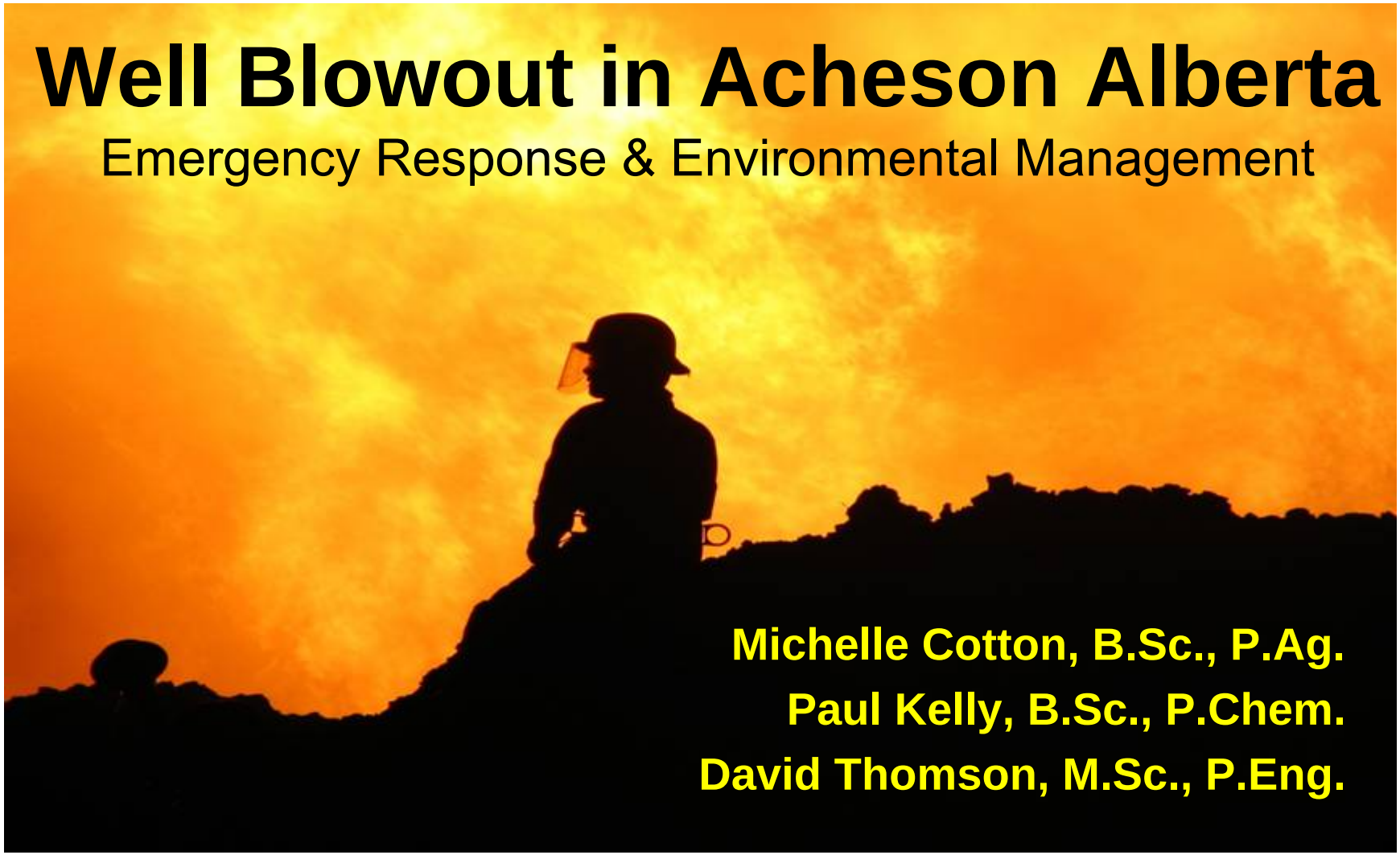
Well Blowout in Acheson Alberta

Emergency Response & Environmental Management



Michelle Cotton, B.Sc., P.Ag.

Paul Kelly, B.Sc., P.Chem.

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The Well

- Acheson 100/02-26-052-26W4M
- Drilled in 1952 by Imperial Oil
- Completed in the Leduc D-3A Pool
- First brought onto production in 1962
- Slightly sour (225 ppm H_2S)
- ~ 25 m Northeast of 102/02-26 Well

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The Location

- Parkland County
  - Agricultural/Rural Residential
- ~ 200 m North of Enoch Cree Nation
- ~ 700 m West of Edmonton City Limit
- Multiple Regulatory Stakeholders
  - Provincial – EUB & AENV
  - Federal – HC
  - Municipal – CHA
- Multiple Community Stakeholders

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The Blowout

- Routine Workover
- Pulled tubing out on 11-Dec-2004
- Downhole casing failure occurred during wellhead pressure reading on morning of 12-Dec-2004
- Uncontrolled release of gas and well fluids at surface (primarily salt water)
- ~ 150 joints of tubing fell from rack on leaning service rig derrick into crater eroding around wellhead

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Service rig destabilized by fluid flow

Rapidly expanding erosion crater

Well Control

- Surface-kill operations attempted
  - Required wellbore entry through existing surface equipment
  - Efforts to stabilize swaying wellhead on 13-Dec-2005 resulted in unplanned ignition
  - Fire extinguished on 14-Dec-2005
  - Inspection revealed wellhead BOPs too damaged by fire for surface wellbore entry
  - Well purposely re-ignited on 16-Dec-2005

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Well Control

- Two relief wells were drilled
- 103/02-26 (northwest) to intercept and mill into the 100/02-26 production casing and allow kill fluids to be pumped into the wellbore
- 104/02-26 (southeast) to drill into the Leduc formation in close proximity to 100/02-26 as a backup to 103/02-26

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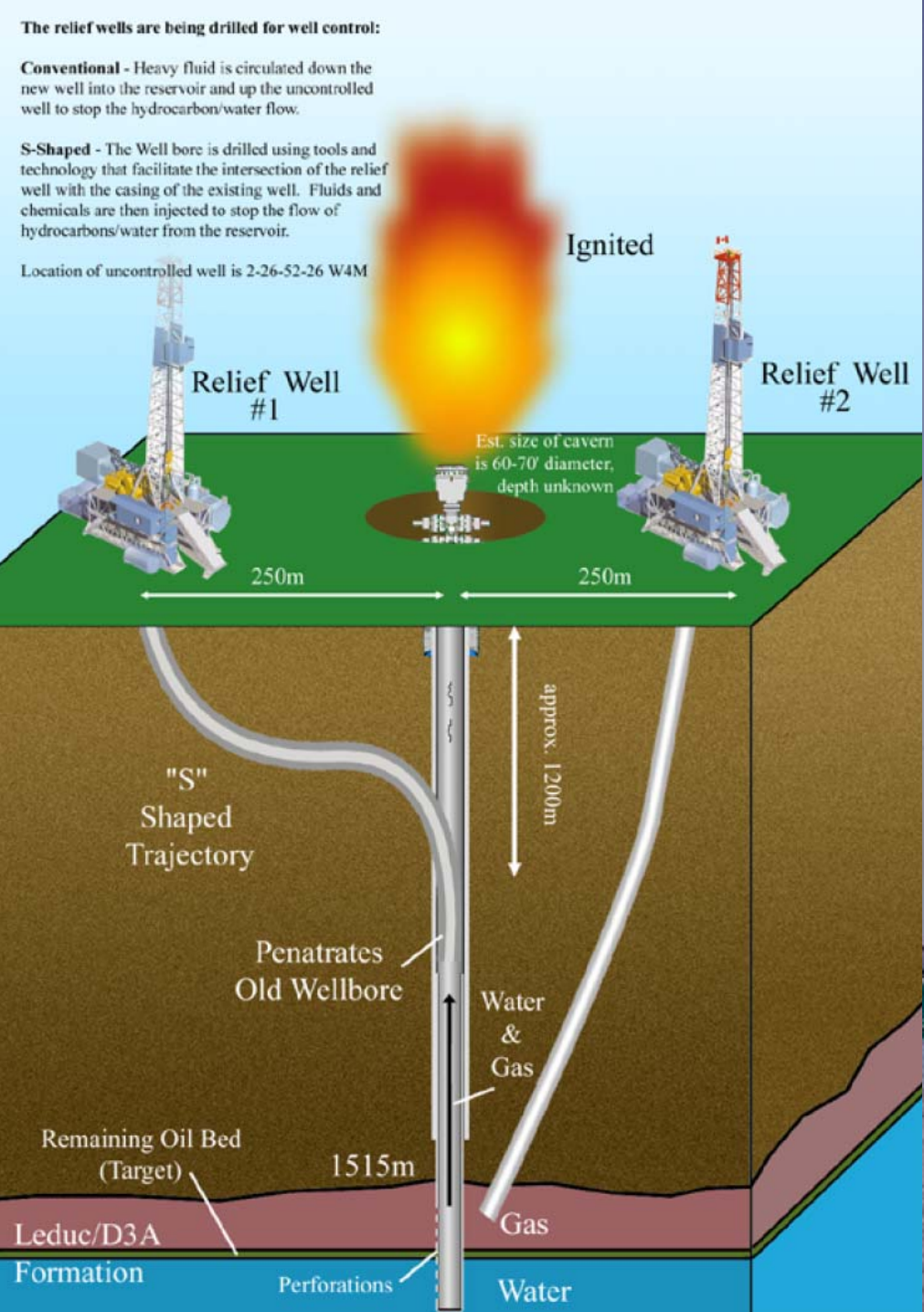
The relief wells are being drilled for well control:

Conventional - Heavy fluid is circulated down the new well into the reservoir and up the uncontrolled well to stop the hydrocarbon/water flow.

S-Shaped - The Well bore is drilled using tools and technology that facilitate the intersection of the relief well with the casing of the existing well. Fluids and chemicals are then injected to stop the flow of hydrocarbons/water from the reservoir.

Location of uncontrolled well is 2-26-52-26 W4M




The well was brought under control on 10-Jan-2005


Peace in the crater

Fluid Control

- Fluids flowing at ~ 100 m^3/hour
- Crater restricted access to wellhead
- Fluid control became a priority
- Trenches and pits constructed to divert fluids away from wellhead

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AREA MAP

SHOWING

EMERGENCY ZONE

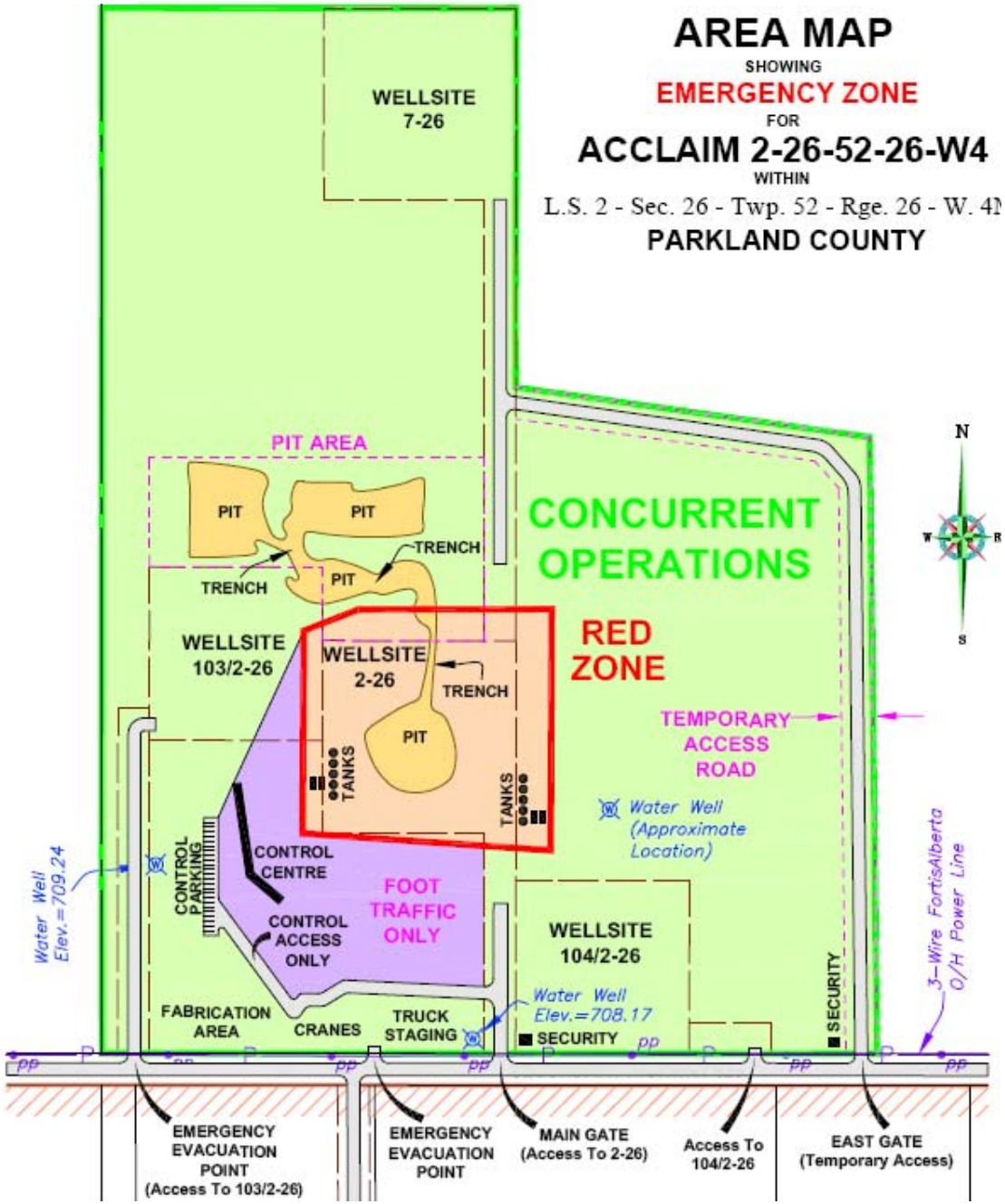
FOR

ACCLAIM 2-26-52-26-W4

WITHIN

L.S. 2 - Sec. 26 - Twp. 52 - Rge. 26 - W. 4M

PARKLAND COUNTY



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Track hoes excavating the East Pit

