RECEIVED

JUN 20 2017

DIVISION OF RECLAMATION
MINING AND SAFETY

ALEXCO

7720 E. Belleview Ave. Ste. B-104
Greenwood Village, CO 80111
Phone (303) 862-3929 Fax (303) 862-3926
www.alexcoresource.com

Application for Underground Injection Control Program Review for Permit or Permit by Rule Authorization

The London Mine water tunnel was constructed in 1912 to provide drainage for the London District of underground gold/silver mines above an elevation of 11,326 feet amsl on London Mountain near Alma, 12 miles northwest of Fairplay Colorado. Since 1949 the water flow from the Water Tunnel has been fairly constant with an average flow of about 1.1 million gallons per day.

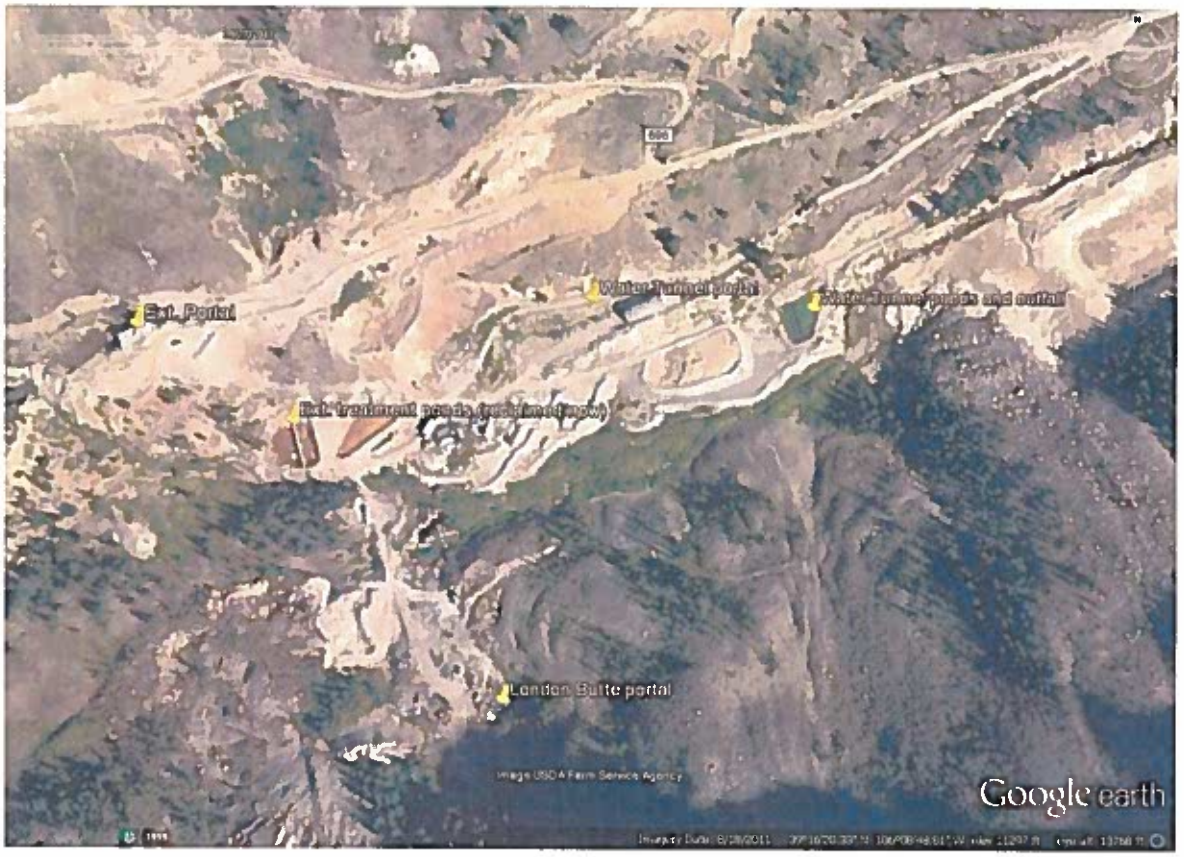


Figure 1 Surface layout

The Water Tunnel discharge is the subject of CDPS Permit No. CO-0038334, which regulates among other parameters cadmium and zinc potentially dissolved in the discharge water at the outfall. Effluent limits include a rolling average of 654 ppb Zn, and 3.2 ppb Cd.

Notice of Violation has been issued by CDPHE to the London Mine LLC in March 2013 for exceedance of zinc and cadmium discharge standards. The London Mine LLC has been discussing with the CDPHE alternatives to attaining and maintaining compliance with that discharge Permit.

The typical discharge from the Water Tunnel over the past several years contains potentially dissolved cadmium at 17 ppb and zinc at 3,800 ppb.

Alexco Resource U.S. Corp. (Alexco) is hereby requesting EPA UIC Program approval for a full-scale one-year demonstration of in-situ treatment of zinc, cadmium and other dissolved heavy metals within the mine pool of the London Butte Mine so that the discharge from the Water Tunnel to South Mosquito Creek can be remediated at full-scale in a sustainable manner.

