February 29, 2024

Patrick Lennberg
Colorado Division of Reclamation, Mining and Safety
1313 Sherman Street, Room 215
Denver, Colorado 80203

RE: Lyons Quarry, Permit No. M-1977-208, Technical Revision 18
C-Pit Selenium Removal System Evaluation and Cost Update

Mr. Lennberg:

With this letter, CEMEX is submitting Technical Revision 18 (TR-18) to the Lyons Quarry Permit No. M-1977-208. The purpose of TR-18 is to update the methods and potential costs associated with the contingency of treating C-Pit water for selenium removal.

In our August 15th, 2023 submittal of the preliminary Adequacy Review Response for our updated Reclamation Cost Estimate, we committed to conducting a new engineering study to update the water treatment methods and costs provided in TR-7 in 2006. CEMEX contracted with Brown & Caldwell to prepare the attached revised methodology and estimated cost to treat the approximately 15 million gallons of water currently held in C-Pit.

If you have questions regarding this submittal, please contact me (303-823-2105, cita.cisse@cemex.com) or our Plant Manager, Erik Estrada (303-823-2101, erik.estrada@cemex.com).

Sincerely,

Cita Cisse
Quarry Manager

Cc: Erik Estrada, CEMEX Lyons Plant Manager
Greg Bridge, CEMEX Corporate Environmental Manager
Robin Bay, Habitat Management, Inc.

Enclosures: C-Pit Selenium Removal System Evaluation and Cost Update Technical Memorandum from Brown and Caldwell

Brown AND Caldwell

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Technical Memorandum

Prepared for: CEMEX

Project Title: CEMEX Lyons Plant C-Pit Selenium Removal System

Project No.: 195747

Technical Memorandum

Subject: C-Pit Selenium Removal System Evaluation and Cost Update

Date: February 28, 2024

To: Greg Bridge, CEMEX Corporate Environmental Manager

From: Dominic Pontarolo, Brown and Caldwell
(dpontarolo@brwncald.com, 704.373.7126)

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Prepared by: A Frantsova
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Section 1: Introduction

On March 10th, 2023, CEMEX submitted an updated Reclamation Bond Estimate for the Lyons Quarry, Permit No. M-1977-208. In response to this submittal, the Colorado Division of Reclamation, Mining and Safety (DRMS) requested additional information and clarification before the DRMS can complete its Reclamation Cost Estimate for the site. One of the requested adequacy items was for CEMEX to provide an updated cost estimate for treatment of the water that remains in C-Pit prior to disposal. The previous cost estimate for the treatment of the C-Pit water was provided in 2006 and was based on a biological treatment process to remove selenium. CEMEX has retained Brown and Caldwell (BC) to re-evaluate the previously selected treatment process and to provide an updated capital and operational cost estimate for the treatment of C-Pit water.

In addition to a biological treatment option, BC also evaluated a thermal treatment option which included a direct heat evaporator system that used a natural gas burner as the heat source to evaporate the water from C-Pit. The evaporated water would be released to the air as a vapor and a salt slurry, or brine, remains, which requires solidification and disposal. While this thermal treatment option had some positives, such as rapid deployment capabilities due to fully skid mounted equipment, after considering the cost for equipment leasing, labor, natural gas, and chemicals for the brine solidification process, this alternative was not feasible. Therefore, a biological treatment system, like the one proposed in the 2006 TR7, was selected as the preferred treatment option. This technical memorandum (TM) presents a conceptual design and cost estimate for a biological water treatment system to remove selenium from water that has accumulated in C-Pit at the CEMEX Lyons Plant.

Section 2: Design Basis

In order to close C-Pit, the estimated 15 million gallons of water residing in the pit would need to be removed and treated prior to backfilling. CEMEX routinely collects pH, total suspended solids (TSS), total dissolved solids (TDS), calcium, magnesium, sodium, potassium, chloride, alkalinity, sulfate, selenium, and thallium water quality information for the C-Pit water. The volume of water treated and the timeline of treatment of about one year was provided to the equipment manufacturer and the proposed biofiltration treatment system has an average flow rate of 50-100 gallons per minute (gpm).

