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Discussion Memo

To:	Faro – Groundwater group	**Date:**	November 3, 2005
cc:		**From:**	Dan Mackie
Subject:	Preliminary 2005 S-Cluster Results	**Project #:**	1CD003.073

This Memo summarises preliminary 2005 results for the S-cluster area. Analyses and interpretation of results are based on working copies of maps and calculations. The objective of this memo is to provide the group with the current conceptual model for the area and preliminary estimates of loading. This is a working discussion document and should not be interpreted as final results.

Figure 1 shows locations of monitoring wells, drivepoints and stream survey flow measurements.

Table 1 summarises results of the 2005 drilling program. S-cluster wells are included for comparison.

2005SRK Monitoring Wells	Easting	Northing	Total Depth (m)	Stick-up Elevation (m.a.s.l.)	Screen Interval (m.b.g.s.)
SRK05-SP-1A	584,727	6,912,901	19.2	1091.99	13.7 - 19.2
SRK05-SP-1B	584,726	6,912,901	12.3	1091.94	9 - 12.3
SRK05-SP-2	584,791	6,912,861	11.0	1086.70	7.9 - 11.0
SRK05-SP-3A	584,651	6,912,924	22.9	1088.50	17.4 - 21.9
SRK05-SP-3B	584,652	6,912,924	12.3	1088.41	8.3 - 11.4
SRK05-SP-4A	584,612	6,912,939	21.6	1087.27	16.5 - 21.0
SRK05-SP-4B	584,611	6,912,939	4.0	1087.44	0.6 - 3.5
SRK05-SP-5	584,576	6,912,956	14.0	1087.53	9.4 - 12.5
SRK05-SP-6	584,492	6,912,975	11.0	1097.73	3.1 - 11.0
S-Cluster Monitoring Wells	**Easting**	**Northing**	**Total Depth (m)**	**Stick-up Elevation (m.a.s.l.)**	**Screen Interval (m.b.g.s.)**
S1a	584,539	6,912,942	12.2	1085.43	9.2 - 12.2
S1b				1085.27	1.3 - 4.3
S2a	584,577	6,912,944	12.2	1086.03	9.2 - 12.2
S2b				1086.30	3.7 - 6.7
S3	584,585	6,912,918	5.6	1085.53	2.6 - 5.6

Table 2 summarises drivepoint completion information

2005 SRK Drivepoint	Easting	Northing	Total Vertical Depth Below River Bottom (m)	Stick-up Elevation (m.a.s.l.)
SRK05-DP1	584,630	6,912,887	1.14	1083.97
SRK05-DP2	584,554	6,912,904	0.53	1082.55
SRK05-DP3	584,514	6,912,901	0.75	1081.89
SRK05-DP4	584,535	6,912,911	0.94	1082.19

Figures 2, 3 and 4 are cross-sections through the S-cluster area. Results of hydraulic conductivity testing and geochemical analyses, summarised below, are included on the cross-sections.

Stratigraphy

In general, stratigraphy at the site can be summarised as follows:

Bedrock shows undulating topography. Weathered bedrock zones were identified in most drillholes. The areas of lowest bedrock elevation were identified slightly to the northeast of the S-cluster wells and suggest a bedrock low trending roughly northeast through the S-cluster area.

Bedrock is overlain by an aquifer unit (deep aquifer) characterised as sand and gravel to silty sand to sandy-gravelly silt. Thickness of this unit varies from approximately 7.5 to 8 meters thickness at SRK05-SP-2 and SRK05-SP-1 in the east, to a maximum of approximately 12 meters at SRK05-3 and SRK05-4 closer to the S-cluster monitoring wells. SRK05-SP6, the westernmost monitoring well shows the least thickness at less than 1 meter, but this may not be the same aquifer unit.

The deep aquifer unit is overlain by sandy-clayey silt layer, interpreted as till, which blankets the entire study area, with the exception of SRK05-SP6.

A shallow aquifer unit was identified at SRK05-4. Approximately 3 meters of gravelly sand was identified, with static water level approximately 3 meters above that of the deep aquifer. The shallow aquifer was not identified at any of the other 2005 monitoring well locations, and is interpreted to represent deposits of a pre-mining creek.

Hydraulic Testing

Hydraulic testing was conducted on all monitoring wells except SRK05-SP1a and b. Testing methods were one of two types:

1. Slug test
2. Mini-pumping tests

Slug tests were conducted by conventional means. Water level changes were recorded using a high-resolution datalogger. Data was analysed using standard methods.

Mini-pumping tests were conducted using a portable transfer pump. Waterra tubing, with a waterra valve, was connected to the pump and used as a suction line. Static water levels were recorded prior to initiation of pumping. Water was discharged away from the test well and pumping rate monitored periodically using a bucket and stopwatch. Water level changes were recorded using a high-resolution datalogger. On cessation of pumping, water levels were recorded until approximately 95% recovery was attained.

Recovery data was analysed to obtain transmissivity values. Conductivity values were determined using assumed aquifer thickness based on geologic logs and hydrostratigraphic interpretations.

2004 was re-analysed and compared with 2005 data.

Table 3 summarises results of hydraulic testing

Well ID	Aquifer Thickness (m)	2005			2004 re-calculation
		Mini-pumping		Slug Testing	Slug Testing
		T (m2/s)	K (m/s)	K (m/s)	K (m/s)
SP1a	10.2	Testing not possible			
SP1b	3.3				
SP2	6.4	3.0E-03	4.7E-04		
SP3a	13.7	1.2E-04	8.8E-06		
SP3b	3.2	5.0E-04	1.6E-04		
SP4a	6.1	4.0E-05	6.6E-06		
SP4b	3.5	1.1E-04	3.1E-05		
SP5	4.3	4.8E-04	1.1E-04		
SP6	7.9				
S1a	12.2	6.8E-04	5.6E-05		
S1b	4.5			3.9E-07	
S2a	12.2			1.5E-06	
S2b	7			2.4E-06	2.3E-06
S3	5.6			6.6E-06	6.8E-06

Results suggest heterogeneity in the distribution of hydraulic conductivity at the site. Results suggest hydraulic conducitivity ranges from a low of approximately 4×10^{-7} m/s to a high of approximately 5×10^{-4} m/s.