Alexco Resource U.S. Corp., has developed the strategy to improve the quality of the Water Tunnel discharge through the following steps, the implementation of such strategy is the subject of this Application:

1. the identification of metal – rich water at various locations in the London Mine prior to the entry of the contaminated water into the main Water Tunnel,
2. the separation and collection of the identified target waters, so that the remaining Water Tunnel discharge will be cleaner in quality and attain the Discharge Standards within the CDPS Permit,
3. the conveyance of the target waters to the area surrounding the London Butte mine shaft,
4. the amendment through addition of sugar solutions (such as molasses or corn syrup) and alcohols (methanol or ethanol) into the target waters at a stoichiometric ratio to cause formation of sulfate reducing conditions within the target waters,
5. the injection of the collected and amended target waters into the London Butte mine workings, which are presently saturated at a level below the hydraulic level of South Mosquito Creek,
6. the in-situ treatment of the zinc and cadmium contamination to precipitate the soluble metal ions as insoluble minerals within the saturated portion of the mine pool of the London Butte Mine.

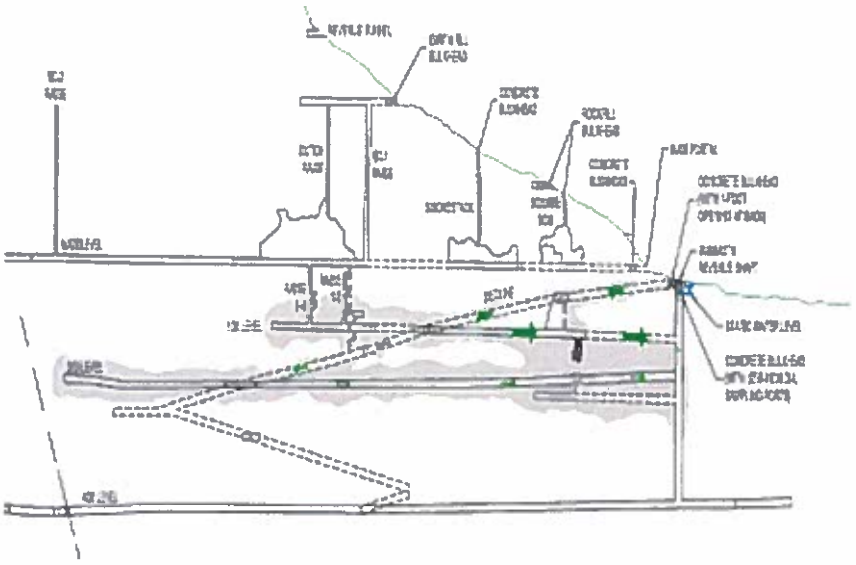
Similar treatment strategies have been implemented with success at other mines and for other sources of contamination in Colorado under EPA UIC Program approval. An example of this success for in-situ zinc immobilization treatment in an underground gold mine is the Platoro Mine in Conejos County Colorado.

The UIC Program has provided three permits by rule authorization for addressing similar mine pool quality issues at Platoro. The first authorization was a one-time pilot test which was implemented in September 2000. Effects of the treatment were rapid, and washed out over the following 3 years. Another authorization was received in 2006 for annual full-scale treatment of the mine pool which has been conducted each year since. The third authorization was received in 2009 for amendment, treatment and transfer of mine water sludge residuals containing high levels of arsenic and zinc along with iron hydroxide. The results are depicted in the following graphics along with a summary table of the average concentrations during each phase since 1999 prior to in-pool mine water treatment.

ALEXCO

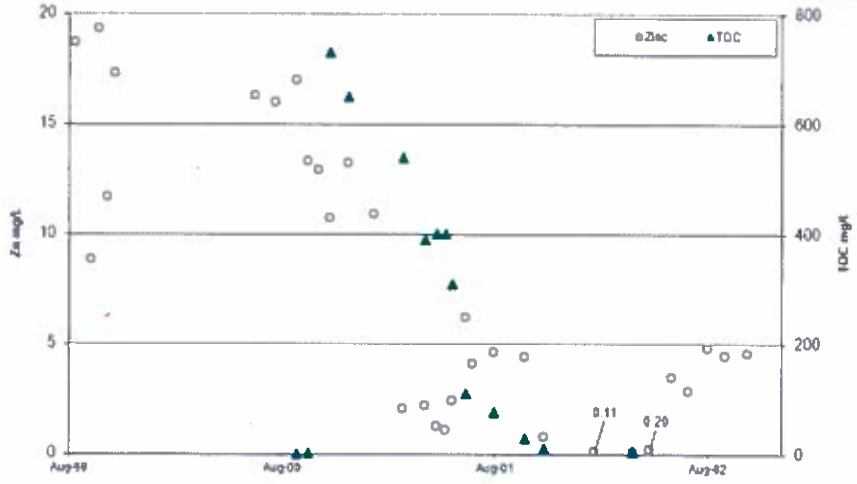
Platoro Mine Water Management Overview

- Mine workings developed in 1980s
- Mine pool serves as water collection system for upper mine workings and pump back collections systems from waste rock storage areas



