Coal Mine Water Treatment and Proposed CMER

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CMER Presentation/Discussion Panel

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Agenda

1. Proposed CMER Effluent Standards
2. Overview of Coal Sector Water Management Model
3. Overview of Coal BATA/BATEA (2014)
4. New Technologies being advance
5. Conclusions

Proposed CMER Standards (Signal Check: Proposed Coal Mine Effluent Regulations)

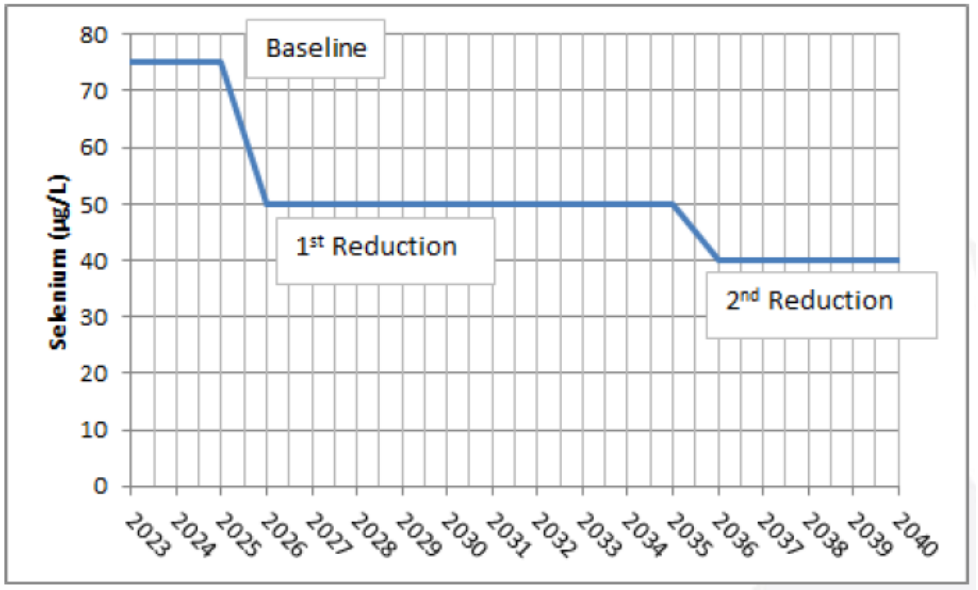
General Approach:

Parameter	Unit	Existing Mines		New Mines and Expansions	
		Max Monthly Mean	Max Grab	Max Monthly Mean	Max Grab
TSS	mg/L	35	70	35	70
Se-T	µg/L	10	20	5	10
NO_3-T	mg-N/L	10	20	3	10

Alternative Approach:

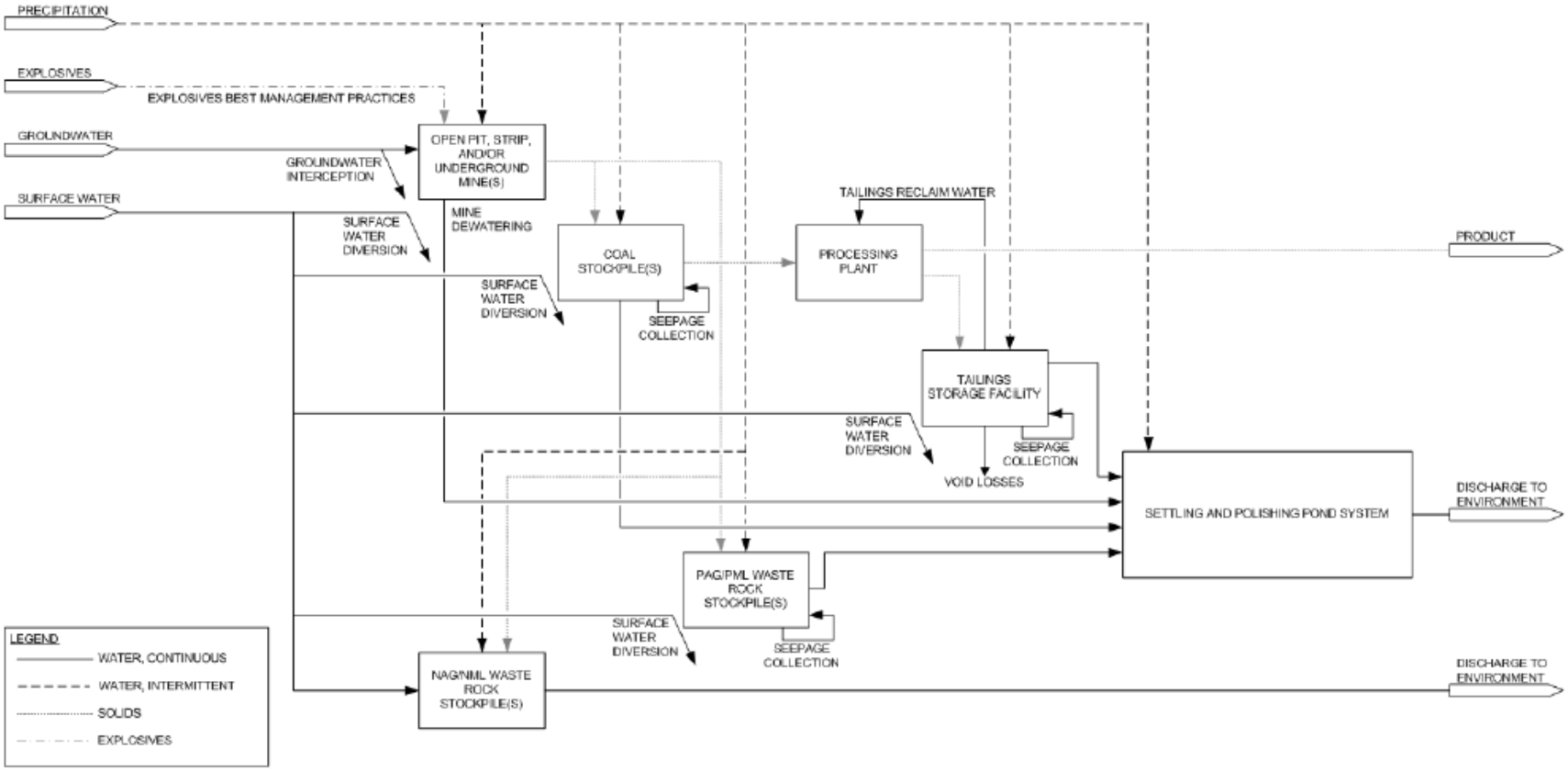
For selenium:

- ECP Receiver-based compliance
- Increasing stringent compliance limits every 10 yrs (see chart)
- Adaptive management approach and EEM results to assign compliance limits



Coal Sector Water Management Model

Source: MEND Report 3.50.1 Figure 6-70 p.245



Overview of BATEA

Coal Sector BATEA Selection Table (Source: MEND Report 3.50.1 Table 10-11 p.508+)

Technology	Effluent Concentrations	Incremental OPEX	Incremental CAPEX
Model Effluent Management and Treatment System	TSS <77 mg/L Se < 380 µg/L	none	none
Sulfide Precipitation (with Polymeric Organosulfide Adds	Se < 50 µg/L	CAD$0.21/$m^3$	CAD$370/$m^3$/hr
Ferric Iron Co-Precipitation	Se < 90 µg/L	CAD$2.78 – 3.53/$m^3$	CAD$19,40 – 24,240/$m^3$/hr
Selective Ion Exchange	Se < 10 µg/L	CAD$0.85/$m^3$	CAD$25,470/$m^3$/hr
Adsorption – Zero valent iron	Se < 10 µg/L	CAD$2.32-3.18/$m^3$	CAD$27,100-$63,730/m^3/hr
Active Anoxic Biological Reduction • FBR • ABMet®	 Se < 5 - 20 µg/L Se < 5 µg/L	 CAD$1.59/$m^3$ CAD$1.29/$m^3$	 CAD$54,670/$m^3$/hr CAD$72,900/m^3/hr
Nanofiltration	Se < 50 µg/L	CAD$0.79/$m^3$	CAD$59,100/$m^3$/hr

