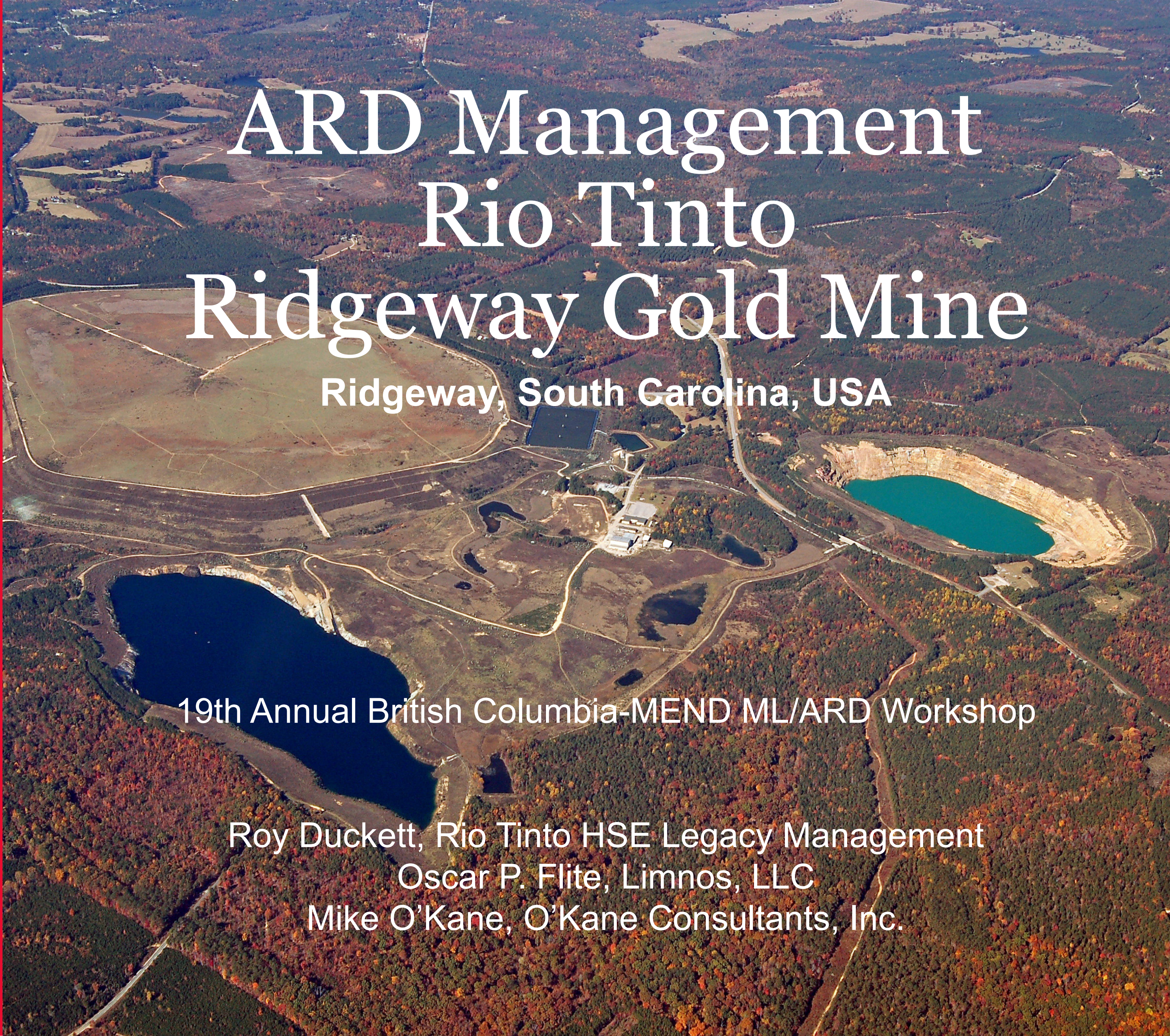

ARD Management Rio Tinto Ridgeway Gold Mine

Ridgeway, South Carolina, USA

19th Annual British Columbia-MEND ML/ARD Workshop

Roy Duckett, Rio Tinto HSE Legacy Management
Oscar P. Flite, Limnos, LLC
Mike O’Kane, O’Kane Consultants, Inc.

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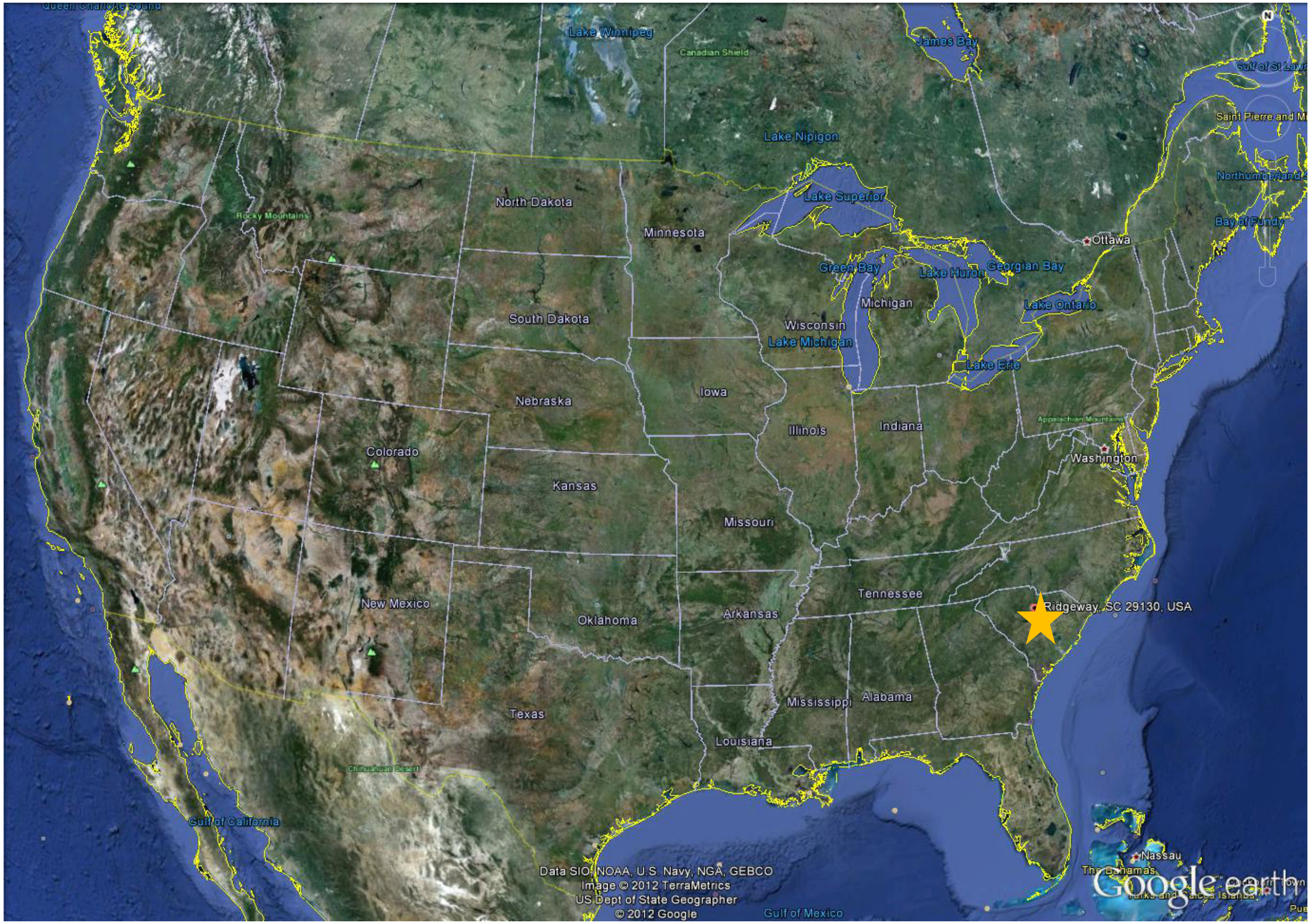
Mine Location