Comparison of results derived from slug vs mini-pumping tests indicate a possible scale influence. Conductivity values derived from slug tests are, in general, lower than those derived from mini-pumping tests. Higher confidence is assigned to results from mini-pumping tests.

Hydraulic testing could not be completed in montoring wells SP1a or b due to the following reasons:

Slug testing – response was too quick to allow collection of enough data to obtain good analytical results
Mini-pumping – depth of water was too great for suction capacity of available pump

Groundwater Quality

Water samples were collected from all of the 2005 monitoring wells, with the exception of SP6, which was dry. The S-cluster wells were sampled on the same dates.

Table 4 summaries results.

Table 4. Water quality summary

		S1A	S1B	S2A	S2B	S3	SP1-A	SP1-B	SP-2	SP3A	SP3B	SP-4A	SP-4B	SP5
5/5/2005	Conductivity	n/a	n/a	n/a	n/a	n/a	Monitoring wells not installed at this time							
	Sulphate	4550	403	1860	1760	4610								
	Zinc	113	0.067	127	8.65	158								
9/12/2005	Conductivity	5600	1430	5440	3660	5850	1130	1170	359	512	537	750	6190	5720
	Sulphate	4070	703	3910	2510	4360	383	309	45.4	245	261	158	4680	4170
	Zinc	118	0.051	178	1.19	165	1.63	0.144	0.161	1.04	0.628	1.10	277	153

Conductivity in uS/cm
Sulphate and zinc shown in mg/L

Figures 5 and 6 are maps showing distribution of zinc by monitoring well and aquifer. Water level contours are included on these figures. Values associated with monitoring well IDs are water level elevations for that monitoring well. Figures 7 and 8 are maps showing distribution of sulphate by monitoring well and aquifer.

For all figures, the concentration contour interval is order of magnitude. The value of each contour is shown on each map.

Preliminary Interpretations and Conceptual Model

The preliminary conceptual model for hydrostratigraphy incorporates shallow and deep aquifer units, separated by a till-like fine grain aquitard.

The shallow aquifer is interpreted to be the channel of a pre-mining creek. This unit was intersected by SRK05-4 and montoring well 4b is completed within the unit.

Shallow piezometers of the S-cluster wells are thought to be part of the shallow system. Geology logs from these drillholes do not indicate a difference between a shallow and deep aquifer, but do show differences in water level elevations between deep and shallow piezometers that correlate with those from SRK05-4. Additionally, the S-cluster wells were completed with an auger drill and may not have allowed definition of separate units.

Monitoring wells of the shallow system include:
SRK05-4b
S1b
S2b
S3

The deeper aquifer is interpreted to represent weathered bedrock and overlying relatively coarse grained material. As shown on figure 2, most of the 2005 monitoring wells are located in the deeper aquifer. Deeper monitoring wells of the S-cluster are assumed to be part of the same deep aquifer system.

Monitoring wells of the deeper system include:
SRK05-1a&b
SRK05-2
SRK05-3a&b
SRK05-4a
SRK05-5
S1a and S2a
Water levels for monitoring wells in the shallow and deep systems, as well as from drivepoints, are shown on figures 5 and 6.

Of note in the shallow system is the potential effect of shallow permafrost, which was identified in SRK05-5 and a number of test pits during the 2004 investigation. The presence of shallow permafrost may be acting to deflect the contaminant plume. The presence of shallow permafrost may also affect where contamination gets into the deeper system.

Both zinc and sulphate distributions, shown on figures 5-8, suggest contamination in both of these aquifer systems, though slightly more significant in the shallow system. The highest dissolved zinc concentration was observed in SRK05-4b.

Geologic logs from 2005 drillholes suggest that the shallow relatively high conductivity materials identified at SRK05-4b are not widely distributed. Contaminant distribution in the shallow system, while not accurately delineated, is anticipated to be relatively constrained to the higher conductivity pre-mining creek bed materials.

The deeper aquifer system appears to be relatively widespread, and of heterogeneous hydraulic conductivity.

Contamination is highest in the same general area as the shallow aquifer, but offset to the west of the idealized pre-mining creek channel of the shallow system. It is conceptualised that contamination in the deeper system is more widely dispersed, possibly resulting from entrance to the deeper system along a wide exposed bedrock surface in the vicinity and/or underneath the upgradient waste rock dump.

Preliminary Groundwater Flux and Loading Calculations

Based on available geology, hydraulic conductivity and concentration data, the following preliminary flow and loading calculations are presented.

