US Army Corps
of Engineers

Baltimore District

September 2003

BUILDING 110
CHROME VESSEL PLATING PIT
CLOSURE RECOMMENDATIONS

WATERVLIET ARSENAL
WATERVLIET, NY

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Building 110 – Chrome Vessel Plating Pit Closure
Watervliet Arsenal, Watervliet, NY

EXECUTIVE SUMMARY

This report addresses closure of the Chrome Vessel Plating Pit in Building 110 at the Watervliet Arsenal, Watervliet, NY. A water main break in the mid-1980's led to flooding of the pit and contamination of the structural members by chemicals from an acid sump at the bottom of the pit. Subsequent corrosion of the steel members has resulted in significant deterioration. Pumps used to keep the pit dry failed in the winter of 2002. A comprehensive structural evaluation by Paik Associate in 1999 found the pit to be unsafe. Demolition or repairs of the pit are therefore not viable closure alternatives given the extensive entry operations that would be required for such work. Closure of the pit by filling with cementitious "flowable fill" materials is therefore recommended. The fluid nature of this material will result in complete filling of the pit and in-place encapsulation of the existing interior structures, utilities and equipment. Structural elements above the building's main floor level (which are uncontaminated) will be demolished and the pit will be topped with a concrete slab to match the grade of the surrounding floor.

Though this pit is not currently regulated under a RCRA SWMU, the regulators would probably enforce RCRA closure criteria. Because of the extreme health and safety risk associated with any remediation other than encapsulation, it is likely that USEPA and NYSDEC will accept encapsulation/stabilization for closure. Though transport of chromium into downgradient groundwater is not currently observed, the potential mobility of any existing chromium will greatly diminish. While no adverse chemical or hydrogeologic effects are expected, it is recommended that well P-2 should be added to the WVA long-term monitoring program to evaluate whether groundwater quality in the vicinity of the pit is affected.

Building 110 – Chrome Vessel Plating Pit Closure Recommendations
Watervliet Arsenal
Watervliet, NY

I. Intent

This report provides recommendations for closure of the Chrome Vessel Plating Pit in Building 110 at the Watervliet Arsenal, Watervliet, NY. It addresses environmental, safety, engineering and cost aspects of the closure as well as the resultant affect of closure on the current subsurface environment.

II. Background and Existing Conditions

The pit was constructed circa 1918 and historically served to house vertical furnaces as part of the Coastal Gun Tube Manufacturing Facility. More recently, the western portion of the pit has been dedicated to Benet Laboratories' research and development activities. Plan dimensions of the pit are approximately 35 feet by 45 feet. The western side of the pit, commonly referred to as the "Benet Side", extends to a depth of 40 feet below the at-grade, main floor level of the building. The eastern side of the pit, commonly referred to as the "Chrome Plating Side", was originally constructed to a depth of 120 feet but was subsequently filled with concrete to its current depth of 72 feet. Several small pits exist at the bottom of the eastern portion of the pit and extend to an overall depth of approximately 78 feet to 86 feet. Refer to the attached drawing showing the approximate plan dimensions and depths of the various sections of the pit.

The periphery walls of the pit are formed primarily of masonry block while the interior structure consists of suspended, steel grate flooring supported by structural steel framing. Floors at the base of the pit consist of cast-in-place concrete. The vertical spacing of the floor levels within the pit varies but is generally on the order of every 10 feet. Interior features of the pit consist of the previously discussed structural components; utilities, along with associated fixtures and panels; and equipment remaining from the previous use of the pit. The pit is currently flooded below a depth of approximately 30 feet due to infiltration of groundwater.

