
FRACTIONAL		PROJECT NO. 1135	COMPANION DRAWINGS:	SIZE D	DRAWING NO. 3971	SHEET 8	REV 2
0 TO LESS THAN 2 IN : ± .010 IN. 2 IN. TO LESS THAN 3 FT : ± .005 IN. 3 FT AND GREATER : ± .010 IN.		SAR REV. 2		SCALE 1/4" = 1'-0"		FILE PATH	

FIGURE WITHHELD UNDER 10 CFR 2.390

FIGURE WITHHELD UNDER 10 CFR 2.390

FIGURE WITHHELD UNDER 10 CFR 2.390


TOLERANCES		 HOLTEC INTERNATIONAL HOLTEC CENTER 855 LINCOLN CENTER MARLTON, NJ 08053	CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)		
INCHES (MILLIMETERS)	ANGULAR		DESCRIPTION TROJAN TRANSFER CASK TOP LID ASSEMBLY		
X ± .1 XX ± .05 XXX ± .010	± .1° ± .2° ± .25°				
FRACTIONAL					
0 TO LESS THAN 2 IN.	1/16 IN.				
2 IN. TO LESS THAN 3 FT.	1/8 IN.				
3 FT. AND GREATER	3/16 IN.				
PROJECT NO. 1135	COMPANION DRAWINGS	SIZE D	DRAWING NO. 3971	SHEET 11	REV 2
A CAD REV 2		SCALE 1 PER PART			

FIGURE WITHHELD UNDER 10 CFR 2.390


TOLERANCES		 HOLTEC INTERNATIONAL HOLTEC CENTER 855 LINCOLN CENTER MARLTON, NJ 08053	CLIENT	
INCHES	MILLIMETERS		ANGULAR	PORTLAND GENERAL ELECTRIC COMPANY (PGE)
X ± .1	± .25	± 1°	DESCRIPTION TROJAN TRANSFER CASK SLIDE DOOR ASSEMBLY	
X ± .05	± .125			
X ± .010	± .25		SIZE	
FRACTIONAL			DRAWING NO.	
0 TO LESS THAN 2 IN.	± 1/16 IN.		3971	
2 IN. TO LESS THAN 3 FT.	± 1/8 IN.		SHEET	
3 FT. AND GREATER	± 3/16 IN.		12	
PROJECT NO.	1135	COMPANY DRAWING	REV	
SAP/REV 2			2	
SCALE			FILE PATH	

FIGURE WITHHELD UNDER 10 CFR 2.390

TOLERANCES		ANGULAR	CLIENT	PORTLAND GENERAL ELECTRIC COMPANY (PGE)	
INCHES	MILLIMETERS				
X ± .1	±.01	±1°	DESCRIPTION	TROJAN TRANSFER CASK DOOR FRAME ASSEMBLY	
XX ± .05	±.02				
XXX ± .010	±.03				
FRACTIONAL					
6 TO LESS THAN 2 IN.	±1/16 IN.				
3 IN. TO LESS THAN 3 FT.	±1/8 IN.				
3 FT. AND GREATER	±3/16 IN.				
PROJECT NO.	1135	COMPANION DRAWINGS	SIZE	DRAWING NO.	SHEET NO.
			D	3971	13
					2

FIGURE WITHHELD UNDER 10 CFR 2.390


TOLERANCES		 HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053	CLIENT	
INCHES (MILLIMETERS)	ANGULAR		PORTLAND GENERAL ELECTRIC COMPANY (PGE)	
X ± .1 (2.5)	± 1°	DESCRIPTION		
X/2 ± .05 (1.2)		-		
X/4 ± .018 (.25)		TROJAN		
FRACTIONAL		TRANSFER CASK ASSEMBLY		
0 TO LESS THAN 2 IN. ± 1/16 IN.		PROJECT NO.	1135	
2 IN. TO LESS THAN 3 FT. ± 1/8 IN.		COMPANY OR DRAWING NO.		
3 FT. AND GREATER ± 3/16 IN.		SIZE	D	
		DRAWING NO.	3971	
		SHEET	14	
		REV	2	

FIGURE WITHHELD UNDER 10 CFR 2.390



TOLERANCES		 HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053	CLASS			
FRACTIONAL 0 TO LESS THAN 1/8 IN. 1/8 IN. TO LESS THAN 3/16 IN. 3/16 IN. TO LESS THAN 1/4 IN. 1/4 IN. TO LESS THAN 3/8 IN. 3/8 IN. TO LESS THAN 1/2 IN. 1/2 IN. TO LESS THAN 3/4 IN. 3/4 IN. TO LESS THAN 1 IN. 1 IN. TO LESS THAN 1 1/4 IN. 1 1/4 IN. TO LESS THAN 1 3/4 IN. 1 3/4 IN. TO LESS THAN 2 IN.	ANGULAR ±1°		PORTLAND GENERAL ELECTRIC COMPANY (PGE)			
PROJECT NO. 1135		DESCRIPTION - TROJAN TRANSFER CASK ASSEMBLY	SIZE	DRAWING NO.	SHEET	REV.
DATE 11/18/83			D	3971	14	2

FIGURE WITHHELD UNDER 10 CFR 2.390

 HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053		CLIENT PORTLAND GENERAL ELECTRIC COMPANY (PGE)	
DESCRIPTION TROJAN TRANSFER CASK LIFTING YOKE GENERAL ARRANGEMENT		DRAWING NO. 3967	
COMPARISON DRAWING:	SIZE D	SHEET 2	REV 1
SCALE NONE		FILE PATH G:\DRAWING\31135\3967	



2.0 SITE CHARACTERISTICS

This chapter discusses the general characteristics of the ISFSI site and vicinity as they relate to the area's geology, seismology, hydrology, and meteorology. Population distribution, land use, and site activities and controls are also discussed. This chapter presents, in complement with more detailed discussions provided in other ISFSI SAR chapters, information showing the overall adequacy of the site for storage of spent nuclear fuel.

2.1 GEOGRAPHY AND DEMOGRAPHY

The ISFSI is located at the Trojan Nuclear Plant site. The Trojan Nuclear Plant site was originally selected to minimize hazards to the general public from the operation of Trojan Nuclear Plant. The site environs have low population densities and minimal usage for such activities as farming and recreation. Some of the site characteristics associated with selection of the site for operation of the Trojan Nuclear Plant remain applicable to the storage of spent nuclear fuel. This chapter provides discussion of those site characteristics applicable to storage of spent nuclear fuel.

2.1.1 SITE LOCATION

The ISFSI site is in Columbia County, Oregon, and lies along the west bank of the Columbia River at approximately River Mile 72.5, 42 miles north of Portland. The specific geographic location of the site is 46° 02' 25" N latitude and 122° 53' 03" W longitude. In the Universal Transverse Mercator coordinate system, the site location is 5098352 meters N by 509000 meters E, and in the Oregon North Zone Lambert Coordinate, the site location is 874375 N by 1394615 E.

The nearest incorporated communities are Rainier, Oregon, approximately 4-1/2 miles northwest; and across the Columbia River in Washington, Kalama, approximately 3 miles southeast, and Longview-Kelso, approximately 6 miles northwest. Within a 5-mile radius of the site are three small unincorporated communities with a total population of less than 2000: Prescott, Oregon, 1/2 mile north; Goble, Oregon, 1-1/2 miles south; and across the Columbia River, Carrolls, Washington, 2-1/2 miles northeast.

Other than the Columbia River and tributaries, there are no nearby natural geographic features of prominence offsite. The Kalama River joins the Columbia at River Mile 73.1, about 1/2 mile upstream on the bank opposite the site. Similarly, the confluence of the Cowlitz and Columbia Rivers is about 4-1/2 miles downstream at River Mile 68. Manmade features include the 492-foot natural draft cooling tower, which rises 589 feet above mean sea level (MSL), an approximately 26-acre man-made reflecting lake, and an approximately 28-acre recreational lake.



Figures 1.1-1 and 2.1-1 are maps that show the Trojan Nuclear Plant and ISFSI site location. Figure 2.1-2 is a map that shows the PGE property, the ISFSI site, surrounding topography, and the Controlled Area as defined in 10 CFR 72.106. Figure 2.1-3 shows the ISFSI site layout.

2.1.2 SITE DESCRIPTION

The ISFSI is located on an approximately 634-acre tract of land owned in fee by Portland General Electric Company (PGE) in Sec. 35 and 36, T. 7 N., R. 2 W., W.M., and in Sec. 1 and 2, T. 6 N., R. 2 W., W.M., Columbia County, Oregon. The tract is all-inclusive of individual and separate parcels as described in the following deed records on file in Columbia County: BK 168, Pages 13 and 14, 22, 23 to 26 inclusive, 81 to 83 inclusive, 117 to 121 inclusive; BK 171, Pages 935 and 936; and BK 174, Page 436.

The eastern boundary of the PGE property is the Columbia River. The eastern boundary (owned in fee) extends to mean low water in the southern part of the property and to mean high water in the northern part of the property. By written agreement with the State of Oregon, who is owner of the submerged and remainder of submersible lands in the river, PGE has control of the uses of such areas out to a line at approximately -20 feet MSL. Beyond this line the U. S. Coast Guard has jurisdiction over river operations.

The western boundary of the PGE property is U.S. Highway 30 in the northern one-third of the property. The western boundary in the southern two-thirds of the property extends past (to the west of) U.S. Highway 30 and includes several parcels of land to the west of U.S. Highway 30.

The ISFSI reinforced concrete Storage Pad, which is approximately 105 feet by 170 feet and is designed to accommodate up to 36 Concrete Casks, is located inside the ISFSI Protected Area fence near the eastern edge of the PGE property. The ISFSI Protected Area fence is within the boundary of the controlled access area fence which defines the ISFSI "site" within which 10 CFR 72 activities are licensed and occur.

Transportation routes that are in the immediate vicinity of the ISFSI site include the Columbia River, U.S. Highway 30, and Portland & Western Railroad, Inc. The nearest edge of the ISFSI reinforced concrete Storage Pad is about 160 feet from the Oregon bank (mean low water) of the Columbia River, about 1/2 mile from the U.S. Highway 30 right of way, and about 700 feet from the railway right-of-way.

Approximately six oceangoing commercial vessels pass the ISFSI site on the Columbia River in a typical day (Reference 1). U.S. Highway 30 is a two-lane roadway that carries moderate passenger and freight traffic between communities along the Columbia River. Portland & Western Railroad, Inc. operates an average of two freight trains per day along their railway right-of-way which traverses the PGE property (Reference 2). Railroad property within PGE property boundaries is "operating" property, i.e., not available for lease or other use.



Four 230kV overhead transmission lines terminate in a switchyard approximately 1000 feet from the ISFSI. The switchyard supplies power to the ISFSI site.

The Controlled Area, as defined in 10 CFR 72.106, immediately surrounds the ISFSI and extends out to 300 meters from the edge of the Storage Pad (Figure 2.1-2). The Controlled Area lies entirely on PGE property with the exception of a portion of the Controlled Area that extends over the Columbia River and the Portland & Western Railroad, Inc. right-of-way. U.S. Highway 30 is not within the Controlled Area. PGE has formal agreements with Portland & Western Railroad, Inc. to restrict traffic over their right-of-way, with the U.S. Coast Guard to restrict traffic on the Columbia River, and with the state of Oregon to evacuate persons from publicly owned lands (i.e., tidelands) in the event of an emergency at the ISFSI.

The doses that could be anticipated at the Controlled Area boundary from an off-normal event or accident are discussed in Chapter 8 and are below the limits of 10 CFR 72.106 and Oregon Administrative Rule (OAR) 345-026-0390.

2.1.2.1 Other Activities Within the ISFSI Site Boundary

No activities unrelated to ISFSI operation are performed within the ISFSI controlled access area boundary.

Several major physical facilities, which were used during Trojan Nuclear Plant operation, are grouped to the south and west of the ISFSI site. These facilities are outside the ISFSI controlled access area and are intended to be made available for commercial activities upon their release for unrestricted use. Leases issued to commercial users of these facilities will limit activities to ensure that postulated events and accident analyses remain bounding. Access to these facilities will not afford access to the ISFSI.

2.1.2.2 Boundaries for Establishing Effluent Release Limits

The only potential effluent release points are the Concrete Casks themselves located at the ISFSI. The analyses presented in the HI-STORM FSAR (Reference 14) demonstrate that the MPC remains intact during all postulated off-normal and accident conditions. In summary, there is no mechanistic failure that results in a breach of the confinement boundary. However, the dose resulting from an effluent release due to a non-mechanistic ground-level breach of the confinement boundary during normal operation and anticipated occurrences (i.e., direct radiation) has been estimated at the Controlled Area boundary and is within the limits specified in 10 CFR 72.104 and OAR 345-026-0390.

The Restricted Area, as defined in 10 CFR 20, has the same boundaries as the controlled access area that surrounds the ISFSI Protected Area. Physical access to the Restricted Area is restricted by the controlled access area fence. Access into the Protected Area is controlled as described in



the ISFSI Security Plan. Radiation protection procedures specify when dosimetry is required in the Restricted Area.

The minimum distance from any effluent release point (Concrete Casks) to the Restricted Area boundary is approximately 50 feet. If members of the public have access to the Controlled Area immediately outside the Restricted Area, then the dose to a member of the general public in this area will be shown to comply with the limits of 10 CFR 20.1301.

Recreational uses within the PGE property boundaries include hiking, picnicking, swimming, fishing, and nature observation. In the event of an emergency that could result in a hazard to the general public, members of the general public making recreational or other casual use of the nonrestricted portions of the PGE property or making commercial use of the buildings on the PGE property can be evacuated.

2.1.3 POPULATION DISTRIBUTION AND TRENDS

The 1990 population distribution within 10 miles of the site, shown in Figure 2.1-4, was derived using 1990 census values (Reference 3). Specific place populations were located within the appropriate sectors. Rural population groups were distributed on the basis of the density of roads within each sector.

The population projections for 2000 and 2010, shown in Figures 2.1-5 and 2.1-6, were made using county growth projections based upon three census data points: 1970, 1980, and 1990 (Reference 3). Individual growth projections were developed for Cowlitz and Columbia Counties. Based upon these historical factors, population growth within 10 miles of the site is about 5 percent per decade.

In addition to the resident population, a limited influx of people into the area of the site occurs when river conditions are conducive to fishing and recreation. This influx is primarily on the Columbia and Kalama Rivers and consists of pleasure boaters, boat fishermen and bank fishermen (Reference 5). The Oregon Department of Fish and Wildlife performed aerial surveys of the river from February to October 1995 and estimated that there were 15,335 angler trips on the river from Longview to Prescott (about 6 miles) and 17,236 angler trips on the river from Prescott to Martin Slough (about 9 miles). During the busiest month, September, there were 4,556 angler trips on the river from Longview to Prescott and 6,279 angler trips on the river from Prescott to Martin Slough. Using these estimates, there would be about 80 anglers per day within 5 miles of the ISFSI from February to October. During September, the month of highest utilization, there would be about 241 anglers per day within 5 miles of the site. Because there are no state or federal parks or campgrounds within 10 miles of the site, any increase in the number of people in the area during the summer months is relatively small.

Public facilities and institutions near the site are listed on Table 2.1-1.



2.1.4 USES OF ADJACENT LANDS AND WATERS

The ISFSI site lies in a heavily timbered area, characterized by rough terrain and suited primarily to logging and other forestry operations. One major population center lies within a 50 mile radius, as do several smaller cities; most heavy industry in the smaller cities is related to forest product processing or agriculture (Reference 6). Well over half of the land is suitable for commercial forestry or grazing, with about 20 percent suitable for farming. Less than 10 percent of the land area is unsuitable for any agricultural pursuit, and a fraction of 1 percent is devoted to urban or incorporated areas.

Lands adjacent to the site lie within Columbia County, Oregon, in which the site is located, and Cowlitz County, Washington, across the Columbia River. The area within a radius of 10 miles of the site lies within these two counties. Both have agriculturally based economies, with land use in the vicinity of the site primarily agricultural. Logs, hay and other feed are the predominant crops. Salient agricultural data for these two counties is indicative of small, generalized family farming, with heavy emphasis on grazing and farm animals. Only 41 of 934, less than 5 percent, of the farms in the counties are larger than 100 acres, while more than one-third have fewer than 20 acres. There are no major milk-producing centers on lands adjacent to the ISFSI site, the major milksheds being 50 or more miles distant (Reference 7).

A land use census completed in 1994 indicated that there were milk cows within five miles of the ISFSI (Reference 8). There were several milk producing goats located within five miles of the site during 1994. Milk from these goats was sampled as part of a Trojan radiological environmental surveillance plan associated with the Trojan Nuclear Plant. The 1994 land use census also surveyed the locations of beef cattle and other meat producing animals as well as vegetable gardens within 5 miles of the ISFSI site. The results of the 1994 land use census are shown in Table 2.1-2.

Other than agriculture, the industrial base of the area around the ISFSI site is centered in forest products and primary metals, and most of the industrial activity is on the other side of the Columbia River. Of the eleven Longview-Kelso industrial facilities listed in Table 2.2-1, four are forest products processors producing lumber, plywood, pulp, paper and paper products, and related wood and wood pulp products. The other large manufacturing firm is an aluminum smelter with an annual capacity of 220,000 metric tons. A small steel furnace smelter and pleasure boat manufacturer are the only other major manufacturers in this area. Near Kalama, upstream of the site, are grain elevators, chemical plants, a steel mill, and a few small mills.

There is relatively little recreational land use within the immediate area of the site. There are no State or Federal parks nearby, nor are there any natural or man-made attractions such as mountains or reservoirs (References 9 and 10).

The 26-acre reflecting lake and 28-acre recreational lake located on PGE property are accessible to the general public from the property entrance road. Fishing activity peaks in the spring (about



30 fisherman per day) when the state of Oregon stocks the recreational lake, and then the fishing activity tapers off to a couple of fisherman per day.

A 3-mile portion of U.S. Highway 30 has been designated as a scenic area by the Oregon State Scenic Area Board (Reference 11). Pleasure boat launchings are located in Rainier, Goble, and Prescott, (Reference 12). Recreational vehicle overnight parking is available in Goble, and Prescott Beach is used for camping and fishing. River access is also available on the Washington shore, directly opposite the site.

The lower Columbia River is well suited to recreational fishing and boating, most of which occurs in the 7 months from March to September. As described in Section 2.1.3, the Oregon Department of Fish and Wildlife performed aerial surveys of the river from February to October 1995. From their estimates, there will be about 8 anglers per day per river mile near the ISFSI from February to October. The heaviest concentration of anglers on the river near the ISFSI will be about 24 anglers per day per river mile in September.

Commercial fishing in the Columbia is regulated by both Oregon and Washington. About 270 miles of the Columbia River and tributaries are open to commercial fishing, with Bonneville Dam being the approximate midpoint. The fishery upriver of Bonneville is reserved for Indians only, while downstream is open to commercial fishing license holders as well.

The Columbia River is a major navigable channel. Approximately 2300 seagoing cargo vessels pass the site annually, carrying wheat and logs outbound and manufactured iron goods, ores and petroleum inbound (Reference 1). Major port facilities are at Portland, Oregon and Longview, Washington.



2.2 NEARBY INDUSTRIAL, TRANSPORTATION AND MILITARY FACILITIES

Potential accidents as a result of external activities in the vicinity of the ISFSI site have been studied to determine their effect on the safety of the ISFSI. This section outlines the activities of the nearby industrial facilities, transportation arterials, and military installations and their potential effects on ISFSI safety. The risk to the operation of the ISFSI resulting from these activities is shown to be minimal.

2.2.1 LOCATIONS AND ROUTES

Most of the local commerce is related to forest products and is centered in Longview, Washington; Rainier, Oregon; and Kalama, Washington.

Due to the emphasis on forest products, industrial development in the area is heavily oriented to river transportation. An aluminum plant, small smelter, and boat manufacturer in Longview, a steel mill, chemical plants, and grain elevators in Kalama, and a fertilizer plant in Columbia City are the only large industries not related to the timber or paper industry. There are also several small quarry sites and gravel pits in the area, the closest being in Goble.

Transportation routes consist of two major highways, two railroads, the Columbia River and an airport and airways. U.S. Highway 30 runs north-south adjacent to the PGE property boundary approximately 1/2 mile from the ISFSI, and is a light-duty, two-lane highway connecting Portland on the south to Astoria, at the mouth of the Columbia River. Interstate 5 (I-5) is part of the West Coast north-south interstate system extending from Mexico to Canada. I-5 in this area is across the Columbia River in Washington approximately 1-3/10 miles east of the ISFSI at its nearest point. The Portland & Western Railroad, Inc. right-of-way passes through the PGE property, approximately 700 feet from the ISFSI. The main line railroad track between Portland and Seattle is located across the Columbia River in Washington, approximately 1-1/10 miles from the ISFSI.

The Columbia River serves as the deep-sea access channel to the important ports of Portland, Oregon and Vancouver, Washington. A 40-foot channel is maintained for deep-draft ocean vessels as far upriver as Portland. The center line of the 600-foot wide ship channel is approximately 3/10 mile from the ISFSI. Upstream from Portland and Vancouver, a 17-foot channel is maintained for barge traffic, extending to Pasco, Washington and a distance into the Snake River (Reference 3). Locks are provided at each of the dams on the river coincident with the 17-foot channel (Reference 4).

About 2300 oceangoing ships a year pass by the ISFSI site on the Columbia River. The major portion of the cargo exported is wheat and logs. Inbound cargo consists of miscellaneous goods such as petroleum, iron and steel products, automobiles, and ores (Reference 1). Portland is one of the largest ports in terms of tonnage on the Pacific Coast and thus it maintains a large number of supporting facilities.



Longview, Washington, downstream of the site also has facilities for oceangoing ships. The Port of Longview maintains facilities for unloading and storage of ship cargo. Significant facilities are a bulk loader with storage for 14,000 metric tons of talc; storage tanks with capacity for 40,000 tons of calcinated coke; a grain elevator, currently not in use, with a capacity of 7.8 million bushels; and log storage yards. Among the commodities routinely stored at the port are pencil pitch (or coaltar pitch), ammonia sulfate, and potash. Additionally, at the port Wilson Oil (doing business as Wilcox & Flegel) operates a petroleum bulk plant which has 14 storage tanks with a total capacity of 26,190 barrels of storage (Reference 2).