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History

Two open pits mined from December 1988 to November 1999:

Ore mined: 60 million tons - 25% oxide, 75 % sulfide (pyrite)

Gold and Silver Grade: 1 gm/t

Waste Rock Mined : 40 million tons

Crushing, Grinding, CIL Milling of entire ore body with tailings pumped to a double lined Tailings Management Facility - No Heap Leach Pads

Metal produced: 1.47 million ounces gold; 900,000 ounces silver

Active Reclamation (first pit lake waste rock backfilling) commenced 1996 and is ongoing until the lakes are complete in ~2020

Primary On-Site ARD Management Facilities

ARD Evolution – Testing and Recognition

Feasibility ARD Test Program (1986 - 1987)

- Static: Acid/base accounting
- Kinetic: Humidity cell tests
- ~20 "Life of Mine" Drill Cuttings and core samples

Results:

- *Tests indicate excess neutralization capacity or lack of acid generating potential*

Production Test Program (1989 - 1993)

- Static & Kinetic Tests
- >200 blasthole cuttings, mine and core samples

Results:

- *Acid generating potential is identified in a limited number of samples*

Field Indicators:1990

Waste rock storage facility sediment control pond develops pH of 2

Mine Site 1990

ARD Evolution – Implement Management Plan

- Leco Furnace Purchase: 1990 - Daily carbon / sulfur assaying of blasthole samples

- Comparisons of Leco numbers to laboratory AGP/ANP duplicates produced an operational waste classification plan:

1. < .25% sulfur is “Inert”
   - Used in haul road construction
   - Used as encapsulation layer for sulfide waste cells

2. >.25% sulfur or >-5 NNP requires ARD management

Survey control began with daily in-pit waste rock staking based on blasthole carbon / sulfur data

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ARD Evolution: Four ARD Management Methods

TMF:

1. Encapsulation of high sulfur waste rock within the TMF embankment followed by lime addition (1992-1996)
2. Hydraulic placement of inert clay monolayer closure cover over the TMF mass

Open Pit Lakes

1. Subaqueous deposition of the waste rock facility, all remaining run-of-mine waste rock and all haul road material into two open pit lakes with lime addition to both rock fill and lake water (1996-2000)
    - » Totaled 17MT of waste rock backfilled
2. Monitoring and management of water quality in two open pit lakes using permitted lime amendment facility

– Subject of Dr. Oscar Flite's Presentation

Tailings ARD Management Component: 1: Tailings Embankment

- Embankment Footprint: 360 acres

- Embankment construction made of five staged lifts containing 23 MT of waste rock
  - Crest heights of +470, 500, 525, 540 and 560 ft. above sea level followed by final reclamation lift to a maximum dam height of 567 ft.

- Double Liner: 60 mil HDPE over 12-inches of compacted clay under tailings mass and compacted clay under the embankment footprint.

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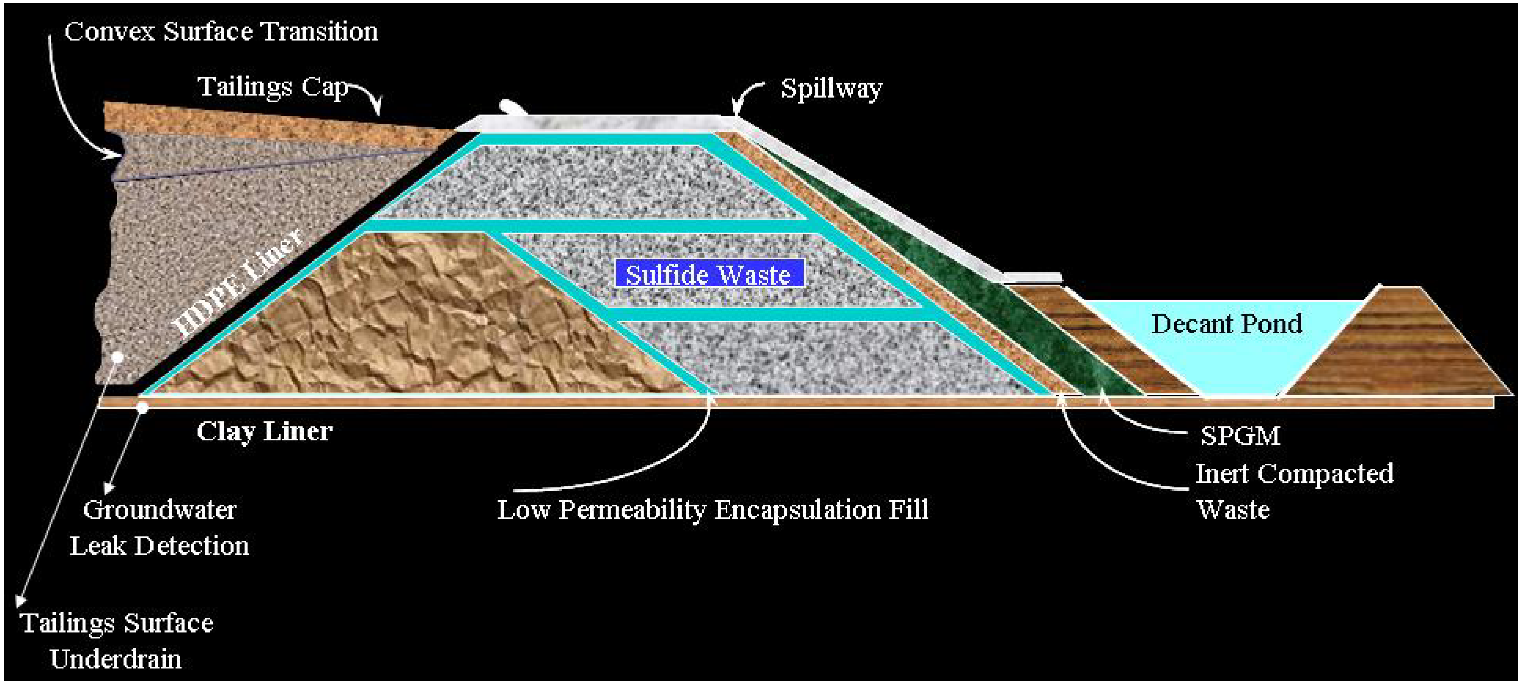
ARD Management – Encapsulation Schematic

