Hydraulic Impacts of Limestone Quarries and Gravel Pits

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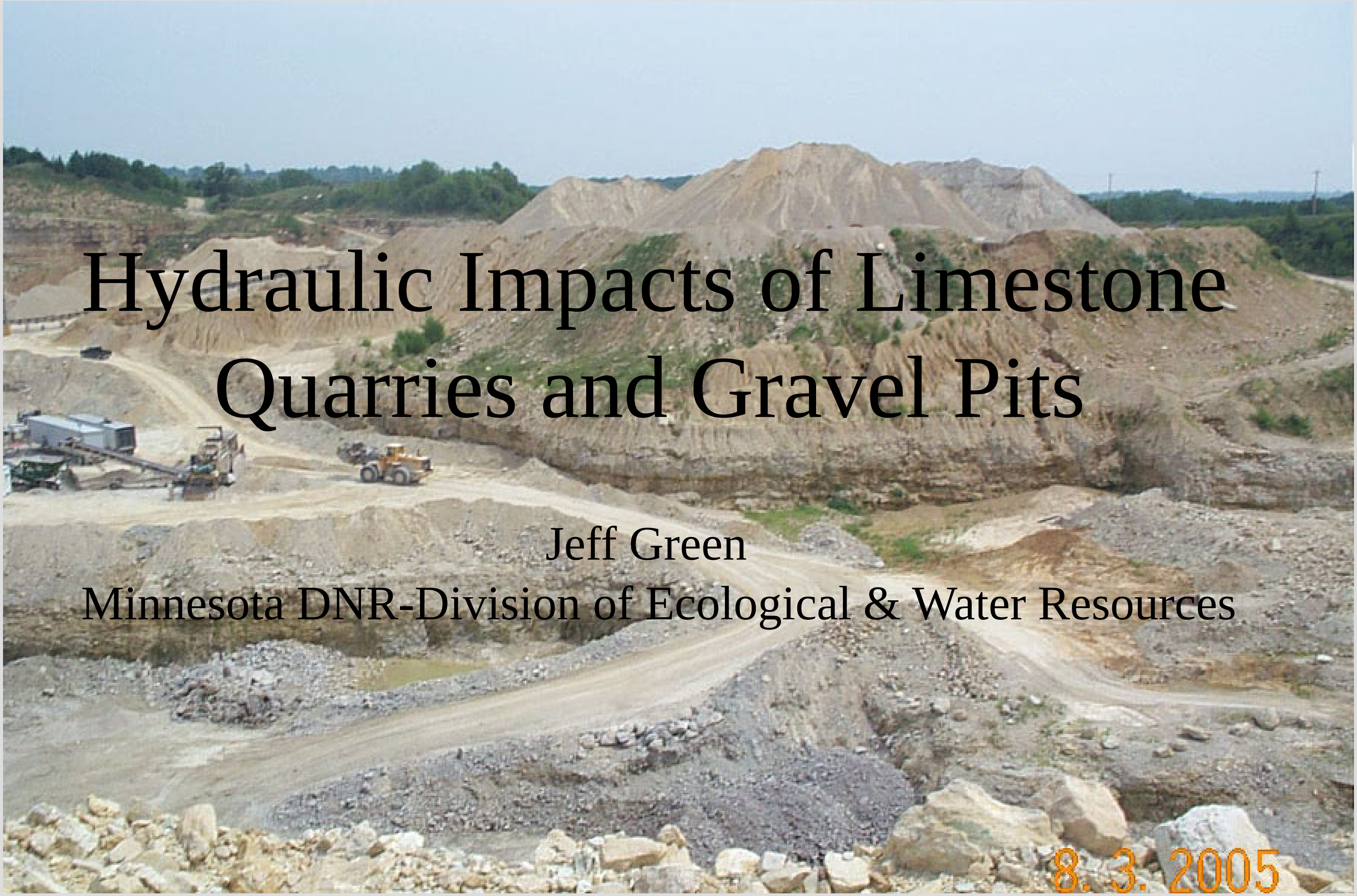
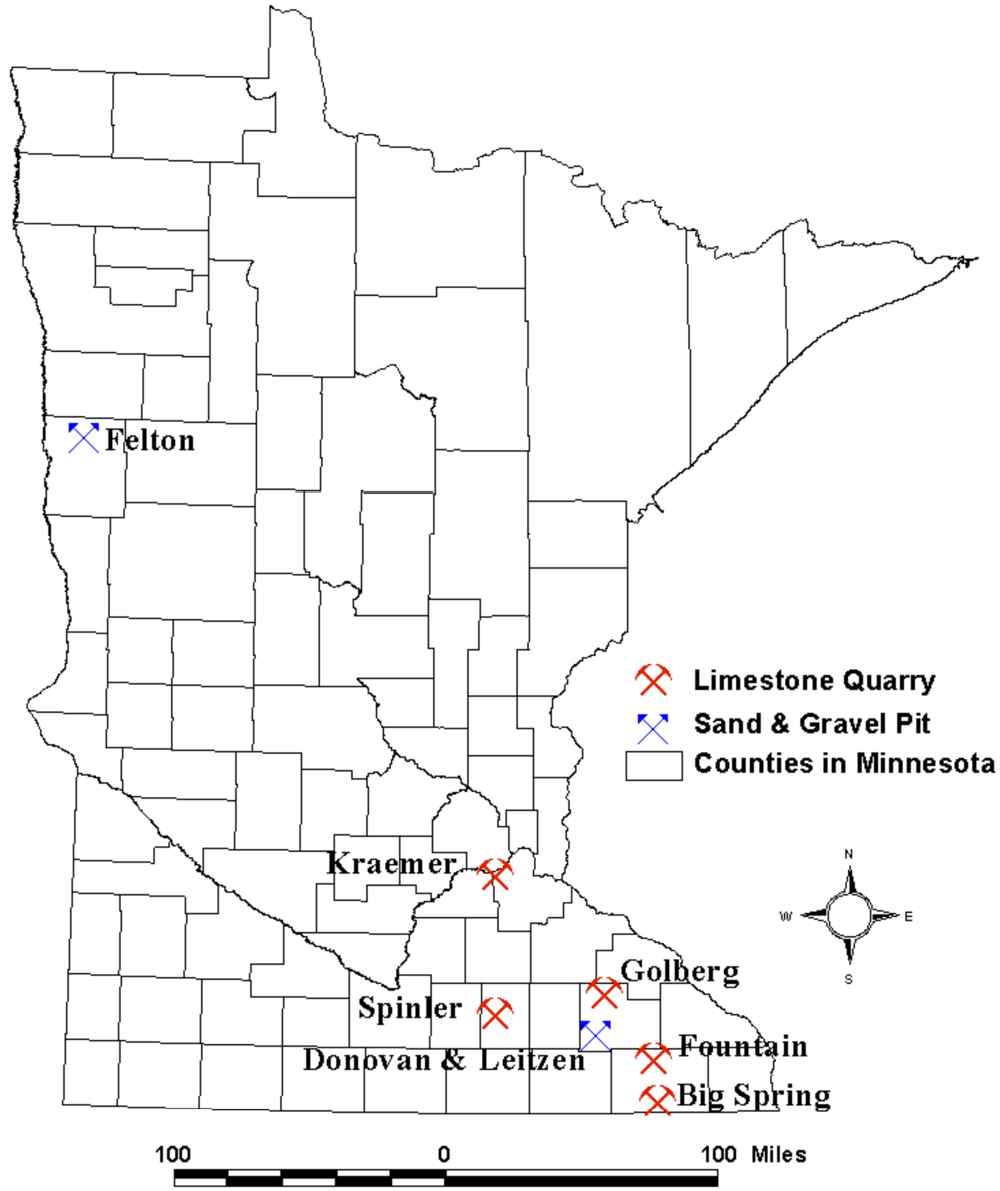