The Kelso-Longview Airport is 5.3-miles north of the site and has a 4,391-foot paved runway oriented northwest-southeast. The airport is not a scheduled airline stop, but is the base for approximately 60 single and twin-engine, private and corporate aircraft. The airport handles about 100 takeoffs and landings per day. The largest planes using the field are a DeHavilland 8 corporate plane, a Siddely Hawker, a Cessna Citation, and a Falcon Jet (Reference 5). The Portland International Airport is located 33 statute miles south of the site, and is the only major airport within a 60-mile radius of the site. Portland inbound and outbound air traffic is controlled for a distance of 30 miles from the airport by Portland Air Traffic Control. Area-wide in-flight traffic control is regulated by Seattle Air Traffic Control (Reference 6).

There are no major military bases in the vicinity of the ISFSI site. The nearest military facilities are Reserve Headquarters for the various branches in Portland and Vancouver (30-40 miles south of the site), and Coast Guard and Naval facilities in Portland, Longview and at the mouth of the Columbia River (Reference 7).

A natural gas main extending to Wauna, Oregon, downriver of the site, runs along the hillside west of the site, approximately 1-1/2 miles from the site. The main is a 16 inch, 3-million foot³/hour line, buried a minimum of 3 feet (Reference 8). In addition, there is an odorizer station on the line at Goble, a river crossing at Deer Island, 4-1/2 miles south of the site, and a river crossing at Rainier.

U.S. Highway 30 provides highway access to the ISFSI site and serves as the traffic arterial between Portland and the communities on the Oregon bank of the Columbia River, carrying an average of 5300 vehicles per day (Reference 9). The highway runs through the communities of Scappoose, Warren, St. Helens, Columbia City, Deer Island and Goble, south of the site; and Rainier, Clatskanie, Westport and Astoria north and west of the site. A bridge at Rainier connects U.S. Highway 30 with Longview, Washington, and a bridge at Astoria, the western terminus of the highway, connects to Megler, Washington.

U.S. Highway 26 provides a shorter Portland-to-Astoria route; thus it carries the bulk of traffic between the two, leaving U.S. Highway 30 to carry local passenger traffic, log trucks, tourists, farm vehicles and truck deliveries to the river communities. There is some shipment of



petroleum products via U.S. Highway 30. Gasoline, diesel and heating oils in tank trucks are regularly delivered to towns beyond the site from suppliers in Portland and St. Helens.

Interstate 5 is the primary north-south traffic route between Portland and the Puget Sound area (Seattle, Tacoma, Olympia) carrying an average of approximately 46,000 vehicles per day. Of this total, approximately 20 percent is made up of truck combinations and the remaining 80 percent is passenger traffic (Reference 10). It is estimated that about one-tenth of the truck traffic could be carrying flammable or hazardous material, of which petroleum products would make up the majority.

An average of two freight trains per day pass through the PGE property on the Portland & Western Railroad, Inc. right-of-way, carrying general commodities, with an annual gross tonnage of 6 million tons (Reference 11). Lumber and forest products make up the bulk of the shipping most of the year. During the peak fishing season, some canned and frozen seafood is carried by rail from the Astoria canneries. An average of about 200 shipments per year with 2-3 cars per shipment of chlorine and caustics are shipped to the Georgia-Pacific Corporation in Wauna, Oregon, on the lower river via the Portland & Western line. Other chemicals shipped include preservatives, fertilizer, resins and paints and a small amount of petroleum and propane.

Three railroads use the tracks on the Washington side of the river: Burlington Northern, AMTRAK, and Union Pacific railroads. Thirty-five to forty freight trains and six passenger trains pass the ISFSI site per day on these tracks (Reference 12). The freight carried varies widely with large quantities of wood products, aluminum, paper products, grains, agricultural products and foodstuffs making up the bulk. Chemicals shipped include large quantities of fertilizers, phenols, caustics, propane and various resins, acids, paints and lumber treatments.

Sharply rising ground to the west and similar high ground across the river to the east provide natural barriers for the site. The ISFSI itself is afforded additional protection on the north and east by earthen berms approximately 50 feet high and on the south and west by the buildings ranging from approximately 30 to 100 feet high.

The highest manmade structure at the site is the cooling tower, rising 492 feet above ground level. The cooling tower is marked with lights in accordance with Federal Aviation Administration regulations.

2.2.2 DESCRIPTION OF PRODUCTS AND MATERIALS

Products and byproducts of the timber industry in the area range from unfinished timber to finished construction lumber, cabinetry, plywood and veneer. Some hardwood products are made in Longview on a small-scale operation, while paper and wood fiber products make up a large percentage of the production of the area. Some chemical use and storage is associated with these industries. Chemicals include resins used in plywood, veneer and chipboard production, acids used in paper and pulp production, and lumber pressure treatments and finish coatings



(stains and varnishes). Chemicals are stored either in tank cars on sidings, or in storage tanks connected to the industry involved (Reference 13).

The aluminum plant in Longview is an aluminum reduction facility operated by Longview Aluminum which produces raw metal in the form of ingots, billet bars, etc. The use of chemicals at this plant corresponds to that of any aluminum plant; namely coke, pitch, chlorine and liquefied nitrogen. Chemical storage facilities at the plant consist of stockpiles, tanks and rail tankers and transportation is by rail tank cars (Reference 13).

Kalama Chemical, Inc., produces phenols with some secondary production of benzoates. The facility receives its raw material, toluene from tankers and stores it in an 80,000-barrel tank. The finished product is shipped by rail tank car (Reference 13).

Hoechst Celanese Corporation, Inc., is located approximately 3-miles southeast of the ISFSI in Kalama, Washington and produces a bleaching agent used in the pulp and paper industry. The facility receives sulfur dioxide by rail tank car and has a storage capacity for this chemical of 300,000 pounds.

All Pure Chemical Company is located approximately 2-miles southeast of the ISFSI in Kalama, Washington. The company produces a number of products including sodium hypochlorite, household ammonia, and water treatment chemicals. It is involved in the repackaging and distribution of chlorine gas. The chlorine gas is received in 90-ton rail tank cars and is repackaged into 1-ton cylinders. The 90-ton rail tank car is the maximum storage capacity for the chlorine gas at the facility.

A listing of nearby industrial facilities, supplementing the summarization above, is provided as Table 2.2-1. The geographic locations of the nearby industrial facilities are shown on Figures 2.2-1 and 2.2-2.

2.2.3 EVALUATION OF POTENTIAL ACCIDENTS

This section provides an evaluation of the capability of the ISFSI to safely withstand the effects of an accident at, or as a result of the presence of, industrial, transportation and military installations or operations within 5 miles of the site. Potential accidents considered include explosions of chemicals, flammable (including natural) gases or munitions; industrial and forest fires; accidental releases of toxic gases; and collapse of the cooling tower.

2.2.3.1 Explosions

Shipments of commercial cargo past the site create the possibility of nearby explosions. For the most part, the rugged construction of the Concrete Casks would protect the spent nuclear fuel from such explosions. In addition, the ISFSI would be shielded from the direct force of these



explosions by the earthen berms on the north and east and by the manmade structures and buildings to the south and west.

Explosions unrelated to transportation are not considered significant. The quarry operations south of the site are located in the hills west of the Columbia River. Presently, there is no storage of explosives at the operating quarry, which is 2 miles from the site. The quarry is not a large operation and only a limited amount of explosives are used. Because of the distance from the site and the protection afforded by the hillside and ridge between the quarry and the site, the quarry operation does not present a hazard to the safety of the ISFSI. The natural gas main runs along the hillside west of the site, approximately 1-1/2 miles from the site. The operation of this line will not present a hazard to the ISFSI from explosion because of the relatively low explosive capacity of the gas and the distance from the ISFSI.

Explosions related to transportation were extensively analyzed for siting of the Trojan Nuclear Plant (same location as the ISFSI). The explosion analysis, which addressed rail, ship, and highway transportation, was described in detail in the Trojan Final Safety Analysis Report (FSAR).

The FSAR analysis used an overpressure limit of 2.2 psi. This overpressure is the maximum overpressure that can be generated by the atmospheric shock from an explosion. As described in Section 8.2.8.2, the Concrete Cask is able to withstand tornado wind pressure up to 2.3 psi and wind pressure as high as 5.87 psi without sliding or overturning. The MPC is designed for a 60 psig external pressure (Reference 14, Table 2.2.1).

The FSAR analysis assumed transportation accident rates and numbers of shipments past the site based on estimates from transportation agencies and companies. These agencies and companies were contacted to confirm that the original estimates were still valid for the ISFSI.

The minimum weight of explosives that could cause a 2.2 psi overpressure was calculated by the FSAR analysis as 70,000 (pounds of TNT equivalent). This weight was originally confirmed for Trojan Nuclear Plant operation to exceed any known or planned shipments and has been reconfirmed for ISFSI operation.

In addition, the FSAR analysis calculated that the probabilities of a rail or barge shipment explosion that would cause a 2.2 psi overpressure are less than 10^{-6} per year each. These probabilities would be similar for the ISFSI because the transportation estimates have not changed appreciably.

Therefore, transportation related explosions would not affect the safe storage of spent nuclear fuel.



2.2.3.2 Toxic Chemicals

The effects of toxic chemicals on human habitability were extensively analyzed for operation of the Trojan Nuclear Plant and addressed in detail in the FSAR. These analyses were predicated on maintaining control room habitability during a toxic gas event. Continuous manning of the ISFSI for operational reasons is not required as in the case for an operating nuclear plant. There are no off-normal events or credible accidents for the ISFSI that require operator action within a prescribed amount of time.

Therefore, a toxic gas event would not affect the safe storage of spent nuclear fuel.

2.2.3.3 Fires

The ISFSI does not require automatic suppression and detection systems because the site specific fire hazards will not exceed the design temperature limits of the Concrete Casks. The fire main, which was installed for 10 CFR 50 fire protection requirements, may be operable for general property insurance requirements of the surrounding buildings, but the fire main is not required or credited for ISFSI fire protection.

Industries and oil storage facilities in the vicinity of the ISFSI are separated from the ISFSI, either by considerable distance or by the Columbia River. Therefore, fires at these facilities would not pose a hazard to the ISFSI.

Fires resulting from transportation accidents on I-5, the railway near I-5, or the Columbia River would be separated from the ISFSI by considerable distance and the Columbia River. Fires from transportation accidents on Highway 30 would be separated from the ISFSI by the recreation lake and reflecting lake. Fires from transportation accidents on the Portland & Western railway would be sufficiently far from the ISFSI to not have an effect on the ISFSI. Therefore, fires from transportation related accidents do not pose a hazard to the ISFSI.

The ISFSI is protected from brush or forest fires on two sides by water, the Columbia River to the east and the recreation lake, reflecting lake and Whistling Swan area to the west. The ISFSI is also afforded localized fire protection by the open area immediately surrounding it.

A fire caused by a rupture of the natural gas main west of the ISFSI would be separated from the ISFSI by a considerable distance and by the intervening lake areas. There is the possibility in the future that a natural gas line will be placed in the vicinity of ISFSI to supply gas turbines used to produce electrical power. The potential hazards posed by placing a natural gas line and gas turbine in the vicinity of the ISFSI are addressed in Chapter 8.

In addition to the natural barriers, Columbia River Fire and Rescue provides fire protection services for the site.



A fire caused by a diesel fuel oil spill from a mobile crane or other diesel fuel oil tank at the ISFSI or in the immediate vicinity of the ISFSI would not affect the safe storage of spent nuclear fuel. This type of fire, which is the only credible fire because of the limited number of fire hazards located at the ISFSI itself, would burn for only a few (6-7) minutes. This short burn time would not be sufficient for much heat transfer to the Concrete Cask or MPC and the temperatures of the Concrete Cask and MPC would not be appreciably raised.

The consequences of a forklift fuel (propane) tank explosion and fire are bounded by the diesel fuel oil spill scenario.

Therefore, fires would not affect the safe storage of spent nuclear fuel.

2.2.3.4 Aircraft Impacts

An analysis was performed that followed the guidance of NUREG-0800, Section 3.5.1.6, Aircraft Hazards. The analysis demonstrated that the probability of aircraft impacting the ISFSI is less than 10^{-7} per year. Therefore, identification of a design basis aircraft and specific analysis of the impact of the design basis aircraft at the ISFSI is not required.

The aircraft hazard analysis considered the probability of aircraft accidents from airways (P_{FA}), civilian and military airports (P_A), designated airspaces (P_M), and holding patterns (P_H). P_M and P_H are equal to zero because the ISFSI is not located in a designated airspace or a holding pattern which left only P_{FA} and P_A to be calculated.

P_{FA} was calculated using the following equation:

$$P_{FA} = (C)(N)\left(\frac{A}{W}\right)$$

The in-flight crash rate, C, used to calculate P_{FA} was 4×10^{-10} per mile, which is the value stated in NUREG-0800 for commercial aircraft.

The number of flights per year, N, used to calculate P_{FA} were for three "V" airways:

1. V112, whose centerline is about 13 statute miles south of the ISFSI;
2. V165, whose centerline is about 8 statute miles west of the ISFSI; and
3. V23-287, whose centerline is about 11 statute miles east of the ISFSI.

The Port of Portland Noise Abatement Department provided the numbers of flights in each airway from December 15, 1994, to December 15, 1995, as follows:



<u>Airway</u>	<u>Jet</u>	<u>Non-Jet</u>	<u>Total</u>
V112	2095	7768	9863
V165	651	6620	7271
V23-287	934	16271	17205

The number of flights in each airway was conservatively doubled to account for random flyovers by jet aircraft that may not be using the "V" airways.

The effective area of the ISFSI, A , used to calculate P_{FA} was 3.12×10^{-4} mile² for non-jet aircraft and 3.09×10^{-3} mile² for jet aircraft. The smaller effective area for non-jet aircraft represents the physical dimensions of the ISFSI array (approximately 87 x 100 feet), whereas, the effective area for jet aircraft (287 x 300) adds a 100 foot buffer around the ISFSI array to account for the larger physical size of jet aircraft as well as the higher speed that would result in more violent impacts, explosions, etc. Conservatively, no shadow areas are assumed to reduce the effective area. No skid areas are assumed to increase the effective area because the ISFSI is protected from low angle aircraft approach by a combination of berms, hillsides, forest cover, man-made structures, and a ridge.

The width of the airway, w , used to calculate P_{FA} was conservatively selected as 12 nautical miles (99% probability) rather than the normally recognized 8 nautical miles (95% probability).

P_A was calculated considering that the Kelso-Longview airport is the only airport within 10 miles of the ISFSI and NUREG-0800 only provides in-flight crash rates for airports up to 10 miles away. P_A was calculated using the following equation:

$$P_A = (C)(N)(A)$$

The in-flight crash rate, C , used to calculate P_A was 1.2×10^{-8} per mile, which is the value stated in NUREG-0800 for general aviation aircraft for sites located 4 - 5 miles from the end of the runway. No value was given in NUREG-0800 for sites 5 - 6 miles from the runway (distance from ISFSI to Kelso-Longview airport is 5.3 miles), but the 4 - 5 mile value should be conservative based on the data trend in NUREG-0800, which indicates that the further the aircraft is from the end of the runway, the less likely it is to crash.

The annual number of flights affecting the ISFSI, N , used to calculate P_A is one-half of the 35,000 annual airport flight operations, i.e., departing flights. Only departing flights are counted



because the Instrument Flight Rules approach to the Kelso-Longview airport is from the north, hence, the flight path of arriving flights would be from the north which would not be near the ISFSI (ISFSI is located directly south of the airport).

The effective area of the ISFSI, A , used to calculate P_A was 3.12×10^{-4} miles². This effective area is used because the Kelso-Longview runway is 4,391 feet in length, hence, only smaller aircraft use this airport and a direct aircraft impact would be required to cause damage to the ISFSI. The effective area was not reduced for shadow areas or increased for skid areas as described above for P_{FA} .

Using the above values, P_{FA} , P_A , and the total probability P_{total} were calculated as:

$$\begin{aligned} P_{total} &= P_{FA} + P_A \\ &= 7.69 \times 10^{-10} \text{ per year} + 6.55 \times 10^{-8} \text{ per year} \\ &= 6.63 \times 10^{-8} \text{ per year} < 10^{-7} \text{ per year} \end{aligned}$$

Therefore, the probability of aircraft impact is less than 10^{-7} per year and aircraft impacts are not analyzed as a design basis event.

2.2.3.5 Cooling Tower Collapse

The cooling tower is designed to withstand winds of up to 190 mph and earthquake loads of 0.15g. In the unlikely event of collapse, the hyperbolic design of the structure, coupled with its thin-shell configuration, provide an inherently safe failure characteristic. The structure would tend to collapse inwardly. In addition, the structure is located sufficiently far (over 800 feet) from the ISFSI to prevent damage.

2.2.3.6 Air Pollutants

Air pollutants are not anticipated at the ISFSI site.



2.3 METEOROLOGY

2.3.1 REGIONAL CLIMATOLOGY

2.3.1.1 General Climate

The marine climate of the region around the ISFSI site is typical of the Pacific coast which is characterized by wet winters and dry summers with mild temperatures year long (References 1 and 2).

This region receives substantial annual rainfall, but the rain showers are of light or moderate intensity and continuous rather than heavy for brief periods. Severe storms and thunderstorms are infrequent. On the average, this region receives 2 inches of snow per year.

Regional temperatures are for the most part, mild throughout the year. The average temperature for the summer season is 65°F and for the winter season 40°F. Surface winds seldom exceed gale force. There have been no major hail storms within a 60-mile radius of the site. Tornadoes rarely occur (References 1 and 2).

2.3.1.2 Severe Weather

The extreme temperatures for Portland, Oregon have been 107 °F on July 30, 1965, and August 8, 1981, and -3 °F on February 2, 1950. The maximum amount of precipitation recorded for a 24-hour period was 7.66 inches in Portland in December 1882. The greatest amount of snowfall ever measured for a 24-hour period was 16.0 inches during January 1937, in Portland. These extremes are based on National Weather Service records for 1880 through 1970 and National Oceanographic and Atmospheric Administration (NOAA) data for 1940 through 1994.

According to Huss (Reference 3), the extreme wind gust expected once in 100 years is 130 mph. However, National Weather Service data for 1928 through 1971 and NOAA data for 1940 through 1994, show that the fastest mile wind speed (1 minute average) at Portland was 88 mph on October 12, 1962. The highest windspeed (1 minute average) in Portland from the windstorm on December 12, 1995, was 52 mph, well below the fastest windspeed.

Tornadoes have occurred occasionally in the site region, usually associated with the passage of fronts from Pacific storms. From 1916 through 1972, 11 tornadoes were reported within a 60-mile radius of the site (References 4 and 5). Of these, only four occurred within 30 miles of the site. One occurred near Longview, Washington while the other three occurred in the Portland-Vancouver metropolitan area. Tornadoes that occur in the northwest region of the United States are usually smaller than tornadoes typical to the midwestern area.

The series of Mount St. Helens eruptions in 1980 resulted in tephra accumulations at the Trojan site of no more than 1/8 inch. If Mount St. Helens were to have another tephra eruption similar



to the May 18, 1980 eruption, only directed towards the ISFSI with winds blowing towards the ISFSI, then the expected ash fall accumulation would be about 1.8 inches.

The greatest air pollution potential in the site region exists during the fall and winter seasons when the tendency is greatest for a quasi stationary anticyclone to develop, associated with wind speeds less than or equal to 5 mph and a shallow mixing depth (References 6 - 9).

2.3.2 LOCAL METEOROLOGY

2.3.2.1 Normal and Extreme Values of Meteorological Parameters

Normals and extremes of available temperature, precipitation, relative humidity and fog for Portland, Oregon and Longview-Kelso, Washington can be found in the "Climatography of the United States No. 20-45, Decennial Census of the United States - Summary of Hourly Observations" (Reference 10).

Meteorological data at the site during the period September 1, 1971, through August 31, 1974, are reported in this section (References 11 - 13). These data compare favorably with National Weather Service data for Portland, Oregon.

The distribution of wind direction and speed is an important factor when considering transport conditions relevant to site diffusion climatology. The topographic features of the site region are a major factor in influencing the wind direction distribution at the ISFSI site. During the 1971-1974 period, the prevailing wind for the 30-foot level was from the south, and south-southeast for the 200-foot level, and the average wind speed at the 30-foot level onsite was 8.2 mph, and was 9.3 mph at Portland.

Wind persistence is extremely important when considering potential effects from a contaminant release. Wind persistence is defined as a continuous flow from a given direction or range of directions. There is only a 5-percent probability of continuous wind direction persistence periods greater than 11.5 hours (References 12 and 13).

Temperatures in the region are generally mild considering its high latitude. During the 1971-1974 period, the annual average temperature onsite was 50°F, the daily annual mean minimum onsite was 44°F, and the annual mean maximum onsite was 58°F.

During the 1971-1974 period, the mean relative humidity onsite was 78 percent, and the annual average precipitation onsite was 62.04 inches.

2.3.2.2 Potential Influence of the ISFSI on Local Meteorology

Operation of the ISFSI is not expected to affect the climate of the region. The natural draft cooling tower is anticipated to remain at the site, but will not be used for ISFSI operation. The



physical structure of the cooling tower is expected to locally increase atmospheric turbulence. There is also a potential for somewhat decreased low-level wind speeds in the vicinity of the tower. This effect diminishes rapidly with increasing distance downwind from the cooling tower and is relatively insignificant offsite.

2.3.2.3 Topographic Description

General topography in the vicinity of the ISFSI site is shown in Figure 2.1-2. Topographical cross sections out to 10 miles are provided in Figures 2.3-1 through 2.3-6.

The ISFSI site is located in the Columbia River Valley, which at this location is in a general north-south orientation. North of the site the Columbia River bends to the northwest, and south of the site the river bends to the southeast. Within the immediate vicinity of the site, there is a bluff one-half mile to the west rising sharply to 400-500 feet with a highest peak of 1187 feet MSL. North of the ISFSI, there is a wooded hill which rises to 100 feet. The remaining area in the immediate vicinity of the site is flat and low. The Columbia River Valley is approximately 2 miles wide at the site and widens to 3 miles north of the site at Longview-Kelso. The valley walls at the site rise to an elevation of 1000 feet MSL within approximately 1.8 miles to the west and not quite so high to the east.

The effect of the topographic features on airflow trajectory regimes and dilution is quite significant at the site. Analyses of annual wind roses reveal that the predominant wind flow is in a north-south direction. Winds within the Columbia River Valley will be effectively channeled and therefore will follow the changing orientations of this Valley. Computations of average χ/Q values based on the straight line model for a ground-level release indicate that the greatest potential concentrations would be north and south of the site, corresponding to the predominant wind directions. In addition, a nonbuoyant plume will generally not rise out of the valley for a ground-level release during stable temperature lapse rate conditions. Estimates of dispersion during stable conditions, based on the Gaussian diffusion model, indicate that a plume oriented in a general north-south direction would most likely not intersect with the valley walls. Therefore, the valley walls have only a limited effect as a potential barrier to prevent dispersion of the plume since the width of the valley increases both to the north and south of the site and the plume width is relatively narrow during stable conditions. Turbulence created by the mountainous terrain would increase the dilution of airborne effluents.

