ADDENDUM #2
Parks and Open Space
Cardinal Mill Environmental Remediation Project
RFP-083-24

June 27, 2024

The attached addendum supersedes the original Information and Specifications regarding RFP-083-24 where it adds to, deletes from, clarifies or otherwise modifies. All other conditions and any previous addendums shall remain unchanged.

ATTENTION: A mandatory meeting has been added to this RFP and the submittal due date has been extended.

A mandatory pre-proposal site visit will take place on **July 10, 2024, at 11:00 a.m.** to be completed before 2:00 p.m. **Parties interested in attending are required to register through Bonfire via the vendor discussions. The last day to register is July 8, 2024, by midnight.** Please indicate the number of seats to reserve as shuttle vans will be required. There is not enough parking for everyone at Cardinal Mill. After the site visit, the County will issue another Addendum.

Bids from firms not represented and signed in at the mandatory, pre-bid meeting, and site visit will not be accepted.

The submittal date has been changed to July 17, 2024, by 2:00 p.m.

Proposals must be submitted electronically on or before the Close Date at https://bouldercounty.bonfirehub.com/.

NO ZIP FILES OR LINKS TO EXTERNAL SITES WILL BE ACCEPTED. THIS INCLUDES GOOGLE DOCS AND SIMILAR SITES. ALL SUBMITTALS MUST BE RECEIVED AS AN ATTACHMENT (E.G. PDF, WORD, EXCEL).

Electronic submittals must be received at the website above. Submittals sent to any other box will NOT be forwarded or accepted. It is the sole responsibility of the

proposer to ensure their documents are received before the deadline specified above. Boulder County does not accept responsibility under any circumstance for delayed or failed submittals. **No exceptions will be made.**

The Board of County Commissioners reserve the right to reject any and all bids, to waive any informalities or irregularities therein, and to accept the bid that, in the opinion of the Board, is in the best interest of the Board and of the County of Boulder, State of Colorado.

Attachments to Addendum:
Geotechnical Investigation Report
Toe Drain Installation Report
Phase II Environmental Report
Electrical Plan
1872 Conger & Sanders Claim, Boulder County Lode

1. Question: Please provide an expectation regarding Task 3 deliverables by the end of December 2025. Is the intent for the contract to design the optimized solution and support BCPOS with construction planning, permitting, and oversight? Based on this response, is there the option to present an alternative schedule/period of performance?

   ANSWER: Please present an alternative schedule / period of performance and we will consider it. Additional meetings with Boulder County Community Planning & Permitting (BCCP&P) have taken place since this RFP was advertised. We have a pathway to permitting the temporary water quality treatment facility located in the current lower parking lot which is "Work Done By Others" in relation to this RFP and intended for installation in the fall of 2024. To be clearer, please add to Task 3 the 30% design of a permanent water quality treatment facility as early as possible in 2025 (recognizing many unknowns at this time which makes this impossible to estimate). It is possible that the temporary water quality treatment facility design (which is unknown at this time) performs very well, but needs a different location or a slight adjustment in performance or aesthetics. This 30% design will be needed to start the long permitting process with BCCP&P for a permanent treatment facility. We do not know how many months it will take to get the proper permits so we will be open to longer time periods for Task 3 to see the project through the permitting process and beyond to construction and construction oversight. Please treat this project as a time & materials project, as there are so many unknowns we cannot anticipate what will happen in this next year that may influence the schedule, scope of work, and costs. We will likely need

contract amendments in the future to go beyond the 30% design to implement the suggestions in the RPO, and we hope to select a proposal that indicates flexibility and availability of your team to see the project through to a successful implemented optimization. Please propose the best plan for Task 3 that you can with limited information, with emphasis on a capable and flexible team. The schedule and costing tables can indicate which sub-tasks are in the budget through the end of 2025, and which will extend outside of 2025 and thus are not included in the budget breakdown. Your cost description can include a list of assumptions that goes into your cost breakdown. At this time, weather and the type of investigations needed for Task 2 may slow down the 30% plan delivery date, and then it may take 9 months or more to get County permits after submittal of the 30% plans in this Task. We recognize that Tasks 1 and 3 are very dependent on other parties, while Task 2 is largely under the control of the Contractor for this RFP.

2. Question: What level of detail does BCPOS want for the costing task breakdown?

   ANSWER: We will be looking for enough detail that will display your selected team's capabilities and your layout of sub-contracted services that you propose to be considered for this project. The hours/rate (costs) and fees and expenses proposed for each task should be supported by a team that is available and has an attached rate table with proposed tasks broken down into estimated hours, or an estimated sub-contracted cost.

3. Question: Can you identify sampling locations for available water quality data?

   ANSWER: We have recently performed a pollutant load analysis, approximate sampling locations shown below in the Google Earth images, with the data to be received later this week. We will provide this data at the pre-bid meeting on July 10th. Most of our sampling data over the years is located at the toe drainpipe outlet labeled "CB SW 6" in this Google Earth picture. We have limited water quality data from other dates and times at "CB SW 1" the mine adit. "CB SW 8, CB SW 9 and CB SW 12 are all points in Coon Track Creek, for which there is also additional data available through other municipal and state sources that we are currently trying to collect. We have an additional date for which data was collected at the hill slope seeps "CB SW 2", "CB SW 3", and a third seep to the south, and this can be provided to the selected Contractor. "CB SW 4.5" is a surface water location for seep water not collected into the toe drain pipe. "CB SW 5" is an additional seep location.

4. Question: Will any additional site-specific geotechnical data be available for the contractor to review in support of Task 2? This could include the results of the geotechnical investigation that Yenter used to design the MSE wall (perhaps done by Loris & Associates?).

   ANSWER: All available reports and information will be made available to the selected contractor after the competitive bid process is complete. A few

selected reports (due to the number and size of the reports) have been attached to this Addendum including the geotechnical report mentioned.

5. Question: During the Brownfields study, was any site characterization carried out to determine the extents and contents of mine waste or mill tailings piles?

   ANSWER: Site characterization for the Brownfields study was limited in our determination and needs to be extended to fully characterize the extents and contents of the mine waste or mill tailings piles. All available reports and information will be made available to the selected contractor.

6. Question: Does Boulder County have any mine maps or records of the Boulder Tunnel?

   ANSWER: We have attached one document that might be relevant, but we expect the selected Contractor to search all available State records for relevant maps or documents.

7. Question: Can BCPOS set up a pre-proposal site visit?

   ANSWER: Yes, a mandatory pre-proposal site visit will take place on July 10, 2024, at 11:00 a.m. to be completed before 2:00 p.m. Parties interested in attending are required to register through Bonfire via the vendor discussions. The last day to register is July 8, 2024, by midnight. Please indicate the number of seats to reserve as shuttle vans will be required. There is not enough parking for everyone at Cardinal Mill. After the site visit, the County will issue another Addendum.

   <u>Bids from firms not represented and signed in at the mandatory, pre-bid meeting, and site visit will not be accepted.</u>

8. Question: If possible, could we request a submittal extension from the 7/9 due date to 7/10?

   ANSWER: Yes, we will extend the submittal date to 7/17/24, submittals due by 2:00 p.m.

9. Question: What is the status of the water treatment system installation?

   ANSWER: No temporary water quality treatment system has been designed to-date, nor installed.

10. Question: What type of treatment is being used/proposed?

ANSWER: For the temporary water quality treatment system, we are considering filtration, pH adjustment, and adsorbent resin. We have visited the water quality treatment facility at the Caribou Mine and Cross Mine upstream of Cardinal Mill as a point of reference for what might be installed at Cardinal Mill. However, they have water storage and dilution capabilities that we do not have and will likely not be able to create at Cardinal Mill.

11. Question: Does the 25-page limit of the proposal include resumes? Are the following forms: sustainability questionnaire, Bonfire Vendor information, and Environmental Cardinal Mill RFP proposal section excluded from the 25-page count?

    ANSWER: Resumes, sustainability questionnaire, Bonfire Vendor information, and Environmental Cardinal Mill proposal section are not included in the 25-page limit.

12. Question: Are there space constraints for the treatment system?

    ANSWER: Yes, topography and environmental and human impact are some of the considerations with respect to the permanent treatment system. With current County parcel ownership, we do not have the luxury of large flat areas for construction. We may need to consider tanks and structures on vertical supports.

13. Question: Can we get site dimensions that indicate how much area is available for the remedial system?

    ANSWER: This is not available. The temporary facility, Work by Others, will be built in the lower parking lot located southeast of the mill. We do not know how much of that parking lot footprint will be taken by the temporary treatment facility nor if we will need to extend the parking lot footprint to the east. We need to stay on County property, but we need to be advised by the Selected Contractor as to what is required for the permanent treatment facility and what might be possible with creativity and technology.

14. Question: For Task 1 “Implementation Assistance 2024” please clarify, what are the expectations for the time to be spent on-site by the successful contractor’s representative to provide assistance for construction implementation (full time, 2-days per week, etc.)?

    ANSWER: Attendance at weekly online (1 hour) meetings starting August 1, review of emails and materials not to exceed 4 hours per week, and on-site visits (2 hours on-site each time) every 2 weeks if not combined with other site visits for Task 2. Basically, as we move through this permit compliance process,

another group of knowledgeable individuals is welcome in the project consultation to optimize project success.

15. Question: For Task 2 "Wholistic Site Investigation and Remediation Strategy Development" can a list of previously developed reports and site investigation information be provided to bidders?

    ANSWER: All available reports and information will be made available to the selected contractor after the competitive bid process is complete.
    Here is a screenshot of the list:

    - 2000-11-22_Phase I Environmental Site Assessment 200 acre Parcel Near Cardinal Boulder County Colorado.pdf
    - 2000-11-22_Phase I Environmental Site Assessment Approximate 5 acre Parcel Near Cardinal Boulder County Colorado.pdf
    - 2000-12-4_Walsh letter report to Lexie.pdf
    - 2002-1-31_Site Visit to Coon Track Creek- New Cardinal Town Site.pdf
    - 2003-8-28_Geo Cal Soils Report for West Retaining Wall Project.pdf
    - 2006 - Toe Drain Installation Report - CDHPE.pdf
    - 2007-11-9_Cardinal_Mill_Phase_I.pdf
    - 2008-4-24_Cardinal Mill Phase II.pdf
    - 2012-07-03_Public Health_167BergrenRd_CardinalMill_Comments.pdf
    - 2013_07_26 EA for Public Access - EME.pdf
    - 2013_07_26 EA for Tunnel Reconstruction - EME.pdf
    - 2017 Cardinal Mill Electrical Plan.pdf

16. Question: For Task 2, please clarify for the nine example tasks which may be involved, shall scoping and budgeting for these tasks be conducted at a later date following review of available information and determination of which tasks are required to develop a remediation strategy? Page 10 of SOW includes discussion of conducting site survey and geotechnical and Hydrology & Hydraulic assessment.

    ANSWER: Yes, the tasks and their scope and budget will need to be developed in detail at a later date following review of available information and determination of which tasks will be required. We are looking for a best estimated budget at this time for the Contract, one that is reasonable to cover a general estimated scope of work and that will aim to minimize future Contract Amendments for budget (although time, budget and scope of work contract amendments will be presented to the Board of County Commissioners as needed). A general scope of work with emphasis on the skills of the team

that will be assigned to work on this project will be sufficient, along with a rate table and estimated workload availability of those individuals to assist with this project.

17. Question: For Task 2, please clarify, who is the “mining team” intended to include?

    ANSWER: “Mining team” listed in Task 2 is intended to include the selected contractor with their internal team.

18. Question: Please confirm a separate construction contractor be responsible for construction of the water treatment plant Sept 15-Oct 15, and discussion of permits, licenses, locates, and codes (SOW pdf page 10) is relevant only to the performance of Task 2 studies.

    ANSWER: Yes, the temporary treatment plant will be constructed under a separate contract in 2024, likely Sept. 15-Oct. 15. The permits, licenses, locates and codes is relevant to both Task 2 and Task 3. Task 3 will be the additional design needed to construct a permanent facility in likely a new location.

19. Question: For Task 3, Remediation Process Optimization (RPO) it is stated that “this task might include retrofits and modifications to existing systems, or installation of a permanent system downstream in an environmentally sound location that minimizes impacts to neighbors.” PDF page 10 of SOW includes discussion that Contractor shall provide final opinion of probable cost for recommendations to be included as part of task 3-RPO, and associated bid item estimate if Construction Bids are needed to implement the RPO. Please clarify, is it BCPOS's intent that this task include an allowance for identifying necessary retrofits, with subsequent designs, equipment purchase and installation to be costed separately?

    ANSWER: YES, that was the original intent. But more detail has been provided in the Answer to Question 1 regarding the inclusion of a set of Permit-Ready 30% plans for those identified retrofits. No final design nor equipment purchase nor installation will be included in this project unless a Contract Amendment specifically allows that to occur.

20. Question: For Task 3, it is stated that “This task could include modifications to sampling programs, reduced sampling frequencies, technology transitions, and other strategies to optimize performance.” Please clarify, is this task intended to include recommendations for modifications or also include development of an alternate sampling programs?

ANSWER: This task is intended to include recommendations for modifications, NOT the development of an alternate sampling program.

21. Question: Is this a lump sum cost project, or will the project be tracked as time and materials?

    ANSWER: Time and materials.

22. Question: Has any background information been collected for sub-surface hydrology characterization for the site? If so, would Boulder County be willing to share that information with bidders?

    ANSWER: We have only measured flows at the surface, no sub-surface hydrological data has been collected.

23. Question: Has any background data been collected related to the pressure associated with water in the mine tunnels?

    ANSWER: No.

24. Question: Are there mine maps of the underground workings surrounding the site available, and would Boulder County be willing to share that information with bidders?

    ANSWER: No maps of underground workings are available from Boulder County, only parcel ownership maps here: https://maps.boco.solutions/propertysearch/ Enter 158310000034 into the search engine to find the parcel associated with the Boulder County tunnel. Parcel shapes are accurate, but parcel locations are not and must be surveyed on the ground.

