# Appendix 4-QQ

## Water Quality Meeting - October 2021

# Crown Mountain Coking Coal Project

# Water Quality Discussion

October 14, 2021

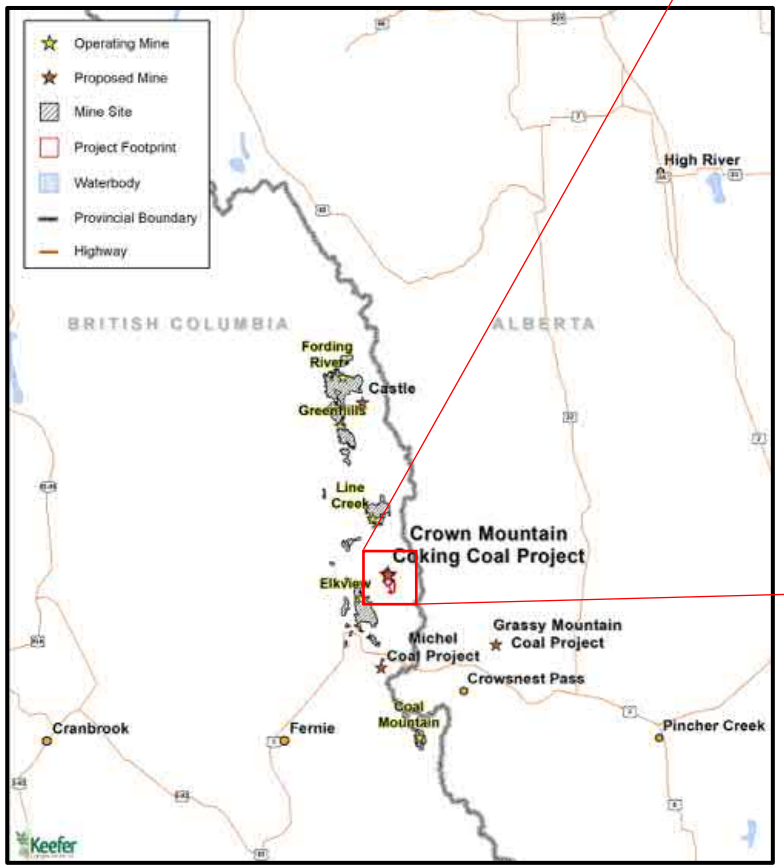
NWP Coal Canada Ltd

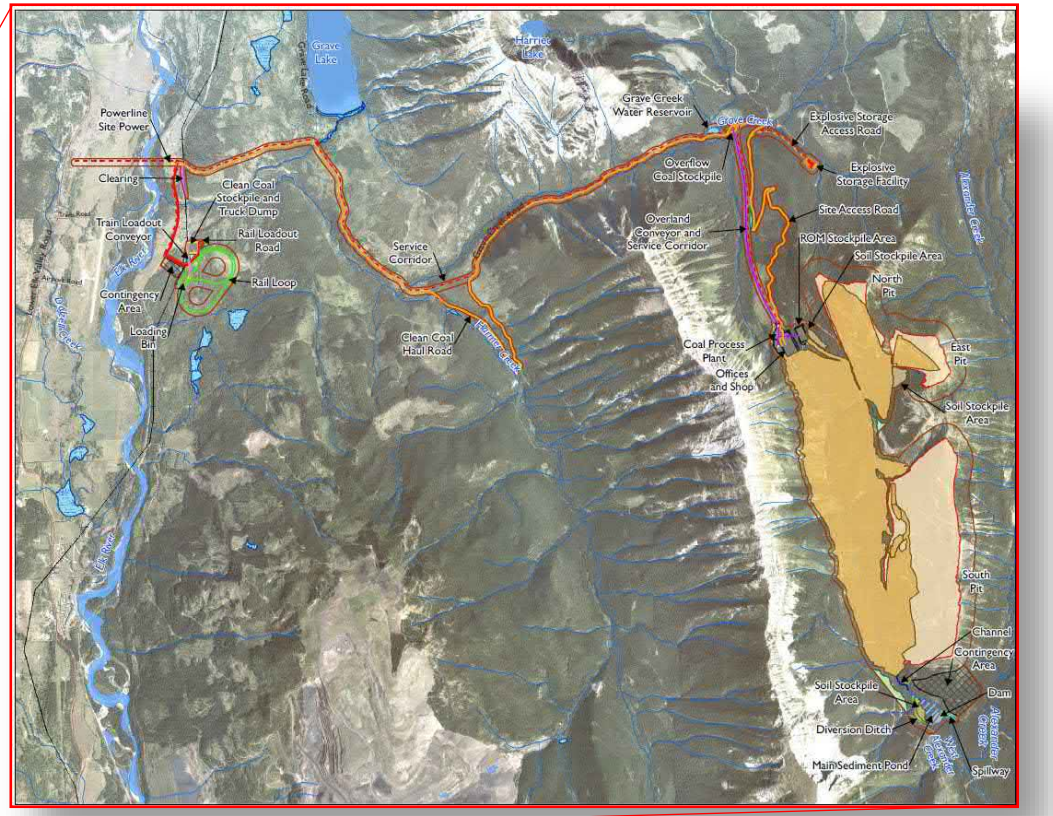
# Agenda

- Roll Call
- Purpose of the Meeting
- Water management overview - passive and active,
- Water Quality Mitigation Approach, Proof of Concept and Efficacy Uncertainty
- EA Application information describing proposed approach and mitigation strategies
- Summary of Water Quality Impacts
- Contingencies
- Questions

NWP Coal Canada Ltd

# The Project: Location and Layout

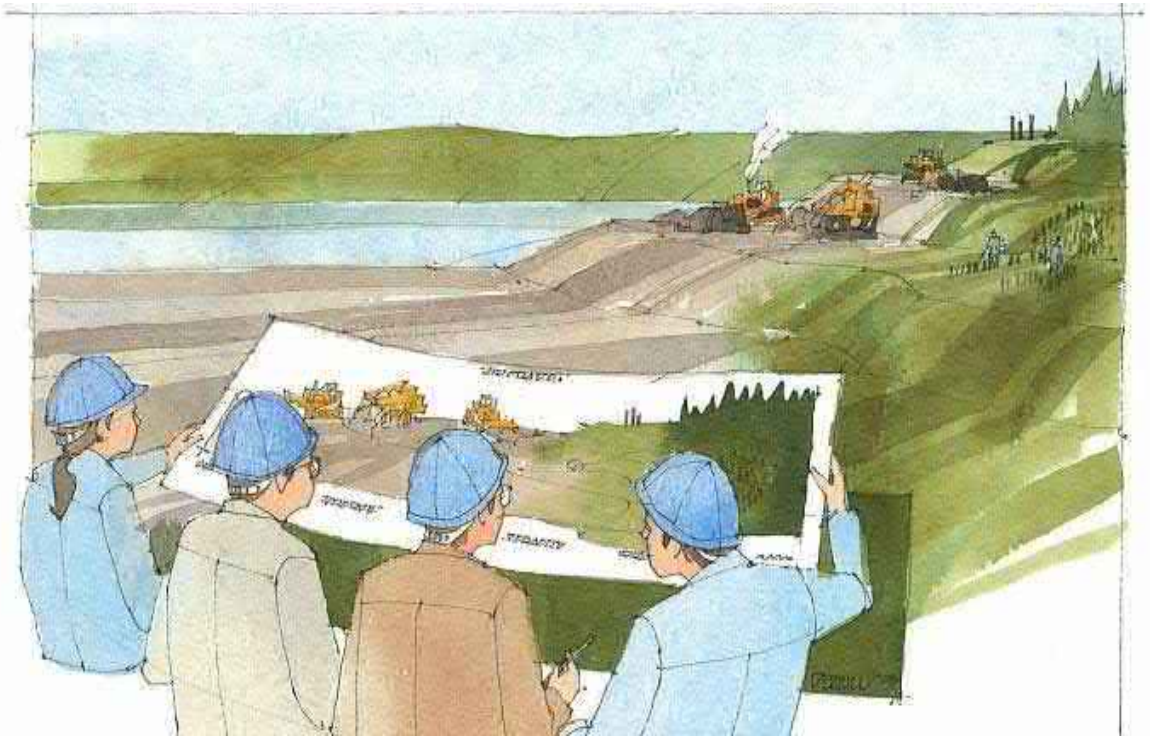



NWP Coal Canada Ltd

# Purpose and Goals of the Layer Cake Approach

- Sustainable approach to selenium treatment
- In-situ treatment of selenium and nitrate
  - Control oxygen, moisture, lithology (carbon) to affect reduction
  - Integrate controls into mine design
  - Saturated fills with management of flow, carbon and nutrients
  - Interbedded Coal Reject/tails with waste rock