Dozers constructing West Pit

Work continues around the clock


Equipment in the crater
required heat shielding


Water was also used
to cool equipment

The main trench
leading from the crater

Pumping fluids up to the South Pit

Pumping into South Pit


Bailing became more effective due to suspended solids choking the pumps


The South Pit


The East Pit

Fluid Control

- Fluids filled pits rapidly requiring efficient removal and disposal
  - ~ 150 Vacuum trucks worked 24-hours/day
  - 20 separate disposal wells/caverns used
  - ¾ of the facilities reached processing capacity
  - Total fluid hauling & disposal costs were running at $ 350,000 - $ 500,000 per day

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Vacuum trucks line up

Pumping out the West Pit

Loading the vacuum trucks

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Fluid control

- Once the situation was under control alternative options were investigated
- Centrifugation & Flocculation were tested to reduce suspended solids
  - did not work due to inconsistent feed
- Construction of containment cells at Acheson 04-02-053-26W4M treatment pad using contaminated soil and plastic liners
  - enabled reduction to 15 vacuum trucks and use of Acclaim disposal well
- **Cost Saving: ~ $ 10 Million**

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Acheson 04-02
Containment Cells
2005/01/11

Unloading at 04-02


Fluids at 04-02

Slurry Waste Receiving Facilities

Disposal Company	# Receiving Locations	Volume m^3
MROR	1	676
Newalta	8	7,589
CCS	9	16,132
CNRL	1	1,007
PDS	1	7
Acclaim - Ponds	1	29,900
Acclaim – injection well	1	12,679
Total Volume	**22**	**67,990**

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Well Abandonment

- Abandonment efforts began once the well had been brought under control
- The breach in the well casing was much deeper than the base of the crater
- Excavation was required below the water table in very unstable, saturated silt/sand
- This was achieved using a well point dewatering system and a custom built shoring box

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The Crater


Slopes stabilized
Casing sleeve installed
Well casing cut to vertical section

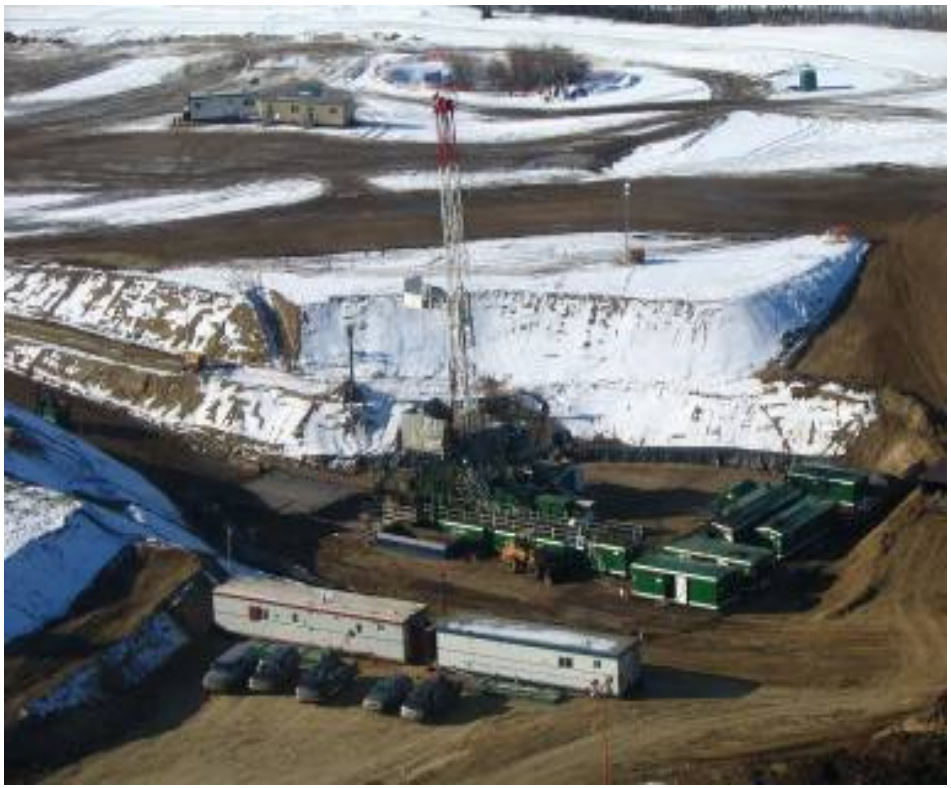

But the casing
breach is deeper


Much deeper


Lowering the shoring box


Recovered
shards of casing

Well Abandonment



- Partial backfilling of the excavation to enable service rig access
- Dewatering system continued to operate to maintain stability
- ~ 12 m^3/hour of water produced for disposal

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Environmental Protection

- Air Monitoring
- Release Control (fluid control)
- Groundwater Monitoring
- Contaminated Soil Removal (source removal)
- Groundwater Remediation

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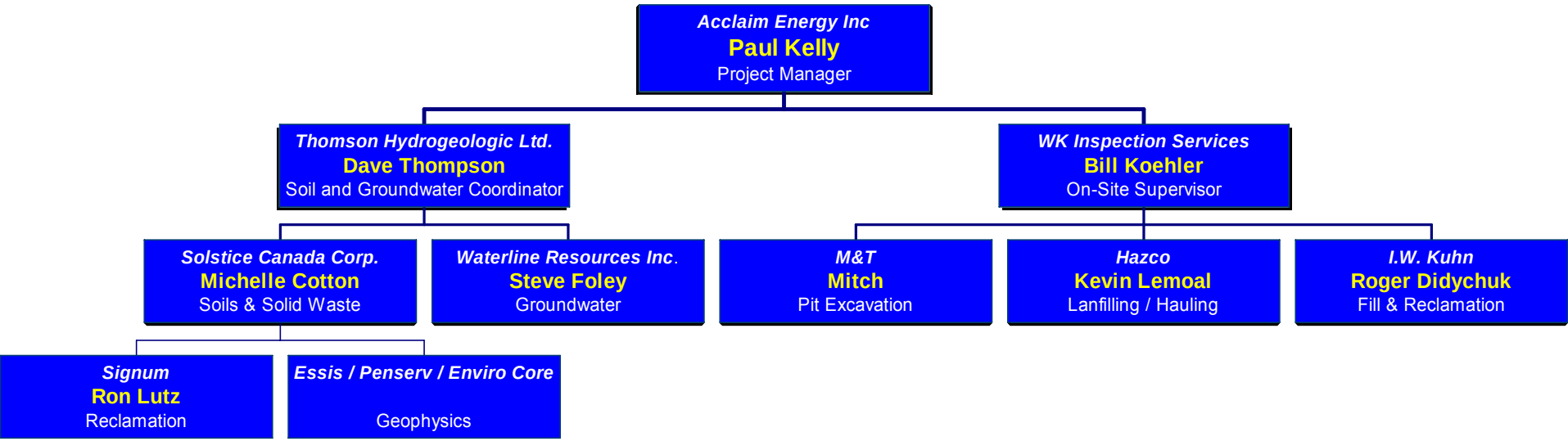
Soil and Groundwater Team



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Air Monitoring

- Air quality monitoring began on the morning of 12-Dec-2004 using hand-held unit ~ 500 m downwind (H_2S & LEL)
- Three mobile monitoring units added
- Eight fixed monitoring units set up
- EUB dispatched two mobile units
- AENV dispatched mobile air monitoring lab
- Highest 1-hour average H_2S reading 70 ppb recorded on 15-Dec-2005 downwind ~ 500 m

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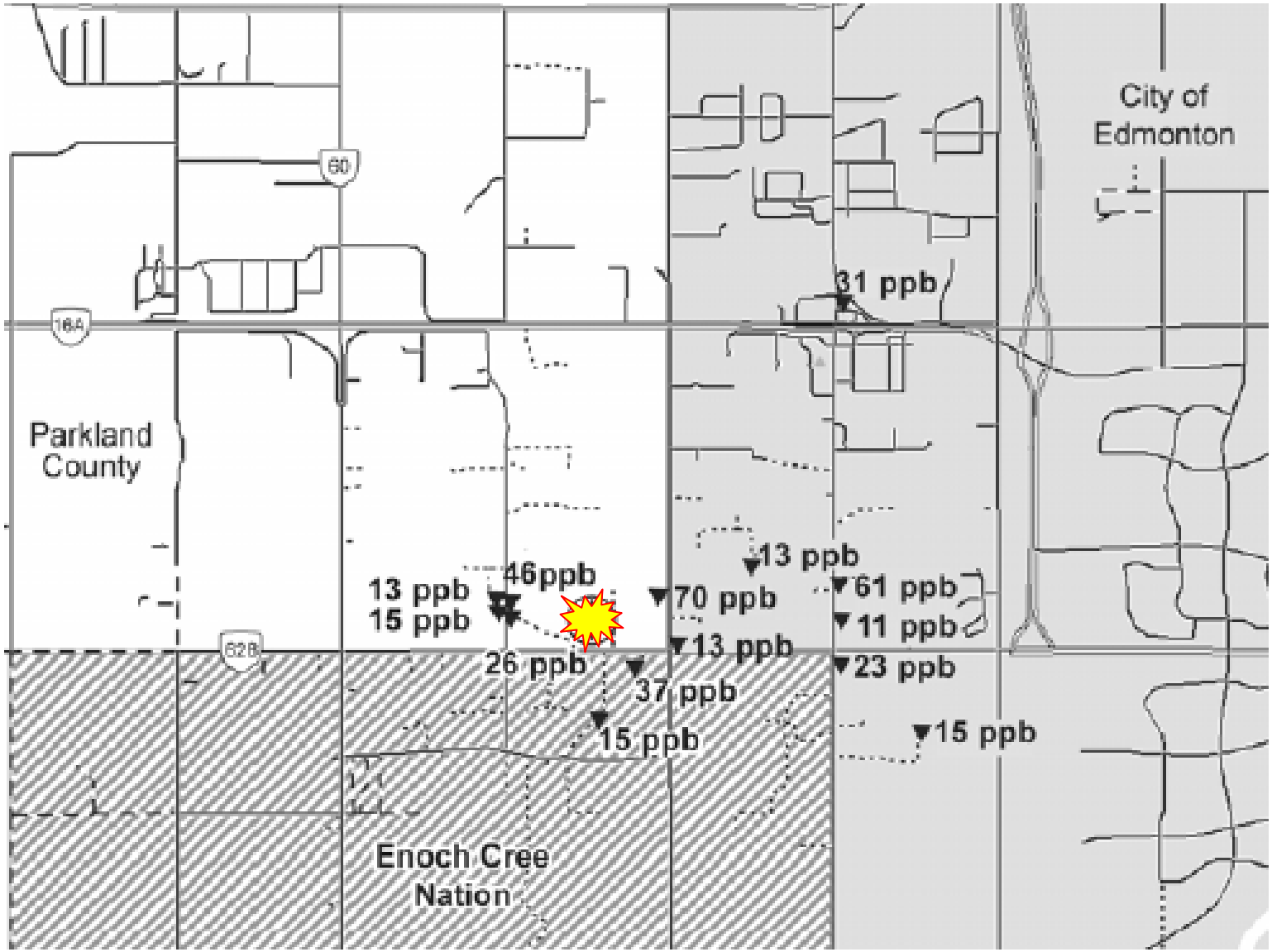

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Mobile air monitoring unit


AIR QUALITY MONITORING
UNIT


Static air
monitoring unit

Groundwater Monitoring

- Unconfined sand aquifer
  - From just below ground surface to bedrock at ~ 30 m
  - Main source of domestic water for acreage properties and residences on Enoch Cree Nation
- Groundwater
  - 30 domestic water wells tested within 2 km
  - Three monitoring wells installed on site
  - Flow velocity = ~ 15 m/yr