25. Question: What is the added benefit of doing the sub-surface hydrology investigation if the discharge point source locations, effluent flow rates, and water chemistry are already known? Sub-surface hydrology investigations are notoriously complex and can be expensive.

    ANSWER: We may not have to do a sub-surface hydrology investigation. Based on recent flow monitoring of the adit and the seeps and the toe drainpipe outfall (the pollutant load investigation we performed and results from which we will provide by July 10 (the pre-bid site visit,)) it appears that largely the flow from the adit is what we are measuring at the toe drain pipe outfall. We have not yet performed a test to see if we capture all of the adit flow and pipe it to the manhole (which connects the perforated toe drainpipe to the non-perforated toe drain pipe) do we then drain up all the hillslope seeps? We are

more confident in this prediction of dry-up than we were a few weeks ago. If this is the case, we would have more options for the permanent treatment plant location and we might be able to remove some of the contamination if it is increased by the water's flow path through the hill slope.

26. Question: Would Boulder County be willing to provide baseline assumptions for the number of water-quality monitoring wells, piezometers, and inclinometers expected for the project in order to provide consistent cost estimates from the bidders?

    ANSWER: We have no information to assist in this question. This is a time and materials type contract, so the best quality proposal benefiting Boulder County will be selected, not the low bid.

27. Question: Does Boulder County have an estimate of waste area and volume at the site? This will be helpful for developing consistent waste characterization costs across bidders.

    ANSWER: No, but we have added a mandatory pre-bid meeting on-site for those Contractors who wish to attend.

28. Question: What type and quantity of debris flow does Boulder County expect from the Boulder County Tunnel?

    ANSWER: Unknown, this is a hypothetical worst case scenario should a debris fall cause water to dam in the Tunnel and then later the dam could fail and cause a debris flow.

29. Question: Would Boulder County be willing to share information on the current mine water treatment system (e.g., general design, treatment media/chemicals, design flow rate of mine water through treatment system)?

    ANSWER: Currently, there is no design and no mine water treatment system. This information will be shared with the selected Contractor as soon as it is available.

30. Question: Is there an approximate area/footprint dimensions available for a water treatment system? If so, who is/are the landowner(s) of this footprint?

    ANSWER: The only available footprints are parcels owned by Boulder County. https://maps.boco.solutions/propertysearch/ Search "167 Bergren Road, Unincorporated" and you will see adjacent parcels owned by Boulder County. We are currently pursuing an administrative process to merge County parcels. A permanent location for the water treatment system will need to follow the

25-ft offset rule from parcel boundaries, and minimize environmental impact caused by grading to make the site suitable for operation and maintenance.

31. Question: Can you provide more details on the available electric power and cellular coverage?

    ANSWER: There is Xcel Energy service to the site. There is a ground mounted transformer at the base of an Xcel power pole approximately 200 feet from the mill along the access road at the top of the mill. It is adjacent to and just east of the adit tunnel entrance. The mill has a 240/120V 100A single phase service meter and panel feed from the transformer. Electrical Plans for the site are attached to this addendum. Any electrical service upgrade will need to be coordinated with the County Electrician and Xcel Energy and can be facilitated by BCPOS staff. Cell coverage connectivity depends on the individual cellular provider service, however BCPOS staff has had cellular connection with Verizon and AT&T at certain times, but not always. Internet service connectivity is available at the site by satellite or line of sight through the local provider Nedernet (www.nedernet.net).

32. Question: Is there a consistent supply of clean running water (either surface water or city water, for example)? If so, what is the approximate flow (in whatever units are available)?

    ANSWER: No. There is no municipal water supply at the site. A new well or new surface water diversions from Coon Track Creek are subject to Division 1 administration and are not a reliable source.

33. Question: Can heavy equipment easily access and maneuver on the site? Is the site accessible all year or just seasonally?

    ANSWER: The site is tight and in steep terrain and has limits to the size of equipment that can easily access it. The site is accessed via Bergren Road from Caribou Road, which is a Boulder County maintained road. Bergren Road is a private road and the upper access road to the site. Bergren Road is gravel and for the most part is a single lane road. Bergen Road is plowed and maintained by the private landowner to the best of their ability each winter. The access road, down to the gravel parking lot at the bottom of the mill building and the toe-drain discharge pipe, is a narrow single lane gravel road approximately 12' wide. Currently, it is not maintained beyond the first weather event in winter. The County understands year-round access is needed and we are looking into alternatives to keep this road accessible over the winter. Options include County staff maintaining this road or the County contracting with a local vendor to respond and plow the road/site each storm event.

34. Question: Are the mine water flows known (approximately) if all possible surface water is diverted from the mine water requiring treatment?

    ANSWER: No, this is one of the questions we expect the Selected Contractor to assist with in Task 2. One task that the County plans to conduct in July is a walk through of the Boulder County Tunnel to identify locations where water (rain water, snow melt, stream crossings) is directed into the Tunnel rather than away from the Tunnel. We expect the Selected Contractor to help the County consult on options to minimize this inflow, and advise on whether it would be cost-effective (for the permanent treatment solution) to reduce the surface inflow.

35. Question: Is the County amenable to a temporary surface and subsurface monitoring program to inform site characterization and treatment design?

    ANSWER: Yes.

36. Question: Is the project tax exempt?

    ANSWER: Yes.

37. Question: Define "limited electric service.

    ANSWER: See answer 31 above.

38. Question: Will Contractor have access to a storage/laydown area, if required (e.g., for drilling operations, etc.)?

    ANSWER: The only flat area owned by Boulder County is the small parking lot located south east of the mill and currently occupied (in part) by a portable toilet shade/housing structure. https://maps.boco.solutions/propertysearch/ Search "167 Bergren Road, Unincorporated" and you will see adjacent parcels owned by Boulder County. This site is currently accessed by a private road and there are private citizens living in adjacent structures. Negotiations with the private landowner may be possible, likely for a fee. The large flat area west of the mill is privately owned and includes a raised septic drain field.

39. Question: Task 2, Item 6 (p8) - "The County may be severely hampered in these efforts if the adjacent landowner is unwilling to participate in these efforts." Should Contractor assume adjacent landowner is willing to participate in these efforts? Confirm coordination with adjacent landowner(s) is responsibility of the County and excluded from Proposer's scope of services.

ANSWER: Coordination with the adjacent landowner is the responsibility of the County. Conversations are open between the County and the adjacent landowner regarding the potential purchase of additional land by the County, should it be deemed necessary for the success of this project.

40. Question: Does the County have knowledge of any private or otherwise potentially unlocatable utilities at the site?

    ANSWER: No.

41. Question: Subcontractors (p11) - confirm submission of subcontractor names is not required with the proposal (but shall be done prior to mobilization of any selected contractors).

    ANSWER: Yes, submission of subcontractor names is not required with the proposal, but shall be done prior to mobilization of any selected contractors.

GEOCAL, INC.
GEOSCIENCES & ENGINEERING

GEOTECHNICAL INVESTIGATION

New Cardinal Mill
Nederland, Colorado

Prepared For

Loris and Associates, Inc.
Attn: Dan Beltzer, P.E.
2585 Trail Ridge Drive East
Lafayette, Colorado 80026

August 28, 2003
G03-839

GEOCAL, INC.
GEOSCIENCES & ENGINEERING

GEOTECHNICAL INVESTIGATION

New Cardinal Mill
Nederland, Colorado

COLORADO REGISTERED PROFESSIONAL ENGINEER
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CONTENTS

1.0 PURPOSE AND SCOPE

This report presents the results of a geotechnical study conducted to provide recommendations for the proposed remedial construction of a wall on the west side of the New Cardinal Mill building near Nederland, Colorado. This study also addresses stability of a steep slope adjacent to the proposed wall construction, and provides recommendations for mitigating water seepage in the lower level of the mill building. The investigation was performed in general accordance with our proposal to Loris & Associates, Inc., dated May 16, 2003.

A field exploration program consisting of site reconnaissance, three borings, and two backhoe test pits was conducted to obtain information on subsurface conditions. Selected samples collected during the field exploration were tested in the laboratory to evaluate engineering characteristics including strength, soils classification, and corrosion potential of on-site soils. Data review, slope stability analyses, subsurface drainage analyses, and conceptual level evaluations of possible earth retaining alternatives were also performed. This report has been prepared to summarize the data obtained and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered.

Information presented in this report is intended to provide sufficient geotechnical data for design-build contractors to bid design alternatives. For specific final designs by design-build contractors, additional investigations may be needed and the costs for these studies should be included in the contractor's bid.

Environmental investigations including evaluations of the occurrence or potential occurrence of hazardous materials are beyond the scope of this study.

2.0 PROPOSED CONSTRUCTION

Several buildings at the New Cardinal Mill site are planned to be renovated including the old mill building and cabins. Restoration of several cabins was in progress at the time of our investigation, and these cabins will become permanent residences. Proposed construction for which the current study has been undertaken involves stabilizing the slope located immediately west of the existing mill building where a very old retaining wall has failed. Drainage improvements are also planned to mitigate water seepage that currently inundates the lowest level of the building. Other phases of the project, not included in the current study, will specifically address rehabilitation of the building so that this approximately 100 year old structure can be preserved. The facing of the new earth retaining system will need to aesthetically fit the historic character of the site.

Preliminary alternatives for slope stabilization include MSE walls or slopes, soil nails, tied back soldier piles, grouted mass, or combinations of these systems. Based on preliminary information provided by Loris & Associates, Inc., the overall height of the retained earth will be on the order of 40 to 45 feet, and the top of the wall be approximately 60 feet long. It will likely be necessary to underpin or otherwise stabilize the top portion of the existing building to perform the retained earth construction in that area.

In addition, a large embankment of apparent waste rock from previous mining activities was deposited to the west of the existing structure, adjacent to the western end of the failed retaining wall. Results of stability analyses presented later in this report indicate that the slope of the waste rock pile should be made flatter.

If the proposed construction is significantly different from that described above, this office should be notified to re-evaluate the recommendations contained in this report.

3.0 SITE CONDITIONS

The New Cardinal Mill site is located within Roosevelt National Forest in the narrow, relatively steep-sided mountain valley of a southeast flowing stream. The stream was named "Caribou Creek" on site drawings provided to us and "Coon Track Creek" on a published USGS Nederland Quadrangle. It is accessed by a one-lane gravel road extending from County Road 128, otherwise known as Caribou Road, located approximately 900 feet to the east. The mill building is built into the north slope of the creek valley in an area of extensive rock debris, spoils, or tailings (all referred to as waste rock), apparently derived from the mining-related Boulder County Tunnel located immediately northwest of the mill site. The natural slopes are moderately grassy with a moderate to thick cover of pine and aspen trees; the valley bottom is covered with thick brush.

The area is located near the western end of the Nederland Tungsten District and the eastern end of the Caribou-Grand Island District, two currently inactive, but historically significant hard rock mining districts of noble metals. The mill is reported to have been active into the 1940's primarily as a processor of tungsten ore derived from mines located up-slope to the northwest and transported to the site through the tunnel.

The mill building consists of a wood-frame structure sided with wood and sheet metal. The foundations are poorly exposed, but appear to be cast-in-place concrete. The mill is stepped down along the slope with an approximately 43-foot drop. Some floors in the mill are concrete slab-on-grade. The access road immediately north of the mill is constructed mostly on fill. A stone masonry retaining wall supporting the road at the northwest corner of the mill has partially collapsed.

Caribou Creek is located 40-55 feet south of the mill building at a slightly lower elevation than the lower level floor. It had a small, mid-summer flow when observed by Geocal, but likely fluctuates between near zero when frozen in the winter and relatively high during spring runoff. Field observation and contour expression on site topographic mapping indicates the waste rock pile at least slightly diverted the creek's original flow channel.

A small flow of water was observed coming from an approximately 8-inch diameter pipe extending out from the collapsed entrance to the Boulder County Tunnel, 165 feet northeast of and slightly above the mill. The pipe, which originally directed tunnel water into catch ponds to the west, is broken and a significant portion of the flow appears to be seeping into the waste rock pile that forms the slope immediately west of the mill. Further, the outlet to the catch ponds appeared to be partly collapsed and may also be contributing flow into the waste rock pile.

Water was observed flowing into the lower level of the mill from the base of the western waste rock pile. Flow direction generally appeared to be from the west-northwest. Flow inside the mill was observed coming through the foundation near the central part of the mill's west wall. Also, flow was seen entering at ground level at the southwest corner. Water flow through the lower level of the mill is from west to east. The source of the water entering the mill could be from upgradient seepage of the tunnel-catch basin and the up-stream creek water, both of which appear to flow through the waste rock pile.

4.0 GEOLOGIC CONDITIONS

4.1 Geology

We reviewed readily available published technical literature and aerial photographs and conducted a site-specific field reconnaissance to characterize the site's geologic conditions. A published standard quadrangle scale geologic map, USGS Map GQ-833/1969, assigns most rock exposures in the immediate mill site area to Older Pre-Cambrian age, now termed "Pre-Cambrian "X", "Biotitic Gneiss" without giving a formal formational name. These are described as generally dominated by mica-quartz gneiss, which is banded fine to intermediate coarsely crystalline metamorphic rock. Lesser intrusive veins of Tertiary age "quartz monzonite group", characterized as coarsely crystalline, granite-like igneous rock, are also mapped in the area.

Our field observations confirmed that in-place bedrock around the site is composed of banded micaceous gneiss with some small quartz veins. The rocks are moderately foliated, typified as flat mineral crystals aligned along common planes, which promotes preferred planes of parting. They are hard and relatively resistant to weathering except where well fractured. This bedrock forms the slope immediately north of the mill. The native slope is partly mantled by thin (up to two feet thick) slope wash colluvial soil. As previously discussed, the slope west of the mill is composed of bedrock spoil, possibly excavated from the tunnel, consisting of coarse sand to small boulder size granitic gneiss and granite-like monzonite. The flat area between the south side of the mill and the creek is underlain by fill, probably composed of tunnel spoils and mill tailings. The creek bottom area includes a relatively narrow band of natural clay to cobble alluvial soil plus common rock fragments from the spoils pile and the mill.