Table 5. Groundwater Flow Estimates

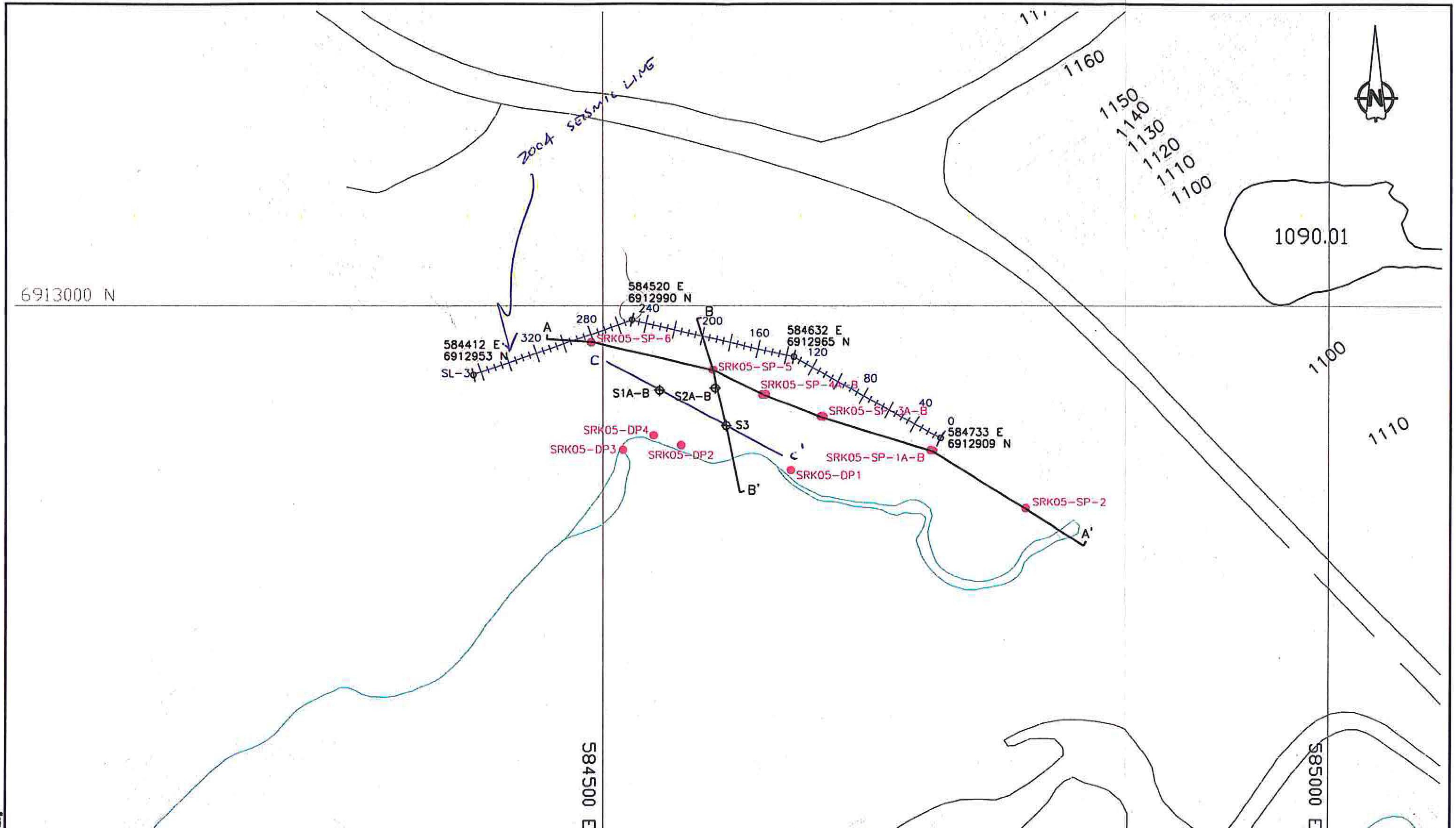
	Ave Width (m)	Ave Depth (m)	Ave Area (m2)	Gradient	K (m/s)		Flux (l/s)	
					max	min	High K	Low K
Shallow System	25	1.5	37.5	0.17	3.1E-05	3.9E-07	2.0E-01	2.5E-03
Deep System	40	4	160	0.05	1.0E-04	1.5E-06	8.0E-01	1.2E-02

Table 6. Groundwater Load Estimates

	Observed Concentration Zn (mg/L)		Load			
	High	Low	High (mg/s)	Low (mg/s)	High (kg/d)	Low (kg/d)
Shallow System	277	10	5.5E+01	2.5E-02	4.7E+00	2.1E-03
Deep System	178	10	1.4E+02	1.2E-01	1.2E+01	1.0E-02

Groundwater flow and load estimates were prepared using high and low values of hydraulic conductivity and concentration to provide a reasonable preliminary range of loading values. High estimates assume high values for both conductivity and concentration. Low estimates assume low values for both parameters.

In general, daily loading estimates are fairly low compared to the ETA area. Potential influence on the North Fork Rose Creek has not yet been assessed.



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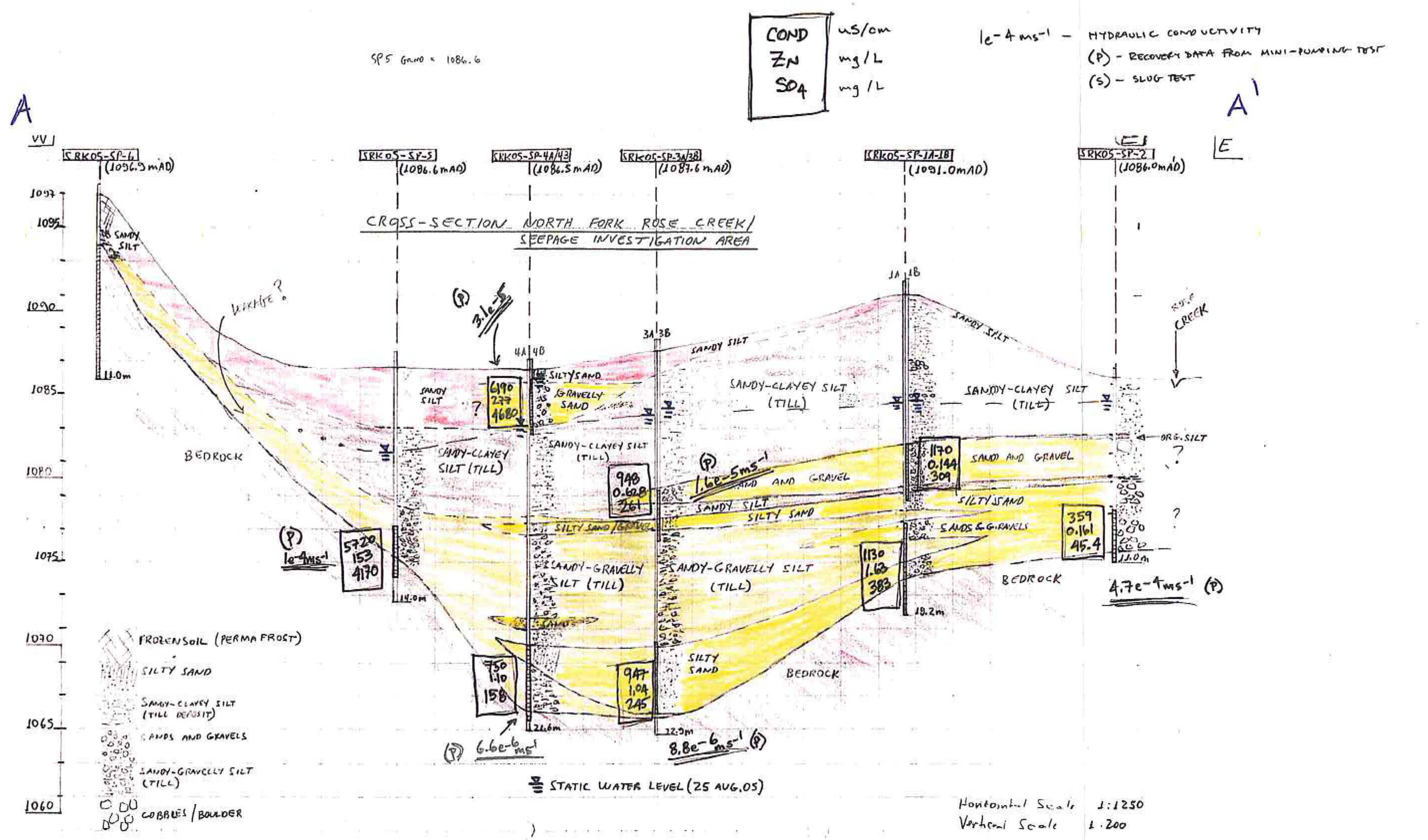
FARO MINE SITE