Passive/Semi-Passive Biological Treatment

Saturated Rock Fill (SRF)

Teck Elk Valley Operations (EVO) new SRF

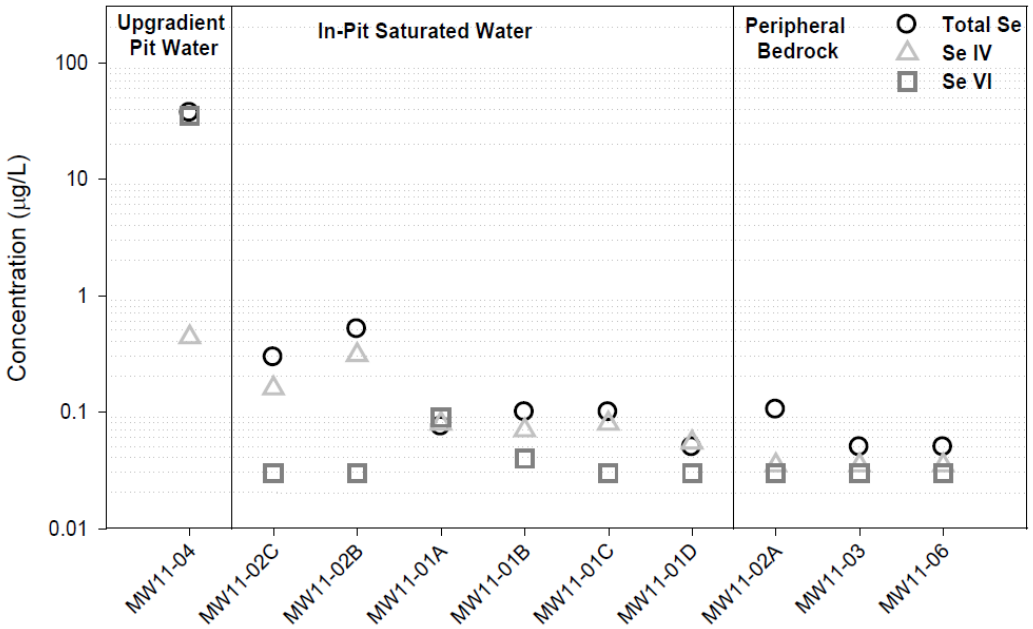
- 10,000,000 million litres/day
- "achieving near-complete removal of selenium and nitrate"
- CAD$41 million
- Exceeds treatment capacity of Teck's West line Creek AWTF.
- Lower OPEX than AWTF

Source: Teck New Release October 15, 2018; Teck Reaches Milestone in Water Quality Research Program

Brule Mine Pilot Test-Trial

- Effluent Se-T concentration < 1 µg/L

Source: Bianchin, M., A., Martin and J. Adams, 2013. in-Situ Immobilization of selenium within the saturated zone of backfilled pits at coal-mine operations [C]. doi:http://dx.doi.org/10.13288/1.0042640. Figure 3.



Summary of Biological Treatment for Metals Removal

Biological Treatment is BAT for Selenium Removal:

- Anoxic Biological Removal Active Treatment (ABMet®) is the only BATEA (MEND 2014)
  - Able to achieve <5 µg/L Se-T in effluent
- Semi-passive Anoxic Biological Active Treatment (SRF) is achieving BATEA-level performance
  - Able to achieve < 1 µg/L Effluent Se-T concentration.
- Other semi-passive Anoxic Biological Active Treatment technologies are being implemented in Western Canada e.g., Biochemical reactors (BCRs).
- New mines and expansions should be able to meet future CMER standards through use of BMPs in water management and BAT/BATEA. Design needs to consider available real-estate available for treatment.
- Treatment levels may be achievable through modular approach of BATs ie. -sediment pond + BCR + polishing pond + settling pond + other polishing (wetland, sulfur modified iron (SMI)).

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