Section 3: Process Description

Figure 1 shows the conceptual design of the biological treatment process. Water is pumped from the C-Pit to the treatment area. Concentrated sulfuric acid is injected by a metering pump into the C-Pit line upstream of an in-line mixer, thereby reducing the influent to a near neutral pH. At the feed tank, a nutrient solution is added by a metering pump. This mixture is pumped through a series of two downflow biofilters containing granular activated carbon where selenium is reduced from the soluble forms of selenate and selenite to elemental selenium. The elemental selenium nanoparticles are bound in the biofilm keeping them retained in the filter. The treated effluent from the biofilters flows by gravity to a small effluent tank for sampling and discharge. Treated water could be pumped from this tank for use at the plant for dust suppression during plant decommissioning and final reclamation of the plant site or disposed of offsite (e.g., land application).

To periodically remove entrained gases and solids, treated effluent is pumped from the effluent storage system to the bottom of the biofilters (one biofilter at a time) for backwashing of the filter. It flows upward through the biofilter dislodging and carrying solids and gases to an overflow trough located near the top of the biofilter tank. Upon overflowing into the trough, the waste stream flows by gravity to the backwash waste tank from where it is sent to the feed tank for reprocessing through the biofilters. The sizing of the biofilters has accounted for the influent TSS.

The bulk of the equipment for this treatment process is provided by Veolia as part of their ABMet system selenium treatment system. This technology was previously tested using C-Pit water and demonstrated its ability to consistently meet the design discharge target of 60 μg/L. The system proposed here includes Veolia's standard sized ABMet biofilters that are 14-foot diameter and 30 feet tall. The proposed system can treat the C-Pit water at an average flow rate of 50 to 100 gpm. Assuming an average flow rate of 75 gpm and an operating uptime of 95 percent, the 15 million gallons of C-Pit water will take approximately 146 days to treat. After all the C-Pit water has been treated, the selenium loaded media from the biofilters can be disposed of at a landfill.

Normal operation will consist of maintaining sufficient acid and nutrient supplies and checking the operation of process pumps. Effluent samples should be collected and analyzed periodically for selenium to monitor water quality.

