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DIVISION OF RECLAMATION
MINING AND SAFETY

MineWater

London Mine Mineral and Water Production – Quarterly Status Update

From COSA § 48: "Each Quarterly Report shall outline activities undertaken in the previous quarter and shall specify what activities will be undertaken within the next quarter to achieve compliance with this Consent Order and Settlement Agreement."

Section 39: Evaluation of the London Mine Water Tunnel Facility's wastewater treatment system:

1. **Inventory of mine flows**
    a. Water Tunnel flows continuously, year round, between 600 – 900 GPM. Concentration of contaminants is 4 mg/L Zn, 15-40 ppb Cd, with pH generally around 7.4. Tunnel was collapsed since May 2015 and water was impounded with sludge settling in the tunnel behind the collapse.
    b. Extension Tunnel flows intermittently, between late May through end of August or September, at rates averaging 5-10 gpm if run-on is first controlled at the steel bridge crossing the portal opening.
    c. Seepage with an orange staining and low pH was noted downgradient of the waste piles near the Ophir tunnel, which dries up later in the year after July. This infiltration/seepage is contributing to the collapse of the Ophir Tunnel entrance. This seepage does not directly enter surface water.
    d. Seepage from the eastern mine dumps is infiltrating above the Water Tunnel portal, and causing a softening of the ground to the bedrock contact and contributing to the collapses that have occurred both within the tunnel and around the tunnel onto the roadway. This seepage does not directly enter surface water.
    e. Combined loading of zinc from sources at the Mine other than the Water Tunnel is about 3 lbs/day.
2. **Inventory of uncontrolled flows into Water Tunnel**
    a. Flow from the 0210 Drift (a drift is a horizontal tunnel within the Mine typically parallel to the vein mineralization) contributes more than 90% of the flow, and contains pH 8.2-8.4, 280 uS/cm electrical conductivity water, and about 300 ppb zinc. This flow contains a mass load of zinc of about 2.7 lbs/day.
    b. Flow from the 0205 Drift was measured at 24 gpm using the mass balance method. This would not all be capturable by collecting all the flow at the 0205 Drift entrance because there are ceiling drips and other flows in the vicinity and the entire floor is covered with sludge, making specific measurement difficult. This flow contains 1.13 lbs of zinc per day.
    c. Flow from the Water Raise Crosscut (a cross cut is a horizontal tunnel typically perpendicular to the vein mineralization) was measured at 19.7 gpm using the mass balance method and confirmed with the rate of collection into a 5 gallon bucket from the pipe leaving the concrete bulkhead. The pH was found to be vary between 2.9 – 4.0, highly variable over short time intervals with electrical conductivity between 1,800 and

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2,500 uS/cm, and zinc concentration around 100 mg/L. Zinc load was found to be 22 lbs/day by mass balance.

d. Numerous seepages were observed to enter the tunnel along partially calcified faults identified as "cross faults" or "water course faults". These fault structures were noted to be approximately perpendicular to the main Water Tunnel and discharged a few gpm containing Ec of 310 – 380 uS/cm and pH between 7.5- 8.2. Overall, these other flows contributed 43 gpm to the Water Tunnel discharge at a zinc concentration of 2.6 mg/L for a total Zn load of 1.35 lbs/day.