SAPSM, 2010

# Layer Cake Test Work

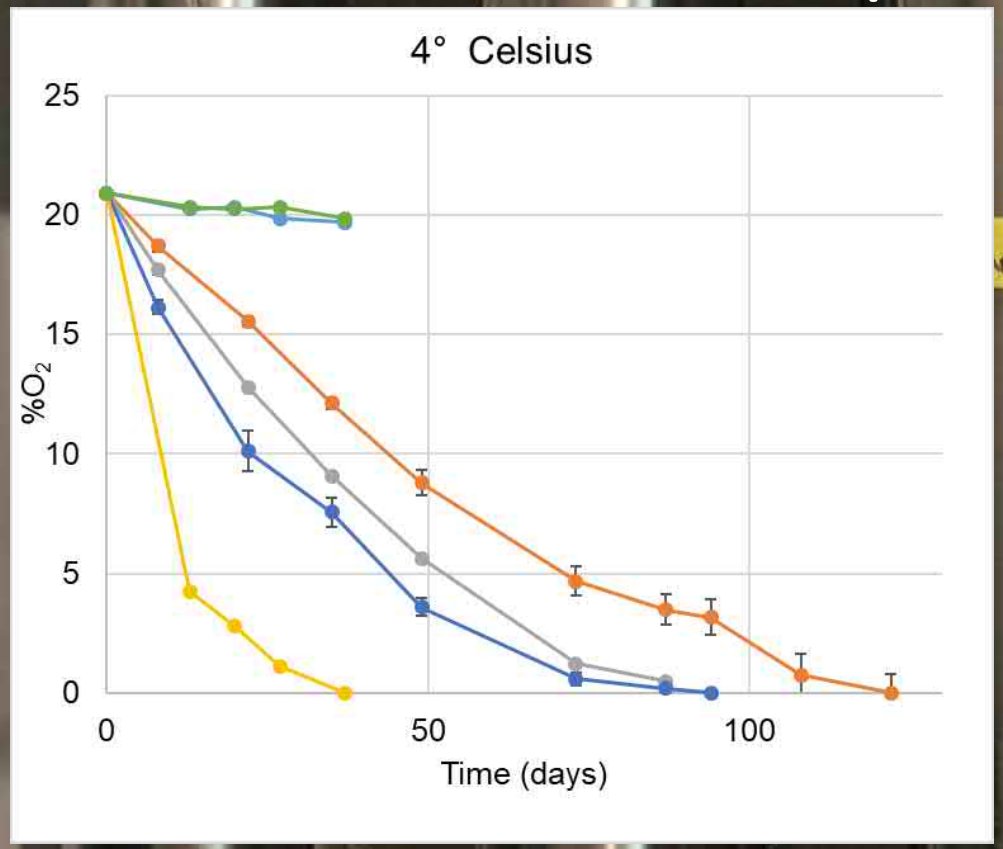
**Lab Project Objectives:**

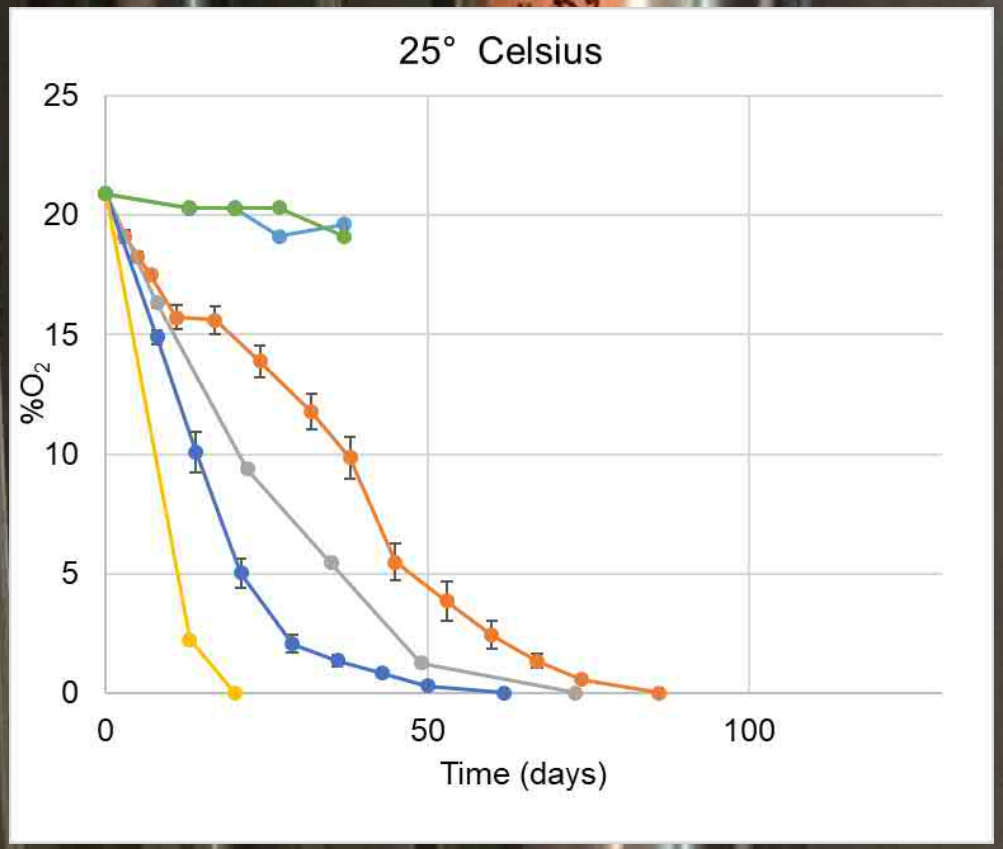
- Characterize progressive consumption of oxygen by biotic and abiotic activity
- Create suboxic conditions needed for nitrate and selenium reduction
- Generate oxygen, nitrate, and selenium reduction rates for use in Layer Cake design

| Parameters Tested | |
|---|---|
| ROM Waste | At 4°C, 10°C, 25°C |
| 3% Coal Reject | |
| 10% Coal Reject | |
| 100% Coal Reject | |
| CR Control | |
| CR Control | |

NWP Coal Canada Ltd

# Respirometry Results




ROM Waste
3% CR
10% CR
100% CR
WR Killed Control
CR Killed Control

NWP Coal Canada Ltd

# Conclusions

- Microbes in coal reject and waste material are capable of nitrate and selenium removal
- Oxygen concentration affects rates and extent of denitrification and selenium reduction.
- Oxygen consumption rates are much higher than previously reported, based on abiotic sulfide oxidation
- O2, nitrate, and selenium reduction rates can be applied to pilot and full-scale dump design for full-scale testing.
- Updated modeling results support pilot testing – reduced time to develop suboxic conditions from years to months.

NWP Coal Canada Ltd

# Design Approach

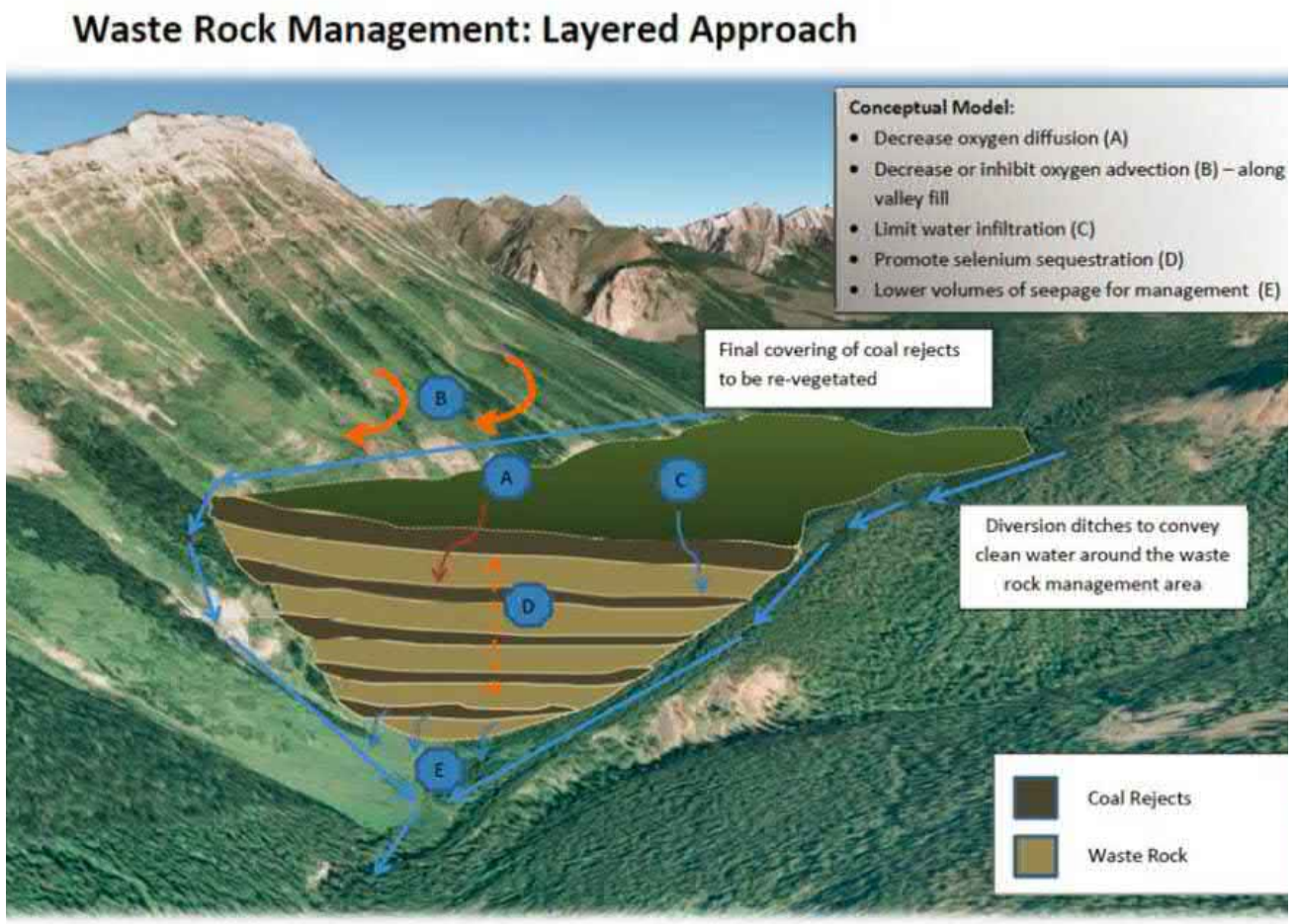
Use the process plant coarse and fine tailings as a carbon source and to reduce oxygen levels waste rock

Incorporate layers of coarse and fine tailings in the spoil pile design

Geotechnical considerations included in the design:

- 50m maximum height of waste rock dumps
- Multiple dump locations with sufficient offset for run-out/roll out protection

Mine Plan to Support the Sequence




NWP Coal Canada Ltd

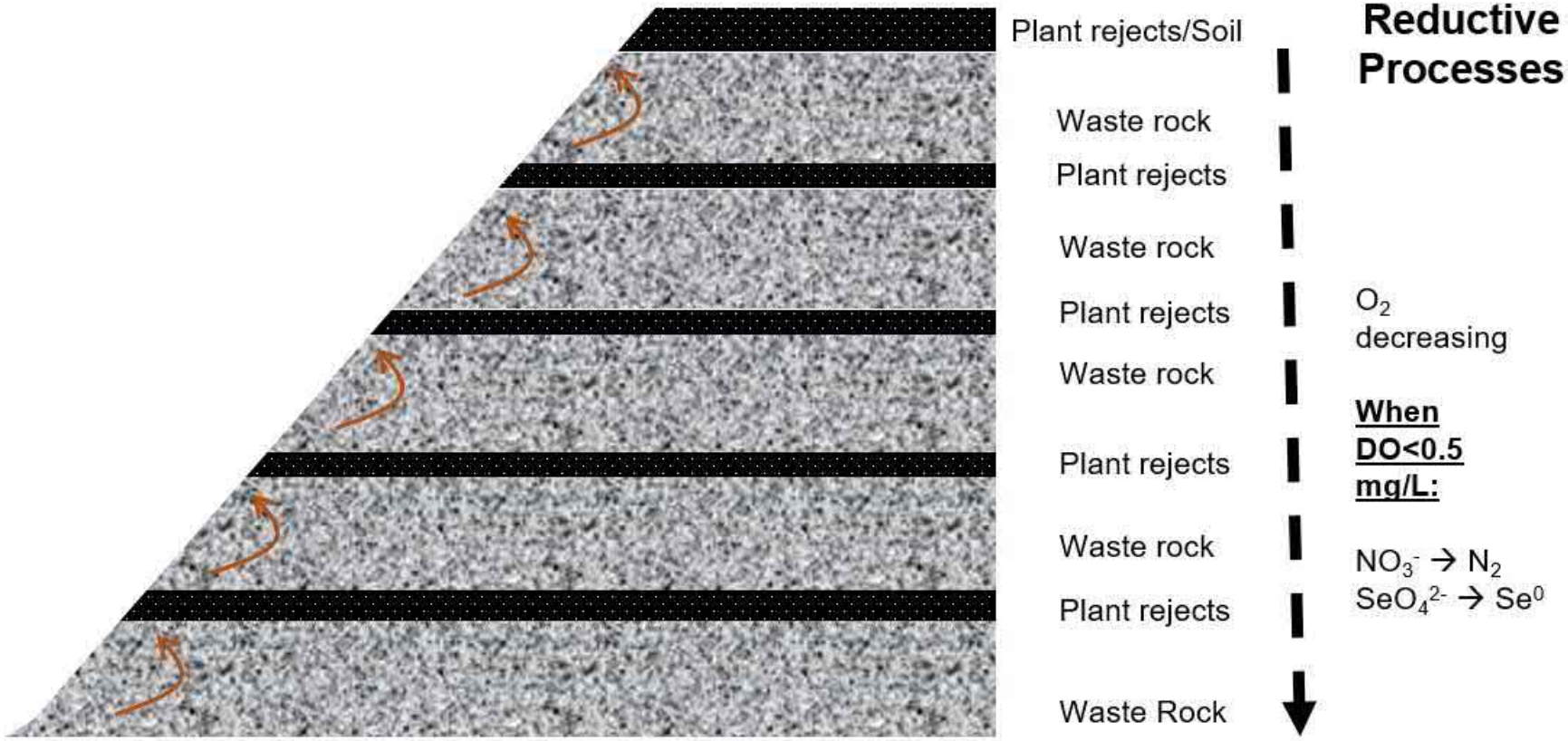
# Conceptual Model For Se and $NO_3$ Attenuation in the Layered Spoil

**Expected role of plant refuse layers:**

- Retain moisture retarding oxygen transport.
- Generate dissolved organic carbon.
- Provide sub-oxic zones where reductive processes could occur.

