Evaluation of the Benefits of Encapsulating Acid-Generating Tailings by Acid-Consuming Tailings

15th ANNUAL BC/MEND METAL LEACHING / ACID ROCK DRAINAGE WORKSHOP
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Acknowledgements

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(Dave Bucar and others)

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Introduction

- Need to relocate high sulphide / acidic tailings stack to expand pit
- Other tailings stacks available with neutral non-acid-generating tailings
- Assessed alternatives at scoping level
- Encapsulation of high sulphide tailings represented attractive alternative
- Two aspects required further assessment:
  - Acid neutralization capacity
  - Water quality of “treated” pore water

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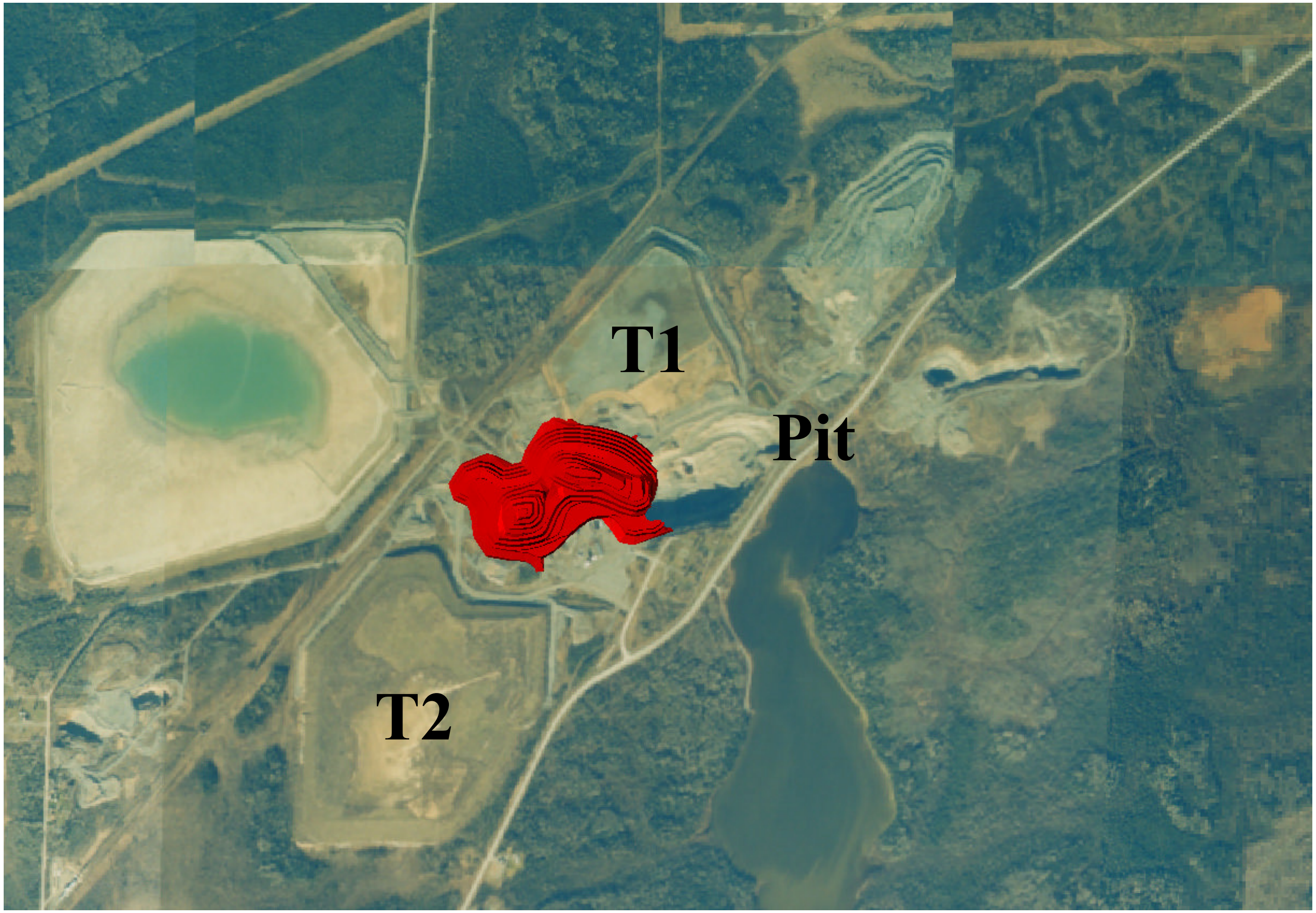
Site Layout



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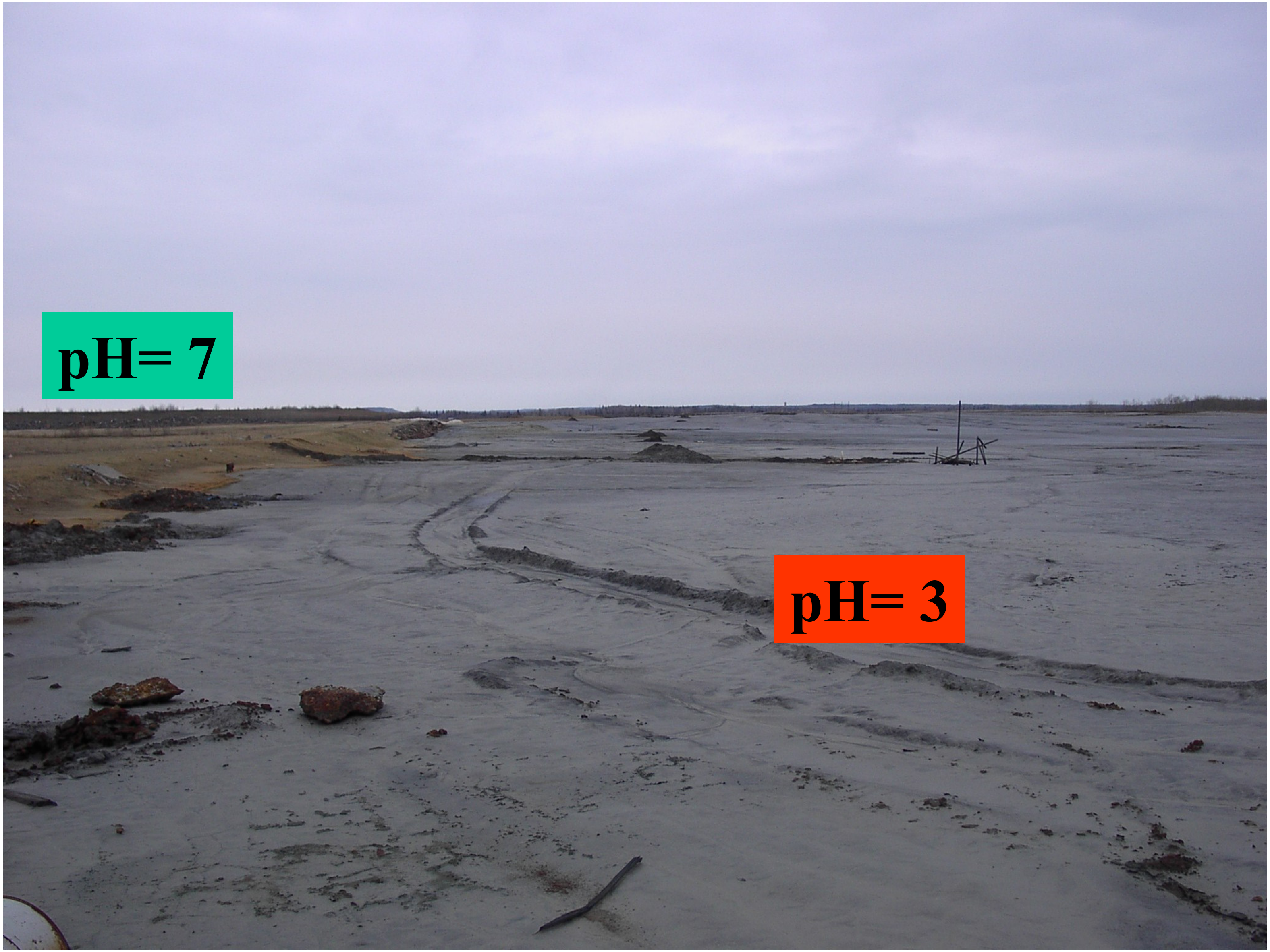

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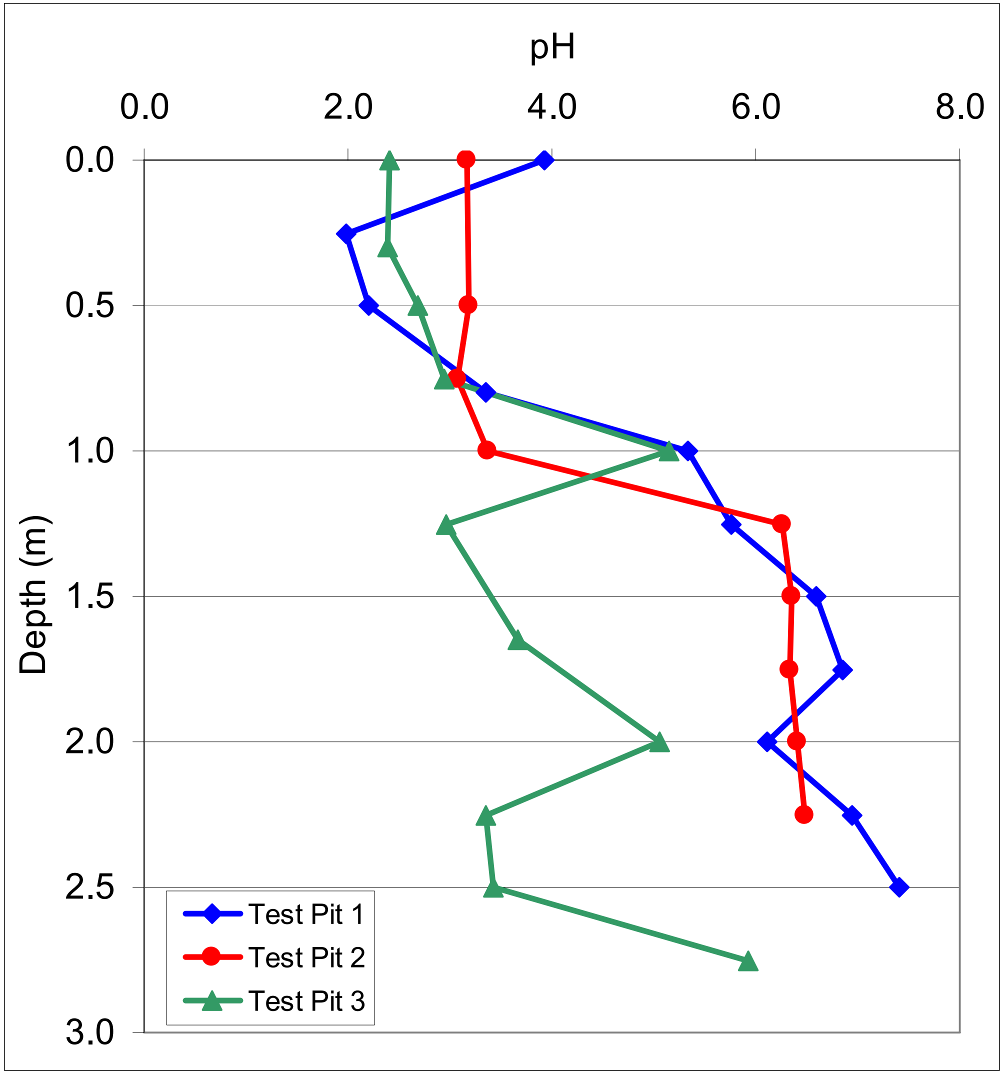
pH with Depth in T1 tails