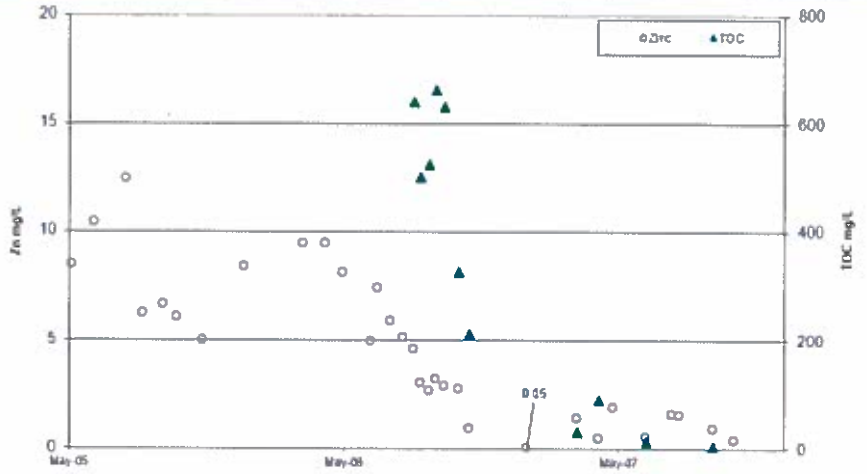
ALEXCO

First Treatment, Zn vs. TOC



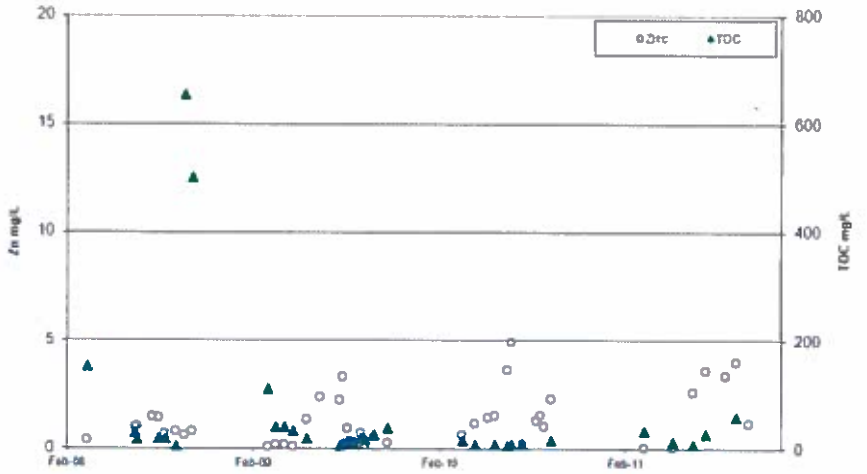
ALEXCO

Second Treatment, Zn vs. TOC



ALEXCO

Sludge Transfer and Treatment, Zn vs. TOC



14 year In Situ Treatment Evaluation

	As	Mn	Fe	Zn	Sulfate
Before Pretreatment (2 years)	39.53	40.44	539.33	14.60	2,499
First Treatment (2 years)	1.97	37.59	638.50	2.86	2,385
Interim (4 years)	16.74	28.85	457.20	6.42	2,128
Second Treatment (2 years)	1.15	23.44	333.00	1.09	1,826
During Sludge Transfer (3 years)	2.68	29.14	197.31	1.27	1,471
After Sludge Transfer (1 year)	0.20	20.80	52.15	0.09	496

Alexco's strategy for in-mine pool treatment at the London Butte Mine Pool was presented to CDPHE in March 2014. This strategy proposed that a technical evaluation proceed to see if it could be implemented at full scale and achieve treatment of the zinc and cadmium and the attainment of the discharge standards in the Water Tunnel Outfall. This proposed strategy included milestones for implementation of the work, commencing with filing this Application with US EPA UIC Program.

It is then proposed that, subject to EPA UIC Program approval, construction of the proposed system will commence in July 2014 and injection operations would commence soon thereafter. Injection, in-situ treatment of metals and monitoring of the treatment progress would continue until June 2015 when a final report would be prepared and provided to CDPHE and recommendations for long-term operations would be developed and reviewed with all stakeholders at that time.

PROPERTY LOCATION The property is comprised of about 4,280 acres of land within sections 6, 7, and 18 of Township 9S, Range 78W and sections 1and 12 of Township 9S, Range 79W, Park County, near the center of the State of Colorado. The mine openings are located in the eastern slope of the Mosquito Range approximately 8 miles east of Leadville and 5 miles due west of Alma, near the headwaters of Mosquito Creek. The property is in the Mosquito and Sacramento Subdistrict of the Alma District, located approximately 75 miles southwest on U.S. Highway 285 from Denver, Colorado to Fairplay, Colorado and 5 miles north on Colorado Highway 9 from Fairplay. From that point, a graveled road follows Mosquito Creek west for approximately 6 miles to the property.