The Hydraulic Impacts of Limestone Quarries and Gravel Pits Study was funded by the 2001 Legislature as recommended by the Legislative Commission on Minnesota Resources. Funding is from the Environment and Natural Resources Trust Fund.

Objectives

- Study the relationship between quarries, gravel pits and ground water systems.
- Better understanding of conditions that lead to ground water impacts.

Project Site Map

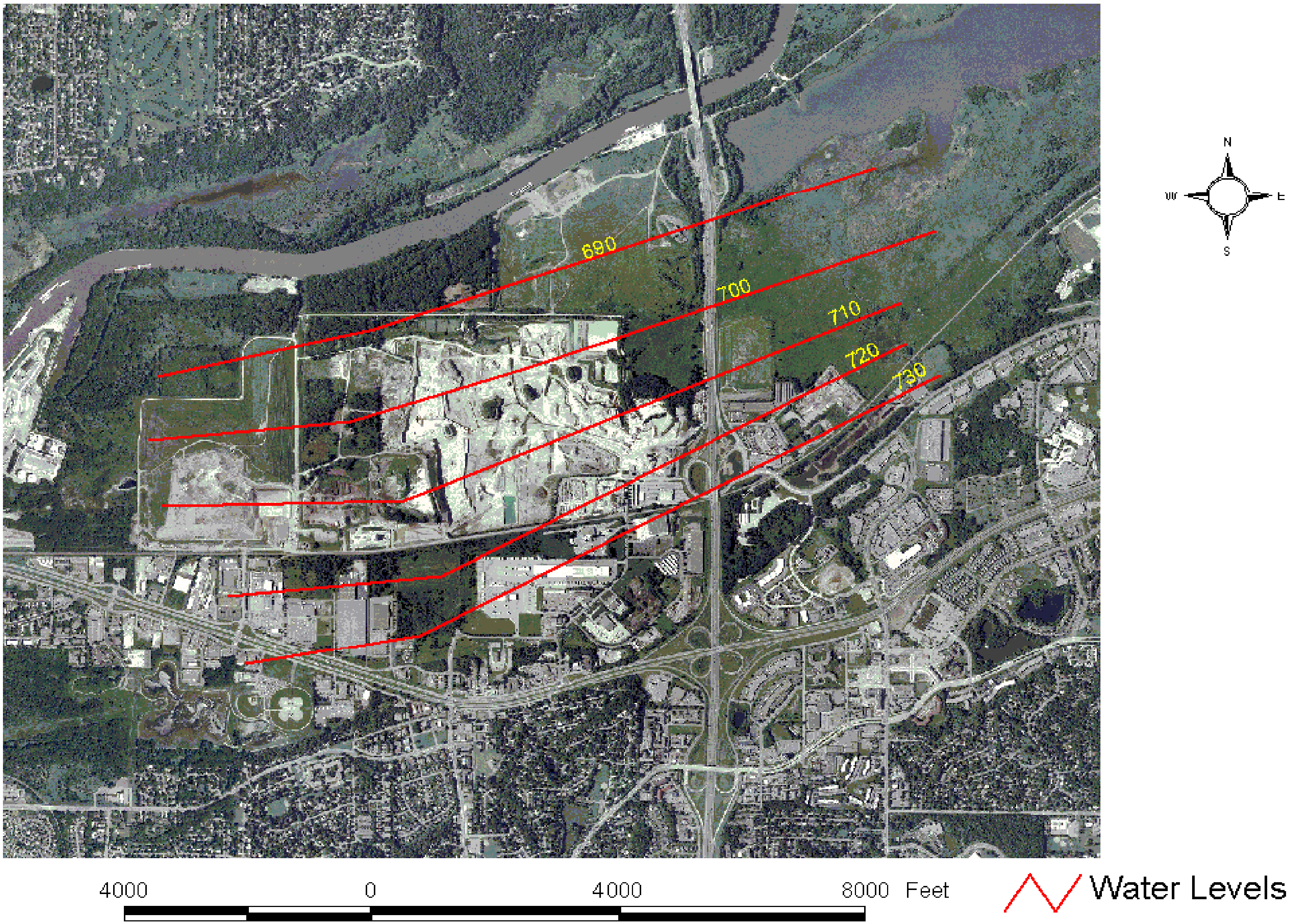


Site	Mineral resource	Ground-water impacts studied			
		Water level	Turbidity	Temperature change	Spring diversion
Kraemer	Prairie du Chien limestone	X	X		
Golberg	Prairie du Chien limestone	X	X		
Spinler	Galena limestone	X			
Fountain	Galena limestone		X		
Big Spring	Galena limestone			X	X
Donovan	Alluvial sand and gravel	X		X	
Leitzen-Grabau	Alluvial sand and gravel	X			
Felton	Glacial beach ridge sand and gravel	X			

