DOE/EA-1570

FINAL

ENVIRONMENTAL

ASSESSMENT

Environmental Assessment for
Construction and Operation of Neutrinos at the Main Injector Off-Axis Electron Neutrino (ν_e) Appearance Experiment (NOνA) at the Fermi National Accelerator Laboratory, Batavia, Illinois, and St. Louis County, Minnesota

U.S. Department of Energy, Lead Agency
Fermi Site Office
Batavia, IL

U.S. Army Corps of Engineers, Cooperating Agency
St. Paul District
St. Paul, MN

June 2008

(DOE/EA-1570)

DISCLAIMER

SUMMARY

Introduction. This Environmental Assessment (DOE/EA-1570) provides information and analysis of proposed U.S. Department of Energy (DOE) activities associated with constructing and operating facilities for a new neutrino physics research program called NO*ν*A. The NO*ν*A Collaboration is composed of almost 200 scientists and engineers from nearly 30 Universities and Laboratories around the world. The Fermi National Accelerator Laboratory (Fermilab) is the lead laboratory for the DOE, and the University of Minnesota is the lead collaborating university through a Cooperative Agreement with the DOE. The program would generate neutrinos at Fermilab in Batavia, Illinois, for analysis in proposed detectors at Fermilab and at a Far Detector Facility proposed to be built near the Ash River, in St. Louis County, Minnesota.

NOvA activities at the Ash River site entail a wetlands action that requires a permit from the U.S. Army Corps of Engineers (USACE). Consequently, this EA incorporates a wetlands assessment, and the USACE is a Cooperating Agency in this EA. Information contained in this EA will be used by the DOE Office of Science (DOE-SC) and the USACE to determine if the proposed action is a major federal action significantly affecting the quality of the environment.

Purpose and Need. Neutrinos are uncharged, non-ionizing elementary particles that only rarely interact with ordinary matter. The study of the oscillation of neutrinos from one type to another is considered a good way to study important physics questions, such as the properties of the weak interaction, neutrino mass, the contribution of neutrinos to the Dark Matter in the Universe, and the relationship between matter and antimatter. Understanding these particles is an important goal of the worldwide physics community, and operation of the NO*ν*A facility would implement the DOE Office of Science mission.

Proposed Action and Alternatives. The major proposed actions of the NO*ν*A Project consist of the facility modification and construction at both the Fermilab site and in St. Louis County, MN (the Ash River site). The region between the two sites would not be affected by construction, operation, or decommissioning of the proposed action.

Proposed activities at Fermilab include an upgrade of the existing Fermilab accelerator complex with an increase of beam power in the Main Injector. A new underground cavern would be excavated at approximately 345 feet below grade adjacent to an existing tunnel. This new cavern requires a modest excavation of about 1,000 cubic yards of rock using conventional civil construction and mining techniques. The cavern would hold a new 222-ton "Near Detector" to monitor the neutrino beam as it leaves the Fermilab vicinity. Two temporary facilities would be employed aboveground. Early in the program a 90-ton prototype detector would be assembled in an existing Fermilab facility to provide development and optimization for the neutrino detector. To support the blending of approximately 4.2 million gallons of scintillation detector fluid a blending facility would be constructed at Fermilab or a commercial blender near Chicago would be contracted. A constituent in the blending operation would be pseudocumene, a toxic organic liquid at approximately 5% of the total volume. Blended scintillation fluid would be transported by tanker truck from the blending facility to the Ash River site.

A proposed new NOνA "Far Detector" Facility would be constructed on a site near the US-Canadian border in St. Louis County, MN. Construction would entail a new building with dimensions 67 feet wide by 375 feet long, which would be sunk 40 feet below the existing grade into granite rock. Site preparation would include improvement to an existing logging road to facilitate all-weather access. A proposed 20,000-ton Far Detector would be constructed in part of the new building with components identical to the ones used in the Near Detector, but with dimensions, number and total volume scaled to the larger size.

The proposed action consists of four main activities: (1) excavation and construction; (2) scintillator blending, detector assembly and testing; (3) performance of the NOνA experiment, and (4) decommissioning. The schedule for the proposed action has construction/excavation and assembly starting in 2008. Construction and assembly would continue through 2013. Experiment performance would begin on parts of the devices during the construction period, but sustained operations would begin in 2013 and continue through at least 2019. Following achievement of experiment objectives, decommissioning would occur over a several-year period.

Affected Environment. The existing accelerator complex at Fermilab forms the infrastructure framework upon which the proposed NOνA Experiment would be built. The Fermilab site is located 61 kilometers (38 miles) west of downtown Chicago, Illinois. Its 6,800 acres straddle the boundary between eastern Kane and western DuPage counties in an area of mixed residential, commercial, and agricultural land use with a 2000 Census population of approximately 1,300,000 persons. The Fermilab facilities are a light-industrial setting supporting high-energy research, including underground accelerator rings and beam tunnels, and the Central Laboratory Area. At Fermilab, approximately 1,600 acres have remained in crop production, and about 1,000 acres have been planted in native prairie vegetation. The mixture of vegetation communities makes the Fermilab site a desirable refuge for many species of animals and many bird species use the site as a stopover during spring and fall migration.

The United States Environmental Protection Agency has designated the area within which Fermilab resides as a non-attainment area in the northeastern part of Illinois for the 8-hour ozone standard and the PM-2.5 standard (particulate matter having a median aerodynamic diameter less than 2.5 micrometers) where there are lower thresholds for air emissions of volatile organic compounds and nitrogen oxides.

The proposed location for the NOνA Far Detector Facility is a currently undeveloped parcel of land about 25 miles southeast of International Falls, MN and approximately 1 mile from the boundary of Voyageurs National Park. At closest approach, the detector building would be approximately 1,000 feet from the nearest point of the Ash River, which discharges into Lake Kabetogama about 2.8 miles away. According to the 2000

Census the population density in the vicinity of the site is approximately 1 person per square mile.

No prime farm land, scarce geological resources, surface water bodies, or floodplains are within the proposed 89.6-acre Far Detector site. The approximately 3-mile long, 18.9-acre access road corridor to the proposed site would follow an existing logging road and pass through a wetlands area just as it leaves St. Louis County Road 129. The proposed site has been primarily utilized for timber cutting operations in the past, and no old growth forest exists on the property. The majority of the site has been recently clear-cut and is devoid of tree cover. During recent biological surveys, five occurrences of federal or state threatened or endangered species or critical habitats were observed within 1.5 miles of the site, but none within the site boundary or access corridor.

Environmental Impacts of Proposed Action. Any environmental impact at Fermilab would affect sites that are in use or have been used for other purposes. Impacts on air quality, local traffic and noise levels associated with construction of the proposed NO*ν*A facilities would be temporary. The proposed construction site at Fermilab is not known to contain sensitive biological resources or habitats that would be affected by construction. Labor staffing during construction would be a small fraction of the worker population accessing Fermilab under existing conditions. Effluents and wastes generated during construction would be minimized to the extent practicable and would be managed using existing facilities and procedures. Off-property impacts of the proposed action would be limited to the areas immediately adjacent to the Fermilab property boundary, where minority or low-income residents are not disproportionately congregated. Health and safety risks to workers and members of the public from construction activities are projected to be small.

Changes in work activities at Fermilab related to the operational phase of the proposed project are few. Increasing the Main Injector beam power would increase estimated radionuclide emissions and tritium in ground water. Such increases could be expected to marginally increase the potential estimated dose rate to workers with minimal offsite impacts. Increased beam power would also lead to increased activity and external dose rates from activated components. “Increased dose rates” refers to the potential for dose. DOE does not anticipate an actual increased dose to workers or the public, since engineered and administrative barriers would control exposure. Fermilab currently has an effective radiation exposure control program that would continue under the proposed action operations.

Because the Ash River site proposed for the Far Detector Facility is currently undeveloped, the proposed project would change the appearance and current use of the site. The project would include clearing, grading and excavation disturbing greater than 5 acres, and would comply with a permit issued for the discharge of storm water associated with construction activity under the National Pollutant Discharge Elimination System as implemented by the Minnesota Pollution Control Agency. The site design would minimize potential impacts to surface water. During construction there would be short-term, localized impacts on air quality from vehicular traffic exhausts and earth-moving operations, similar to construction of any commercial facility of comparable size.

Construction of the access road would result in filling approximately 3.5 acres of wetlands, requiring a permit from the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act and conformance with the requirements of the Wetland Conservation Act of Minnesota. Approximately 5.2 acres of banked wetlands would be purchased to mitigate impacts to existing wetlands due to excavation and construction at the Far Detector site. Under Executive Order 11988, *Floodplain Management*, and Executive Order 11990, *Protection of Wetlands*, Federal agencies are required to consider the impact of proposed actions on wetlands and floodplains. The DOE requirements for compliance with Executive Orders 11988 and 11990 are found in Title 10, *Code of Federal Regulations* (*CFR*), Part 1022, "Compliance with Floodplain/Wetlands Environmental Review Requirements." A wetland assessment is included in this EA, and satisfies all the requirements of 10 *CFR* 1022. The wetlands permitting process has not been completed due to a U.S. Army Corps of Engineers requirement to first have NEPA documentation in place.

Concerns over the potential for archeological resources to be present in the project area at the Ash River site led DOE and the University of Minnesota to coordinate with the Minnesota State Historic Preservation Office and several Native American Tribes with interests in Northern Minnesota. As a result of the consultation under Section 106 of the National Historic Preservation Act, DOE prepared an Analysis of Effects Report. Subsequently, a programmatic agreement was negotiated to perform an archeological survey of the project area in the spring of 2008, prior to construction. The survey would include further investigation of historical resources, including both architectural and cultural resources. The parties to the agreement include the Minnesota State Historic Preservation Officer, the Bois Forte Band of Minnesota Chippewa Tribal Historic Preservation Officer (THPO), the White Earth Band of Minnesota Chippewa THPO, and the DOE. Other invited signatories include the University of Minnesota and the National Park Service, Voyageurs National Park.

Design criteria would be defined to minimize the visual impact of any portion of the Far Detector building that might be visible from Voyageurs National Park. The Far Detector building, which would have an above-ground height of approximately thirty-seven feet or approximately two stories, would not include any windows facing north to minimize reflected sunlight. An earthen berm with native grasses would surround much of the Far Detector building up to the roof line. Exterior colors for all buildings would be muted grays and browns. All north facing building walls would be in neutral colors to decrease contrast and visibility. Native plants and trees would be planted to soften the outlines of all buildings. In addition, the NO*ν*A Project would work with the National Park Service to design additional measures to screen or soften the appearance of the site buildings.

With 100% secondary containment of liquid scintillator and other liquids at every stage of the assembly and installation process, there should be no impact to ground water at the Ash River site during assembly, installation and operation. The adhesive that would be used to assemble the detector modules contains methyl methacrylate (MMA), a volatile organic compound and a federal hazardous air pollutant. The health and safety plan developed for the project would detail the proposed ventilation controls intended to comply with occupational and environmental concentration standards. Site workers and contractors would conduct work under a University of Minnesota site health and safety plan and procedures for installation and assembly operations.

Some impacts to employees would be expected from the installation and assembly or operation of the NO*v*A experiment. The multiple shipments of materials via truck, tanker or rail car on and between the project sites are subject to routine traffic accidents and accidental spills. Based upon traffic accident statistics, one accident and one injury are expected during materials transportation. Nine accidents and two injuries are expected during worker commutes. Not transportation fatalities are expected. Occupational Safety and Health Administration (OSHA) reportable cases would be approximately 19, or about 1-2 per year of project schedule.

The spill of methyl methacrylate (MMA) or pseudocumene in an accident during delivery from the distributor to the NO*v*A Project in a wetland or other sensitive area could impact exposed sensitive species. While an accident during transport has a calculable probability of *occasional* (approximately 0.03~0.04), the probability that an accident would occur that also causes a spill at an environmentally sensitive area would be several orders of magnitude less (1E-04).

Table of Contents

SUMMARY .... **iii**

GLOSSARY .... **xii**

DEFINITION OF TERMS .... **xvi**

CONVERSION CHART .... **xx**

SCIENTIFIC NOTATION CONVERSION CHART .... **xxi**

1. INTRODUCTION **1**

1.1 NATIONAL ENVIRONMENTAL POLICY ACT COMPLIANCE 1
1.2 COMPLIANCE WITH WETLAND ENVIRONMENTAL REVIEW 3
1.3 DOE OFFICE OF SCIENCE AND FERMILAB RESEARCH ACTIVITIES 3

2. PURPOSE AND NEED **4**

3. PROPOSED ACTION AND ALTERNATIVES **5**

3.1 SUMMARY OF THE PROPOSED ACTION 5
3.1.1 Proposed Activities at Fermilab 5
3.1.2 Proposed Activities at the Ash River Site 5
3.1.3 Activities by NOvA Collaborators at Individual Institutions 6
3.1.4 Sequencing and Schedule 6
3.2 DESCRIPTION OF THE NOνA DETECTORS 7
3.3 FERMILAB SITE PROPOSED ACTION 7
3.3.1 Excavation and Construction Activities at Fermilab 7
3.3.2 Assembly and Installation Activities at Fermilab 13
3.3.3 Operations at Fermilab 15
3.3.4 Facility Decommissioning at Fermilab 16
3.4 PROPOSED ACTION AT THE ASH RIVER SITE 17
3.4.1 Excavation and Construction Activities at the Ash River Site 18
3.4.2 Assembly and Installation Activities at the Ash River Site 23
3.4.3 Operations at the Ash River Site 25
3.4.4 Decommissioning / Disposal at the Ash River Site 25
3.5 ALTERNATIVES TO THE PROPOSED ACTION 26
3.5.1 Alternatives not addressed in detail in the EA 26
3.5.2 Scintillator Blending Facility Alternatives 27
3.6 NO ACTION ALTERNATIVE 29

4. AFFECTED ENVIRONMENT **31**

4.1 FERMILAB SITE 31
4.1.1 Land Use at Fermilab 31
4.1.2 Air Quality at Fermilab 32
4.1.3 Hydrogeology at Fermilab 34
4.1.4 Surface Water Resources at Fermilab 36
4.1.5 Biological Resources at Fermilab 37
4.1.6 Cultural and Historical Resources at Fermilab 38
4.1.7 Socioeconomics / Demographics at Fermilab 38
4.1.8 Occupational Health and Safety Experience at Fermilab 40
4.1.9 Transportation at Fermilab 40
4.2 ASH RIVER MN SITE 41
4.2.1 Land Use at Ash River 41
4.2.2 Air Quality at Ash River 42
4.2.3 Hydrogeology at Ash River 42
4.2.4 Surface Water Resources at Ash River 43
4.2.5 Biological Resources at Ash River 43

4.2.6 Wetlands ... *44*
4.2.7 Cultural and Historical Resources at the Ash River Site ... *46*
4.2.8 Socioeconomics / Demographics at the Ash River Site ... *46*
4.2.9 Occupational Health and Safety at the Ash River Site ... *47*
4.2.10 Transportation at the Ash River Site ... *47*

5. POTENTIAL ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION AND THE NO ACTION ALTERNATIVE ... 48

5.1 POTENTIAL ENVIRONMENTAL IMPACTS FROM ACTIVITIES AT THE FERMILAB SITE ... 48
5.1.1 Excavation and Construction at Fermilab ... *48*
5.1.2 Installation and Assembly at Fermilab ... *52*
5.1.3 Operations at Fermilab ... *54*
5.1.4 Decommissioning Impacts at Fermilab ... *59*
5.1.5 Cumulative Impacts at Fermilab ... *61*
5.1.6 Socioeconomic Impacts and Environmental Justice ... *61*
5.2 POTENTIAL ENVIRONMENTAL IMPACTS AT THE ASH RIVER SITE ... 62
5.2.1 Excavation and Construction at the Ash River Site ... *62*
5.2.2 Installation and Assembly at the Ash River Site ... *74*
5.2.3 Operations at the Ash River Site ... *78*
5.2.4 Decommissioning at the Ash River Site ... *79*
5.2.5 Cumulative Impacts at the Ash River Site ... *80*
5.2.6 Socioeconomic Impacts and Environmental Justice ... *80*
5.2.7 Voyageurs National Park ... *81*
5.3 IMPACT ANALYSIS OF THE BLENDING FACILITY PROPOSED ACTION ... 82
5.3.1 Land Use ... *82*
5.3.2 Air Quality ... *82*
5.3.3 Water Quality ... *82*
5.3.4 Occupational Human Health and Safety ... *82*
5.3.5 Transportation ... *83*
5.3.6 Decommissioning Impacts at Fermilab ... *84*
5.4 CUMULATIVE HUMAN HEALTH IMPACTS ... 85
5.5 IMPACT ANALYSIS OF THE POTENTIAL NO ACTION ALTERNATIVE ... 86

6. ACCIDENT ANALYSIS ... 87

6.1 ACCIDENT CONSEQUENCE CATEGORIES ... 87
6.2 ACCIDENT SCENARIO ... 88
6.3 INTENTIONAL DESTRUCTIVE AND TERRORIST ACTS ... 89
6.4 METHODS FOR ACCIDENT AVOIDANCE AND BARRIERS TO RELEASE ... 90
6.4.1 Mitigation Measures for Potential Leaks or Spills ... *90*
6.4.2 Mitigation Measures for Spills while Transporting Chemicals and Liquid Scintillator ... *91*
6.5 ENVIRONMENTAL RESPONSE IN THE EVENT OF A RELEASE ... 91
6.5.1 Fermilab ... *91*
6.5.2 Ash River Site ... *91*

7. LIST OF OUTSIDE AGENCIES CONSULTED ... 93

8. REFERENCES ... 94

8.1 FEDERAL REGULATIONS, NOTICES, AND LAWS ... 94
8.1.1 Code of Federal Regulations ... *94*
8.1.2 Federal Register Notices ... *94*
8.1.3 United States Code ... *95*
8.2 STATE REGULATIONS, NOTICES, AND LAWS ... 95
8.3 REFERENCE DOCUMENTS ... 96

9.0 LIST OF PREPARERS ... 102

LIST OF APPENDICES

APPENDIX A: Minnesota Environmental Assessment Worksheet
APPENDIX B: Description of NOνA Detectors
APPENDIX C: Material Safety Data Sheets for Chemicals
APPENDIX D: Biological Resource Review Correspondence
APPENDIX E: Cultural and Historic Resource Documentation
APPENDIX F: Correspondence from U.S. Army Corps of Engineers Regarding Wetland Determination
APPENDIX G: Responses to Comments on the NOνA Draft Environmental Assessment
APPENDIX F: Finding of No Significant Impact

FIGURES

Figure 1.1: Map of the central United States showing Fermilab, the NuMI beamline, and the proposed NOνA Far Detector site at Ash River, Minnesota.................... 1

Figure 3.1: Plan view layout of the Fermilab proton source consisting of the Linac, Booster, Recycler, MI and NuMI neutrino line. 9

Figure 3.2: Plan view and elevation (top) views of the NuMI beam line at Fermilab.. . 11

Figure 3.3: A detailed plan view of the MINOS access tunnel 11

Figure 3.4: Plan view of the location of the NOνA IPND in the MINOS Surface Building... 13

Figure 3.5: Example commercial secondary containment system 14

Figure 3.6: Map showing the proposed Far Detector site at Ash River. 18

Figure 3.7: Topographic map of the Ash River area. 19

Figure 3.8: The plan view of the Far Detector site. 21

Figure 3.9: A perspective view of the proposed NOνA Far Detector building looking east.. 22

Figure 3.10: Neutrino beam view of the NOνA Far Detector Hall. 22

Figure 3.11: The full NOνA Far Detector composed of 8 Superblocks and a 2 block section.. 24

Figure 4.1: Fermilab and the surrounding communities. 31

Figure 4.2: Diagram of Groundwater Flowing into the NuMI Tunnel.......................... 35

TABLES

Table 3.1 Composition of NOνA liquid scintillator 27
Table 3.2 Chemical names of NOνA Liquid Scintillator components 28
Table 4.1 Estimated release of Criteria Air Pollutants at Fermi in tons per year for 2006 33
Table 4.2 Estimated annual release of radionuclide air emissions and estimated maximum dose at the Fermilab site boundary during operations of NuMI at 400 kW of beam power for the MINOS Project. 34
Table 4.3 Measured concentrations of tritium in the NuMI discharge water and Fermilab ICW ponds during NuMI operations for the MINOS Project and the DOE regulatory limits. 36
Table 4.4 Measured concentrations of sodium-22 in the NuMI discharge water and Fermilab ICW ponds during NuMI operations for the MINOS Project and the DOE regulatory limits. 37
Table 4.5 Demographic statistics describing the populations in DuPage County, in Kane County and in the State of Illinois 39
Table 4.6 Summary of Wetland Types at the Far Detector Site 45
Table 4.7 Demographic statistics describing the populations in St Louis County and in the State of Minnesota 47
Table 5.1 Estimated radionuclide concentrations in the ground water immediately adjacent to the NuMI tunnel. 56
Table 5.2 Estimated concentrations of tritium in the NuMI sump and Fermilab ponds... 57
Table 5.3 Estimated concentrations of sodium-22 in the NuMI sump and Fermilab ponds. 57
Table 5.4 Construction Equipment Emissions during Excavation and Construction at the Far Detector Site 63
Table 5.5 Summary of Wetland Impacts at the Far Detector Site 66
Table 5.6 Summary of Wetland Impacts and Replacements at the Far Detector Site 69
Table 5.7 Summary of Wetland Replacement Credits at the Far Detector Site........ 70
Table 5.8 Estimated Emissions and Maximum Concentrations of Criteria Air Pollutants from Propane Fuel Combustion 73
Table 5.9 Summary of Human Health Impacts from the Proposed Action 84

GLOSSARY

Acronyms and Abbreviations

ac	acre(s)
ACGIH	American Congress of Governmental Industrial Hygienists
AET	American Engineering Testing
ALARA	As Low as Reasonably Achievable
APD	Avalanche photodiodes
AQI	Air Quality Index
Argon-41	Argon-41 radionuclide
bis-MSB	1,4-di-(2-methylstyryl)-benzene
Bq	Becquerel
bgs	below ground surface
Carbon-11	Carbon-11 radionuclide
CAS#	Chemical Abstract Service Number
CDR	Conceptual Design Report
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
Ci	curie(s)
cm	centimeter(s)
CP	Charge Parity
CUB	Central Utility Building
CY	Calendar year
DCG	Derived Concentration Guide
DEHS	Department of Environmental Health & Safety
DOE	U.S. Department of Energy
DOE-SC	U.S. Department of Energy Office of Science
DOT	U. S. Department of Transportation
EA	Environmental Assessment
EAW	Minnesota Environmental Assessment Worksheet
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EQB	Minnesota Environmental Quality Board
ES&H	Environment, Safety, and Health
Fermilab	Fermi National Accelerator Laboratory, Batavia, Illinois
FEMA	Federal Emergency Management Agency

FESHM	Fermilab Environment, Safety, & Health Manual
FNAL	Fermi National Accelerator Laboratory, Batavia, Illinois
FONSI	Finding of No Significant Impact
FRCM	Fermi Radiological Control Manual
ft	foot/feet
FY	Fiscal Year, Federal (October 1 through September 30)
gal	gallon(s)
gpd	gallons per day
gpm	gallons per minute
GeV	giga-electron volts, a billion electron volts
ha	hectare(s)
HEPAP	High Energy Physics Advisory Panel
Hydrogen-3	Hydrogen-3 radionuclide, also known as tritium
Hz	Hertz
IBC	International Building Code
ICARUS	Imaging Cosmic And Rare Underground Signals
ICRP	International Commission on Radiological Protection
ICW	Industrial Cooling Water
IEPA	Illinois Environmental Protection Agency
IFC	International Fire Code
in	inch(es)
IPND	Integration Prototype Near Detector
ISM	Integrated Safety Management
ISO	International Standards Organization
kg	kilogram
km	kilometer(s)
kt	kiloton
kW	kilowatt(s)
L	liter(s)
LCF	Latent cancer fatality
lbs	pound(s)
m	meter(s)
μCi	microcurie(s)
mi	mile(s)
MI	Main Injector
MINOS	Main Injector Neutrino Oscillation Search
ml	milliliter

MMA	methyl methacrylate adhesive
MNDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
mrem	millirem
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MW	MegaWatt
NAAQS	National Ambient Air Quality Standards
NCRP	National Council on Radiation Protection & Measurements
ν_e	Electron neutrino
NEPA	National Environmental Policy Act of 1969
NERP	National Environmental Research Park
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NHIP	National Heritage Information Program
NRHP	National Register for Historic Places
Nitrogen-13	Nitrogen-13 radionuclide
NO*ν*A	NuMI Off-axis νe Appearance
NPDES	National Pollution Discharge Elimination System
NRCS	National Resource Conservation Service
NSF	National Safety Foundation
NuMI	Neutrinos at the Main Injector
OSHA	U.S. Occupational Safety and Health Administration
Oxygen-15	Oxygen-15 radionuclide
Pa	Pascals
pCi	picocurie
PEL-TWA	Permissible Exposure Limit – Time Weighted Average
PPE	Personal Protective Equipment
ppm	parts per million
PPO	2,5-diphenyloxazole
psi	pounds per square inch
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act of 1976
R&D	Research and development
RF	Radio Frequency
RGU	State of Minnesota Responsible Governmental Unit
RPVC	rigid polyvinyl chloride
SAD	Safety Assessment Document

SEH	Short Elliot Hendrickson
Sv	Sievert
Sodium-22	Sodium-22 radionuclide
SHPO	State Historic Preservation Office (Minnesota)
SPCC	Spill Prevention Control and Countermeasures Plan
STEL	Short-Term Exposure Limit
SWPPP	Storm Water Pollution Prevention Plan
TEC	Thermoelectric cooling
TEDE	Total Effective Dose Equivalent
TLV-TWA	Threshold Limit Value-Time Weighted Average
Tritium	Hydrogen-3 radionuclide
USACE	U.S. Army Corps of Engineers
USBM	U.S. Bureau of Mines
WLS	wavelength shifting
yd	yard(s)

DEFINITION OF TERMS

Accelerator. A device that accelerates charged particles (such as electrons, protons, and atomic nuclei) to high velocities, thus giving them high kinetic energies.

Aquifer. A body of rock or sediment that is capable of transmitting ground water and yielding usable quantities of water to wells or springs.

Attainment area. An area that the EPA has designated as being in compliance with one or more of the National Ambient Air Quality Standards (NAAQS) for sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and particulate matter.

Background radiation. Radiation from (1) cosmic sources, (2) naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear materials), and (3) global fallout as it exists in the environment.

Cherenkov radiation. Electromagnetic radiation emitted when a charged particle passes through an insulator at a speed greater than the speed of light in that medium. The characteristic "blue glow" of nuclear reactors is due to Cherenkov radiation.

Combustible liquid. A combustible liquid is any liquid having a flashpoint at or above 100° F (37.8° C). Combustible liquids are divided into two classes: *Class II Liquids* having flashpoints at or above 100° F (37.8° C) and below 140° F (60° C), and *Class III Liquids* having flashpoints at or above 140°F (60°C).

Criteria Air Pollutants. Six principal pollutants for which the US Environmental Protection Agency has set National Ambient Air Quality Standards, as required by the Clean Air Act. The criteria pollutants are carbon monoxide, lead, nitrogen dioxide, particulate matter, ozone, and sulfur oxides.

curie (Ci). A unit of radioactivity equal to 37 billion disintegrations per second (i.e., 37 billion becquerels); also a quantity of any radionuclide or mixture of radionuclides having 1 curie of radioactivity.

Detector. A particle detector is any device used to sense the passage of atomic or subatomic particles or to measure their properties. For many particle detectors, this involves observing and measuring the radiation (electromagnetic or ionizing) released as particles interact with a gaseous, liquid, or solid medium or an electromagnetic field.

Electron neutrino. Neutrinos are elementary particles, which exist in three different types or "flavors". They are uncharged, non-ionizing and only rarely interact with ordinary matter.

Flammable gas. A gas that is flammable in a mixture of 13% or less (by volume) with air, or the flammable range with air is wider than 12% regardless of the lower limit, at atmospheric temperature and pressure.

Flammable liquid. A liquid having a flashpoint below 37.8°C (100°F) and having a vapor pressure not exceeding 276 kPa (40 psia) at 37.8°C (100°F) is known as a Class I flammable liquid. Class I flammable liquids are further divided into sub-classes depending on the boiling point and flash point.

Fluvial. Of, pertaining to, or inhabiting a flowing river or stream.

Ground water. Water below the ground surface in a zone of saturation.

Hazardous air pollutant. Hazardous air pollutants, also known as toxic air pollutants, are those pollutants that are known or suspected by USEPA to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects.

Hazardous chemical. Any chemical that is a physical or health hazard.

Physical hazard – any chemical for which there is scientifically valid evidence that it is a

- Flammable or combustible liquid
- Compressed gas
- Explosive
- Flammable solid
- Oxidizer
- Peroxide
- Pyrophoric
- Unstable (reactive) or water-reactive substance.

Health hazard – any material for which there is statistically significant evidence that acute or chronic health effects may occur in exposed individuals. Such material include

- Carcinogens
- Mutagens
- Teratogens
- Toxic or acutely toxic agents
- Reproductive or developmental toxins
- Irritants
- Corrosives
- Sensitizers
- Liver, kidney, and nervous system toxins
- Agents that act on the blood-forming systems
- Agents that damage the lungs, skin, eyes, or mucous membranes.

Hazardous Material. The U.S. Department of Transportation defines a hazardous material as a substance or material, which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety and property when transported in commerce, and which has been so designated. The term includes hazardous substances, hazardous wastes, marine pollutants, and elevated temperature materials as defined in 49 *CFR* 172.8, materials designated as hazardous under the provisions of 49 *CFR* 172.101, and materials that meet the defining criteria for hazard classes and divisions of 49 *CFR* 173.

Hazardous waste. Waste that contains chemically hazardous constituents regulated under Subtitle C of the Resource Conservation and Recovery Act (RCRA), as amended (40 *CFR* 261) and regulated as a hazardous waste and/or mixed waste by the EPA.

Hectare. Land area equal to approximately 2.47 acres.

Kaon. A kaon (also called K-meson) is any one of a group of four mesons distinguished by the fact that they carry a quantum number called strangeness.

Kilowatt. a thousand watts

Lacustrine. Living or growing in or along the edges of a lake.

Latent cancer fatalities. Deaths from cancer resulting from, and occurring some time after, exposure to ionizing radiation or other carcinogens.

Leptons. Leptons are fundamental (elementary) particles that have no strong interactions. The six known types of leptons are electrons, electron neutrinos, muons, muon neutrinos, taus, and tau neutrinos.

Limnetic. Of or occurring in the deeper, open waters of lakes or ponds.

Linac. **Lin**ear particle **ac**celerator.

Littoral. Of or on a shore, especially a seashore.

Mesic. Of, characterized by, or adapted to a moderately moist habitat.

Migmatite. A composite rock composed of igneous or igneous-looking and / or metamorphic materials which are generally distinguishable megascopically.

microcuries (μCi). One-millionth of a curie

milliliter. One-thousandth of a liter

millirem: A unit of radiation dose equivalent that is equal to 1/1000 of a rem.

Muon neutrino. Neutrinos are elementary particles, which exist in three different types or “flavors”. They are uncharged, non-ionizing and only rarely interact with ordinary matter.

Palustrine. Of, pertaining to, or living in, a marsh or swamp; marshy.

picocurie (pCi). One trillionth of a curie

PM-10. Particulate matter having a median aerodynamic diameter less than 10 micrometers.

PM-2.5. Particulate matter having a median aerodynamic diameter less than 2.5 micrometers.

Pion. A pion (abbreviation for pi meson) is the collective name for three subatomic particles: π^0, π^+, and π^-. Pions are the lightest mesons and play an important role in explaining low-energy properties of the strong nuclear force.

rem. A unit of radiation total effective dose equivalent (TEDE) based on the potential for impact on human cells.

Risk. The product of the probability of occurrence of an event or activity and the consequences resulting from that event or activity. For example, an accident that is expected to occur once in 100 years and result in a 1 in 1,000 probability of latent cancer fatality (LCF) in the affected population would be associated with a risk of (0.01 per year) x (0.001 LCF) = 0.00001 LCF/year, or a risk of LCF equal to 1 in 100,000 per year of operation.

Scintillant. In this report, the scintillant is pseudocumene.

Sievert. The SI (International System of Units) unit of radiation dose equivalent. (1 SV = 100 rem)

Surface water. All bodies of water on the surface of the earth and open to the atmosphere, such as rivers, lakes, reservoirs, ponds, seas, and estuaries.

Tau neutrino. Neutrinos are elementary particles, which exist in three different types or "flavors". They are uncharged, non-ionizing and only rarely interact with ordinary matter.

Total Effective Dose Equivalent (TEDE). The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). TEDE is expressed in units of rem.

CONVERSION CHART

Into metric units | Into English units

If you know	Multiply by	To get	If you know	Multiply by	To get
Length			**Length**		
inches	25.40	millimeters	millimeters	0.03937	inches
inches	2.54	centimeters	centimeters	0.393701	inches
feet	0.3048	meters	meters	3.28084	feet
yards	0.9144	meters	meters	1.0936	yards
miles (statute)	1.60934	kilometers	kilometers	0.62137	miles (statute)
Area			**Area**		
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.09290304	square meters	square meters	10.7639	square feet
square yards	0.8361274	square meters	square meters	1.19599	square yards
square miles	2.59	square kilometers	square kilometers	0.386102	square miles
acres	0.404687	hectares	hectares	2.47104	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir.)	28.34952	grams	grams	0.035274	ounces (avoir.)
pounds (avoir.)	0.45359237	kilograms	kilograms	2.204623	pounds (avoir.)
tons (short)	0.9071847	tons (metric)	tons (metric)	1.1023	tons (short)
Volume			**Volume**		
ounces (U.S., liquid)	29.57353	milliliters	milliliters	0.033814	ounces (U.S., liquid)
quarts (U.S., liquid)	0.9463529	liters	liters	1.0567	quarts (U.S., liquid)
gallons (U.S., liquid)	3.7854	liters	liters	0.26417	gallons (U.S., liquid)
cubic feet	0.02831685	cubic meters	cubic meters	35.3147	cubic feet
cubic yards	0.7645549	cubic meters	cubic meters	1.308	cubic yards
Temperature			**Temperature**		
Fahrenheit	subtract 32 then multiply by 5/9ths	Celsius	Celsius	multiply by 9/5ths, then add 32	Fahrenheit
Energy			**Energy**		
kilowatt hour	3,412	British thermal unit	British thermal unit	0.000293	kilowatt hour
kilowatt	0.94782	British thermal unit per second	British thermal unit per second	1.055	kilowatt
Force/Pressure			**Force/Pressure**		
pounds (force) per square inch	6.894757	kilopascals	kilopascals	0.14514	
Torr	133.32	Pascals	Pascals	0.0075	

Source: *Engineering Unit Conversions*, M.R. Lindeburg, PE, third Ed., 1993, Professional Publications, Inc., Belmont, California.