2.3.3 ONSITE METEOROLOGICAL MEASUREMENTS PROGRAM

The onsite meteorological program at the site began in October 1969 with wind and temperature instrumentation at four elevations: one 500-foot tower plus a 30-foot satellite tower on the bank of the Columbia River. To more accurately define low wind speed conditions, a Climet system was installed on a 33-foot tower located along the site access road. In addition, one 11-inch rain gauge was installed west of the Turbine Building.



Meteorological data were collected during nuclear plant operation and for a time during defueled operation, but data will not be collected during ISFSI operation. The source terms for ISFSI operation are much lower than the source terms for nuclear plant operation. Accidents and off-normal events do not result in releases that would exceed 10 CFR 72.106 limits and OAR 345-026-0390. As a result, meteorological monitoring for the calculation of off-site doses from normal operation and accident conditions is not necessary. These doses can be effectively calculated by using conservative values for atmospheric dispersion (γ/Q) from the onsite historical data.

As stated above, meteorological data for the site during the period September 1, 1971 through August 31, 1974 compared favorably with National Weather Service data for Portland, Oregon. Hence, if real time meteorological data is desired, then data from the National Weather Service for Portland could be used.

2.3.4 DIFFUSION ESTIMATES

Diffusion estimates were made for 3-30 day average conditions only. Worst case postulated long-term (routine) releases associated with operation of the ISFSI were modeled using a 50% probability diffusion value. The long-term diffusion estimate is $3.75E-05 \text{ sec/m}^3$ at 200 meters. Determination of the long-term diffusion value at 200 meters is conservative since the Trojan ISFSI Controlled Area Boundary is at 300 meters.

A hypothetical accident was also postulated to determine the concentrations and doses that could occur following the release. The 30 day accident diffusion estimate is obtained from the Trojan Nuclear Plant Safety Analysis Report. The hypothetical accident γ/Q at 200 meters is $3.25E-04 \text{ sec/m}^3$, which as stated above is conservative since the Trojan ISFSI Controlled Area Boundary is at 300 meters.



2.4 HYDROLOGIC ENGINEERING

The site location and design of the Concrete Casks assures that the systems and structures that are important to safety withstand the additional forces that might be imposed by the hydrology of the area without loss of the capability to protect the public.

Hydrologically-related design bases, performance requirements, and the design for important to safety structures, systems and components reflect thorough consideration of the following phenomena:

1. Runoff-type floods up to and including the probable maximum flood (PMF).
2. Surges and wave actions.
3. Tsunamis.
4. Artificial floods due to dam failures or landslides.
5. Ice jam flooding.
6. Dilution and dispersion characteristics of normal and accidental release to the hydrosphere relating to existing and potential future users of surface and groundwater resources.

The following sections discuss the hydrological characteristics of the ISFSI site and their influence on ISFSI design and operation.

2.4.1 HYDROLOGIC DESCRIPTION

2.4.1.1 Site and Facilities

The ISFSI site is on a rock outcropping located on the Oregon bank of the Columbia River at River Mile 72.5 in the northwest section of the 634-acre tract of PGE property. The concrete reinforced Storage Pad is about 160 feet from the Oregon bank (mean low water) with an intervening hill. Equipment important to safety is located at or above ground elevation 45 feet MSL, which is above postulated flood levels. There is no potential for flood induced erosion because the ISFSI reinforced concrete Storage Pad is founded on impervious rock.

The Columbia River is about 1/2 mile wide adjacent to the ISFSI. In the vicinity of the ISFSI there are holes in the river deeper than -120 feet MSL. Directly across from the ISFSI the deepest profile is about -70 feet MSL. Topography nearby and on the site area is shown on Figures 2.1-2 and 2.4-1.



The ISFSI site has excellent drainage. The east side of the rocky ridge drains directly into the Columbia River, while runoff on the west side flows into the old river channel and thence by Carr Slough northward until it joins the Columbia River. Neer Creek, a small stream, flows off the steep hillside west of the site and old river channel. Its flow varies from over 30 cfs at times during the winter to essentially zero during dry summer periods. Neer Creek provides flow through the recreational lake with the outflow passing into Carr Slough as it did prior to construction of the Trojan Nuclear Plant.

The northern, unpaved area of the PGE property drains to the perimeter drainage ditch, which is approximately 3 feet lower than the ground elevation of the PGE property. This ditch drains to the reflecting lake, and the south drainage ditch empties into the recreational lake. The roads around the PGE property are sloped so that they drain either to the drainage ditch or toward the river except for those portions of roads shown by cross-hatching in Figure 2.4-2, which drain to the indicated catch basins.

2.4.1.2 Hydrosphere

The Columbia River is the major hydrographic feature in the area. It represents one-third of the potential hydropower of the United States, and has an annual discharge of approximately 180,000,000 acre-ft (59 trillion gallons), and drains an area of 260,000 square miles (Reference 1). The Columbia River has an average flow rate of 230,000 cfs at the site with a corresponding average current velocity of 1.8 fps.

A most important factor in considering flows in the Columbia River is the large amount of storage available for flood control and power use. With the dams constructed in the United States and Canada by 1973, more than 30 million acre-ft of storage (Reference 2) is usable in controlling floods on the lower Columbia River.

Tidal effects on the Columbia River can be seen as far upstream as Bonneville Dam, at River Mile 140. The tides at Astoria are typical of the Pacific Northwest tidal pattern. The tides are of a semidiurnal nature with an average period of approximately 12.4 hours.

The effect of tides at the site is dependent to a large part on the flow of the river at the time. Flow reversal occurs at the site on about one-quarter of the tides during a normal year. The extreme tidal range at the site is less than 5 feet, and a maximum upstream flow of 129,000 cfs with an average current velocity of 1.3 fps. The Columbia River has five significant tributaries near the site. None is large enough to have serious effect upon the hydrology at the site.



2.4.1.2.1 Surface Water Use

To determine the extent to which surface water is used within 5 miles and 20 miles of the ISFSI, a survey was made of registered surface water rights. The survey used a 12-mile by 12-mile area and a 36-mile by 36-mile area surrounding the ISFSI in lieu of a 5-mile and 20-mile circle because the Township/Range coordinate system used to identify the location of water rights in the states of Washington and Oregon uses 6-mile by 6-mile boxes. The survey showed that 824 rights are registered within the 36-mile by 36-mile area with an allowed use of 12,480 cfs. Of these rights, 117 are located within the 12-mile by 12-mile area with an allowed use of 401 cfs. The users of surface water will not be adversely affected by the ISFSI because there are no routine effluent releases associated with normal operation and no credible off normal events or accidents that result in liquid effluents.

2.4.2 FLOODS

2.4.2.1 Flood History

Columbia River floods are generally divided into two categories:

1. Spring floods caused by the melting snowpack usually in the upper reaches of the Columbia Basin east of the Cascades.
2. Winter floods caused by intense rain occasionally augmented by melting snowpack in the Willamette and other basins west of the Cascades.

The maximum natural or unregulated flood on record of the Columbia River is that of 1894, which resulted from a combination of hydro-meteorologic conditions including heavy snowpacks and rapid melt plus rainfall. The peak discharge for the Columbia River was 1,240,000 cfs as measured at The Dalles, Oregon. The large floods which have occurred were spring floods resulting from the melt of a large snowpack combined with the spring rain.

On February 8 and 9, 1996, the Columbia River had an estimated flood flow of 850,000 to 900,000 cfs near the Trojan site. This flow resulted in a peak water surface level at the Trojan site of about 22.5 feet. The flood was caused by warm rainstorms from the mid-Pacific falling on snow in the lower Columbia River basin.

2.4.2.2 Flood Design Considerations

The ISFSI Storage Pad surface elevation of approximately 46 feet MSL is sufficient to be considered safe from projected floods. Equipment important to the safety is situated at or above this level. There is no potential for flood induced erosion because the ISFSI reinforced concrete Storage Pad is founded on impervious rock.



Water surface elevations were determined for several cases including: the standard project flood (1000-year); the 10,000-year flood; the probable maximum flood; potential dam failures; probable maximum surge flooding; and tsunamis.

In addition, studies were made superimposing more than one case and adding surges from wind activity, wave action and tidal effects. Thus, use of highly conservative methods provide a large degree of assurance that the safety of the ISFSI is guaranteed from any potential flooding. The most critical flood level for the site is the combination of an unlikely failure of Grand Coulee Dam and the resultant surge combined with a 25-year flood.

2.4.2.3 Effects of Local Intense Precipitation

The following historical data shows the probable maximum precipitation (PMP) based on the U. S. Weather Bureau Hydro meteorological Report No. 43:

<u>Hour</u>	<u>Cumulative Precipitation (in.)</u>	<u>Hour</u>	<u>Cumulative Precipitation (in.)</u>
½	0.45	6	3.37
1	0.83	12	5.62
1-½	1.19	18	7.28
2	1.52	24	8.63
2-½	1.82	36	10.69
3	2.09	48	12.25
4	2.60	60	13.46
5	3.02	72	14.44

The PMP does not create substantial loads because the tops of the Concrete Casks will not collect standing water. Even if a few inches of water accumulated, the loads from this water would be bounded by the analysis for the worst case snow load.

The site drainage, as described in Section 2.4.1.1, is adequate for the duration and amounts of rainfall listed above.

2.4.3 PROBABLE MAXIMUM FLOOD (PMF) OF STREAMS AND RIVERS

The standard project flood (SPF) and the PMF for the Columbia River were established by the U.S. Army Corps of Engineers. The Corps of Engineers issued their findings in a report dated September 1969 (Reference 1). Because the Columbia River is the major river in the area and is adjacent to the site, the PMF for the Columbia River is the controlling event in studies of natural river and stream flooding for the site.



The 1000-year flood (SPF) with an 850,000 cfs discharge will result in a maximum water surface elevation in the Columbia River at the ISFSI site of 21 feet MSL (Reference 2). The unregulated flow for the 1000-year flood is 1,550,000 cfs at The Dalles or 1.25 times the maximum historical flood of 1894.

The 10,000-year flood with a discharge of 1,050,000 cfs will cause a river water elevation of 24 feet MSL at the site. The PMF, as computed by the North Pacific Division of the Corps of Engineers, will have a discharge of 2,200,000 cfs associated with a water elevation of 36 feet MSL at the site and it can be safely passed by existing dams, and those under construction on the main stem of the Columbia River and its major tributaries, except Bonneville Dam. The effect of a failure of Bonneville Dam, which is the nearest upstream dam, would be, according to the Corps of Engineers, negligible in terms of additional flooding.

The PMF was considered to be caused primarily by snowmelt over an extended period of 2 or 3 months with significant runoff contributions from storm rainfall during the snowmelt period. The combination of conditions for the PMF derivation was the most severe considered "reasonably possible" in the Columbia River Basin.

The wave run up during the PMF, based on an overland wind speed of 40 mph, would be approximately 3.2 feet. For the maximum discharge of 2,200,000 cfs, the highest water surface level at the site, as a result of wave run up, would be 39.2 feet MSL, which is 5.8 feet below site grade.

Further detailed discussions of the model used to determine the flood levels are contained in the Trojan Nuclear Plant FSAR. The Corps of Engineer report of 1969 has not been revised, indicating that the description in the FSAR is applicable for the ISFSI.

2.4.4 POTENTIAL DAM FAILURES

Studies have been made of potential dam failures that could affect the ISFSI site by the Corps of Engineers (References 3 and 4) and by Portland General Electric Company (PGE). Two types of failures were considered: a seismically induced failure, and a volcanically induced failure. The potential for the most severe flood caused by an earthquake concerns the Columbia River, while the worst possible volcanically induced dam failure concerns the Lewis River in Washington.

2.4.4.1 Seismically Induced Dam Failure

The maximum artificial flood that can occur at the ISFSI site is a catastrophic, massive and sudden failure of Grand Coulee Dam at Columbia River Mile 597. The seismically induced failure of the Grand Coulee Dam, an event of almost inconceivable proportions, has been correlated to Corps of Engineers reports to provide a limiting case conservative assumption. Based on these reports, the resulting flood, depending on the exact conditions of the breach, natural flow conditions, and routing, would cause a discharge ranging from 3,600,000 to



4,400,000 cfs at the site. Steady state discharge versus height curves for the river at Trojan predict maximum river elevations ranging from 39 to 46 feet MSL. It would reach the site approximately 2 days after the failure of the Grand Coulee Dam.

Because the artificial flood peak travels as a surge of much shorter duration than a natural flood, additional calculations were performed assuming an unsteady flow. The results of these calculations show that the water surface elevation for the maximum artificial flood (4,400,000 cfs) would be approximately 41 feet MSL and for the smaller flood (3,600,000 cfs) would be approximately 40 feet MSL. Wave run up based on an overland wind speed of 20 mph would be 1.75 feet, resulting in a peak water level at the site of 42.75, which is 2.25 feet below grade level. Further details and assumption of this analysis are contained in the Trojan Nuclear Plant FSAR.

2.4.4.2 Volcanically Induced Dam Failure

The Lewis River enters the Columbia River approximately 14 miles upstream of the ISFSI site. An artificial flood caused by the eruption of Mt. St. Helens and the domino-type failure of Swift, Merwin, and Yale dams on the Lewis River would result in a maximum discharge of 3,300,000 cfs at the site. Considering dam failure permutations and routing of the artificial flood, the peak water at the site corresponding to the peak flow (3,300,000 cfs) will be from 39 to 41 feet MSL. Wave run up based on an overland windspeed of 20 mph would be 1.75 feet, resulting in a peak water level at the site of 42.75 feet, which is 2.25 feet below site grade. Further details and assumptions of this analysis are contained in the Trojan Nuclear Plant FSAR.

Subsequent to the May 18, 1980 eruption of Mt. St. Helens, the Northwest Forecast Center of the National Weather Service performed a failure analysis of the Swift Dam using their dam break and wave models. Their results indicate that the generated flood wave would reach Woodland, Washington, in about 1 hour and inundate the areas to a height of 35 feet MSL. This wave would be expected to reach Rainier, Oregon, in approximately 3 hours with a peak elevation of less than 30 feet MSL. This is well below the site elevation of the ISFSI (Reference 5).

2.4.4.3 Spirit Lake Blockage Failure

Spirit Lake is located on the North Fork of the Toutle River within a few miles of Mount St. Helens. When Mount St. Helens erupted on May 18, 1980, mud and debris caused a blockage at Spirit Lake and raised the lake's surface elevation. The North Fork of the Toutle River flows into the Cowlitz River, which in turn flows into the Columbia River about 4 1/2 miles downstream of the Trojan site. Therefore, if the blockage were to suddenly fail, the released water and sediment presented a potential flooding hazard to the Trojan site.

The blockage at Spirit Lake is not a potential flooding hazard to the ISFSI site. Spirit Lake has been drained to a level where the blockage no longer confines lake water, thus eliminating the potential for flooding should the blockage be seismically dislodged.



2.4.5 PROBABLE MAXIMUM SURGE FLOODING

The ISFSI is located a considerable distance from the outlet of the Columbia River to the Pacific Ocean and is well protected by the terrain. Furthermore, although storms with winds of up to about 70 mph occur off the coast, hurricane-force winds are rare in the Pacific Northwest (Reference 6). Storm wave heights, as reported by the Columbia River Lightship off the mouth of the Columbia River, rarely exceed 30 feet. The Columbia River estuary acts as a dampener to wave action, such that ocean-bred wind waves are indistinguishable from normal river wind-wave action a few miles upstream from the mouth. Surge flooding of the site (ocean-bred), therefore, is considered unlikely.

2.4.6 PROBABLE MAXIMUM TSUNAMI FLOODING

Historically, the evidence demonstrates that the mouth of the Columbia River is relatively insensitive to tsunamis when compared to Crescent City, California, 310 miles south of the Columbia River entrance.

The tsunami effects at the mouth of the Columbia River are further dissipated inside the river due to the characteristics of the estuary, as was demonstrated during the tsunami generated by the Alaskan earthquake of March 28, 1964.

The grade elevation of the ISFSI site is 45 feet MSL. Because of the large margin between the ISFSI grade elevation and the river surface and because of the insensitivity of the river to tsunami effects, tsunamis are not considered in the design criteria for the ISFSI.

2.4.7 ICE EFFECTS

The general climate in the lower Columbia River Basin is not conducive to ice formation. In addition, the flow of the river during periods of freezing temperatures is sufficiently large (200,000 to 400,000 cfs) that ice formation is impossible in the main streamflow. During extended periods of freezing temperatures, some icing is experienced along the banks of sloughs and inlets where the water is slow moving or stagnant. The lowest recorded river temperature at the site was 34.1°F on February 6, 1971 (period of record 1967 to 1972) (Reference 7). Any surface ice formation would not affect the ISFSI because the ISFSI does not require water for operation.

2.4.8 FLOODING PROTECTION REQUIREMENTS

Facilities/equipment that are important to safety are located at or above elevation 45 feet MSL and none of the postulated floods exceeds that level. Therefore, there are no requirements for flood protection.



2.4.9 ENVIRONMENTAL ACCEPTANCE OF EFFLUENTS

The spent nuclear fuel at the ISFSI is maintained in dry Concrete Casks. There are no routine effluent releases and no credible off normal events or accidents that result in liquid effluents. Therefore, the ISFSI will have no effect on surface or ground waters.



2.5 SUBSURFACE HYDROLOGY

2.5.1 REGIONAL AND SITE CHARACTERISTICS

The ISFSI site is located on an extremely impervious rocky ridge that is bounded on one side and end by the Columbia River and on the other side and end by an old river channel that has been filled with alluvial sediments.

The old channel is bow-shaped, about 2,000 feet wide and 2 miles long. It is carved in the Eocene Goble Volcanics, which borders the old channel on the west side, and forms a rock knob on the east side that separates the old channel from the Columbia River. The ground elevation in the old channel is between 14 feet and 17 feet. The Goble Volcanics have poor aquifer characteristics.

The slough is filled with fine-grained alluvium of Quaternary age. Previous seismic surveys done in the area indicate the bedrock to be up to 340-foot depth. None of the borings drilled in the deep section of the slough penetrated the full thickness of the alluvium. One of the deep borings - DH-7 - terminated about 9 feet in a gravel bed at the 269-foot depth, which is overlain by 154 feet of fine sand, beneath a 114-foot-thick layer of organic silt with a trace of clay. A layer of volcanic ash occurs near 70-foot depth within the silt layer.

The entire alluvial section appears to be hydraulically connected to the river on both ends of the slough. Water levels in the two domestic water wells located near the south end of the alluvial channel respond to tidal fluctuations. A gravel bed below the fine sand is the aquifer for the two wells that supply the Trojan site. These wells are 8 inches in diameter and were drilled through the 158-foot-thick impermeable gray silt bed and 117 feet of fine sand into about 28 feet of gravel at the bottom of the alluvial channel. The gravel bed appears to be bimodal or strongly gap graded. It is composed of medium-to-coarse gravel with a very fine sand matrix. This fine sand controls the aquifer characteristics. These wells are each capable of producing approximately 250 gpm of high-quality domestic water, but the demand is anticipated to be much less than this capacity.

A survey of existing wells and natural springs was made in the area between Goble and the south edge of Rainier to determine the extent to which groundwater is utilized, and to determine the elevation of the permanent water table in the area of the site. The survey showed that bedrock supplies most of the groundwater to existing wells in the area. Approximate water levels in the existing wells were determined, and piezometers were installed in six of the drill holes at the Trojan site to indicate water levels in the alluvium and in the bedrock.

Static water levels in wells, and the elevation of springs emanating from the ridge west of U.S. Highway 30, show that water levels in the ridge are considerably higher than are the water levels in the alluvium, even during periods of very high flow in the river. Consequently, it is apparent that the water table in the alluvium does not feed the water table in the ridge. Thus, the precise



local direction of movement of the water is not as important as is the fact that the water in the rock and in the alluvium moves toward the Columbia River and not toward existing offsite wells or springs. The hydraulic gradient of the water table precludes contamination of the portion of the bedrock that now supplies groundwater to offsite wells or springs. It is therefore concluded that there is virtually no possibility of contamination of existing or future offsite groundwater supplies by accidental release of radioactive materials onto the alluvium or rock at the site.

2.5.2 CONTAMINANT TRANSPORT ANALYSIS

Four permeability tests of the alluvial material in Drill Holes 9 and 10 showed permeability ranging from 10 feet to 20,000 feet per year. If accidental discharge of contaminated water onto the alluvium should occur, the water would move through the upper portion of the alluvium and toward the Columbia River at a rate of approximately 15 feet per year. If accidental discharge of contaminated water onto the foundation rock would occur the water would also move toward the Columbia River. If it moved through the fractures and pores in the rock, it would move at a much slower rate than the rate in the alluvium.



2.6 GEOLOGY, SEISMOLOGY AND GEOTECHNICAL ENGINEERING

This section describes and evaluates the geologic and seismic conditions for the region around the ISFSI site. Foundation conditions are evaluated. The seismic history of the region is examined, and the earthquake design criteria are developed and described. These discussions have been summarized from the Trojan Nuclear Plant Final Safety Analysis Report (FSAR) with slight modifications to address ISFSI specifics. Further details and figures, such as geologic profiles, may be found in the FSAR.

2.6.1 BASIC GEOLOGIC AND SEISMIC INFORMATION

The ISFSI site is 31 miles north of the city limits of Portland, Oregon on the Oregon bank of the Columbia River. A portion of the PGE property is underlain by a north-south trending steep-sided ridge of volcanic rock that borders the river and rises to a maximum elevation of 134 feet above MSL. The remainder of the PGE property is underlain by a flat alluvial plain with elevation ranging between 5 and 18 feet. Approximately ½ mile west of the site, a north-south trending range of hills rises steeply above the alluvial plain to elevation in excess of 1000 feet MSL. The Columbia River flows in a northerly direction at the site, but turns to the west several miles downstream.

The ISFSI is located on the east side of the PGE property in a flat, yard area at an elevation of 45 feet MSL. The reinforced concrete slab on which Concrete Casks sit is located on competent rock.

Upon original siting for nuclear plant operation, investigations were performed that may be used in determining the suitability of the PGE property for the storage of spent nuclear fuel. The investigations were conducted to determine the characteristics of the foundation material, especially in regard to their suitability for supporting the structures, to determine the depth and configuration of the groundwater table, to determine the characteristics of the soil and rock materials with respect to their effect on the migration of radioactive solutions if such solutions come in contact with them, and to evaluate the seismicity of the area so that appropriate parameters for seismic design could be selected. Consultants in geology and seismology were retained to evaluate independently the results of the field investigations.