- Encapsulation
  - 2 ft. of inert clay horizontal lifts on top and bottom of each encapsulation cell
  - 20 ft. of sulfide rock placed in 5 ft. lifts
  - 12 ft. of inert clay on exterior slope of encapsulation cell
  - 24 ft. of oxide rock placed over inert clay to protect from erosion
  - 1 ft. of suitable plant growth medium placed over oxide rock



Finished TMF Embankment 2012

- Rio Tinto conducts biennial Tailings Storage Facility inspections
- TMF Embankment reclamation has been classified as complete by South Carolina regulatory permitting agency

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Tailings ARD Management Component 2: TMF Clay Closure Cover - Design Criteria

Construct an inert 3-ft. thick monolayer clay saprolite hydraulically-placed cover system which:

- Functions to limit oxygen ingress to the underlying tailings material by maintaining a high degree of tension saturation (>85% saturation)
- Provides a suitable growth medium for vegetation
- Functions as a water infiltration barrier to reduce percolation to the underlying tailings material through storage and release to the atmosphere
  - Climate is humid with approximately 50-inches annual rainfall and 40-inches of potential evaporation
- Is contoured to manage a Probable Maximum Precipitation event of 42-inches of rain / 24 hours through a single constructed spillway (Rio Tinto requirement)

Clay Closure Cover As-Built

Cover Thickness: 2.7 million tons used in construction	Percent of Total Surface Acreage	Total Area acres (ha)
>/= to 48” (120 cm)	60%	186 (75)
36” (90 cm) to 48” (120 cm)	33%	100 (40.5)
</= 36” (90 cm)	7%	21 (8.5)
Total Cover Material >/= to targeted 36” (90 cm) depth	93%	286 (116)
Slope angles	0.5 to 0.69% 0 to 0.15% 0.4 to 0.6%	Center Dome Wetlands Perimeter Slope Inward
Notes: 18-inch HDPE pipeline; Densities: 45-55% solids; Density and pH measured in process 10 times per 12 hours shift; pH controlled 7.5 to 8.5 using process plants lime silo		

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TMF Closure and Cover Placement Procedure

- Convert concave tailings surface to convex shape using center-point discharge during processing of final 7 million tons of ore
- Dewater final 100 million gallon tailings surface water pool
  - Treat CN with H2O2 and discharge into South Pit Lake under SC regulatory ND Permit
- Mine 2.7 million ton inert clay fill supply in conjunction with development of surface water management channels from the tailings facility spillway to each open pit
- Process clay through existing mill circuit and pump to tailings surface at ~50% solids
- Distribute clay with center-point, center-line, and perimeter discharge pipeline on 24/7 schedule while driving the water to the spillway
- Maintain survey control using Hover-craft mounted GPS
- Vegetate with LGP equipment, hydroseeding, and helicopter broadcasters

Cover Placement Procedure: Concave to Convex

Concave Mass Surface 1998

Convex Mass Pre-Dewatering
November 1999

Final Surface Post-dewatering
December 1999

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Cover Placement Procedure : Clay Placement

Clay Milling

Center Point and Center Line Clay Deposition

Clay Cover Placement – First Deposition

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Final Clay Cover

Clay Cover Final Surface Water Flow Paths

Cover Vegetation

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TMF Cover ABA Work: What is being Covered and Why?

Analysis from 2005 ABA drill samples in tailings:

from Mark Logsdon – Geochemica

- 21 hole locations drilled to 28 ft. depth
- Split spoon samples of cover clay material and tailings mass
- ABA, Trace Metals, Whole Rock