2005 BOREHOLE AND TEST PIT LOCATIONS

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.073	Oct. 2005	DM	1



COND uS/cm
ZN mg/L
SO4 mg/L
1e-4 ms-1 – HYDRAULIC CONDUCTIVITY
(P) – RECOVERY DATA FROM MINI-PUMPING TEST
(S) – SLUG TEST
SP5 Grnd = 1086.6
A
A1
E
SRK05-SP-6 (1096.9 mAD)
SRK05-SP-5 (1086.6 mAD)
SRK05-SP-4A/4B (1086.5 mAD)
SRK05-SP-3A/3B (1087.6 mAD)
SRK05-SP-1A-1B (1091.0 mAD)
SRK05-SP-2 (1086.0 mAD)
CROSS-SECTION NORTH FORK ROSE CREEK/
SEEPAGE INVESTIGATION AREA
SANDY SILT
LEAKAGE?
BEDROCK
SANDY-CLAYEY SILT (TILL)
SILTY SAND
GRAVELLY SAND
SANDY-CLAYEY SILT (TILL)
SAND AND GRAVEL
SILTY SAND/GRAVEL
SANDS & GRAVELS
SANDY-GRAVELLY SILT (TILL)
ORG. SILT
ROSE CREEK
(P) 3.1e-5
(P) 1.6e-5ms-1
(P) 1e-4ms-1
(P) 6.6e-6ms-1
8.8e-6ms-1 (P)
4.7e-4ms-1 (P)
6190 277 4680
948 0.628 261
1170 0.144 309
5720 153 4170
1130 1.63 383
359 0.161 45.4
750 1.10 158
947 1.04 245
11.0m
14.0m
21.6m
22.9m
18.2m
11.0m
FROZEN SOIL (PERMA FROST)
SILTY SAND
SANDY-CLAYEY SILT (TILL DEPOSIT)
SANDS AND GRAVELS
SANDY-GRAVELLY SILT (TILL)
COBBLES / BOULDER
STATIC WATER LEVEL (25 AUG.05)
Horizontal Scale 1:1250
Vertical Scale 1:200

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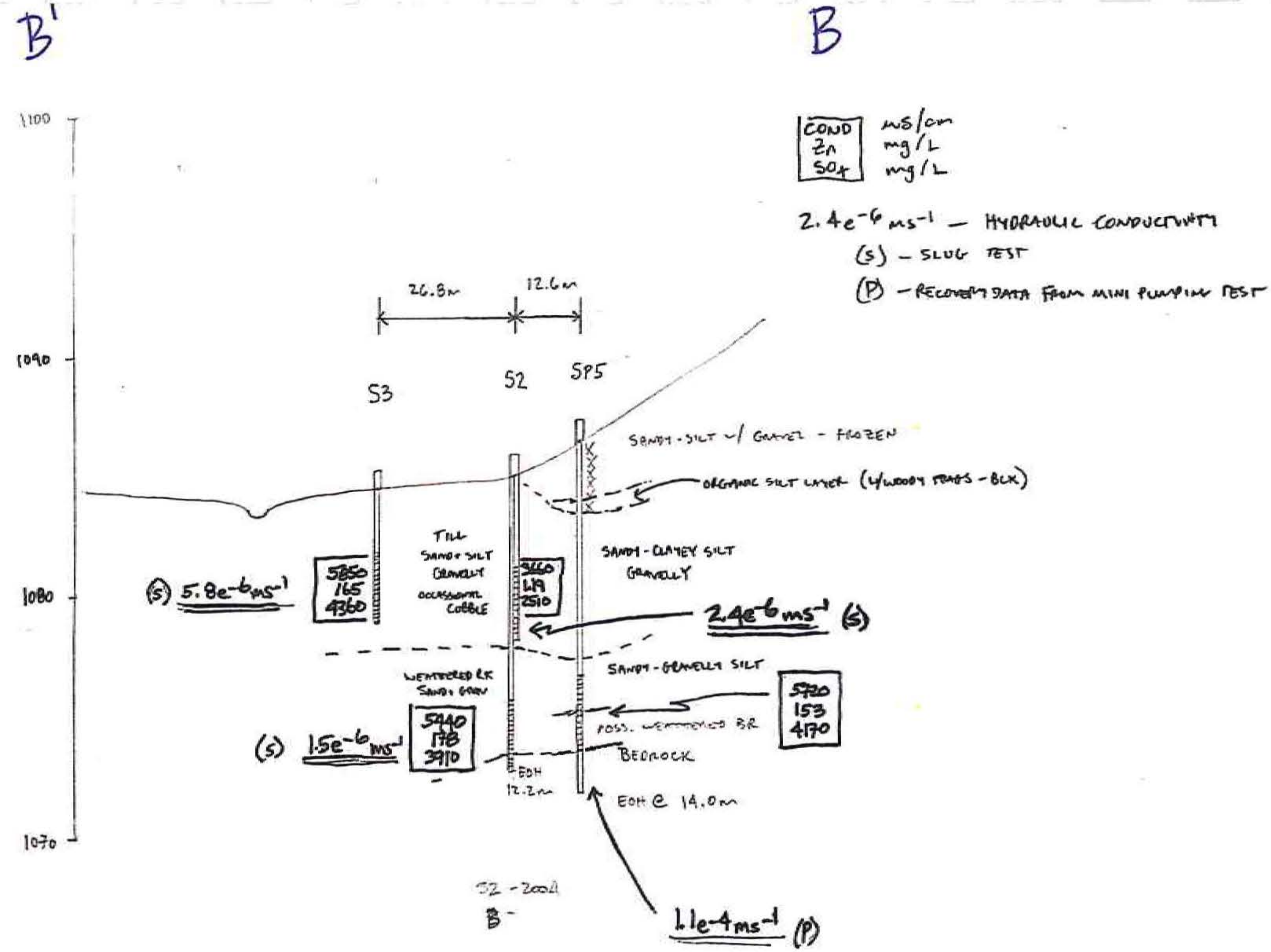
Project No. ______ Site ______
Prepared by ______ Date ______
Approved by ______ Date ______
Subject ______ Sheet ______ of ______



