U.S. Department of Energy (DOE)

Finding of No Significant Impact (FONSI)

Neutrino Beams at the Main Injector (NuMI) Project

at

Fermi National Accelerator Laboratory (Fermilab)

Batavia, Illinois

AGENCY: DOE

ACTION: FONSI

SUMMARY: DOE has prepared an Environmental Assessment (EA), DOE/EA-1198, for the "Proposed Neutrino Beams at the Main Injector (NuMI) Project." This action includes the construction, operation and future decommissioning of a new target station, beam transport system, and two experimental halls in an underground tunnel approximately 1500 meters (4900 feet) long at Fermilab in Batavia, Illinois. The action would also involve the expansion of existing facilities and construction, operation and future decommissioning of a new experimental facility at the Soudan Underground Laboratory at Soudan, Minnesota, 730 kilometers (454 miles) to the northwest of Fermilab. The Soudan Underground Laboratory is operated by the University of Minnesota under a grant from DOE. An Environmental Assessment Worksheet (EAW) which analyzes the environmental impact of the action to be performed at Soudan has been prepared in accordance with State of Minnesota regulations by the State of Minnesota Department of Natural Resources. This EAW is incorporated into the EA for NuMI.

The study of neutrinos, a type of subatomic particle, has been the subject of major experiments at Fermilab for approximately 25 years. For the proposed NuMI project, neutrinos produced using the facilities on the Fermilab Site would be studied both on

the Fermilab Site (the "short baseline" experiment) and at the Soudan Underground Laboratory (the "long baseline" experiment) to determine whether neutrinos change families or oscillate. The long distance between Fermilab and the Soudan Underground Laboratory provides time for the neutrinos to oscillate and then be detected in the Main Injector Neutrino Oscillation Search (MINOS) detector. Experiments conducted solely on the Fermilab Site would explore different types of neutrino oscillations which would be observed by the Cosmologically Significant Muon Neutrino Oscillation Search (COSMOS) detector. No physical connection (i.e., excavation) of any kind between these two locations is planned or is needed since neutrinos interact with material only extremely rarely and thus travel passively through the Earth between Illinois and Minnesota.

Based on the analyses in the EA, the DOE has determined that the proposed action does not constitute a major Federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act of 1969 (NEPA). Therefore, the preparation of an Environmental Impact Statement is not required.

DESCRIPTION OF THE PROPOSED ACTION:

The proposed action, the NuMI project, would be to design, construct, operate, and decommission a facility at Fermilab for producing a high flux beam of neutrinos having energies in the range of 1 to 40 billion electron volts (GeV). The facility would be connected with the Fermilab Main Injector (FMI) at a beam extraction point known as MI-60 by a large evacuated pipe through which would pass a beam of protons of energies up to 150 GeV. Following this pipe, an underground tunnel approximately 1500 meters (4900 feet) would be excavated. This tunnel would be aligned toward the Soudan Underground Laboratory at a downward angle of 3.3 degrees and thus would

reach a depth of approximately 90 meters (300 feet). The tunnel would house a pretarget area, target area, beam absorber region, and two experimental halls. Most of the tunnel would be excavated using underground tunneling techniques with no impact on surface features. Structures on the surface would consist of buildings to house the tops of access shafts and a few small buildings constructed to house some items of equipment needed to conduct the physics experiments. A new experimental hall would be constructed at the Soudan Underground Laboratory in Minnesota. Experiments would be conducted in the two experimental halls located on the Fermilab Site and the new experimental hall at the Soudan Underground Laboratory.

ALTERNATIVES AND THEIR IMPACTS:

Six alternatives were considered: (1) construction at other DOE facilities, (2) construction of a completely new facility, (3) construction of a new far detector facility, (4) construction within the existing Fixed Target Areas at Fermilab, (5) construction at extraction points other than MI-60, and (6) no action.

The first three alternatives would most likely result in a greater environmental impact than the proposed action and would cost a great deal more. Construction within the existing Fixed Target Areas at Fermilab is not preferred as it would limit the future use of the Fixed Target areas for other experiments and it also would not fully address the scientific questions that motivate this project (i.e., would not meet the "purpose and need" of the proposed action, as described in the EA). Construction at extraction points other than MI-60 is not preferred because it would require additional civil construction which would affect jurisdictional wetlands (with consequent environmental impacts) and it would necessitate the procurement of a substantial amount of additional equipment to provide the desired proton beam. The no action alternative would result in no environmental impacts (at Fermilab or at the Sudan Underground

Laboratory) and would also mean that the United States would be unable to study the properties of neutrino oscillations in this manner any time in the near future.

ENVIRONMENTAL IMPACTS:

Construction:

The construction of the proposed NuMI beamline and experimental halls on the Fermilab Site would result in the removal of approximately 67,000 cubic meters of rock and soil. This material would be stockpiled only temporarily as it would be removed from the Fermilab Site, except for a small portion needed to fill certain excavations. Care would be taken to prevent erosion of this material by means of storm water runoff. Truck traffic used to remove this rock and soil would use adjacent, heavily traveled truck routes and have negligible impact. Other wastes generated as a result of construction activities would be minimal and would be disposed of in accordance with applicable Federal and State Regulations. During the construction of the tunnel, standard industrial practices would be employed to control noise, dust, vibrations, and ground movements. Monitoring of vibrations would be performed to assure insignificant impacts to structures both on and off the Fermilab Site. Standard techniques would be employed to seal the tunnel as it is constructed in order to avoid both excess inflow of water into the tunnel and any significant effects on neighboring drinking water wells. There would be no construction in jurisdictional wetlands and no impact on Federal or State threatened or endangered species. The safety of workers would be assured by following standard industrial construction practices and by assuring compliance with Federal and State Regulations. There would be no exposure of members of the public to man-made sources of ionizing radiation during the construction.

Operations:

Potential radiation exposures due to the operations of the proposed NuMI facility have been assessed in the EA and are below the requirements of applicable Federal and State regulations and are as low as reasonably achievable. Radiation doses to members of the public would be too low to measure. A small number of workers and experimental personnel would be exposed to low levels of ionizing radiation due to the operation and maintenance of the target station which would unavoidably become radioactive due to the interactions of the proton beam. These radiation exposures would be comparable to those currently experienced by workers at Fermilab and would be routinely monitored. The radiation exposure of members of the public due to NuMI operations has been assessed in the EA and found to be negligible. The annual radiation doses to the small number of workers receiving the largest exposures would be no more than 1000 mrem compared with the regulatory limit of 5000 mrem. The release of airborne radionuclides to the environment and the total released by Fermilab during NuMI operations would be comparable to those presently experienced during Fermilab operations and would amount to a maximum radiation dose at the Fermilab site boundary of 0.007 mrem per year compared with the regulatory standard of 10 mrem. Due to the extremely rare interactions of neutrinos with matter, as evidenced by their ability to pass without attenuation through the Earth, there would be no significant radiation exposures to members of the public or the experimenters due to neutrinos both on and off the Fermilab Site.

The operations of NuMI would result in some radioactivation of the soil and rock in the vicinity of the tunnel. Shielding of the components of NuMI would be designed to assure that concentrations of radionuclides in groundwater resources would be less than those specified in applicable regulatory limits. The maximum annual radiation dose to someone who might use water drawn from the region within one meter of the portion of the facility on the Fermilab Site as their primary source of drinking water

would be less than the regulatory standard of 4 mrem. The generation of chemical and low-level radioactive wastes has been assessed in the EA and found to be comparable to that currently experienced in operations at Fermilab. These wastes would be disposed of in accordance with existing regulatory requirements. Since the operation of NuMI would replace comparable operations at Fermilab, it would represent an insignificant increase in total laboratory usage of public utilities, and would not impair their ability to supply other users.

Impacts of Construction and Operation at the Soudan Underground Laboratory:

The major impacts of the construction of the cavern and operation of the detector located at the Soudan Underground Laboratory have been assessed in the State of Minnesota EAW. The main issues identified in that assessment concern the management of the spoil from the mining operation that would be employed to excavate the new experimental hall and the protection of species of bats that are found in the Soudan mine. The spoil would be placed on the surface in such a way as to not detract from the character of the historic mine area and thus not conflict with the existing use of the area as a park. It was determined that this material has a low potential for erosion and sedimentation. Thus the management of the excavated material would have no significant impact on the environment. The issue of protection of the bats concerns the possibility that the excavation activities could disturb their hibernation patterns. It was concluded that blasting activities would be started prior to when the bats arrive for hibernation, thus discouraging their hibernation in areas where their hibernation would be disturbed by blasting. Previous studies have shown that bats can adapt to alternative hibernia, without impacting their survival. The mine appears to provide adequate suitable habitat away from the construction area so that the impact on the bats would not be significant.

Operation of the present high energy physics facility at Soudan has negligible impact on the environment. The proposed operations at Soudan would be similar in scope and design and thus would have negligible impact on the environment.

Cumulative Impacts:

Significant cumulative or long-term environmental effects would not result from the proposed action. During the period of construction of the NuMI facility, there would be no other large construction projects on the Fermilab Site or at the Soudan Mine. Operations of the NuMI facility would replace other parts of the Fermilab research program and operations at the Soudan Underground Laboratory would have negligible impact on the environment.

Decommissioning:

Since it is anticipated that most of the equipment and materials involved in the proposed NuMI facility would be used in other current or new experiments, either at Fermilab or similar facilities, it is expected that minimal impact would be made on the cumulative amounts of disposed material. This would also be true for the proposed facility at the Soudan Underground Laboratory.

DETERMINATION:

Based on the analysis in the EA, the DOE has determined that the proposed construction, operation, and decommissioning of the proposed NuMI project facilities does not constitute a major Federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act of 1969. Therefore, the preparation of an Environmental Impact Statement on the proposed action is not required.

PUBLIC AVAILABILITY: Copies of this EA (DOE/EA-1198) are available from:

Andrew E. Mravca, Manager
Fermi Group
U. S. Department of Energy
P. O. Box 2000
Batavia, IL 60510
(630)840-3281

For further information regarding the DOE NEPA process, contact:

Dr. W. S. White
NEPA Compliance Officer
Chicago Operations Officer
U. S. Department of Energy
9800 South Cass Avenue
Argonne, IL 60439
(630)252-2101

Issued in Argonne, IL this 16 day of January 1998.

John P. Kennedy, Acting Manager
Chicago Operations Office

DOE/EA-1198

ENVIRONMENTAL ASSESSMENT

PROPOSED NEUTRINO BEAMS AT THE MAIN INJECTOR PROJECT

December 1997

TABLE OF CONTENTS

1 INTRODUCTION 1

2 BACKGROUND INFORMATION ON NEUTRINOS 4

3 PURPOSE AND NEED 5

4 THE NuMI FACILITY (PROPOSED ACTION) AND ALTERNATIVES

4.1 Description of the Proposed Action 6

4.1.1 Construction 12

4.1.2 Operation 13

4.1.3 Decommissioning 14

4.1.4 Proposed Schedule 14

4.1.5 New or Modified Permits and Licenses 14

4.1.6 The Soudan Underground Laboratory Facility 15

4.2 Alternatives and their Impacts

4.2.1 Construction at Other DOE Facilities 15

4.2.2 Construction of a Completely New Facility 16

4.2.3 Construction at Extraction Points Other than MI-60 16

4.2.4 Construction Within the Existing Fixed Target Areas at Fermilab 16

4.2.5 Construction of a New Far Detector Experimental Hall 16

4.2.6 No Action Alternative 17

5 THE AFFECTED ENVIRONMENT

5.1 Site Description and Land Use 18

5.2 Air Quality 18

5.3 Geology and Groundwater 18

5.4 Surface Water 19

5.5 Waste Generation and Disposal 19

5.6 Sensitive Resources 20

5.7 Occupational Safety and Health....20

5.8 Socioeconomic Issues....21

5.9 The Soudan Underground Laboratory Facility....22

6 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

6.1 Construction of the Proposed Action....23

6.1.1 Excavation....23

6.1.2 Occupational Safety and Health....26

6.1.3 Air Quality and Noise....27

6.1.4 Groundwater....28

6.1.5 Surface Water....28

6.1.6 Waste Generation and Disposal....29

6.1.7 Sensitive Resources....29

6.1.8 Socioeconomic Issues....29

6.2 Normal Operation of the Proposed Action....30

6.2.1 Land Use....30

6.2.2 Work Force....30

6.2.3 Occupational Safety and Health....30

6.2.4 Utilities....31

6.2.5 Ionizing Radiation and Waste Generation....31

6.2.5.1 Penetrating Radiation....32

6.2.5.2 Soil and Ground Water....33

6.2.5.3 Surface Water and Closed-loop Cooling Water....34

6.2.5.4 Air Activation....35

6.2.5.5 Residual Activation....36

6.2.5.6 Waste Generation and Disposal....37

6.3 Off-Normal Operation of the Proposed Action....37

6.4 The Soudan Underground Laboratory Facility....37

6.5 Cumulative Effects of the Proposed Action:

Construction and Operation 38

6.6 Decommissioning of the Proposed Action 38

6.6.1 Cumulative Effects: Decommissioning 39

REFERENCES 40

LIST OF ABBREVIATIONS AND ACRONYMS 43

GLOSSARY 44

APPENDIX A: Environmental Assessment Worksheet (EAW) for the Proposed Modifications to the Soudan Underground Laboratory

APPENDIX B: Correspondence with State and Federal Agencies Concerning Threatened and Endangered Species

APPENDIX C: Figures Showing Beamline Details in the Region of the Extraction and Pretarget Areas.

LIST OF TABLES:

Table 6.1 Listing of below Grade Structures that would be Constructed as Part of the Proposed NuMI Project on the Fermilab Site (along with their Approximate Volumes and Dimensions)..... 25

Table 6.2 Listing of above Grade Structures that would be Constructed as part of the NuMI Project (along with their approximate surface areas).....26

Table 6.3 Summary of Estimated Maximum Annual Doses Due to Ionizing Radiation Associated with the Proposed NuMI Project Construction and Operation.....31

LIST OF FIGURES:

Figure 1.1 Map showing location of Fermilab in the context of the Chicago area..... 2

Figure 1.2 Regional map showing the locations of the Fermi National Accelerator Laboratory and the Soudan Underground Laboratory.....3

Figure 4.1 Schematic layout of the main Fermilab accelerator complex showing the location of the Fermilab Main Injector along with the existing Tevatron accelerator and the various experimental areas that are explained in the text.....7

Figure 4.2 Schematic layout of the southwest corner of the Fermilab site showing the below grade components of the proposed NuMI project.....8

Figure 4.3 Schematic layout of the southwest corner of the Fermilab site showing the above grade components of the proposed NuMI project.....9

Figure 4.4 Conceptual elevation view of the NuMI facilities planned for the Fermilab site.....10

Figure 6.1 Schematic layout of the southwest corner of the Fermilab site showing the above grade components of the proposed NuMI project..... 24

FIGURES IN APPENDIX C:

Figure C1a Conceptual plan view of beamline components used to extract the proton beam from the Fermilab Main Injector and direct it toward the target used to produce the neutrinos.

Figure C1b Conceptual elevation view of beamline components used to extract the proton beam from the Fermilab Main Injector and direct it toward the target used to produce the neutrinos.

Figure C2a Conceptual plan view of the beamline components used to complete the delivery of the proton beam to the target used to produce the neutrinos.

Figure C2b Conceptual elevation view of the beamline components used to complete the delivery of the proton beam to the target used to produce the neutrinos.

1 INTRODUCTION

The U.S. Department of Energy (DOE) proposes to build a **beamline** on the Fermi National Accelerator Laboratory (Fermilab) site to accommodate an experimental research program in neutrino physics (see Figures 1.1 and 1.2). The proposed action, called Neutrino Beams at the Main Injector (NuMI), is to design, construct, operate and **decommission** a facility for producing and studying a high flux beam of neutrinos in the energy range of 1 to 40 GeV (1 **GeV** is one billion or 10^9 electron volts). The proposed facility would initially be dedicated to two experiments, **COSMOS** (Cosmologically Significant Mass Oscillations) and **MINOS** (Main Injector Neutrino Oscillation Search). The neutrino beam would pass underground from Fermilab to northern Minnesota. A tunnel would not be built in this intervening region because the neutrinos easily pass through the earth, not interacting, similar to the way that light passes through a pane of glass. The beam is pointed towards the MINOS detector in the Soudan Underground Laboratory in Minnesota. Thus, the proposed project also includes construction, operation and decommissioning of the facility located in the Soudan Underground Laboratory in Minnesota that houses this MINOS detector.

This environmental assessment (EA) has been prepared by the US Department of Energy (DOE) in accordance with the DOE's National Environmental Policy Act (NEPA) Implementing Procedures (10 CFR 1021). This EA documents DOE's evaluation of potential environmental impacts associated with the proposed construction and operation of NuMI at Fermilab and its "far" detector facility located in the Soudan Underground Laboratory in Minnesota. Any future use of the facilities on the Fermilab site would require the administrative approval of the Director of Fermilab and would undergo a separate NEPA review. Fermilab is a Federal high-energy physics research laboratory in Batavia, Illinois operated on behalf of the DOE by Universities Research Association, Inc., a consortium of more than 80 major research universities.

The facility at Soudan is leased by the University of Minnesota from the State of Minnesota Department of Natural Resources. It is planned that improvements to this facility would be funded by a Grant from the United States Department of Energy. The modifications to and operations of this facility are also subject to environmental assessment requirements of the State of Minnesota. Appendix A is the environmental assessment of this portion of the proposed action, prepared in accordance with State of Minnesota procedures, which is called an Environmental Assessment Worksheet (EAW). The EAW was published for public comment on August 25, 1997. Appendix A includes a list of the agencies, organizations, and individuals who were provided the opportunity to review the EAW. Based upon the comments received concerning the EAW, the Minnesota Department of Natural Resources issued a Record of Decision on September 26, 1997, that an Environmental Impact Statement is not required.

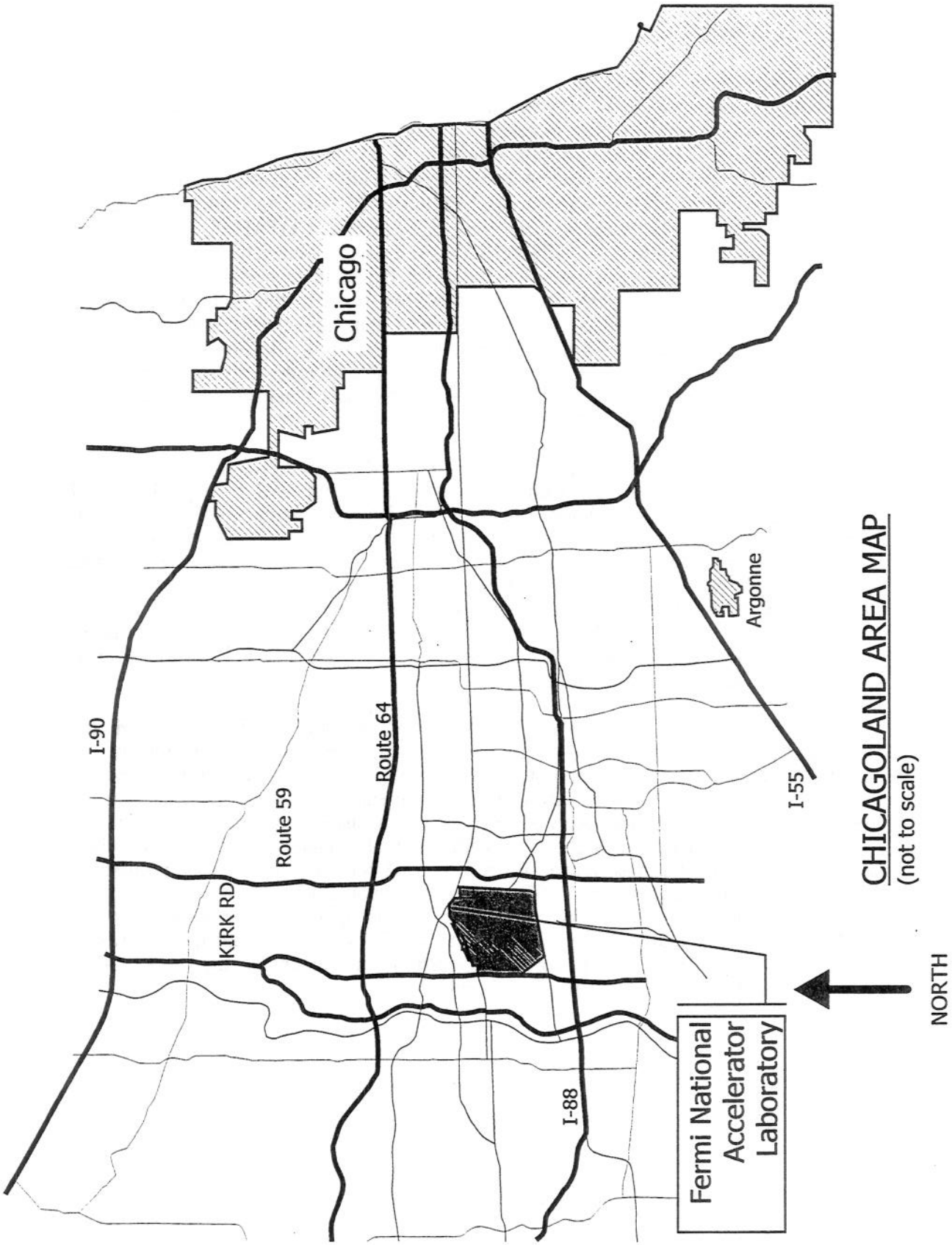


Figure 1.1 Map showing location of Fermilab in the context of the Chicago area.

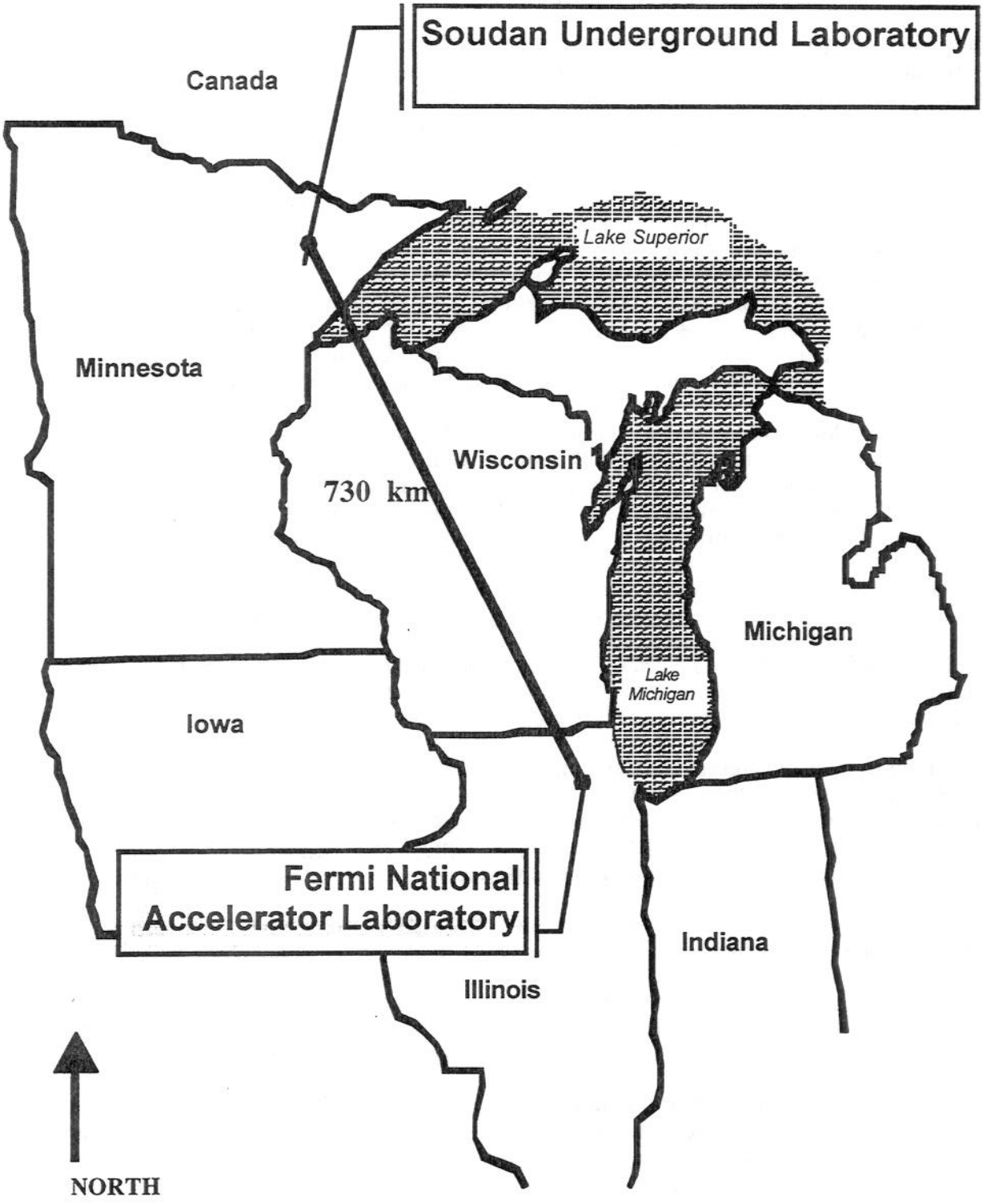


Figure 1.2 Regional map showing the locations of the Fermi National Accelerator Laboratory and the Soudan Underground Laboratory.

2 BACKGROUND INFORMATION ON NEUTRINOS

Some 40 years after the first direct observation of the electron **neutrino**, very little is known about neutrinos. As early as the late 1950s, physicists suggested that neutrinos could have mass, and, if they do, would be able to change from one type to another. Although several attempts have been made to check this hypothesis, no one has ever made a direct experimental observation of this phenomenon, known as neutrino **oscillation**.

Neutrinos are fundamental elementary particles which interact very weakly with matter. In nature they are observed in cosmic rays, in reactions in the sun, and in the **decay** of many **radionuclides**. The earth receives neutrinos continuously from cosmic sources. They interact so weakly with matter that they can easily pass through many miles of rock, indeed, through the entire Earth, without affecting a single atom in their passage. It is important to note that neutrinos are not like alpha, beta and gamma **ionizing radiation** since neutrinos rarely ionize matter as they pass through. Because they interact so rarely, abundant sources of neutrinos and very massive detectors are needed to study them.

In the Standard Model of elementary particle physics there are three types, or "families", of particles that do not interact strongly with matter. Collectively, they are called **leptons**. Each family is composed of a lepton having electric **charge** and an associated neutrino. The three electrically charged leptons are: the **electrons**, which are one of the building blocks of ordinary matter; **muons**, which are a major component of the cosmic rays; and **taus**, which so far have been observed only in experiments at high energy physics laboratories. To date, the electron neutrino and the muon neutrino have been observed in connection with electrons and muons, respectively. The tau neutrino has yet to be directly observed. Neutrinos have not been observed to change from one family to another. Such oscillations would imply that neutrinos, originally assumed to be without mass, have mass. There are compelling hints from both theory and experiment that such family-changing, or oscillation, could provide a solution to several scientific puzzles.

There is a puzzle in the present understanding of the number of electron neutrinos produced by the sun. Fewer of these neutrinos are observed experimentally than are predicted theoretically. The deficit is consistent over several experiments. A possible explanation is that the electron neutrinos oscillate to another family and hence are not found in experiments designed to see only electron neutrinos.

A similar deficit is seen in atmospheric neutrinos. Secondary cosmic rays, those seen at the Earth's surface, consist largely of muons produced in the upper atmosphere by primary cosmic rays. Muon neutrinos are produced in conjunction with the muons and their number can be predicted based on the number of muons. However, experiments designed to look specifically for **muon** neutrinos find fewer neutrinos than expected. Consequently, oscillation of the muon neutrinos to another family might provide an explanation.

A third puzzle is the source of "**dark matter**" which astronomers have deduced must exist in the universe. The observed gravitational attraction between distant galaxies is greater than can be accounted for by the mass of the stars visible in them. Since neutrinos are known to permeate the universe and a consequence of oscillations is that neutrinos must have mass, the observation of neutrino oscillations would provide a plausible explanation of the dark matter.

3 PURPOSE AND NEED

Neutrino studies are needed to assist the US scientific community in explaining the "deficit" in both the number of electron neutrinos produced by the sun and the number of muon neutrinos produced by cosmic rays, and identifying the source of dark matter. The Department of Energy's High Energy Physics Advisory Panel (HEPAP) established a Sub-Panel on Accelerator-Based Neutrino Oscillation Experiments in January 1995. The purpose of the HEPAP Sub-Panel was to "Evaluate the existing evidence for neutrino oscillations and consider the feasibility of testing this phenomenon in experiments in U.S. **accelerator** facilities." They were also tasked to "...recommend to the Department of Energy a cost-effective plan for pursuing this physics" (HEPAP 1995).

The purpose of the proposed NuMI project would be to construct a facility capable of providing a **beam** of neutrinos and to provide experimental facilities needed to investigate neutrino interactions with matter. Studies could determine whether neutrinos have mass and measure their participation in family changing or oscillations. Several scientific puzzles could be answered if neutrinos were found to oscillate and have mass; the solar neutrino problem: the atmospheric neutrino problem and the issue of dark matter.

4 THE NuMI FACILITY (PROPOSED ACTION) AND ALTERNATIVES

More detailed information on the proposed action can be found in the impact analysis in Section 6.