A river bottom survey ("Boomer" survey) was made by EG&G of Goleta, California, using continuous seismic profiling, to define the shape of the river bottom adjacent to the PGE property. A geophysical survey was performed by Geo-Recon Inc., of Seattle, Washington, across the alluvial valley to the west of the PGE property. A geophysical survey was made at the reactor site, by P.C. Exploration of Carmichael, California, to measure P-wave and S-wave velocities and to calculate the dynamic modulus of elasticity of the foundation rock. Drilling and sampling was done by Lynch Bros. of Seattle, Washington, under the direction of Bechtel Corporation. Soil tests were designated by Bechtel and done by Shannon and Wilson, Inc.,



Seattle, Washington, in their Portland laboratory. Selected rock core samples from the drill holes were tested by Bechtel in their laboratory in San Francisco.

A comprehensive geophysical survey was made to investigate geologic conditions in the Columbia River channel adjacent to the PGE property. Studies included seismic refraction, resistivity, aeromagnetic, and gravity surveys. The results of these investigations were evaluated by a special advisory board and the results are presented in a geophysical survey report dated August 1, 1972 (Reference 1).

2.6.1.1 Regional Geology

The ISFSI site is located in the Oregon Coast Range section of the Pacific border physiographic province. The Coast Range is farther divided, and the site is on the southeastern margin of the Willapa Hills subsection. The Coast Range section is bordered on the north by the Olympic Range and on the south by the Klamath Mountains. In the area near the site and along the northern two-thirds of the Coast Range, the Puget Trough forms the eastern boundary. The southern third is bounded on the east by the Sierra-Cascade Province.

The Cascade Range east of the site is marked by a chain of volcanic cones whose activity spans most of Tertiary time. Lava flows and pyroclastic deposits range from Eocene to Recent in age. Due to the proximity of the site to these Tertiary features, a detailed study was made to determine the possible effect on the site of lava flows, ash release, or mud flows related to volcanic activity in the region. Special emphasis was placed on studies of Mt. St. Helens, the volcanic cone closest to the site, and one that was active during Recent time.

The rocks exposed in the area are Cenozoic in age. They include marine and terrestrial sediments, and volcanic rocks. The volcanic rocks predominate in quantity. The oldest rocks are a thick sequence (over 5000 feet) of Upper Eocene basaltic flows, pyroclastics, and associated sediments called the Goble series. The foundation rock on the PGE property is part of the Goble series. The unit is widespread in parts of northwestern Oregon and southwestern Washington. Marine tuffaceous sandstones and other sediments, which were derived in part from the erosion of the Goble series, were later deposited in an advancing Oligocene sea. Accompanying or following the retreat of the sea, the rocks were folded and then eroded to form an area of moderately low relief. During Miocene time, intermittent flows of basaltic lavas poured over this eroded Oligocene surface and buried it to depths of as much as 700 feet. After a period of weathering and erosion followed by some folding, the Troutdale sediments were deposited during the Pliocene period by the ancestral Columbia River. Later tectonic activity folded both the Columbia River basalt and the Troutdale sediments. Changes in sea level during and after Pleistocene contributed to considerable erosion which in places has removed the younger geologic units and exposes the older Goble series, as it has on the PGE property. During Pleistocene, the sea level was 300 to 500 feet lower than its present level and the Columbia River channel near the site was eroded to depths of at least 340 feet below the present sea level. Alluvium has partially filled in the channel since that time.



Folding generally conforms to the northwest Coast Range structural trend. The Eocene formations north of the Columbia River have been folded into a syncline which dips as high as 45 degrees but generally about 10 to 20 degrees. The Goble series underlying the PGE property dips gently to the south or southwest, usually at less than 10 degrees. Pleistocene and recent deposits are apparently flat-lying. No rift-type faults or extensive, continuous faults are in existence in southwest Washington and northwest Oregon. Earthquake activity during the period 1858 to 1965 does not indicate any major active fault near the site. Berg and Baker state in the Bulletin of the Seismological Society of America, January 1963, that the grouping of earthquake epicenters in the Portland area and in other parts of Oregon is associated with the local faulting in those areas. They also state that the probable extension of the San Andreas Fault is clearly exhibited by the alignment of offshore epicenters trending northwest off the coast of Oregon. These offshore epicenters are over 200 miles west of the site.

The presence of some ancient faulting in the area is suggested by topography, but the faulting is apparently minor since mapped faulting is generally of small displacement. No evidence of post-Pleistocene faulting has been found. It was therefore concluded that the evidence indicates there are no active faults in the area.

2.6.1.2 Site Geology

Geologic mapping was performed to locate the various geologic units and their contacts and to determine the geologic structure and the characteristics of the geologic units at and near the site. Seismic lines totaling 4350 feet in length were run across the alluvial-filled valley to the west of the rock ridge to obtain a profile of the subsurface materials. River bottom soundings near the site were obtained by continuous seismic profiling to define the shape of the river bottom. A geophysical survey was made to measure the dynamic modulus of elasticity of the foundation rock for the reactor. A drilling program was conducted, consisting of 59 diamond drill and soil sampling holes totaling about 5200 feet, and three piezometer holes totaling 153 feet. Samples were not taken in the piezometer holes. Piezometers were installed in three of the holes. Existing water wells and natural springs near the site were located, and information obtained on the occurrence, present utilization, and movement of the groundwater in the area.

Diamond drill holes are located in the area in order to define the characteristics and configuration of the bedrock which provides the foundation for the structures. Soil borings were located in the alluvium to check the foundation conditions for the main access road and the railroad track.

Groundwater hydrology and seismology are discussed in Sections 2.5.1 and 2.6.2, respectively.

The PGE property is underlain by bedrock, which is a part of the Goble series of Upper Eocene age, and by recent alluvium. Outcrops of bedrock have not been distinguished or separated from areas where bedrock is obscured by a relatively thin cover of residual soil. The bedrock is exposed on the ground surface along a narrow, elongated ridge bordering the left bank of the



Columbia River. The ISFSI reinforced concrete Storage Pad is founded on the rock which forms the ridge. This ridge was formerly an island in the river, but alluvium has since filled in the old river channel west of the ridge to elevations of 5 to 18 feet.

Drill hole DH-4 penetrates the rock in the ridge to an elevation of -240 feet or approximately 285 feet below the general foundation grade. Forty-two other holes also penetrate the rock which forms the ridge. Three holes are located at the intake structure to define foundation conditions. Approximately five holes are situated along the access road and railroad alignment.

The bedrock is volcanic in origin and consists principally of tuffs with lesser amounts of flow breccias, tuff breccias, agglomerates, and basalt flows. Basalt and agglomerate often are exposed on the ground surface since they are more resistant to erosion than is the tuff; however, tuffs and flow breccias are the predominant rock type in the ridge. There are numerous interbedded thin basalt flows, and based on DH-4 and other borings, basalt may be the predominant rock type below river level. Since the basalt often flowed onto eroded or uneven surfaces, it varies greatly in thickness, but in the ridge the basalt flows are generally thin. Some of the individual flows are not continuous across the ridge, probably because at the time they occurred they only filled in depressions in the ground surface.

The tuffs, tuff breccias, and flow breccias are soft to moderately hard, gray with some white spots and veinlets, commonly quite porous, and bedding is commonly not distinguishable. They are usually lightly to moderately fractured but occasionally highly fractured. The fractures are commonly rehealed and tight.

The agglomerate varies in color from reddish blue to blue grey. It is moderately hard, moderately well cemented, and occasionally vesicular. It commonly is more fractured than the other rocks but not as fractured in place as a superficial inspection of the core recovered from drilling might indicate. Nearly all fractures are at least partially rehealed by the deposition of secondary minerals, and the rock is commonly essentially impervious.

The predominant mineral that has rehealed fractures in the rock is calcite, but chlorites and zeolites also occur. The presence of these minerals increases the overall strength of the rock by increasing the cohesion and consequently the shear strength along fractures in which they occur. The presence of these secondary minerals is not, however, required in order for the rock to have sufficient strength to provide an adequate foundation. Materials with no cohesion, such as clean sands and gravels, have high bearing capacities provided they are dense. Fractures in the rock are irregular, and the rock in the foundation is confined, thus the fractures have considerable shear strength.

The basalt varies from vesicular to dense but is generally vesicular. It is blue to blue-black, usually fine grained but occasionally slightly porphyritic. When unweathered it is very hard. Both core and outcrops of basalt commonly exhibit a high degree of fracturing, due to cooling stresses rather than tectonic forces.



The rock in the ridge is often broken by closely spaced fractures and often contains weathered zones, some of which are at considerable depths. Soil cover on the ridge is usually thin. Rock frequently crops out on the ground surface. There are, however, some depressions in the top of the bedrock, and several old stream channels have been eroded across the ridge. An old channel containing potholes filled with sand occurred under the southeast edge of the cooling tower.

Thick alluvial deposits occur in the valley to the west of the ISFSI location. The geophysical survey indicated that the alluvium has a maximum thickness of approximately 340 feet in the area between the ridge and the hills to the west of the site. The accuracy of the geophysical survey was partially verified by DH-7, which was drilled at a point where the survey indicated the alluvium to be approximately 280 feet thick. The hole penetrated alluvium to a depth of 278 feet but it had to be abandoned at that depth. However, the total thickness of the alluvium at the hole is considered to be close to 280 feet since the hole terminated in gravels and boulders which probably occur near the top of bedrock.

The upper approximately 80 to 100 feet of the alluvium usually consists of soft to very soft clayey silt to silty clay with varying amounts of intermixed fine sand and layers of silty fine sand. It also contains considerable amounts of decomposed wood fragments and vegetation, particularly in the 50-foot depth range. In DH-5, -9, and -10, and P-1, -2, and -3, the upper 25 to 35 feet of the alluvium is predominantly silty fine sand, but contains significant quantities of silty clay and clayey silt. DH-7 contains less sand in the upper 35 feet than do the above holes. Holes in the alluvium encountered principally soft clayey silt between approximately 30 to 90 feet in depth.

The seismic survey distinguished a denser material, as indicated by a higher velocity, below a depth of approximately 80 feet, and DH-7 confirmed the existence of the denser material, which is a thick layer of fine and very fine-grained sand. In DH-7, progressively more sand was encountered below a depth of about 100 feet, and between depths of 115 feet and 270 feet the material was essentially fine sand.

2.6.2 VIBRATORY GROUND MOTION

2.6.2.1 Seismicity

The ISFSI is located in an area that experiences moderate seismic activity. Most of the seismic activity has been concentrated in three areas - one about 40 miles east of the site, another approximately 25 miles south of the site, near Portland, Oregon, and a third approximately 65 to 120 miles north of the site, along a belt between Olympia and Seattle, Washington. It is important to note that there is no alignment of epicenters to suggest the existence of any active fault near the site (References 2 - 5).



2.6.2.2 Geologic Structures and Tectonic Activity

Bedrock at the site consists chiefly of basaltic flows and associated pyroclastics included in the Goble series. This unit contains a thick section of widespread volcanics that crop out along both sides of the Columbia River in this area. The unit is Upper Eocene in age. Generally, the rock ranges from dense to vesicular basalt with interbedded agglomerates. As is common with the volcanics of this area, the rocks show closely spaced fractures and locally contain weathered zones.

The data obtained from the geologic study, core drilling and geophysical surveys indicate that the foundation is composed of moderately hard, competent rock that is suitable for an ISFSI. Rock types include tuffs, tuff breccias, flow breccias, basalts, and agglomerates. Of these, tuffs are the most prevalent. Unconfined compressive strengths of the 41 samples of tuffs, tuff breccias, and flow breccias (200 tons/sq. foot) with an average of 1225 psi (88 tons/sq. foot). The specific gravity of the tuffs range from about 1.84 to 2.33 with an average of about 2.10. Absorption ranges from 5 to 17 percent with an average of around 10 percent. The ISFSI reinforced concrete Storage Pad is founded on rock. Therefore, studies for liquefaction, thixotropy, or differential consolidation of soils were not required.

Geophysical surveys showed compression wave velocities to be 8,200 to 10,600 fps, which indicates adequate foundation conditions. Shear wave velocities of foundation rock ranged from 4,500 to 5,000 fps. A value of 1.9×10^6 psi was used for the dynamic modulus of elasticity, based on the geophysical measurements. Values for static modulus of elasticity were obtained by numerous laboratory tests on representative core samples. A conservative value of 0.8×10^6 was used for the design. No uphole velocity measurements were made.

2.6.2.3 Maximum Earthquake Potential

The largest historically recorded shock center within 50 miles of the site occurred on November 5, 1962. It had an epicentral intensity of VII about 35 miles south of the site near Vancouver, Washington. At Longview, Washington, and at Rainier, Oregon, the intensity was reported as VI; however, the damage was confined to cracked plaster.

On October 12, 1877, an intensity VII earthquake was felt in Portland, Marshfield (now called Clackamas), and Cascades (now called Cascade Locks), Oregon. The location of the epicenter of this shock is uncertain. It is plotted 45 miles from the site in the southern part of Portland, near Clackamas. The epicenter may have been farther east toward Cascade Locks, Oregon. The original reference to this earthquake is by Rockwood (Reference 6). Unfortunately, he does not state exactly what his source is. His account follows:

“October 12, 1877. Quite severe shocks were felt in Oregon occurring in Portland at 1:53 p.m. (Two shocks being noticed; at Marshfield, Clackamas Co., at 1:45 p.m.; and at



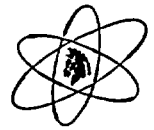
Cascades at 9:00 a.m.) The vibrations were in each case from north to south and were sufficiently violent to overthrow chimneys.”

A second reference by Holden (Reference 7) assigned an intensity VIII on the Rossi-Forel (R-F) scale to this earthquake. Townley and Allen (Reference 8) also showed intensity VIII (R-F scale). Rasmussen (Reference 9) and Berg (Reference 2) both used intensity VIII but changed to the Modified Mercalli (MM) scale. The U.S. Coast and Geodetic Survey (Reference 4) shows intensity VII. It is generally accepted that VII (MM) is the equivalent of VIII (R-F).

In correspondence with Bechtel, Mr. Don Tocher, Director of the Earthquake Mechanism Laboratory of the U.S. Coast and Geodetic Survey in San Francisco, stated that he believes an intensity VII (MM) to be correct for the October 12, 1877, earthquake, and states that the intensity VIII (MM) referred to by Berg (Reference 2) and Rasmussen (Reference 5) is probably a result of carelessness in designated scales when changing from the Rossi-Forel scale to the Modified Mercalli scale.

Seven earthquakes of maximum intensity VI were centered within 50 miles of the site. On February 3, 1892, a shock of intensity VI occurred at Portland, and strong vibrations were felt at Astoria, Salem, and Lake Harney, 235 miles southeast of Portland. On December 29, 1941, a shock of intensity VI was felt near Portland, Oregon, about 38 miles south of the site. Another shock, centered near Portland on December 15, 1953, was felt with intensity IV at Kalama, Washington. On September 15, 1961, an earthquake was centered about 33 miles east of the site. The maximum intensity of VI was reported at Swift Dam on the Lewis River, which was designed for 0.10 g, but no damage was done to the dam. At Rainier, the shock on September 15, 1961, was also of intensity IV, and at Carrolls, the intensity was I to III. An after shock on September 17, 1961, was also intensity VI, but was not felt at Rainier or Carrolls. On November 6, 1961, a shock was centered about 30 miles south of the site. At Rainier, the intensity was reported as V. On December 26, 1963, an earthquake of intensity VI occurred about 30 miles southwest of the site. The intensity was reported as V in Longview, and III at Goble. It was not felt in Rainier.

The largest earthquakes within 150 miles of the site were two shocks of epicentral intensity VIII which occurred on April 13, 1949, and April 29, 1965. The epicenters were in the Puget Sound area, approximately 70 miles and 95 miles, respectively, northeast of the site. Heavy damage, deaths, and injuries were reported in the epicentral areas. The accelerograms indicate a maximum resultant horizontal acceleration of about 0.10 g at Seattle, where the intensity was VIII. At Rainier, which is about the same distance from the epicenter as is Seattle, the intensity was also given as VIII, which is the greatest intensity reported historically at Rainier from any earthquake. However, the intensity at Rainier was based on damage to only one building, and that building was founded on marshy ground. A study of the damage reported at Rainier indicates that a lower intensity might reasonably be assigned. At Goble, the intensity due to the 1949 earthquake was only VI, apparently because Goble is founded on rock. The ISFSI is founded on rock belonging to the same unit as the rock that underlies Goble.



The April 29, 1965, earthquake caused lower intensities in the site area than the 1949 earthquake. The intensity at Kelso and Longview was VI; at Rainier it was V; and at Goble only IV.

2.6.2.4 Seismic Margin Earthquake

The maximum intensity that has been reported at Rainier is VIII. Since this intensity occurred on overburden, it is probable that on rock at the site the intensity for this same shock was not over VII. Intensity VII correlates with a horizontal acceleration of 0.12 g according to Hershberger (Reference 10). This historical data formed the bases for assigning the Safe Shutdown Earthquake (SSE).

The SSE was determined such that any probable earthquake experienced at the site would not exceed the intensity selected. An intensity of VIII was selected since it was probable that an earthquake of that magnitude had never been experienced at the site. An intensity VIII is equivalent to an acceleration of 0.25 g.

There have been significant changes in the perception of earthquake hazards in the Pacific Northwest since the time of the initial design and licensing of the Trojan Plant. It is now commonly believed among the geoscience community that large subduction zone earthquakes likely occurred along the Oregon-Washington-Vancouver Island coast (known as the Cascadia margin, or Cascadia Subduction Zone) within the recent past (Holocene), and that the potential for such events to occur in the future should be considered in any evaluation of safety and reliability of critical facilities during earthquake loading.

In 1987, in response to the emerging issue of potential subduction zone earthquakes, PGE initiated a program of close monitoring of earthquake hazard research conducted along the Cascadia margin. The results of these studies, together with studies initiated by PGE, have been used to characterize the maximum events that could be expected to occur in the region and the resulting free-field ground motions that may occur at the site. This maximum potential earthquake that could affect the site is called the Seismic Margin Earthquake (SME).

These studies determined a value for the SME peak horizontal ground acceleration of 0.38 g (Reference 11). A 1994 earthquake in Northridge, California slightly changed the conclusions of these studies in that the controlling earthquake varies from the intraslab source for peak ground acceleration, to the crustal earthquake for periods between 0.1 and 0.6 seconds, to the interface source for longer periods, whereas in the original study, only the intraslab and interface sources were controlling (Reference 12). Nonetheless, the response spectra are bounded by the Regulatory Guide 1.60 spectrum shape when anchored at the 0.38 g peak acceleration. Therefore, input from recent earthquakes shows that the SME is the appropriate design basis event for the ISFSI, as required by OAR 345-026-0390, and the ISFSI design considers the SME peak horizontal acceleration of 0.38g.



2.6.3 SURFACE FAULTING

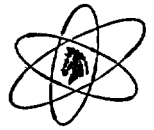
The site is in the Willapa Hills geomorphic province, a part of the Coast Range. Most of the region is below 2000 feet in elevation. The descent from the hills to the Columbia River is rather precipitous, but elsewhere the hills merge gradually into the surrounding lowlands.

The bedrock in the area is comprised of a series of moderately folded tertiary formations of both sedimentary and volcanic origin. The folding in the area conforms generally to the northwest Coast Range structural trend. The Eocene formations north of the Columbia River are folded as part of a syncline. Pliocene sediments in the vicinity of the site are only slightly warped and the Pleistocene and Recent deposits appear to be flat lying and undisturbed. A detailed discussion of the regional geology is presented in Section 2.6.1.1.

Faulting is minor in the structural development of the area, and is generally of small displacement. Many of the mapped faults in the area are based on topographic lineations in the pre-Pleistocene strata. No evidence of post-Pleistocene surface displacement has been found in the area.

An extensive investigation to locate faults that might be significant to the site was made as part of the geologic evaluation for siting the Trojan Nuclear Plant. A special effort was made to detect any lineations or indications of offset in the alluvium, terrace deposits, or the Pleistocene alluvial deposits. The details of the investigation are contained in the Trojan Nuclear Plant FSAR. As a result of the investigation, the following conclusions were reached:

1. The "Kelso Fault," as indicated in Bulletin 54 of the Washington Division of Mines and Geology (Reference 13), does not exist.
2. The available geologic evidence indicates that there is not a fault in the old stream channel west of and adjacent to the site.
3. The field evidence indicates that the Clatskanie fault does not extend farther east than indicated on the Oregon State Geologic Map.
4. The available geologic evidence does not indicate that a fault exists along the Columbia River adjacent to the site.
5. The fault zone exposed in the road cut southeast of Kelso and 4.7 miles from the site is apparently not extensive and probably has not experienced movement since deposition of the Troutdale formation during lower Pliocene time. This fault zone is not significant to the site.
6. There is no fault within 5 miles of the site which has experienced movement since Pleistocene time.



The size of faults within a 200-mile radius of the site, together with the known historical activity and distance from the site, suggest that ground accelerations reaching the site from these mapped faults would fall well below those for which the ISFSI was designed.

2.6.4 STABILITY OF SUBSURFACE MATERIALS AND FOUNDATIONS

The existing gravel fill was removed during excavation for the ISFSI reinforced concrete Storage Pad and a nominal 2 ft. layer of graded and compacted gravel fill was placed under the concrete slab. No soluble or cavernous rocks underlie the site area, and no poorly consolidated or mineralogically unstable rocks occur at the site. No oil, gas, other mineral extraction, or subsurface mining occurs or has occurred in the vicinity of the site. It is therefore concluded that future subsurface subsidence is not a problem at the site.

No evidence of recent regional warping was encountered, and USGS Bulletin 1119, 1963, by Donald E. Trimble (Reference 14), states:

“...deformations of the region apparently ended in early Pliocene time as the Troutdale formation is the youngest one involved in the warping. The undeformed boring lava overlies an erosional surface of considerable relief cut on the Troutdale. Post-Troutdale crustal movements, if any, have consisted only of vertical movement of regional extent.”

The geologic mapping near the site, and the study of aerial photographs, did not disclose any indications of recent regional warping.

Because the ISFSI reinforced concrete Storage Pad is founded on the crest of a rock ridge which shows no evidence of deformation since Pliocene time, no unrelieved residual stresses should be expected to exist in the foundation rock. No evidence of unrelieved residual stress was observed during previous excavations for the nuclear plant foundations.