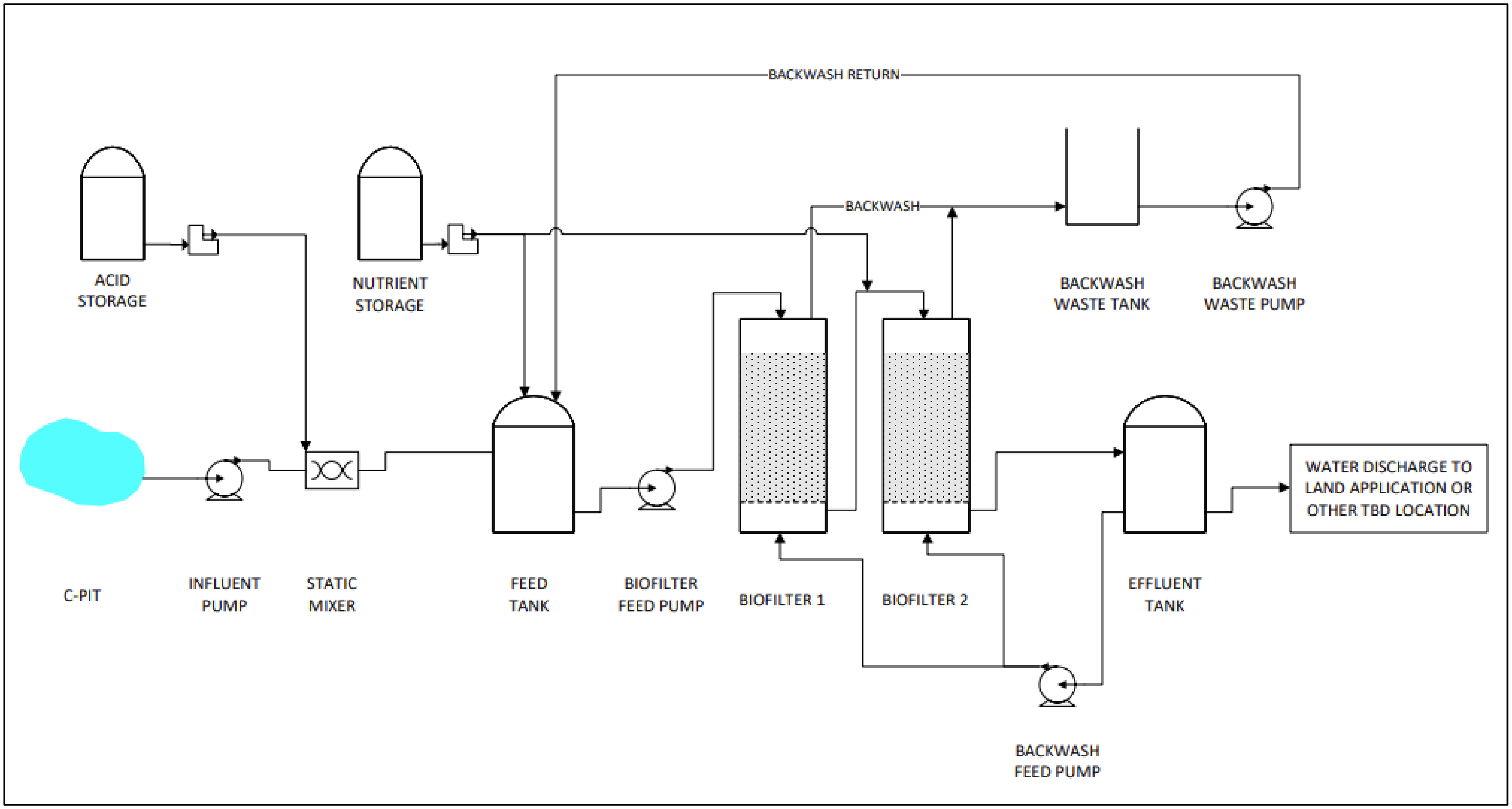


Figure 1. Process flow diagram for the biological selenium removal system conceptual design

Section 4: Cost Estimate

Based on vendor quotes, the purchased equipment cost for the treatment system described in Section 3, is $1.78 million. The equipment proposal for the biological treatment system from Veolia is included in Attachment A. After considering the costs for other direct (e.g., installation, instrumentation and controls, piping, electrical systems, yard improvements or site development, and service utilities) and indirect costs (e.g., engineering, construction expenses, contractor's fee, and contingency), the total installed cost (TIC) estimate is $5.75 million. A breakdown of the TIC estimate and details of the basis for the estimate is included in Attachment B. The costs associated with disposal of the treated water (e.g., dust suppression or land application) are not included in this estimate. This cost estimate was developed in accordance with the Association for the Advancement of Cost Engineering International (AACE) criteria for a Class 5 estimate.

Table 1 shows the estimated operational and maintenance cost (O&M) for the treatment system.

Table 1. Treatment O&M Costs

O&M Category	Monthly Operating Cost [A]	Total O&M Cost
Labor	$11,900	$58,000
Chemicals and Other Consumables	$25,200	$123,000
Electrical	$400	$2,000
Residuals Disposal	$2,900	$14,000
Contingency	$8,100	$39,400
Total O&M	$48,500	$236,400

[A] *During months of operation only.*

The O&M costs in Table 1 assume the following:

- The treatment system operates at an average flow rate of 75 gpm with an operational uptime of 95 percent and the 15 million gallons of water from C-Pit is treated in 146 days.
- An operator will be required on site for 40 hours per week at a rate of $70 per hour.
- The electrical cost is $0.10 per kWh.
- The landfill tipping fee for disposal of the spent biofilter media at the end of operations is $45 per ton.
- A 20 percent contingency is applied to the sum of the other O&M costs.