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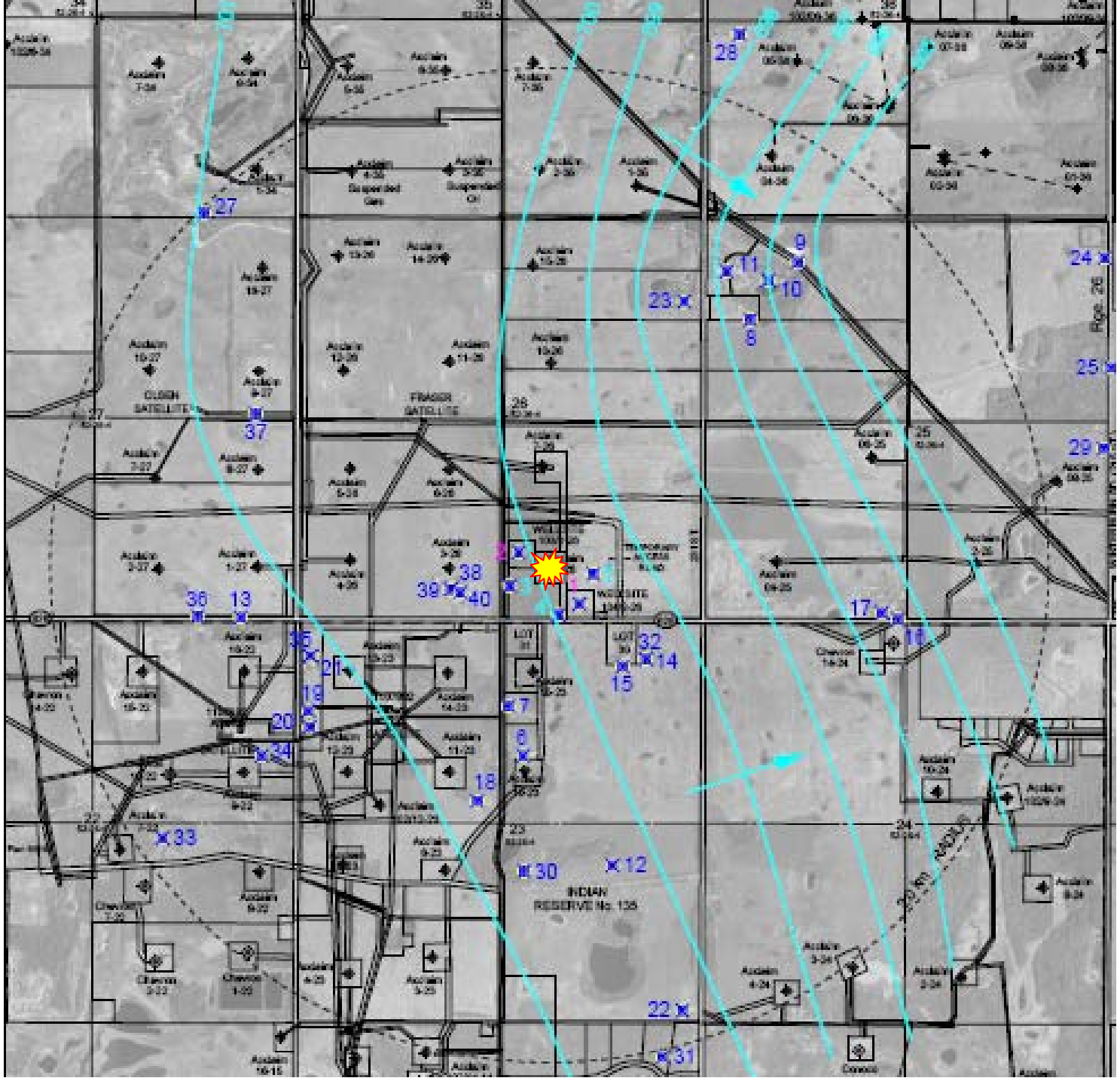
28
27
9
11
10
24
23
8
25
37
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38
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40
36
13
17
18
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14
15
35
21
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20
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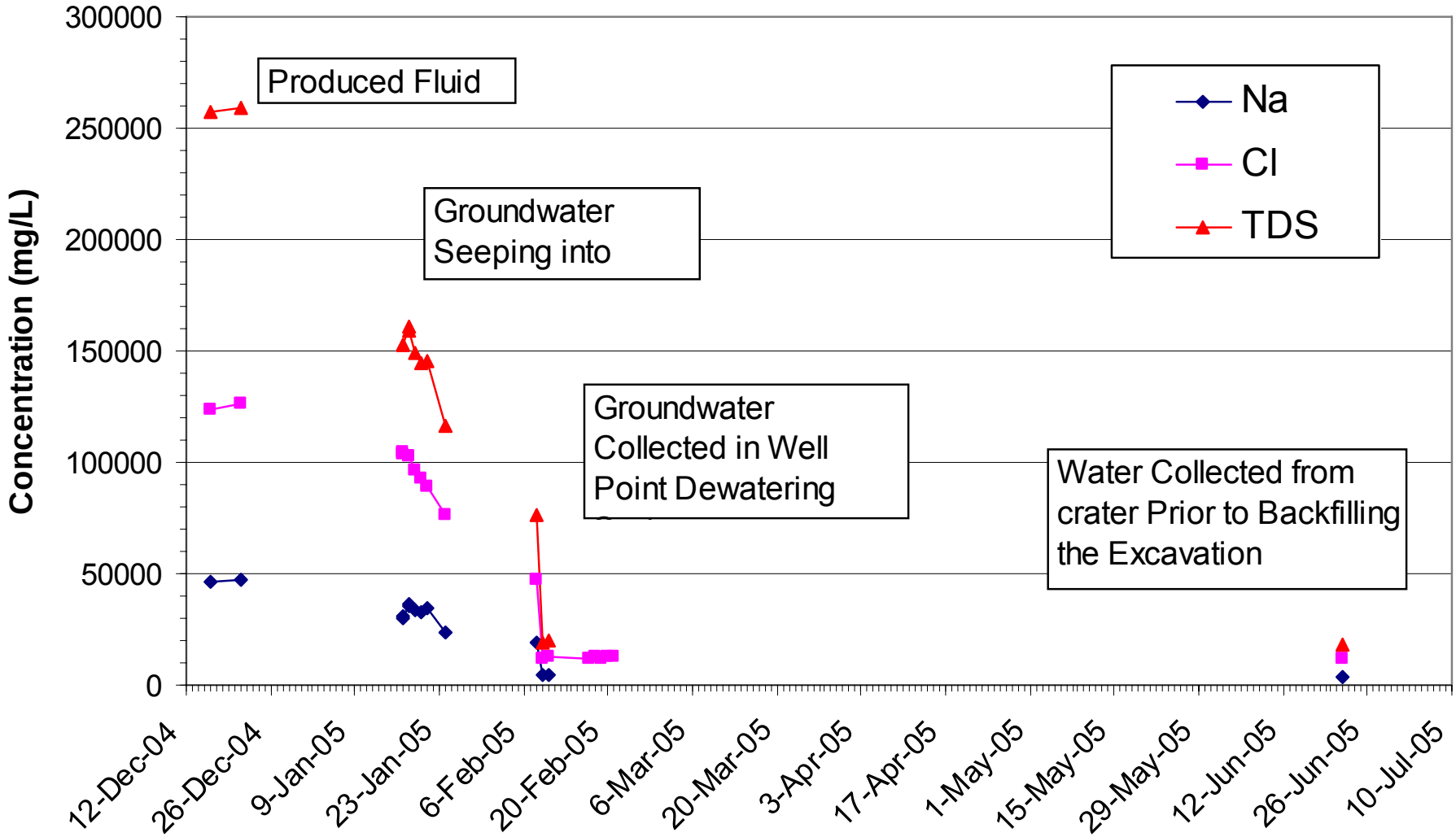
6
34
18
33
30
12
INDIAN
RESERVE No. 135
22
31

Sodium, Chloride and TDS in Water



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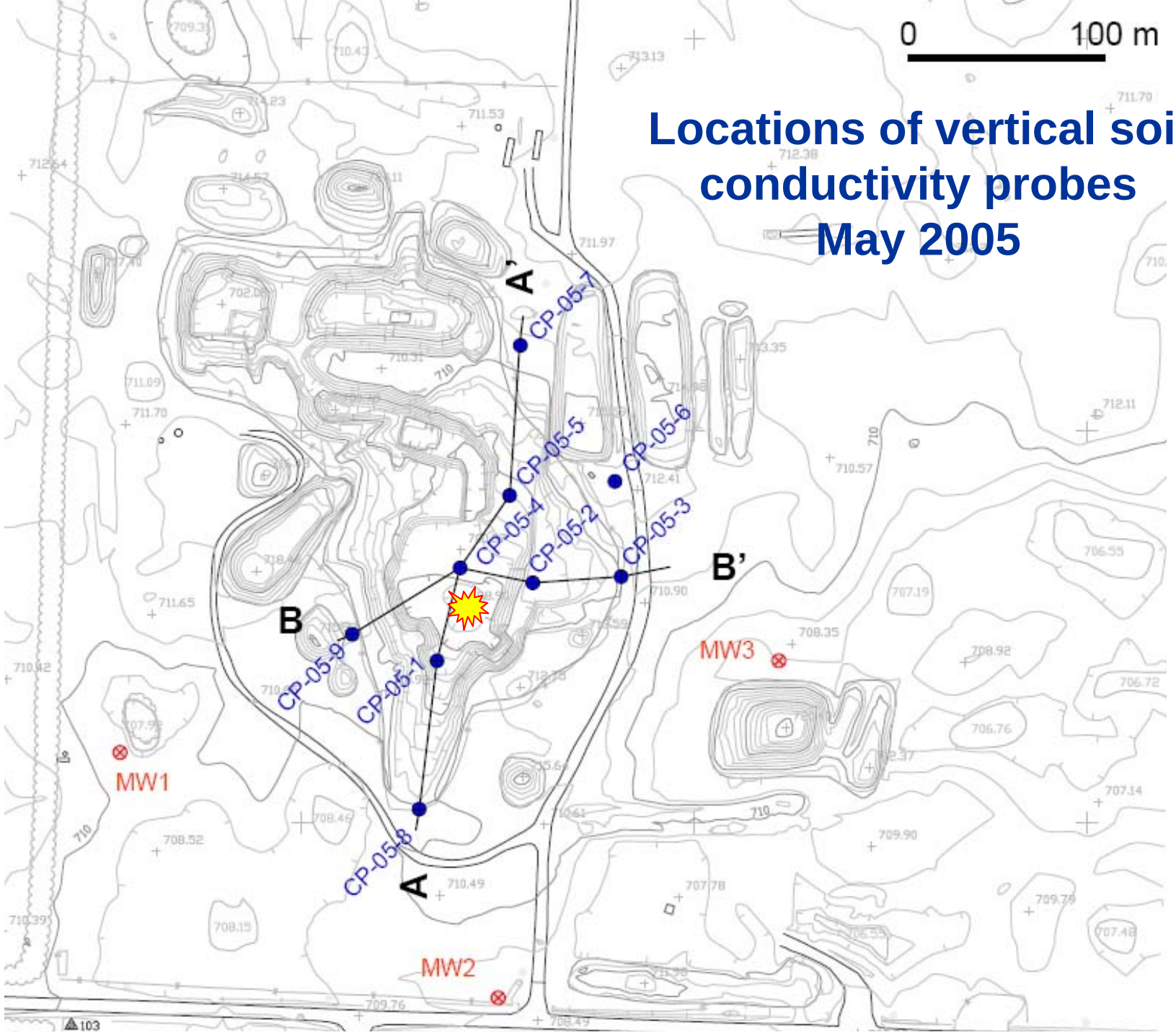
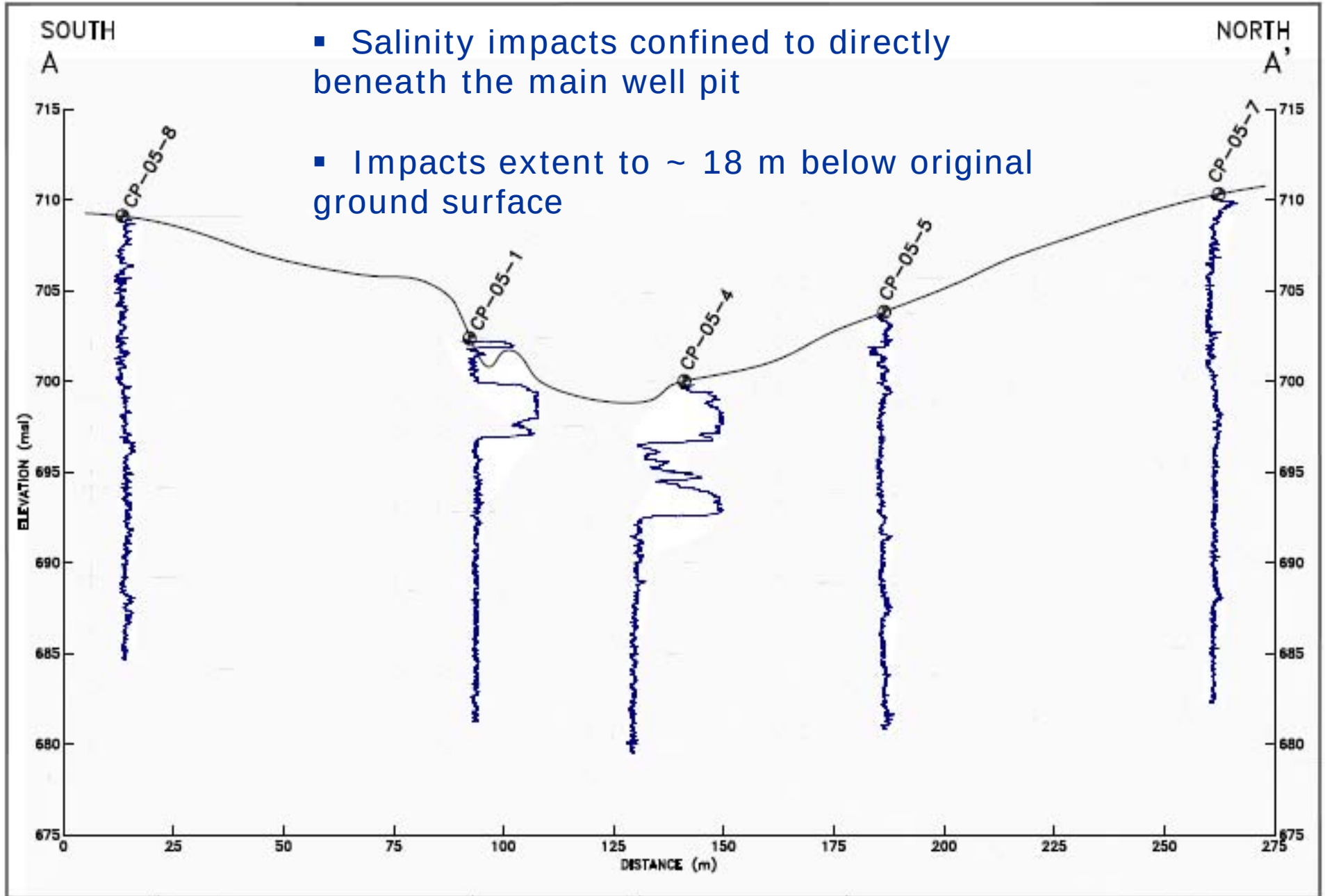
Geoprobe Testing the Excavation


0
100 m
Locations of vertical soil conductivity probes
May 2005
A'
A
B
B'
CP-05-7
CP-05-6
CP-05-5
CP-05-4
CP-05-3
CP-05-2
CP-05-9
CP-05-1
CP-05-8
MW1
MW2
MW3