3. **Capabilities of current Water Tunnel Treatment Facility.**
   a. Existing facilities only provide for settling and sedimentation of sludge particles with an effective residence time of less than 2 hours. Previous attempts at baffling the pond to increase the residence time have failed. Given that the pH of the combined flow is generally around neutral pH most of the iron, aluminum and manganese will be in a particulate form so the settling pond at the outfall does prevent intermittent sludge releases in the mine from directly impacting the quality of the outfall. The pond does not effectively remove dissolved contaminants such as zinc and cadmium.
4. **Potential improvements**
   a. Addition of a cationic acrylic polyacrylamide polymer diluted to 0.15% at a rate of 3-5 mL/min at a standpipe near the northeast corner of the Quonset building was found to be an effective method to enhance settling during mine entry efforts that could dislodge solids that accumulate throughout the mine workings. If polymer is added in this manner solids can be retained in the pond at the typical flow rates encountered (800 - 900 gpm) without exceeding 5 mg/L TSS (about 9 NTU).
   b. Direction of the waste flow from the Water Raise drift to the previously identified in-mine treatment area and addition of 1,400 ppm of a 80% methanol, 10% ethanol/water mixture to the captured flow has resulted in a flow upwelling from the Lower Davis workings at about 20 gpm at a pH of 6.9 and exhibiting a biological, slightly swampy odor and reduced iron coloration (dark brown/black indicative of iron monosulfide mineral formation).
   c. MineWater plans to redo the mass balance around the Lower Davis workings now that the treatment has been ongoing since November, and will add this flow to the inventory of flows.
5. **Capability of in-mine treatment**
   a. In-mine treatment should be able to keep the captured water in an iron-reduced state (ferrous rather than ferric), allow the mineral acidity to contact the limestone host rock and neutralize the pH to above 6.0 while precipitating most of the zinc and cadmium as metal sulfide minerals within the reaction area. Once the reactions have stabilized and the line power is restored, MineWater will characterize the flow and present an update in an upcoming quarterly report, when the data is first available, on the quality of the discharge from the treatment area.

Results of this evaluation will be used to inform a feasibility-based solution to address the Water Tunnel discharge.

Section 40. File a petition for site-specific rule-making seeking a feasibility – based solution to address Water Tunnel discharge.

This was filed and accepted by WQCC in December 2016.

Section 41. Repair of the Water Tunnel and implement the Work Plan. Work Plan to be used during mine repairs, and shall include:

1. **Inspecting, repairing and maintaining the settling pond system**
2. **Removing sludge to an on-site repository**
3. **Real – time monitoring of flow during active repairs (TSS, pH and Ec)**
4. **Directing cleaner water around the pond**
5. **Directing the worst quality water for treatment**
6. **Amending the water with polymer flocculent and NaOH if needed.**

Repairs were initiated in August 2016 and are ongoing. We have not needed to bypass the treatment pond. When sludge is encountered in the mine we have been able to settle it within the mine without generating a sustained waste flow containing a level of turbidity that would be untreatable. This is due to the effectiveness of the polymer dosing. We maintain a webmaster with online access (accessible by satellite communications) that provides real time quality at all times for Ec, and we maintain the turbidimeter and pH hand held meters on-site for any newly encountered flows during repair work. We anticipate that the sludge stockpiled behind the Water Raise Drift bulkhead will require a bypass if we have to climb the Water Raise, but we are trying to develop methods of directing the Extension Level drainage to the treatment area without having to disturb the sludge behind the Water Raise bulkhead.

Section 42. Implement measures to

1. **permanently segregate uncontrolled flows of low pH high metals concentration waters.**
    a. Coffer dam was constructed in October 2016 at the Water Raise Drift bulkhead, and a titanium impeller / plastic housing 0.5 HP Tsurumi pump (20 lbs) was installed with 480v 3Phase power supplied from the Extension Level Treatment Facility capable of pumping up to 60 GPM at 4 feet of head to the Lower Davis workings for in-mine treatment. The initially planned Toyo (Hi-Chrome/stainless) pump (140 pounds) completely corroded out and failed within 2 weeks of installation.
2. **begin in-mine treatment of such segregated waters**
    a. **results of electrical conductivity survey**
        i. 0210 water is about 280-320 uS/cm
        ii. WRD water is about 1900 uS/cm
        iii. Combined WT discharge is about 420 uS/cm
        iv. After removal of the WRD water to the Lower Davis treatment area, the conductivity of the Combined WT discharge decreased of about 320 uS/cm.
        v. The conductivity of the Lower Davis treatment area discharge is about 900 uS/cm consistent with the high sulfate / bicarbonate content expected from the neutralized waters. Once this water began to mix with the Water Tunnel

discharge, the conductivity has crept up to about 340 uS/cm since early March.

b. **constructability assessment for separation of the high conductivity waters.**
   i. Construction is complete and separation of the high conductivity water from the Water Raise Drift is at better than 95% effectiveness as calculated from the baseline Ec of the 0210 drift water.

c. **sampling report from the contributing water sources**

Zinc survey and mass balance. (additional balance info available from attached TestAmerica certificate of analysis from October 13 sampling event).

