

# Planning for Future Initiatives at Soudan

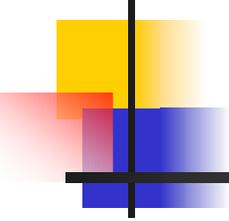


Marvin L. Marshak

*University of Minnesota*

May 15, 2003

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.



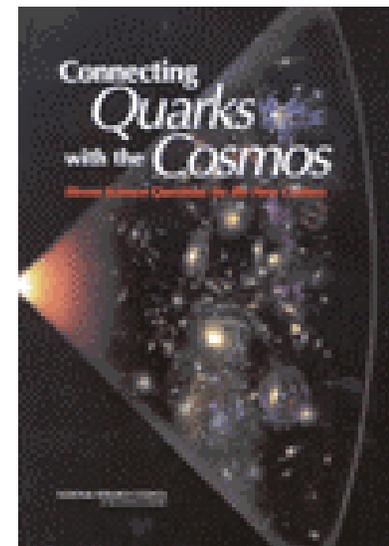
# Science Motivations

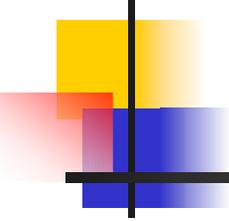
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- The NUMI beam and the Soudan Lab are a unique international resource
- What science questions can we address?
- Neutrino mass and couplings
- Dark Matter
- Nucleon stability

**Off-Axis**

**NUSEL**





# Goals of Off-Axis

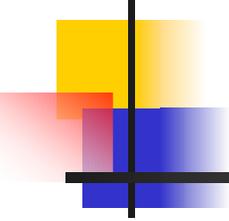
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- Measure  $\theta_{13}$
- Depending on  $\theta_{13}$  and  $\Delta m_{13}^2$ , then study matter effects, neutrino mass hierarchy and CP violation
- Requires 50 kT, low density, low Z detector with good ability to distinguish electrons from  $\pi^0$ 's

# NUSEL Science and Technology Foci

- Solar  $\nu$ 's
- $\beta\beta$  Decay
- Dark Matter
- Neutron Decay
- Atmospheric  $\nu$ 's
- Long baseline  $\nu$ 's
- Supernova  $\nu$ 's
- Nuclear astrophysics
- Geomicrobiology
- Geoscience

- Geoengineering
- New Understanding of Mineralization
- Materials Development
- Nuclear Nonproliferation
- Deep Underground Pumped Hydro Energy Storage



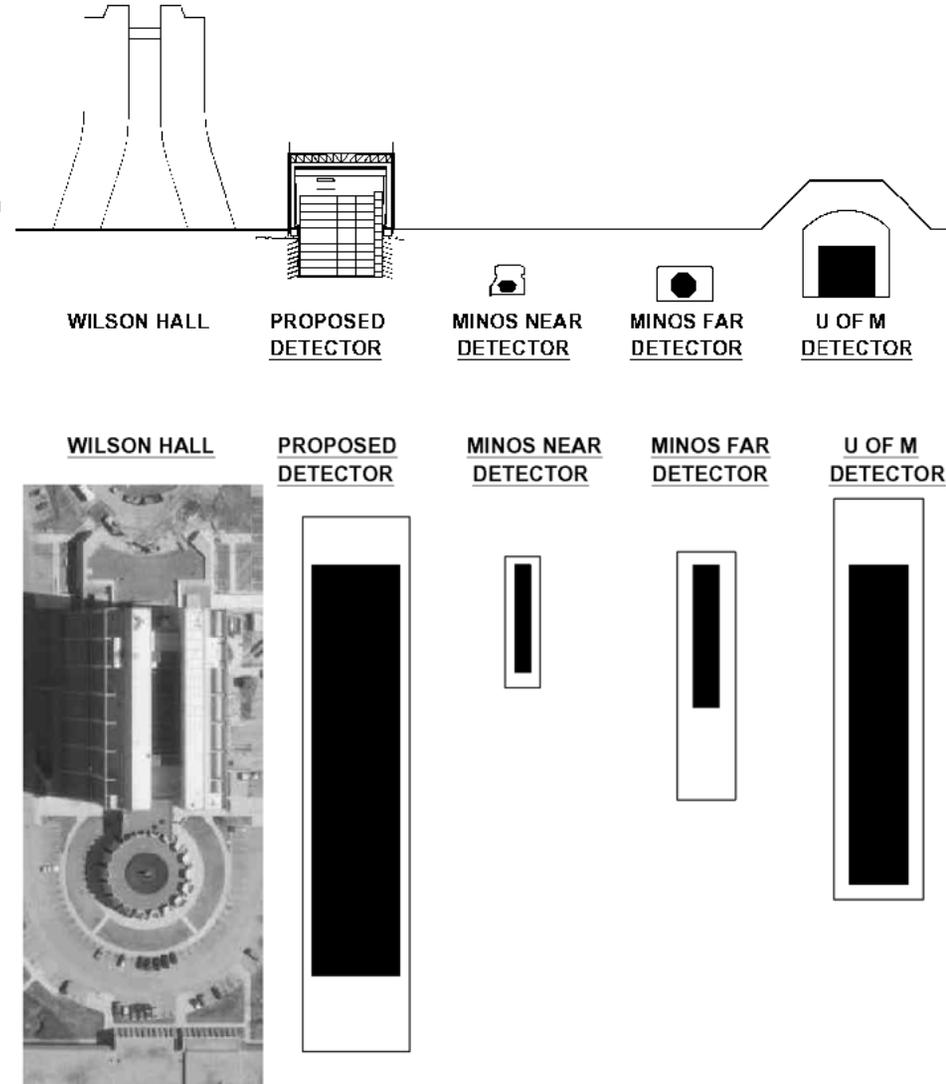
# Effectiveness and Efficiency

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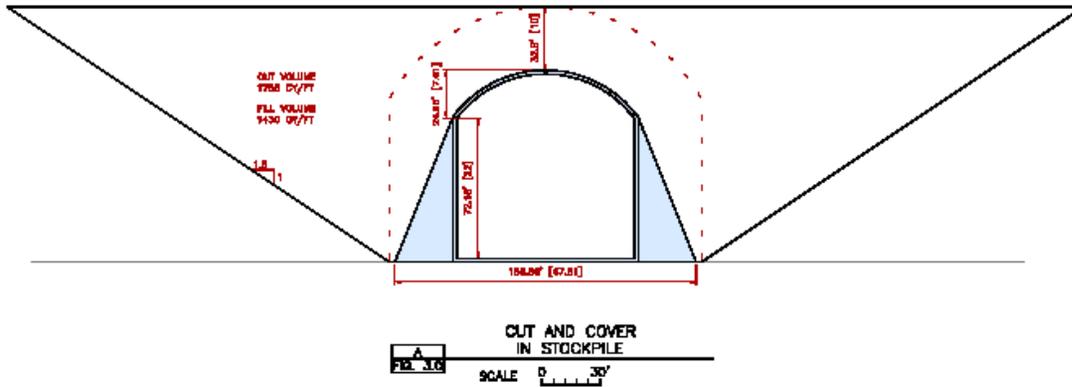
- What is common to both Off-Axis and Soudan NUSEL is the **effectiveness** and **efficiency** of the **University of Minnesota** as a partner to **Fermilab**
- **UM** is large enough to accept challenges and small enough to do them (\$2.2 billion budget, \$525 million in research)
- **UM** has extraordinary powers—constitutional corporation, powers of a municipality (permitting, condemnation, etc.), sovereign immunity
- **UM** has 23 years experience managing science at Soudan—project management, technical staff

# Off-Axis

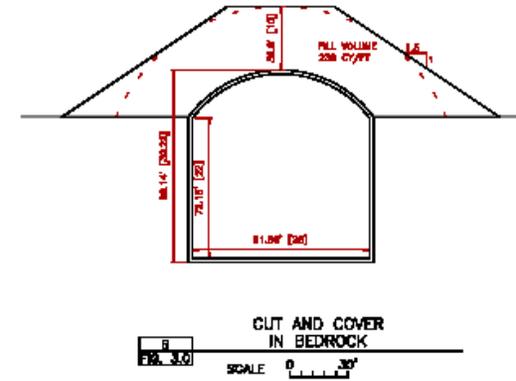
- 50 kiloton, low density, low Z detector