The pit is currently in a highly advanced state of structural deterioration. A water main rupture in the mid-1980's resulted in flooding of the pit and exposure of the structural members to chemicals (primarily chrome, sulfuric and phosphoric acids, and lead) from the acid sump at the base of the pit. The subsequent related corrosion of these members has resulted in extensive damage. A comprehensive structural evaluation performed in July 1999 by Paik Associate concluded that "The corrosion, and the resulting damage to the structure, is so severe that the structure is totally inadequate to carry the intended loads, and any access to the pit should be prohibited. If access is absolutely necessary, the personnel should be clearly warned of the danger associated with the access.". Subsequent to this report, measures were implemented to temporarily stabilize the Benet section of the pit. This was accomplished by suspending the existing structural system in that area from new structural members installed at the main floor level of the building. The structural report and drawings were quite clear that such measures

were only temporary for the Benet section and in no way improved the safety of the structure for the eastern (chrome plating) section of the pit.

III. General Closure Approach

The previously referenced structural evaluation report indicates that the structural framing for the eastern, chrome plating section of the pit "is not only beyond repair, but also present[s] grave danger to workers if repair or demolition work is to be undertaken.". As demolition or repair of the pit would clearly present an unacceptable risk to human health and safety, it is recommended that closure be accomplished by complete filling with "flowable fill" materials as discussed in the subsequent portions of this report. It should be noted that the Benet side of the pit, which was made accessible by the previously discussed temporary stabilization, has recently been cleaned of lead based paint.

IV. Flowable Fill

A. General: "Flowable Fill" is a commonly used term for materials more formally referred to as "Controlled Low Strength Material" in American Concrete Institute (ACI) publication 229R. Flowable fill is a cementitious, self-compacting, self-levelling material that is somewhat similar in appearance to cementitious grout. Compressive strengths vary with the materials and mixture proportions used but are generally in the range of 50 to 1200 psi.

B. Applicability : The primary reasons for selection of flowable fill as the material of choice for the pit closure are as follows:

- Flowable fill allows the closure to be performed with minimal to no personnel entry into the structurally unsafe pit. Other fill materials would require demolition of many elements of the pit to ensure thorough filling and would require entry for compaction or consolidation. This is unnecessary with flowable fill as the extremely fluid nature of the material will allow it to flow around and encapsulate the structural members, utilities, equipment and other features which crowd the interior of the pit.

- The flowable fill is sufficiently dense to contain the existing lead based paint to the walls of the pit. Entry into the unsafe pit for environmental clean up activities is therefore unnecessary.

- The use of flowable fill will prevent future settlement of the area. It thereby provides a stable base for construction of a concrete slab at the main floor level.

- Flowable fill materials can be produced by ready-mix concrete suppliers and are therefore readily available.

C. Material Requirements: The final design and requirements of the flowable fill mix require close coordination with the material supplier and contractor. The final materials and mixture proportions selected must be appropriate for the placement techniques used, must ensure complete filling of the pit and must meet all other applicable requirements. A discussion of various relevant properties of the materials and mixture are discussed in the following paragraphs.

1. *Materials*: The mixture should generally consist of cement, water and fine aggregate. Additional materials such as blast furnace slag, fly ash, and chemical admixtures may also be used in the mix to achieve the desired properties. The exact size and gradation of aggregates should be selected as appropriate for the project conditions and requirements. It is generally anticipated that sand sized fine aggregates of 1/8 inch and less will be used to achieve the high fluidity mix required and to promote flow into all the narrow openings that exist between interior features of the pit.

2. *Flowability*: The "flowability" or "fluidity" of the mix should be such that the entire void space within the pit is completely filled. Specific criteria for the flowability should be determined by the contractor during development of the mix design in coordination with and approval of the government. Such criteria may require revision during placement based upon the observed behavior of the material. Flowability of the mix should be measured with a flow cone (ASTM C939) during the work to ensure conformance with the established criteria.

3. *Permeability*: Typical flowable fill permeabilities of 10^{-4} to 10^{-5} cm/s will be sufficient to ensure that the lead based paint on the walls of the pit is adequately encapsulated. Laboratory tests can be performed during development of the mix design to verify the permeability of the material.

