

US EPA ARCHIVE DOCUMENT



SITE LOCATION MAP

- jk EAGLE PROJECT
- o AIRPORT
- HIGHWAY
- MAJOR ROAD
- ROAD
- COUNTY BOUNDARY
- URBAN AREA
- HYDROGRAPHY
- RAILROAD



Reference
 Data provided by ESRI, Michigan Center for Geographic Information
 Projection & Datum: UTM NAD 83 Zone 16N

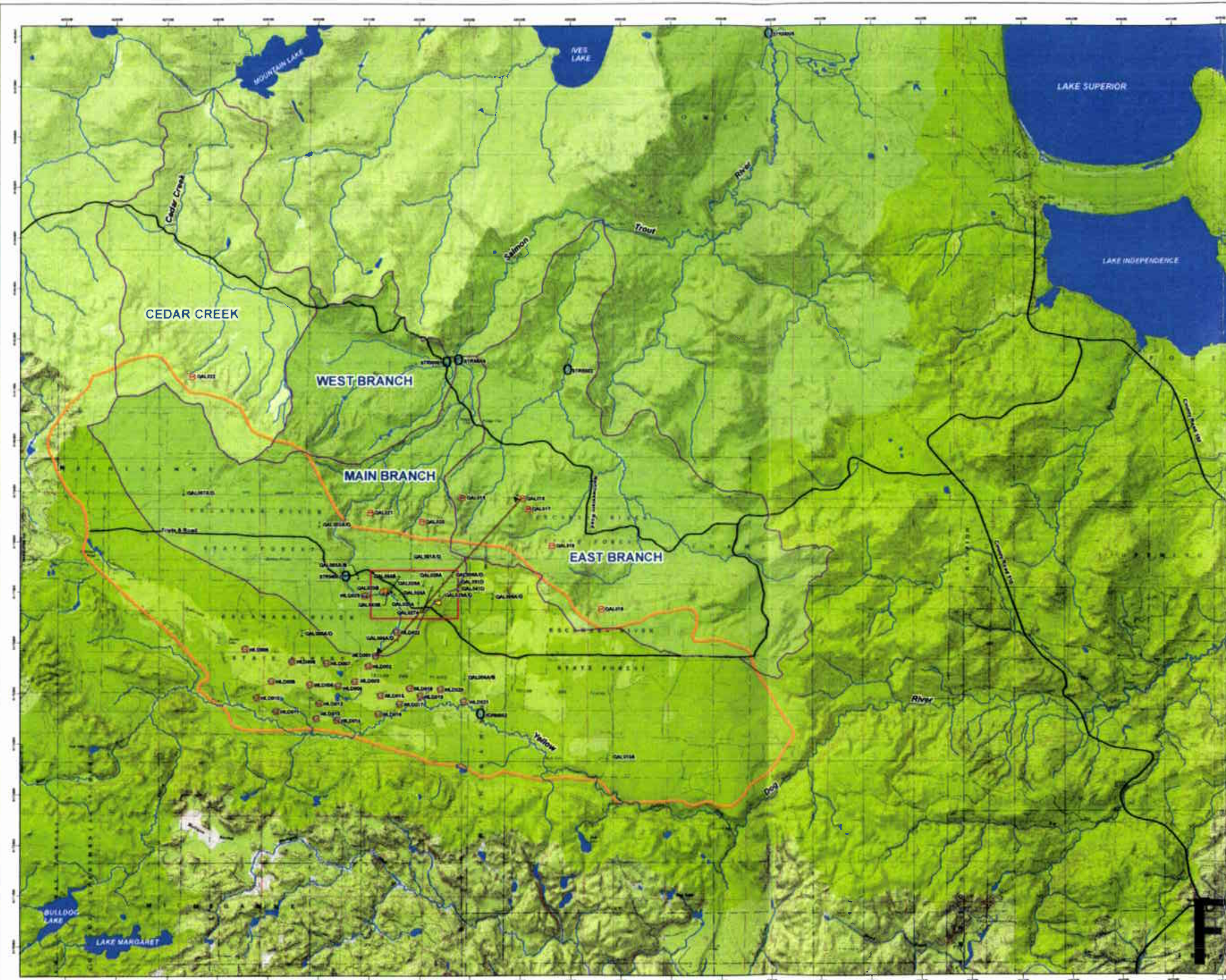
0 10 20 Miles
 Scale: 1:500,000

Kennecott Minerals

Eagle Project
 Groundwater Discharge Study
 Kennecott Minerals Company

North Jackson Company
 ENVIRONMENTAL SCIENCE & ENGINEERING

Figure: 1



REGIONAL OVERVIEW

- ORE BODY
- OUTCROP
- EAGLE PROJECT
- PINE RIVER WATERSHED
- SALMON TROUT RIVER WATERSHED
- YELLOW DOG RIVER WATERSHED
- SUBWATERSHED
- YELLOW DOG PLAINS
- HYDROGRAPHY
- ROAD
- CROSS SECTION
- MONITORING WELL
- SEEP PIEZOMETER
- SURFACE WATER MONITORING
- WETLAND PIEZOMETER

Reference

Data provided by Michigan Center for Geographic Information, North Jackson Company
Projection & Datum: UTM NAD 83 Zone 18N

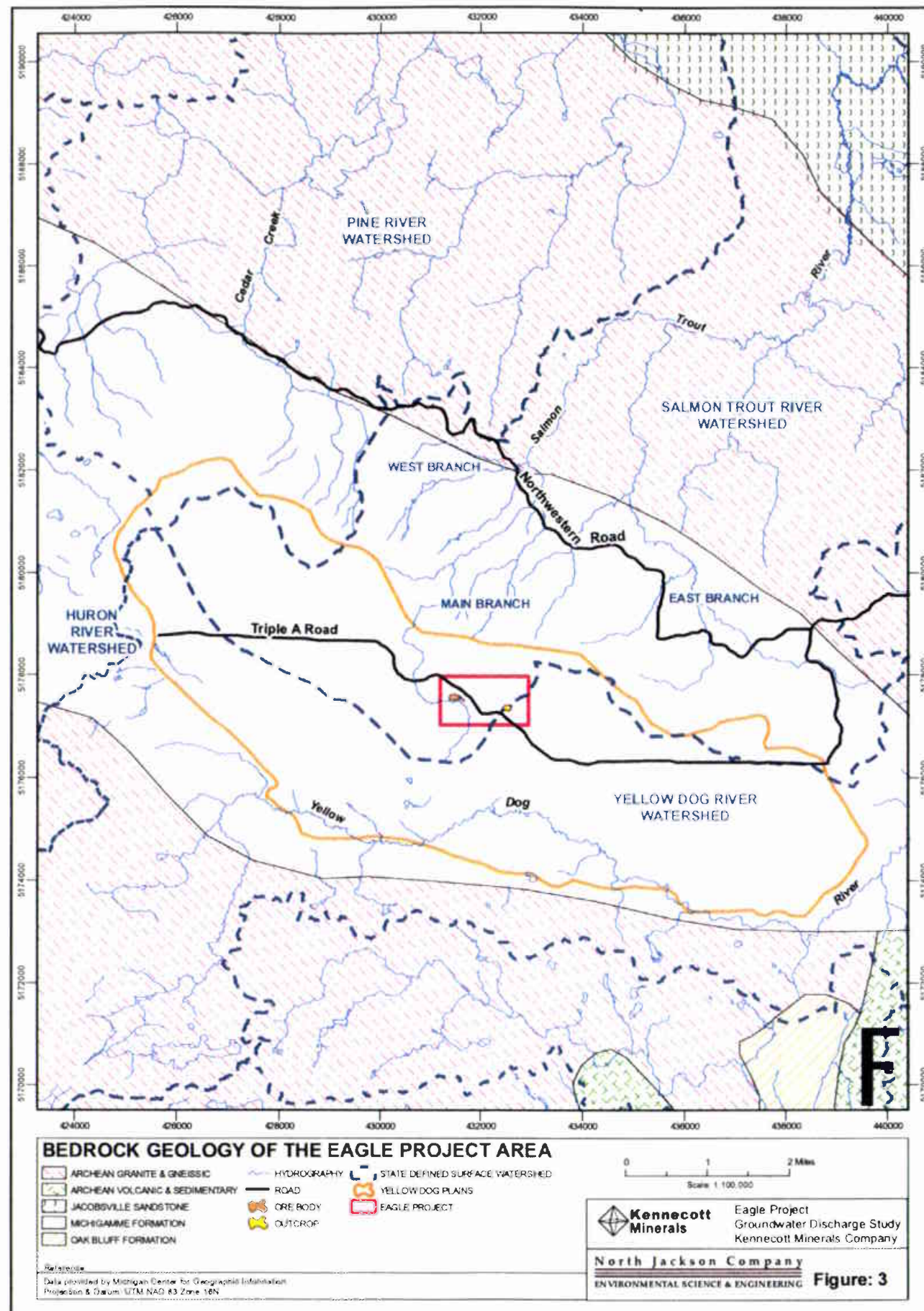
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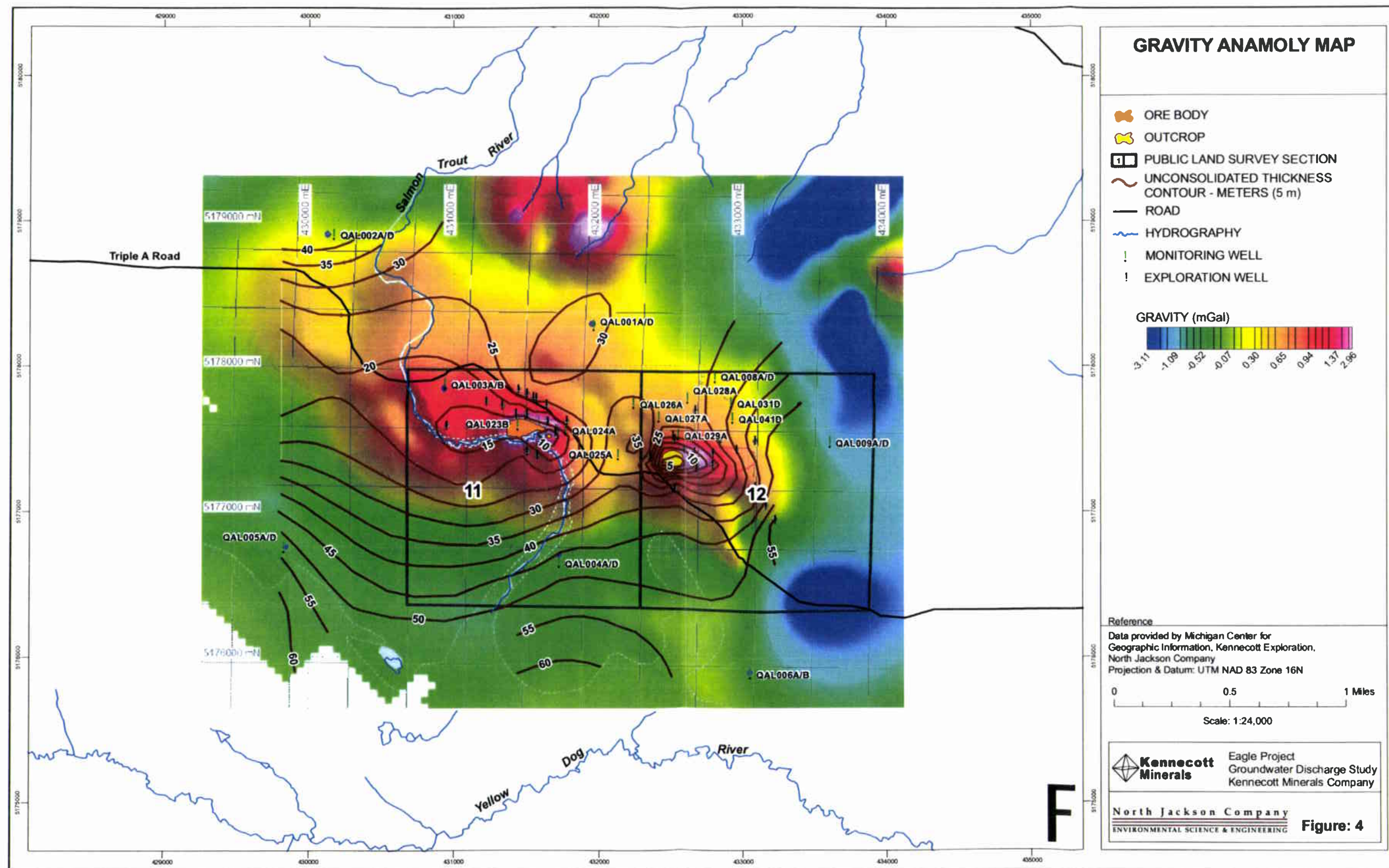


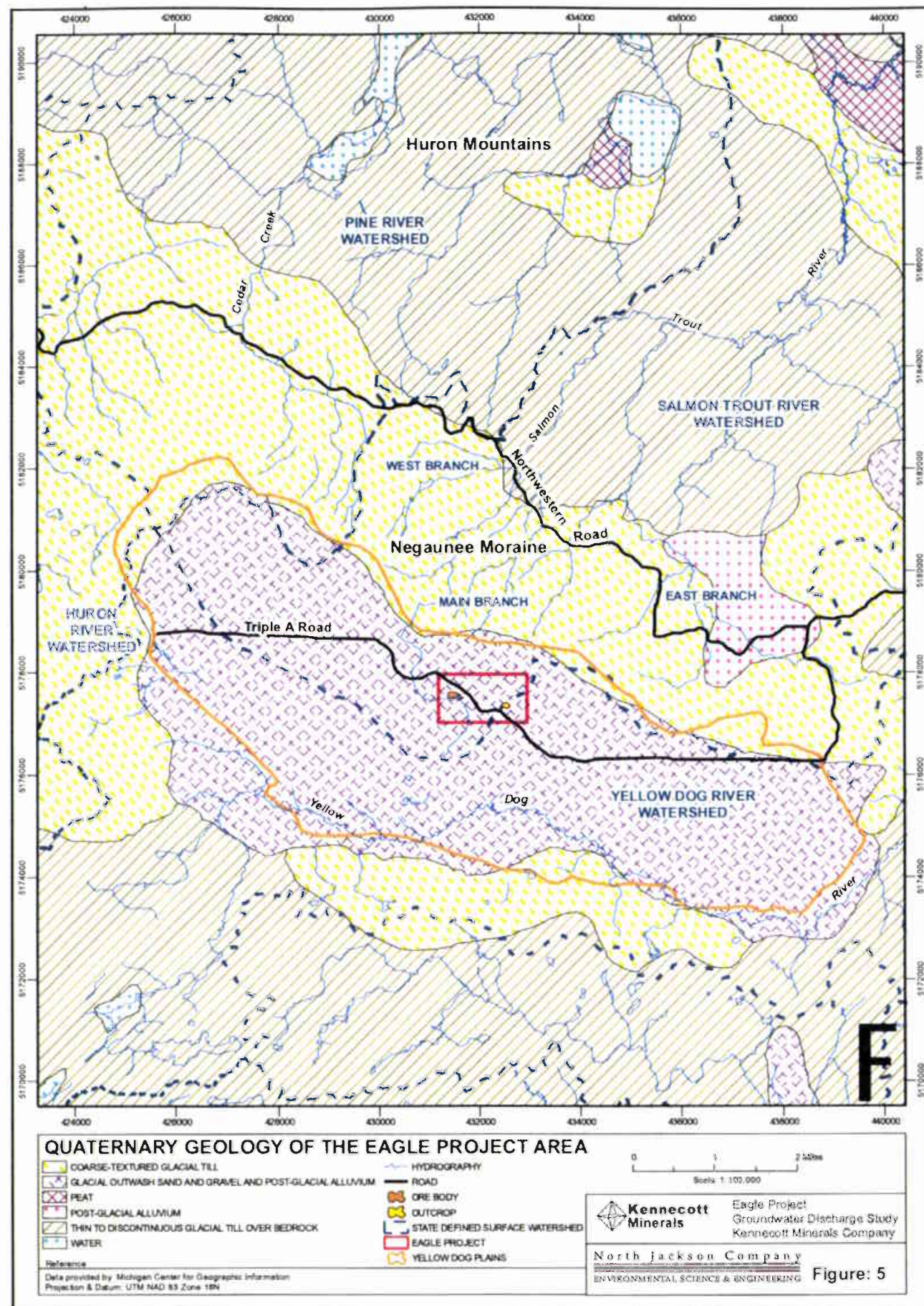
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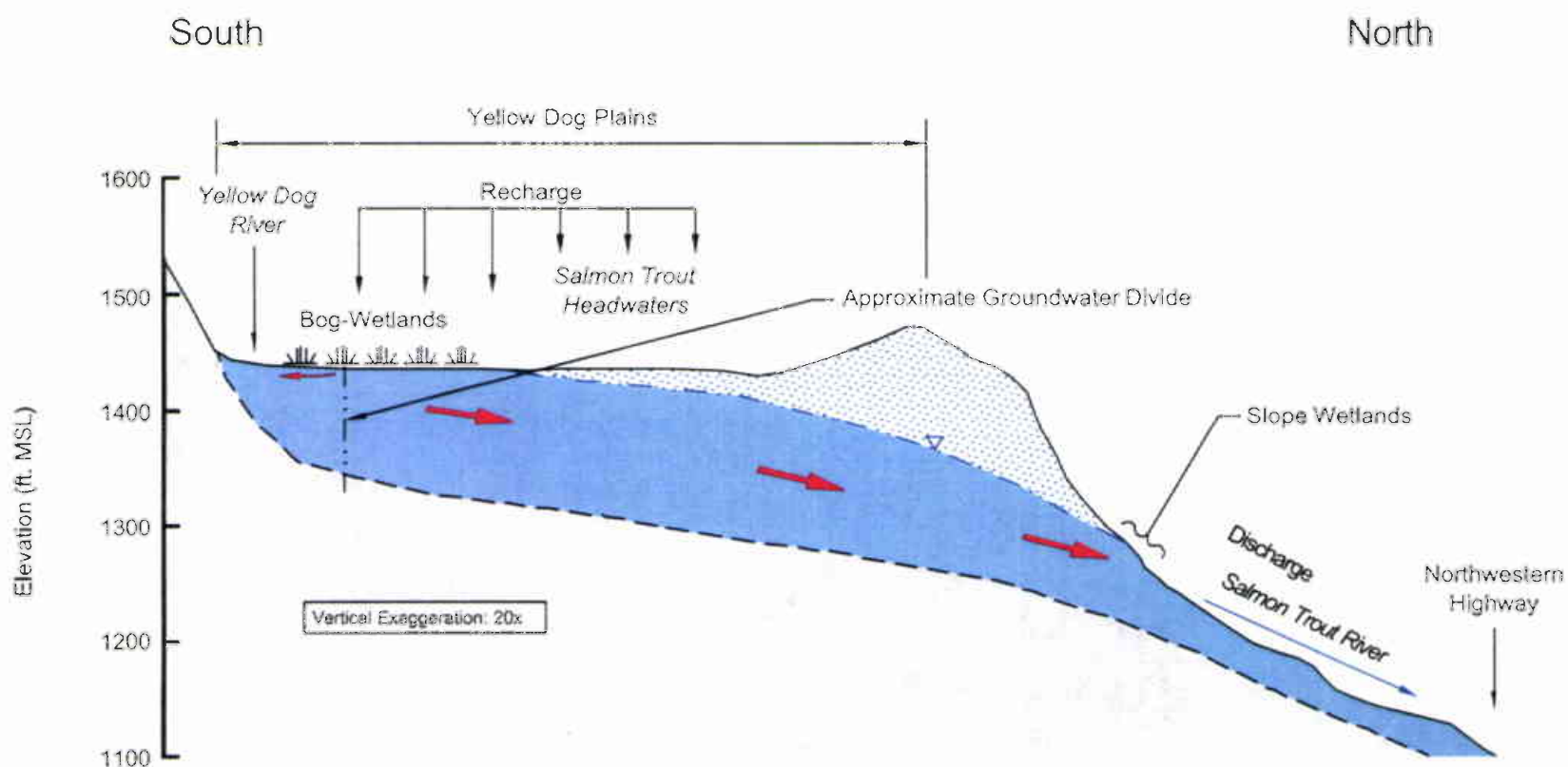
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Figure: 2