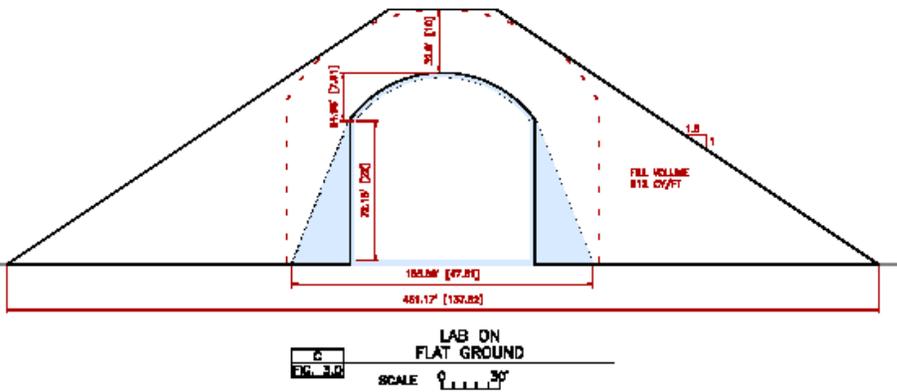
# Burial in Stockpile



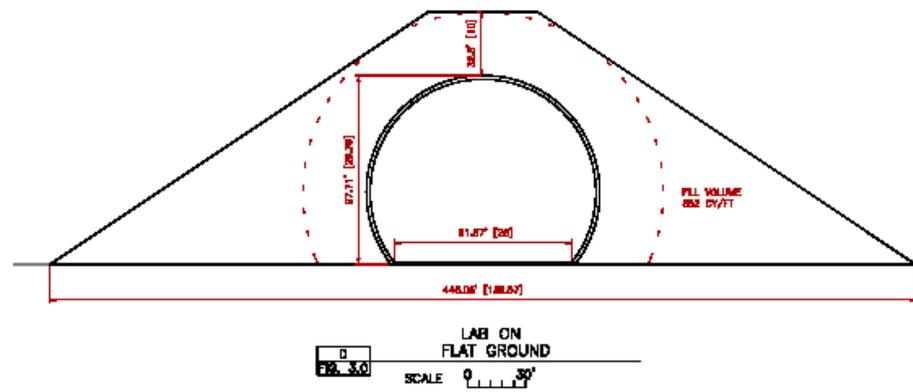
# Burial in Bedrock



# Burial on Flat Land



# Burial on Flat Land



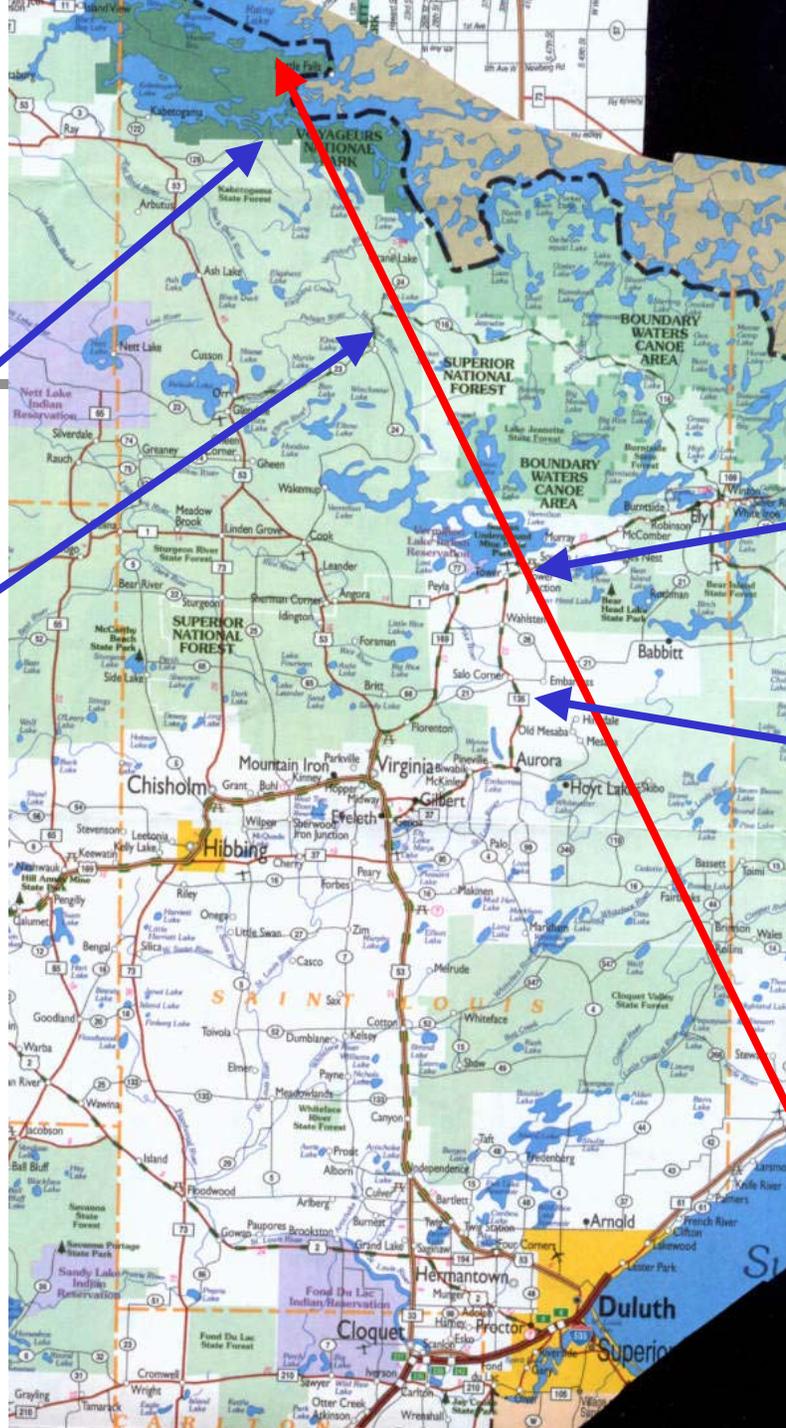
# Off-Axis Sites

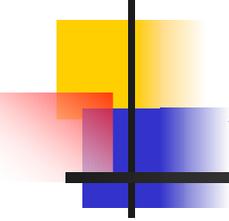
Ash River

Buyck

Soudan

Cliffs-Erie

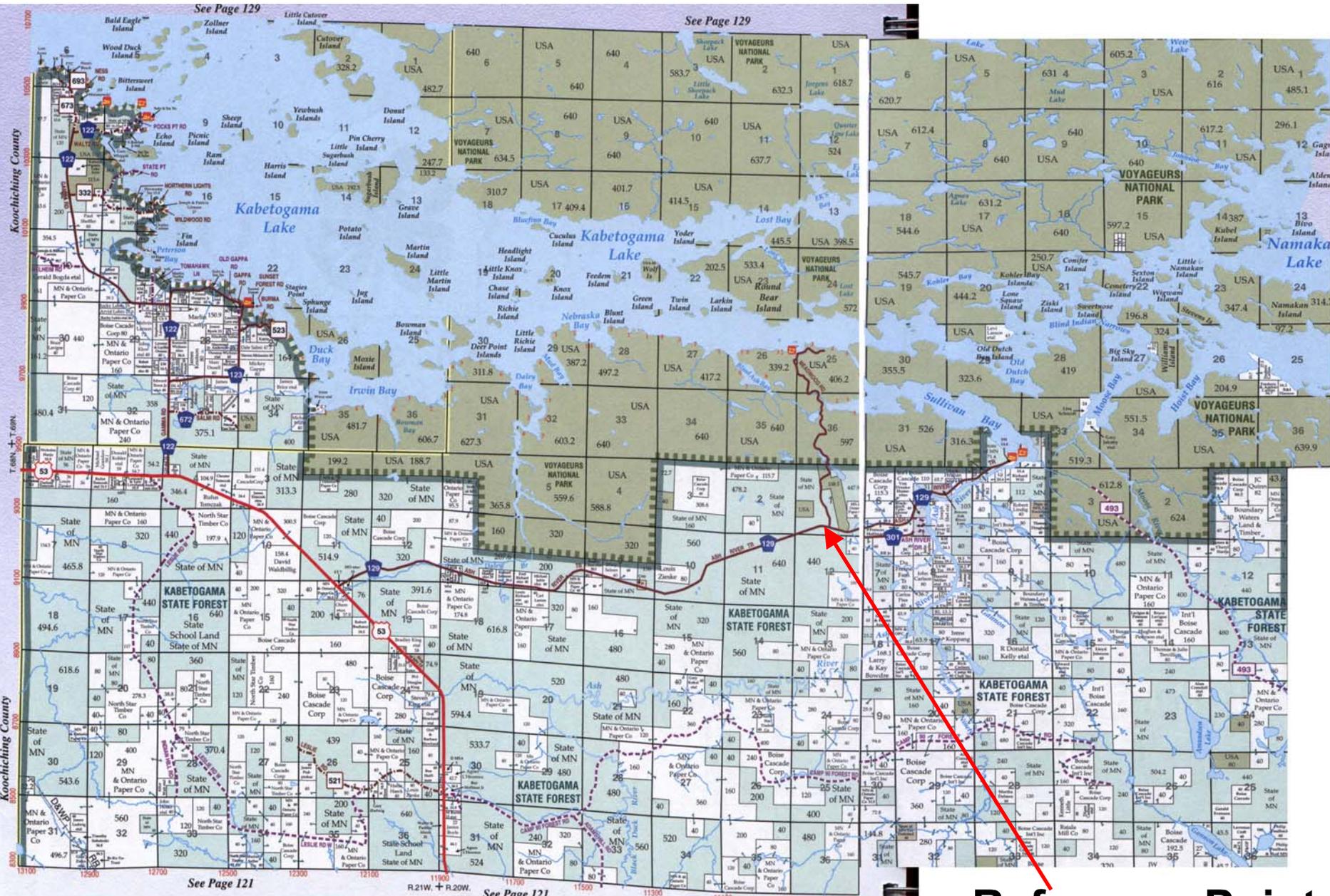




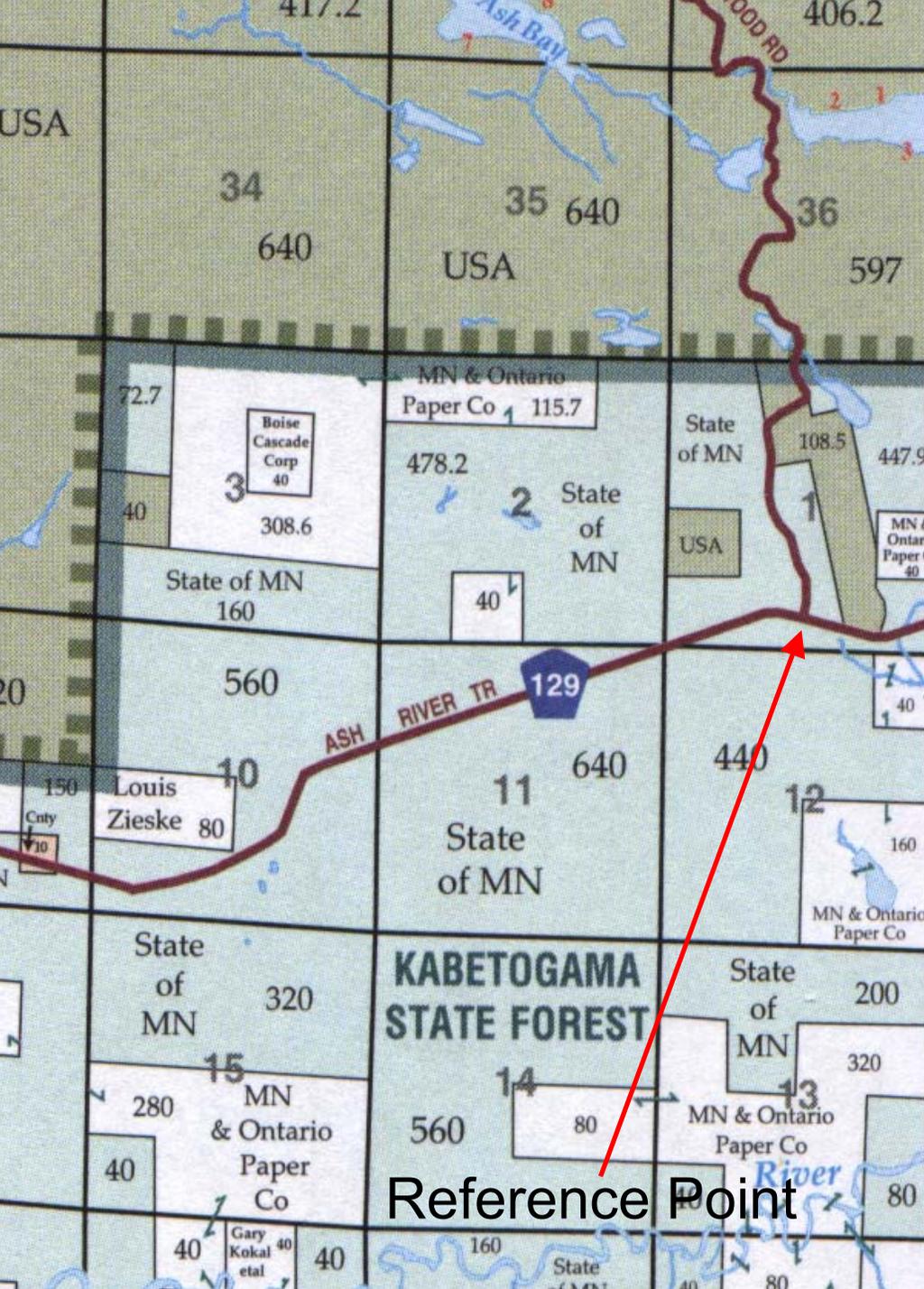
# Ash River

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- East of U.S. 53, SE of International Falls, southern border of Voyageurs' National Park (Intersection of Ash River Trail and Meadwood Road) 48.3979° N, 92.8373° W, 811.7 km from Fermilab, 11.8 km off-axis