**Oxygen movement internally by diffusion nc advection.**

**Convection in exposed faces.**




NWP Coal Canada Ltd

# Material Properties

- Waste Rock – standard blasted rock consistent with other Elk Valley coal mines in size and consistency
- Plant Rejects – a combined coarse coal reject and fine coal rejects (tailings) material
- Soil – salvaged soil from site

| | Y0 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y7 |
|---|---|---|---|---|---|---|---|---|
| ROMt Coal | 0.5 | 3.5 | 3.8 | 3.7 | 3.8 | 3.7 | 3.7 | 3.9 |
| Waste Rock (Placed $Mm^3$*) | 2.7 | 15.5 | 21.2 | 19 | 22.8 | 23.4 | 23.5 | 23.1 |
| Rejects (Placed $Mm^3$**) | 0.15 | 0.97 | 1.20 | 1.24 | 1.3 | 1.09 | 1.03 | 1.14 |
| Ratio WR:Rejects | 18.3 | 16.0 | 17.6 | 15.3 | 17.6 | 21.5 | 22.8 | 20.3 |
| | **Y8** | **Y9** | **Y10** | **Y11** | **Y12** | **Y13** | **Y14** | **Y15** |
| ROMt Coal | 3.8 | 3.8 | 3.8 | 3.8 | 3.7 | 3.7 | 3.8 | 2.2 |
| Waste Rock (Placed $Mm^3$*) | 23.3 | 23.1 | 30.7 | 31.3 | 31 | 23.8 | 23.8 | 12.8 |
| Rejects (Placed $Mm^3$**) | 1.03 | 1.02 | 1.08 | 1.05 | 1.04 | 1.02 | 1.21 | 0.41 |
| Ratio WR:Rejects | 22.6 | 22.7 | 28.5 | 29.7 | 30.0 | 23.2 | 19.6 | 31.1 |

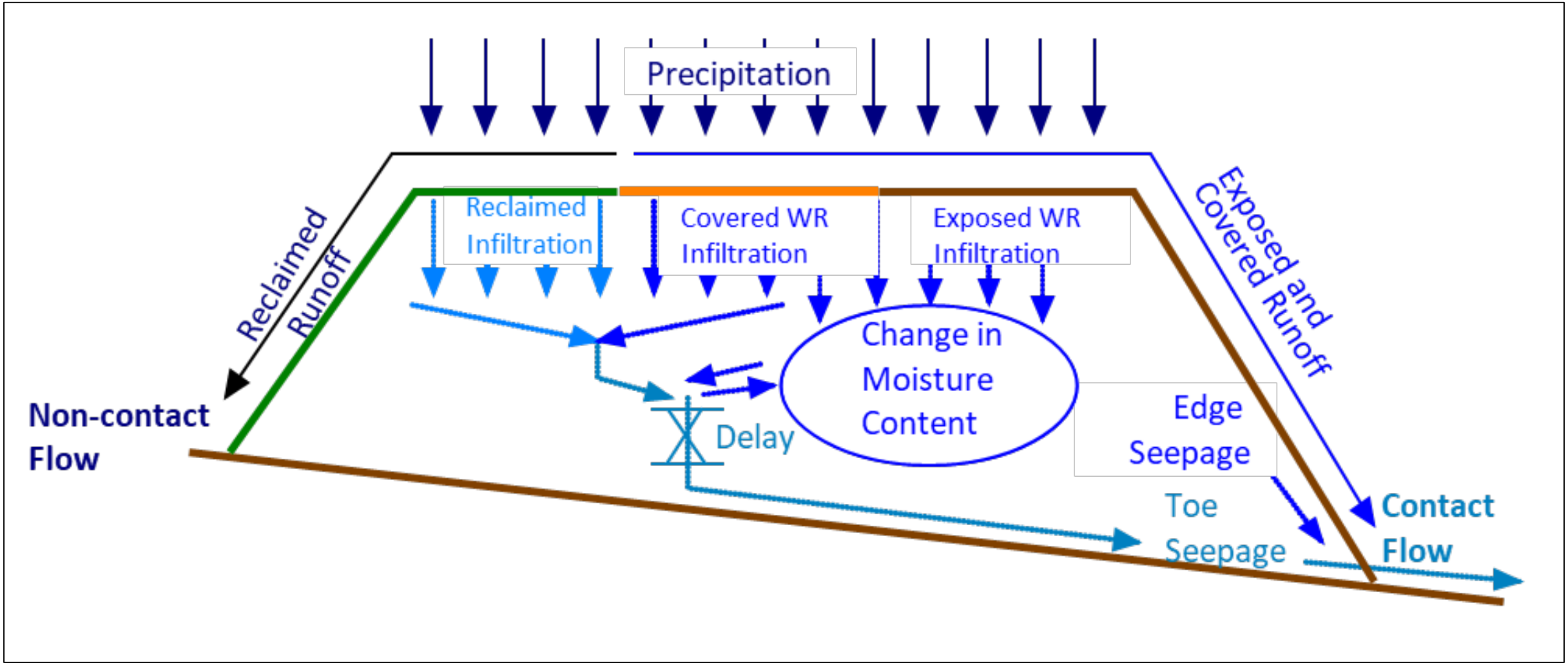
* estimated 30% swell factor
** estimated placed density of 1.4t/m3

NWP Coal Canada Ltd

# Waste Rock Dump Modeling Methodology Implementation in GoldSim

- Differentiate between hydrologic performance of different surfaces
  - Exposed Waste Rock: Low Runoff, High Infiltration
  - Covered Waste Rock: Moderate Runoff, Moderate Infiltration
  - Reclaimed Waste Rock: High Runoff, Low Infiltration
- Some infiltration into the waste rock assumed to short circuit majority of waste rock and will report to toe essentially immediately
- Remainder of Infiltration into the waste rock will be lagged and attenuated before it reports to the toe as seepage
  - Velocity based on unsaturated flow equations, using calculated average moisture content in waste rock profile
  - Travel time based on average velocity and waste rock thickness
- Calibrated to Hydrus 1D unsaturated flow modeling

