



DE BEERS
GROUP OF COMPANIES

DE BEERS GAHCHO KUÉ WATER LICENCE AMENDMENT TECHNICAL SESSIONS PRESENTATION

Yellowknife (Location TBD)
May 24, 2018

TOPIC 6 - GEOCHEMISTRY



GEOCHEMICAL CLASSIFICATION OF MINE ROCK

- Kimberlite is hosted by granitic rock (95%) with minor amounts of altered granite, granodiorite / diorite and diabase, and overlain by overburden
 - Overburden is non-potentially acid generating
 - Granite has a low sulphur content (median 0.01% sulphide sulphur)
- Based on the results of geochemical tests, mine rock is operationally classified as potentially acid generating (PAG) if it contains **greater than 0.1% total sulphur**
 - It is anticipated that 7.5% of the total mine rock tonnage will be operationally classified as PAG



MINE ROCK MANAGEMENT

- Mine rock will be stored in the following locations:
 - South Mine Rock Pile (Area 6)
 - West Mine Rock Pile (Area 5)
 - Mined-out 5034 Pit
 - Mined-out Hearne Pit (if required)
 - Rock mined from the 5034 Pit will report to the South and West Mine Rock Piles
 - Rock mined from the Hearne Pit will report to the West Mine Rock Pile
 - Rock mined from the Tuzo Pit will report to the West Mine Rock Pile and the 5034 pit



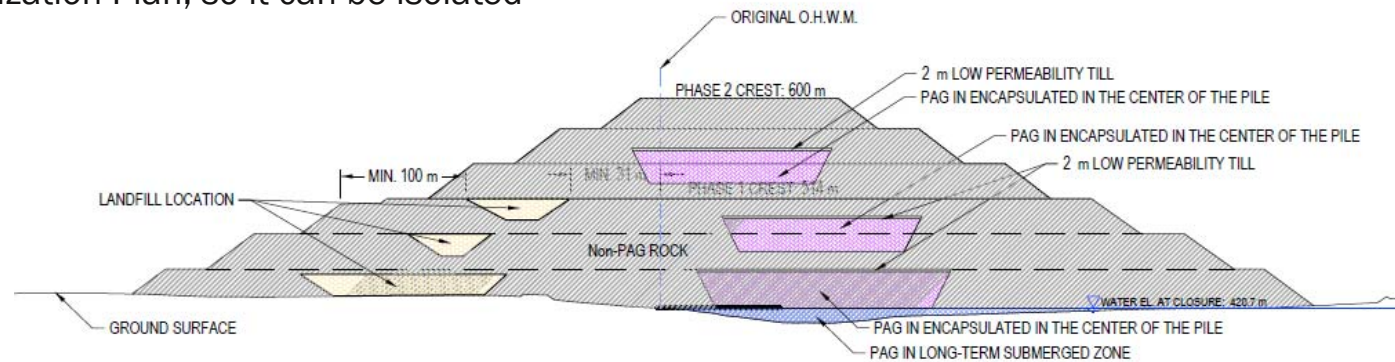
ACID NEUTRALIZATION POTENTIAL OF KIMBERLITE (ECCC-15)

- Kimberlite neutralization potential (NP) ranges from 2.4 to 600 kg CaCO₃/t
 - The average NP is 124 kg CaCO₃/t
 - NP attributable to carbonate and non-carbonate minerals
- Kimberlite has a low total sulphur concentration (average 0.04%)
- Long-term kinetic test results (humidity cell tests) confirm that there is sufficient NP to neutralize the acidity generated by sulphide mineral oxidation



PAG ROCK MANAGEMENT (GNWT-ENR-41)

- PAG mine rock and barren kimberlite will be sequestered in the interior of the mine rock piles OR will be underwater when Kennedy Lake is re-filled
- Rock will be monitored during mining to identify PAG rock requiring special handling, as outlined in the Geochemical Characterization Plan, so it can be isolated