Sample locations	Zn, ppb	Sample locations	FlowEst	Water flow, lbs/day	Zn mass
O210	290	O210	90%	9,403,517	2.73
O205	3900	O205	24.1	289,457	1.13
USWR	400	USWR		9,692,974	3.88
WR	93000	WR	19.7	236,191	21.97
DSWR	2600	DSWR		9,929,165	25.82
WT001	2600	WT001	870	10,448,352	27.17
SMCUSWT	120	SMCUSWT	4.31	23,243,731	2.79
SMC003	890	SMC003		33,692,083	29.99
NMC001	24	NMC001	12.02	64,800,929	1.56
MC001	320	MC001		98,493,012	31.52
MCKKRD	200	MCKKRD		157,588,819	31.52

On October 13th the flow from the Water Tunnel was recorded at around 870 GPM. This flow contained 2600 ppb zinc. 21.97 lbs of the 27.17 lbs of zinc loading in the Water Tunnel flows on that date arose from the Water Raise (WR). The largest single source of zinc loading entering the Water Tunnel other than the Water Raise was drainage from the 0205 drift, at 24.1 GPM. While this source could be treated using in-mine treatment, it would displace other higher concentration flows during the higher flow times of the year, and it is not readily captured, collected and conveyed to the treatment location given its passage (upstream of the first possible capture point) through the limestone host rock causing partial neutralization and resultant formation of large amounts of iron hydroxide sludge.

The immediately downstream location SMC003 was flowing at an unknown flow rate, but the metal load was measured at a concentration of 890 ppb zinc. By principles of conservation of mass, we can solve for the minimum flow to be able to dilute this load to this concentration, meaning that the flow had to be around 4.3 CFS in the stream after addition of the water tunnel flow at a rate of 1.94 CFS. Upstream of the water tunnel, the entire South Mosquito valley was draining at a rate of 2.37 CFS.

Once this zinc load moved down to mix with the North Mosquito Creek the product of that mixing was observed at MC001, and the concentration was 320 ppb. The effective dilution from SMC003 to MC001 is 2.78 times, meaning that 12.02 CFS entered the South Mosquito Creek at the confluence with North Mosquito Creek to cause the 4.31 CFS at SMC003 to be diluted to 320 ppb. All of these calculations are back-validated by analysis of the upstream zinc (or sulfate or copper or electrical conductivity) so that we are not assuming distilled water dilution but the actual dilution from existing observed concentrations of on-site flows. In most cases the difference was negligible, with North Mosquito carrying 24 ppb zinc, and upstream of the Water Tunnel on South Mosquito Creek (SMCUSWT) carrying a load of only 120 ppb zinc.

The drainage area of the two valleys (North and South Mosquito Valleys) tributary to these flow measurement points was measured on Google Earth Pro to be both about 5(+/-0.3) square miles. Mean annual runoff from this area should be about 48'' water x 10 square miles/12 months, or 38 CFS. In the month of October we would anticipate lower flow rates, tailing down to below the mean annual average, but the difference beween north and south valleys is far greater than could be explained by statistical variation. This observation is very supportive of the development of additional water from behind the London Fault through additional mineral exploration.

In summary, this mass balance is very supportive of there being a large portion of the incident rainfall and snowmelt that does not contribute to the flow out of the South Mosquito Creek valley in comparison to the flow that arises at similar elevation, and similar climate, from the North Mosquito Creek drainage area.

d. construction documentation report

i. system design

1. final system design report will be completed in summer 2017 after line power is reinstalled.
2. Main elements of the design are:
    a. Daily addition of 40 lbs of dissolved organic carbon in the form of alcohols (methanol and ethanol) into the intake of the collection pump within the coffer dam, and
    b. Pumping the carbon-amended wastewater from the Water Raise Drift to the Lower Davis workings via the C148 escape raise located at the end of the 0202 cross cut,
    c. Reaction of the carbon amended acidic waste water with limestone in the walls of the workings, and with the dissolved organic carbon, to form sulfate-reducing conditions and precipitation of metals.

ii. photographs documenting constructed system

1. documentation will be provided once we are back onto grid electric power.
2. Upwelling water from the treatment area visually looks treated (no longer orange/red low pH but rather neutral pH and black-tinted water.

e. evaluation of the effectiveness of the in-mine treatment system

Power issues. MineWater has installed (late March-early April) a backup generator power system at the mouth of the Water Tunnel so that if other power issues arise, we can maintain treatment operations without interruption. It is likely that we will have more than one source of power (diesel, wind, solar) for maximum reliability of the long-term treatment solution.