# Waste Rock Dump Implementation Schematic



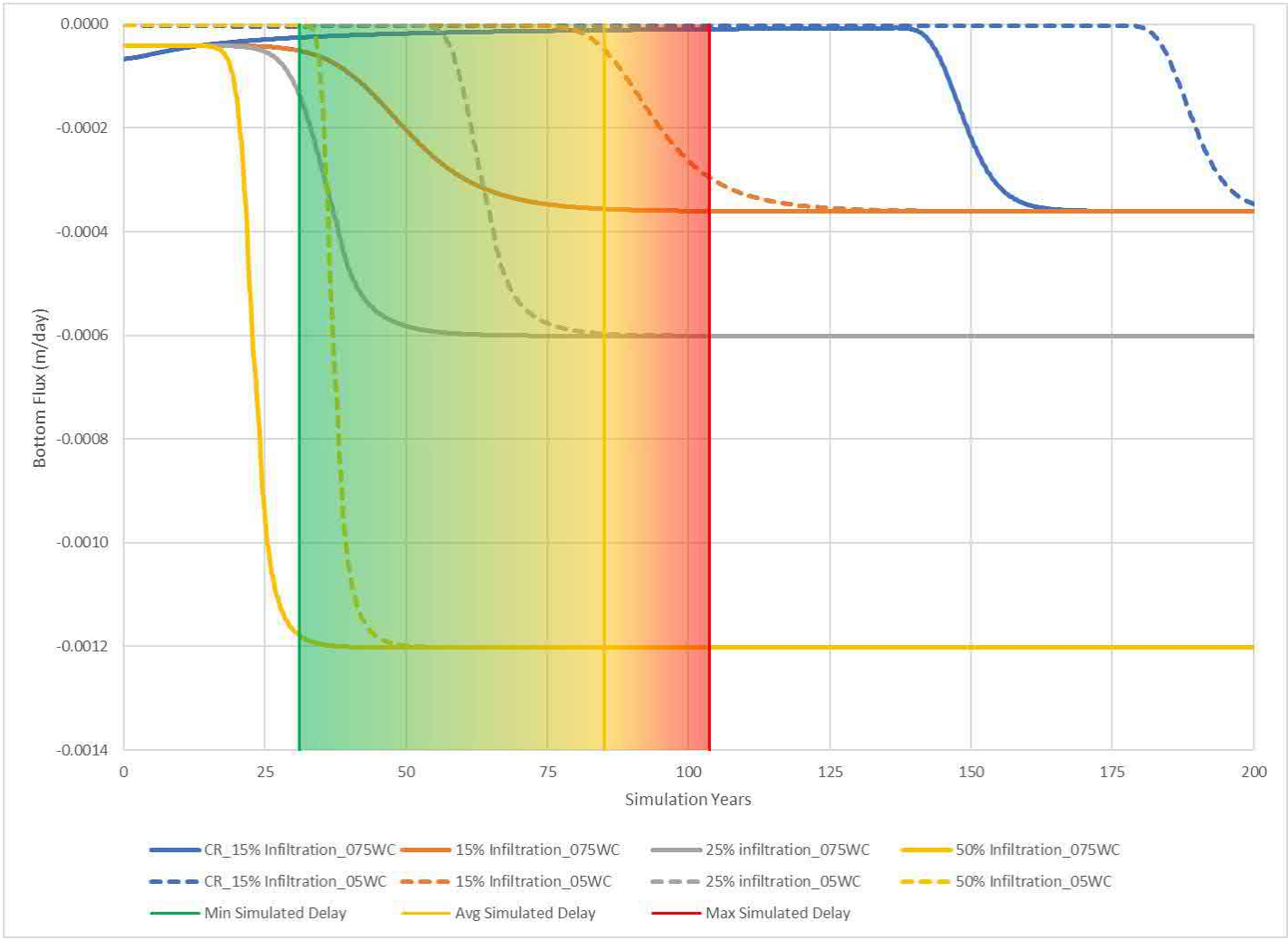

NWP Coal Canada Ltd

# Simulation of flow through the WRD in the Goldsim Model

Flow velocity based on approximation of unsaturated flow behavior

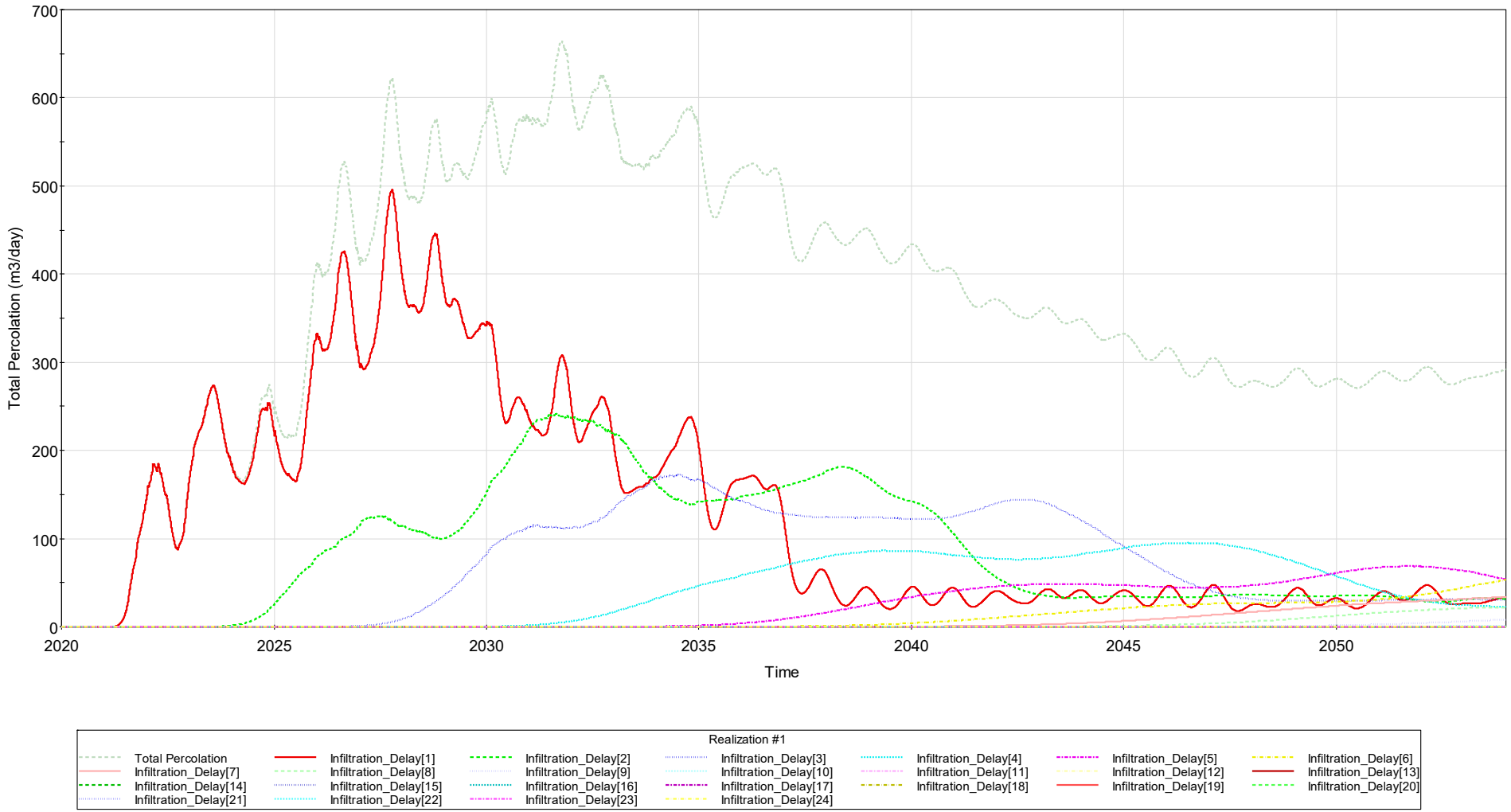
Simulated Travel times for percolation of water through the WRD falls in line with HYDRUS 1D modeling results

- Dashed line shows Waste at 5% moisture content
- Solid Line shows Waste at 7.5% moisture content




NWP Coal Canada Ltd

# Delayed Percolation

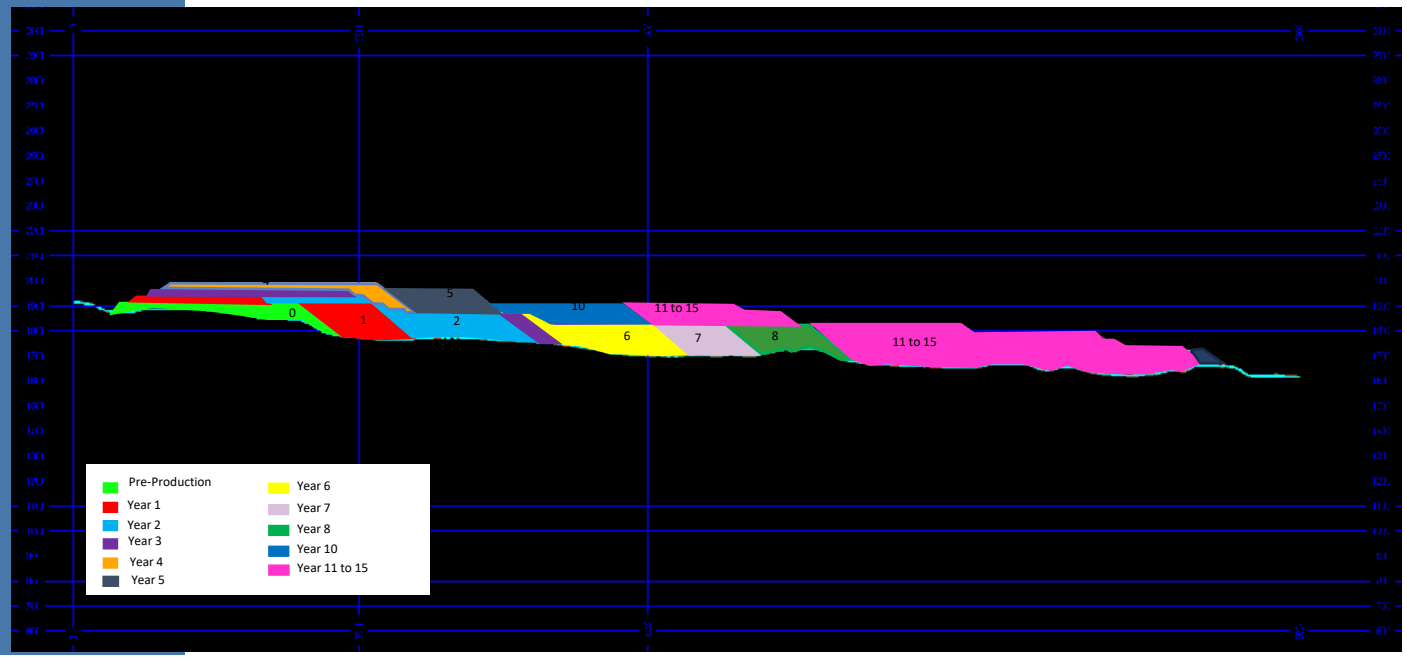



NWP Coal Canada Ltd

# Hydrologic Simulation of WRD

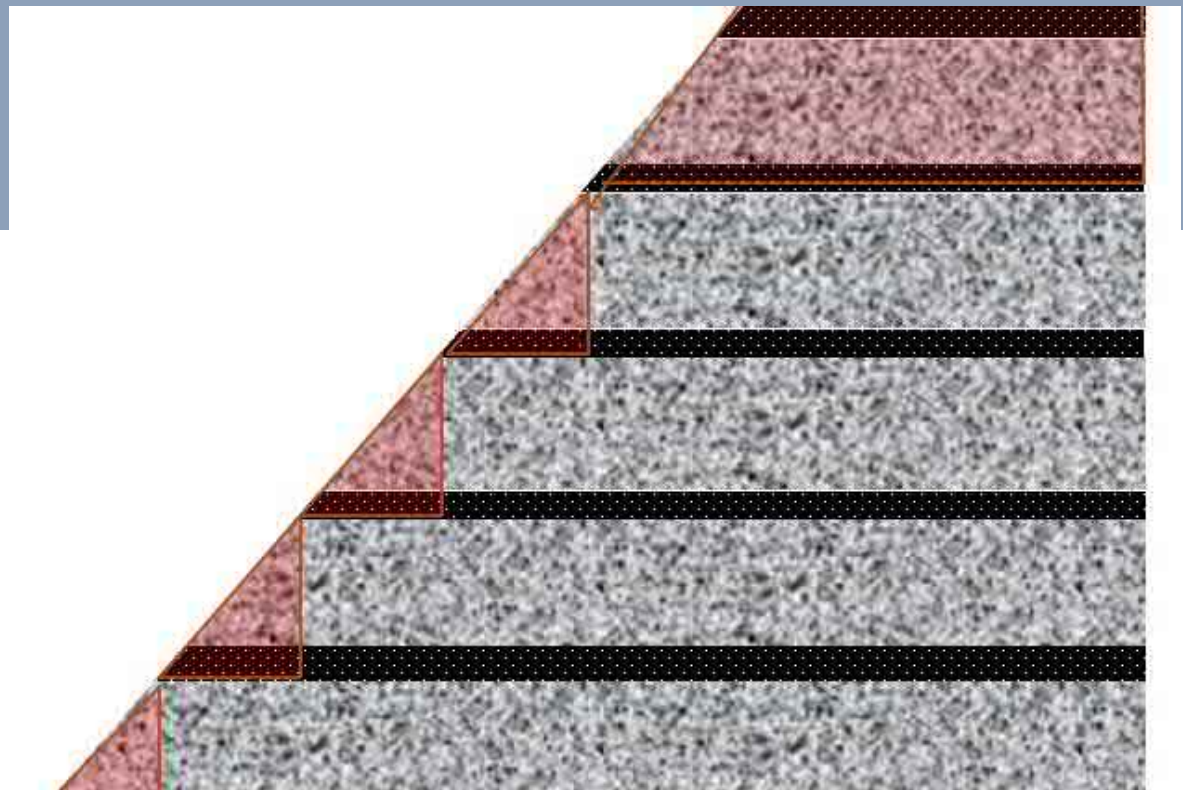
- MRSF split into three Sections:
  - Exposed Waste Rock
  - Covered Waste Rock
    - Covered with Process Rejects
  - Reclaimed Waste Rock
    - Resloped and vegetated cover
- Areas and MRSF thickness extracted from annual mine planning drawings

| Parameter | Exposed Waste Rock | Covered Waste Rock | Reclaimed Waste Rock |
|---|---|---|---|
| SCS CN | 77 | 86 | 91 |
| Infiltration (%) | 50 | 15 | 5 |
| Short Circuit (%) | 5 | 3 | 1 |