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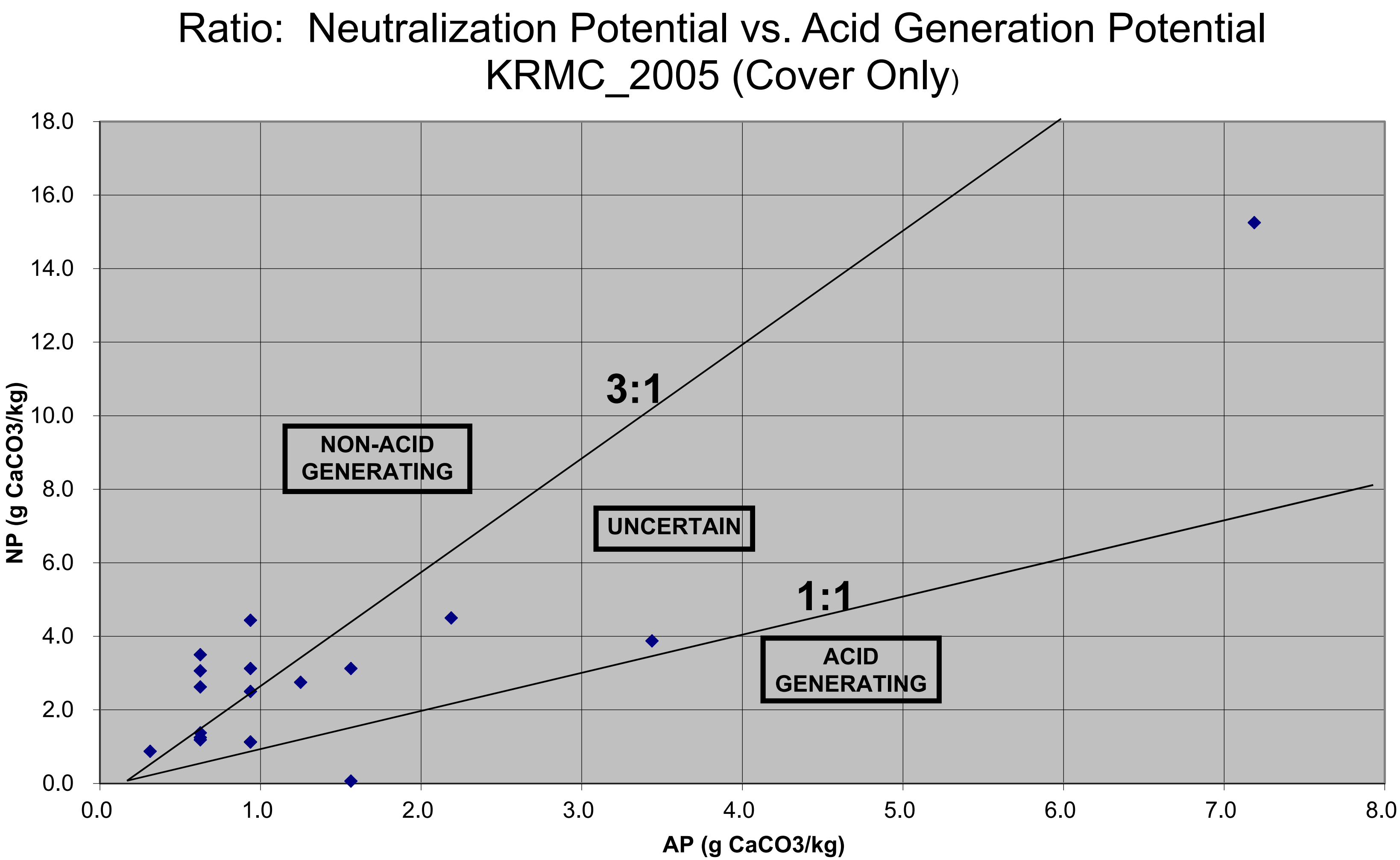
ARD Management – Hydraulically Placed Clay Closure Cover: What is being Covered and Why?

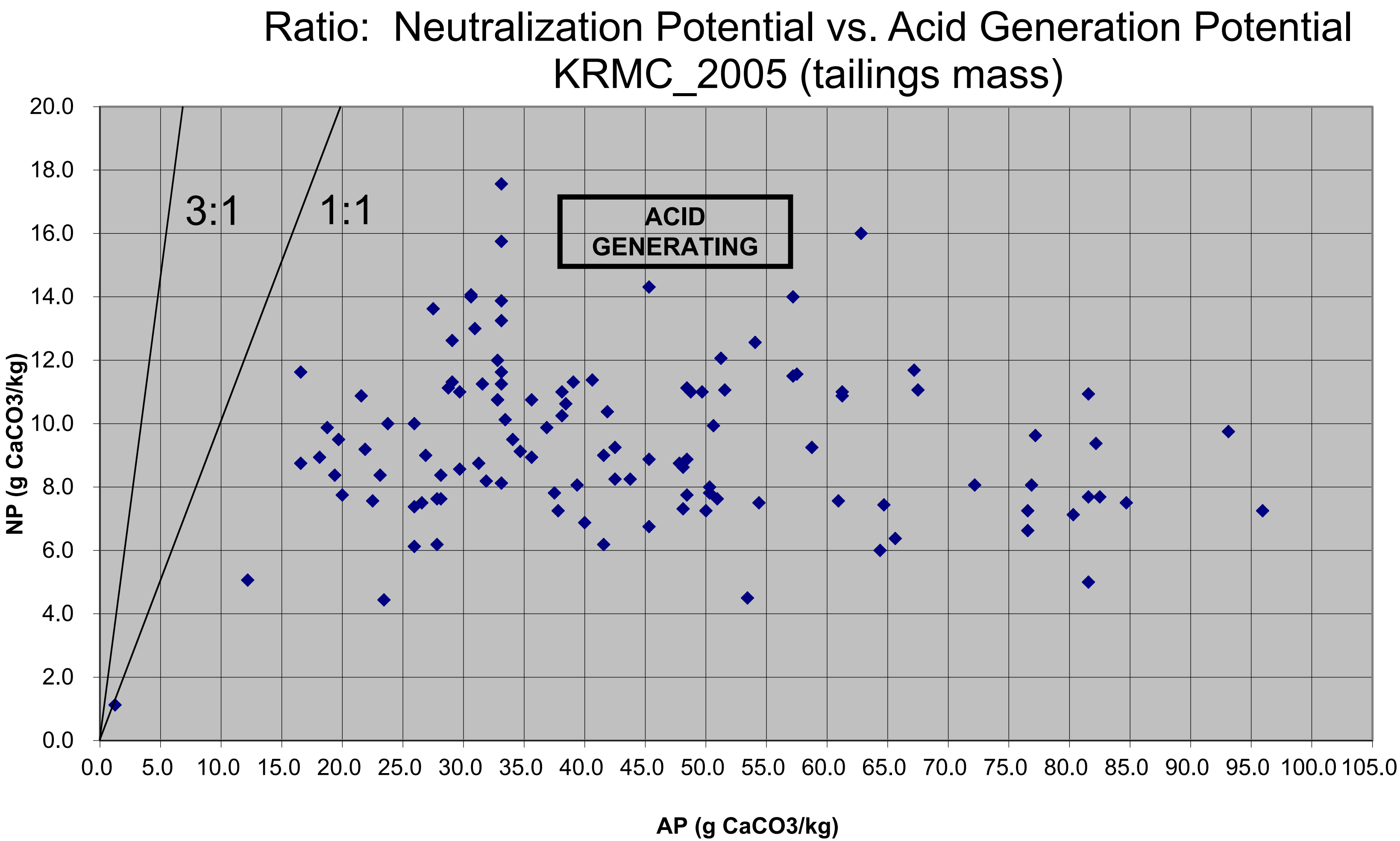
ABA Results – Mean Values from 21 Drill holes