* Throughout this EA, units customary to the project team are used. This table is provided to eliminate the need to report the conversion factor between Metric and English systems every time a unit is used.

SCIENTIFIC NOTATION CONVERSION CHART

Numbers that are very small or very large are often expressed to scientific or exponential notation as a matter of convenience. For example, the number 0.000034 may be expressed as 3.4×10^{-5} or 3.4E-05, and 65,000 may be expressed as 6.5×10^{4} or 6.5E+04. In this document, some of the numerical values less than 0.001 or greater than 9999 are generally expressed in exponential notation, or 1.0E-03 and 9.9E+03, respectively.

Multiples or sub-multiples of the basic units are also used. A partial list of prefixes that denote multiple and sub-multiples follows, with the equivalent multiplier values expressed in scientific and exponential notation:

Name	Symbol	Value Multiplied by:		
pico	p	0.000000000001	or 1×10^{-12}	or 1E-12
nano	n	0.000000001	or 1×10^{-9}	or 1E-09
micro	µ	0.000001	or 1×10^{-6}	or 1E-06
milli	m	0.001	or 1×10^{-3}	or 1E-03
cento	c	0.01	or 1×10^{-2}	or 1E-02
deci	d	0.1	or 1×10^{-1}	or 1E-01
--		1	or 1×10^{0}	or 1E+00
deka	da	10	or 1×10^{1}	or 1E+01
hecto	h	100	or 1×10^{2}	or 1E+02
kilo	K	1,000	or 1×10^{3}	or 1E+03
mega	M	1,000,000	or 1×10^{6}	or 1E+06
giga	G	1,000,000,000	or 1×10^{9}	or 1E+09
tera	T	1,000,000,000,000	or 1×10^{12}	or 1E+12

The following symbols are occasionally used in conjunction with numerical expressions.

Symbol	Indicates the preceding value is:
<	less than
≤	less than or equal to
>	greater than
≥	greater than or equal to

In some cases, numerical values in this document have been rounded to an appropriate number of significant digits to reflect the accuracy of data being presented. For example, the numbers 0.021, 21, 2100, and 2,100,000 all contain 2 significant digits. In some cases, where several values are summed to obtain a total, the rounded total may not exactly equal the sum of its rounded component values.

1. INTRODUCTION

The U.S. Department of Energy (DOE) is proposing to conduct a new experimental research program in neutrino physics. Neutrinos are uncharged, non-ionizing elementary particles that only rarely interact with ordinary matter, including the human body. The experiment would generate neutrinos at the Fermi National Accelerator Laboratory (Fermilab) in Batavia, IL, with observations 504 miles (mi) distant at a proposed Far Detector Facility near the Ash River, in St. Louis County, Minnesota (MN) (the Ash River site). The research program is called NO*ν*A [**N**uMI **O**ff-**A**xis Electron Neutrino (ν_e) **A**ppearance Experiment]. NuMI is an acronym for Neutrinos at the Main Injector. The Main Injector (MI) is a proton accelerator at Fermilab and the proposed Far Detector near the Ash River are shown in Figure 1.1. The NO*ν*A Collaboration is composed of almost 200 scientists and engineers from nearly 30 Universities and Laboratories around the world. The Fermilab is the lead laboratory for the DOE, and the University of Minnesota is the lead collaborating university through a Cooperative Agreement with the DOE.

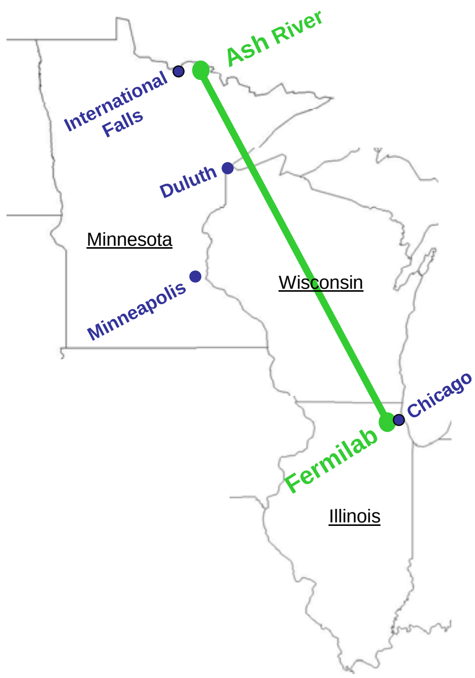


Figure 1.1: Map of the central United States showing Fermilab, the NuMI beamline, and the proposed NO*ν*A Far Detector site near the Ash River, St. Louis County, Minnesota

1.1 National Environmental Policy Act Compliance

In accordance with the National Environmental Policy Act of 1969 (NEPA), Council on Environmental Quality (CEQ) regulations at Title 40, *Code of Federal Regulations* Part

1500, and DOE NEPA implementing procedures at Title 10, *Code of Federal Regulations* Part 1021, DOE has prepared this Environmental Assessment (EA) of the direct, indirect, connected, and cumulative environmental impacts of this research program. NOvA activities at the Ash River site entail a wetlands action that requires a permit from the U.S. Army Corps of Engineers (USACE). Consequently, this EA incorporates a wetlands assessment, and the USACE is a Cooperating Agency in this EA. Information contained in this EA will be used by the DOE and USACE to determine if the proposed action is a major federal action significantly affecting the quality of the human environment. If the proposed action is determined to be a major federal action with potentially significant environmental impacts, an Environmental Impact Statement (EIS) would be required. If the proposed action is not determined to be a major federal action that could result in significant environmental impacts, a Finding of No Significant Impact (FONSI) will be issued, and the action may proceed.

Proposed actions evaluated in this EA include (1) excavation and construction of facilities; (2) blending of scintillator and installation, assembly and filling of detectors; (3) conduct of an experimental research program including operation of an accelerator at an increased power; and (4) future decommissioning activities. Some of the actions would be performed by or for Fermilab Research Alliance, LLC, on behalf of the DOE, at the Fermilab site in Illinois; some of the actions would take place in Minnesota under the auspices of the University of Minnesota through a Cooperative Agreement with DOE.

The Minnesota Environmental Assessment Worksheet (EAW) contained in Appendix A is incorporated into this EA by reference. The University of Minnesota prepared the EAW, acting as the State of Minnesota Responsible Governmental Unit (RGU) and submitted it to the Minnesota Environmental Quality Board (EQB) per State of Minnesota procedures. The EAW has completed State review and has been determined to satisfy State environmental analysis requirements. Its inclusion by reference in this EA follows the CEQ regulations (Title 40, *Code of Federal Regulations*, Section 1506.2) regarding elimination of duplication with State and local procedures.

The State of Minnesota environmental review process is similar to the Federal process for NEPA compliance review, providing public notice, a review and comment period, and a final decision record. The review and comment period for the EAW began on September 10, 2007 with the publication of the notice of availability in the *EQB Monitor* (EQB 2007a). The EAW was distributed to interested parties and local libraries as listed in Appendix A. On November 8, 2007, the RGU determined that an EIS was not necessary, and the decision was published in the *EQB Monitor* on November 17, 2007 (EQB 2007b). Comments received during the review period have been considered and addressed in this EA.

DOE performed a gap analysis comparing the DOE Environmental Assessment guidance to the EAW. Analyses of impacts at the Ash River site are summarized in this EA, supplemented with additional information required by DOE NEPA regulations and guidance.

1.2 Compliance with Wetland Environmental Review

Part of the proposed action includes adding fill to a wetland during construction of the access road to the Far Detector. Under Executive Order 11988, *Floodplain Management*, and Executive Order 11990, *Protection of Wetlands*, Federal agencies are required to consider the impact of proposed actions on wetlands and floodplains. The DOE requirements for compliance with Executive Orders 11988 and 11990 are found in Title 10, *Code of Federal Regulations* (*CFR*), Part 1022, "Compliance with Floodplain/Wetlands Environmental Review Requirements." A floodplain/wetlands assessment consists of a description of the proposed action, a discussion of its effects on the floodplain and wetlands, and consideration of the alternatives. The Executive Orders require Federal agencies to implement floodplain and wetland requirements through existing procedures, such as those established to implement the NEPA. Hence, a wetland assessment is included in this EA, and satisfies all the requirements of 10 *CFR* 1022.

1.3 DOE Office of Science and Fermilab Research Activities

The NOνA project would capitalize on the DOE's investment in the existing NuMI beamline at Fermilab. The NuMI beamline brings high energy protons extracted from the Main Injector into a graphite target. Two parabolic magnetic horns focus the resulting secondary beam which produces neutrinos from pion and kaon decay. The neutrino beam is aimed at the existing Main Injector Neutrino Oscillation Search (MINOS) Far Detector in the Soudan Mine located in Tower, Minnesota.

Whereas MINOS technology was optimized for detecting muon neutrinos, the NOνA design is optimized for detecting electron neutrinos. The proposed NOνA Near Detector at Fermilab would reveal the NuMI neutrino beam composition before oscillations occur, and a proposed Far Detector in northern Minnesota would measure the oscillations after the neutrino beam travels through several hundred kilometers of the earth's surface.

The NOνA Near Detector would be located in the existing NuMI underground experimental hall. The NOνA Far Detector would be positioned approximately 7.5 mi from the central axis of the NuMI neutrino beam in the area of the Ash River. The neutrino beam would pass underground from Fermilab to northern Minnesota. Tunneling is not required; since the neutrinos have so little mass, they simply pass through the earth's crust.

Detailed explanations of the NOνA experiment can be found at the project's website (http://www-nova.fnal.gov). Further information on the research programs of the DOE is available at the DOE Office of Science website (http://www.sc.doe.gov).

2. PURPOSE AND NEED

The purpose of the NOνA experiment is to advance human understanding of the physics of the neutrino particle. Neutrinos are useful probes of the weak interaction, one of the four fundamental forces in the Universe. They exist in three different forms, and a study of the oscillation of neutrinos from one form to another is considered a good way to study important physics questions, such as the properties of the weak interaction, neutrino mass, the contribution of neutrinos to the Dark Matter in the Universe, and the relationship between matter and antimatter.

The DOE Office of Science has previously constructed a neutrino laboratory and detector at Soudan, MN, which intercepts a neutrino beam from Fermilab, near Batavia IL. The proposed detector at the Ash River site will be aligned to use the same Fermilab-to-Soudan neutrino beam, but at a greater distance. In contrast to the Soudan neutrino detector, which measures the parameters of a neutrino oscillation that is known to occur, the Ash River neutrino detector will search for a different, previously unobserved oscillation.

The observation of neutrino oscillations means that neutrinos have non-zero masses. Knowledge about these oscillations is needed to determine the ordering of the neutrino masses and to search for the effects of neutrino oscillations violating Charge Parity (CP) conservation. CP violation by neutrinos could provide information leading to an understanding of why the Universe is composed solely of matter, rather than equal amounts of matter and antimatter. Understanding these particles is an important goal of the worldwide physics community, and operation of the NOνA facility would implement the DOE Office of Science mission to support basic research in the physical sciences.

3. PROPOSED ACTION AND ALTERNATIVES

This section describes the proposed action and alternatives to the proposed action, including the No-Action Alternative. Facility design and construction details described for the proposed action are based on conceptual plans described in the NO*v*A *Conceptual Design Report* (Cooper and Ray 2006), as modified by the NO*v*A *Technical Design Report* (NO*v*A 2007b). The final design for construction may differ from that discussed within this EA. However, the nature, scope, and environmental impacts of the proposed action described in this document are expected to substantially reflect and bound those associated with actual construction and operation of the facility as described in the NO*v*A *Technical Design Report*.

3.1 Summary of the Proposed Action

The proposed action would consist of activities occurring in four phases: excavation and construction; detector assembly and installation; operation and performance of the NO*v*A experiment, and decommissioning. All four phases would occur at both Fermilab and at a site near the Ash River in St. Louis County, MN. The NO*v*A Project consists of the following proposed facility modification and construction activities. Details of the facilities are discussed in Section 3.3 for Fermilab and in Section 3.4 for Ash River. Alternatives to the proposed action are identified in Section 3.5, and the No Action Alternative is discussed in Section 3.6.

3.1.1 Proposed Activities at Fermilab

Proposed new or upgraded facilities to be constructed at Fermilab include:

- An Upgrade of the Existing Fermilab Accelerator Complex from 400 kilowatt (kW) to 700 kW beam power
- A 90-ton Integration Prototype Near Detector (IPND) to evaluate components of the NO*v*A detector in an initial research and development phase
- Use of a commercial facility in the Chicago metropolitan area for blending the approximately 4 million gallons needed to fill the three NO*v*A detectors (The alternatives are discussed in Section 3.5)
- A new underground cavern to hold the Near Detector adjacent to the existing MINOS detector in the existing NuMI tunnel at Fermilab
- A 222-ton Near Detector installed in the new underground cavern to measure the inherent NuMI beam as it leaves the Fermilab complex.

3.1.2 Proposed Activities at Ash River

The proposed Far Detector Facility would include new or upgraded facilities to be constructed at the Ash River site. These include:

- A Proposed 20,000-ton (20-kiloton) NO*v*A Far Detector;

- A building to house the detector and Detector Hall; to provide areas for detector assembly and filling; and to accommodate experiment operations and logistical support;
- An upgrade to an existing logging road to allow all-weather access to the site, including adding fill to a wetland.

3.1.3 Activities by NO*ν*A Collaborators at Individual Institutions

The NO*ν*A Collaboration is composed of almost 200 scientists and engineers from nearly 30 Universities and Laboratories worldwide. Work execution described in this assessment relies on the efforts of these collaborators to design, test and evaluate both calculational models and actual physical samples of the materials and methods discussed herein. Therefore the materials and methods encompassing the proposed action may be performed in small scale using laboratory-sized samples at many locations not specifically identified.

Because of the small scale and limited materials in process, environmental impacts of these NO*ν*A-related activities would be anticipated to be similar to and within the range of existing operations at the various educational facilities. Normally, these kinds of activities are categorically excluded from NEPA. The production scale activities which would have the greatest potential for environmental impacts are discussed and evaluated in this assessment.

3.1.4 Sequencing and Schedule

At Fermilab start on the excavation and construction of the new underground cavern would be delayed until 2011, to allow planned use of the NuMI beam by existing experiment plans. In the interim, research and development (R&D) efforts on the IPND would begin with small-scale quality assurance tests on blending operations from the commercial blending facility in the Chicago area and the assembly, filling, and testing of the IPND in 2009. Fewer than 10 personnel would be involved. Construction of the cavern and the blending facility and full-scale blending operations would occur during 2010 to 2013 with approximately 30 scientists and excavation/construction workers. Detector operation is expected through 2020, with an average staff of 2 and several intermittent scientific visitors. At the end of the detector operation period in 2020, draining the detector and demolition of the PVC structure would occur in 6-8 months with a staff of fewer than 10.

At the Ash River site, the University of Minnesota would commence construction in 2008, depending on funds availability and the weather. Site excavation and building construction are expected to last through 2010 with a staff of 10-40 workers. Detector assembly and installation are expected to occur between 2010 and 2013. During installation, 30 to 50 people are expected to work at the site, either as employees or contractors. Detector operation is expected through 2020. Average staff and scientific visitor count during operations is expected to be fewer than 10 people. At the conclusion of the detector operation period, draining the detector and demolition of the polyvinylchloride (PVC) structure would extend to 2025 with 3-5 personnel. The Cooperative Agreement between DOE and the University will require the DOE to remove all of its equipment and to remediate any issues resulting from its equipment. The University will own the site and buildings.

3.2 Description of the NO*ν*A Detectors

Appendix B describes the detector technology for the NO*ν*A Experiment and introduces the facilities design and operation and other components required for the experiment. This discussion provides background for understanding the need for the extent of the activities proposed for Fermilab followed by a similar discussion for the Ash River site.

3.3 Fermilab Site Proposed Action

3.3.1 Excavation and Construction Activities at Fermilab

The construction of the proposed NO*ν*A facilities at Fermilab would follow conventional construction practices for both surface and tunneling. Access to construction areas would be limited to construction workers and to Fermilab and DOE employees who would administer and monitor construction activities. Experienced contractors would perform the tunneling. All construction activities would conform to applicable regulations of the U. S. Mine Safety and Health Administration (30 *CFR* Parts 1 to 199), the U. S. Occupational Safety and Health Administration (29 *CFR* Part 1926) and the U. S. DOE (10 *CFR* Part 851), as applied through policies and procedures of the Fermilab Environment, Safety and Health Manual (FESHM) (Fermilab 2006) to assure safety to workers and the public and to protect the environment. For example, work plans would address worker protection on excessively cold and hot days.

Fermilab imposes safety requirements on construction contractors by including an appropriate standard appendix in the construction contract. *Exhibit A, Schedule and Supplementary Terms and Conditions* (Fermilab 2006) imposes specific requirements for ensuring that the contractor's health and safety program elements conform to the principles of Integrated Safety Management (ISM) and comply with requirements of the FESHM. The contractor's implementation of the conditions of *Exhibit A* into work practices and compliance with regulatory safety standards during job performance are subject to review by at least two Fermilab officials, the Fermilab Construction Coordinator and the Fermilab ES&H Safety Coordinator. *Exhibit A* describes responsibilities of these officials (Fermilab 2006).

Applicable environmental controls also would be required. For instance, a Storm Water Pollution Prevention Plan (SWPPP) would be prepared in accordance with guidance from the Illinois Environmental Protection Agency (IEPA). Implementation would include erection and maintenance of proper soil erosion barriers around all disturbed soil and rock stockpile areas as specified in the Illinois Urban Manual (USDA 2002). A combination of silt fences, hay bales and excavated temporary waterways would be used to direct storm water away from wetlands and sensitive resources and to detain water long enough for the sediment to settle prior to flowing into surface water. If needed, a stormwater discharge permit would be obtained from the IEPA.

3.3.1.1 Upgrade of the Neutrino Beam

The neutrino beam from NO*v*A would be generated by transporting the accelerated protons along the existing NuMI beam line to a target. Proton interactions in the target produce secondary particles, which are refocused along the NuMI line by an electromagnetic device called a horn. Decays of these secondary particles produce the neutrinos used by NO*v*A. The NuMI neutrino line would handle the increased beam power with upgrades to cooling systems. A new NuMI target would be required to handle the increased beam power and the focusing horn would be moved about 40 ft to optimize the neutrino intensity for NO*v*A.

Figure 3.1 shows the Fermilab accelerator complex and proton source for NO*v*A. The accelerator and NuMI upgrades for NO*v*A would provide an increased beam power relative to the current output (from 400 kW to 700 kW). Increased beam power is accomplished by reconfiguring the Recycler into a proton storage device and by increasing the acceleration rate and repetition rate of the Main Injector (MI). The Recycler and the MI share a common circular tunnel. Cooling modifications to the proton source and upgrades in the NuMI neutrino line are also required to handle the higher beam power. In most cases existing components in the accelerator complex are simply reconfigured for the NO*v*A upgrade, but a few additional new components are required as described in this section.

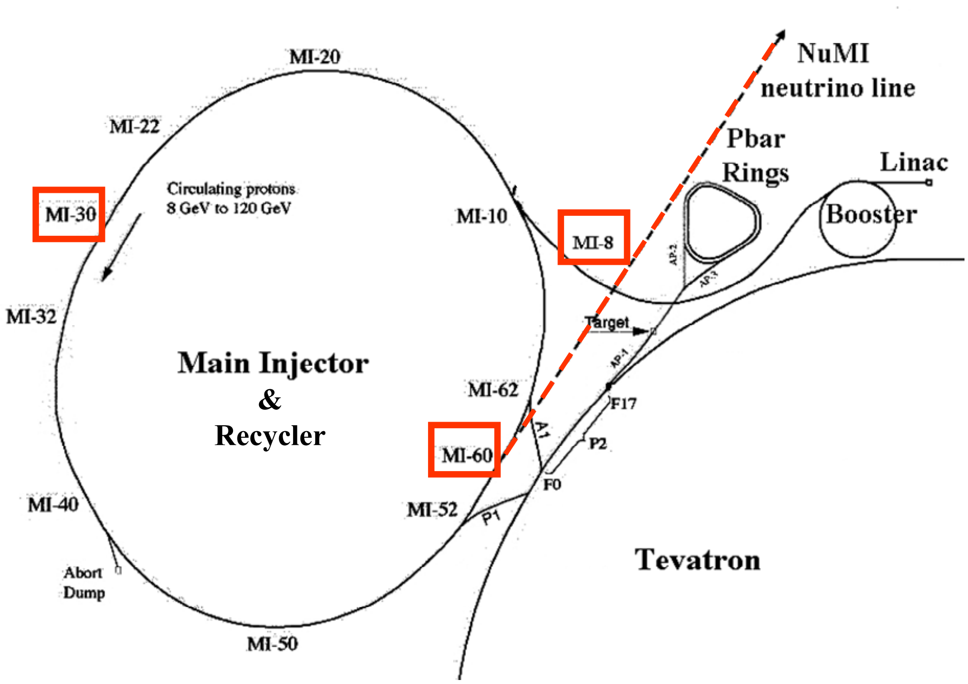


Figure 3.1: Plan view layout of the Fermilab proton source consisting of the Linac, Booster, Recycler, MI and NuMI neutrino line. The Recycler and MI are in the same tunnel.

Recycler Upgrades

The Recycler is a permanent magnet machine designed for beam transport at a single energy (8 GeV). A string of magnets with a single strength can steer a charged beam in a circle, but the beam can only move at a single speed, so machines like the Recycler can store charged particle beams but cannot accelerate those beams.

The Recycler is an existing machine in the MI tunnel and currently serves as the main anti-proton storage ring for the ongoing Tevatron Collider program. As mentioned, when Tevatron Collider operations cease in 2010, the Recycler would be converted for use as a proton storage ring for the MI for NO*ν*A. Eleven batches of protons from the Fermilab Booster accelerator can be put into the Recycler over a short period of time. This process is called beam stacking. Figure 3.1 shows the layout of the Recycler, MI and NuMI beamline.

Anti-proton-specific devices would be removed from the Recycler to convert from an anti-proton storage ring to a proton storage ring for the NO*ν*A experiment. A new line of magnets would be built to steer protons from the Fermilab Booster accelerator to the Recycler. This proton injection line would be built in an existing tunnel connecting MI-8 (from the Booster) into the Recycler. Similarly, a new extraction line from the Recycler to the MI would be built within the existing tunnel at MI-30. Figure 3.1 indicates the MI-

8 and MI-30 locations around the Main Injector / Recycler tunnel. The injection and extraction beamlines would require new kicker magnet systems to kick (or push) the beam from the beamline into (or out of) the circular machines.

Even a coasting beam at a single energy requires some additional energy input to keep it going, so a new Radio Frequency (RF) system is required for this additional energy input. This coasting beam would use two new RF cavities with controls and power installed in the MI-60 service building. An RF system works by giving the protons an electromagnetic kick along their direction of travel each time they complete a circuit of the circular machine. Each time a proton enters an RF cavity, it sees a voltage difference designed to push it forward. The Recycler instrumentation for beam monitoring would be upgraded as part of the NO*ν*A project.

<u>Main Injector Upgrades</u>

Unlike the Recycler, the MI uses electromagnets, and these magnets can strengthen with time by increasing the electrical power to the electromagnet windings. The MI accelerates protons to an energy of 120 GeV. For NO*ν*A the MI would accelerate only 10% more protons than in current operations, but the beam power out of the MI would be much larger because the MI cycle time (time required to increase the magnet strength) would be reduced from 2.2 seconds to 1.33 seconds. This reduction is accomplished by using the Recycler Ring for beam stacking and avoiding the time currently lost in the MI as the Booster protons are stacked there. The reduction is also accomplished by increasing the maximum MI acceleration rate (rate at which the magnets increase their strength). This faster rate requires an upgrade to one of the magnet power supplies.

The MI magnets give a push to the protons perpendicular to their direction of travel so that the protons keep moving in the circular orbit of the machine. An accelerator like the MI accelerates the beam by giving the protons a push with RF along their direction of travel each time they complete a pass around the circle. Since additional energy must be added to accelerate the beam more quickly, two extra RF stations would be added to complement the existing 18 stations.

<u>NuMI Beamline Upgrades</u>

The target and focusing horn locations would be changed to positions optimized for NO*ν*A neutrino production. A new target would be required to handle the increased beam power. Other parts of the NuMI beamline upgrade would consist of cooling modifications to handle an increase in beam power from 400 kW to 700 kW and power supply upgrades to allow operations at the faster cycle time.

3.3.1.2 NOνA Near Detector Cavern

The proposed NO*ν*A Near Detector would be located in a new underground cavern off the existing MINOS access tunnel as shown in Figure 3.2. This new cavern requires an excavation of about 1,000 yd^3 of rock using conventional civil construction and mining techniques. Access to the underground area is via the existing MINOS vertical shaft.

This Near Detector site would be located 3,287 ft from the NuMI Target Hall and 345 ft below grade. The proposed cavern is on a level grade and can meet the size requirements for the near detector. Necessary utility services can be drawn from supplies existing in the tunnel. The cavern and Near Detector are located off-axis at the same angle of 14.6 milliradians (mrad) as the Far Detector in Ash River, as illustrated in Figure 3.3.

Figure 3.2: Plan view and elevation (top) views of the NuMI beam line at Fermilab. The NOνA Near Detector would be located in the underground tunnel in the area labeled "NOνA cavern".

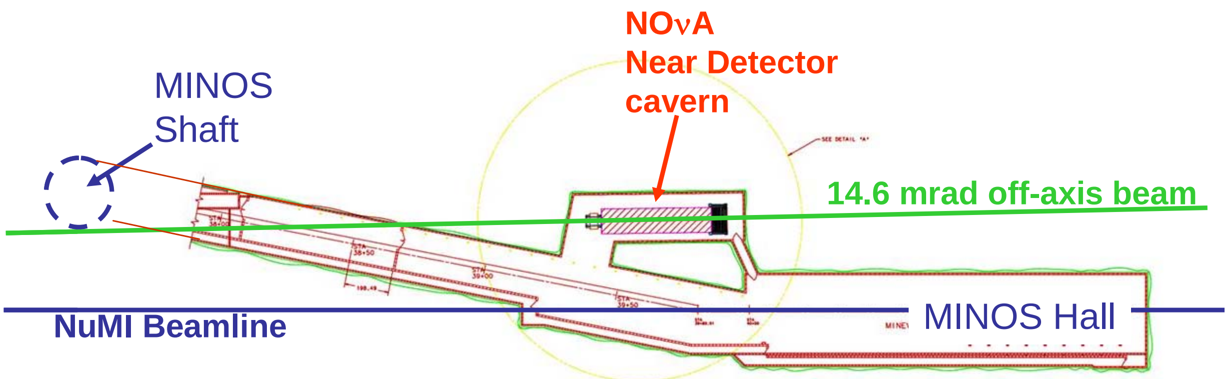
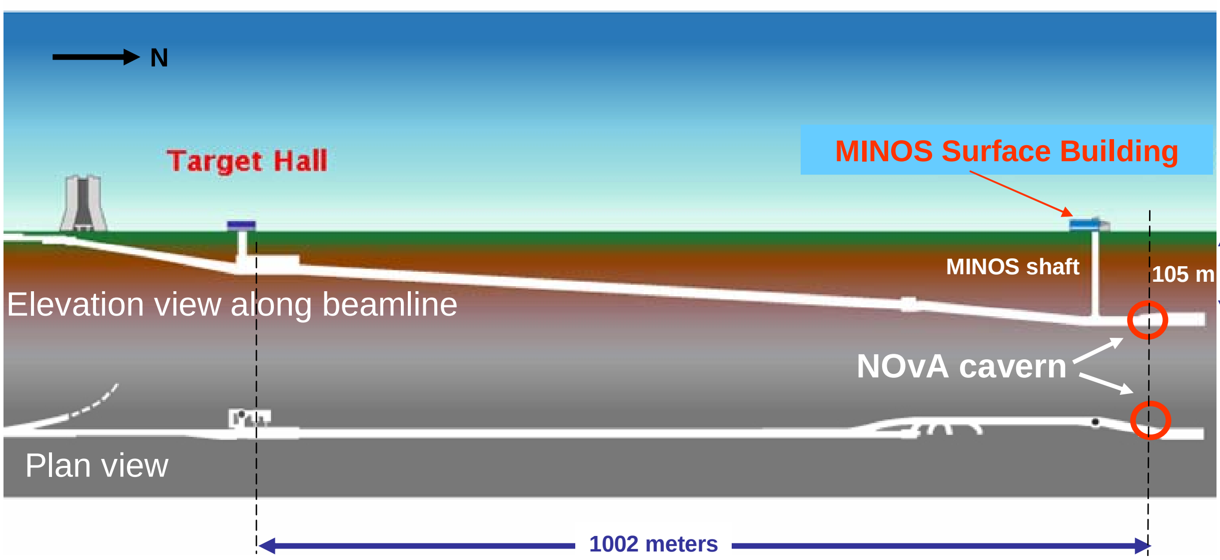


Figure 3.3: A detailed plan view of the MINOS access tunnel from the vertical MINOS shaft to the MINOS hall. The proposed NOνA cavern is indicated.



Removing the waste rock would involve precautions to ensure that particulates would not be introduced into the NuMI tunnel sump which empties into the Fermilab Industrial Cooling Water (ICW) system. At this distance from the Target Hall, the excavated rock should not be activated; however it would be surveyed for radioactivity and managed according to requirements of the FESHM. Spoils removed from tunnel, primarily shale, would be put into stock piles at Fermilab in accordance with existing permits. The estimated 1000 yd^3 of spoils represents an addition of 2% to the existing 50,000 yd^3 currently in Fermilab stock piles.

The raw exposed rock in the new tunnel cavern would be covered with shotcrete. Shotcrete is concrete projected or "shot" under pressure using a feeder or "gun" onto a surface to form structural shapes including walls, floors, and roofs. The shotcrete helps to maintain integrity, minimize cleaving and reduce falling rock and provides a finished surface to the raw rock cavern.

The construction area in Figure 3.2 would have an interior secondary containment volume sized to hold 100% of the liquid scintillator in the NO*v*A Near Detector. The new excavation would be separated from the existing tunnel by a full floor to ceiling wall to provide two separate fire protection areas. The fire protection system would incorporate a water mist (fog), water foam, or inert gas system (with breathable levels of oxygen) to address potential scintillator (mineral oil) fires. Fire protection is relevant since PVC outgases chlorine byproducts in the event of a fire.

3.3.1.3 Blending Materials for the Liquid Scintillator

The NO*v*A experiment requires approximately 4.3 million gal of blended scintillator material to fill the NO*v*A detectors (see Section 3.3.2.2). Mixing the scintillator components would utilize a facility that can mix them in batches of approximately 7,000 gal.

<u>Scintillator Blending R&D</u>

The initial R&D for blending NO*v*A scintillator liquid will be performed on a hard stand area north of the Silicon Detector Complex at Fermilab, using less than 1% of the total liquid scintillator quantities that would be needed for the experiment duration. This limited R&D effort to develop procedures and demonstrate the quality of the blended product has been reviewed and approved as a categorical exclusion to further NEPA review (DOE 2007a).

<u>Scintillator Blending Facility</u>

The NO*v*A Project team analyzed two options for mechanically blending the scintillator materials. The first option would be to use a local commercial toll blender and transport blended materials from that location to Fermilab and Minnesota. The second would be to construct and operate a blending facility at an existing Fermilab site. These alternatives are discussed in Section 3.5

3.3.2 Assembly and Installation Activities at Fermilab

3.3.2.1 Detector Installation and Assembly

Details of NO*ν*A detector design are provided in Appendix B.

Integration Prototype Near Detector

The IPND is an early prototype of the Near Detector, and would be assembled as part of the R&D effort for NO*ν*A. The IPND consists of planes of PVC cells in alternating horizontal and vertical layers. The layers are joined with Devcon-60, a glue containing methyl methacrylate adhesive (MMA), which is a volatile organic compound (VOC) and a federal hazardous air pollutant (HAP). MMA evaporates and is emitted during adhesive application.

The plan is to operate the IPND in the MINOS Surface Building shown in Figure 3.4. Locating the prototype detector on the earth's surface rather than underground allows measurement of the unshielded cosmic ray backgrounds in the detector. Secondary containment for the approximately 20,000 gal of liquid scintillator would be provided by commercially available secondary containment as shown in Figure 3.5. When the detector R&D goals have been accomplished, the liquid scintillator in the IPND would be drained and recovered for subsequent use in the Near Detector. The PVC detector structure would be disassembled and sent down into the new cavern to be used in the Near Detector.

