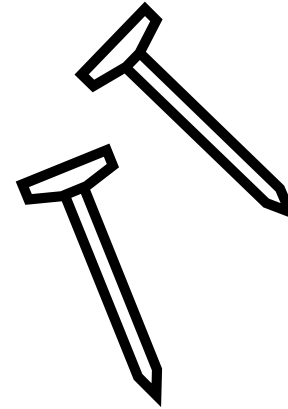


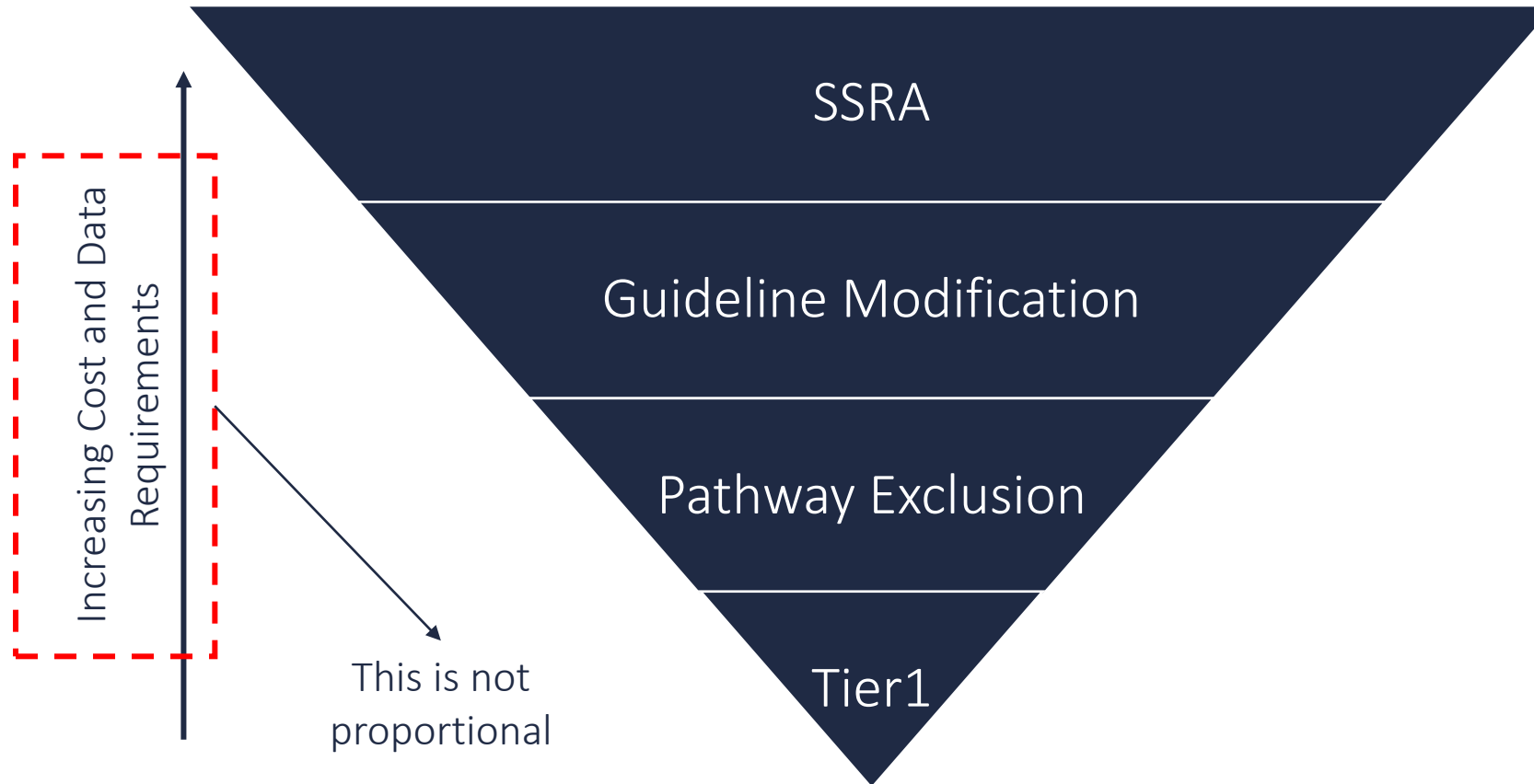


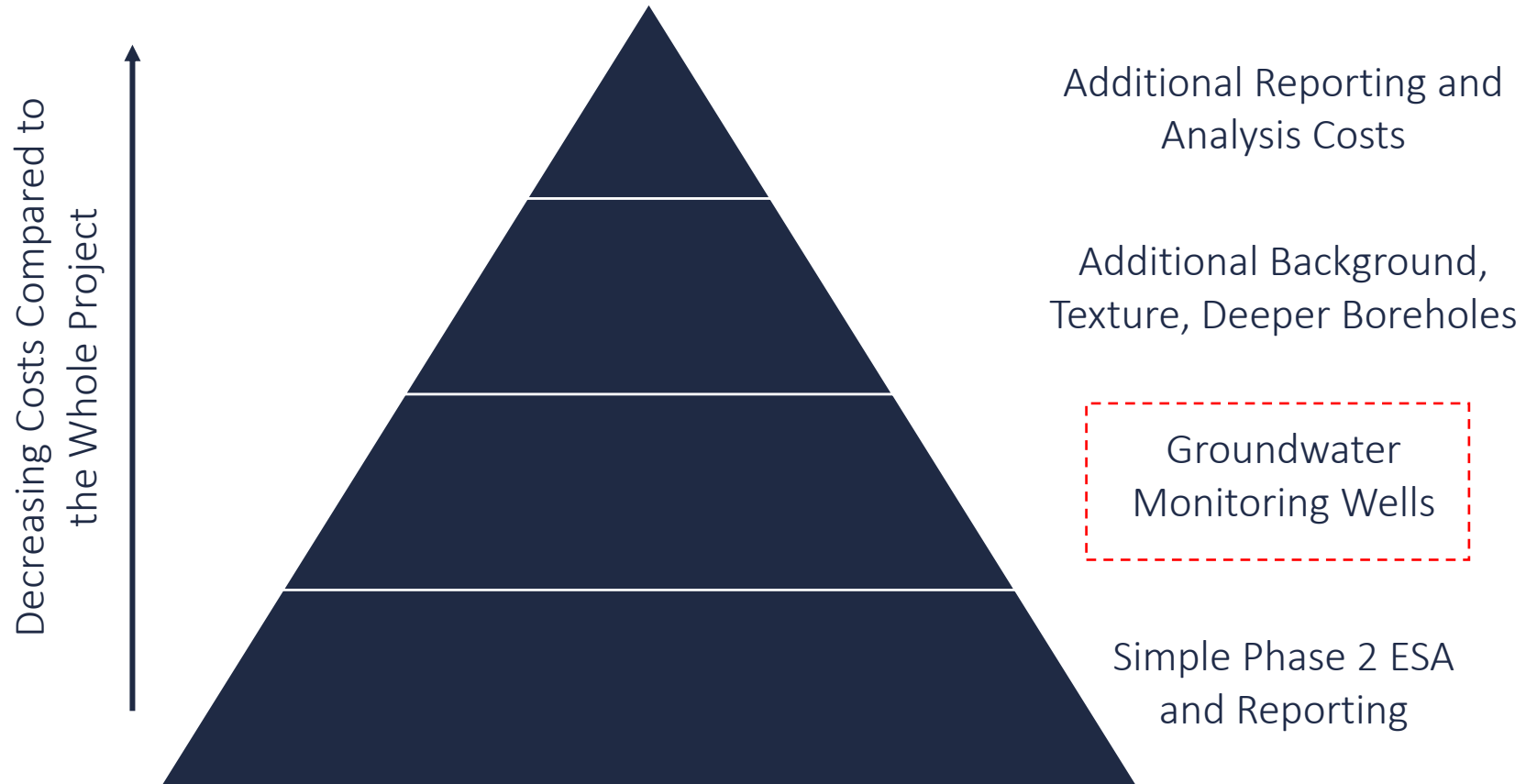
KEEP IT SIMPLE, SCIENTISTS:
THE BENEFITS OF APPLYING RISK
PRINCIPALS TO SIMPLE SITES AND
THE DATA THAT GETS YOU THERE

LORI VICKERMAN, M.Sc., P.BIOL

OCTOBER 2023







Assessment and Remediation Guidelines

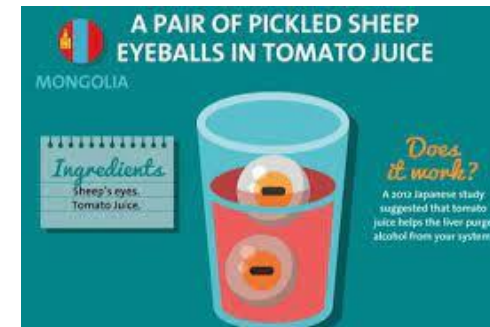
- Tier 1 - generic guidelines designed using relatively conservative assumptions
- Non-alcoholic example, as it is Friday morning!!!