Treatment of mine water within the mine. We began to see breakthrough of treated water upwelling from the reservoir in the lower Davis workings in early March. This was consistent with our views of the capacity of the treatment area, meaning that we will likely have a little more than 2 weeks treatment retention time

in the mine pool at peak (60 gpm) flow. The pH of the treated water was at 6.9, while the incoming water was around 3.0. Electrical conductivity out of the treatment area was 920 uS while incoming was at 1900 uS. All of these measurements are indicative of good reaction with the limestone in the workings, and the results from metals analysis in the effluent indicate that we continue to achieve better than 95% removal of the metals entering the treatment area.

Section 43. Due by November 22, 2017 Fully installed in-mine treatment system. Begin optimization of the system to reduce exceedances of the effluent limits.

MineWater has already begun optimization efforts.

3D Model. During the first quarter 2017, MineWater worked with All One River GIS (Michele White, PG) to construct a three dimensional model depicting the mine workings, the geology of the area, the phreatic water surface as measured in September 2016 during our field work, and the land holdings and topography of the development area. Once this model was working at a draft level, we then convened a peer review team comprised of the former chief mine geologist (Dean Misantoni, CPG), a professional hydrogeologist (Mark Stacy, CPG), the modeler (Michele White, CPG), several peer reviewers internal to Lidstone Associates for hydrology review supporting Mark Stacy, and Joe Harrington. The model was finalized in February 2017.

This 3D model helps to design the full scale dewatering of the Paleozoic Aquifer (PA) to prevent intrusion of the artesian water from the PA entering the pyrite-rich porphyry rock confining and overlying the PA. Dewatering will prevent or reduce the intrusion of clean water into pyrite rock and prevent or reduce the generation of acid rock drainage from the mine workings.

One particular fly-by view of this 3D model is viewable at www.minewater.com, then selecting 'more' from the action menu at the top of the page, selecting Development Results from the drop-down menu bar, and entering the password 'brittan'.

Drilling design. MineWater retained Lidstone Associates to prepare the well design, including methods of construction of the wells, the number of wells, diameter and depth of the wells, materials of construction, and the location of the wells. Particular thought has been devoted to the acidization design with a subconsultant (Scott Andrews, PE) retained for this portion of the design. Lidstone recommends installation of 2 large diameter boreholes cased with 30" casing to bedrock, then 24" boreholes to full depth planned at 1,000 feet. The wells will be completed with a 16" casing and the appropriate formation stabilization methods to prevent collapse of the lithology against the well components.

Downhole equipment and electric service. MineWater anticipates that developed water will be produced from the fault-bounded and Belden-shale confined Leadville Limestone/ Paleozoic Aquifer by two large (24" boreholes) 16" screened wells completed to a depth of 1000 feet, which will dewater into the workings of the London Mine and thence will be discharged to the existing measurement point and the existing permitted Outfall. The water level above the pumps is to be maintained at 250 feet, and the pumps are 70 feet long and set 50 feet above the bottom of the boreholes.