- Land owned by State of Minnesota (Kabetogama State Forest), Boise Cascade and Minnesota and Ontario Paper Company

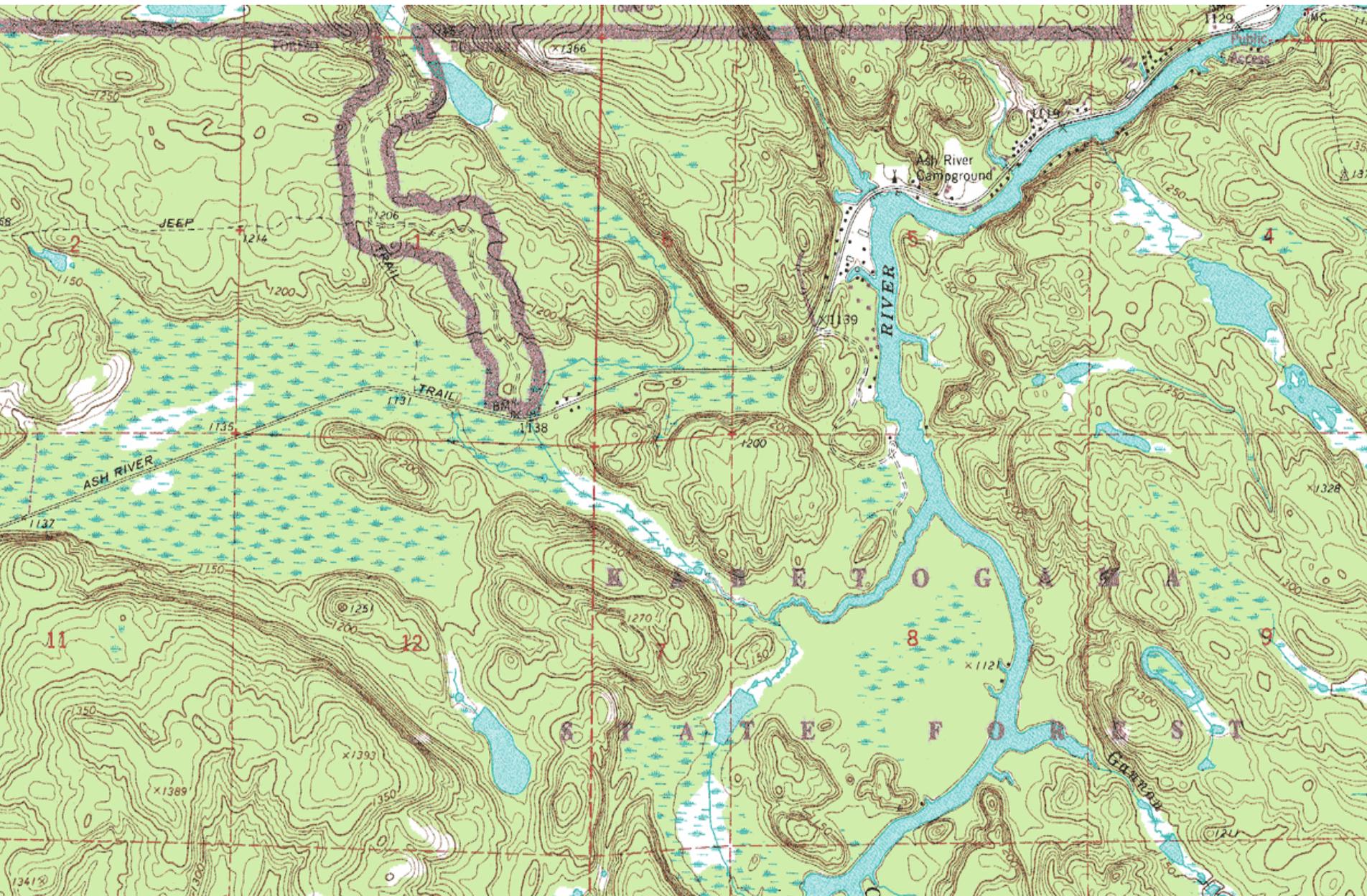


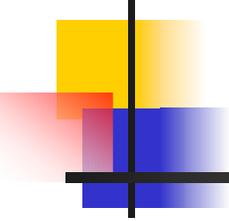
**Reference Point**  
10



Reference Point



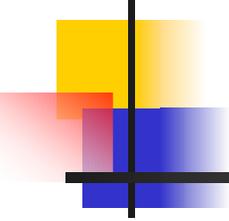




# Buyck

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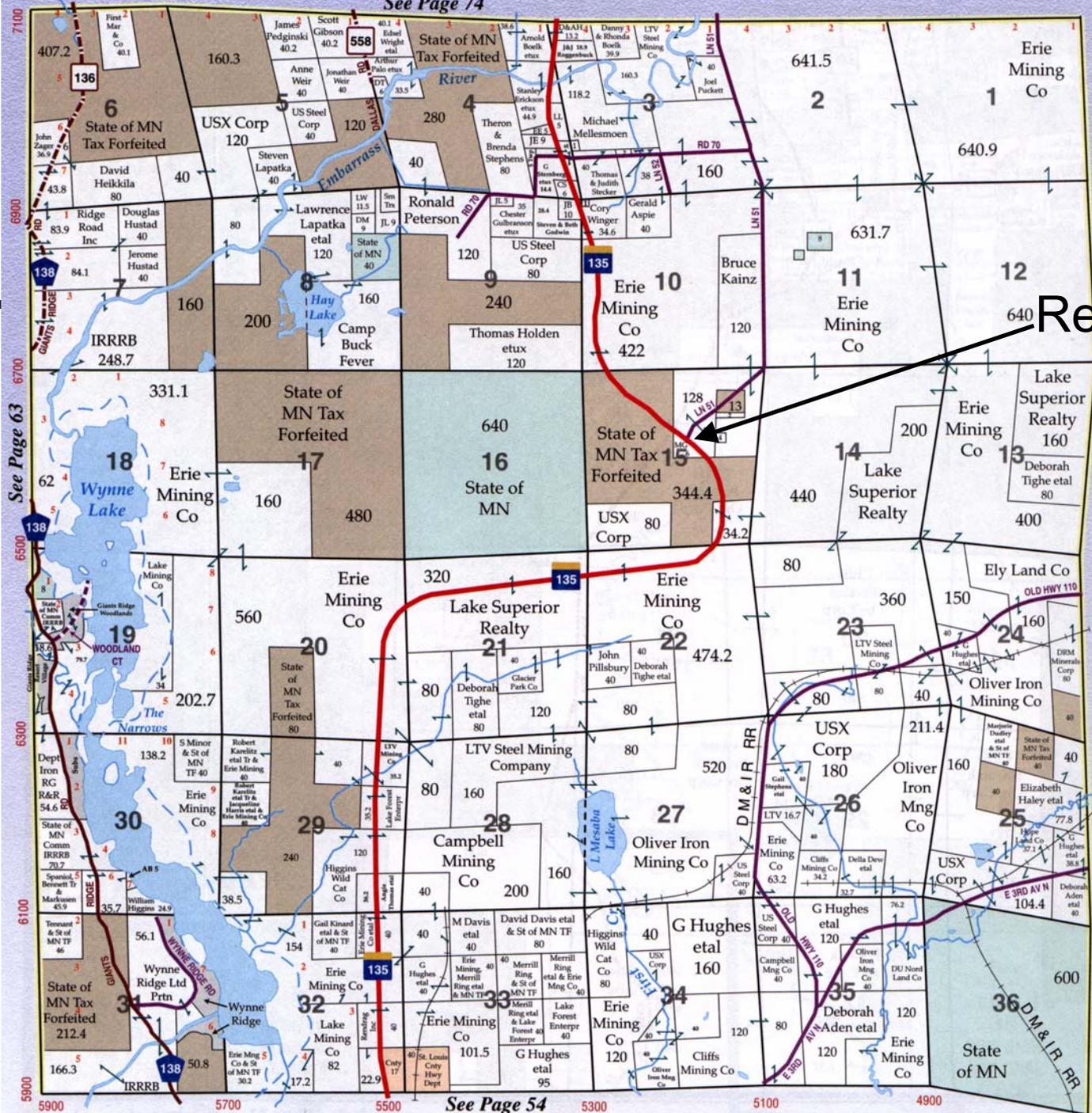
- East of U.S. 53 at Orr, MN. Intersection of County Road 23 (Orr-Buyck Road) and Unnamed Road from SE corner of Kjostad Lake  $48.099733^\circ$  W,  $92.582767^\circ$  N, 773.7 km from Fermilab, 9.3 km off-axis