2.6.4.1 Geological Foundation Evaluation

Fifty-five samples of rock core from the drill holes were tested in the Bechtel Geology Laboratory in San Francisco for the original siting of Trojan Nuclear Plant. Standard testing procedures were used in the determination of the physical properties of the rocks.

Rock types include tuffs, flow breccias, basalts, and agglomerates. Since contacts between rock types are not always horizontal, and the rock units are often lenticular, the ISFSI reinforced concrete Storage Pad may rest on one rock type in one portion of the Storage Pad and a different rock type in another part of the Storage Pad. This does not complicate the design, however, since the Storage Pad is designed for the strength of the weakest rock types, which tests have consistently shown to be the tuffs.



Since the tuff is assumed to form the foundation for the reinforced concrete Storage Pad, its strength will generally determine the allowable bearing capacity of the foundation rocks. The lowest and highest unconfined compressive strength of the 41 samples of tuff which were tested are 360 psi (26 tons/ft²) and 2790 psi (200 tons/ft²). The average is 1225 psi or 88 tons/ft².

Testing showed the specific gravity of the tuff to be in the range of about 1.84 to 2.33 with the average of about 2.10. Porosity varies from 10.3 to 32.4 percent with 22 percent being about the average. Absorption ranges from 5.0 to 17 percent with an average of around 10 percent.

Soil test data such as grain size, Atterberg limits, water content, soil density, and shear strength were not required because the ISFSI reinforced concrete Storage Pad is founded on rock. Tests were made in the flat alluvial area where access roads are found.

The geophysical survey showed the compression wave velocities in the bedrock to be 8,200 to 10,600 fps, which indicates adequate rock for good foundation conditions. Shear-wave velocities of the foundation rock ranged from 4,500 to 5,000 fps. The flat alluvial area west of the rock ridge had compression wave velocities of 2,000 to 2,500 fps for the overburden and velocities of 4,700 to 5,100 fps for the older compacted overburden. No equipment important to safety is founded on this alluvial material.

In determining the bearing capacity of these rocks, it was noted that the rock which will form the foundation has been preloaded by the weight of overlying material, much of which has been removed by erosion. This, as well as the jointing and weathering, were considered in determining the allowable bearing capacity of the rock.

Values for the static modulus of elasticity were obtained by numerous laboratory tests of representative core samples. A conservative value of 0.8×10^6 psi for the static modulus of elasticity was used for design. For dynamic modulus of elasticity, a value of 1.9×10^6 psi was used in design. The value was determined by geophysical measurements on in-site foundation rock. Values for Poisson's ratio (dynamic) range from 0.28 to 0.36. From these values, the bulk modulus was computed to be 1.8×10^6 , and a value of 0.7×10^6 psi was calculated for the shear modulus. For design purposes, soil structure and rock foundation interaction was assumed to be negligible, thus no damping was used for the rock.

Observations of groundwater levels at the site indicated that the ridge supports a local groundwater mound, probably maintained by rainfall trapped in depressions on the top of the ridge. Previous excavation for the nuclear plant showed the water to be trapped in joints and fractures in the rock and the water drained off rapidly. No artesian pressures were encountered during the previous excavation.



2.6.5 STABILITY OF SLOPES

Permanent excavated slopes to the north and east of the ISFSI are through rock and no problem with long-term stability of such slopes should be anticipated. Sloughing of small amounts of loose weathered surface material would likely not reach the ISFSI, and would not represent a hazard to the ISFSI in any event.

2.6.6 VOLCANOLOGY

Due to the proximity of existing inactive volcanoes in the Cascade Range east of the site, the significance of renewed activity of these volcanoes was considered with regard to the possible effects on the site. The historical seismicity of the Cascade volcanoes was considered as well as the type of volcanic activity that might conceivably occur in the future. The volcanoes that were considered and their distances and direction from the site are:

1. Mt. St. Helens, Washington - 34 miles - ENE
2. Mt. Adams, Washington - 67 miles - E
3. Mt. Hood, Oregon - 74 miles - SE
4. Mt. Rainier, Washington - 77 miles - NE

The details of volcanology are described in the Trojan Nuclear Plant FSAR. In summary, the conclusions of the FSAR were that while predictions related to future volcanic activity are impossible to make, the possibility of volcanic activity significant to the site is considered very remote. In addition, even if activity did occur, it is extremely unlikely that it would occur without warning.

The series of Mount St. Helens eruptions in 1980 resulted in tephra accumulations at the Trojan site of no more than 1/8 inch. If Mount St. Helens were to have another tephra eruption similar to the May 18, 1980 eruption, only directed towards the ISFSI with winds blowing towards the ISFSI, then the expected ash fall accumulation would be about 1.8 inches.

For these reasons, the risk to the ISFSI from volcanic cones in the Cascade Range is considered minimal.



2.7 SUMMARY OF SITE CONDITIONS AFFECTING CONSTRUCTION AND OPERATING REQUIREMENTS

The site-specific phenomena and characteristics described in this chapter have been used to define appropriate design criteria, as described in Chapter 3. Table 2.7-1 is a summary of site-specific information for the ISFSI.



2.8 REFERENCES

REFERENCES FOR SECTION 2.1

1. Telecon No. WRN-T15-92, W. R. Nehrenz to D. Hefty at Merchant's Exchange.
2. Ken Pellens, Roadmaster, Burlington Northern Railroad (now known as Portland & Western Railroad, Inc.), Telecon (June 1992).
3. U.S. Census Bureau, 1990 Census of Population.
4. Population and Household Trends in Washington, Oregon and Northern Idaho, 1960-1980, Pacific Northwest Bell (March 1967).
5. Pleasure Boating in Oregon, July 1, 1972, Oregon State Marine Board.
6. Derived from U.S. Department of Commerce, Bureau of Census, 1987 United States Census of Agriculture - County Data, Oregon Columbia County, pp 167-177; County Report for Columbia County (December 9, 1991); Washington-Cowlitz County, pp 65-72 (September 1961).
7. "State Milk Surveillance Activities," Radiological Health Data and Reports, 9:637 (1968).
8. Portland General Electric, Supplement to Applicant's Environmental Report, Post Operating License Stage, PGE-1063.
9. Richard M. Highsmith and Jon M. Leverenz, Ed., Atlas of the Pacific Northwest, 4th Edition, Oregon State University Press, Corvallis (1968) pp 155-159.
10. Bureau of Governmental Research and Service, University of Oregon, Planning for Parks - Columbia County, Oregon, a Report for the Columbia County Planning and Park Commissions (June 1968).
11. Bureau of Governmental Research and Service, "Preliminary Road Plan, Columbia County, Oregon" (March 1967).
12. Gary Fritz, Caretaker-Prescott Beach Park, Telecon (July 1992).
13. John Haxton, Oregon State Game Commission, Personal Communication (July 1972).
14. Holtec Report No. HI-2002444, Final Safety Analysis Report for the HI-STORM 100 System, Revision 0, July 2000.



REFERENCES FOR SECTION 2.2

1. Telecon No. WRN-T15-92, W. R. Nehrenz to D. Hefty, Merchant's Exchange.
2. Telecon No. WRN-T38-92, W. R. Nehrenz to K. Barney, Port of Longview.
3. Telecon No. WRN-T19-92, W. R. Nehrenz to S. Perkins, U.S. Army Corps of Engineers.
4. Corps of Engineers, Portland.
5. Harry O'Neil, Kelso-Longview Airport Manager, Telecon (June 1992).
6. Federal Aviation Administration (1972).
7. U.S. Department of Defense (1972).
8. Northwest Natural Gas Company. (1972).
9. Telecon No. WRN-T20-92, W. R. Nehrenz to H. Nale, Oregon Department of Transportation, Planning Section.
10. Telecon No. WRN-T21-92, W. R. Nehrenz to J. Sorrell, Washington Department of Transportation, District 4 Traffic Office.
11. Ken Pellens, Roadmaster, Burlington Northern Railroad (now known as Portland & Western Railroad, Inc.), Telecon (June 1992).
12. John Myers, Train Master Vancouver Office, Burlington Northern Railroad (June 1992).
13. Survey Conducted by PGE in Trojan Area (1972).
14. Holtec Report No. HI-2002444, Final Safety Analysis Report for the HI-STORM 100 System, Revision 0, July 2000.



REFERENCES FOR SECTION 2.3

1. Local Climatological Data, Annual Summary with Comparative Data, Portland, Oregon, 1971, Environmental Data Services.
2. Climatic Atlas of the United States, ESSA, U. S. Department of Commerce (June 1968).
3. P. O. Huss, Relation Between Gusts and Average Winds for Housing Load Determination, DGAI 140, Daniel Guggenheim Airship Institute, Akron, Ohio (June 1946), p 23.
4. Storm Data, Environmental Data Service, NOAA, U. S. Department of Commerce (1961-1972) (issued monthly).
5. David M. Ludlum, Weather Record Book: United States and Canada, Princeton: Weatherwise Inc. (1971), p 98.
6. C. R. Hosler, "Low-Level Inversion Frequency in the Contiguous United States," Monthly Weather Review, 89, 9 (1961) pp 319-332.
7. V. J. Schaefer, (Chairman), Glossary of Terms Frequently Used in Air Pollution, Boston: American Meteorological Society (1968) p 34.
8. G. C. Holzworth, Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States, Preliminary Document, Environmental Protection Agency (May 1971) p 146.
9. G. C. Holzworth, "A Study of Air Pollution Potential for the Western United States," Journal of Applied Meteorology, 1, 3 (1962) pp 366-382.
10. Climatology of the United States No. 10-45, Decennial Census of the United States - Summary of Hourly Observations, Kelso-Longview, Washington, U. S. Department of Commerce (1970).
11. The Meteorological Program at the Trojan Nuclear Plant Site - 9/71 - 2/72, NUS 924, NUS Corporation (November 1972).
12. The Meteorological Program at the Trojan Nuclear Plant Site - 9/71 - 8/72, NUS-1002, NUS Corporation (July 1973).
13. The Meteorological Program at the Trojan Nuclear Plant site - 9/71 - 8/73, NUS-1169, NUS Corporation (July 1974).



REFERENCES FOR SECTION 2.4

1. Lower Columbia River - Standard Project Flood and Probable Maximum Flood, North Pacific Division Corps of Engineers (September 1969).
2. Department of the Army, Portland District, Corps of Engineers.
3. Artificial Flood Possibilities on the Columbia River, Special Study 5-1-1, U. S. Army Corps of Engineers (November 1951).
4. Artificial Flood Considerations for Columbia River Dams, U. S. Army Corps of Engineers (August 1963).
5. Charles Goodwin Jr. letter (PGE) to U. S. Nuclear Regulatory Commission dated September 15, 1980.
6. Oregon State University Marine Science Center, Newport, Oregon, private communication.
7. Thermograph Charts for Trojan Thermograph, Portland, General Electric Company.

REFERENCES FOR SECTION 2.5

None



REFERENCES FOR SECTION 2.6

1. Trojan Geophysical Advisory Board, August 1972 Geophysical Survey Report - Trojan Nuclear Power Plant Site.
2. J. W. Berg, Jr., and C. D. Baker, "Oregon Earthquakes, 1841 through 1958," Bulletin of the Seismological Society of America, 53, 1 (1963).
3. H. A. Coombs, "A Summary of Washington Earthquakes," Bulletin of the Seismological Society of America, 93, 1 (1953).
4. R. A. Eppley, Earthquake History of the United States, Revised ed. through 1963, u. S. Coast and Geodetic Survey, (1965).
5. Norman Rasmussen, Washington State Earthquakes, 1940 through 1965:, Bulletin of the Seismological Society of America, 57, 3 (1967).
6. C. G. Rockwood, "Notices of Recent American Earthquakes," American Journal of Science and Arts, (1878).
7. Abstracts of Earthquake Reports, 1967 - September 1968, quarterly publication of the U.S. Department of commerce, U.S. Coast and Geodetic Survey.
8. S. D. Tomley and M. W. Allen, "Description Catalog of Earthquakes of the Pacific coast of the United States 1769 to 1928," Bulletin of the Seismological Society of America, 29, 1 (1939).
9. ESSA Earthquake Hypocenter Cards, Jan. 1968 - Sept. 1968, U.S. Department of Commerce.
10. H. A. Coombs, Faults Peripheral to the Trojan Nuclear Plant, Oregon (May 1972).
11. Seismic Margin Earthquake for The Trojan Site, Project 1348, Geomatrix Consultants, May 1993.
12. Update of Seismic Margin Earthquake, Geomatrix Consultants; July 18, 1995.
13. V. E. Livingston, Jr. "Geology and Mineral Resources of the Kelso-Cathlamet Area, Washington," Washington Division of Mines and Geology Bulletin No. 54, (1966).
14. D. E. Trimble, "Geology of Portland, Oregon and Adjacent Areas," USGS Bulletin 1119, (1963).



Table 2.1-1

Public Facilities and Institutions

	<u>Enrollment</u>	<u>Distance (mi)</u>	<u>Direction</u>
<u>WASHINGTON SCHOOLS:</u>			
<u>Longview</u>			
Broadway	114	7	NNW
Carrolls	131	2-1/4	NNE
Cascade Middle School	910	8-1/2	NNW
Columbia Heights	329	8-1/2	NNW
Columbia Valley Gardens	496	8-1/2	NNW
Kalama High School	413	3	SE
Kalama Grade School	410	3	SE
Kessler	535	7	NNW
Lower Columbia Jr. College	3869	7-1/2	NNW
Mark Morris High School	1189	7-3/4	NNW
Mint Valley	688	8-3/4	NNW
Monticello Middle School	866	7-2/3	NNW
Natural High School	24	8-3/4	NNW
Olympic	562	7-2/3	NNW
R. A. Long High School	952	7-2/3	NNW
Robert Gray	582	10-1/2	NNW
Rose Valley	173	5	NNE
St. Helens	421	7	NNW
<u>Kelso</u>			
Barnes	552	8-1/4	N
Beacon Hill	447	9-1/4	N
Butler Acres	528	8-2/3	N
Catlin	426	7-2/3	NNW
Coweman Middle School	662	7	N
Huntington Middle School	583	8	N
Kelso High School	1222	7	N
Wallace	467	6-2/3	N



Table 2.1-1

Public Facilities and Institutions

	<u>Enrollment</u>	<u>Distance (mi)</u>	<u>Direction</u>
<u>Private</u>			
Columbia Heights	175	8-3/4	NNW
Kelso Christian Academy	200	7-1/4	NNW
Longview Christian School and Day Care	700	8	NNW
St. Rose	237	7	NNW
Seventh Day Adventist	31	7	NNW
<u>OREGON SCHOOLS:</u>			
Columbia City Elementary	151	10-1/4	SE
Goble Elementary	119	2-1/4	S
Hudson Park	349	6-1/4	WNW
Rainier Elementary	307	4-1/4	NW
Rainier High School	441	6	NW
Rainier Middle School	244	3-3/4	NW
<u>HOSPITALS</u>			
St. Johns Medical Center	340	6-2/3	NNW
<u>NURSING HOMES</u>			
American Convalescent & Retirement Home	74	7	NNW
Campus Towers	110	7-2/3	NNW
Canterbury Retirement Inn	104	7	NNW
Cowlitz Convalescent Center	46	7-1/4	NNW
Delaware Plaza	87	6-1/2	NNW
Frontier Extended Care Facility	136	6-3/4	NNW
Manor Nursing Home	51	7	NNW
Northwest Continuum Care Center	66	9-1/2	NNW
Park Royal	49	7	NNW
Woodland Care Center	58	10	SSE



Table 2.1-1

Public Facilities and Institutions

	<u>Enrollment</u>	<u>Distance (mi)</u>	<u>Direction</u>
<u>PARKS</u>			
Bailey Park		8-3/4	NNW
Clearview Park		6-1/2	NNW
Cloney Park		7	NNW
Gerhart Gardens Park		5	N
Highlands Park		6	NNW
Hudson Parcher Park		4	NW
John Null Park		8-1/3	NNW
Kellogg Park		8	NNW
Kelso Rotary Park		8	N
Lake Sacajawea Park		7	NNW
Prescott Beach Park		1	NNW
R. A. Long Square		7-1/4	NNW
Riverside Park		10	N
Roy Morse Park		10-3/4	NNW
Scott Hollow Park		7-1/4	N
Seventh Avenue Park		6-1/2	NNW
Tam O'Shanter Park		6-3/4	N
Vandercook Park		7-1/4	NNW
Windermere Park		10-3/4	NNW
<u>COUNTY FAIR GROUNDS</u>			
Cowlitz County	56,000 during fair - 54,000 total during rest of year	7	NNW

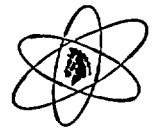


Table 2.1-2

1994 LAND USE CENSUS

NEAREST LOCATION TO TROJAN WITHIN A FIVE-MILE RADIUS

Radial Mileage for Nearest Location

<u>Directional Sector</u>	<u>Residence</u>	<u>Garden</u>	<u>Milk Cow</u>	<u>Milk Goat</u>	<u>Meat Animal</u>
N	0.70	0.80	None	None	None
NNE	2.00	2.80	4.00	2.00	None
NE	1.60	2.00	None	None	2.00
ENE	2.30	None	None	None	4.00
E	1.30	1.30	None	None	1.30
ESE	0.80	2.40	None	None	2.40
SE	2.30	2.80	None	None	2.70
SSE	1.40	3.00	None	None	3.00
S	1.20	1.40	None	None	2.00
SSW	0.90	2.60	None	2.60	1.00
SW	1.50	3.00	None	3.00	2.10
WSW	1.40	1.60	None	None	3.20
W	1.70	2.10	None	None	2.20
WNW	1.70	1.70	None	None	1.70
NW	1.20	1.20	None	None	2.00
NNW	0.60	0.60	None	None	None



Table 2.2-1

Nearby Industrial Facilities

Map Ref No.	Company	Distance from site (mi)	Description of Products or Services	Annual Production	Product Storage	Shipments: In	Shipments: Out	Hazardous Chemicals Used	Storage
1	Port of Longview	5.6	Dock facilities loading, unloading, storage	180-200 ships per year	3.3 million sq ft	Ship Rail Truck	Ship Rail Truck		
2	International Paper Company	5.5	Logs, woodchip export	[b]	logs 20 million board ft chips 20,000 bone dry units	Truck Rail	Ship Truck	Diesel Fuel	5,000 gal [c]
3	Longview Fibre Company	5.0	Paper products and paper board	1.2 million tons	[b]	Rail Truck Ship Barge	Rail Truck Ship	Sulfuric Acid Caustic Soda Chlorine Fuel Oil Liquid Propane Ammonia Phosphoric Acid Nitric Acid Hydrogen Peroxide	740,000 lb 500,000 lb 28,000 lb 9,800,000 gal 10,000 gal 30,000 lb 40,000 lb 60,000 lb 70,000 lb
4	Cytec Industries	6.0	Paper, water, and mining chemicals	35 million lbs	400,000 gal	Rail Truck	Truck Rail	Acrylic Acid Acrylamide Dimethylamine Paraffin solvent Caustic Soda Sulfuric Acid Hydrochloric Acid Formaldehyde Sulfur Dioxide	10,000 gal 30,000 gal 30,000 gal 30,000 gal 8,000 gal 3,500 gal 6,000 gal 15,000 gal 250 lbs
5	Specialty Minerals	7.0	Chemicals and products for paper industry [b]	[b]	[b]	Truck	Truck	Calcium Carbonate Calcium Hydroxide Calcium Oxide Acid	500,000 lb [c] 50,000 lb [c] 500,000 lb [c] 50,000 lb [c]



Table 2.2-1

Nearby Industrial Facilities

Map Ref No.	Company	Distance from site (mi)	Description of Products or Services	Annual Production	Product Storage	Shipments: In	Shipments: Out	Hazardous Chemicals Used	Storage
6	Weyerhaeuser	7.0	Lumber, wood pump, paper board, kraft pulp, container board, printing and writing materials	4.5 million tons	[b]	Rail Truck Ship Barge	Rail Truck Ship Barge	Sulfuric Acid Alum Chlorine Caustic Starch Clay	300,000 lb[c] 200 tons [b] [b] 400 tons [c] 200 tons [c]
7	North Pacific Paper Company	7.75	Newsprint	675,000 tons	21,600 tons	Rail Truck	Rail Truck	[b]	[b]
8	Longview Aluminum	8.7	Aluminum billet	220,000 tons	Little	Ship Rail	Ship Rail Truck	Alumina Coke Bituminous Pitch Propane Chlorine	70,000 tons 10,000 tons 100,000 gal 80,000 gal 1 tank car
9	Wayron	6.5	Industrial machine shop, custom machine building, welding, and painting	2,000 tons	500,000 lbs	Truck	Truck		
10	Peavy Grain	3.5	Grain handling and storage	200 million bushels	2 million bushels	Ship Rail	Ship Barge Truck		
11	Kalama Chemical Company	2.0	Phenols, aldehydes, amines, benzoates, and K-flex plasticizers	750 million lbs	[b]	Ship	Rail Truck	Toluene	5,000,000 gal
12	Northwest Natural Gas Pipeline	1.6	16 in O.D. natural gas pipeline	3 million cu ft per hour capacity					
13	Kelso-Longview Airport	6.5	Municipal Airport	35,000 operations	60 planes	-	-	Aviation Fuel	10,000 gal



Table 2.2-1
Nearby Industrial Facilities

Map Ref No.	Company	Distance from site (mi)	Description of Products or Services	Annual Production	Product Storage	Shipments: In	Shipments: Out	Hazardous Chemicals Used	Storage
14	Gram Lumber Company RSG Forest Products	3.0	Cedar lumber, Dimensional lumber	180 million board ft	[b]	Truck	Truck Rail Barge	Natural Gas	Pipeline
15	Coastal St. Helens Chemical Company	9.25	Fertilizer	200,000 tons	20,000 tons	Pipeline	Rail Barge Truck	Natural Gas	Pipeline
16	Olympic Pipeline Company	1.9	14 inch O.D. refined petroleum product pipeline	~8,000 bbl per hour					
17	Solvay Interlox	8.5	Manufacture hydrogen peroxide	143 million lbs	8 million lbs	Truck	Rail Truck	Natural gas	Pipeline
18	All Pure Chemical Company	2.0	Repackage chlorine gas, sodium hypochlorite, household ammonia, products for water treatment	~70 gal/min	15,000 gal	Rail	Truck	Chlorine Caustic Soda Sodium Hypochlorite	180,000 lbs 180,000 lbs 15,000 gal
19	Hoechst Celanese Corporation	3.0	Bleaching agents for pulp and paper industry, zinc oxide, sodium hydrosulfite	12 million lbs	9,500 lbs	Rail Truck	Rail Truck	Sulfur Dioxide Sodium Hydrosulfide	300,000 lbs 200,000 lbs
20	Steelscape	0.5	Zinc/aluminum coated and painted steel strip in coils (est. 1997)	400,000 tons	[b]	Truck Ship Rail	Truck Rail	Liquid Hydrogen Hydraulic Oils Paint Caustic Soda Diesel Fuel Propane Gas Hydrochloric Acid Natural Gas Passivation Chemical Paint Solvents	5,000 gal 10,000 gal 15,000 gal 20,000 lbs 10,000 gal 20,000 gal 20,000 gal Pipeline 500 gal 500 gal