4.1 Description of Proposed Action

The completion of the Fermilab Main Injector (FMI), now under construction, will provide an unprecedented opportunity for simultaneous operation of both **collider** and **fixed target physics** programs (see Figure 4.1). The Main Injector will accelerate protons to kinetic energies up to 150 GeV. These protons will be used for anti-proton production, injected into the Tevatron accelerator for acceleration up to approximately one (1) TeV (1000 GeV), or extracted every few seconds for use by fixed target experiments (such as NuMI). Extracted intensities from the FMI as high as 60 trillion (6×10^{13}) protons per cycle would make it possible to design a high intensity secondary beam which would produce a neutrino beam capable of addressing the question of neutrino oscillations with a few years of operation. The beam energy is also appropriate for studying neutrino oscillations. The HEPAP report recognized the need for a neutrino facility and Fermilab's appropriateness for it, and concluded "The very high flux Fermilab Main Injector... has the potential to provide a neutrino beam of unique capabilities for the field of neutrino oscillation science" (HEPAP, 1995).

The proposed NuMI beam, nominally 120 GeV protons, would be **extracted** from the existing Fermilab Main Injector (FMI) at MI-60 (see Figure 4.2). A large fraction of the beam would interact with a target, creating a secondary beam of **pions** and **kaons**. (Figures in Appendix C show some of the beamline detail.) A series of magnets would then be used to bend away the negatively charged particles and to focus the remaining pion/kaon beam. Some of the positively charged pions and kaons will decay into muons and muon neutrinos in the long decay pipe. At the end of the decay pipe would be approximately 250 meters (825 feet) of rock and steel. The rock and steel are used to absorb the remaining pions and kaons, and to stop the muons. Thus, beyond the dirt and steel, a nearly pure beam of muon neutrinos would be produced which would be directed downward through the Earth toward the Soudan Underground Laboratory (at an angle of approximately 3.3 degrees relative to the horizontal). The below grade and above grade structures for the proposed NuMI beamline on the Fermilab site are shown in Figures 4.2 and 4.3, respectively.

The neutrino oscillation probability depends upon the length of the flight path, or baseline, provided for the neutrinos to oscillate. A major strength of the proposed NuMI experimental program would be the available distances between the detectors. There would be both a **long baseline** experiment (provided by the distance between Fermilab and the Soudan Underground Laboratory, see Figure 1.2) as well as a **short baseline** experiment (on the Fermilab site).

The COSMOS detector would be located in an underground experimental hall (see Figure 4.4) on the Fermilab site, about 1 kilometer from the target. Because this detector is so close to the neutrino source, the experiment that uses this detector is a short baseline experiment. Short-baseline experiments can detect oscillation, if it occurs, of neutrinos whose mass lies in the range that is relevant to the question of dark matter.

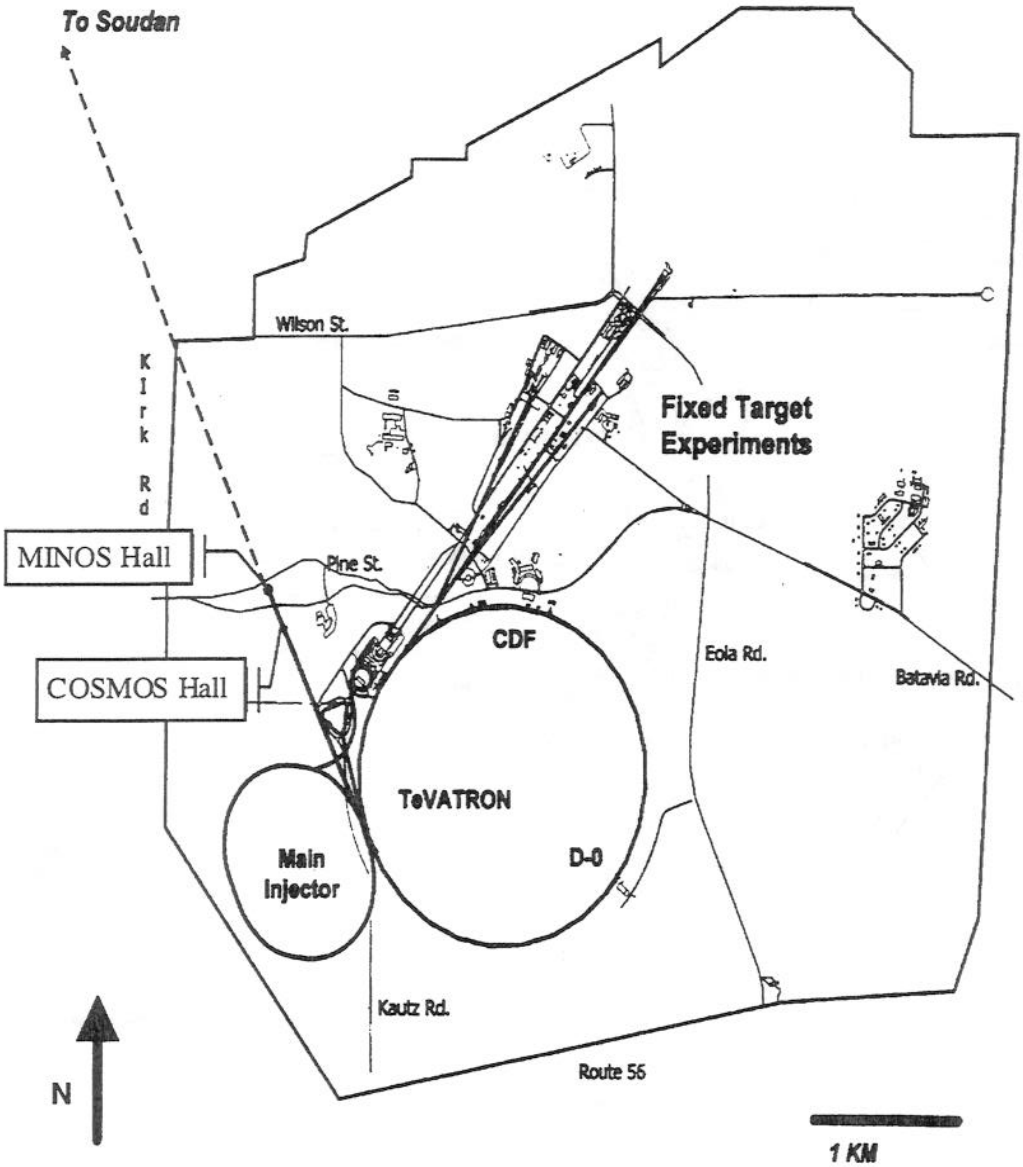


Figure 4.1 Schematic layout of the main Fermilab accelerator complex showing the location of the Fermilab Main Injector along with the existing Tevatron accelerator and the various experimental areas which are explained in the text.

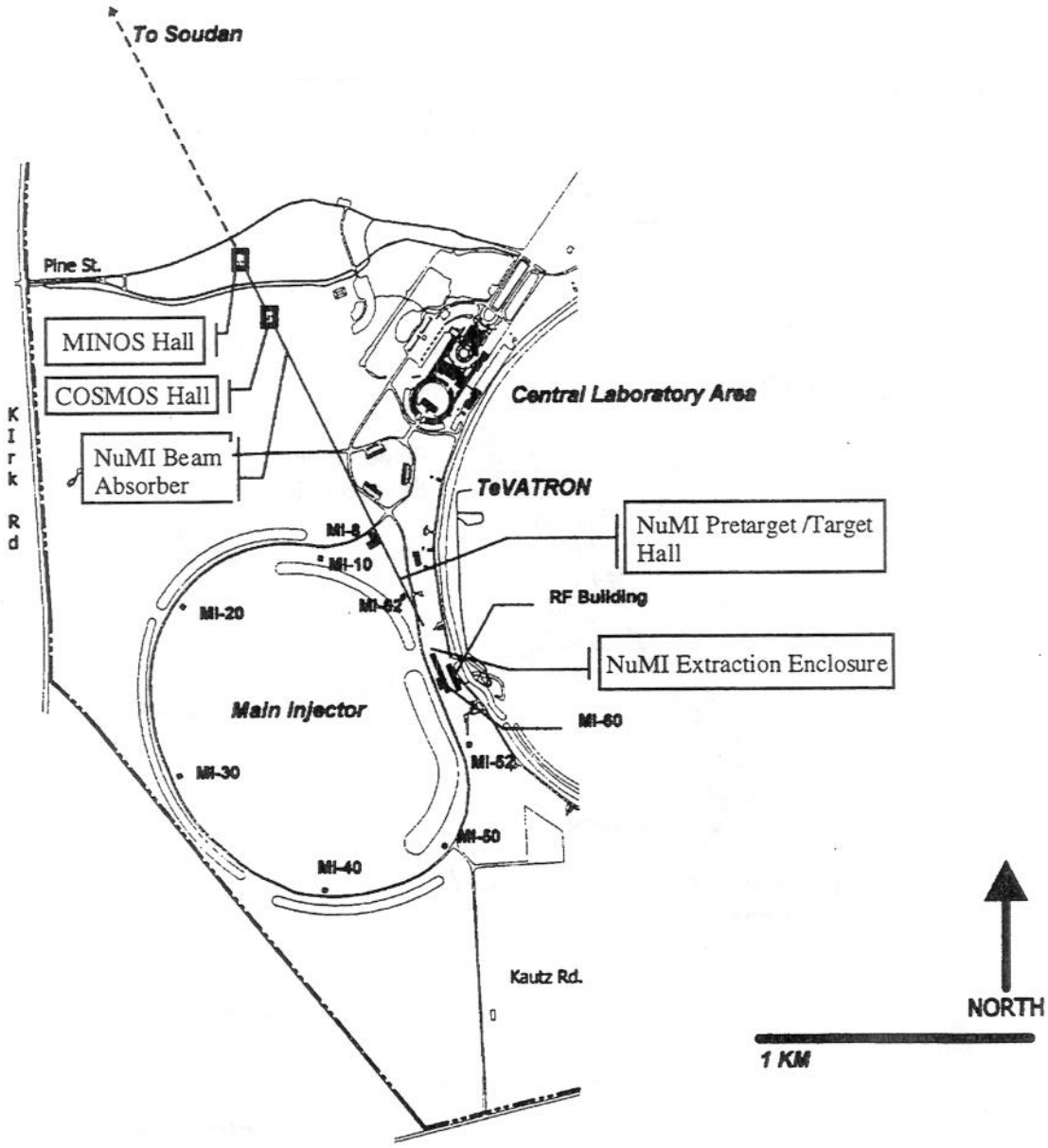


Figure 4.2 Schematic layout of the southwest corner of the Fermilab site showing the below grade components of the proposed NuMI project.

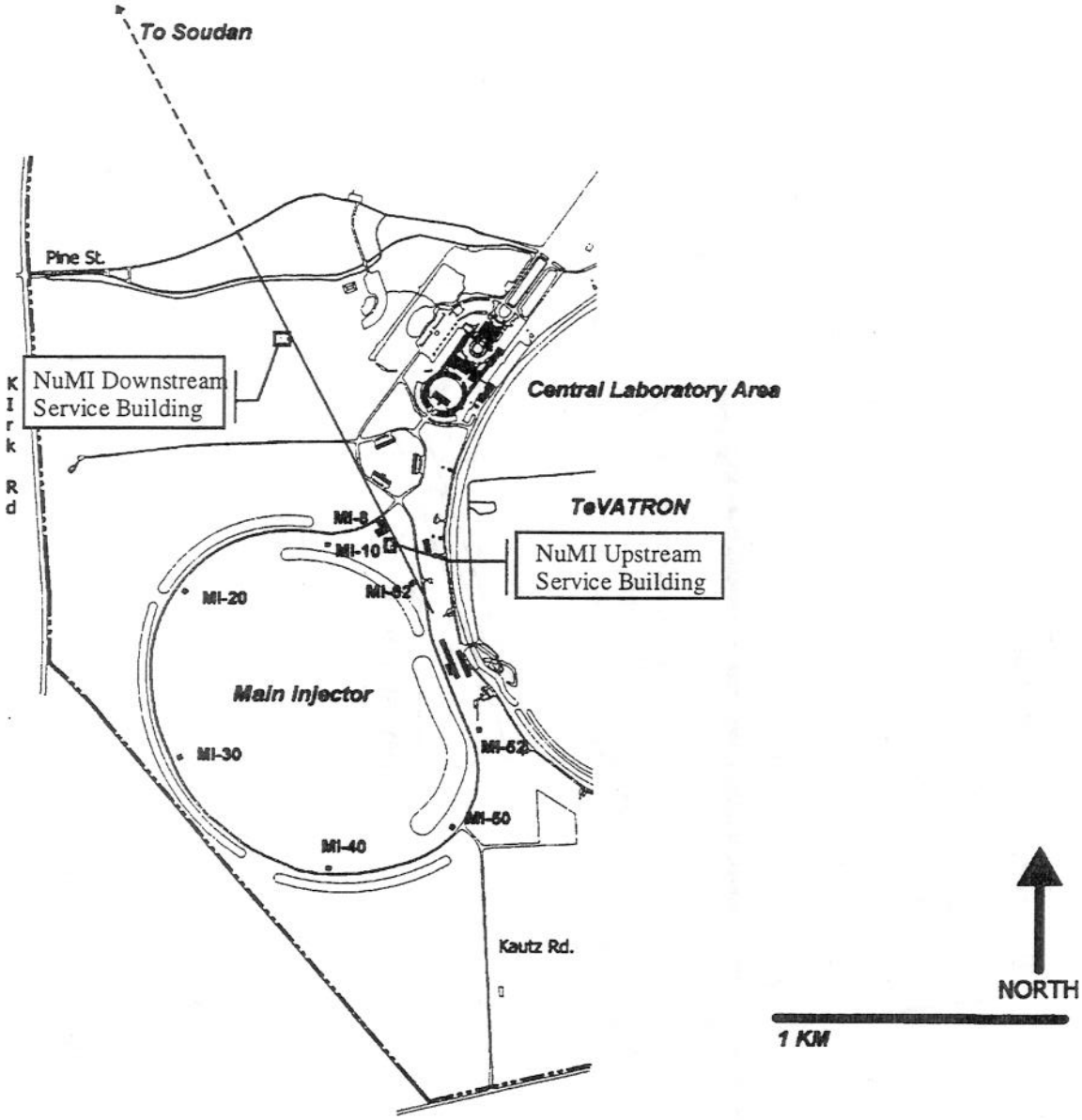


Figure 4.3 Schematic layout of the southwest corner of the Fermilab site showing the above grade components of the proposed NuMI project.

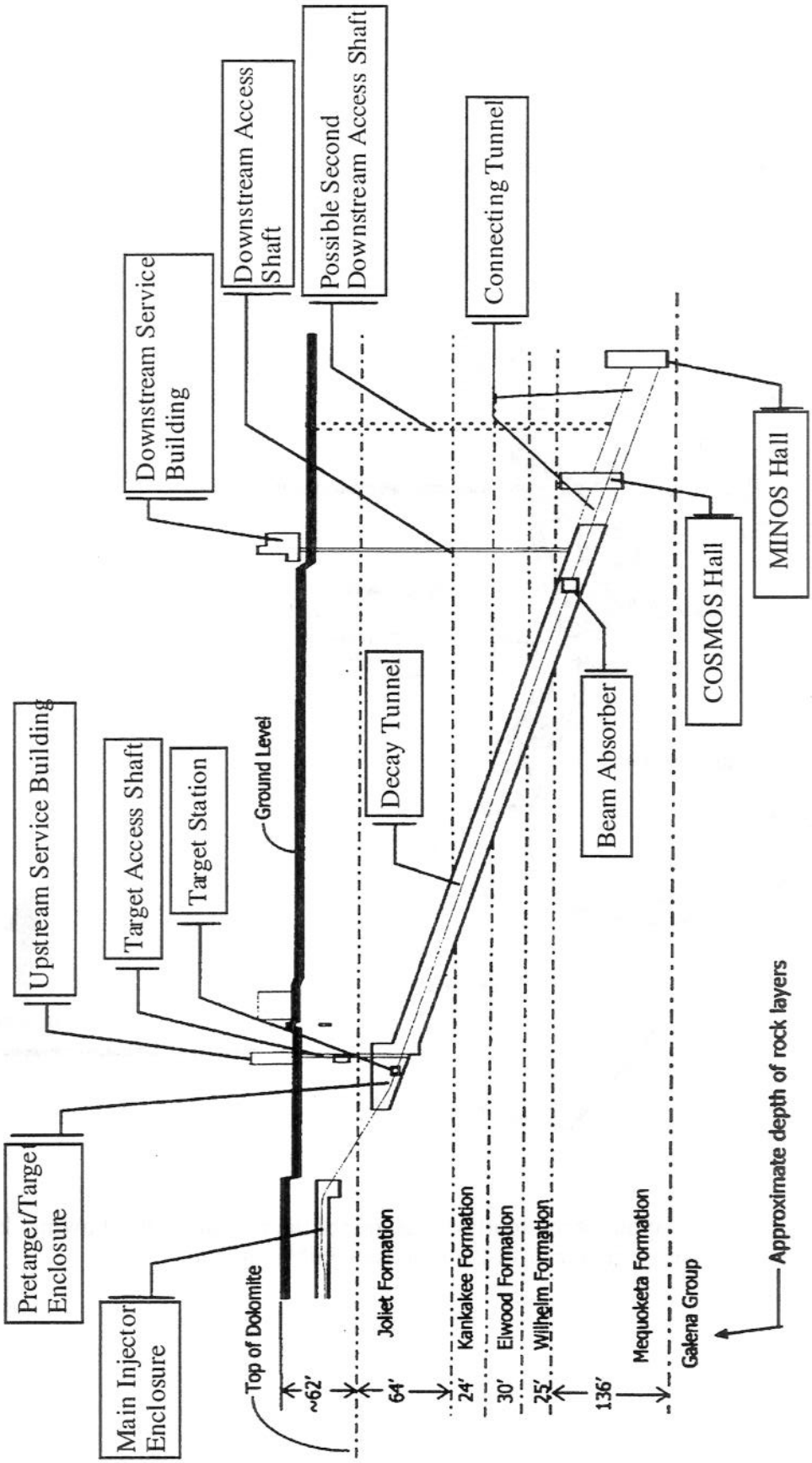


Figure 4.4 Conceptual elevation view of the NuMI facilities planned for the Fermilab site. The black horizontal line represents the ground surface. (Cross section looking west, not to scale.)

The other presently planned experiment, called MINOS, would be specifically designed to provide a long flight path for the neutrinos. For this experiment the neutrinos would need to be detected in two detectors. One would be located at Fermilab and the other in the underground iron mine at the Soudan Underground Laboratory in Minnesota. The neutrinos would travel 730 kilometers through the earth from Fermilab to the iron mine in Minnesota. The neutrinos would emerge from the ground in Minnesota, approximately 12 kilometers (7.5 miles) to the northwest of the Soudan Underground Laboratory at an angle of approximately 3.3 degrees relative to the horizontal. The long intervening distance gives muon neutrinos more opportunity to change type before they reach the detector, allowing experimenters to detect much smaller neutrino masses than in the short baseline (COSMOS) experiment.

The scope of the proposed NuMI Project includes the following elements :

1. Civil engineering, design and construction of beamline tunnels, underground experimental halls and above ground service buildings on the Fermilab site (See Figures 4.2, 4.3 and 4.4), including :
   - Pre-target/Target Enclosure (underground)
   - Upstream Service Building (above ground)
   - Decay Tunnel (underground)
   - Hadron Beam Absorber Enclosure (underground)
   - Downstream Service Building (above ground)
   - Two Experimental Halls (underground)
   - Two or Three Access shafts (above ground to underground)

2. Technical design, construction and installation of the beamline components necessary to safely produce a neutrino beam (see Figures in Appendix C).

3. Design, construction and installation of the COSMOS and two MINOS detectors. The COSMOS detector would be based on **photographic emulsion** and associated detector **chambers**. The MINOS near detector on the Fermilab site would be smaller, but technically similar to the far detector at Soudan. It would consist of many alternating layers of iron and detector chambers.

4. The expansion of existing facilities and construction of a new experimental facility at the Soudan Underground Laboratory at Soudan, Minnesota, to house the MINOS far detector.

The part of the proposed action which occurs at the Soudan Underground Laboratory at Soudan, Minnesota will be discussed in separate sections under "Proposed Action", "Affected Environment" and "Environmental Consequences". These discussions will only highlight the major issues associated with that portion of the proposed action. This is done in an effort to reduce duplication between NEPA and comparable State and local requirements. Appendix A is the environmental assessment of this action, prepared in accordance with State of Minnesota procedures, which is called an Environmental Assessment Worksheet (EAW).

4.1.1 Construction

Figure 4.1 shows a schematic layout of the main Fermilab accelerator complex and the location of the proposed NuMI Project experimental halls (caverns). This figure shows the Tevatron (existing) and Main Injector (presently under construction) accelerators as well as the presently operating areas for conducting experimental physics research called the "Fixed Target Experiments", "CDF", and "D0". The NuMI beamline would be located on the southwest corner of the Fermilab site as shown in Figures 4.2 (NuMI underground structures) and 4.3 (NuMI above ground structures). The experimental halls on the Fermilab site that would house the two experiments associated with NuMI, called COSMOS and MINOS, are also indicated. Figure 4.4 is an elevation view of the proposed NuMI facilities on the Fermilab site.

The proposed project area on the Fermilab site is approximately 1500 meters (4900 feet) long by approximately 50 meters (160 feet) wide and approximately 90 meters (300 feet) deep at the downstream end. The underground parts of facilities constructed as part of the proposed NuMI project would consist of a carrier pipe, (which transports the beam from the Main Injector Enclosure to the pretarget area), pretarget hall enclosure, target hall enclosure, decay tunnel, beam absorber cavern, and the experimental halls (see Figs. 4.4 through 4.8). Two or three access shafts would connect the surface areas with the underground tunnel; one in the target region and one or two near the experimental halls. The access shafts would be used during construction to move machinery and equipment into the underground halls. After construction, these access shafts would be used for personnel and equipment access, electrical cables and ventilation.

During the construction phase approximately 4 hectares (10 acres) would be affected. It is estimated that the construction activities would result in the removal of approximately 63,000 cubic meters (2.2 million cubic feet) of soil or rock. This spoil would be temporarily stockpiled, on the Fermilab site, pending removal by the tunneling subcontractor. It is anticipated that only a small portion of the tunnel spoil would be present on the Fermilab site at any one time.

The area of the above ground portion of the site that is anticipated to be permanently disturbed is approximately 0.8 hectares (2 acres). Structures on the surface would consist of buildings to house the tops of access shafts (two or three), a few small buildings constructed to house some items of equipment needed to conduct the physics experiments and two service buildings associated with the target hall enclosure, the beam absorber enclosure and the experimental halls.

The civil construction involved in the project on the Fermilab site would consist of several phases:

- The preparation and mobilization phase would last approximately six months, and would involve work to prepare the site for construction. During this period survey monuments would be erected, temporary utilities, roads, and stockpile areas would be established, and erosion control would be installed.

- The underground construction phase would last approximately 3 years, and would involve construction of the on-site surface and subsurface elements. A tunnel approximately 6.6 meters (22 feet) in diameter and approximately 1300 meters long (4300 feet) would be excavated to house the various elements of the project. Specifically included would be segments containing the beamline components and two underground experimental halls to house the experimental detectors. Because

of the downward pitch of the beam, the far downstream structure (the downstream experimental hall) would be more than 90 meters (300 feet) underground.

- The final phase of construction would complete the above ground structures, utilities, and roads.

The construction of the proposed NuMI facilities would follow conventional construction practices for both surface construction and for tunneling. For the proposed underground construction both drill and blast and tunnel boring may be used. An upper limit would be set on vibrations and noise to minimize impact on the human environment (see Section 6.1.3).

The tunnel would be sealed to limit water inflow. Concrete and steel shielding would be installed around the beamline, target and absorber areas to keep soil and ground water activation during NuMI operations within limits prescribed by the Fermilab Radiological Control Manual (FRCM, 1997), DOE Orders and U. S Environmental Protection Agency (EPA) Regulations and Illinois Environmental Protection Agency (IEPA) Regulations (see Section 6.2.5).

Utilities, including sanitary sewers, natural gas, and drinking water needed for this facility would be provided by the construction of extensions of the services already present at Fermilab. Some additional services would be needed for the proton beam target system including: water flow and water temperature monitoring, electricity, remote computer controls and communications and radiation monitoring. These elements would be located in a portion of the Fermilab site that has previously been extensively developed. The electrical capacity of the Fermilab site available after completion of the FMI construction project has been evaluated by qualified electrical engineers and is sufficient to meet the demands of the proposed NuMI project (see Section 6.2.4).

4.1.2 Operation

Operation of the proposed NuMI beamline and experiments on the Fermilab site would comply with standard Fermilab safety and beam operations procedures and guidelines (FRCM, 1997). These procedures are based on the principle of As Low As Reasonably Achievable (ALARA) in the area of radiation protection. Beam **interlock** safety systems, management-approved running conditions, beam permits, and on-shift operations personnel would be required for NuMI beam operation. A Safety Assessment Document would also be written and approved before operation of the beamline.

The NuMI beam intensity would be maintained within normal operation levels approved by the Laboratory Director in accordance with the Fermilab Radiological Control Manual. Normal operation of the NuMI primary proton beam would be approximately 4 trillion (4×10^{13}) protons per pulse. The beamline, target hall enclosure and absorber would all be adequately shielded to accept off-normal beam conditions in which the entire FMI beam is delivered to NuMI. These conditions are discussed in Section 6.3. The operation of the proposed NuMI facilities would generate some releases such as small amounts of radioactive air emissions and releases to soils (see Section 6.2.5). Sealing portions of the tunnel walls would limit seepage into the tunnel. The water pumped from the tunnel during operation is anticipated to be approximately 100 gallons per minute (see Section 6.1.4)

Some radioactive beamline components in the course of normal operations would, from time to time, need to be replaced. The proposed NuMI beamline is being designed to limit

the radiation **doses** that personnel might receive in such situations. Some low level radioactive wastes would be generated as well (see Section 6.2.5.6).

4.1.3 Decommissioning

The facilities constructed as part of this project would eventually need to be decommissioned. Fermilab has established specific, written policies and procedures for creating and maintaining proper documentation for all facilities in order to facilitate their transfer to other uses in the future (FESHM, 1997). Information necessary for the future decommissioning of the proposed NuMI project would be maintained in compliance with these policies. Decommissioning activities associated with the proposed NuMI project are difficult to define in detail at the present time. They depend on the future use of the NuMI beamline and experimental hall, which would depend on the goals of the physics research program as established by the Department of Energy in the future. The apparatus, beamline, and experimental hall could be used for future experiments at their present location. It is presently anticipated the experimental apparatus would be of use well into the 21st Century. New projects would require appropriate review under the National Environmental Policy Act.

4.1.4 Proposed Schedule

NuMI would be the only major construction activity on site at Fermilab from 1999 to 2001. The following schedule is proposed (in calendar years) for the Fermilab portion of the proposed action:

- Conceptual Design work would begin in late 1997 and continue through 1998.
- Site preparation for tunnel excavation would be completed during 1999.
- Tunnel construction would start late 1999 and be completed by mid-2000.
- Some of the experimental components would be procured, staged in an existing laboratory assembly building in 1999 and 2000, and tested prior to installation.
- The remainder of construction would take place during 2001.
- Commissioning could begin in late 2001 and operation of this facility as a laboratory for physics research would occur thereafter.

4.1.5 New or Modified Permits and Licenses

Fermilab currently holds a National Emissions Standard for Hazardous Air Pollutants (NESHAP) permit issued by the Illinois Environmental Protection Agency (IEPA, 1996), for radionuclide emissions stacks associated with the operation of the Tevatron accelerator, including the Fermilab Main Injector (FMI). Requirements pertaining to such emissions are specified by Federal Regulations (40 CFR 61). The additional emissions of radionuclides due to operations of the proposed NuMI project would require that Fermilab apply for approval to construct an air pollution source and a modification to the existing operating permit.

A new National Pollutant Discharge Elimination System Permit (NPDES) issued by the Illinois Environmental Protection Agency would be needed to address stormwater runoff

from the construction site. The need for modifying Fermilab's present NPDES permit for discharges of commingled non-process, non-contact cooling water (IEPA, 1994) to operate a treatment works for non-process, non-contact cooling water would be evaluated as the detailed design proceeds in order to assure compliance with IEPA requirements (35 IAC 309).

4.1.6 The Soudan Underground Laboratory Facility

The facilities to house one of the two particle detectors that would be part of the MINOS experiment would be constructed as an addition to the Soudan Underground Laboratory in northern Minnesota. The new experimental hall that would be excavated to house this detector would require the removal of approximately 17,000 cubic meters (22,000 cubic yards) of rock. New experimental apparatus would be constructed and installed in this experimental hall. The main environmental issues associated with this action concern the present population of bats in the mine and the material removed in the course of the excavation.

It would take a minimum of two years to complete the facility, depending on funding. It is proposed that the Soudan cavern excavation would begin in April 1999. The installation of apparatus in the cavern would begin in January 2001. The operation of this part of the MINOS experiment would be concurrent with operations of the NuMI beam at Fermilab (see Section 4.1.4).

Decommissioning of this facility as part of the NuMI project would result in its further utilization for experiments that do not involve the operation of particle accelerators. If at that time there is no further identified need for this facility, then the cavern constructed for NuMI would be incorporated into the remainder of the former iron mine used for the Soudan Underground Laboratory, which is maintained as a historic restoration by the State of Minnesota.

4.2 Alternatives and their Impacts

4.2.1 Construction at Other DOE Facilities

When it became obvious that the study of neutrino oscillations could be an important tool to use to better understand fundamental science, the various accelerator facilities in the United States began considering how they might perform experiments to study this exciting problem. By 1995 there were two major facilities, Brookhaven National Laboratory and Fermi National Accelerator Laboratory, which had developed sophisticated plans for beamlines and associated experiments to examine the subject of neutrino oscillations. To decide which facility could best address the subject, HEPAP (HEPAP, 1995) organized a special sub-panel to visit each of the facilities to examine their capabilities and to listen to the facts presented by each to promote their selection.