Attachment A: Vendor Equipment Proposal

Veolia ABMet System Proposal

Brown and Caldwell – Colorado Mine Opportunity

ABMet Process Overview and Budgetary Estimate

The ABMet system is built around an advanced anoxic/anaerobic biological wastewater treatment process that uses naturally occurring, non-toxic, non-pathogenic microbes in a specially developed blend, which reduce and precipitate target compounds from solution, or convert target compounds into their insoluble chemical components.

The ABMet system is arranged as a series of packed bed biofilters. Each biofilter contains a bed of Granular Activated Carbon, or GAC, on which specifically selected microbes grow, develop a biofilm and are retained. The GAC is ideal as a media due to its large surface area, much of which is in the form of crevices within each carbon particle thus sheltering biomass from shear and abrasive forces as well as helping to minimize the impacts of upset conditions.

Water entering the system will typically have a positive redox level. As the flow progresses downward through the biofilter, the redox potential gradually decreases as a result of the microbial activity. To create this redox gradient the bioreactors are designed to operate with a plug flow regime as the water flows from top to bottom by gravity. ABMet's engineered nutrient solution is used to control the degree of redox gradient within each biofilter. As more nutrient is added, the redox potential decreases and vise-versa.

The efficiency and effectiveness of the ABMet system is based on five key components:

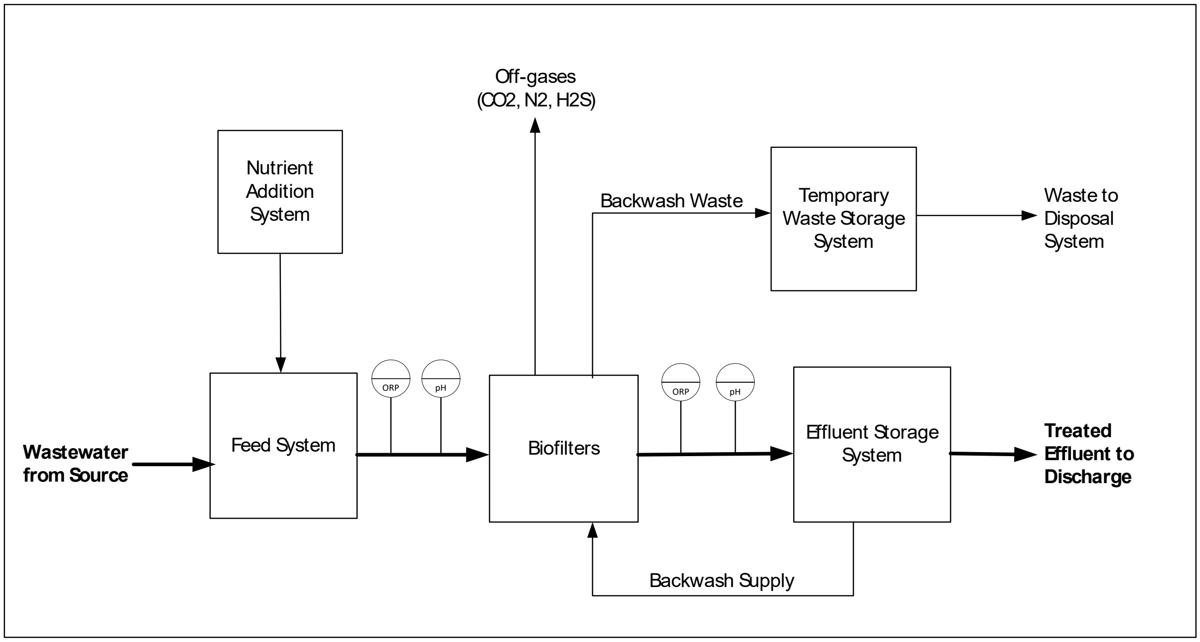
- Process-optimized microbial cultures
- Process-optimized engineered nutrient
- Process-optimized matrix for bio-film growth and stability
- Proprietary packed bed biofilter design
- Solid engineering for trouble free operation
- Proven, guaranteed performance