TOPOGRAPHY AND CLIMATE. The London Mine (surface features) is located on the east slope of the Mosquito Range in glaciated terrain of extreme topographic relief, ranging in elevation from 11,300 to 13,500 feet. London Mountain (elevation 13,194 feet) forms the divide between the east-flowing North and South Mosquito Creeks. Pennsylvania Mountain (Penn Mountain) forms the divide between South Mosquito and Sacramento Creeks. The three drainages join the South Platte River south of Alma. The property is entirely within Pike National Forest and is predominantly above

timberline. Precipitation averages 25 to 35 inches per year and climate is colder than most regions at the same latitude because of the high altitude. Winters are long and cold, and summers short and cool. In most years, heavy snow accumulations on north-facing slopes remain throughout summer months. In June, July and August hail storms are frequent and snow flurries often occur.

HYDROLOGY OF THE MINE AREA

According to the water court decree in Case W-8314-76 paragraph 8;

> *"London Fault is a reverse fault with considerable upthrust on the easterly portion. A fault gouge was created, which is impermeable and prevents water originating westerly of the fault from escaping through it to the east. A portion of the precipitation falling in the recharge areas enters formations dipping towards the London Fault, or generally easterly into the London Syncline.*
> *That syncline dips to the south or southeasterly. In the areas nearer London Mountain, the syncline is overlain with Belden Shale, which is essentially impervious to water. Beneath the Belden Shale is the Leadville Dolomite, sometimes called Leadville Limestone, which is highly fractured in the bottom of the syncline, particularly in close proximity to the London Fault. These fractures permit water to move down gradient from the recharge area of the London Mountain towards South Park and the Arkansas Valley. They do not come to the surface for many miles and travel for tens of thousands of years before they surface, if at all. Where the syncline crosses South Mosquito Creek, it is overlain by 600 feet of impermeable Belden Shale. The syncline can neither feed the creek nor be fed by it. The waters in the syncline are in a geologic trap and are nontributary waters. The equilibrium level of the water in the syncline is also well below the creek level. Generally, low discharge occurs in May and June, and a high discharge occurs in October and November."*

Two sectional views of this hydrological situation are presented here below:

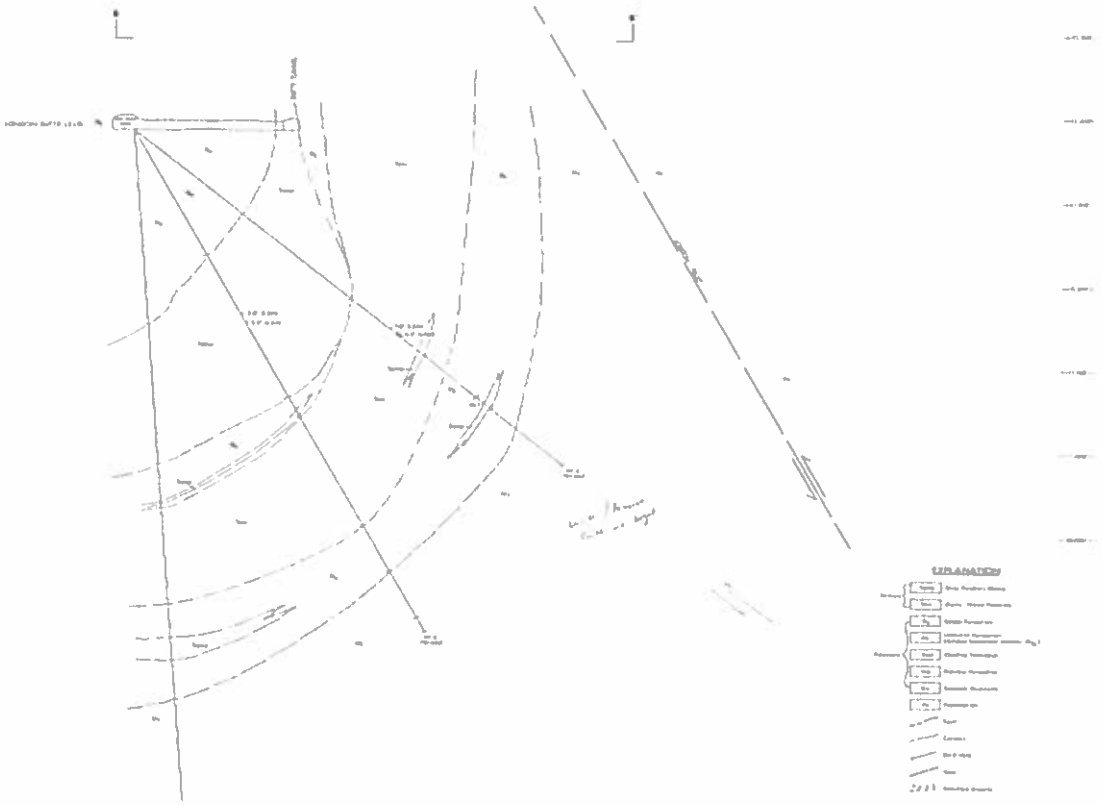


Figure 2 London Butte Mine Geologic Cross Section

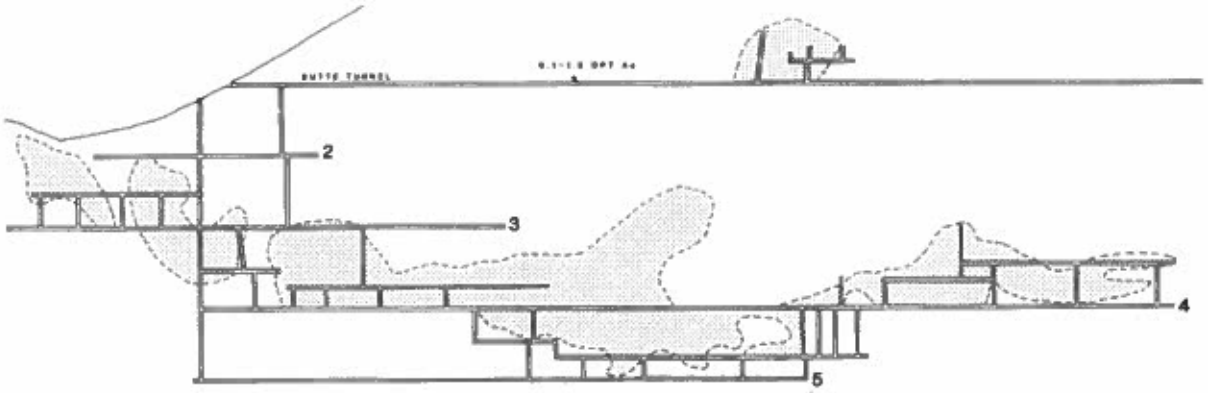


Figure 3 Longitudinal Section of the London Butte Mine workings (approximately perpendicular to Figure 2 & 4)