Table 2.2-1

Nearby Industrial Facilities

Map Ref No.	Company	Distance from site (mi)	Description of Products or Services	Annual Production	Product Storage	Shipments: In	Shipments: Out	Hazardous Chemicals Used	Storage
21	Wilson Oil (dba Wilcox & Flegel)	5.6	Petroleum distribution	7 million gal	26,190 bbl	Truck	Truck	Petroleum	26,190 bbl
22	Northwest Pipeline	3.5	26 inch and 30 O.D. natural gas pipelines	20 million cu ft per hour capacity					

[a] Shipping is noted in order of importance

[b] Proprietary data or not available

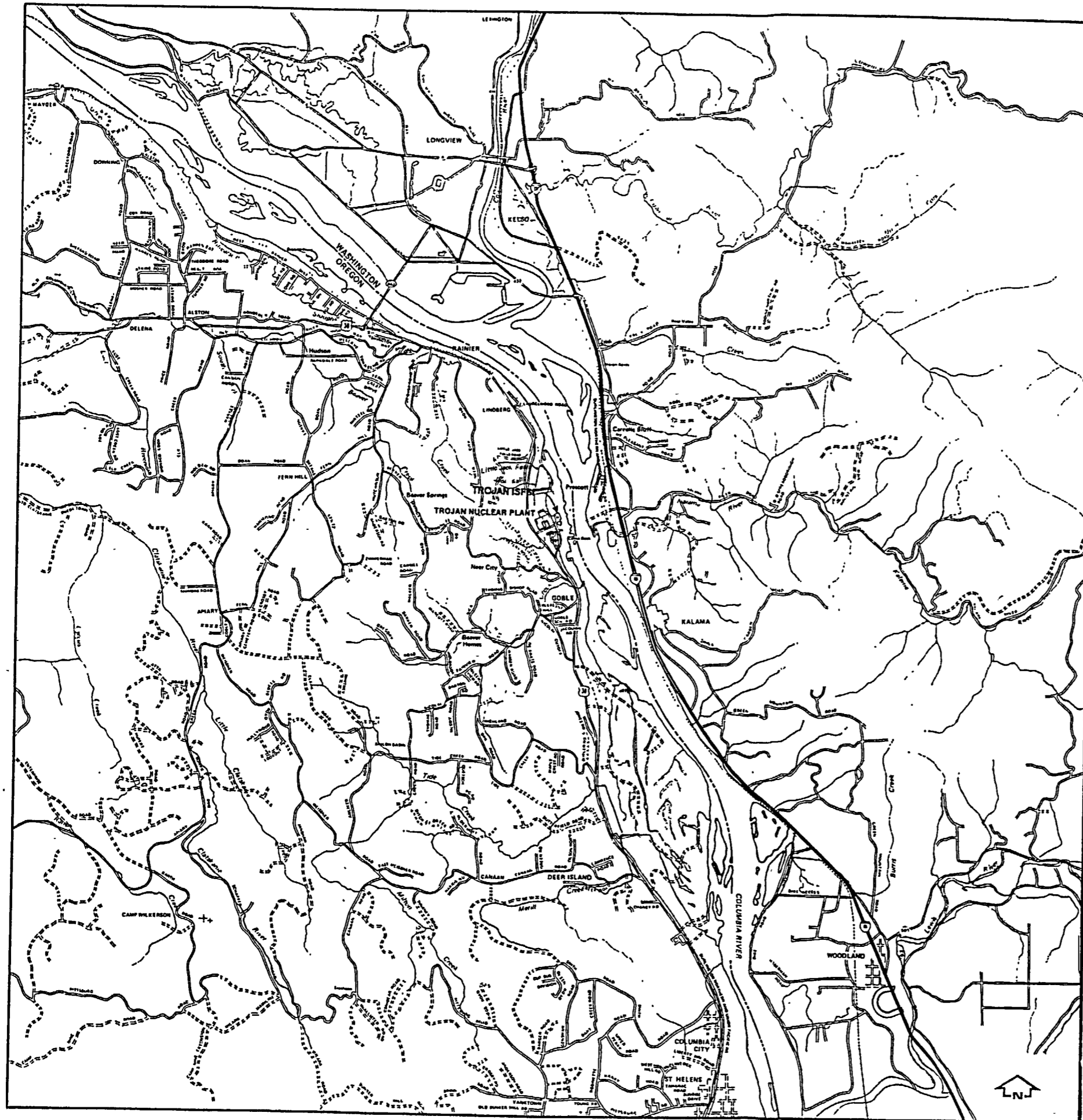
[c] Estimated



Table 2.7-1

Summary of Site Conditions Affecting Construction and Operating Requirements

<u>Parameter</u>	<u>Extreme Value Measured or Estimated</u>	<u>Design Value</u>
Ambient Temperature	-20°F minimum, 105°F maximum (Longview/Kelso, Washington) -3°F minimum, 107°F maximum (Portland, Oregon)	-40°F minimum 100°F maximum 125°F short term extreme
Tornado Winds/Pressure Drop	240 mph, maximum 190 mph, rotational 50 mph, translational 1.5 psi, pressure drop 0.6 psi/sec, rate of pressure drop (Regulatory Guide 1.76, Region III)	360 mph, maximum 290 mph, rotational 70 mph, translational 3.0 psi, pressure drop 2.0 psi/sec, rate of pressure drop
Maximum Flood Level	42.75 ft MSL (estimated - seismically induced dam failure with coincident wave runup)	None required - nominal ISFSI grade elevation is 46 ft MSL
Snow and Ice Loading	10 inches of snow in 24 hours (Longview/Kelso) 16 inches of snow in 24 hours (Portland)	100 psf ground load (12 inches of snow exerts from 1 to 6 psf)
Seismic Margin Earthquake	0.38g, horizontal acceleration (estimated) 0.25g, vertical acceleration (estimated)	0.38g, horizontal acceleration 0.25g, vertical acceleration



LEGEND

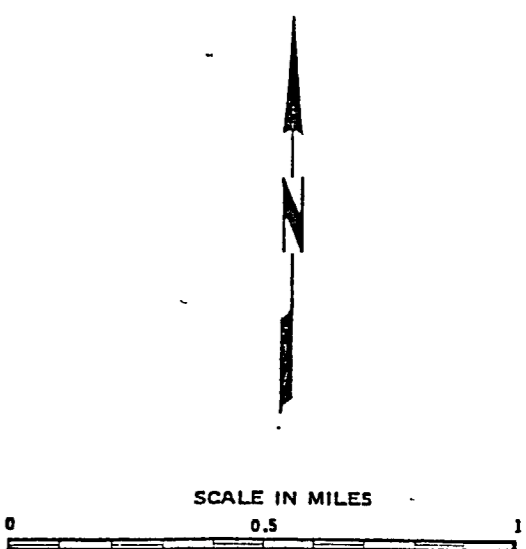
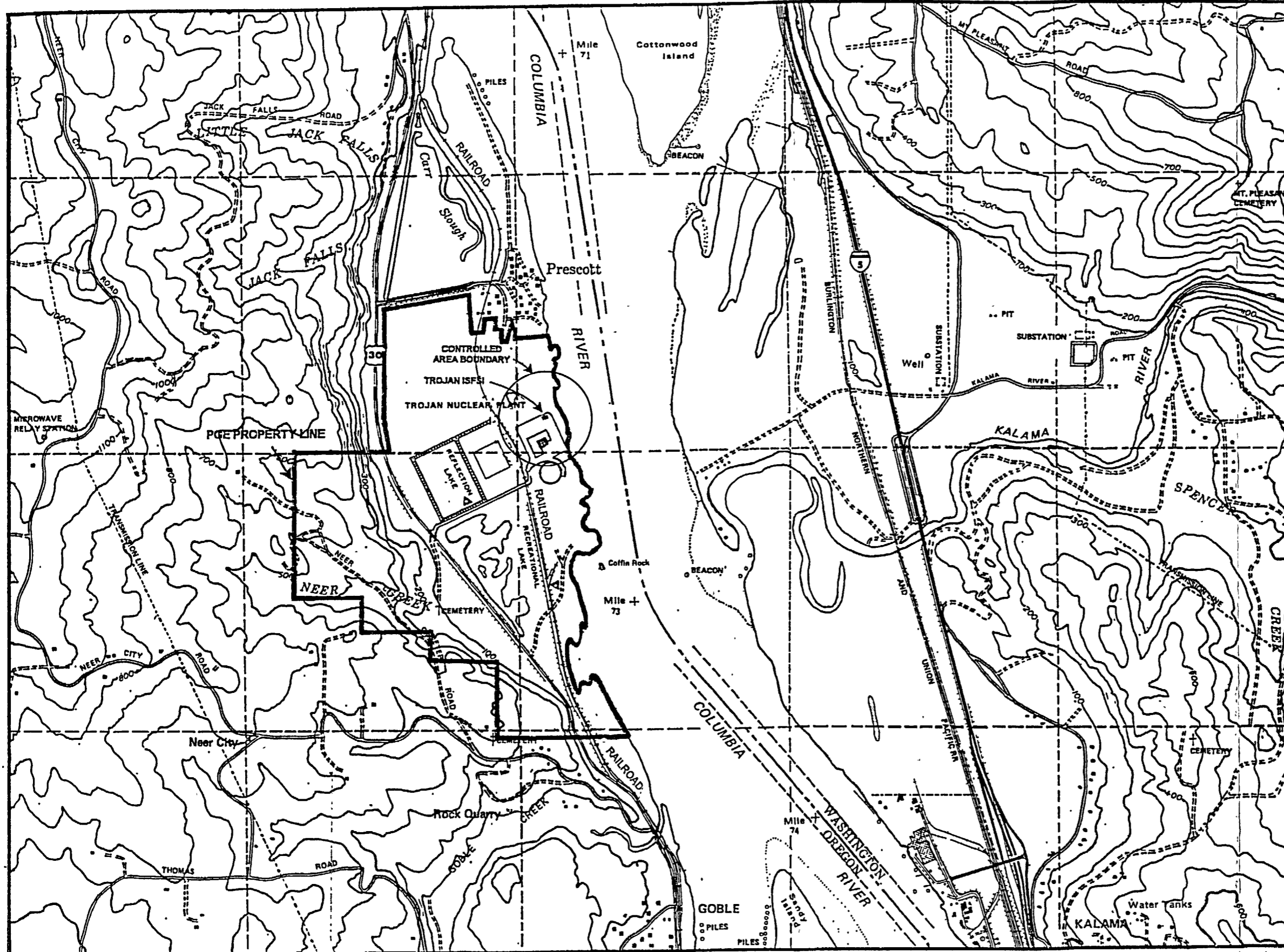
- HIGHWAY, HIGH TYPE
- HIGHWAY, LOW TYPE
- ALL WEATHER ROAD
- SECONDARY ROAD