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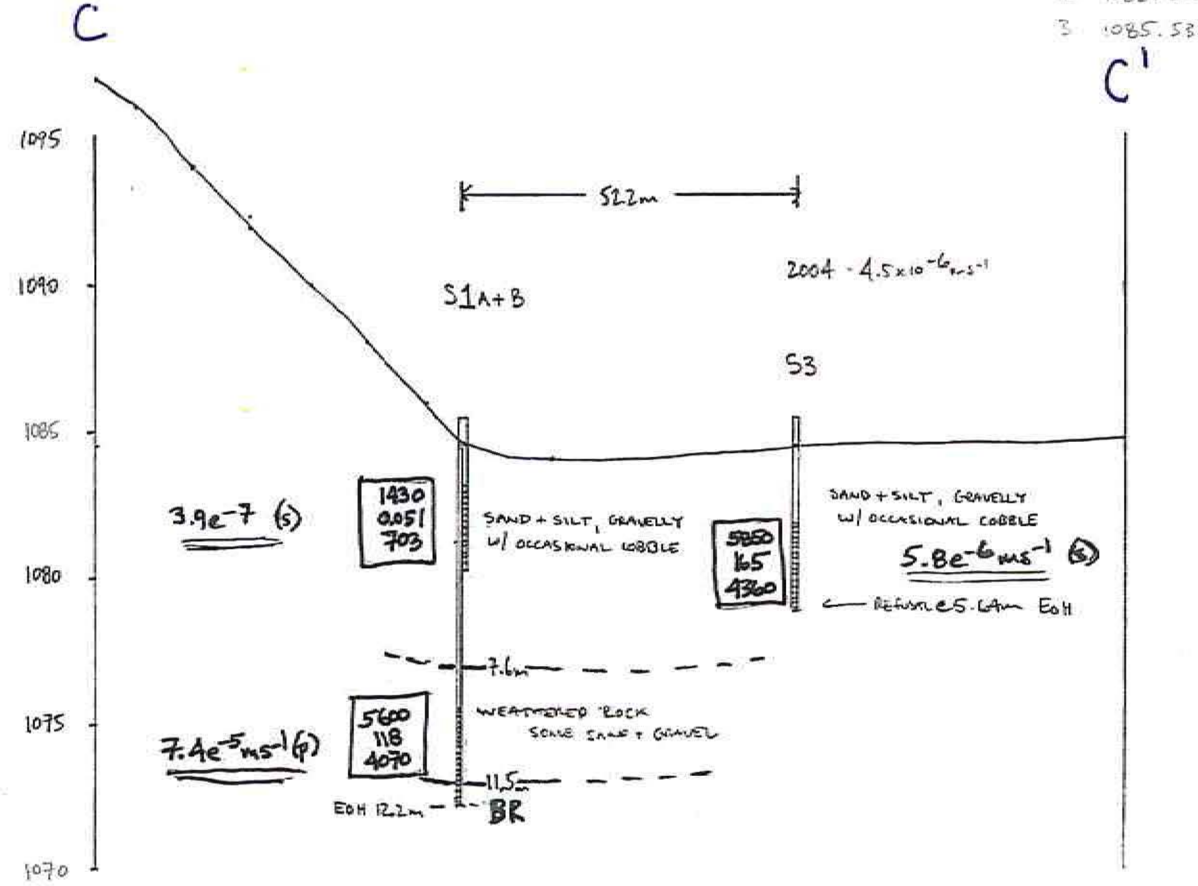
Prepared by ______ Date ______
Approved by ______ Date ______
Subject ______ Sheet ____ of ____