4.2 Slope Stability Reconnaissance

The exposed slope areas surrounding the mill were observed for evidence of their relative stability. Some of our observations were made well away from the mill building to gather information that could affect the proposed wall construction, and the discussion below is presented only in the context of the wall construction on the west side of the mill. Specific slope stability analyses and geologic hazards assessments were not conducted for the rest of the site as part of our scope of work, but additional studies away from the proposed construction may be necessary.

- The natural and cut slope north of the mill displayed no obvious evidence of creep, seeps, or rock fall. Foliation and jointing provide natural planes of weakness; however, these weaknesses appear to have been mitigated by flatter excavation slopes. Planar dips appear more commonly across-slope than down-slope. A portion of the vertical slope cut north of the Supervisor's House appears stable, even though a very weathered, intensely fractured shear zone occurs within slope face. Most trees and wooden power poles are vertical. One large pine tree at the southeast corner of the Supervisor's House is leaning down-slope, but at that location is undercut by the main access road. Common recent rockfall has occurred from the steep fill slope above the east extension of the mill. Cobbles, possibly loosened by access road activity, have hit the wall of the mill.

- Except for rock fill immediately adjacent to the mill, most of the eastern slope appears to be sound, natural bedrock partly covered with thin colluvial soil and some gravel-cobble debris from the access road above. Well-defined foliation in outcrops dips at near right angles to the slope; major joints are vertical and parallel to the slope. No significant evidence of slope movement was observed. One large pine tree is leaning down-slope, but at a location that is undercut by the lower access trail. The only moisture observed is associated with runoff from the mill, described previously, onto the lower access trail where the ground is saturated, but firm.

- The low relief area between the south side of the mill and the creek is vegetated and marshy in spite of being underlain by mostly sandy gravel-cobble fill. Soft ground conditions currently appear to be surficial with the overall ground remaining firm for light travel loads; heavy and frequent loading will likely cause significant deterioration in ground conditions.

- The major east-facing slope of the waste rock pile, built of rock spoil from various excavations, appears to be marginally stable with significant evidence of slope raveling. Old ore cart railroad tracks along the top edge of the slope have been undermined and distorted along its length. The approximately 36 foot high slope facing the mill is steep (1.2:1 or greater), but generally uniform with no evidence of deep failures. The top of the fill embankment is currently dry. Water flow exits the rock debris near the toe of the slope. Rockfall of large cobbles and boulders may occasionally occur, and appears to have struck the side of the mill in the past. Future construction, loading, and vibration may affect overall slope stability and would likely increase the amount of rockfall.

A review of several governmental publications and online data base summaries shows the greater Nederland area to be classified as having a low incidence of significant historic earthquake activity and a generally low seismic hazard rating. The USGS National Earthquake Information Center's current web site was accessed to view their National Seismic Hazard Map. This source classifies the area as having seismic hazard potential of 12%g peak acceleration with 2% probability of exceedance in 50 years. Of the faulting mapped in the area, none has been identified as having Quaternary age, or geologically recent, movement. Boulder County's Comprehensive Plan for land use classifies the area as having "Moderate" geologic hazard risk for rock fall, snow avalanche, and mine subsidence, presented in decreasing order of risk.

5.0 SUBSURFACE INVESTIGATION

The field subsurface investigation was performed on August 6th, 7th, and 13th, 2003. Three exploratory borings were drilled and two backhoe test pits were excavated at the approximate locations shown on Figure 1. Borings were advanced with a truck-mounted CME-55 drill rig using 4½-inch outside diameter solid stem and 4¼-inch inside diameter hollow-stem augers. The underlying rock was cored using NX drill steel with water for drilling fluid. A representative of Geocal, Inc. logged the borings. Test pits were excavated with a rubber tired backhoe. Slotted PVC casing was installed in all three borings and the two test pits for future water measurements.

Subsurface soil samples were obtained using a nominal 2-inch inside diameter California spoon sampler and a 1-3/8 inch inside diameter standard split spoon sampler. The samplers were driven into the various strata with blows from a 140-pound hammer falling 30 inches, similar to the ASTM D1586 test standard. Field penetration test values (blow counts) when properly evaluated indicate the relative density or consistency of soils and bedrock. Depths at which samples were taken and penetration resistance values are shown on the Boring Logs (Figure 2) with Legend and Notes presented on Figure 3.

We will retain samples for 6 months after submittal of this report. Soil and core samples may be viewed by the design-build bidders in our laboratory if adequate notice is given.

6.0 SUBSURFACE CONDITIONS

As shown on the boring logs, subsurface conditions encountered in the three borings consisted of 15 to 38 feet of man placed fill materials and natural soils overlying weathered gneiss and gneiss bedrock.

In Borings B-1 and B-2, the upper 10 to 13 feet of soils encountered consisted predominantly of gravelly to very gravelly, slightly clayey sand with cobbles. Fill encountered in Boring B-3 contained more gravel, cobbles, and small boulders than B-1 and B-2. The maximum boulder diameter encountered during drilling was estimated to be about 2 feet. Based on the blow counts, the fill materials at the site are considered to be loose to medium dense. Natural soils below the fill consisted of clayey, gravelly sand to very silty gravel, and these soils are dense to very dense based on the blow count data.

Test Pit TP-4 contained significant gravel, cobbles and small, angular boulders with maximum size estimated at approximately 18 inches. Boulder size materials were estimated at approximately 30 percent of the volume. In addition to soil, cobbles, and boulders, fill materials encountered in TP-4 included wood, brick, and metal debris, estimated to comprise up to 30 percent of the fill volume. Test Pit TP-5 contained significantly less cobbles than TP-4 and no boulders were observed; however, the type of fill materials and estimated quantity was similar to TP-4. Photos of the test pits are shown on Figures 4 and 5.

Weathered gneiss bedrock was explored using both solid stem and hollow stem augers, and is medium hard to very hard with penetration resistance values ranging from 82 to as low as 50 for 2 inches of penetration. Gneiss bedrock shown on the boring logs was very hard, requiring core drilling methods to obtain samples. Photos of the core are presented on Figure 6. More detailed descriptions of the subsurface materials are provided on the legend, Figure 3 and in Section 4.0, Geology.

Measurements of water levels in the borings were made by lowering a weighted tape measure into the open hole shortly after drilling, and within a few days subsequent to drilling. The location of the water levels measured and the number of days subsequent to drilling are shown on the logs of exploratory drilling.

7.0 LABORATORY TESTING

Samples collected from the exploratory borings were examined and visually classified in the laboratory by the project engineer. Laboratory tests conducted on selected soil samples consisted of natural moisture content and unit weight, grain-size distribution (gradation), percent passing the No. 200 sieve, moisture-density relationship, Atterberg Limits, direct shear, electrical resistivity, pH, chloride concentration, and water soluble sulfate concentration.

Gradation test results are shown on Figures 7 and 8, and moisture-density relationship results are presented on Figure 9. Direct shear test results are shown on Figures 10 through 12. A summary of laboratory test results is included in Table 1, and test results for corrosion potential are presented on Table 2.

Gradation and Atterberg Limits Tests: Results of gradation analyses were used to quantify the particle size distribution of samples collected during the field investigation and for classification purposes. Atterberg Limits provide a measure of the consistency of the soil at differing moisture contents. It should be noted that the gradation results from the borings often do not include the larger particle sizes because it was not feasible to obtain them with the exploration and sampling methods used. Likewise, very large cobbles and boulders from test pit exploration were not included because of the impracticality of obtaining, transporting, and testing boulder sized materials.

Moisture-Density Relationship Tests and Natural Unit Weight: The moisture-density test is a measurement of the unit weight variation that will occur with different moisture contents utilizing the same compaction effort. Results of the testing indicate that the maximum dry unit weight of a bulk sample from Boring B-2 was 136.5 pcf at 8.0 percent optimum moisture content. When the rock correction is applied, the values are 143.7 pcf at an optimum moisture content of 6.2 percent. A wider range of moisture-density relationships probably exists for the soils at the site than was measured in this one test. The natural dry unit weight of a soil sample from similar depth and location as the bulk sample subjected to moisture-density testing was 115 pcf. Based on these limited results (and penetration resistance values), it is believed that the embankment fill materials and natural soils are generally in the range of 80% to 85% of standard Proctor maximum dry density. These percentages tend to indicate that the fill placed in the areas investigated was probably not compacted in an engineered fashion.

Corrosion Testing: Water soluble sulfates, chlorides, pH, and electrical resistivity tests were performed to provide information about corrosion of the soils encountered at the site. The results are summarized on Table 2.

Water soluble sulfate concentrations measured ranged from 0.0016% to 0.0052%. Electrical resistivity testing indicated minimum laboratory resistivity ranging from 2,480 to 8,000 ohm-cm, and the pH of the tested materials varied form 6.7 to 7.6. Measured chloride concentrations ranged from 0.0015% to 0.0059%. According to Table 3.1 of the FHWA "Manual for Design & Construction Monitoring of Soil Nail Walls ((1996)", the soils are not considered aggressive. However, design build contractors should interpret the test results independently and perform additional testing if needed.

Direct Shear Testing: Consolidated, drained direct shear testing, performed in general accordance with ASTM D3080-98, was conducted on a representative bulk sample of the on-site soils (B-2@15'-20'). A dry unit weight of approximately 111 pcf was targeted for the remolded samples to roughly correlate to 80% of the maximum standard Proctor dry unit weight. Samples were consolidated with normal loads of 10, 20, and 40 psi prior to shear displacement, but they were not inundated with water.

Three cursory strength interpretations including the stress at 10% displacement, stress at 15% displacement, and the peak stress are presented on Figures 10 through 12. Results indicate variability in the friction angle depending on the amount of displacement. Interpreted friction angles are 35°, 45°, and 52° for the tested specimens at 10% displacement, stress at 15% displacement, and the peak stress. The appropriate design value(s) should be interpreted by the design-build contractor.

8.0 RETAINED EARTH ALTERNATIVES

Early on in the project design scoping phase, it was recognized that a design-build approach for this project would be prudent because of the challenging nature of the work and required construction sequencing. It was also recognized that the design could be optimized by a design-build contractor based on their resources. Additionally, the effectiveness of a design depends greatly on construction methods, quality and experience of contractor personnel, and equipment available at the site, all of which can be controlled by a design-build contractor.

Design-build contractors should be allowed to develop their own design concepts with acceptance by the owner team. General descriptions of various approaches are presented in this section of the report. Other approaches not discussed in this report should also be considered.

8.1 Mill Building Stabilization

It will likely be necessary for the upper level of the existing mill building to be stabilized in some fashion or moved and replaced to facilitate retaining wall construction. Traditionally, some form of underpinning is performed to accomplish this. Drilled pier or micropile alternatives for underpinning are presented below. Of course, the requirements for stabilizing the structure will depend on the construction approach used for the adjacent wall construction.

8.1.1 Drilled Piers

Drilled pier underpinning consists of drilling one or more vertical open shaft piers immediately adjacent to the portion of the structure requiring support. The pier diameter can be 12 inches or larger. The pier is drilled to a depth sufficient to support the necessary load in soils or some penetration of bedrock. A haunch or other brace is constructed on the pier to extend under the structure to transfer the structural load to the pier. Some small movement of the structure/underpinning element must occur to activate the strength of the pier/soil/bedrock system. Drilled piers are relatively simple to install and are capable of relatively high vertical and horizontal load carrying capacities. They can be readily adapted to steel haunch or brace underpinning elements.

Drilled pier installation require some clearance for the drill rig and the cutting handling, as well as auxiliary elements such as concrete delivery trucks. Depending on the dimensions of the shaft, a crane may also be necessary for reinforcing installation. Mobilization and material costs may be relatively high when considering a remote site such as this. Additionally, cobbles and boulders that may be encountered during drilled shaft excavation could make construction difficult. Casing would likely be needed.

8.1.2 Micropiles

Micropiles can be used for underpinning structures. Micropile installation is similar to drilled piers with the exception of much smaller diameter shafts, typically 4 to 6 inches. Multiple micropiles are typically installed due to the lower vertical and horizontal load carrying capacity than drilled piers.

Micropiles are somewhat simpler to install than drilled piers due to the much smaller diameter. This could be of benefit in the type of overburden materials (fill and soils) encountered at the project site with potentially large particles that would refuse penetration of large diameter auger bits. The equipment used to install micropiles typically requires much less room to function and does not require the extent of auxiliary equipment or materials. Micropiles can also be installed at angles other than vertical. Micropiles are installed with much smaller equipment than drilled shafts, and drilling in very coarse materials could be difficult because of the lower downward crowd capabilities and potentially caving soils.

8.2 Earth Retention Systems

Various methods exist to provide long-term stable slopes that can be aesthetically adapted for the desired historic appearance of the walls adjacent to the west side of the mill building. Three alternatives, MSE walls (or slopes), soil nailing, and mass grouting are described in following sections. Cmbinations of these systems may also prove to be feasible.

Other methods of slope stabilization were considered, such as tied-back soldier piles, but were rejected due to high costs and potentially destabilizing the slopes as a result of installation procedures. Minimum pile lengths necessary for overall stability of a soldier pile wall would likely require penetration into the very hard bedrock which underlies the site and may be very costly.

The proposed geometry of the new retaining system relative to the subsurface profile is a very important consideration that may dictate the feasibility of the design options. Only preliminary information regarding the final geometry of the proposed retaining system was available at the time of this report. A cross section (Section A-A on Figure 1) is presented on Figure 2 that shows the subsurface data plotted in relation to the existing topography and preliminary orientation of the overall slope of the proposed earth retention system. The preliminary concept for the overall slope design is 0.75:1

(horizontal:vertical). The overall slope may consist of a series of benches or possibly a continuous slope.