After visiting each site, this HEPAP sub-panel decided that Fermilab had a more far-reaching proposal to both discover and study the existence of the phenomenon of neutrino oscillations. The versatility of the Fermilab proposal, with two beams, two experiments and three detectors, led to its eventual selection as the preferred alternative, with construction at other DOE facilities thus not preferred.

Construction at DOE facilities, other than Brookhaven National Laboratory, would require the construction of an entire accelerator complex (see Section 4.2.2).

4.2.2 Construction of a Completely New Facility

Construction of a completely new accelerator facility, solely devoted to this research, would require a site of approximately 700 hectares (1700 acres, approximately one fourth of the size of the present Fermilab site). A complete accelerator complex capable of accelerating protons to approximately 150 GeV kinetic energy and a neutrino beamline and experimental halls would need to be built. This would necessitate large scale civil construction in a new location with commensurate impact on the environment. The other impacts due to the production of radiation and **radioactivity** would be approximately the same as those associated with the chosen site. This would result in a much larger environmental impact than would the proposed NuMI project.

4.2.3 Construction at Extraction Points Other than MI-60

Several extraction points located around the circumference of the FMI were considered besides MI-60 (see Figure 4.2). The design of the FMI accelerator allows for extraction of the proton beam only at selected locations; these being MI-40, MI-52, and MI-60. MI-60 is preferred since equipment necessary to extract beams from the Main Injector for its other designed uses will already be installed at that location. This equipment could be used in the extraction of the protons for NuMI. The use of a different extraction point would require significant civil construction in jurisdictional wetlands and additional cost for installing beam extraction components.

4.2.4 Construction Within the Existing Fixed Target Areas at Fermilab

The COSMOS experiment could, with modifications, be accommodated within the present Fixed Target Experimental Areas at Fermilab. This choice would avoid construction of the long underground decay tunnel (see Figure 4.4). However, this choice, while viable for COSMOS, would preclude simultaneous operation of the MINOS experiment since the neutrinos would not be directed toward the Soudan Underground Laboratory. Thus the range of neutrino oscillations that could be explored would be substantially reduced.

This alternative would require the installation of an additional beam extraction system from the Main Injector and it would limit the future use of the Fixed Target areas. The amount of above-ground construction required for this alternative would be approximately equivalent to that associated with the preferred choice at MI-60. Operation within the existing fixed target areas would result in the delivery of more ionizing radiation to outdoor areas in the vicinity of the facility relative to those expected for the proposed site. This is due to the fact that less shielding would be present given the proximity to the surface. The releases of airborne radionuclides would also be larger, relative to the proposed site, because of the much shorter pathway to the outdoor environment which would allow less time for radioactive decay.

4.2.5 Construction of a New Far Detector Facility

The neutrino physics to be done requires that the far detector experimental backgrounds be extremely low, and that it be hundreds of kilometers distant from Fermilab. The Soudan Underground Laboratory is the only existing facility that meets these requirements. It is 730 Km from Fermilab and approximately 1 km underground. The depth helps make the experimental backgrounds low since the detector is shielded from cosmic rays. The Soudan Underground Laboratory has been used for a number of years for physics experiments, and it is therefore already equipped with the support facilities needed for the far detector of the MINOS experiment. Construction of an entirely new facility would be much more costly and could result in a more significant environmental impact due to the need to construct a complete support infrastructure in addition to the excavation.

4.2.6 No Action Alternative

The no action alternative would mean that the achievement of the scientific goals for the studies of neutrino oscillations would not be possible in the U.S. in the near future. There is no other known method by which the topic of particle physics addressed by this project can be explored. This alternative would not fulfill the objectives of the U. S. High Energy Physics Program as identified by HEPAP (HEPAP, 1995).

There would be no environmental impacts from implementing the no action alternative. The present research program being conducted on the Fermilab site would continue, as modified by the ever-changing needs and scientific goals of the particle physics research community. At the Soudan Underground Laboratory, this alternative would also leave the human environment at that location essentially unchanged.

5 THE AFFECTED ENVIRONMENT

5.1 Site Description and Land Use

The proposed action would involve the expansion of existing facilities at the Soudan Underground Laboratory as well as construction of new experimental facilities at both Fermilab and the Soudan sites. The region between Fermilab and the Soudan Underground Laboratory would not be affected by the construction, operation, or decommissioning of the proposed NuMI facility.

The Fermilab site is located 38 miles (61 kilometers) west of downtown Chicago, Illinois. Its 6800 acres (2750 hectares) 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 (11,220 population), to the west is Batavia (17,076 population), to the north is West Chicago (14,796 population), and to the south is Aurora (99,581 population. Figure 1.1 shows the location of Fermilab in the greater Chicago area.

Immediately adjacent to the proposed Fermilab NuMI Site and to the east are previously developed areas that include the 4 mile circumference underground accelerator ring (Tevatron), the Anti-Proton Area, the Lederman Education Center, the Prairie Interpretive Trail and the Central Laboratory Area. To the southwest lies the newly constructed Main Injector Ring and remedied wetlands. None of these areas would be impacted by the proposed activities. The below-grade structures for the proposed NuMI beamline would be constructed in areas previously disturbed by farm activities and currently consisting of undeveloped remnant woodlands and old fields of non-native grasslands and scrub plant communities. During construction of the proposed NuMI project at Fermilab approximately 10 acres (4 hectares) would be affected with ultimately only 2 acres (0.8 hectares) permanently changed.

5.2 Air Quality

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 per cent. The average wind velocity is typically 3 meters per second (6.7 miles per hour). The average annual precipitation at Fermilab ranges from 76 to 89 centimeters (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 Fermilab site is within an ozone-nonattainment 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 debonding oven (IEPA, 1996).

5.3 Geology and Groundwater

A number of studies have documented the subsurface characteristics in the vicinity of the Fermilab site (Rust, 1996, Visocky, 1988, and Visocky, 1995). The upper geology at Fermilab consists of glacial deposits (Glacial Till) from the Wisconsin Episode of glaciation overlying bedrock of Silurian-age dolomite (see Figure 4.4). The glacial deposits are predominantly subglacial and ice-marginal deposits, mainly fine to medium grained,

massive, **diamicton**, composed of a silty clay matrix with varied amounts of non- to poorly sorted, coarse gravel. The glacial deposits vary in thickness from 18 to 30 meters (60 to 100 feet) over the Lab. There are some localized, sorted sand and gravel within the individual diamictons, but none that appear to be continuous layers between individual diamictons. The lowest diamicton, which is generally less than 10 feet thick, can contain sorted sand and gravel. The Maquoketa shale, which underlies the Silurian-age dolomite, acts as a regional confining unit. Specific studies would be performed to further characterize the subsurface conditions in the impacted areas prior to the commencement of construction (STS, 1997).

Even though recharge to the upper bedrock aquifer (located within the Silurian-age dolomite) does occur from the glacial deposits, ground water movement through these deposits is very slow. Because of the sporadic occurrence of localized higher permeable regions and the existence of extensive, undocumented drain tile lines from past agricultural use, localized predictions of ground water flow can be difficult. Ground water flow in the glacial deposits is generally downward. The water table fluctuates seasonally between 1.5 - 4.6 m (5 and 15 feet) below the ground surface. The upper 9 m (30 feet) of the Silurian-age dolomite formation, which is connected locally to the lower sorted, diamicton, can yield sufficient quantities of water for private production wells.

The direction of natural ground water flow in the upper bedrock aquifer beneath Fermilab is generally toward the south/southeast. Flow is heavily influenced, however, by ground water extraction wells used to supply drinking water to the majority of the site. These wells are 220 feet deep and are drilled into the shallow Silurian aquifer system.

5.4 Surface Water

The Fermilab site is relatively flat as a result of past glacial action. The highest area, with an elevation of 244 m (800 ft) above mean sea level is near the northwestern corner. The lowest point, 218 m (715 ft) above mean sea level is toward the southeast. There are three watersheds that collect water on site. Most of the Fermilab surface water runoff is to the southeast 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.

Fermilab holds several NPDES (National Pollution Discharge Elimination System) permits that regulate the discharge of liquid effluent to surface water bodies and to publicly owned treatment works in Batavia. One permit governs discharges of commingled non-process, non-contact cooling water and stormwater runoff to surface waters through outfalls to Kress, Indian and Ferry Creeks (IEPA, 1994). Additional NPDES permits have been held for the stormwater discharges associated with construction activities involving greater than 5 acres and a pretreatment process.

5.5 Waste Generation and Disposal

Fermilab presently generates approximately 15 cubic meters of regulated chemical waste annually. These wastes are typical of light industrial operations and are disposed of in accord with DOE, state and federal regulations. Fermilab has implemented a program to minimize the generation of theses wastes in accordance with the Resource, Conservation, and Recovery Act. Operation of existing accelerators at Fermilab results in the generation of a similar volume of low level radioactive wastes annually. Fermilab disposes of the radioactive wastes at specified DOE disposal facilities outside of the State of Illinois. Approximately 6000 cubic meters (210,000 cubic feet) of solid wastes, other than regulated chemical wastes and low level radioactive wastes, are also generated annually and disposed

of in local sanitary landfills. No waste is disposed on the Fermilab site. All wastes leaving the site for disposal are packaged in accordance with Department of Transportation (DOT) regulations.

5.6 Sensitive Resources

Fermilab has conducted comprehensive surveys for prehistoric and historic sites within its boundaries (Lurie, 1990, Bird, 1991, Schaffer, 1993). No archaeological or historical resources were found in the proposed NuMI project area so that there would be no impact on such resources from the NuMI project.

The mixture of vegetational 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 U. S. Fish and Wildlife Service has been consulted to determine if the potential exists for the presence of Federal endangered or threatened species within the NuMI project area on the Fermilab site. The Illinois Department of Natural resources has also been consulted to determine if the potential exists for the presence of State endangered or threatened species within the NuMI project area. Appendix B 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 NuMI project 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. A qualified expert has assessed the NuMI project area for jurisdictional wetlands (CTE, 1997). One small jurisdictional wetlands area was identified in the vicinity of the NuMI project. The effect on this wetland is addressed in Section 6.1.7.

It has also been determined that the proposed NuMI project would have no impact on the 100 year Floodplain for Indian Creek as determined by reference to information provided by the Federal Emergency Management Agency (FEMA) (FEMA, 1982).

5.7 Occupational Safety and Health

Most of the occupational hazards at Fermilab are not unusual. Two exceptions are ionizing radiation and oxygen deficiency. Radiation exposure may occur from radioactive materials as well as from particles scattered from the beam during accelerator operation. Exposures are controlled through design of facilities and equipment. When an area has an increased **dose** rate, warning signs are posted and personnel are provided with training and radiation monitoring devices. Access to areas with higher dose rates is strictly controlled using physical barriers and secure access control hardware. Personnel working near cryogenic systems such as superconducting magnets are exposed to a risk of oxygen deficiency. If there is a leak, the escaping liquefied gas will expand 700 times and push out surrounding air. A quantitative risk analysis is used to prescribe precautions necessary to reduce the chance of fatality to an acceptable level. These precautions include posting of warning signs, training, medical surveillance, and oxygen monitoring. These procedures would be followed to mitigate the comparable hazards that would be associated with NuMI construction and operation (FESHM, 1997). It is not completely determined if cryogenic

hazards to personnel in the NuMI tunnel would be present. Similar procedures would be followed to mitigate the hazards associated with NuMI construction and operation if such hazards are included in the project (FESHM, 1997).

Most other occupational hazards can be characterized as typical of general industry. These include manual material handling, powered lifting equipment, wood/metal working equipment, electricity, pressurized gas, chemicals, and noise. In fact, the most common occupational injuries involve material handling (back/shoulder injuries, items dropped onto workers, etc.) and slips/falls. Fermilab has a broad spectrum of programs to address these problems including protective devices, inspections, "environmental" monitoring, incident tracking, policies, training, and in-depth reviews. An attempt is made to evaluate and correct hazards during the earliest stages of an operation. These practices would be applied during the course of the NuMI project construction and operation.

Fermilab's program for implementing environment, safety, and health requirements is stated in the Fermilab Environment, Safety, and Health Manual (FESHM, 1997). This document implements Federal and State requirements as well as best management practices. Policies that address ionizing radiation hazards are found in the Fermilab Radiological Control Manual (FRCM, 1997). Fermilab has implemented a program for keeping radiation exposures to its employees as low as reasonably achievable (ALARA). A cornerstone of this program is Fermilab's self-imposed guideline of limiting annual radiation exposures to workers to less than 25,000 microSieverts (2500 mrem). In the 17 years that this limit has been in place, it has never been exceeded. In fact, it is rare for an annual dose to an individual to exceed 5000 microSieverts (500 mrem). The annual collective dose to Fermilab employees is presently approximately 250,000 microSieverts (25,000 person-mrem) to the 1500 radiation workers at Fermilab.

The construction and operation of the proposed NuMI project would result in no occupational safety and health hazards that are markedly different from that associated with present Fermilab operations with the singular exception of those associated with underground tunneling operations (see Section 6.1.2).

5.8 Socioeconomic Issues

Fermilab has approximately 2000 employees, and 1400 experimenters from all over the world who use the facilities. Most of the employees are located in a large office building, Wilson Hall, approximately 1.6 km (1 mile) east of the proposed NuMI construction. The experimenters work primarily in the areas in Fig. 4.3 labeled "Fixed Target Experiments", "CDF", and "D0". Approximately one hundred experimenters would work on the proposed NuMI experiments (COSMOS and MINOS), principally at the experimental halls that would be built on the Fermilab site. The overall number of scientists who conduct research at Fermilab is not anticipated to change significantly from present levels. On an annual basis, 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. The closest residences to the proposed NuMI project are approximately one km from the proposed site.

Operation of the Fermilab Accelerators and associated beamlines produce ionizing radiation such as muons. Beamlines and experiments are designed so that most of the muons remain under the ground surface, however some remain above the surface and present a small potential for radiation dose. Annual doses to members of the public are limited to 100 microSieverts (10 mrem/year) due to Fermilab operations.

5.9 The Soudan Underground Laboratory Facility

The Soudan Underground Mine is part of a 1200 acre state park in Minnesota. The park, which includes a museum, provides opportunities for visitors to tour the mine, buildings, and machinery of a historic mining site. The mine area of the park includes the underground mine, buildings, roads, and parking lots, abandoned surface mine pits, and waste rock piles. The Minnesota Department of Natural Resources has prepared a separate environmental assessment, which is incorporated into this assessment as Appendix A, that evaluates the potential environmental impacts of the construction and operation of the proposed Soudan facility. Figure 1.2 is a regional map showing the locations of Fermilab and the Soudan Underground Laboratory.

Significant numbers of hibernating Little Brown Myotis, Northern Myotis, and Eastern pipistrelle bats were found in a recent survey of the Soudan Mine (Altenbach, 1996). The Northern Myotis and Eastern pipistrelle are listed species of Special Concern by the State of Minnesota. The mine is considered an important hibernation site. Regions of the mine well removed from the proposed disturbance are used by bats and could accommodate far more bats. The species can move at least once during the hibernating season. The disturbance of these bats is discussed further in Section 6.4.

More information can be found in the Minnesota EAW in Appendix A.

6.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

This section describes the anticipated environmental consequences of the construction, operation, and decommissioning of the proposed action and alternatives. The main environmental issues have been identified and are addressed in detail.

The region between Fermilab and the Soudan Underground Laboratory would be unaffected by the construction, operation, or decommissioning of the NuMI facility since no excavation is required in that region. Neutrinos rarely interact with material, and therefore do not need to travel through a vacuum pipe. For the same reason, they do not activate material in this region either. The NuMI neutrinos would ultimately emerge from the Earth's surface in northern Minnesota, approximately 12 kilometers (7.5 miles) to the northwest of the Soudan Underground Laboratory.

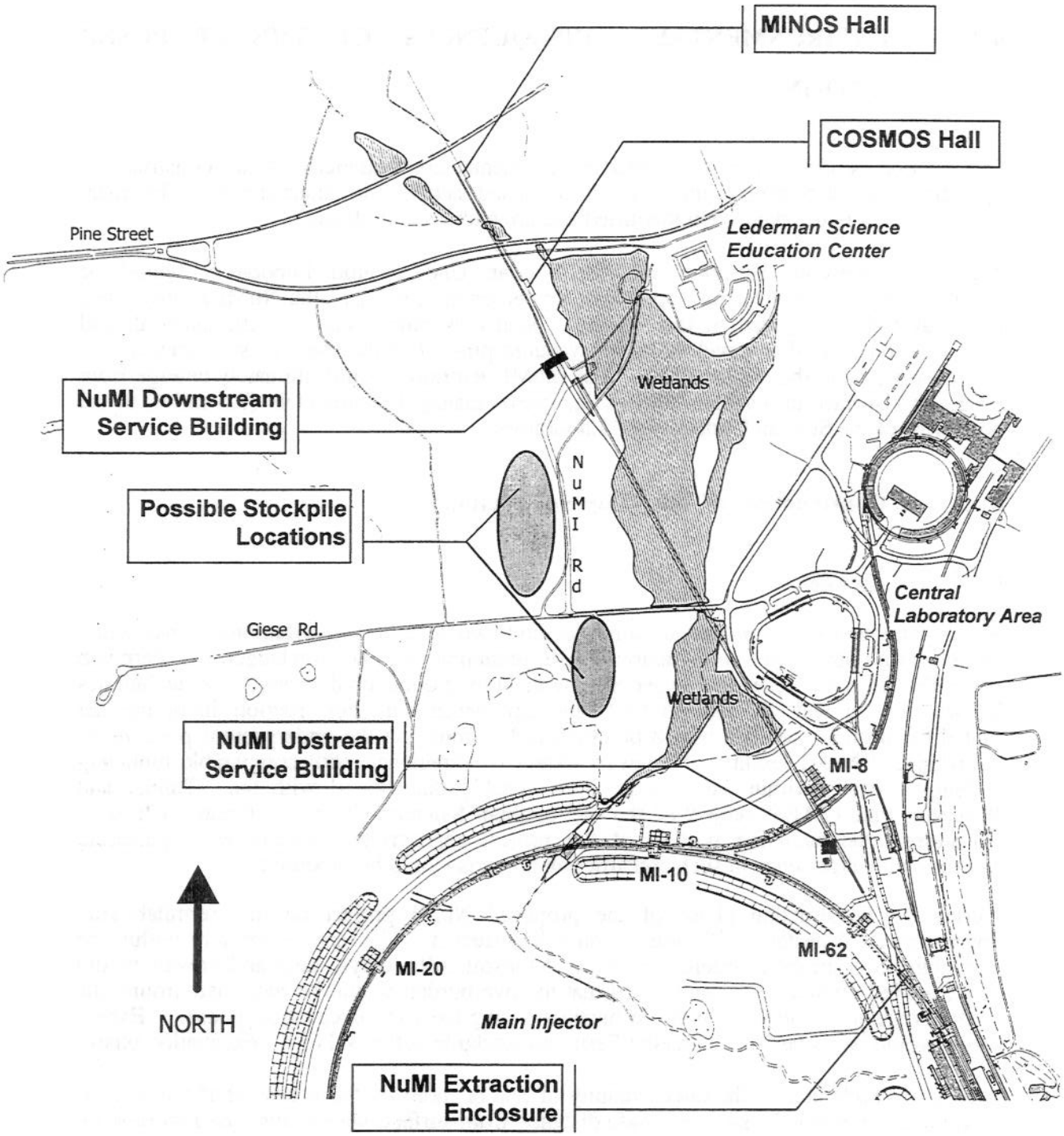
6.1 Construction of the Proposed Action

6.1.1 Excavation

The construction of the proposed NuMI facilities would follow conventional construction practices for both surface construction and for tunneling. It is acknowledged that Fermilab presently has rather extensive experience with underground civil construction techniques known as "cut and fill" but no first-hand experience with construction involving the tunneling through rock that would be employed to construct the underground portions of the proposed NuMI facility. However, extensive experience with comparable tunneling techniques exists within the Chicago area, notably that gained with the Tunnel and Reservoir Plan (TARP) project of the metropolitan Sanitary District of Greater Chicago. To address the tunneling portion of the project appropriate, experienced engineering services with experience in such construction projects would be procured.

During the construction phase of the proposed NuMI project on the Fermilab site, approximately 4 hectares (10 acres) would be affected. This area is entirely within the Fermilab site. The overburden, consisting of topsoil, silts, clays, sand and gravels would be stockpiled on site. It is anticipated that the overburden would be mounded around the shafts, vegetated, and used as noise barriers during the rock excavation phase. Excess spoils would be moved to an existing Fermilab stockpile at the end of the excavation phase.

A rock stockpile area in the direct vicinity of one or more of the access shafts would be established. It would be situated a safe distance from surface waterways (see Figure 6.1). The stockpile areas have been evaluated as part of the project and thus their impacts are also covered in Section 6.1.5 and 6.1.7. Rock stockpile areas are anticipated to contain approximately 10 days of spoil or approximately 10,000 - 20,000 cubic yards. The total area of the stockpile would be less than three acres. The rock would be held for five to seven days so that excess moisture could be removed prior to transport. The stockpile areas would be located on future parking, building or hardstand sites or returned to their original condition.



PARTIAL PLAN

No Scale

Figure 6.1 Schematic layout of the southwest corner of the Fermilab site showing the above grade components of the proposed NuMI project

The rock spoil would most likely be moved by truck. Rock used on other construction projects on the Fermilab site has been transported by truck. The maximum number of trucks (12 yard trucks) transporting rock would be about 240 per day or 30 per hour in an 8 hour shift. The Main Injector and other recent Fermilab projects have had concrete deliveries near this limit for several hours without adversely affecting traffic patterns. This level of truck traffic would not represent a significant increase on the surrounding roadways.

Table 6.1 lists the below grade structures that would be built for the proposed NuMI project on the Fermilab site, approximate dimensions and volumes are given. Excavation work done in the till and rock would be noisy and would create vibrations, especially if blasting were involved (see Section 6.1.3).

Table 6.1 Listing of below Grade Structures that would be Constructed as Part of the Proposed NuMI Project on the Fermilab Site (along with their Approximate Volumes and Dimensions).

Structure	Approximate Dimensions (meters)	Approximate Volume (cubic meters)
Carrier pipe	0.30 m radius, 91 m long	26
Pretarget Enclosure	2.4 m wide, 2.4 m to 4.5 m high, 46 m long	330
Target Enclosure	6.7 m wide, 4.3 m to 6.4 m high, 61 m long	2100
Target Access Shaft	12 m wide, 12 m long, 33 m deep	4800
Decay Tunnel	3.3 m radius, 853 m long	29,000
Beam Absorber Hall	3.3 m radius, 30 m long	1030
Tunnel from Decay Tunnel to 1st Experimental Hall	3.3 m radius, 183 m long	6300
Upstream Experimental Hall (COSMOS Hall)	15 m wide, 15 m high, 26 m long	5900
Tunnel from Upstream Experimental Hall to Downstream Experimental Hall	3.3 m radius, 183 m long	6300
Downstream Experimental Hall (MINOS Hall)	15 m wide, 15 m high, 26 m long	5900
Downstream Access Shaft	2.3 m radius, 61 m deep	1000
possible 2nd Downstream Access Shaft	2.3 m radius, 91 m deep	1500
Total		63,000

The area of the above ground portion of the site that is anticipated to be permanently disturbed is approximately 0.8 hectares (2 acres). Structures on the surface would consist of buildings to house the tops of access shafts, a few small buildings constructed to house some items of equipment needed to conduct the physics experiments and service buildings associated with the target hall enclosure, the beam absorber enclosure and the experimental halls. The major above ground structures are listed in Table 6.2 (and shown in Figure 4.3 and 6.1) along with their approximate dimensions.

Table 6.2 Listing of above Grade Structures that would be Constructed as part of the NuMI Project (along with their approximate surface areas).

Structure	Approximate Dimensions (meters)	Approximate Area (square meters)
Target Service Building	19 m long, 21 m wide	400
Experiment Service Building	13 m by 31 m and 9 m by 26 m (L-shaped)	650
Total		1050

During the construction phase of the proposed NuMI project, equipment would only be operated along defined construction roads or access routes and no overland hauling or off-path travel would be permitted. Access to the Fermilab site for material and equipment would usually be from the South on Kautz Road (see Figure 4.1). The Kautz Road gate would be open from about 6:00 AM to about 6:00 PM. Truck traffic would be routed from the project site, south on Kautz Road to Route 56 which is a designated truck route with similar traffic. Route 56, Kirk Road and Roosevelt Road are designated truck routes. The subcontractor would be required to construct hardstand areas for the storage of construction equipment and materials as well as parking areas for their employees. These areas would be located such that they would not impact any wetlands. The maximum work force would not be expected to exceed 200 people per shift. This number is less than Fermilab's normal fluctuations due to summer employment and thus would not represent a significant effect on on-site traffic.

The main environmental issues associated with the excavation quantities are the stockpile and the transportation/traffic associated with moving the stockpile(s). The stockpile(s) would be less than 20,000 cubic yards and the truck traffic associated with moving the stockpile(s) would be less than 240 trucks per day. Neither of these would have a significant effect on the environment. Other issues associated with the excavation (noise, air quality, water, etc.) are covered in the following sections.

6.1.2 Occupational Safety and Health

All construction activities would be conducted in accordance with applicable State, Federal, and Local regulations to assure safety to workers and the public and to provide protection for the environment. Fermilab employees, visitors and experimenters, and members of the public would not be impacted by the construction activities as these areas would be restricted to construction workers and those Fermilab and U. S. Department of Energy employees who would be engaged in the administration and monitoring of construction activities. Protection of the latter individuals would be assured through conformance to standard construction safety Regulations promulgated by the U. S. Occupational Safety and Health Administration (29 CFR 1926).

Given the nature of the tunnel excavation, specific expertise, which is abundant in the Chicago area and elsewhere, would be obtained to assure the safety of worker and the public during these operations.

Excavation activities at the proposed site, except for the connection to the Fermilab Main Injector, would be conducted in areas where levels of ionizing radiation are comparable to natural background levels. Those construction activities associated with the connection

with the Fermilab Main Injector would be conducted in accordance with the applicable Federal Regulations and U. S. Department of Energy Orders concerning radiological protection (10 CFR 835, DOE 5400.5). The protection of workers during the construction phase would specifically consider radiation exposure to radon gas.

The "unique" main concerns to personnel during construction are those due to the tunneling and the connection with the Fermilab Main Injector. To help address the safety concerns of the tunneling part of the project appropriate, experienced engineering services would be procured. Such tunneling operations are commonly performed in the Chicago area and the requisite expertise is readily available.

6.1.3 Air Quality and Noise

Movement of this excavated spoil would result in the movement of up to about 240 truckloads of material per day during a construction period that would last for approximately 36 months. The noise levels would be indistinguishable at off-site locations from that due to the normally large volume of traffic on Kirk Road, the major north-south arterial highway that is parallel to the western boundary of the Fermilab site.

Tunnel construction is estimated by assuming the work would be done in two ten hour shifts with a four hour maintenance period. Construction noise levels, not associated with drill and blast, would be typical of those associated with previous construction activities on the Fermilab site. This would consist of noise due to the occasional operation of excavating equipment, trucks, and cranes. Miscellaneous automobiles and light duty trucks would also be used. The location of all construction activities associated with the proposed NuMI project would be more than 600 meters (2000 feet) away from the nearest offsite location. The noise levels due to construction (other than blasting) at this point on the boundary of the Fermilab site, based on similar experience with other projects, would be quite low.

One of the sources of concern is the noise and vibration due to drilling and blasting, especially in areas near the access shafts. There are several methods to reduce blasting vibrations and ground movements. Data from seismic monitoring instruments would be used to modify blasting rounds as necessary. The US Bureau of Mines determined that a ground motion velocity of 50 mm (2 in.) per second is considered the point at which damage can start to occur for blasting at frequencies of 40 Hz or more (USBM, 1987). Experience from TARP (Tunnel And Reservoir Plan for the metropolitan sanitary district of greater Chicago) is that people are highly sensitive to noise and vibration in the frequency range associated with blast vibrations and thus the peak particle velocity for blasting was reduced to 19 mm (0.75 in.) per second (Rajaram, 1991). For the proposed NuMI project, the goal would be to limit the peak particle velocity for blasting to 19 mm (0.75 in.) per second or less at the site boundary (approximately 0.7 km distant). The corresponding peak particle velocity would be lower at the nearest residences (approximately 0.8 km distant). Monitoring would be used to protect the public against undesired levels of noise and vibration.

During construction there would be minor, short-term, localized impacts on air quality from vehicular traffic and earth-moving operations. To the maximum extent practical, dust would be controlled by established engineering practices, chiefly by water sprinkling of all distributed earth surfaces and earth stockpiles. Exhaust fumes, such as hydrocarbons, from construction traffic and internal combustion equipment used at the construction site, should be rapidly dispersed. Dust conditions would be controlled by the Subcontractor to insure a healthful environment for all workers. Standard techniques, including the application of water, would be used to control the dust evolved in the course of performing

the excavation. The techniques would be those successfully employed in the Chicago area to control dust created during similar tunnel excavation operations.

Noise and vibrations would be monitored to ensure that the environmental impacts are negligible in that regard. Air quality would be minimally affected by the construction activities.

6.1.4 Groundwater

Based on the available groundwater characterization data, the proposed NuMI tunnel system, if left totally ungrouted, would have an estimated inflow of several hundred to a few thousand gallons per minute. Care would be taken in the detailed planning of construction to incorporate standard industry practices associated with tunnel excavation activities in order to assure that excessive water volume would not enter the tunnel in order to both facilitate tunnel construction and also to prevent significant reduction on water table levels in neighboring wells, both on and off of the Fermilab site.

Experience on the TARP tunnels has shown that high initial inflows tend to decrease with time to become lower sustained inflows (Fluor, 1997). Extreme water flows would be remediated immediately. Otherwise, grouting would start one or two days later in order to allow the flow rate to stabilize. Experience with TARP also indicates that inflow into the proposed NuMI tunnel would be substantially reduced by grouting fractures, which are expected to cover less than 5% of the tunnel walls. After doing this, the final dewatering rate would be less than about one hundred gallons per minute, the equivalent of the flow in a fire hose connected to an open fire hydrant. This rate would have no significant impact on local wells.