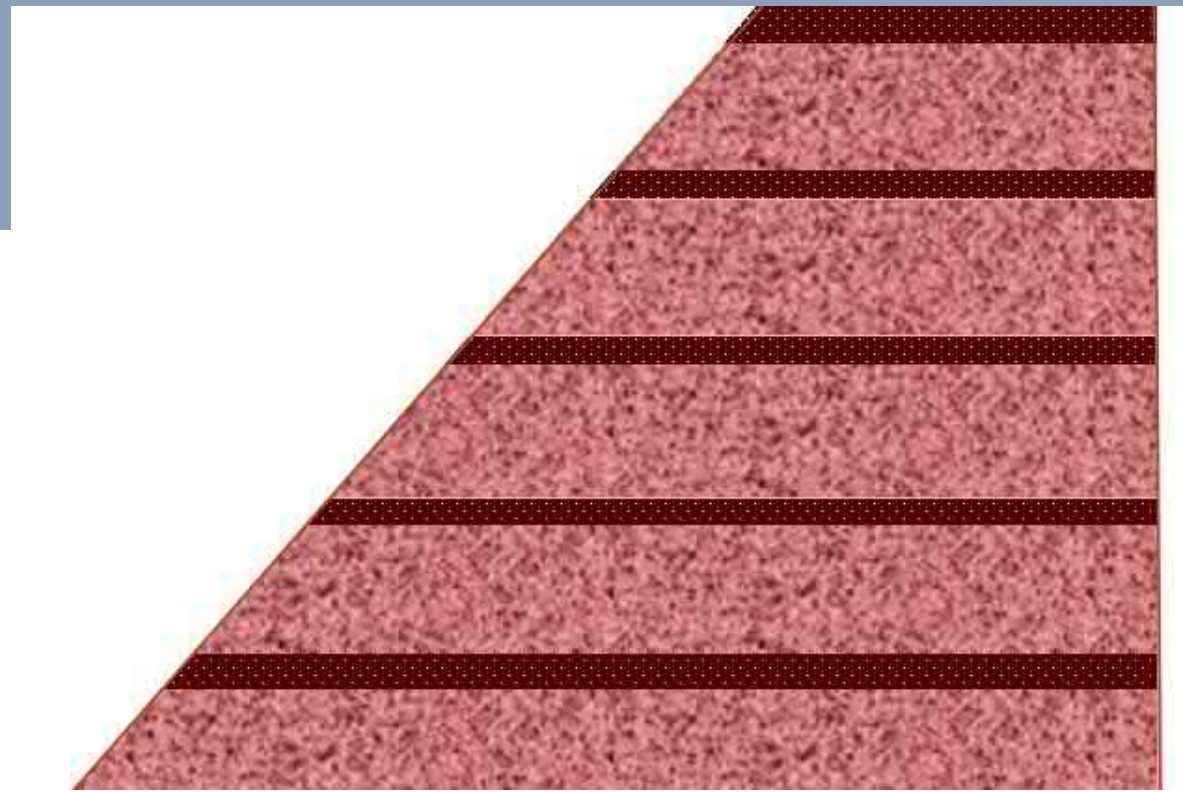

NWP Coal Canada Ltd

# Source Term Cases - Waste Rock



**Successful Development of Low O2 Conditions.**

- O2 is unlimited oxidant on the exposed slopes and top lift
- Sub-oxic conditions through-out the rest of MRSF



**Layering System Fails to Develop Low O2 Conditions**

- O2 is unlimited oxidant in the entire spoil

NWP Coal Canada Ltd

# Selection of WQ Results

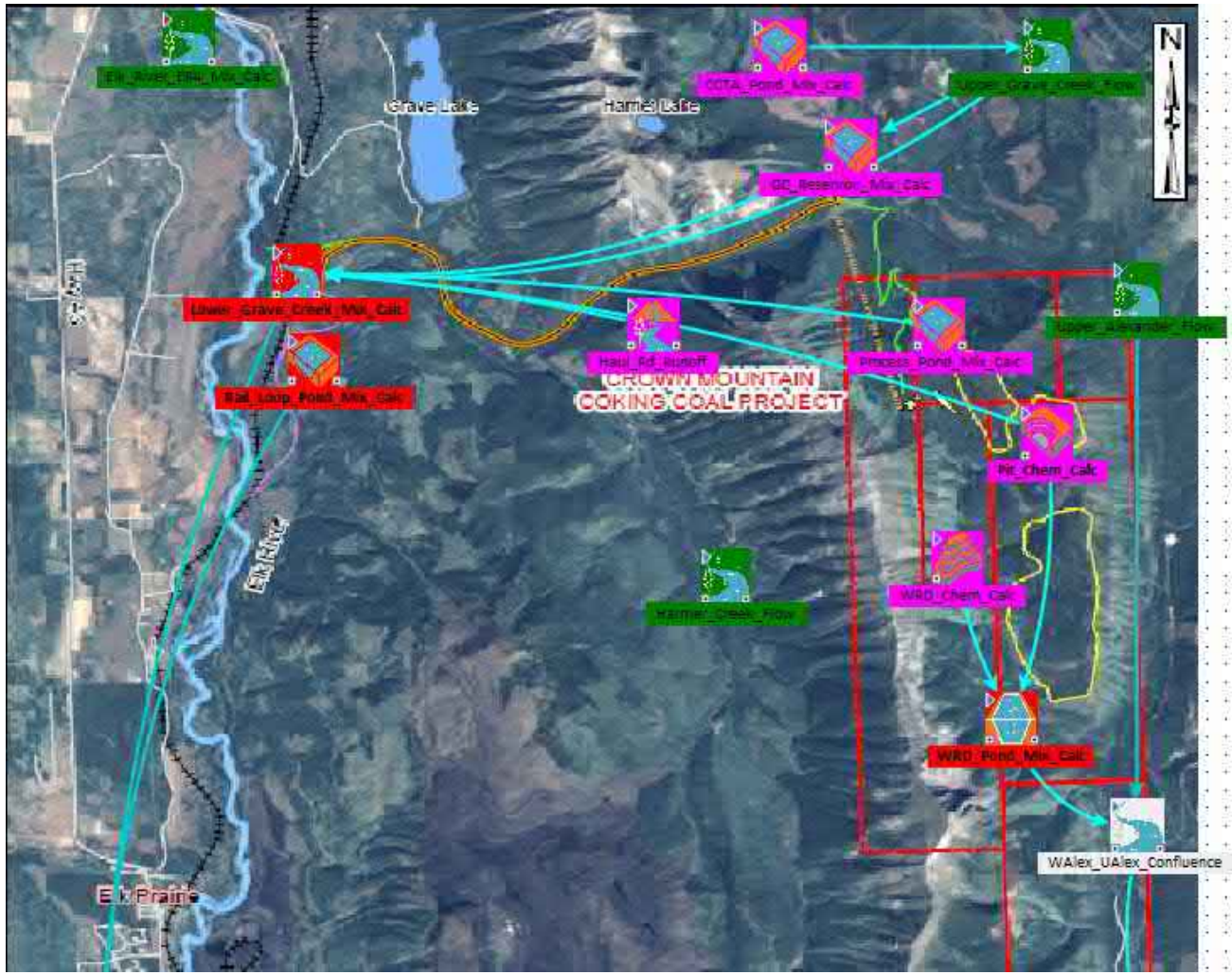
The GoldSim model calculates water quality projections at 17 locations within the model, including Pits, WRD, ponds, and confluences

Chemistry for all 43 chemical constituents (“species” in GoldSim) tracked by the model at each node is available

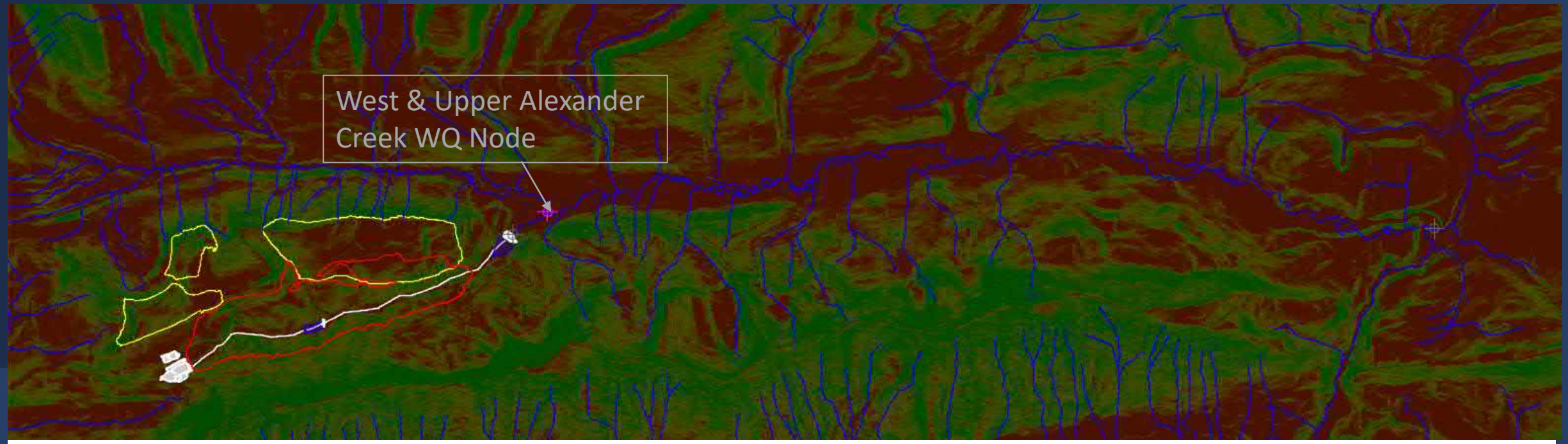
3 key species selected to indicate performance (Se, $NO_3$, $SO_4$)

Model was run for 4 Scenarios

- Average ($P_{50}$) and Upper case ($P_{95}$) Source Terms
- Successful and Failed WRD layered system