- Salinity impacts confined to directly beneath the main well pit
- Impacts extent to ~ 18 m below original ground surface

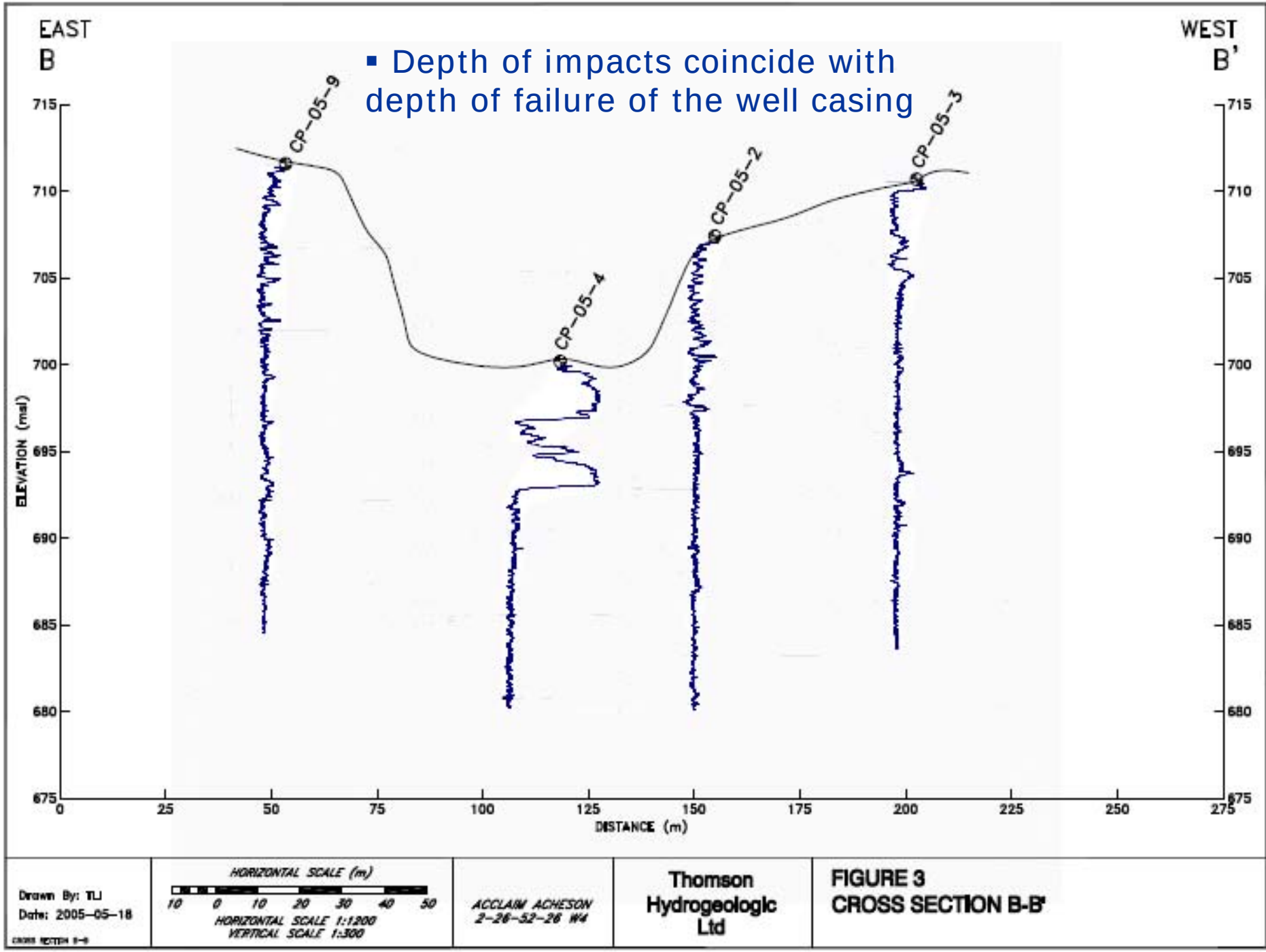
Drawn By: TLI
Date: 2005-05-18

HORIZONTAL SCALE (m)
10 0 10 20 30 40 50
HORIZONTAL SCALE 1:1200
VERTICAL SCALE 1:300

ACCLAIM ACHESON
2-26-52-26 W4

Thomson Hydrogeologic Ltd

FIGURE 2
CROSS SECTION A-A'



- Depth of impacts coincide with depth of failure of the well casing

Groundwater Management

- No evidence of GW impacts in the domestic wells or the on-site monitoring wells
- Following surface restoration a series of vertical conductivity probes are planned
- Subsequently - Piezometer installation & GW monitoring
- Implementation of GW Remediation Plan: Engineering & Risk Management

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Soil Management: Objectives

- Waste Characterization: Source & Piles
  - Field screening
  - Lab confirmation
- Remove impacts from the unsaturated zone
  - Pit area
  - Under stockpiles & traffic areas
- Site Reclamation

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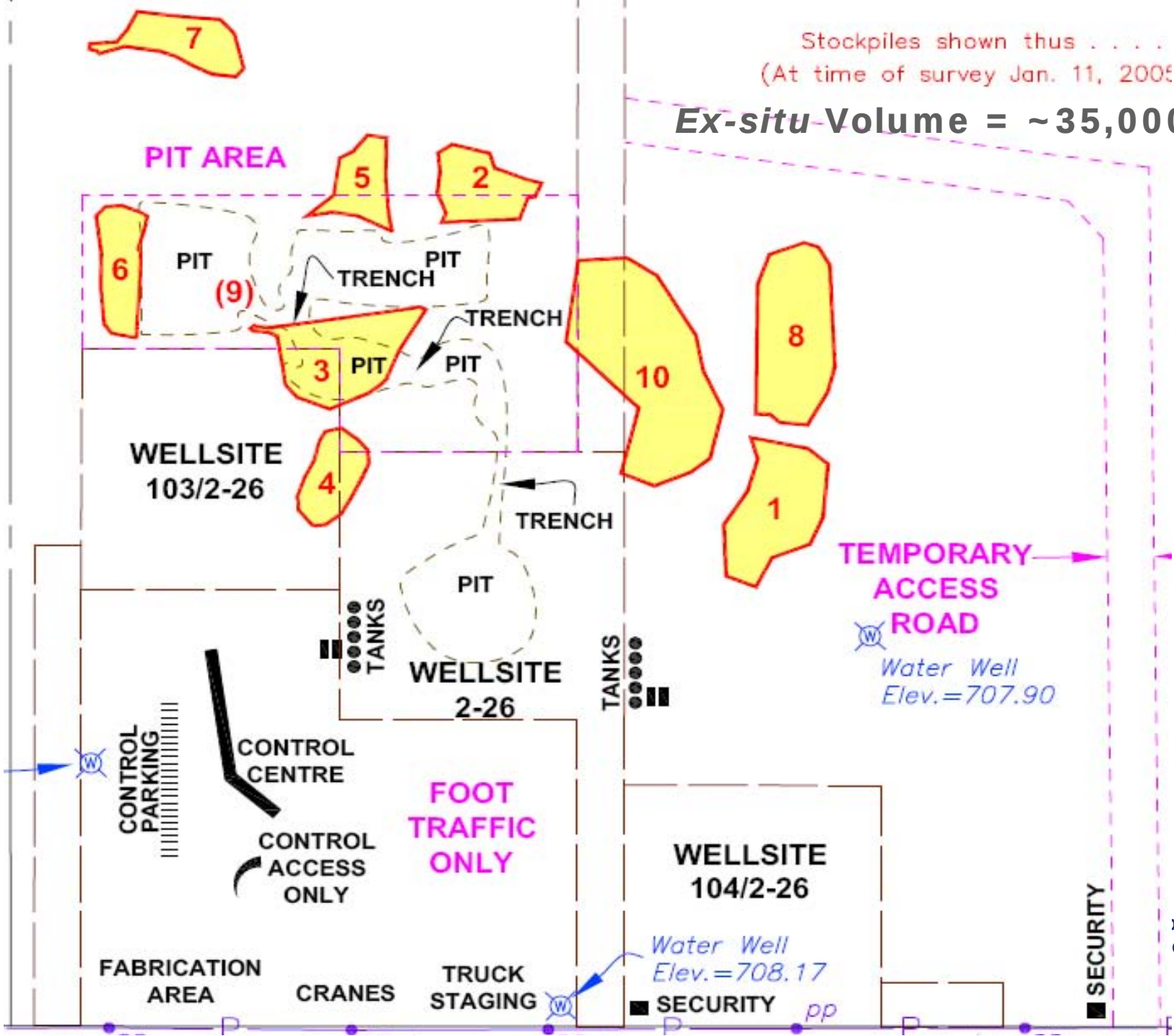
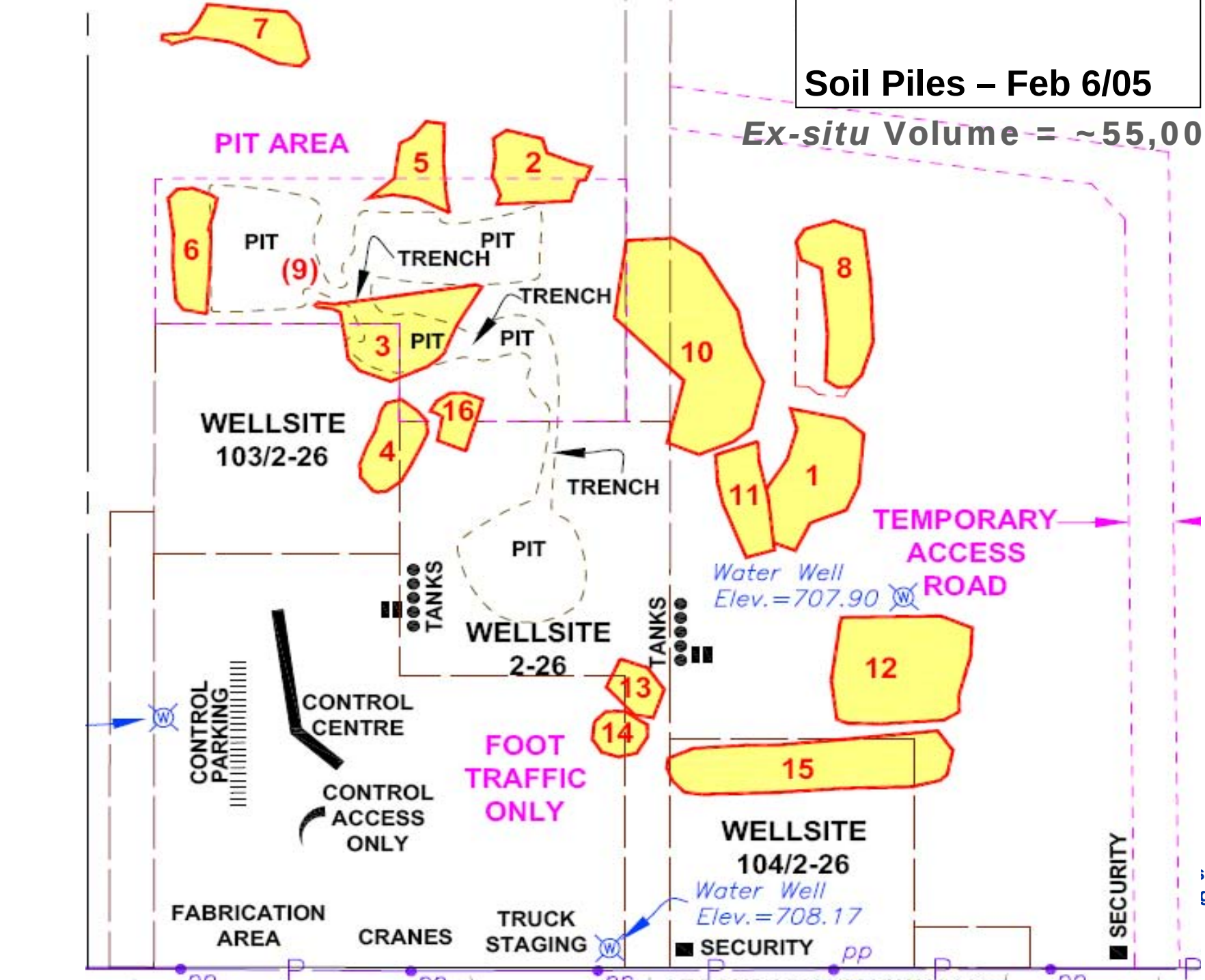
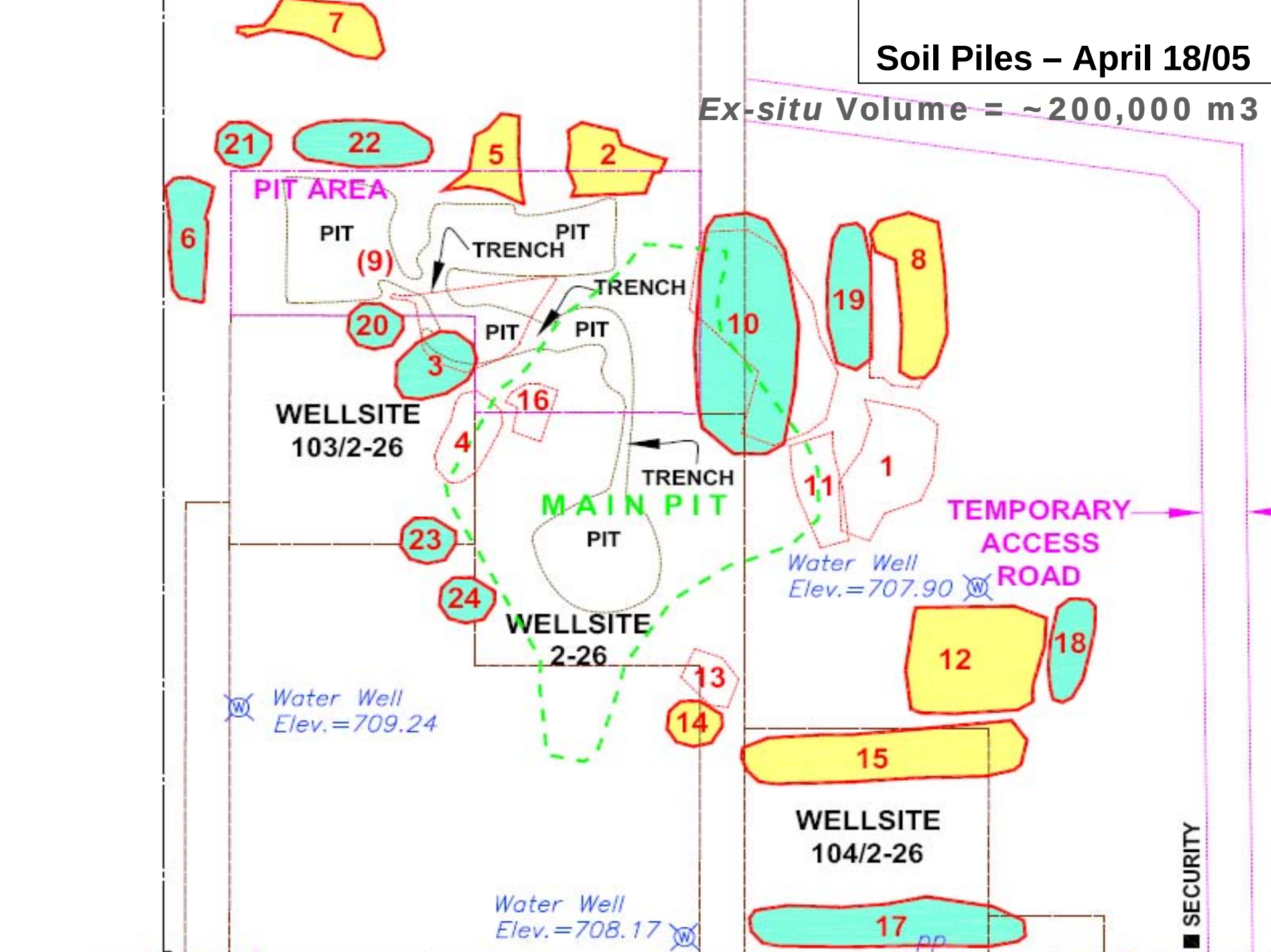