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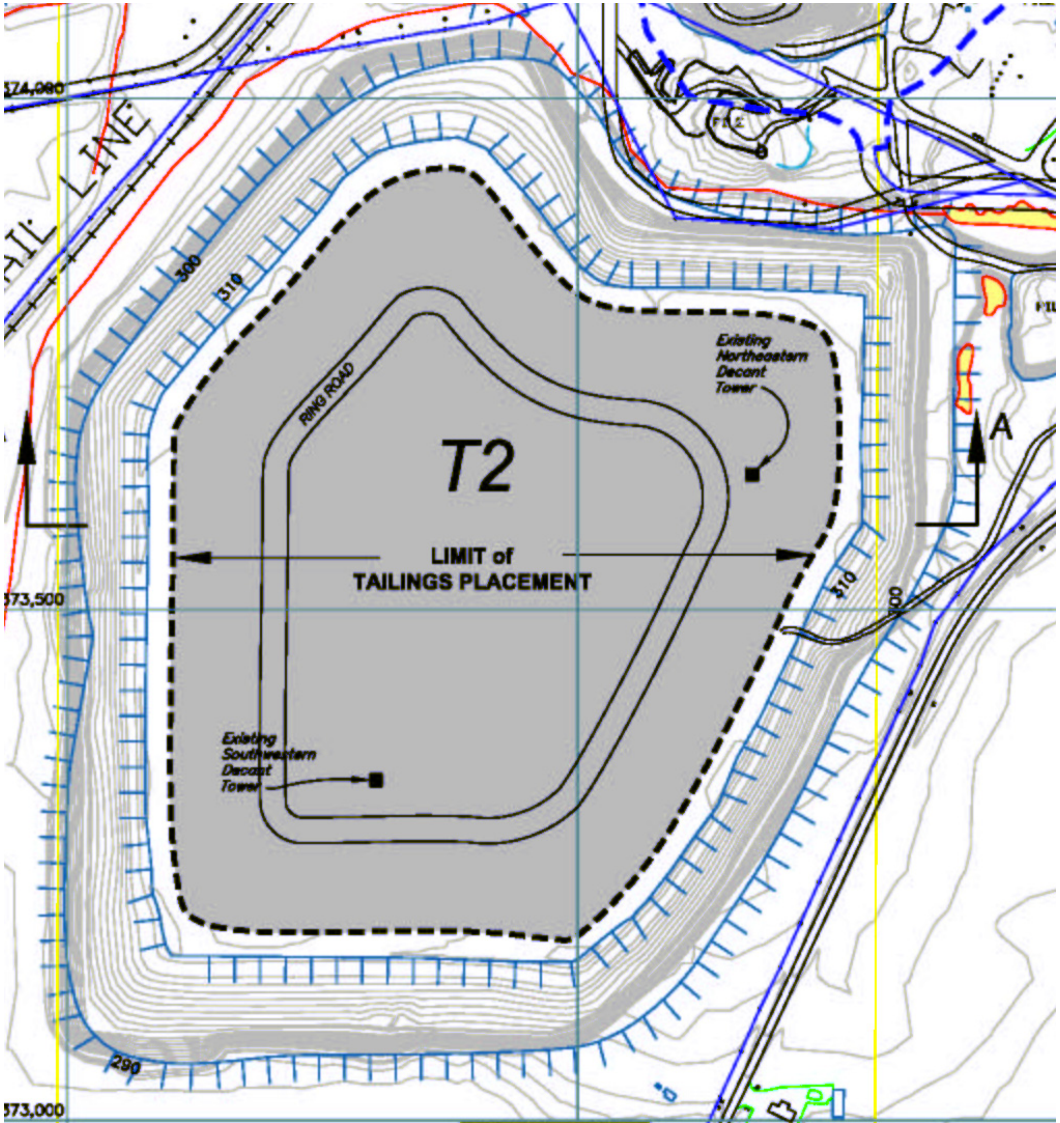
T1 Placement on T2
Schematic Plan-View



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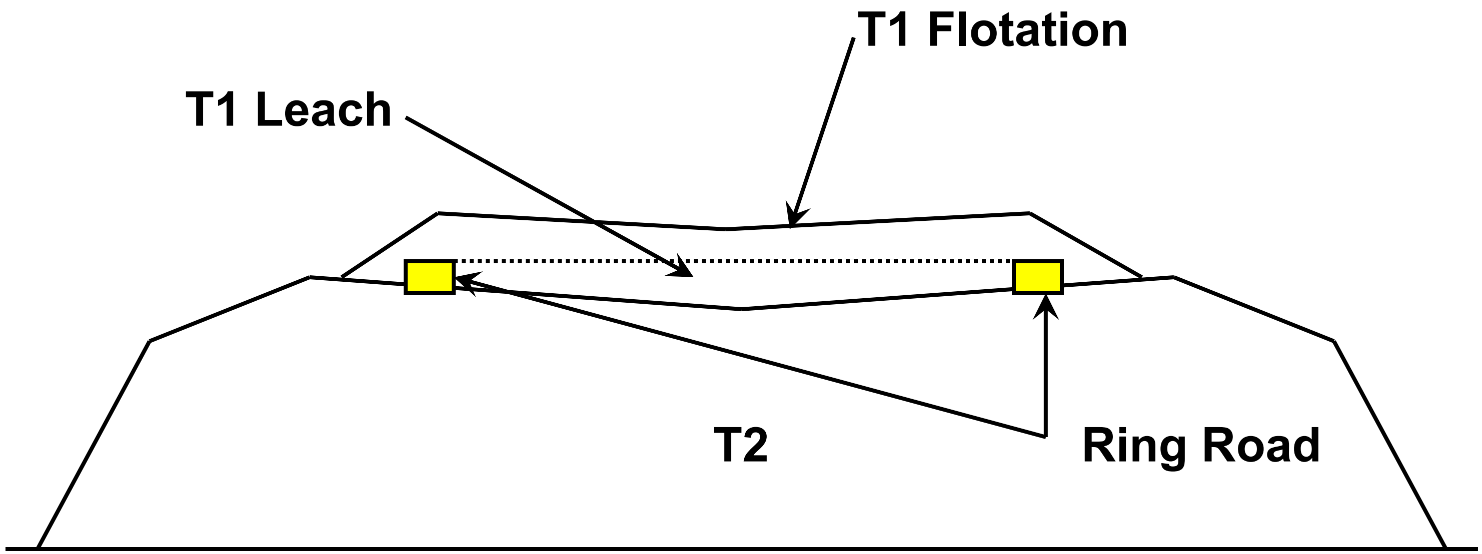
T1 Placement on T2
Schematic Cross-Section



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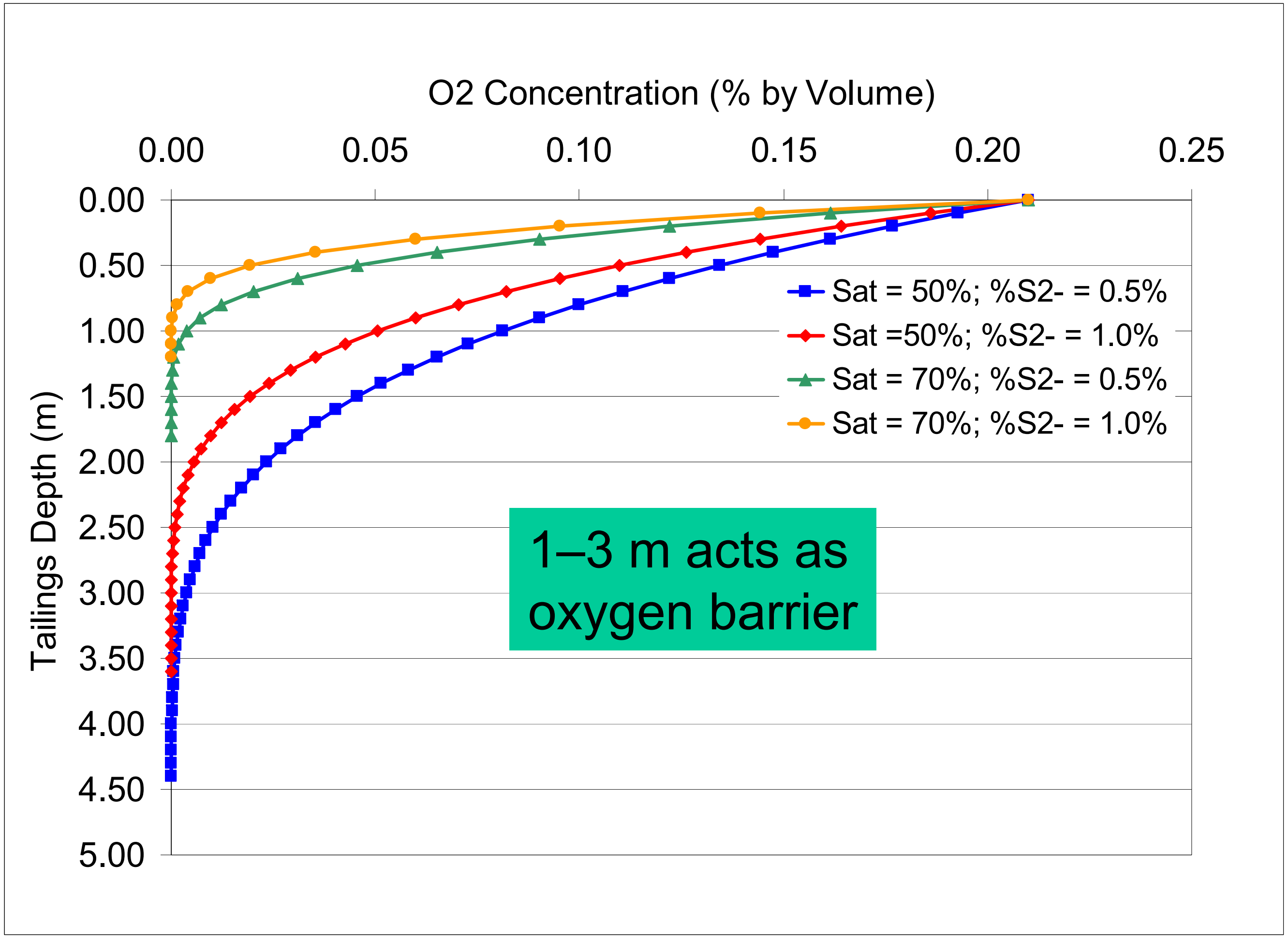
Theoretical oxygen profiles in upper Neutral tailings layer