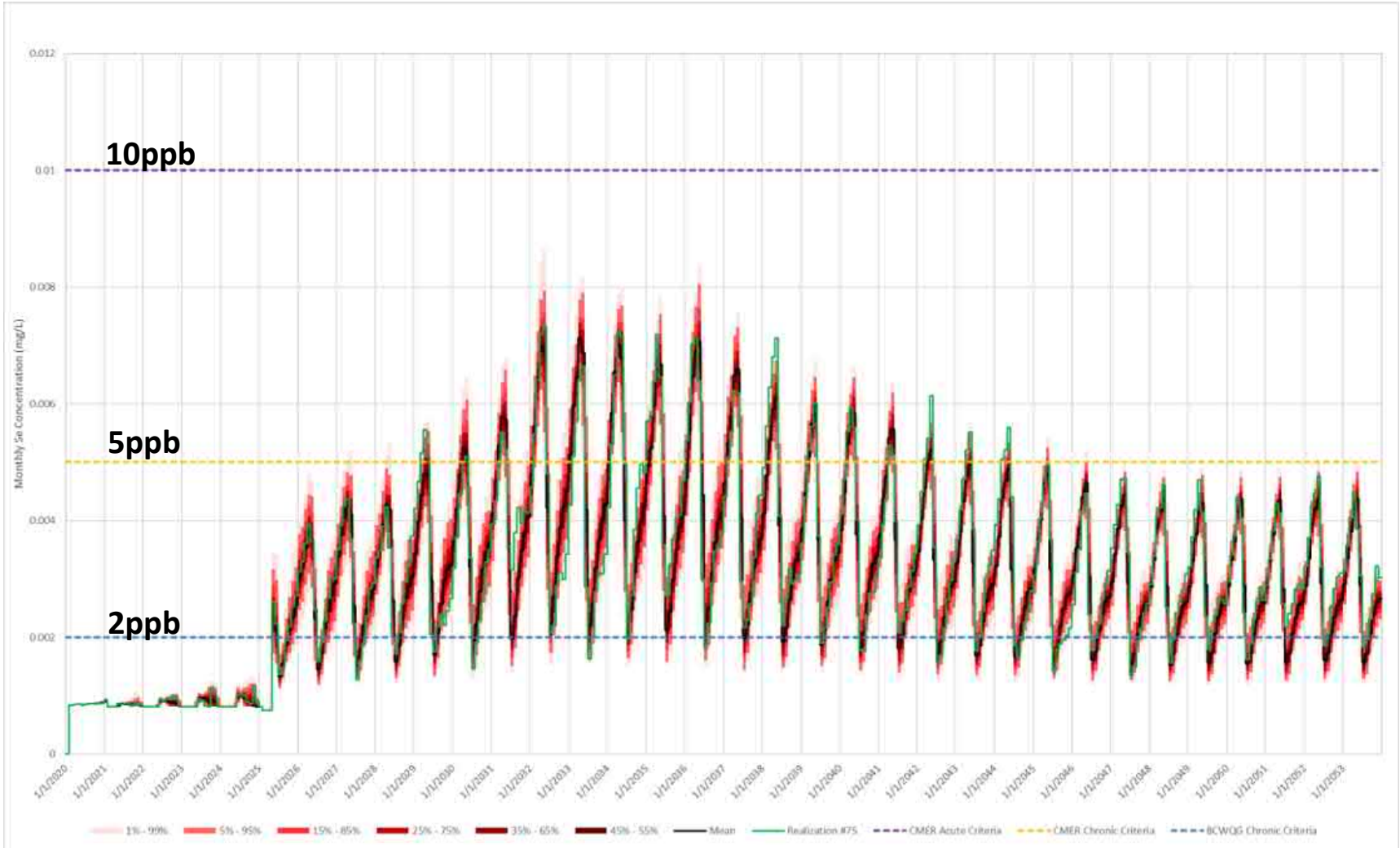

NWP Coal Canada Ltd




# Selenium WQ Results Confluence of W. Alexander Ck. and Upper Alexander Ck.

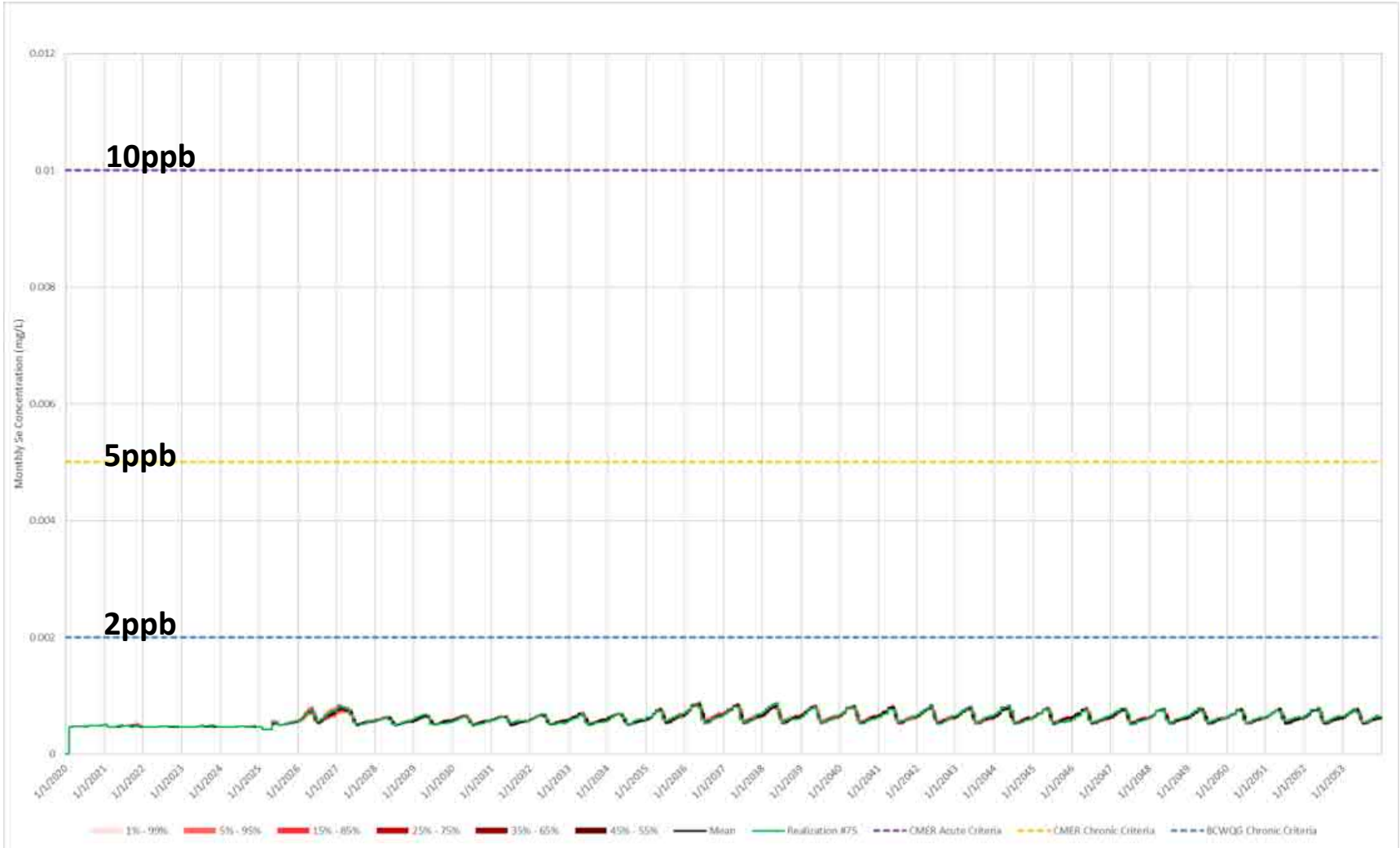
Results for all 17 nodes and all 43 species available but not presented for the sake of brevity