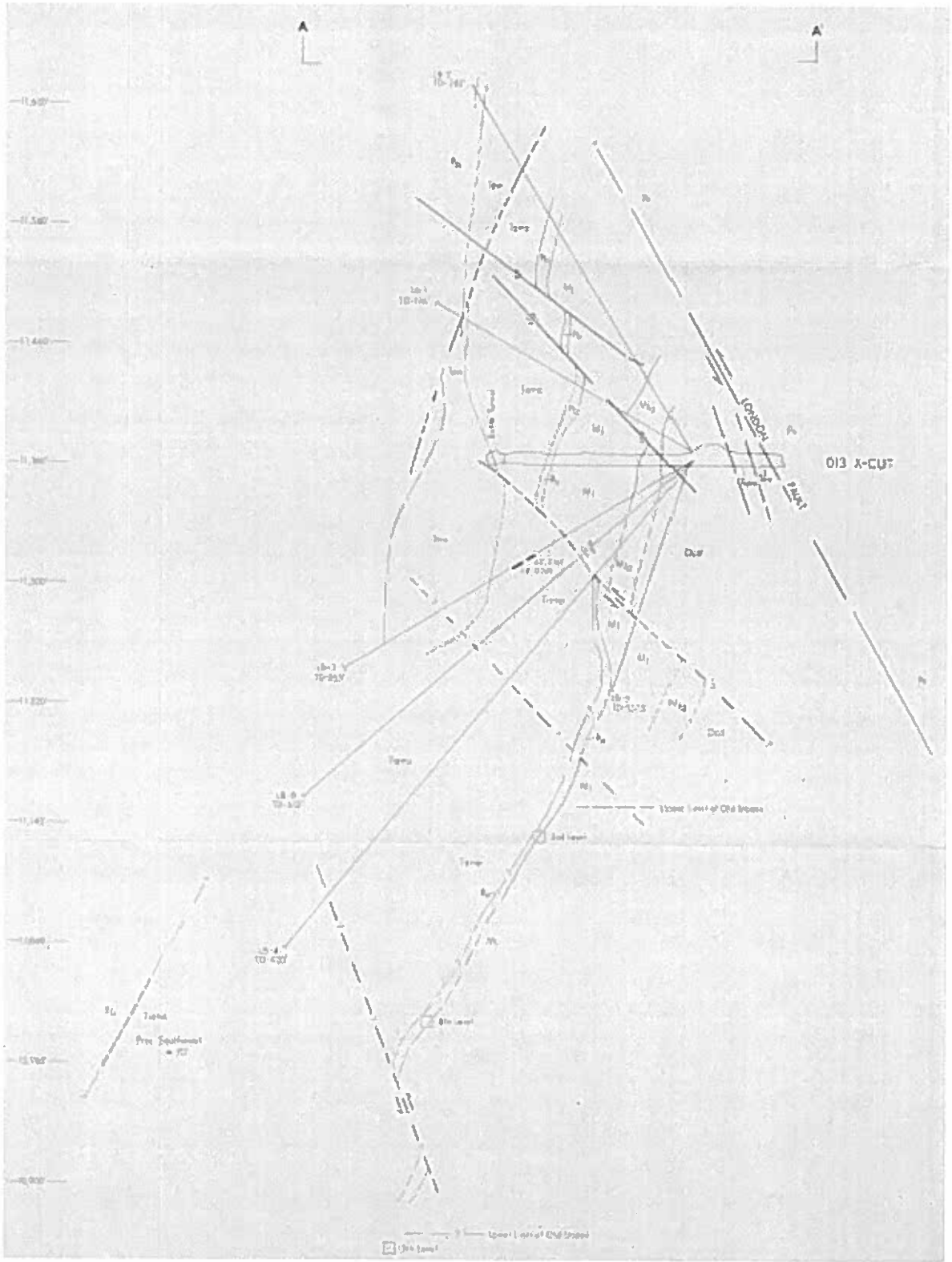


Figure 4 Cross Section of London Butte Mine

CHEMISTRY OF THE MINE WATER

The London Mine discharges about 650 GPM from the Water Tunnel containing zinc and cadmium at concentrations presently in excess of the discharge permit standards. Historical observations reveal that the water in the Water Tunnel has generally been good quality, and does not typically exceed standards, but it is being comingled with 20-50 GPM of much poorer quality water from a particular area of the upper workings of the London Mine, known as the Extension Level (the London Extension Tunnel). The London Extension Tunnel workings have degraded to such an extent that contaminated water from the London Extension Tunnel are flowing into the cleaner water in the London Water Tunnel.

The recently reported flow rate and quality of the two water types is presented here in the following table, along with an estimate of the future quality of the drainage from the Water Tunnel after these proposed actions are taken to separate, amend and treat the London Extension water:

Table 1: Loading and Concentrations typical of main water types at the London Mine (data adapted from DMRs, Misantoni personal communication, and from MES Report – 2011)

Water Source	Dis - Zn	Dis - Cd	Cu	Fe	Pb	Mn	Ni	Flow, MGD
London Mine, Water Tunnel, ppb	3,810	17	77	3,200	2	450	14	1.12
loading from Water Tunnel, lbs/day	35.6	0.16	0.72	29.9	0.02	4.20	0.13	
London Extension Mine Water	77,700	315						0.050
Loading from Extension, lbs/day	32.7	0.13	-	-	-	-	-	
Projected Quality, Water Tunnel, ppb	**328**	**3.0**						

Monitoring Plans

The treatment process would be monitored in-situ to ensure that the quality of the mine pool is actually improved through precipitation of zinc and cadmium sulfide minerals and clean water could then be extracted from the London Butte Mine pool if desired, to maintain hydraulic control of the injection, or for other purposes. Alexco proposes to place a pump within the London Butte workings so that a sample can be continuously drawn from the pool and recirculated as needed back to the pool. This will help to distribute treatment reagents and will provide Alexco the opportunity to continuously monitor the redox voltage of the water to ensure that sufficient reagents are added to the water to induce and maintain sulfate reducing conditions to form iron monosulfide (FeS) throughout the mine pool. It is likely that the pump will be placed in the internal shaft, and the water reinjected into the external shaft as depicted on Figure 2.