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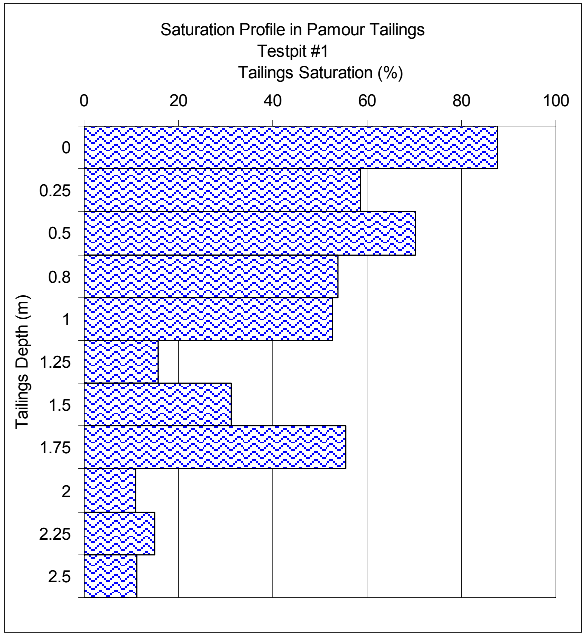
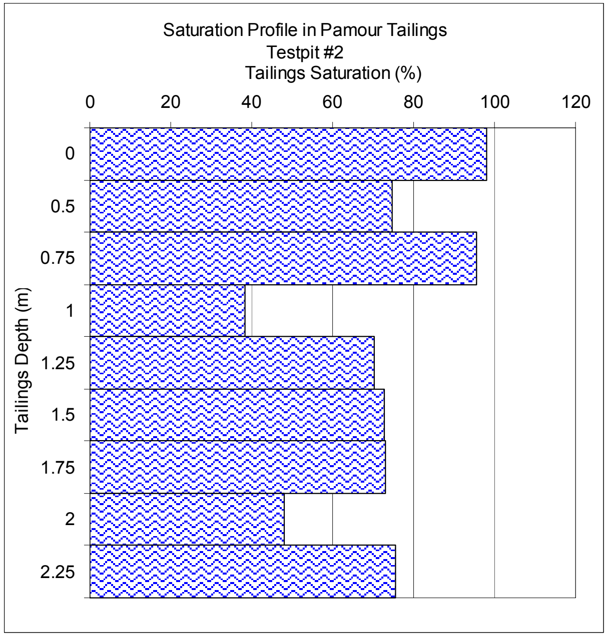
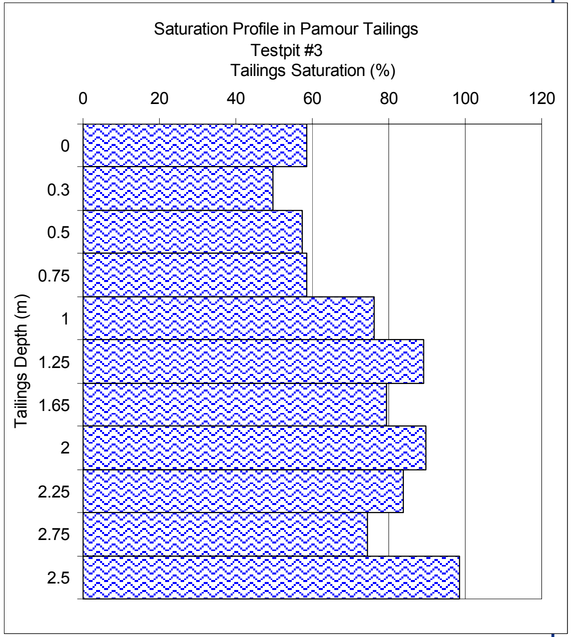
Measured Moisture Content (Saturation) in surface tailings







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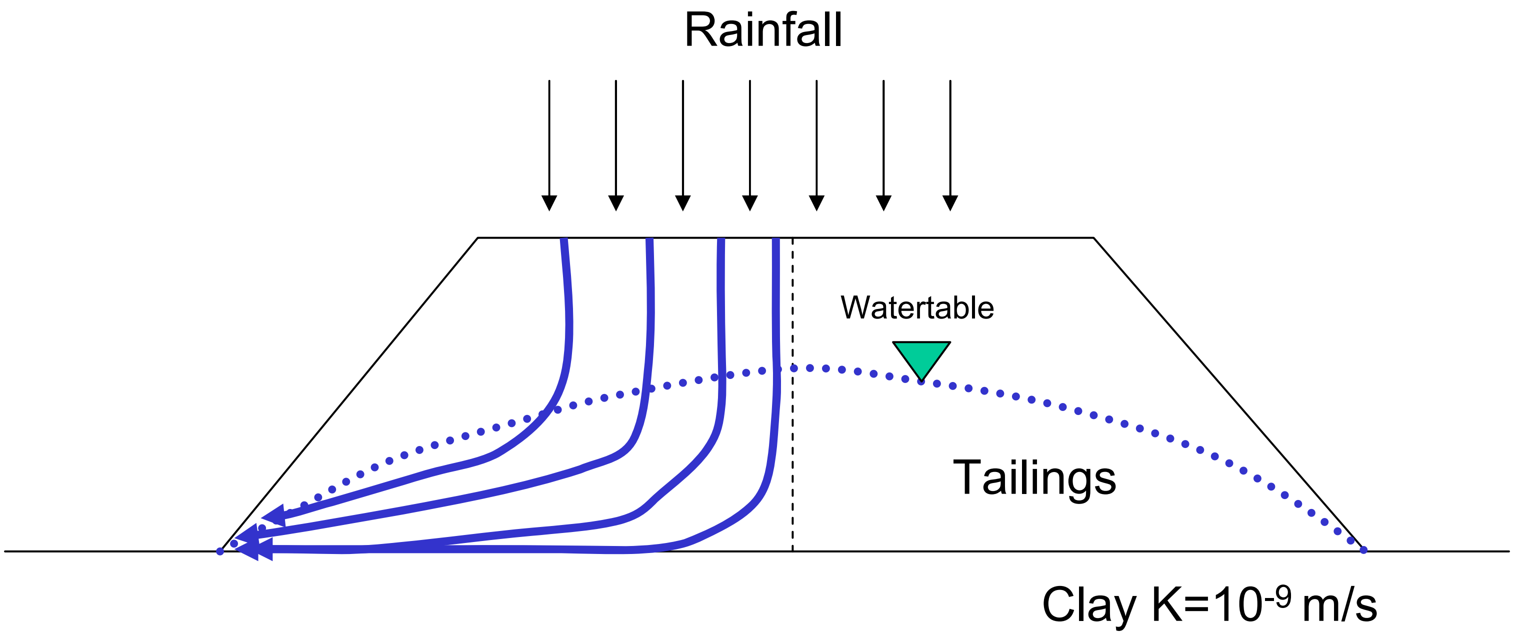
T2 Stack

Conceptual Schematic



Seepage at T2

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Objectives and Scope

- Assess water quality resulting from passage of acidic / metal containing pore waters through neutral tailings layers

- Laboratory study with columns

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Tailings and Their Properties

Leach Tails

pH=2.7
S^{2-}=25%
NP= -14
NNP = -800

Neutral Float Tails 1

pH=7.1
S^{2-}=<0.01%
NP= 76
NNP = +76

Neutral Float Tails 2

pH=8.3
S^{2-}=<0.01%
NP= 103
NNP = +103

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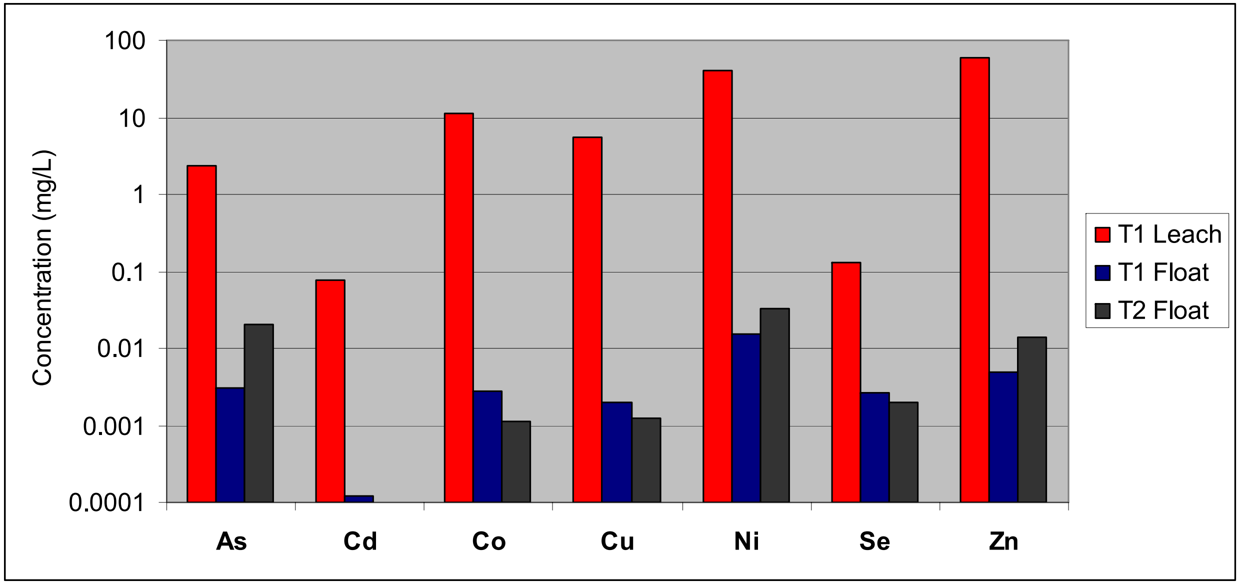
Solids