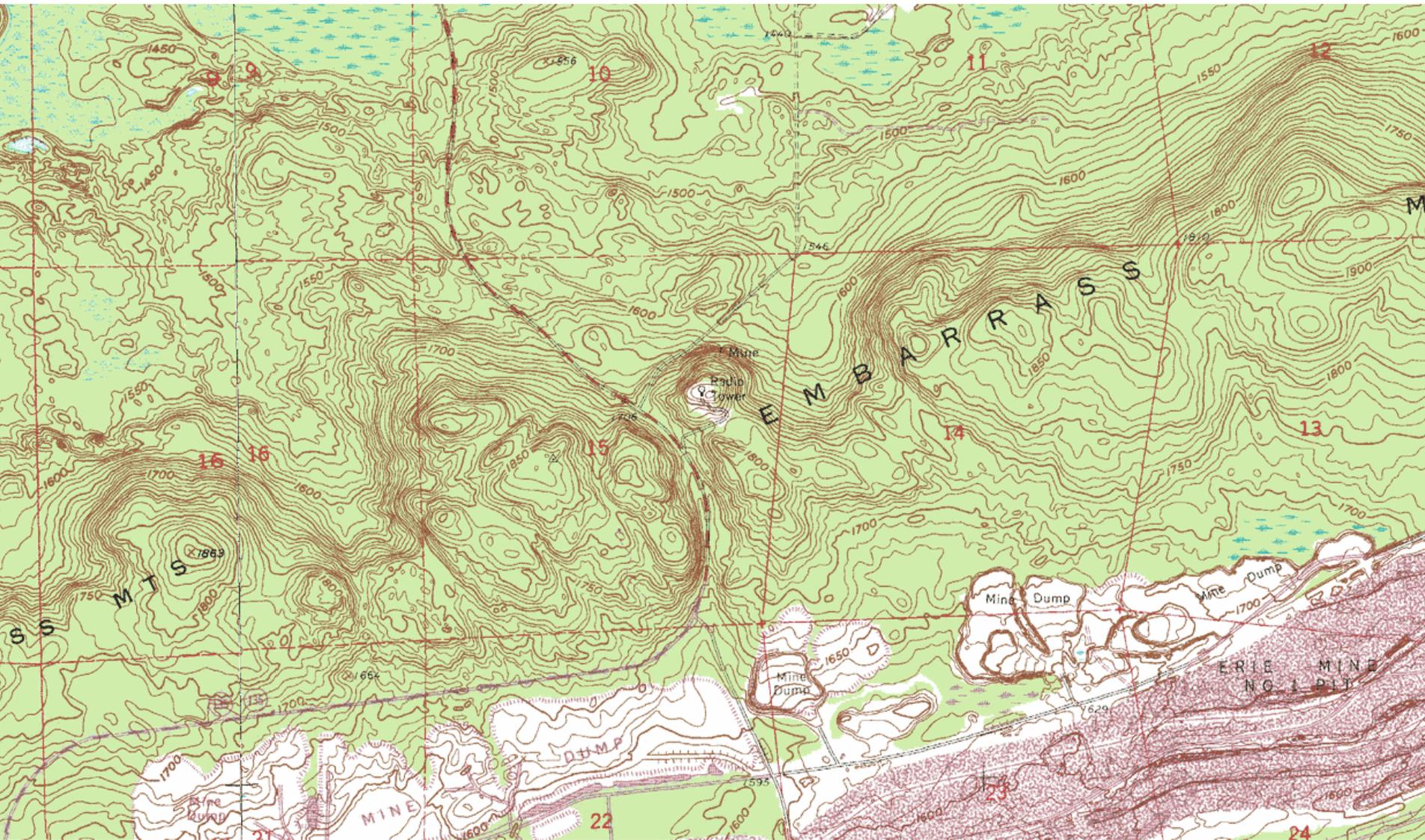
# Cliffs-Erie

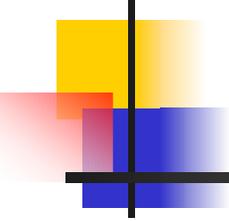
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- MN 135 north of Aurora, MN.  
Intersection of MN 135 and LN51  
47.598167° N, 92.228233° W, 712.1 km  
from Fermilab, 10.5 km off-axis



Reference P

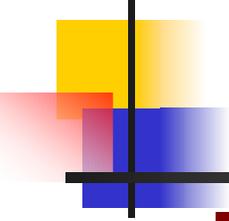




# Sites in Canada



- Three possible sites in Canada
- 40 km east of Fort Frances is just across Rainy Lake from Ash River
- 80 km NE of Fort Frances: very isolated
- 60 km east Kenora: most feasible site, requires study by Canadian collaborators (Scott Menary, York U.)



# Key Underground Science Lab Parameters

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- Depth (to reduce cosmic ray muon flux)
- Size (of laboratories and access)
- Ability to use difficult materials—for example, cryogenics and flammables (isolation, ventilation, life safety systems)

No. 8 Shaft

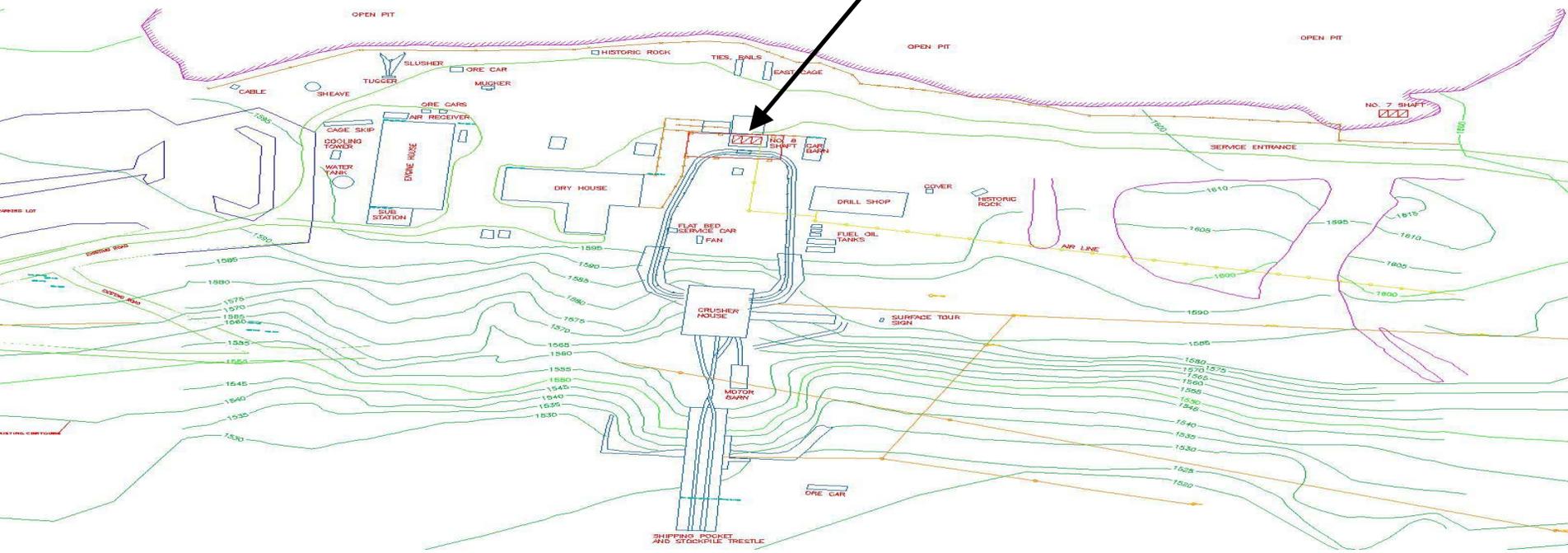


Fig. 2: Plan view of the surface area in the vicinity of the No. 8 shaft of the Soudan Mine.