4. *Strength*: A compressive strength of approximately 100 psi is recommended. This will provide a material with sufficient stability and strength for future building operations but is soft enough to allow for future excavation with mechanical equipment such as backhoes. Higher strengths can be specified if desired. The exact strength requirement should remain somewhat flexible as the contractor's mix design proportioning to meet other requirements (flowability, etc) will affect the final strengths achieved.

5. *Reactivity*: Recent laboratory test results for a sample of groundwater from the pit are attached. Given the slightly alkaline pH of the water tested, deterioration of the concrete by acid attack is not a concern. Other chemicals do exist in the groundwater and will therefore come into contact with the flowable fill throughout its life. During development of the mix design, the material supplier should verify that the mix will not undergo significant deterioration when exposed to conditions

represented by the attached test results. At the present time, no adverse reactions are expected.

V. Sequence of Closure

The following discussion details the general sequence of work that will be required for closure of the pit.

A. Utility Shut Off: Any active utilities within the pit should be de-activated at the start of closure operations.

B. Dewatering: Pumping operations should be performed to remove water from the pit. As pumping operations at the pit have been on-going since the construction of the pit, procedures and infrastructure exist for discharge to the wastewater treatment plant (IWTP) and will be used for such operations. It is currently planned that West Central (the contractor working on the Benet side of the pit) will install new pumps on the Arsenal side, which will allow significant dewatering of the entire pit. If full dewatering can not be achieved due to an excessive rate of infiltration, due to noticeable instability caused by the unbalanced hydrostatic pressure or other reasons, it should be possible to place the flowable fill using tremie methods as discussed in the subsequent paragraph. Dewatering is, however, preferable to placement by tremie as it allows for closer observation of the work and eliminates the potential for "wash out" of the mix that can occur with placement underwater.

C. Placement of Flowable Fill: The existing doorways and interior building layout will allow access to the pit area by concrete trucks. Methods used for placement should be appropriate for the mix design and should ensure complete filling of the pit. Given the congested nature of the pit interior, it is anticipated that an "elephant trunk" will be necessary to properly convey the flowable fill to the bottom of the pit. If dewatering of the pit can not be fully achieved, the use of tremie methods will be required to place the fill below the water. Installation by tremie displaces the water upwards to a level where it can be pumped off of the top of the flowable fill. Appropriate mix design and placement considerations (such as multiple tremie tube locations) would need to be addressed to ensure that the fill will remain cohesive and not "wash out". The new pumps will need to be raised above the level of the fill during emplacement to prevent their loss and to more effectively remove the water.

The fluid nature of the material will allow it to maintain a relatively uniform level as it fills the voidspace of the pit. Continuous placement of the fill is unnecessary and operations can stop and later restart as necessary based on schedule considerations, material availability, etc. The fill will exert a buoyant force on items within the pit. If concern exists over uplift of certain utilities, equipment, or other items within the pit, the fill can be placed in stages. This would entail placing the fill a portion of the way up of the item of concern and allowing the fill to harden before continuing with

placement activities. A staged approach can also be used as necessary to prevent the fluid pressure of the fill from crushing and/or leaking into any existing features within the pit such as the furnace.

The vertical furnace is an enclosed structure composed of Pyro Block and does not contain any asbestos. It will have to be filled separately from the main cavity. The lateral strength of the walls is unknown; however, so fill placement should occur alternately between the main pit and the furnace to eliminate a large head difference between the two spaces.

The flowable fill placement should be stopped approximately 2 feet below the level of the building's main floor slab and allowed to harden. Some subsidence will likely occur prior to hardening as the fill consolidates and excess water in the mix moves to the surface. This subsidence may be on the order of several feet and will require filling with additional flowable fill.

D. Removal of Surface Structural Members: Structural members should be cut at the top of the flowable fill, approximately 2 feet below the level of the building's main floor slab. It is possible that the release of existing internal stresses in the members during such work could result in rapid, unexpected movement of such members. All cutting activities must therefore be accomplished in a manner that will ensure the safety of those performing the work. It is assumed that surface materials will not be contaminated. They can be recycled onsite or removed by the contractor.