Depth	Paste pH	S(T) %	S(SO4) %	AP	NP	Net NP	NP/AP	TIC %	TC %	Carbonate NP
0-4 ft.	7.3	0.1	0.02	1.4	3.1	1.7	2.7	0.1	0.1	5.0
4-8 ft.	8.1	1.7	0.03	53.1	8.3	-44.8	0.2	0.1	0.1	8.8
8-12 ft.	8.2	1.8	0.03	56.0	9.5	-46.5	0.2	0.1	0.1	9.9
12-16 ft.	8.3	1.5	0.03	46.9	11.5	-35.4	0.3	0.2	0.2	13.1
16-20 ft.	8.3	1.3	0.03	39.7	9.8	-29.9	0.3	0.1	0.2	10.8
20-24 ft.	8.3	1.1	0.03	33.1	8.9	-24.2	0.3	0.1	0.1	9.9
24-28 ft.	8.5	0.8	0.03	23.8	9.0	-14.8	0.4	0.1	0.1	9.3

NP vs. AGP for Clay Cover Material



NP vs. AGP for Tailings Mass Material



2005 ABA Conclusions

- Tailings mass is acid generating to tested depths of 28-ft. (8.5 m)
- Cover material is inert with low insoluble metals
- the paste pH values for all tailing samples remains around pH 8.3
- Maximum sulfate sulfur 0.6%,
- there is no current evidence of weathering in tailings

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Cover Performance
Is the Cover Working and Will It Work Long Term?

2001-2007: Rio Tinto retained O'Kane Consultants. Inc. to:

1. Evaluate field performance of the cover system

PTMS#: Three primary tailings monitoring sites installed 09/2001 to record *in situ* suction, moisture content, and temperature conditions.

STMS#: Fourteen secondary tailings monitoring sites installed 09/2001, each consisting of a PVC access tube for insertion of a portable moisture sensing probe.

Surface runoff-monitoring site installed in the cover spillway to monitor flow during precipitation events.

2004: Automated Bowen Ratio Station (indirect measurement of AET) installed

In-situ hydraulic conductivity: Lab, Direct field measurement using Guelph Permeameter and Tension Infiltrometer, and large scale field K-tests

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Cover Performance
Is it working and Will It Work Long Term

2006: Rio Tinto retained O'Kane Consultants. Inc. to:

1. Perform 1D field response and 50 and 100-year predictive modeling of the cover system

Objectives:

First, to use the measured field responses to develop a set of calibrated hydraulic properties for the cover and upper tailings materials.

Second, to use the calibrated model to evaluate cover performance given differing vegetation and climate scenarios over a 100-year period.

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Seven Model Scenarios and Input Changes

Scenario # - Name	Input Parameters*			
	Cover	Vegetation	Climate	Base Seepage
1 – Base Case PTMS-3	PTMS#3	Grass	Historic	None
2 – No Vegetation	PTMS#3	***None***	Historic	None
3 – Forest Vegetation	PTMS#3	***Forest***	Historic	None
4 – Successional Vegetation	PTMS#3	***Successional***	Historic	None
5 – Climate Change	PTMS#3	Grass	***Climate Change***	None
6 – Liner Failure	PTMS#3	Grass	Historic	***1x10-6 cm/s***
7 – PTMS#2 Cover	***PTMS#2***	Grass	Historic	None

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Cover Performance Modeling Outcome

Long-term simulations of seven cover and climate scenarios produced three performance groups:

1. **Acceptable Performance**
2. Marginal
3. **Unacceptable Performance**

Key performance criterion for the cover system is:

1. the resulting location of the water table within the tailings mass and
2. the resultant elevation of the >85% saturated state

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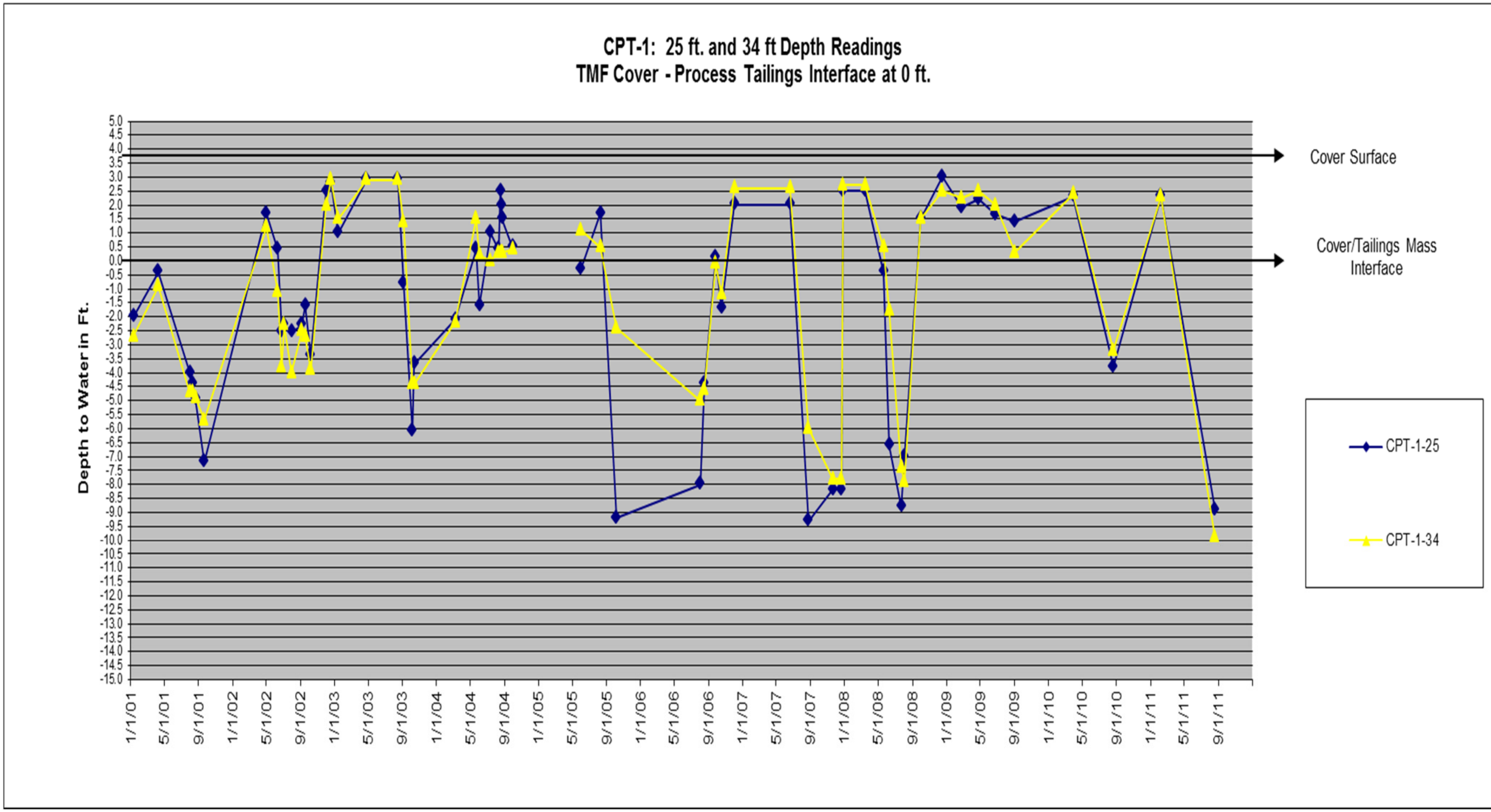
Max., Min., Mean Water Table, Tension Saturated Level and Oxygen Ingress for 100-Yr Simulations