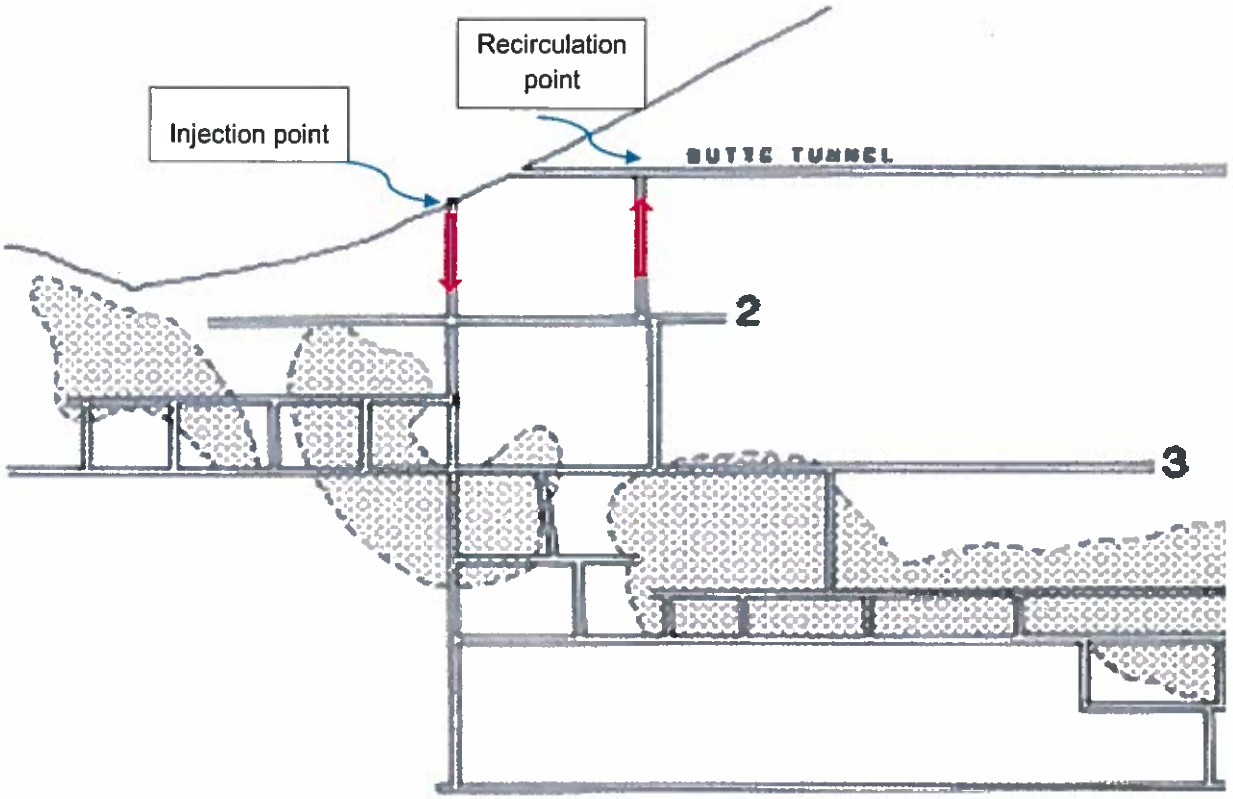


Figure 5 Mine Pool Injection & Recirculation

Monitoring of the discharges is presently conducted, and would continue to be conducted under the CDPS Permits in-place for both the London Water Tunnel and the London Extension Tunnel.

Each year the oxidation of sulfide minerals within the upper mine workings liberate about 15,000 lbs of zinc and about 70 lbs of cadmium. The collection and treatment of these heavy metals is beneficial to the quality of South Mosquito Creek, and could be accomplished through anaerobic sulfide precipitation using sulfate reduction within the London Butte Mine (the lowest mine pool in the district). This objective would be achieved through addition of molasses and alcohols (methanol or ethanol) into the collected water and the injection of the amended collected water mixture into the saturated mine workings below the hydraulic level of the creek. Monitoring of the mine pool where treatment was anticipated to occur would be for redox voltage (mV), and for dissolved zinc. If the treatment is being performed in compliance with the project objectives, the redox of the mine pool will decrease to less than -50 mV and periodically to less than -200 mV, and the dissolved zinc concentrations will be decreased with more than 90% mass loading reduction of zinc. Samples of the London Butte mine pool will be taken to design the final dosage of reagents to be added to the Extension Tunnel water as it is injected into the London Butte mine pool.