The ABMet system has been proven effective for the removal of inorganic compounds such as nitrate, selenate and selenite. The simple system design makes the ABMet system very inexpensive to operate and maintain over the long term.

As shown in the diagram below, an ABMet plant is comprised of a feed system, nutrient addition system, biofilters, effluent storage system and temporary waste storage system.

Wastewater flows from the source to the feed system where nutrient is added and is then pumped to the top of the biofilters. It flows downward through the biofilters and then out to the effluent storage system by gravity. From there it is sent to the discharge location via pumps or gravity depending on the hydraulics of the site. To periodically remove entrained gases and solids, treated effluent is pumped from the effluent storage system to the bottom of the biofilters (one biofilter at a time). It flows upward through the biofilter dislodging and carrying solids and gasses to an overflow trough located near the top of the biofilter tank. Upon overflowing into the trough, the waste stream flows by gravity to the temporary waste storage system from where it is sent for further processing and disposal.

Typical Process Flow Diagram:

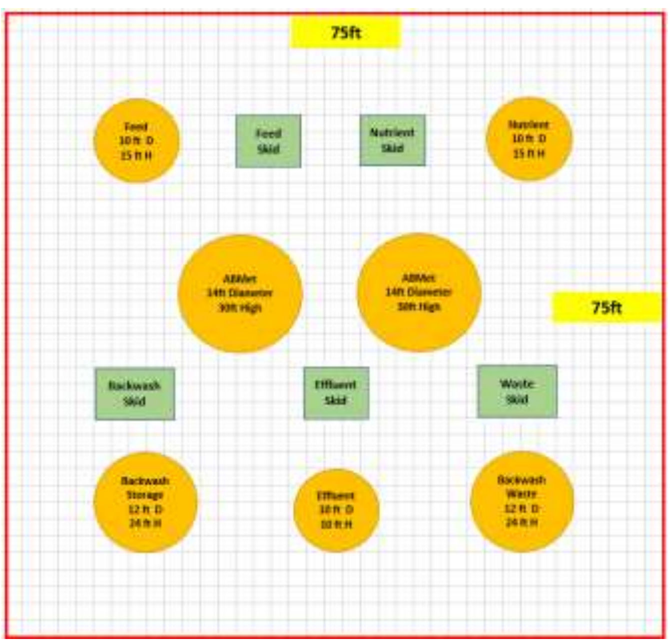


Based on the information currently available regarding this project, the following are estimates for an ABMet facility of this scope and size.

- Average flow ~50 – 100 gpm
- Influent Selenium ~450 µg/L
- Effluent Selenium ~60 µg/L
- Number of ABMet Biofilters ~ qty=2 (14ft dia x 30ft high)
- Facility footprint required including process equipment and tanks ~ 75 x 75 ft

- Capital cost estimate for the ABMet technology package ~ $1,750,000 USD
- Power consumption estimate (annually) ~ 50,000 kWh/year
- Consumables estimate (nutrient/chemicals/consumables) ~ $250,000/year
- Labor estimate (visual checks, valves, backwashing, chemical feeds) ~ 40 hours weekly

Concept Footprint Layout:



Concept Layout Photo #1:

Concept Layout Photo #2:

Attachment B: Basis of the TIC Estimate

The opinion of probable total installed capital (TIC) cost for the CEMEX C-Pit water treatment system is $5.75 million. A breakdown of the TIC estimate is shown in Table B-1. This TIC cost is considered a Class 5 cost estimate per the Association for the Advancement of Cost Engineering International (AACE) guidelines with an estimated accuracy of +50 percent/-50 percent. The cost estimates are based on Brown & Caldwell's (BC) experience, information from major equipment suppliers, historical cost information from previous projects, parametric and comparative factored estimates in conformance with AACE Recommended Practice No. 59R-10, and BC's understanding of water/wastewater treatment equipment costs.