LEGEND:

- Quaternary Unsaturated Alluvium
- Quaternary Saturated Alluvium
- Proterozoic Metasediments/Intrusives
- Groundwater Flow

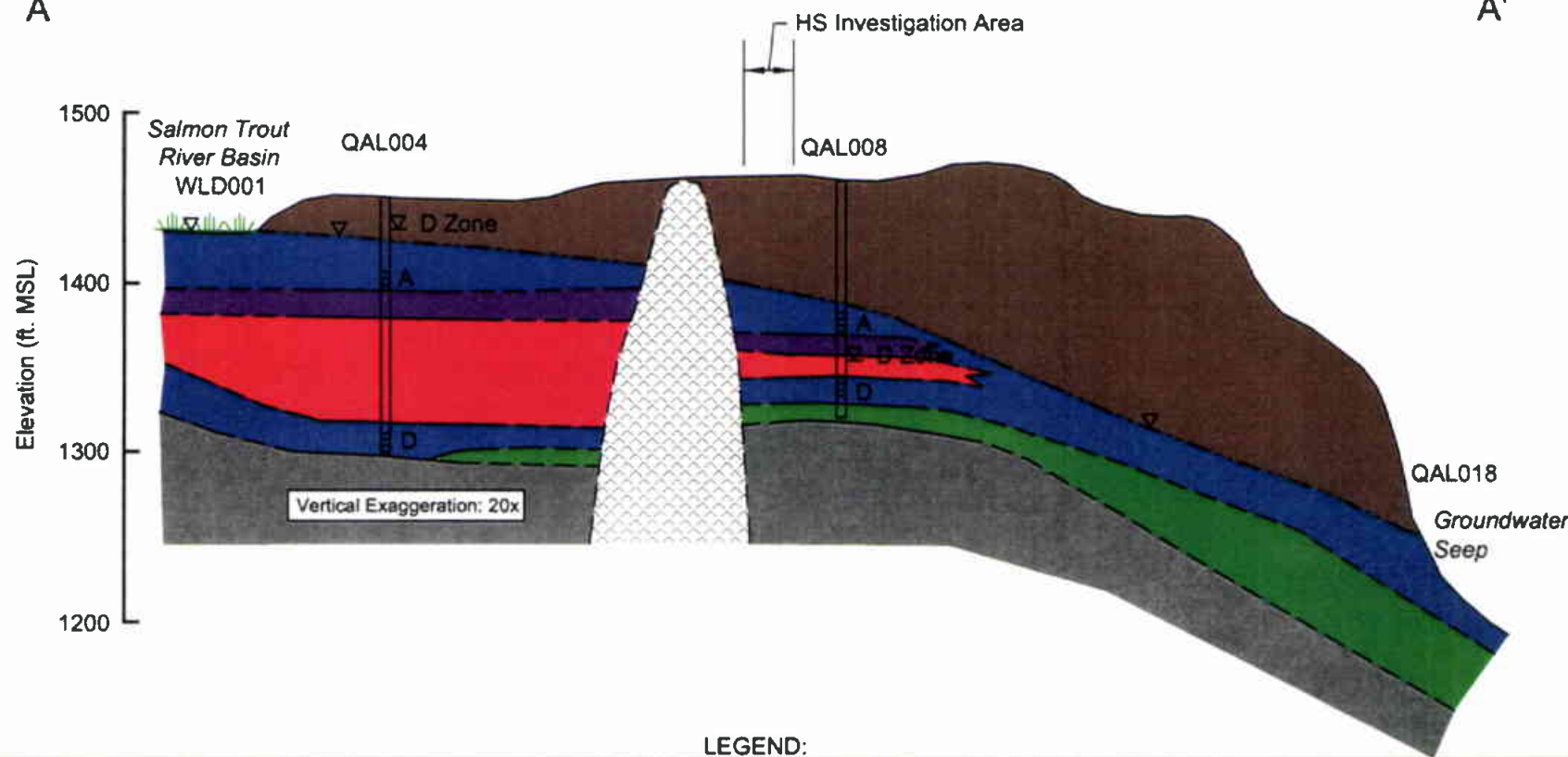
NORTH JACKSON COMPANY
 1004 Harbor Hills Drive, Suite 102
 Marquette, MI 49855

0 3,000
 Feet
 Vertical Exaggeration: 20x

FIGURE 6
CONCEPTUAL HYDROGEOLOGIC CROSS SECTION
 Eagle Project

Southwest
A

Northeast
A'



LEGEND:

- | | | |
|-------------------------------------|--|-----------------------------|
| Water Table | Unsaturated Sand | Clayey Glacial Till |
| Monitoring Well with Screened Zones | Saturated Sand (upper and lower zones) | Bedrock: Metasedimentary |
| D Zone Water Elevation D Zone | Fine Sand Silt and Clay | Bedrock: Igneous Intrusives |
| | Lean Clay | |

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0 2,000
Feet
Vertical Exaggeration: 20x

FIGURE 7
**CONCEPTUAL HYDROGEOLOGIC
CROSS SECTION A-A'**
Eagle Project

Figure 8
Hydrographs of Mean Daily Flow for Salmon Trout River and Yellow Dog River Continuous Monitoring Locations
(September 2004-May 2005)
Eagle Project

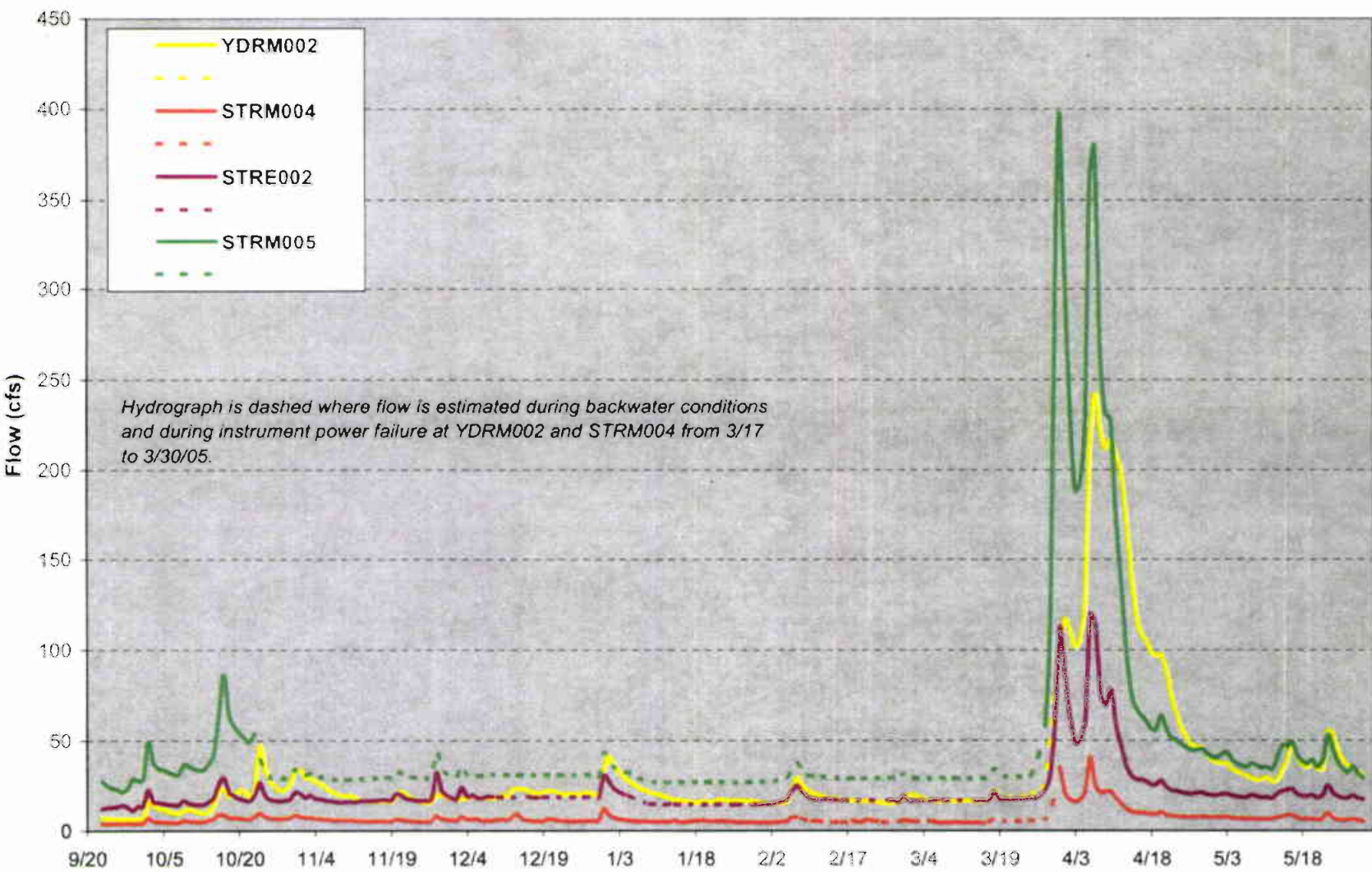
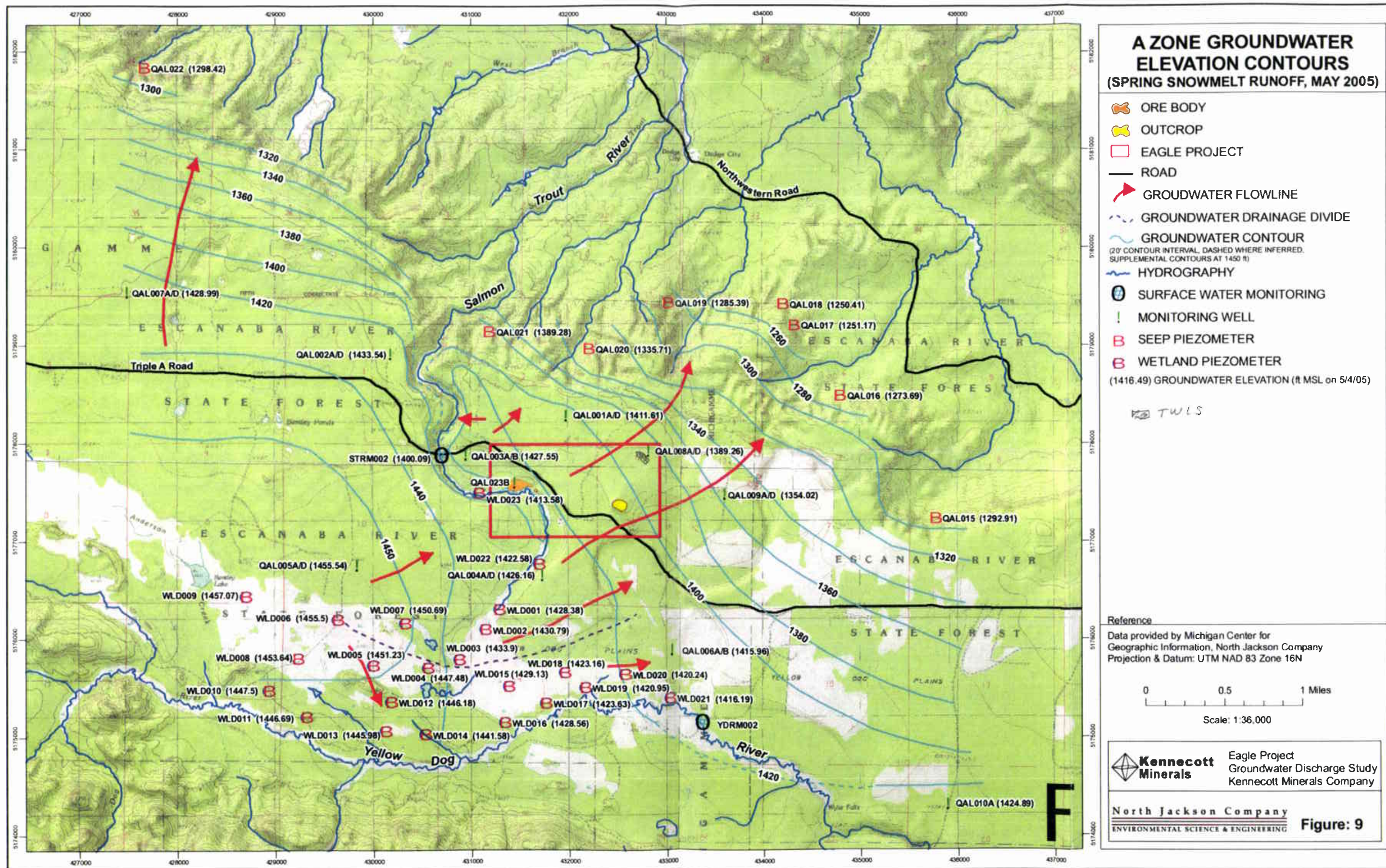
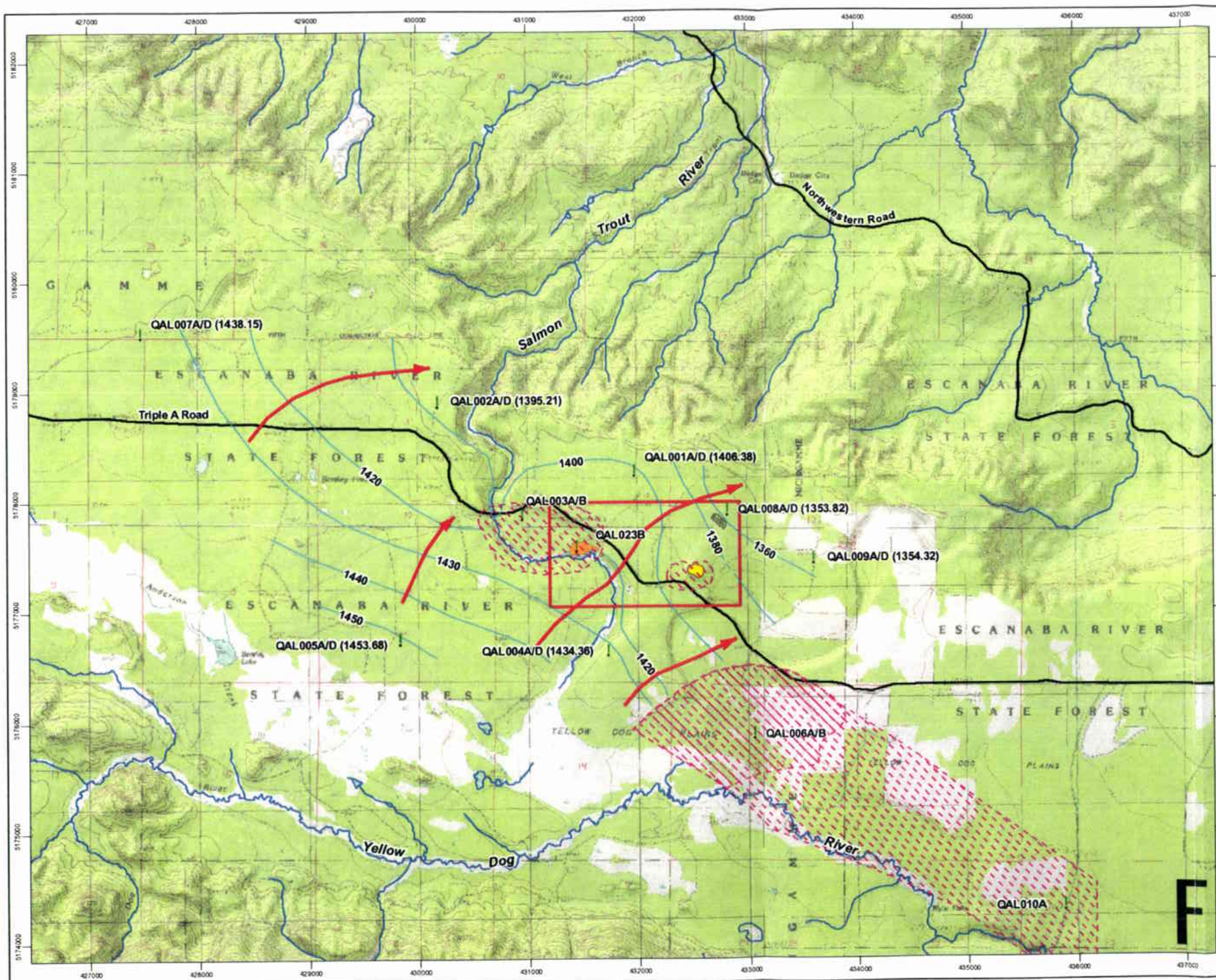