4cm
1000 cm

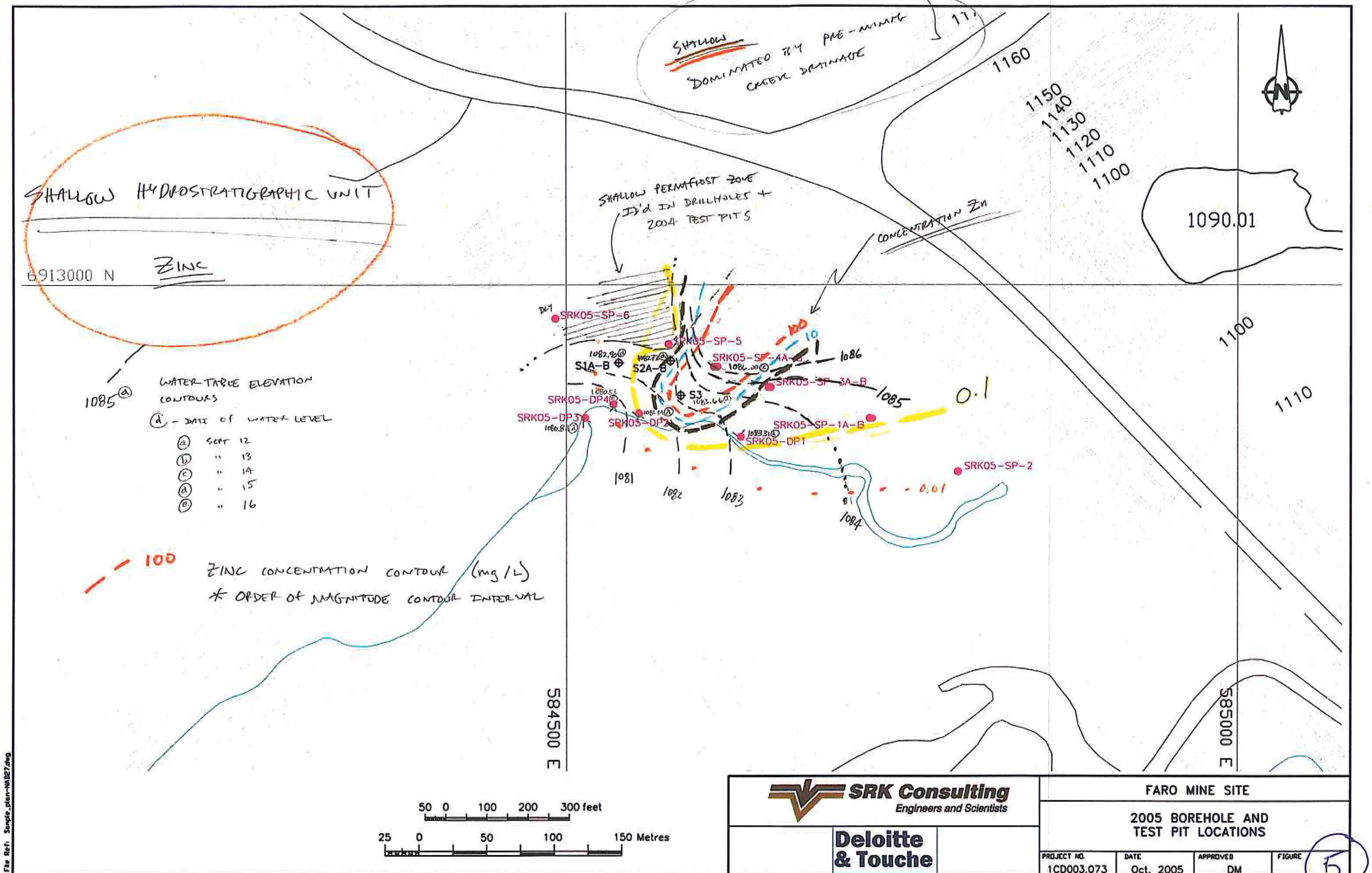
4.5
5220

STICK UPS S1a 1085.431 GROUND 1084.761 ~1084.5
1b 1085.267
3a 1086.03 1084.75
b 1086.304 1085.124
3 1085.533 1082.5