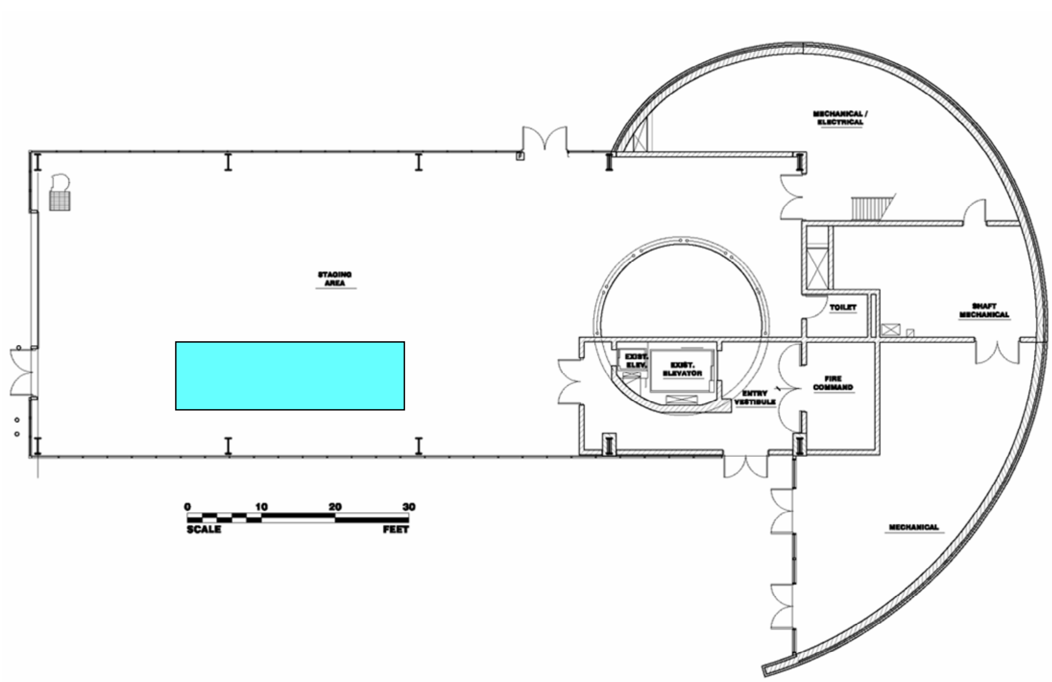


Figure 3.4: Plan view of the location of the NO*ν*A IPND in the MINOS Surface Building.

Figure 3.5: Example commercial secondary containment system which would be attached to the interior side of the drywall walls of the IPND structure inside the existing MINOS Service Building.

<u>Near Detector</u>

An alcove would be cut into the side of the MINOS access tunnel to accept the Near Detector installation at the proper angle to the NuMI beam. Access to the tunnel is through an existing vertical shaft. The Near Detector is an identical copy of the Far Detector, except that the extrusion modules are shorter to accommodate the restrictions of the NuMI underground tunnel and MINOS access shaft.

The detector would need electrical support infrastructure in the tunnel. Necessary readout electronics require one standard 7-ft relay rack and a cooling system. The racks fit easily in the access tunnel downstream of the proposed detector. Electrical power is readily available from existing utilities in the tunnel. Once assembled, the Near Detector would be filled with liquid scintillator. Secondary containment for the full volume of liquid scintillator would be provided by commercially available secondary containment similar to that used for the IPND.

3.3.2.2 Filling Detectors with Liquid Scintillator

Although the NO*ν*A Project involves blending over 4 million gal of liquid scintillator, only approximately 1% (50,000 gal) would be used in detectors at Fermilab. The majority of the scintillator fluid would be shipped to the Far Detector site, and those operations are discussed below in Section 3.4.

At both locations, a liquid transfer system would fill the PVC modules at a precisely controlled flow rate. During the fill, all piping from the tanker trucks to the detector would be protected with appropriate secondary containment systems and spill control plans.

Filling the IPND with Liquid Scintillator
Filling the IPND would utilize a liquid scintillator distribution system that can accept scintillator from tanker trucks parked within the MINOS Service building. During fill, the scintillator distribution system would deliver any displaced vapor volume from the extrusion modules to the tanker.

Filling the Near Detector with Liquid Scintillator
Once assembled in the cavern, the Near Detector would be filled with liquid scintillator. As with the IPND, the liquid scintillator distribution system would accept liquid scintillator from delivery tankers parked within the MINOS Service building at the top of the shaft and deliver vapors displaced from the modules to the tanker. Delivery from the tanker to the detector would be through a double-walled pipe the length of the shaft and extending to the detector location. A pressure reducing valve would reduce the liquid pressure of the long vertical pipe. A separate pipe would vent vapor back to the tanker.

3.3.3 Operations at Fermilab

Following the period of detector assembly, detector filling, and prototype checkout, the NO*ν*A project enters a phase of experimental performance. Accelerators at Fermilab generate particles that are sent in the direction of the NuMI target and the Near Detector. Electronics in both the Near Detector and the Far Detector observe the particle interactions and record the resulting signals. Collaborating researchers access, analyze, and interpret data files remotely and do not rely on direct access to the detectors. However, routine maintenance, electronic calibrations and repairs, and physical integrity inspections would involve personnel accessing the Detector Halls.

Specific parts of the NO*ν*A Near Detector would be subjected to a safety analysis and operational readiness review by an ES&H Review Panel. A subject matter expert would perform an environmental review, to address any potential issues associated with a proposed operational activity. For instance, this review would ensure that any necessary environmental permits are secured prior to commencement of any permit-required activities. This review also would address proposed activities which would utilize chemicals or which would install/utilize any equipment or process that results in air emissions, so that these operations would be in compliance with the FESHM.

Access to the accelerators, tunnels and detectors of the NO*ν*A Project is required for routine maintenance, calibration and to observe/adjust operation parameters. Anyone who works in the NuMI tunnel would be required to take the Fermilab Underground safety course (NuMI/MINOS Underground Safety Training, Course Code FN00034/CR) and would be required to use appropriate personal protective equipment.

Routinely, a staff of 2 personnel would be available to support the Near Detector and several visiting scientists during experiment operations. At infrequent occurrences of off-normal operations, access may be necessary to respond to electrical, electronic or mechanical disruptions. As the NO*ν*A project is a research driven project, adjustments and modifications to the installed components may be necessary to respond to experimental observations. All work is planned and performed to be in compliance with the principles and requirements of the FESHM.

3.3.4 Facility Decommissioning at Fermilab

For the duration of the proposed NO*ν*A experiment, information necessary for eventual decommissioning of the NO*ν*A experiments would be collected, documented, and retained for future reference in accordance with existing Fermilab policies. This information would include the details of the design, the history of operation, and records of environmental monitoring.

During the period of decontamination and decommissioning, radioactivity previously produced in the vicinity of the NuMI tunnel would continue to be collected and discharged to the Fermilab surface ponds and ICW system to prevent the radioactivity from entering the aquifer. The monitoring program would continue and results would be evaluated to determine measures needed to adequately protect workers, members of the public, and the environment. Studies are already underway to evaluate the measures to be taken in the context of the present operations of the NuMI beamline in support of the MINOS experiment and possible upgrades to higher beam intensities (Cossairt 2006).

3.3.4.1 Beamline Elements

Each component of the beam line to be removed would be surveyed by health physics personnel in order to identify, label and isolate all components made radioactive by beam operations. Radioactive components for which there is no longer a use would be packaged for shipment and disposed of as radioactive waste according to DOE specifications and Federal, State, and Local regulations in effect at the time of disposal. Non-radioactive wastes would be properly disposed, in accordance with applicable regulatory requirements. There are no disposal sites for any waste materials on the Fermilab site and none are currently planned for the future.

3.3.4.2 Integration Prototype Near Detector

The parts from the IPND would be reused in the construction of the Near Detector. Parts that are not reused would be decommissioned as described above. The drywall enclosure in the MINOS Service building would be dismantled. Each component of the IPND would be surveyed by health physics personnel in order to identify, label and isolate any components made radioactive by beam operations. It is anticipated that all IPND components would be free of radioactivity because they would only be used in a neutrino beam.

3.3.4.3 Blending Facility

Decommissioning of the Fermilab Blending Facility would require removal of all the tanks, tanker trucks, pumps, and piping used in the blending process. These items can all be cleaned by commercial vendors and offered for recycling via the DOE surplus system.

3.3.4.4 Near Detector

When the NO*v*A Near Detector at Fermilab is to be decommissioned, the experimental apparatus would be disassembled. The components would be reused elsewhere at Fermilab, shipped to other laboratories for use, or made available as surplus equipment according to standard procedures for disposition of United States Government properties. The PVC extrusion modules would be drained of liquid and disposed of as demolition waste; once the Devcon-60 adhesive cures, it no longer poses an eye, skin, or inhalation hazard. The liquid scintillator could be used as an alternative fuel for incineration plants if it is not reused. The underground Near Detector enclosure would remain in place for future use. Each component of the Near Detector would be surveyed by health physics personnel in order to identify, label and isolate any components made radioactive by beam operations. It is anticipated that all Near Detector components would be free of radioactivity since they would only be used in a neutrino beam.

3.4 Proposed Action at Ash River

DOE selected the University of Minnesota as the recipient of a Cooperative Agreement to build and operate the NO*v*A Far Detector facility and access road in collaboration with the NO*v*A Project headquartered at Fermilab. As described in Section 1.1, the University of Minnesota followed and relied upon the State process to prepare an Environmental Assessment Worksheet (EAW) identifying potential environmental impacts. The EAW is incorporated by reference (Appendix A). Analyses of impacts at the Ash River site are summarized in this EA, supplemented with additional information required by DOE NEPA regulations and guidance.

Fermilab and the University of Minnesota have developed a Memorandum of Understanding (MOU) as an agreed-upon plan, intended to establish and maintain management controls that will protect worker safety and the environment during the construction phase and to perform mitigative measures during the construction phase if necessary (NO*v*A 2007a). The excavation and construction on the project will conform to the environmental, safety and health requirements of The University of Minnesota. Project-specific safety requirements would be developed and applied as appropriate. These requirements would include the *Minnesota State Building Code,* which ensures that MN Occupational Safety and Health Administration regulations would be enforceable.

The following description presents the current contemplated size of facility and detector. The facility and detector finally constructed may be smaller.

3.4.1 Excavation and Construction Activities at Ash River

3.4.1.1 The Far Detector Facility Site

The proposed NOνA Far Detector Facility site is an approximately 89.6-acre plot that would be acquired by the University of Minnesota. The site is near the Ash River in Section 18 of Township 68 North, Range 19 West, in St. Louis County, MN. The site is 504 mi from Fermilab (as shown previously in Figure 1.1), near the entrance to Voyageurs National Park (Figures 3.6 and 3.7). Of all the alternative United States sites accessible by road, the Ash River site has the optimal characteristic of being the furthest location from Fermilab in the direct line of the NuMI beam.

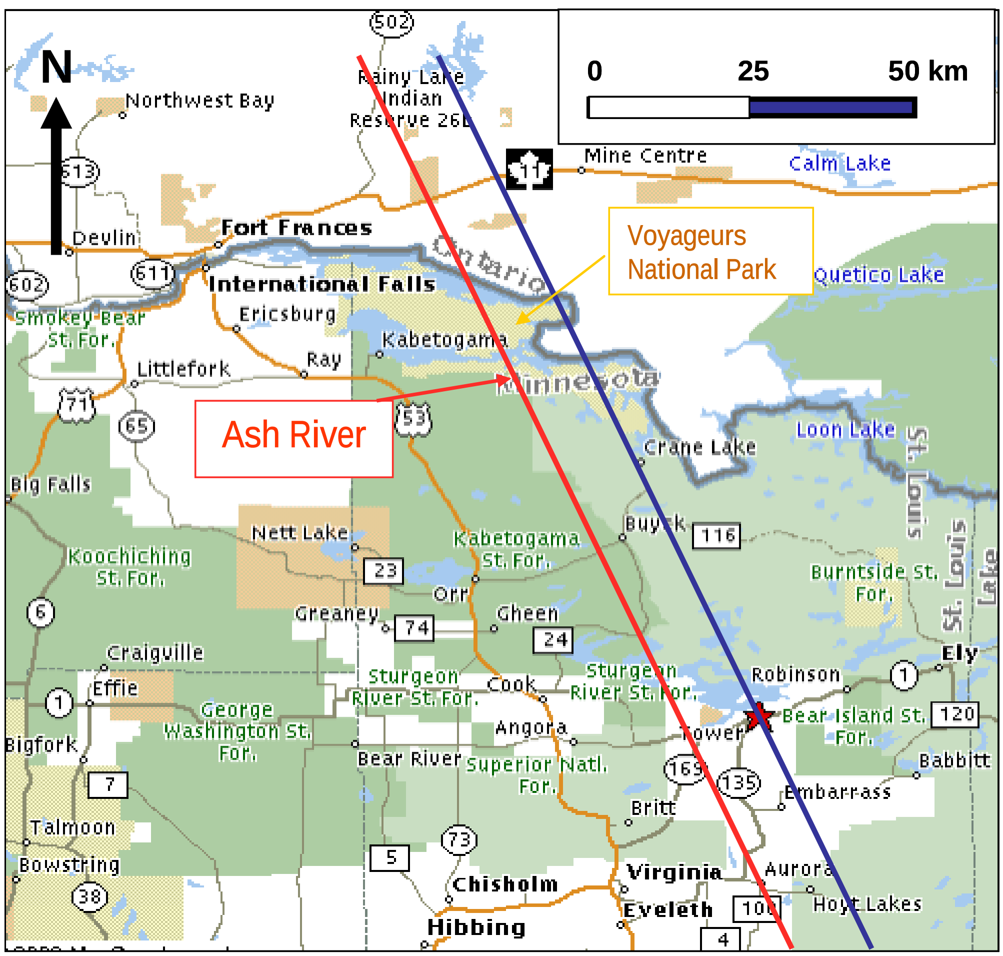


Figure 3.6: Map showing the proposed Far Detector site at Ash River. The NuMI beam centerline (blue) passes through the MINOS detector underground at Soudan (red star). The NOνA Ash River site is on the red line to the left (west) of the NuMI beam centerline, ~11.8 km (14.6 mrad) off-axis. Voyageurs National Park and the US-Canada border are just north of the site.

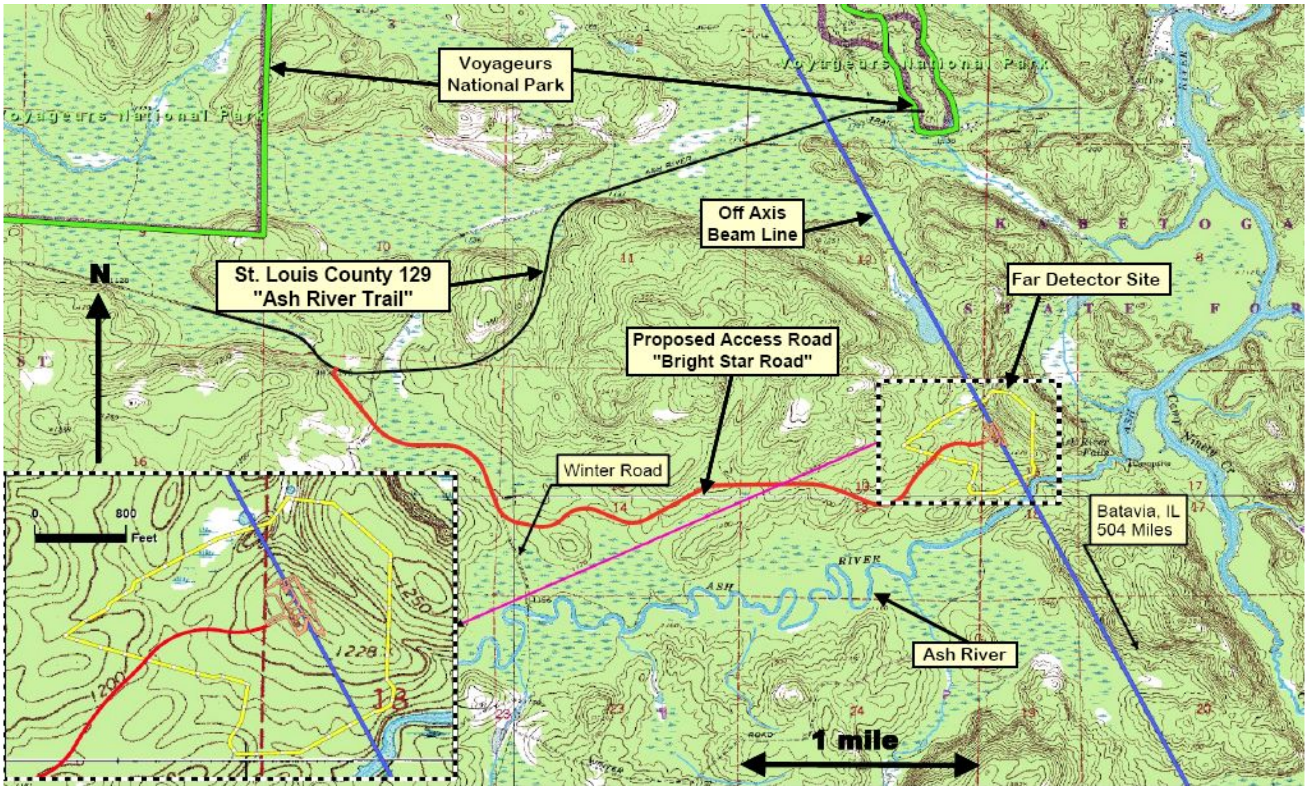


Figure 3.7: Topographic map of the Ash River area and Proposed Far Detector Site. The NO*v*A site is in the rectangle at the end of the access road (red) off St. Louis County Road 129. The inset in the lower left corner shows the site in more detail with the NO*v*A building sitting near the top of a hill at an altitude 1,228 ft above sea level. The entrance road to the Visitor's Center in Voyageurs National Park is shown at the top right center of the map.

3.4.1.2 Access Road and Utilities

Both U.S. 53 and St. Louis County 129 are maintained year-round. Access to the site is currently via an old clay base logging road off St. Louis County 129, known locally as the Ash River Trail. The University of Minnesota would acquire an easement for a proposed 18.9-ac access road corridor, approximately 3 mi in length along the existing roadway. The access road would pass through a wetlands area just as it leaves St. Louis County 129, and an USACE permit would be required to allow construction of an all weather road like St. Louis County 129 to replace the existing logging road. Replacement wetlands would be purchased from a private wetlands bank as mitigation for impacts to existing wetland due to excavation and construction at the Ash River site. Special design features would be incorporated to ensure historical properties are protected.

Under the current plan, the finished road would have two paved traffic lanes, shoulders and open ditches for drainage, similar to St. Louis County 129. Utilities would be buried on either side of the road. The road work would include grading, excavation, potential dewatering, paving and re-vegetation activities. Possible equipment to be used includes standard construction machinery such as trucks, backhoes, graders, compactors, skid-steers, cranes, loaders, compressors, and possibly dewatering pumps.

The proposed site work includes the extension of existing electric and communication utilities and the installation of domestic water well and septic systems. Electric utilities and fiber optic communication lines would be extended from St. Louis County Road 129 along the improved access road. Improvements to the existing transmission system serving the site would also be required but include only upgrades to existing transmission lines to increase capacity. Planned utility upgrades are discussed in Section 28 of the EAW (Appendix A).

3.4.1.3 NOνA Far Detector Facility at Ash River

Figure 3.8 provides a plan view of the Ash River site. The Far Detector Facility would contain an at-grade Service Building, an adjacent, below-grade Assembly Area, and the below-grade NOνA Detector Hall. A perspective view of the building exterior is provided in Figure 3.9. Figure 3.10 shows a cross section through the Detector Hall. More detailed design drawings are available in the EAW, Appendix A. The building footprint, impervious surfaces and landscaping would occupy approximately 6.7 ac. Visual impacts of constructed facilities at the site are discussed in Section 26 of the EAW, Appendix A.

The Detector Hall and Assembly Area would be approximately 67 ft wide by 375 ft long by 38 ft high and excavated 40 ft below the existing grade into granite rock. The roof of the building would consist of 1.5 ft of cast-in-place concrete over 2.5 ft of precast concrete planks. This composite would provide support for 0.5 ft of loose barite (barium sulfate) roof ballast that is necessary to reduce the background radiation from electromagnetic cosmic rays. The sides of the building would be shielded with granite spoils from the excavation. The adjacent Service Building area would be 67 ft wide by 130 ft long by 38 ft high and would be at grade.

The concrete floor and walls of the Assembly Area and Detector Hall would function as secondary containment for scintillator fluid in the PVC modules. The floor and walls would be treated with a sealant (e.g., epoxy based paint) to prevent liquid scintillator from penetrating the porous concrete surface. A space at the base of the detector would create an observation zone for leak detection. The sloped floor of the Detector Hall and Assembly Area would collect and route any spilled scintillator fluid to a scintillator sump.

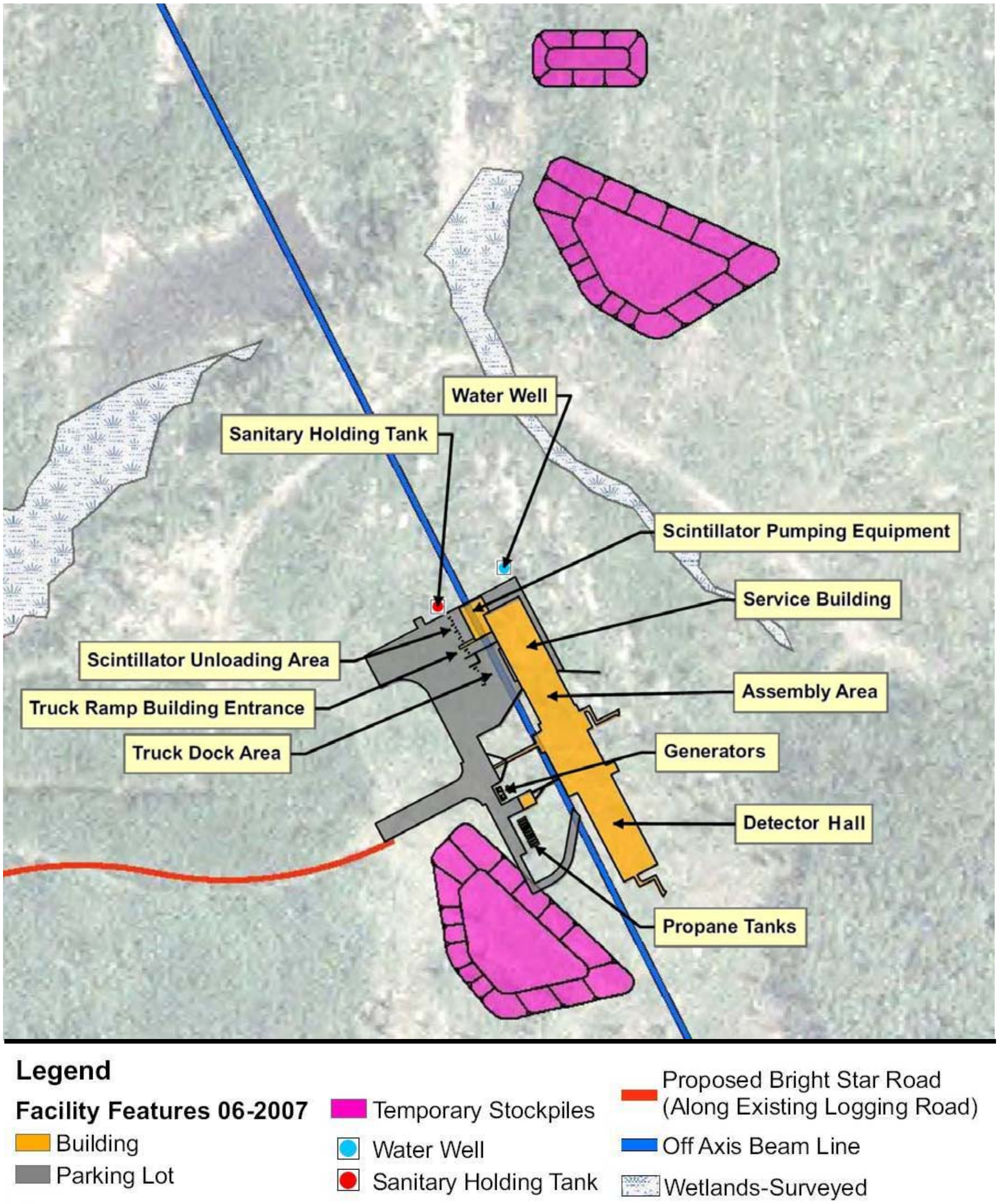


Figure 3.8: The plan view of the Far Detector Facility site. The Detector Hall sits in the south end of the building next to an Assembly Area also below grade. A loading dock and tanker truck delivery area are at grade at the north end of the building, next to the service building**.**

Figure 3.9: A perspective view of the proposed NOνA Far Detector building looking east. The bermed area (green) is composed of granite spoils from the excavation. The detector area would be on the right hand side with a module assembly area to its left. A loading dock service area is located to the left of the Assembly Area with recessed and drive-in truck bays. A scintillator tanker handling area is shown on the far left with adjacent bays for four tanker trucks.

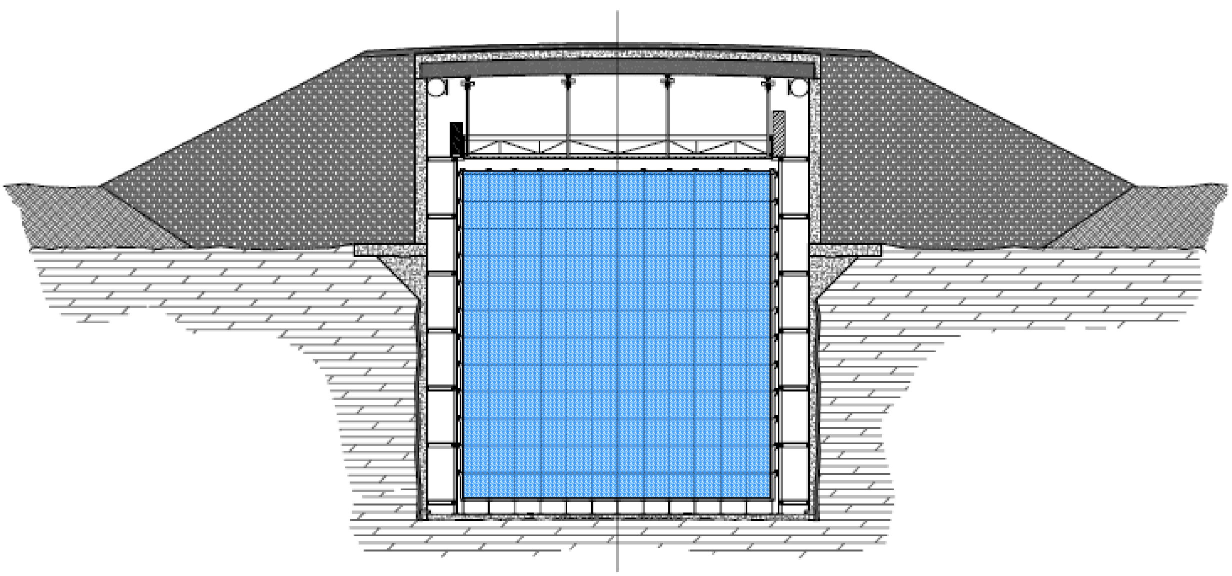


Figure 3.10: Neutrino beam view of the NOνA Far Detector Hall. The detector face is shaded blue. It is surrounded by access catwalks and the top is accessible via a rolling access platform suspended from the ceiling. The soil (light gray) has been removed at the detector site for excavation into the granite (block gray). The spoils from the excavation are loaded back on the sides of the detector to a minimum shield depth of 10 ft.

All groundwater would be collected between the solid granite bathtub and the concrete foundation. The groundwater sumps would be isolated from the scintillator sumps, would be exterior to the bathtub, and would be monitored for water levels. Accumulated water would be managed according to NPDES permit and/or SWPPP as appropriate.

The sides of the detector (see Figure 3.10) would be accessible by catwalks along the sides of the Detector Hall. The top of the detector would be accessible by a rolling platform hung from the ceiling of the hall.

The Facility would require an appropriate fire protection system for areas in which the scintillator is handled, stored or used. A water mist (fog) system, water foam system, or inert gas system (with breathable levels of oxygen) would be used. Support spaces including a loading dock, shop, storage and related functions would be housed in the Service Building area, which is the above ground portion of the structure adjacent to the Detector Hall and Assembly Area in the plan view of the building in Figure 3.8.

An outside parking area would be built for four trucks delivering liquid scintillator (see Figure 3.8). This area would be equipped with a sump and a spill-control berm that is sufficient to contain 100% of the liquid from four tankers. Because of the remote site location, the truck turning area next to the loading bays would have a designated helicopter landing area for use in an emergency.

Construction of the proposed Far Detector Facility would include grading, rock and soil excavation, potential de-watering, concrete formwork, structural steel, metal siding and roofing as well as the associated mechanical and electrical infrastructure to support the detector assembly and operation. Possible equipment to be used includes standard construction machinery such as trucks, backhoes, graders, compactors, skid-steers, cranes, loaders, compressors and possibly de-watering pumps.

Construction of a facility the size of the Far Detector Facility requires significant construction staging and segregated stockpiling areas. The stockpiled material would be segregated into topsoil, clay and rock areas. Each stockpile would require sediment and erosion control devices as well as adequate access. Figure 3.8 shows the local area around the building and the proposed stockpile areas.

3.4.2 Assembly and Installation Activities at Ash River

3.4.2.1 Far Detector Assembly

In the Assembly Area of the Far Detector Building, twelve of the extrusion modules get placed side by side on a flat assembly table to form one plane of the NO*ν*A Far Detector. Thirty-one such planes are bonded together with Devcon-60 into a block to form the strong honeycomb-like structure shown in Figure B.4 (Appendix B). 156 metric tons of Devcon-60 with MMA are required for the full 20-kt detector, which places requirements on the building ventilation system due to concerns for MMA vapors in workspaces. MMA has been selected as the adhesive because it has the largest shear and peel strength of all the adhesives tested to date, and high strength is required for this five-story-tall PVC object.

A custom vacuum lifting fixture would be used to move the modules from incoming truck pallets to a custom glue machine for the MMA application and subsequently onto the flat assembly table. The empty 31-plane block is assembled in a horizontal position, moved down the Far Detector Hall to the previously constructed blocks, and rotated 90 degrees into a standing position.

Five of the 31-plane blocks get attached to one another to form a detector "Superblock". Between Superblocks a gap of 0.75 in serves as an expansion joint (like in a concrete sidewalk) so that when the Superblock is filled with scintillator the stress in the PVC would be limited. If all the Superblocks touched, then filling the blocks would drive the PVC stresses to unacceptably high levels. The expansion gaps serve to limit the stress build-up.

A total of 8 Superblocks plus one smaller set of 2 blocks comprise the full 1302 planes in the NO*v*A Far Detector. The detector is built from south to north, starting against a strong bookend at the south end of the building. When all 42 blocks are in place, the block pivoter is braced to form a north bookend as shown in Figure 3.11.

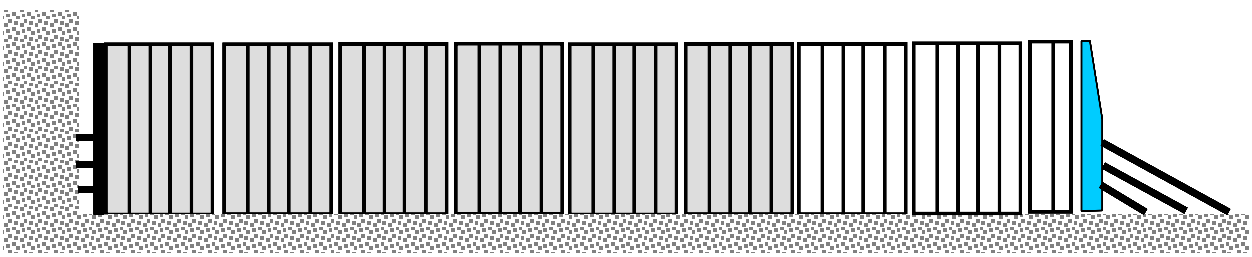


Figure 3.11: The full NO*v*A Far Detector composed of 8 Superblocks and a 2 block section. Expansion gaps are shown between the Superblocks. The detector is built from left to right starting against a strong bookend and assembly ends with the conversion of the block pivoter into another bookend at the right end. This figure shows 6 of the superblocks full of scintillator with 3 blocks yet to be filled**.**

Filling the Far Detector with Liquid Scintillator

The Far Detector would be filled with 4,310,000 gal of liquid scintillator. As construction of blocks proceeds, blocks are filled while additional blocks are being assembled. To avoid a long serial schedule for completion of the detector, scintillator transfer and fill occurs almost in parallel with the PVC plane erection, following the empty PVC module assembly front by one Superblock (5 blocks) in a total 27-month schedule. The required scintillator fill rate of about 18 gal per minute is accomplished with a custom metering machine which fills eight extrusion modules in parallel.

The liquid would be delivered to Far Detector Facility in 7,000-gal tanker trucks. Approximately 600~615 separate tanker truck loads (about 15 tankers per 31 plane block) are required over a period of several years. The liquid scintillator distribution system would be designed to accept liquid scintillator from inbound tankers at a rate of one tanker per day. The delivery system would include components that ensure that filling of the PVC Modules is done at a precisely controlled flow rate. During fill, a large volume of vapor would be displaced from the extrusions and would be returned from the modules back to the tankers. Spill control plans, counter measure materials, personal protective equipment (PPE) and working procedures would be developed for each process that involves work with the blended liquid scintillator.

Outfitting the detector with electronics follows the filling task with about a one-month delay per block. Therefore the Far Detector becomes active linearly throughout the ~ 24 month assembly period.

3.4.3 Operations at the Ash River Site

Following the period of detector assembly, liquid scintillator transfer, detector filling and checkout, the NO*v*A project enters a phase of experimental performance. Accelerators at Fermilab generate particles that are sent in the direction of the NuMI target, the Near Detector and the Far Detector. Electronics in the Far Detector observe the particle interactions and record the resulting signals. Collaborating researchers access data files remotely and need not rely on direct access to the detectors to analyze and interpret the data. Routine maintenance, electronic calibrations and repairs, and physical integrity inspections would involve personnel accessing the Detector Hall. Routinely, a staff of 5-8 personnel would be at the Far Detector site during experiment operations.