# Upper Case ($P_{95}$) and Layer Approach Fails Selenium



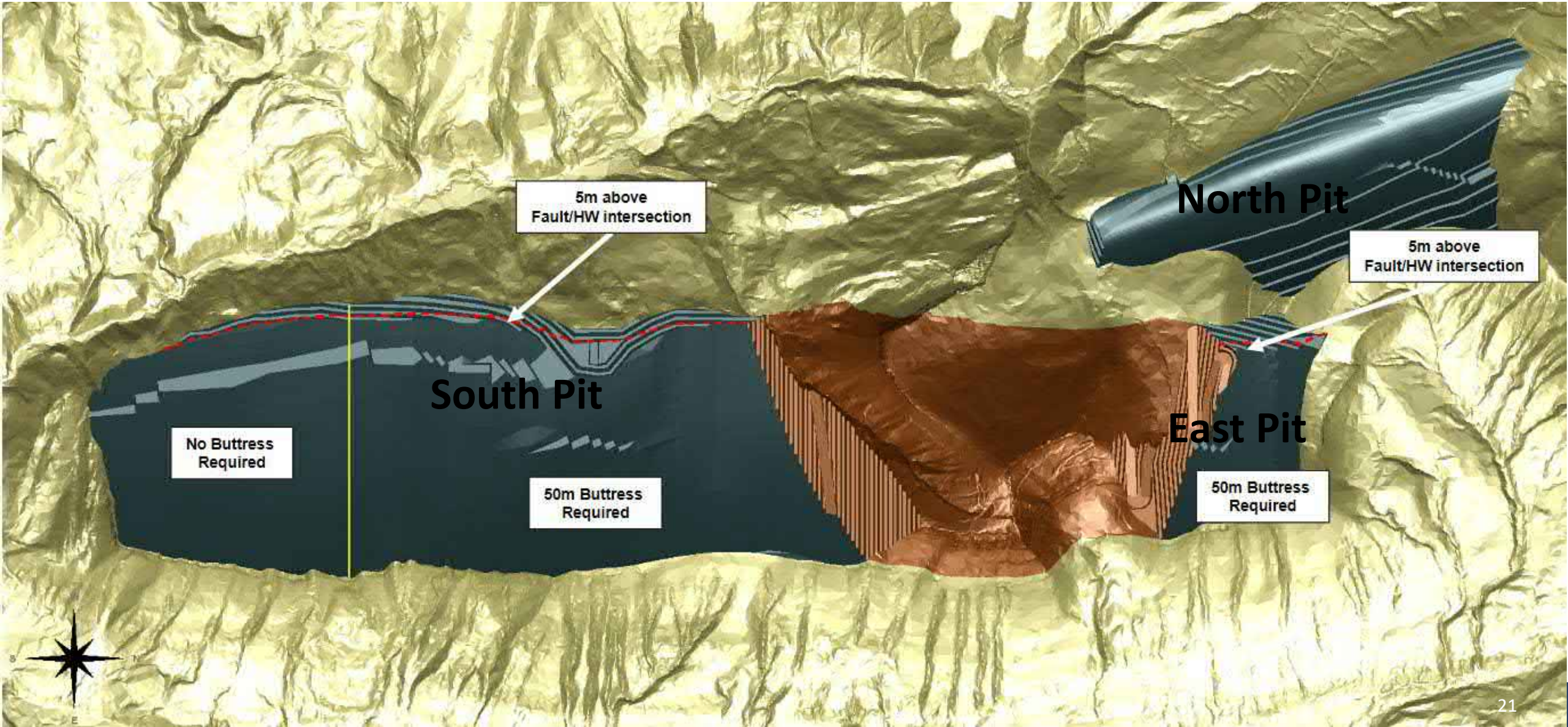

NWP Coal Canada Ltd

# Average Case ($P_{50}$) and Layer Approach Succeeds Selenium

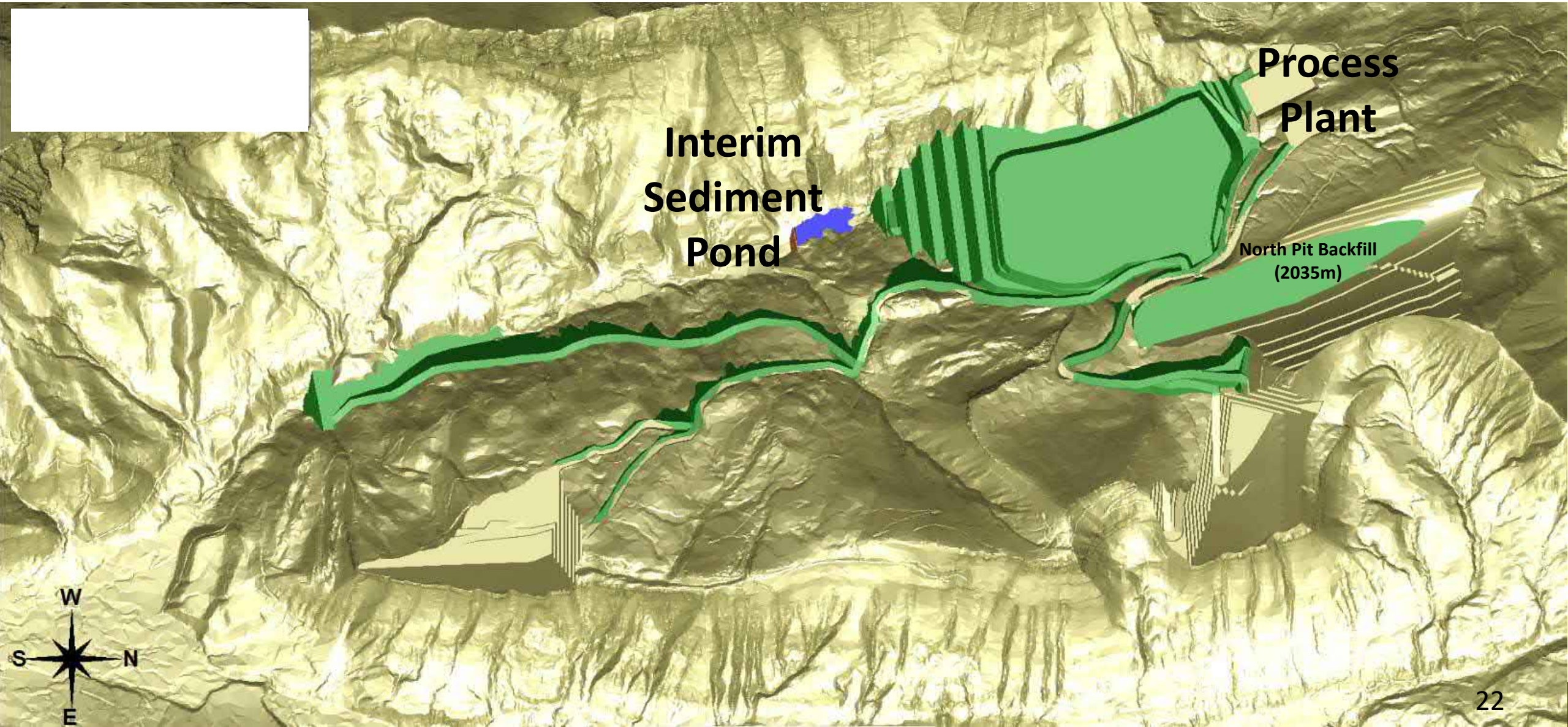



NWP Coal Canada Ltd

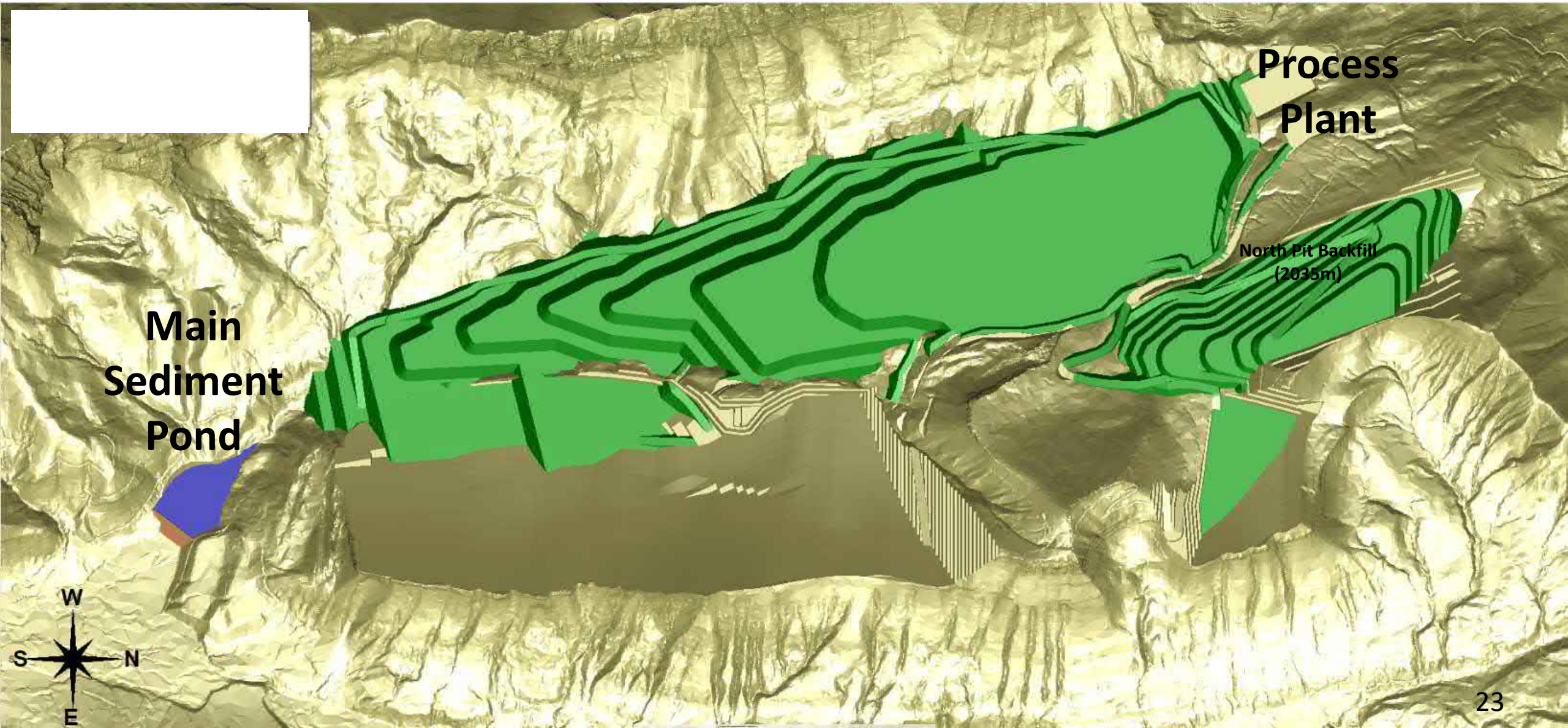
# Pit Configuration



# North Pit Backfill (~Y5)

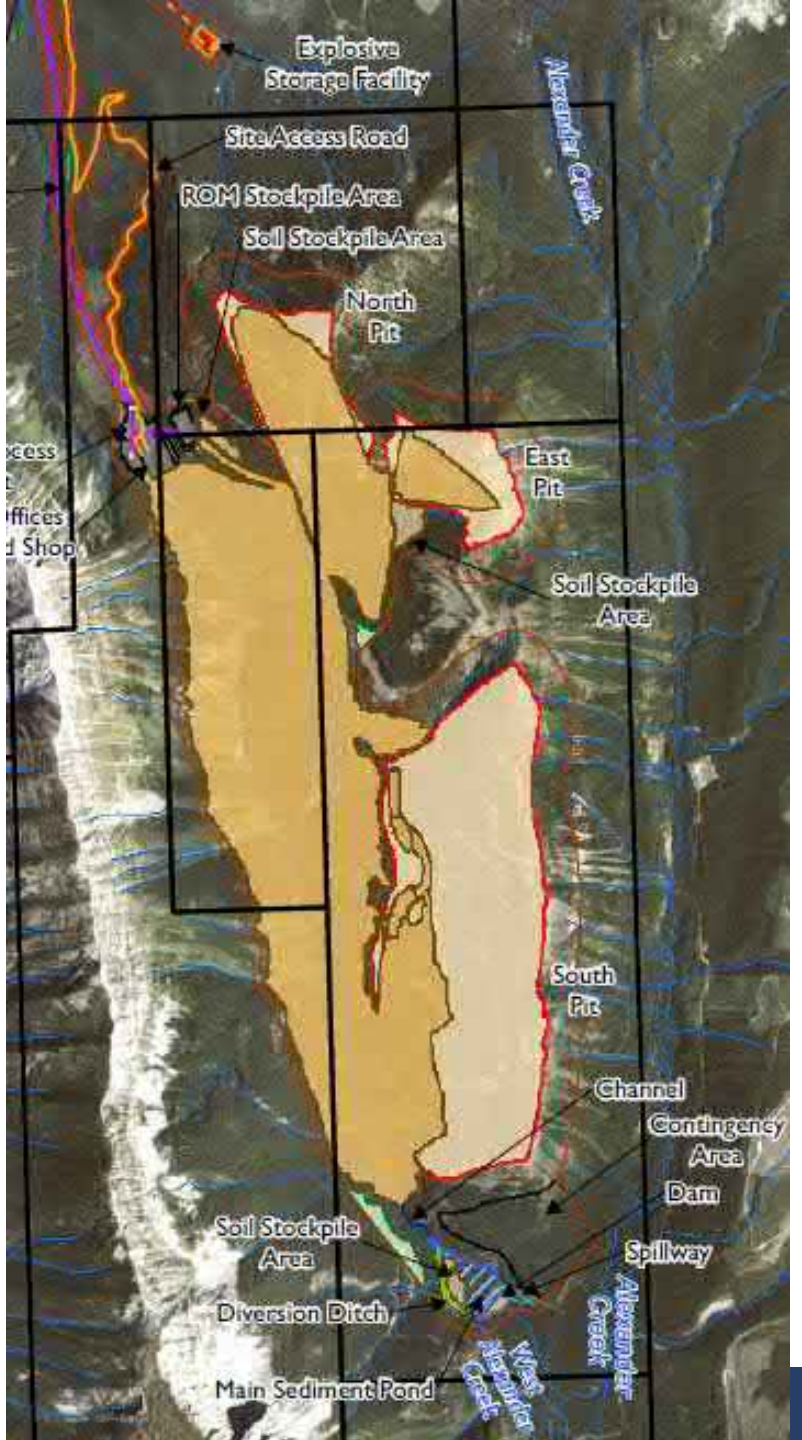


# End of Mine Footprint



# Contingency

- Water Reclaim to Process Plant from Main Sediment Pond
- North and East Pit Saturated Zones
  - Saturated Zone in North Pit of 2Mm3 (130 days resident time)
  - Saturated Zone in East Pit
- Geomembrane
  - Configuration of MRSF allows for Geomembrane – closure solution
- Allowance for Active Water Treatment Plant