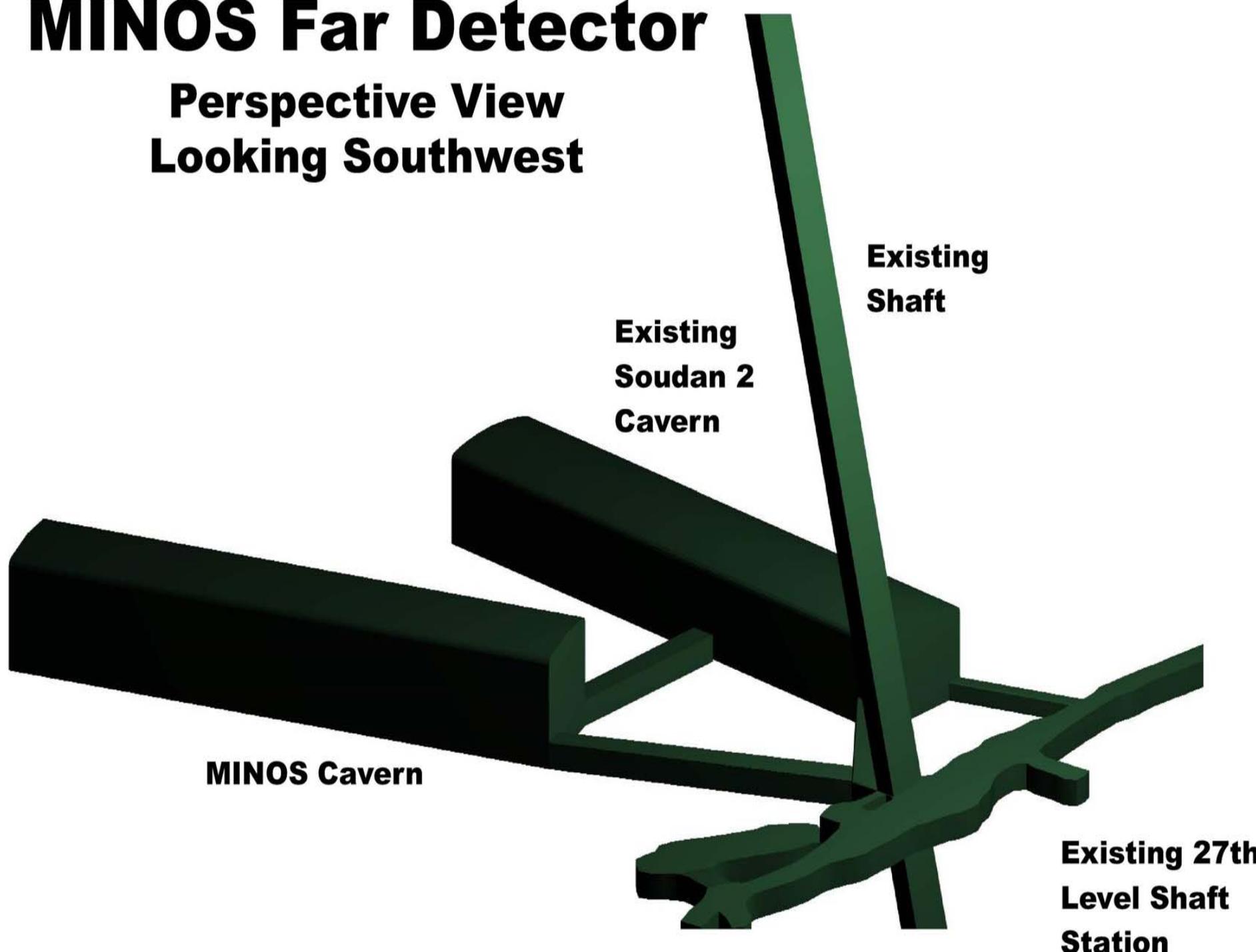
No. 8 Shaft

MINOS Surface Building  
MINOS Rock Pile



# MINOS Far Detector

Perspective View  
Looking Southwest

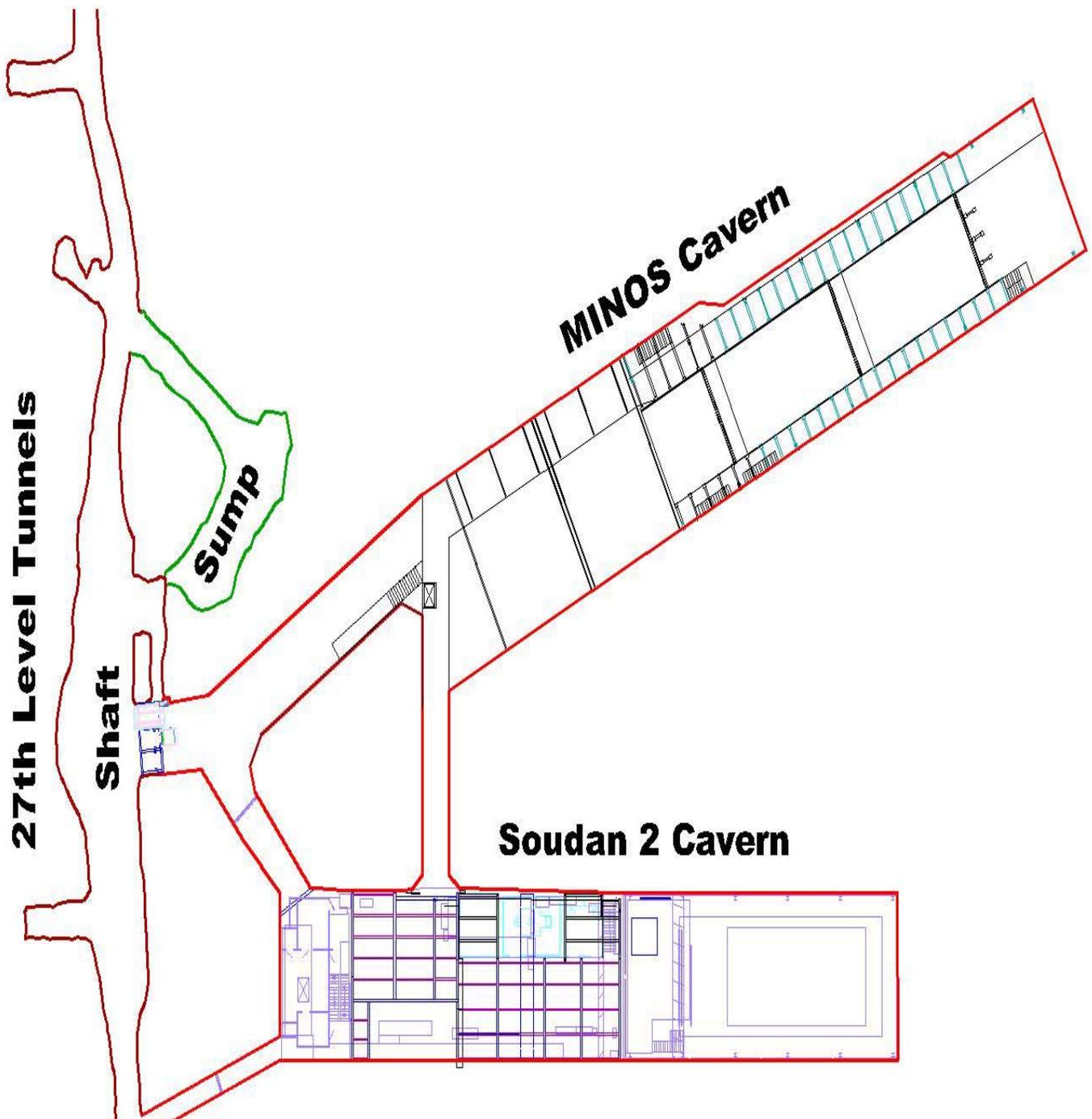
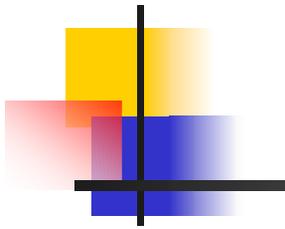


Existing  
Shaft

Existing  
Soudan 2  
Cavern

MINOS Cavern

Existing 27th  
Level Shaft  
Station



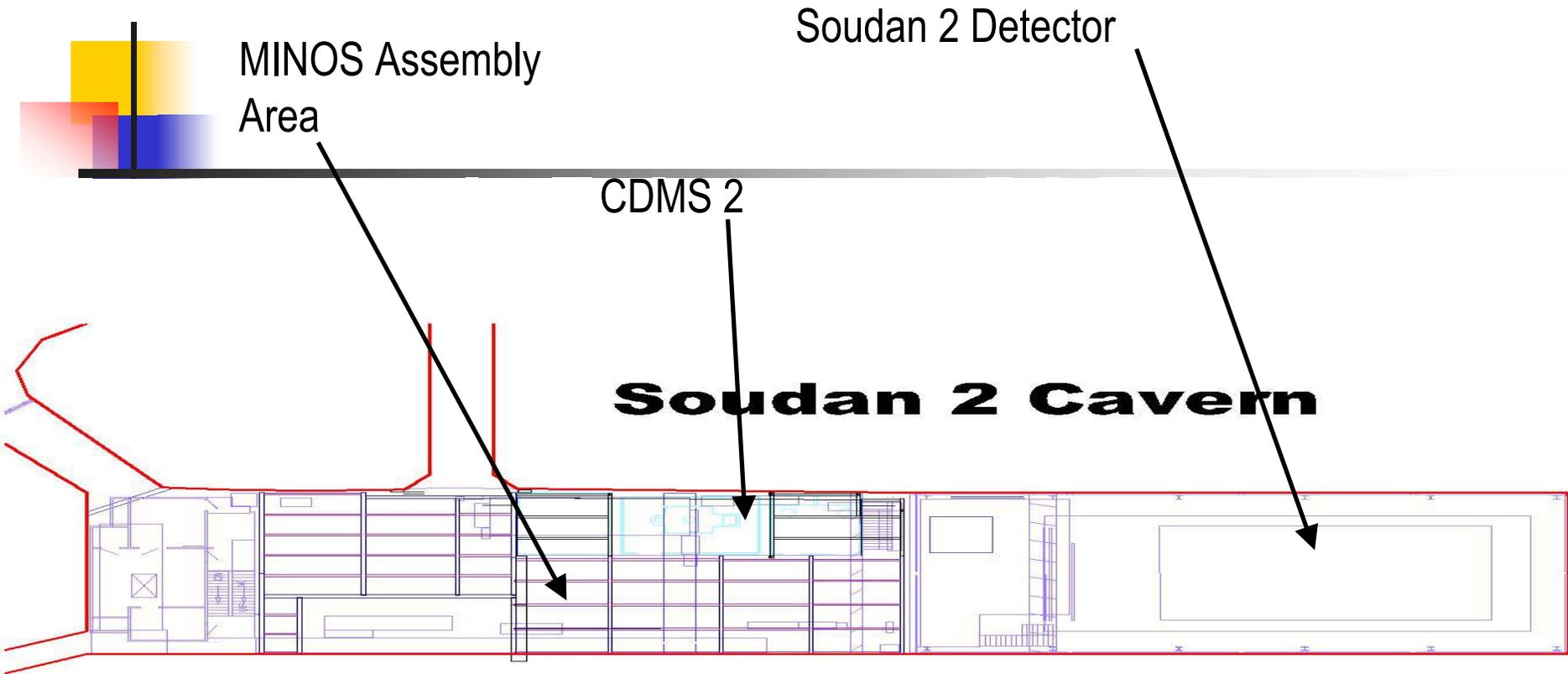


Fig. 10: A plan view of the Soudan 2 Laboratory.