E. Slab Placement: After the completion of demolition activities, additional flowable fill material should be placed to the level of the bottom of the adjacent building slab and allowed to harden. A concrete floor slab should then be constructed at the top of the pit using a 4000 psi compressive strength mix. The floor should be given a finish consistent with the adjacent areas and proper curing measures employed to prevent excessive shrinkage cracking. Joints shall also be formed or sawn into the slab as necessary to control cracking.

VI. Quality Control

A. Mix Design: Appropriate testing should be performed for flowability, strength, permeability, material physical properties (such as aggregate gradation) and material chemical properties (such as chemical composition of cement). Any tests necessary to ensure that there will not be detrimental interaction between the various mix components or between the materials and chemicals in the groundwater should also be performed. Close coordination with the material supplier and contractor is necessary during the mix design stage to ensure that the flowable fill provides the desired properties.

B. Construction: Flow cone testing should be performed during the work to verify that the material meets the criteria established during development of the mix design. Samples for strength testing can be obtained if it is desired to know the in-place strength of the material. Strength testing will not, however, be performed in a timeframe that will allow its use for mix control during the work. It is also recommended that sufficient lighting be provided to allow observation of the material placement. This will help ensure that the material is completely filling the pit as desired.

VII. Anticipated Regulatory Issues for Building 110 North Pit Closure

A. Regulatory Status: Although the northern Building 110 pit is not a listed RCRA Solid Waste Management Unit (SWMU), it is likely that RCRA closure criteria would be applied to the project by the NYSDEC and USEPA. While there have been efforts to clean the surfaces in structurally safe portions of the pit, there is residual chromiumVI contamination in the concrete floors and walls. It is likely that the NYSDEC and USEPA would concur that "clean closure" of the pit is not feasible due to the health and safety considerations associated with the structural instability of the pit. Given this, encapsulation/stabilization of the chromium-containing materials in the pit (i.e., concrete) using flowable fill should represent an acceptable closure alternative.

C. Groundwater: Based on the Final RCRA Facility Investigation (RFI) report, the only process pits which must be pumped and maintained by the WVA to control the migration of petroleum, oils, and lubricants (POLs) in the Main Manufacturing Area (MMA) are the furnace pit in Building 135 and one process pit in the southern end of Building 35 (SWMU WVAA-27 – currently closed). As such, the discontinuation of pumping in the north Building 110 pit will not affect the closure of SWMU WVAA-27. Although chromium has been detected in the water in the pit at concentrations ranging from 33.7 to 150 milligrams per liter (mg/l), concentrations are on a downward trend. Chromium was not detected in a May 2003 groundwater sample obtained from monitoring well P-2. This well is set in bedrock down gradient of the process pit, adjacent to the east wall of Building 110. Volatile and semi-volatile organic compounds (VOCs and SVOCs) have never been detected in the groundwater in the area of the pit and were not detected in the May 2003 groundwater sample from P-2. These data indicate that chromium is not leaching out of the pit into the surrounding groundwater. Furthermore, given that the pH of the water in the pit (7.35) and in the surrounding groundwater (6.9) was neutral, leaching of hexavalent chromium into the groundwater via acid mobilization is not expected.

D. Effect of Proposed Closure Method: Closure of the pit using flowable fill will minimize groundwater contact with chromium in the concrete forming the pit walls and floors, thereby greatly reducing the potential for leaching and subsequent migration of chromium beyond the pit walls. In addition, the use of flowable fill may raise the pH of

the groundwater that does contact the pit – further minimizing the potential for leaching. Given that no evidence of POLs has been detected in this area of Building 110, the cessation of pumping in the north pit will not mobilize POLs.