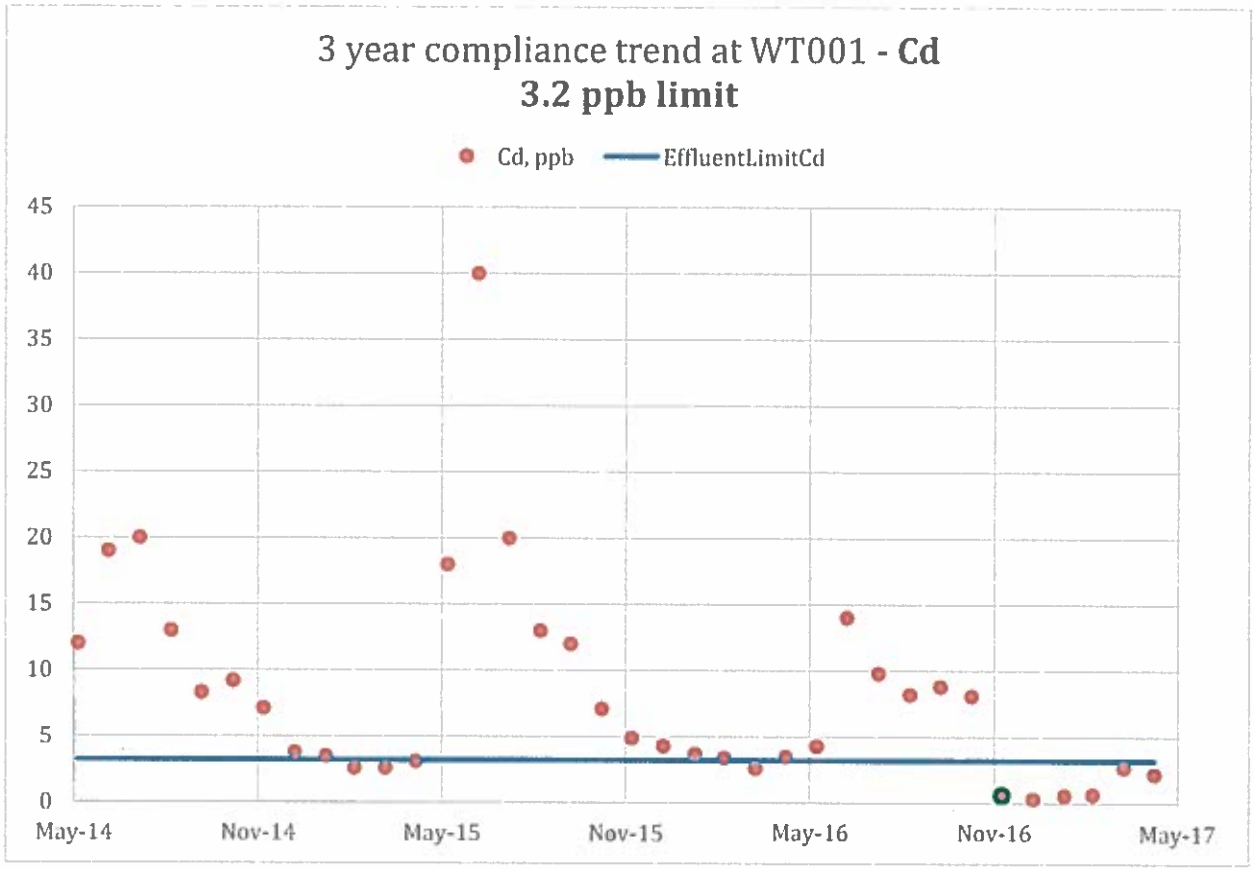
Section 44. Due by September 30, 2018. Complete optimization efforts to attain permit limits as they may be revised prior to that date or to comply with a discharger specific variance.

Section 45. Stream sampling at SMC003 for zinc, cadmium, arsenic, lead, copper and silver. Samples have been taken since October 2016. Trends are presented here:

Section 46. Upgrades at Extension Tunnel. Sulfide dosing if needed, sampling for sulfate/sulfide only if sulfide is used.
A clarifier was installed in June 2016 in the Extension Tunnel Treatment Facility to better remove solids during the first stage of treatment. Sulfide dosing was not needed to maintain compliance during the late summer samples due to changes in composition. MineWater is reviewing these records with the ORC to determine conditions that may require sulfide dosing and if required, sampling for sulfide/sulfate will be initiated at that time. We anticipate that all source water will be routed to the Water Tunnel in-mine treatment system by May 25, 2017 and that the Extension Tunnel Treatment Facility will be held on standby, with no treatment planned, during this upcoming quarter.