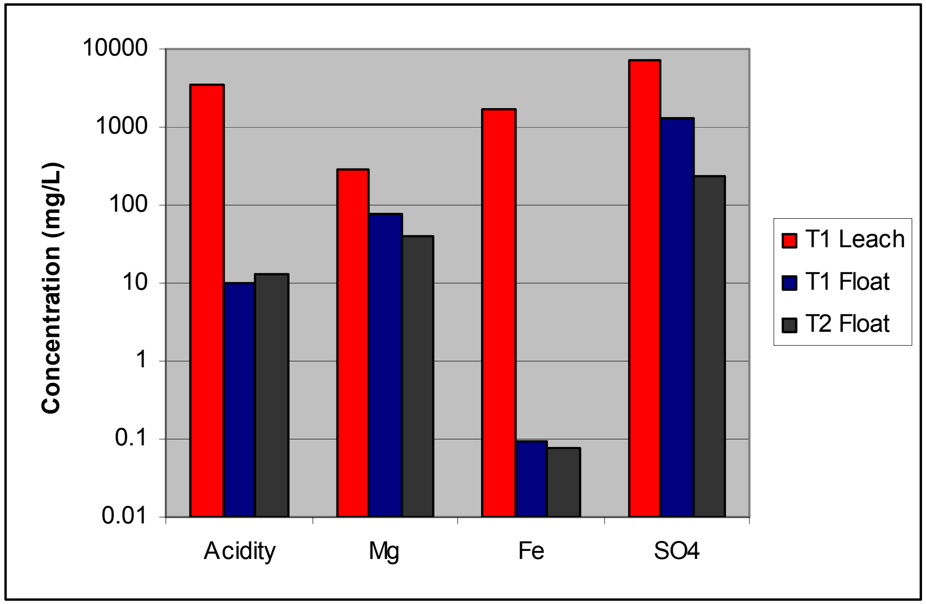
Solid Content	Units	T1-Leach	T1-Float	T2-Float
Arsenic	ppm	6120	146	103
Cadmium	ppm	3.7	0.3	< 0.1
Calcium	%	2.99	3.44	3.42
Cobalt	ppm	412	14	13
Copper	ppm	1700	25	16
Iron	%	21.80	3.58	4.69
Magnesium	%	2.07	2.33	3.52
Nickel	ppm	1290	84	125
Selenium	ppm	22.0	1.3	1.3
Sulphur	%	25.36	0.26	0.15
Zinc	ppm	881	50	60

Shake Flask Results for the Three Tailings



Trace Metals

Major Constituents



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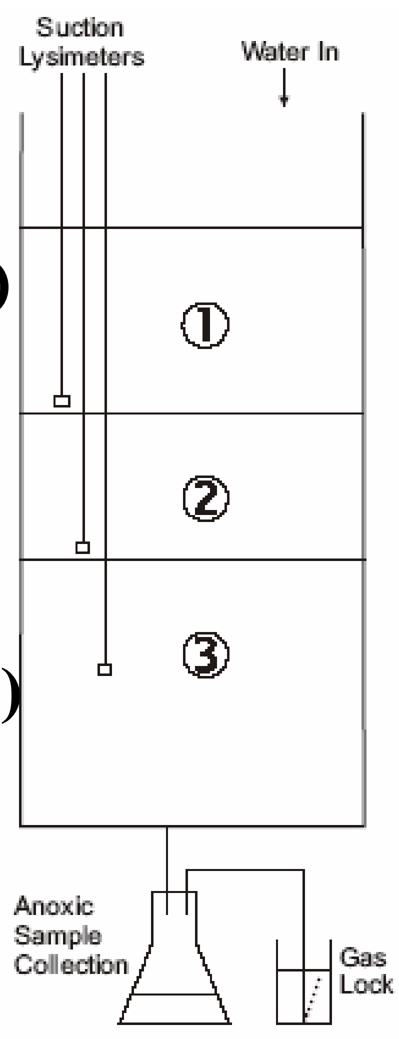
Schematic of Column Design with Layered Tailings for Laboratory Study

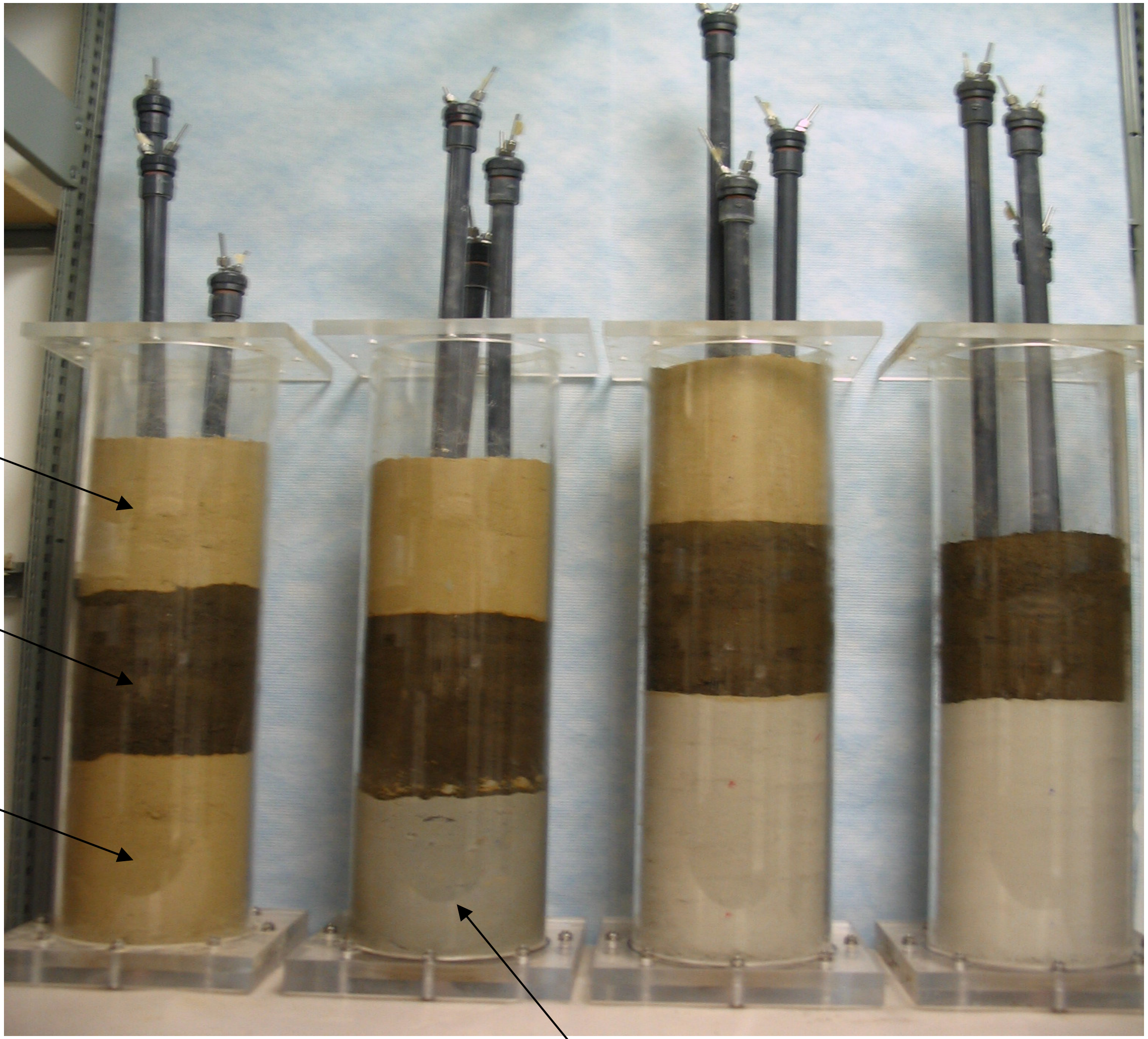
Neutral Tails (T1)

Acid Tails (T1)

Neutral Tails (T2)



Colum Setup



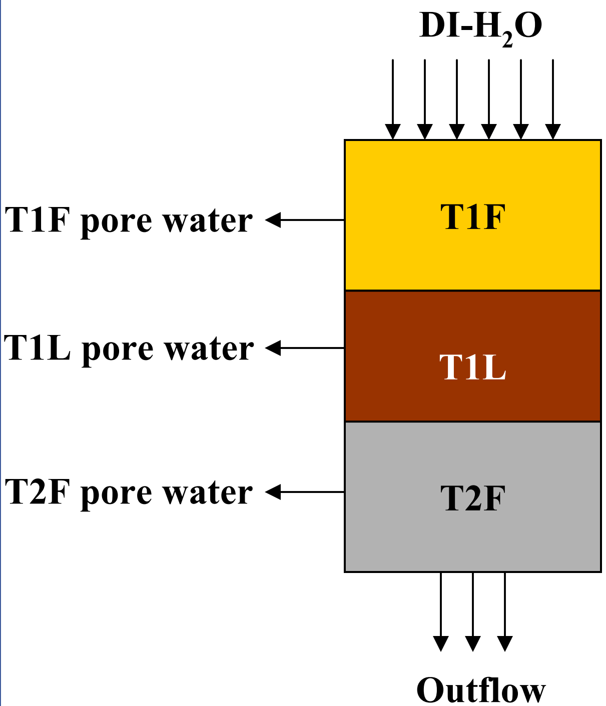
T1F

T1L

T1F

T2F

Pore-water Displacement



Time (day)	6	14	24	41	58	80	103	134	167	259	283	321	401
Column 1	0.46	0.76	1.00	1.42	1.91	2.34	2.74	3.15	3.56	-	-	-	-
Column 2	0.18	0.38	0.74	1.07	1.44	1.74	2.03	2.31	2.52	-	-	-	-
Column 3	0.10	0.31	0.43	0.61	0.85	1.04	1.20	1.38	1.44	1.53	1.71	1.79	1.83
Column 4	0.24	0.51	0.75	1.00	1.29	1.54	1.79	2.07	2.30	2.49	2.64	2.68	2.70