- Mitigation will limit the potential for development of PAG conditions during the period that PAG material may be exposed:
 - PAG rock will be encapsulated with a till layer within Mine Rock Piles to limit water penetrating into PAG rock zones
 - PAG rock will be enclosed in a thick zone of non-AG rock to limit oxygen ingress, and to buffer any potential seepage flow
 - Minimal interaction of runoff and ingress of infiltration is anticipated in PAG rock zones

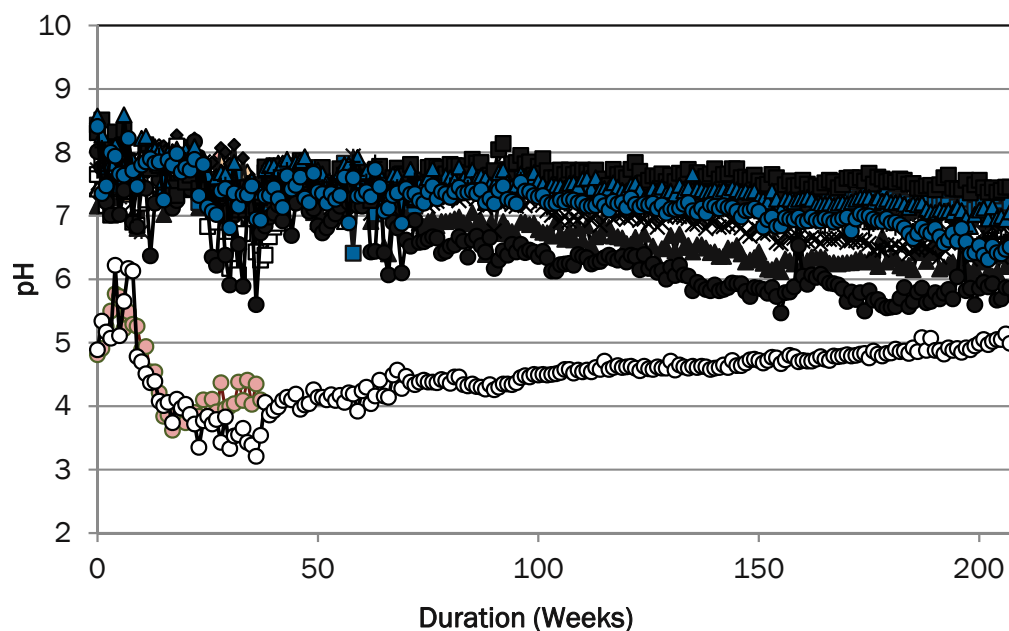
PAG ROCK MANAGEMENT (GNWT-ENR-41, CONT'D)

- Under the current mine plan, PAG material in the rock piles will be exposed above the surface water zone for periods of time during operations and closure:
 - PAG rock in the South Mine Rock Pile is in a relatively dry state from the start of operations to about 16 years after start of refilling
 - Some PAG material will be partially submerged for a short period (between 16 years to about 19 years after the commencement of refilling)
- Some PAG rock in West Mine Rock Pile will be partially submerged for a few years during operation until the water level rises to about elevation 420 masl in 2021, and be then be submerged to until 2026.
 - The water level will drop to about 417.0 masl while the pits are being filled.
 - It will be partially submerged during the refilling phase.
- During the operations and closure period, site monitoring (e.g., SNP, GCP) will be maintained, which will identify any seepage/water quality concerns around the rock piles during periods when the PAG rock is partially submerged

PAG ROCK MANAGEMENT (GNWT-ENR-41, CONT'D)

Time to Onset of Acid Generation

- One humidity cell test generated acidity during testing (HC 16 = 0.1% total sulphur)
 - This result suggests that PAG rock could generate acidity in the short term
- All other HCTs contained 0.01 to 0.07% total sulphur
 - Total sulphur and NP depletion calculations performed
 - Conservatively predicted depletion of sulphide prior to NP in all but three HCTs
 - HC 7, HC 9, and HC 14
 - Even if available NP depleted prior to sulphide in these samples, acid generation is unlikely owing to low sulphur content (0.02 to 0.07%)



PAG ROCK MANAGEMENT (GNWT-ENR-43)