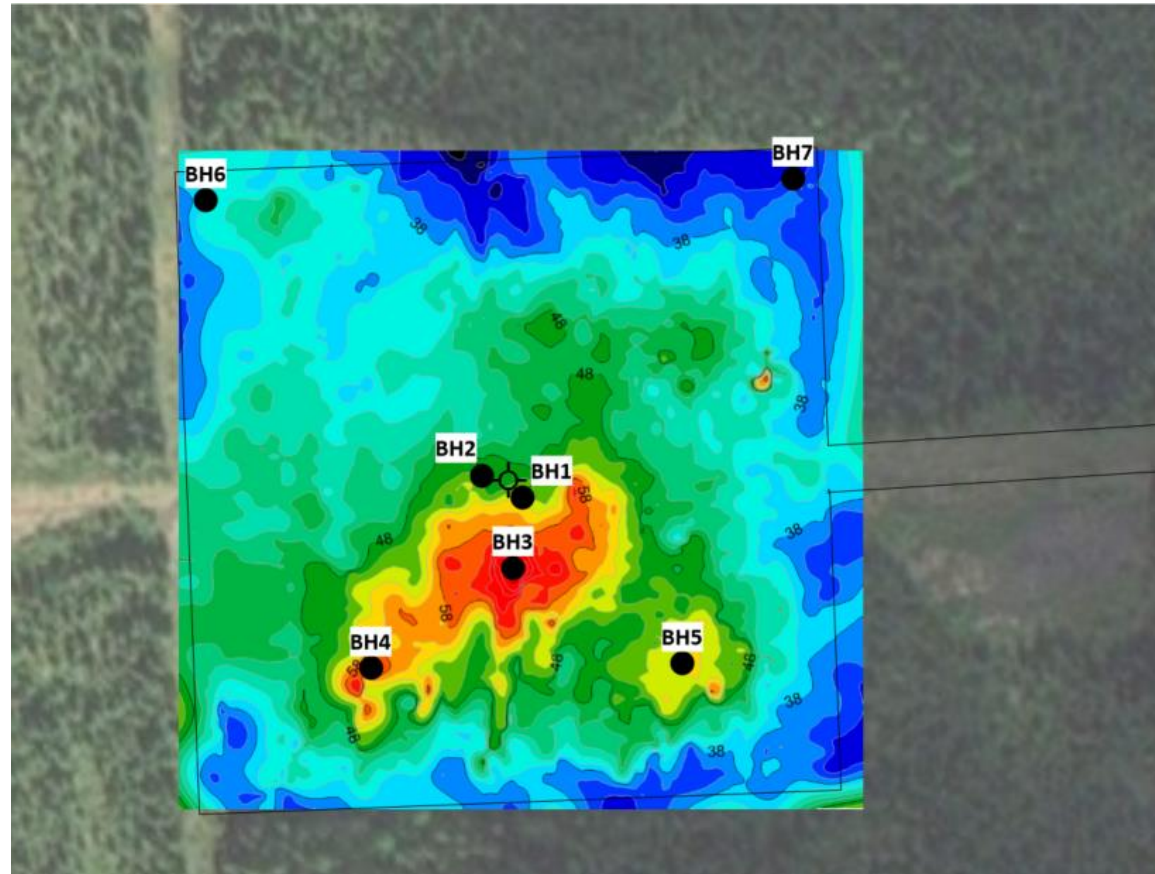
Tier 1



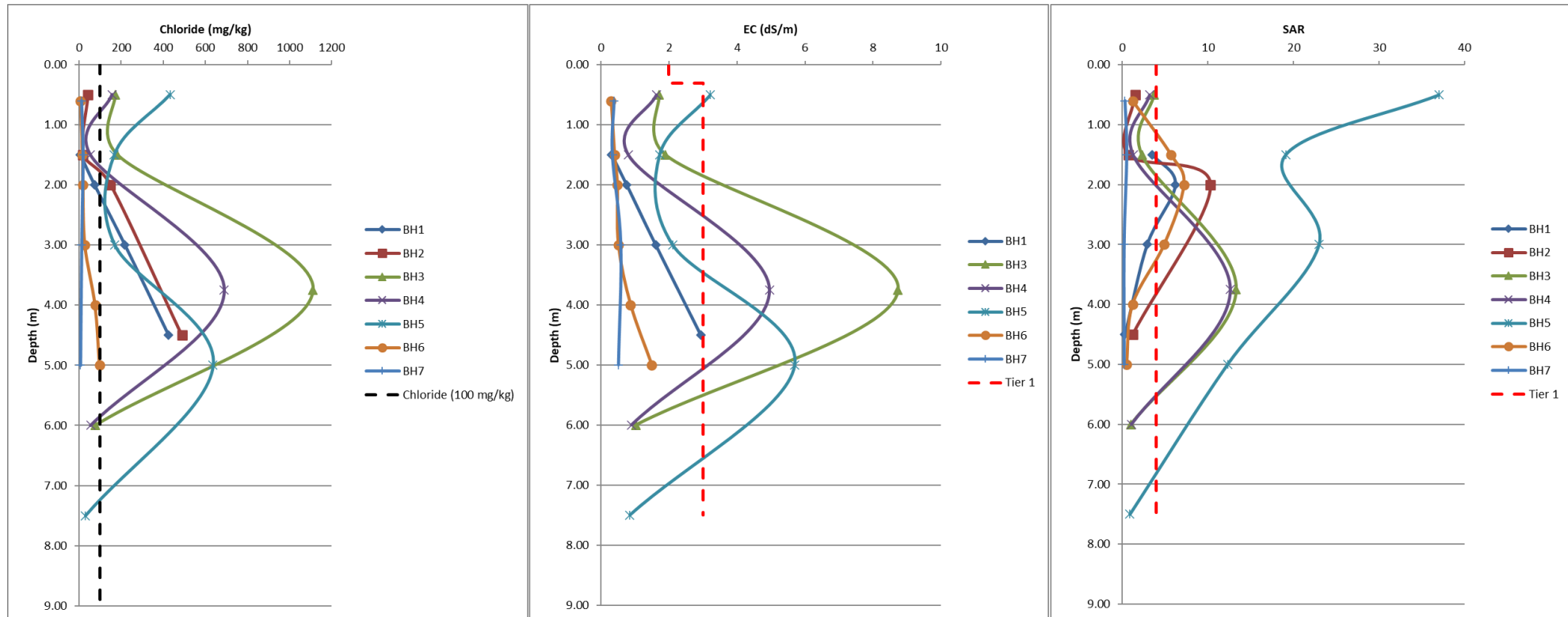
Tier 2



A Tale Of “One Simple Site”: Approached Two Different Ways

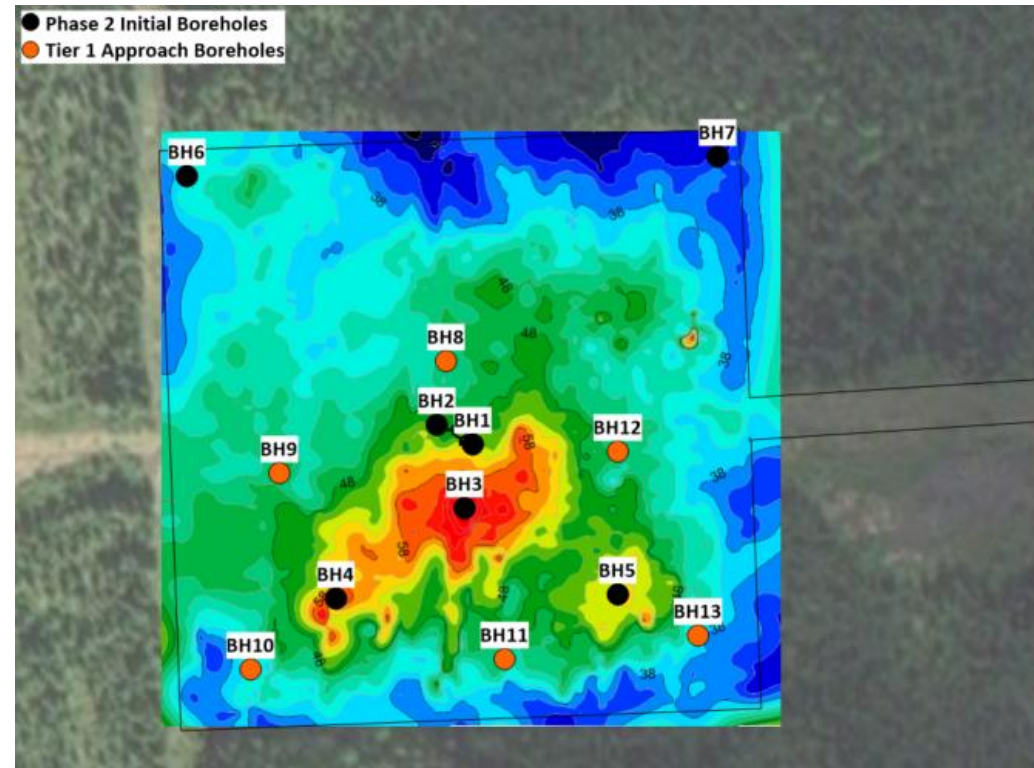