8.2.1 MSE Walls and Reinforced Slopes

Mechanically Stabilized Earth (MSE) walls or slopes are constructed by simultaneously placing backfill soil lifts interceded with reinforcing media, such as geotextile fabric, geogrid mesh, metal mesh, or metal straps. When steel reinforcements are used, they are typically attached to structural facing elements. Geotextile reinforcing can be physically attached to the facing, placed between facing elements with frictional bonding considered, or lapped between lifts of backfill. MSE walls can be constructed to relatively great heights with adequate long-term stability. The facing can be adapted to various aesthetic requirements, including stacked stone masonry. The facing elements for geosynthetic reinforced earth walls are normally considered to be non-structural.

MSE walls are very cost-effective for straightforward projects with few geometric constraints. However, geometric limitations at this site could result in relatively high costs. MSE walls would require significant overexcavation of the slope for installation to ensure proper reinforcing length behind the facing. As a result, they require significant staging area as well. For nearly vertical walls, a preliminary estimate of reinforcement lengths is approximately 70% of the wall height. Undermining of the existing building would need to be prevented if large excavations will be made.

Reinforced soil slopes are similar to MSE walls in concept. A slope may be considered to be reinforced, rather than an MSE wall, when it is more than 80° from vertical. Geosynthetics are typically used for reinforced slope construction and usually consist of relatively long primary reinforcements necessary for internal stability and short reinforcements to prevent surficial sloughs at the face. As with MSE walls, several facing elements could be used.

8.2.2 Soil Nailing

Unlike MSE wall construction which requires bottom up construction, soil nailing allows a wall or slope to be constructed from the top down. Top down construction at this site is advantageous because it would limit excavation quantities. The process of soil nailing, when appropriately applied, results in a reinforced section that is internally stable and able to retain the ground behind it. As with MSE walls, the nail reinforcements develop their reinforcing action through nail-ground interactions as the ground deforms somewhat during and following construction.

Soil nailing is usually performed by drilling small diameter holes horizontally or subhorizontally behind the exposed soil face; then inserting and grouting steel reinforcing bars in place. The soil nails are installed from the top down by working from a temporary bench made by excavating a 3 to 6 feet deep unsupported excavation. Drainage strips and reinforcing mesh are placed over the reinforced face and nail head and then shotcrete is applied as a permanent surface. An aesthetic veneer can be placed over the shotcrete consisting of cast-in-place concrete, masonry, or stone. The process of benching, installing soil nails, and shotcreting is then repeated until the base of the wall is reached. Equipment used to install soil nails is relatively small and can access difficult areas.

Preliminary calculations to assess the feasibility of soil nail walls were performed using SNAILZ software developed by CalTRANS. These results indicate that soil nails on the order of 25 feet long and spaced in a 4' x 4' or 5' x 5' grid pattern may be feasible. If soil nails anchored in bedrock are necessary based on the final wall configuration, costs could be relatively high. The final design and stability of a soil nail wall should be performed by the design-build contractor.

8.2.3 Grouted Mass

Another possible slope stabilization alternative would be to create a sufficiently large mass of grouted material to satisfy stability requirements. This process would likely be performed by injecting a high slump grout under pressure through grout tubes driven through the overburden soils. Grouting would occur in bottom up stages. Grout quantities could be large resulting in high costs. Additionally, coarse materials in the overburden soils could require that the grouting be performed through continuous flight augers. Another difficulty with this concept is that the limits of grout travel are difficult to know and could result in an unacceptably low factor of safety with regard to stability. A grouted mass may cause hydrostatic pressure buildup that would need to be considered in the design.

8.0 SLOPE STABILITY

8.1 Waste Rock Pile Slopes

Slope stability analyses were performed for the existing waste rock pile configuration west of the mill building where Boring B-3 was drilled. This slope was analyzed because of its proximity to the proposed construction activities. The analyses were performed using the computer program XSTABL. Results indicate that the existing slope, approximately 1.2:1 (horizontal:vertical) is marginally stable. It is recommended that the slope be laid back 1.5:1 slope or flatter.

Material properties (density, cohesion, and friction angle) were selected based on the field exploration, laboratory index test results, and the existing slope angle. The following table presents the material properties that were assumed.

Material Number	Bulk Density (pcf)	Sat. Density (pcf)	Cohesion (psf)	Friction Angle (degrees)
1 Waste Rock Fill Soils	125	135	0	40

The range of blow counts obtained in the waste rock materials during exploration indicates that the friction angles generally vary from 29° to 36° (Peck, Hanson & Thornburn), but this information is somewhat misleading. SPT blow count correlations to friction angle in rock fill materials must be used with caution, if at all. The SPT blow counts were generally taken after penetrating through or displacing cobbles or small boulders and likely were performed in loosened materials. For these reasons, a friction angle of 40° based on the angle of repose of the existing slope was deemed appropriate for use in the stability analyses. The assumption that the friction angle is equal to the angle of repose is reasonable for normally consolidated young materials (Terzaghi, Peck & Mesri). We understand that the waste rock pile has been in its present configuration for many decades, and it is likely that very little compaction was applied during placement. In addition, work by Leps (1970) regarding shear strength of rock fill materials indicates that a friction angle of 40° for low density, poorly graded, weak particles (note that the geiss particles at this site are considered to be relatively strong) is a reasonable lower bound for the height of this rock fill.

Phreatic surface levels used for the stability model within the embankment were chosen based on water level readings measured in Boring B-3 and the observed seepage at the toe of the slope. For seismic conditions, a horizontal pseudo-static coefficient of 0.06 (½ of the peak horizontal ground acceleration) was used.

Results of the analyses indicate that the existing slope is marginally stable with regard to shallow failures with a static factor of safety equal to 1.0. Deeper failures were calculated to have a minimum factor of safety of 1.2. The minimum calculated pseudo-static factor of safety for a deep failure is less than 1. Typically, a minimum factor of safety of 1.3 to 1.5 is desired for the static condition depending on the intended use, and a factor of safety of 1.0 or greater is desired for the pseudo-static condition.

We recommend that the waste pile rock slope be laid back to a 1.5:1 slope to achieve a static factor of safety greater than 1.3. The slope should be laid back to 1.75:1 to achieve a static factor of safety greater than 1.5. Both of these slopes have calculated factors of safety greater than 1.0 for the seismic condition. Either of these slopes will reduce the potential for rock fall from the slope; flatter slopes will be more stable with regard to rock fall.

8.2 Preliminary Stability Analysis of Possible Earth Retention Systems

Cursory stability analyses of possible retaining systems indicate that a properly designed and constructed system can be implemented to maintain global stability of the system. Design-build contractors should perform their own stability assessments based on their proposed construction.

Temporary excavation slopes and shoring requirements should be determined according to OSHA criteria by the contractor's "competent person".

9.0 DRAINAGE OF LOWER LEVEL OF MILL

As previously discussed, the lower level of the mill building is currently inundated with water. For the mill's ultimate use which will involve guided tours, it is desirable to mitigate the seepage that is occurring. A practical method for accomplishing this goal appears to be through the use of an interceptor drain installed on the west and south sides of the mill building that would discharge downstream of the structure into the creek. Other methods such as cutoff walls would be expensive and would be unable to cutoff seepage that may enter the floor area from the north beneath the building.

The interceptor drain is envisioned to consist of a perforated PVC pipe surrounded by drain rock wrapped in properly designed geosynthetic filter material. The drain rock should be installed from the pipe invert to the top of the trench and should be at least 18 inches wide. Drain rock material should consist of minus 4 inch clean aggregate with at least 50% retained on the No. 4 sieve and less than 2% passing the No. 200 sieve. The pipe invert should be installed at least 5 feet below the lowest floor level. Grading should be designed so that surface drainage will flow away from the building.

Due to the difficulty of estimating seepage quantities and the planned phased construction for this project, we recommend that a phased approach for the drainage system be considered as well, and that additional capacity be added if necessary during future construction activities. The interceptor drain may be able to sufficiently lower the water level beneath the floor elevation, however, it may also be necessary to install lateral subdrain lines beneath the floor of the lower level connected to a header pipe running parallel to the south side of the building. Specific designs for a floor underdrain system should be performed after details of the mill building renovation are available.

Preliminary theoretical calculations indicate that infiltration into the interceptor drain will be on the order of 0.05 cfs per foot of pipe length. Our calculations are based on permeability information resulting from our experience and empirical correlation's between grain size and permeability. The actual quantities of water which must be carried by the drainage system will not be known until construction occurs. The final interceptor drain design should be performed by the design-build contractor.

10.0 LIMITATIONS

This report has been prepared in accordance with generally accepted geotechnical engineering practices used in this area at this time. The conclusions and recommendations are based upon the data obtained from the borings and test pits at the approximate locations shown on Figure 1. The nature and extent of the variations between borings may not become evident until excavation is performed. If during construction, soil, bedrock, or groundwater conditions appear to be different from those described, this office should be advised so that re-evaluation of our recommendations may be made.

REFERENCES

USGS Professional Paper 223 (1950): "Geology and ore deposits of the Front Range, Colorado"

USGS Professional Paper 245 (1953): "Geology and ore deposits of the Boulder County Tungsten District, Colorado"

USGS Professional Paper 1101 (1980): "The Boulder Creek Batholith, Front Range, Colorado"

USGS Map GQ-833 (1969): "Geologic map of the Nederland Quadrangle, Boulder and Gilpin Counties, Colorado"

USGS National Earthquake Information Center (2003): "Colorado Seismic Hazard Map", as provided from the NEIC website {neic.gov/neis/states/colorado/hazards}

Boulder County, Land Use Department (amended 9/6/84): "Boulder County Comprehensive Plan, Geologic Hazards and Constraints"; as provided from the county's "Government Online" website {www.co.boulder.co.us/assessor}.

COEM Information Circular (1999): "Colorado Earthquake Hazards", particularly 'Earthquake epicenters and Quaternary faults and folds' summary map.

CGS Internet Map Server (2003): "Colorado late Cenozoic fault and fold database"; as provided from the Survey's website {www.geosurvey.state.co.us/pubs}

Stereo-pair Aerial Photographs (source unknown), flown 10/8/98, scale approximately 1"=3900'; as examined at Colorado Aerial Photo Service on 7/23/03

USGS= U. S. Geological Survey; CGS= Colorado Geological Survey; COEM= Colorado Office of Emergency Management.

LEGEND

FILL, predominantly SAND (Boring B-3 is GRAVEL),gravelly to very gravelly, clayey with cobbles and small boulders (max. size estimated at 2 ft. diameter), angular to subangular broken crystalline fragments, generally loose to medium dense, slightly moist, light brown to gray.

SAND, gravelly, clayey to very silty, to GRAVEL, very sandy, angular to subangular, dense to very dense, slightly moist, light brown to brown.

Weathered GNEISS, medium hard to very hard, fragmented (gravel to large cobble size), medium to coarsely crystalline, well fractured, slightly moist to moist, mixed rust, gray, and gold colors.

GNEISS BEDROCK, very hard, well banded, weak to moderate foliation, fine to medium crystalline with occasionaly 1" to 3" thick zones of crumbly, coarse crystals, well fractured, slightly moist to moist, mixed rust, gray, and gold colors.

25/12 Drive sample blow count, Indicates that 25 blows of a 140-pound hammer falling 30 inches were required to drive the California or SPT sampler 12 inches.

Indicates drive sample, 2-inch I.D. California liner sample.

Indicates drive sample, Standard Penetration Test, 1 3/8-inch I.D. split spoon sample.

Indicates P.V.C. pipe installed in hole to depth shown.

Indicates disturbed bulk sample.

6 Indicates depth to water level and number of days after drilling measurement was made.

Indicates depth at which boring caved.

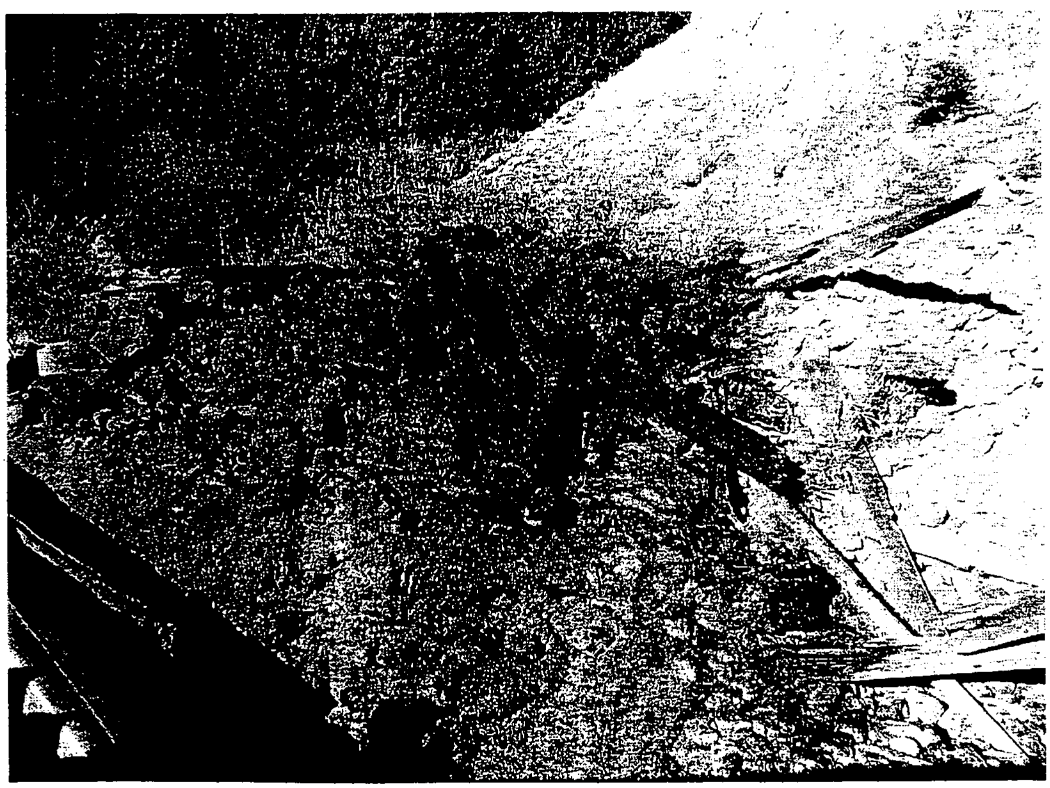
RUN 4 100 / 64 Test hole advanced using NX core.
Core run number 4, core recovery = 100 %, RQD = 64%

NOTES

1. Borings were drilled on August 6 and 7, 2003 with a truck mounted CME-55 rig equipped with 4-inch diameter solid stem and a 6-inch diameter hollow stem continuous flight augers. Coring was also done with a NX core bit.
2. Locations of borings shown on Figure 2 are approximate and were located by measuring from existing features .
3. The lines between strata represent approximate boundaries between material types. Transitions between materials may actually be gradual.
4. Water level readings shown on the logs were made at the time and under conditions indicated. Fluctuations in the water level may occur with time.