3.4.4 Decommissioning/Disposal at Ash River

The operations at the proposed NO*v*A Far Detector Facility, as part of the Fermilab Neutrino experimental program, would cease with the decommissioning of the NO*v*A Project. It is possible that this facility would continue to be used for other experiments not associated with the operation of the Fermilab accelerators. If redeployed by DOE, an appropriate NEPA review would be performed.

When the proposed NO*v*A Facility is decommissioned, the experimental apparatus would be disassembled. It is anticipated that all Far Detector components would be free of radioactivity since they would only be used in a neutrino beam. The components would be reused, shipped to other laboratories for use, or made available as surplus equipment according to standard procedures for disposition of United States Government properties. The PVC modules would be drained and disposed of as normal waste. The liquid scintillator (primarily mineral oil) could be recycled as an alternative fuel.

Information necessary for eventual decommissioning of the NO*v*A Project facilities would be collected and documented during the operations, and the records would be retained for future reference. This information would include the details of the design, the history of operation, and records of environmental monitoring. At the end of the NO*ν*A detector decommissioning, the building at Ash River would continue to be the property of the University of Minnesota under the terms of the Cooperative Agreement.

3.5 Alternatives to the Proposed Action

NEPA requires evaluation of the impacts of "reasonable alternatives." "Reasonable Alternatives" are those that satisfy the purpose and need of the proposed action.

3.5.1 Alternatives not addressed in detail in the EA

The following Alternatives were considered and details of these alternatives are discussed in the NO*ν*A *Conceptual Design Report* (Cooper and Ray 2006).

- Alternate Near Detector sites were examined at Fermilab, but all options required more excavation and were more expensive.
- Alternate Far Detector sites were examined in Minnesota and Canada. The number of such sites is small due to the small number of all-weather east-west roads in the vicinity. All other possible sites between Lake Superior and the Trans-Canada highway were scientifically inferior. The criteria used to judge possible sites included:
    a) The ability to have the detector as far away from Fermilab as possible;
    b) The ability to have a detector ~ 12 km off-axis from the central NuMI neutrino beam;
    c) Access to the site by existing roads;
    d) Ability to do construction in all seasons on the experimental hall and on the detector;
    e) Access to power, telephone lines, and fiber optic data connections;
    f) The availability of a relatively flat area for construction;
    g) The availability of high ground well above the water table with no wetlands;
    h) The absence of features likely to provoke controversy or litigation; and
    i) A location in Canada would require participation by a Canadian institutional collaborator.
- Alternate roads to the proposed Ash River site that avoid wetlands were considered. A more direct route from the north (see Figure 3.7) across St. Louis County 129 would be shorter and cheaper, but concerns that this would impact wildlife and old growth forest in the area and the view from Voyageurs National Park led to the proposed road along an existing logging road.
- Alternate building designs at Ash River were considered but the proposed design makes the best use of the excavated granite as a cosmic ray shield for the detector.
- Alternate detector technologies were considered for the Far Detector. Most were scientifically inferior, while one alternate required too many years of R&D to be considered viable

3.5.2 Scintillator Blending Facility Alternatives

3.5.2.1 Scintillator Blending

The NO*v*A Project team analyzed two options for mechanically blending the scintillator materials. The first option would be to use a local commercial Toll Blender in the Chicago Area and transport blended materials from that location to Fermilab and Minnesota. The second option would construct and operate a blending facility at an existing Fermilab site.

The NO*v*A Project would purchase the scintillator component ingredients in Table 3.1 and blend them mechanically over a period of several years. Blending materials for the liquid scintillator is a mixing operation, as opposed to a chemical reaction. Table 3.2 shows the chemical names of the ingredients in Table 3.1. Material Safety Data Sheets (MSDS) for the chemicals are provided in Appendix C.

component	purpose	mass fraction	volume (gal)	tot mass (kg)
mineral oil	solvent	94.4%	4,079,841	13,127,298
pseudocumene	scintillant	5.5%	230,057	762,875
PPO	waveshifter #1	0.1%		16,788
bis-MSB	waveshifter #2	0.002%		235
Stadis-425	antistatic agent	0.0003%		62.6
tocopherol (Vit.E)	antioxidant	0.0010%		139
Total		**100.0%**	**4,309,899**	**13,907,259**

Table 3.1: Composition of NO*v*A liquid scintillator

Component	Chemical name
Mineral Oil	NO*v*A would use a Technical grade White Mineral Oil. Chevron ParaLux 701 is an example.
Pseudocumene	1,2,4-Trimethybenzene
PPO	2,5-diphenyloxazole
Bis-MSB	1,4-di-(2-methylstyryl)-benzene
Stadis-425	Proprietary mixture, but primarily composed of kerosene and toluene
Tocopherol	Tocopherol

Table 3.2: Chemical names of NO*v*A Liquid Scintillator components

The mineral oil would arrive by rail car in 25,000 – 30,000 gal loads. The mineral oil from the rail cars would be transferred into a fixed tank to comply with Title 41 of the *Illinois Administrative Code* (IAC) Section 160. Pseudocumene, also a liquid, would arrive in 7,000 gal stainless steel tanker trucks. The waveshifters (PPO and Bis-MSB) are powders and would be delivered to in 5 – 25 kg (11 – 55 lb) fiber drums. The Stadis-425 and Tocopherol additives are liquids added as parts per million to the final blend.

The blending would be performed in two steps: First the wavelength shifting powders would be dissolved in pseudocumene. This blending can be done with in-line blenders. The second step would blend the concentrate with the mineral oil and would result in the final liquid scintillator composition required by the NO*ν*A Project.

3.5.2.2 Toll Blending in the Chicago Area

Many facilities in the Chicago Area are capable of blending oils with chemical additives and simply charge a fee per gallon for the service. A pre-bid request for information by the Fermilab Purchasing Department for the NO*ν*A Project elicited ten responses.

Typical vendors have large sites in industrial areas around Chicago with oil tank farms consisting of tens to hundreds of tanks in the 10,000 to 630,000 gal range. These vendors are usually blending volatile gasoline products for automobile and truck consumption, so blending of the less flammable NO*ν*A Project components would not be outside their envelope of experience.

No tanks would be constructed for the NO*ν*A Project, but tanks dedicated to NO*ν*A would be cleaned and painted on the inside with epoxy-based paint to ensure no contaminants could enter the NO*ν*A mixture. In some cases stainless steel tanks would be available and require only cleaning. Dedicated piping between tanks would allow off-loading the NO*ν*A Project components into two separate tanks and blending the two main components into a third tank. The dedicated piping also would be cleaned before use by the NO*ν*A Project.

Each tank used in blending would come equipped with a surrounding secondary containment berm. Piping systems between tanks would also have secondary containment. At some facilities the entire site serves as a tertiary containment area with another berm on the site boundary. Qualified vendors would already be equipped with secondary containment and electric power.

3.5.2.3 Blending at Fermilab

An alternative blending facility at Fermilab would appear similar to a neighborhood gasoline station with an overhead canopy but with several above ground tanks and pipelines instead of the underground tanks in a typical neighborhood gas station. Possible facility sites have been identified on the northern edge of Fermilab adjacent to the Fermilab railhead. Each possible Fermilab site is a previously disturbed level area that is not currently in use.

The Fermilab railhead is an optimum location because the dominant mineral oil component of liquid material would arrive in railcars. Commercially available liquid containment for railcars would be constructed. The mineral oil from the rail cars would be transferred into a small 7,000 – 10,000 gal fixed tank to comply with Title 41 of the *Illinois Administrative Code* (IAC) Section 160.

Additional electric power would be needed at a Fermilab blending facility. The blending facility would have 100% secondary containment constructed as a curbed concrete area under the canopy and sized for containment of all liquids including the volume of 24-hour rainfall as determined by a 25-year storm.

The main difference in blending operations between a Fermilab facility and a commercial Toll Blender would be in the batch size. While a Toll blender would probably blend 25,000 - 50,000 gal per batch, a Fermilab facility would operate at a smaller scale and blend only 7,000 gal per batch matched to the size of the tanker trucks used to transport the blended scintillator to Minnesota. A Fermilab blending operation would also employ a closed loop system to capture all vapors, which might eventually be vented elsewhere at Fermilab.

Blending operations and quality assurance of the blends would typically require two Fermilab technicians.

3.5.2.4 Decommissioning of Blending Facility

Decommissioning of a Toll Blender facility would be straightforward. Any tanks or piping used by the NO*ν*A Project would have to be cleaned just like they were cleaned before NO*ν*A Project use. This is standard practice at Toll Blenders.

Decommissioning of a Fermilab Blending Facility would require removal of all the tanks, tanker trucks, pumps, and piping used in the blending process. These items can all be cleaned by commercial vendors and offered for recycling via the DOE surplus system.

3.6 No Action Alternative

Under the no action alternative, the scientific goals for the studies of neutrino oscillations would not be achieved in the U.S. in the near future. There is no other known method by which all the topics of particle physics addressed by this experiment can be explored.

At Fermilab, the no action alternative on NO*ν*A would leave the remainder of the large physics research programs unchanged. Tevatron would cease operations in 2010, as planned. Other large collaborative experiments would continue research on neutrino characteristics under existing protocols until about 2012. Fermilab scientists and management would continue research and design towards siting the International Linear Collider, the next generation of large particle accelerator that is being planned by international science panels. Environmental impacts of the No Action Alternative are discussed in Section 5.5.

At the Minnesota location this alternative would leave the environment essentially unchanged as no other uses for the site are envisioned at this time.

4. AFFECTED ENVIRONMENT

4.1 Fermilab Site

4.1.1 Land Use at Fermilab

The Fermilab site is located 38 mi west of downtown Chicago, Illinois. Its 6,800 ac straddle the boundary between eastern Kane and western DuPage Counties in an area of mixed residential, commercial, and agricultural land use. Immediately to the east is the town of Warrenville (13,363 population), to the west is Batavia (23,866 population), to the north is West Chicago (23,469 population), and to the south and southwest is Aurora (142,990 population). Figure 4.1 shows the location of Fermilab, major transportation resources, and the surrounding communities.

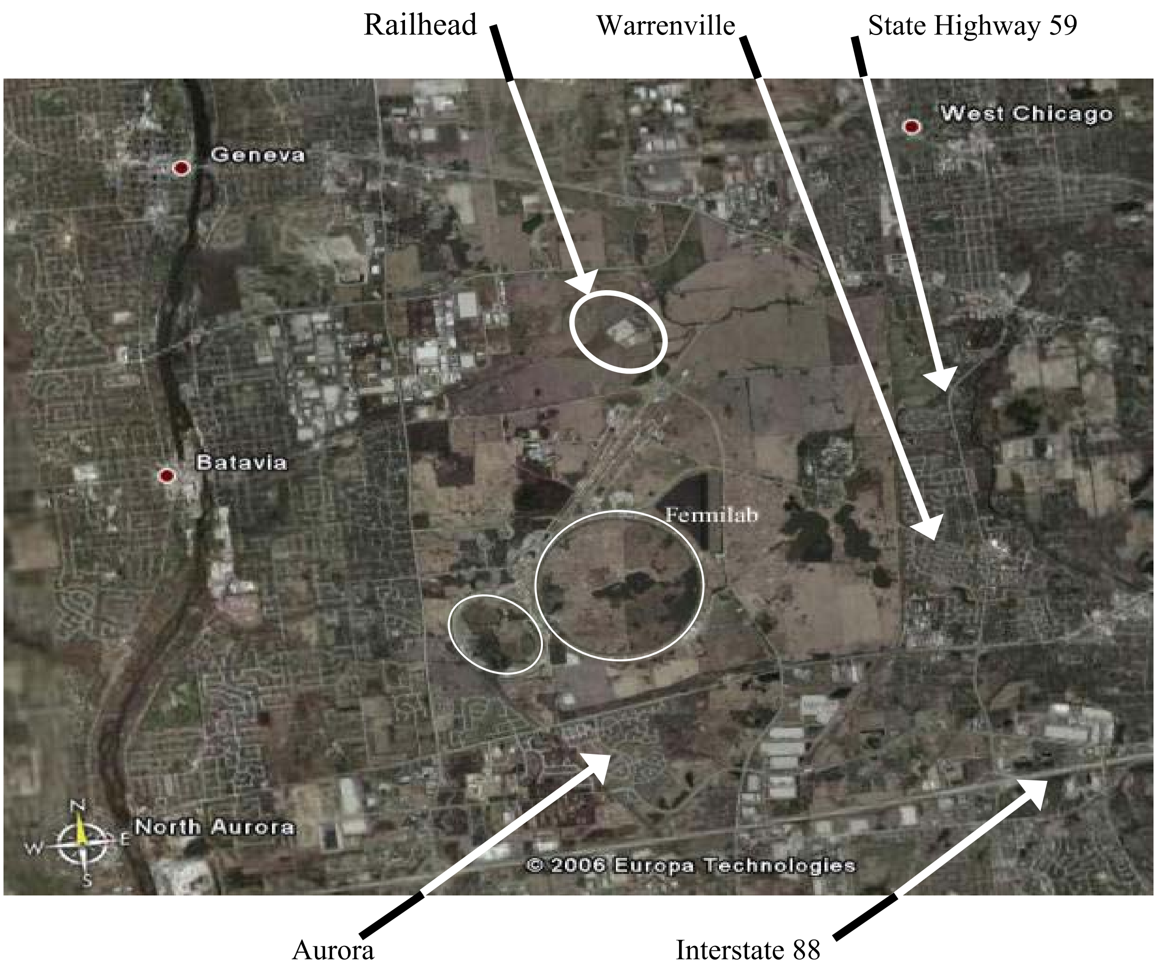


Figure 4.1: Fermilab and the surrounding communities.

Since the spring of 2005, the NuMI facility at Fermilab has been in operation for the MINOS Project. An environmental assessment (DOE 1997) performed for the NuMI facility led to a DOE Finding of No Significant Impact (FONSI) (DOE 1998a) for NuMI operations up to 400 kilowatts (kW) of beam power delivered on target. This section of document gives a description of the Fermilab environment including the effects of operations with the NuMI beamline for the MINOS Project at a beam power of approximately 400 kW. This chapter includes a description of the air, surface water, groundwater, and occupational safety conditions.

4.1.2 Air Quality at Fermilab

The climate of the area is continental, with cold winters and hot humid summers. There are frequent short period fluctuations in temperature, humidity, and wind speed and direction. The predominant wind direction is generally westerly with the wind direction from the southwest quadrant occurring with a frequency of almost 50 percent. The average wind velocity is typically 6.7 mi per hour. The average annual precipitation at Fermilab ranges from 30 to 35 inches, with roughly two-thirds of the total falling in the period from April 1 to September 30, often in the form of heavy showers and thunderstorms. The relatively flat topography does not significantly affect air flow over or near the site.

The United States Environmental Protection Agency (EPA) established National Ambient Air Quality Standards for particulate matter (PM-2.5) in 1997 and in 2004 established the 8-hour ozone national ambient air quality standard for all areas of the United States. In the northeastern part of Illinois, DuPage and Kane Counties have been designated as moderate non-attainment areas for the 8-hour ozone standard and the PM-2.5 standard. The Fermilab site is within this non-attainment area where there are lower thresholds for air emissions of volatile organic compounds and nitrogen oxides. Fermilab has an Air Pollution Permit that regulates these and other emissions from onsite fuel combustion sources, vapor degreasing operations, and a fuel dispensing facility, in addition to radionuclide emissions from beamline ventilation stacks and a magnet de-bonding oven. Table 4.1 summarizes the emissions of Criteria Air Pollutants from the Fermilab site during operations in 2006.

Pollutant	Besco Boilers	Emergency Generator	Magnet Debonding Oven	Gasoline Storage Tank	CDF[1] & MIPP[2]	Totals in tons
Carbon Monoxide (CO)	1.062	0.168	0.000394	0	0	1.231
Ammonia (NH3)	0.040	0.000	0	0	0	0.040
Nitrous Oxides (NOx)	1.264	0.734	0.000768	0	0	1.999
Particulates	0.096	0.021	0.00241	0	0	0.120
Sulfur Dioxide (SO2)	0.008	0.012	0	0	0	0.020
Volatile Organic Material (VOM)	0.070	0.022	0.000228	0.0204	0.956	1.068

[1] CDF is Collider Detector at Fermilab
[2] MIPP is Main Injector Particle Production

Table 4.1: Estimated release of Criteria Air Pollutants at Fermilab in tons per year for 2006

Tritium and other short-lived radionuclides are produced as a normal by-product of NuMI operations. The airborne radionuclides produced in the NuMI facility are released into the atmosphere through vent stacks to the surface of the Fermilab site. Environmental emissions are limited by minimizing the ventilation of the tunnels during beam operations. Ventilation is maximized for personnel access; however, air emissions are still limited by allowing sufficient time for decay after beam shutdown and before accessing. Air from the ventilation stacks is monitored for radionuclide emissions.

The annual radioactivity of typical releases from Fermilab (site-wide) in recent history (2005 and 2006) and the estimated maximum dose rate at the site boundary from these releases are summarized in Table 4.2 (Martens 2007). This dose rate at the site boundary is assessed for a hypothetical member of the public who would spend the entire year at the location of maximum exposure at the Fermilab site boundary. Total releases are reported annually to the IEPA and the EPA in accordance with conditions of the relevant NESHAP permit (IEPA 2006).

The operations of the NuMI facility for the MINOS Project have not caused Fermilab to approach the regulatory limits for total activity releases or for the dose limit at the site boundary.

Source of Radionuclide Air Emissions	Annual Release of Radionuclides	Estimated Maximum Dose at Site Boundary
Fermilab Accelerators (Excluding NuMI)	30 Curies/year	0.02 mrem/year
NuMI Air Ventilation (Short Lived Radionuclides †)	50 Curies/year	0.02 mrem/year
NuMI Tritiated Water Vapor	20 Curies/year	0.0002 mrem/year
Fermilab Site Wide Total	**100 Curies/year**	**0.04 mrem/year**
Regulatory Limits	**2,000 Curies/year (NESHAP Permit)**	**10 mrem/year (40 CFR 61)**

† The principal radionuclides typically measured to be present include carbon-11, oxygen-15, nitrogen-13, and argon-41 (half-lives from 2 minutes to 1.8 hours).

Table 4.2: Estimated annual release of radionuclide air emissions and estimated maximum dose at the Fermilab site boundary during operations of NuMI at 400 kW of beam power for the MINOS Project.

4.1.3 Hydrogeology at Fermilab

The surficial geology at Fermilab consists of glacial till about 80 ft deep overlaying carbonate layers of bedrock to a depth of about 215 ft thick. Ground water flow in the glacial deposits is generally downward and slow, and the water table fluctuates seasonally between 5 - 15 ft below ground surface (bgs). Water moving through the glacial deposits recharges the underlying bedrock aquifer, which the IEPA has classified as a Class I groundwater aquifer (IEPA 1998).

Below the carbonate bedrock is a shale formation which serves as a low permeability aquitard that confines deeper aquifers. This barrier isolates the groundwater in the vicinity of the NuMI tunnel from the deeper aquifers.

In some cases, the earth shielding around high intensity beam loss areas or around the beam targets becomes radioactive (or is *activated*). Leaching of radionuclides into water or activation of the water in the soil provides a possible mechanism for transport of radioactivity into the surface water from the groundwater. Of the leachable radionuclides known to be produced in Fermilab soil only tritium (H-3) and sodium-22 have the long half-lives, significant production rates, and largest leachabilities into water flowing through the soil to pose the greatest potential hazard. Experience at Fermilab has found that a measurement or estimate that indicates that tritium and sodium-22 concentrations are at or below acceptable levels is a strong indicator that this will hold for the other radionuclides as well (Fermilab 2007c).

The hydrogeology of the Fermilab site along with the NuMI tunnel construction ensures that groundwater in the vicinity of the NuMI facility continuously flows into the NuMI tunnel (Figure 4.2). Therefore, radionuclides produced in the water in the immediate vicinity of the NuMI tunnel flow toward the tunnel. The ground water that flows into the tunnel is collected and continuously pumped to the surface water management system, where it is considered surface water. This water is not a drinking water supply.

Public drinking water supplies in the Batavia area generally withdraw water from the "deeper aquifer" at a depth of 700 ft, whereas private wells are generally situated in the "shallow aquifer" at 200 ft. Some private wells have tapped groundwater at depths from 25 to 100 feet bgs (IEPA 1998 and 2000). The closest private well is between 1 – 1.5 mi from the NuMI tunnel target area.

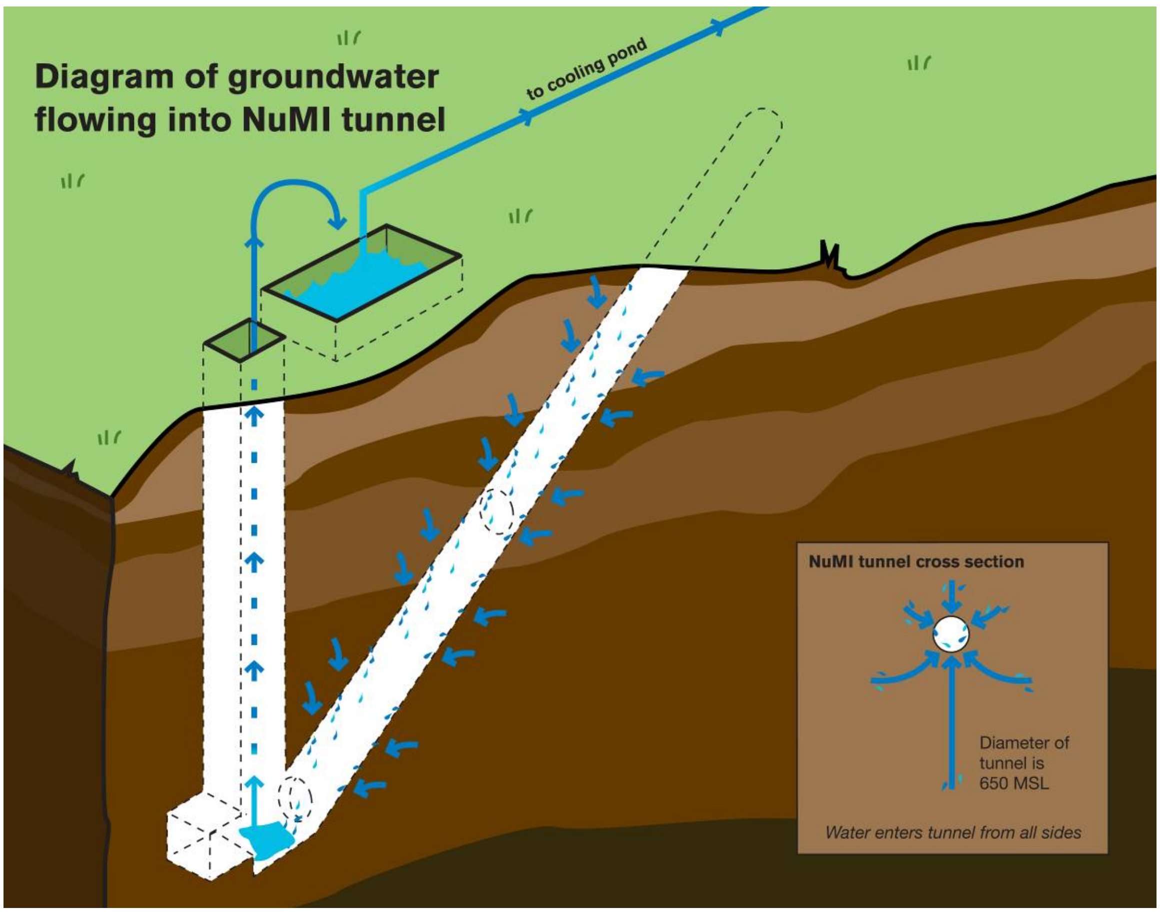


Figure 4.2: Diagram of Groundwater Flowing into the NuMI Tunnel. The NuMI tunnel centerline is 650 feet below mean sea level (MSL).

4.1.4 Surface Water Resources at Fermilab

Three watersheds collect water on site. Surface water runoff in the southeast is into Ferry Creek. The northern part of the site drains to Kress Creek. These two creeks drain to the West Branch of the DuPage River. Surface drainage in the west and southwest is to Indian Creek and the Fox River.

Water flows inward toward the NuMI tunnel from the surrounding dolomite at a rate of about 170 gal per minute. The water flowing into the tunnel is collected in a drainage system and pumped continuously to the surface where it is introduced into the ICW system. The water pumped from the NuMI tunnel can be radioactive; the radionuclides of primary concern are tritium and sodium-22.

The water in the NuMI tunnel and the water in the ICW ponds are subject to DOE standards for surface water as documented in the Fermilab Radiological Control Manual (FRCM Fermilab 2007c). Measurements of tritium in the NuMI discharge water and in the ICW Pond Water and their respective regulatory limits are shown in Table 4.3. The data in Table 4.3 show that tritium was observed at only a small fraction of the regulatory limit, (0.25% to 0.4% of the limit in the NuMI discharge water and 0.05% of the limit in the ICW Pond Water). Similar measurements and regulatory limits for sodium-22 shown in Table 4.4 indicate that sodium-22 was below the analytical detection limit in both water sources (less than 0.3% of the limit in the NuMI discharge water and less than 0.1% of the limit in the ICW Pond Water).

Since the initiation of experiments in the NuMI facility, several steps have been taken to reduce the amount of tritium in the water discharged from the NuMI tunnel. These mitigation steps resulted in a reduction of the tritium levels in the water pumped from the NuMI tunnel by a factor of about 7. All of the measured concentrations are well below the regulatory limit for surface water.

	Tritium Levels (NuMI Discharge Water)	**Tritium Levels (ICW Pond Water)**
NuMI/MINOS Present operations	5-8 pCi/ml †	< 1 pCi/ml
DOE Regulatory Limits for Surface Water (DCGs)	2,000 pCi/ml	2,000 pCi/ml

† Due to daily fluctuations in the NuMI operating conditions, the tritium concentration in the NuMI discharge water ranges from 5 to 8 pCi/ml.

Table 4.3: Measured concentrations of tritium in the NuMI discharge water and Fermilab ICW ponds during NuMI operations for the MINOS Project and the DOE regulatory limits.

	Sodium-22 Levels (NuMI Discharge Water)	**Sodium-22 Levels (ICW Pond Water)**
NuMI/MINOS Present operations	< 0.03 pCi/ml *	< 0.01 pCi/ ml *
DOE Regulatory Limits for Surface Water (DCGs)	10 pCi/ml	10 pCi/ml

* No sodium-22 was measured in the NuMI discharge water at the detectable limit of 0.03 pCi/ml. Therefore the sodium-22 concentrations are upper limits.

Table 4.4: Measured concentrations of sodium-22 in the NuMI discharge water and Fermilab ICW ponds during NuMI operations for the MINOS Project and the DOE regulatory limits.

4.1.5 Biological Resources at Fermilab

Most of the land that Fermilab now occupies was actively farmed prior to the existence of Fermilab. Approximately 1,600 ac has remained in crop production, primarily corn. About 1,000 ac has, to date, been planted in native prairie vegetation. The biotic communities within Fermilab include upland forests, oak savannas, prairie remnant, reconstructed prairie, non-native grasslands, old fields, pastures, turfgrass lawns, fence rows, row-crop fields, and various types of wetlands. A mesic upland forest, about 69 ac in size, has bur oak as the dominant canopy tree with other common species including red oak, sugar maple, white ash, swamp white oak, hop hornbeam, basswood, hawthorn, black cherry, bitternut hickory, and box elder. Wetlands include persistent emergent palustrine wetlands, palustrine forested wetlands along the flood plain of Indian Creek, and small palustrine scrub-shrub wetlands.

The mixture of vegetation communities, open fields, deciduous forests, restored prairie, wetlands, and mowed areas, coupled with a large degree of protection from human intrusion, makes the Fermilab site a desirable refuge for many species of animals. It attracts many birds and mammals that are characteristically found in open fields, forests, and forest-edge communities. In addition, many bird species use the site as a stopover during spring and fall migration.

The presence of Federal- or State-identified threatened or endangered species on the Fermilab site was reviewed in 1997 during the assessment of the NuMI project. The conclusion at that time was there were no threatened or endangered species in the area of the NuMI Project. The proposed action under the NO*ν*A Project would occur in the same areas previously reviewed.

The U. S. Fish and Wildlife Service has confirmed the absence of Federal endangered or threatened species within the NuMI/NO*ν*A experimental area (USFWS 2007). The

Illinois Department of Natural Resources (IDNR) was consulted to identify changes to the presence of State endangered or threatened species within the NO*v*A experimental area (IDNR 2007). Appendix D contains the correspondence related to this inquiry. The conclusion of this process was that there are no endangered or threatened species in the area of the NO*v*A experiment at Fermilab.

Various types of wetland communities also exist around the Fermilab site. The wetland types at Fermilab include primarily palustrine emergent, forested, scrub-shrub and unconsolidated bottom varieties, lacustrine limnetic and littoral wetlands and riverine intermittent wetlands. The wetlands exist along the creek banks and in the area surrounded by the Main Ring ponds; they are not in the affected area of the NO*v*A Project.

4.1.6 Cultural and Historical Resources at Fermilab

Comprehensive surveys for prehistoric and historic sites have been conducted within the Fermilab boundaries (Lurie 1990, Bird 1991, and Schaffer 1993). A site-wide Cultural Resources Management Plan completed in 2002, incorporates information from a number of these archeological and architectural surveys (Lurie 2002). The plan identifies, maps, and classifies archeological resources found at Fermilab. No archaeological or historical resources were found in the areas that would be disturbed during construction activities

4.1.7 Socioeconomics / Demographics at Fermilab

Fermilab lies in western DuPage County and eastern Kane County, the westernmost of the six collar counties around Chicago. The populations of DuPage and Kane Counties are growing rapidly. DuPage County is largely urbanized, although considerable development is still occurring in the western part. DuPage County population, currently about 930,000, is expected to be about 985,000 (a 6% increase) by the year 2010. The eastern part of Kane County is the more rapidly developing edge of urbanization which is moving out from the Chicago metropolitan area. The central and western parts of Kane County are mostly agricultural with a few cities, housing developments, and villages dotting the countryside. Kane County population, now about 490,000, is expected to increase to over 590,000 (more than 20%) by the year 2010. Demographic statistics describing the populations in DuPage County, in Kane County and in the State of Illinois are provided in Table 4.5.

Population Demographic	Kane County	DuPage County	Illinois
Population, 2006 estimate	493,735	932,670	12,831,970
Population, percent change, April 1, 2000 to July 1, 2006	22.20%	3.10%	3.30%
Population, 2000	404,119	904,161	12,419,293
Persons under 18 years old, percent, 2005	29.40%	25.80%	25.40%
Persons 65 years old and over, percent, 2005	8.10%	10.20%	12.00%
White persons, percent, 2005 (a)	89.90%	84.80%	79.40%
Black persons, percent, 2005 (a)	5.60%	4.10%	15.10%
American Indian / Alaska Native persons, percent, 2005 (a)	0.40%	0.20%	0.30%
Asian persons, percent, 2005 (a)	2.80%	9.70%	4.10%
Native Hawaiian / Other Pacific Islander, percent, 2005 (a)	0.10%	0.00%	0.10%
Persons of Hispanic or Latino origin, percent, 2005 (b)	27.50%	11.30%	14.30%
White persons not Hispanic, percent, 2005	63.40%	73.90%	65.80%
Persons with a disability, age 5+, 2000	55,563	101,008	1,999,717
Median household income, 2004	$61,246	$66,697	$47,711
Per capita money income, 1999	$24,315	$31,315	$23,104
Persons below poverty, percent, 2004	7.90%	6.00%	11.90%

(a) Includes persons reporting only one race.
(b) Hispanics may be of any race, so also are included in applicable race categories.

Source: U S Bureau of the Census (Census 2000)

Table 4.5 Demographic statistics describing the populations in DuPage County, in Kane County and in the State of Illinois

Fermilab has approximately 2,000 employees, and 1,400 experimenters from all over the world who use the facilities. Most of the employees work in Wilson Hall, a large office building on the Fermilab site, approximately 1 mi east of the proposed NO*v*A site. Approximately 100 experimenters would work on the proposed NO*v*A Project, principally performing computations remotely, from offices in Wilson Hall. They would have no need to access the detector or beam facilities. The overall number of scientists who conduct research at Fermilab is not anticipated to change significantly from present levels. Annually, the Laboratory typically has approximately 50,000 day visitors who visit Wilson Hall to attend cultural activities, to take self-guided tours, to participate in activities at Fermilab's science education center, and to conduct business with the Laboratory.

4.1.8 Occupational Health and Safety Experience at Fermilab

Over a 5-year period from 2001 to 2005, the total recordable cases of occupationally-related injuries and illnesses at Fermilab averaged 1.5 cases per 200,000 worker hours (DOE 2007). This rate is lower than the average incidence rate for DOE sites (1.9 cases per 200,000 worker hours). For comparative purposes, the DOE average incidence rates were well below the Bureau of Labor Statistics rates for U.S. private industry of 5.4 cases per 200,000 worker hours during the 5-year period from 2000 to 2004 (most recent data available) (DOE 2007).

Ionizing radiation is produced at Fermilab during operation of the NuMI beamline. The radiation is generated by the interaction of the proton beam with objects such as the target, focusing magnets, collimators, the walls of the tunnels and beam absorbers, or any other material that the proton beam may strike. A major portion of this radiation, known as prompt radiation, is present only when the beam is operating. Exposure of Fermilab employees, visitors, scientific users, and members of the public to this radiation is regulated by DOE in 10 *CFR* 835 and in DOE Order 5400.5 (DOE 1998b), and these regulations are implemented at Fermilab through a detailed written policy in the FRCM (Fermilab 2007c).

The DOE Office of Environment, Safety and Health reports occupational radiation exposure data for monitored DOE and contractor employees (DOE 2007). In 2005, approximately 1,600 Fermilab workers were monitored for occupational radiation exposure. Of that number, only 426 workers actually had a measurable dose equivalent. The average measurable dose equivalent was 38 mrem, and the maximum dose received by any worker was 280 mrem. These values are considerably below the DOE regulatory dose equivalent annual limit of 5 rem (5,000 mrem) or the Fermilab administrative dose goal of 1,500 mrem annually.