Specific studies would be performed to further enhance the characterization of the subsurface conditions prior to the commencement of construction. This would be done largely to obtain a detailed understanding of issues associated with both civil construction and groundwater protection order to safely design the tunnel.

In summary, groundwater would not be affected by the construction of the proposed NuMI project as the tunnel would be grouted to limit inflow. This condition should serve to prevent contamination of groundwater during construction.

6.1.5 Surface Water

It is expected that the proposed action would create some potential for erosion during construction activities. Erosion and sediment controls would be instituted as part of a Stormwater Pollution Prevention Plan according to guidance from the Illinois Environmental Protection Agency (IEPA, 1987). Proper soil erosion barriers would be erected and maintained around all rock stockpile areas. A combination of silt fences, hay bales and excavated temporary waterways would be used to direct stormwater away from wetlands and sensitive resources and to detain water long enough for the sediment to settle prior to flowing into surface water. Figure 6.1 shows the proposed locations of the temporary stockpiles relative to the wetlands and other surface water features.

Surface discharges associated with the construction of the proposed NuMI project would be evaluated in accordance with State and Federal Regulations concerned with the discharges of surfaces waters (35 IAC 309). Some permit modifications may be indicated (See Section 4.1.5). The water flowing into the tunnel, discussed in Section 6.1.4, would be brought to the surface for discharge. Discharged water would be detained to moderate the flow rate into waters of the State. The water would most likely either be discharged

into the Main Injector ponds or into ditches leading to Swan Lake. The current structures that retain water during heavy storms in these two systems would function for these flows easily. Once flow rates stabilize and grouting is applied, the rate at which water would be pumped from the tunnel to the surface would be less than about one hundred gallons per minute. This rate would increase the average flow rate in Indian Creek, where the surface drainage flows to in this region, by approximately 20%.

The impact on the surface waters during construction would be small as good erosion control would be practiced and the amounts of water discharged to the surface waters would be controlled.

6.1.6 Waste Generation and Disposal

A suitable portion of the rock spoil may be recycled for use on the proposed NuMI project, in particular for the backfill over the target and pretarget area, hardstand areas, and under building slabs. Where possible, the new beamline would use components from other beamlines at Fermilab which no longer require them. Off-site disposal of clearing and grubbing debris, demolished building material, vegetative matter, trash, rubbish and all waste material would be in accordance with the requirements set forth by the Resource Conservation and Recovery Act (RCRA), Toxic Substance Control Act (TSCA), 40 CFR Parts 262-265 and Illinois Administrative code Title 35, Sub-title G - Waste Disposal. All materials would be surveyed for possible contaminants before being removed from the Fermilab site. Fermilab typically generates approximately 15 cubic meters (530 cubic feet) of regulated chemical waste annually. The proposed NuMI project construction would not significantly increase this quantity of wastes. These wastes would be those typical of light industrial operations and are disposed of in accord with state and federal regulations.

6.1.7 Sensitive Resources

It has been determined that the project would have no impact on any 100 year floodplain as determined by reference to information provided by the Federal Emergency Management Agency (FEMA, 1982).

The impact of the proposed project on jurisdictional wetlands has been analyzed by qualified experts (CTE, 1997). The pathway for the proposed NuMI Project beam would directly cross underneath identified wetlands but, since the beam enclosure would be constructed by tunneling techniques, the project would not be expected to impact the wetlands. The design of surface features of the project would specifically avoid surface construction in any of the jurisdictional wetlands identified (see Figure 6.1).

There would be no impacts on sensitive resources including floodplains, wetlands, archeological and historic resources (see Section 5.6), or threatened or endangered species (see Section 5.6) that would result from the proposed NuMI project.

6.1.8 Socioeconomic Issues

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority and Low-income Populations," require federal agencies to analyze disproportionately high and adverse environmental effects of proposed actions on minority and low-income populations. Off-property impacts of the proposed action would be minimal and limited to the area immediately surrounding the Fermilab property where this is no significant presence of minority or low-income residents.

6.2 Normal Operation of the Proposed Action

Prior to the initial operation, or **commissioning**, of the NuMI facility, all civil construction would be completed as well as installation and commissioning of the new beamline components.

6.2.1 Land Use

The land use of the Fermilab site would continue essentially the same as that associated with the present operations of Fermilab. There would be no significant additional impact on the human environment.

6.2.2 Work Force

It is anticipated that the current work force at Fermilab would remain in place for the duration of the NuMI project during both the construction and operational phases. Likewise, the population of experimental personnel would remain essentially unchanged during that period.

6.2.3 Occupational Safety and Health

The beamline and experimental hall shielding would be certified as complete and sufficient to allow NuMI operation within the environment, safety, and health requirements specified by established Fermilab policies (FESHM, 1997 and FRCM, 1997), which implement the applicable regulations. A Safety Assessment Document (SAD) for the proposed NuMI project would be written and it would address the COSMOS and near MINOS detectors.

After the beamline and experiments are configured according to the design parameters and all the safety requirements are met, beam would be extracted and the data collection would begin. Operation of the experiments amounts to collecting the data and remotely monitoring the equipment during periods of their operations. Protection of workers against exposures to other hazards besides those due to ionizing radiation would be controlled in accordance with Regulations established by the Occupational Safety and Health Administration (29 CFR 1910). Specific review procedures would be implemented to assure proper control of all materials used in the experiments in order to maintain a safe working environment. Particular attention would be placed upon the control of flammable materials and provisions for egress from the underground areas in accordance with the standards of the National Fire Protection Association (NFPA). The impact of ionizing radiation hazards are discussed in 6.2.5.

Areas where the proton beam may interact (or is designed to interact) with materials are greatly restricted due to the creation of ionizing radiation. During the operation cycle of the experiments with the proton beam being extracted, no access to these areas is allowed. Life safety access control into any of these areas is maintained by a series of locks and interlocks that disable the primary beam if any entry points are breached. The process of setting the locks and interlocks to operational readiness, established by written Fermilab policies (FRCM, 1997), requires that all enclosures be searched and secured by a two-person operation crew that sets the interlocks for each enclosure after an exhaustive visual search. The personnel conducting these searches receives special training for this task. No secondary beam, including the neutrino beam, is possible without the primary proton beam.

Hazards encountered during the operation of NuMI, except for ionizing radiation hazards, are typical of those found in light industry and are hence minimal. Radiation issues are addressed in Section 6.2.5.

6.2.4 Utilities

Any increase in Fermilab's utility requirements as a result of NuMI operations would not impair the ability of public utilities to supply their users.

6.2.5 Ionizing Radiation and Waste Generation

There would be some generation of ionizing radiation and radioactive wastes in the course of operations of the proposed NuMI project on the Fermilab site (see the following sections). Due to the extremely rare interactions of the neutrinos, there would be no production of radionuclides, radioactive materials or wastes at the Soudan Underground Laboratory. Table 6.3 summarizes the estimated annual doses that may be received from various sources of ionizing radiation due to the proposed action.

Table 6.3 Summary of Estimated Maximum Annual Doses Due to Ionizing Radiation Associated with the Proposed NuMI Project Construction and Operation (See explanation in text.)

Source (who is receiving the dose)	Maximum Annual Dose (microSieverts)	Maximum Annual Dose (mrem)
Construction activities (all other entries are due to NuMI operation)	0	0
Neutrons produced during operation (members of the public or occupational workers)	0	0
Muons produced during operation (members of the public or occupational workers)	0	0
Use of radioactive sources (radiation workers)	100	10
Neutrinos (occupational at Fermilab)	3	0.3
Neutrinos (members of the public at Fermilab)	0	0
Neutrinos (members of the public and occupational workers at the Soudan Underground Laboratory)	0.000010	0.000001
Radionuclides produced in groundwater surrounding the tunnel (members of the public)	40	4
Air activation (members of the public at the Fermilab site boundary)	0.07	0.007
Work on radioactivated target station components, maximally exposed worker (occupational worker)	10,000	1000

6.2.5.1 Penetrating Radiation

The design goal for the proposed NuMI primary beamline and target shielding would be specified assuming the delivery to NuMI of 40 trillion (4×10^{13}) protons per **spill** for 30 spills per minute at 120 GeV. This beam intensity, while large, is comparable to those used over the years at Fermilab. The goal would be a dose rate of no more than 10 microSieverts (1 mrem) per hour outside the shield. The units, "microSievert" or "mrem", which measure radiation dose, are used to quantify the degree to which ionizing radiation can cause damage to biological tissues. For example, on the average each person receives approximately 3600 microSieverts (360 mrem) annually (NCRP, 1987) from natural sources. Levels of less than 10 microSieverts per hour are readily achievable by surrounding beam enclosures with approximately 7.5 meters (25 feet) of earth. Furthermore, the majority of the beam transport line and the entirety of the target hall, decay pipe and beam absorber would be far greater than 7.5 meters underground. The part of the facility that would generate the vast majority of the radiation, the target station, would be more than 30 meters (100 feet) below the surface. Each meter of concrete or earth shielding results in a reduction in the radiation dose external to the shield by a factor of ten.

Typical radiation workers at Fermilab receive no more than 1000 microSieverts (100 mrem) in a year while the highest levels received are typically less than 10,000 microSieverts (1000 mrem) in a year. These levels are well below the annual limits set by Federal Regulations (10 CFR 835) of 50,000 microSieverts. Procedures implemented currently at Fermilab have continued to successfully assure compliance with these regulations and maintenance of exposures as low as reasonably achievable. These same results would be true for those who maintain the NuMI target station. The International Commission on Radiation Protection has calculated the risk of latent cancer fatalities to be 0.4 latent cancer fatalities (LTF) per 10 million people per person-microSievert (ICRP, 1991). Thus, the health effect attributable to this dose to workers from NuMI operations is far too small to reliably calculate.

Ionizing radiation would be produced during the operation of the proposed NuMI beamline. It would be controlled in conformance with Federal and State Regulations and U. S. Department of Energy Requirements promulgated to protect Fermilab employees, visitors and scientific users, and members of the public (10 CFR 835 and DOE 5400.5). These Regulations and Requirements are implemented by detailed written Fermilab policies (FRCM, 1997) which specify design criteria. The radiation would be generated by the interaction of the proton beam with objects such as the target, focusing elements, **collimators**, the walls of the decay pipe and beam absorbers or other material that the proton beam might strike. A major portion of this radiation, known as **prompt radiation**, would be present only when the beam is operating. It consists primarily of particles called **neutrons** and muons.

Neutrons would be produced in all directions relative to the proton beam interaction point while muons are produced primarily along the direction of the beam. The neutrons would be shielded by combinations of soil, rock, concrete, or steel surrounding the beamline. The amount of shielding required depends on the duration, energy, and amount of beam that interacts with material and the desired level of precaution to be taken outside the shield in order to meet the design criteria.

Muon radiation, because it is produced largely along the beam direction, can be most effectively shielded by keeping the muons below grade level. Since the NuMI proton beam would be deliberately deflected downward in order to direct the neutrinos toward the Soudan Underground Laboratory, measurable muon radiation exposure to members of the

public and the environment due to the operation of NuMI would not occur. Furthermore, the COSMOS and MINOS experiments require that the detectors on the Fermilab site be well-shielded against these same muons to levels that would not interfere with the experiments. These levels are far below limits set for workers. Sufficient amounts of intervening earth and rock between the end of the beam absorber and the experimental hall would be used to eliminate muons.

It is conceivable that some of the experimenters would also work with radioactive sources in the process of building and maintaining their experimental apparatus. Such sources are of low activity and are used primarily to monitor proper function of the detectors. It is exceedingly unlikely that the annual dose due to such activities would exceed 100 microSieverts (10 mrem). At 0.4 latent cancer fatalities (LTF) per 10 million people per person-microSievert (ICRP, 1991), the health effect attributable to the dose from NuMI operations to workers is too small to reliably calculate.

The neutrinos would proceed from their point of production on the Fermilab site to the detector in the Soudan mine in Minnesota. They would emerge from the earth's surface at an angle of approximately 3.3 degrees relative to the horizontal approximately 12 kilometers (7.5 miles) to the northwest of the Soudan mine. Since these particles do not readily interact with matter, they are not capable of delivering a measurable radiation dose. Also, the neutrinos would not produce radioactive material. However, to assure proper understanding of this topic, the dose due to these neutrinos has been evaluated (Cossairt, 1997). They would be most intense as they emerge from the target. At the experimental halls, 90 meters below the surface, the dose rate due to the neutrinos would be approximately 12 microSievert (1.2 mrem) per year. Assuming that any given experimenter would be actually be present and working in the experimental hall 25 per cent of the time, the annual dose this such a person would be 3 microSievert (0.3 mrem) per year. No neutrinos would be present at the surface. At the Fermilab site boundary, about 2.5 kilometers (1.6 miles) from the target the neutrinos would already be approximately 160 meters (530 feet) underground and hence not accessible to individuals. At that depth, on the center line of the beam, the annual radiation dose would be approximately 2 microSieverts (0.2 mrem). Between Fermilab and the Soudan Underground Laboratory the neutrinos would be far underground as they would follow a straight line through the Earth between these two locations. In the Soudan Underground Laboratory, at the location where the flux of neutrinos would be most intense, the dose would be less than 10 microSieverts (1 mrem) per million years of operation. The same dose due to the neutrinos would be found at the location in Minnesota to the northwest of the Soudan Underground Laboratory where the neutrino beam eventually emerges from the surface of the Earth.

In summary, the effects of penetrating radiation on workers or members of the public would be negligible.

6.2.5.2 Soil and Ground Water Activation

The decay pipe (possibly the target station also) for the proposed NuMI project would be located in the dolomite rock layer, the top of which lies approximately 20 meters (65 feet) below the surface. Under the Regulations on groundwater resources promulgated by the Illinois Environmental Protection Agency, in view of preliminary studies conducted in support of this assessment, this dolomite layer constitutes a Class I groundwater resource (35 IAC 620). Radioactivity due to the operation of NuMI could be produced in the soil and rock surrounding the NuMI target station and decay pipe regions. Leaching can occur when water passes through rock or soil containing radioactivity, leading to the presence of radioactivity in ground water in the vicinity of the NuMI tunnel. Studies of the leachable radioactivity produced in soil and rock adjacent to Fermilab target stations and elsewhere

show that the two principal radionuclides of concern are tritium and sodium-22 (Borak, 1972, and Baker, 1994). The concentrations of the radionuclides produced in the dolomite decrease rapidly as one proceeds outward radially from the beamline through the rock. For approximately each 90 centimeters (3 feet) of additional rock, the concentrations would be about 10 times smaller.

Standard computer modeling techniques have been used to calculate the potential radionuclide concentrations in the groundwater resources adjacent to the proposed NuMI facility. The result is a conceptual shielding design for the proposed NuMI facility that protects the groundwater resources so that radionuclide concentrations in the groundwater would be below regulatory limits specified in State Regulations for water quality in groundwater resources, 35 IAC 620, (Wehmann, 1997). The final shielding design would most likely be a modification of this conceptual design as improvements to it are made in a continuing effort to improve the effectiveness of the protection of groundwater resources and to keep doses ALARA. Adherence to these regulatory limits assures that anyone who would use the water immediately outside of the tunnel as their primary source of drinking water on a full time basis would receive less than 40 microSieverts (4 mrem) per year (40 CFR 141). Such direct usage of this source of water is exceedingly improbable.

Two methods for monitoring the concentrations of radionuclides in the groundwater would be employed. One method would use standard monitoring wells placed near the tunnel, and at the depth of, three elements of the facility; the target hall, the most heavily grouted region of the decay tunnel, and the beam absorber. These wells would be designed to intercept the flow of groundwater from near the NuMI facility. These locations are those where the levels of activation of the rock surrounding the tunnel would be the greatest. The second method would take advantage of the fact that the proposed facility would be located directly in the aquifer and would have a net (albeit small) inflow into the tunnel. Small diameter holes would be drilled into the sides of the tunnel and fitted with taps and thus water samples could be taken directly from the rock just outside the shielding. These samples would be used to measure the radionuclide concentrations as close to the radionuclide production sources as possible. In the unlikely event that during the course of NuMI operations, radionuclide concentrations measured through either of these two techniques were found to be higher than anticipated, either the proton beam intensity would be reduced or the shielding configuration modified in order to prevent any of the regulatory limits from being exceeded.

The tunnel containing the target station and the decay pipe would be pumped as needed to assure that the water present in the dolomite would not fill the tunnel. As discussed in Section 6.1.4, the water collected by this means would be limited in order to have no impact on neighboring wells.

Shielding calculations have been done in order to estimate the level of activation in the groundwater around the proposed NuMI beamline. The result is a conceptual shielding design that meets regulatory requirements. Better designs are being pursued. A groundwater monitoring program would be implemented to ensure that regulatory limits would not be exceeded.

6.2.5.3 Surface Water and Closed-loop Cooling

There would be a small inward flow of water toward the proposed tunnel from the surrounding dolomite (on the order of a 380 liters (100 gallons) per minute) that would be collected and pumped to the surface where it would be discharged in accordance with U. S. Department of Energy requirements concerning discharges to surface waters at DOE facilities (DOE 5400.5). This water would be periodically analyzed to determine the

concentration of accelerator-produced radionuclides. It would be discharged in accordance with U. S. Department of Energy guidelines (DOE 5400.5) concerning discharges to surface waters at DOE facilities as stated in 6.2.5.2. The discharge of tunnel inflow water to the surface would be limited to approximately 380 liters (100 gallons) gallons per minute and would not represent a significant additional water source to the Indian Creek drainage system.

The proposed NuMI project target station magnet and beam absorber may be cooled by a circulating **closed-loop** water system, similar to existing Fermilab target stations. The cooling water becomes radioactive with the primary radionuclide of concern being tritium. The hazard associated with water containing radioactivity at a particular concentration is ranked by comparing that concentration with the Derived Concentration Guide for water (DCG) listed in DOE Order 5400.5. The DCG is the level at which a person drinking water containing radioactivity at this concentration for an entire year would receive a dose of 100 mrem. For tritium the DCG is 2000 picoCuries per cubic centimeter. Concentrations of tritium in existing Fermilab fixed target area closed-loop systems are known from experience to be typically less than 10,000 **picoCuries** per cubic centimeter. The cooling system volumes are typically approximately 190 liters (50 gallons). The NuMI closed loop cooling water system would be similar to those already at Fermilab, with similar radionuclide concentrations produced. Consequently, secondary containment for possible leaks would be provided for the NuMI system. Leaking closed-loop water within the enclosure would be collected for proper disposal in accordance with Federal, State, and Local regulations by employing commonly used spill protection techniques. Some permit modifications may be indicated (See Section 4.1.5 and 5.4).

The effects of the discharge on the tunnel inflow to the surface water and the use of a closed-loop water system would negligibly impact the environment.

6.2.5.4 Air Activation

Radionuclide emissions to the atmosphere due to operation of NuMI have been estimated (Crane, 1995). These emissions consist of short-lived gaseous emissions produced as an unavoidable result of proton interactions with targets. 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). The most important radionuclide of concern is carbon-11, which has a half life of 20.5 minutes.

Environmental emissions would be limited by minimizing the ventilation of the tunnels during operations and by allowing sufficient time for decay of the airborne radioactivity after a beam shutdown and prior to any personnel access. For example, a one hour decay period followed by rapid ventilation of the target hall enclosure would result in the release of no more 1 (one) Curie of carbon-11 to the environment. The activities of the other radionuclides would be less than the release of the carbon-11. It is estimated that this target station would be opened to access in a manner that would release these radionuclides a maximum of twice per month. Thus, a maximum of approximately 25 Curies per year would be released to the environment. This would be within the limits of the present Fermilab NESHAP permit, which limits releases to less than 100 Ci/year on average and a maximum of 900 Curies per year. Typical releases from Fermilab in recent history are around 30 Curies per year. Thus the operation of NuMI will not cause Fermilab to approach either air permit limits. All releases would 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 environmental permit (IEPA, 1996).

Compliance with 40 CFR 61 requirements, limiting dose to any member of the public to 100 microSieverts (10 mrem) in any given year, (assuming that that person be present at

the Fermilab site boundary on a full time basis) would be assured. In a typical recent year of operation of the present Fermilab accelerators, the release of 34 Curies of such radioactivity resulted in an estimated maximum dose to a member of the public of approximately 0.1 microSieverts (0.01 mrem). The maximum release of 25 Curies estimated above for NuMI should result in a maximum dose to a member of the public of 0.07 microSieverts (0.007 mrem). At 0.4 latent cancer fatalities (LTF) per 10 million people per person-microSievert (ICRP, 1991), the health effect attributable to the off-site dose from NuMI operations is far too small to reliably calculate.

The concentrations within the enclosure in the region of the target station during operations would be considerable, many times the allowable limits for occupational workers set forth in Federal Regulations. However, personnel would be excluded from this area when the proposed NuMI facility is operational (beam on). Due to the relatively short half-lives of the airborne radionuclides produced, procedures would be implemented to require an approximate two hour period following the cessation of operations before allowing entry to the enclosure. Thus, the concentration limits for occupational workers specified by Federal regulations (10 CFR 835) would readily be met due to the intervening period that would allow decay of the radionuclides. Along with other sources of radiation exposure to the project workers, these exposures would be properly monitored in accordance with Federal Regulations applicable to occupational radiation exposures.

Personnel associated with the physics experiments would be present in the experimental halls during beam operations. However, the ventilation systems for these experimental halls would be completely separate from that used for the target station in order to preclude exposure of these individuals to the radioactive air.

6.2.5.5 Residual Activation

High energy beams striking beamline components produces residual activation of those beamline components. This residual radioactivity remains after the beam is turned off. Residual radioactivity in beamline components and shielding within the proposed NuMI beamline enclosures would not produce detectable dose rates above ground because the amount of shielding required for prompt radiation is more than sufficient to shield the residual radiation to undetectable levels (Crane, 1995).

The target station and associated equipment would become radioactive due to the operation of proposed NuMI beamline. This equipment is inaccessible during beam operations and must be serviced and maintained with the beam turned off. The radiation dose rates due to both long and short-term operations of the target station have been calculated (Crane, 1995). The source of the radiation exposure would be gamma rays. With proper shielding design, it would be feasible to achieve dose rates of less than 100 microSieverts per hour (10 mrem per hour) for large portions of the target station area. There would be a few accessible locations near the target itself that could have levels ranging from 1000 to 15,000 microSieverts per hour. Clearly, dose rates of this magnitude would require that the target and other beam line components be designed carefully to minimize personnel exposure during maintenance and replacement activities. This would be achieved by designing the equipment to be as reliable as practical. In addition, the individuals who would perform this work would receive special training and be supervised in this work to assure that radiation exposures are kept as low as reasonably achievable. The radiation exposures to these workers would be routinely monitored. It is estimated that significant radiation exposures would be received by only a small number of radiation workers. These exposures would typically be less than 10,000 microSieverts (1000 mrem) per year compared with the regulatory limit (10 CFR 835) of 50,000 microSieverts (5000 mrem) per year.

6.2.5.6 Waste Generation and Disposal

Waste disposal is not presently conducted on the Fermilab site nor would waste disposal be conducted on the Fermilab site during the operation of the proposed NuMI facility. The operation of the NuMI facility would largely replace existing operations on the Fermilab site and thus would not significantly increase or decrease the quantities of regulated chemical wastes generated at Fermilab.

During current operations, Fermilab typically produces approximately 15 cubic meters (530 cubic feet) of low level radioactive wastes annually. The levels of radioactive waste generated for disposal by the operations of NuMI do not constitute a significant addition to the present levels generated by Fermilab and thus would not have a significant impact on the environment.

6.3 Off-Normal Operation of the Proposed Action

The most significant off-normal operations due to the proposed NuMI beamline would be the situation in which the proton beam is absorbed by the beamline components in some unplanned location part of the beam line upstream of the target. Such unplanned "losses" of beam would be anticipated to be infrequent as extensive instrumentation would be employed to prevent such loss of beam. As stated in Section 6.2.5, the prompt radiation shielding for the NuMI project would be designed to meet levels established in Fermilab policies, written in accordance with Federal Regulations (FRCM, 1997). These policies impose stringent requirements on the design of shielding in order to control such unplanned interactions of the proton beam. Given the depth below the surface at which the majority of the facility would be located, sufficient shielding against this source of radiation would readily be achieved.

Under off-normal conditions, the activation of rock and soil in the vicinity of the NuMI tunnel would not be significant as these undesired operational conditions would be quickly detected and corrected.

6.4 The Soudan Underground Laboratory Facility

The major impacts of the construction of the cavern and operation of the MINOS detector located at the Soudan Underground Laboratory have been assessed in the State of Minnesota EAW (see Appendix A). A potential issue discussed in that assessment concerns the management of the spoil from the mining operation that would be employed to excavate the cavern. The spoils would be placed on the surface in such a way as to not detract from the character of the historic mine area and thus not conflict with the existing use of the area as a park. It was determined that this material has a low potential for erosion and sedimentation. Thus the management of the excavated material would have no significant impact on the environment.

A second potential issue that was identified in the assessment concerns the bats that are found in the Soudan mine. The nature of the concern is related to the possibility that the excavation activities could disturb the hibernation patterns of these bats. It was concluded that measures would be taken to keep the bats out of those areas where severe disturbance of the bats would be likely. To discourage bats from hibernating in the immediate project vicinity, construction would commence in early fall before bats begin seeking hibernation sites. The mine appears to provide adequate suitable habitat away from the construction. The University of Minnesota and the Department of Natural Resources (DNR) would cooperatively monitor the effects of blasting and construction on the bats throughout the mine. The DNR does not believe that significant impacts to the bats would result from this

project, but would require the University of Minnesota to modify blasting and construction methods should this not be the case.

Operation of the present high energy physics facility at Soudan has negligible impact on the environment. The proposed MINOS facility at Soudan is similar in scope and design and thus would similarly have negligible impact on the environment.

6.5 Cumulative Effects of the Proposed Action: Construction and Operation

The NuMI Project would be the only major construction project that would be taking place on the Fermilab site during the time period 1998-2001. During this period there would be no other soil erosion or noise-producing projects. The cumulative effects of construction activities required to build the NuMI experimental facilities both on the Fermilab site and at the Soudan Underground Laboratory upon the human environment would be minimal.

Operations of NuMI would result in delivery of heat to the cooling water at the target station that would be discharged in accordance with the Laboratory's NPDES permit. It would not represent a significant new discharge of heat. The discharge of heat would be to on-site cooling waters which would continue to be in compliance with an existing environmental permit issued by the Illinois Environmental Protection Agency. The electrical power utilized would be similar in magnitude to that presently used in the operation of the Fermilab research program. It would not represent a significant additional power requirement. Operations of the experimental facility at the Soudan Underground Laboratory would have minimal impact upon the human environment.

6.6 Decommissioning of the Proposed Action

If the NuMI facility at Fermilab were to be decommissioned, the experimental apparatus and beamline 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. For the duration of the proposed NuMI project, information necessary for eventual decommissioning of the NuMI 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.

The operations of the proposed new facility at the Soudan Underground Laboratory, as part of the NuMI experimental program, would cease with the decommissioning of the NuMI project. It is entirely possible that this facility would continue to be used, as in the past, for other experiments not associated with the operation of the Fermilab accelerators.

Each component of the experimental apparatus and beam line would be surveyed by health physics personnel in order to identify, label and isolate all components made radioactive by beam operations. It is anticipated that many components, excluding some of the beam line and target station items, the decay pipe, and beam absorber material would be free of radioactivity. 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 would be planned for the future. Review under the National Environmental Policy Act would be performed for these activities at that time. There would

be no radioactive wastes involved with the decommissioning of the proposed facility at Soudan Underground Laboratory.

6.6.1 Cumulative Effects: Decommissioning

Since it is anticipated that most of the equipment and materials involved in the proposed NuMI facility would be used in other current or new experiments, either at Fermilab or similar facilities, it is expected that minimal impact would be made on the cumulative amounts of disposed material. This would also be true for the proposed facility at the Soudan Underground Laboratory.

REFERENCES

(Altenbach, 1996) J. S. Altenbach, "An Evaluation of the Bat Occupancy and Habitat Potential in the Tower Soudan Mine, Tower, Minnesota", 1996.

(Baker, 1994) S. Baker, J. Bull, and D. Goss, "Leaching of Accelerator-Produced Radionuclides", Superconducting Super Collider Laboratory, Report SSCL-Preprint-538, May, 1994.

(Bird, 1991) M. C. Bird and R. Lurie, "Report of the 1990 Field School Investigations at Fermi National Accelerator Laboratory: Anti-proton Collider Hall and Pine Street Prairie Restoration Area", Midwest Archaeological Research Services, Inc., February 12, 1991.

(Borak, 1972) T. B. Borak, et al., "The Underground Migration of Radionuclides Produced in Soil Near High Energy Proton Accelerators", Health Physics, Volume 23, pp. 679-687, 1972.

(10 CFR 835) Code of Federal Regulations, Title 10, Part 835, "Occupational Radiation Protection".

(10 CFR 1021) Code of Federal Regulations, Title 10, Part 1020, "National Environmental Policy Act Implementing Procedures".

(29 CFR 1910) Code of Federal Regulations, Title 29, Part 1910, "OSHA General Industry Standards".

(29 CFR 1926) Code of Federal Regulations, Title 29, Part 1926, "OSHA Construction Industry Standards".

(40 CFR 61) Code of Federal Regulations, Title 40, Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities".

(40 CFR 141) Code of Federal Regulations, Title 40, Part 141, "National Primary Drinking Water Regulations".

(Cossairt, 1997) J. D. Cossairt, N. L. Grossman, E. T. Marshall, "Assessment of Dose Equivalent Due to Neutrinos", Fermi National Accelerator Laboratory, Fermilab Report FERMILAB-Pub-97/101, April, 1997.