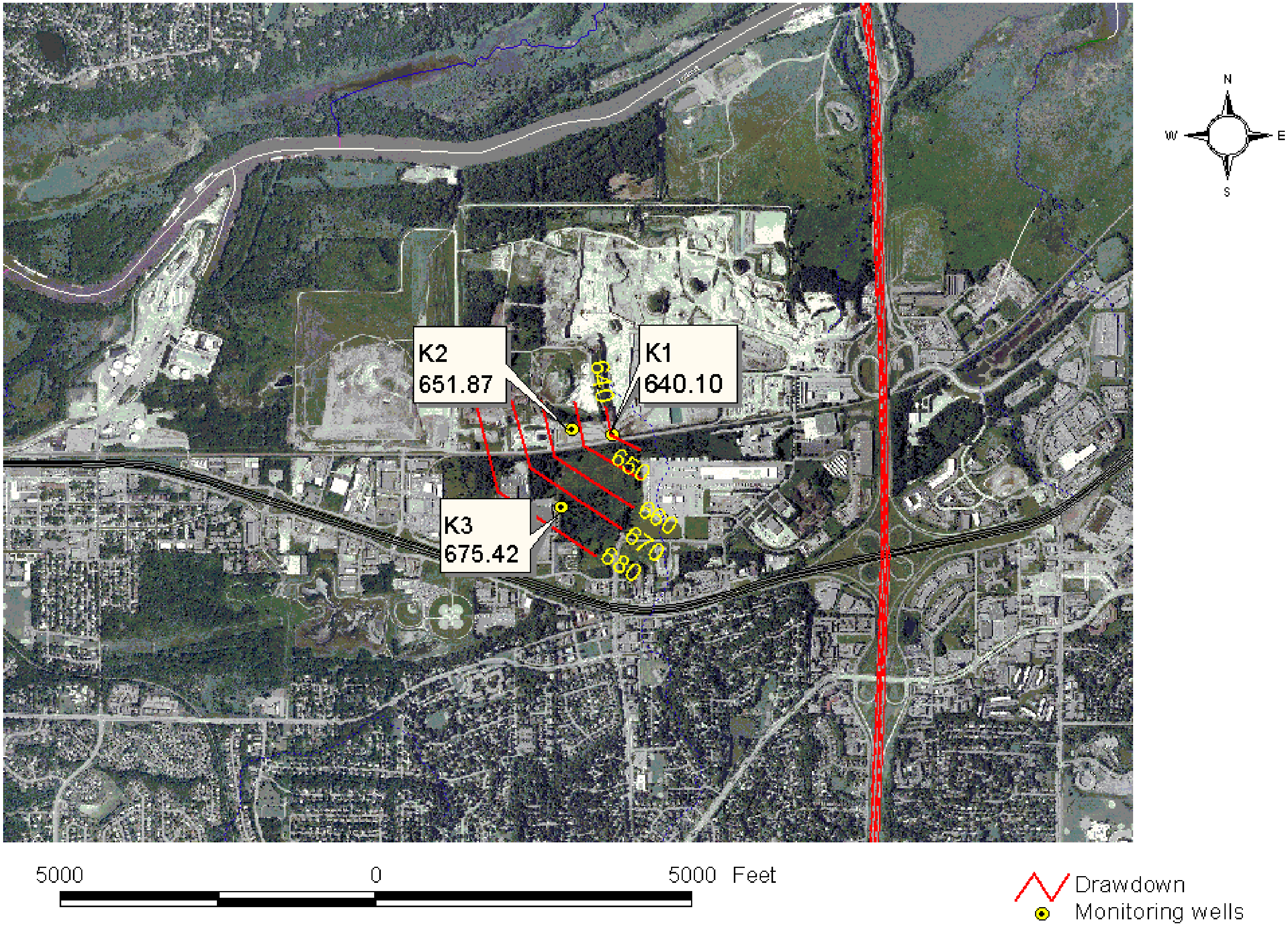
Kraemer Quarry, Burnsville MN

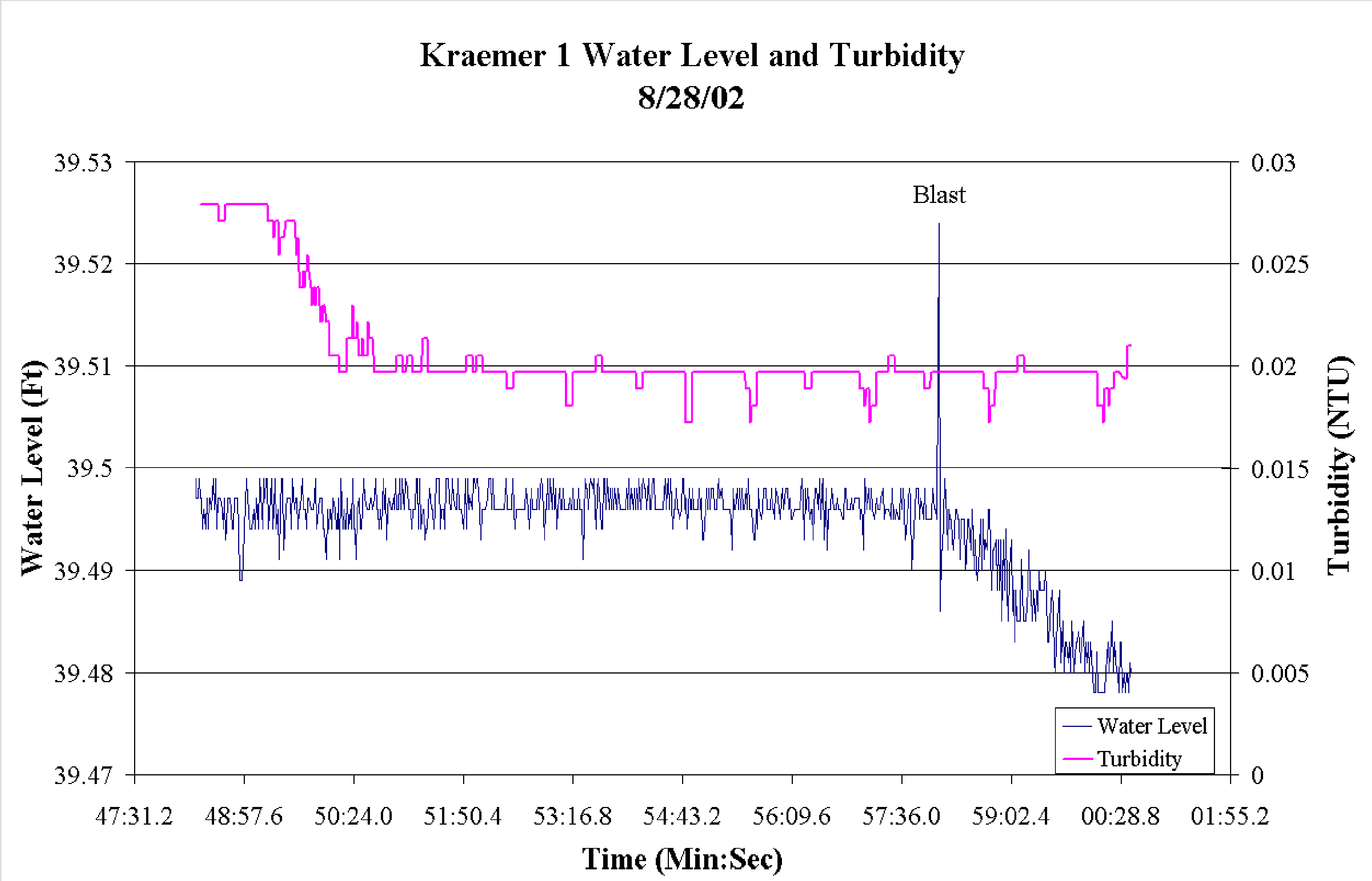
Kramer Burnsville

Kraemer Historic Water Levels



Kraemer Drawdown
10/12/2004





Kraemer 1 Water Level and Turbidity
8/28/02
Blast
39.53
39.52
39.51
39.5
39.49
39.48
39.47
Water Level (Ft)
0.03
0.025
0.02
0.015
0.01
0.005
0
Turbidity (NTU)
47:31.2
48:57.6
50:24.0
51:50.4
53:16.8
54:43.2
56:09.6
57:36.0
59:02.4
00:28.8
01:55.2
Time (Min:Sec)
Water Level
Turbidity

Video logging Results- Kraemer & Golberg Quarry Wells

During the spring of 2005, DNR Waters staff used a downhole camera to inspect the 5 observation wells at these sites