The scope of this opinion of probable cost includes:

- All water treatment equipment, tanks, pumps, mixers, and installation.
- A contingency line item of 30 percent, which also serves to account for costs not itemized in other cost categories.

The scope of this cost does not include:

- Pipelines that carry wastewater to and from the water treatment system.
- No piles have been included in this estimate. Soils are assumed to be of adequate nature to support the structures.

Table B-1. Total Installed Cost Summary	
	Cost
Direct Costs	
Purchased equipment cost	$1,780,000
Freight and Sales Tax	$178,000
Purchased equipment delivered subtotal	$1,958,000
Purchased equipment installation	$509,000
Instrumentation and controls (installed)	$108,000
Piping (installed)	$274,000
Electrical systems (installed)	$206,000
Buildings	-
Yard improvements	$210,000
Service utilities	$186,000
Direct cost subtotal	$3,451,000
Indirect Costs	
Engineering and supervision	$274,000
Contractor's fee	$345,000
Permits and legal expenses	$35,000
Construction expenses – general conditions	$383,000
Contingency	$1,264,000
Indirect costs subtotal	$2,301,000
Total Installed Cost	
Total Installed Cost (TIC)	$ 5,752,000

Estimate Markups

Descriptions of the estimate markups are shown in Table B-2.

Table B-2. Description of Capital Cost Estimate Markups	
Item	**Definition**
Direct Cost Markups	
Freight	Material shipping and handling
Sales Tax	State and local for materials, process equipment and construction equipment rentals, etc.
Purchased Equipment Installation	Installation of equipment provided for the water treatment system (e.g., labor, foundations, structural supports, platforms, insulation, paint/coatings)
Instrumentation and Controls (Installed)	Instrument costs, installation and calibration labor, expenses for auxiliary equipment and materials
Piping (Installed)	Process piping, pipe hangers, fittings, valves, insulation, equipment
Electrical Systems (installed)	Power wiring, lighting, transformation and service, and electrical equipment (switches, conduit, wire, fittings, feeders, grounding, lighting, panels, etc.)
Yard Improvements	Site development, clearing, grading, roads, walkways, etc.
Service Utilities (installed)	Steam, water, power, refrigeration, compressed air, fuel, waste disposal, fire protection, and miscellaneous service items.
Contractor Packages	A direct cost that is not calculated as a markup of the purchased equipment, rather this line item is based on contractor/vendor quotes that do not require additional direct cost markups. This line item includes tanks and other equipment for which installation was already included in the quoted price.
Indirect Cost Markups	
Engineering and Supervision	Engineering costs: administrative, process, design and general engineer, drafting, cost engineering, procuring, expediting, reproduction, communications, scale models, consultant fees, travel. Engineering supervision and inspection.
Construction Expenses	Construction, operation and maintenance of temporary facilities, office, road, parking lots, railroads, electrical, piping, communication, fencing. Construction tools and equipment. Construction supervision, accounting, timekeeping, purchasing, expediting. Warehouse personnel and expense, guards, permits, field tests, special licenses, taxes, insurance, interest.
Permits and Legal Expenses	Identification of applicable federal, state, and local regulations. Preparation and submission of forms required by regulatory agencies Acquisition of regulatory approval Contract negotiations
Contractors Fee	Contractor profits and mark-ups
Contingency	Contingency for project/construction. The contingency factor covers unforeseen conditions, area economic factors, and general project complexity. This contingency is used to account for those factors that cannot be addressed in each of the labor and/or material installation costs.