Stockpiles shown thus . . . .
(At time of survey Jan. 11, 2005
Ex-situ Volume = ~35,000 m3
PIT AREA
7
5
2
6
PIT
(9)
TRENCH
PIT
TRENCH
3
PIT
PIT
10
8
WELLSITE
103/2-26
4
TRENCH
1
TEMPORARY
ACCESS
ROAD
PIT
TANKS
WELLSITE
2-26
TANKS
Water Well
Elev.=707.90
CONTROL
PARKING
CONTROL
CENTRE
FOOT
TRAFFIC
ONLY
CONTROL
ACCESS
ONLY
WELLSITE
104/2-26
FABRICATION
AREA
CRANES
TRUCK
STAGING
Water Well
Elev.=708.17
SECURITY
pp
SECURITY


Soil Piles – Feb 6/05
Ex-situ Volume = ~55,000 m2
PIT AREA
7
5
2
6
PIT
(9)
TRENCH
PIT
TRENCH
3
PIT
PIT
10
8
WELLSITE
103/2-26
16
4
TRENCH
11
1
TEMPORARY
ACCESS
ROAD
PIT
Water Well
Elev.=707.90
TANKS
WELLSITE
2-26
TANKS
12
13
14
CONTROL
PARKING
CONTROL
CENTRE
FOOT
TRAFFIC
ONLY
15
CONTROL
ACCESS
ONLY
WELLSITE
104/2-26
Water Well
Elev.=708.17
FABRICATION
AREA
CRANES
TRUCK
STAGING
SECURITY
pp
SECURITY


Soil Piles – April 18/05
Ex-situ Volume = ~200,000 m3
7
21
22
5
2
PIT AREA
6
PIT
PIT
(9)
TRENCH
TRENCH
20
PIT
PIT
3
10
19
8
16
WELLSITE
103/2-26
4
TRENCH
MAIN PIT
PIT
11
1
TEMPORARY
ACCESS
ROAD
23
Water Well
Elev.=707.90
24
WELLSITE
2-26
12
18
13
Water Well
Elev.=709.24
14
15
WELLSITE
104/2-26
Water Well
Elev.=708.17
17
SECURITY

Pile Sampling

- 571 samples collected and field screened from ~205,000 m^3 of solids
- Each sample represented ~350 m^3
- 122 samples submitted for analytical verification

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Field-Lab Correlations: Salinity Data

Correlation coefficients	Field EC	Field Cl	Lab EC	Lab SAR	Lab Cl
Field EC	1.00	0.94	0.92	0.88	0.91
Field Cl	0.94	1.00	0.98	0.91	0.95
Lab EC	0.92	0.98	1.00	0.95	0.99
Lab SAR	0.88	0.91	0.95	1.00	0.94
Lab Cl	0.91	0.95	0.99	0.94	1.00

Correlations ≥0.75 are shown as:

Correlations ≥0.90 are shown as:

Correlations = 1.00 are shown as:

- Compared field and lab results for over 400 samples
- Field EC had high correlations with Field Cl, Lab EC, Lab SAR, Lab Cl
- Field Cl had high correlations but problems with readings (silt)
- Field EC is best to predict Lab EC and Lab Cl (especially Cl<5,000 mg/kg)

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Field-Lab Correlations: Hydrocarbon Data

Correlation coefficients	Field HCs: PF	Field HCs: OVA	Lab HCs: Light HCs	Lab HCs: Heavy HCs	Lab HCs: Total HCs
Field HCs: PetroFLAG	1.00	0.19	0.47	0.60	0.60
Field HCs: OVA	0.19	1.00	0.16	0.15	0.15
Lab HCs: Light HCs (BTEX + F1)	0.47	0.16	1.00	0.65	0.66
Lab HCs: Heavy HCs (F2+F3+F4)	0.60	0.15	0.65	1.00	1.00
Lab HCs: Total HCs	0.60	0.15	0.66	1.00	1.00

- Compared field and lab results for over 150 samples
- Prior work: OVA good for light HCs, PetroFLAG good for heavy or total HCs
- Initial results: OVA weak with all, PetroFLAG weak with light HCs, fair with heavy and total
- OVA <100 ppm: no correlation
- OVA >100 ppm: strong correlation with lighter HCs

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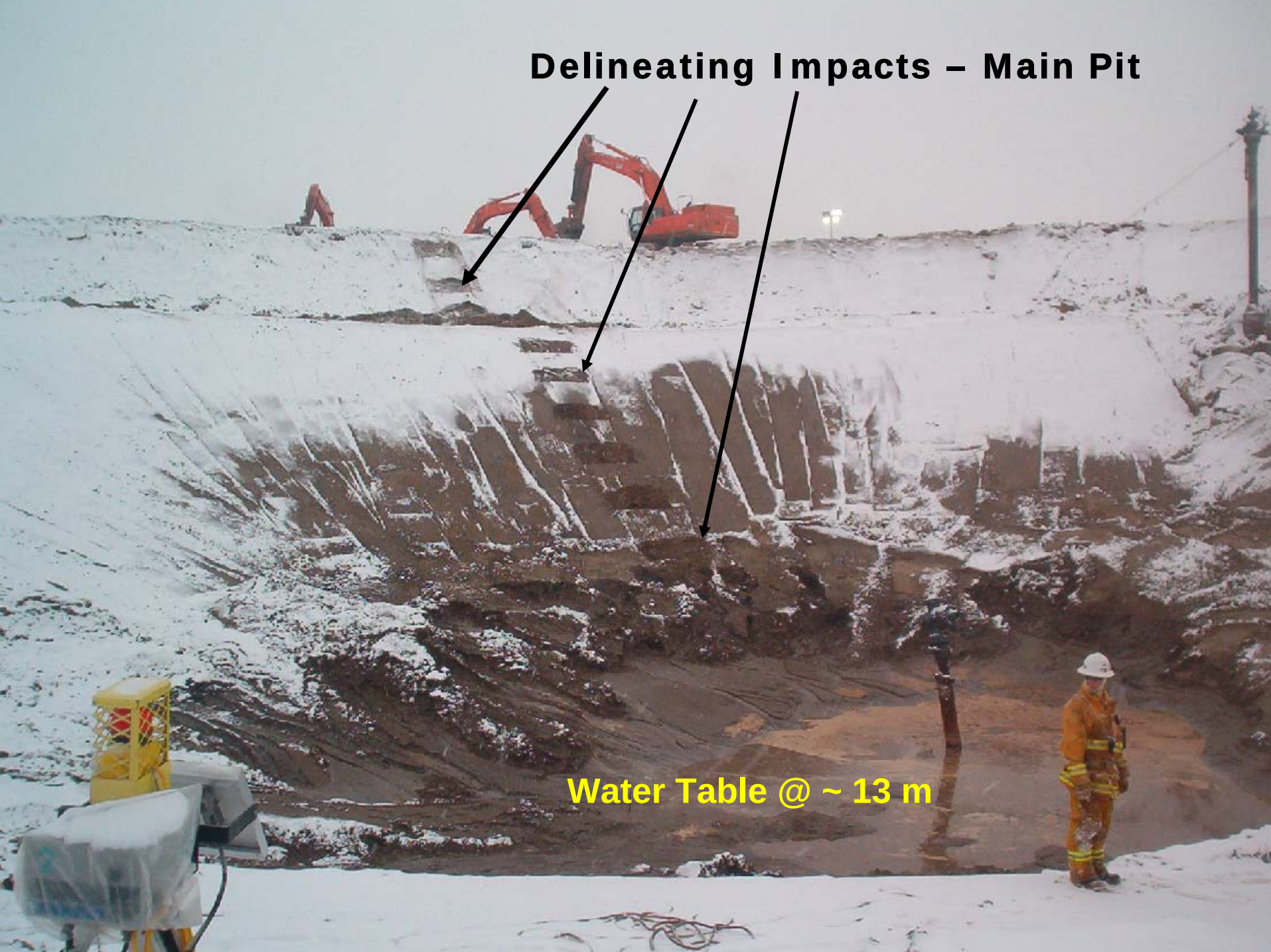
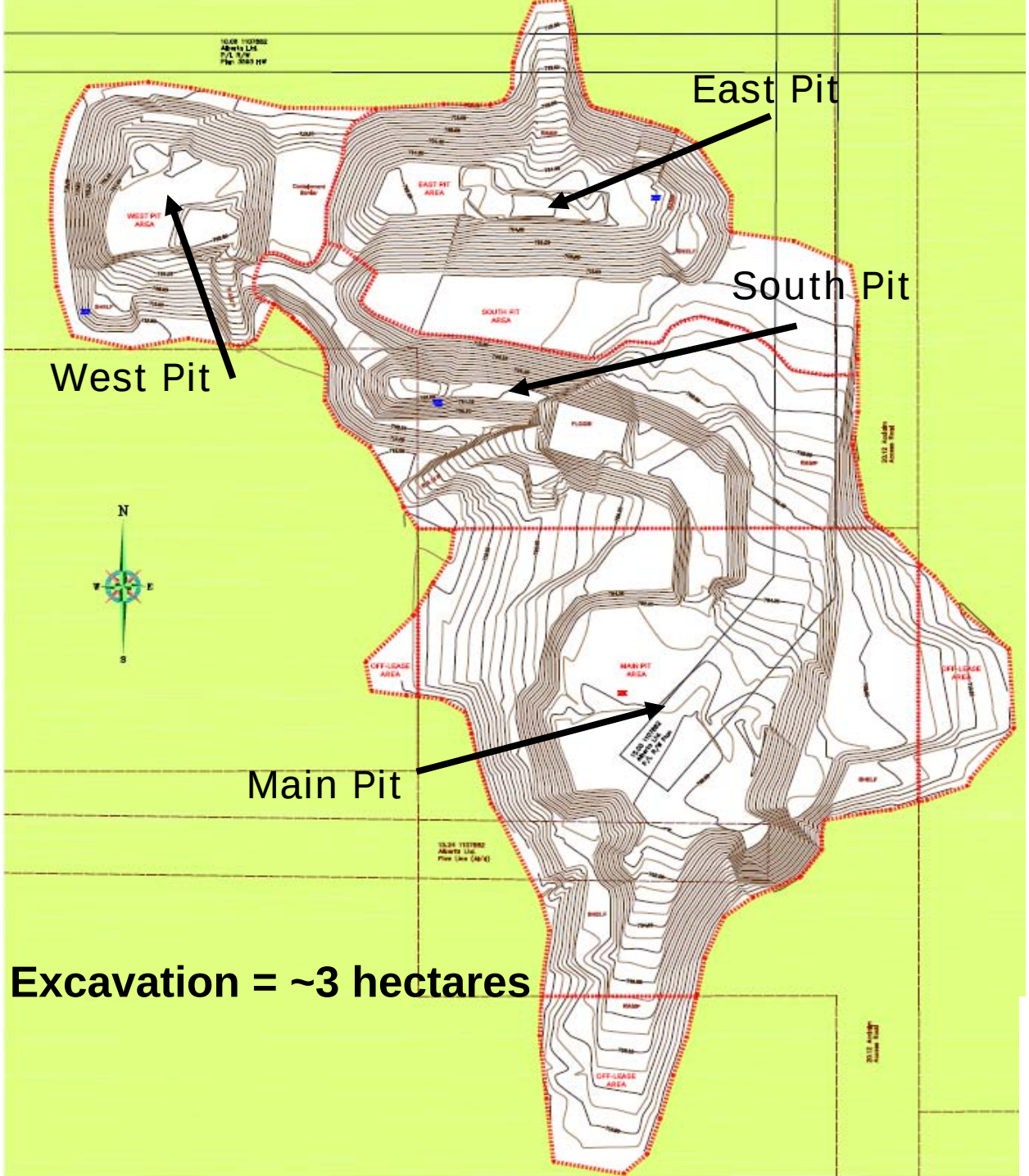
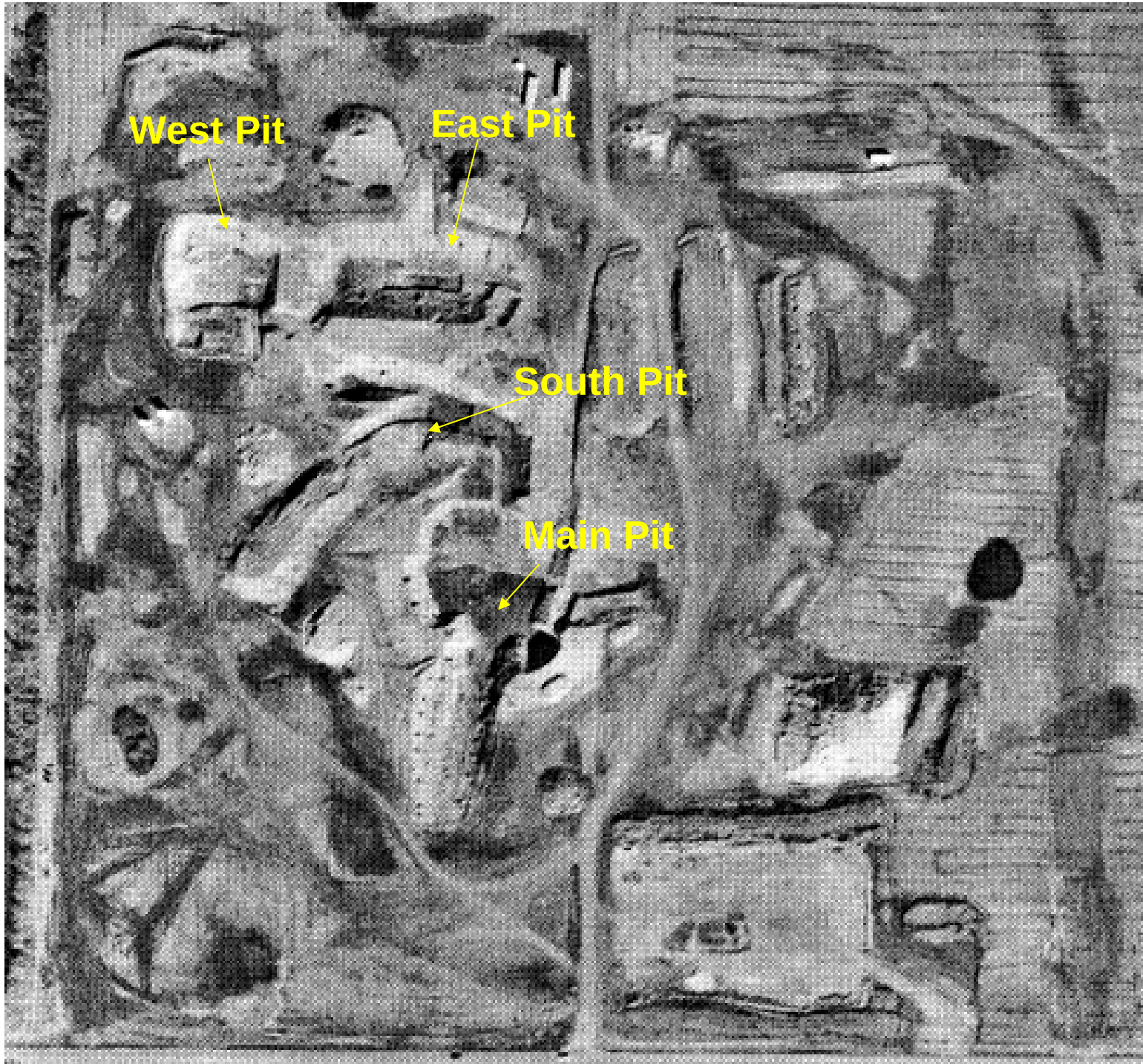
HSE