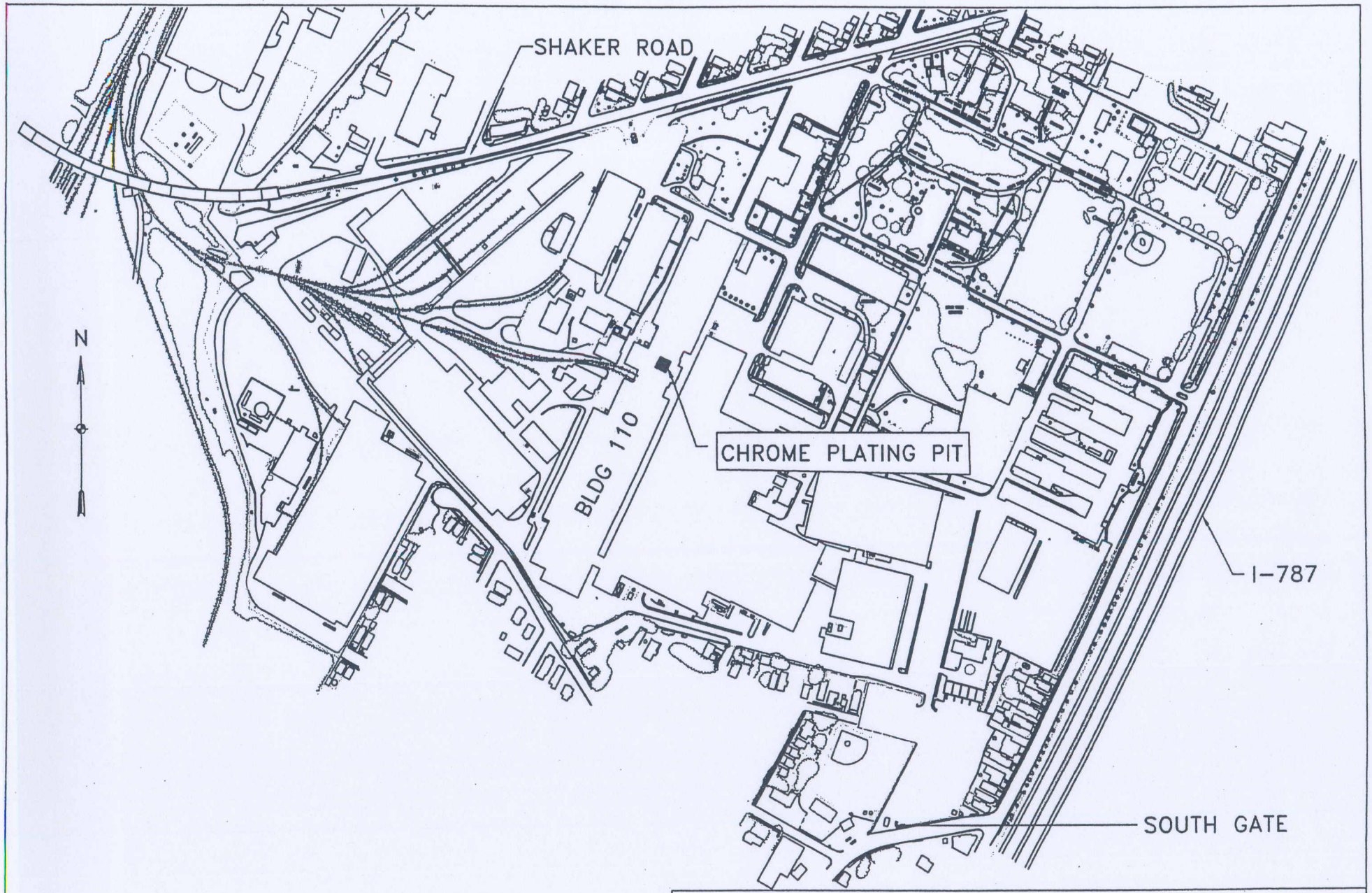
E. Monitoring: If closure of the pit is implemented, monitoring well P-2 should be added to the WVA long-term monitoring program to evaluate whether groundwater quality in the vicinity of the pit is affected.

VIII. Alternatives

There are no feasible alternatives to the approach presented herein as other methods of closure would require significant entry into the unsafe pit.