Fermilab also tracks the collective dose statistic (the sum of the individual doses measured in the monitored workforce), which is an indicator of the overall workforce radiation exposure. In 2005, the Fermilab collective dose was about 16 person-rem. For perspective, the 426 individuals with measurable dose equivalent would have received about 153 person-rem from background radiation sources during 2005.

4.1.9 Transportation at Fermilab

The regional highway network in the vicinity of Fermilab consists of several main routes: a DOE-maintained road network within the site; US Interstate 88, a multi-lane, high volume route running east-west to the south side of the site, and State Highway 59, a principal 4-6 lane north-south arterial to the east of the site. At peak periods, commuter traffic is often heavy on all primary routes to and from Fermilab. Freight rail service is available at a railhead adjacent to the north side of the site. Transportation resources are shown in Figure 4.1.

4.2 Ash River MN Site

The Minnesota Environmental Assessment Worksheet (EAW) contained in Appendix A is incorporated into this EA by reference. It was prepared by the University of Minnesota, acting as the State of Minnesota Responsible Governmental Unit (RGU) for this environmental review process. For the NO*v*A Project environmental review, Barr Engineering Co, Duluth, MN reviewed the draft EAW and provided the RGU an independent assessment and verification of the information in the EAW (Barr 2007). Information in the following sections is a summary of the EAW, which should be reviewed for detailed discussions of the affected environment.

4.2.1 Land Use at the Ash River Site

The proposed location for the NO*v*A Far Detector Facility is a currently undeveloped parcel approximately 25 mi southeast of International Falls, MN. Details of the land, its proposed use, existing cover types, and proposed changes are discussed in Sections 9 and 10 of the EAW (Appendix A).

4.2.1.1 NOvA Far Detector Facility Site

The proposed facility site consists of three land parcels that total 89.6 ac. Two (2) of the parcels are currently owned by the Minnesota Department of Natural Resources (MNDNR). The third section is currently owned by the Forest Capital Partners (formerly Boise Cascade). Access to the site is via an old clay base logging road which crosses land owned by Forest Capital Partners and the MNDNR. The properties have been primarily utilized for timber cutting operations in the past. The MNDNR Division of Forestry is responsible for management of the site and these timber production areas are parcels within the Kabetogama State Forest.

The proposed facility site contains several logging roads and trails providing access throughout the site. No old growth forest exists on the site. The upland forest cover consists of young stands of trees in areas recently harvested, to middle aged trees in older cut areas. Approximately 80% of the existing tree cover consists of quaking aspen (*Populus tremuloides*). The majority of the site has been clear-cut recently and is devoid of tree cover.

4.2.1.2 Access Road Alignment Right-of-way

The proposed access road alignment consists of 18.9 ac and is approximately 3 mi in length. The access road alignment crosses both wetland and upland land uses that are similar to those found on the facility site. The road also transects through MNDNR-owned timber parcels and private parcels. There are no residential or developed parcels along the proposed access road alignment. Similar to the facility site, there are numerous clearcuts and other recent impacts from timber production in the vicinity of the access road alignment. Neither the proposed facility site nor access the road alignment shows evidence of potential pollution concerns or potential environmental hazards due to past site uses.

4.2.2 Air Quality at the Ash River Site

St. Louis County in Minnesota continues to meet all federal ambient air quality standards. The air quality in the Ash River area is rated as "good" based upon measurements of the air quality index (AQI). The AQI uses numbers from 0 to 500 to describe the air quality conditions and their possible effects on human health. Readings of 0-50 are described as Good, 51-100 as Moderate, 101-150 as Unhealthy for Sensitive Groups, 151-200 Unhealthy, 201-300 Very Unhealthy, and 301 and above Hazardous. The rating for the Ash River area is based upon an annual average of 257 days with ratings less than a 50.

4.2.3 Hydrogeology at the Ash River Site

The Ash River area of northern Minnesota is characterized by thin glacial deposits overlying Pre-Cambrian shield rocks. The near surface, unconsolidated material is clayey in nature ranging from lean to fat clay to clayey sand. Underlying the clayey surface layer is silty sand extending to the surface of the bedrock. Bedrock geology in the vicinity of the site consists of granitoid rocks and granite-rich migmatite to a depth of over several hundred meters (MNDNR 2001).

Two borings have been made at the proposed Ash River building site to a depth of approximately 60 ft and found 7 – 10 ft of glacial till over solid hard granite to full depth. Two units are identified with the unconsolidated deposits, an upper clayey unit (including lean to fat clay and clayey sand) and a lower silty sand unit. The clay unit was encountered to 2.5 and 4 ft bgs, underlain by the silty sand to 6.5 and 7.5 ft bgs where granitic bedrock was encountered. A packer test done at one boring found the granite exhibited no significant fracturing at these depths.

Twenty-seven additional borings were completed on site. Unconsolidated deposits in these borings are also consistent with the glacial till and have sandy and gravelly deposits overlying bedrock. The depth to bedrock in these borings ranges from 4 - 18 ft bgs. In the wetland portion of the proposed access road to NO*ν*A just off St. Louis County 129, the glacial till is much thicker with one boring not reaching bedrock even at 40 ft in depth. A detailed geotechnical engineering report of the Ash River site is available (SEH 2007).

Groundwater elevations were found to be approximately 2.5 ft below the surface. Given the lack of weathering in the bedrock at the site, it is possible that water infiltrating through the upper soil deposits perches on top of the bedrock. The direction of groundwater movement likely follows the slope of the bedrock. Results of the monitoring and testing indicate the distribution of water is highly variable across the proposed Far Detector site. The occurrence of dry wells and low quantities of water, in wells that exhibit water, suggest that a water table aquifer is not present at the site to the depths investigated, as low as 60 ft bgs. Additional information applicable to geologic and groundwater resources can be found in the EAW Sections 13, 18 and 19.

4.2.4 Surface Water Resources at the Ash River Site

The Ash River site is currently undeveloped, and surface water would follow the natural contours of the lands to the south. At closest approach, the detector building would be approximately 1,000 feet from the nearest point of the Ash River, which discharges into Lake Kabetogama about 2.8 mi away.

There is a 100-year floodplain along the Ash River identified on the National Flood Insurance Program Flood Insurance Rate Map, as seen in Figures 4 and 5 in the EAW (Appendix A). In addition, the Ash River is a Protected Water and has a designated shoreland area within 300 feet of its bank (EAW Figure 7). The shoreland zone also includes the area of the floodplain where it extends beyond the 300-foot defined shoreland area. None of the proposed facility impact footprint is within either the shoreland area or the floodplain of the Ash River. The surface water conditions at the proposed Ash River site are described in the EAW Sections 12, 14 and 17.

4.2.5 Biological Resources at the Ash River Site

The proposed Ash River site is undeveloped woodland that has been previously used for logging. The EAW describes the area in Section 9, the types of cover in section 10, and wildlife and ecological conditions in Section 11.

The habitats within the site boundary are entirely comprised of forested uplands that have been subjected to recent clearcutting activities. There are no fluvial or lacustrine habitats in the affected environment. Patches of un-cut timber are present amid the recently clearcut areas within the facility site boundary. Soils are thin or comprised of exposed Precambrian bedrock outcrops within a relatively rugged topography. These habitats represent the common types of upland habitats found in the surrounding area.

The MNDNR Natural Heritage Information Program (NHIP) was contacted to identify potential state and federally listed Threatened, Endangered, Special Concern species, and sensitive resources in the project area. Consultations with the NHIP concerning threatened and endangered species are discussed in Section 11 of the EAW.

State Threatened, Endangered and Special Concern Species and NHIP Occurrences

The NHIP identified 5 occurrences within a 1.5-mi radius of the project site and is the basis for the following discussion. No occurrences are found within the facility site boundary or footprint of the proposed access road. Four of the five noted occurrences were of tiger beetles (*Cicindela denikei* – state status, Threatened). Two of the tiger beetle occurrences were recorded in 2001 and 2004 approximately 1.5 to 2 miles south of the facility site, up-gradient of a tributary to the Ash River. One location of a population of Lapland buttercup (*Ranunculus lapponicus* – state status, Special Concern) was identified along St. Louis County 129 west of the intersection of the site access road.

Federally Listed Threatened and Endangered Species

St. Louis County is within the breeding range of the bald eagle (*Haliaeetus leucocaphalus* – federal status, Threatened – proposed for delisting), the distributional range of the grey wolf (*Canis lupus* – federal status, Threatened), and the distributional range of the Canada lynx (*Lynx canadensis* – federal status, Threatened). No bald eagle nesting areas are identified within or within a one-mile radius of the site boundary and none were observed during a site reconnaissance. Suitable nest trees for eagle nests were lacking and there were no lakes that serve as foraging habitats for bald eagles in the vicinity of the site boundary. Canada lynx habitat is marginal to poor within the site boundary, due to extensive clearcutting.[1] Grey wolves are known to occur throughout the project area, an area where wolves have long been established prior to and since they were federally listed.

4.2.6 Wetlands at the Ash River Site

The University of Minnesota completed a wetland delineation of the proposed Far Detector Facility site including field delineation in accordance with the Routine Onsite Determination Method and the 1987 USACE Wetland Delineation Manual (USACE 1987). The resulting delineation report was merged with the Combined Wetland Permit Application prepared for the project and submitted to the USACE (RUMN 2007b). In the delineation process two wetlands were identified within the proposed site boundary, and five wetlands were identified along the proposed access road alignment. The EAW in Appendix A discusses wetlands at the Ash River location in Sections 10 and 12, and the locations of the wetlands are shown on Figure 6 of the EAW.

Wetland classification follows the U.S. Fish and Wildlife Service (USFWS) systems as required by Section 404 and the Minnesota Wetlands Conservation Act (WCA). At USACE's request, *Eggers and Reed* (USACE 1997) classifications were also applied to the delineated wetlands. Wetland plant species nomenclature in the application follows the *National List of Plant Species that Occur in Wetlands* (U.S. Department of the Interior 1988), and field guides for the region aided identification.

USFWS Wetland Classifications

Two different classification systems are commonly used in Minnesota to classify wetlands (BWSR 2007). The Circular 39 system, developed by the USFWS in 1956 (USFWS 1956), divides wetlands in Minnesota into eight types. The main differences between them are depth of water and variety of vegetation.

Type 1 wetlands are either seasonally flooded basins or floodplains.
Type 2 wetlands are wet meadows.
Type 3 wetlands are shallow marshes.
Type 4 wetlands are deep marshes.
Type 5 wetlands are open water wetlands, including shallow ponds and reservoirs.
Type 6 wetlands are shrub swamps.

---

[1] The U.S. Fish and Wildlife Service proposed regulations February 28, 2008 (73 *Federal Register* 10860) to extend the designated critical habitat for the Canada lynx to include St. Louis County, MN. DOE will coordinate with the FWS on this issue as needed.

Type 7 wetlands are wooded swamps.
Type 8 wetlands are bogs.

The Cowardin system, developed by the USFWS in 1979 (Cowardin 1979), is a far more precise classification system, which uses numerous alphabetic and numeric codes to describe a tiered classification system. Each tier describes the components of a wetland more specifically and narrowly than the last. For example for a wetland coded PEMB:

P means its system is Palustrine (shallow ponds, marshes, swamps, sloughs);
EM means its class is Emergent Vegetation (erect, rooted and herbaceous vegetation adapted to wet soil conditions); and
B is its hydrology modifier (substrate is saturated but standing water is seldom present).

An explanation of the detailed codes and a description of the classification systems are available in the respective references.

Far Detector Site Wetland Description

Figure 6 in the EAW (Appendix A) shows the delineated wetlands, and Table 4.6 presents the wetlands areas and classifications. The first two wetlands are on the proposed site; the remaining wetlands are along the access road.

Basin ID[2]	USFWS Wetland Classification			Total Wetland Area (acre)
	Eggers and Reed	Cowardin	Circular 39	
Wetland 1	Sedge Meadow/Shallow Marsh/Deep Marsh/Coniferous Swamp	PEMB/C/F PSS1B/PFO1B	Type 2/3/4/5/7	>5 ac[1]
Wetland 2	Sedge Meadow/Shallow Marsh/Deep Marsh	PEMB/C/F	Type 2/3/4	6 ac[1]
Wetland 4	Coniferous Swamp/Hardwood Swamp	PFO1B	Type 7	0.05 ac
Wetland 5	Sedge Meadow	PFO1A	Type 1	0.01 ac
Wetland 6	Shrub Carr/Alder Thicket	PSS1C	Type 6	0.05 ac
Wetland 7	Shrub Carr/Alder Thicket/ Coniferous Swamp/Hardwood Swamp	PSS1B/PFO1B	Type 6/7	>40 ac[1]
Wetland 8	Shrub Carr/Alder Thicket/ Coniferous Swamp/Hardwood Swamp	PSS1B/PFO4B	Type 6/7	>40 ac[1]

[1] Wetland extends outside the project limits. The entire wetland was not delineated and the area shown is estimated

[2] Wetland 3 was tentatively identified but further analysis showed it lay outside the project boundary

Table 4.6 Summary of Wetland Types at the Far Detector Site

4.2.7 Cultural and Historical Resources at the Ash River Site

In December 2005, The 106 Group Ltd. conducted a Cultural Resources Assessment in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended (T106 2006). The assessment found that no architectural history surveys have been conducted and no properties have been inventoried within the project area. It also shows that no archaeological sites have been recorded or reported within the Project Area, but one site has been recorded (confirmed) and three sites have been reported (not field checked) within one mile of the Project Area. These four sites include three logging camps and a railroad trestle. No previously recorded pre-contact archaeological sites are located within a one-mile radius of the study area.

The study identified an abandoned railroad grade that may retain sufficient integrity to convey potential significance as an early logging road. This section of railroad passing through the western portion of the project area is identified as a “Winter Road” and is shown on Figure 2 of the EAW (Appendix A). The road extends south until it reaches the Ash River. The western portion of the existing access road to the project site originated as this “Winter Road” and was later used as the basis for the rail line that was likely a spur extending from the VRL Railway, which operated a network of rail lines in northern St. Louis and Koochiching counties. This railroad grade would likely be considered for eligibility for the National Register for Historic Places (NRHP), either under Criterion A, for the broad patterns of history related to timber procurement, or under Criterion C, if the grade represents a significant designed system or if the surviving features demonstrate design attributes that help explain how the various components work. Portions of the rail grade have been converted to a lightly traveled gravel road, which has been widened to accommodate local traffic. Cultural resources are further discussed in Section 25 of the EAW.

Although a Phase I archaeological survey has not been conducted, the Cultural Resources Assessment states that areas within 150 meters of the Ash River have high potential to contain pre-contact archaeological materials.

4.2.8 Socioeconomics / Demographics at the Ash River Site

The proposed Ash River site is in an undeveloped rural area of Northeastern Minnesota. The population density is 1 person per square mile (Census 2000). Approximately 35 workers would be needed at the site during construction and only 5 - 8 people would be needed for experiment operations. Demographic statistics describing the populations in St Louis County and in the State of Minnesota are provided in Table 4.7.

Population Demographic	St Louis County	Minnesota
Population, 2006 estimate	196,097	5,167,101
Population, percent change, April 1, 2000 to July 1, 2006	-2.20%	5.00%
Population, 2000	200,528	4,919,479
Persons under 18 years old, percent, 2006	20.05%	24.34%
Persons 65 years old and over, percent, 2006	15.70%	12.14%
White persons, percent, 2006 (a)	94.65%	89.33%
Black persons, percent, 2006 (a)	1.03%	4.47%
American Indian / Alaska Native persons, percent, 2006 (a)	2.12%	1.17%
Asian persons, percent, 2006 (a)	0.75%	3.50%
Native Hawaiian / Other Pacific Islander, percent, 2006 (a)	0.03%	0.05%
Persons of Hispanic or Latino origin, percent, 2006 (b)	0.86%	3.80%
White persons not Hispanic, percent, 2005	93.96%	85.93%
Persons with a disability, age 5+, 2000	31,900	592,448
Median household income, 2004	$43,078	$54,023
Per capita money income, 1999	$23,313	$27,591
Persons below poverty, percent, 2004	12.9%	9.8%

(a) Includes persons reporting only one race.
(b) Hispanics may be of any race, so also are included in applicable race categories.

Source: U S Bureau of the Census (Census 2000)

Table 4.7 Demographic statistics describing the populations in St Louis County and in the State of Minnesota

4.2.9 Occupational Health and Safety at the Ash River Site

The proposed site is undeveloped. Therefore, there is no baseline for occupational health and safety.

4.2.10 Transportation at the Ash River Site

The functional average daily traffic capacity for a rural two-lane county roadway like St. Louis County 129 is in the range of 8,000 to 10,000 vehicles per day (VPD). It currently serves approximately 310 VPD. Transportation at Ash River is discussed in Sections 21 and 22 of the EAW (Appendix A).

5. POTENTIAL ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION AND THE NO ACTION ALTERNATIVE

This section describes the anticipated environmental impacts of the four elements of the proposed NOνA Project: excavation and civil construction, installation and assembly, operation of the experiment, and decontamination and decommissioning of the facilities. This section discusses impacts associated with "normal" activities - those that proceed as planned. Potential impacts related to "off-normal" or accident scenarios are addressed in Chapter 6.

This Chapter describes impacts associated with the Fermilab and Ash River project sites separately, in Sections 5.1 and 5.2, respectively. Section 5.3 discusses the impacts of the blending facility alternatives. The region between Fermilab and the NOνA Far Detector would be unaffected by the construction, assembly, operation, and decommissioning activities since the NOνA experiment requires no disturbance within the region. Because neutrinos rarely interact with material, they do not activate the material they pass through. Therefore, impacts are not associated with project operations in the region between the near and far detectors. A summary of human health impacts is provided in Section 5.4, and Section 5.5 identifies the potential impacts due to the no action alternative.

1

5.1 Potential Environmental Impacts from Activities at Fermilab

At Fermilab the proposed action would include an upgrade of the existing Fermilab accelerator complex, construction of an underground cavern, and installation of two neutrino detectors, the above-ground IPND and the underground Near Detector. Blending the approximately 4.3 million gal of materials that are needed to fill the three NOνA detectors (IPND, Near, and Far) would occur at a commercial blender in the Chicago area or at a blending facility proposed to be built at Fermilab, as described in Section 3.3.2. Impacts from a blending facility at Fermilab include those from construction, blending operations, and material transport. Using a commercial blender would include impacts from blending operations and materials transport, except there would be no construction, and transportation miles to/from Fermilab and Minnesota could be increased slightly, depending on vendor location. The blending facility and prototype detector would be decommissioned early in the experiment schedule when their purpose has been fulfilled. After an extended period of experiment operations and data collection, the other facilities would be decommissioned.

5.1.1 Excavation and Construction at Fermilab

5.1.1.1 Land Use

The areas where excavation and construction would take place on the Fermilab site are currently in use or have been previously used for other purposes.

5.1.1.2 Air Quality

During excavation and construction, the operation of diesel-powered equipment would be expected to introduce quantities of SO_2, NO_2, particulates, and other criteria pollutants to the atmosphere, typical of similar-sized construction projects. These releases would be temporary and reversible, and would not cause any air-quality standards to be exceeded. Particulates (dust) generated during earthmoving activities and vehicle movement over unpaved areas would be minimized by frequent watering or other dust-control measures.

The planned cessation of the Tevatron program during excavation would diminish routine radionuclide emissions to the air. Such emissions are regulated in a permit issued by IEPA pursuant to the State National Emissions Standard for Hazardous Air Pollutants program. NO*ν*A construction and excavation activities would not release radionuclides, volatile organic chemicals or other chemicals to the air.

5.1.1.3 Water Quality

Ground Water

The hydrogeology of the Fermilab site along with the NuMI tunnel construction enables ground water in the vicinity of the NuMI facility, including the proposed NO*ν*A Project, to flow continuously into the NuMI tunnel. Hydrologic modeling indicates that ground water within a 30-ft radius of the tunnel flows towards and into the tunnel at a rate of approximately 170 gal per minute (Martens 2007). Water flowing into the NuMI tunnel enters a drainage system that leads to a sump near the bottom of the tunnel. Water in the sump is pumped to the surface continuously and is used for replenishing the industrial cooling water (ICW) supply ponds at Fermilab.

No other subsurface disturbance or excavation is proposed. As described below, runoff from proposed surface construction activities would be controlled, which also would prevent drainage into ground water.

Surface Water

Surface areas disturbed by construction activities, including equipment staging and laydown areas, stockpile areas for excavated rock, access roads, and subsequent landscaping would be managed under the Fermilab SWPPP. Proper containment and erosion controls would be provided to prevent transport of soil or sediment and machinery lubricants and other construction chemicals into surface waters during storm events.

5.1.1.4 Biological Resources and Wetlands

The surface disturbing activities associated with construction and excavation activities would occur in areas at Fermilab where natural vegetative cover and habitat have been disturbed.

The proposed project would not involve activities within a 100-year floodplain (FEMA 1982). The potential impact of the NuMI beam line on jurisdictional wetlands was analyzed by qualified experts who determined that no adverse impacts would be expected (CTE 1997). The proposed NO*ν*A Project beam line is physically identical to the evaluated NuMI pathway; therefore the proposed action would not introduce any new adverse environmental impacts. And since no threatened or endangered species are present, there would be no impact to them.

5.1.1.5 Cultural and Historical Resources

As described in Section 4.1.6, none of the archeological locations identified in the *Fermi National Accelerator Laboratory Cultural Resource Management Plan* (Lurie 2002) coincide with or are near the locations that would be disturbed by construction or excavation-related activities. DOE made a determination of "no historic properties affected" under the National Historic Preservation Act (DOE 2007c). A copy of the determination is included in Appendix E.

5.1.1.6 Occupational Health and Safety

Fermilab employees and contractors would conduct work under the FESHM and implementing procedures for construction and excavation operations. Excavation workers in the tunnel would not be working in areas that have been activated by past accelerator operations, and the beam would be off-line during construction. As indicated in Section 3.1.4, the number of additional personnel on the Fermilab site during the excavation/construction phase is expected to be about 30 individuals or fewer, and project labor hours would be fewer than 60,000 per year.

Based on the Fermilab average incidence of 1.5 cases of injury/illness per 200,000 labor hours, 1 (0.9) case of injury/illness would occur during the two-year period of excavation/construction activities. Based on a national average underground mining incidence rate of 3.5 cases per 200,000 labor hours (DOL 2007), 2 (2.1) cases of injury/illness would be an upper bound on cases occurring during the two-year period. In this and subsequent discussion, "cases" refers to occupational injuries and illnesses that are recordable under U.S. Occupational Safety and Health Administration (OSHA) regulations in Title 29 *CFR* Part 1904. When using reportable case rates and worker hours to calculate total cases, the phrase "a calculation results in" is used to present the numerical estimate resulting from the statistical calculation, and it is not meant to imply that a particular number of injuries or illnesses will actually happen.

5.1.1.7 Transportation

The increase in the number of workers due to construction of the NO*ν*A Project would result in only a marginal increase in traffic. For 10 Fermilab construction worker vehicles, assuming a conservative average commute distance of 86 mi (round-trip) for each vehicle, (based on a one-way distance of 43 mi between Chicago and Batavia), results in a total of 430,000 vehicle-miles. For this total a calculation results in 2 (1.68) accidents, 0 (0.005) fatalities, and 0 (0.48) injuries due to construction worker commutes during the 2-year period. This is based upon Illinois accident, fatality, and injury statistics, which are 3.91E-06, 1.26E-08, and 1.04E-06, per vehicle-mile, respectively (IDOT 2005).

In this and subsequent discussion of transportation impacts, "a calculation results in" is a phrase used to present the numerical estimate resulting from a statistical calculation based on estimates of incident rates, number of vehicles and distances traveled. Distances traveled are estimated in either miles or kilometers, depending on the units of the referenced incident rates. The calculated result is not meant to imply that a particular number of accidents, injuries or fatalities will actually happen.

An estimate of the highway accidents of trucks associated with the construction phase is based on the number of truckloads of spoil material to be moved from the excavation to an existing Fermilab stockpile. It is estimated that approximately 1,000 yd^3 of rock spoils would require removal for the NO*ν*A Project. The truck traffic associated with moving the spoils to on-site stockpile(s) is estimated to be fewer than 10 trucks per day, and would be limited by the rate of excavation and spoil removal operations from the tunnel. Conservatively assuming 15 cubic yards per truckload, this would require the movement of a total of approximately 67 truckloads of spoil material. Hence, the total distance traveled would be low (less than 1,000 vehicle-miles total), and associated impacts essentially zero.

5.1.1.8 Noise and Vibration

The removal of the rock from the existing NuMI tunnel would require blasting operations that would be conducted in accordance with the FESHM. The proposed action, removing 1,000 yd^3 from deep in the tunnel represents only about 1.3% of the 75,000 yd^3 removed in the original NuMI blasting. The noise and vibration effects of the more extensive blasting and excavating for the original NuMI tunnel were evaluated in the NuMI Environmental Assessment (DOE 1997) and found to be not environmentally significant. The proposed blasting, involving a far smaller magnitude, would generate proportionately less noise and vibration.

5.1.1.9 Waste Generation and Disposition

Although the NO*ν*A experiment represents additional activity at Fermilab, the amount of additional waste generated would be a small percentage of routine waste volumes. Most construction wastes would be recycled; however, about 40 m^3 (50 yd^3) might be disposed as routine dumpster/landfill waste. In comparison, Fermilab landfill waste was over 8,700 m^3 in 2006 (Fermi 2007b). Under normal operations, excavation and construction would not produce hazardous wastes.

5.1.2 Installation and Assembly at Fermilab

5.1.2.1 Land Use

The areas where installation and assembly would take place on the Fermilab site are currently in use or have been previously used for other purposes. The site of the proposed assembly of the IPND would be inside of an existing building, thereby avoiding new land use.

5.1.2.2 Air Quality

In this phase the only criteria air pollutant emission sources would be light vehicles used for transportation of experimental components, and emissions from the vehicles of the 8 or so additional workers expected at Fermilab during the installation and assembly phase. This is well within normal Fermilab traffic fluctuations, as the site is open to visitors as well as students and researchers.

Assembly and installation of the IPND and the Near Detector requires the use of the MMA adhesive to glue the PVC layers together. Planning and design indicates the use of less than 2 metric tons (4,400 lbs) to glue both detectors. (Recall that the PVC components of the IPND would be recycled/assembled for use in the Near Detector). MMA evaporates and is emitted during adhesive application. According to the adhesive manufacturer, approximately 2.7% (by mass) of the MMA product will vaporize, so the potential MMA vapor source could be about 120 lbs, with approximately 50 lbs released during assembly of the IPND and the remaining 70 lbs during assembly of the Near Detector several years later. DOE and Fermilab have an established health and safety program that routinely addresses operations of this small scale, and impacts to air quality would be essentially zero.

The only other volatile emission sources associated with the NO*ν*A Project might be small quantities of paints or coatings that are routinely used at the Fermilab site and that are addressed by Fermilab ES&H training and procedures for handling open containers and materials with volatile constituents. These releases would not be expected to cause any air quality standards to be exceeded.

5.1.2.3 Water Quality

Ground Water
One hundred percent secondary containment and sumps would be in place prior to filling to contain and remove any spill or release of material and prevent contact with ground water.

Surface Water
Installation and assembly activities, including filling of the Near Detector, would not involve surface disturbance, and therefore would not be expected to cause erosion, or

increased site drainage to surface water in the area. Activities such as assembly of the IPND would take place in existing buildings, and the blending facility would be erected in a previously disturbed area. Using a commercial blending facility in the Chicago metropolitan area would have little if any effect on surface water, since secondary containment would be employed to prevent releases. The pseudocumene in the scintillation liquid is hazardous to aquatic organisms, so the NO*ν*A project would provide 100% secondary containment for all transfer, storage and use facilities to prevent release to the environment. Potential spills and other accidental releases during transportation are addressed in Chapter 6 and the NO*ν*A Project *Accident Analysis Summary* (NO*ν*A 2007c).

5.1.2.4 Occupational Human Health and Safety

The greatest potential of affecting occupational health and safety during installation and assembly would be the injuries to workers during "normal" activities. With fewer than 10 individuals actually engaged in assembly and installation activities, labor hours would be less than 20,000 per year. A calculation based on Fermilab average incidence of 1.5 cases of injury/illness per 200,000 labor hours results in 0 (0.15) cases of injury/illness during detector assembly and filling operations. Based on a national average for nonresidential building construction incidence rate of 5.4 cases per 200,000 labor hours (DOL 2007), 1 (0.5) case of injury/illness would be an estimated upper bound on cases occurring during the half-year period.

Accidents or "off-normal" occurrences are discussed in Chapter 6. Blending liquid scintillator could expose workers from the commercial facility to pseudocumene, but closed loop transfers and closed-tank blending would reduce potential exposure. Symptoms and effects of exposure to these blending chemicals are described in the MSDS information included in Appendix C. DOE and Fermilab have an established safety program that routinely addresses operations of this small scale.

During detector filling, vapors that potentially could be released to the atmosphere would be analyzed to assure compliance with FESHM air emission requirements. Ventilation controls and ES&H operational procedures would be developed for the project to minimize worker exposure and ensure that any exposures that do occur are well below the American Conference of Governmental Industrial Hygienists (ACGIH) time-weighted average (TWA) threshold limit value (TLV) and also below the short-term exposure limit (STEL).

5.1.2.5 Transportation

For the 8 employees associated with project assembly and installation, and assuming a conservative average commute distance of 86 mi (round-trip) (based on a one-way distance of 43 mi between Chicago and Batavia), a calculation results in an additional 1 (0.67) accidents, 0 (0.002) fatalities, and 0 (0.18) injuries for the six months to one year of this phase as a result of workers commuting 172,000 vehicle-miles to/from the Fermilab site. The calculation is based on the state of Illinois accident, fatality, and injury rates per vehicle-mile, which are 3.91E-06, 1.26E-08, and 1.04E-06, respectively (IDOT 2005). These numbers represent a minimal increase given the total number of employees at Fermilab and would be offset by workforce reductions due to programmatic changes at Fermilab during the period (i.e., termination of Tevatron operations).

Materials shipments for the assembly and filling of the detectors are few due to the small scale of the facilities at Fermilab. For example, the MMA adhesive would be delivered in two shipments from the distributor resulting in fewer than 1,000 vehicle miles and associated impacts essentially zero.

5.1.2.6 Waste Generation and Disposition

Hazardous materials used during the assembly and installation of the detectors include the liquid MMA adhesive. The Project would receive 660 gal of the Devcon-60 glue in 2 shipments totaling 12 plastic-lined drums. After glue is pumped from the drum, the residual adhesive (perhaps ~0.5%) necessitates that the liner be managed as a hazardous waste. Once the contaminated liner is removed, the uncontaminated metal drum is recyclable. The approximately 3 gal of residual liquid (0.5% of 55 gal in 12 drums) can be fixed by placing absorbent material in the liner. The plastic liners can be volume reduced through compaction to less than 1 m^3. Wastes would be submitted to a licensed waste hauler for disposal at a licensed disposal facility. Such a small volume would easily be managed within the existing waste volumes of Fermilab. In 2006 Fermilab disposed over 20 m^3 of hazardous wastes, of which 75% was “non-routine”, so this volume would not place undue strain on waste disposal capacity.

5.1.3 Operations at Fermilab

Operation of the proposed NO*ν*A experiment on the Fermilab site would follow the requirements of the FESHM. The FESHM implements a fully developed Integrated Safety Management System. Written work plans and emergency response procedures would be developed for all tasks that could pose a hazard.

Operation of the proposed upgraded beamline and NO*ν*A experiment would comply with existing Fermilab safety and beam operations procedures and guidelines as required by the Fermilab Radiological Control Manual (Fermilab 2007c). These procedures are based on the principle of As Low As Reasonably Achievable (ALARA) in the area of radiation protection. Written access procedures would be developed for all areas. A Safety Assessment Document would be written and approved before operation starts.

Total releases to the environment from beamline operations would continue to be reported annually to the Illinois Environmental Protection Agency (IEPA) and the U.S. Environmental Protection Agency (EPA) in accordance with conditions of the relevant NESHAPs permit (IEPA 2006).

A Fermilab Technical Memorandum *An Assessment of Radiological Releases from the NuMI Facility during MINOS and NOνA Operations* (Martens 2007) analyzes the radiological releases for operating the NuMI facility during proposed NO*ν*A operations has been written. The following sections discussing radionuclide releases and potential concentrations in air, ground water, and surface water are based on the content of this document.

5.1.3.1 Air Quality

Hazardous air emissions from the operation of the project would include radionuclides from the target and its vicinity. Under normal conditions, some of the radionuclides produced by the operation of the Fermilab accelerator become airborne in the form of tritiated water vapor and enter the atmosphere through three mechanisms: 1) ventilation of air from the NuMI underground facility, 2) evaporation of tritiated water from the Central Utility Building (CUB), and 3) evaporation from the Fermilab ponds. Releases under current operations are discussed in Section 4.1.2.

Operating the NuMI beam line under NO*ν*A operating conditions would increase the existing level of radionuclide emissions to the atmosphere commensurate with the proposed increase in beam power to 700 kW. Fermilab estimated bounding radionuclide emissions from the modified NuMI beam line using an operating beam power of 1,500 kW in order to determine potential radiological impacts of increasing the beam power. Estimating the emissions entailed scaling the current radionuclide measurements by the ratio of beam power. Calculating emissions at 1,500 kW, which is over twice the power level proposed for the NO*ν*A experiment operation, provides a very conservative estimate. At a beam power of 1,500 kW, the estimated total radionuclide air emissions that would be released into the atmosphere through vent stacks to the surface of the Fermilab site are 260 Ci/yr (Martens 2007). This estimated radionuclide release is well below the regulatory limit of 2,000 Ci/yr imposed by the Fermilab NESHAPS permit (IEPA 2006).

Hazardous materials are routinely used during Fermilab operations with no impact on air quality. Criteria pollutant emissions from the vehicles of eight additional workers (commuters) could be expected during operations and would fall within the normal site fluctuations.