(Crane, 1995) D. A. Crane, et al., "Status Report: Technical Design of Neutrino Beams for the Main Injector (NuMI)", Fermi National Accelerator Laboratory, Report FERMILAB-TM-1946, July, 21, 1995.

(CTE, 1997) Consoer Townsend Envirodyne Engineers, Inc., Chicago, Illinois, "Fermi National Accelerator Laboratory Wetland Delineation and Special Areas Report, Proposed Neutrino Beams for the Main Injector Project", June 1997.

(DOE 5400.5) U. S. Department of Energy Order 5400.5, "Radiation Protection of the Public and the Environment". Portions of this DOE Order are presently in the Rulemaking process proposed as 10 Code of Federal Regulations, Part 834, "Radiation Protection of the Public and the Environment".

(FEMA, 1982) Federal Emergency Management Agency, Federal Insurance Administration, National Flood Insurance Program Rate Map Community Panel Number 170896 0055, March 1, 1982.

(FESHM, 1997) "Fermilab Environment, Safety, and Health Manual", January 1997 edition. -This document contains Fermilab's policies for assuring worker safety and protection of the public and environment in accordance with Federal, State, and Local Regulations and good management practices.

(Fluor, 1997) Fluor Daniel and Harza Engineering, "Review of the STS Hydrogeological Evaluation Report for the NuMI Project Dated, April 2, 1997 and Initial Discussion of Expected Inflows into the NuMI Tunnel", May 30, 1997.

(FRCM, 1997) Fermilab Radiological Control Manual, January 1997 edition. This document contains Fermilab's policies for assuring worker safety and protection of the public and the environment from sources of ionizing radiation. It is part of the Fermilab Environment, Safety, and Health Manual (see FESHM, 1997).

(HEPAP, 1995) High Energy Physics Advisory Panel, "Report of High Energy Physics Advisory Panel, Subpanel on Accelerator-Based Neutrino Oscillation Experiments", 1995.

(35 IAC 309) Illinois Administrative Code, Title 35, Part 309, Subpart A, "NPDES Permits".

(35 IAC 620) Illinois Administrative Code, Title 35, Part 620 "Groundwater Quality Standards".

(ICRP, 1991) International Commission on Radiological Protection, "1990 Recommendations of the International Commission on Radiological Protection", ICRP Publication 60, Pergamon Press, 1991.

(IEPA, 1987) Illinois Environmental Protection Agency, "Standards and Specifications for Soil Erosion and Sediment Control", Illinois Environmental Protection Agency, Springfield, IL, 1987.

(IEPA, 1996) Illinois Environmental Protection Agency, NESHAP Source Permit, Application Number 79070012, Identification Number 043807, Issued November 25, 1996.

(IEPA, 1994) Illinois Environmental Protection Agency, NPDES Permit Number IL0026123, Issued August 2, 1994.

(Lurie, 1990) R. Lurie, "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", Midwest Archaeological Research Services, Inc., January 28, 1990.

(NCRP, 1987) National Council on Radiation Protection and Measurements Report 94, "Exposure of the Population in the United States and Canada from Natural Background Radiation, Washington, DC, 1987.

(NFPA) National Fire Protection Administration. "National Fire Codes" (NFPA Standards).

(Rajaram, 1991) V. Rajaram, et al., "Impacts of the No-Blasting Specification on the Deep Tunnel Project Chicago, IL", Mining Engineering, Vol. 254, March 1992, pp. 254-258.

(RUST, 1996) RUST, "NS1 and NS2 Hydrogeologic Site Characterization and Well Installations and Aquifer Pumping Test Report", Fermi National Accelerator Laboratory, Batavia, Illinois, 1996.

(Schaffer, 1993) M. Shaffer, E. Goldsmith, and R. Lurie, "Report on the 1990 Historical Site Survey at Fermi National Accelerator Laboratory, Batavia, Illinois", Midwest Archaeological Research Services, Inc., May 25, 1993.

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

(USBM, 1987) U. S. Bureau of Mines, "Surface Mine Blasting, Bureau of Mines Technology Transfer Seminar", IC 9135, U. S. Government Printing Office, Washington, DC, 1987.

(Visocky, 1988) Visocky, A.P., et al., "Ground-Water Investigations for Siting the Superconducting Super Collider in Northeastern Illinois", ISWS/CIR-170/88, Illinois State Water Survey, Champaign, Illinois, 1988.

(Visocky, 1995) Visocky, A.P., et al., "Geology, Hydrology, and Water Quality of the Cambrianand Ordovician Systems in Northern Illinois", Illinois State Water Survey, Illinois State Geological Survey, U.S. Geological Survey Cooperative Groundwater Report 10, Champaign, Illinois, 1995.

(Wehmann, 1997) A. Wehmann, et al., "Groundwater Protection for the NuMI Project", Fermi National Accelerator Laboratory, Report FERMILAB-TM-2009, October, 1997.

LIST OF ABBREVIATIONS AND ACRONYMS

argon-41	Argon-41 radionuclide
Bq	Becquerel
carbon-11	Carbon-11 radionuclide
COSMOS	Cosmologically Significant Mass Oscillations
CY	Calendar Year
DOE	(U.S.) Department of Energy
EA	Environmental Assessment (U. S. Department of Energy)
EAW	Environmental Assessment Worksheet (State of Minnesota)
ES&H	Environment, Safety, and Health
EPA	(U. S.) Environmental Protection Agency
FNAL	Fermi National Accelerator Laboratory
FMI	Fermilab Main Injector
FY	Fiscal Year, Federal (October 1 through September 30)
hydrogen-3	Hydrogen-3 radionuclide, also known as tritium
HEPAP	(DOE) High Energy Physics Advisory Panel
IEPA	Illinois Environmental Protection Agency
kW	kiloWatts
MINOS	Main Injector Neutrino Oscillation Search
mrem	millirem
μCi	microCurie, one millionth of a Curie
nitrogen-13	Nitrogen-13 radionuclide
sodium-22	Sodium-22 radionuclide
NFPA	National Fire Protection Association
NPDES	National Pollutant Discharge Elimination System
NSF	National Science Foundation
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NuMI	Neutrinos at the Main Injector
oxygen-15	Oxygen-15 radionuclide
pCi	picoCurie
SSC	Superconducting Super Collider
tritium	Hydrogen-3 radionuclide
USBM	U. S. Bureau of Mines

GLOSSARY

accelerator	A device for increasing the velocity and energy of charged particles, for example electrons or protons, through application of electrical and/or magnetic forces. Accelerators have made particles move at velocities approaching the speed of light. Types of accelerators include cyclotrons, synchrotrons, and linear accelerators.
antiproton	Matter in which the ordinary nuclear properties of the proton are replaced by correspondingly opposite properties of the antiproton. An anti-hydrogen atom, for example could be conceived as a negatively charged antiproton with a positively charged orbital **positron**.
beam	A stream of particles or electromagnetic radiation, going in a single direction.
beamline	A collective term referring to all the devices used to control, monitor, and produce a beam. The common elements of a beamline are magnets, intensity monitors, beam position monitors, and collimators.
chambers	A technique used in high energy physics experiments in which a given volume of space is made into a sensitive detector of the particles that pass through it and indicate such passage through the generation of an electrical signal.
charge	Electric charge carried by an elementary particle.
closed-loop	A system of circulating water in completely enclosed pipes where the water is isolated from any external surfaces.
collider physics	A method of study used in high energy physics in which two high energy beams of particles are directed towards each other so that the particles interact with each other in head-on collisions.
collimator	An adjustable aperture, capable of absorbing the beam outside of the aperture opening, and permitting the transport of the beam within the aperture.
commission	The task of bringing into operation a designed system for the first time.
Curie	The basic unit to describe the intensity of radioactivity in a sample of material. The curie is equal to 37 billion disintegrations per second, which is approximately the rate of decay of 1 gram of radium. A Curie is also a quantity of any nuclide having 1 Curie of radioactivity. Named for Marie and Pierre Curie, who discovered radium in 1898.

dark matter	Material present in the Universe in addition to that found in the visible stars, which is needed to account for the gravitational attraction between different galaxies.
decay	The spontaneous transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide. The process results in a decrease, with time, of the number of the original radioactive atoms in a sample. It involves the changing of the nucleus by emission, absorption or fission.
decommission	The completion and disassembly of a system.
diamacton	A glacial sediment, generally unstratified, that is non-to poorly sorted and contains a wide range of particle sizes.
dose	As used in this assessment, the energy deposited in a unit of mass of tissue multiplied by a factor that takes into account the differences in biological effects due to different kinds of radiation. The unit of dose is the microSievert. One microSievert equals 10 millirem.
electron	The lowest mass lepton which is found bound in ordinary atoms and has negative electrical charge.
fixed-target physics	A method of study used in high energy physics in which a beam of high energy particles is collided with a material target that is stationary, or "fixed", in space.
GeV	The unit of measure of the kinetic energy of particles accelerated by high energy accelerators. A proton accelerated through an electrical potential of 1 billion volts would have a GeV of kinetic energy.
half-life	The time in which half of the atoms of a particular radioactive substance disintegrates to another nuclear form. Measured half-lives vary from millionth of a second to billions of years.
interlock	A locked device engaged to beam components such that changes in the device will permit or not permit the components to operate.
ionizing radiation	particles or rays that can cause electrons to be added to or removed from neutral atoms. Examples of ionizing radiation include alpha particles, beta particles, muons, gamma/X-rays and neutrons.

isotope	One of two or more atoms with the same atomic number (the same chemical element) but with different atomic weights. An equivalent statement is that the nuclei of isotopes have the same number of protons but different numbers of neutrons. Thus carbon-12, carbon-13, and carbon-14 are isotopes of the element carbon, the superscripts denoting the differing mass numbers, or approximate atomic weights. Isotopes usually have very nearly the same chemical properties, but somewhat different physical properties.
kaon	An elementary particle having a mass about 970 times that of an electron.
lepton	A class of elementary particles that only interact by means of the electromagnetic and weak forces.
long baseline	A feature of certain neutrino oscillation experiments in which two similar or identical detectors are separated by a long distance, typically many kilometers, to study the changes on the neutrinos that occur over the intervening distance
Main Injector	A synchrotron at Fermilab that is designed to accelerate protons and **antiprotons** to an energy of 150 billion electron volts, (150 GeV).
millirem	One one-thousandth of a rem (10^{-3}). Rem is an acronym for roentgen equivalent man. The unit of dose of any ionizing radiation that produces some biological effect, such as a unit of absorbed dose of ordinary X rays.
muon	An elementary particle, classed as a lepton with 207 times the mass of an electron. It may have a single positive or negative charge.
neutrino	An electrically neutral elementary particle with a negligible mass. It interacts very weakly with matter and hence is difficult to detect. It is produced in many nuclear reactions, for example, in beta decay, and has high penetrating power; neutrinos from the sun usually pass right through the earth.
neutron	An uncharged elementary particle with a mass slightly greater than that of the proton, and found in the nucleus of every atom heavier than hydrogen. A free neutron is unstable and decays with a half-life of about 13 minutes into an electron, proton, and neutrino.
oscillation	The transition of a neutrino from one type to another.
pico	A prefix that divides a basic unit by one trillion (10^{-12}). Same as micromicro, $(10^{-6})(10^{-6})$.
pions	An elementary particle having a mass 274 times that of an electron.

photographic emulsion	A technique in high energy physics research in which photograph film exposed to high energy particles that leave tracks in the emulsion which can be measured by developing the film.
positron	The antiparticle of the electron that has the same mass as the electron but has positive electrical charge.
prompt radiation	Radiation produced by the interaction of the beam with materials such as a target and consisting primarily of neutrons and muons, also considered as penetrating radiation.
radioactivity	The spontaneous decay or disintegration of an unstable atomic nucleus, usually accompanied by the emission of ionizing radiation. (Often shortened to "activity".)
radionuclides	A radioactive nuclide.
short baseline	A feature of certain neutrino oscillation experiments in which two similar or identical detectors are separated by a very small distance, typically only a few meters or less, to study the changes on the neutrinos that occur over the intervening distance
spill	An event in which the beam is extracted from the accelerator.
subatomic	Any of the constituent particles of an atom: electron, neutron, proton, etc.
taus	The most massive known lepton which has a mass 3491 times that of an electron.
Tevatron	A synchrotron at Fermilab that is designed to accelerate protons and **antiprotons** to an energy of one trillion electron volts, (1 TeV).
tritium	A radioactive isotope of hydrogen with two neutrons and one proton in the nucleus. It is man-made and is heavier than deuterium (heavy hydrogen). Tritium was used in industrial thickness gauges, and as a label in experiments in chemistry and biology. It is also denoted as ^3H.

APPENDIX A:

Environmental Assessment Worksheet (EAW) for the Proposed Modifications to the Soudan Underground Laboratory

Environmental Assessment Worksheet (EAW)

NOTE TO PREPARERS
This worksheet is to be completed by the Responsible Governmental Unit or its agents. The project proposer must supply any reasonably accessible data necessary for the worksheet, but is not to complete the final worksheet itself. If a complete answer does not fit in the space allotted, attach additional sheets as necessary.

For assistance with this worksheet contact the Minnesota Environmental Quality Board (EQB) at (612) 296-8253 or (toll-free) 1-800-652-9747 (ask operator for the EQB environmental review program) or consult "EAW Guidelines," a booklet available from the EQB.

NOTE TO REVIEWERS
Comments must be submitted to the RGU (see item 3) during the 30-day comment period following notice of the EAW in the EQB Monitor. (Contact the RGU or the EQB to learn when the comment period ends.) Comments should address the accuracy and completeness of the information, potential impacts that may warrant further investigation, and the need for an EIS. If the EAW has been prepared for the scoping of an EIS (see item 4), comments should address the accuracy and completeness of the information and suggest issues for investigation in the EIS.

1. **Project Title** Physics Laboratory Expansion: Soudan Underground Mine

2. **Proposer** University of Minnesota
   Contact person Dr. Earl Peterson
   Address School of Physics and Astronomy
   116 Church Street SE
   Minneapolis, MN 55455
   Phone 612/624-0319

3. **RGU** Minnesota Department of Natural Resources
   Contact person Rebecca Wooden
   and title Environmental Planner
   Address 500 Lafayette Road, Box 10
   St. Paul, MN 55155-4010
   Phone 612/297-3355

4. **Reason for EAW Preparation**
   ___ EIS scoping ___ mandatory EAW ___ citizen petition X RGU discretion ___ Proposer volunteered

   If EAW or EIS is mandatory give EQB rule category number(s) _____

5. **Project Location**
   NE 1/4 SW 1/4 Section 27 Township 62N Range 15W
   County St. Louis City/Twp Breitung

   Attach copies of each of the following to the EAW:
   a. a county map showing the general location of the project;
   b. copy(ies) of USGS 7.5 minute, 1:24,000 scale map (photocopy is OK) indicating the project boundaries;
   c. a site plan showing all significant project and natural features.

6. **Description** Give a complete description of the proposed project and ancillary facilities (attach additional sheets as necessary). Emphasize construction and operation methods and features that will cause physical manipulation of the environment or produce wastes. Indicate the timing and duration of construction activities.

The University of Minnesota proposes to enlarge its underground physics research facility on the 27th level of the Soudan Mine, situated within Soudan Underground Mine State Park, and leased from the State. Constructed in 1984-86, the University's existing laboratory is 70 yards long, 15 yards wide, and 12 yards high. The University proposes to construct a second laboratory room, approximately 50 yards east of the existing laboratory, 100 yards long, 15 yards wide, and 15 yards high. The new laboratory would house a 10,000-ton particle detector to intercept neutrinos generated and released at Fermi National Accelerator Laboratory, in Batavia, Illinois. The neutrinos would travel underground, passing through the detectors in the new Soudan mine laboratory.

There are three varieties of neutrino, electron-, muon-, and tau-. The primary purpose of the project is to determine whether neutrinos can change from one type to another. Appendix A provides a more detailed description of the neutrinos, the project purpose, and the scientific questions the project will address.

Construction of the new laboratory would require blasting and removal of approximately 22 thousand cubic yards of rock. The new laboratory cavern will be excavated using traditional drill-and-blast methods. This approach involves excavating the upper one-third to one-half of the cavern in two or three stages, then excavating the remaining cavern height in two or three additional stages. Each of these stages is commonly called a heading or bench, so there might be two or three top headings and two or three bench, or lower, headings. Drill-and-blast excavation is done in a fixed, repeating cycle of steps:

1) Drill blast holes into the rock at the heading;
2) Load initiation devices and blasting agents in the holes;
3) Blast;
4) Allow smoke to clear;
5) Inspect and scale;
6) Use loaders to remove broken rock; and
7) Install rock support.

Depending upon the size of the headings, the equipment used, and the rock support necessary, the excavation cycle might be repeated as frequently as every 8 to 12 hours, but commonly every 24 hours.

There are three types of explosives in common use for underground construction: 1) dynamite, a nitroglycerin-based explosive; 2) water gels, an ammonium nitrate-based explosive; and, ANFO, a commercially-prepared combination of ammonium nitrate and fuel oil, primarily used in surface blasting, but sometimes used underground.

Water gel explosives will likely be used for top heading excavation, and either water gels or possibly ANFO will be used for bench excavation. Excavated material would be hauled to the surface using the existing hoist system, and placed on the ground in the mine area. The University proposes to construct the new laboratory between Fall 1998 and Spring 2000.

The DNR and the University will negotiate a lease for excavation and use of the laboratory space. DNR expects the lease term to be 10 years. In addition to all aspects of project construction and operation, the lease will address what decommissioning will be required when the project terminates.

Provide a 50 or fewer word abstract for use in EQB Monitor notice:

The University of Minnesota proposes to construct a second underground laboratory in Soudan Underground Mine State Park. The 22,000 cubic-yard laboratory will house a particle detector to detect neutrinos generated at Fermi National Accelerator Laboratory in Chicago and directed toward the underground mine. Excavated rock will be hauled to the surface and stockpiled in the mine vicinity.

7. **Project Magnitude Data**

Total Project Area (acres) <1 or Length (miles) _____

Number of Residential Units NA

Unattached _____ Attached _____

Commercial / Industrial / Institutional Building Area (gross floor space)

Total 13,500 square feet;

Indicate area of specific uses:

Office _____ Manufacturing _____

Retail _____ Other Industrial _____

Warehouse _____ Institutional 13,500 sf

Light Industrial _____ Agricultural _____

Other Commercial (specify) _____

Building heights(s) _____

8. **Permits and Approvals Required** List all known local, state, and federal permits, approvals, and funding required:

Unit of Government	Type of Application	Status
MN Department of Natural Resources	Lease	Under Discussion
State Historic Preservation Office	Section 106 Review	Pending

9. **Land Use** Describe current and recent past land use and development on the site and on adjacent lands. Discuss the compatibility of the project with adjacent and nearby land uses; indicate whether any potential conflicts involve **environmental** matters. Identify any potential environmental hazard due to past land uses, such as soil contamination or abandoned storage tanks.

Soudan Underground Mine State Park comprises 1200 acres of land donated to the State by U.S. Steel in about 1965. The most significant feature of the park is the underground mine, which is open for public tours. The proposed laboratory would be constructed within the underground mine.

The mine area of the park includes the underground mine, buildings, roads, parking lots, mining, loading, and rail equipment, abandoned surface mine pits, and waste rock piles. Excavated material will be hauled to the surface using the same hoist system that is used by the public. For safety reasons and to avoid disrupting tours, the University will blast only when the mine is closed to the public. The University has determined that all excavated material can be hauled to the surface during evening/night hours when the park is closed to visitors so that this activity will not affect public mine tours. Provided the excavated rock is not placed where it will detract from the character of the historic mine area, the project will not conflict with the existing use as a park.

10. **Cover Types** Estimate the acreage of the site with each of the following cover types before and after development (before and after totals should be equal):
Cover type acreages will not change as development will occur underground. Less than one acre of previously-disturbed surface will be used to stockpile excavated materials.

	Before	After		Before	After
Types 2 to 8 Wetlands	0	0	Urban / Suburban lawn Landscaping	0	0
Wooded / Forest	0	0	Impervious surface	0	0
Brush / Grassland	0	0	Other (Mine/Lab facilities):	<1	<1
Cropland	0	0			

11. **Fish, Wildlife, and Ecologically Sensitive Resources**
   a. Describe fish and wildlife resources on or near the site and discuss how they would be affected by the project. Describe any measures to be taken to minimize or avoid adverse impacts.

Based on park personnel observations, 113 bird, 37 mammal, and 15 reptile and amphibian species inhabit or visit the park area. Because the project will occur primarily underground, the DNR expects little or no impact to fish and wildlife species, with the exception of bats, as described below.

   b. Are there any state-listed endangered, threatened, or special-concern species; rare plant communities; colonial waterbird nesting colonies; native prairie or other rare habitat; or other sensitive ecological resources on or near the site?

X Yes ___ No

If yes, describe the resource and how it would be affected by the project. Indicate if a site survey of the resources was conducted. Describe measures to be taken to minimize or avoid adverse impacts.

There are four species of cave bats found in Minnesota: Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septrentrionalis*), Eastern Pipistrelle (*Pipistrellus subflavus*), and Big Brown Bat (*Eptesicus fuscus*).

Recent surveys conducted in the Soudan Mine found significant numbers (several thousand individuals) of Little Brown myotis and Northern myotis. Eastern pipistrelles also have been documented as hibernating in the mine. The Northern myotis and Eastern pipistrelle are state-listed Special Concern species.

The DNR regards the Soudan Mine hibernaculum as extremely important due to its northern location and the lack of other nearby sites. It is the most important site for Northern myotis in the state, and as a winter location for Eastern pipistrelle, is the northernmost in Minnesota, and perhaps the northernmost throughout the species' range.

The primary concern regarding bats is that blasting and excavation could disturb them during hibernation, when they are particularly vulnerable. Although a 1996 study in the Soudan Mine found that previous blasting and excavation did not devastate the bat population, it strongly recommends minimum disturbance during hibernation.

Blasting will begin in early fall, 1988, before October, which will discourage bats from entering and hibernating in the excavation area. Construction and blasting will continue throughout fall and winter to discourage bats from settling in areas of the mine where severe disturbance is likely. The mine appears to provide adequate suitable habitat, away from the construction area, for bats displaced by excavation.

In cooperation with the University of Minnesota, the DNR proposes to monitor the effects of blasting and construction on the bats hibernating throughout the Soudan Mine. DNR staff are preparing a monitoring plan; the University has agreed to provide partial funding.

12. **Physical Impacts on Water Resources** Will the project involve the physical or hydrologic alteration (dredging, filling, stream diversion, outfall structure, diking, impoundment) of any surface water (lake, pond, wetland, stream, drainage ditch)? ___ **Yes** _X_ **No**

    If yes, identify the water resource to be affected and describe: the alteration, including the construction process; volumes of dredged or fill material; area affected; length of stream diversion; water surface area affected; timing and extent of fluctuations in water surface elevations; spoils disposal sites; and proposed mitigation measures to minimize impacts.

13. **Water Use**
    a. Will the project involve the installation or abandonment of any wells? ___ **Yes** _X_ **No**
    For abandoned wells give the location and Unique well number. For new wells, or other previously unpermitted wells, give the location and purpose of the well and the Unique well number (if known).

    b. Will the project require an appropriation of ground or surface water (including dewatering)? ___ **Yes** _X_ **No**
    If yes, indicate the source, quantity, duration, purpose of the appropriation, and DNR water appropriation permit number of any existing appropriation. Discuss the impact of the appropriation on ground water levels.

The Soudan Underground Mine State Park has a water appropriation permit (90-2131) for dewatering the Soudan Mine. Water collects in sumps on several mine levels and is pumped to the surface and discharged. Although some water will be encountered and used during construction, the proposed project is not expected to cause significant additional amounts of water to collect in the sumps.

However, it should be noted that the Park's appropriation permit allows pumping of 30 million gallons per year, a level that is routinely exceeded by 5 to 10 percent. The Park may need to amend its appropriation permit regardless of whether the proposed project goes forward.

    c. Will the project require connection to a public water supply? ___ **Yes** _X_ **No**
    If yes, identify the supply, the DNR water appropriation permit number of the supply, and the quantity to be used.

14. **Water-related Land Use Management Districts** Does any part of the project site involve a shoreland zoning district, a delineated 100-year flood plain, or a state or federally designated wild or scenic river land use district? ___ **Yes** _X_ **No**
    If yes, identify the district and discuss the compatibility of the project with the land use restrictions of the district.

15. **Water Surface Use** Will the project change the number or type of watercraft on any water body? ___ **Yes** _X_ **No**
If yes, indicate the current and projected watercraft usage and discuss any potential overcrowding or conflicts with other users or fish and wildlife resources.

16. **Soils** Approximate depth (in feet) to:
Groundwater: minimum _>20_ median _175_ Bedrock: minimum _0_ average _0_
Describe the soils on the site, giving SCS classifications, if known. (SCS interpretations and soil boring logs need not be attached.)

There is groundwater in the mine, even at Level 27, which is 2300 to 2400 feet below the surface. The porosity of the bedrock at this level is very low. The sump on Level 27 collects from levels 23, 25, and 27 and accounts for about 5 gal/minute.

The most extensive soil in the park is a shallow loam over bedrock, generally unsuited for development. However, the project will be constructed underground where soil suitability is not an issue. Excavated material will be placed in areas already disturbed by past mining activities.

17. **Erosion and sedimentation** Give the acreage to be graded or excavated and the cubic yards of soil to be moved:
acres _<1_ ; cubic yards _22,000_.
Describe any steep slopes or highly erodible soils and identify them on the site map.
Describe the erosion and sedimentation measures to be used during and after construction of the project.

The project will not involve soil disturbance. The excavated material will be blasted bedrock, which has low potential for erosion and sedimentation.

18. **Water Quality - Surface Water Runoff**
    a. Compare the quantity and quality of site runoff before and after the project. Describe methods to be used to manage and/or treat runoff.

Direct surface runoff from the mine area travels generally southwest, entering wetlands that feed the East Two River. The DNR has not characterized the quality of existing runoff at the project site. Excavated material will be placed on the surface where it will be exposed to rainfall. Depending on the composition of the excavated rock, it could generate acidic runoff, contributing to metals leaching.

At present, the department is conducting a detailed analysis of core drilled from rock where the proposed project will be constructed to determine the potential for the excavated material to cause water quality impacts through leaching and runoff. The analysis includes: 1) visual inspection, which has revealed relatively minor amounts of sulfide mineralization; 2) chemical analysis by an independent laboratory (completed but not yet interpreted); and 3) thin section analysis.

If department technical staff determine the rock has the potential to generate acidic leachate, they will evaluate various prevention, treatment, and mitigation options, which may be included as lease conditions to maintain area water quality. Potential options would include: monitoring, covering the excavated material so that it is not exposed to rain, isolation of problematic rock (if only small amounts are found), and collection of low pH leachate for shipment to municipal wastewater treatment facilities, and construction of a passive treatment system.

During construction, water used in drilling will collect within the mine sumps and be discharged to the surface. The collected water will likely contain particulate matter generated during drilling and blasting. Exposure of additional rock surface after the laboratory is constructed is not expected to affect the quality of dewatering discharge.

b. Identify the route(s) and receiving water bodies for runoff from the site. Estimate the impact of the runoff on the quality of the receiving waters. *(If the runoff may affect a lake consult "EAW Guidelines" about whether a nutrient budget analysis is needed.)*

Water discharged from the Soudan mine is routed southwest into a roadside drainage ditch. The ditch carries water through the community of Soudan, emptying into a wetland that is drained by the East Two River, which eventually empties into Pike Bay of Lake Vermillion. The proposed project is not expected to affect the quality of the receiving waters.

19. Water Quality - Wastewaters

a. Describe sources, quantities, and composition (except for normal domestic sewage) of all sanitary and industrial wastewaters produced or treated at the site.

The only wastewaters generated will be from employee washing/drinking facilities. At present, sink wastewater empties into the shaft sump. The University has investigated a sealed sink waste collection system. Whether a closed system will be installed in the new laboratory will be determined in lease negotiations.

Chemical toilets are used in the mine to collect human waste; they are hauled to the surface and collected by a licensed handler.

b. Describe any waste treatment methods to be used and give estimates of composition after treatment, or if the project involves on-site systems, discuss the suitability of the site conditions for such systems. Identify receiving waters (including ground water) and estimate the impact of the discharge on the quality of the receiving waters. *(If the discharge may affect a lake consult "EAW Guidelines" about whether a nutrient budget analysis is needed.)*

NA

c. If wastes will be discharged into a sewer system or pretreatment system, identify the system and discuss the ability of the system to accept the volume and composition of the wastes. Identify any improvements which will be necessary.

NA

20. Ground Water -- Potential for Contamination

a. Approximate depth (in feet) to ground water: >20 minimum; 175 median.

b. Describe any of the following site hazards to ground water and also identify them on the site map: sinkholes; shallow limestone formations / karst conditions; soils with high infiltration rates; abandoned or unused wells. Describe measures to avoid or minimize environmental problems due to any of these hazards.

The project would be located in highly impermeable bedrock. Small amounts of groundwater seep into the mine and collect in the sumps where they are pumped to the surface. Infiltration to groundwater from the project area on Level 27 is unlikely.

c. Identify any toxic or hazardous materials to be used or present on the project site and identify measures to be used to prevent them from contaminating ground water.

During construction, heavy machinery will be used to excavate the cavern. There is minor potential for fuel or oil leakage. During construction, a temporary sump would be employed to collect potential spills.

21. Solid Wastes; Hazardous Wastes; Storage Tanks

a. Describe the types, amounts, and compositions of solid or hazardous wastes to be generated, including animal manures, sludges and ashes. Identify the method and location of disposal. For projects generating municipal solid waste indicate if there will be a source separation plan; list type(s) and how the project will be modified to allow recycling.