Section 47. Sampling required unless extreme weather conditions are documented. Sampling has been difficult for each monthly sample during the quarter, and in subsequent events to the present. Samplers have to hike in from the junction between CR12 and CR696 to the outfall, an elevation gain of more than 500 feet and traversing large snow drifts often deeper than 15 feet over the 3 mile route. Plowing the road is not viable because it drifts over rapidly due to the high winds typical of the area. It is not impossible, but it is a judgment call whether the safety of the sampler is of higher importance than the value of the sample results. [redacted] If a sample at the property boundary could be used in the future to define a compliance point during winter months (near or at SMC003) then it would lessen the risk of bodily harm to the sampler. MineWater will continue to evaluate safety thresholds and other types of sampling methods (drones?) to see if another strategy could lessen the risk to our people.

Sample results are shown below for WT001 for each of Cd and Zn. We have been operating on generator power for two months (April and May 2017) and this lack of reliable power is partially the cause of increased concentrations of zinc and cadmium in the discharge. The generator has been operating for about 85% of the time with the causes ranging from breakdown to running out of fuel. As a result the treatment process has been online about 88% of the time since March 28th. The difference between generator on-line and treatment online is that when the system is operational, the collection dam can hold several hours of capacity, so it instantly comes back online when the generator starts up, and then the treatment fails over time as the collection dam fills and overtops the cofferdam without a working pump due to lack of electric power. We are constantly checking the system but we have not been able to provide a 24/7 on-site operator until weather factors allow for immediate access to the site.


3 year compliance trend at WT001 - Cd
3.2 ppb limit
Cd, ppb
EffluentLimitCd
45
40
35
30
25
20
15
10
5
0
May-14
Nov-14
May-15
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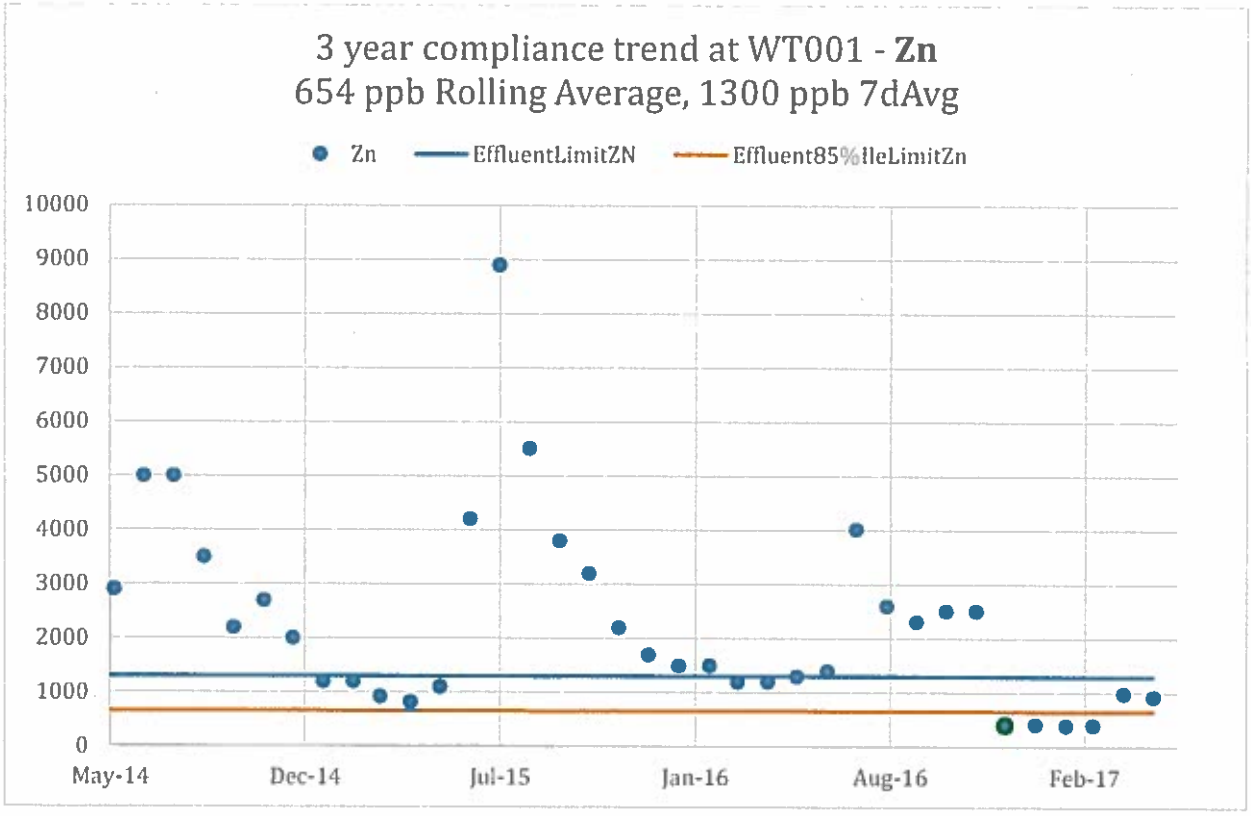
May-16
Nov-16
May-17