Scenario # – Name	End-of-Year Water Table (ft below surface)			End-of-Year Tension Saturated (ft below surface)			Oxygen Ingress (g/m2/year)		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
1 – Base Case PTMS#3	**0.2**	**8.4**	**16.4**	**0.0**	**1.1**	**4.0**	**-0.3**	**3.7**	**36.6**
2 – No Vegetation	8.2	46.6	70.4	0.0	25.4	48.7	12.0	942	3038
3 – Forest Vegetation	7.3	20.1	31.1	0.0	4.0	7.3	2.0	50.1	255
4 – Successional Vegetation	3.9	18.4	30.9	0.0	3.9	7.3	0.8	36.0	253
5 – Climate Change	**3.6**	**8.0**	**13.6**	**0.0**	**1.0**	**4.2**	**0.4**	**3.7**	**60.3**
6 – Liner Failure	5.9	137.6	138.5	0.0	4.0	72.5	3.8	103	3252
7 – PTMS#2 Cover	**0.4**	**6.5**	**15.4**	**0.0**	**0.5**	**2.6**	**0.7**	**7.0**	**144**

Supporting Field Data to Confirm Performance

Fluctuation in phreatic surface in piezometers in response to climate



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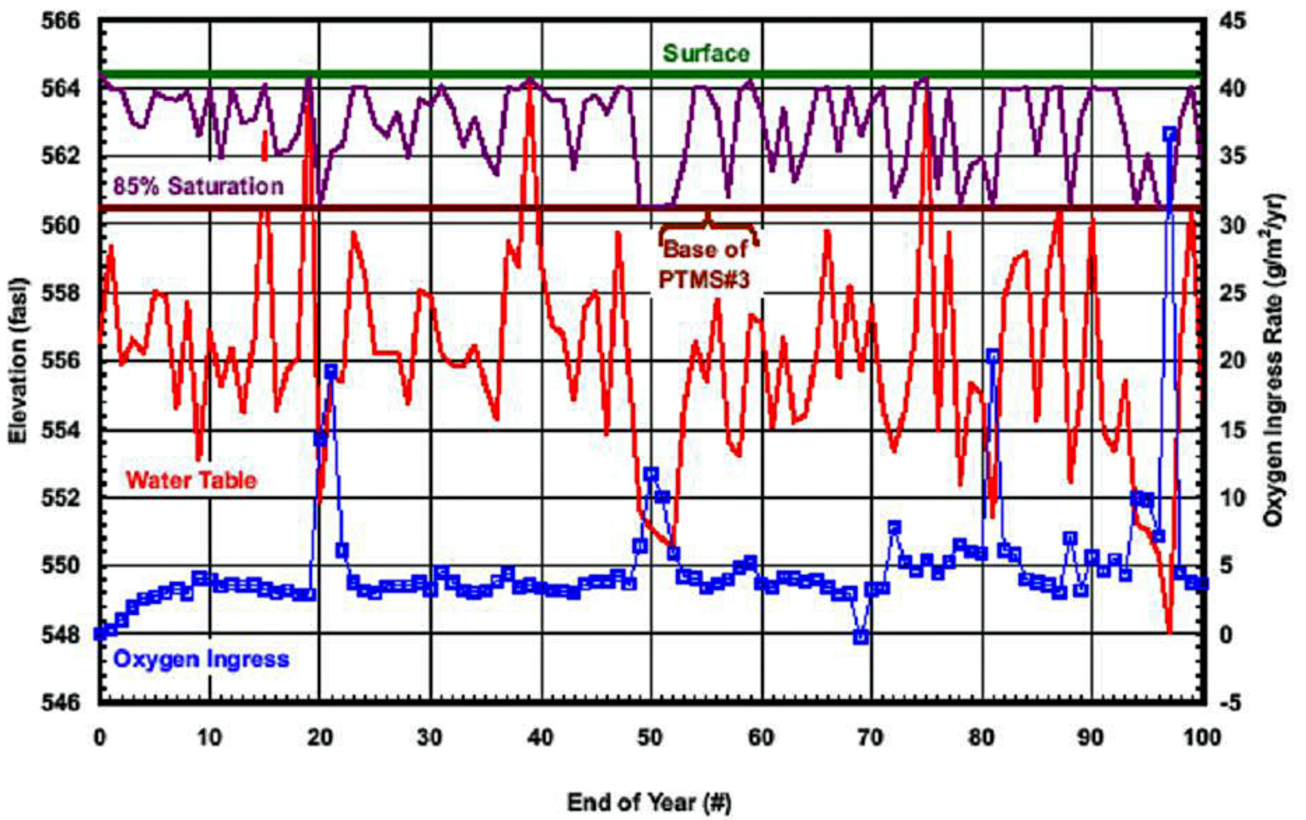
Base Case PTMS 3: Water Table, 85% Saturation Elevations, and Oxygen Ingress Rates



O'Kane Consultants Inc.	CLIENT:	Kennecott Ridgeway Mining Company	PROJECT:	1D Field Response and Predictive Modeling
	SITE:	Tailings Storage Facility, Ridgeway Mine	FIGURE 4.2:	Predicted water table and tension (85%) saturation elevations and oxygen ingress rates for the 100-year base scenario
OKC PROJECT NO.: 668/1	REPORT NO.: 668/1-01	DATE: December 2007		