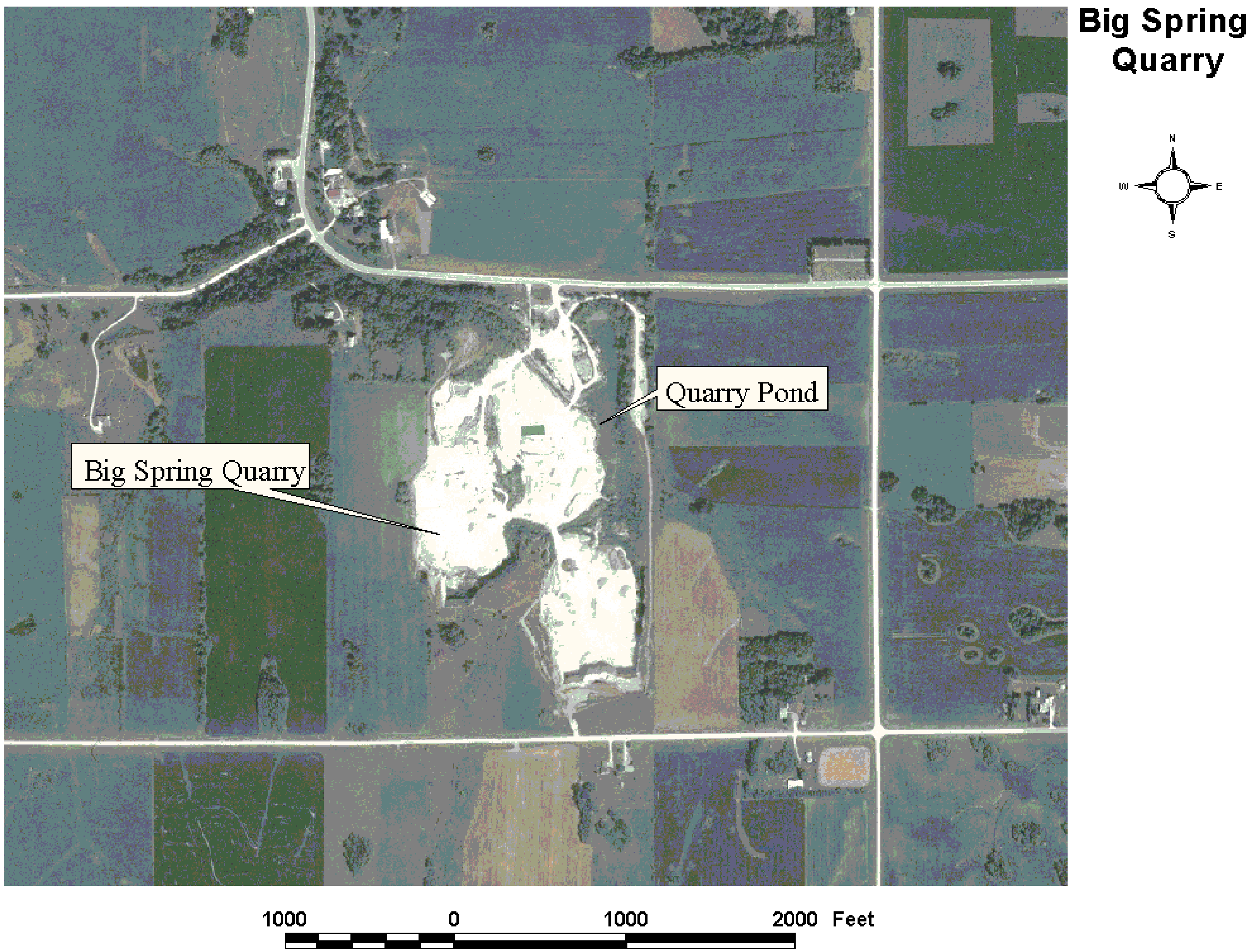
Staff inspected both the cased and open hole sections

No deformation or damage to the cased portions of the wells was visible

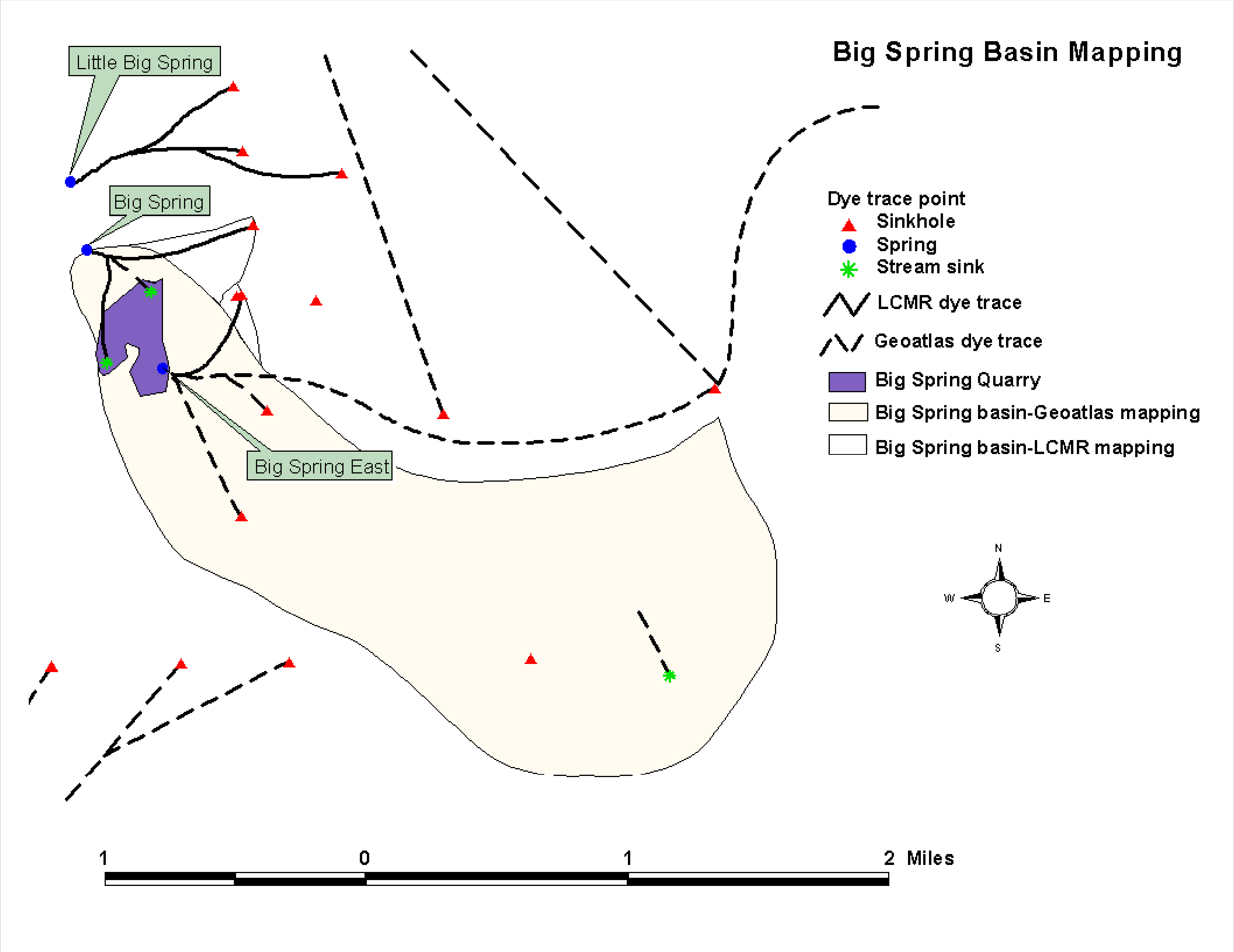
No obvious impacts to the open hole sections were visible