After construction, use of the laboratory will generate typical office-related solid wastes, which will be hauled to the surface and recycled or disposed using the municipal waste disposal process. Any chemical wastes will be taken to the University of Minnesota (Duluth or Twin Cities) for disposal in accordance with current University procedures.

b. Indicate the number, location, size, and use of any above or below ground tanks to be used for storage of petroleum products or other materials (except water).

The underground laboratory will have both cryogenic and high-pressure tanks for argon, carbon dioxide and helium, all widely-occurring gases.

22. **Traffic** Parking spaces added __0__ Existing spaces (if project involves expansion) _____ Estimated total Average Daily Traffic (ADT) generated _25__ Estimated maximum peak hour traffic generated (if known) and its timing: _____, _____. For each affected road indicate the ADT and the directional distribution of traffic with and without the project. Provide an estimate of the impact on traffic congestion on the affected roads and describe any traffic improvements which will be necessary.

Laboratory operation will require an additional 25-50 staff members. During the summer use season, the park does not have adequate parking area for 25 to 50 additional vehicles. At this time, the DNR does not plan to construct additional parking areas. The University will need to develop a transit plan (park & ride, carpool, etc.) for the additional staff to use during the summer. During the remainder of the year, laboratory staff will be able to use the existing parking facilities.

The DNR does not expect the additional 25-50 cars to affect traffic congestion in the Tower/Soudan area.

23. **Vehicle-related air emissions** Provide an estimate of the effect of the project's traffic generation on air quality, including carbon monoxide levels. Discuss the effect of traffic improvements or other mitigation measures on air quality impacts. *(If the project involves 500 or more parking spaces, consult "EAW Guidelines" about whether a detailed air quality analysis is needed.)*

No effect is expected.

24. **Stationary source air emissions** Will the project involve any stationary sources of air emissions (such as boilers or exhaust stacks)? _X_ **Yes** ___ **No**
If yes, describe the sources, quantities, and composition of the emissions; the proposed air pollution control devices; the quantities and composition of the emissions after treatment; and the effects on air quality.

Up to 100 cubic feet per day of argon, carbon dioxide and helium may be released by instrumentation in the underground laboratory. The released gases should have little effect on air quality, since they naturally occur in the atmosphere in much larger quantities.

25. Will the project generate dust, odors, or noise during construction and / or operation? _X_ **Yes** ___ **No**
If yes, describe the sources, characteristics, duration, and quantities or intensity, and any proposed measures to mitigate adverse impacts. Also identify the locations of sensitive receptors in the vicinity and estimate the impacts on these receptors.

<u>During Construction</u>
Blasting will produce vibrations in the air and rock at the location of the blast. The air vibrations, or "air blast", is transmitted through the air in the tunnels, shafts and other openings. Because these openings are rough and poorly connected, the vibrations rapidly diminish with distance from the source. Likewise, the rock vibrations rapidly diminish with distance from the source. Both air and rock vibrations will range from imperceptible to barely perceptible at the surface near the shaft.

Surface activity will involve front-end loaders carrying excavated rock from the shaft to the rock storage pile. The rock pile will be wetted as necessary to control dust. The nearest residences are about 1/4 mile from the proposed rock pile site.

Because blasting, excavation, and hauling will occur when the park is closed, these activities will not affect park visitors.

During Operation
The project will not generate dust, odors, or noise during operation.

26. Are any of the following resources on or in proximity to the site:
    a. archaeological, historical, or architectural resources? _X_ Yes ___ No
    b. prime or unique farmlands? ___ Yes _X_ No
    c. designated parks, recreation areas, or trails? _X_ Yes ___ No
    d. scenic views and vistas? _X_ Yes ___ No
    e. other unique resources? ___ Yes _X_ No
    If any items are answered Yes, describe the resource and identify any impacts on the resource due to the project. Describe any measures to be taken to minimize or avoid adverse impacts.

Archaeological, Historical or Architectural Resources
The Soudan Underground Mine State Park is unusual in the Minnesota State Park system because it preserves a man-made historic site rather than an area of natural beauty or biological diversity. Soudan was the earliest-producing iron ore mine in Minnesota, and the second to last to operate. The site is listed on the National Register of Historic Places because of its national significance to American history and culture.

The Park provides a unique opportunity for visitors to view the actual mine, buildings, and machinery. The tours and museum, which the DNR operates at Soudan, provide interpretation to enrich the experiences of the approximately 40,000 people who visit the park each year.

The proposed laboratory will not be visible to the visiting public. The only long-term visual effect of the project will be the additional stockpiling of excavated rock. The new stockpiles will differ visually from existing stockpiles, on which vegetation has become established. From the perspective of managing a historic mining site, this vegetation is generally undesirable. Potential stockpiles sites are shown in figure 6, however the final disposition of the excavated material will depend on the results of mineralogic studies underway by the DNR (see Item 18 of the EAW).

The 18 months of construction activity will be noticeable both on the surface and underground. To the casual observer, evidence of construction may simulate historic mining activity. The University will fund necessary maintenance and improvement of the historic mining equipment (hoist), which might not otherwise be done.

The University has consulted, and will continue to work with, the State Historical Preservation Office to ensure the proposed project will not negatively affect the historical qualities of the Soudan site.

Scenic Views
The scenic view at Soudan is from the ridge where the No. 8 shaft is located, looking south over the valley in which Soudan, Tower, and Highway 169 are located. The proposed project will not affect the scenic view.

27. Will the project create adverse visual impacts? *(Examples include: glare from intense lights; lights visible in wilderness areas; and large visible plumes from cooling towers or exhaust stacks.)* ___ Yes _X_ No
    If yes, explain.

28. **Compatibility with plans** Is the project subject to an adopted local comprehensive land use plan or any other applicable land use, water, or resource management plan of an local, regional, state, or federal agency? _X_ Yes ___ No
    If yes, identify the applicable plan(s), discuss the compatibility of the project with the provisions of the plan(s), and explain how any conflicts between the project and the plan(s) will be resolved. If no, explain.

In October 1981, the DNR prepared a Management Plan for the Soudan Underground Mine (then Tower Soudan) State Park. Management objectives include:

To utilize resource management techniques that will harmonize with the park's natural systems;
To improve diversity and perpetuate renewable resources;
To identify, interpret, and protect the park's historic resources.

Once constructed, laboratory operation would not affect visitor use or enjoyment of the park. During the 18 months of construction, excavation activities will be evident, but will not detract from the character of the historic mine area. Blasting and excavation will not interfere with public use of the park.

29. **Impact on Infrastructure and Public Services** Will new or expanded utilities, roads, other infrastructure, or public services be required to serve the project? ___ **Yes** _X_ **No**
If yes, describe the new or additional infrastructure / services needed. *(Any infrastructure that is a "connected action" with respect to the project must be assessed in this EAW; see "EAW Guidelines" for details.)*

30. **Related Developments; Cumulative Impacts**
    a. Are future stages of this development planned or likely? ___ **Yes** _X_ **No**
    If yes, briefly describe future stages, their timing, and plans for environmental review.
    b. Is this project a subsequent stage of an earlier project? _X_ **Yes** ___ **No**
    If yes, briefly describe the past development, its timing, and any past environmental review.

The existing laboratory (12,600 cubic yards) was excavated in Soudan Mine in 1984-86. The project did not undergo environmental review, although it was reviewed at the time by the DNR and the Minnesota Historical Society.

    c. Is other development anticipated on adjacent lands or outlots? ___ **Yes** _X_ **No**
    If yes, briefly describe the development and its relationship to the present project.
    d. If a, b, or c were marked **Yes,** discuss any cumulative environmental impacts resulting from this project and the other development.

Cumulative impacts to historic character of the park:
The amount of material to be excavated from the mine is relatively minor compared to the mining-related pits and stockpiles that already exist at the historic mine site. Excavated materials will be placed so that they do not detract from the historic character of the park.

Cumulative impacts to bats:
Current activities (public use, on-going laboratory work) appear to have minimal effects on the resident bat population. The DNR does not expect operation of the new facility to cause additional impacts, but will monitor the population throughout project construction.

31. **Other Potential Environmental Impacts** If the project may cause any adverse environmental impacts which were not addressed by items 1 to 28, identify and discuss them here, along with any proposed mitigation.

The project will not cause adverse environmental effects which were not addressed by items 1 to 28. However, there may be public interest in the behavior of neutrinos in the environment, which is generally described here and in Appendix A. The proposed project involves interception of neutrinos generated at Fermi National Accelerator Laboratory in Batavia, Illinois. The neutrinos do not pose any significant radiation hazard. Neutrinos that do not interact pose no hazard at all, and almost all of the neutrinos that leave Chicago will pass through 400 miles of rock and exit into space without hitting anything. Those that do interact in the 10,000-ton detector or in the rock surrounding the laboratory (or just before exiting at ground level) will correspond to an increase in the naturally-occuring background radiation levels of less than one part in 10 million, which is very small. The net effects of the neutrinos are thousands of times smaller. No measurable residual effects of the neutrinos are foreseen.

32. **SUMMARY OF ISSUES** *(This section need not be completed if the EAW is being done for EIS scoping; instead, address relevant issues in the draft Scoping Decision document which must accompany the EAW.)* List any impacts and issues identified above that may require further investigation before the project is commenced. Discuss any alternatives or mitigative measures that have been or may be considered for these impacts and issues, including those that have been or may be ordered as permit conditions.

Potential impacts to bats using the Soudan Underground Mine are not expected to be significant and do not require further investigation before the project is commenced. However, the Department, with the University's cooperation, will monitor effects on hibernating bats during project construction.

The potential for excavated materials to contribute to water quality problems through runoff and mine dewatering is currently under investigation, and must be resolved before the project can commence. Prior to construction, the DNR will determine whether the excavated rock poses the potential for heavy metal contamination of surface water runoff. Should the rock characterization studies show potential for heavy metal leaching, mitigation measures will be required in the lease for use of the mine. Mitigation measures could include constructing the stockpile so that runoff can be collected and treated before discharge to surface waters; covering the stockpile so that rainfall cannot contact it, or retaining some excavated material within the mine if only small, fairly isolated, portions demonstrate leaching potential.

CERTIFICATIONS BY THE RGU ***(all 3 certifications must be signed for EQB acceptance of the EAW for publication of notice in the EQB Monitor)***

A. I hereby certify that the information contained in this document is accurate and complete to the best of my knowledge.
Signature Rebecca A. Woods

B. I hereby certify that the project described in this EAW is the complete project and there are no other projects, project stages, or project components, other than those described in this document, which are related to the project as "connected actions" or "phased actions," as defined, respectively, at Minn. Rules, pts. 4410.0200, subp. 9b and subp. 60.
Signature Rebecca A. Woods

C. I hereby certify that copies of the completed EAW are being sent to all points on the official EQB EAW distribution list.
Signature Rebecca A. Woods

Title of signer ENVIRONMENTAL PLANNER Date 8/17/97

Minnesota Environmental Quality Board. Revised June 1990.

APPENDIX A

Neutrinos are fundamental elementary particles that interact very weakly with matter. In nature, they are observed in cosmic rays, in reactions in the sun, and in the decay of many radionuclides. They interact so weakly with matter that they can easily pass through many miles of rock, indeed, through the entire earth, without affecting a single atom in their passage. Because they interact so rarely, very intense sources of neutrinos are needed to study them.

In the Standard Model of elementary particle physics there are three types, or "families", of particles that do not interact strongly with matter. Collectively, they are called leptons. Each family is composed of an electrically charged lepton and an associated neutrino. The three electrically charged leptons are: 1) electrons, which are one of the building blocks of ordinary matter; 2) muons, a major component of cosmic rays, and 3) taus, which so far have been observed only in experiments at high energy physics laboratories. To date, the electron neutrino and the muon neutrino have only been observed in connection with electrons and muons, respectively. The tau neutrino has yet to be directly observed. Neutrinos have not been observed to change from one family to another, however, there are compelling hints from both theory and experiment that such family-changing, or oscillation, could provide a solution to several scientific puzzles. Such oscillations would imply that neutrinos, originally assumed to be massless, have mass.

The major scientific questions are as follows:

- One such puzzle is a discrepancy, or "deficit", in the number of electron neutrinos produced by the sun. Fewer of these neutrinos are observed experimentally than are predicted theoretically. The deficit is consistent over several experiments. A possible explanation is that the electron neutrinos oscillate to another family and hence are not found in experiments designed to see only electron neutrinos.

- A similar deficit is seen for atmospheric neutrinos (muon). Secondary cosmic rays, those seen at the earth's surface, consist largely of muons produced in the upper atmosphere by primary cosmic rays. Muon neutrinos are produced in conjunction with the muons and their number can be predicted based on the muon flux. However, experiments designed to look for muon neutrinos find fewer neutrinos than expected. Once again, oscillation of the muon neutrinos to another family might provide an explanation.

- Another puzzle is the source of a "dark matter" which astronomers have deduced must exist in the universe. The observed gravitational attraction between distant galaxies is greater than can be accounted for by the mass of the stars visible in them. Since neutrinos are known to permeate the universe and a consequence of oscillation is that neutrinos must have mass (they were originally assumed to be massless), the observation of neutrino oscillations would provide a plausible explanation of dark matter.

The proposed facility at Fermi National Accelerator Laboratory, in conjunction with the experiments designed to use it, would be able to search for this effect and hence determine if neutrinos do have mass, by measuring the oscillations of one type of neutrino into another. Construction of this project would give Fermilab a unique opportunity to study neutrino physics. The NuMI (Neutrino Beams for the Main Injector) facility would be designed to accommodate future enhancements to the physics program that could push the search for neutrino mass well beyond the initial goals established for this project. NuMI would remain the forefront facility for accelerator-based neutrino oscillation studies well into the next century. Major strengths of the proposed NuMi experimental program are the available distances between the detectors which would include provision for a very long path length (the "baseline"), provided by the distance between the Fermi laboratory and the Soudan Underground Laboratory, over which the neutrinos could oscillate, and the energies of neutrinos that will be available.

The Department of Energy's High Energy Physics Advisory Panel (HEPAP) established a subpanel on Accelerator-Based Neutrino Oscillation Experiments in January, 1995 to "[e]valuate the existing evidence for

neutrino oscillations and consider the feasibility of testing this phenomenon in experiments in U.S. accelerator facilities", and "...recommend to the Department of Energy a cost-effective plan for pursuing this physics." This review panel concluded that "[t]he very high flux Fermilab Main Injector...has the potential to provide a neutrino beam of unique capabilities for the field of neutrino oscillation science."

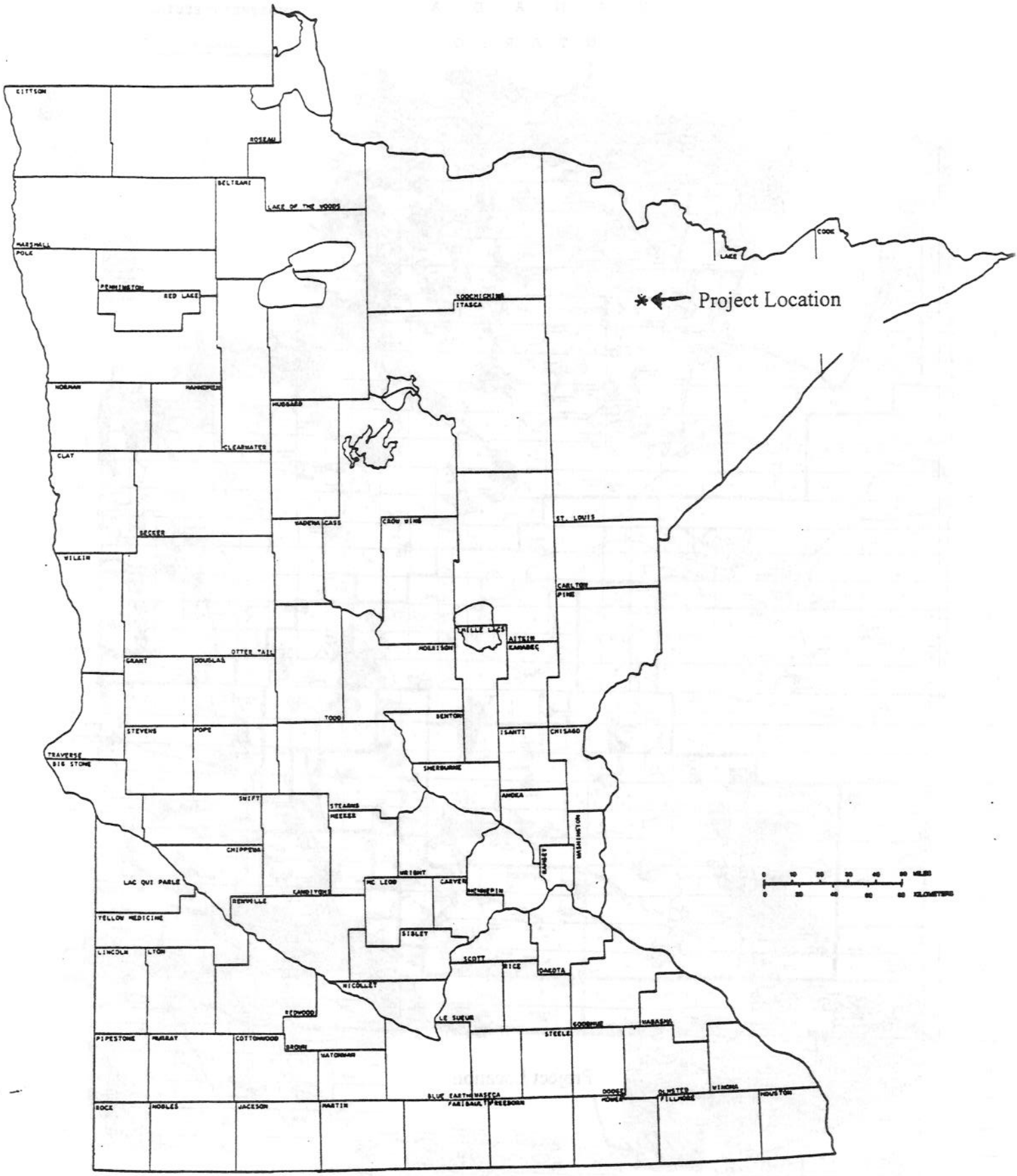


FIGURE 1 - State & County Map

GENERAL HIGHWAY MAP
ST. LOUIS COUNTY MINNESOTA
(NORTHEAST SECTION)