“One Simple Site”: Approached Two Different Ways



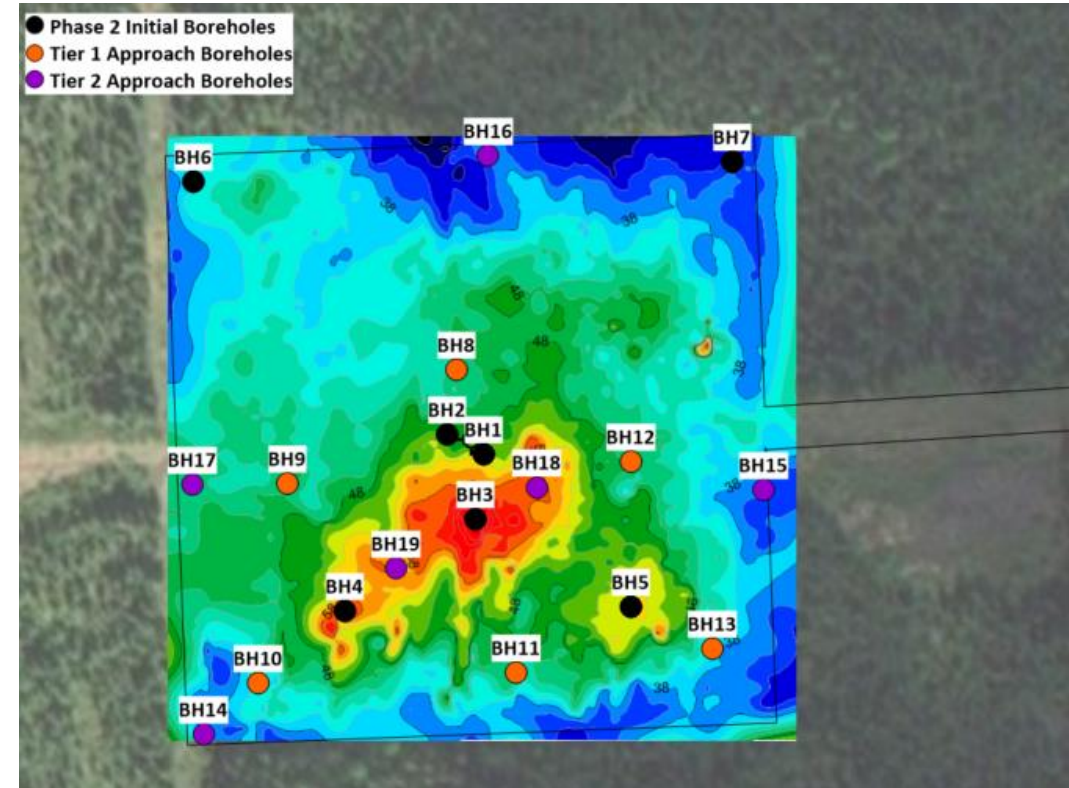
“One Simple Site”: Approach Method 1

- Approach as a Regular Tier 1 Site
 - Assuming groundwater is not impacted
 - Characterize and delineate APECs to Tier 1
 - Two background boreholes
 - Vertical and lateral closure for chloride
 - Cost is approximately \$8,000 to \$12,000