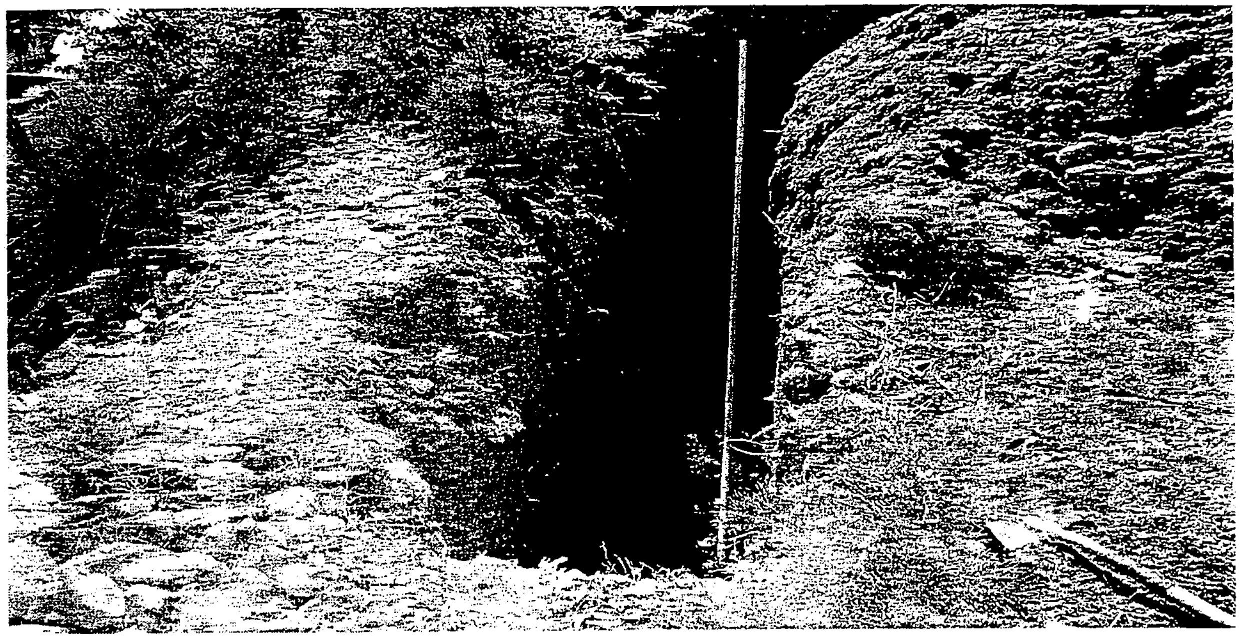
G03-839	GEOCAL, INC.	NEW CARDINAL MILL LEGEND AND NOTES	FIGURE 3