Figure 8: Hydrographs

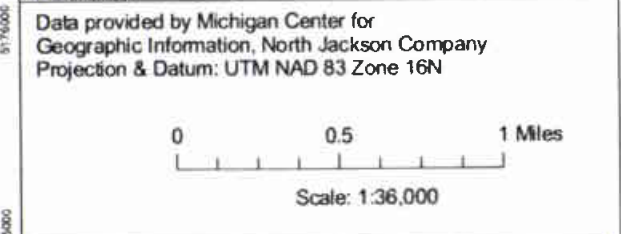




D ZONE GROUNDWATER ELEVATION CONTOURS (SPRING SNOWMELT RUNOFF, MAY 2005)

- ORE BODY
- OUTCROP
- EAGLE PROJECT
- ROAD
- HYDROGRAPHY
- MONITORING WELL
- D-ZONE DISCONTINUITY
- GROUNDWATER FLOWLINE
- GROUNDWATER CONTOUR
(20' CONTOUR INTERVAL, DASHED WHERE INFERRED
SUPPLEMENTAL CONTOURS AT 1430 ft & 1450 ft)
- (1416.49) GROUNDWATER ELEVATION (ft MSL on 5/4/05)

Reference
Data provided by Michigan Center for
Geographic Information, North Jackson Company
Projection & Datum: UTM NAD 83 Zone 16N



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Figure: 10

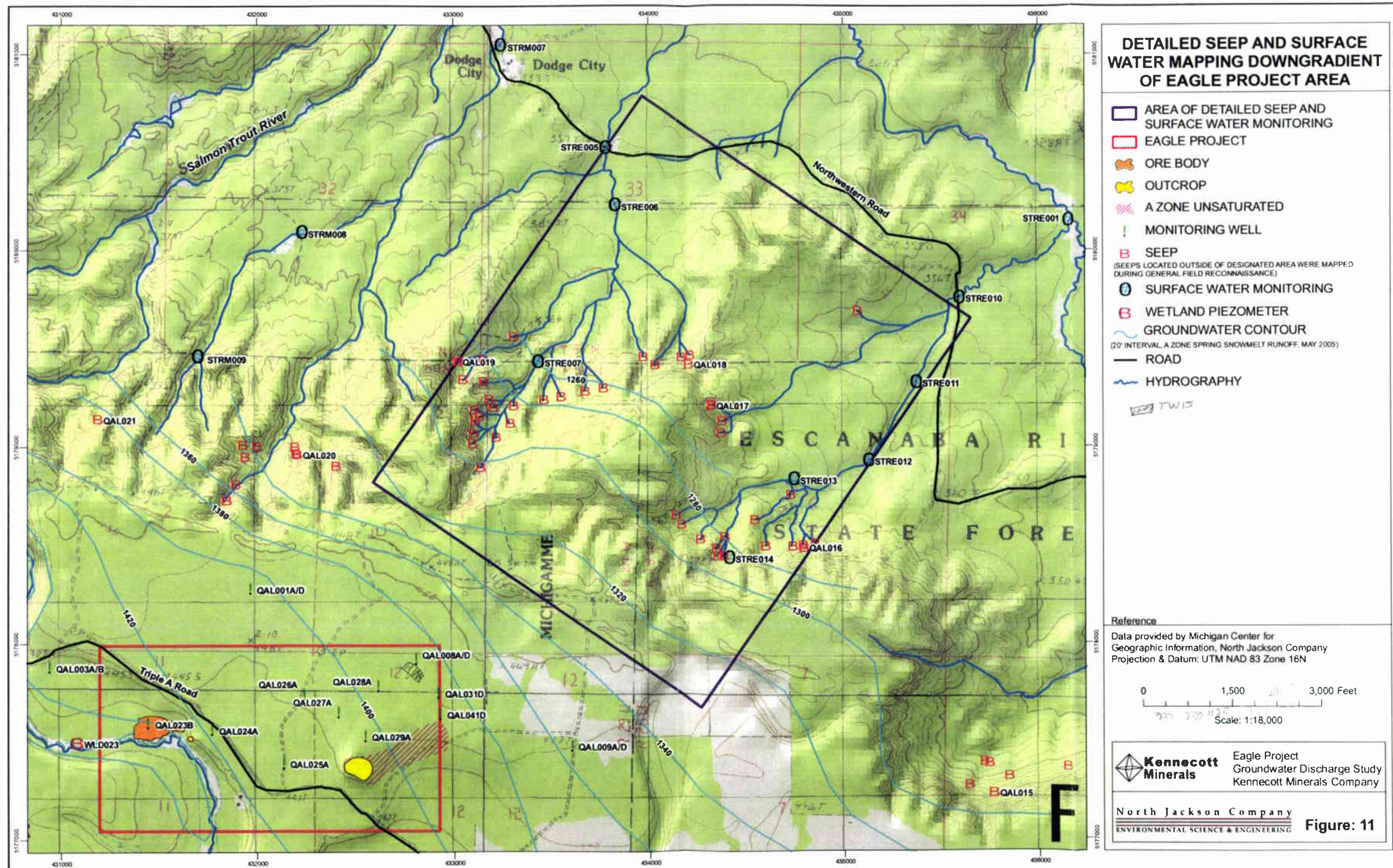


Figure 12
Continuous Groundwater Elevation Data
(August 2004 - May 2005)
Eagle Project

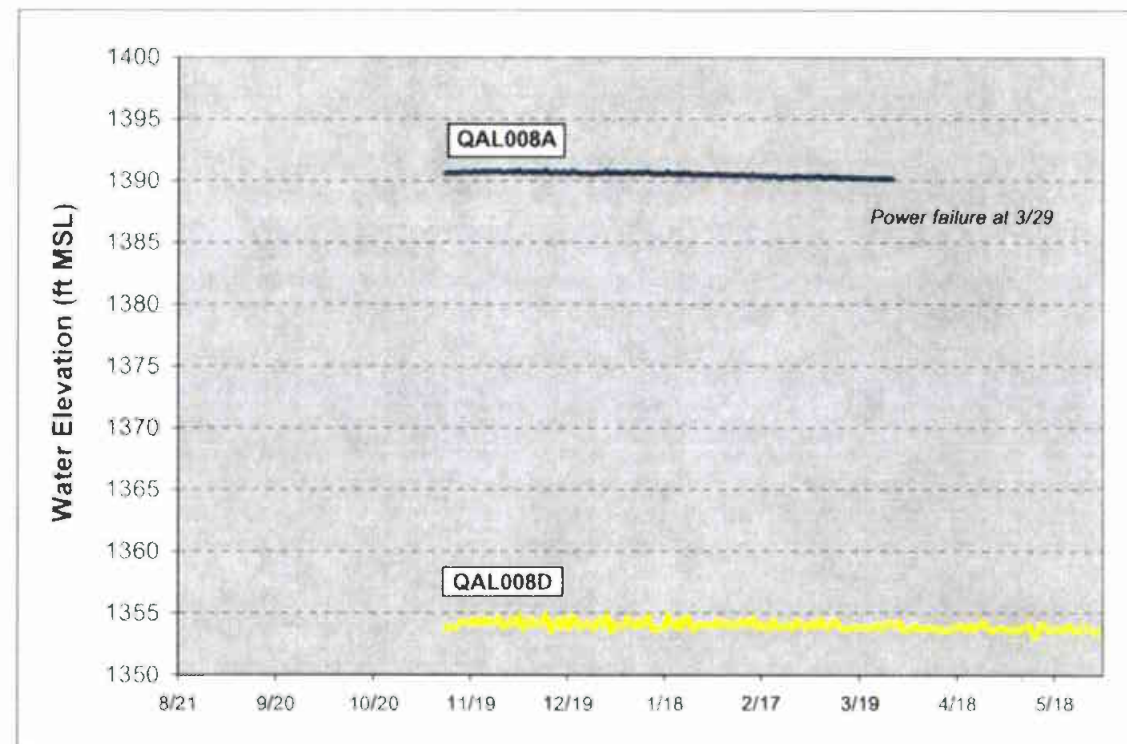
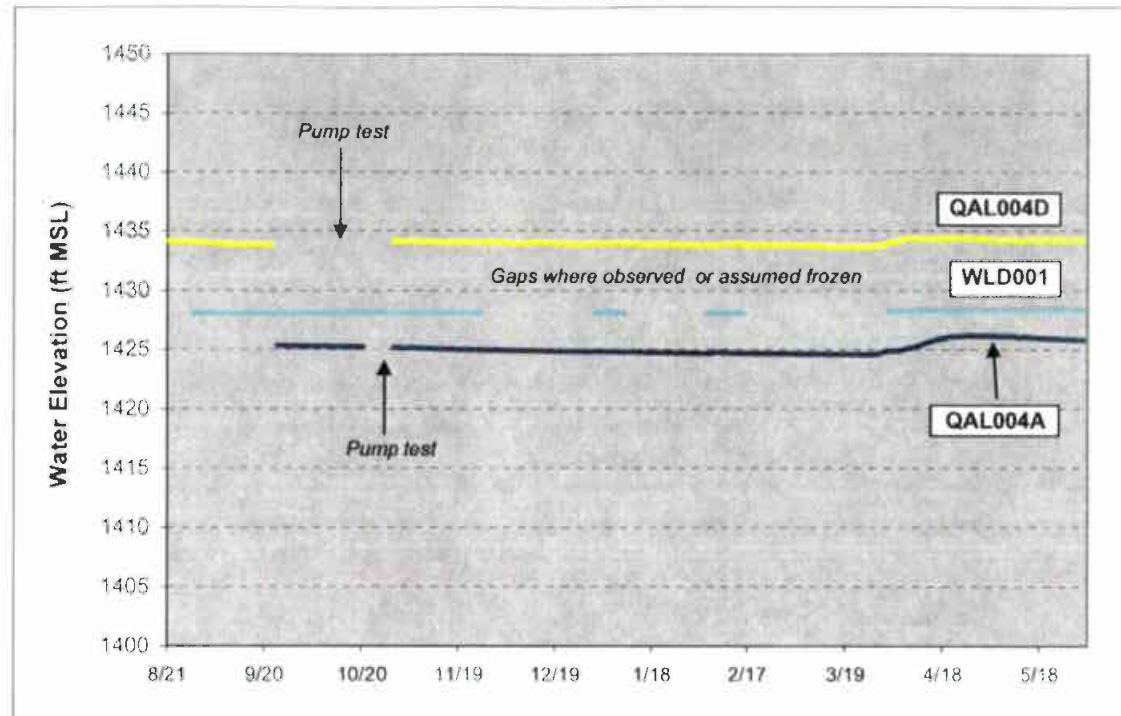


Figure 12: GW Elevation Plot

Figure 12
Continuous Groundwater Elevation Data
(August 2004 - May 2005)
Eagle Project

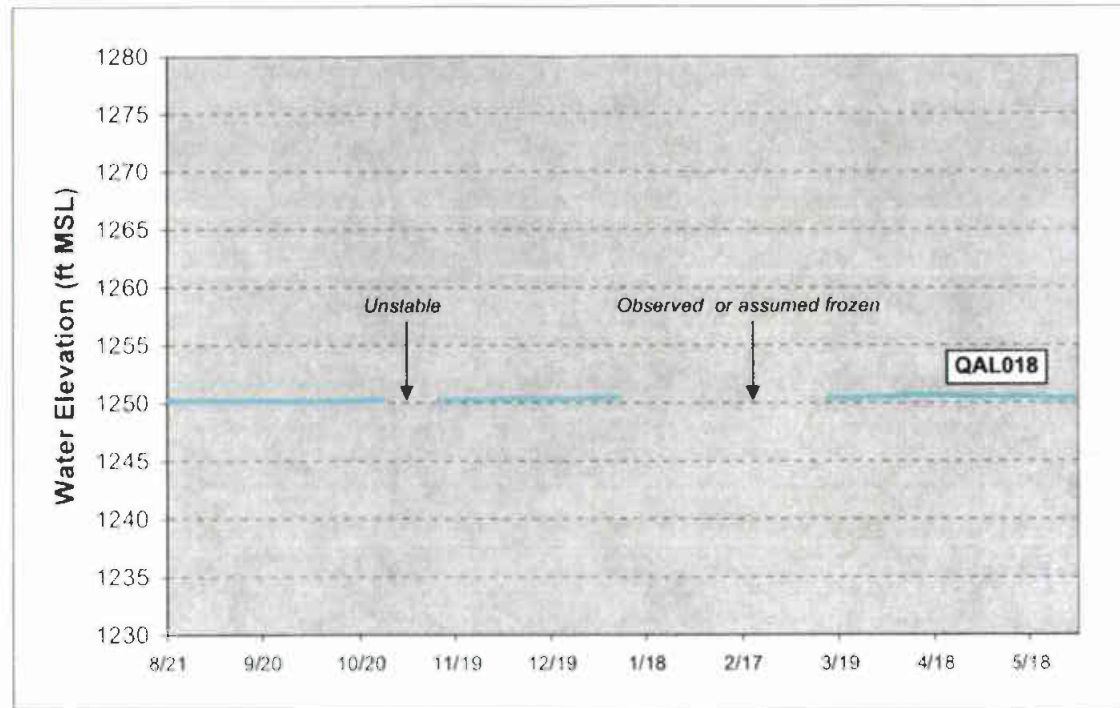


Figure 12: GW Elevation Plot

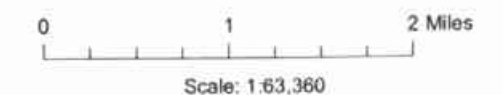
LAYER 2 (A ZONE) MODEL EQUIPOTENTIAL SIMULATION (WITH GROUNDWATER BASIN DIVIDES)

- ORE BODY
- OUTCROP
- EAGLE PROJECT
- APPROXIMATE LIMIT OF ACTIVE MODEL AREA
- RIVER CELL
- EQUIPOTENTIAL
(10' CONTOUR INTERVAL, DASHED WHERE INFERRED)
- ROAD
- GROUNDWATER BASIN DIVIDE
STR - SALMON TROUT RIVER
YDR - YELLOW DOG RIVER
- MONITORING WELL
- SEEP PIEZOMETER
- SURFACE WATER MONITORING

*Tw 13
Missing QAL008*

Reference

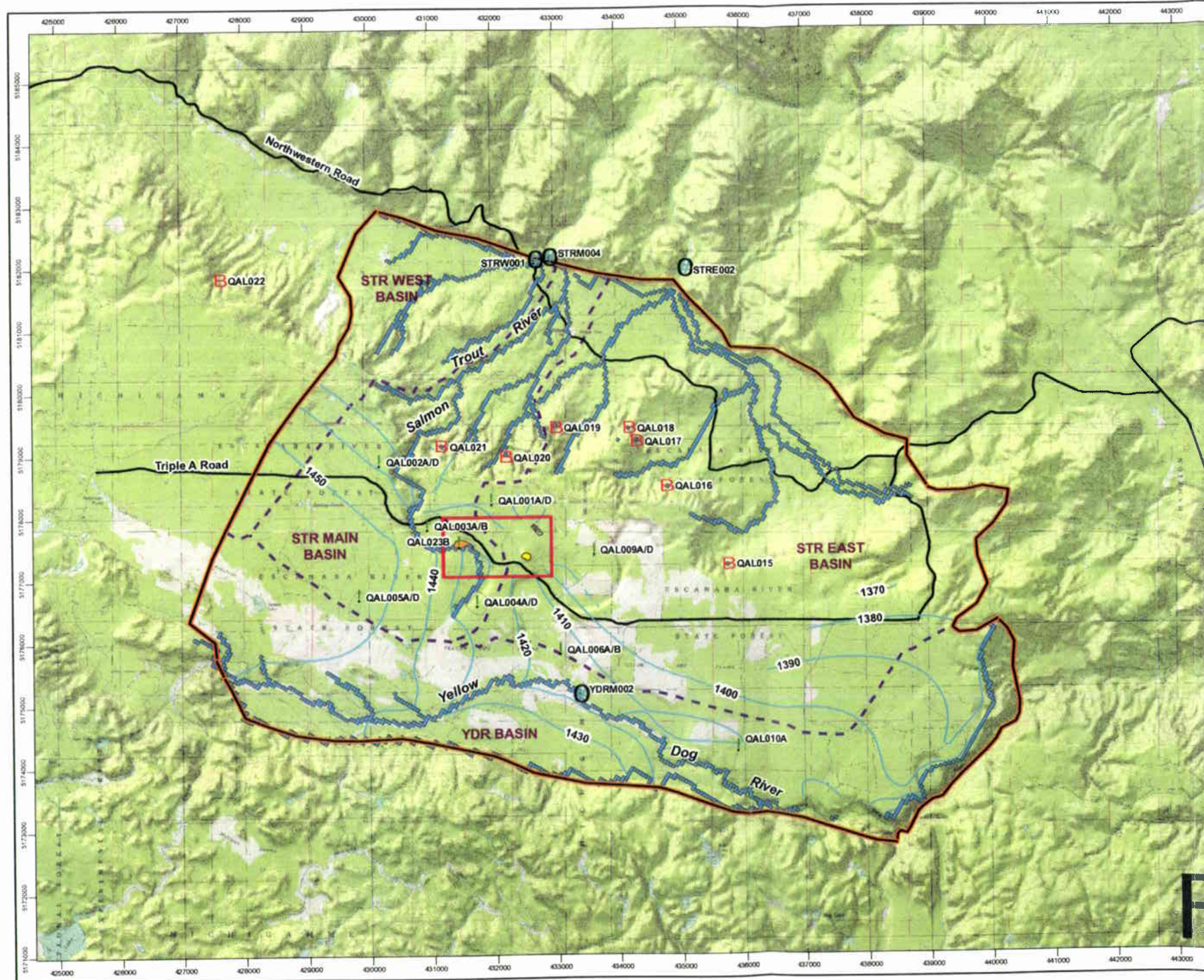
Data provided by Michigan Center for Geographic Information, North Jackson Company, Fletcher Driscoll & Assoc.
Projection & Datum: UTM NAD 83 Zone 16N