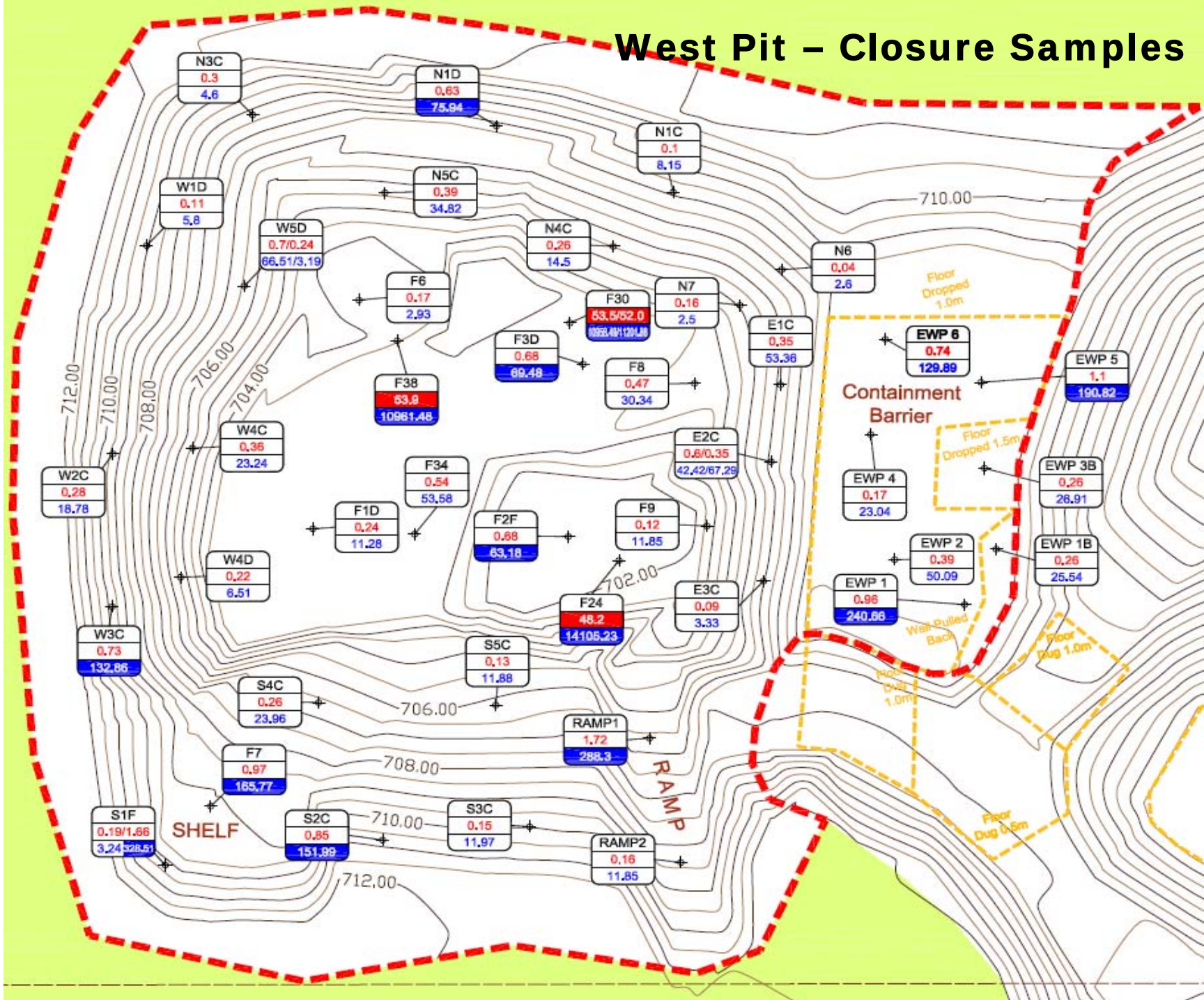

Delineating Impacts – Main Pit
Water Table @ ~ 13 m


East Pit
South Pit
West Pit
Main Pit
N
W
E
S
Excavation = ~3 hectares


West Pit
East Pit
South Pit
Main Pit

Removing Impacted Soil

West Pit – Closure Samples



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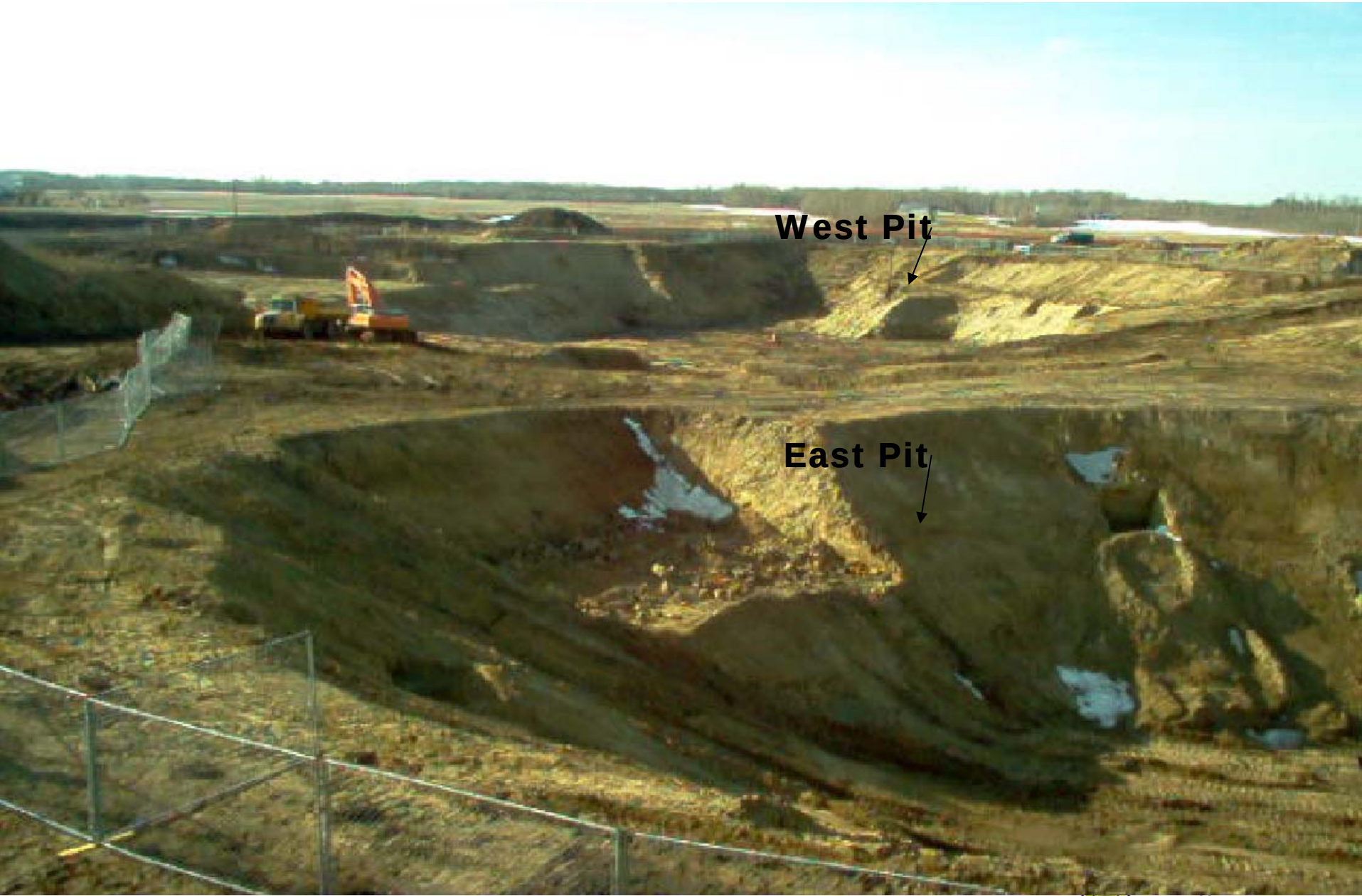
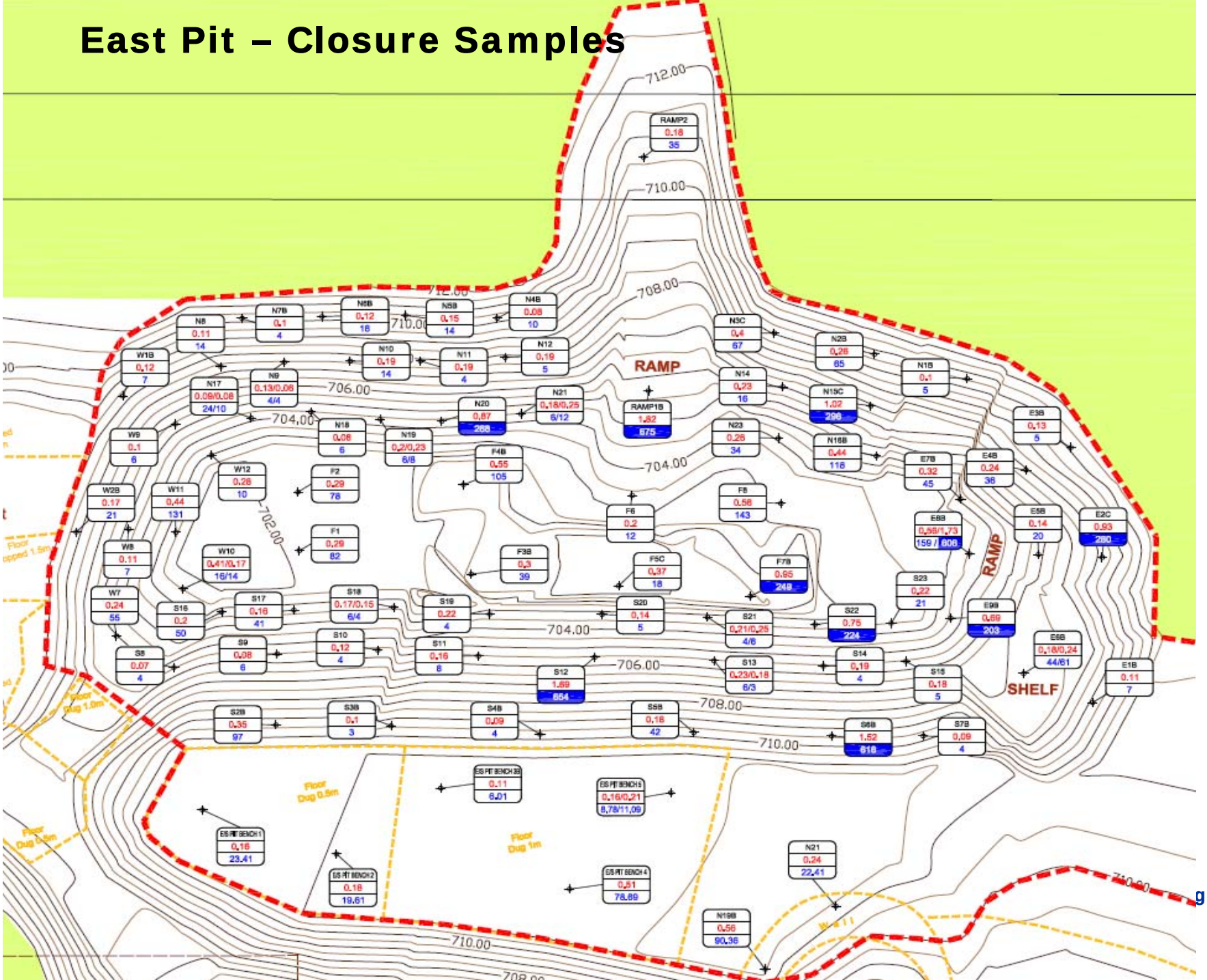