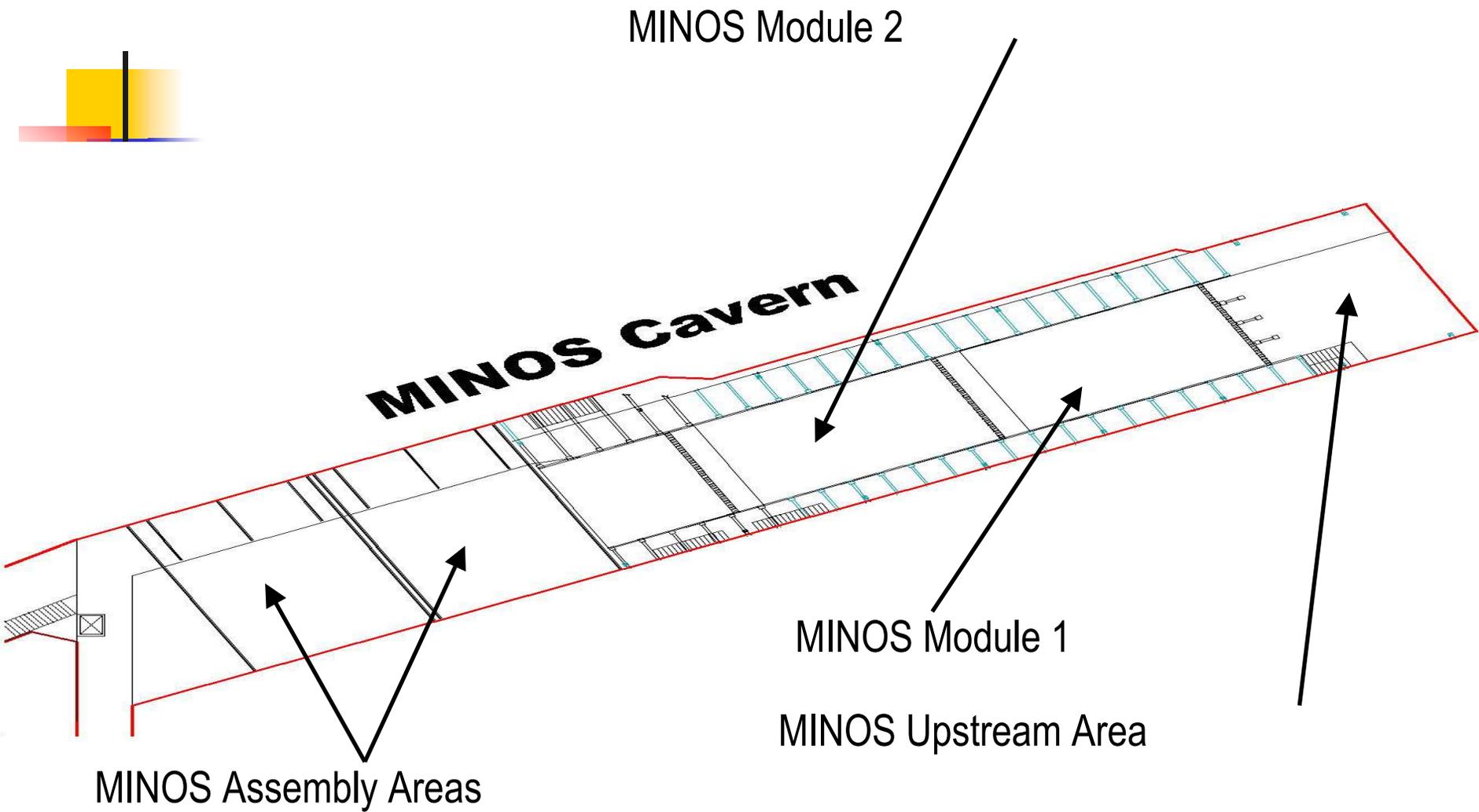


Fig. 13: Plan view of the MINOS Laboratory.

No. 8 Shaft

Proposed Expansion Area

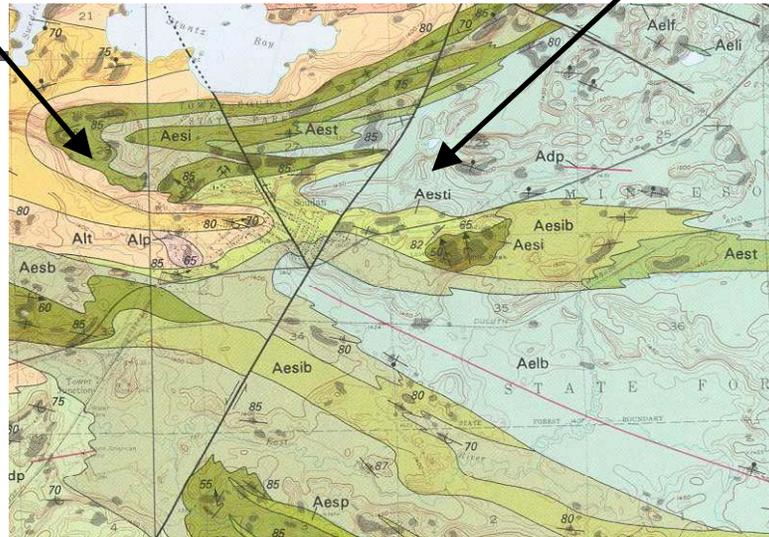


Fig. 4: A geological map of the area in the vicinity of the Soudan Mine. The grid shows sections with an area of 1 square mile. The rock shown as light blue is basalt. The various shades of green represent greenstone, jasper and iron ore.

No. 8 Shaft

Proposed Expansion Area

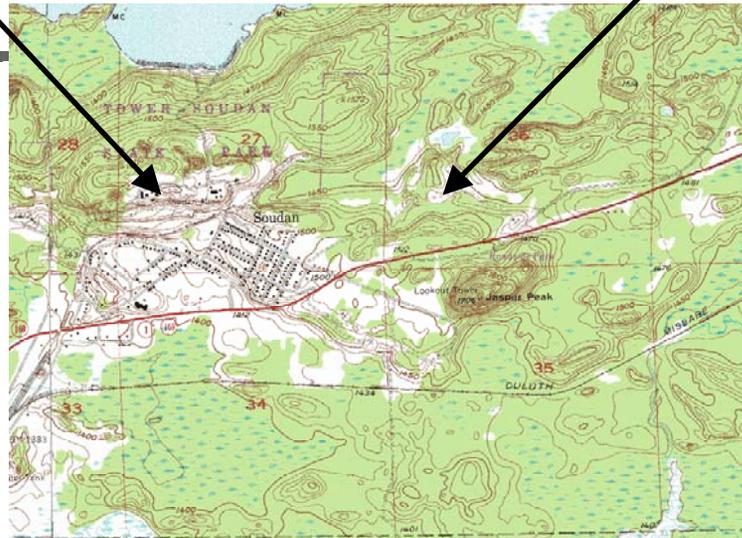


Fig. 5: The USGS 1:24000 topographic map of Sections 26, 27, 34 and 35 of T62N, R15W, St. Louis County, Minnesota. Minnesota Highway 169 is shown by the red line running mostly horizontally across the map. Jasper Peak is the most prominent elevation change. The locations of the No. 8 shaft and the proposed expansion area are marked.

No. 8 Shaft

Proposed Expansion Area

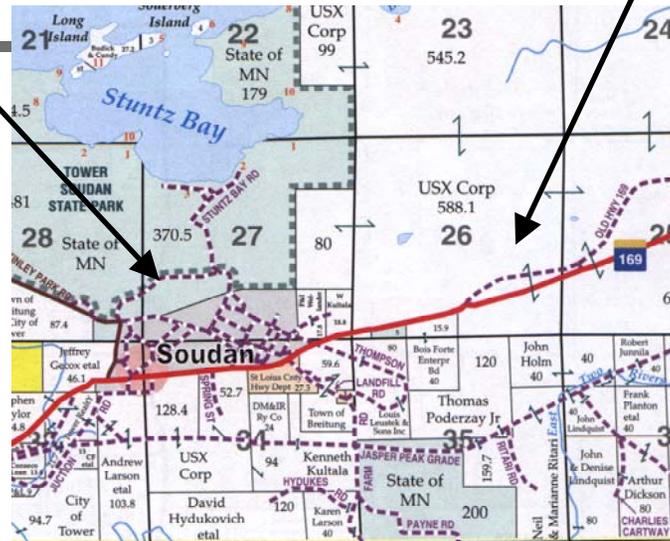


Fig. 6: The St. Louis County 2002 plat map of Sections 26, 27, 34 and 35 of T62N, R15W. Minnesota Highway 169 is shown by the red line running mostly horizontally across the map. The locations of the No. 8 shaft and the proposed expansion area are marked.