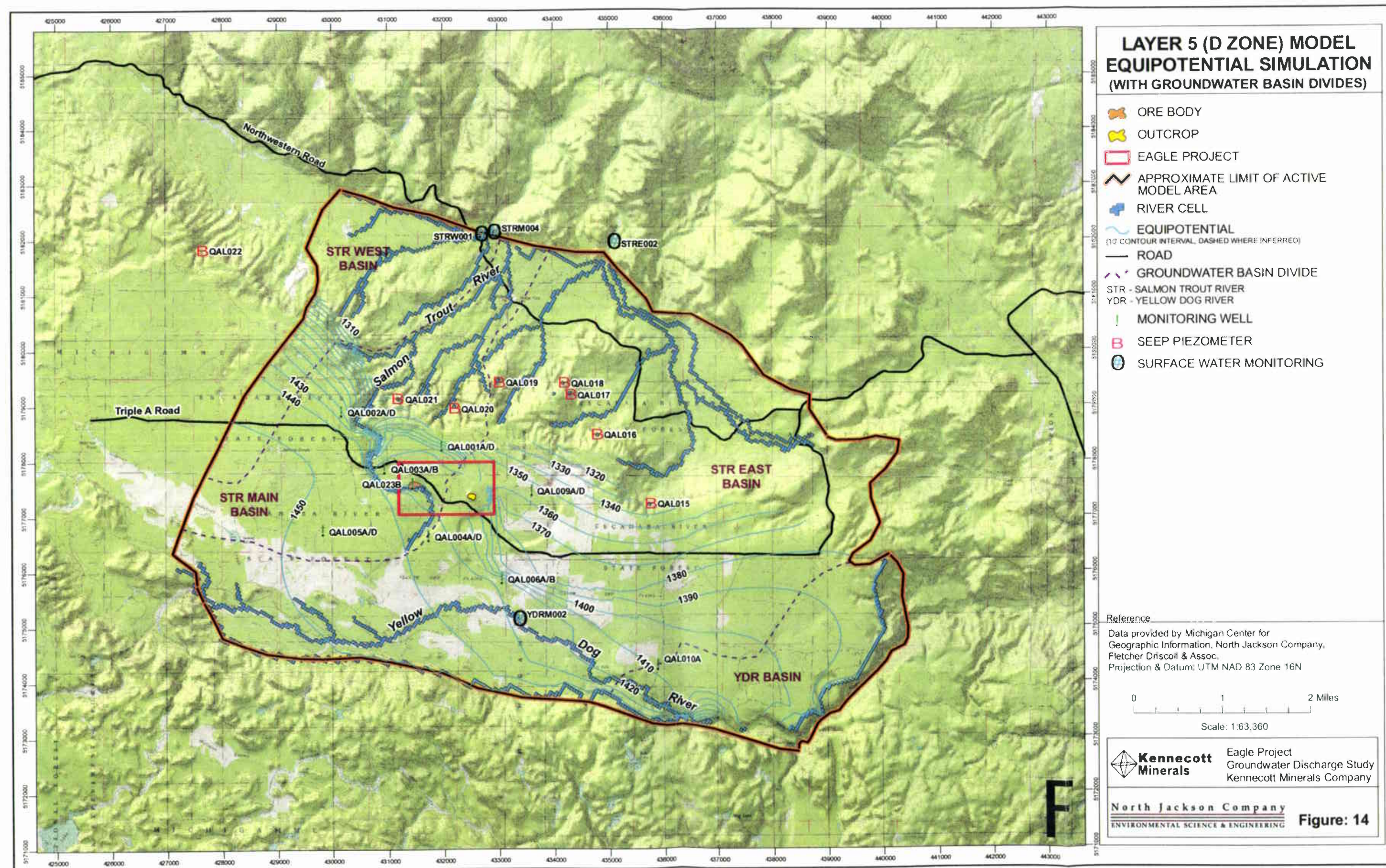


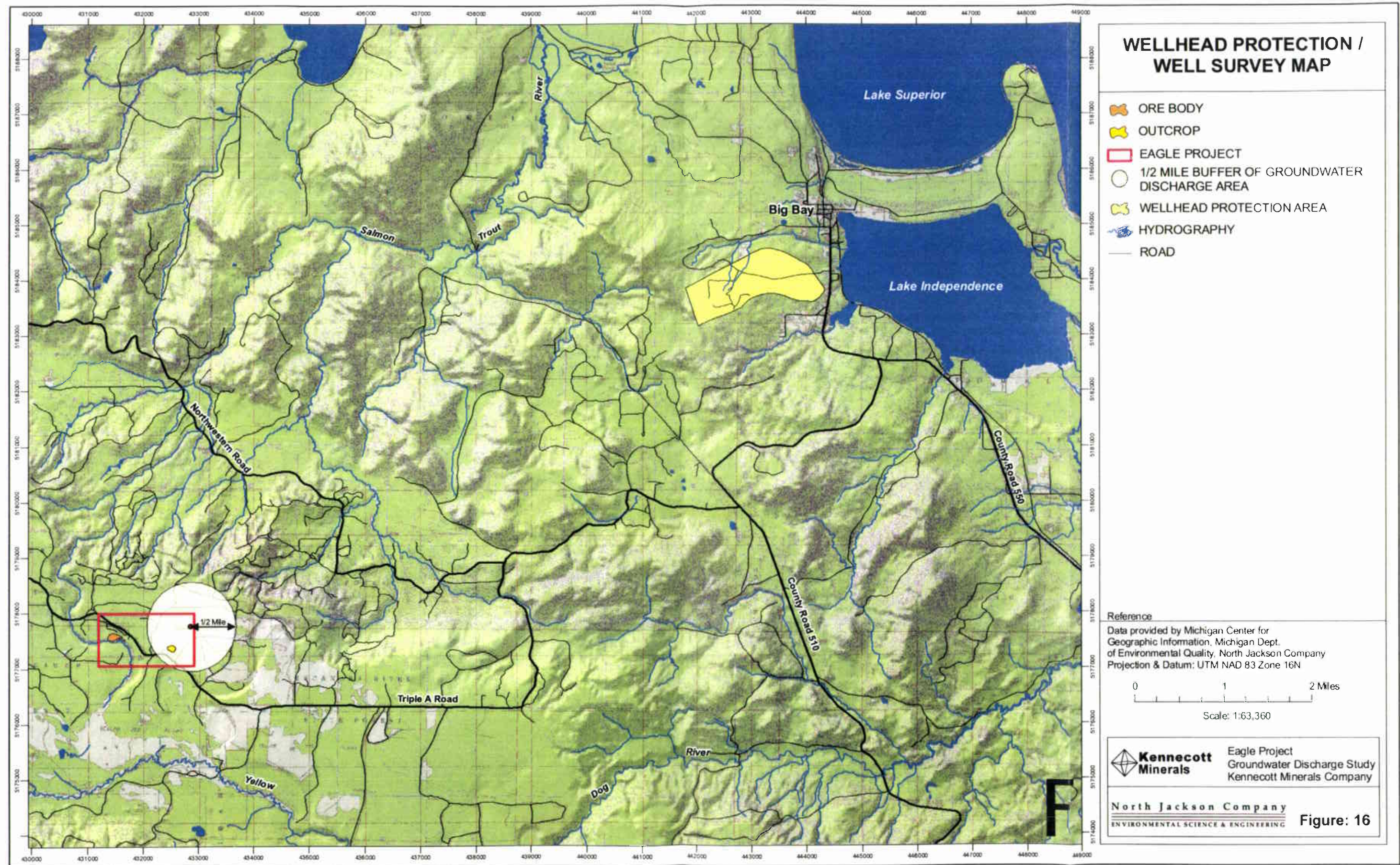
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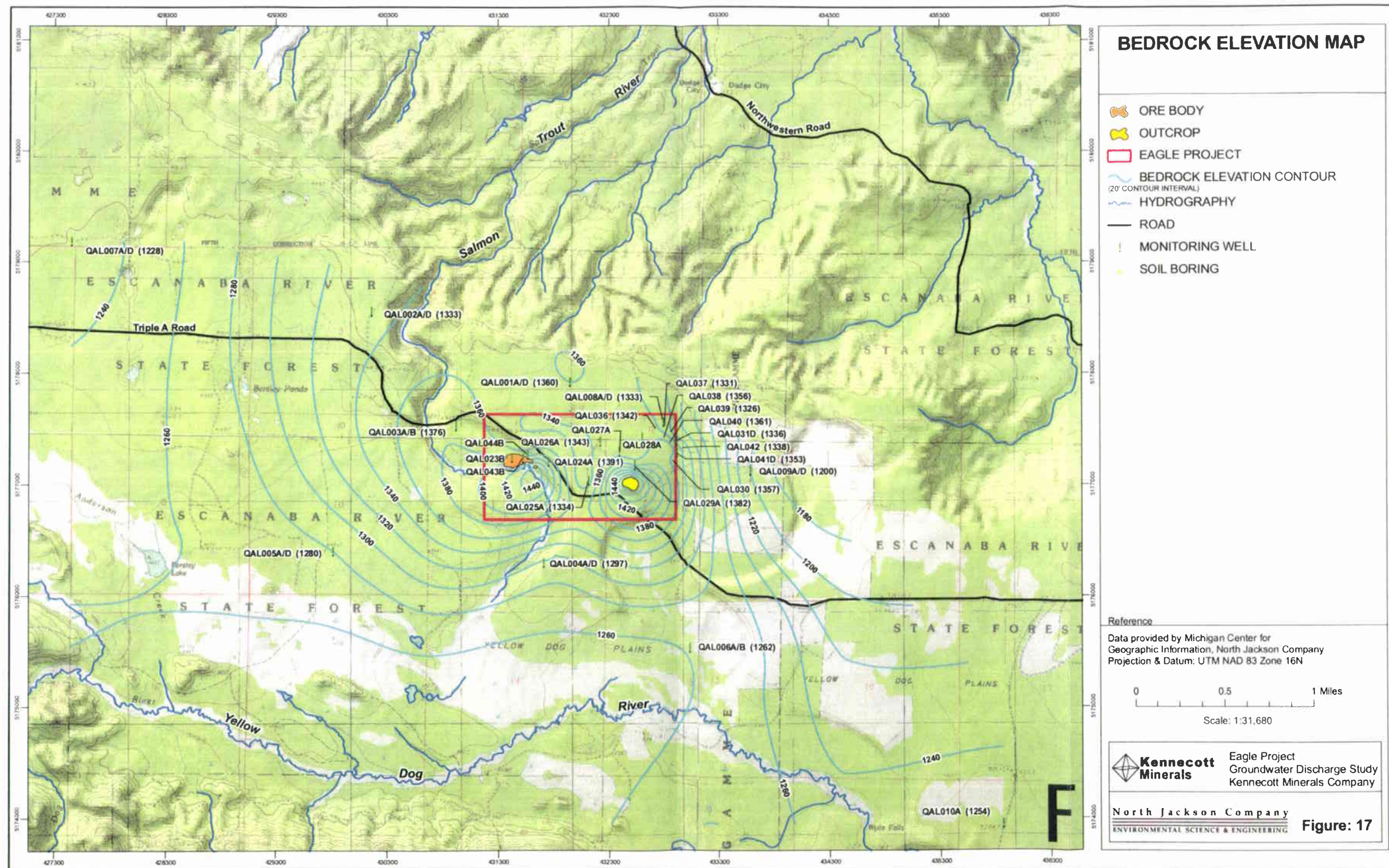
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Figure: 13









QUATERNARY DEPOSIT ISOPACH HS VIEW

- ORE BODY
- OUTCROP
- PROPOSED SITE PLAN
- PROPOSED DISCHARGE AREA
- QUATERNARY ISOPACH
(20' CONTOUR INTERVAL)
- SOIL BORING
- MONITORING WELL
- WETLAND PIEZOMETER
(128) QUATERNARY THICKNESS (ft)

Reference
Data provided by Kennecott Minerals,
North Jackson Company, Foth & Van Dyke
and Assoc. Inc.
Projection & Datum: UTM NAD 83 Zone 16N

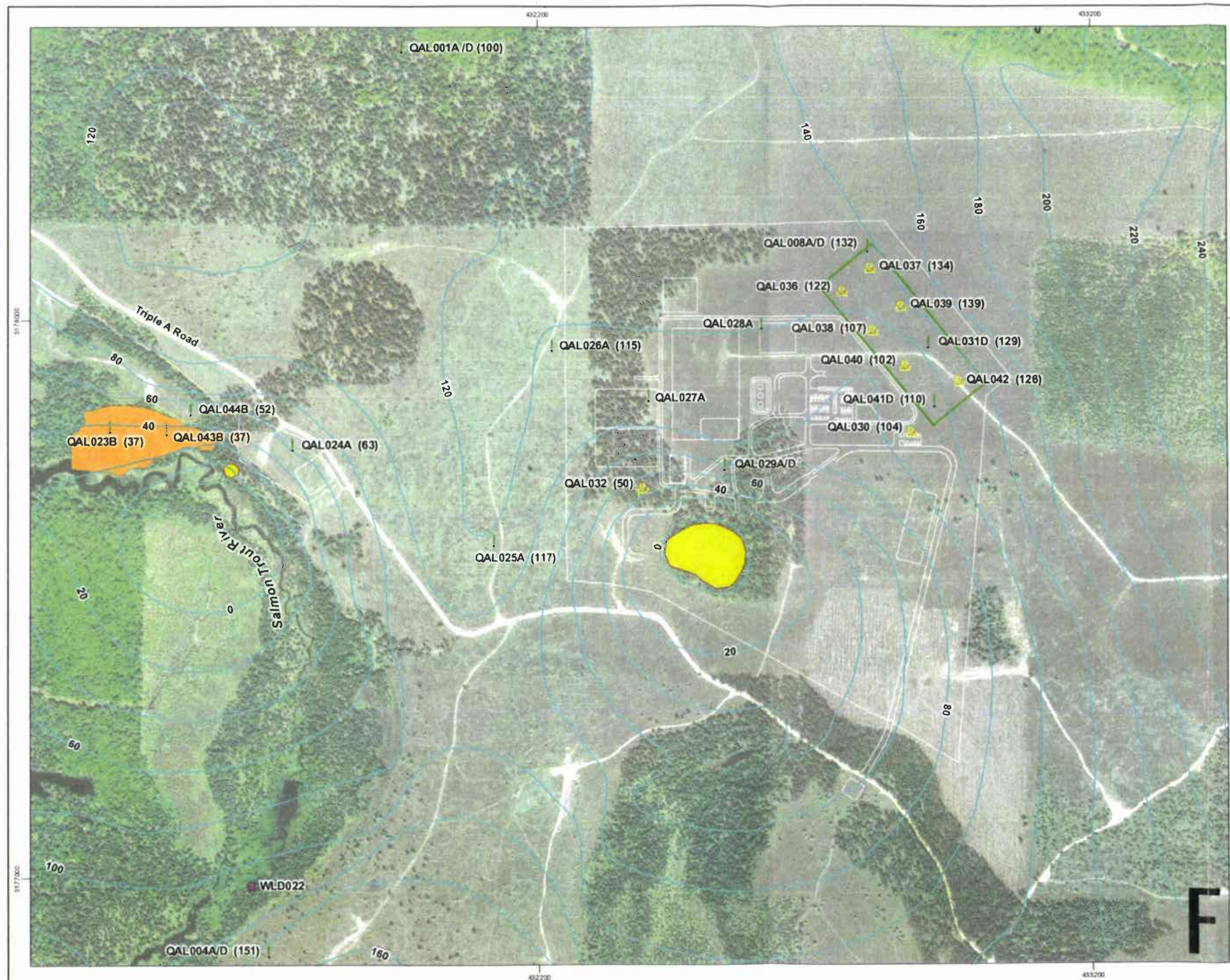
0 600 1,200 Feet
Scale: 1:7,200



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Figure: 18



UNSATURATED ISOPACH HS VIEW

- ORE BODY
- OUTCROP
- PROPOSED SITE PLAN
- PROPOSED DISCHARGE AREA
- UNSATURATED ISOPACH
(20' CONTOUR INTERVAL)
- MONITORING WELL
- WETLAND PIEZOMETER
(100) UNSATURATED THICKNESS (ft)

Reference
Data provided by Kennecott Minerals, Foth &
Van Dyke and Assoc. Inc., North Jackson Company
Projection & Datum: UTM NAD 83 Zone 16N



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Figure: 19



CONFINING UNIT (B&C ZONE) ISOPACH HS VIEW

- ORE BODY
- OUTCROP
- PROPOSED SITE PLAN
- PROPOSED DISCHARGE AREA
- CONFINING UNIT (B&C ZONE) CONTOUR
(CONTOUR INTERVAL 20', DASHED WHERE INFERRED)
- MONITORING WELL
- SOIL BORING
- WETLAND PIEZOMETER

Reference

Data provided by Kennecott Minerals,
North Jackson Company, Foth & Van Dyke
and Assoc. Inc.
Projection & Datum: UTM NAD 83 Zone 16N