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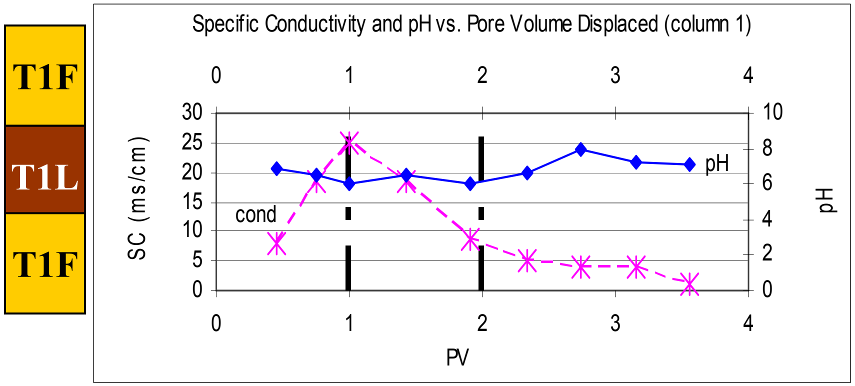
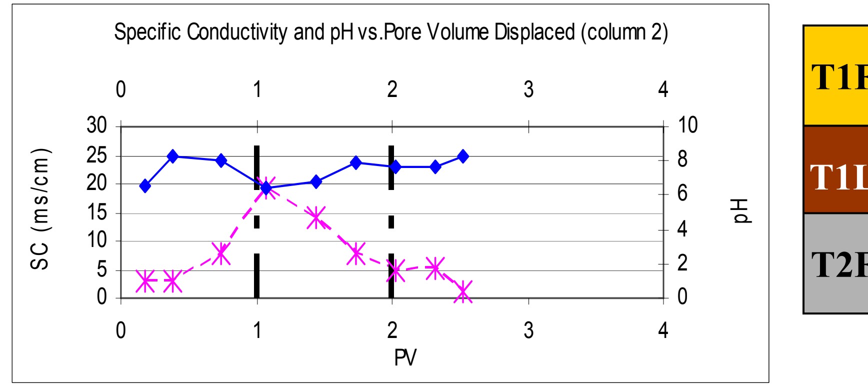
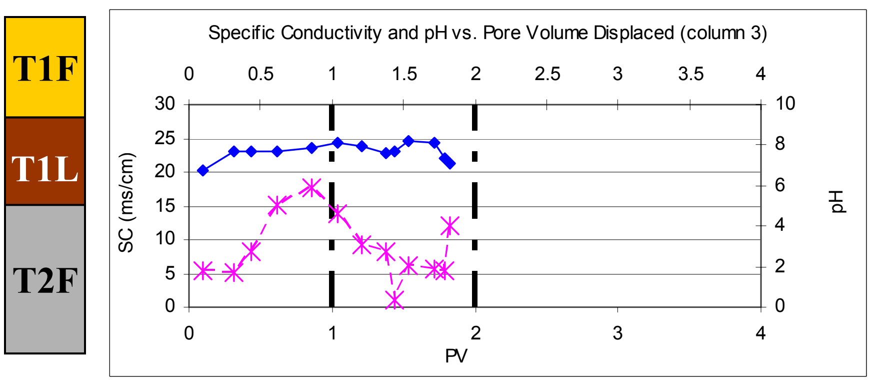
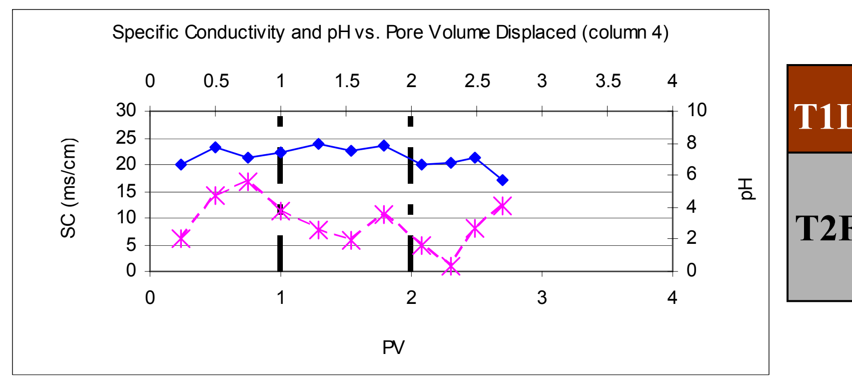
1
2
3

pH and Conductivity of Effluent



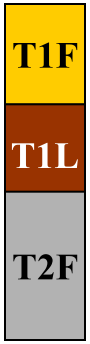


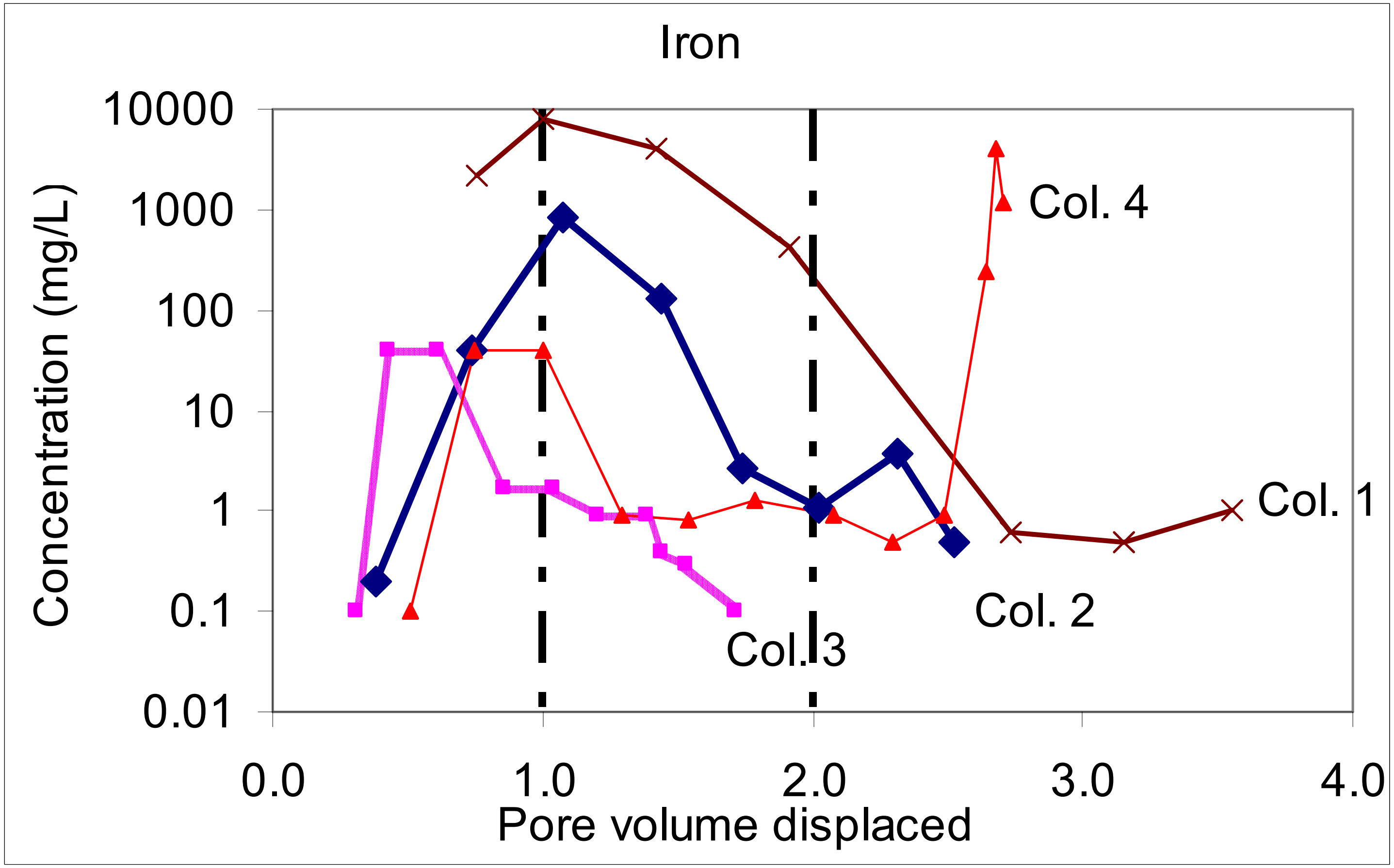




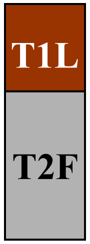
Iron Concentrations in Effluent

1


3




2


4


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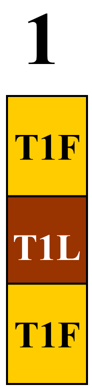
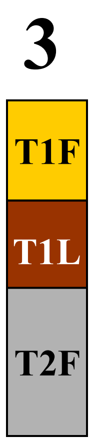
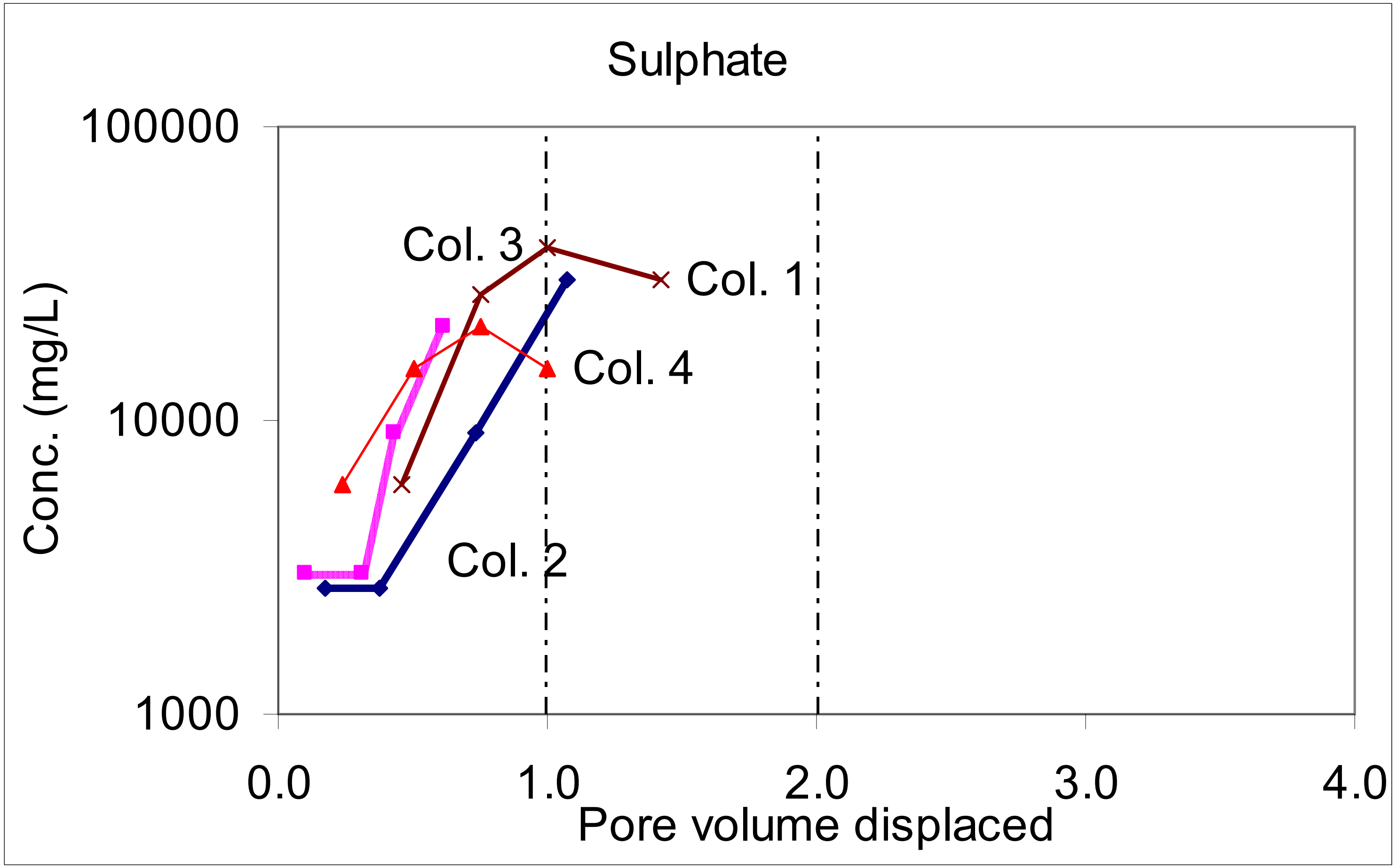
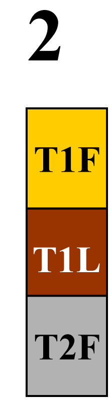
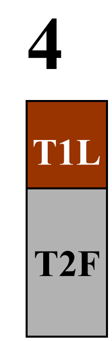
Sulphate Concentrations in Effluent