5.1.3.2 Ground Water

Studies of the leachable radioactivity produced in soil and rock adjacent to NuMI tunnel show that the two principal radionuclides of concern are tritium and sodium-22 (Martens 2007). As shown in Table 5.1, conservative estimates of radioactivity levels in ground water immediately adjacent to the tunnel wall from beam line operations at 1,500 kW (over twice the beam power proposed for NO*ν*A operations) could exceed regulatory drinking water limits for sodium-22. However, this water source is not available for consumption.

Fermilab measurements and calculations show that 99% of all radionuclides that would be produced would be within the first 6 ft of the tunnel wall, and the ground water within a radius of 30 ft flows into the NuMI tunnel (Martens 2007). Ground water collected within a radius of 30 feet from the tunnel would reduce the concentration of radionuclides including sodium-22, due to NuMI operations to levels much lower than the drinking water regulatory limit. Moreover, this activated water would be collected in the sump at the end of the tunnel and discharged to the Fermilab surface water pond system and subsequently used in the ICW system on site as is the current practice. The cooling ponds that receive the ground water that is pumped from the tunnel are underlain with naturally occurring clay, which inhibits radionuclides, such as tritium or sodium-22 produced during the NuMI and NO*ν*A experiments from re-entering ground water. This water would not be available for public use or consumption, nor would it undergo subsurface transport once entering the ICW.

Spills or accidents involving liquid scintillator from the Near Detector in the NuMI tunnel that might enter the ground water system are addressed in Chapter 6. Releases would be controlled by primary and secondary containment systems as described in Section 3.3.2.

Type of Operations	Estimated Maximum Tritium Level	Estimated Maximum Sodium-22 Level
NuMI/at 1,500 kW	7 pCi/ml	0.7 pCi/ml
Illinois Drinking Water Standard	**20 pCi/ml**	**0.4 pCi/ml**

Table 5.1: Estimated radionuclide concentrations in the ground water immediately adjacent to the NuMI tunnel. Radionuclide levels are estimated within 6 ft outside of the NuMI tunnel under operating conditions that would be expected during the running of the NuMI facility at 1,500 kW of beam power.

5.1.3.3 Surface Water

Discharge of radionuclides from the MI cooling ponds into waters of the State of Illinois is exceedingly rare – only in the event of a rain event of a 500-year flood; however, the discharge is covered by Fermilab's NPDES permit. Volume, flow and concentrations are managed under the FESHM to ensure surface water impacts are controlled.

The estimates for the concentration of tritium and sodium-22 in pond water presented in Tables 5.2 and 5.3 respectively are exceedingly conservative because they assume drought conditions (Martens 2007). In drought conditions the volume of water in the Fermilab pond system would be reduced resulting in a higher concentration of radionuclides. Even under the conservative assumptions of drought conditions, these concentrations would be well below the regulatory limit for radionuclides in surface water. However, release of water from the MI cooling ponds into surface creeks would not occur under drought conditions.

Phase	Tritium Levels (NuMI Sump Water)	Tritium Levels (Pond Water)
NuMI/ NOνA	100 - 200 pCi/ml	25 - 50 pCi/ml
DOE Surface Water Regulatory Limits[1]	**2,000 pCi/ml**	**2,000 pCi/ml**

[1]Source: U. S. Department of Energy Order 5400.5, "Radiation Protection of the Public and the Environment".

Table 5.2: Estimated concentrations of tritium in the NuMI sump and Fermilab ponds. Radionuclide levels are estimated considering current NuMI operations and at 1,500 kW of beam power.

Phase	Sodium-22 Levels (NuMI Sump Water)	Sodium-22 Levels (Pond Water)
NuMI/ NOνA	< 1.2 pCi/ml	< 0.3 pCi/ml
DOE Surface Water Regulatory Limits[1]	**10 pCi/ml**	**10 pCi/ml**

[1]Source: U. S. Department of Energy Order 5400.5, "Radiation Protection of the Public and the Environment".

Table 5.3: Estimated concentrations of sodium-22 in the NuMI sump and Fermilab ponds. Radionuclide levels are estimated considering current NuMI operations and at 1,500 kW of beam power.

5.1.3.4 Utilities at Fermilab

The increase in the Fermilab utility requirements as a result of assembly and operation of the NOνA experiment would not impact public utility supply. Any increase in power, water, and electricity consumption at Fermilab from NOνA would be offset by the projected closure of the Tevatron collider operations scheduled in 2010. Analyses indicate that shutting down Tevatron would save approximately 18 MegaWatt (MW), while NOνA-related improvements to the Main Injector (4.3 MW) and the Booster (2.5 MW) would result in a net decrease in power consumption of approximately 11.2 MW. Utility requirements for the small project staff, including sanitary sewer, natural gas, and drinking water needed for this facility would be provided by existing services at Fermilab, with no upgrade required.

5.1.3.5 Occupational /Human Health and Safety

Occupational impacts projected for the NOνA Project would be similar to any workforce in an educational, office or light industrial workplace. Since data are in electronic format, the analysis can and would occur at distributed locations of the collaborating institutions. With fewer than 5 individuals actually assigned to the NOνA Project on the Fermilab site to support detector operations, project labor hours would be less than 10,000 per year. A calculation based on Fermilab average incidence of 1.5 cases of injury/illness per 200,000 labor hours results in 0 (0.45) cases of injury/illness during the 6-year period of detector operations. An additional 1 (0.65) accidents, 0 (0.01) fatalities, and 0 (0.17) injuries might result from 5 workers commuting 22 miles per day during the six years of operations (165,000 vehicle-miles).

Occupational Exposure

Exposure from existing Fermilab activities are discussed in Section 4.1.8. Changes in Fermilab accelerator work activities related to the proposed project are few and would not be expected to impact potential occupational exposures. Increased beam power would raise estimated radionuclide emissions and could be expected to marginally raise the potential estimated dose rate to workers from airborne releases, with minimal offsite impacts.

Increased beam power also would raise activity and external dose rates from activated components. Fermilab has an effective radiation exposure control program documented in the Fermilab Radiological Control Manual (Fermi 2007c), the Fermilab ES&H Manual (Fermi 2007a), and associated implementing procedures. Operational controls would be employed and modified as necessary to respond effectively to expected marginal increases in radiation and radioactivity. That is, at the increased beam power proposed, the Fermilab radiological control program and associated engineering and administrative controls would be used to manage potential worker exposures to be as low as reasonably achievable. Values will remain considerably below the DOE regulatory dose equivalent annual limit of 5 rem and the Fermilab administrative dose goal of 1500 mrem annually.

Public Dose

The estimated maximum annual radiation dose at the site boundary that would result from the airborne releases identified in Section 5.1.3.1 is 0.04 mrem (Martens 2007). This dose at the site boundary assumes a hypothetical member of the public who would spend the entire year at the location of maximum exposure at the Fermilab site boundary. This estimated maximum dose is far below the regulatory limit of 10 mrem in a year identified in the NESHAPS regulations (Title 40 *CFR* Part 61).

The total annual dose equates to a probability of latent cancer fatality (LCF) of 2.5×10^{-7} for an individual based on a dose-to-LCF factor of 0.0006 LCF per person-rem for both workers and the general public (ISCORS 2002), essentially zero. This LCF assumes a 10-year operating period for the project.

5.1.3.6 Waste Generation and Disposal

Although the NOνA experiment represents additional activity at Fermilab, the amount of additional waste generated would not significantly alter the current waste volumes. Under normal operations, the experiment does not generate a continuous waste stream; intermittent failed electronic components are replaced, minor liquid leaks are cleaned, and data are analyzed on computers. Quantities of routine waste in a year would be 2-3 m^3 of dumpster/landfill waste. This would be only a minor fluctuation in the waste volume that routinely occurs at Fermilab where landfill waste was over 8,700 m^3 in 2006 (Fermi 2007b). Under normal operations, the experiment would not generate a hazardous waste stream.

5.1.4 Decommissioning Impacts at Fermilab

Facility decommissioning at Fermilab was described in Section 3.3.4, and includes removal of the scintillation liquid and disassembly of the Near Detector from the underground cavern. It is anticipated that most of the equipment and materials involved with the accelerators, NUMI beamline, and target would remain in place to be used in other current or future experiments.

5.1.4.1 Air Quality

Because decommissioning is a low-intensity, methodical process, it will have impacts similar to those in the operations phase (see previous sections). With the NUMI beam off, or no longer assigned to NOνA operations, generation of criteria pollutants could decrease during the decommissioning phase.

5.1.4.2 Water Quality

Water quality impacts during decommissioning would be expected to be less than the impacts during operations discussed in Section 5.1.3.2 and Section 5.1.3.3. With the NUMI beam off, or no longer assigned to NOνA operations, the activation of radionuclides in the ground water would decrease. Radioactivity levels in the sump would decrease as pumping/flow continues, but new radioactivity production would end. Removing liquids from the Near Detector and from the cavern would be in 100% volume secondary containment or pumped through closed loop systems. On the surface, water pumped from the sumps has less radioactivity, so the impact is less, however, continuing operations to support other experiments would preclude the impact from going to zero. Dismantling the blending facility would require dust suppression and storm water runoff controls identified in the FESHM similar to those invoked during installation.

5.1.4.3 Occupational/Human Health and Safety

Decommissioning the NOνA facilities would proceed with little radiological impact, because the detector and equipment in the cavern were exposed only to the neutrino beam. For ALARA and control purposes ES&H personnel would survey equipment for radioactivity and manage it according to requirements of the FRCM.

With fewer than 10 individuals participating in the NOνA Project decommissioning on the Fermilab site, project labor hours would be less than 20,000 per year. A calculation based on Fermilab average incidence of 1.5 cases of injury/illness per 200,000 labor hours results in 0 (0.15) cases of injury/illness per year during detector decommissioning. With decommissioning scheduled to occupy less than a year, the calculated injury/illness value is an overestimate.

5.1.4.4 Transportation

For employees associated with the project decommissioning, 8-10 worker vehicles are projected at Fermilab. A larger workforce could not work efficiently within the confines of the NUMI tunnel and NOνA cavern. A conservative average commute distance of 86 mi (round-trip) is assumed for each worker, based on a one-way distance of 43 mi between Chicago and Batavia. For the State of Illinois, the accident, fatality, and injury rates per mi are 3.91E-06, 1.26E-08, and 1.04E-06, respectively (IDOT 2005). An additional 1 (0.67) accidents, 0 (0.002) fatalities, and 0 (0.18) injuries might result for the six months to one year of decommissioning due to workers commuting 172,000 vehicle-miles to/from the Fermilab site.

Transport of waste and recycled materials would be a small fraction of the total vehicle miles from commuting, due to the small volumes of materials. (See discussion of decommissioning wastes in Section 5.1.4.5). These vehicle miles represent a minimal increase given the total number of employees and vehicles at the Fermilab, and are an overestimate, as the decommissioning is scheduled to occupy less than one year.

5.1.4.5 Waste Generation and Disposal

At the completion of the NOνA Project, the liquid scintillator will be drained, the detector and associated support systems will be removed, and the cavern will be returned to an empty state. The approximately 30,000 gal used scintillator fluid will be recycled for its mineral oil content.

Once drained of scintillator, the PVC components of the detector can be broken or cut down into manageable sections. The Near Detector is a semi-hollow PVC box with volume of 174 m^3 (228 yd^3). With the Devcon-60 glue residue the detector has no value as recyclable PVC feed stock; however, it is not a hazardous waste and can be disposed as dumpster/industrial waste. The 174 m^3 waste volume is approximately 2% of the 8,700 m^3 dumpster/industrial waste disposed by Fermilab in 2006 (Fermi 2007a), so it should have little impact on landfill capacity.

Decommissioning the surface-level blending facility (if built at Fermilab) would require dismantling storage vessels, blending tanks and piping. Much of the tanks and piping likely could be reused or recycled and would not be dispositioned as “waste”. Drywall from decommissioning the IPND room in the MINOS building should be in the neighborhood of less than 5 m^3, which would not significantly impact the annual volume of industrial waste from Fermilab. Both these waste streams are non-radioactive, and would qualify as dumpster/landfill waste previously discussed.

5.1.5 Cumulative Impacts at Fermilab

Radiological impacts of the NO*ν*A experiment result from increasing the beam power from 400 kW to 700 kW in the NuMI accelerator. As discussed in this EA, the NO*ν*A proposed action would be an incremental change to the existing Fermilab operational base and would be offset by decreases due to completing the Tevatron Collider research program. Increases in beam power would primarily affect radiological conditions. There are no other current or reasonably foreseeable future projects at Fermilab that may interact with the project described in this EA in such a way as to cause cumulative impacts.

The potential radiological impacts on the environment and human health and safety present the greatest interest to the public. Potential occupational and Fermilab boundary dose increases associated with the increased beam power for NO*ν*A operations are discussed in Section 5.1.3.5. The impacts of the proposed action when added to those from existing accelerator operations are not expected to result in any exceedence of occupational health and safety standards, regulatory limits, or regulatory compliance standards with respect to potential releases to the environment or to general health and safety impacts to workers or the general public.

5.1.6 Socioeconomic Impacts and Environmental Justice at Fermilab

The population demographics for DuPage and Kane Counties and the State of Illinois were shown in Table 4.5. Minority and low-income populations in the Fermilab vicinity are proportionally smaller than in the State-wide population. Off-site impacts of noise and vibration from the proposed action would be limited to the areas immediately adjacent to the Fermilab property boundary, where minority or low-income residents are not disproportionately congregated. Since there is no disproportionality, there is no environmental justice impact.

The number of additional site personnel and contractors required for construction and operations associated with the NO*ν*A experiment at Fermilab would have a marginally positive effect on the local and regional economy. However, the alteration in Fermilab's staffing level or the local and regional construction labor services would not increase appreciably beyond normal historical fluctuations.

5.2 Potential Environmental Impacts at the Ash River Site

At the Ash River site, this proposed action would include improvement to an access road, excavation for and construction of the Far Detector Facility, and assembly of the Far Detector, experiment operations, and facility decommissioning. Operations, activities and procedures would be under the management control of the University of Minnesota and subject to regulatory compliance. Potential environmental impacts are discussed in detail in the Minnesota Environmental Assessment Worksheet (EAW), which is provided in Appendix A. The discussion in the following sections summarizes the information in the EAW and refers the reader to the appropriate section of the EAW for more detailed discussion.

5.2.1 Excavation and Construction at the Ash River Site

5.2.1.1 Land Use

Land use at the Far Detector location is discussed in Sections 9 and 10 of the EAW.

Access Road
Much of the western third of the proposed access road traverses a wetland on an old railroad embankment. Although this road section impacts a wetland, its environmental impact is less than any alternative new right-of-way. Alternative routes would likely affect mature, not recently logged forests and would certainly establish new migration routes for wildlife. Impacts to the wetland and proposed mitigation are discussed in Section 5.2.1.5.

Facility Site
Permanent impacts to this upland habitat will total 5.0 ac and will be restricted to areas that are graded, impervious surfaces (parking and buildings), and the area that is converted to landscaping/turf that will surround the underground facility. A breakdown of this impact area is as follows:

- Detector Facility = 0.67 ac
- Parking area comprised of impervious surfaces = 0.93 ac
- Lawn and landscaping adjacent to building and parking lot = 3.39 ac

The remaining area within the 89.6 ac facility site boundary will remain as undisturbed upland habitat.

Eight (8) acres of temporary stockpiles will be placed within the facility site during construction entirely within the recently clear cut wooded forest cover type. Upon completion of construction, temporary stockpiles would be removed and those areas restored.

5.2.1.2 Air Quality

Construction of the access road and detector building, anticipated to begin in 2008, is estimated to take approximately 2.5 years. During that time, the operation of diesel-powered construction equipment would be expected to introduce quantities of SO_2, NO_2, particulates, and other Criteria Air Pollutants to the atmosphere, typical of similar-sized construction projects. Table 5.4 lists the major types, number, sizes, and operating hours for construction equipment expected to be required during site preparation and construction of the access road and the Far Detector Building (Burns and McDonnell 2007).

Major Construction Sources	Number in Use	Size, Horse-power	Total Engine hours/yr	CO tpy	Total Organic Compounds tpy	SOx, tpy	NOx, tpy	PM-10, tpy
Backhoe/loader	2	50- 100	1000	0.33	0.12	0.10	1.55	0.11
Fork lift	2	50- 100	1000	0.33	0.12	0.10	1.55	0.11
Asphalt Paver	1	100- 175	200	0.12	0.04	0.04	0.54	0.04
Asphalt Roller	1	100- 175	200	0.12	0.04	0.04	0.54	0.04
Water Tanker	1	100- 175	500	0.29	0.11	0.09	1.36	0.10
Excavator	1	100- 175	500	0.29	0.11	0.09	1.36	0.10
Bulldozer	2	175- 300	500	0.50	0.19	0.15	2.33	0.17
Motor Grader	2	175- 300	500	0.50	0.19	0.15	2.33	0.17
Crane – 100 ton	1	300- 600	500	1.00	0.37	0.31	4.65	0.33
Total Tons per year (tpy)				3.5	1.3	1.1	16.2	1.1
EPA AP-42 Emissions Factors, lb/hp-hr				6.68E-03	2.47E-03	2.05E-03	3.10E-02	2.20E-03

Table 5.4. Construction Equipment Emissions during Excavation and Construction at the Far Detector Site

The anticipated annual emissions of criteria pollutants shown in Table 5.4 were estimated using the EPA AP-42 emission factors for small diesel engines shown in the bottom row of the table (EPA 1995). Emissions were calculated using the horsepower at the high end of the typical range for each equipment type as shown in the following example calculation. Therefore it is expected that the actual emissions would be less than shown in the table. Short-term, localized impacts on air quality from vehicular traffic exhausts and earth-moving operations would be similar to construction of any commercial facility of comparable size. These releases would not be expected to cause any air-quality standards to be exceeded.

Example Calculation forBackhoe/Loader (50-100HP) CO emissions:

6.68 E-03 lb of CO/hp-hr x 100 HP x 1,000 hours x 1ton/2,000lbs = 0.33 tons per yr

Dust generated during earthmoving activities and vehicle movement over unpaved areas would be minimized by frequent watering or other dust-control measures. No substantial air-quality impacts associated with implementing the construction phase of the proposed action would be expected.

The potential impacts to air quality at the Ash River site are discussed in Sections 21, 22, 23 and 24 of the EAW included as Appendix A.

5.2.1.3 Water Quality

Ground Water

Dewatering of perched ground water would be required during construction. During construction a temporary dewatering permit would be obtained from the Minnesota Department of Natural Resources (MNDNR). Subsurface investigations indicate the lack of a water table aquifer in the vicinity of the project site down to a depth of greater than 1000 feet. However, if ground water is determined to exist within the bedrock, dewatering throughout the life of the project may be needed to protect the underground structures. Further evaluation would be needed to determine the pumping rate for dewatering; however, if dewatering is required, an additional water appropriations permit would be required from the MNDNR.

The proposed project would require one or more wells for domestic water purposes and to fill storage tanks for fire protection. The well(s) would supply potable water for the normal operating occupancy of 8 – 10 people and would charge the fire protection system (60,000 gallons of storage). A 50 gal/min well drawing from fractures in the granite and perched (non-aquifer) ground water would be suitable for domestic water purposes. Ground water investigations indicated the distribution of water is highly variable, with the occurrence of dry holes and low quantities of water from shallow perched sources, suggesting that supplemental bottled water may be necessary. Well production if successful would not likely impact the productivity of other wells, if there were any in the vicinity of the site.

Hazardous materials used during construction, including oil, gasoline, and paint, would be properly stored within secondary containment, to prevent spills or leaks from escaping into groundwater or surface water.

The potential impacts to the ground water are discussed in detail in Sections 13, 19 and 31 of the EAW included as Appendix A.

Surface Water

If, as anticipated, clearing, grading and excavation could disturb greater than five acres, a permit for the discharge of storm water associated with construction activity would be required from the Minnesota Pollution Control Agency (MPCA). The National Pollutant Discharge Elimination System (NPDES) permit would require implementation of a Storm Water Pollution Prevention Plan (SWPPP) prior to initiating construction. Since runoff from the site would flow toward the Ash River, which is classified by MNDNR as a "Special Water", the SWPPP would need to assure compliance with higher standards than the general NPDES permit requirements. These standards would include storing hazardous materials used during construction, including oil, gasoline, and paint, within secondary containment, to prevent spills or leaks from being carried by storm water into surface water.

The site design also would minimize potential runoff to surface water by minimizing impervious surfaces, using vegetated swales between impervious areas, and using infiltration or evapotranspiration techniques for collected runoff. Any site dewatering during construction would be discharged to a temporary or permanent sedimentation basin or otherwise treated such that the receiving water or downstream waters are not adversely affected. Final site stabilization following construction would occur according to requirements of the SWPPP and the NPDES permit. The potential impacts to surface water are discussed in detail in Sections 12, 16, 17 and 31 of the EAW included as Appendix A.

5.2.1.4 Biological Resources

Threatened, Endangered and Special Concern Species

Threatened, endangered and special concern species were described in Section 4.2.5 and in Section 11 of the EAW (Appendix A). Further, the DOE initiated consultation with the U.S. Fish and Wildlife Service by requesting advice on federally protected species in the project area (USFWS 2008). By aligning the access road corridor along the existing logging road, destroying additional habitat by constructing a new, more-direct roadway has been avoided. The nature of the project and the surrounding habitats and land uses are such that no measurable effects to Canada lynx or grey wolves or their habitats are anticipated. Measurable effects could be possible if the project were to result in cumulative impacts with other reasonable and foreseeable projects in the area, none of which are proposed to date.

Invasive Species

The introduction of construction and landscaping materials and the transit of multiple vehicles have the potential to introduce exotic and invasive species at the Ash River site. Under Executive Order 13112 DOE has a responsibility to minimize or prevent the introduction of invasive species and provide control.

A major influence on introduction of invasive species is the origin of the traffic and materials and the distance from the site. Distance ranges for traffic and materials have been estimated as (Burns and McDonnell 2007):

- 75 miles: This range is approximately from Virginia, MN, to International Falls, MN. It is expected that the majority of the construction workers will be drawn from an area within 75 miles of the project site. In addition, gravel, sand and concrete sources likely will be found within this range. Of the estimated 3,879 construction-related trips, 55% are expected within this range.
- 150 miles: This range includes Duluth, MN. It is expected that construction materials and raw materials will arrive from within 150 miles of the project site. Of the estimated 3,879 construction related trips, 35% are expected within this range.

- 300 miles: This range includes Minneapolis/St. Paul. It is expected that construction components such as precast concrete planks and pre-fabricated assemblies such as the metal building components may originate within this range. Of the estimated 3,879 construction related trips, 10% are expected within this range.

Preventive measures to avoid or minimize introduction and spread of invasive plants will include education, inspection and design components. The education component will inform the contractors of the potential for invasive species as well as provide them with the information to identify and report invasive species. The inspection component will include incoming construction vehicles for invasive species and require a plan for treatment if discovered. The design component will prohibit purchases or acquisition of plants identified by MNDNR as invasive in Minnesota for use on the project site. In addition, the site will be restored with appropriate alternative native or noninvasive species for planting.

5.2.1.5 Wetlands

Proposed construction at the Far Detector site would impact existing wetlands in the area. All of the wetland impacts are associated with the proposed access road. There are no impacts within the footprint of the building and parking area. Wetland impacts are discussed in Section 10 and 12 of the EAW, shown in Figure 6 of the EAW (Appendix A), and summarized in Table 5.5. Wetland classification codes in Table 5.5 were discussed previously in Section 4.2.6.

Detailed results of the wetlands assessment can be found in the Combined *Wetland Permit Application and Replacement Plan* developed for the project (RUMN 2007b).

Basin ID	Wetland Classification			Total Wetland Area (acre)	Wetland Impact Area	Impact Area as % of Total Wetland Area
	Eggers and Reed	Cowardin	Circular 39			
Wetland 1	Sedge Meadow/Shallow Marsh/Deep Marsh/Coniferous Swamp	PEMB/C/F PSS1B/PFO1B	Type 2/3/4/5/7	>5 ac[2]	No Impact	0%
Wetland 2	Sedge Meadow/Shallow Marsh/Deep Marsh	PEMB/C/F	Type 2/3/4	6 ac[2]	No Impact	0%
Wetland 4	Coniferous Swamp/Hardwood Swamp	PFO1B	Type 7	0.05 ac	1,192 ft2 0.03 ac	60%
Wetland 5	Sedge Meadow	PFO1A	Type 1	0.01 ac	18 ft^2 0.0004 ac	4%
Wetland 6	Shrub Carr/Alder Thicket	PSS1C	Type 6	0.05 ac	No Impact	0%
Wetland 7	Shrub Carr/Alder Thicket/ Coniferous Swamp/Hardwood Swamp	PEMB/PSS1B/ PFO1B	Type 6/7[1]	>40 ac[2]	73,662 ft^2 1.69 ac	<5%
Wetland 8	Shrub Carr/Alder Thicket/ Coniferous Swamp/Hardwood Swamp	PSS1B/PFO4B	Type 6/7[1]	>40 ac[2]	75,958 ft^2 1.74 ac	<5%
Total				>91 ac	**150,830 ft^2 3.46 ac**[2]	<4%

[1] The entire wetland complex is Type 6/7. The wetland impacts occur primarily to Type 6 wetlands that exist near the current access road.
[2] Wetland extends outside the project limits. The entire wetland was not delineated and the area shown is estimated.

Table 5.5 Summary of Wetland Impacts at the Far Detector Site

[2] The EAW, completed in 2006, estimated 2.5 acres of wetland impact prior to completing the design of the access road layout and other design refinements that occur during the course of a project schedule. The acreage increase to 3.46 acres results from these design changes and is a more accurate estimate of wetland impacts determined after the EAW was completed.

Regulatory Requirements for Wetlands

Wetlands affected by the project are regulated by several agencies at the federal, state, and local levels including the USACE and the Environmental Protection Agency (EPA) at the federal level; the Minnesota Board of Water and Soil Resources (BWSR) and the Minnesota Pollution Control Agency (MPCA) at the state level; and St. Louis County at the local level. St. Louis County has accepted the responsibility for administering the Minnesota Wetland Conservation Act (WCA) of 1991.

a. Federal Regulations

The USACE is the permitting authority for Section 404 of the Clean Water Act and Section 10 of the River and Harbors Act. The MPCA is the designated approving authority for Section 401 of the Clean Water Act on behalf of the EPA. Upon receipt of the Wetland Permit Application, the USACE must complete a Jurisdictional Determination analysis to determine the extent of Section 404 jurisdiction based upon connectivity to U.S. Navigable Waters.

Federally funded and/or sponsored actions must also comply with federal Executive Order 11990, "Protection of Wetlands", which mandates that federal agencies through their actions, will implement measures to minimize the loss of wetlands. Minimizing the loss of wetlands is achieved by following the Section 404 requirements and permitting through the USACE.

b. State Regulations

Wetlands in the project area are also under the jurisdiction of the Minnesota Wetland Conservation Act of 1991 (WCA), Minnesota Rules (M.R.) Chapter 8420. WCA approvals are implemented by the designated Local Governmental Unit (LGU) and the LGU for the project area is the North St. Louis County Soil and Water Conservation District (SWCD).

Wetlands that are designated Public Waters under M.R. 8420, Parts 6115.0010 – 615.0810 are regulated by the Minnesota Department of Natural Resources (MNDNR). Impacts to Public Waters require a Public Water permit from the MNDNR.

Actions implemented by state agencies that result in wetland impacts are exempt from requiring a WCA permit approval from the designated LGU. Since the University of Minnesota is a state agency, a WCA permit approval will not be required. Nevertheless, State agencies must comply with Governor's Executive Order 00-02, which directs State Departments and Agencies to follow a "No Net Loss Policy" in regard to wetlands. State agencies follow the process, requirements, and mitigation implemented under the WCA and Public Waters rules. Following these requirements, a wetland permit application is submitted to the LGU for review and comment, and the state agencies follow the prescriptive process, although permit approval is not required from the designated LGU.

Wetland Permitting for Ash River

The University of Minnesota prepared a Combined Wetland Permit Application and Replacement Plan and submitted it to the USACE to determine potential impacts to Section 404 jurisdictional wetlands (RUMN 2007b). The USACE has acknowledged receipt and has indicated a preliminary determination that wetland impacts would require a permit and mitigation (USACE 2008). A copy of the USACE correspondence is provided in Appendix F.

The University also submitted the combined application and plan to the WCA LGU for comments to comply with the Governor's Executive Order 00-02. There are no affected Public Waters wetlands affected by the project, so the University did not submit the permit application to the MNDNR.

The Combined Permit Application demonstrates the *wetland sequencing* measures that have been and would be implemented for the project including, in order of importance: wetland impact avoidance; wetland impact minimization; and wetland mitigation. The Application contains the necessary avoidance and minimization analyses. Wetland impact avoidance and minimization were implemented by positioning the footprint of the building and parking area outside of wetland boundaries and by using an existing road alignment for the proposed access road rather than a new road alignment. The application described wetland impact minimization measures that would be implemented during the final design and construction of the access road, which include: road cross section reductions; culverts; slight alignment shifts; and best management practices.

Wetland Mitigation

The Wetland Replacement Plan submitted with the Combined Wetland Permit Application defines the wetland mitigation proposed for the project. Wetland mitigation in Minnesota under both WCA and the Section 404 programs must follow the methods in the St. Paul District Draft Compensatory Mitigation Policy for Minnesota (USACE, 2007). The policy dictates a sequential, "in-kind" and "in-place" approach to identify and locate suitable wetland mitigation for a project within the state.

The proposed NO*v*A Far Detector site is located within Wetland Bank Service Area #2 (Rainy River Basin), and within Major Watershed #77 (Rainy River). The WCA and the USACE rules require wetland replacement at a minimum ratio of one acre for each acre of wetland impact (1:1) and a maximum ratio of 2.5 acres for each acre of impact (2.5:1). The minimum or maximum ratio applies depending upon criteria defined is the USACE draft Compensatory Mitigation Policy (USACE 2007). This policy also contains criteria for "in advance" wetland mitigation, i.e., prior to the impacts from the proposed project.

The same USACE criteria apply for wetland banking. For wetland banking, the "in-advance" requirement is met automatically if credits are purchased from an approved wetland bank. The "in-place" requirement is met if the wetland credits are purchased from a wetland bank in the same Bank Service Area (as defined by the WCA and the USACE) as the impacts. The USACE policy and guidance base the ratios applied for a project on the amount of in-kind, out-of-kind, and off-site mitigation proposed, and on the quality and nature of the wetland impacts.

Following the USACE policy generated the following results. There were no viable on-site wetland mitigation opportunities besides wetland creation, which is not preferable. Effectively drained wetlands and ditched wetlands are lacking in the project area to provide opportunities for wetland restoration as mitigation. Similarly, wetland restoration opportunities are lacking within the Major Watershed and Bank Service Area. Due to the extensive and intact wetland base in Northern Minnesota, wetland restoration opportunities are very limited when compared to other Bank Service Areas towards the south and west.

Following the USACE policy, opportunities were explored in adjacent Bank Service Areas. In such circumstances, the preferred method of wetland replacement is purchasing credits from an approved private wetland bank. The University of Minnesota entered a purchase agreement with a wetland bank account owner in Bank Service Area #3 in Beltrami County, which is adjacent to Bank Service Area #2. The sale is contingent upon project approval.

St. Louis County, where wetlands impacts would occur, is a county with greater than 80% pre-settlement wetlands, so the required wetland replacement ratios would be 1.5:1. The replacement would be classified as Not-in-Place because the wetland bank is in a different Bank Service Area from the project area where impacts would occur. The replacement would be Out-of-Kind because the impacts in the project area are primarily to Type 6 (scrub swamp) and Type 7 (wooded swamp) wetlands, and the replacement would be from a bank with Type 2 (wet meadow) wetlands. The mitigation is being provided In-Advance of the project impacts. Project wetland impacts and replacement are shown in Table 5.6.

Wetland Area	**Wetland Impact Area (ft^2 / acres)**	**Wetland Replacement**		
		Type	**WCA (1.5:1)**	**USACE (1.5:1)**
Wetland 4	1,192 ft^2 0.03 ac	Private Bank	1,788 ft^2 0.04 ac	1,788 ft^2 0.04 ac
Wetland 5	18 ft^2 0.00 ac	Private Bank	27 ft^2 0.00 ac	27 ft^2 0.00 ac
Wetland 7	73,662 ft^2 1.69 ac	Private Bank	110,493 ft^2 2.54 ac	110,493 ft^2 2.54 ac
Wetland 8	75,958 ft^2 1.74 ac	Private Bank	113,937 ft^2 2.62 ac	113,937 ft^2 2.62 ac
Total Impacts	**150,830 ft^2 3.46 ac**			
		Total Replacement Needed:	**226,245 ft^2 5.19 ac**	**226,245 ft^2 5.19 ac**

Table 5.6 Summary of Wetland Impacts and Replacements at the Far Detector Site

The wetland credits that would be withdrawn from the Beltrami Wetland Bank Account are summarized in Table 5.7.

Wetland Replacement	**WCA 1.5:1 Credits Provided**	**USACE 1.5:1 Credits Provided**
Onsite Mitigation	N/A	N/A
Private Wetland Bank – New Wetland Credit	226,245 ft^2 5.19 ac	226,245 ft^2 5.19 ac
Private Wetland Bank – Public Value Credit	N/A	N/A
Total Mitigation Provided	**226,245 ft^2 5.19 ac**	**226,245 ft^2 5.19 ac**
Total Mitigation Required	**226,245 ft^2 5.19 ac**	**226,245 ft^2 5.19 ac**

Table 5.7 Summary of Wetland Replacement Credits at the Far Detector Site

The University of Minnesota anticipates receiving Section 404 permit approval in June of 2008, after the USACE completes its review of the draft EA and its Jurisdictional Determination analysis in the late spring of 2008. The University is purchasing WCA credits to comply with the Governor's Executive Order 00-02.