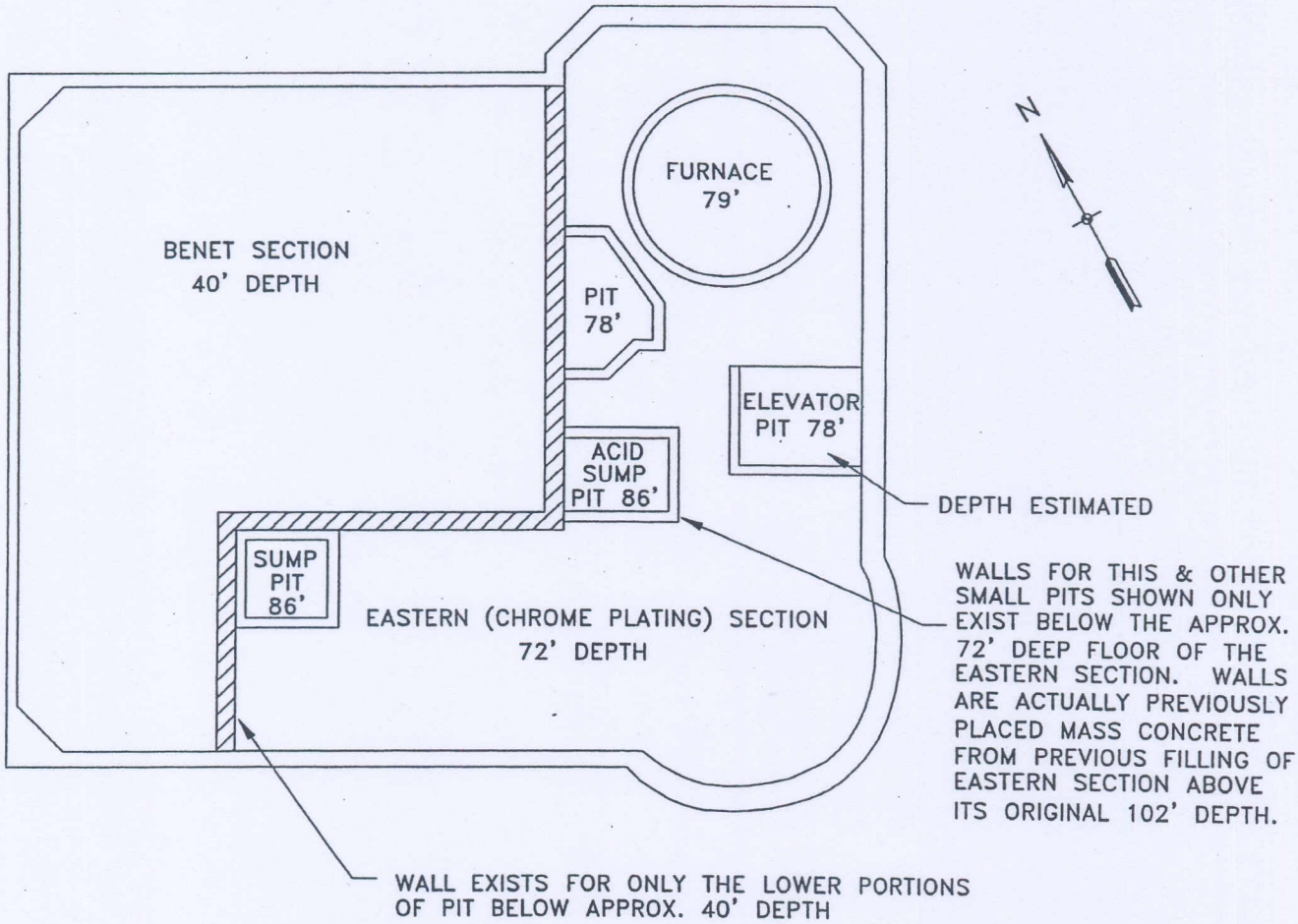
IX. Cost Estimate

Using the conservative assumption that the pit is completely empty, the total volume requiring flowable fill would be approximately 3500 cubic yards. Using a local delivered price of $42 per cubic yard, the price for the fill material alone would be $147,000. Considering the pit is not completely empty—by a factor that is impossible to estimate, the actual price of fill material will be lower. Assuming reasonable costs for management, plan preparation, labor, subcontracting, surface demolition and disposal, and installation of the surface slab, the total cost for this project would probably not exceed $250,000. It is assumed that the Arsenal will perform the pumping and disposal of the excess water in the pit.