Preferential (conduit flow) was observed in several of the wells

Landscape Modification Impact on Water Resources


Big Spring Quarry
N
W
E
S
Quarry Pond
Big Spring Quarry
1000
0
1000
2000
Feet


2. 14. 2003



Over 90% of the basin feeding the Big Spring now rises in the quarry

Conclusions

Summary of Impacts and Study Results

Site	Impacts studied	Study results
Kraemer Quarry	Water level	Significant decline in aquifer water levels due to quarry dewatering and rock removal.
	Turbidity and well construction	No impacts observed.
Golberg Quarry	Water level	Significant decline in aquifer water levels due to quarry dewatering and rock removal.
	Turbidity and well construction	No impacts observed.
Spinler Quarry	Water level	Hydraulic gradient between the upper and lower aquifers has been reversed; the Straight River has been changed from a gaining to a losing stream.
Fountain Quarry	Turbidity	Blasting caused a slight increase in spring turbidity levels.
Big Spring Quarry	Spring diversion	Ground water that previously discharged directly at the Big Spring now discharges in the quarry. Some of it sinks and emerges at the Big Spring; the rest flows overland to Camp Creek.
	Temperature change	Significant temperature increases were noted in a summer measurement. Monitoring is continuing.
Donovan Pit	Water level	Mining had minimal impact on aquifer water levels.
	Temperature change	Ground-water temperature changes were noted but were not consistent. Monitoring is continuing.
Leitzen-Grabau Pit	Water level	Mining had minimal impact on aquifer water levels.
Felton Pit	Water level	Mining has altered ground-water flow paths affecting the water supply to a calcareous fen.

Table 1. Summary table of sites and impacts studied.

Information Needs for the Permit Process

Recommendations for local governments, producers, and consultants

What the company had planned

What the planning commission member imagined

Recommendations:

Applicants should submit detailed maps and information on:

- site topography
- geology
- hydrology
- karst
- mining plans
- reclamation plans
- monitoring system design

This information will allow LGU's and state agencies to fully evaluate the potential impacts and make good, informed decisions on quarry and pit proposals.

Topography

These questions will allow you to assess the mining company's ability to identify any potential impacts of flooding or runoff in the affected area.

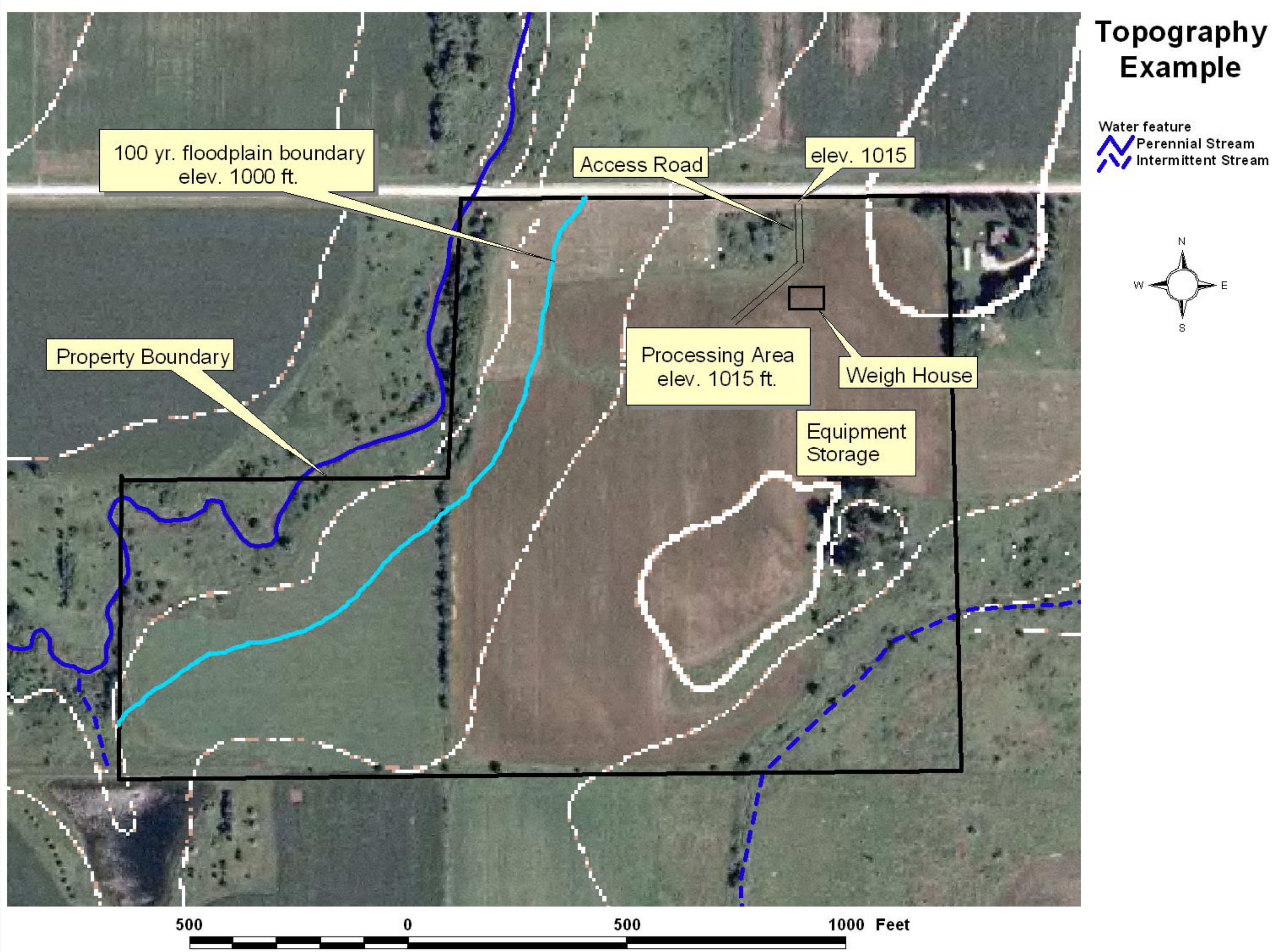
- What is the slope of the area?
- If the land is sloping, where will runoff go?
- Is the site in a floodplain?