Test Pit TP-4

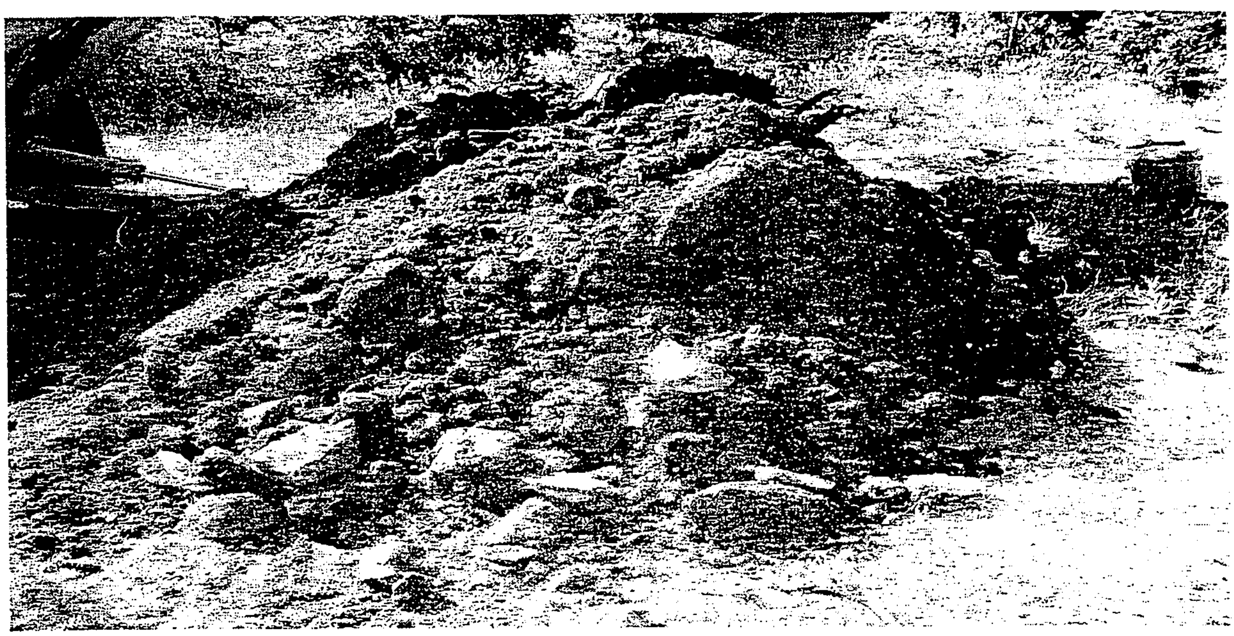


Excavated Materials from Test Pit TP-4

G03-839	GEOCAL, INC.	NEW CARDINAL MILL TEST PIT PHOTOS	FIGURE 4

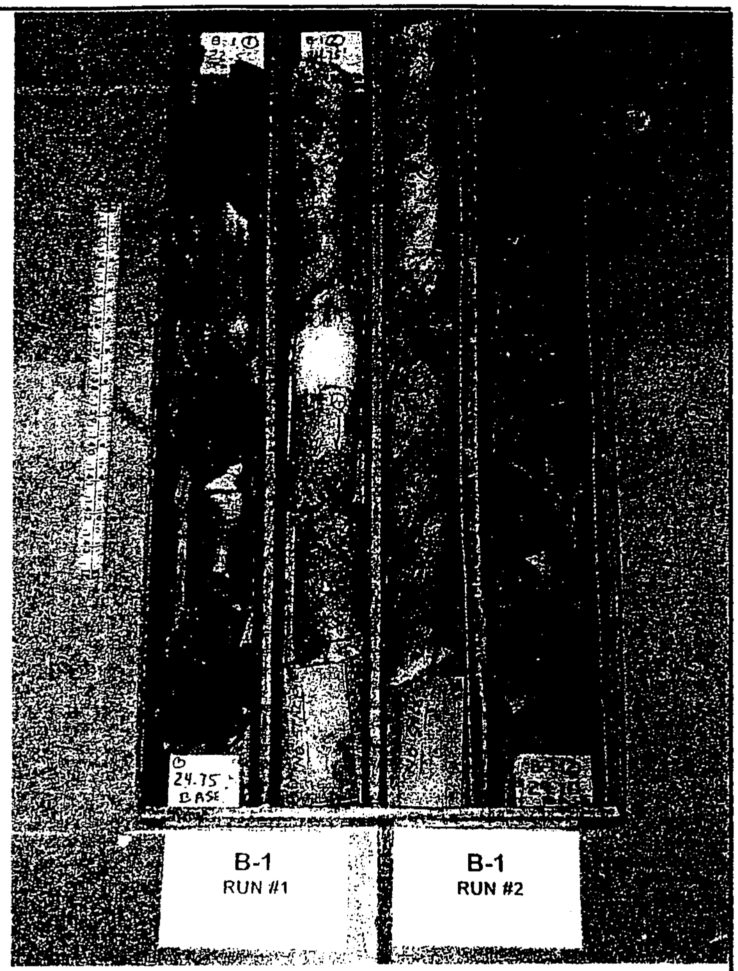


Test Pit TP-5

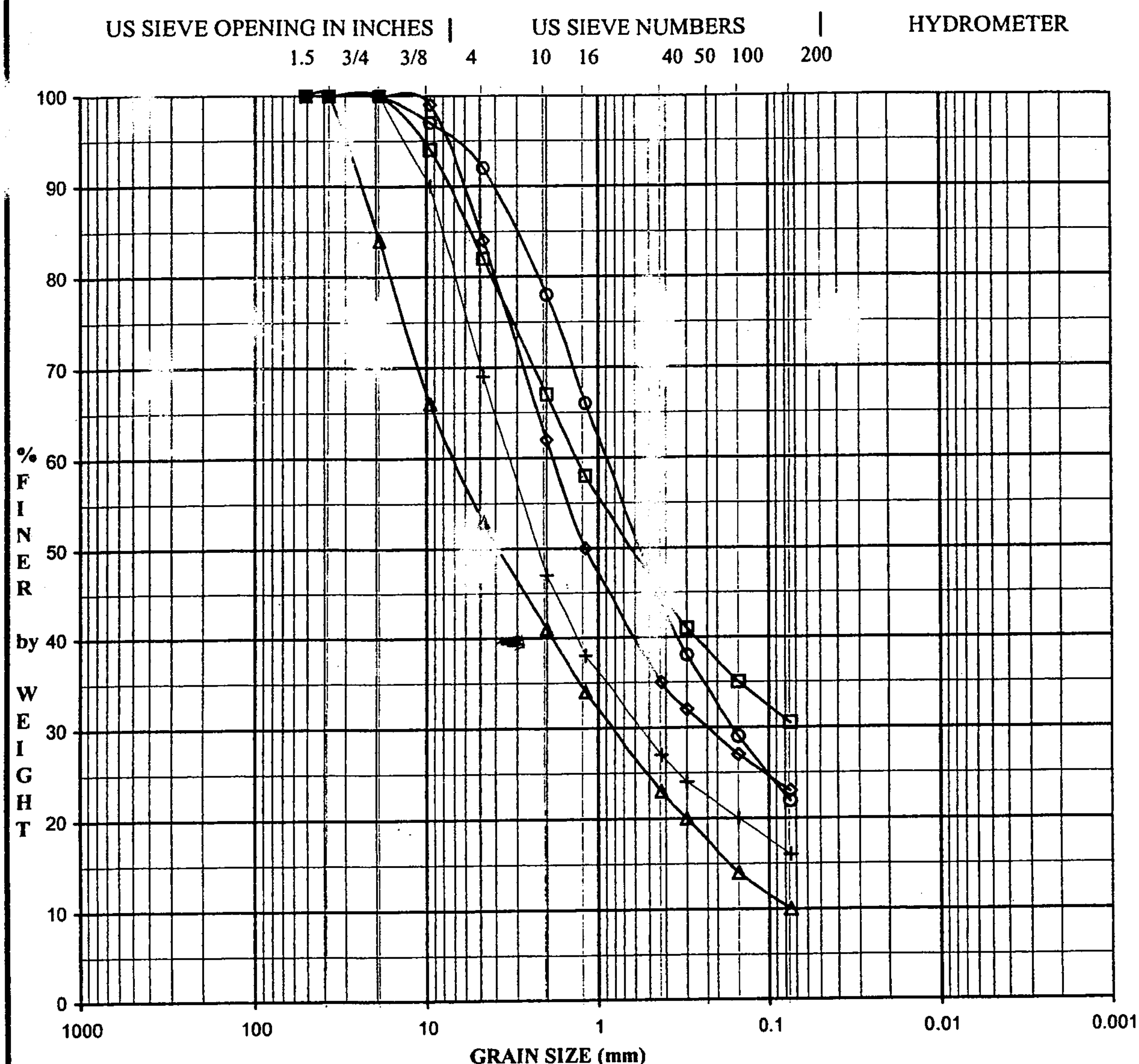


Excavated Materials from Test Pit TP-5

G03-839	GEOCAL, INC.	NEW CARDINAL MILL TEST PIT PHOTOS	FIGURE 5



G03-839	GEOCAL, INC.	NEW CARDINAL MILL TEST PIT PHOTOS	FIGURE 6

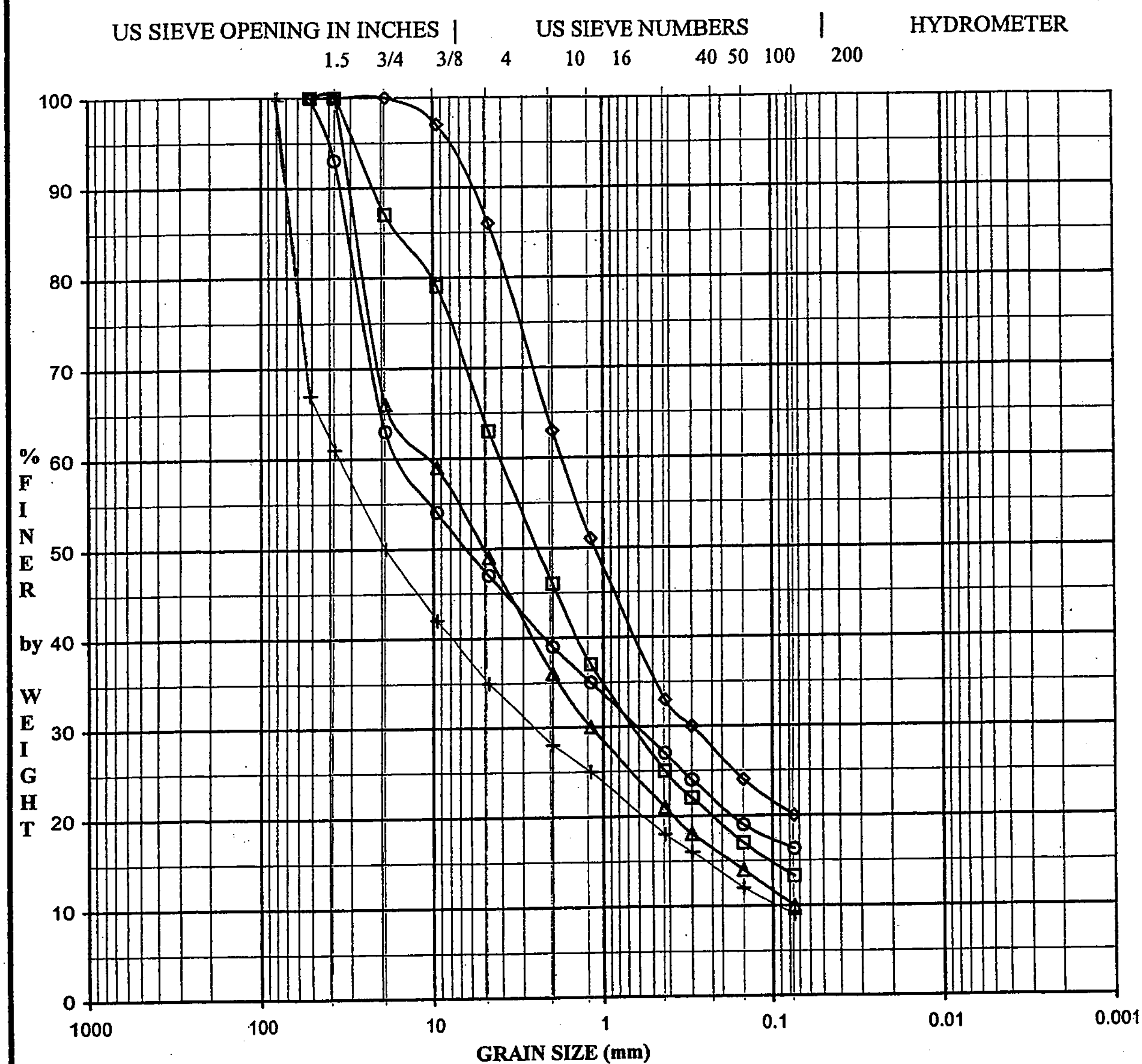


COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MED	FINE	

Specimen I.D.				Description
◊	B-1	@ 9	FEET	FILL-SAND, clayey, gravelly
□	B-1	@ 1-19	FEET	FILL-SAND, clayey, gravelly
Δ	B-2	@ 5	FEET	FILL-GRAVEL, very sandy, sl. clayey
O	B-2	@ 25	FEET	Weathered GNEISS
+	B-2	@ 15-20	FEET	SAND, gravelly, clayey

Specimen I.D.				D100	D60	D30	D10	Cc	Cu	%Gravel	%Sand	%Silt&Clay
◊	B-1	@ 9	FEET	19.00	1.86	0.240				16	61	23
□	B-1	@ 1-19	FEET	19.00	1.36					18	52	31
Δ	B-2	@ 5	FEET	37.50	6.35	0.905				47	43	10
O	B-2	@ 25	FEET	19.00	0.97	0.167				8	70	22
+	B-2	@ 15-20	FEET	19.00	3.63	0.631				31	53	16

GEOCAL, INC.	NEW CARDINAL MILL	JOB NO.	G03-839
	GRADATION TEST RESULTS	FIGURE NO.	7



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MED	FINE	

Specimen I.D.			Description
◊	B-2	@ 25-30FEET	Weathered GNEISS
□	B-3	@ 9 FEET	FILL-SAND, v. gravelly, sl. clayey
Δ	B-3	@ 24 FEET	FILL-GRAVEL, v. sandy, sl. clayey
O	TP-4	@ 7.5-8 FEET	GRAVEL, very sandy, clayey
+	TP-5	@ 8.5-9 FEET	GRAVEL, very cobbly, sandy, sl. clayey

Specimen I.D.			D100	D60	D30	D10	Cc	Cu	%Gravel	%Sand	%Silt&Clay
◊	B-2	@ 25-30FEET	19.00	1.80	0.300				14	66	20
□	B-3	@ 9 FEET	37.50	4.26	0.740				37	50	13
Δ	B-3	@ 24 FEET	37.50	7.08	1.180				51	39	10
O	TP-4	@ 7.5-8	37.50	9.22	0.708				53	31	16
+	TP-5	@ 8.5-9 FEET	37.50	14.57	2.786	0.100	5.33	145.71	65	26	9

GEOCAL, INC.

NEW CARDINAL MILL

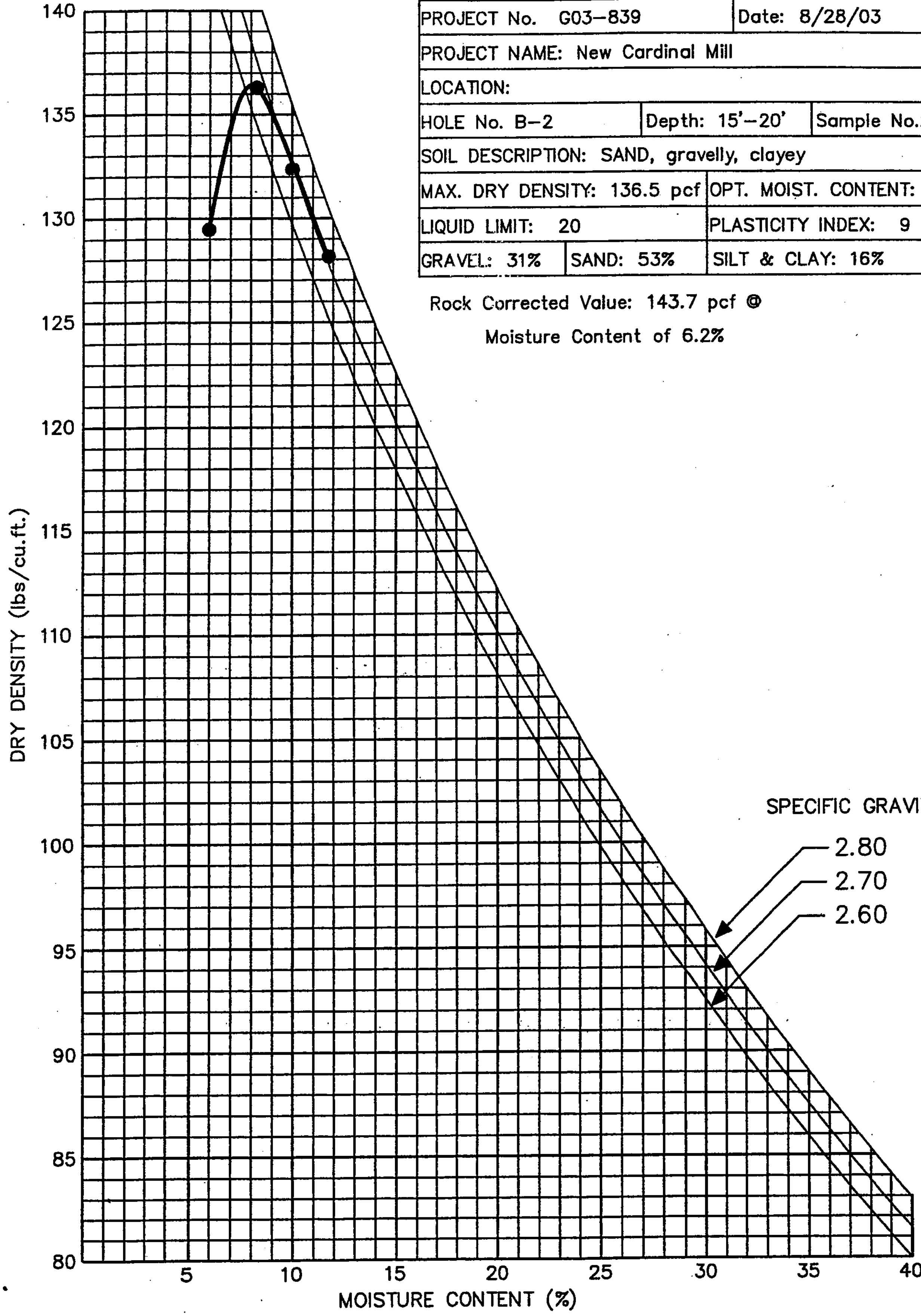
GRADATION TEST RESULTS

JOB NO. G03-839

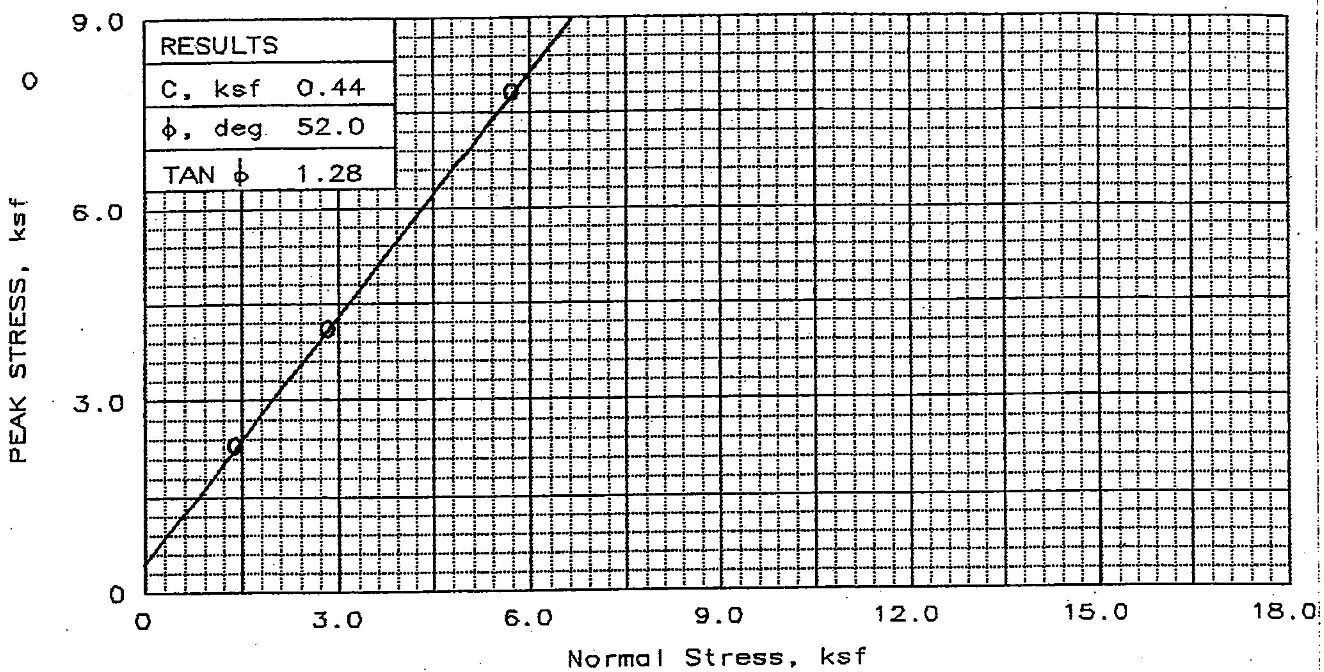
FIGURE NO. 8

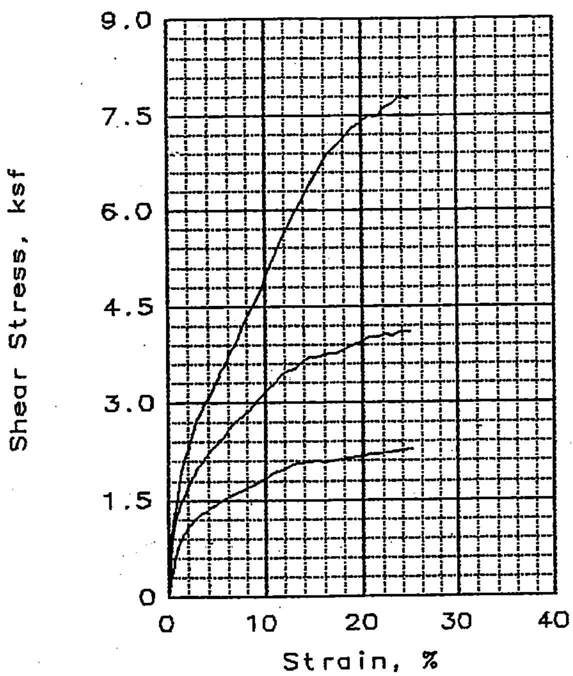
PROCEDURE: ASTM D698, Method A		
PROJECT No. G03-839	Date: 8/28/03	
PROJECT NAME: New Cardinal Mill		
LOCATION:		
HOLE No. B-2	Depth: 15'-20'	Sample No.2400-7
SOIL DESCRIPTION: SAND, gravelly, clayey		
MAX. DRY DENSITY: 136.5 pcf	OPT. MOIST. CONTENT: 8 %	
LIQUID LIMIT: 20	PLASTICITY INDEX: 9	
GRAVEL: 31%	SAND: 53%	SILT & CLAY: 16%