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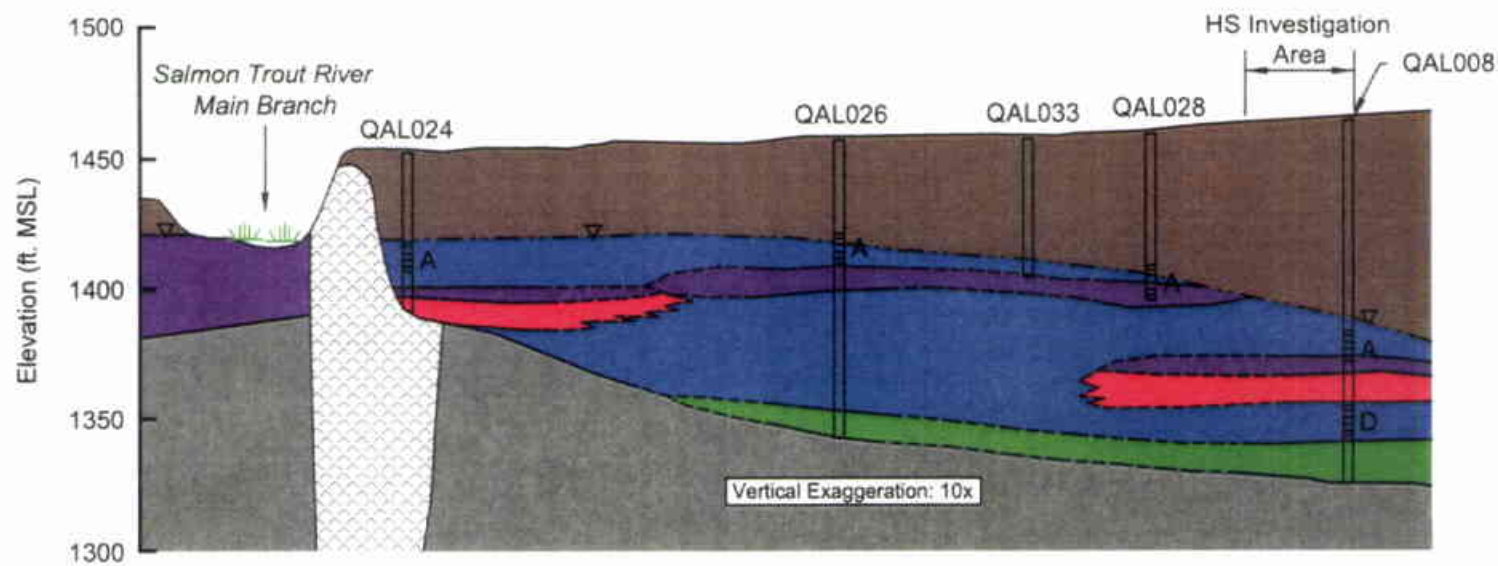
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Figure: 20



Southwest
B

Northeast
B'



LEGEND:

- | | | |
|-------------------------------------|--|-----------------------------|
| Water Table | Unsat. Sand | Clayey Glacial Till |
| Monitoring Well with Screened Zones | Saturated Sand (upper and lower zones) | Bedrock: Metasedimentary |
| | Fine Sand Silt and Clay | Bedrock: Igneous Intrusives |
| | Lean Clay | |

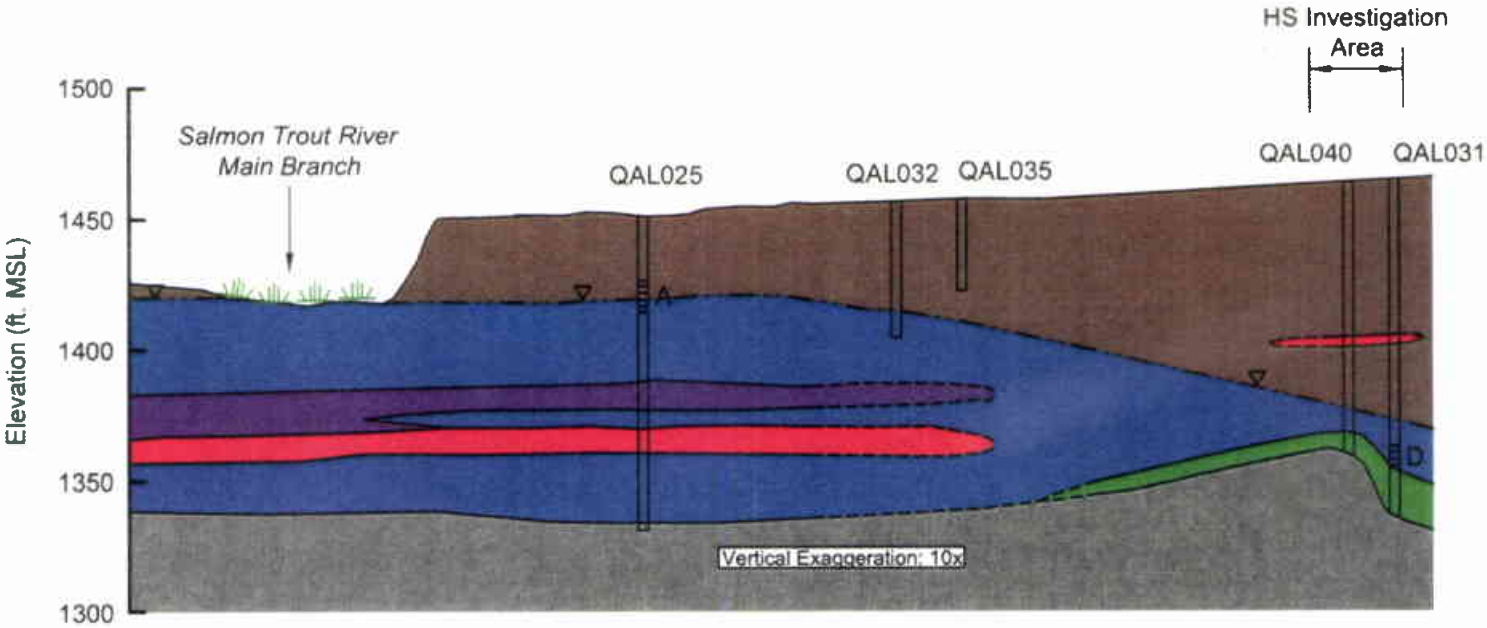
NORTH JACKSON COMPANY
1004 Harbor Hills Drive, Suite 102
Marquette, MI 49855

0 700
Feet
Vertical Exaggeration: 10x

FIGURE 21
CONCEPTUAL HYDROGEOLOGIC
CROSS SECTION B-B'
Eagle Project

Southwest
C

Northeast
C'



LEGEND:

—▽— Water Table

Monitoring Well with
Screened Zones

Unsaturated Sand

Saturated Sand (upper and lower zones)

Fine Sand Silt and Clay

Lean Clay

Clayey Glacial Till

Bedrock: Metasedimentary

Bedrock: Igneous Intrusives

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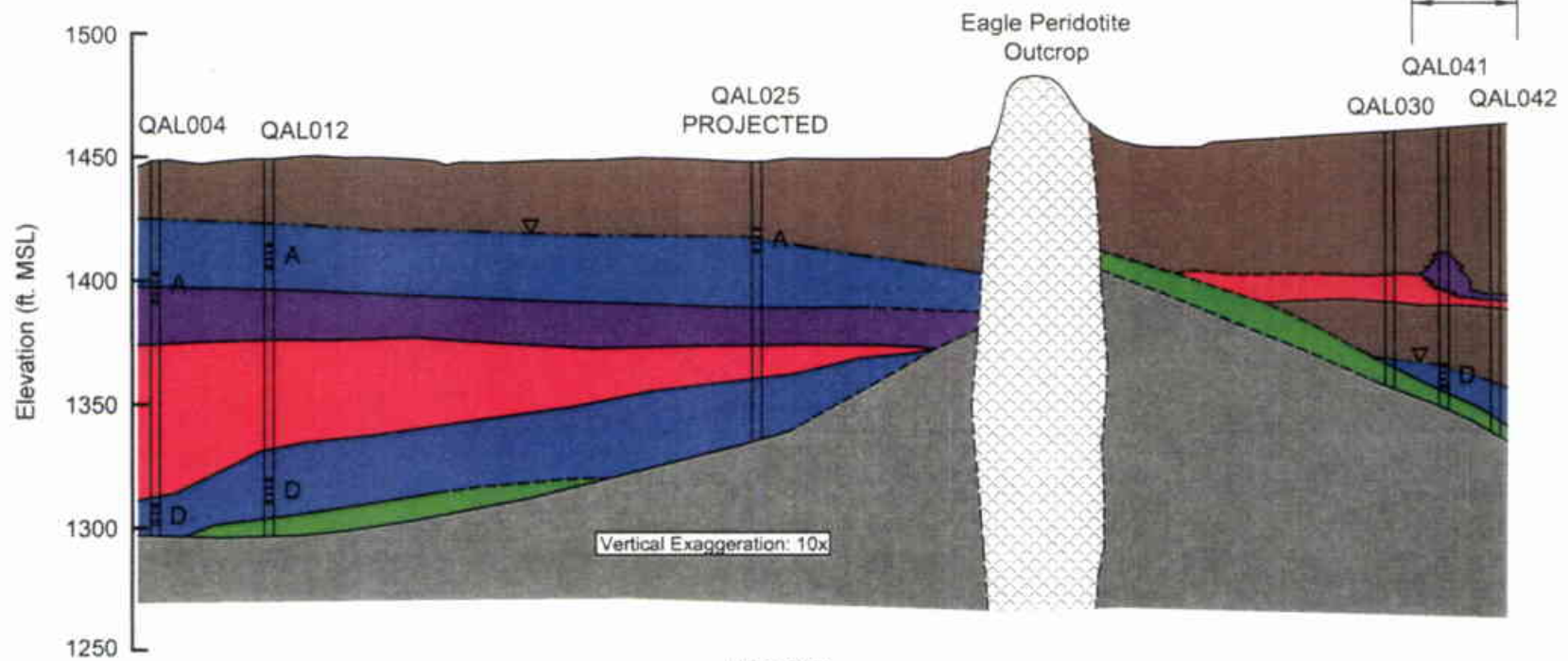
0 700
Feet
Vertical Exaggeration: 10x

FIGURE 22
CONCEPTUAL HYDROGEOLOGIC
CROSS SECTION C-C'

Eagle Project

Southwest
D

Northeast
D'



LEGEND:

—▽— Water Table

A Monitoring Well with Screened Zones

Unsaturated Sand

Saturated Sand (upper and lower zones)

Fine Sand Silt and Clay

Lean Clay

Clayey Glacial Till

Bedrock: Metasedimentary

Bedrock: Igneous Intrusives

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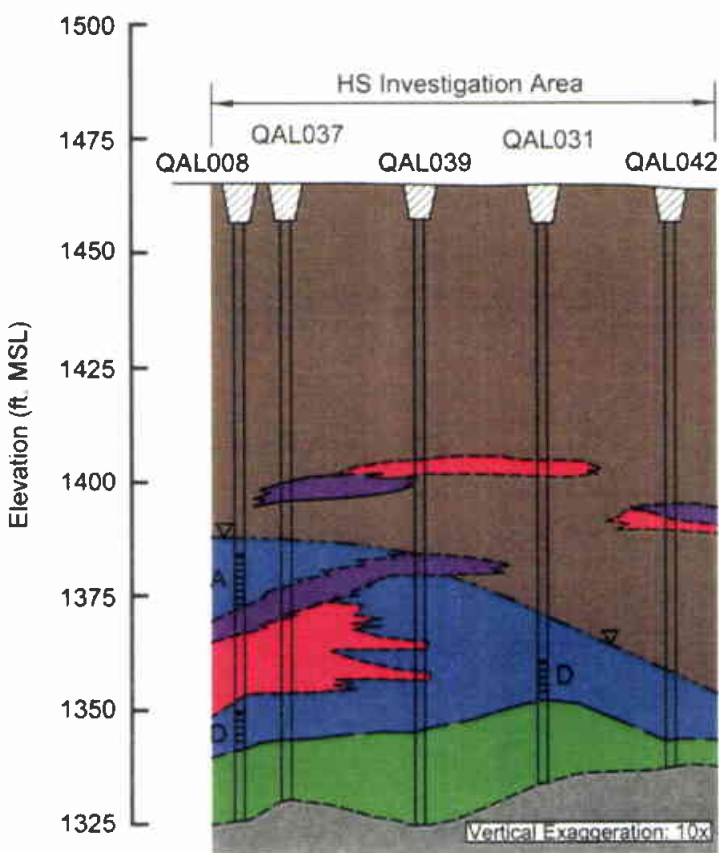
1004 Harbor Hills Drive, Suite 102
Marquette, MI 49855

0 700
Feet
Vertical Exaggeration: 10x

FIGURE 23
CONCEPTUAL HYDROGEOLOGIC
CROSS SECTION D-D'
Eagle Project

Northwest
E

Southeast
E'



LEGEND:

- | | | |
|-------------------------------------|--|-----------------------------|
| Water Table | Unsaturated Sand | Clayey Glacial Till |
| Monitoring Well with Screened Zones | Saturated Sand (upper and lower zones) | Bedrock: Metasedimentary |
| Test Pit / Infiltration Test | Fine Sand Silt and Clay | Bedrock: Igneous Intrusives |
| | Lean Clay | |

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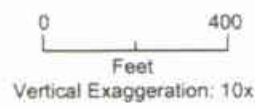
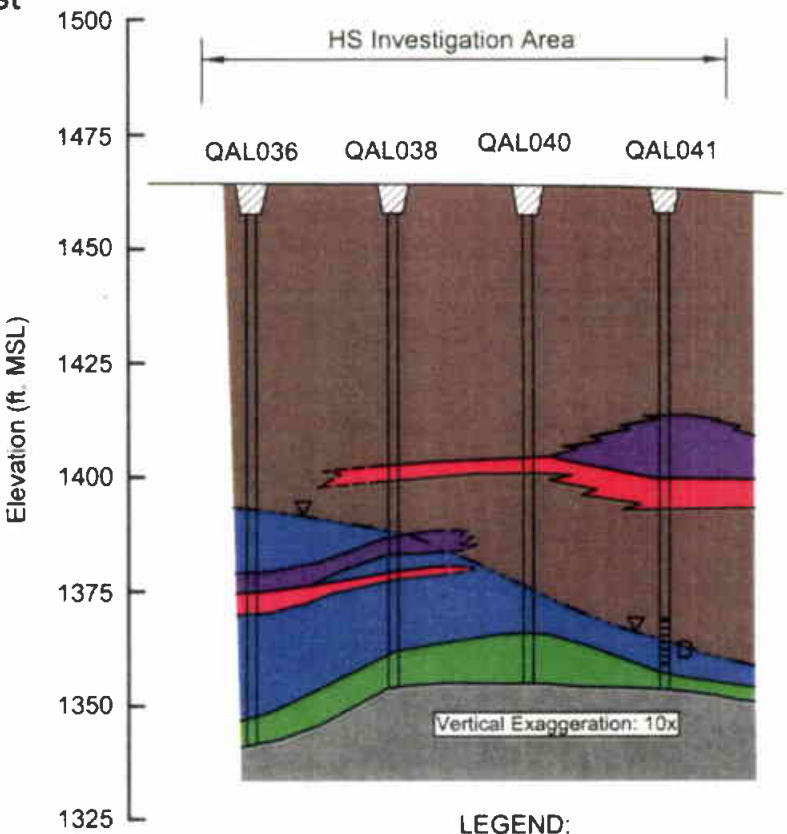


FIGURE 24
CONCEPTUAL HYDROGEOLOGIC
CROSS SECTION E-E'
Eagle Project

Northwest
F

Southeast
F'



LEGEND:

—▽— Water Table

Monitoring Well with
Screened Zones

Test Pit / Infiltration Test

Unsaturated Sand

Saturated Sand (upper and lower zones)