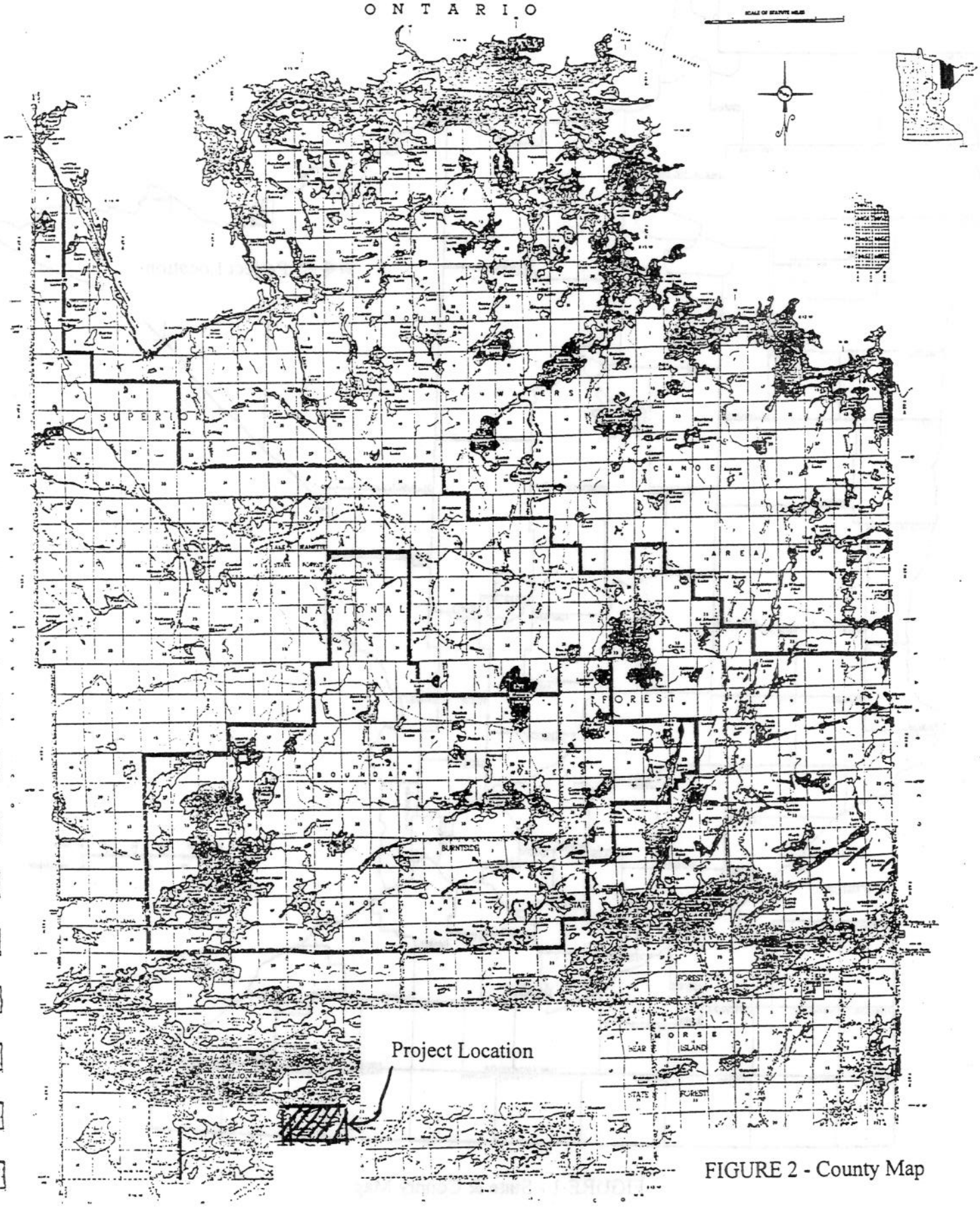


FIGURE 2 - County Map

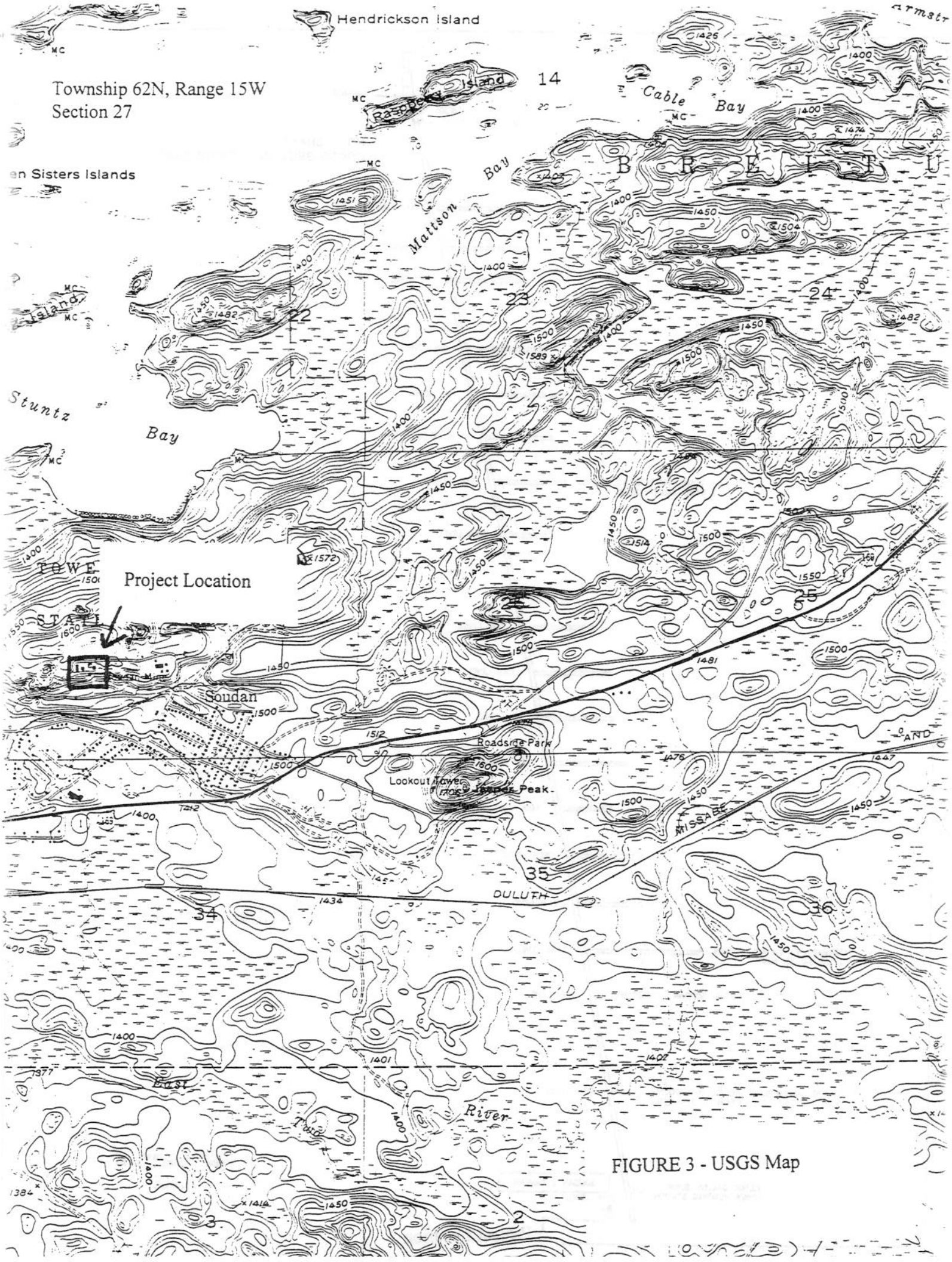


FIGURE 3 - USGS Map

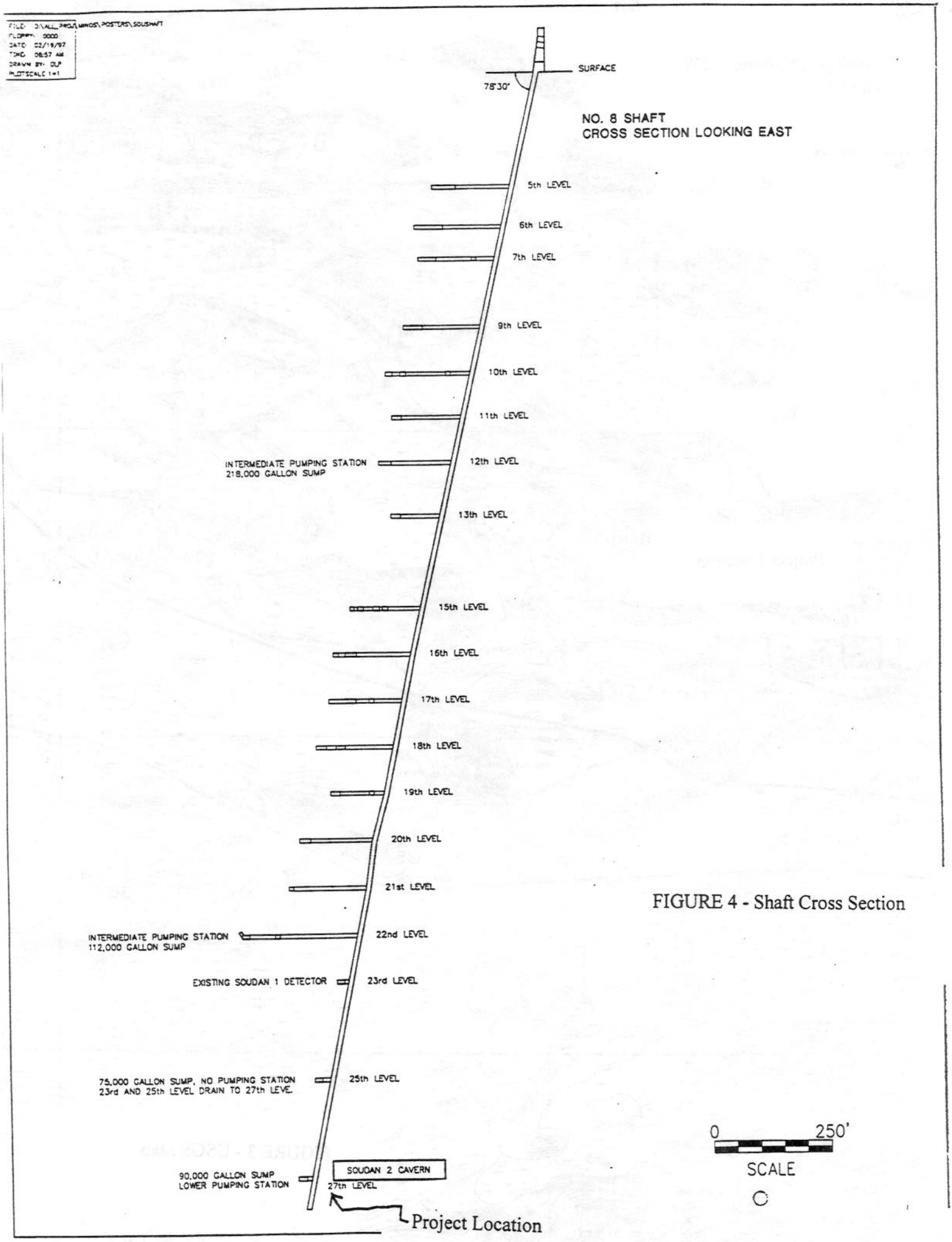


FIGURE 4 - Shaft Cross Section

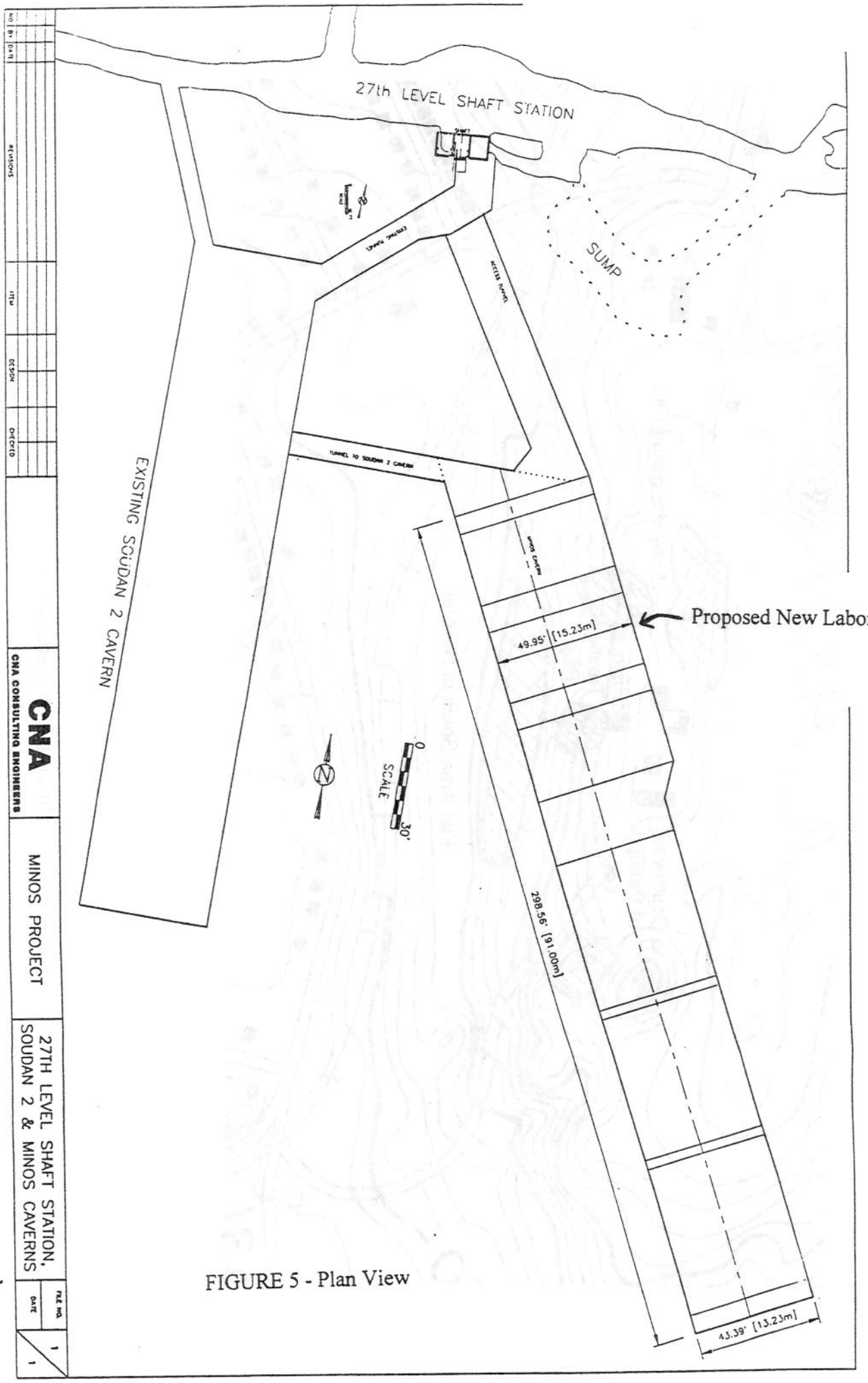


FIGURE 5 - Plan View

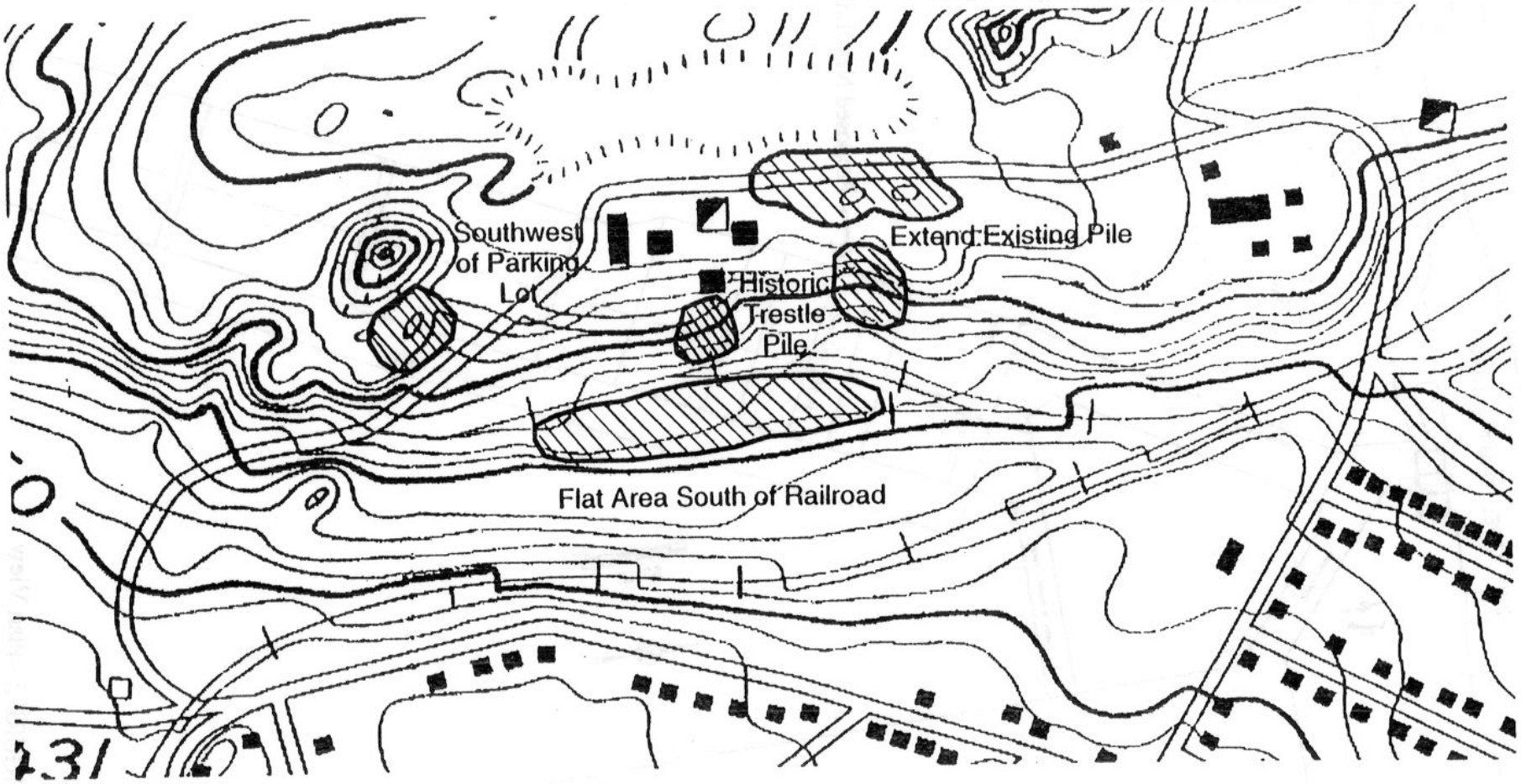


FIGURE 6 - Potential Sites for Excavated Material

Minnesota Department of Natural Resources

500 Lafayette Road
St. Paul, Minnesota 55155-4010

Date: August 17, 1997

To: Parties on the EAW Distribution List
Other interested parties

From: Rebecca Wooden
Environmental Review Section
Office of Planning

Phone: (612)297-3355

Re: Physics Laboratory Expansion: Soudan Underground Mine
Environmental Assessment Worksheet (EAW)

The Department of Natural Resources (DNR) has prepared the attached Environmental Assessment Worksheet (EAW) for the University of Minnesota's proposed construction of a second underground laboratory in Soudan Underground Mine State Park. The 22,000 cubic-yard laboratory will house a particle detector to detect neutrinos generated at Fermi National Accelerator Laboratory in Chicago and directed toward the underground mine. Excavated rock will be hauled to the surface and stockpiled in the mine vicinity.

A 30-day review and comment period will begin on August 25, 1997, when the notice of availability for the EAW is published in the EQB Monitor.

Written comments on the EAW must be received by Wednesday, September 24, 1997, at 4:30 P.M., and should be sent to:

Rebecca A. Wooden
Office of Planning
Minnesota Department of Natural Resources
500 Lafayette Road
St. Paul, MN 55155-4010

Attachment: EAW for Physics Laboratory Expansion: Soudan Underground Mine

MINOS/MINOS8.doc
#970181-01

file

DEPARTMENT OF NATURAL RESOURCES
OFFICE OF PLANNING

STATE OF MINNESOTA

Office Memorandum

Date: August 17, 1997

To: Gregg Downing, EQB

From: Rebecca Wooden
Environmental Review Section

Phone: 297-3355

Re: Physics Laboratory Expansion: Soudan Underground Mine
Environmental Assessment Worksheet (EAW)

Please publish a Notice of Availability in the August 25, 1997 EQB *Monitor* for the Physics Laboratory Expansion: Soudan Underground Mine EAW.

The University of Minnesota proposes to construct a second underground laboratory in Soudan Underground Mine State Park. The 22,000 cubic-yard laboratory will house a particle detector to detect neutrinos generated at Fermi National Accelerator Laboratory in Chicago and directed toward the underground mine. Excavated rock will be hauled to the surface and stockpiled in the mine vicinity.

A press release will be submitted to at least one newspaper of general circulation in the project vicinity. A copy of the EAW will be available for public review at: the DNR Library in the DNR building in St. Paul; the DNR Regional Office in Grand Rapids, and the Tower and Duluth public libraries.

The EAW will be sent to all parties on the attached distribution list, which includes all parties on the EQB's EAW Distribution List.

Please contact me if you need additional information. Thank you.

Attachment: EAW Distribution List

#970181-01
MINOS/MINOS7.doc

Gerald Larson, MN/DOT
3485 Hadley Avenue North
Oakdale, MN 55128
INTEROFFICE (3)

EQB Envt'l Review Program
Centennial Office Building
658 Cedar Street
St. Paul, MN 55155
INTEROFFICE (2)

John Kundert
Dept. of Public Service
121 7th Place East, Suite 200
St. Paul, MN 55101-2145
INTEROFFICE

Rita Messing
MN Dept. of Health
121 7th Place East, Suite 220
St. Paul, MN 55101-2145
INTEROFFICE

Doug Thomas
Soil & Water Resources Board
One West Water Street, Suite 200
St. Paul, MN 55107
INTEROFFICE

Paul Hoff
Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155
INTEROFFICE (3)

Bob Patton
Department of Agriculture
90 West Plato Boulevard
St. Paul, MN 55107
INTEROFFICE

Environmental Conservervation Library
300 Nicollet Mall
Minneapolis, MN 55401 (2)

U.S. Army Corps of Engineers
Ben Wopat, Chief
Regulatory Functions Branch
190 5th Street East
St. Paul, MN 55101-1638

Carol Blackburn
Legislative Reference Library
645 State Office Building
St. Paul, MN 55155
INTEROFFICE (2)

State Historic Pres. Office
MN Historical Society
345 Kellogg Blvd. West
St. Paul, MN 55102
INTEROFFICE

U.S. Environmental Prot. Agency
Attn: Shirley Mitchell
Environmental Review
77 West Jackson Blvd.
Chicago, IL 60604

Arrowhead Regional
Development Commission
330 South Canal Park Drive
Duluth, MN 55802

Lynn M. Lewis
US Fish & Wildlife Service
Twin Cities Field Office E.S.
4101 East 80th Street
Bloomington, MN 55425-1665

Mark Johnson
St. Louis County
Planning and Zoning
222 East Superior St.
Duluth, MN 55802

Duluth Public Library
520 West Superior Street
Duluth, MN 55802

D. Lee Peterson
CNA Consulting Engineers
2800 University Ave. SE
Minneapolis, MN 55414

Earl Peterson
U of MN Physics & Astronomy
116 Church Street SE
Minneapolis, MN 55455

J. D. Cossairt, MS 119
Fermilab, P.O. Box 500
Batavia, IL 60510

Mayor
City of Tower
City Hall, P.O. Box 576
Tower, MN 55790

Chair
Town of Soudan
Soudan, MN 55782

Chair
Breitung Township Board
Soudan, MN 55782

Tower Library
City Hall
P.O. Box 576
Tower, MN 55790

Internal Review
of Draft & Courtesy Copies of Final

Nancy Albrecht
Parks
Box 39
INTEROFFICE

Tom Balcom
Office of Planning
Box 10
INTEROFFICE

Con Christianson
Ecological Services
Box 25
INTEROFFICE

Kim Lapakko
DNR Minerals
1525 3rd Avenue East
Hibbing, MN 55746

Paul Eger
Minerals
Box 45
INTEROFFICE

John Guenther
DNR Region II
Box 15
INTEROFFICE

Dave Holmbeck
Region II, Eco. Services
Box 15
INTEROFFICE

Amy Loiselle
DNR Waters
2005 Hwy 37
Eveleth, MN 55734

Gerda Nordquist
Wildlife
Box 7
INTEROFFICE

Dave Olfelt
Region II, Parks
Box 15
INTEROFFICE

Pete Otterson
Waters
Box 32
INTEROFFICE

Paul Pojar
Minerals
Box 45
INTEROFFICE

Fred Thunhorst
DNR Wildlife
1429 Grant McMahon Blvd
Ely, MN 55731

Paul Wannarka, Manager
Soudan State Park
1379 Stuntz Bay Road
Soudan, MN 55782

Tom O'Hern
Attorney General's Office
NCL Tower, Suite 900
445 Minnesota Street
St. Paul, MN 55101-2127

Additional Internal Distribution for
Final EAW

Colleen Mlecoch
DNR - Library
Box 21
INTEROFFICE

Carbon copies of Cover Memos

Jim Lawler
Real Estate Management
Box 30
INTEROFFICE

Brad Moore
Commissioners Office
Box 34
INTEROFFICE

Jon Nelson
Forestry
Box 44
INTEROFFICE

Dave Olson
Minerals
Box 45
INTEROFFICE

EAW Mailing List
MINOS/MINOS2.doc
#970181-01

Minnesota Department of Natural Resources

500 Lafayette Road
St. Paul, Minnesota 55155-40_10

DATE: September 26, 1997

TO: Parties on the EAW Distribution List
Other interested parties and persons

FROM: Rebecca Wooden, Environmental Planner **PHONE**: (612)297-3355
Environmental Review Section
Office of Planning

RE: Physics Laboratory Expansion: Soudan Underground Mine
St. Louis County, Minnesota
Environmental Assessment Worksheet (EAW)
Record of Decision

The Department of Natural Resources (DNR), as Responsible Governmental Unit for environmental review of the University of Minnesota's proposed construction of a second underground laboratory in Soudan Underground Mine State Park, in St. Louis County, Minnesota has prepared the attached Record of Decision regarding the need for an Environmental Impact Statement (EIS) for the project. The DNR concludes that an EIS is not required and orders that a Negative Declaration be recorded. The justification for this determination is contained in the Record of Decision.

The Negative Declaration concludes the state environmental review process under the Environmental Quality Board rules, Minnesota Rules parts 4410.1000 to 4410.1700. This project may proceed to permitting.

Attachment: Record of Decision

#970181-01
MINOS/Minos19.doc

STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES

RECORD OF DECISION

In the Matter of the Determination of Need for an Environmental Impact Statement for the University of Minnesota's Proposed Underground Laboratory in Soudan Underground Mine State Park St. Louis County, Minnesota

FINDINGS OF FACT, CONCLUSIONS, AND ORDER

FINDINGS OF FACT

1. The Department of Natural Resources (DNR) prepared an Environmental Assessment Worksheet (EAW) pursuant to Minnesota Rules part 4410.1000, subpart 3., for the University of Minnesota's proposed construction of a second underground laboratory in Soudan Underground Mine State Park, in St. Louis County, Minnesota.

2. The EAW was filed with the Minnesota Environmental Quality Board (EQB) and notice of its availability was published in the EQB Monitor on August 25, 1997. A copy of the EAW was sent to all parties on the EQB's EAW Distribution List, and to any person who requested a copy. A press release announcing the availability of the EAW was sent to at least one newspaper of general circulation in the project vicinity.

3. As indicated in the EAW, the University of Minnesota proposes to enlarge its physics research facility on the 27th level of the Soudan Mine. The new laboratory will be 100 yards long, 15 yards wide, and 15 yards high, and will house a 10,000-ton particle detector to intercept neutrinos generated and released at Fermi National Accelerator Laboratory, in Batavia, Illinois. Construction requires the excavation of twenty-two thousand cubic yards of rock.

4. The EAW is incorporated by reference into this Record of Decision on the determination of need for an Environmental Impact Statement.

5. The 30-day EAW public review and comment period began August 25, 1997 and ended September 24, 1997.

6. During the public review and comment period, the DNR received written comments from Mr. Paul Hoff on behalf of the Minnesota Pollution Control Agency (MPCA). In its letter, MPCA offered several comments relating to existing mine dewatering discharge, which is regulated by their NPDES permit, and the potential for new waste rock to cause acidic leaching of heavy metals. The comments and responses are as follows:

Comment: MPCA Water Quality Division staff should be involved in identifying appropriate prevention, treatment, and mitigation options if waste rock testing indicates there is a potential for acidic leachate generation.

Response: The DNR will work with MPCA staff to evaluate appropriate prevention, treatment and mitigation options for waste rock with the potential to generate acidic leachate.

Comment: Present dewatering from the Soudan Mine frequently does not meet effluent limits for cobalt, aluminum, manganese, and copper. The NPDES permit for this discharge requires the DNR to develop a treatment system that brings the discharge into compliance by July 1, 1998.

Response: Comment noted. The DNR is working with MPCA staff to bring the discharge into compliance.

Comment: It is MPCA policy to not allow additional runoff or pollutant loads from a system until the current discharge meets the effluent limits. Therefore, MPCA staff will not permit any additional dewatering activities at the site until the discharge from the mine meets the permit's effluent limits, unless the DNR can show that no additional flow beyond already permitted volumes or increased copper loads will result from the construction activities.

Response: The DNR does not expect the proposed project to cause a change in the volume or pollutant load in the mine dewatering discharge. The proposed laboratory will be constructed at level 27 of the mine. At this level, there is very little groundwater present. In addition, the electronic equipment housed in the laboratory is moisture-sensitive; the laboratory will be sealed to prevent water from entering it.

Comment: Item 8 of the EAW should indicate that, due to discharge changes proposed by the project, the NPDES permit will require modification.

Response: The DNR does not anticipate discharge changes to result from the project, but will confer with MPCA staff to determine whether an NPDES permit modification will be required nonetheless.

Comment: Due to the use of explosive reagents during construction, the MPCA may consider adding nitrogen/ammonia limits to the permit.

Response: Comment noted.

Comment: The MPCA requests that the DNR postpone a final decision on the need for an EIS for 30 days in order to determine whether the waste rock will generate acidic leachate.

Response: Through chemical analysis and visual inspection, the DNR has developed adequate information to determine the potential for acidic leachate generation, and does not find necessary a 30-day postponement to obtain this information.

The DNR has determined that approximately twenty-five percent of the waste rock (5600 cubic yards) contains greater than one tenth of a percent sulfur, the mineral that, when exposed to water, may contribute to acidic runoff. This is a very conservative

level in that DNR staff have not observed acidic leachate generation in rock with sulfur levels below 3 tenths of a percent.

The DNR will require the University to segregate the waste rock containing greater than one tenth of a percent sulfur and isolate it from rain or surface water, or capture any runoff that contacts it. Possible isolation methods include:

1) Covering the material with an impermeable membrane to prevent rainwater from contacting it;
2) Placing the material on an impermeable liner to capture and treat runoff;
3) Crushing and encasing the rock in concrete or asphalt, in which case it could either be left on the surface or used as fill or road material; and
4) Crushing the material and mixing it with a neutralizing agent such as calcium carbonate.

The University is presently evaluating the feasibility and cost of these options. The DNR and the University will agree on a disposal option and include it as a requirement of the lease for development and use of the facility. The remainder of the waste material will be placed on the surface.

7. The rules of the Minnesota Environmental Quality Board set forth the following standards and criteria (Minn. Rules part 4410.1700, subps. 6 and 7) to which a project is to be compared to determine whether it has the potential for significant environmental effects:

A. *Type, extent, and reversibility of environmental effects.*

The EAW identified the following potential adverse effects of the proposed project:

Hibernating Bats. Construction of the proposed project may disturb bats hibernating in the mine. To discourage bats from hibernating in the immediate project vicinity, where effects would be most severe, construction will commence in early fall before the bats begin seeking hibernating sites. The University and the DNR will cooperatively monitor the effects of blasting and construction on bats throughout the mine, providing valuable information about their sensitivity and hibernating requirements. The DNR does not believe that significant impacts to bats will result from the project, but will require the University to modify its blasting and construction methods should this not be the case.

Surface Water Quality. There is the potential for some of the excavated material to generate acidic leachate. To prevent this from occurring, rock with greater than one tenth of one percent sulfur either will be isolated or treated so that it does not come into contact with rain or surface water, or placed on an impermeable membrane so that runoff from the material can be collected and treated, if necessary.

Parking. There is not adequate summer parking for the additional staff that will be employed in the new laboratory. As a condition of the lease for construction and use of the facility, the University will provide car-pooling options or "park and ride" facilities to ensure that employee parking is accommodated.

Historical Resources. Soudan Underground Mine is on the National Register of Historic Places. It is important that the new laboratory is developed and used in a manner that does not detract from the site's historic significance. The State Historic

Preservation Office must approve any alterations to the site. The DNR and the University will continue to work with Historical Society staff in this regard.

B. *Cumulative potential effects of related or anticipated future projects*:

There are no anticipated future projects in the Soudan Mine. The existing laboratory has not created negative environmental effects and the DNR does not expect additional or cumulative effects from the proposed new laboratory.

C. *Extent to which the environmental effects are subject to mitigation by on-going public regulatory authority*:

The proposed project will be subject to a lease negotiated between the University of Minnesota and the DNR. The lease may be modified or terminated if unforeseen environmental effects should occur. The lease also will require environmentally safe decommissioning of the site when the project terminates.

The MPCA regulates water discharge quality. Although the proposed project is not expected to affect the quality of discharged water, the site will be monitored regularly with remedial steps taken if necessary.

D. *Extent to which environmental effects can be anticipated and controlled as a result of other environmental studies undertaken by public agencies or the project proposer or of EISs previously prepared on similar projects.*

In anticipation of the proposed construction, a study evaluating Soudan mine bat occupancy and recommending protection measures was completed in 1996. The study recommends that blasting begin before September, in the fall, or no earlier than May, in the spring. In addition, the study recommends a follow-up observation and monitoring program before and during construction. The DNR and the University will cooperatively implement these recommendations.

The DNR Division of Minerals has conducted extensive research on the generation, treatment, and prevention of acid mine waste. The results of this effort will be employed to prevent any additional acid runoff generation or metals leaching at the site.

Although not part of the proposed project, the DNR is using the results of this research to develop treatment and mitigation recommendations for the current dewatering discharge at the mine.

CONCLUSIONS

1. The Department of Natural Resources has fulfilled all relevant procedural requirements of law or rule applicable to the consideration of the need for an Environmental Impact Statement on the University of Minnesota's proposed construction of a second underground laboratory in Soudan Underground Mine State Park, in St. Louis County, Minnesota

2. The potential environmental effects of the project can be anticipated and controlled as a result of other studies undertaken by the DNR and other public agencies.

3. There are no elements of the project that pose the potential for significant environmental effects that cannot be addressed through proper project design and on-going regulatory processes.

4. Based on consideration of the criteria and factors specified in the Minnesota Environmental Review Program Rules, and on the findings and record in this matter, the DNR determines that the University of Minnesota's proposed construction of a second laboratory in Soudan Underground Mine State Park, in St. Louis County, Minnesota does not have the potential for significant environmental effects.

5. An Environmental Impact Statement on the proposed the University of Minnesota's proposed construction of a second laboratory in Soudan Underground Mine State Park, in St. Louis County, Minnesota is not required.

6. Any Findings that might properly be termed Conclusions and any Conclusions that might properly be termed Findings are hereby adopted as such.

ORDER

Based on the above Findings of Fact and Conclusions:

The Department of Natural Resources determines that an Environmental Impact Statement is not required for construction of the University of Minnesota's proposed laboratory in Soudan Underground Mine State Park.

Dated this 26th day of September, 1997.

STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES

Ronald Nargang

RONALD NARGANG
Deputy Commissioner

APPENDIX B:

Correspondence with State and Federal Agencies Concerning Threatened and Endangered Species

ILLINOIS
DEPARTMENT OF
NATURAL RESOURCES

524 South Second Street, Springfield 62701-1787

Jim Edgar, Governor ● Brent Manning, Director

August 29, 1997

Brian Smith
Consoer Townsend Envirodyne Engineers, Inc.
303 East Wacker Drive, Suite 600
Chicago, Illinois 60601-5212

Re: Endangered Species Consultation, #44121
Proposed Fermilab Expansion, Kane County

Dear Mr. Smith:

Thank you for your call clarifying the project limits and providing new information regarding the bird species identified in my last letter. No further coordination with this office will be necessary since no State agency or local unit of government will perform, fund, or approve the proposed project.

Additionally, our original concerns regarding impacts to the resources identified earlier have been abated due to 1) no wetland impacts anticipated, and 2) the colonial nesting birds have abandoned the site.

Thank you for the opportunity to comment on this project. If you have any questions or need additional information, please do not hesitate to contact me at (217) 785-5500.

Sincerely,

Kim M. Roman

Kim M. Roman
Project Manager
Endangered Species Consultation Program

[printed on recycled and recyclable paper]

CTE ENGINEERS

CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.

303 East Wacker Drive

Suite 600

Chicago, Illinois 60601-5212

Phone: (312) 938 0300

Fax: (312) 938 1109

July 1, 1997

Illinois Department of Natural Resources
Division of Natural Resources Review and Coordination
Attention: Dr. Deanna Glosser
524 South Second Street
Springfield, IL 62701-1787

Subject: Fermi National Accelerator Laboratory
Proposed Neutrino Beams for the Main Injector Project
Batavia, Illinois

Dear Dr. Glosser,

The Fermi National Accelerator Laboratory (Fermilab) is intending to install a new facility for the study of neutrinos and their interactions with matter. This facility will be an underground tunnel which will be utilized to aim a high flux beam along a trajectory. The underground tunnel will be approximately 1.5 kilometers long and 6.6 meters in diameter. In support of this new facility, two service buildings and parking lot will be built at the surface level.

In preparation for this new facility, Fermilab is preparing an Environmental Assessment. Consoer Townsend Envirodyne Engineers, Inc. has already conducted a wetland identification/delineation study of the corridor to support the Environmental Assessment. If it is determined that any wetland impacts would occur as a result of this project, a Section 404 permit application will be submitted.

In anticipation of a possible permit application, and in support of the Environmental Assessment, we are hereby requesting that the Illinois Department of Natural Resources examine their data base to determine if the potential exists for the presence of endangered or threatened species within the project corridor.

Fermilab is located in Kane and DuPage Counties within the U.S.G.S. topographic quads Aurora North and Naperville, Illinois; the Neutrino project will be located in Section 25 of Township 39N, Range 8E. We have enclosed a project location map and a copy of the National Wetland Inventory map with the

CTE ENGINEERS
CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.

project area delineated on it. We would appreciate your advising us as to the potential presence of sensitive species.

Thank you.

Sincerely,

CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.

Cheryl M. Nash

Cheryl M. Nash
Environmental Scientist

c: Dr. J. Donald Cossairt, Fermi National Accelerator Laboratory

CTE ENGINEERS
CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.

303 East Wacker Drive
Suite 600
Chicago, Illinois 60601-5212
Phone: (312) 938 0300
Fax: (312) 938 1109

July 1, 1997

U. S. Fish and Wildlife Service
Attention: Ms. Amelia Orton-Palmer
1000 Hart Road
Suite 180
Barrington, IL 60010

Subject: Fermi National Accelerator Laboratory
Proposed Neutrino Beams for the Main Injector Project
Batavia, Illinois

Dear Ms. Orton-Palmer,

The Fermi National Accelerator Laboratory (Fermilab) is intending to install a new facility for the study of neutrinos and their interactions with matter. This facility will be an underground tunnel which will be utilized to aim a high flux beam along a trajectory. The underground tunnel will be approximately 1.5 kilometers long and 6.6 meters in diameter. In support of this new facility, two service buildings and parking lot will be built at the surface level.

In preparation for this new facility, Fermilab is preparing an Environmental Assessment. Consoer Townsend Envirodyne Engineers, Inc. has already conducted a wetland identification/delineation study of the corridor to support the Environmental Assessment. If it is determined that any wetland impacts would occur as a result of this project, a Section 404 permit application will be submitted.

In anticipation of a possible permit application, and in support of the Environmental Assessment, we are hereby requesting that U. S. Fish and Wildlife Service examine their data base to determine if the potential exists for the presence of endangered or threatened species within the project corridor.

Fermilab is located in Kane and DuPage Counties within the U.S.G.S. topographic quads Aurora North and Naperville, Illinois; the Neutrino project will be located in Section 25 of Township 39N, Range 8E. We have enclosed a project location map and a copy of the National Wetland Inventory map with the

CTE ENGINEERS
CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.

project area delineated on it. We would appreciate your advising us as to the potential presence of sensitive species.

Thank you.