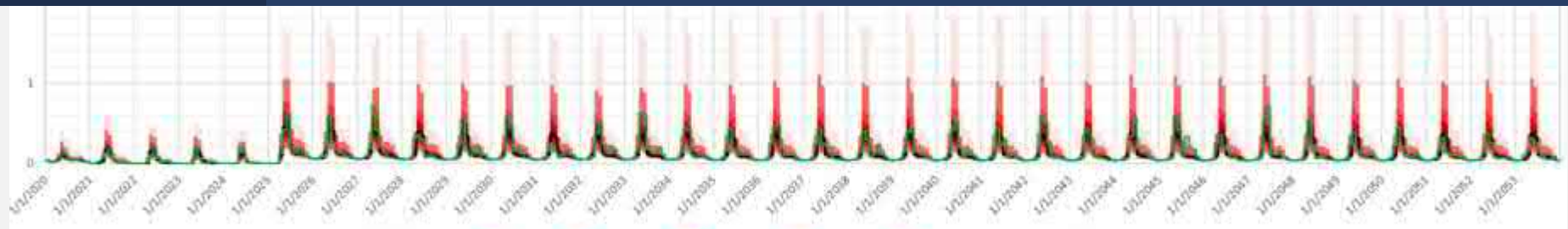

NWP Coal Canada Ltd

# Contingency

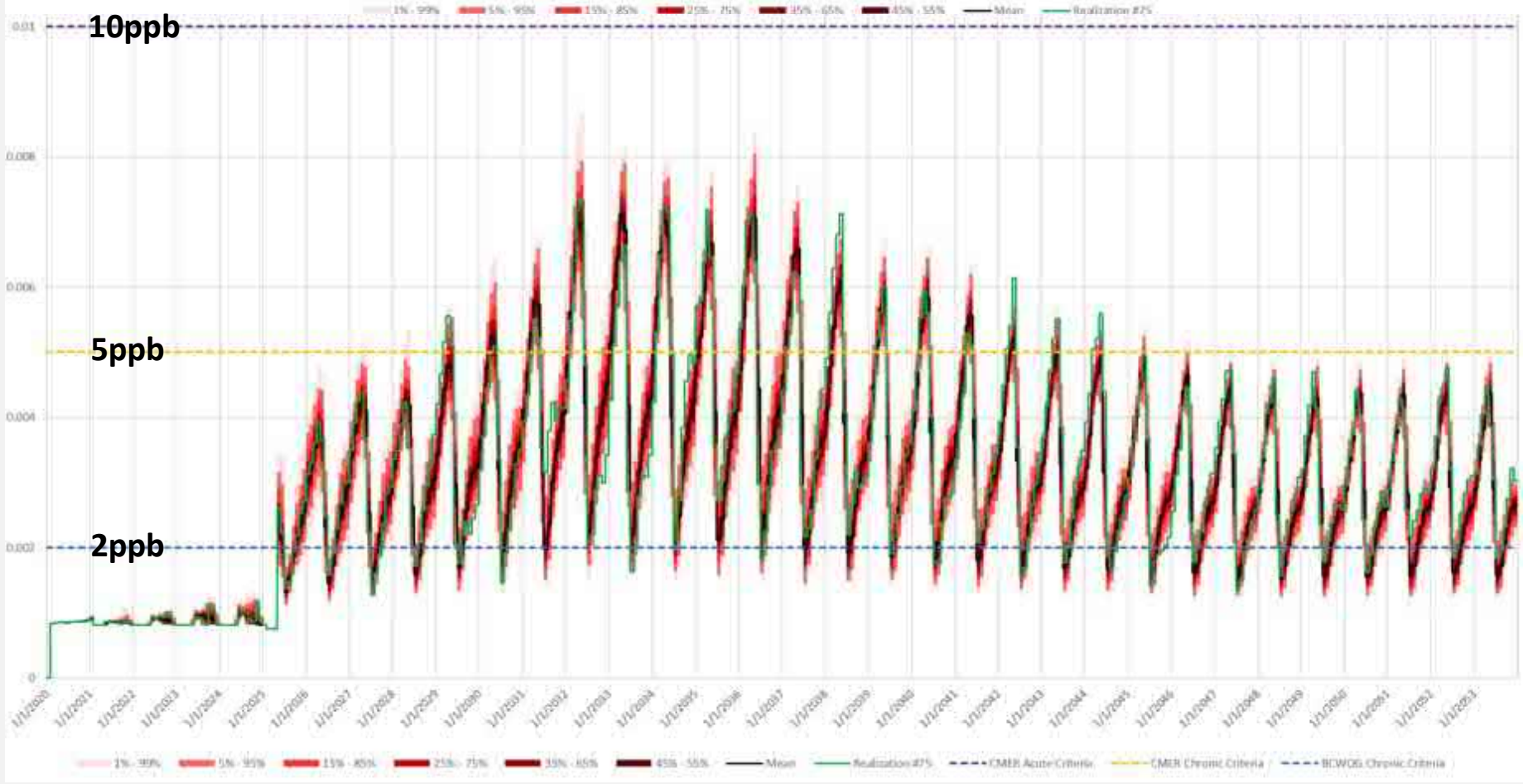
- 10 years to reach peak selenium
- 3 years to confirm performance of Layer Cake
- Contingencies
  - Water Reclaim to Process Plant (interim solution)
    - 1 year to permit
    - 1 year to construct
  - Saturated Rock Fill (SRF)
    - 3 years to permit
    - 1 year to construct  (based on the water reclaim to the process plant)
  - Active Water Treatment
    - 5 year to permit
    - 2 years to construct

NWP Coal Canada Ltd

Mine Effected Water (m3/s)

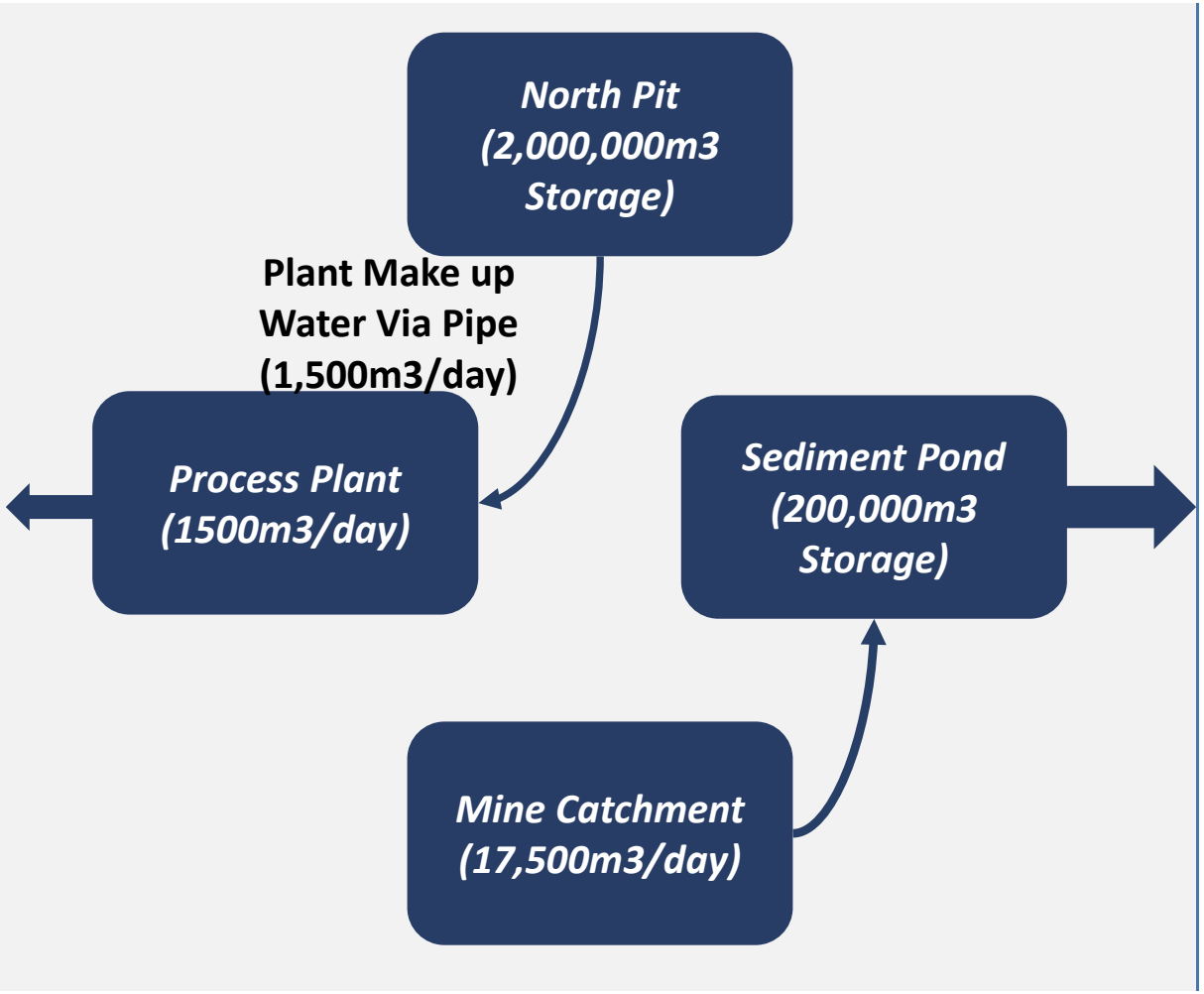


Selenium at Confluence of West Alexander and Alexander (Failure of Layer Cake)

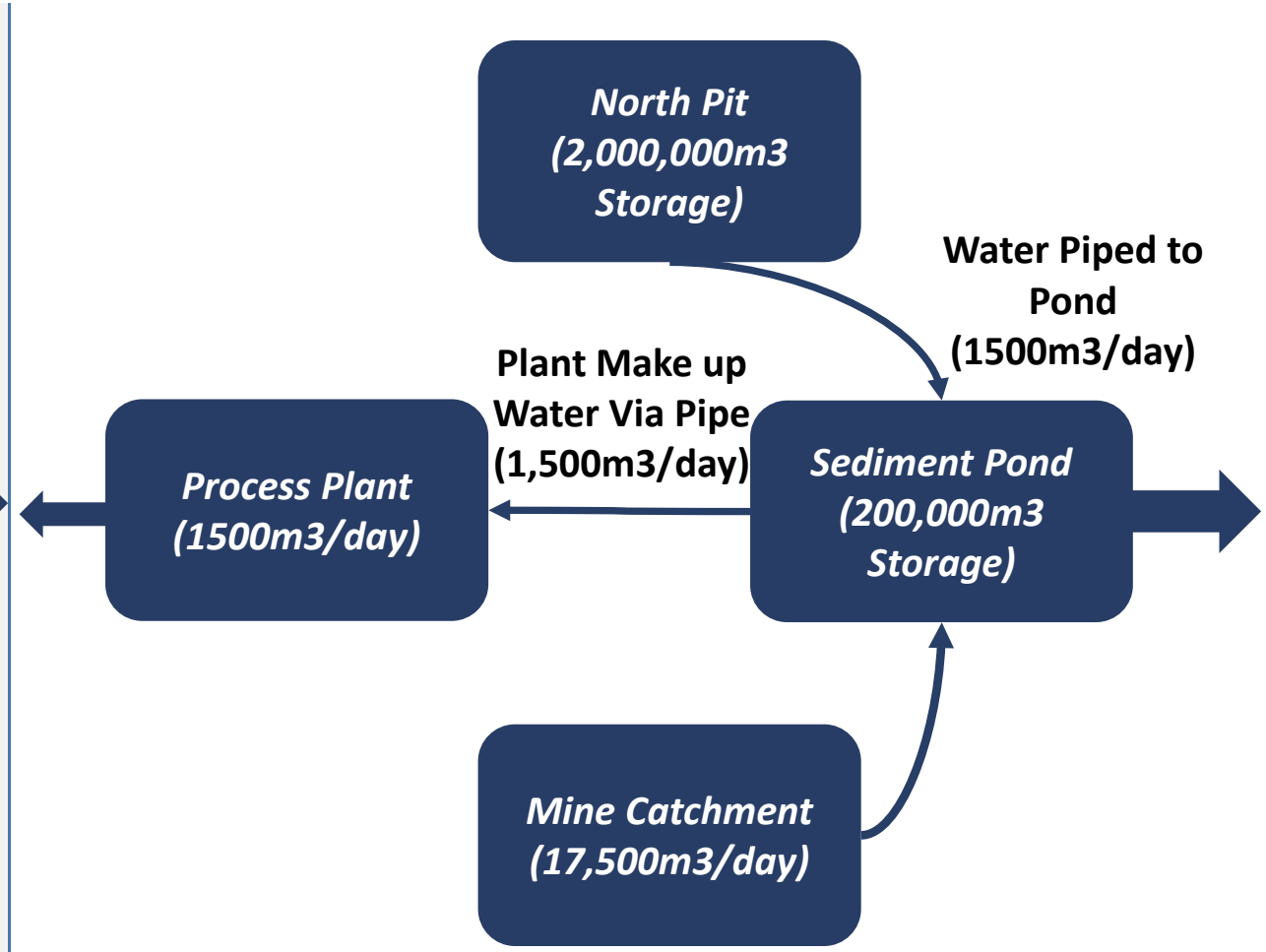


# Flow Diagram

## EA Base Case




## EA Contingency



# Contingency Impacts

- Pump Back to Plant
  - Results in 7% to 8% decrease in Selenium (Average Flow Conditions)
  - Change to Hydrograph
- Pump back to Plant on Pipe North Water to Main Sediment Pond
  - Results in 9% decrease in Selenium (Average Flow Conditions)
  - Results in 18% decrease in Selenium (Low Flow Conditions)
- SRF has capacity to treat up to 15,000m3 (130 day retention)
  - Results in 80% reduction in Selenium

# Questions?