5.2.1.6 Cultural and Historical Resources

DOE and the University of Minnesota coordinated with the Minnesota State Historic Preservation Office (SHPO), the Bois Forte Band of Minnesota Chippewa Tribal Historic Preservation Officer (THPO), the Leech Lake Band of Ojibwe THPO, White Earth Band of Minnesota Chippewa THPO, Grand Portage Band of Chippewa THPO, and the Fond du Lac Band of Lake Superior Chippewa Reservation THPO concerning the potential for archeological resources to be present in the project area at Ash River.

Because of the winter conditions during the preparation of an Analysis of Effects Report, a programmatic agreement (PA) was negotiated with the MN SHPO and the Bois Forte and White Earth THPOs. None of the other Bands indicated a desire to consult on the project, and the Advisory Council on Historic Preservation declined an invitation to participate. The PA stipulates that DOE (or the University of Minnesota) would perform an archeological survey of the project area in the spring of 2008, prior to construction, to validate the 2008 Analysis of Effects Report findings. The survey would include further ground investigation to determine whether historical resources are present, both architectural and cultural. The concern is potential impact to a historic railroad grade as well as the potential for occurrences of cultural resources. If such are identified, the PA establishes a process to be followed. Key National Historic Preservation Act documentation is included in Appendix E.

Sections 11, 25 and 26 of the EAW (Appendix A) address cultural and sensitive resources.

5.2.1.7 Occupational/Human Health and Safety

Site excavation workers, construction workers and contractors would conduct work in accordance with a University of Minnesota site health and safety plan and procedures for contractor operations, as required by the NO*ν*A Project MOU (NO*ν*A 2007a). Potential hazards would be those typically associated with civil excavation and construction. Excavation and construction would involve approximately 35 workers on site for up to 2.5 years for a total of approximately 175,000 labor hours. A calculation based on industry average incidence of 5.4 cases of injury/illness per 200,000 labor hours for construction workers (DOL 2007) results in approximately 5 (4.7) cases of injury/illness during excavation and construction. There are no near-by facilities or concurrent activities that would cause a hazard to construction workers, or vice versa. Emergency response at the remote location would be via helicopter as discussed in Section 3.4.1.3.

5.2.1.8 Transportation

Construction of the proposed NOvA Far Detector Facility, including the Service Building, Assembly Area, and Detector Hall, is anticipated to begin in 2008/2009 and be completed in 2011/2012. During construction, an average of 35 workers is expected to be on site each day. It is estimated that this would result in approximately 20 to 35 cars accessing the site each day, generating 40 to 70 trips per day on St. Louis County 129 for approximately 20 months.

A conservative average commute distance of 50 mi (round-trip) is assumed for each worker, based on a one-way distance of 25 mi between the Ash River site and International Falls. For the state of Minnesota, the accident and fatality rates per vehicle-mile are 1.39E-06, and 8.7E-09, respectively (MDPST 2007). The calculation results in an additional 1 (1.2) accidents and 0 (0.006) fatalities for the slightly less than two years of site excavation and construction as a result of workers commuting 437,500 vehicle-miles to/from the Ash River site.

The NO*ν*A Project has estimated 3,879 vehicles delivering materials to the Ash River site during combined excavation/construction and installation/assembly phases (average ~650 vehicles per year). Origins and distances traveled for the vehicles were discussed in Section 5.2.1.4., which would result in 960,052 vehicle miles (1,550,000 vehicle km) for material deliveries. Total accident, fatality, and injury rates for heavy combination trucks in the state of Minnesota were used in the calculations. These rates were 1.76E-07 accidents/km, 1.2E-08 fatalities/km, and 1.21E-07 injuries/km (Saricks and Tompkins 1999). Using the total accident, fatality, and injury rates for Minnesota one calculates an additional 0 (0.26) accidents, 0 (0.019) fatalities, and 0 (0.18) injuries might result during the combined excavation/construction and installation/assembly period.

No traffic congestion is anticipated as a result of excavation/construction activities. The additional traffic generated would not significantly increase the vehicles per day traveled on the roads in the site vicinity or result in congestion in this rural area. Additional traffic would be well within road capacity reported in Section 4.2.9

5.2.1.9 Utilities at Ash River

Power and fiber optic service for the facility would be provided from existing services along St. Louis County 129. These utilities would be extended to the site by buried service installed during construction of the access road. No improvements to the existing fiber optic service are anticipated. Improvements to the existing power transmission service serving the site would be required. Service upgrades would include replacement of the transformer at the Kabetogama substation as well as related service upgrades along the existing transmission line. No new or additional transmission lines would be constructed.

No impacts are expected as a result of buried utility line extension and power transmission improvements. The SWPPP developed for the project would address erosion and sedimentation control and related requirements to ensure that appropriate mitigation measures are implemented in accordance with NPDES requirements. The SWPPP would be submitted to the MPCA for review and approval prior to the start of utility improvements as required. Section 28 of the EAW (Appendix A) addresses utility issues.

5.2.1.10 Waste Generation and Disposal

Hazardous materials used during construction, including oil, gasoline, and paint, would be properly stored, including secondary containment, to prevent spills or leaks, and any waste material would be disposed according to applicable regulatory requirements. Any hazardous wastes generated at the facility would be small volume and would be collected by a licensed waste hauler for disposal at a licensed disposal facility.

Conventional wastes (packaging, empty containers, concrete forms and used lumber) would be typical of that resulting from constructing a 30,000 ft^2 light industrial building. The estimated waste volume of several hundred yd^3 is less than 1% of the 10-year, 430,000 yd^3 dumpster/industrial waste projection by St Louis County for inclusion into its overall 1,204,000 yd^3 of available landfill capacity (SLC 2003).

Based on the proposed actions, waste generation would not create environmental impacts at the Ash River site. Section 20 of the EAW (Appendix A) addresses waste generation and disposal.

5.2.2 Installation and Assembly at the Ash River Site

5.2.2.1 Air Quality

According to the construction and assembly schedule and the estimated number of vehicles and trucks accessing the site, there would be a maximum of 40 site workers and five trucks accessing the site on a daily basis. This would add a maximum of 90 vehicle trips to St. Louis County 129 each day during the peak of the detector assembly. No decrease in local or regional air quality from vehicle-related air emissions is expected as a result of the project during installation and assembly or operations.

Estimated Emissions of Criteria Air Pollutants from Propane Fuel

Propane (or liquefied natural gas)-fired boilers or burners would be installed for space heating and humidification needs. All boilers would employ state-of-the-art, clean-burning technology and would not be expected to require supplemental emission controls. Propane-fueled generators would be used to provide electricity in the event of the loss of utility power. The generators would also be required to employ Best Available Control Technology for emissions, including the use of low-sulfur fuel. Emissions of criteria pollutants from the Ash River facilities shown in Table 5.8 were estimated based on an estimate fuel use of 200 gal/day (750 L/day) for heaters and 460 gal/day (1,740 L/day) for generators using the SCREEN3 atmospheric dispersion code (EPA 1995). (Note emissions at these estimated levels would continue during operations and decommissioning phases of the project).

Criteria Pollutant	Propane Emission Factor (lbs per 1,000 gal)	Emissions		Max Ground Conc	Ground Conc at 2 km	NAAQS Standard	% Standard at max	% Standard at 2 km
		(T/y)	(g/s)	ug/m^3		ug/m^3		
Particulate Matter (PM)	0.6	0.0216	0.00063	0.63	0.10	50	1.3%	0.21%
Sulfur Dioxide (SO_2)	0.108	0.0039	0.000113	0.11	0.019	78	0.14%	0.024%
Nitrogen Oxide (NO_x)	19	0.684	0.0200	20.0	3.3	100	20.0%	3.3%
Carbon Monoxide (CO)	3.2	0.115	0.00336	3.4	0.56	10000	0.034%	0.0056%

Table 5.8 Estimated Emissions and Maximum Concentrations of Criteria Air Pollutants from Propane Fuel Combustion

Estimated Emissions of Hazardous Air Pollutants

The assembly adhesive that would be used to construct the detector modules, Devcon-60 contains methyl methacrylate (MMA), a volatile organic compound (VOC) and a federal hazardous air pollutant (HAP). MMA and other volatile constituents would evaporate during product application. Vapors from the use of Devcon-60 are expected to contribute less than 5 tons of additional VOCs to facility emissions (2.7% of 168 metric tons total, Section 23 of the EAW, Appendix A). Using the SCREEN3 atmospheric dispersion code (EPA 1995) with a conservative assumption that all releases occur in a single year, the maximum estimated ground-level concentration occurs on the site approximately 113 m from the facility exhaust and is 0.46 mg/m^3, considerably less than the OSHA Permissible Exposure Limits (PEL) of 410 mg/m^3 (100 ppm). As MMA and other VOC potential emissions would not exceed regulatory limits on emissions of HAPs per year, an air permit should not be required.

Potential impacts to air quality are discussed in more detail in Sections 20, 21, 22, 23 and 24 of the EAW included as Appendix A.

5.2.2.2 Water Quality

Ground Water

Based on the proposed actions with 100% secondary containment of liquid scintillator and other liquids at every stage of the assembly and installation process, there should be no impact to ground water at the Ash River site during installation and assembly. The potential impact to ground water from a spill or accident involving liquid scintillator is addressed in Chapter 6.

Surface Water

The SWPPP would include mitigation measures and requirements for the protection of surface water during each phase of construction, installation and assembly, operations and decommissioning. No impacts are foreseen with respect to installation and assembly operations. The potential impact to surface water from a spill or accident involving liquid scintillator is addressed in Section 6. The potential impacts to surface water are discussed in detail in Sections 13, 16, 17 and 31 of the EAW included as Appendix A.

5.2.2.3 Occupational/Human Health and Safety

Site workers and contractors would conduct work under a University of Minnesota site health and safety plan that will be developed for the project and according to University procedures for installation and assembly operations. With 40 to 50 individuals actually assigned to the NOνA Project on the Ash River site to support detector installation and assembly for a 4-year period, project labor would be approximately 360,000 labor hours. A calculation based on construction industry average incidence of 5.4 cases of injury/illness per 200,000 labor hours results in 10 (9.7) cases of injury/illness during the 4-year period of detector assembly and filling operations.

The methyl methacrylate (MMA) in the assembly adhesive is an eye, skin and respiratory irritant. MMA and other volatile constituents would evaporate during product application. The MSDS for MMA is provided in Appendix C. The irritant nature of the MMA vapors necessitates that the project health and safety plan develop ventilation controls intended to maintain potential personnel exposures below the ACGIH TLV of 50 ppm and also below the STEL of 100 ppm.

Small quantities of other hazardous products that may be used during assembly and installation operations (e.g., paints or coatings) would be stored and used in accordance with applicable site health and safety procedures and hazardous material regulations.

The MPCA has given NO*v*A a written determination that the blended liquid scintillator to be used in the detector is not considered a hazardous material (MPCA 2005). However, material handling controls will recognize that hazardous constituents were blended into the liquid.

5.2.2.4 Transportation

Assembly of the Far Detector is anticipated to take approximately 48 months and will require up to 45 people on the site each day. It is estimated that this will result in a total of 20 to 45 vehicles accessing the site each day, generating 40 to 90 trips per day on St. Louis County 129. Using logic similar to that described in Section 5.2.1.7, an additional 3 (3.1) accidents and 0 (0.02) fatalities could occur during assembly and filling as a result of workers commuting 562,500 vehicle-miles per year to/from the Ash River site. Accidents and injuries estimated from the estimated 3,879 vehicles delivering materials to the Ash River site, during excavation/construction and installation/assembly phases combined were addressed in Section 5.2.1.7.

During installation/assembly, two materials shipments will vary from the origin of materials described in Section 5.2.1.4: delivery of MMA and delivery of the blended scintillator fluid.

Highway Accident Involving Delivery of MMA

Approximately 42,000 gal of Devcon-60 plastic glue containing MMA would need to be shipped via truck for detector assembly at the Ash River. It is assumed that the Devcon-60 would be supplied in 55-gal drums from a distributor in the Massachusetts area with a travel distance of approximately 2,300 km to St. Louis County. The transport would occur within the states of Massachusetts, Connecticut, New York, Pennsylvania, Ohio, Indiana, Illinois, Wisconsin and Minnesota, primarily on interstate highways. Considering workload projections for the Far Detector assembly, the Devcon-60 would be delivered in 16 shipments of 48 drums each.

Total accident, fatality, and injury rates for heavy combination trucks in the state of Pennsylvania were used in the calculations for the shipment of glue. Pennsylvania has the highest total accident, fatality, and injury rates of the transited states; therefore, applying the total accident, fatality, and injury rates for the state of Pennsylvania to the entire transport route is conservative. The rates for Pennsylvania were 6.79E-07 accidents/km, 2.43E-08 fatalities/km, and 5.33E-07 injuries/km (Saricks and Tompkins 1999). Based on these rates, a calculation results in 0 (0.03) accidents, 0 (0.001) fatalities, and 0 (0.02) injuries over the shipping period for MMA.

Highway Accident Involving Delivery of Blended Scintillator Fluid

A total of approximately 4.2 million gal of liquid scintillator are needed for the Far Detector. Using the 7,000-gal average capacity for the tanker truck, an estimated 600 tanker trucks would drive the approximately 950 km (590 mi) from the vicinity of Fermilab to the Ash River site.

The transport route for the shipment of liquid scintillator from Batavia to St. Louis County would involve travel in Illinois (10%), Wisconsin (65%), and Minnesota (25%). Wisconsin has the highest total accident, fatality, and injury rates of the three states. Therefore, applying the total accident, fatality, and injury rates for the state of Wisconsin to the entire transport route is conservative. Using the total accident, fatality, and injury rates for Wisconsin, a calculation results in an additional 0 (0.3) accidents, 0 (0.01) fatalities, and 0 (0.2) injuries over the shipping period. Total accident, fatality, and injury rates for heavy combination trucks in the state of Wisconsin were used in the calculations for the shipment of liquid scintillator from Batavia , IL (Fermilab or off-site blending facility) to St. Louis county, MN (Far Detector site). These rates were 5.51E-07 accidents/km, 2.22E-08 fatalities/km, and 4.1E-07 injuries/km (Saricks and Tompkins 1999). These values for the accident, fatality, and injury rates are conservative given the transport route for the shipment of liquid scintillator.

The majority of the transport route (97%) is federal interstate or U.S. highways. Interstate accident, fatality, and injury rates are lower than the corresponding total rates used in the calculations, reflecting travel on all types of roads. The use of the total rates gives a more conservative potential number of accidents, fatalities, and injuries than the interstate rates, which would be considered more applicable, given that most of the transport route is interstate/highway.

5.2.2.5 Waste Generation and Disposal

Hazardous materials used during the assembly and installation of the detector include the MMA adhesive. The Project would receive 42,000 gal of the Devcon-60 glue in 16 shipments of 48 drums, for a total of 768 fifty-five gal drums. The drums arrive with a plastic liner containing the liquid, which when pulled leaves the metal drum uncontaminated and a “normal” waste. While the glue is pumped from the drum for use, residual fluid (perhaps ~0.5%) would remain creating a hazardous waste stream for disposition. The approximately 211 gal of residual liquid (0.5% of 55 gal in 768 drums) can be fixed by placing absorbent material in the liner. The plastic liners can be volume reduced through compaction, so that the entire waste stream could be reduced to 5-10 drums (2-4 m^3). Wastes would be submitted to a licensed waste hauler for disposal at a licensed disposal facility. Other potentially hazardous wastes including oil, gasoline, and paint, would be properly stored, including secondary containment, to prevent spills or leaks, and any waste material would be disposed in accordance with applicable regulatory requirements.

Solid wastes generated at the facility would be submitted to a licensed waste hauler for disposal at a licensed disposal facility. The regional landfill in St Louis County currently accepts approximately 50,000 tons per year of mixed municipal solid waste (SLC 2003). Incidental wastes of less than 10 tons per year from the assembly and installation at the Far Detector will have little impact on the local landfill capacity.

5.2.3 Operations at the Ash River Site

5.2.3.1 Air Quality

During normal operation of the facility 8 to 10 people would be commuting daily to the site, much less traffic than during construction or detector assembly. The additional traffic generated during operation would neither significantly increase the vehicles per day traveled on the roads in the site vicinity nor result in congestion in this rural area. Combustion products from propane building heaters (discussed in Section 5.2.2.1) would be the only routine emission during normal operations.

Based on the proposed actions, there would be no impact on local or regional air quality during operations at the Ash River site. Sections 21, 22, 23 and 24 of the EAW address air quality issues related to operations.

5.2.3.2 Water Quality

Ground Water

Based on the proposed actions with 100% secondary containment of liquid scintillator and other liquids, there should be no impact to ground water at the Ash River site during operations. An on-site septic system with a drain field may be constructed to treat the domestic waste output. A site suitability and soils analysis would be completed prior to construction to determine the most appropriate system design. The suitability analysis may indicate the requirement for a holding tank in lieu of a septic system.

The potential impact to ground water from a spill or accident involving liquid scintillator is addressed in Section 6 of this EA. Sections 13 and 18 of the EAW (Appendix A) address activities with the potential for ground water impacts related to operations.

Surface Water

The SWPPP would include mitigation measures and requirements for the protection of surface water during facility operations. No operational impacts to surface water are foreseen. The potential impact to surface water from a spill or accident involving liquid scintillator is addressed in Section 6 of this EA. The potential impacts to surface water are discussed in detail in Sections 13, 16, 17 and 31 of the EAW included as Appendix A.

5.2.3.3 Occupational/Human Health and Safety

Operations at the Far Detector Facility are discussed previously in Section 3.4 of this EA. Site worker and contractors would conduct operations under a University of Minnesota site health and safety plan and procedures for operations. No adverse impacts to employees are expected from the routine operation of the NO*v*A experiment. With fewer than 10 individuals participating in the NO*v*A Project operations on the Ash River site, project labor hours would be fewer than 20,000 per year for a total of 140,000 labor hours for the 7-year operational period. A calculation based on the educational services industry average incidence of 2.3 cases of injury/illness per 200,000 labor hours (DOL 2007) results in approximately 2 (1.6) cases of injury/illness during facility operations.

5.2.3.4 Transportation

Operations at the Far Detector Facility are discussed previously in Section 3.4 of this EA. Operation of the Far Detector is anticipated to take approximately seven years and will require fewer than 10 people on the site each day. This volume will result in an estimated total of 10 vehicles accessing the site each day, generating 20 trips per day on St. Louis County 129. A conservative average commute distance of 50 mi (round-trip) is assumed for each worker, based on a one-way distance of 25 mi between Ash River Site and International Falls. For the State of Minnesota, the accident and fatality rates per vehicle-mile are 1.39E-06, and 8.7E-09, respectively (MDPST 2007). A calculation results in an additional 1 (1.2) accident and 0 (0.007) fatalities for the 7-year period of detector operations due to workers commuting 875,000 vehicle-miles to/from the Ash River site.

5.2.3.5 Waste Generation and Disposal

Hazardous materials used during operation could include oil, gasoline, and paint, and would be properly stored, including secondary containment, to prevent spills or leaks, and any waste material would be disposed in accordance with applicable regulatory requirements. No hazardous wastes are expected to be generated during the operation of the facility.

In Section 10 of the EAW, conventional wastes generated during the operations phase are estimated to be 30 lbs per day or around 10,000 lbs (5 tons) per year. The regional landfill in St Louis County currently accepts approximately 50,000 tons per year of mixed municipal solid waste (SLC 2003). Wastes from the operations at the Far Detector Facility will have little impact on the local landfill capacity.

5.2.4 Decommissioning at the Ash River Site

Decommissioning at the Far Detector Facility is a low-intensity, methodical process, so it will have impacts similar to those in the operations phase (see previous sections). The building would not be demolished, but the detector and its support systems would be removed. Removal actions take place primarily indoors, so the air would be managed and filtered prior to exhaust. Combustion products from propane building heaters (discussed in Section 5.2.2.1) would be the only routine emissions. Scintillation fluid would be drained/pumped within the 100% containment, to minimize the potential hazard to water resources from spills. The same closed loop transfer systems would contain vapors and displaced gases/fluids during scintillation fluid pumping. The PVC detector structure would be mechanically size-reduced, eliminating the potential hazard from use of solvents. The PVC with the cured glue is not hazardous. Transportation accidents and workplace injuries would continue to be negligible due to a similar small workforce.

Waste Generation and Disposal

The major difference in this phase is the generation of waste volumes significantly different from that generated in previous phases of the Project. Once drained of scintillator, the rigid PVC components of the detector would be broken or cut down into manageable sections to fit waste containers. Further compaction of the hollow cells may be investigated, but the strength of the PVC may preclude further significant volume reduction.

The Far Detector is a semi hollow PVC box with volume of 27,500 yd^3. With the Devcon-60 glue residue the detector has no value as recyclable PVC feed stock; however, it is not a hazardous waste and can be disposed of as dumpster/industrial waste. The 27,500 yd^3 waste volume is approximately 6% of the 430,000 yd^3 dumpster/industrial waste projection by St Louis County for inclusion into its overall 1,204,000 yd^3 of landfill capacity (SLC 2003).

Although several hundred truckloads may carry away the detector waste, the disposal would be local (~50 mi or less round trip) so that total vehicle miles would be less than 100,000 (or 160,000 vehicle-km). For the State of Minnesota these rates were 1.76E-07 accidents/km, 1.2E-08 fatalities/km, and 1.21E-07 injuries/km (Saricks and Tompkins 1999). A calculation results in an additional 0 (0.028) accident and 0 (0.002) fatalities and 0 (0.02) injuries for the period of detector decommissioning.

5.2.5 Cumulative Impacts at the Ash River Site

There are no current activities or future phases of development planned for the Ash River site, nor are there any other activities or developments proposed by others that are reasonably foreseeable in the area of the proposed project. Therefore no cumulative impacts are anticipated in the area. As discussed in Section 29 of the EAW (Appendix A), future logging efforts are not considered "reasonable and foreseeable actions" in terms of evaluating cumulative impacts as logging has been occurring in the area for over a hundred years and would continue indefinitely in the region as a renewable and managed resource.

5.2.6 Socioeconomic Impacts and Environmental Justice at the Ash River Site

The number of additional site personnel and contractors required for construction and assembly activities associated with the NOνA Project would have a marginally positive and temporary effect on the local and regional economy and construction labor services. However, the low staffing level for the experiment operation phase and the finite limit to the experiment duration indicates that local and regional economy would not increase appreciably.

The population demographics for St Louis County and the state of Minnesota were shown in Table 4.6. Minority populations in St Louis County are proportionally smaller than in the State-wide population while low-income population is slightly larger. Off-site impacts of noise and vibration from the proposed action would be limited to the areas immediately adjacent to the Ash River site property boundary, where minority or low-income residents are not disproportionately congregated. Since there is no disproportionality, there is no environmental justice impact.

5.2.7 Voyageurs National Park

Visual Impacts
Although portions of the proposed site buildings may be visible from some upland areas of the Voyageurs National Park at a distance of more than two miles, the buildings would be a low feature in contrast to nearby wooded outcrops (RUMN 2007a). The Ash River site is nested among higher hills which screen the site from Voyageurs National Park, and is at least two miles from upland areas of the park from which site buildings may be visible. The NO*v*A Far Detector Facility would be located on rolling terrain with mixed elevations at ground level ranging from 1,120 to 1,393 feet above mean sea level. Many of the higher elevations are forested with treetops as high as approximately 1,450 feet above mean sea level. The highest point of any building on the site would be approximately 1,271.5 feet above mean sea level.

Design criteria would be defined to minimize the visual impact of any portion of the Far Detector building that might be visible from Voyageurs National Park (RUMN 2007a). The Far Detector building, which would have an above-ground height of approximately thirty-seven feet or approximately two stories, would not include any windows facing north to minimize reflected sunlight. An earthen berm with native grasses would surround much of the Far Detector building up to the roof line. Exterior colors for all buildings would be muted grays and browns. All north facing building walls would be in neutral colors to decrease contrast and visibility. Native plants and trees would be planted to soften the outlines of all buildings. In addition, the NO*v*A Project would work with the National Park Service to design additional measures to screen or soften the appearance of the site buildings. The potential visual impacts are discussed in detail in Sections 26 of the EAW included as Appendix A.

Noise Impacts
Noise and dust would primarily occur as a result of drilling and blasting to remove granite bedrock. Noise would also result from road construction. These are temporary effects that would occur only during the construction of the facility. Although the project site is relatively remote and greater than one mile from any inhabited dwellings or structures, noise could impact the serenity experienced by nearby residents and visitors to Voyageurs National Park as well as impact wildlife. Hence efforts to mitigate it would be undertaken.

The University of Minnesota estimates that the loudest blast associated with construction will be approximately 140 decibels at the blast site. The sound level from such a blast at the entrance to the park on NPS Highway #1 with no attenuation from vegetation and the rolling topography would be 65 decibels. This decibel level is equivalent to normal conversation. Considering natural attenuation from shrubs and trees in the area, the sound level at the entrance to the park drops to a range of 20 to 30 decibels. This decibel level is equivalent to a whisper or to the noise level found in a rural area.

Drilling/blasting impact would be avoided primarily by completion of that construction phase as quickly as possible, likely within a two- to four-month period. Other construction-related noise impacts would also be mitigated by limiting duration. Additionally, construction activities would occur between 7:00am to 7:00pm where possible. Impacts would be temporary and would return to ambient levels upon completion of the estimated 24-month project construction period. Dust generated would be mitigated by water spray application. These impacts are discussed further in Section 24 of the EAW in Appendix A.

5.3 Impact Analysis of the Blending Facility Alternative

5.3.1 Land Use

The site of the proposed blending facility if at a commercial blending facility would be previously established and blending would occur within existing facilities.

5.3.2 Air Quality

If the liquid scintillator were to be blended at Fermilab, hazardous air emissions would be prevented by the closed loop, chemical handling and blending system, including the capture and minimum release of vapors during operations. Blending at a commercial facility would be regulated by the State of Illinois. Blending would be conducted to ensure that any emissions remained within levels permitted by the State.

5.3.3 Water Quality

All blending, storage and use facilities at the commercial blender or at Fermilab would have 100% secondary containment to prevent release to the environment. The secondary containment would protect vulnerable aquatic organisms from the potentially hazardous pseudocumene in the scintillation liquid.

5.3.4 Occupational Human Health and Safety

The greatest potential of affecting occupational health and safety during blending operations would be the injuries to workers during “normal” activities. With only 2 individuals actually engaged in blending activities at Fermilab, labor hours would be less than 4,000 per year. A calculation based on Fermilab average incidence of 1.5 cases of injury/illness per 200,000 labor hours results in 0 (0.03) cases of injury/illness during detector assembly and filling operations. A calculation based on a national average for nonresidential building construction incidence rate of 5.4 cases per 200,000 labor hours (DOL 2007) results in 0 (0.1) case of injury/illness as an upper bound on cases occurring during the blending period.

Accidents and reportable cases at the commercial blender would be similar to the upper bound limit for Fermilab, essentially 0 (0.1) case.

During blending, vapors that potentially could be released to the atmosphere would be analyzed to assure compliance with FESHM air emission requirements. Ventilation controls and ES&H operational procedures would be used by a developed for the project to minimize worker exposure and ensure that any exposures that do occur are well below the American Conference of Governmental Industrial Hygienists (ACGIH) time weighted average (TWA) threshold limit value (TLV) and also below the short-term exposure limit (STEL). Commercial blending facility. would have similar monitoring program to insure compliance with State permit limits.

5.3.5 Transportation

Transportation impacts would be similar between the two blending alternatives. For the 2 employees associated with project blending, and assuming a conservative average commute distance of 86 mi (round-trip) (based on a one-way distance of 43 mi between Chicago and Batavia), an additional 0 (0.17) accidents, 0 (0.001) fatalities, and 0 (0.04) injuries might result for this phase due to workers commuting 45,000 vehicle-miles to/from the blending site. The calculation is based on the state of Illinois accident, fatality, and injury rates per vehicle-mile, which are 3.91E-06, 1.26E-08, and 1.04E-06, respectively (IDOT 2005). For Fermi, these numbers represent a minimal increase given the total number of employees at the Fermilab, and would be offset by workforce reductions due to programmatic changes at Fermilab during the period (i.e., termination of Tevatron operations).

Materials shipments include the delivery of the mineral oil and the pseudocumene for blending operations.

<u>Private Vehicles</u>

For the 2 employees associated with project blending, and assuming a conservative average commute distance of 86 mi (round-trip) (based on a one-way distance of 43 mi between Chicago and Batavia), an additional 0 (0.17) accidents, 0 (0.001) fatalities, and 0 (0.04) injuries might result for this phase due to workers commuting 45,000 vehicle-miles to/from the blending site. The calculation is based on the state of Illinois accident, fatality, and injury rates per vehicle-mile, which are 3.91E-06, 1.26E-08, and 1.04E-06, respectively (IDOT 2005).   For Fermi, these numbers represent a minimal increase given the total number of employees at the Fermilab, and would be offset by workforce reductions due to programmatic changes at Fermilab during the period (i.e., termination of Tevatron operations).

Materials shipments include the delivery of the mineral oil and the pseudocumene for blending operations.

Rail Accident involving Mineral Oil
It is assumed that the mineral oil would be shipped via rail car from a distributor in the Texas Gulf Coast to a blending facility at Fermilab or to a commercial blending facility in the Fermilab vicinity, with a maximum rail trip distance of 1,800 km. The total projected amount of mineral oil needed for blending the liquid scintillator product is approximately 4.1 million gal. Assuming that the tank cars used for transporting the mineral oil via rail would have approximately 24,000 gal capacity, a total of 171 rail car shipments would be required. The transport would occur within the States of Texas, Arkansas, Missouri, and Illinois. Total accident, fatality, and injury rates for rail transport in the state of Illinois were used in the calculations for the shipment of mineral oil. Illinois has the highest total accident, fatality, and injury rates of the transited states; therefore, applying the total accident, fatality, and injury rates for the State of Illinois to the entire transport route is conservative.

The rates for Illinois were 9.53E-08 accidents/railcar-km, 2.58E-08 fatalities/railcar-km, and 4.35E-08 injuries/railcar-km (Saricks and Tompkins 1999). Therefore, a calculation results in an estimated 0 (0.03) rail accidents, 0 (0.008) rail fatalities, and 0 (0.01) rail injuries due to rail shipment of the total volume of mineral oil.

Highway Truck Accident Involving Pseudocumene Transport
Pseudocumene would need to be shipped via truck to the blending facility at the Fermilab or off-site location. A total of 230,000 gal of pseudocumene, or approximately 35 of the 7,000-gal truck shipments would be required. It is assumed that the pseudocumene would come from a distributor in the Texas Gulf Coast area and that the travel distance would be no more than 1,800 km. The tankers are assumed to be dedicated use so the round-trip distance of 3,600 km is considered resulting in a total of 126,000 vehicle-km. The transport would occur within the States of Texas, Oklahoma, Missouri, and Illinois. Total accident, fatality, and injury rates for heavy combination trucks in the state of Texas were used in the calculations for the shipment of pseudocumene. Texas has the highest total accident, fatality, and injury rates of the transited states; therefore, applying the total accident, fatality, and injury rates for the state of Texas to the entire transport route is conservative.

The rates for Texas were 6.58E-07 accidents/highway-km, 2.70E-08 fatalities/highway-km, and 5.37E-07 injuries/highway-km (Saricks and Tompkins 1999). Assuming similar rates in all states through which transportation will occur, a calculation results in 0 (0.078) accidents, 0 (0.0032) fatalities, and 0 (0.064) injuries during the shipping period for pseudocumene.

5.3.6 Decommissioning Impacts at Fermilab

Facility decommissioning at Fermilab includes removal and contour restoration of the surface-level Blending Facility. Decommissioning of the Fermi surface-level blending facility would require dismantling storage vessels, blending tanks and piping. It is anticipated that most of the tanks and piping can be reused or recycled and will not be dispositioned as “waste”. Any waste should be in the neighborhood of less than 5 m^3, which would not significantly impact the annual volume of industrial waste from Fermilab. This waste stream is non-radioactive, and would qualify as dumpster/landfill waste previously discussed.

Decommissioning would not have to be considered at the commercial facility.

5.4 Cumulative Human Health Impacts

From the discussions in the earlier sections of Chapter 5, the highest impacts to human health occur from transportation of materials, routine worker commuting and accidents and illnesses associated with the workplace activities. Table 5.9 summarizes the accidents, fatalities, injuries and OSHA Reportable Cases estimated for each of the phases at both locations. Assumptions and risk coefficients are discussed in the individual Sections. Also shown in Table 5.9 are the human health impacts from blending operations described in Section 5.3.

Transportation of materials would cause an estimated 1 accident, 1 injury and 0 fatalities with the major contributor being delivery of materials, MMA and scintillation fluid to the Ash River site. Routine daily commuting would cause an estimated 9 accidents, 2 injuries and 0 fatalities, approximately equally divided between Illinois and Minnesota sites [Note: Because the risk coefficients for traffic injuries in Minnesota are not provided (MDPST 2007), the injuries for commuting in Minnesota are assumed to be similar to those in Illinois]. OSHA Reportable cases would be approximately 19, or about 1~2 per year of the Project schedule.

	Transportation of materials			Worker Commuting			Workplace Reportable Cases
Project Phase	accidents	fatalities	injuries	accidents	fatalities	injuries	
Fermilab. IL Site							
Excavation/ Construction	essentially zero			2 (1.68)	0 (0.005)	0 (0.48)	1 (0.9) to 2(2.1)
Installation and Assembly	essentially zero			1 (0.67)	0 (0.002)	0 (0.18)	0 (0.16) to 1 (0.5)
Operations	essentially zero			1 (0.65)	0 (0.01)	0 (0.17)	0 (0.45)
Decommissioning	essentially zero			1 (0.67)	0 (0.002)	0 (0.18)	0 (0.15)
Blending Facility	0 (0.11)	0 (0.011)	0 (0.07)	0 (0.17)	0 (0.001)	0 (0.04)	0 (0.1)
Ash River MN Site							
Excavation/ Construction	0 (0.26)	0 (0.019)	0 (0.18)	1 (1.2)	0 (0.006)	Injury data not available for MN	5 (4.7)
Installation and Assembly	0 (0.33)	0 (0.011)	0 (0.22)	3 (3.1)	0 (0.02)		10 (9.7)
Operations	essentially zero			1 (1.2)	0 (0.007)		2 (1.6)
Decommissioning	0 (0.028)	0 (0.002)	0 (0.02)	essentially zero	essentially zero		essentially zero
TOTAL	1 (0.73)	0 (0.04)	1 (0.5)	9 (9.17)	0 (0.05)	2 (2x1.0)	19 (19.3)

Table 5.9 Summary of Human Health Impacts from the Proposed Action

5.5 Impact Analysis of the Potential No Action Alternative

If the NO*v*A Project does not proceed, the environmental impacts of this no action alternative would be those from current NuMI operations at Fermilab and from logging operations at the Ash River site. The impacts of these existing operations are described in Section 4 of this document. The impacts would cease if and when those activities were ultimately shut down.