Fine Sand Silt and Clay

Lean Clay

Clayey Glacial Till

Bedrock: Metasedimentary

Bedrock: Igneous Intrusives

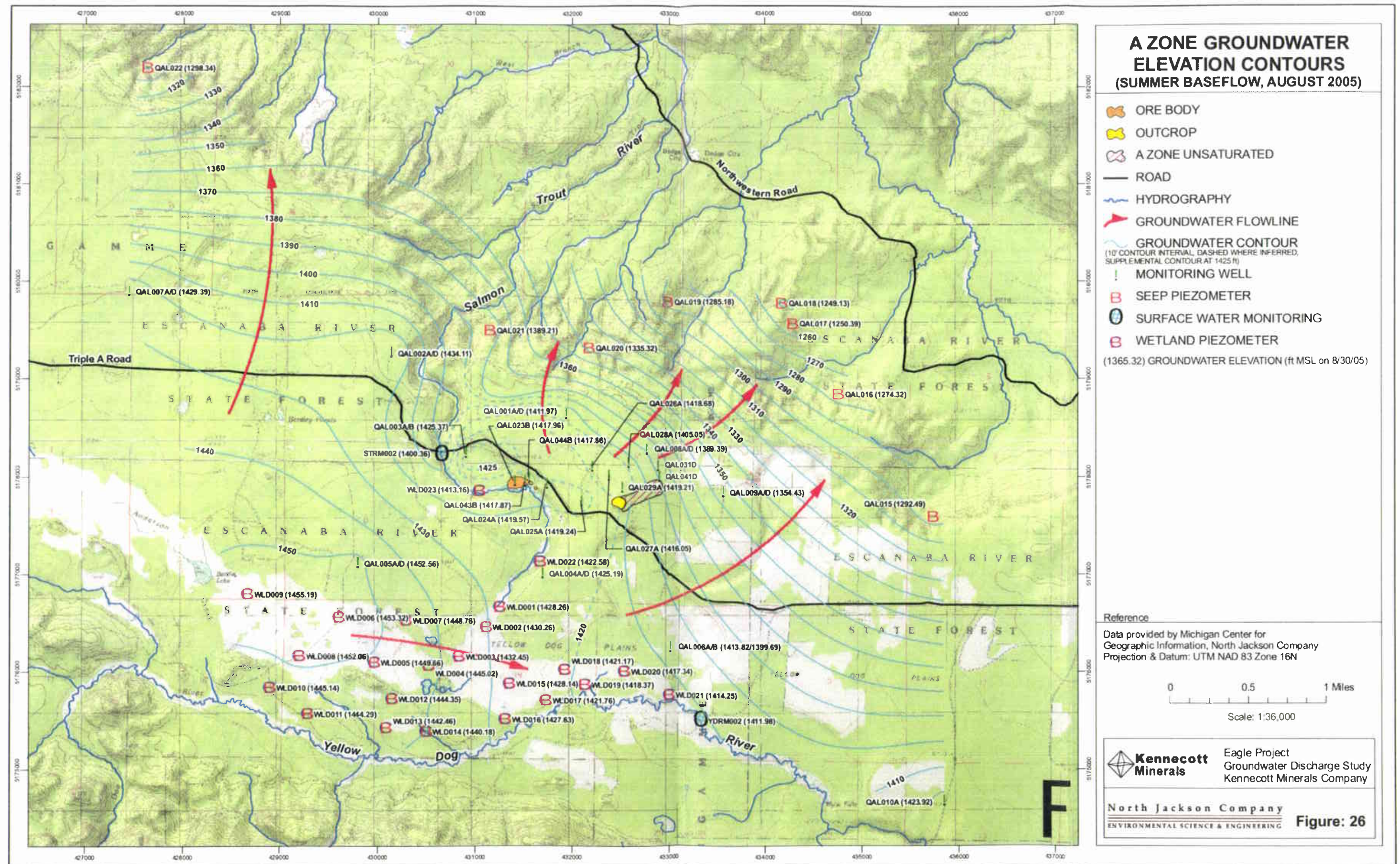
**NORTH JACKSON
COMPANY**

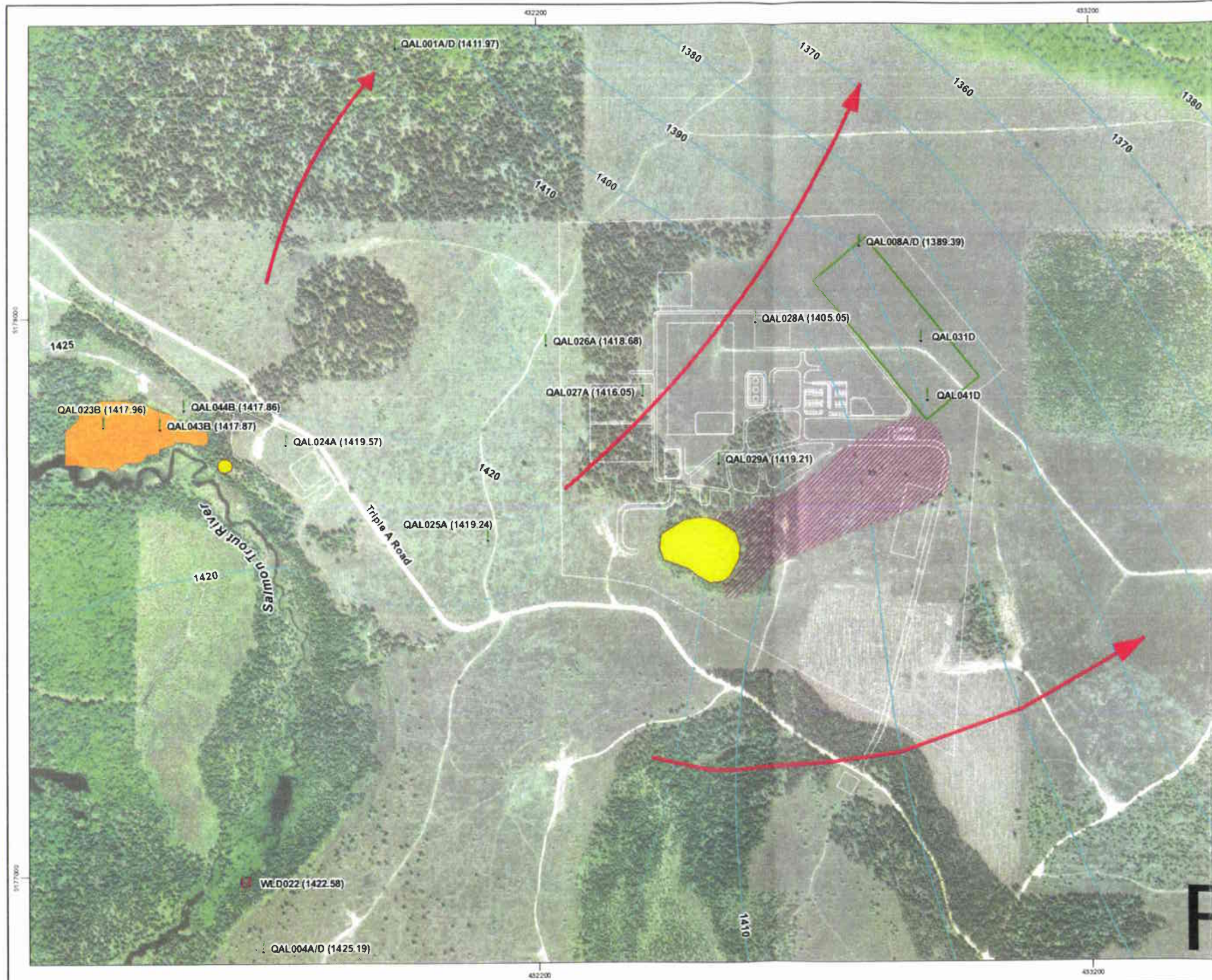
1004 Harbor Hills Drive, Suite 102
Marquette, MI 49855

0 400
Feet
Vertical Exaggeration: 10x

FIGURE 25
CONCEPTUAL HYDROGEOLOGIC
CROSS SECTION F-F'

Eagle Project





A ZONE GROUNDWATER ELEVATION CONTOUR

(SUMMER BASEFLOW, AUGUST 2005) HS VIEW

- ORE BODY
- OUTCROP
- A ZONE UNSATURATED
- PROPOSED SITE PLAN
- PROPOSED DISCHARGE AREA
- GROUNDWATER FLOWLINE
- GROUNDWATER CONTOUR
(10' CONTOUR INTERVAL, DASHED WHERE INFERRED, SUPPLEMENTAL CONTOUR AT 1425 ft)
- MONITORING WELL
- WETLAND PIEZOMETER
(1365.32) GROUNDWATER ELEVATION (ft MSL on 8/30/05)

Reference

Data provided by Kennecott Minerals, Foth & Van Dyke and Assoc., Inc., North Jackson Company
 Projection & Datum: UTM NAD 83 Zone 16N

Scale: 1:7,200

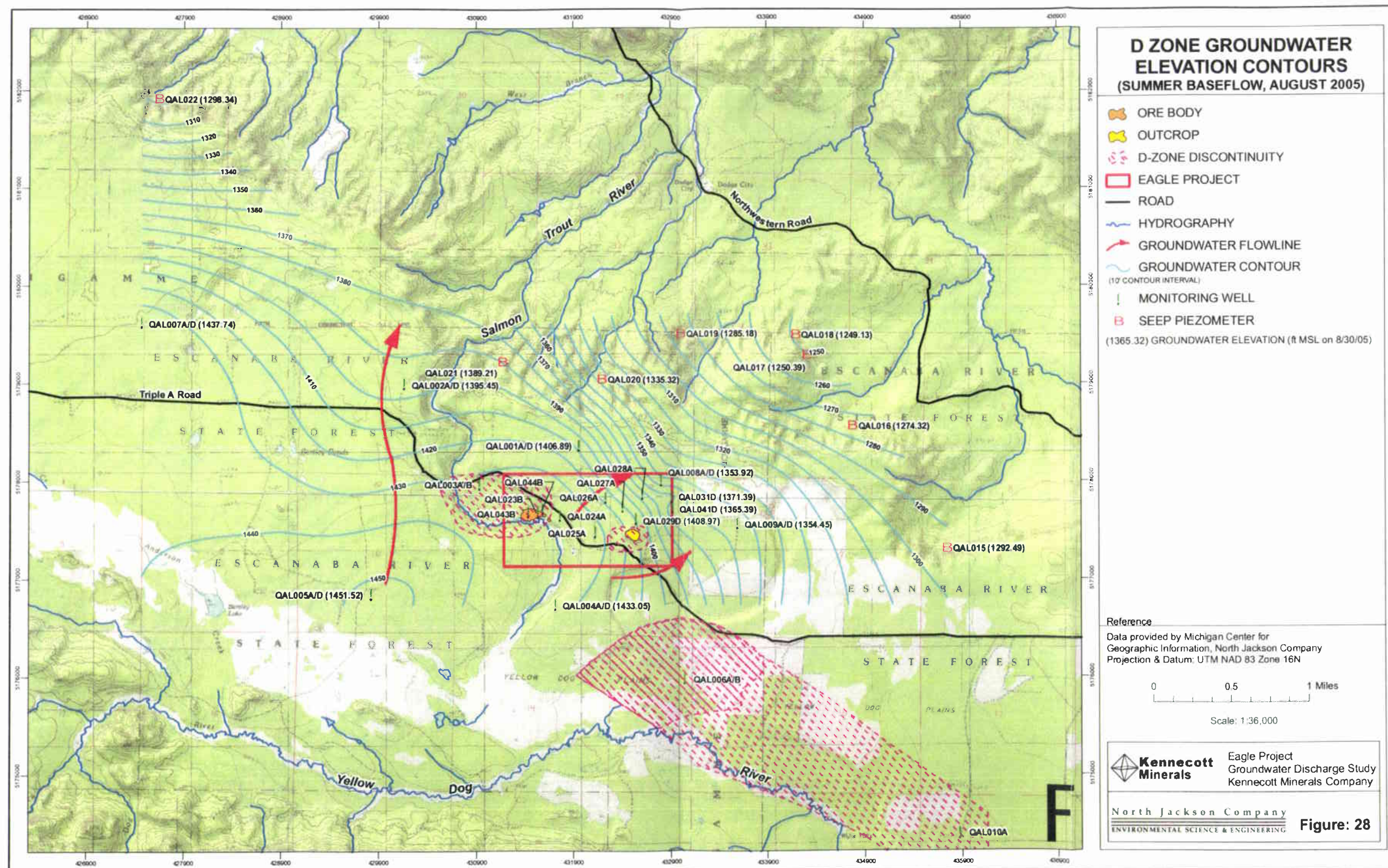
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Groundwater Discharge Study
Kennecott Minerals Company

North Jackson Company

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Figure: 27



D ZONE GROUNDWATER ELEVATION CONTOURS

(SUMMER BASEFLOW, AUGUST 2005) HS VIEW

-  ORE BODY
-  OUTCROP
-  D-ZONE DISCONTINUITY
-  PROPOSED SITE PLAN
-  PROPOSED DISCHARGE AREA
-  GROUNDWATER FLOWLINE
-  GROUNDWATER CONTOUR
(10' CONTOUR INTERVAL)
-  MONITORING WELL
-  WETLAND PIEZOMETER
(1365.32) GROUNDWATER ELEVATION (ft MSL on 8/30/05)

Reference
Data provided by Kennecott Minerals,
North Jackson Company, Foth & Van Dyke
and Assoc. Inc.
Projection & Datum: UTM NAD 83 Zone 16N

0 600 1,200 Feet
Scale: 1:7,200

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Figure: 29



Figure 30
Continuous Groundwater Elevation Data
(August 2004 - September 2005)
Eagle Project

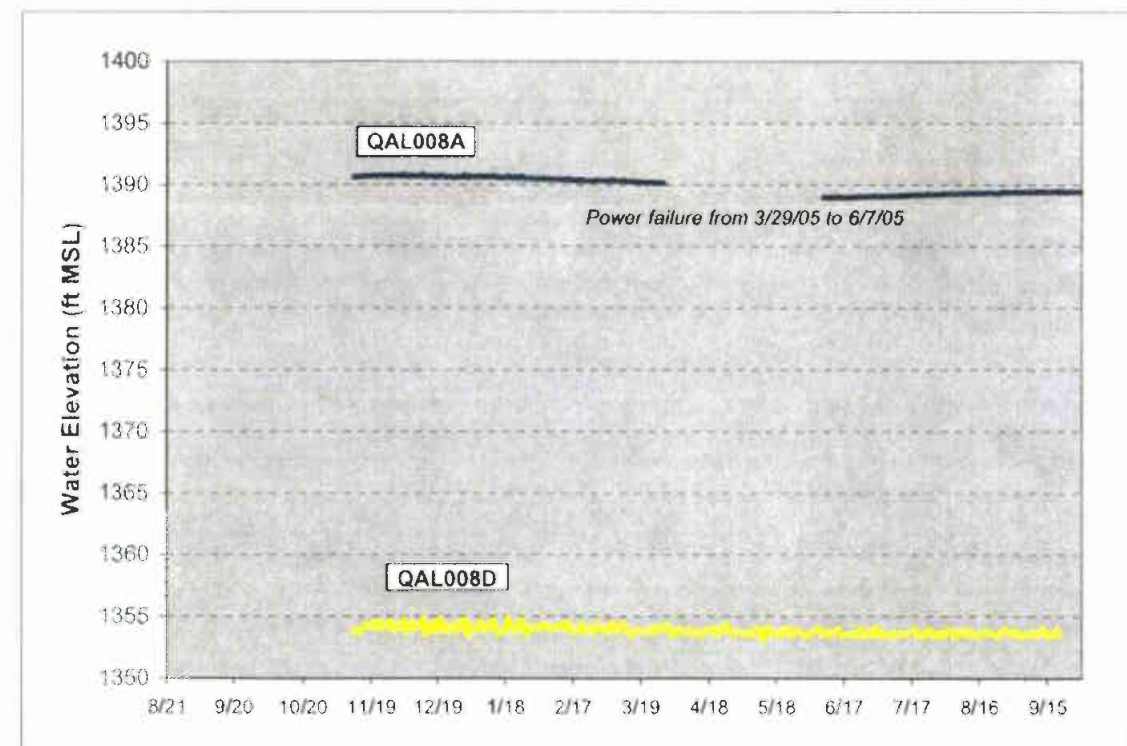
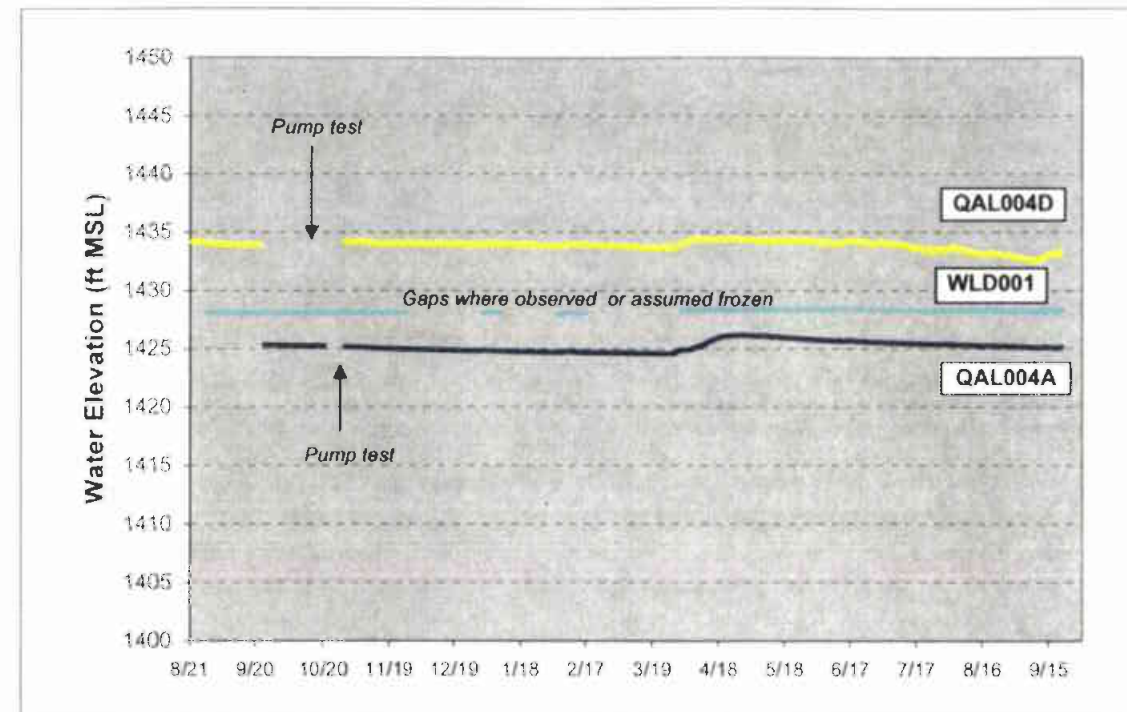


Figure 30: GW Elevation Plot

Figure 30
Continuous Groundwater Elevation Data
(August 2004 - September 2005)
Eagle Project