0 1 2 3 4 5 miles

**TROJAN ISFSI
SAFETY ANALYSIS REPORT**

**FIGURE 2.1-1
SITE LOCATION**



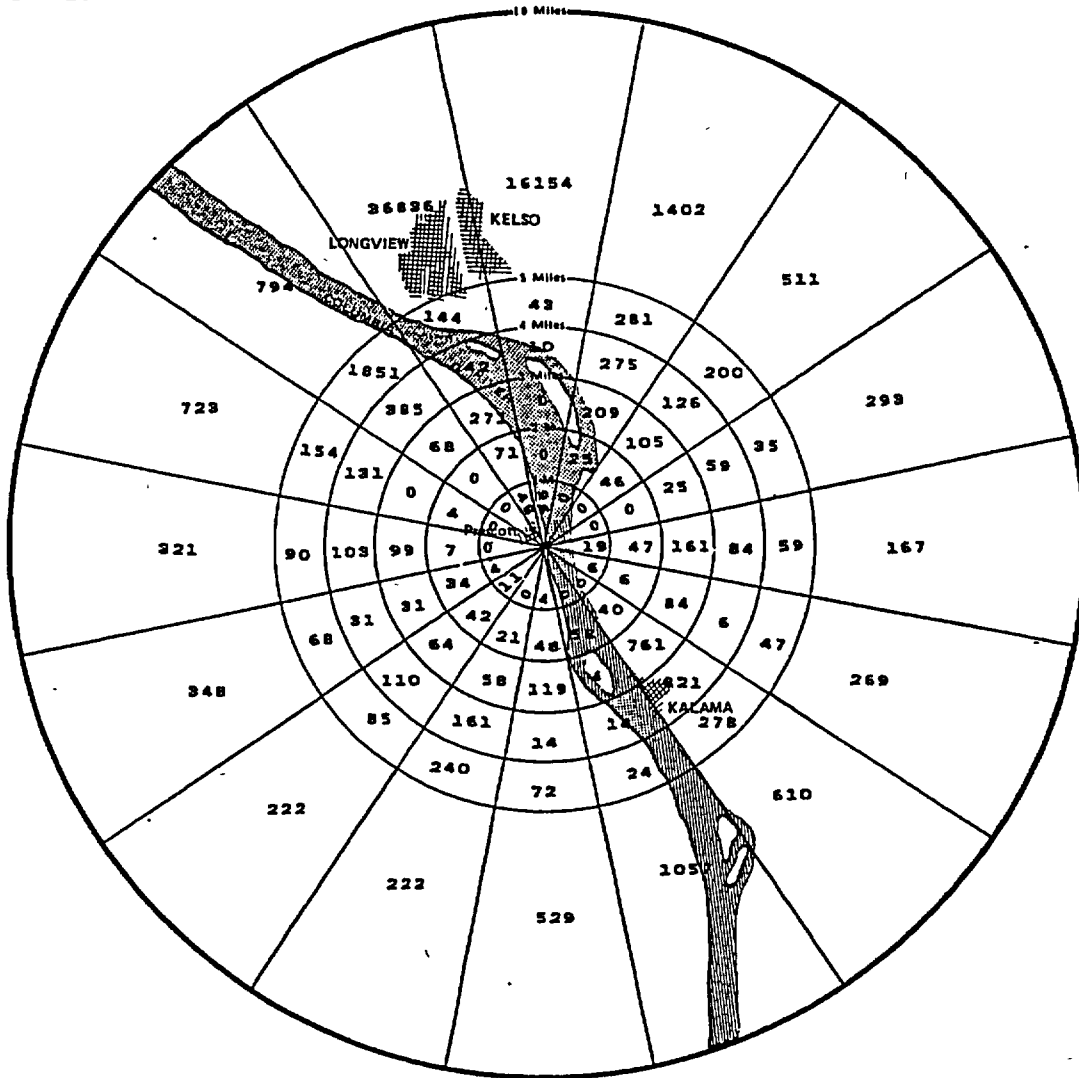
TROJAN ISFSI
SAFETY ANALYSIS REPORT

FIGURE 2.1-2
 PGE PROPERTY, ISFSI SITE, AND
 CONTROLLED AREA BOUNDARY
 Revision 2

POPULATION IN ANNULAR RINGS	
0 - 1	188
1 - 2	449
2 - 3	2059
3 - 4	2572
4 - 5	3671
5 - 10	60458



POPULATION WITHIN RADIAL DISTANCE of SITE	
1	188
2	637
3	2696
4	5268
5	8939
10	69397



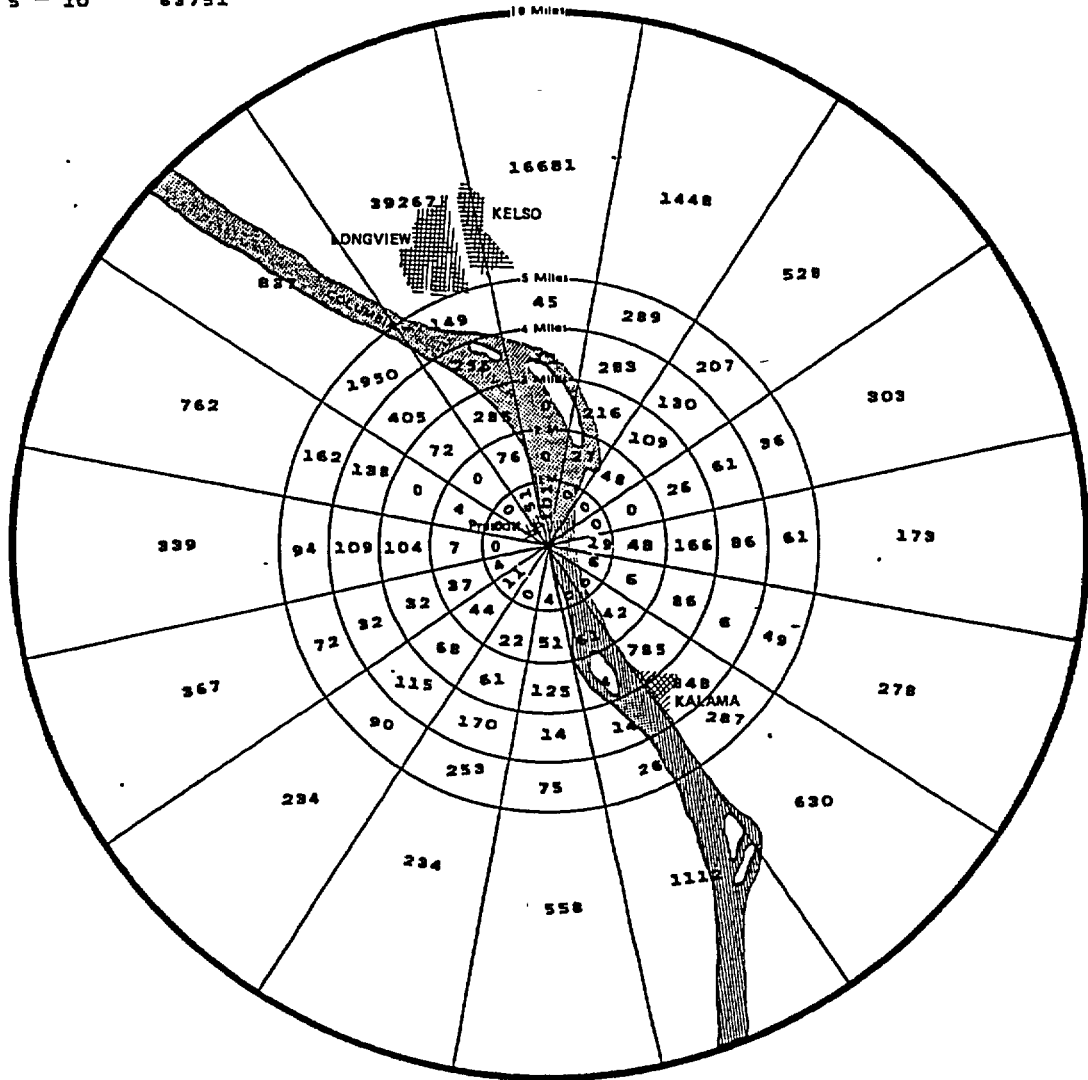
**TROJAN ISFSI
SAFETY ANALYSIS REPORT**

**FIGURE 2.1-5
2000 PROJECTED POPULATION
DISTRIBUTION WITHIN 10 MILES**

POPULATION IN ANNULAR RINGS	
0 - 1	196
1 - 2	473
2 - 3	2139
3 - 4	2677
4 - 5	3845
5 - 10	63751

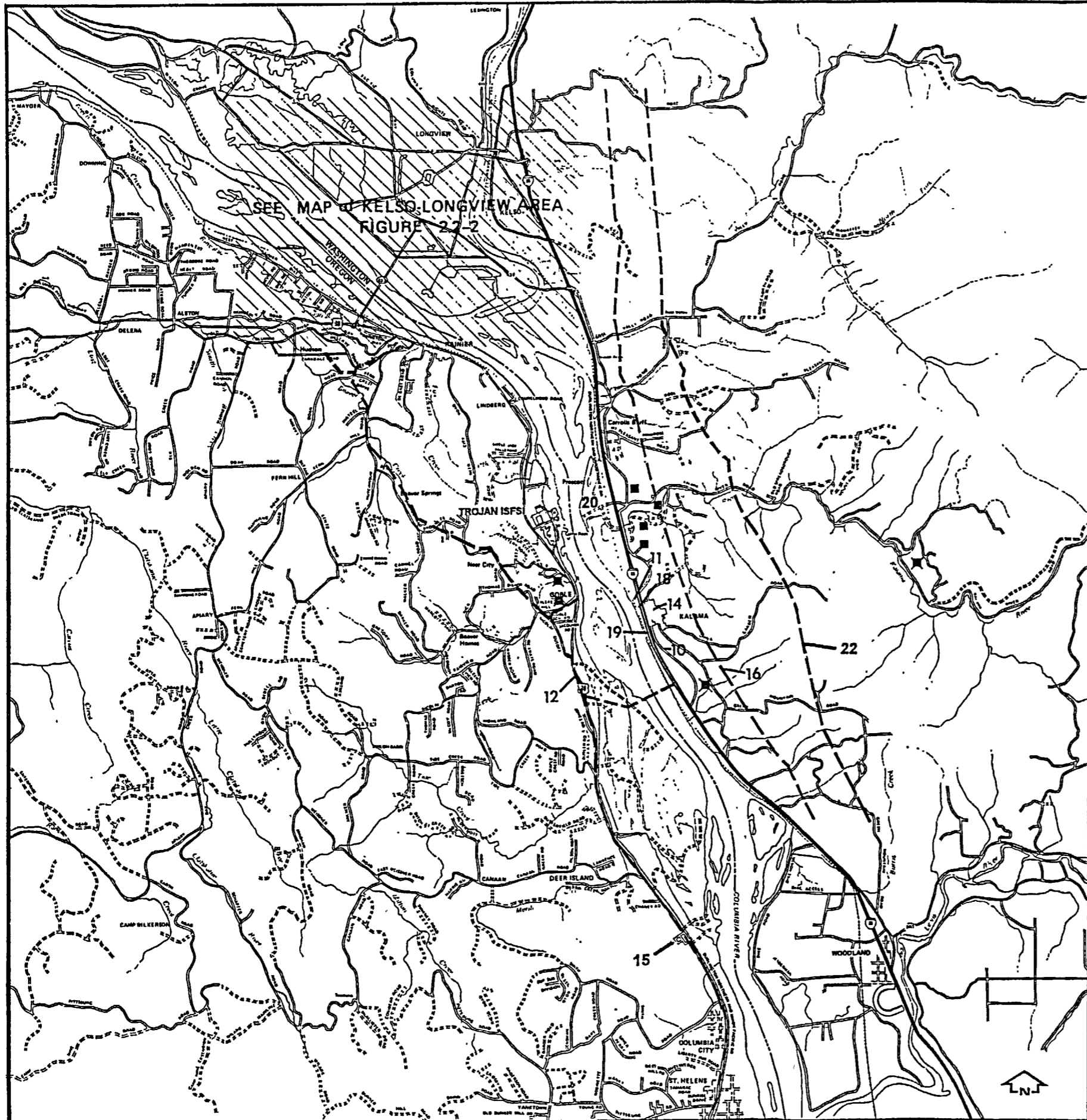





POPULATION WITHIN RADIAL DISTANCE of SITE	
1	196
2	669
3	2808
4	5485
5	9330
10	73081







TROJAN ISFSI
SAFETY ANALYSIS REPORT

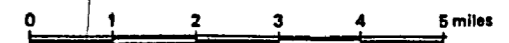
FIGURE 2.1-6
2010 PROJECTED POPULATION
DISTRIBUTION WITHIN 10 MILES



-  GAS or OIL TANKS
-  QUARRY
-  GRAVEL PIT

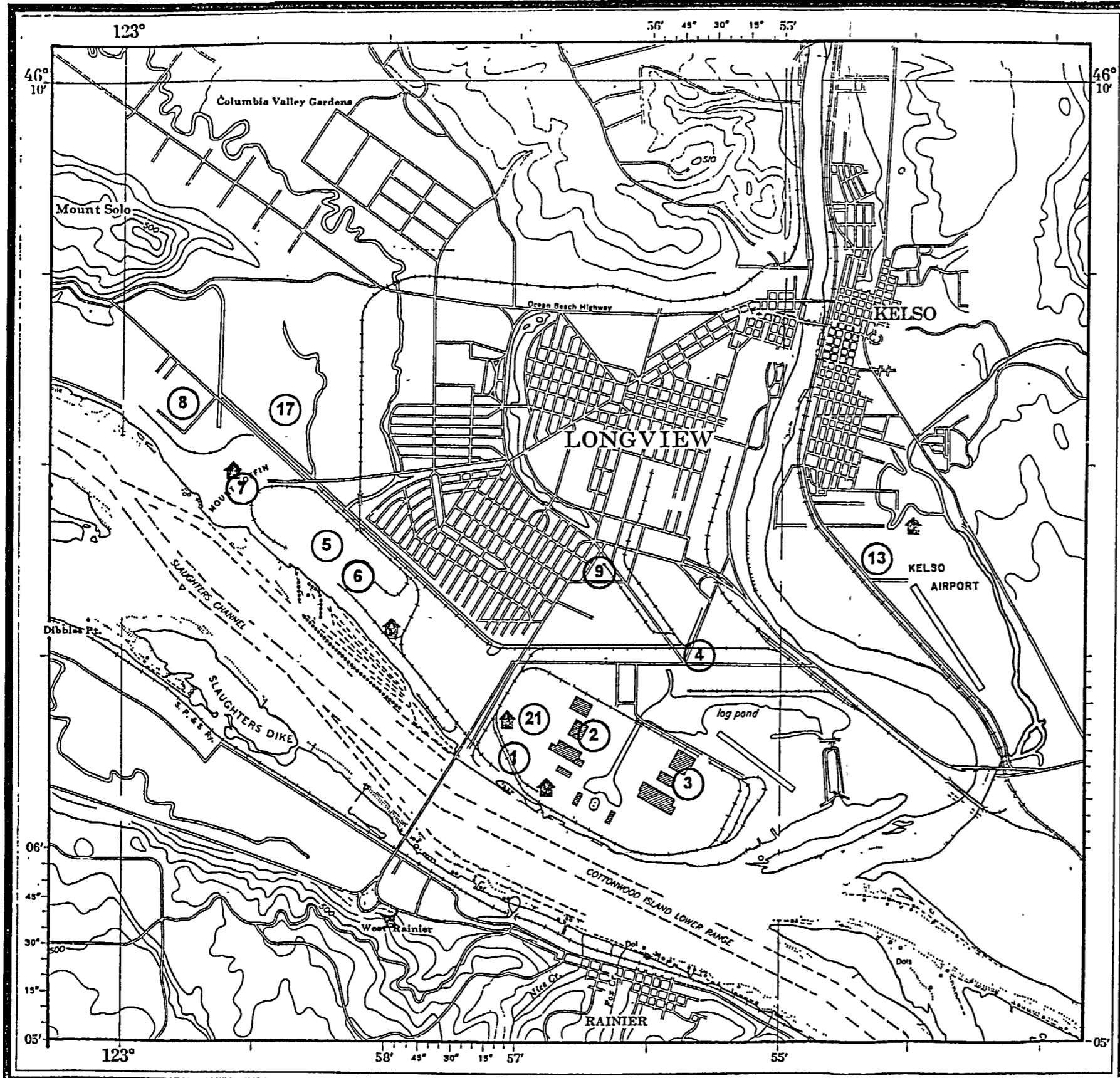
Note: Numbers Refer to Table 2.2-1



- LEGEND
- HIGHWAY, HIGH TYPE 
 - HIGHWAY, LOW TYPE 
 - ALL-WEATHER ROAD 
 - SECONDARY ROAD 



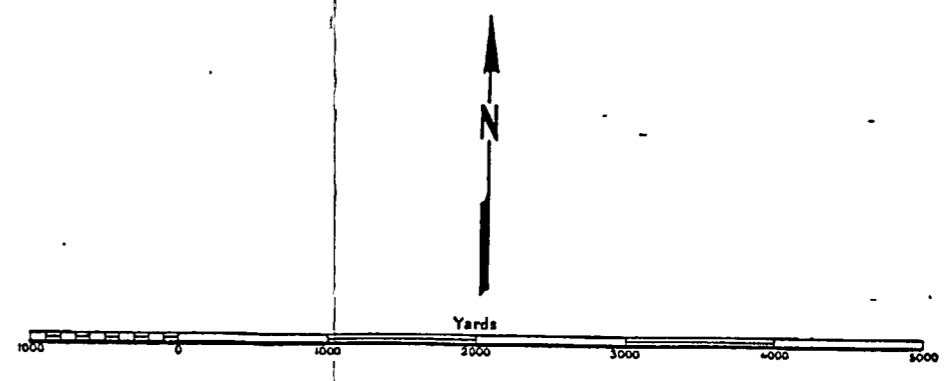
TROJAN ISFSI
SAFETY ANALYSIS REPORT

FIGURE 2.2-1
NEARBY INDUSTRIAL ACTIVITY



 GAS or OIL TANKS
 QUARRY

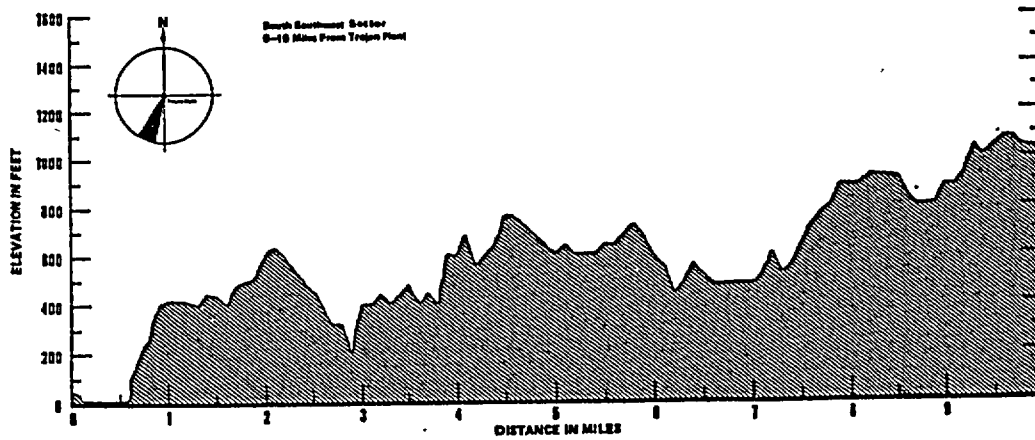
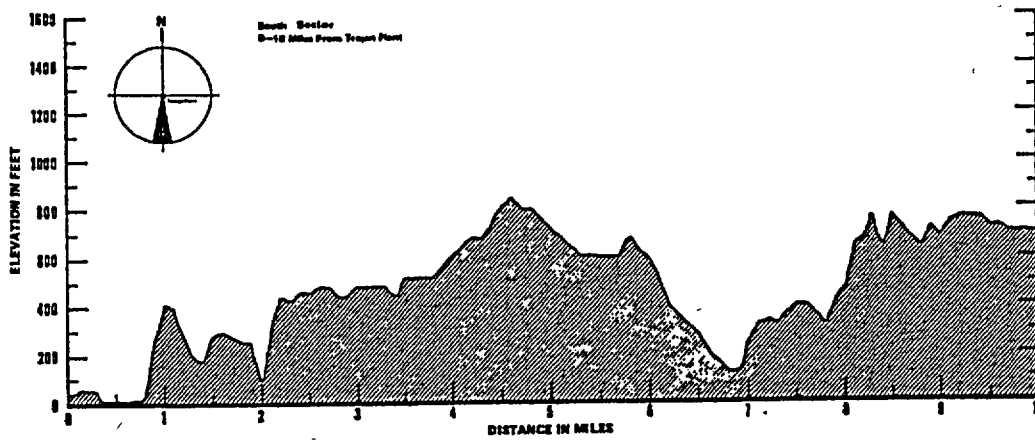
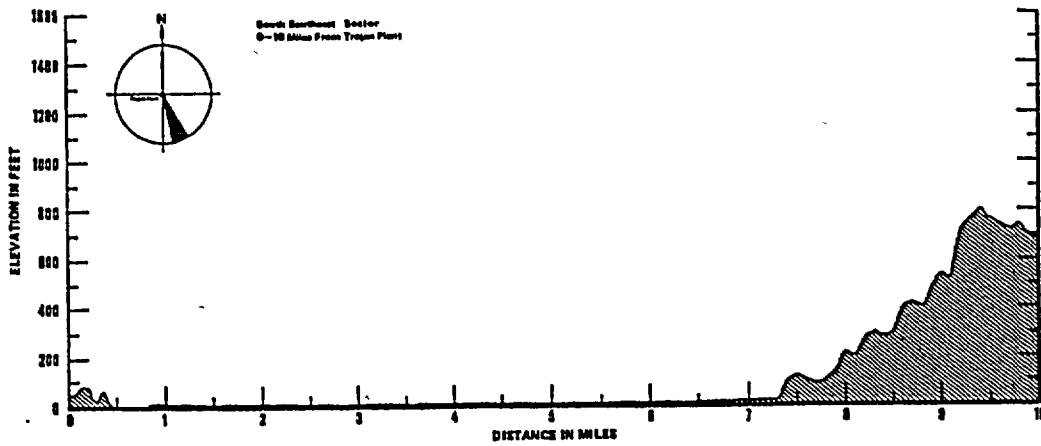
Note: Numbers Refer to Table 2.2-1



TROJAN ISFSI
 SAFETY ANALYSIS REPORT

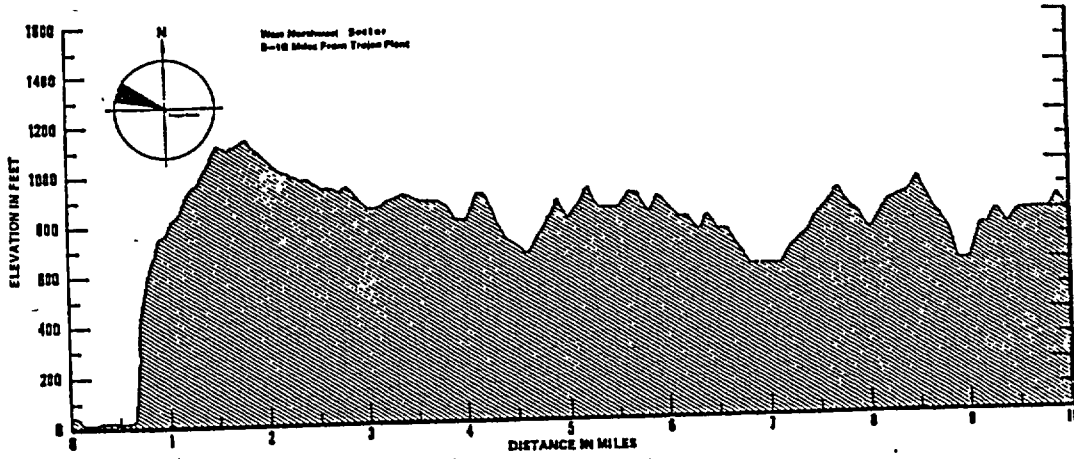
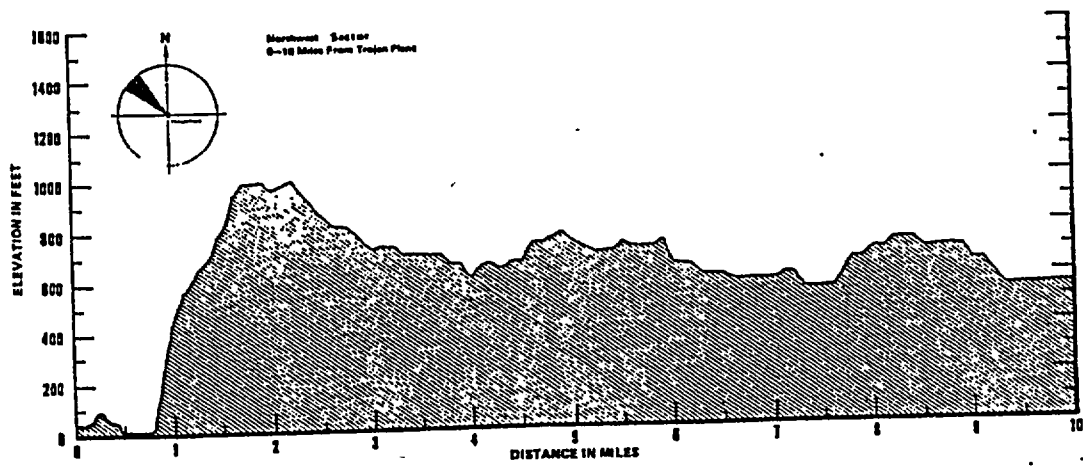
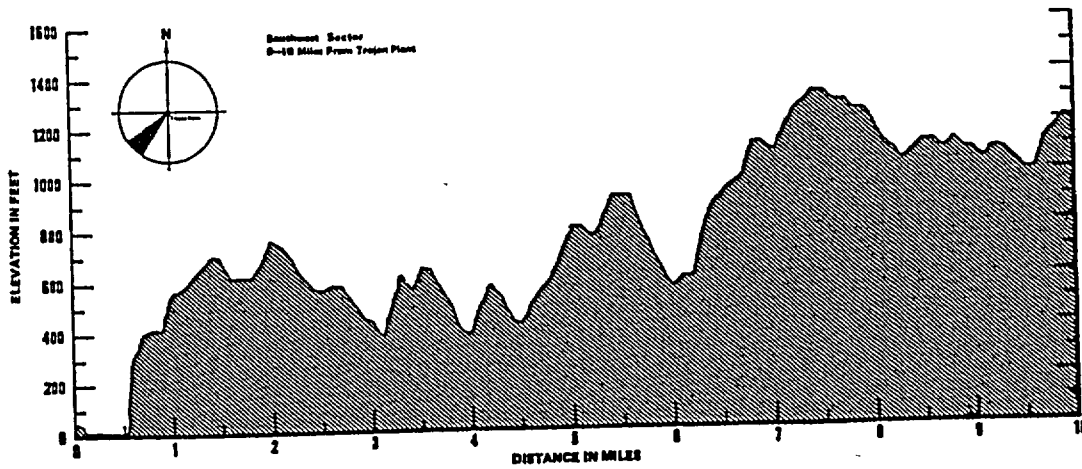
FIGURE 2.2-2
 LONGVIEW AREA
 INDUSTRIAL ACTIVITY

Source: U.S. Coast and Geodetic Survey 68



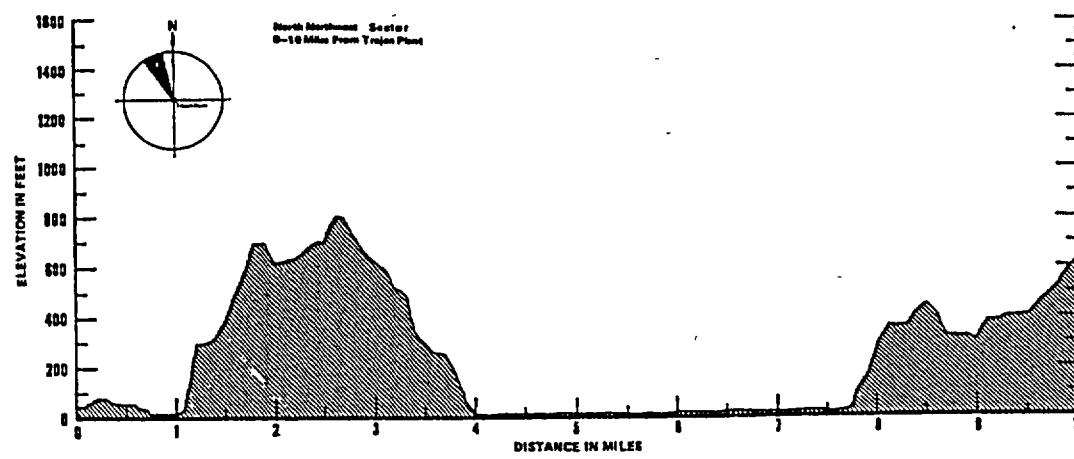
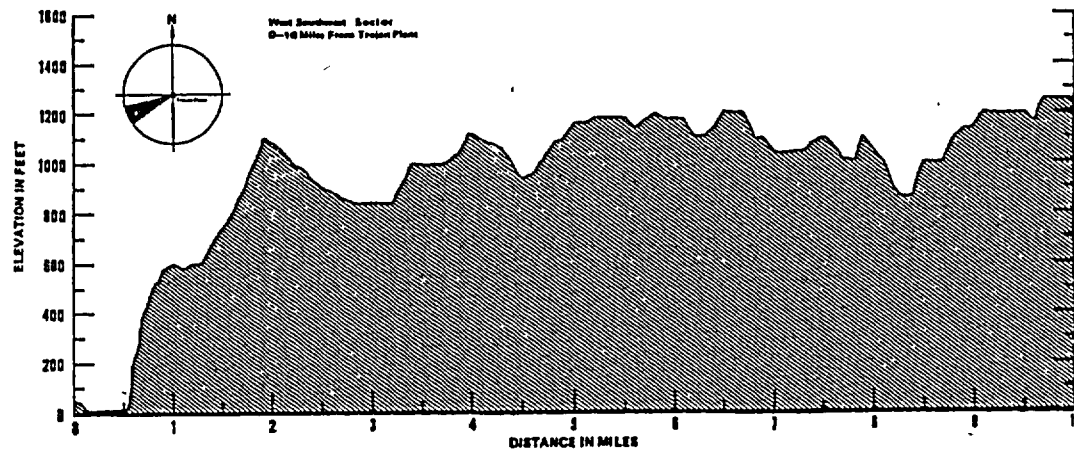
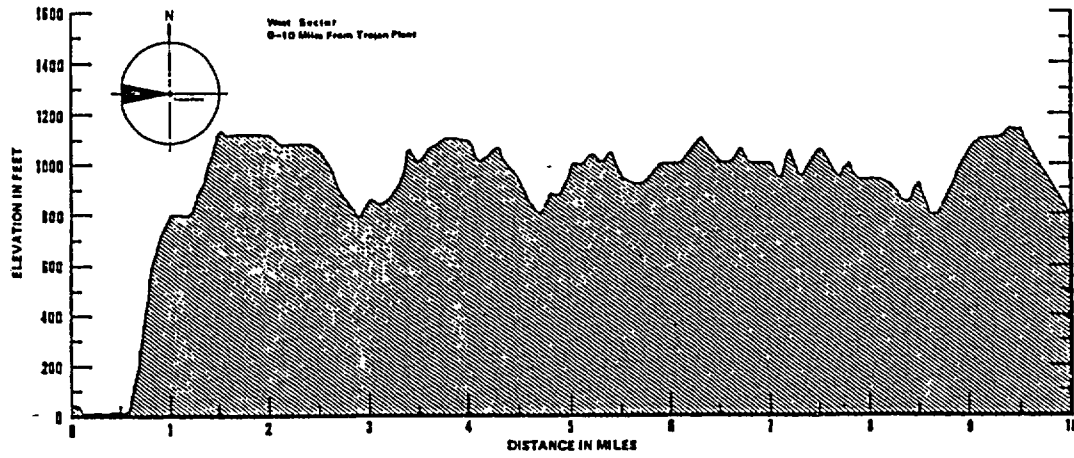
**TROJAN ISFSI
SAFETY ANALYSIS REPORT**