3 year compliance trend at WT001 - Zn
654 ppb Rolling Average, 1300 ppb 7dAvg
Zn
EffluentLimitZN
Effluent85%ileLimitZn
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
May-14
Dec-14
Jul-15
Jan-16
Aug-16
Feb-17

49. Demonstration that Extension Tunnel flows are "adequately addressed by improvements constructed and operating in the Water Tunnel".

The goal of the Extension Level work is to prevent the movement of contaminated mine water toward the portal on the Extension Level, and to separate surface melt from mine impacted water and redirect the Extension Level mine-impacted water sources to one location, the Water Raise, for subsequent pumping to the Lower Davis workings which are permitted (by EPA) for underground injection control activities. MineWater has expended great efforts to rehabilitate the ladder connection from the Water Tunnel via the 0205 drift tunnel to the Escapeway Raise to the Extension Level. Access to the base of the wooden ladder took about 2 weeks of work to get road access open, repair past the collapses in the 0205 drift, and repairs to the concrete cofferdam that is located most of the way back to the back of the drift near the base of the ladder. Efforts to access the Extension Level using the Escapeway Raise ladder were foiled with the partial failure of the pre-existing wooden ladder in late January during preliminary testing of the competency of the ladder once access to the base was established.

After meeting with all parties including our outside contractor (Kessler Reclamation of Canon City, CO) MineWater elected to hire a group of mountain climbing experts (Denver Mountain Guides) who agreed to enter the mine and assist MineWater in installing a new steel ladder 160 feet (vertically) from the Water Tunnel to the Extension Tunnel workings. Procurement of supplies was completed during February and training was completed in March. The training was designed so that we can have qualified personnel who can safely tie off and transit the ladder while loaded with supplies for the Extension Level repairs, and mitigate the risk of serious injury as a result of repairs on the Extension Level.

These efforts were full-time during March-early May. In early May we encountered a blockage about 120 feet up the route of the planned ladder that, at this time, has foreclosed the option of completing the ladder route. 120 feet of steel ladder has been constructed in the mine escapeway raise. We are considering and studying ways to get around this obstruction. We also conducted reconnaissance in the Extension Level to determine if access could be achieved from the Extension Level portal to the Water Raise. The Extension Level was found to contain about 3 feet of muck from behind the first major collapse 200 feet in from the bulkhead, to about 700 feet in. Our team traversed 4 major collapses during the mission, but were unable to safely advance any further due to precarious rock conditions overhanging the tunnel.

We also have opened up the Water Raise drift to see if we could achieve access by directly climbing the Water Raise itself. We discovered that there are very difficult conditions in that drift that may require a temporary bypass under Section 41 to get to the base of the Raise.

Given all of these conditions, MineWater has decided to install a collection system within the Extension Level at the Bulkhead, and to segregate the surface snow melt from the internal groundwater flow at that location. Captured contaminated water will be directed to the Water Tunnel using a 2" HDPE pipe, and pumped to the Lower Davis workings for in-mine treatment. After completion of the dewatering system to the west of the Extension Level workings we anticipate that some of the water will stop entering the workings and arriving on the Level for treatment. When this has equilibrated, we intend to drill from the surface, through the Extension Level and then into the Lower Davis workings, without hitting the Water Tunnel level workings. This work is planned for completion in the summer of 2018. The boreholes will be kept open using a screened intake, lined the entire length, and have a downhole cleanout system so that sludge can be broken up periodically to ensure continued capture of source water and direction of any remaining captured source water to the treatment zone.