West Pit
East Pit

East Pit – Closure Samples



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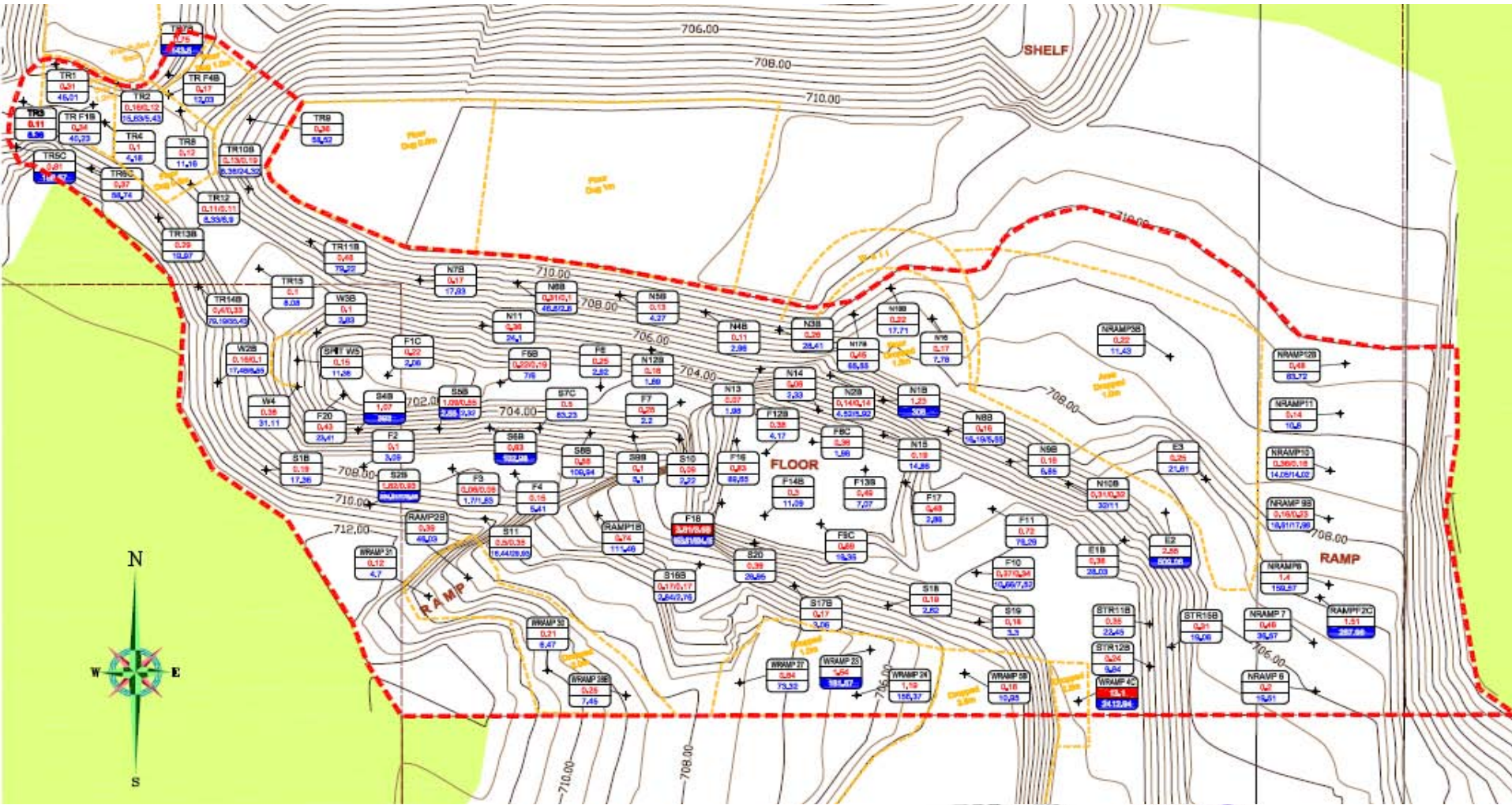

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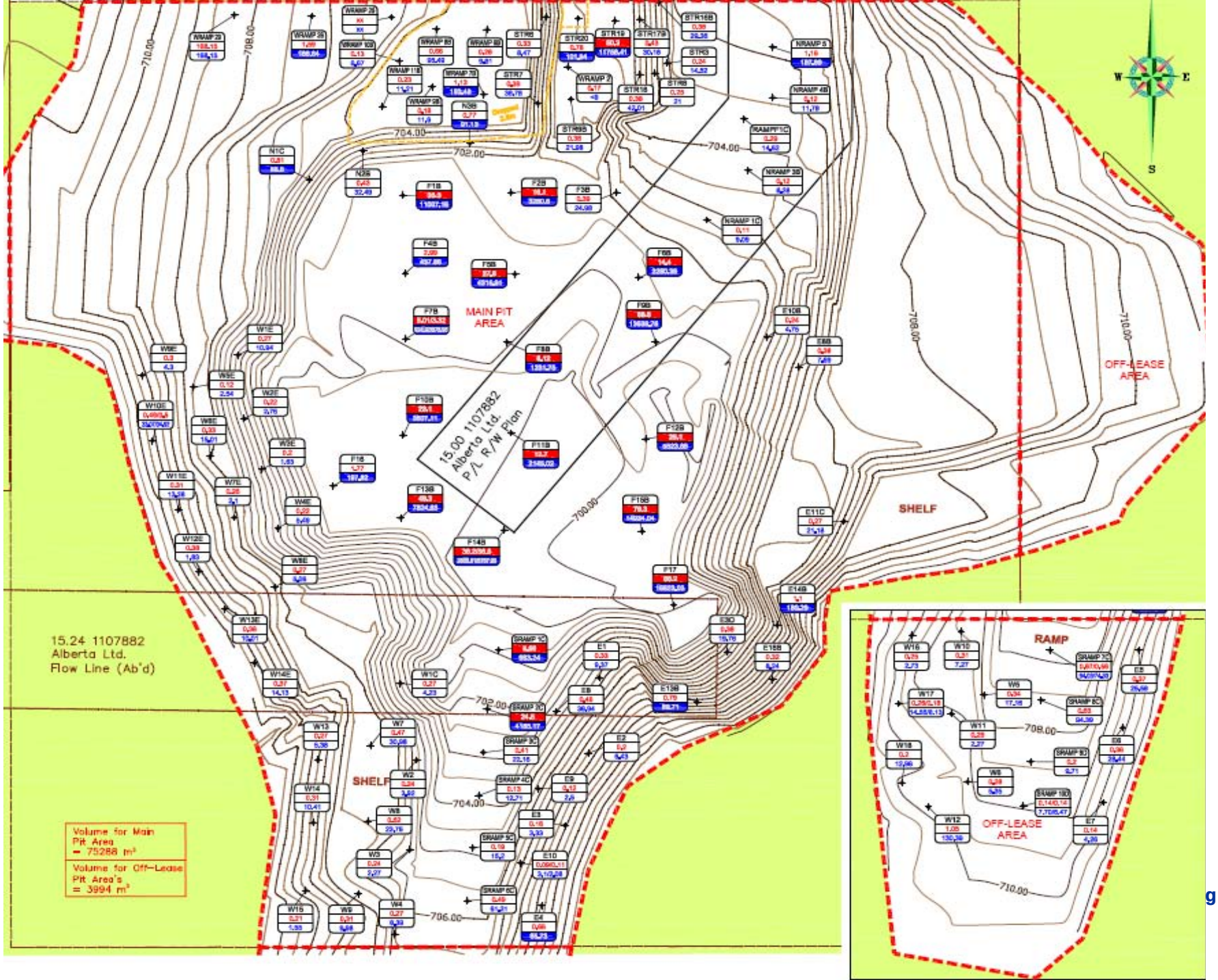
MAIN PIT AREA
SHELF
OFF-LEASE AREA
15.00 1107882 Alberta Ltd. P/L R/W Plan
15.24 1107882 Alberta Ltd. Flow Line (Ab'd)
Volume for Main Pit Area = 75288 m³
Volume for Off-Lease Pit Area's = 3994 m³
RAMP
710.00
708.00
706.00
704.00
702.00
700.00
N
S
E
W

gic


Main Pit
South Pit

Excavation Sampling

- More than 900 samples were collected and field tested from the walls & floors
- More than 300 samples submitted for analytical verification