“One Simple Site”: Approach Method 2

- Approach With a Risk Perspective
 - Delineate APECs
 - Six background boreholes, higher sample intensity, more texture by sieve and hydrometer
 - Vertical and lateral closure for chloride
 - Minimum four boreholes per APEC
 - One deeper borehole for DUA buffer
 - Shelby tubes
 - Cost is approximately \$17,000 to \$20,000



“One Simple Site”: Approached Two Different Ways

- Cost Breakdown of Investigation and Reporting (approximate)
 - Tier 1 – \$8,000 to \$12,000
 - Tier 2 – \$17,000 to \$20,000

- Volumes / Cost Breakdown for Remediation

Guidelines Applied	Area (m ²)	Depth (m)	Volume (m ³)	Estimated cost (\$125/m ³)
Tier 1	750	6	4500	\$ 562,500.00
Tier 2	750	1.5	1125	\$ 140,625.00
Additional Costs for Tier 2 Investigation				\$ 10,000.00
Tier 2 Actual Cost				\$ 150,625.00
Cost Savings				\$ 411,875.00

Water Well Drilling Reports:

ESA1 identifies water wells within 300 m of the site. Review in detail during ESA2 planning.

Oil Well Spud Date:
March 24, 1994

Oil Well Drilling Contractor:
Arkoma Drilling Rig #25

Water Well Drilling Date:
March 21, 1994

Water Well Owner:
Arkoma/Kenting 25#Camp Well

Lithology:
21 m Sandy Clay

Alberta Water Well Drilling Report [View in Imperial](#) [Export to Excel](#)

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 376893
GoA Well Tag No.
Drilling Company Well ID
Date Report Received: 1994/03/31

GOWN ID

Well Identification and Location										Measurement in Metric	
Owner Name ARKOMA/KENTING 25#CAMP WELL		Address 1410-407 2 ST SW, CALGARY		Town		Province		Country		Postal Code T2P 2Y3	
Locality	M	TSP	RGE	W of MER	Lot	Block	Plan	Additional Description			
4	13	60	11	5							
Measured from Boundary of				GPS Coordinates in Decimal Degrees (NAD 83)				Elevation _____ m			
_____ m from _____				Latitude <u>54.183263</u> Longitude <u>-115.523170</u>				How Elevation Obtained _____			
_____ m from _____				How Location Obtained _____				Survey-Air _____			
Field				Field				Survey-Air			

Drilling Information			
Method of Drilling Rotary		Type of Work New Well	
Proposed Well Use Domestic		Plugged 1994/05/06	
		Plugged with <u>Unknown</u>	
		Amount _____	

Formation Log			Measurement in Metric
Depth from ground level (m)	Water Bearing	Lithology Description	
21.64		Sandy Clay	
24.38		Gravel	

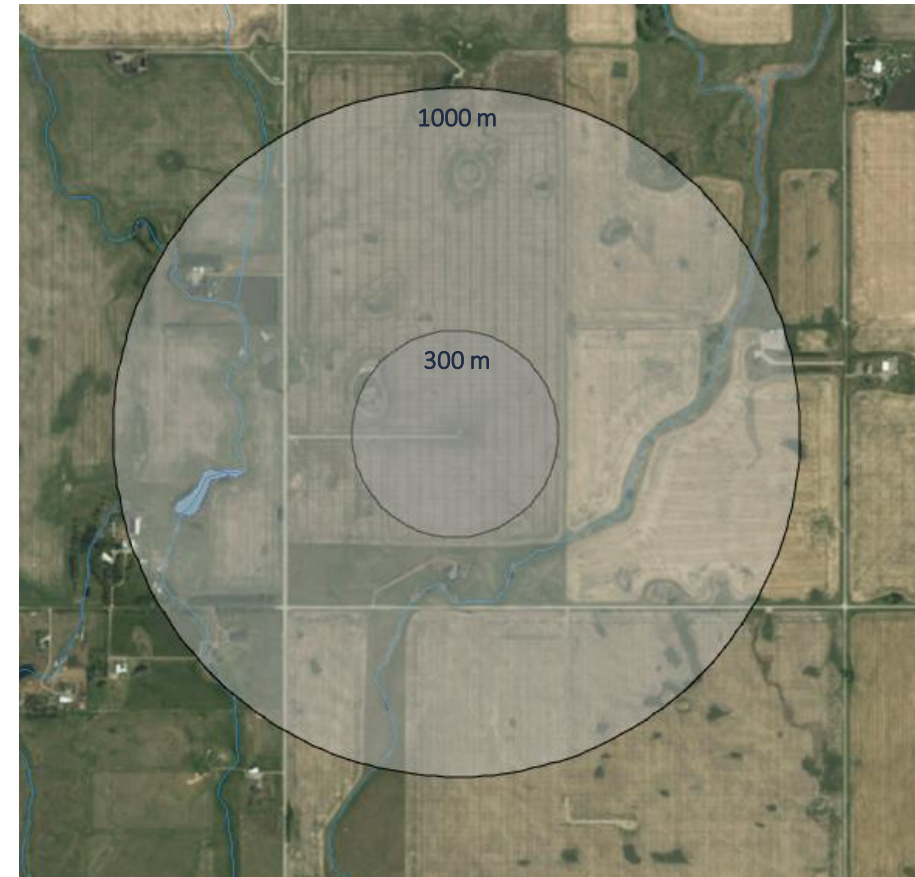
Yield Test Summary			Measurement in Metric
Recommended Pump Rate <u>27.28</u> L/min			
Test Date	Water Removal Rate (L/min)	Static Water Level (m)	
1994/03/21	27.28	12.19	