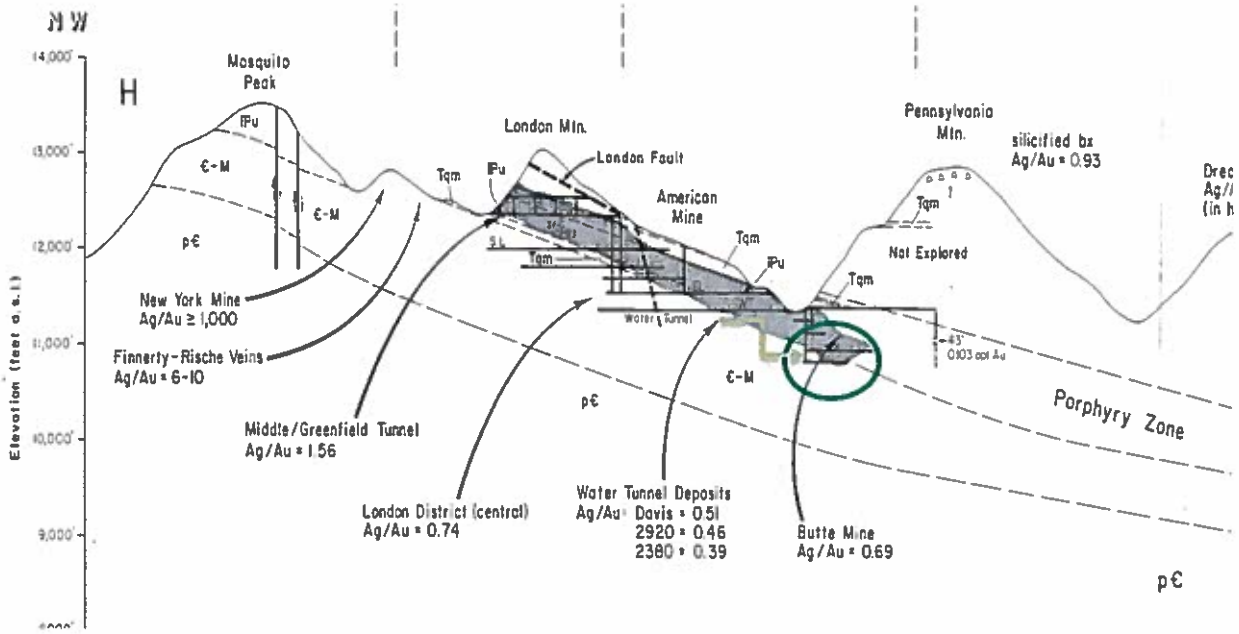


Figure 6: A northwest – southeast trending longitudal section looking northeast of the mine workings is shown here with the targeted treatment zone generally indicated by a green oval (modified from Misantoni, 1992)

1992):

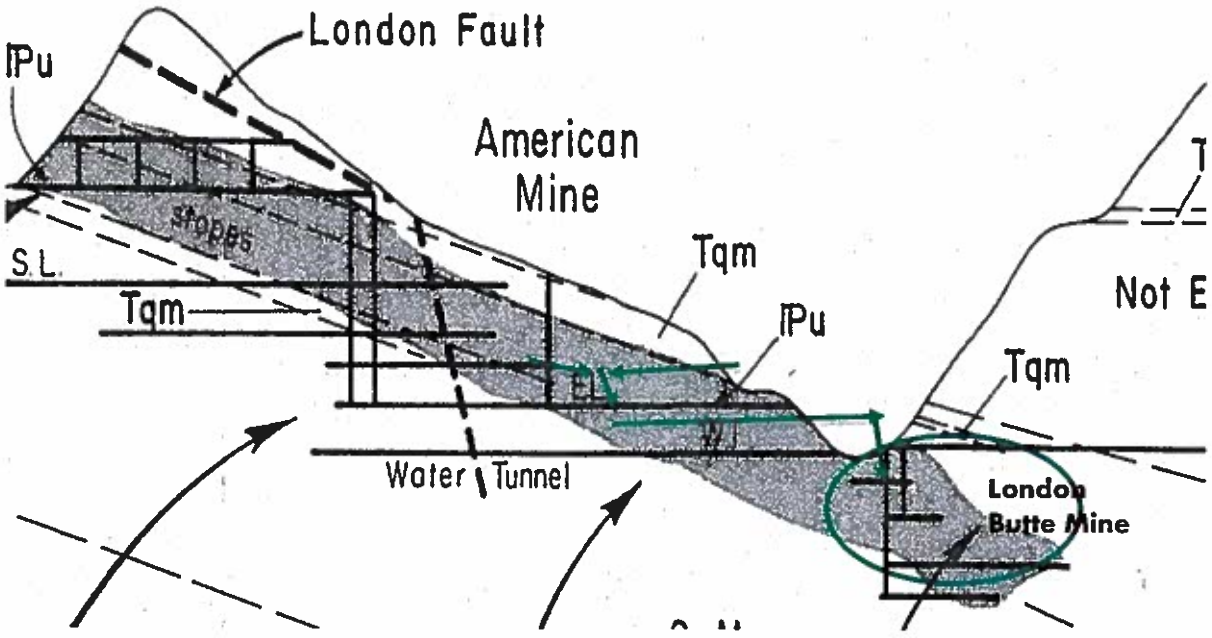


Figure 7: Inset showing the capture of the water from the Extension Level (EL) upon its arrival to the Water Tunnel level (WT) and the proposed delivery of this water by pipeline (conceptually shown in green arrows) along the WT to the London Butte Mine workings

The expected benefits of this treatment includes the removal through treatment of more than 10,000 pounds of zinc and more than 50 lbs of cadmium from the watershed drainage each year. The dosage of molasses and alcohol into the treated water will be at low concentration (less than 1 gram per liter, and most likely less than 0.2 grams per liter) and is being biologically consumed in mine workings that are not in hydraulic communication with the creek. The injection of reagents will form iron sulfides (FeS) in the London Butte Mine which will enable the beneficial effects of the treatment to extend long after the cessation of treatment dosage. This extended benefit of treatment is achieved by the preferential displacement reaction where either cadmium or zinc will displace iron from iron monosulfide to form cadmium sulfide or zinc sulfide, thereby removing zinc and cadmium from solution and releasing a stoichiometricly equivalent, low concentration (less than 1 ppm) of dissolved iron.

Conclusion

Alexco requests review and approval of this strategy by the UIC Program to enable this solution to be pursued through full-scale testing in 2014. Due to the remote location of the work the optimal construction and operational season is limited to generally between June-October of each year.

Thank you for your consideration of this request. We welcome the opportunity to address any questions. Please don't hesitate to contact my office at 303-862-3927 or my cell phone at 720-883-6700.

Sincerely,

Joseph G. Harrington

VP – Technology and Strategic Development

Alexco Resource U.S. Corp.