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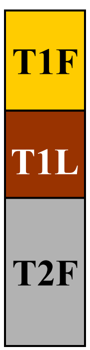
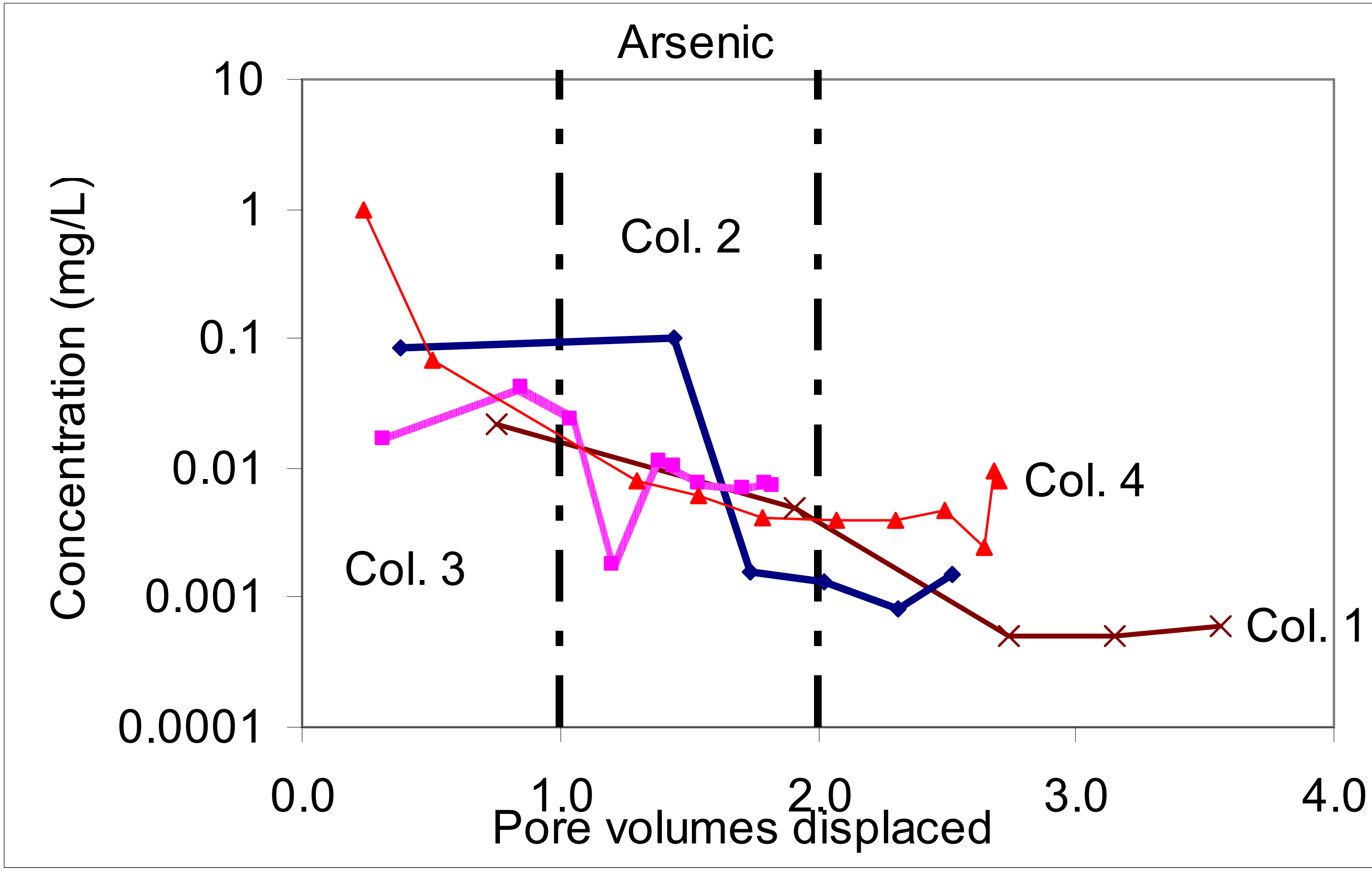
Arsenic Concentrations in Effluent

1

3





2

4

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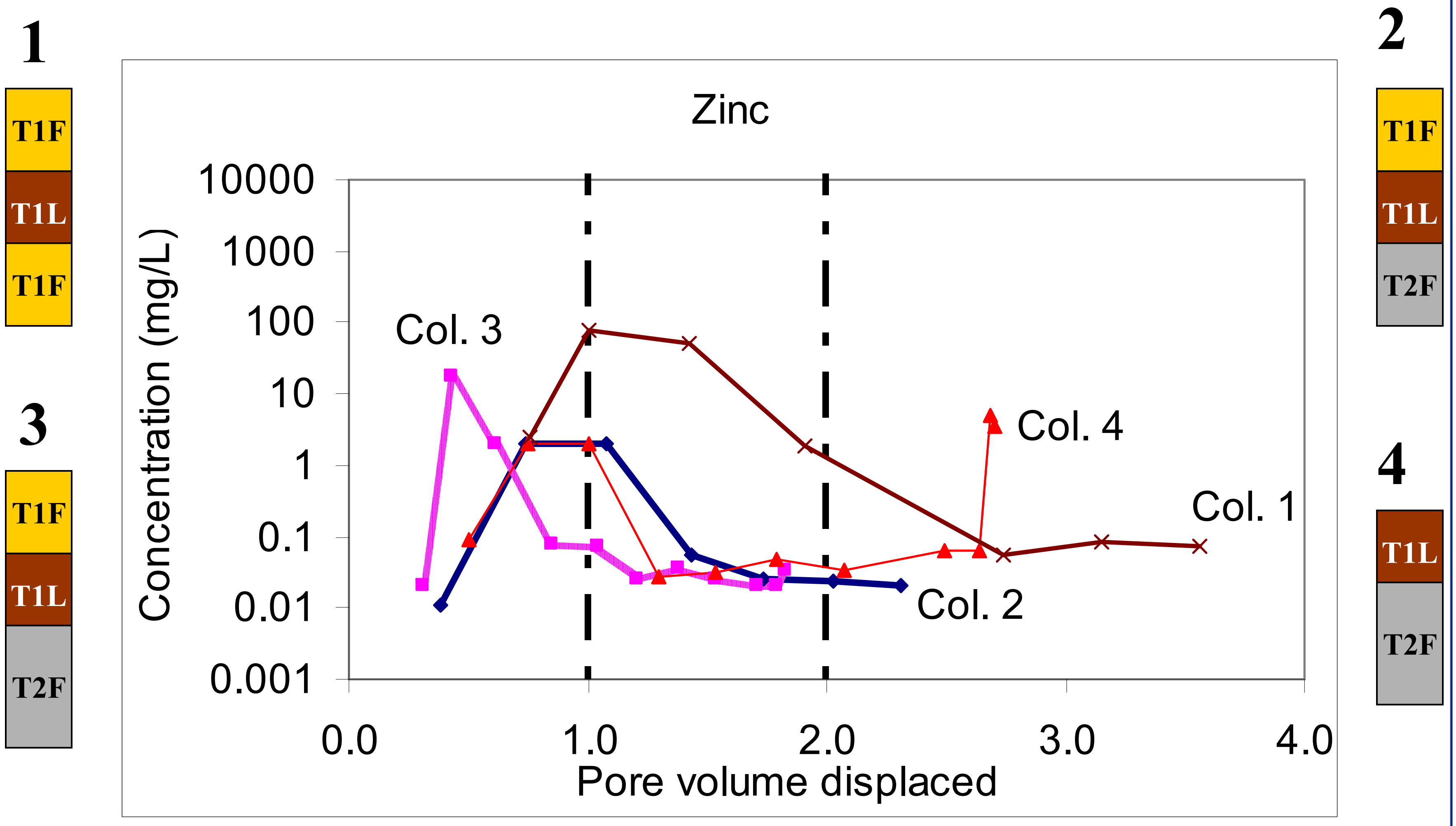
Zinc Concentrations in Effluent