Well Completion				Measurement in Metric
Total Depth Drilled	Finished Well Depth	Start Date	End Date	
24.38 m		1994/03/21	1994/03/21	
Borehole				
Diameter (cm)	From (m)	To (m)		
0.00	0.00	24.38		
Surface Casing (if applicable)		Well Casing/Liner		
Steel		Steel		
Size OD :	<u>13.97</u> cm	Size OD :	<u>0.00</u> cm	
Wall Thickness :	<u>0.620</u> cm	Wall Thickness :	<u>0.000</u> cm	
Bottom at :	<u>24.38</u> m	Top at :	<u>0.00</u> m	
		Bottom at :	<u>0.00</u> m	

On Lease Water Well -Support for Potential DUA Receptor Exclusion

Freshwater Aquatic Life

- Tier 1 assumes FAL 10 m from impacts
- Identify all waterbodies that can support an aquatic ecosystem 1000 m from
- Potential Exclusion of Pathway for BTEX (groundwater flow direction and parameter specific)
- Can not be excluded for salts but the farther away the better
- Depending on the contaminants of concern, a recalculation under Tier 2 using the actual distance to the closest aquatic ecosystem, can substantially relax guidelines.



Chlorides:

The swear word heard in oil/gas company offices in Western Canada, but the most challenging and fun part of the work for environmental consultants.

The Tier 1 requirement to delineate chlorides in soil to meet the lowest applicable guideline is often either overlooked or misunderstood in basic Phase 2 assessments. This can lead to regulatory rejection of the ESA 2 at the time of reclamation, or over excavation of salt impacted soils.