- Geochemical testing of mine rock and kimberlite material has indicated:
 - a low proportion of mine rock would be potentially acid-generating (PAG) (<7%)
 - all PK non-acid generating (NAG)
 - therefore, runoff and seepage from the mine rock piles and PK storage facilities in the post-closure phase not anticipated to provide any adverse risk to Kennady Lake
- Potential for acidic drainage and metals release will be addressed through ongoing environmental monitoring (including field tests) and seepage studies associated with the Geochemical Characterization Plan
- In addition to monitoring, two reclamation plans in the ICRP will confirm and/or refine seepage mass loading predictions from the mine rock and PK disposal facilities in post-closure conditions and confirm the long-term performance of the designed mine rock covers for the Fine PKC Facility and Coarse PK Pile:
 - # 2.2: Post-closure seepage quality and quantity and
 - #3.1: Physical stability of engineered rock covers
- The design of the mine rock piles will facilitate surface runoff and further limit infiltration and water contact with PK or PAG mine rock material prior to entering Kennady Lake:
 - storage of PAG material well within the piles, and
 - use of engineered mine rock covers on the Fine PKC Facility and Coarse PK Pile

PAG ROCK MANAGEMENT (GNWT-ENR-43, CONT'D)

- During operations and closure phases, adaptive management action levels for seepage monitoring results at mine rock piles and the PK storage facilities have been established:
 - approved under the Geochemical Characterization Plan
- Action levels have been developed with two primary objectives:
 - to prevent the formation of acid rock drainage
 - to minimize the potential for discharge of acidic drainage or seepage that could cause an adverse environmental effect

PAG PROPORTION IN MINE ROCK (MVLWB-25)

- Table 5 of the Geochemistry Characterization Plan was reviewed and the 2017 data regarding a summary of acid generation potential for mine rock by rock type was updated in the response (MVLWB-25)

Rock Type		Total Number of Samples	>0.1% Sulphur	
			n	Percent (%)
De Beers (2012a)	Granite	1,189	63	5
	Altered granite	10	7	70
	Diabase	7	3	43
	Diorite	1	1	100
	Gneissic granite	9	2	22
	Granodiorite	6	1	17
	Altered granodiorite	16	16	100
	Total number of Samples - Baseline Geochemical Characterization	1,238	93	7.5
Operational Monitoring - 2016		2,314	208	9.0
Operational Monitoring - 2017		2,409	141	5.9

INPUT SOURCE TERMS (MVLWB-26)

- The reference to the Geochemical Characterization Plan in the updated Water Quality Model Report (Golder 2018) regarding the geochemical source term inputs was an error.
- Tabulated data and reasoning for all source inputs from mine rock to the updated water quality model remain consistent with those developed as part of the EIS Supplement (De Beers 2012):
 - a geochemical source term profile was developed for each lithology based on humidity cell testing, which was then prorated based on the relative proportion in the pile
 - TP treated slightly differently – P inputs very conservative in EIS supplement, so input concentrations updated using the most up-to-date humidity and saturated column test results (MVLWB-26)

PAG ROCK MONITORING DURING OPERATIONS (NHX-11, NHX-12)

- Challenging to visibly detect sulfide material in blasted mine rock
 - Rock material analyzed for total sulphur content prior to blasting
 - Samples of rock chips collected from drill hole cuttings from blast holes are analyzed using an on-site calibrated LECO laboratory
 - A sub-set of samples are submitted for external verification
- Sulphide minerals occur as heterogeneously distributed grains in mine rock and kimberlite material
- If PAG rock is identified, material is managed as outlined in the Geochemical Characterization Plan
 - PAG rock flagged for movement to appropriate PAG rock zone in active mine rock pile
 - If a greater than anticipated volume of PAG rock is identified, the following tasks will be completed:
 - a review of samples relative to the mine plan to identify geochemical and mineralogical trends
 - confirmation of availability of space in the mine rock piles to sequester PAG rock
 - initiation of a follow-up investigation to determine the implications of greater than anticipated amount of PAG rock

THANK YOU

Questions