VERTICAL 1:250
HORIZ 1:1160

4



SHALLOW HYDROSTRATIGRAPHIC UNIT
ZINC
6913000 N
SHALLOW DOMINATED BY PRE-MINING CREEK DRAINAGE
1160
1150
1140
1130
1120
1110
1100
1090.01
SHALLOW PERMAFROST ZONE ID'd IN DRILLHOLES + 2004 TEST PITS
CONCENTRATION Zn
SRK05-SP-6
SRK05-SP-5
SRK05-SP-4A-B
SRK05-SP-3A-B
SRK05-SP-1A-B
SRK05-SP-2
SRK05-DP1
SRK05-DP2
SRK05-DP3
SRK05-DP4
S1A-B
S2A-B
S3
100
10
0.1
0.01
1086
1085
1084
1083
1082
1081
WATER-TABLE ELEVATION CONTOURS
(d) - DATE OF WATER LEVEL
(a) SEPT 12
(b) " 13
(c) " 14
(d) " 15
(e) " 16
ZINC CONCENTRATION CONTOUR (mg/L)
* ORDER OF MAGNITUDE CONTOUR INTERVAL
584500 E
585000 E
50 0 100 200 300 feet
25 0 50 100 150 Metres
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FARO MINE SITE
2005 BOREHOLE AND TEST PIT LOCATIONS
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FIGURE 5
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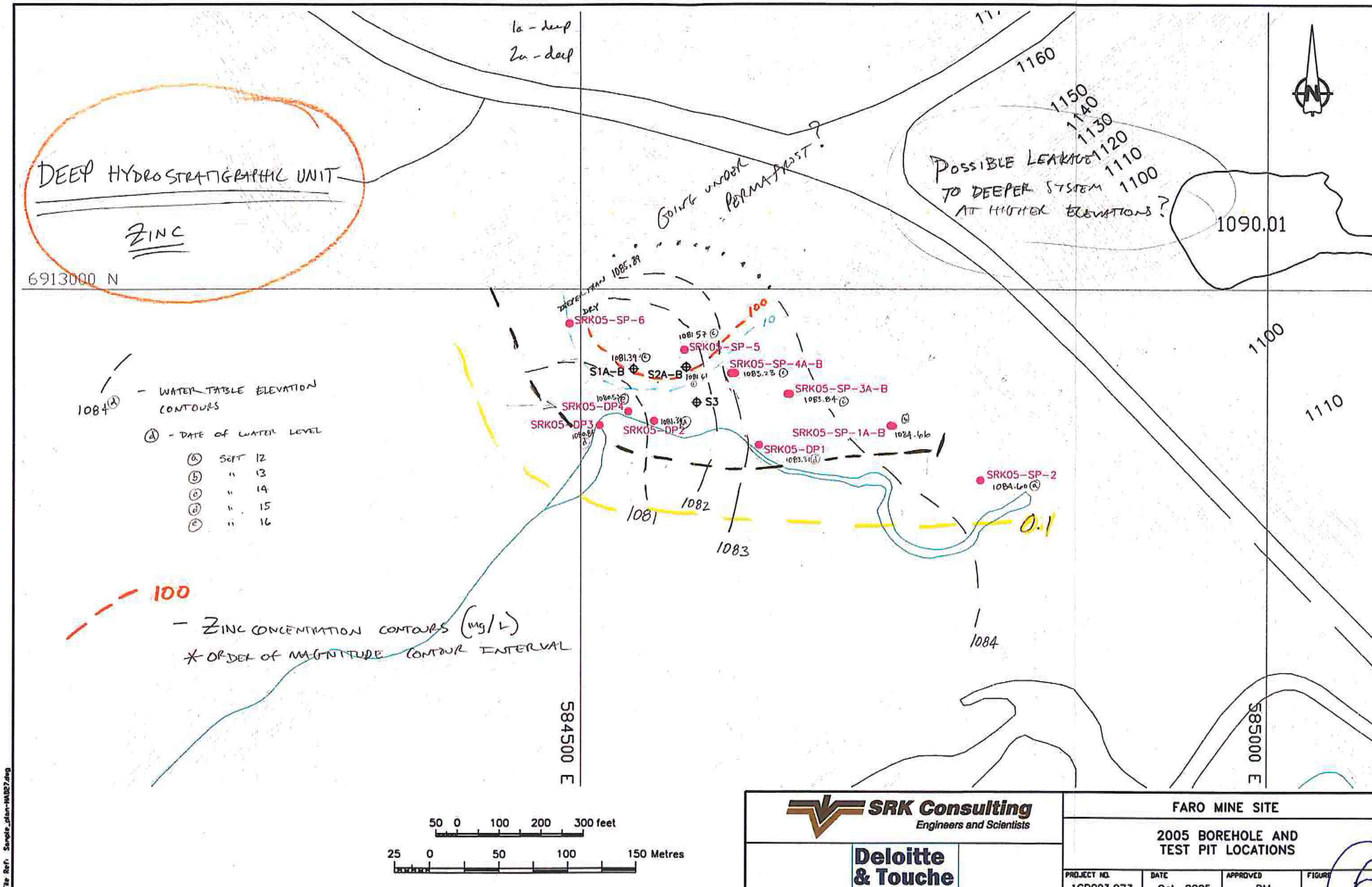