Mobil
Synthetic
Lubricant
5.12.2003

To answer these questions, a topographic map of the site should be provided. The map should include the following features:

- Elevations
- Roads
- Surface-water bodies
- Property lines
- Buildings
- Equipment and fuel storage areas

If part of the property is in a floodplain, an accurate floodplain delineation based on site survey and hydrologic data should be included in order to assess the risk of inundation of the mine, equipment, and fuel storage areas.



Site Topography Example

Geology

These questions will allow you to assess the operation's size, future expansion possibilities, depth of mining, and the potential for overburden stockpiling.

What is the size of the deposit?

How deep is it?

How much overburden is there?

Are there geologic boundaries (change from one type of material to another)?

Are there clay or shale units present that might act as aquitards?

To answer these questions, a geologic map, at the appropriate scale should be supplied. It should display the following:

•Areal extent and depth of the deposit

•Geologic units and contacts

•Confining units (clay, shale, siltstone)

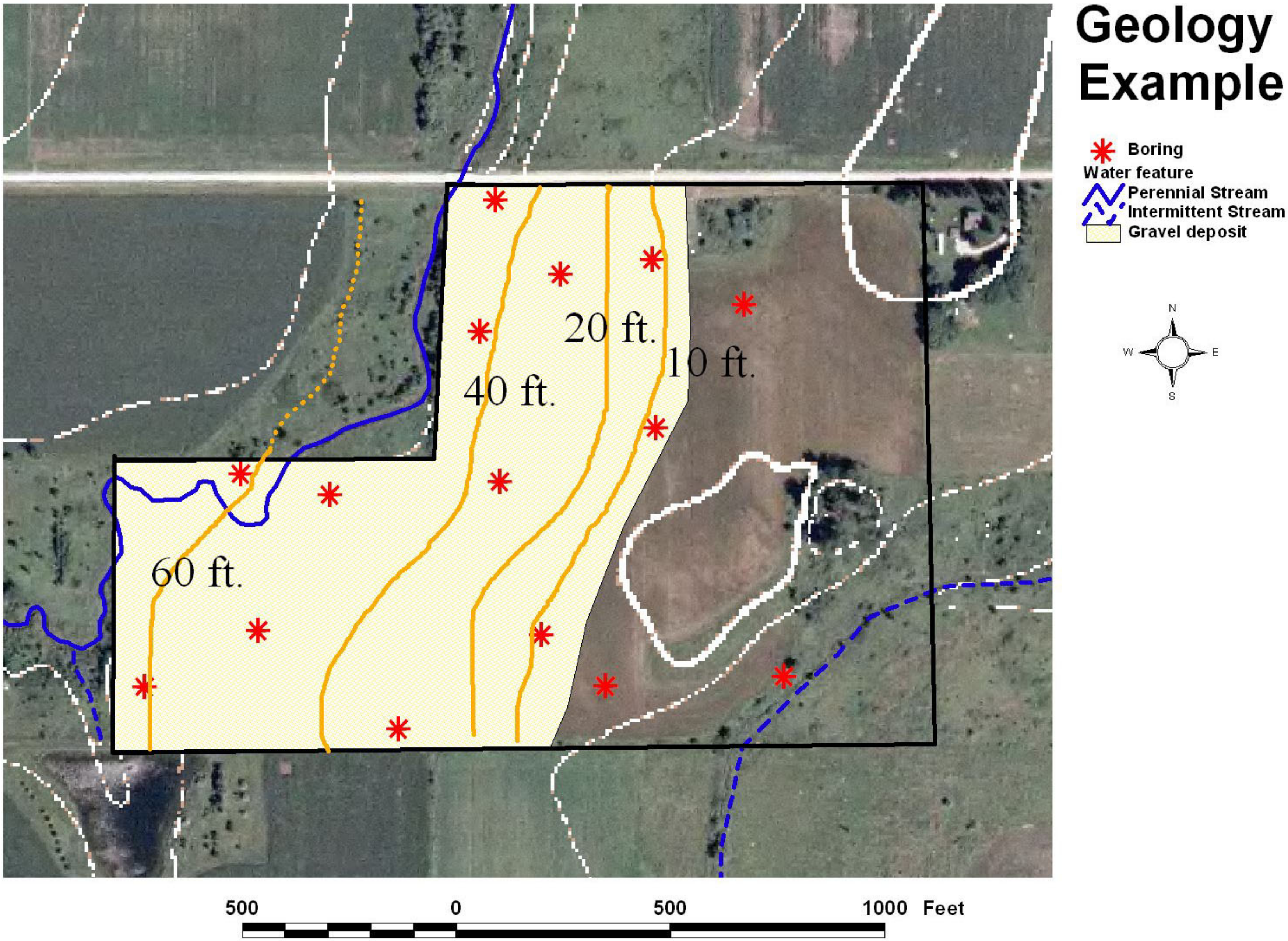
•Depth to bedrock (if applicable)