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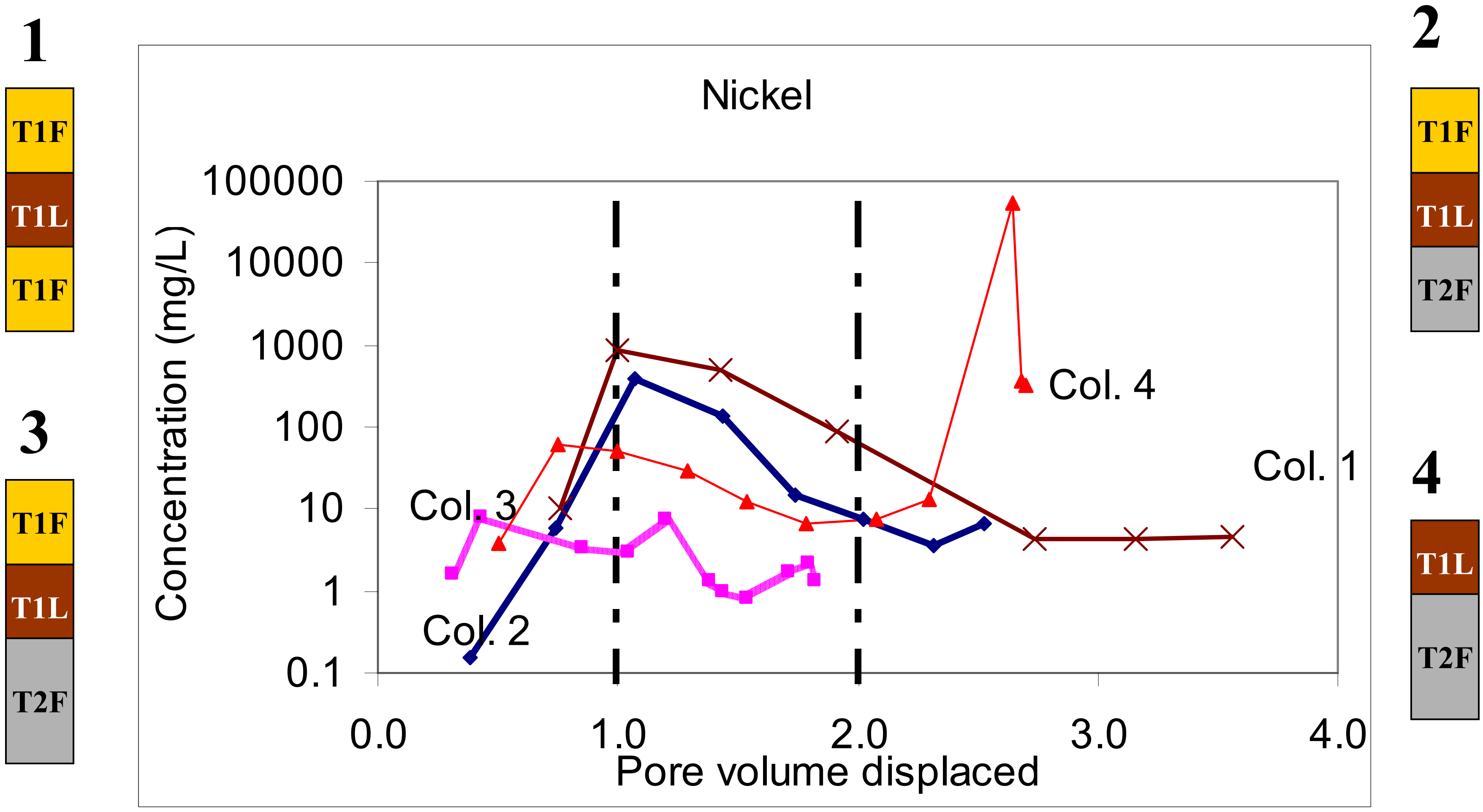
Nickel Concentrations in Effluent



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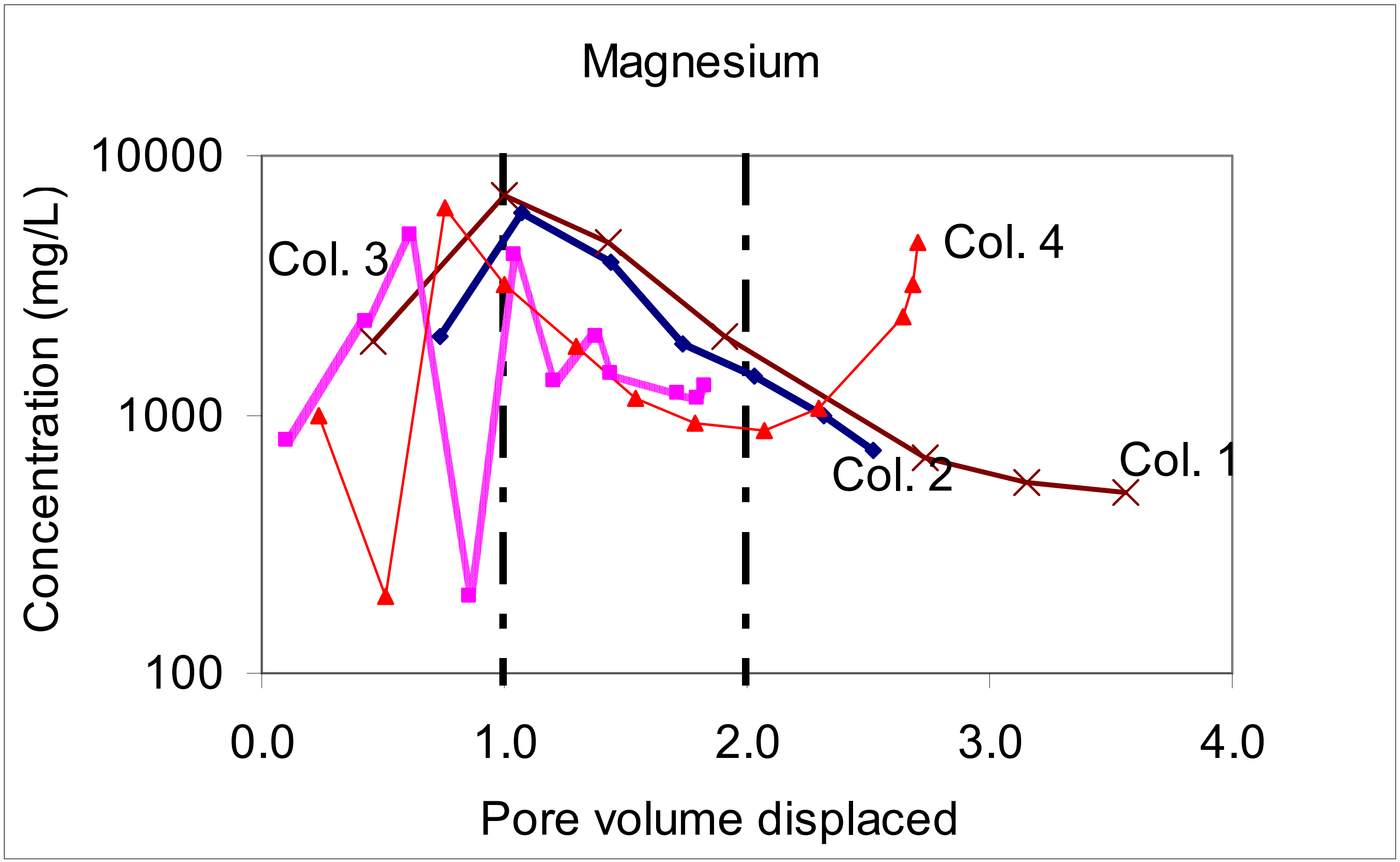
Magnesium Concentrations in Effluent

1

T1F
T1L
T1F

2

T1F
T1L
T2F



3

T1F
T1L
T2F

4

T1L
T2F

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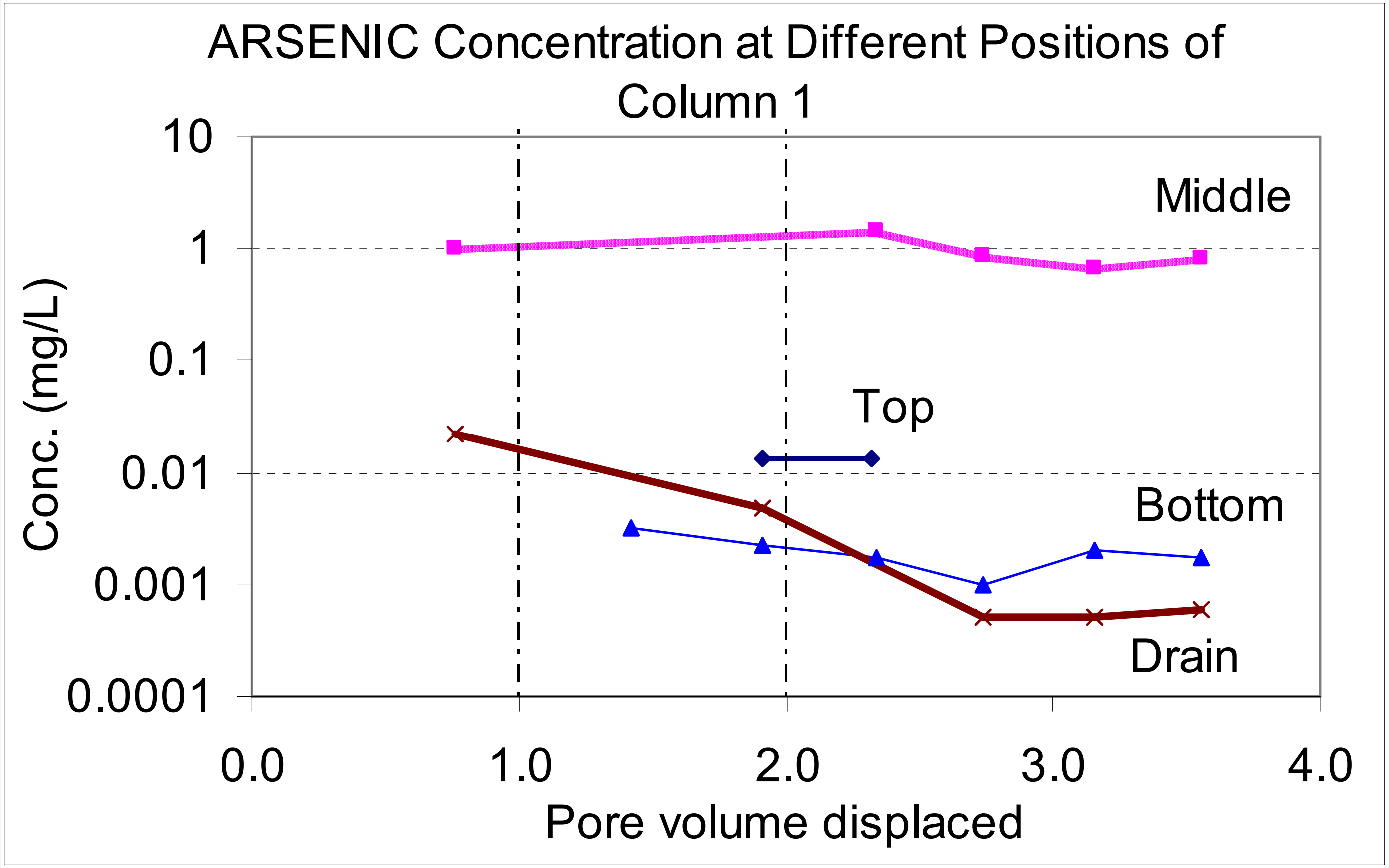
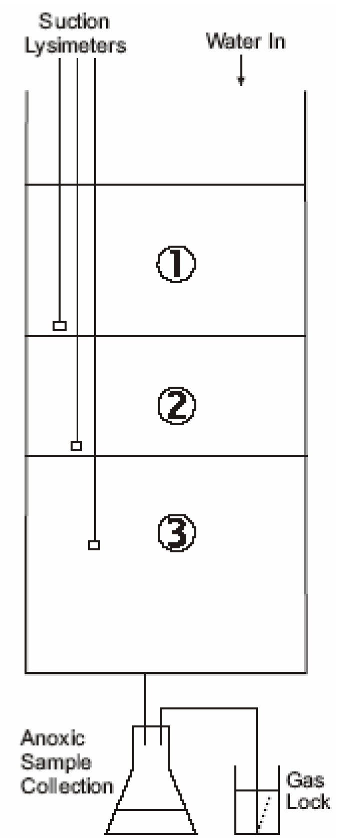
Arsenic Concentrations in Lysimeters