**FIGURE 2.3-1
TOPOGRAPHICAL CROSS SECTIONS
(MAXIMUM ELEVATIONS)
SSE, S, SSW**



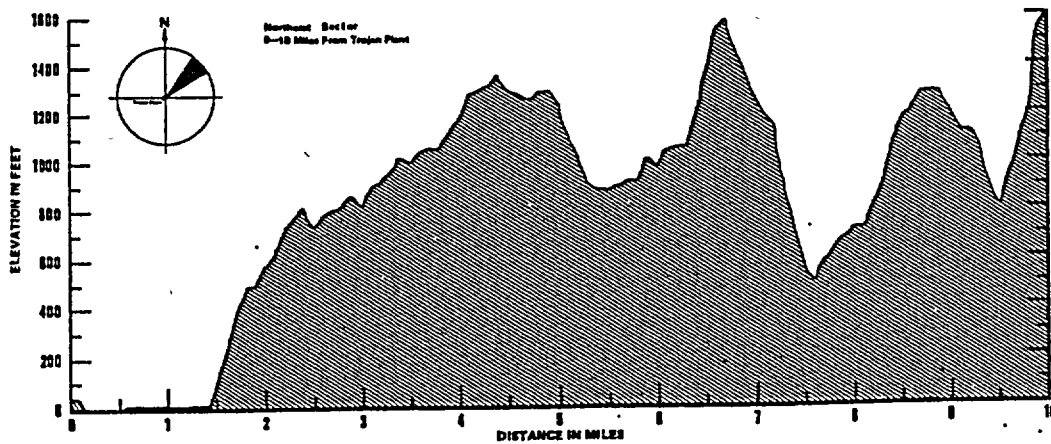
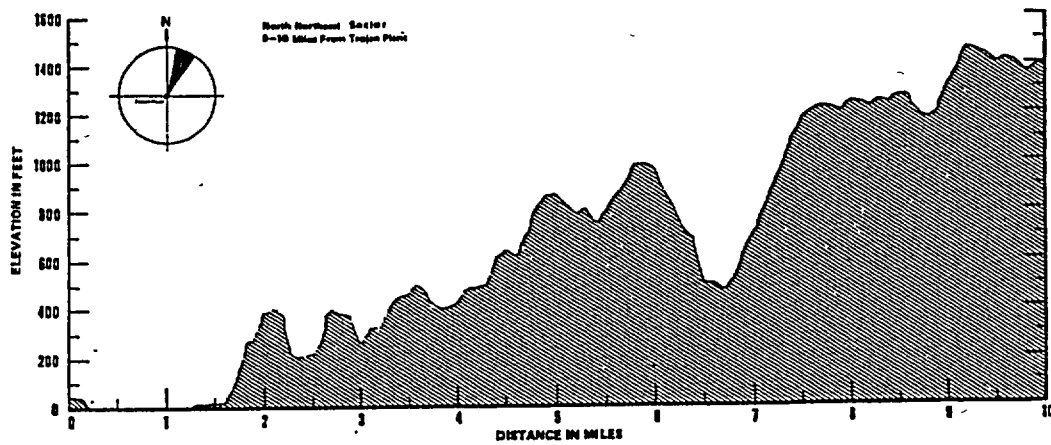
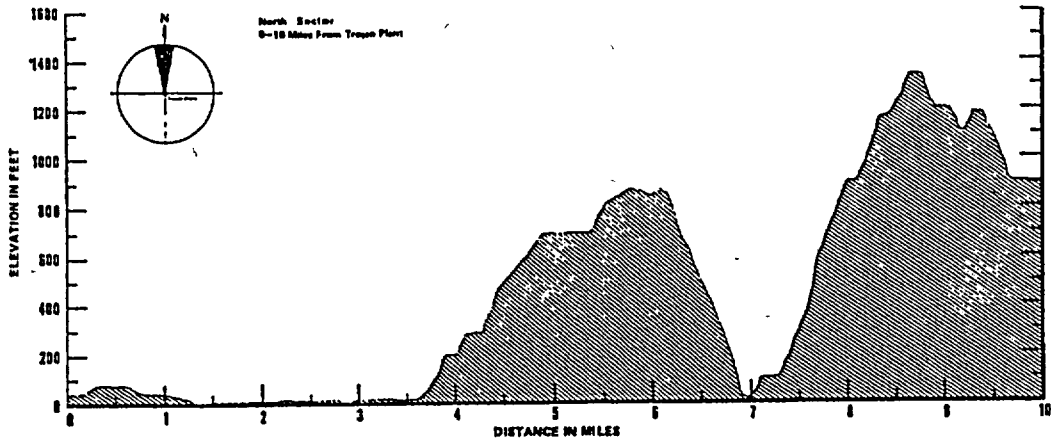
**TROJAN ISFSI
SAFETY ANALYSIS REPORT**

**FIGURE 2.3-2
TOPOGRAPHICAL CROSS SECTIONS
(MAXIMUM ELEVATIONS)
SW, NW, WNW**



TROJAN ISFSI
SAFETY ANALYSIS REPORT

FIGURE 2.3-3
TOPOGRAPHICAL CROSS SECTIONS
(MAXIMUM ELEVATIONS)
W, WSW, NNW



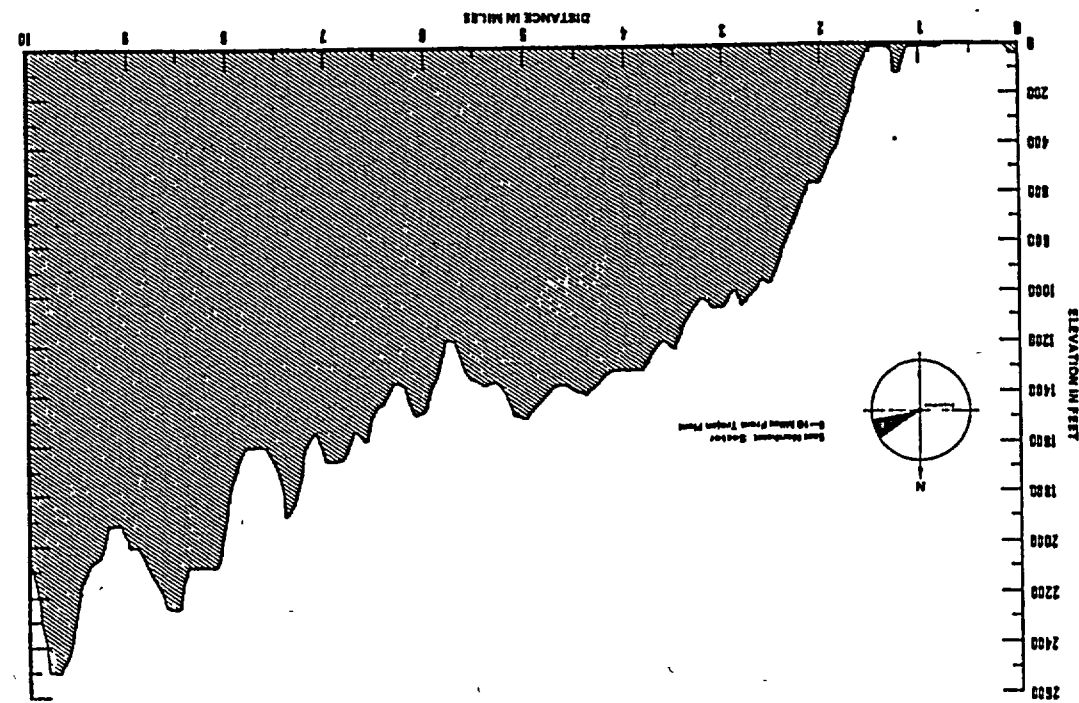
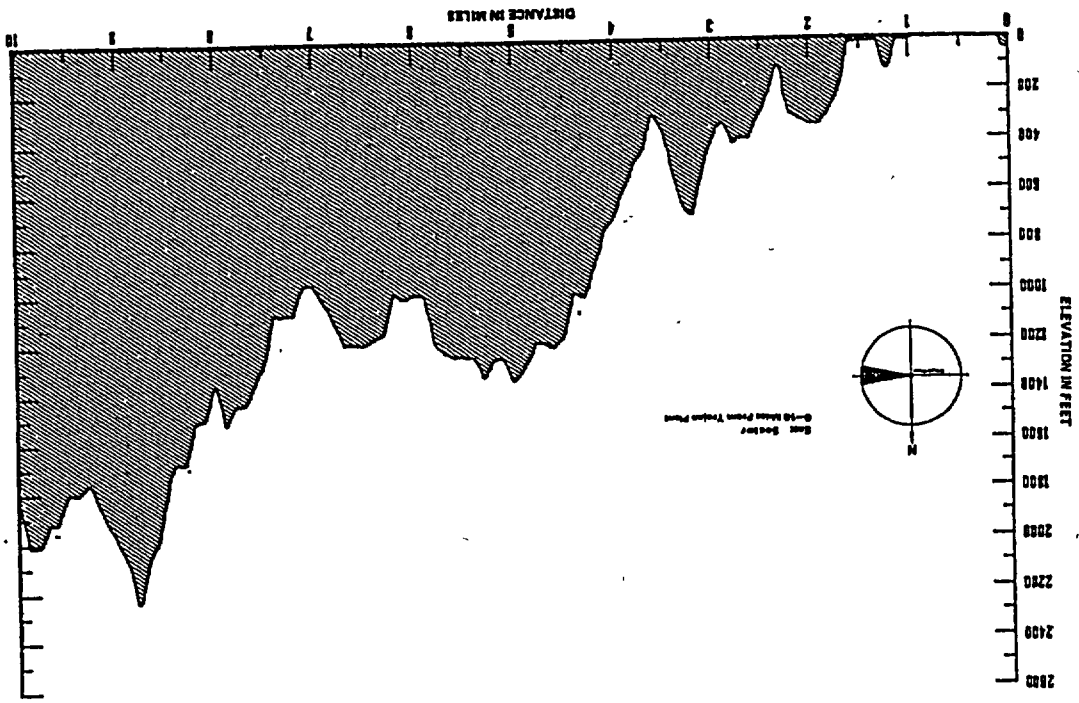
**TROJAN ISFSI
SAFETY ANALYSIS REPORT**

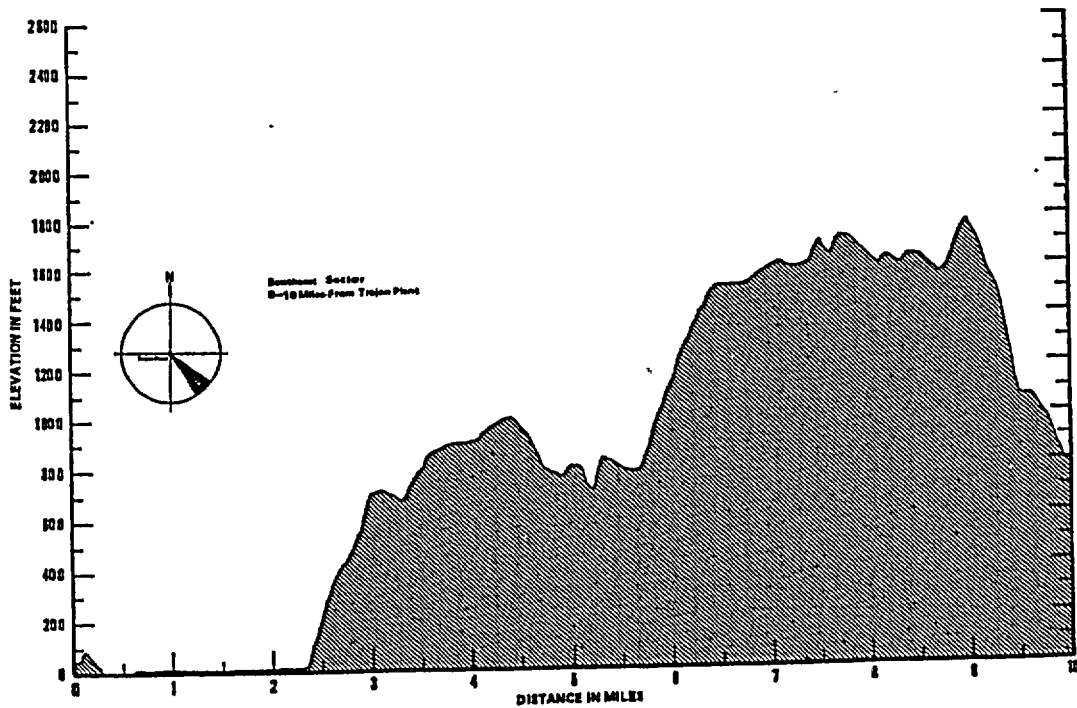
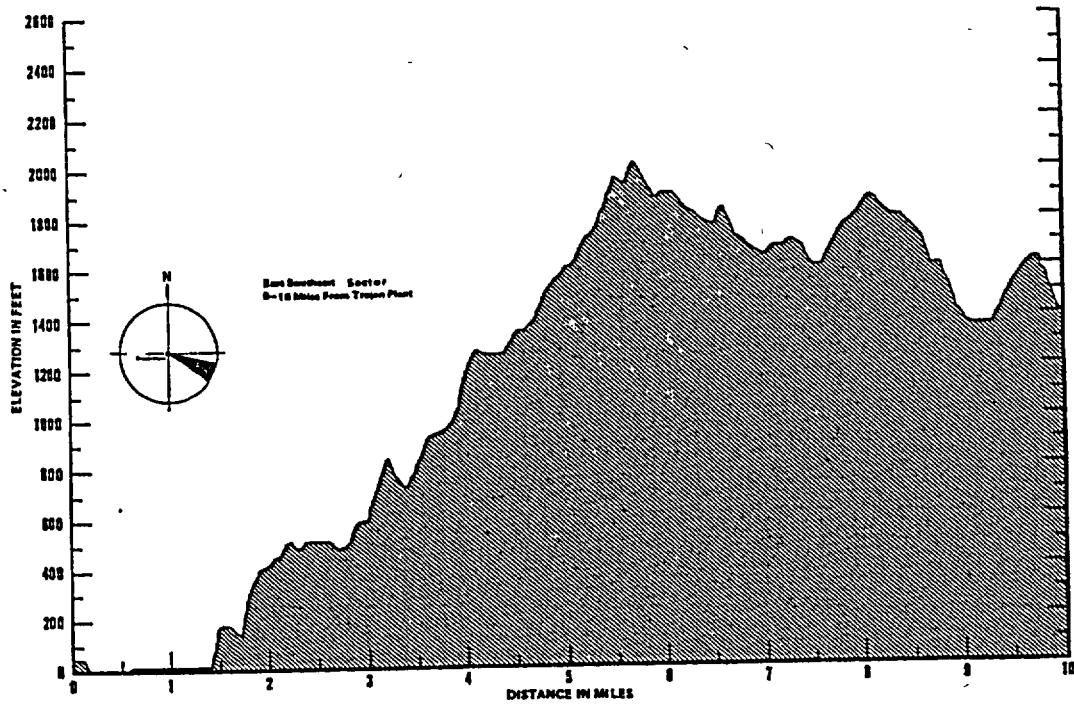
**FIGURE 2.3-4
TOPOGRAPHICAL CROSS SECTIONS
(MAXIMUM ELEVATIONS)
N, NNE, NE**

ENE, E
(MAXIMUM ELEVATIONS)
TOPOGRAPHICAL CROSS SECTIONS

FIGURE 2.3-5

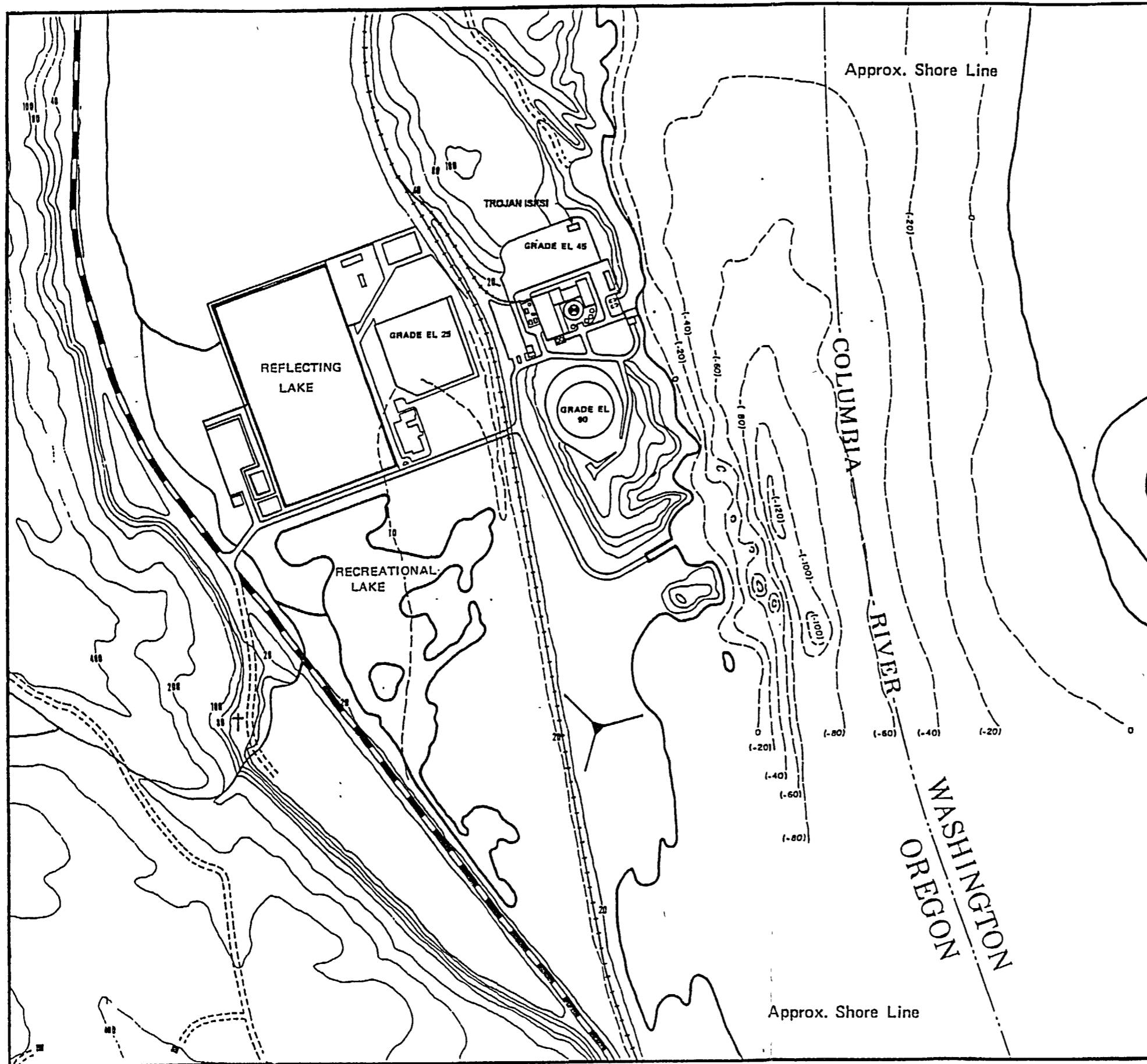
TRAJAN ISFSI
SAFETY ANALYSIS REPORT





**TROJAN ISFSI
SAFETY ANALYSIS REPORT**

**FIGURE 2.3-6
TOPOGRAPHICAL CROSS SECTIONS
(MAXIMUM ELEVATIONS)
ESE, SE**

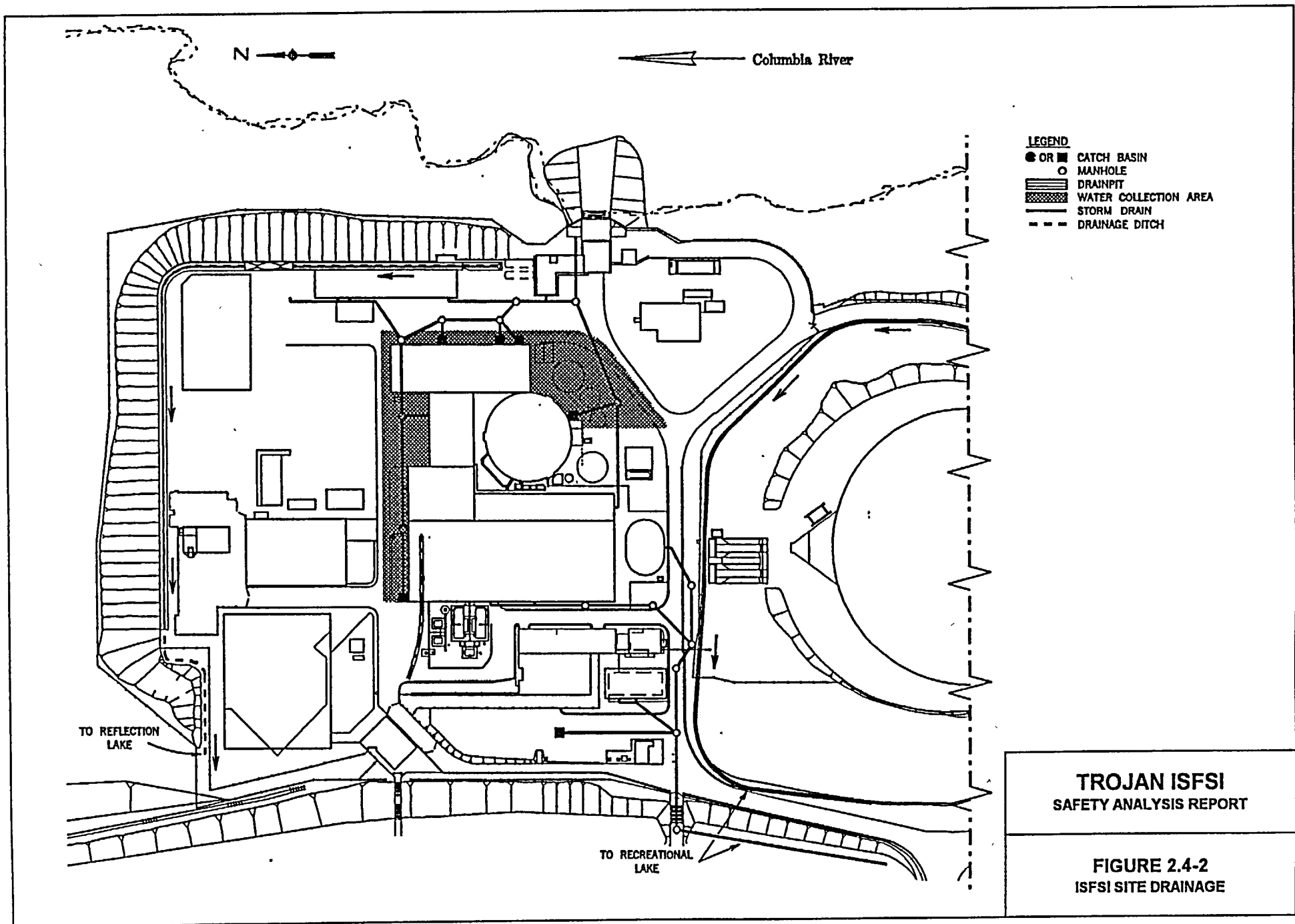


CONTOUR INTERVAL 100 FEET EXCEPT AS NOTED
 CONTOUR LINES DASHED WHERE APPROXIMATE



TROJAN ISFSI
 SAFETY ANALYSIS REPORT

FIGURE 2.4-1
 ISFSI TOPOGRAPHY



- LEGEND**
- OR ■ CATCH BASIN
 - MANHOLE
 - ▭ DRAINPIT
 - ▨ WATER COLLECTION AREA
 - STORM DRAIN
 - - - DRAINAGE DITCH

**TROJAN ISFSI
SAFETY ANALYSIS REPORT**

**FIGURE 2.4-2
ISFSI SITE DRAINAGE**