Rock Corrected Value: 143.7 pcf @ Moisture Content of 6.2%



G03-839	GEOCAL, INC.	NEW CARDINAL MILL MOISTURE-DENSITY RELATIONSHIP	FIGURE 9



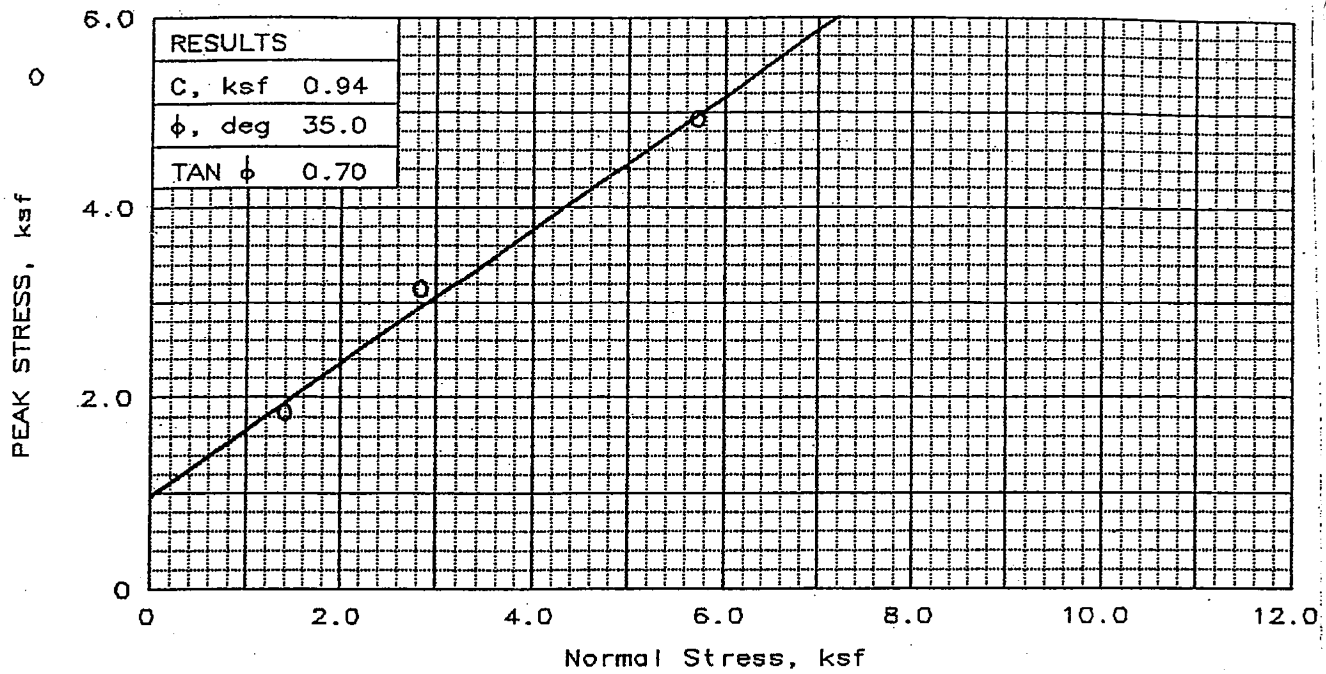


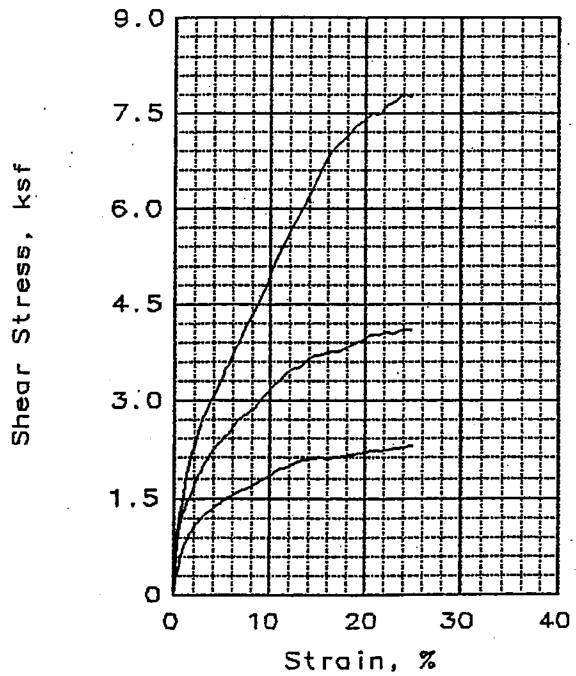
SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	8.0	8.0	8.0
	DRY DENSITY, pcf	110.6	110.6	110.6
	SATURATION, %	42.7	42.7	42.7
	VOID RATIO	0.496	0.496	0.496
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	1.00	1.00	1.00
AT TEST	WATER CONTENT, %	6.6	6.6	6.6
	DRY DENSITY, pcf	110.6	110.6	110.6
	SATURATION, %	35.2	35.2	35.2
	VOID RATIO	0.496	0.496	0.496
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	1.00	1.00	1.00
NORMAL STRESS, ksf		1.44	2.88	5.76
PEAK STRESS, ksf		2.29	4.10	7.81
STRAIN, %		25.1	24.9	24.1
ULTIMATE STRESS, ksf				
STRAIN, %				
Strain rate, %/min		0.14	0.14	0.14

Sample Type: **Remolded.**
Sample Location: **B-2@15'-20'**
Description: **SAND, gravelly, clayey.**
Specific Gravity = **2.65**
Date: **8/28/2003**

Remarks:
1) **Failure tangent drawn at peak stress.**
2) **Specific gravity estimated.**
3) **Specimens were not inundated.**

G03-839	GEOCAL, INC.	NEW CARDINAL MILL DIRECT SHEAR TEST RESULTS	FIGURE 10



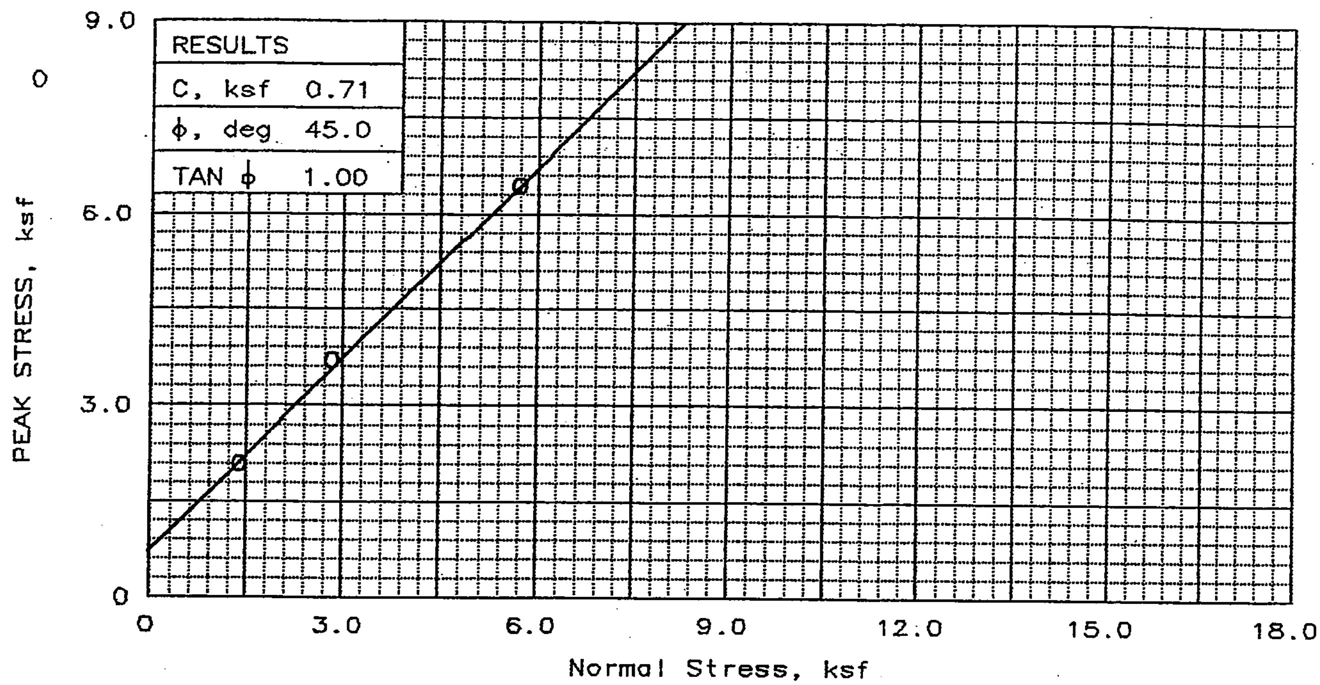


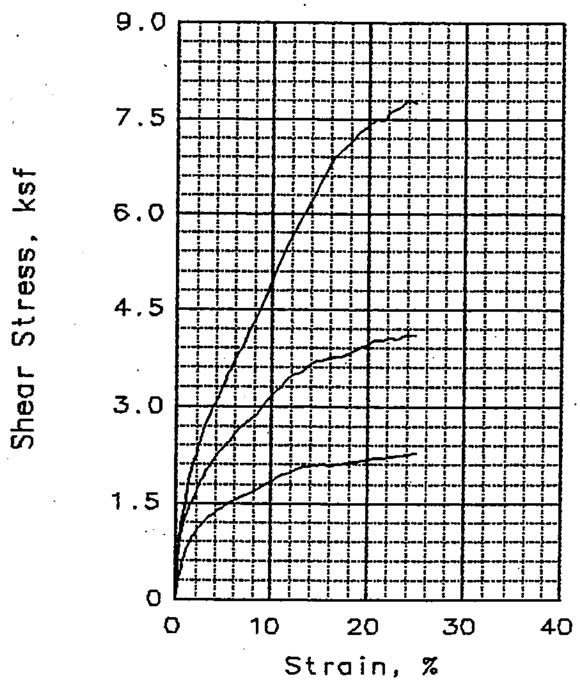
SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	8.0	8.0	8.0
	DRY DENSITY, pcf	110.6	110.6	110.6
	SATURATION, %	42.7	42.7	42.7
	VOID RATIO	0.496	0.496	0.496
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	1.00	1.00	1.00
AT TEST	WATER CONTENT, %	6.6	6.6	6.6
	DRY DENSITY, pcf	110.6	110.6	110.6
	SATURATION, %	35.2	35.2	35.2
	VOID RATIO	0.496	0.496	0.496
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	1.00	1.00	1.00
NORMAL STRESS, ksf		1.44	2.88	5.76
PEAK STRESS, ksf		1.84	3.14	4.92
STRAIN, %		9.9	9.8	10.0
ULTIMATE STRESS, ksf				
STRAIN, %				
Strain rate, %/min		0.14	0.14	0.14

Sample Type: **Remolded.**
Sample Location: **B-2@15'-20'**
Description: **SAND, gravelly, clayey.**
Specific Gravity = **2.65**
Date: **8/28/2003**

Remarks:
1) **Failure tangent drawn at 10 % displacement.**
2) **Specific gravity estimated.**
3) **Specimens were not inundated.**

G03-839	GEOCAL, INC.	NEW CARDINAL MILL DIRECT SHEAR TEST RESULTS	FIGURE 11





SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	8.0	8.0	8.0
	DRY DENSITY, pcf	110.6	110.6	110.6
	SATURATION, %	42.7	42.7	42.7
	VOID RATIO	0.496	0.496	0.496
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	1.00	1.00	1.00
AT TEST	WATER CONTENT, %	6.6	6.6	6.6
	DRY DENSITY, pcf	110.6	110.6	110.6
	SATURATION, %	35.2	35.2	35.2
	VOID RATIO	0.496	0.496	0.496
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	1.00	1.00	1.00
NORMAL STRESS, ksf		1.44	2.88	5.76
PEAK STRESS, ksf		2.08	3.69	6.44
STRAIN, %		14.6	14.8	14.9
ULTIMATE STRESS, ksf				
STRAIN, %				
Strain rate, %/min		0.14	0.14	0.14

Sample Type: **Remolded.**
Sample Location: **B-2@15'-20'**
Description: **SAND, gravelly, clayey.**
Specific Gravity = **2.65**
Date: **8/28/2003**

Remarks:
1) **Failure tangent drawn at 15% displacement.**
2) **Specific gravity estimated.**
3) **Specimens were not inundated.**