No. 8 Shaft

Proposed Expansion Area

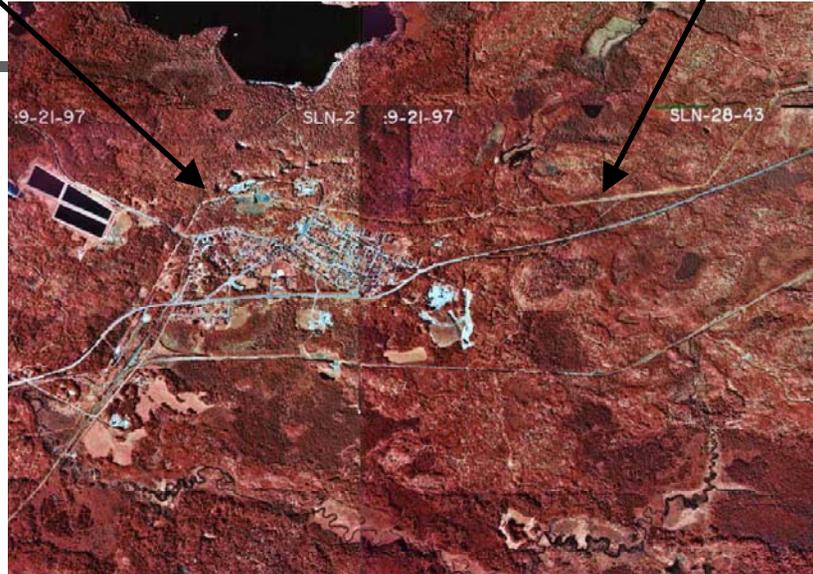
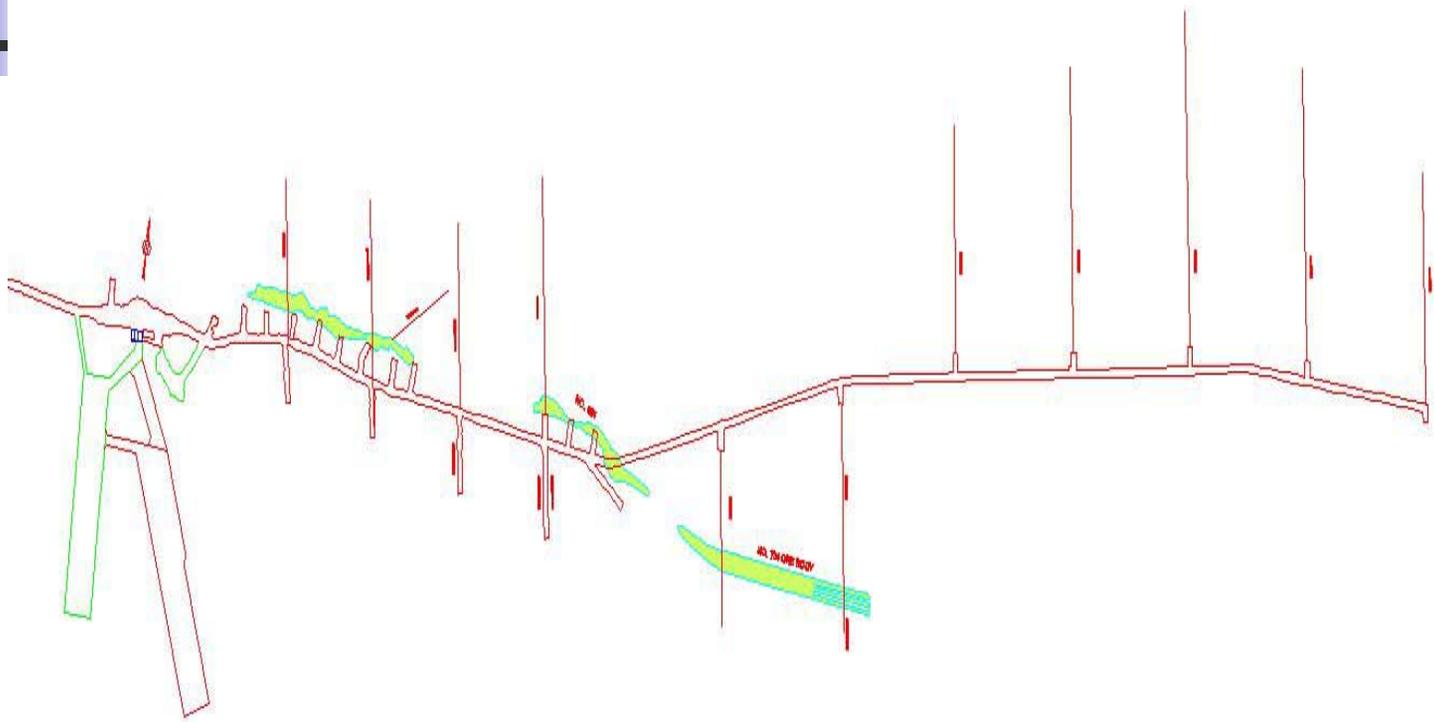
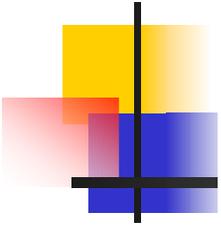
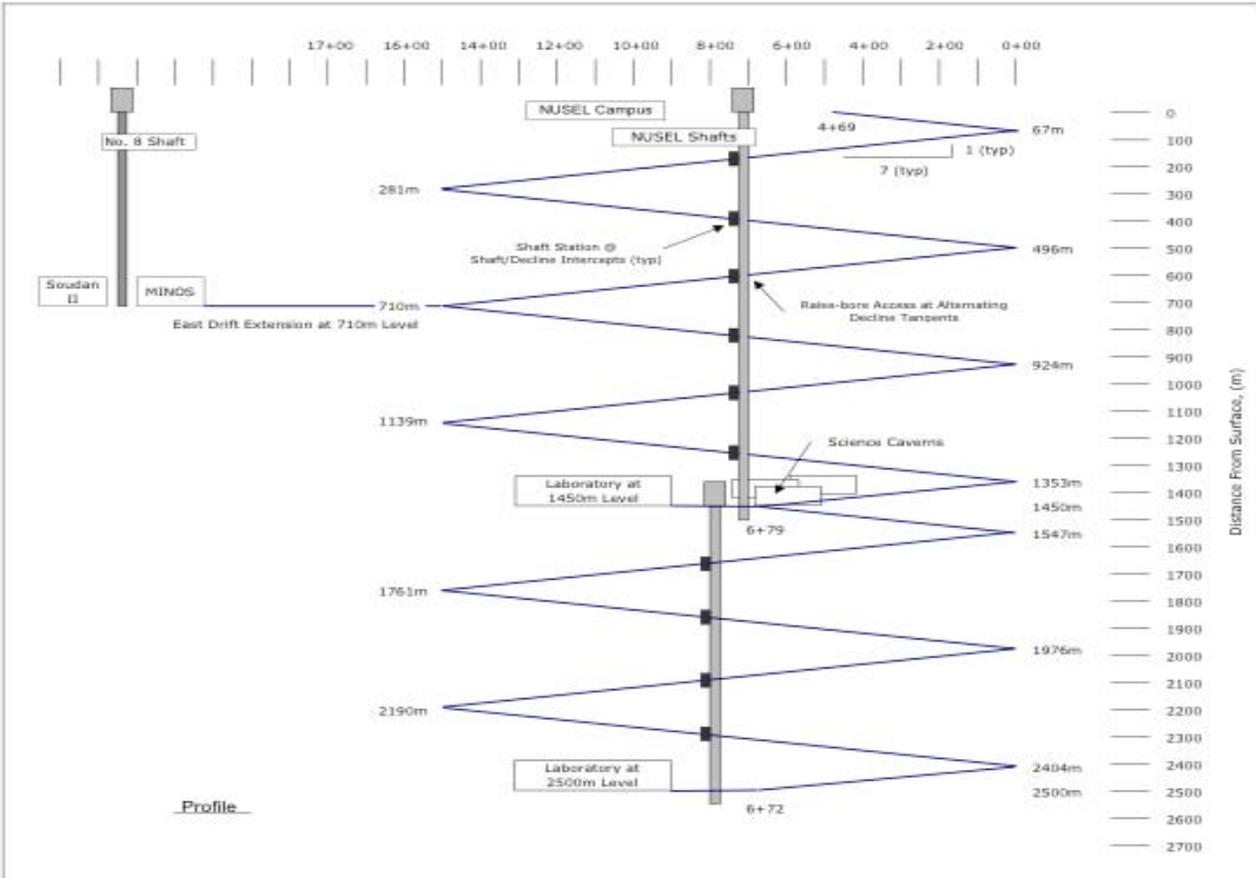
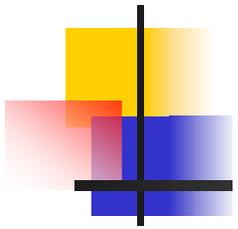
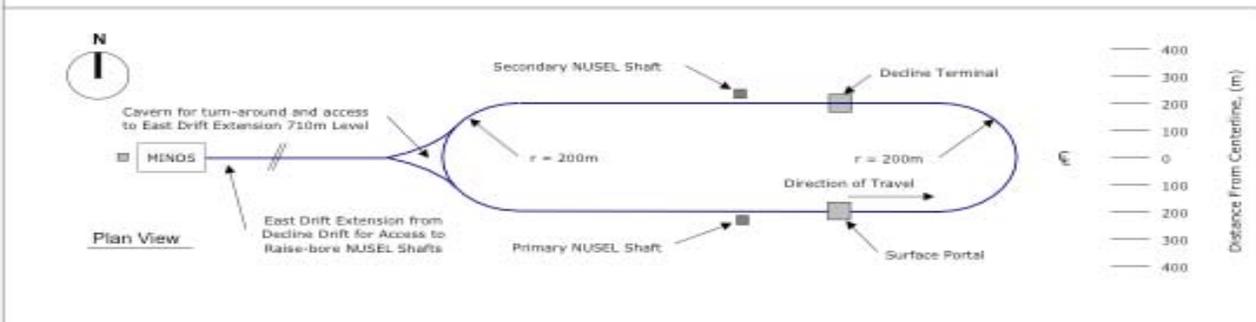


Fig. 7: Aerial photograph of the Soudan NUSEL area taken on September 21, 1997. Minnesota Highway 169 is the middle one of the three corridors crossing the photograph from west to east. The northern corridor is a powerline. The southern one is the abandoned DM&IR railroad.





Profile



Plan View

	<b>Soudan National Underground Science &amp; Engineering Laboratory (NUSEL)</b> Concept Plan - Decline Tunnel and East Drift Intercept	University of Minnesota Minneapolis, MN 	Layout: GRM Date: 05/01/03 Drawn by: Date: Chkd by: Date:	T-1
			Job No: P-LCPMN0309.00	