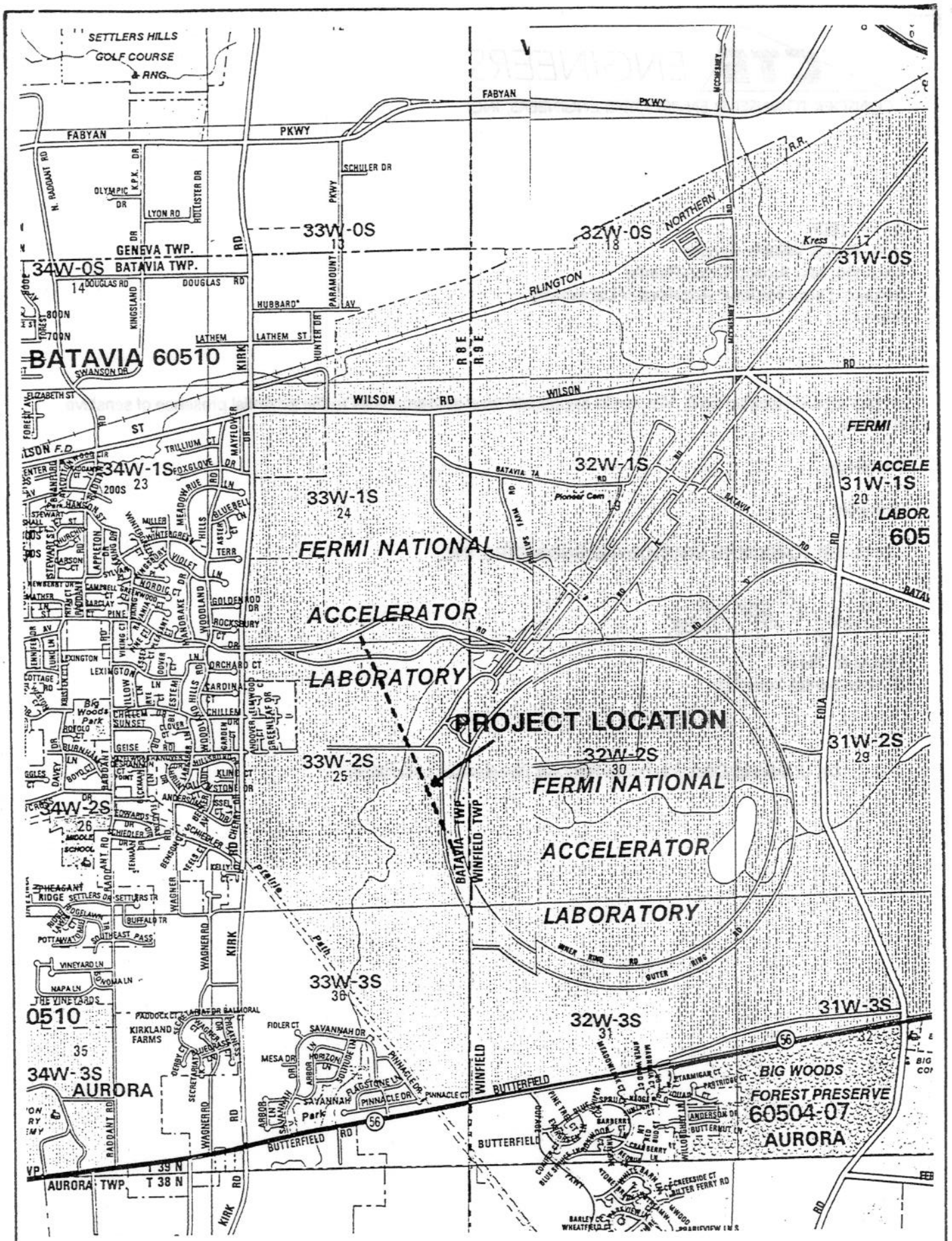
Sincerely,

CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.

Cheryl M. Nash

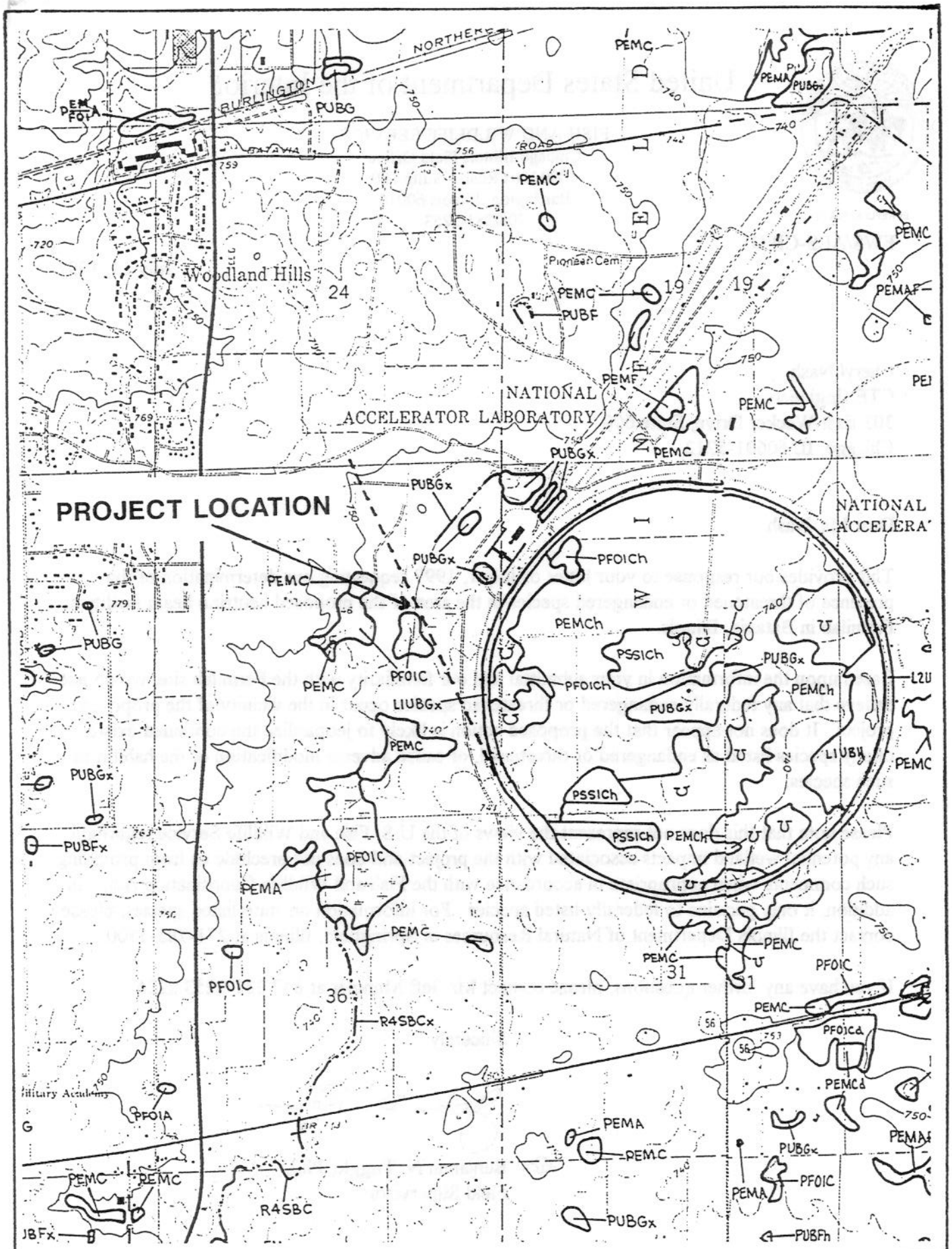
Cheryl M. Nash
Environmental Scientist

c: Dr. J. Donald Cossairt, Fermi National Accelerator Laboratory



Consoer Townsend Envirodyne Engineers, Inc.
303 East Wacker Drive
Chicago, Illinois 60601
(312) 938-0300

Fermi National Accelerator Laboratory
Proposed Neutrino Beams for the Main Injector Project
Exhibit 1: Project Location Map



Consoer Townsend Envirodyne Engineers, Inc.
303 East Wacker Drive
Chicago, Illinois 60601
(312) 938-0300

Fermi National Accelerator Laboratory
Proposed Neutrino Beams for the Main Injector Project
Exhibit 2: National Wetland Inventory Map

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Chicago Illinois Field Office
1000 Hart Road – Suite 180
Barrington, Illinois 60010
708/381-2253

IN REPLY REFER TO:

FWS/AES-CIFO

July 23, 1997

Cheryl Nash
CTE Engineers
303 East Wacker Drive, Suite 600
Chicago, IL 60601-5212

Dear Ms. Nash:

This provides our response to your letter of July 1, 1997 requesting our determination of the presence of threatened or endangered species in the area of the proposed neutrino beam facility at Fermilab in Batavia, Illinois.

Based upon the information in your submittal and our familiarity with the Fermilab site, we do not believe that any federally endangered or threatened species occur in the vicinity of the proposed project. It does not appear that the proposed action is likely to jeopardize the continued existence of any species listed as endangered or threatened, or cause adverse modification of the habitat of such species.

Please note that this does not represent the views of the U.S. Fish and Wildlife Service regarding any potential wetland impacts associated with the project and does not preclude us from providing such comments when appropriate in accordance with the Fish and Wildlife Coordination Act. In addition, it only pertains to federally-listed species. For information on state-listed species, please contact the Illinois Department of Natural Resources in Springfield, Illinois at 271-785-5500.

If you have any further questions, please contact Mr. Jeff Mengler at 847/381-2253 x226.

Sincerely,

John D. Rogner

for Benjamin N. Tuggle, Ph.D.
Field Supervisor

ILLINOIS
DEPARTMENT OF
NATURAL RESOURCES

524 South Second Street, Springfield 62701-1787 Jim Edgar, Governor ● Brent Manning, Director

August 12, 1997

Cheryl M. Nash
Environmental Scientist
Consoer Townsend Envirodyne Engineers, Inc.
303 East Wacker Drive, Suite 600
Chicago, Illinois 60601-5212

RE: Endangered Species Consultation, #44121
Proposed Fermilab Expansion, Kane County

Dear Ms. Nash:

Thank you for sending the above project to this office for review of the presence of endangered and threatened species, Illinois Natural Area Inventory (INAI) sites, and dedicated Illinois Nature Preserves. As we discussed on the phone today, our database shows records for several State-listed bird species within and adjacent to the Fermilab boundaries (listed below, and shown on enclosed map).

Common Name	Status	Nesting Habitat/Location
Upland Sandpiper	Endangered	Fermilab prairie restoration area
Loggerhead Shrike	Threatened	Open grasslands with hedgerows
Brown Creeper	Threatened	Floodplain forest, north of Prairie Path
Great Egret	Threatened	Center of ring, on Logo Lake
Black-Crowned Night Heron	Endangered	Center of ring, on Logo Lake

It is likely these species use a larger area than what is shown on the map. Our database cannot conclusively state the presence or absence of a particular species; we can only relay *known* species occurrences at the time of the request.

Impacts to the upland sandpiper and loggerhead shrike are considered unlikely because their habitats appear to be restricted to outside the project area. However, since wetlands may be affected by the construction of the new facility, impacts to the other species will need a more thorough evaluation. The brown creeper may utilize the floodplain where the underground tunnel is proposed to cross. What impacts are anticipated to the riparian area because of the

[printed on recycled and recyclable paper]

construction? Does suitable habitat for this species exist? The great egret and black-crowned night heron are known to forage several miles from their nesting sites. Are there any wetlands used for foraging in the vicinity of the proposed tunnel? Will construction activities and excessively loud blasting (for the creation of the tunnel) take place during critical nesting periods?

Although this project is early in the planning stages, the Endangered Species Consultation Process will remain "open" until impacts to these species have been evaluated. Termination of this process is mandatory before any environmentally altering project is either performed, funded, or authorized/permitted by a State agency or local unit of government.

Also be aware, if any portion of this project will be **funded** by an Illinois State agency, the Interagency Wetlands Policy Act (IWPA) must be followed, in addition to complying with Federal regulations administered by the U.S. Army Corps of Engineers. Questions regarding the IWPA can be directed to Mr. Pat Malone, of this office.

I assume the remaining segments of the project corridor will follow shortly. Since the project corridor is extensive and potential impacts to a wide variety of natural resources exist, I recommend submitting several copies of the project description (and accompanying maps) to this office so they can be distributed to appropriate divisions within the Department. This will facilitate a thorough review, and comments from the Department can be considered in the Environmental Assessment.

If you would like to discuss this project, please do not hesitate to contact me or Mr. Malone at 217-785-5500.

Sincerely,

Kim M Roman

Kim M. Roman
Project Manager
Endangered Species Consultation Program

Map Enclosed

cc: Pat Malone (e-mail)

CTE ENGINEERS
CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.

303 East Wacker Drive
Suite 600
Chicago, Illinois 60601-5212
Phone: (312) 938 0300
Fax: (312) 938 1109

August 20, 1997

Fermi National Accelerator Laboratory
Attention: Dr. J. Donald Cossairt
P. O. Box 500
Batavia, Illinois 60510

Subject: Nutrino Beams for the Main Injector Project
Threatened and Endangered Species

Dear Dr. Cossairt,

We have received responses to our requests for information on threatened or endangered species at Fermilab from the U.S. Department of Interior's Fish and Wildlife Service and the Illinois Department of Natural Resources. These responses are attached and can be included in the Environmental Assessment.

The U.S. Department of Interior's Fish and Wildlife Service advises that no federally endangered or threatened species are known to occur within the vicinity of the proposed project. Therefore, this letter constitutes Fermilab's sign-off for federal projects.

The Illinois Department of Natural Resources (IDNR) advises that the potential exists for the presence of five state endangered or threatened species within the project area. IDNR has requested additional information be provided for three of these species. The additional information may not be required if Fermilab's response can satisfy the IDNR that wetland habitat would not be disturbed by the proposed project. Furthermore, Fermilab or the Department of Energy may not be required to provide the additional information since they are a Federal rather than State agency.

In addition, IDNR has requested information on the "remaining segments of the project corridor". We believe this request is in response to a misunderstanding on their part with regards to the extent

CTE ENGINEERS
CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.

of the project. It appears that they are anticipating the project to be above ground throughout the distance to Minnesota.

CTE Engineers would be pleased to respond on behalf of Fermilab to IDNR's request for additional information. Should Fermilab or the Department of Energy desire to provide the threatened and endangered surveys, additional field work would be necessary. The field work necessary to determine the presence of these species is sensitive to seasonal timing. The presence of the Great Egret and Black-Crowned Night Heron could be addressed up until fall migration, or until approximately late September. Fermilab could assume any use of Indian Creek by these species would be for foraging only, since the habitat is not suitable for nesting. It is recommended that a survey for the presence of the Brown Creeper not be done until next spring, however, so that if it this species is found it can be determined it's presence is due to breeding, foraging, or migration.

Please advise if you wish CTE Engineers, Inc. to provide additional services. If you have any questions, please do not hesitate to contact us.

Sincerely,

CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.

Brian Smith
Project Manager

630-840-3390

CTE ENGINEERS

CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.

RECORD OF TELEPHONE CONVERSATION

Date: 8-25-97 **Job No.:** 44456

Time: 10:30am **Subject:** T&E Correspondence

Contact: Name: Kim Roman **Affiliation:** IDNR
Phone No.: 217-785-5500 **File No:**

Initiated by: x **Contact** ___ **Author** **Sheet No.:** 1 **of** 1

Summary of Discussion:

I called Ms. Roman to discuss the 8/12/97 correspondence from her office. Regarding the last paragraph concerning the extensive length of the corridor, I informed Ms. Roman the project construction was limited to Fermilab property. I explained there would be no constructing of a tunnel connecting Fermilab to Minnesota and that the beams are to be shot through the Earth's crust. She agreed there was a misunderstanding and no further coordination is necessary as to the extent of the project.

I then asked if coordination was necessary if the project does not involve wetland impacts since the Section 404 issues would not come into play. She thought there may be a stream crossing which could trigger involvement. I will check the plans and report back to her whether or not there would be a permit required. I then told her that surveys for the Brown Creeper may not be necessary anyway, since construction activities are not near the mature trees which would be suitable habitat. She agreed surveys would not likely be necessary then. She said to keep in mind the noise impacts however and that if a situation does arrive the construction activity should be restricted during the breeding/nesting season.

Regarding bird surveys and potential wetland impacts, the IDNR may not require further coordination. Ms. Roman stated that if the project does **not** involve state or local funding, then the IDNR would not be involved further. I told her I thought that the project was using federal funds only but would check and report back.

Therefore it is unlikely that further coordination is necessary with IDNR. I will check on the stream crossing and the project funding source; then let Ms. Roman know so she can close the file.

pc: C. Nash

Author: Brian J. Smith

303 EAST WACKER DR. · CHICAGO, ILLINOIS 60601 · (312) 938-0300 · FAX (312) 938-1109

ILLINOIS
DEPARTMENT OF
NATURAL RESOURCES

524 South Second Street, Springfield 62701-1787 Jim Edgar, Governor ● Brent Manning, Director

August 29, 1997

Brian Smith
Consoer Townsend Envirodyne Engineers, Inc.
303 East Wacker Drive, Suite 600
Chicago, Illinois 60601-5212

Re: Endangered Species Consultation, #44121
Proposed Fermilab Expansion, Kane County

Dear Mr. Smith:

Thank you for your call clarifying the project limits and providing new information regarding the bird species identified in my last letter. No further coordination with this office will be necessary since no State agency or local unit of government will perform, fund, or approve the proposed project.

Additionally, our original concerns regarding impacts to the resources identified earlier have been abated due to 1) no wetland impacts anticipated, and 2) the colonial nesting birds have abandoned the site.

Thank you for the opportunity to comment on this project. If you have any questions or need additional information, please do not hesitate to contact me at (217) 785-5500.

Sincerely,

Kim M. Roman

Kim M. Roman
Project Manager
Endangered Species Consultation Program

[printed on recycled and recyclable paper]

APPENDIX C:

Figures Showing Beamline Details in the Region of the Extraction and Pretarget Areas

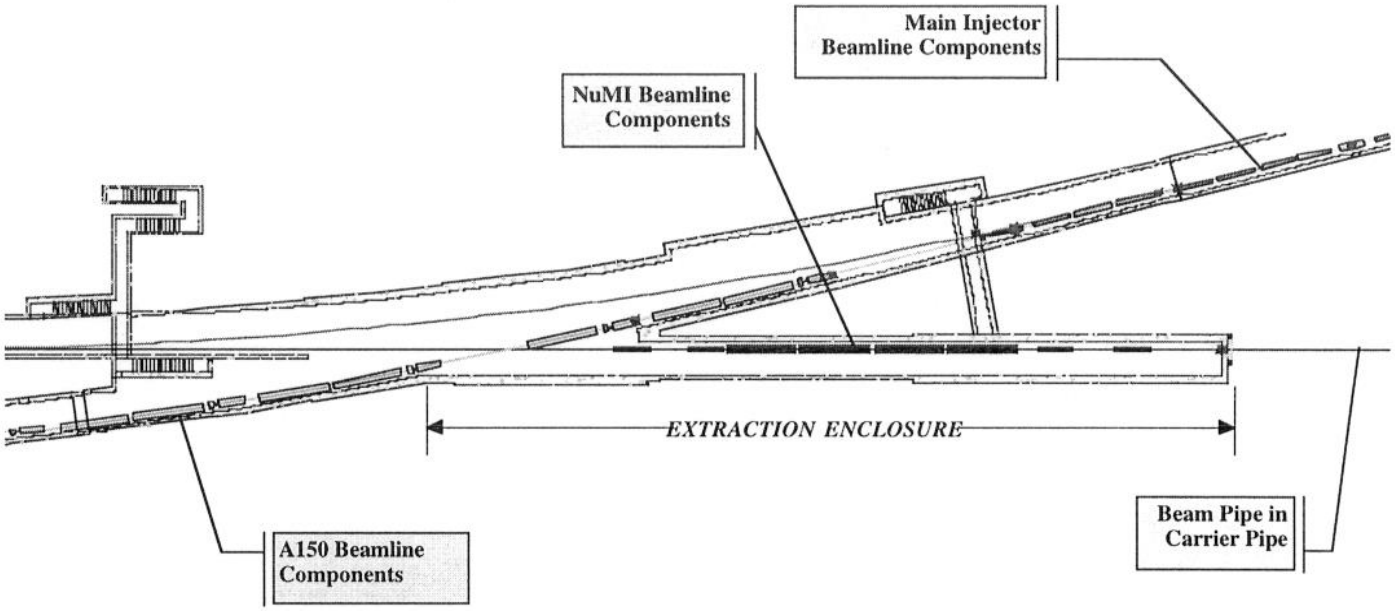


Figure C1a Conceptual plan view of beamline components used to extract the proton beam from the Fermilab Main Injector and direst it toward the target used to produce neutrinos. Beamline components such as electromagnets are indicated as small boxes in the Figure. The filled boxes are those associated with the extraction of the proton beam for NuMI while the open boxes are part of the Fermilab Main Injector.

NORTH

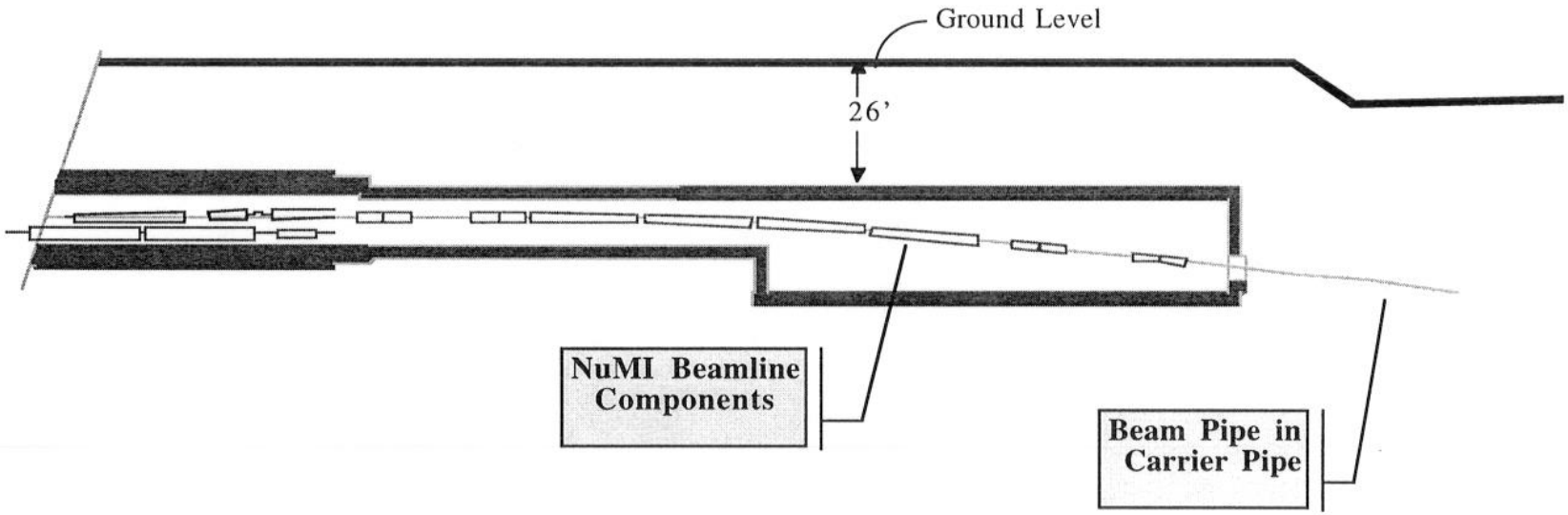


Figure C1b Conceptual elevation view of beamline components used to extract the proton beam from the Fermilab Main Injector and direct it toward the target used to produce the neutrinos. Beamline components such as electromagnets are indicated as small boxes in the Figure. The filled boxes are those associated with the extraction of the proton beam for NuMI while the open boxes are part of the Femilab Main Injector. (Not to scale.)

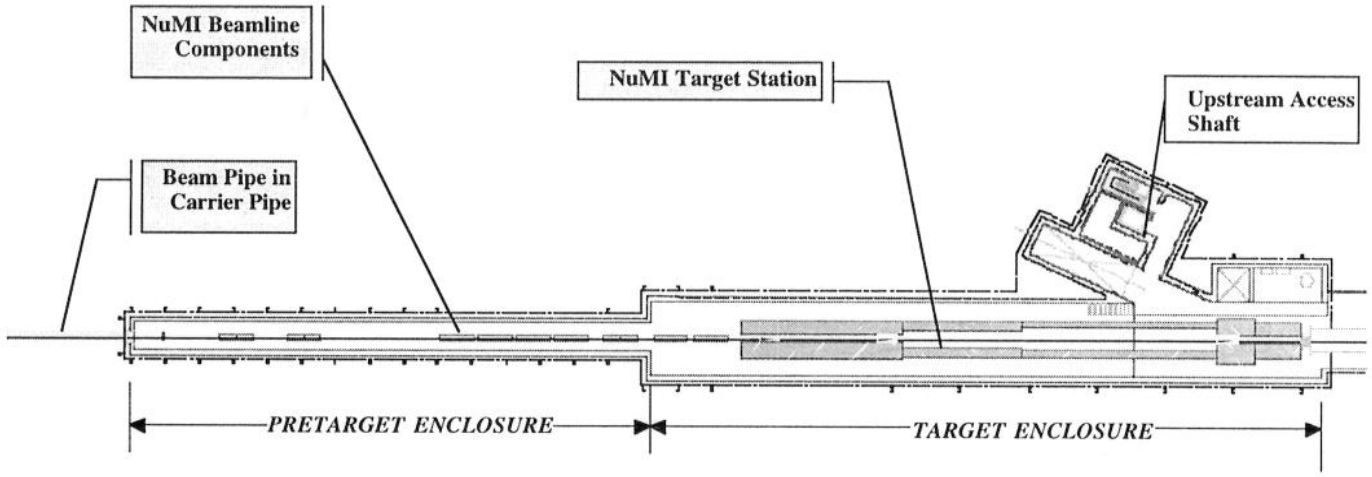


Figure C2a Conceptual plan view of the beamline components used to complete the delivery of the proton beam to the target used to produce the neutrinos. (not to scale)

NORTH

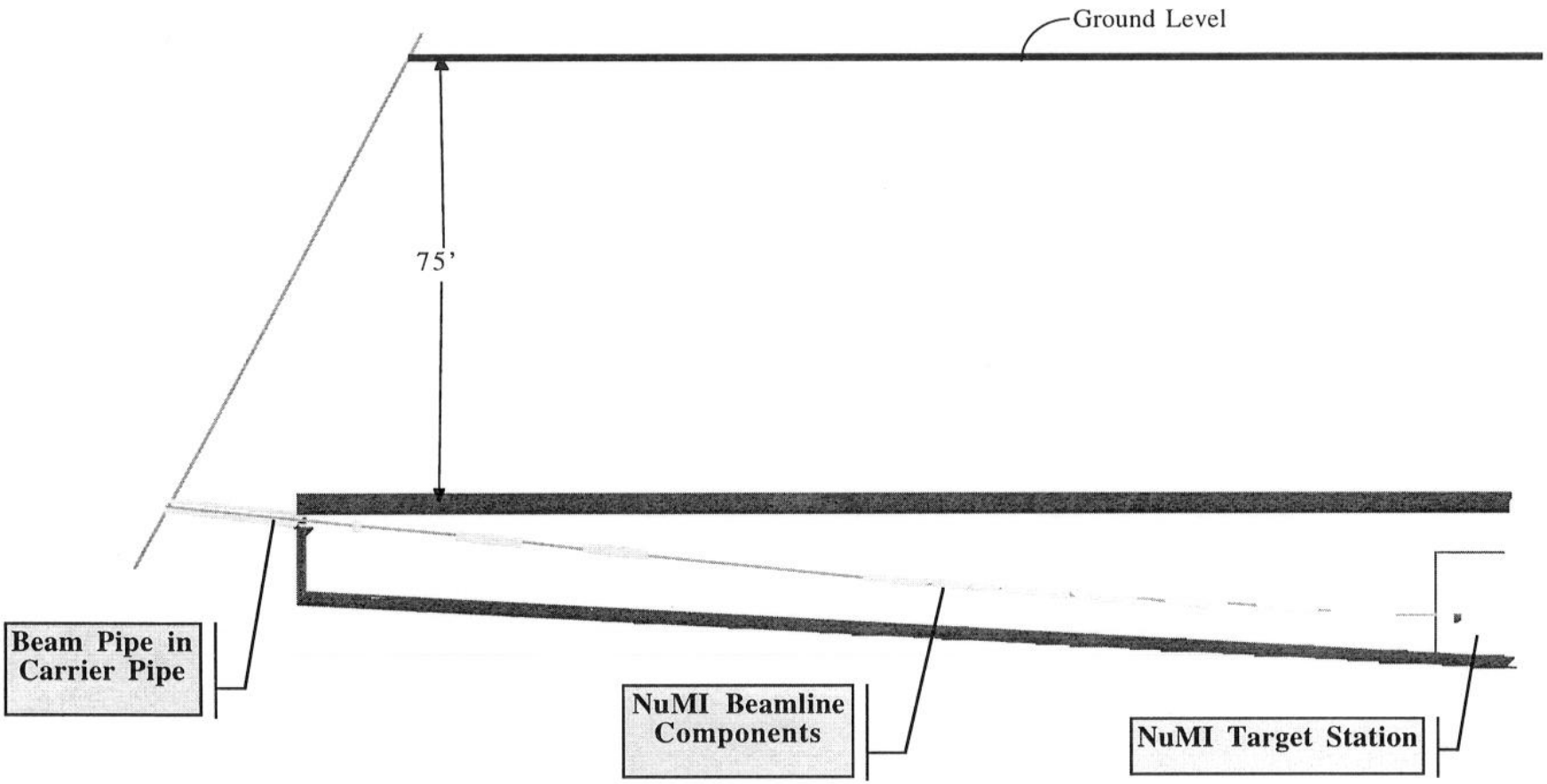


Figure C2b Conceptual elevation view of the beamline components used to complete the delivery of the proton beam to the target used to produce the neutrinos. (Not to scale.)