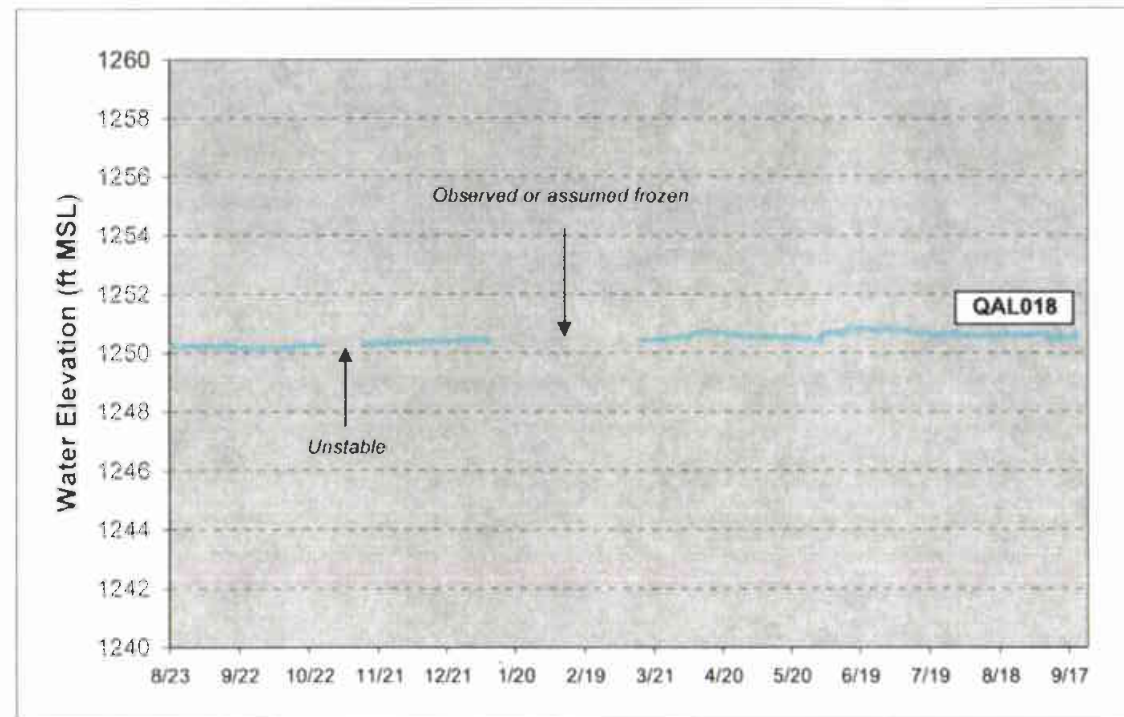


Figure 31
Infiltration Rates Within Proposed Discharge Area
Eagle Project

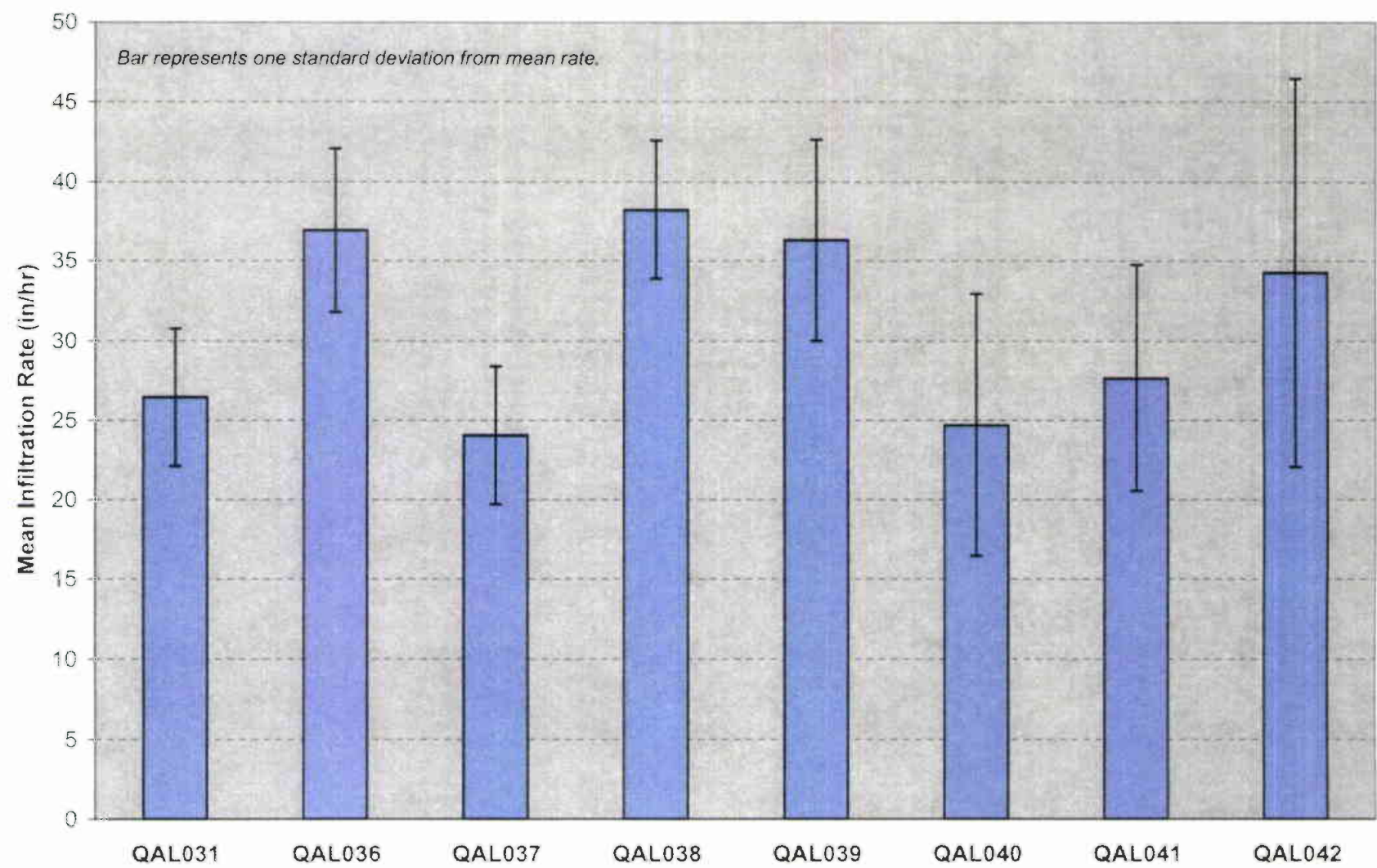


Figure 31: Infiltration Rate Plot

Figure 32 Hydraulic Conductivity Values Determined by Different Methods
Eagle Project

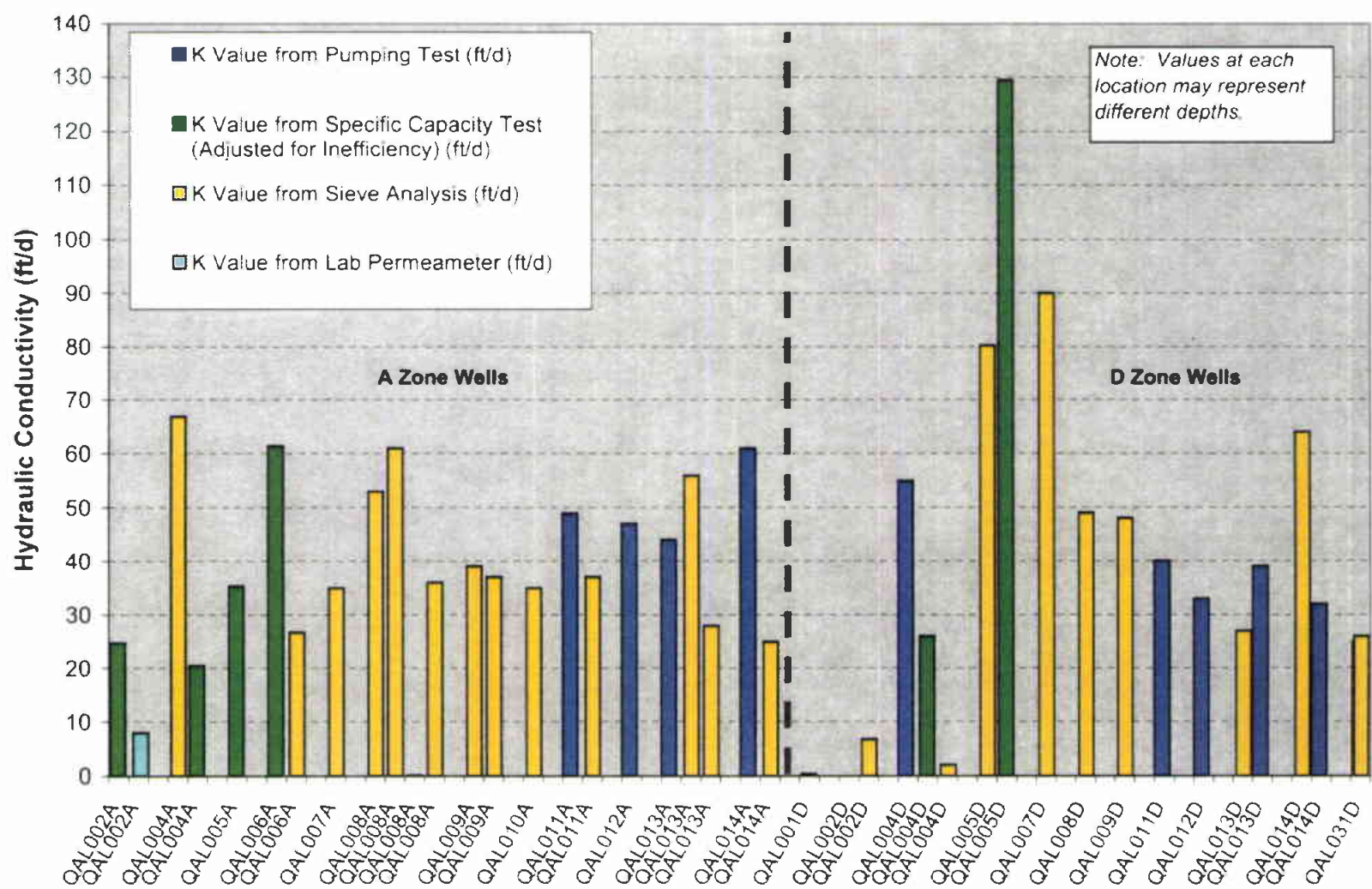
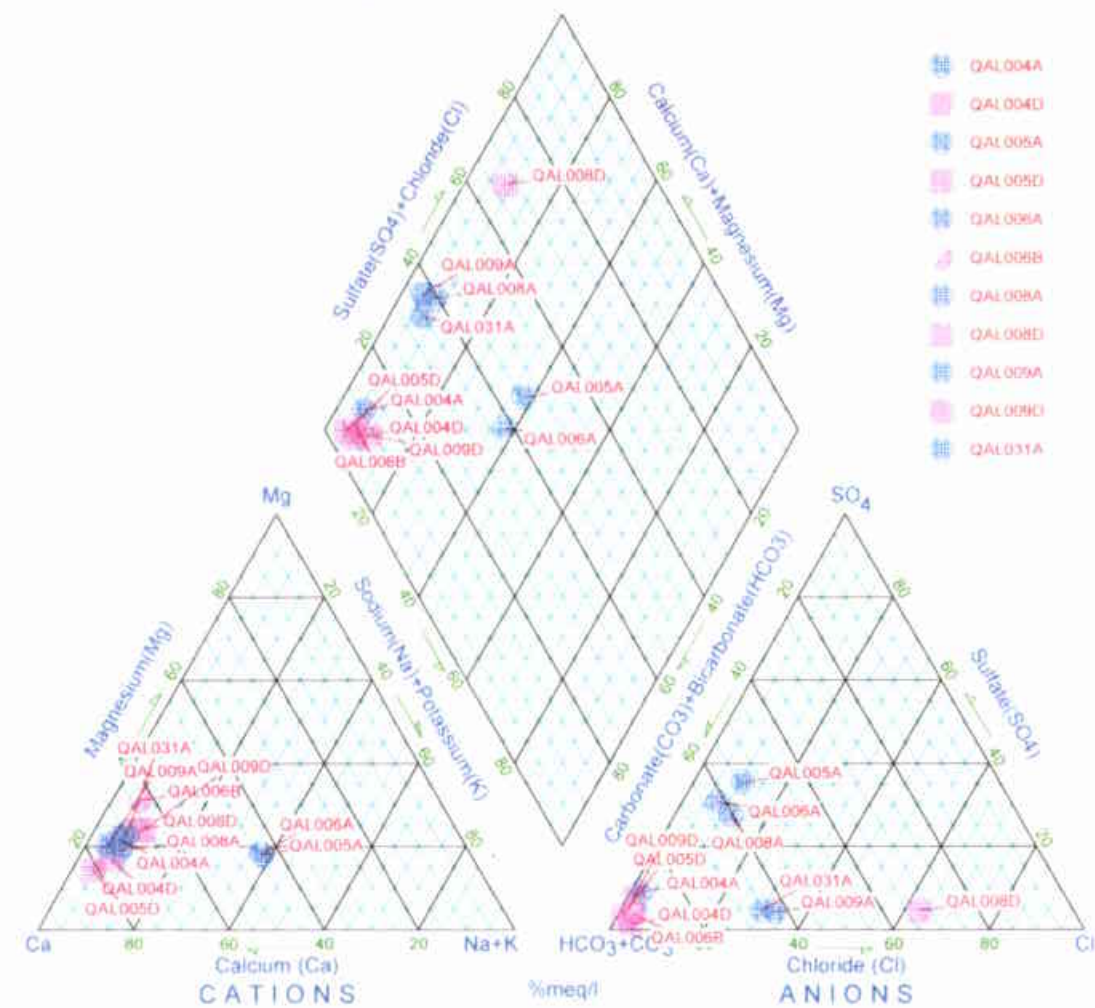
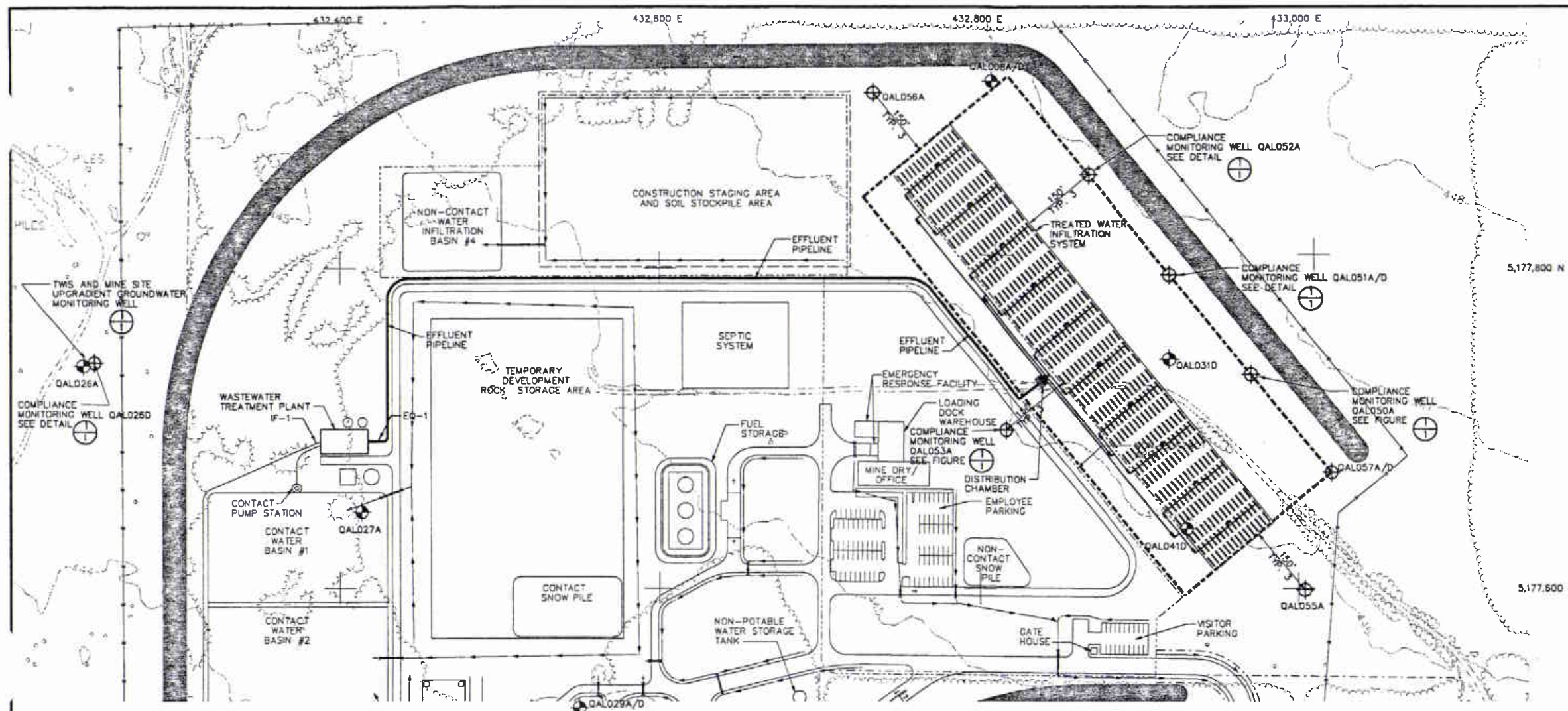


Figure 32: Hydraulic Conductivity
Fletcher Driscoll & Associates LLC

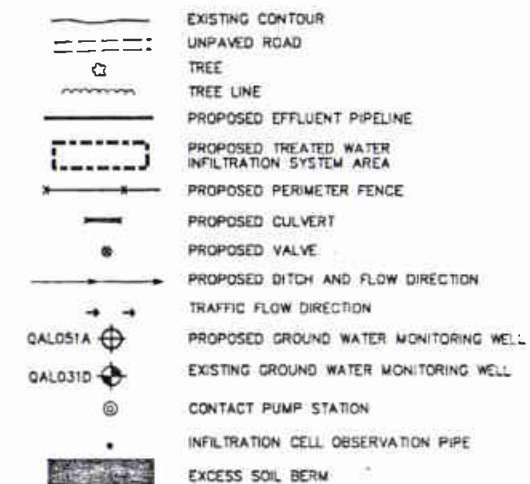
Figure 33 Piper Diagram
Groundwater (Summer Baseflow 2005)