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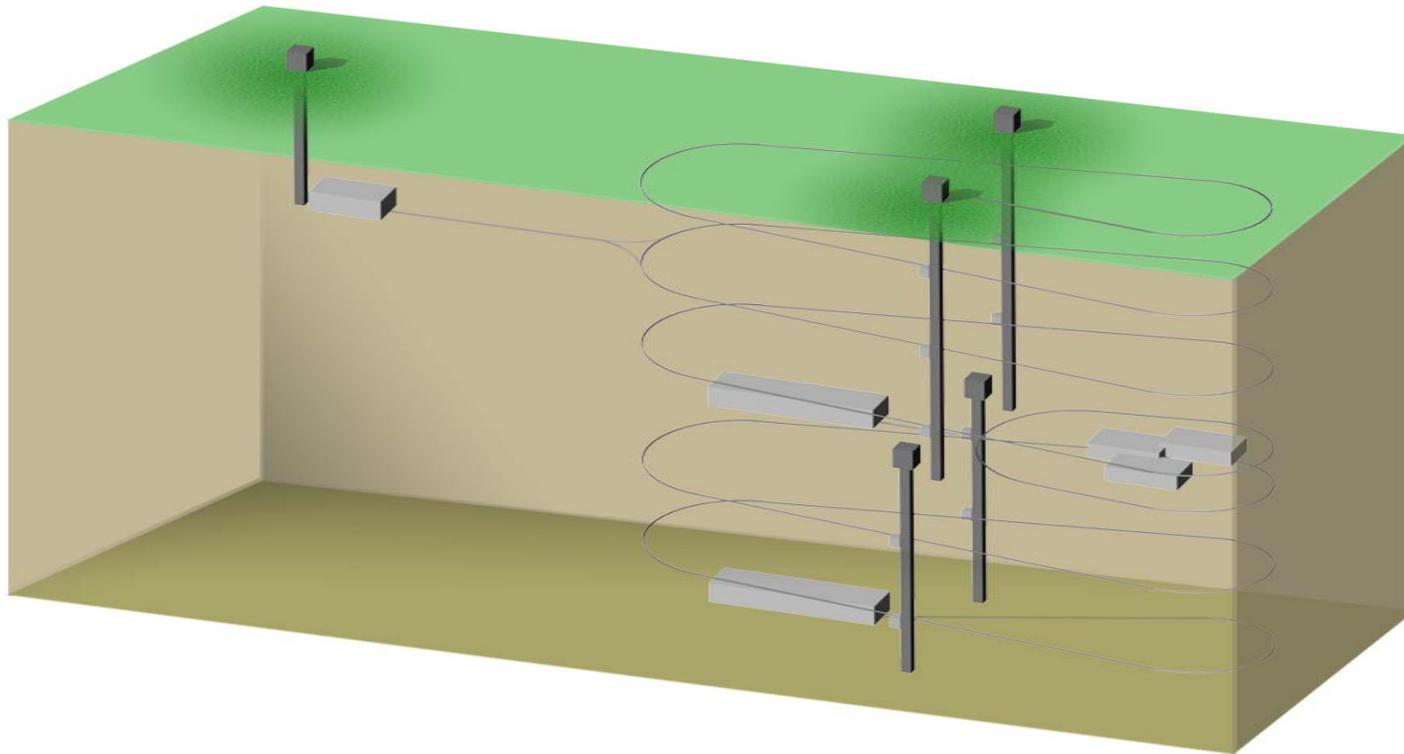
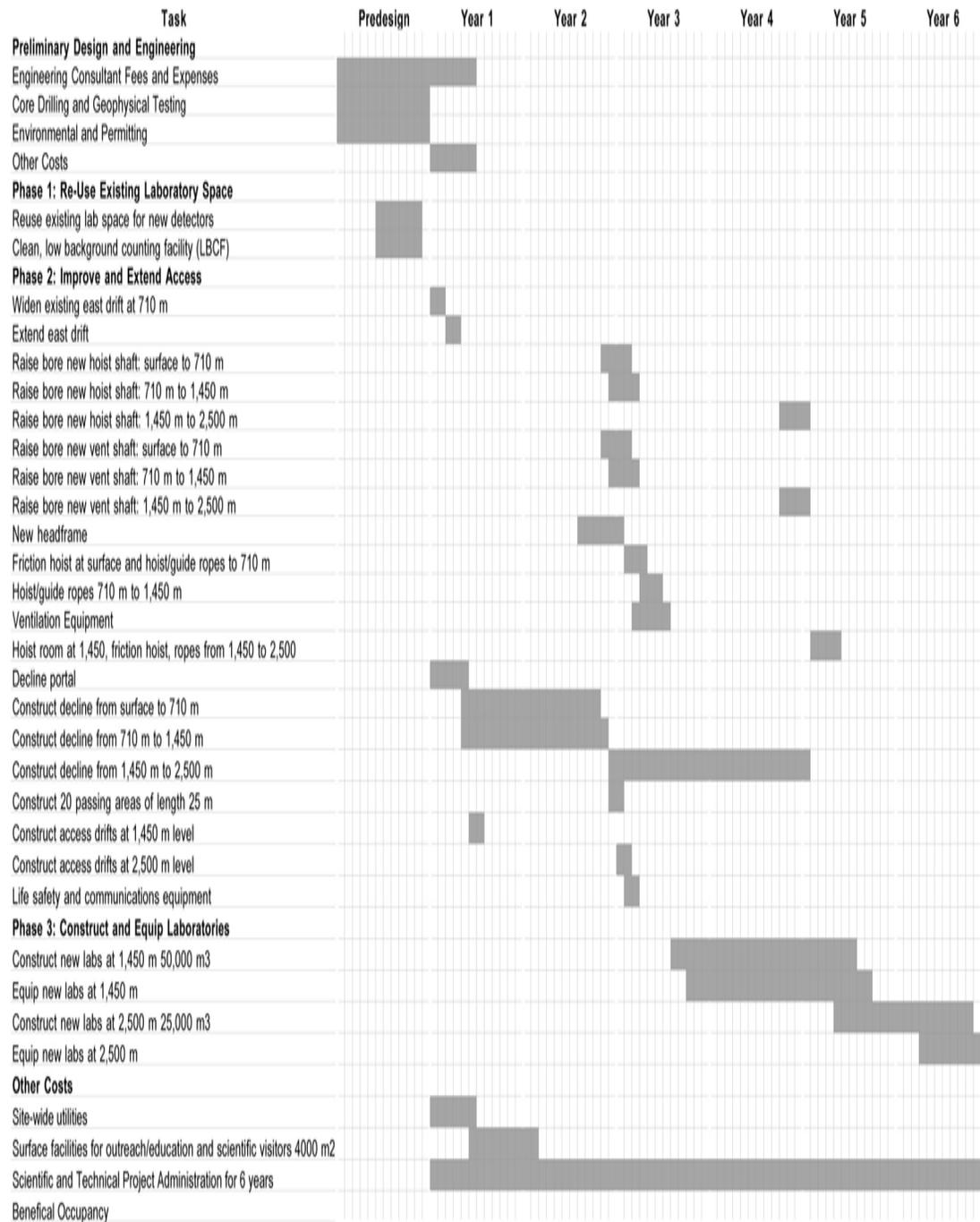
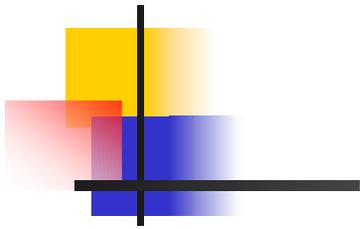


Fig. 17: An isometric view of the new construction proposed or Soudan NUSEL. The No. 8 shaft is at left. The decline and the new access and ventilation shafts are at right. The size and location of the laboratories at the 1,450 m and the 2,500 m levels are only illustrative.



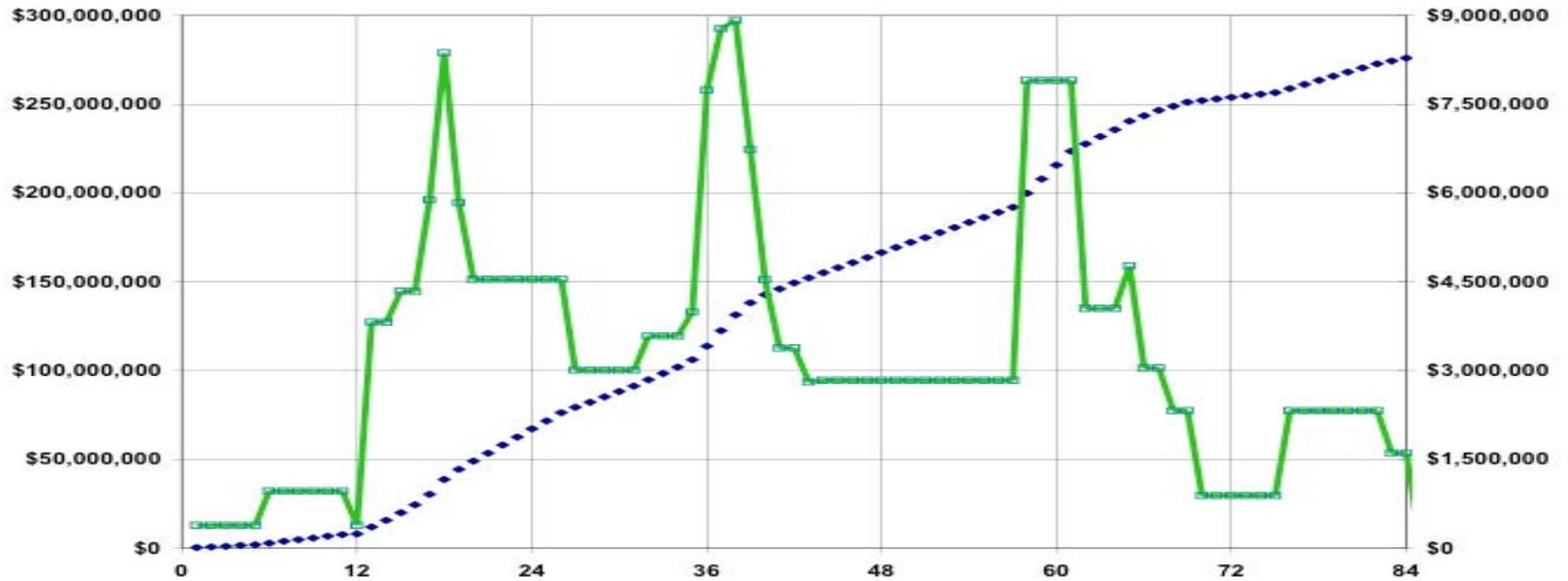


Fig. 19: Graphs of the cash flow per month( green line and right axis) and the integrated cash flow( blue symbols and left axis) for the schedule shown in Fig. 17 and the costs shown in Table 2.

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Hosted by Rachel Reabe

Friday, July 26, 2002: 11 a.m. to 1 p.m. CT

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Mainstreet Radio started in 1987 with the mission of reporting from rural Minnesota to all of Minnesota. Each month, Mainstreet Radio presents a two-hour special focusing on rural issues.

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MPR's Mainstreet Radio looks at the history and future of the Soudan underground mine in northern Minnesota. It's Minnesota's oldest mine, but now scientists are doing cutting-edge research in a futuristic laboratory deep inside the historic mine.

**The Soudan mine** was Minnesota's first mine, beginning operation in 1883. It has a rich history over its 80 years of operation as an active mine. Even after mining activity was ended, the facility never closed down. Instead, it became a historic site open to the public for tours. More than one million people have visited the Soudan Underground Mine since tours began in the 1960s.

**Guests:**

**Andy Larson**, president of the Tower Soudan Historical Society. Larson is a third generation miner

**Pete Pellinen**, guide/interpreter

**Rick Fields**, interpretative supervisor

**John Berquist**, folk music performer who specializes in the music, traditions and culture of the Iron Range

**Listen to Part One****Listen to Part Two**

**Scientists, not miners**, now work in the Soudan mine. They are conducting groundbreaking research in a futuristic laboratory deep inside the historic mine. Physicists from around the world are studying neutrinos, tiny atomic particles that can pass through solid rock.



A 6,000-ton neutrino detector is being constructed, part of a \$46 million grant from the U.S. Department of Energy. Ultimately, the experiment could provide vital information about the origin and creation of the universe.

**Guests:**

**Marvin Marshak**, University of Minnesota physicist and a project leader of the neutrino study

**W. Louis Barrett**, Western Washington University physicist and researcher at Soudan

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