- Natural versus anthropogenic sources
- Shallow impacts and deep groundwater



Phase 2: Sampling with Tier 2 in Mind

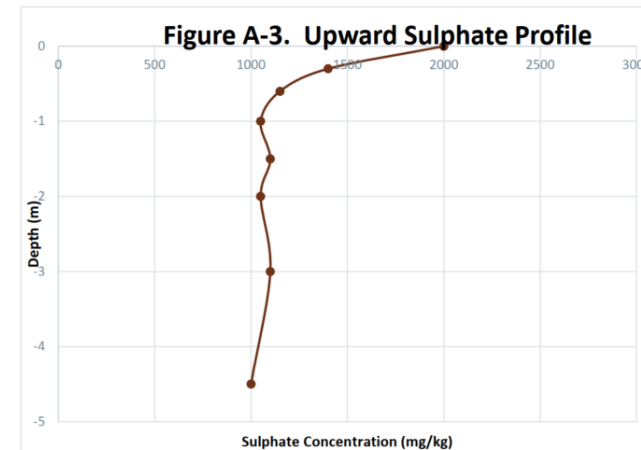
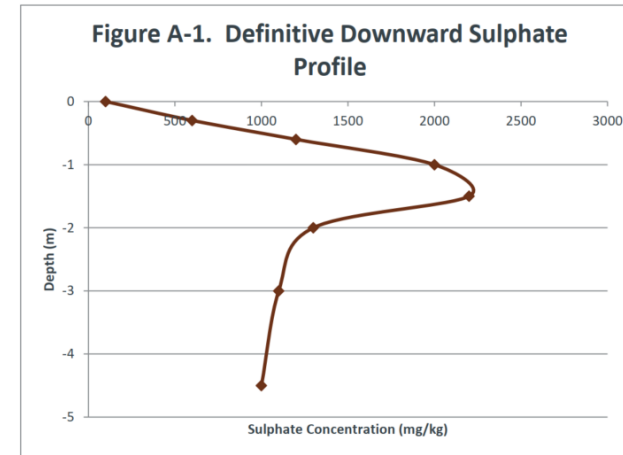
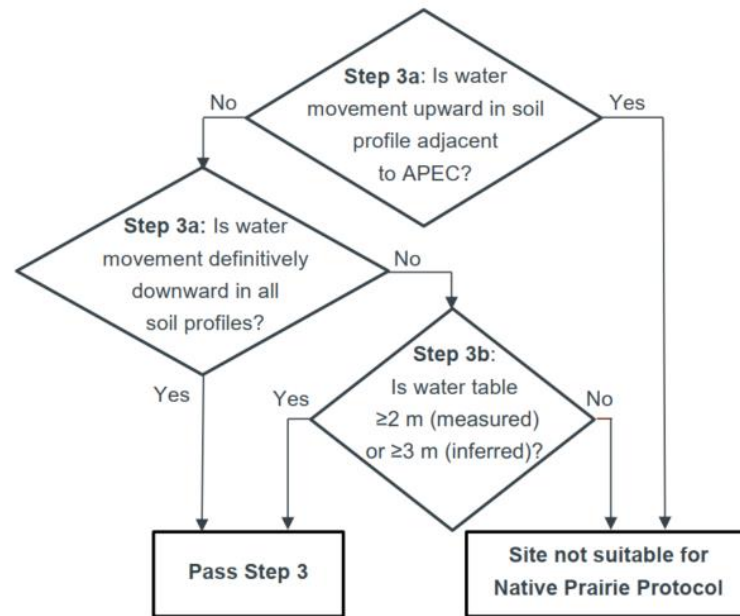
- Texture requirements
 - Texture by sieve and hydrometer (sand % / silt % / clay %) from 0 to 1.0 m, 1.0 to 1.5 m and subsoil (>1.5 m)
 - Three samples from each depth interval / unique lithology observed
- One deeper borehole (not in the impacted area)
 - Potentially to exclude the DUA for BTEX and relax SST guidelines
 - Need 5 m of “isolating geologic unit” with a hydraulic conductivity less than 1×10^{-7} m/s
 - Shelby tubes are relatively inexpensive to obtain and very valuable, if required
- Minimum four boreholes within each impacted area
- Lateral and vertical delineation

Native Prairie Protocol (NPP)

- Soil salinity > Tier 1 guidelines
- Meets SST guidelines for all pathways except root zone
- No adverse effects to the plant community
- Demonstrate no likely future adverse effects
 - Groundwater deeper than 2 m
 - Min one soil profile near each salt impacted area
 - Minimum of three soil profiles in background
 - Total of eight samples should be collected from each borehole between surface and 4.5 m in depth with closer sample spacing at shallow depths and wider spacing with increasing depth
 - Potential to change RZ drainage rate in SST regardless of vegetation
- Plan to collect required data during initial/supplemental ESA2.
- Complete a native grasslands DSA in conjunction with obtaining data to support SST/NPP.



Native Prairie Protocol (NPP)



Phase 2: Sampling with Tier 2 in Mind

- Do you really need monitoring wells?
 - FAL is constraining; need at least 3 shallow
 - DUA is constraining; 3 deep may help but not if lithology indicates groundwater is slow
 - Nested pairs can help with rooting zone and DUA guidelines
- But...
 - Can use borehole logs for depth to GW, per the SST
 - Determine background TDS by sulphate concentrations in soil
 - Look for coarse intervals in Sat% data





Complicated, Simplified

- Detailed review of available background information
- Look at information from other local area sites
- Data, Data, Data – characterize and delineate
- Employ expertise early
- Client Perception – Tier 1 is too conservative, but Tier 2 is too costly. Potential major savings on remediation



Questions?