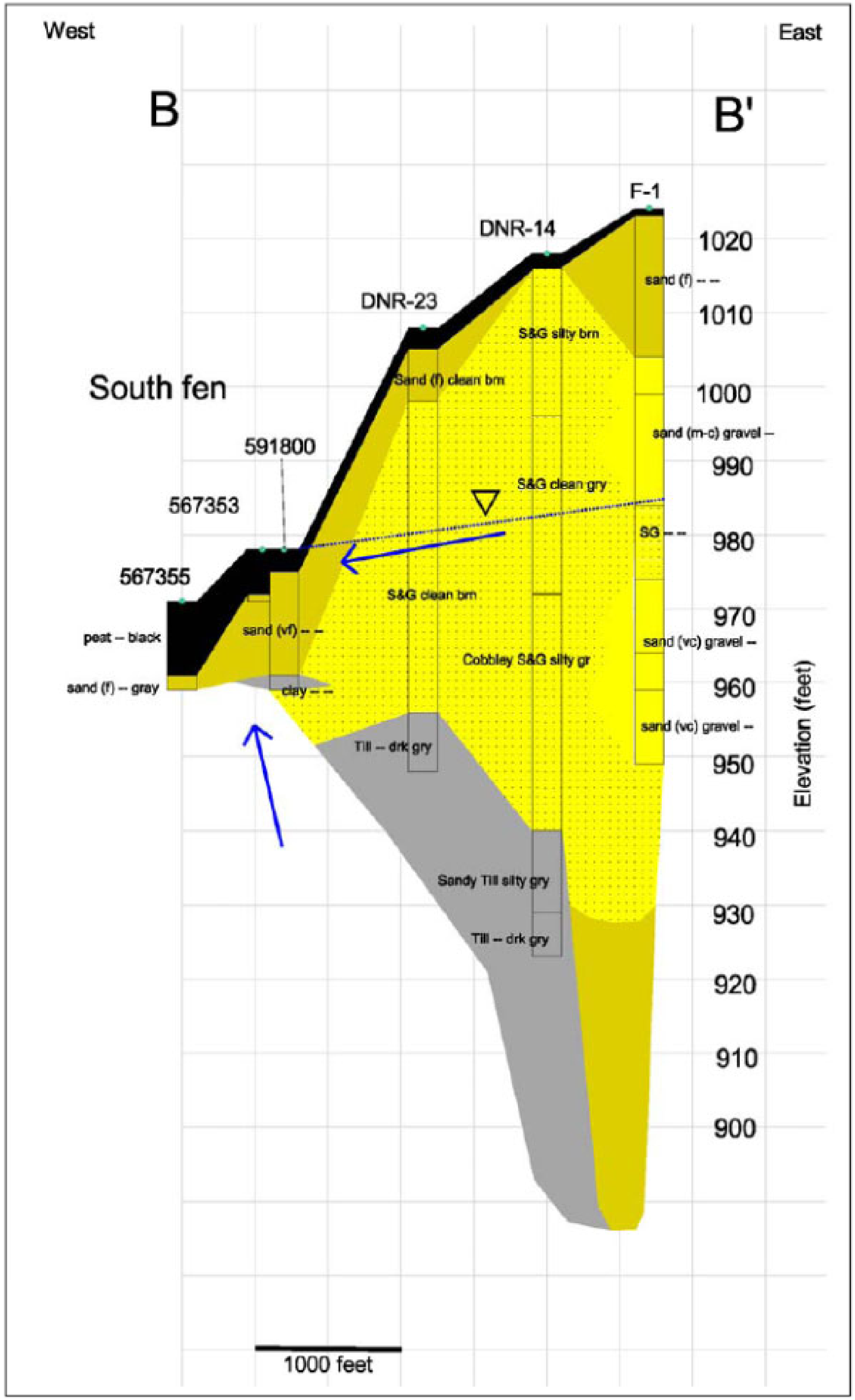
•Cross-sections diagrams of the deposit and site

•Fracture patterns and traces (rock quarries)

•Test hole locations

Geology Example




West
East
B
B'
F-1
DNR-14
DNR-23
South fen
591800
567353
567355
1020
1010
1000
990
980
970
960
950
940
930
920
910
900
Elevation (feet)
sand (f) -- --
S&G silty brn
Sand (f) clean brn
sand (m-c) gravel --
S&G clean gry
SG -- --
S&G clean brn
sand (vf) -- --
peat -- black
sand (f) -- gray
clay -- --
Cobbley S&G silty gr
sand (vc) gravel --
sand (vc) gravel --
Till -- drk gry
Sandy Till silty gry
Till -- drk gry
1000 feet

Similar Information Should be Provided On:

- **Hydrology**
- **Karst**
- **Mining Plan**
- **Reclamation Plan**
- **Monitoring Plan**

Summary

- Doing good, thorough site investigations will allow mining companies to select those sites with the least potential for water resource impacts
- Providing that information in a clear form will allow local governments to make good & reasonable decisions about mining operations
- This information is part of the DNR Waters Hydraulic Impacts of Quarries and Pits report. The full report is available at:

http://www.dnr.state.mn.us/publications/waters/quarries_impacts.html