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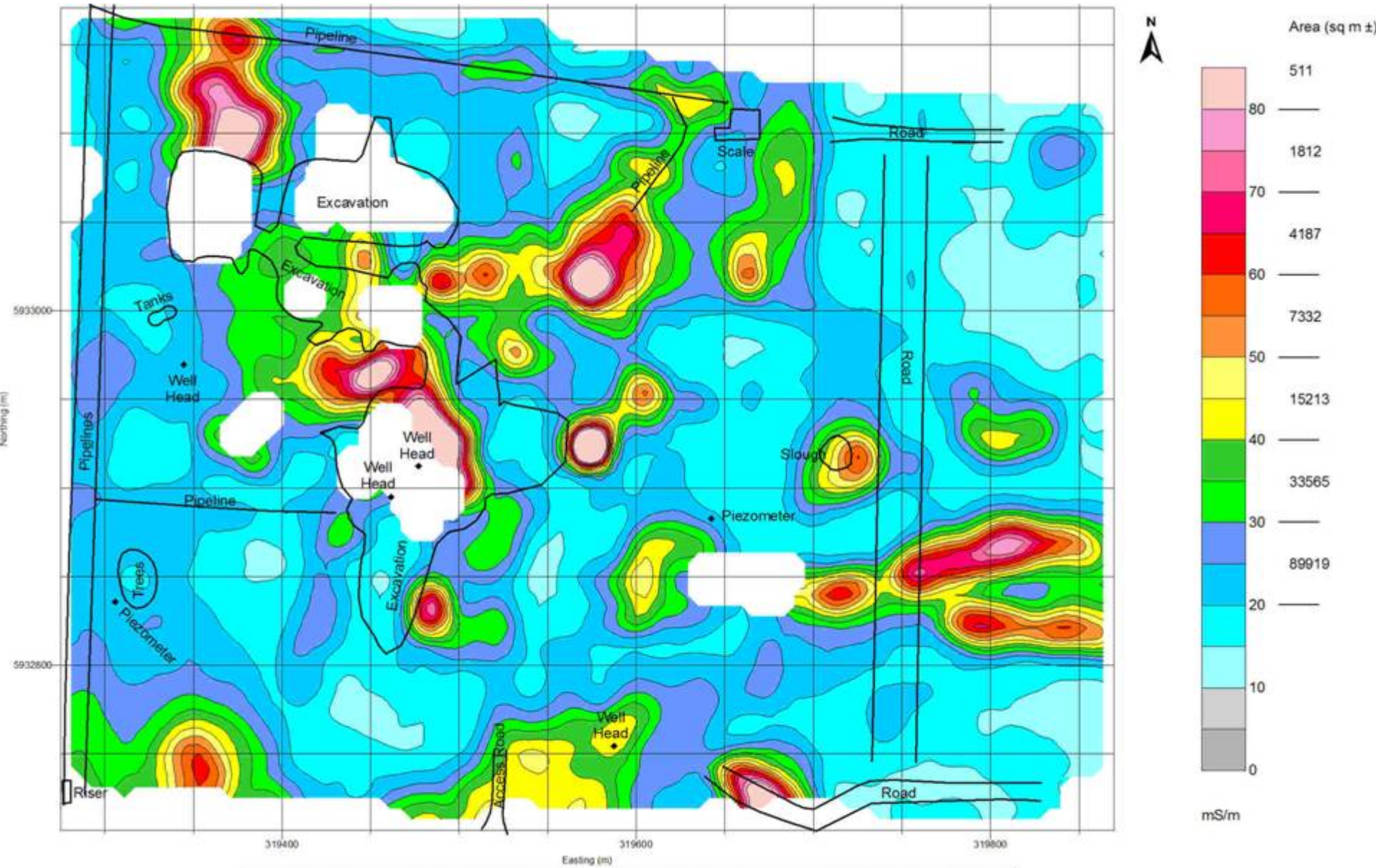
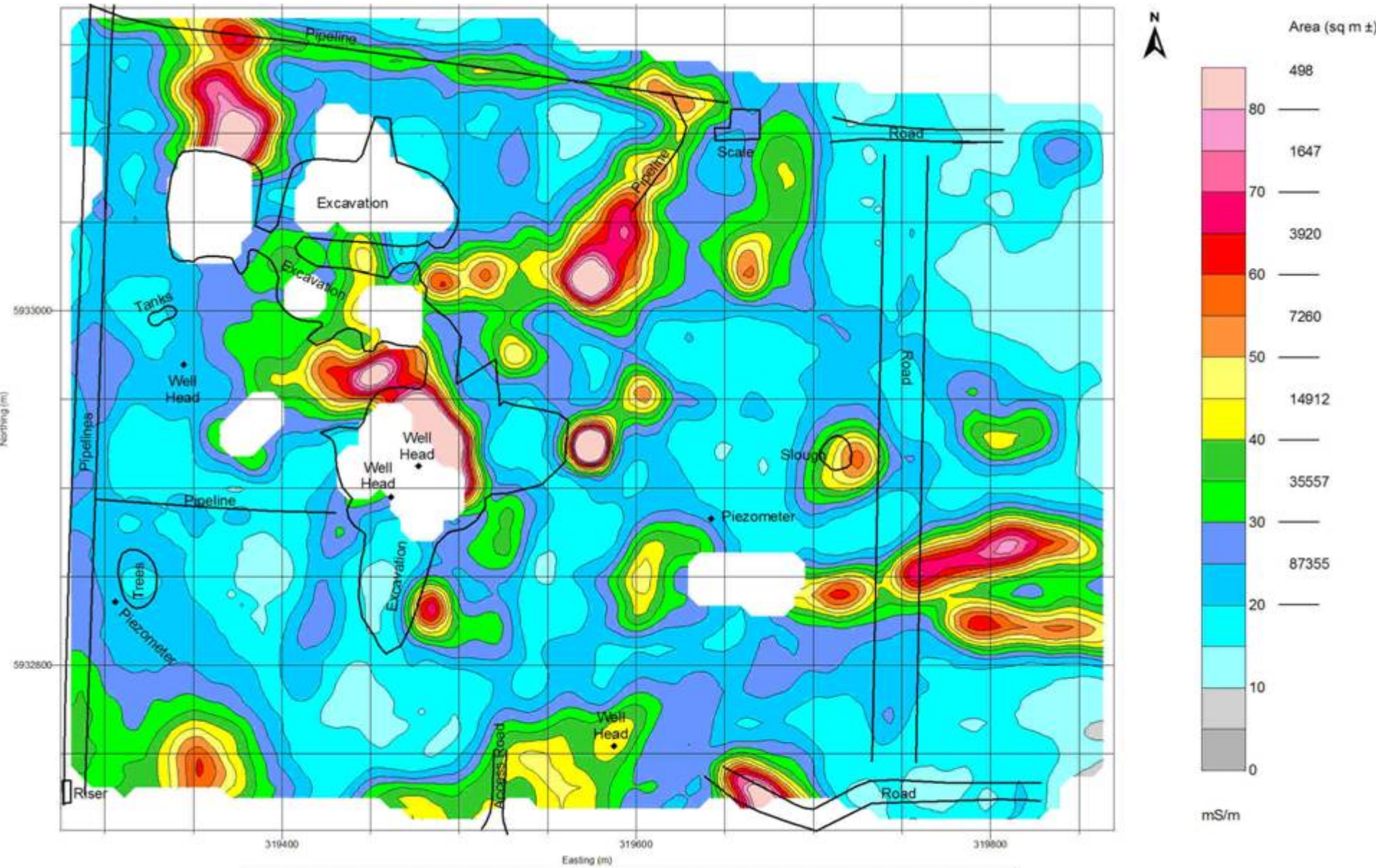
Geophysics Map – 1.5 m



Geophysics Map – 5 m




Geophysic Hot Spot for Removal

Soil Management

- Clean/impacted soil handled separately
- Impacted soil - landfilled
- All impacts in the unsaturated zone have been removed from the pit area
- Minor surface impacts identified with geophysics – currently being removed

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Soil Waste Material Balance

Waste Source	Type	Volume (m^3)	Volume (T)
2-26 Red-zone	Impacted	33,777	50,666
	Geophysics hotspots	11,446	17,168
2-26 Non-red zone	Impacted	98,511	147,767
	Geophysics Pit Hotspots	2,000	3000
	Geophysics Surface Impacts	10,350	15,525
Sub-total: 2-26	**Impacted Soil**	**149,084**	**223,625**
4-02 Solids	Berms & Sludge	33,323	49,985
	Injection Well	10,284	15,426
Sub-total: 4-02	**Impacted Soil**	**43,607**	**65,411**
2-26 Red-zone	Clean	9,494	14,241
2-26 Non-red zone	Clean	14,967	22,451
Sub-total	**Clean Soil**	**24,461**	**36,692**
TOTAL		**224,152**	**325,727**

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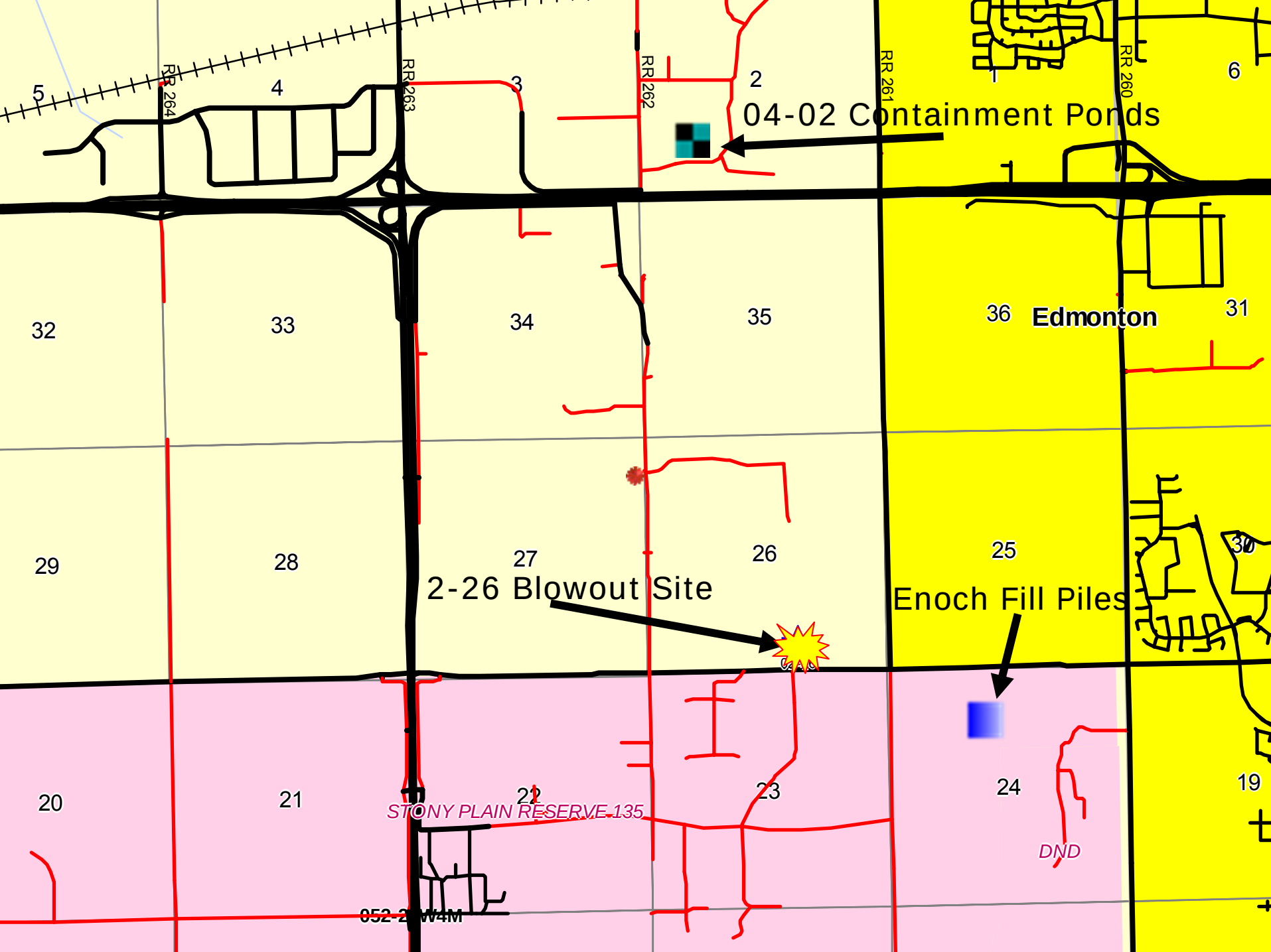
Soil Management – Residual Impacts

- Main Pit: Salinity, F2 hydrocarbon & boron impacts remain in the saturated zone
- West Pit: Salinity impacts remain at the base (saturated zone) of the west pit
- South Pit: Minor salinity impacts remain in the saturated zone (EC – 3.61 dS/m)

ACCLAIM Energy Inc.

SOLSTICE CANADA CORP.

Thomson Hydrogeologic Ltd.


04-02 Containment Ponds
2-26 Blowout Site
Enoch Fill Piles
Edmonton
STONY PLAIN RESERVE 135
DND
RR 264
RR 263
RR 262
RR 261
RR 260
5
4
3
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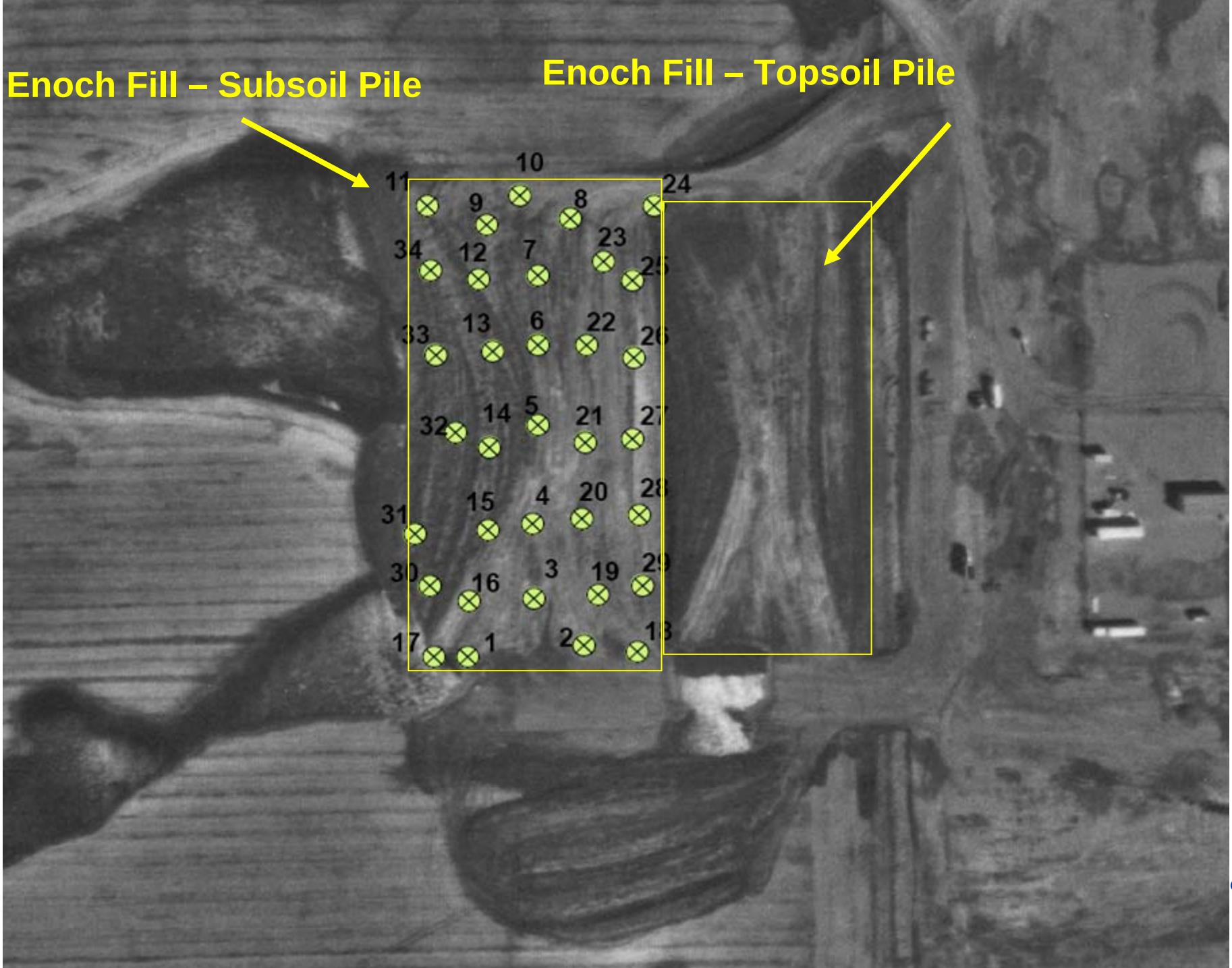
Enoch Fill – Subsoil Pile
Enoch Fill – Topsoil Pile
10
11
24
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19
17
1
2


Filling the Main Pit
Wellheads


Wellheads


Wellheads

04-02 Pond Remediation

04-02 Slurry Ponds

- Characterization
- Remediation
- Reclamation

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4-2-53-26-W4 Oct-18-05 Material ready to haul to landfill.

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Questions???

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