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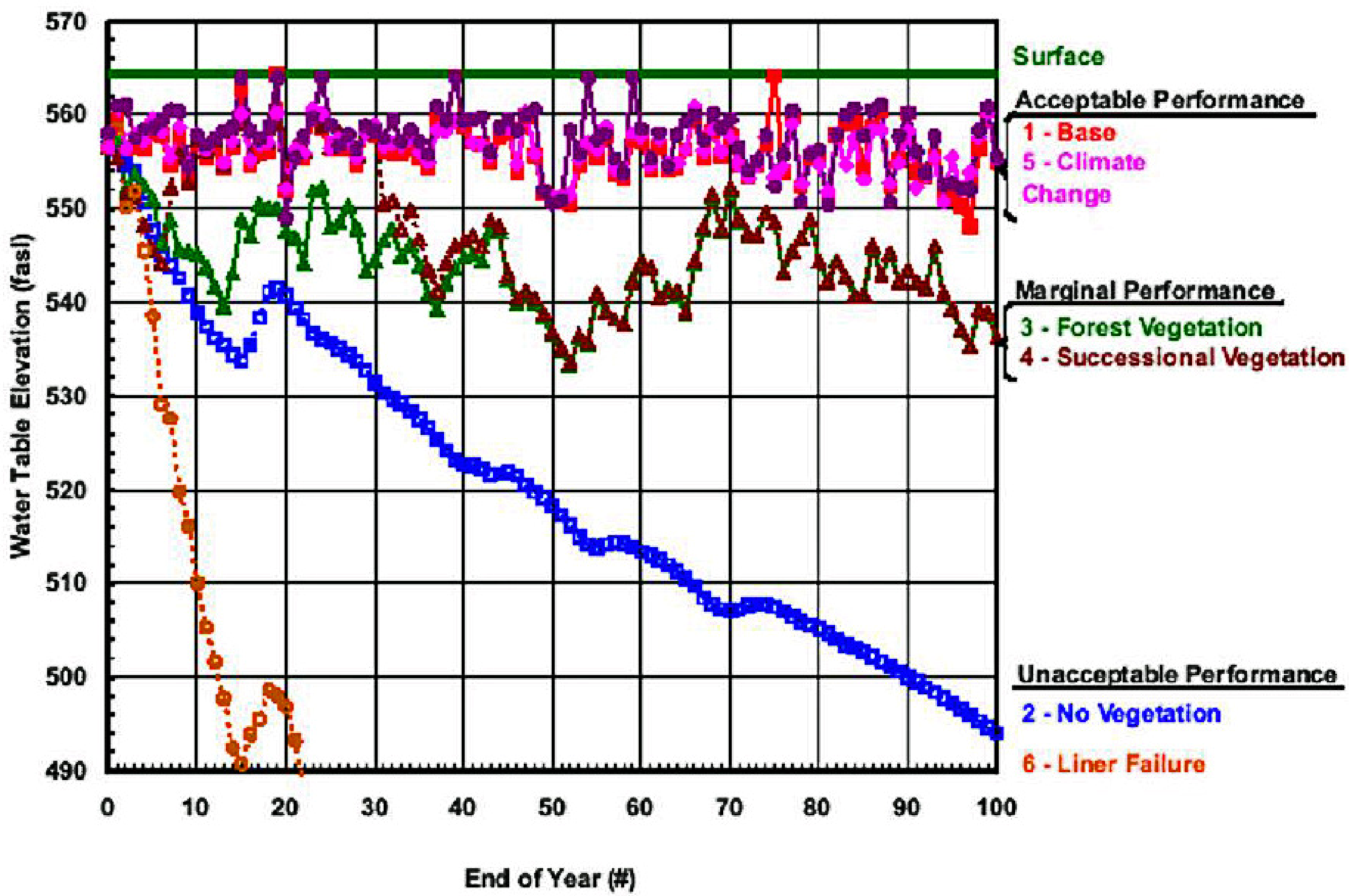
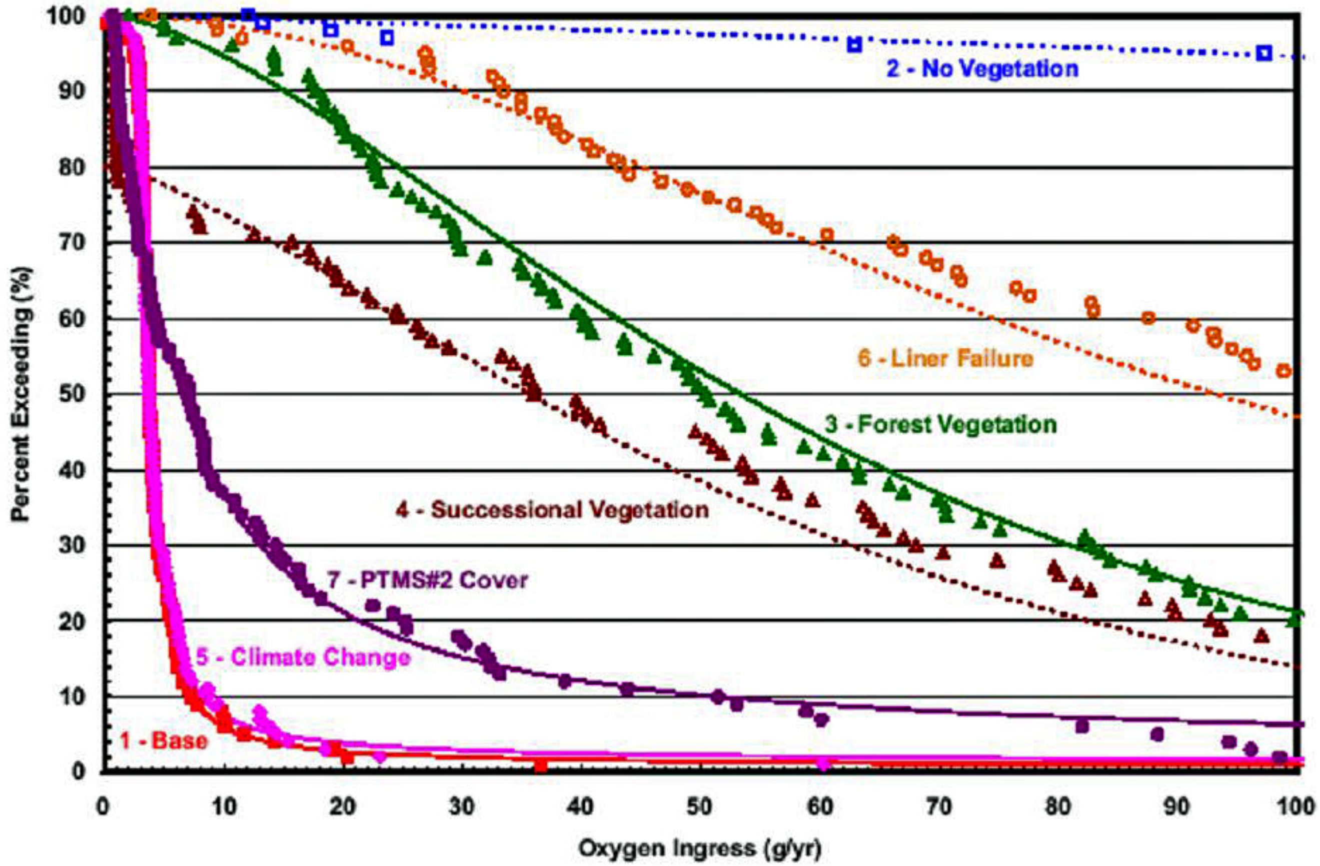
Scenario Comparisons Based on Water Table Elev.