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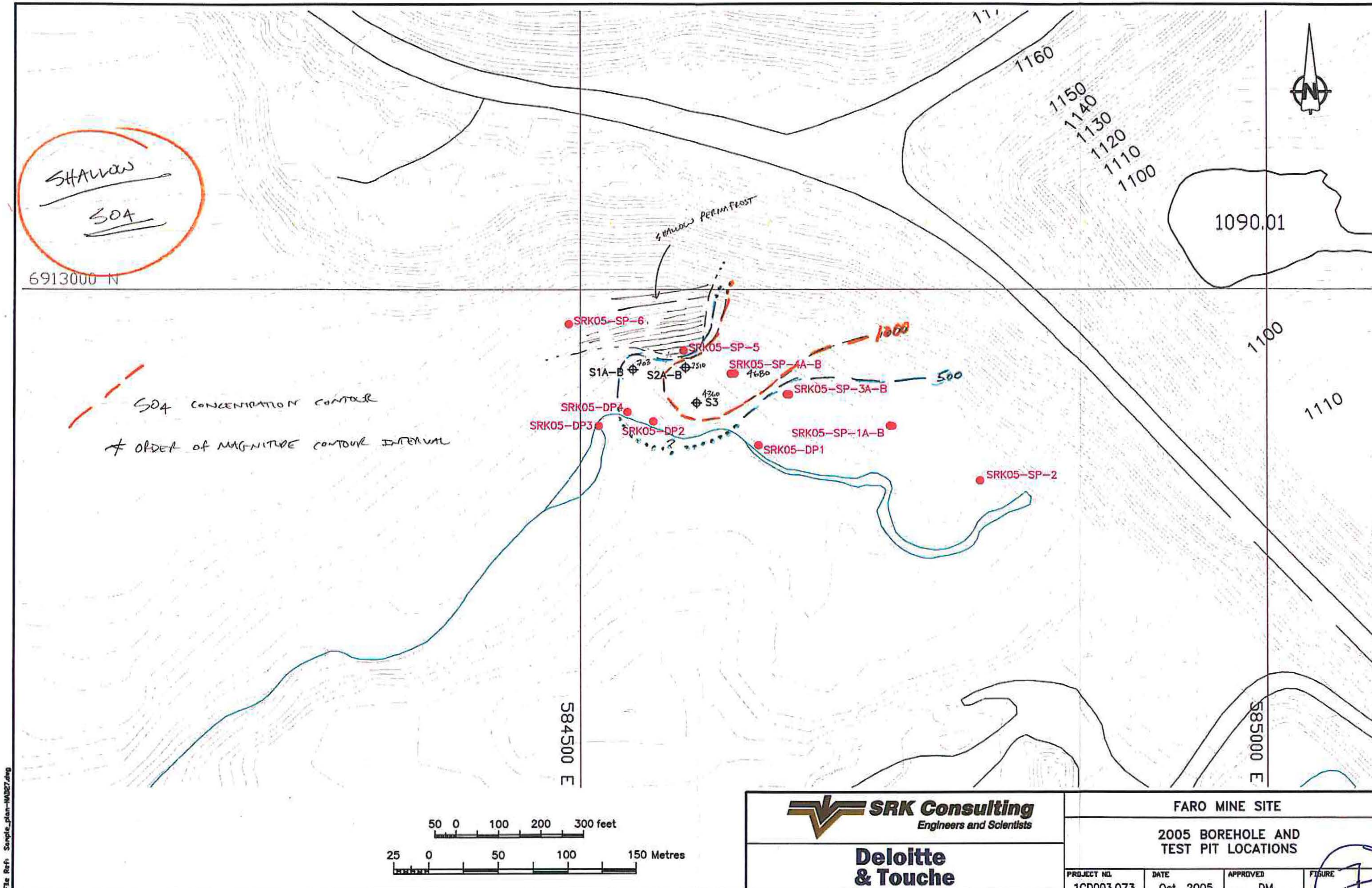
SHALLOW
SO4
6913000 N
SHALLOW PERMAFROST
1160
1150
1140
1130
1120
1110
1100
1090.01
1100
1110
1000
500
SRK05-SP-6
SRK05-SP-5
SRK05-SP-4A-B
4680
S1A-B
703
S2A-B
7510
4360
S3
SRK05-SP-3A-B
SRK05-DP4
SRK05-DP3
SRK05-DP2
SRK05-DP1
SRK05-SP-1A-B
SRK05-SP-2
SO4 CONCENTRATION CONTOUR
* ORDER OF MAGNITUDE CONTOUR INTERVAL
584500 E
585000 E
50 0 100 200 300 feet
25 0 50 100 150 Metres
File Ref: Sample_plan-HAD27.dwg
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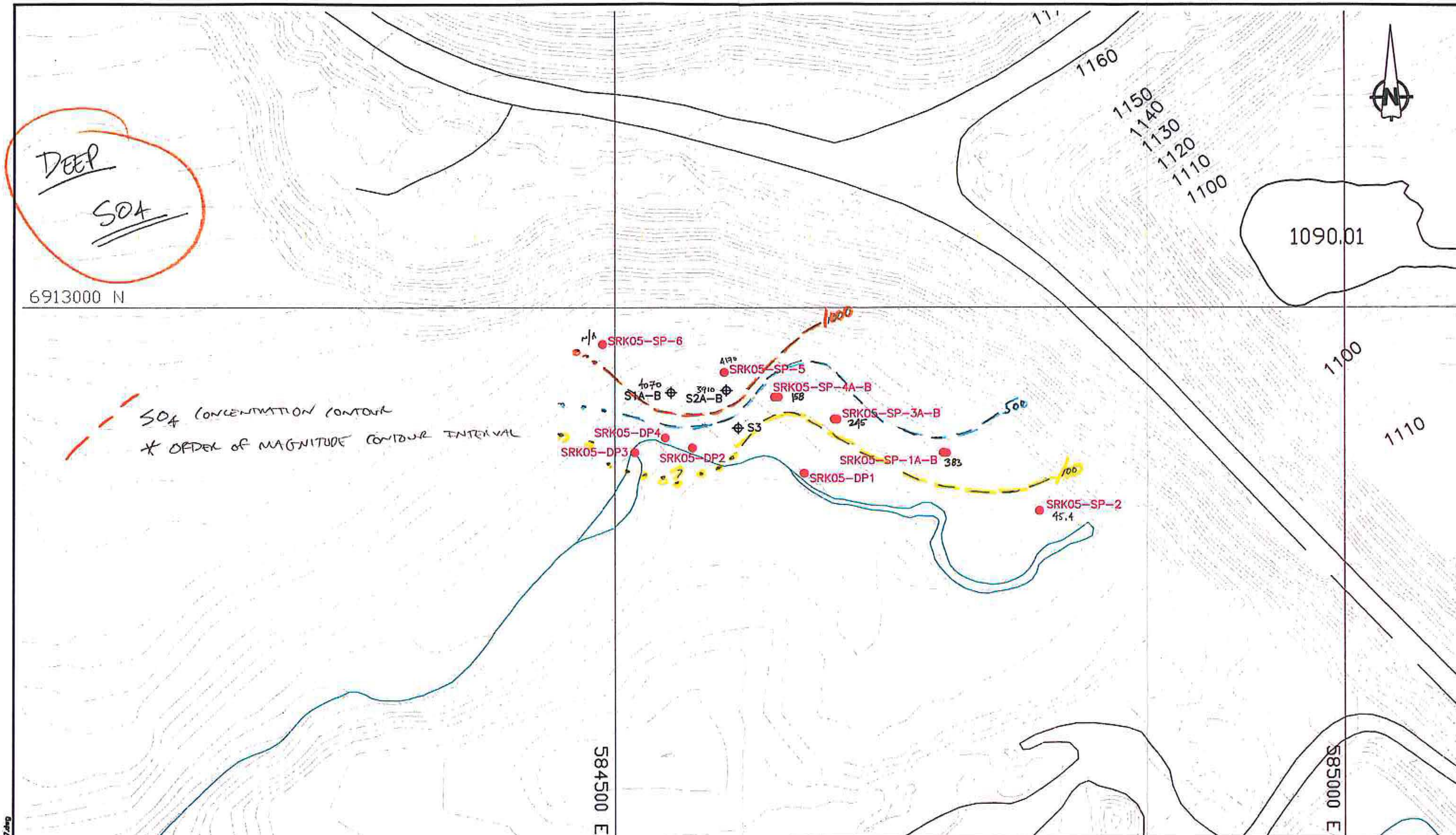
2005 BOREHOLE AND TEST PIT LOCATIONS
PROJECT NO. 1CD003.073
DATE Oct. 2005
APPROVED DM
FIGURE 7



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FARO MINE SITE

2005 BOREHOLE AND TEST PIT LOCATIONS

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.073	Oct. 2005	DM	8

File Ref: Sample_plan-NA027.dwg