WATERVLIET ARSENAL
LOCATION PLAN

SCALE: NOT TO SCALE	DATE: AUG 2003	FIGURE 1



NOTES:

THE INTENT OF THIS DRAWING IS TO SHOW THE APPROXIMATE MAXIMUM DEPTHS OF THE VARIOUS AREAS OF THE CHROME VESSEL PLATING PIT.

DEPTH VALUES SHOWN ARE IN RELATION TO THE MAIN FLOOR SLAB OF BUILDING 110 AND ARE APPROXIMATE.

APPROXIMATE SCALE: 1 IN.=10 FT.

10 0 10 20

US Army Corps of Engineers
Baltimore District

WATERVLIET, NY
WATERVLIET ARSENAL – BLDG 110
CHROME VESSEL PLATING PIT PLAN

DATE: AUG 2003
SCALE: AS SHOWN
FIGURE 2

RECENT LABORATORY TEST RESULTS FOR WATER IN PIT

CHAIN OF CUSTODY RECORD

PAGE 1 OF 1

NORTHEAST ANALYTICAL, INC.

2190 Technology Drive, Schenectady, NY 12308
Telephone (518) 346-4592 Fax (518) 381-6055
www.nealab.com information@nealab.com

LRF # 03080064 (NEA USE ONLY)

DISPOSAL REQUIREMENTS: (To be filled in by Client)

- ○ RETURN TO CLIENT
- ⊘ DISPOSAL BY NORTHEAST ANALYTICAL
- ○ ARCHIVAL BY NORTHEAST ANALYTICAL

Additional charges incurred for disposal (if hazardous) or archival. Call for details.

CLIENT (REPORTS TO BE SENT TO): West Central Environmental	PROJECT/PROJECT NAME: Watervliet Arsenal
PROJECT MANAGER: Dave Cumings, Bill Geoghine	LOCATION (CITY/STATE) ADDRESS: Bldg. 110 Center Pit USA Side East
PHONE: 518 272 6891	REQUIRED TURN AROUND TIME: Normal Turn
SAMPLED BY: (Please Print) Bill Geoghine	NAME OF COURIER (IF USED): NE
SAMPLING FIRM: WCE	

RESULTS TO BE E-MAILED ☐ E-MAIL ADDRESS: dlss
RESULTS TO BE FAXED ☒ FAX #: 518 272 [illegible]

SAMPLE ID	DATE	TIME	MATRIX	GRAB/ COMP	LAB SAMPLE ID (NEA USE ONLY)
030802	8-6	1400	Liquid	Grab	AG10721

ENTER ANALYSIS AND METHOD NUMBER REQUESTED

PRESERVATIVE CODE	
BOTTLE TYPE:	GHP
BOTTLE SIZE:	1GT
NUMBER OF CONTAINERS	1
RCRA Metals + PH	X

PRESERVATIVE KEY
0 - NONE
1 - HCL
2 - HNO3
3 - H2SO4
4 - NaOH
5 - Zn. Acetate
6 - MeOH
7 - NaHSO4
8 - Other _____

REMARKS: USA Pit Bldg 110 East Side

AMBIENT OR CHILLED: TEMP: 19.5 COC TAPE: Y (N) PROPERLY PRESERVED: (Y) N OTHER NOTES:
RECEIVED BROKEN OR LEAKING: Y (N) COC DISCREPANCIES: Y (N) RECVD W/I HOLDING TIMES: (Y) N

RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY
SIGNATURE: Bill Geoghine	SIGNATURE: [illegible]	SIGNATURE: [illegible]	SIGNATURE: [illegible]	SIGNATURE	SIGNATURE
PRINTED NAME: Bill Geoghine	PRINTED NAME: Barry Lowthy	PRINTED NAME: Gary Lowthy	PRINTED NAME: Greg Cromwell	PRINTED NAME	PRINTED NAME
COMPANY: West Central Environ.	COMPANY: NEA	COMPANY: NEA	COMPANY: NEA	COMPANY	COMPANY
DATE/TIME: 1430 - 8-6-03	DATE/TIME: 8/7/03 705	DATE/TIME: 8/7/03 925	DATE/TIME: 8/7/03 9:25	DATE/TIME	DATE/TIME

NORTHEAST ANALYTICAL

ENVIRONMENTAL LAB SERVICES

2190 Technology Drive, Schenectady, NY 12308

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CERTIFICATE OF ANALYSIS
08/11/2003

WEST CENTRAL ENVIRONMENTAL CORP
PO BOX 83
RENSSELAER, NY 12144
CONTACT: BILL GOODINE

CUSTOMER ID:	030802	**NEA ID:**	AG10721
MATRIX:	LIQUID	**DATE SAMPLED:**	08/06/2003 **TIME:** 14:00
DATE RECEIVED:	08/07/2003 **TIME:** 9:25	**PROJECT:**	WATERVLIET ARSENAL
SAMPLED BY:	B. GOODINE	**LOCATION:**	WATERVLIET, NY
CUSTOMER PO:	N/A	**LAB ELAP #:**	11078

PARAMETER PERFORMED	METHOD	FLAGS	RESULTS	PQL	UNITS	DATE ANALYZED
Arsenic	EPA 1979 200.7		0.0763	0.0559	mg/L	08/08/2003
Barium	EPA 1979 200.7		0.0139	0.00911	mg/L	08/08/2003
Cadmium	EPA 1979 200.7		0.00543	0.00436	mg/L	08/08/2003
Chromium	EPA 1979 200.7		33.7	0.00535	mg/L	08/08/2003
Lead	EPA 1979 200.7		ND	0.0568	mg/L	08/08/2003
Mercury	EPA 1979 245.2		ND	0.0002	mg/L	08/08/2003
Microwave Digestion	SW-846 3015		COMPLETED			08/08/2003
Selenium	EPA 1979 200.7		ND	0.0496	mg/L	08/08/2003
Silver	EPA 1979 200.7		ND	0.00923	mg/L	08/08/2003

Note: ND (Not Detected) Denotes analyte not detected at a concentration greater than the PQL
PQL (Practical Quantitation Limit) Denotes lowest analyte concentration reportable for the sample

AUTHORIZED SIGNATURE:

Northeast Analytical, Inc.
Robert E. Weimer, Laboratory Director

TOTALS MEET TCLP

pulled 1' below surface

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CERTIFICATE OF ANALYSIS
08/08/2003

WEST CENTRAL ENVIRONMENTAL CORP
PO BOX 83
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CONTACT: BILL GOODINE

MATRIX:	LIQUID	**DATE SAMPLED:**	08/06/2003
DATE RECEIVED:	08/07/2003 **TIME:** 9:25	**PROJECT:**	WATERVLIET ARSENAL
SAMPLED BY:	B. GOODINE	**LOCATION:**	WATERVLIET, NY
CUSTOMER PO #:	N/A	**LAB ELAP #:**	11078

NEA ID	CUSTOMER ID	METHOD	RESULTS	DATE ANALYZED	TIME ANALYZED
pH in Water at 20°C					
AG10721	030802	EPA 1979 150.1	7.35	08/07/2003	16:20

Note: ND (Not Detected) Denotes analyte not detected at a concentration greater than the PQL
PQL (Practical Quantitation Limit) Denotes lowest analyte concentration reportable for the sample

AUTHORIZED SIGNATURE:

Northeast Analytical, Inc.
Robert E. Wagner, Laboratory Director