Figures



LEGEND

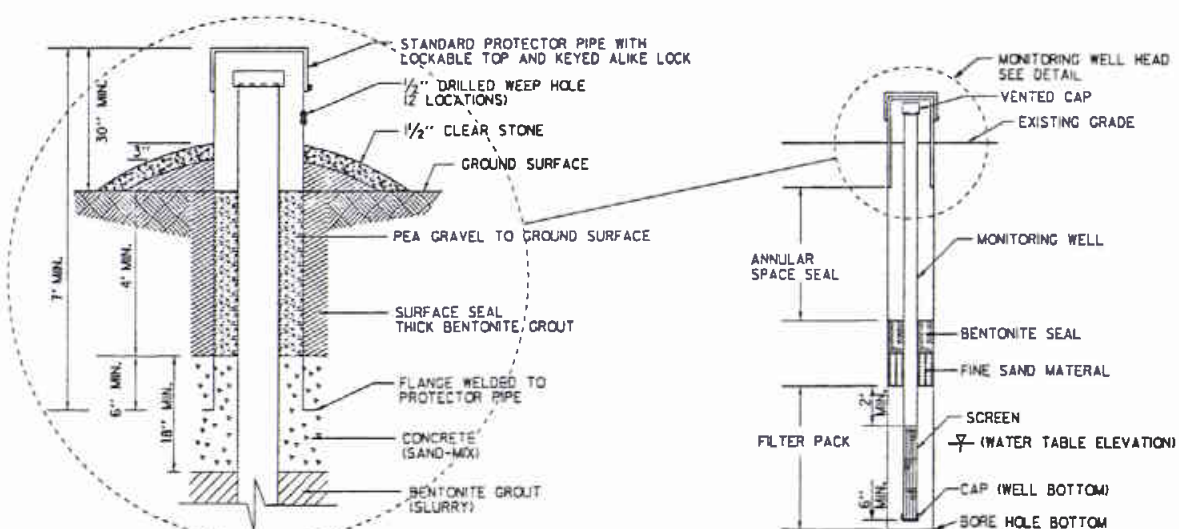


TREATED WATER INFILTRATION SYSTEM LAYOUT



NOTES:

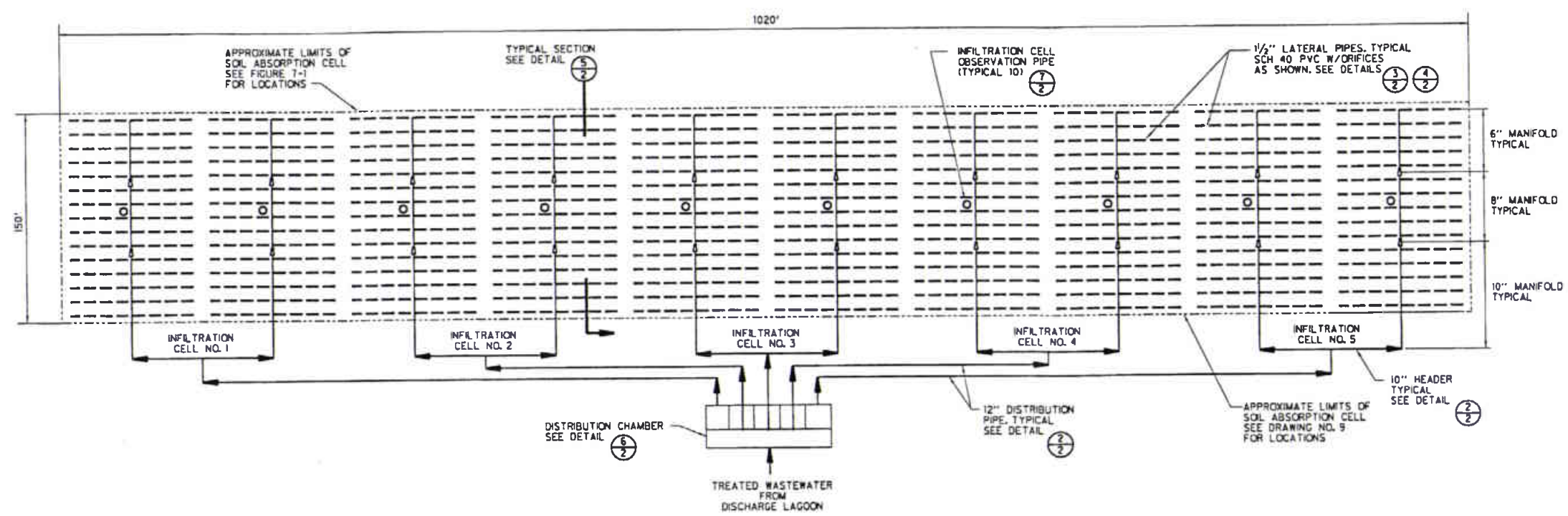
- WELLS QAL041D AND QAL027A TO BE ABANDONED PER R 323.2223 (4)(J)
- WELL QAL031D TO BE USED FOR MONITORING GROUNDWATER LEVELS ONLY. QAL031D IS NOT A COMPLIANCE MONITORING WELL.



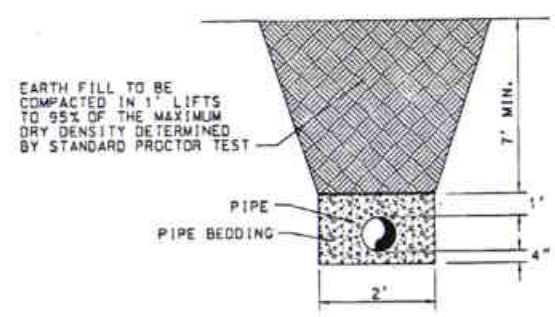
NOTE: MONITORING WELL SHALL BE CONSTRUCTED, DEVELOPED AND DOCUMENTED IN ACCORDANCE WITH ALL CODE REQUIREMENTS

1 MONITORING WELL DETAIL NOT TO SCALE

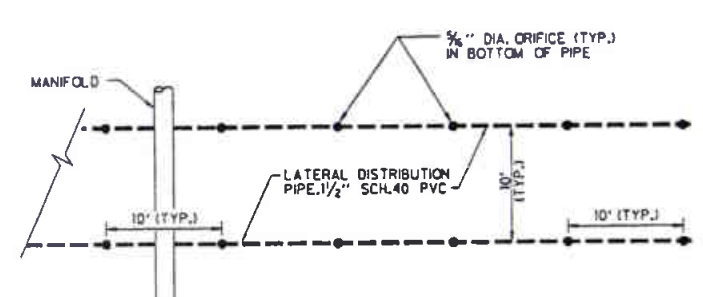
Fath Infrastructure & Environment, LLC					
REVISED	DATE	BY	DESCRIPTION		
				FIGURE 1 TREATED WATER INFILTRATION SYSTEM LAYOUT AND DETAILS	
CHECKED BY:	PAK	DATE:	MARCH '07		
APPROVED BY:	SV01	DATE:	MARCH '07		
APPROVED BY:		DATE:		Scale:	AS SHOWN
				Date:	MARCH, 2007
				Prepared By:	JRB2
				Project No.	04W018



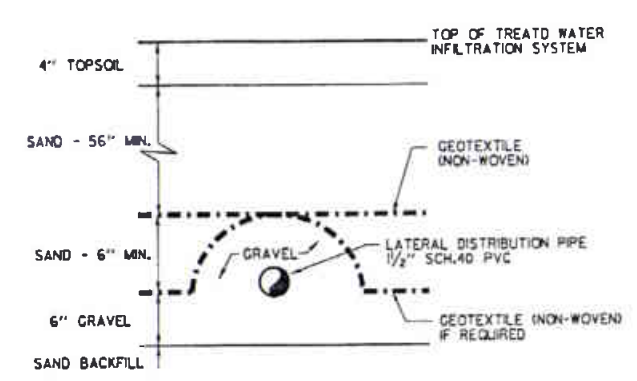
1 TREATED WATER INFILTRATION SYSTEM - SCHEMATIC
NOT TO SCALE



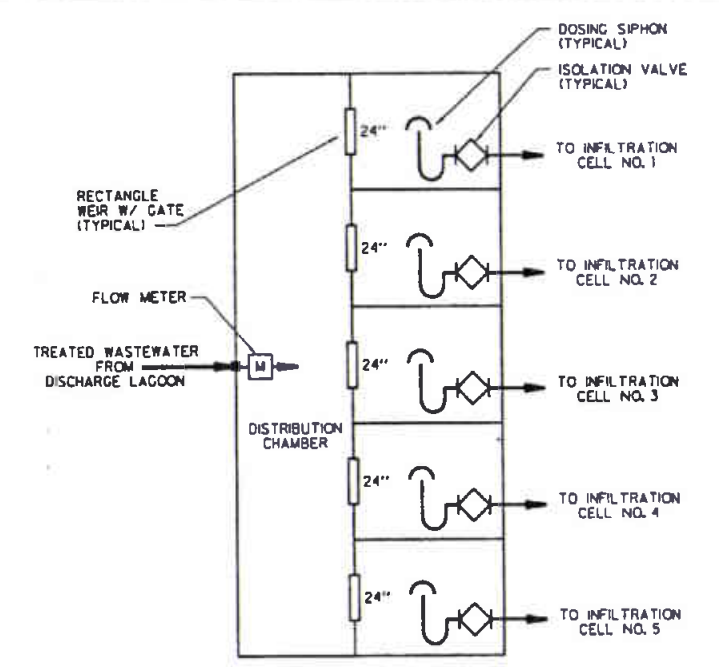
2 TYPICAL TRENCH SECTION FOR BURIED PIPELINES
NOT TO SCALE



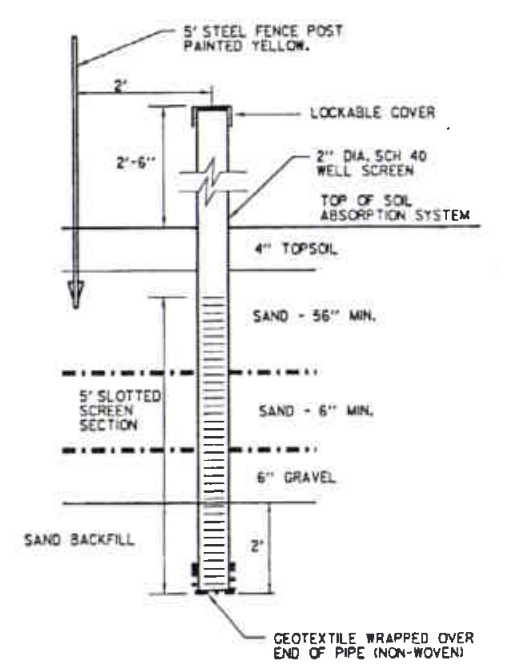
3 LATERAL DETAIL
NOT TO SCALE



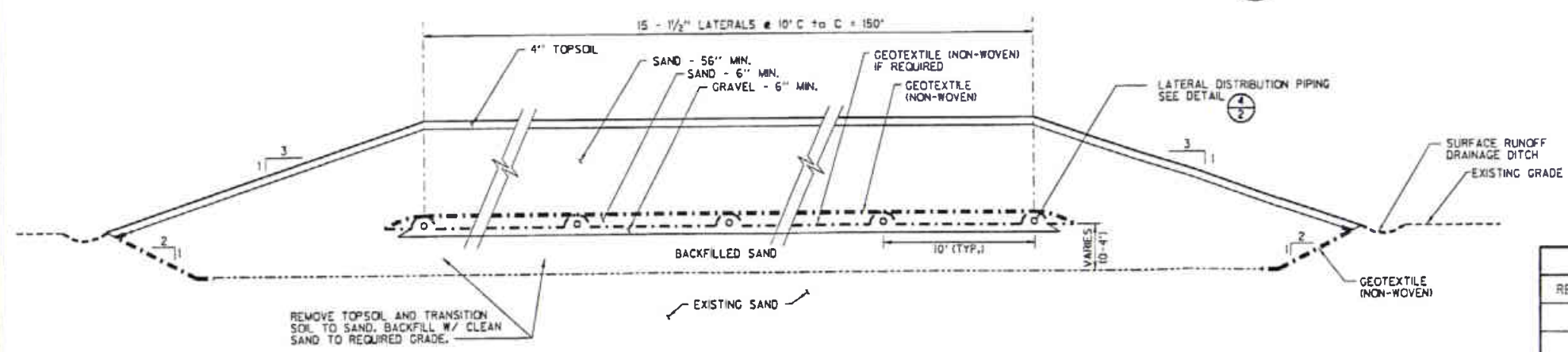
4 LATERAL DISTRIBUTION PIPING DETAIL
NOT TO SCALE



6 DISTRIBUTION CHAMBER
NOT TO SCALE

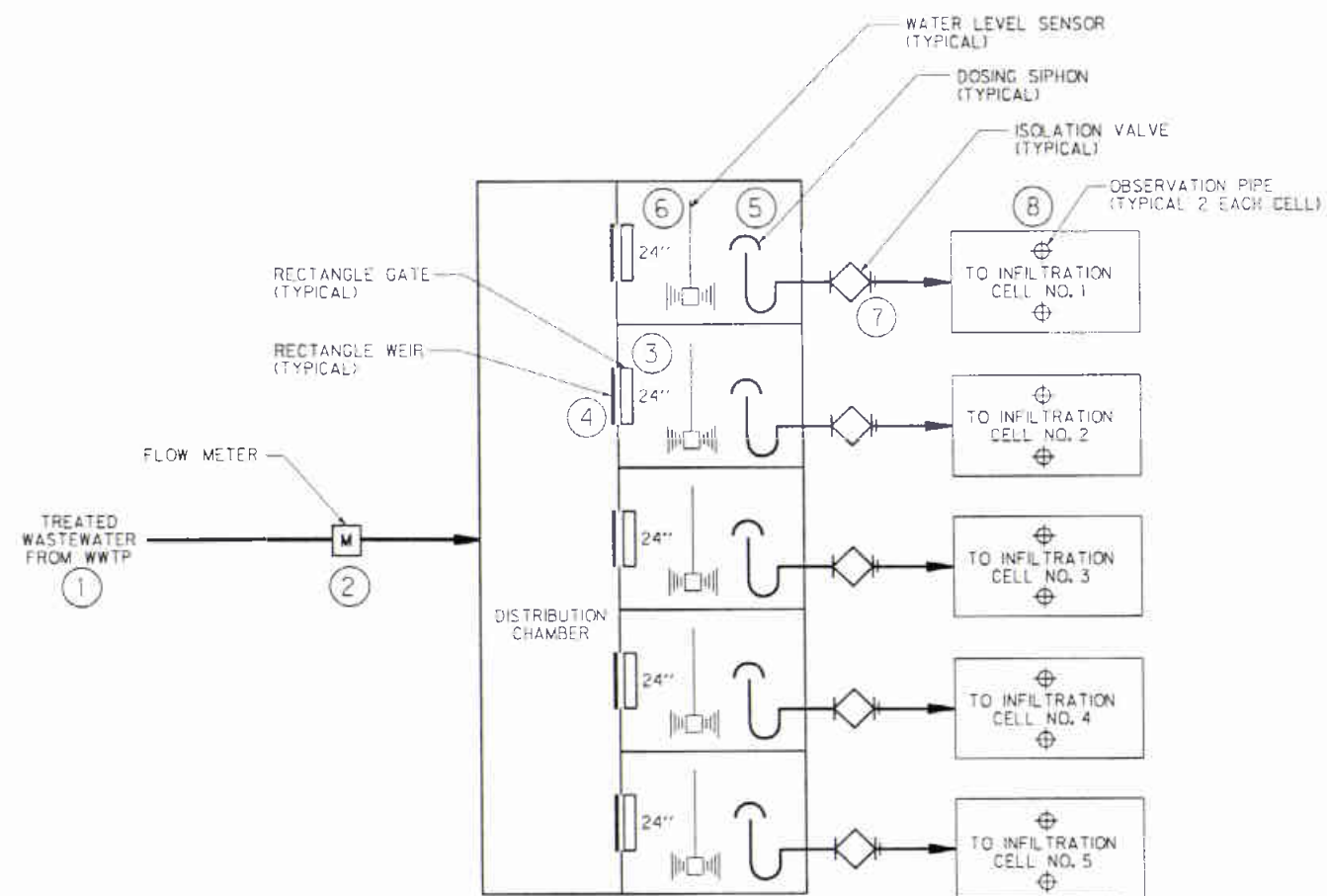


7 INFILTRATION CELL OBSERVATION PIPE DETAIL
NOT TO SCALE



5 TREATED WATER INFILTRATION SYSTEM - TYPICAL SECTION
NOT TO SCALE

Foth Infrastructure & Environment, LLC					
REVISED	DATE	BY	DESCRIPTION		
				FIGURE 2 TREATED WATER INFILTRATION SYSTEM DESIGN AND DETAILS	
CHECKED BY:	PAK	DATE:	MARCH '07		
APPROVED BY:	SVD1	DATE:	MARCH '07		
APPROVED BY:		DATE:			
				Scale:	NOT TO SCALE
				Prepared By:	JRB2
				Date:	MARCH, 2007
				Project No.	04W018



DISTRIBUTION CHAMBER

NOT TO SCALE

- ① IF WATER DOES NOT MEET WATER QUALITY REQUIREMENTS ROUTE BACK TO CONTACT WATER BASINS.
- ② MONITOR TOTAL FLOW TO THE TWS.
- ③ OPEN OR CLOSE GATES AS REQUIRED TO OPERATE CELLS.
- ④ CHECK WEIRS FOR ELEVATION. CHECK AND MAINTAIN THEM TO PREVENT LEAKAGE.
- ⑤ CHECK AND MAINTAIN FOR PROPER DOSING SIPHON OPERATION.
- ⑥ CHECK AND MAINTAIN WATER LEVEL SENSORS TO INSURE PROPER MONITORING OF FLOW AND HIGH WATER ALARM.
- ⑦ OPEN OR CLOSE VALVES AS REQUIRED TO OPERATE CELLS.
- ⑧ MONITOR OBSERVATION WELLS FOR GROUNDWATER MOUNDING.

Foth Infrastructure & Environment, LLC				 Kennecott Eagle Minerals
REVISED	DATE	BY	DESCRIPTION	
				FIGURE 3 DISCHARGE MANAGEMENT PLAN OPERATION GUIDE
CHECKED BY:	PAK	DATE:	MARCH '07	Scale: NOT TO SCALE
APPROVED BY:	SVDI	DATE:	MARCH '07	Date: MARCH, 2007
APPROVED BY:		DATE:		Prepared By: JRB2
				Project No. 04W018