The impacts from no action would be largely programmatic and socioeconomic rather than environmental, resulting in loss of employment and delay or disruption of affected DOE and other agency research programs. This alternative could result in potential dismissal of about 200 Fermilab scientific and support staff for lack of programmatic support and funding. Fermilab's support of the nation's strategic goals in science, energy, and the environment for DOE and multiple Federal agencies would be substantially reduced.

In Minnesota, there are no foreseeable developments proposed by others in the area of the proposed project. Economic stimulus from supply and services during the construction and installation/assembly phases of the project would be not be realized.

6. ACCIDENT ANALYSIS

An accident is an unplanned event or sequence of events that results in undesirable consequences. NEPA requires agencies to consider reasonably foreseeable accidents commensurate with their potential adverse consequences. The term "reasonably foreseeable" generally is assumed to be those occurring with a probability greater than the range of one in a million to one in ten million (DOE 2002). Accident analysis is also required to address the results of an intentional destructive or terrorist act (DOE 2006).

The NO*v*A Project conducted a detailed hazard analysis that identifies the various categories of ES&H hazards that were evaluated for the proposed project (NO*v*A 2006). An extensive analysis of the entire range of accidents (construction, explosion/fire, transportation, and natural phenomena) that are reasonably foreseeable for the NO*v*A Project has been compiled in the NO*v*A Project *Accident Analysis Summary* (NO*v*A 2007c). That analysis identifies the accident analysis methods, the details of accident consequences and the Spill Prevention Control and Countermeasures (SPCC) Plans that would be developed to mitigate the consequences.

6.1 Accident Consequence Categories

Accident risk is based on two factors: probability of occurrence, and magnitude of consequence. For NEPA considerations, the accident analysis focuses on the highest consequence accident. In the NO*v*A *Accident Analysis Summary*, accidents have been assigned to relative probability categories based on both qualitative and semi-quantitative analyses. The range of accidents discussed and their consequences are:

- *Occasional* Accidents with probability of 1 in 100 to 1 in 10,000
  Minor accidents such as a worker trips and falls and other physical injuries (e.g., spraining an ankle) are the most common type of accident that would likely happen occasionally, especially given the duration of the construction phases of the NO*v*A Project. The next most common accident is assumed to be a traffic accident involving commuting workers at the Fermilab or Ash River site with serious injuries to vehicle occupants.

- *Remote* Accidents with probability of 1 in 10,000 to 1 in 1,000,000
  A vehicle rollover or tank rupture accident and chemical release involving one of the trucks transporting liquid scintillator, pseudocumene or MMA is considered to be *remote*.

- *Improbable* Accidents with probability of less than 1 in 1,000,000
  Accident scenarios related to construction, blending of chemicals, detector operation, and decommissioning are considered to be similar in frequency or *improbable*.

There are two considerations in identifying the highest consequence credible accident.

- <u>Human Impact</u>. In terms of impact on humans, the common traffic accident occurring during routine commuting is the accident that is most likely to occur. While the probability of an individual trip resulting in a fatal accident is *improbable*, the number of workers, the commuting distance and the construction duration combine to move the probability of a fatal traffic accident into the *occasional* category (0.005 at Fermilab and 0.03 at Ash River). A human fatality is a "high consequence," but traffic fatality accidents are a recognized occurrence in the modern workplace.

- <u>Environmental Impact</u>. The highest consequence credible accident with environmental impact would be the spill of pseudocumene or MMA in an accident during delivery from the distributor to the NO*ν*A Project. Such a release in a wetland or other sensitive area could impact exposed sensitive species. While an accident during transport has a calculable probability of *occasional* (approximately 0.03~0.04 for either chemical) the probability that an accident would occur that also causes a spill at an environmentally sensitive area would be several orders of magnitude less or *remote* (<1E-04).

The NO*ν*A Project does not involve the handling or use of radioactive materials, and interactions of the neutrino beam in the Near and Far Detectors do not result in activation or in hazardous external radiation levels. Therefore, no accidents involving the potential release of radiochemicals or exposure to radiation are discussed in this analysis.

6.2 Accident Scenario

The reasonably foreseeable accident scenarios for each project phase were developed based on accidents that have occurred in the past when similar activities have been conducted at other facilities or that were considered possible given the type of work, the materials handled and the setting. An accident could result from a wide variety of causes, including tripping, falling, excavation slope failure, vehicular traffic, electric shock, or equipment or construction materials falling on a worker.

When evaluating accident consequence both impact to humans and to the environment and biota are considered. Common accidents of low consequence are recognized to happen but are not considered further in this analysis.

The discussion here is focused on the single, reasonably foreseeable accident of greatest consequence that might occur in the course of the NO*ν*A Project, namely, a transportation accident involving a chemical or liquid spill. The NO*ν*A Project involves the use of MMA, a toxic material recognized as a hazardous air pollutant, to construct the detectors. The project also would blend, ship, and use approximately 4.3 million gal of liquid scintillator comprised of mineral oil, pseudocumene, and small quantities of other chemicals (most in powder form) listed in Table 3.2 to fill and operate the detectors. Pseudocumene is an irritant to humans through inhalation or skin contact and is very toxic to aquatic organisms.

Although the presence of flammable and combustible liquids in NO*v*A Project operations has the potential to contribute to an accident severity, an analysis in the NO*v*A hazard Analysis Document (NO*v*A 2006) identifies characteristics and actions that reduce the potential risk of fire. Some of these are:

- Limiting the volume of flammable liquids such as pseudocumene and MMA to minimum necessary for the stage of use;
- Reducing the risk/consequences of a fire by limiting proximity to public way, restricting personnel access and the restriction of ignition sources or open flames;
- Once the pseudocumene has been blended with the mineral oil the potential for fire is greatly reduced as the flash point is raised considerably; and
- Ignition of the blended scintillator liquid en route to or in the detectors requires a high energy source, such as a torch and is much less likely with low energy sources such as sparks or wood fires.

With considerations of the above mitigating measures the fire hazard is credible, but one of low risk and not of highest environmental consequence. The consequences of a fire at the proposed blending facility were addressed in NO*v*A Project *Accident Analysis Summary* (NO*v*A 2007c). Mitigation and response would be similar to what is described in the following sections.

Only a fraction of the transportation accident risks discussed in Sections 5.1 and 5.2 would be expected to involve a tank penetration, rupture, rollover, or serious accident that could include an explosion or fire and the possibility of the shipping contents being released. DOE and Fermilab procedures to pre-qualify contractors with excellent safety records would predict even lower probability of occurrence of accidents than general traffic statistics indicated here. One could expect at least an order of magnitude or more reduced likelihood (10 to 20 times less probable) of an accident occurring where a significant volume of the pseudocumene or MMA might be released to the environment.

6.3 Intentional Destructive and Terrorist Acts

A terrorist attack involving malicious acts intended to destroy the NO*v*A Project resulting in damage to the environment and loss of life was considered by DOE as required by the DOE Policy (DOE 2006). Fermilab is an access-controlled, secure area, provided with 24-hour security. The Ash River site is located within an isolated area that would also have controlled access and security. The two sites would be constructed and the project would be operated in such a manner that would not create a “highly visible” target for malicious acts or acts of terrorism. Because of their nature, a probability of occurrence for intentional acts can not be estimated. If malicious or terrorist acts did occur on the NO*v*A Project sites, consequences most likely would be in the large volume liquid spill category. If the secondary containment were also to be compromised, spills would be expected to have impacts similar to those from conventional accidents discussed in the NO*v*A *Accident Analysis Summary*.

6.4 Methods for Accident Avoidance and Barriers to Release

The environmental impact accidents described in this section and in the NO*ν*A *Accident Analysis Summary* are unlikely to occur because of the safety procedures that would be observed in accordance with the NO*ν*A Project hazard analysis, SAD documentation, and corresponding ES&H plans and procedures.

Mitigation measures for the various types of construction and operational activities are described in detail in the hazard analysis document prepared for the NO*ν*A Project (NO*ν*A 2006) and summarized in the NO*ν*A *Accident Analysis Summary*. Attachment B of the NO*ν*A hazard analysis provides a detailed worksheet for each environmental and safety and health hazard and identifies administrative controls, engineering controls, and mitigation measures for each hazard identified. The primary objective of this worksheet is to protect worker safety and health and the environment and reduce the potential for accidents.

6.4.1 Mitigation Measures for Potential Leaks or Spills

Passive mitigation measures. The passive mitigation measures that would be taken at the Fermilab and Ash River sites to limit the potential environmental impacts of a leak or spill are:

a) All PVC extrusions would be assembled into planes with manifolds and bottom plates. These assemblies would be pressure tested for leaks prior to being assembled and filled with scintillator.
b) Primary containment of liquid scintillator would be provided in the PVC extrusions. Subdivision of the detector into parts containing at most 275 gal of scintillator minimizes the potential for large leaks.
c) All piping systems for filling the NO*ν*A detectors would be in accordance with National Fire Protection Association (NFPA) Standard 30, Chapter 5.
d) 100% secondary containment would be provided for all areas where liquid scintillator is located and where transfer operations would occur.

Active mitigation measures. The active mitigation measures that would be taken at the detector sites to limit the potential environmental impacts are:

a) Flow sensors would be built into all filling machines.
b) Emergency stop buttons would be provided on automated transfer systems.
c) Leak detection and alarms would be provided to monitoring leaks.
d) Material and equipment for management of spills would be available at the work site to minimize the volume of any leaks and spills in accordance with the facility SPCC plan.
e) Sumps and collection systems would be provided to provide 100% secondary containment in the event of a spill or release.

6.4.2 Mitigation Measures for Spills while Transporting Chemicals and Liquid Scintillator

The mitigation measures that would be taken for transporting the liquid scintillator to the detector sites to limit potential environmental impacts are:

a) A qualified transportation company would be required to maintain an excellent safety record and regulatory history.
b) All equipment and operators used to transport the liquid scintillator would be required to meet State and Federal Department of Transportation (DOT) certification requirements.
c) All truck shipping would be in a 7,000-gal top fill tanker truck, or similar, that is DOT-approved and meets ISO-certification standards.
d) The transporter would comply with all 49 *CFR* (DOT) regulations for marking, labeling, placarding, and shipping, and shall have all required shipping papers prior to acceptance at the site.
e) A documentation package supplied with each shipment would have an appropriate "Bill of Lading", material MSDS, and State and facility Emergency Response Team phone numbers.
f) Each truck would be required to have a satellite phone or equivalent during transit.
g) The shipper would be instructed to call 911 or State Emergency Response phone number and have the local jurisdiction assume authority in the event of an accident in transit.
h) On-scene first responders would secure the Bill of Lading in the event of any emergency and call 630.840.3414, available 24 hours; Fermilab personnel would provide the first responders with shipment information as needed.

6.5 Environmental Response in the Event of a Release

6.5.1 Fermilab

Fermilab has an established and functional emergency response organization. Potential facilities and operations have been defined, designed and coordinated with the Fermilab Fire Protection Engineer (NO*ν*A 2006) and the FESHM. Emergency response requirements for the NO*ν*A facilities will be integrated into required operational reviews

- Prior to operation of the NO*ν*A detectors, they will be subject to an operational readiness review by the Particle Physics Division.
- Prior to operation of the NO*ν*A detector, it must receive written approval to operate by the Accelerator Division.

6.5.2 Ash River Site

If a release were to occur along the 5.6-km road into the Ash River site, St. Louis County Road 129, or other roads in isolated or sensitive locations, a delayed response time from the St. Louis County or the State of Minnesota could lead to environmental impacts. For example, since wetlands are located adjacent to the currently planned Ash River site access road, an accident could potentially release blended liquid scintillator (containing pseudocumene) or Devcon-60 (containing MMA) into this environment.

- The spill of the plastic glue into or adjacent to wetlands or waterways could have a negative impact on aquatic life forms due to the toxicity of the MMA constituent. With viscosity similar to a paste, the glue components do not flow readily, nor mix well in water. Vapors from a breached drum are inhalation irritants impacting species in the vicinity of the release, including human responders. Vapors from a breached drum may travel a distance to an ignition source causing flash back.

- The spill of pseudocumene into or adjacent to wetlands or waterways could have a negative impact on aquatic life forms due to its toxicity. Vapors from a punctured tanker truck are inhalation irritants impacting species in the vicinity of the release, including human responders. Vapors may form explosive mixtures with air.

- The spill of blended scintillator would mimic the conditions of a fuel oil spill as the scintillation fluid is 95% mineral oil, but much less flammable. A 7,000 gal spill would result in an oil puddle approximately 30 m by 30 m with a depth of 3 cm (100 ft by 100 ft with a depth of 1 in).

Emergency response plans similar to those implemented for an oil spill would apply to an accident of this type. Responders would use readily available containment technology supplies such as pads and sand to absorb the material. Booms and dykes would be used to contain and direct the flow to less sensitive collection areas.

Material and equipment for management of spills would be available at the work site to minimize the volume of any leaks and spills in accordance with the facility SPCC plan. Sumps and collection systems would provide 100% secondary containment in the event of a spill or release in the fixed facility.

7. LIST OF OUTSIDE AGENCIES CONSULTED

Advance notice and briefings as requested were provided to the following agencies of DOE's proposed action addressed in this EA. The EA also was made available for review and comment.

Fermilab/DOE Consultations

- Illinois Department of Natural Resources
- Office of the Governor of Illinois
- Illinois Historic Preservation Agency
- National Park Service, Voyageurs National Park
- Minnesota Historical Society
- Bois Forte Band of Minnesota Chippewa
- Leech Lake Band of Ojibwe
- White Earth Band of Minnesota Chippewa
- Grand Portage Band of Chippewa
- Fond du Lac Band of Lake Superior Chippewa Reservation
- U.S. Fish and Wildlife Service
- U.S. Army Corps of Engineers, St. Paul, Minnesota, District
- Minnesota Department of Natural Resources
- The Advisory Council on Historic Preservation

University of Minnesota Consultations

- National Park Service, Voyageurs National Park
- U.S. Army Corps of Engineers, St Paul, MN
- Minnesota Environmental Quality Board
- Minnesota Department of Natural Resources
- MNDNR Natural Heritage Information Program
- Minnesota Pollution Control Agency
- Minnesota Natural Resources Conservation Service
- St. Louis County, MN
- Forest Capital Partners, International Falls, MN (private stakeholder)

8. REFERENCES

8.1 Federal Regulations, Notices, and Laws

8.1.1 Code of Federal Regulations

(Online at http://www.gpoaccess.gov/cfr/index.html)

10 *CFR* 851. "Worker Safety and Health Program." *Code of Federal Regulations*. U.S. Department of Energy.

10 *CFR* 1021. "National Environmental Policy Act Implementing Procedures." *Code of Federal Regulations*. U.S. Department of Energy.

10 *CFR* 1022. "Compliance with Floodplain/Wetlands Environmental Review Requirements." *Code of Federal Regulations*. U.S. Department of Energy.

29 *CFR* 1904. "Recording and Reporting Occupational Injuries and Illnesses." *Code of Federal Regulations*. U.S. Department of Labor, Occupational Safety and Health Administration.

29 *CFR* 1926. "Safety and Health Regulations for Construction." *Code of Federal Regulations*. U.S. Department of Labor, Occupational Safety and Health Administration.

30 *CFR* 57. "Safety and Health Standards – Underground Metal and Non-metal Mines." *Code of Federal Regulations*. U.S. Department of Labor, Mine Safety and Health Administration.

40 *CFR* 61. "Subpart H - National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities". *Code of Federal Regulations*. U.S. Environmental Protection Agency.

40 *CFR* 261. "Identification and Listing of Hazardous Waste." *Code of Federal Regulations*. U.S. Environmental Protection Agency.

40 *CFR* 1500-1508. "Council on Environmental Quality Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act." *Code of Federal Regulations*. U.S. Environmental Protection Agency.

8.1.2 Federal Register Notices

42 *FR* 26951, Executive Order 11988 of May 24, 1977, "Floodplain Management", *Federal Register,* (1977).
On-line at http://www.eh.doe.gov/nepa/tools/guidance/volume1/2-2-eo_11988.pdf

42 *FR* 26961, Executive Order 11990 of May 24, 1977, "Protection of Wetlands", *Federal Register,* (1977).

On-line at http://www.eh.doe.gov/nepa/tools/guidance/Guidance-PDFs/14633.pdf

64 FR 6183, Executive Order 13112 of February 3, 1999, "Invasive Species." *Federal Register* (February 8, 1999). On-line at http://www.nepa.gov/nepa/regs/eos/eo13112.html

[Citation for NO*v*A EA, when published]

8.1.3 United States Code

(On-line at http://www.gpoaccess.gov/uscode/index.html)

16 USC 1531 et seq. *Endangered Species Act of 1973*. Public Law 100-478, as amended.

42 USC 4321 et seq. *National Environmental Policy Act of 1969*. Public Law 91-190, as amended.

42 USC 6901 et seq. *Resource Conservation and Recovery Act of 1976*. Public Law 94-580.

8.2 State Regulations, Notices, and Laws

Statute 103G.222-.2373. *Wetlands Conservation Act of 1991.* Minnesota Laws Chapter 354.

EQB 2007a Regents of the University of Minnesota, A NO*v*A Off Axis Facility, *EQB Monitor*, Vol. 31, No. 19, September 10, 2007. On-line at: http://www.eqb.state.mn.us/monitor.html)

EQB 2007b Regents of the University of Minnesota, A NO*v*A Off Axis Facility, *EQB Monitor*, Vol. 31, No. 24, November 19, 2007. On-line at: http://www.eqb.state.mn.us/monitor.html)

RUMN 2007a Regents of the University of Minnesota, Facilities Committee Agenda Item No. 2:EAW for NO*v*A, Meeting on November 8, 2007

RUMN 2007b Regents of the University of Minnesota, NO*v*A Off Axis Facility, Wetland Permit Application, November 14, 2007 [also available as NOVA-doc-1892]

MNDOL 2007 *Minnesota State Building Code*, MN Occupational Safety and Health Administration, September 2007. On-line at http://www.doli.state.mn.us/bc_minnesota_state_building_code.html

MNEO 2000 State Register, April 14, 2000, Executive Order 00-02: Directing State Departments and Agencies to Follow a "No-Net Loss" Policy in Regard to Wetlands, pp 1543-1544.

8.3 Reference Documents

Barr 2007 — Letter dated May 31, 2007, from N. J. Dent, Vice President, Barr Engineering Co, Duluth MN to Marvin Marshak, Institute of Technology, University of Minnesota, Minneapolis, MN, Subject: Review Summary – EAW Review for the NO*v*A Off Axis Detector Facility at Ash River Site.

Bird 1991 — *Report of the 1990 Field School Investigations at Fermi National Accelerator Laboratory: Anti-proton Collider Hall and Pine Street Prairie Restoration Area,* M C Bird and R Lurie, Midwest Archeological Research Services, Inc., February 1991

Breen 1999 — *Evaluation of Boundary Conditions for the Two Dimensional Groundwater Simulations*, F Breen, Brimly, MN. Technical Memorandum, June 12, 1999

Breen 2004 — *NuMI 3D Groundwater Model Update*, Breen GeoScience Inc., Brimly, MN, August 2004

Burns and McDonnell 2007 — *Estimate of Vehicle Trips for Construction,* Burns and McDonnell, Downers Grove, IL, July 3, 2007, NOVA-doc-2333-v1

BWSR 2007 — *Wetlands in Minnesota Brochure*, Minnesota Board of Water and Soil Resources, St. Paul, MN, 2007. On-line at http://www.bwsr.state.mn.us/wetlands/publications/index.html

Census 2000 — *Population Data for Kabetogama, St. Louis County, Minnesota,* U. S. Bureau of the Census. On-line at www.factfinder.census.gov accessed April 2007

Cooper and Ray 2006 — *NOvA Conceptual Design Report*, J Cooper and R Ray, March 31, 2006, NOVA-Doc-536

Cossairt 2006 — *Options and Considerations in the Decontamination and Decommissioning of the Neutrinos at the Main Injector (NuMI) Beamline0*, J.D. Cossairt, Fermilab EP Note No. 26, December 2006

Cowardin 1979 — Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. *Classification of Wetlands and Deepwater Habitats of the United States*. Technical Report FWS/OBS-79/31, U.S. Fish and Wildlife Service, 1979. On-line at http://www.fws.gov/nwi/Pubs_Reports/publi.htm

CTE 1997 — *Fermi National Accelerator Laboratory Wetland Delineation and Special Areas Report, Proposed Neutrino Beams for the Main Injector*

Project, Consoer Townsend Envirodyne Engineers, Inc., Chicago Illinois, June 1997

DOE 1997 *Environmental Assessment, Proposed Neutrino Beams at the Main Injector Project*, U. S. Department of Energy, Fermilab Site Office, Batavia, IL. DOE/EA-1198, December 1997

DOE 1998a *Finding of No Significant Impact: Neutrino Beams at the Main Injector (NuMI) Project at Fermi National Accelerator Laboratory*, Batavia, Illinois. U. S. Department of Energy, Fermilab Site Office, Batavia, IL. January 16, 1998

DOE 1998b *Radiation Protection of the Public and the Environment, Order 5400.5*. U.S. Department of Energy, July 24, 1998

DOE 2002 *Recommendations for Analyzing Accidents Under the National Environmental Policy Act*, U.S. Department of Energy, July 10, 2002

DOE 2006 Memorandum from the Office of NEPA Policy and Compliance, U. S. DOE, Subject: Need to Consider Intentional Destructive Acts in NEPA Documents, dated December 1, 2006

DOE 2007a Letter from DOE Fermi Site Office (Livengood) to Fermilab (Chrisman), subject: NEPA Determination at Fermi National Accelerator Laboratory – "R&D for Blending NOvA Scintillator Liquid," dated August 30, 2007

DOE 2007b *DOE Computerized Accident/Incident Reporting System (CAIRS)*. U.S. Department of Energy, web page dated 8/2/2006, Accessed September 2007) On-line at http://tis.eh.doe.gov/CAIRS

DOE 2007c Letter from DOE Fermi Site Office (Siebach) to Illinois Historic Preservation Agency (Haaker), subject: National Historic Preservation Act Determination – Fermilab National Accelerator Laboratory (Fermilab) Neutrino Detector, Batavia, Illinois, dated December 18, 2007

DOE 2008 Letter from DOE Chicago Operations Office (Siebach) to Minnesota Historic Society (Gimmestad), subject: National Historic Preservation Act Finding – Neutrino Detector, Near Ash River, Minnesota, Argonne, Illinois, dated February 28, 2008

DOL 2007 *Current Injury, Illness and Fatality Data, OSHA Recordable Cases*, U.S. Department of Labor, Bureau of Labor Statistics, (Accessed September 2007). On-line at www.bls.gov/iif/#tables

Earth Tech 1999 *Two-Dimensional Groundwater Flow Model Results: Estimated Inflow to NuMI Tunnel,* Earth Tech, Inc., Plymouth, MN May 1999

Eggers Reed 1997 Eggers, S.D. and D.M. Reed. *Wetland Plants and Plant Communities of Minnesota and Wisconsin.* U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota, 1997.
On-line at
http://www.npwrc.usgs.gov/resource/plants/mnplant/index.htm

EPA 1995a *Compilation of Air Pollution Emission Factors: Volume I – Stationary Point and Area Sources*, U.S. Environmental Protection Agency, January, 1995. On-line at www.epa.gov/ttn/chief/ap42/ [on-line edition updated through Supplement C, November 1997]

EPA 1995b *SCREEN3 Model User's Guide*, Report No. EPA-454/B-95-004, U.S. Environmental Protection Agency, September, 1995. On-line at http://www.epa.gov/scram001/dispersion_screening.htm

FEMA 1982 *National Flood Insurance Program Rate Map Community Panel Number 170896 0055*, Federal Emergency Management Agency, Federal Insurance Administration, March 1982

Fermilab 2000 *Ground Water Protection Management Plan*, Fermilab, January 2000.

Fermilab 2007a *Fermilab Environment Safety and Health Manual*, Fermilab, Batavia, IL, accessed September 2007 On-line at
http://www-esh.fnal.gov/pls/default/esh_home_page.page?this_page=800,

Fermilab 2007b *Report to the Director on the Fermilab Environment CY2006*, May 2007. On-line at http://www-esh.fnal.gov/Envir_Reports/2006EnvRep.htm

Fermilab 2007c *Fermilab Radiological Control Manual*, Fermilab, Batavia, IL, December 2007. Accessed February 2008. On-line at
http://www-esh.fnal.gov/pls/default/esh_home_page.page?this_page=900.

Grossman 2007 *Conceptual Design Report Proton Plan 2* (Addition to the NO*v*A CDR), January 31, 2007, NOVA-Doc-1468

ILDNR 1997 Letter dated August 29, 1997, from K. M. Roman, Endangered Species Consultation Program, Illinois Department of Natural Resources, Springfield, IL. to Brian Smith, CTE Engineers, Chicago, IL. Subject: Endangered Species Consultation, #44121, Proposed Fermilab Expansion, Kane County.

IDOT 2005 *2004-2005 Crash Facts and Statistics*, Illinois Department of Transportation, On-line at: http://dot.state.il.us/, 2005, accessed July 2007

IEPA 1998 *Batavia Groundwater Contamination Study, Fact Sheet #2*, Illinois Environmental Protection Agency, March 1998. On-line at http://www.eps.state.il.us/community-relations/fact-sheets/batavia-groundwater/batavia-2.html

IEPA 2000 *Batavia Groundwater Contamination Study Fact Sheet #4,* Illinois Environmental Protection Agency, April 2000. On-line at http://www.epa.state.il.us/community-relations/fact-sheets/batavia-groundwater/batavia-4.html

IEPA 2006 Lifetime Operating Permit - National Emissions Standards for Hazardous Air Pollutants (NESHAP), Illinois Environmental Protection Agency Issued March 2, 2006, and application number 79070012, dated March 1, 1991

IPCB 2007 Illinois Administrative Code, Title 35: Part 302 Water Quality Standards and Title 35: Part 611 Primary Drinking Water Standards. Illinois Pollution Control Board, Accessed July 2007. On-line at http://www.ipcb.state.il.us/SLR/IPCBandIEPAEnvironmentalRegulations-Title35.asp

ISCORS 2002 *A Method for Estimating Radiation Risk from TEDE*. ISCORS Technical Report No. 1, Interagency Steering Committee on Radiation Standards, Washington, D.C. 2002, On-line at http://homer.ornl.govoepa/guidance/risk/iscors.pdf

Lurie 1990 *Report on the Wooded Areas Survey, Gazebo Site Testing, Collector Interviews, and Review of Prehistoric Site Status and Location at Fermi National Accelerator Laboratory, Batavia, Illinois,* R Lurie, Midwest Archeological Research Services, Inc., January 1990

Lurie 2002 *Fermi National Accelerator Laboratory Cultural Resource Management Plan* (Cultural Resource Management Report 1080), Lurie, R., *et al,* Midwest Archaeological Research Services, Inc, Marengo, Illinois, prepared for the U.S. Department of Energy, September 13, 2002

Martens 2007 *An Assessment of Radiological Releases from the NuMI Facility during MINOS and NOvA Operations*, M Martens, Fermilab Technical Memo FERMILAB-TM-2375-AD, February 20, 2007

MNDNR 2001 *Minnesota Ground Water Provinces - Generalized Cross Sections*, MN Department of Natural Resources, St. Paul, MN, 2001.

MDPS 2006 *2006 Minnesota Motor Vehicle Crash Facts*, Minnesota Department of Public Safety Accessed July 2007. On-line at http://www.dps.state.mn.us/

MPCA 2005 Letter dated August 25, 2005, from R. Sisk, Minnesota Pollution Control Agency, Customer, Employee & Agency Development Section, Technology, Education & Assistance Division, St Paul, MN to E. Peterson, Un of MN, Minneapolis, MN

NO*v*A 2006 *Hazard Analysis Document*, November 2006. NOVA-Doc-618.

NO*v*A 2007a Memorandum of Understanding for Implementation of a Cooperative Agreement, Fermilab – Un of MN, December 2007. NOVA-Doc-2824.

NO*v*A 2007b *Technical Design Report*, October 2007.

NO*v*A 2007c *Accident Analysis Summary for the NOvA Project*, October 2007. NOVA-Doc-2737.

Saricks and Tompkins 1999 *State-Level Accident Rates of Surface Freight Transportation: A Reexamination*, The Center for Transportation Research, Energy Systems Division, Argonne National Laboratory, Argonne, IL, 1999.

Schaffer 1993 *Report on the 1990 Historical Site Survey at Fermi National Accelerator Laboratory, Batavia, Illinois,* M Schaffer, E Goldsmith and R Lurie, Midwest Archeological Research Services, Inc., May 1993

Schirmer 2006 *Fire Protection Recommendations for Blending and Storage of Liquid Scintillator at Fermilab*, Schirmer Engineering, Deerfield, IL, March 17, 2006,

SEH 2007 *Geotechnical Engineering Report, SEH No A-FERMI0604.00*, Short Elliot Henderson, St Paul, MN, February 20, 2007. NOVA Document 1225-v4

SLC 2003 Comprehensive Solid Waste Management Plan Update, St Louis Co, MN, 2003. On-line at http://www.co.st-louis.mn.us/Solid_Waste/SLC%20 Solid%20Waste%20Management%20Plan.pdf

STS 1997 — *Hydrogeological Evaluation Report, Neutrino Main Injector (NuMI) Project, Fermi National Accelerator Laboratory, Batavia, IL,* STS Project No. 12050-DL, STS Consultants, Ltd, Vernon Hills, IL

T106 2005 — *Cultural Resources Assessment for the Fermilab NOvA Project – Ash River Falls Site, St. Louis County, Minnesota*, The 106 Group, Ltd, Project No. 05-53, for Short Elliot Hendrickson, Inc. December 2005.

USACE 1987 — *Corps of Engineers Wetlands Delineation Manual*, Technical Report Y-87-1, US Army Corps of Engineers, Waterways Experiment Station. Vicksburg, MS, January 1987.
On-line at http://www.mvn.usace.army.mil/ops/regulatory/manual.htm

USACE 2007 — Draft *St. Paul District Wetland Compensatory Mitigation Policy for Minnesota*. U.S. Army Corps of Engineers, St. Paul, MN, 2007.
On-line at
http://www.mvp.usace.army.mil/docs/regulatory/special%20notices/MN%20Mitigation%20Policy%20Mar%2007.pdf

USACE 2008 — Letter from St. Paul District Corps of Engineers (Whiting) to DOE (Siebach), subject: Regulatory Operations (2007-4858-TWP), St. Paul, MN, January 25, 2008

USDA 2002 — *Illinois Urban Manual*, U. S. Department of Agriculture, Natural Resources Conservation Service. On-line at
http://www.il.nrcs.usda.gov/technical/engineer/urban/index.html

USFWS 1956 — Shaw, S.P. and C.G. Fredine. *Wetlands of the United States*. U.S. Fish and Wildlife Service, Circular 39. 1956 (reprinted 1971)

USFWS 1997 — Letter, from B. N. Tuggle, Field Supervisor, U.S. Department of Interior, Fish and Wildlife Service, Barrington, IL to C. M. Nash, CTE Engineers, Chicago, IL, dated July 23, 1997

USFWS 2007 — Letter, from John D. Rogner, Field Supervisor, U.S. Department of Interior, Fish and Wildlife Service, Barrington, IL to Sally C. Arnold, DOE Fermi Site Office, Batavia, IL, dated October 22, 2007

USFWS 2008 — Letter, from Tony Sullins, Field Supervisor, U.S. Department of Interior, Fish and Wildlife Service, Bloomington, MN to Sally C. Arnold, DOE Fermi Site Office, Batavia, IL, dated March 18, 2008

9.0 LIST OF PREPARERS

Sally Arnold
EA Document Manager
DOE Fermi National Accelerator Laboratory Site Office

Vicki L. Prouty
Assistant Chief Counsel
DOE Office of Science Chicago Office

Peter R. Siebach
NEPA Compliance Officer
DOE Office of Science Chicago Office

Brad Kovach
Lead Author: Minnesota Environmental Assessment Worksheet
Short Elliot Hendrickson Inc., St. Paul, Minnesota

John Cooper
NO*ν*A Project Manager, Lead Author: Detector Sections, Peer Reviewer
Fermi National Accelerator Laboratory

Larry W. Luckett
Document Coordinator, Lead Author: Affected Environment Section, Peer Reviewer
URS Corporation

Nancy Grossman
Lead Author: Accelerator Sections
Fermi National Accelerator Laboratory

Jeffery Linn
Lead Author: Accident Analysis
URS Corporation

Mike Martens
Lead Author: Tritium Sections
Fermi National Accelerator Laboratory

Keith Schuh
Lead Author: Initial Technical Draft
Fermi National Accelerator Laboratory

Don Cossairt
Peer Reviewer
Fermi National Accelerator Laboratory

Janet Dalgleish
Peer Reviewer, Minnesota EAW
University of Minnesota

Steve Dixon
Peer Reviewer, Minnesota EAW
Fermi National Accelerator Laboratory

Teri Dykhuis
Peer Reviewer
Fermi National Accelerator Laboratory

Marvin Marshak
Peer Reviewer, Minnesota EAW
University of Minnesota

Stephen Pordes
Peer Reviewer
Fermi National Accelerator Laboratory

Document Production

Carol Scholl
Lead Editor
URS Corporation

Laura Westcott
Senior Administrative Assistant
URS Corporation