Demonstrates ongoing elevated arsenic in pore water in middle layer and attenuation in bottom layer

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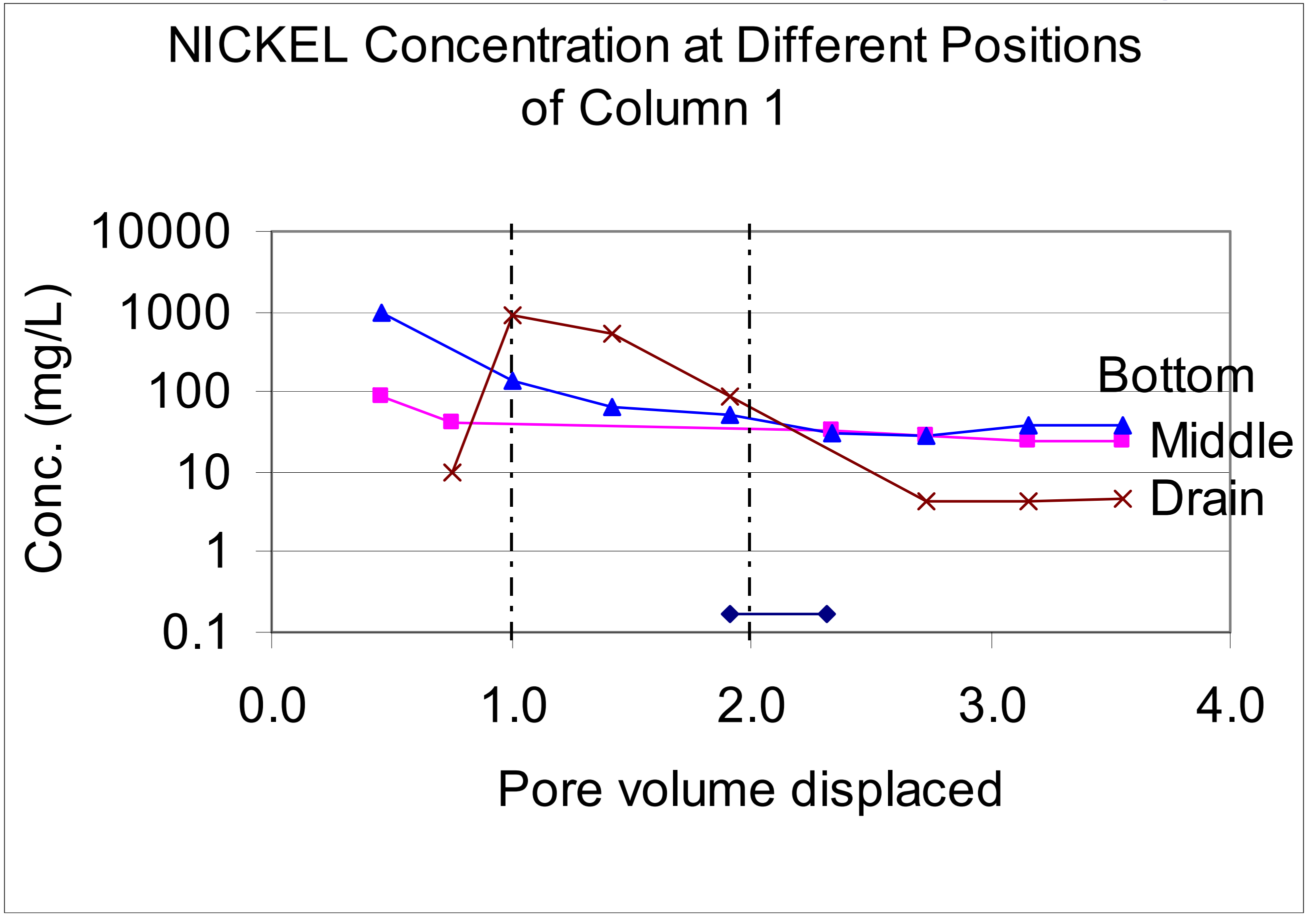
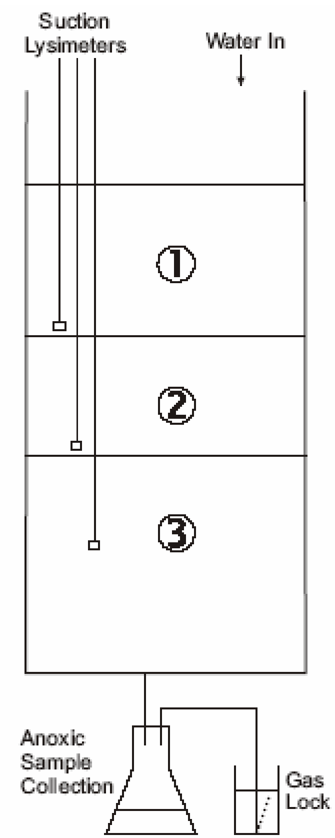
Nickel Concentrations in Lysimeters





Demonstrates release of nickel in pore water in lower layer as acid front moves down from upper layer

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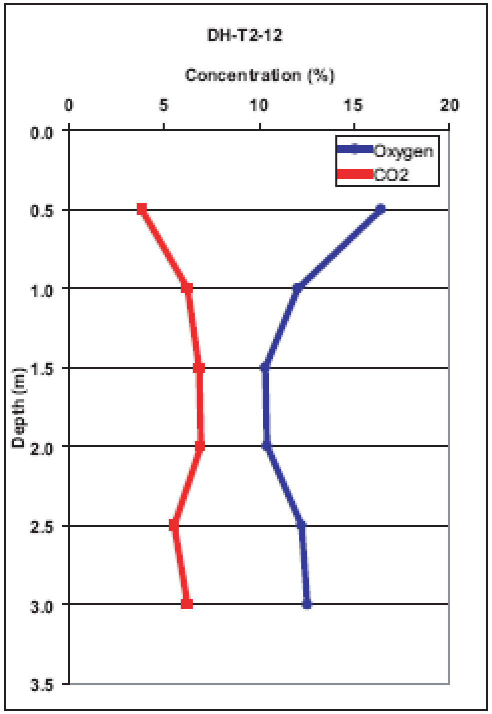
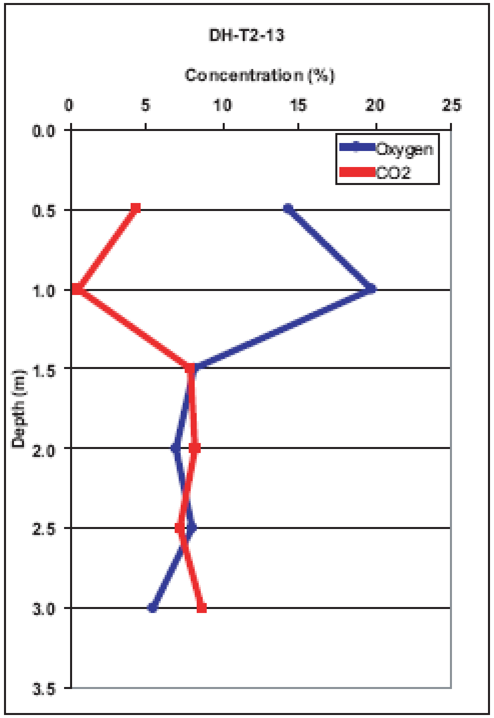
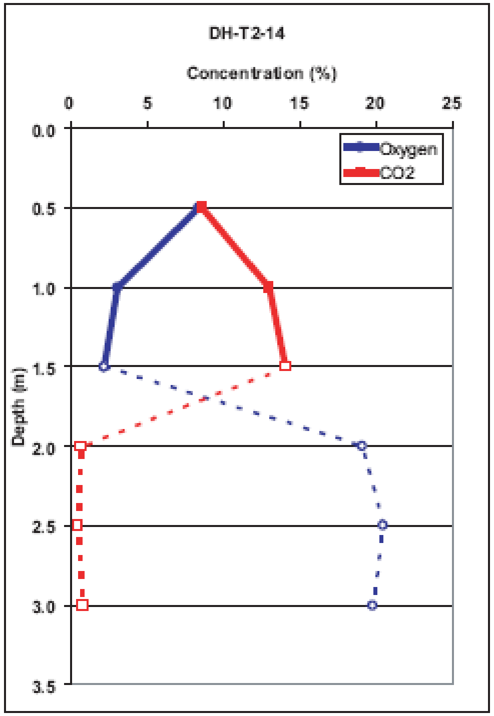
3

Field Follow-up – O_2 and CO_2 Profiles







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Conclusions

- Consumption of existing acid occurred and pH remained neutral in the effluent
- Arsenic and other constituents are highly attenuated by neutral tailings layer
- Residence time (and thickness of bottom neutral tailings layer) is important – more attenuation with longer residence time
- Nickel may be less attenuated than other constituents and need further investigation related to residence time
- Need for management of iron in final seepage (wetlands, polishing ponds, etc.)

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Conclusions

- Upper cover layer acts as an oxygen barrier
- Ongoing field verification required

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Thank You