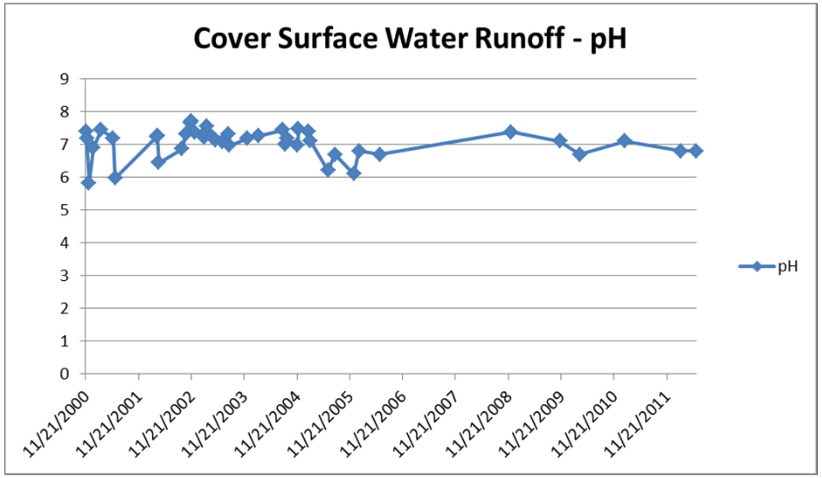


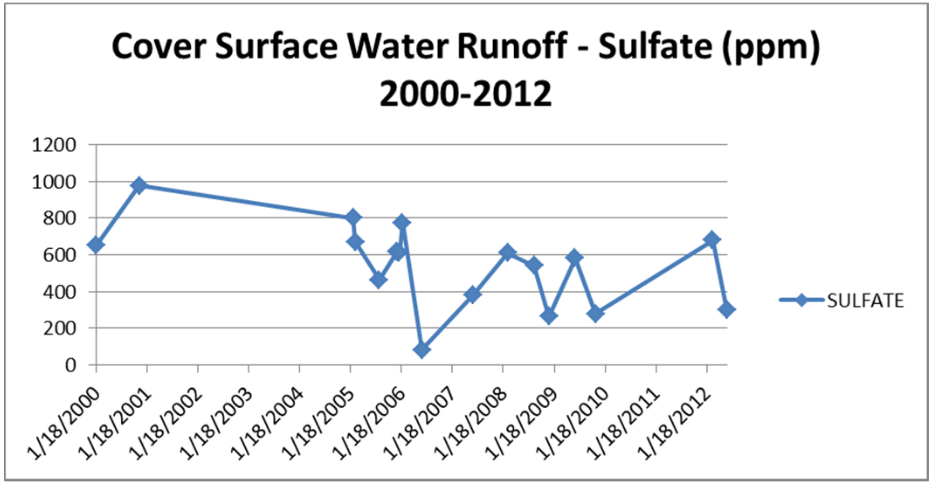
Scenario Comparisons Based on Oxygen Ingress

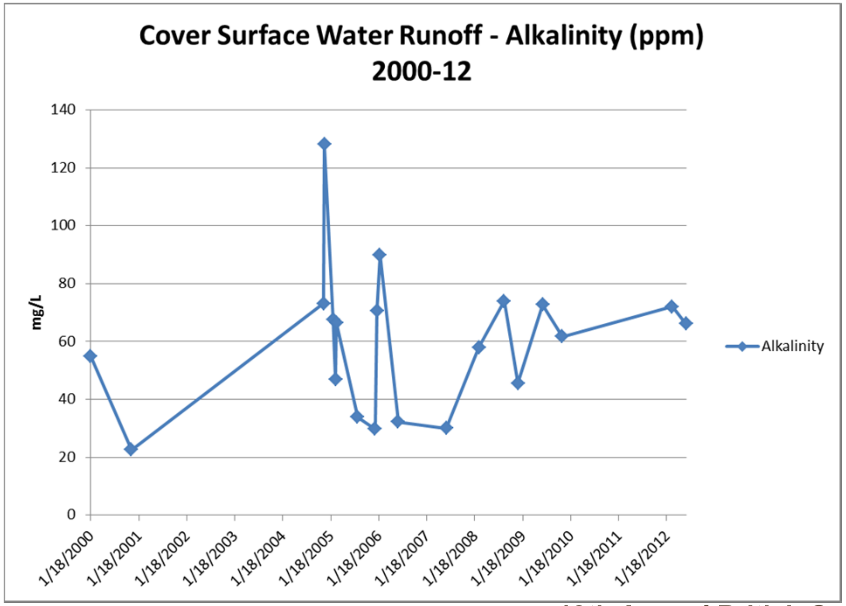


O'Kane Consultants Inc. Integrated Geotechnical Engineering Services Specialists in Unsaturated Zone Hydrology	CLIENT: Kennecott Ridgeway Mining Company		PROJECT: 1D Field Response and Predictive Modeling
	SITE: Tailings Storage Facility, Ridgeway Mine		FIGURE 4.4: Probability of exceedance curves for the seven scenarios' predicted oxygen ingress rates
OKC PROJECT NO.: 668/1	REPORT NO.: 668/1-01	DATE: December 2007	

Cover Runoff Water Chemistry Indicators 2001 - June 2012







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Summary and TMF ARD Management Going Forward

Summary : The Cover and Embankment performance indicators to date are acceptable.

Way Forward

1. Control vegetation in support of maintaining cover performance criteria
2. Ongoing periodic piezometer monitoring and pore water chemistry
3. Ongoing cover runoff monitoring as it takes place

New task:

1. 2013: Obtain construction permit for HDPE pipeline irrigation system to maintain tailings saturation during prolonged drought periods
   - Using water from the South Pit lake

Thank You

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