G03-839	GEOCAL, INC.	NEW CARDINAL MILL DIRECT SHEAR TEST RESULTS	FIGURE 12

TABLE B-1
SUMMARY OF LABORATORY TEST RESULTS

Project # **G03-839**

Client: **Loris & Associates, Inc.**
Project Name: **New Cardinal Mill**

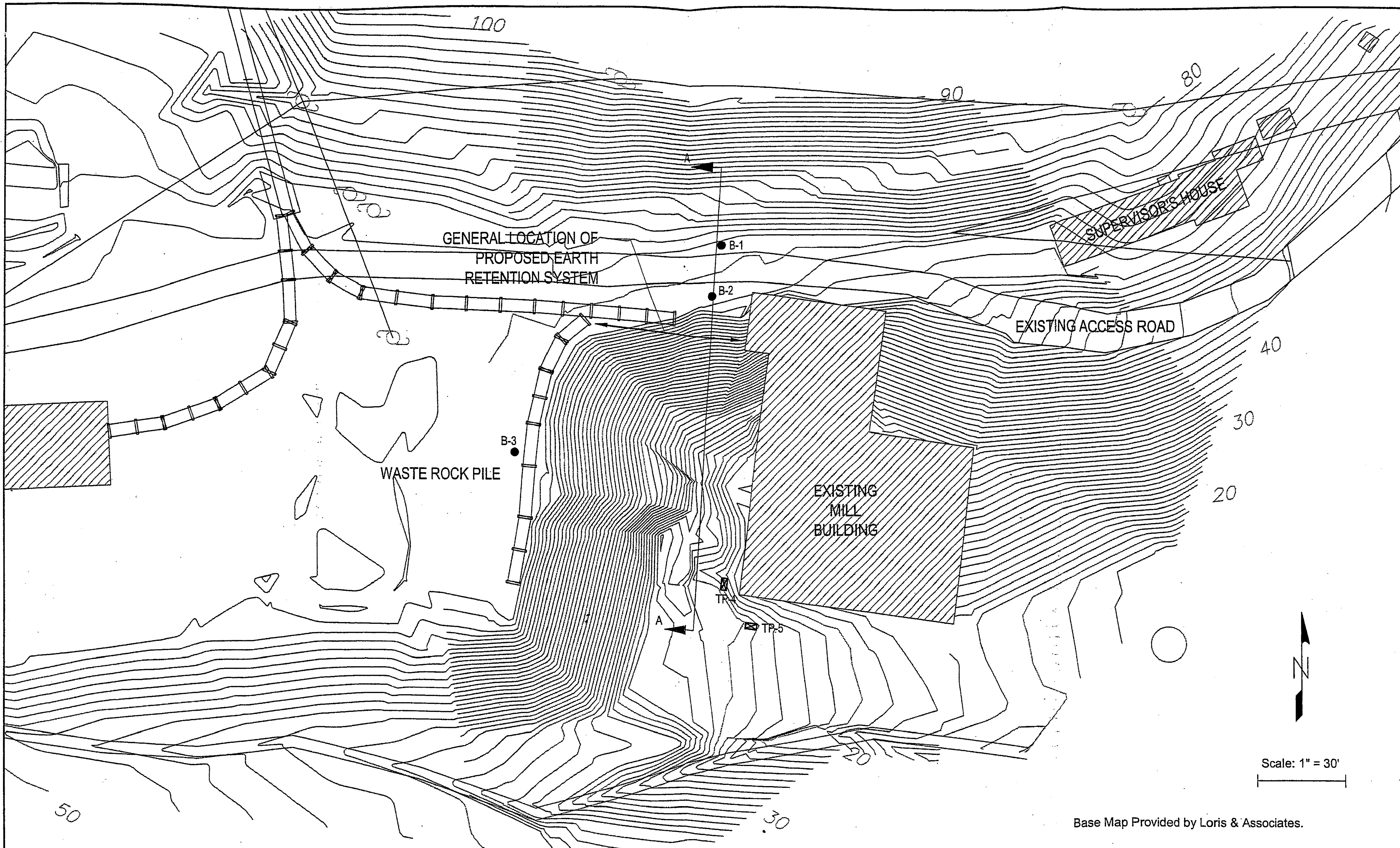
SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (PCF)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (ksf)	SWELL w/0.2 or 1.0 ksf SURCHARGE (%)	SOIL OR BEDROCK DESCRIPTION
BORING NO.	DEPTH (FEET)			GRAVEL (%)	SAND (%)		LIQUID LIMIT (%)	PLASTICITY INDEX (%)			
B-1	9	4.8	115	16	61	23					FILL-SAND, clayey, gravelly
B-1	1-19			18	52	30	28	15			FILL-SAND, clayey, gravelly
B-2	5			47	43	10					FILL-GRAVEL, very sandy, sl. clayey
B-2	25			8	70	22					Weathered GNEISS
B-2	15-20			31	53	16	20	9			SAND, gravelly, clayey
B-2	25-30			14	66	20	19	8			Weathered GNEISS
B-3	9			37	50	13	33	17			FILL-SAND, v. gravelly, sl. clayey
B-3	24			52	38	10					FILL-GRAVEL, v. sandy, sl. clayey
TP-4	7.5-8			53	31	16	39	10			GRAVEL, very sandy, clayey
TP-5	8.5-9			65	26	9	28	12			GRAVEL, v. cobbly, sandy, sl. clayey

TABLE B-2
SOIL CORROSIVITY TEST RESULTS

Project # **G03-839**

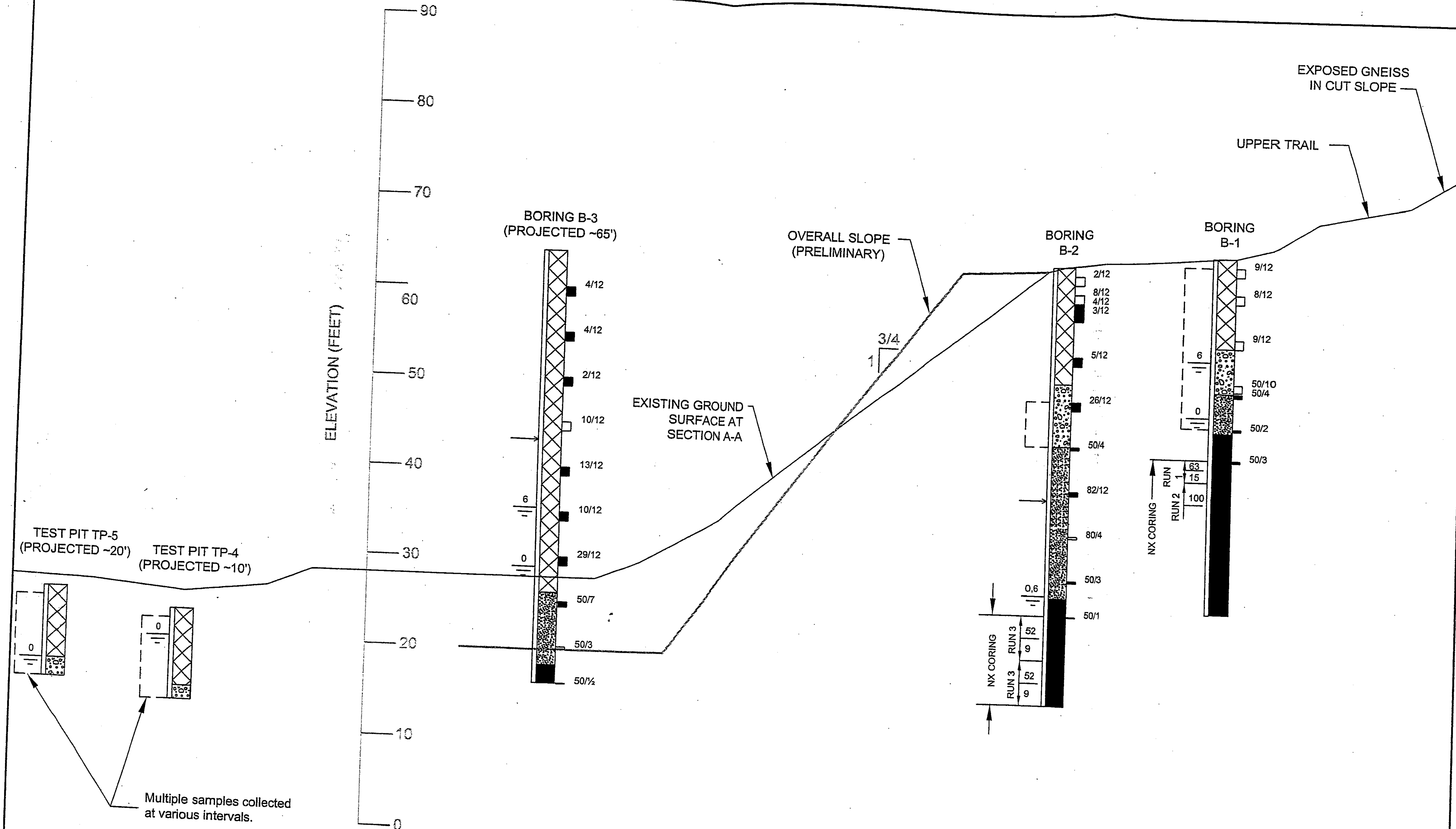
Client: **Loris & Associates, Inc.**
Project Name: **New Cardinal Mill**

SAMPLE LOCATION		MINIMUM RESISTIVITY (ohm-cm)	pH	WATER SOLUBLE SULFATES (%)	CHLORIDES (%)	SOIL OR ROCK DESCRIPTION
BORING NUMBER	DEPTH (feet)					
B-1	1-19	2480	6.7	0.0036	0.0015	FILL-SAND, clayey, gravelly
B-2	15-20	4400	7.3	0.0016	0.0059	SAND, gravelly, clayey
B-2	25-30	8000	7.6	0.0052	0.0031	Weathered GNEISS



Base Map Provided by Loris & Associates.

G03-839	GEOCAL, INC.	NEW CARDINAL MILL SITE PLAN AND BORING LOCATIONS	FIGURE 1



SCALE: 1" = 10'

G03-839	GEOCAL, INC.	NEW CARDINAL MILL BORING LOGS AND SECTION A-A	FIGURE 2

New Cardinal Mill Retaining Wall Reconstruction
Near Nederland, Boulder, County Colorado
By Angus Campbell, CDPHE Project Manager
March 17, 2006

Summary of Action

The New Cardinal Mill Retaining Wall Reconstruction Project is located in the historic town site of New Cardinal. New Cardinal is approximately two miles west of the town of Nederland, Colorado, on Caribou Road, adjacent to a historic mill site. The mill building was sold to Boulder County in October 2002. Adjacent to the mill building, and part of the deeded land, a historic Cornish wall of stacked stone had collapsed in the recent past. This wall originally provided stability to a mine waste pile associated with operation of the mine and historic mill. The collapsed wall allowed for a release of mine waste to approach the adjacent stream named Coon Creek. The wall also provided stability to the historic mill buildings foundations and access road to the historic town site. An active ground water seep also ran through the mine waste material and into the base of the historic mill building, where it pooled up in several 3-4 foot deep pools before the water flowed to Coon Creek.

The property and the associated mill building are owned by Boulder County. Currently the mill building is being re-furbished, utilizing grants from the State of Colorado Historical Fund and other funds provided by Boulder County and Science and Cultural Facilities District (SCFD). The property was purchased by Boulder County from Ms. Alexandra Armatage in 2002. Ms. Armatage submitted a voluntary cleanup plan for the adjacent property to address elevated metal contamination in soil (lead and arsenic) associated with the historic mining and milling operation. The application was approved in 2002, however, the plan has not been implemented to date. The applicant has requested an extension until August 2006, in order to complete the work.

CDPHE was approached to perform the reconstruction work on the Cornish wall waste containment structure and the ground water conveyance by Boulder County, and the site was scored, and it ranked high enough to give the project priority in utilization of House Bill 1306 funds (State Brownfields law). CDPHE contracted with Loris and Associates from the State Buildings As-Needed list of Architects/ Engineers to design the waste containment structure and the construction of a ground water diversion conveyance. The initial design called for a soil nail wall that was faced by a mechanically stabilized earth (MSE) wall, along with a ground water collection system, which collects the seeping water into a French drain and diverted the flow to a discharge point nearer to the creek. This combination of earth stabilization techniques (the soil nail and MSE walls) allowed for the resulting wall to have a large vertical face that would retain the historical look of the structure. This design was bid in July 2004; the quotes received were too high for the construction budget, which had been established by the Design Engineer. Loris and Associates was tasked to redesign the wall to keep within budget. The resulting design eliminated the soil nail wall portion of the design, while retaining the MSE portion of the design. This design resulted in a terraced wall with three levels and a larger foot that extended approximately 20 feet further from the foot of the original wall. The redesigned plan was coordinated with Historic Boulder and the State Historical Fund. After several rounds of fine-tuning the design drawings, Boulder County, State Historical Fund and Historic Boulder accepted the new plan, and CDPHE approved the design. A second construction bid was let in April 2005, and the successful bidder was Yenter Companies. Construction commenced in August 2005 and was completed in October of 2005. A punch list was developed, and the items were addressed in November 2005. A Notice of Substantial Completion, prepared by Yenter and accepted by Loris and Associates, and was submitted to CDPHE on November 1, 2005. The Notice of Acceptance was given by CDPHE and State Buildings in December 2005. Final payment and contract closeout was conducted in March 2006.

Contract costs were as follows.

CDPHE Design:

Loris and Associates: Original Contract: $43,027.00. Dated: June 16, 2003.

Supplement #1: $1,190. Dated: December 23, 2004.

Design Contract Total: $44,217.00

CDPHE Construction Contract:

Yenter Companies: Original Contract: $156,210.00. Dated: July 27, 2005.

Total CDPHE cost: $200,427.00

Notice of Substantial Completion: Dated: November 30,2005.

Notice of Acceptance: Dated: December 7, 2005.

Release of Retainage: Dated: February 9, 2006.

Upon completion of this project by CDPHE, the State Historical Fund and Boulder County work could begin on the restoration of the historic New Cardinal Mill Building itself. Boulder County received Grants from the State Historical and SCFD for a two-phased project.

Phase I
State Historical Fund: $120,000
SCFD (Scientific and Cultural Facilities District) Tier III: $1000
Board of County Commissioners: $40,000

Phase II
State Historical Fund: $213,797
Boulder County Parks & Open Space: $90,141 (cash & in-kind)

With the 1306 funds of $200,427, an additional $424,978 of funding was leveraged to complete the project, for a total of $625,405 spent on the restoration of a significant historic mine mill.

The project successfully contained the mine waste rock material. This will keep the waste material from releasing hazardous substances or other pollutants and contaminants associated with mine operations to Coon Creek. In addition, the ground water was successfully collected and diverted from the mill building. This allowed for the segregation of the clean ground water from contacting and possible contamination by waste material associated mining and milling processes.

Pictures:

Source: Denver Public Library

New Cardinal Mill pre Cornish Wall

New Cardinal Mill photo showing Cornish type stonewall Source: Denver Public Library

New Cardinal Mill building pre construction 2005 Source: Ron Abel, CDPHE (composite photo)

The site was initially cleaned and grubbed, beginning in August 2005 Source: Carol Beam Boulder County

Source: Carol Beam, Boulder County

After cleaning and grubbing, drainage system was installed collection channels going up the back of the fill area and perforated pipe which collected the drainage in a manifold system which discharged the collected water at the base of the wall.

Source: Carol Beam: Boulder County

Construction of the MSE wall. Gravel is hauled to the construction site by a small tracked vehicle the material is placed in the wall fill by an excavator.

Source: Carol Beam, Boulder County

Once placed, the gravel was tamped with a hand held compactor (orange machine in foreground) then a geo-fabric was placed on the gravel fill material by workmen.

Source: Dennis Copeland Loris and Associates

After the fabric is placed, a new course of stone is lain by workers for the face of the wall.

Source: Dennis Copeland, Loris and Associates

The MSE wall was constructed in 6-inch lifts throughout the entire wall. This photo of one of the Terraces shows the completed lifts with fabric material enclosing the 6-inch gravel lift. This sloped back area is being covered with a final fabric layer that will have a final cover of rock for the face.

Source: Carol Beam, Boulder County

On the terraces, workers place a final rock face. Groundwater seeping out of toe of mine waste pile

Source: Ron Abel, CDPHE

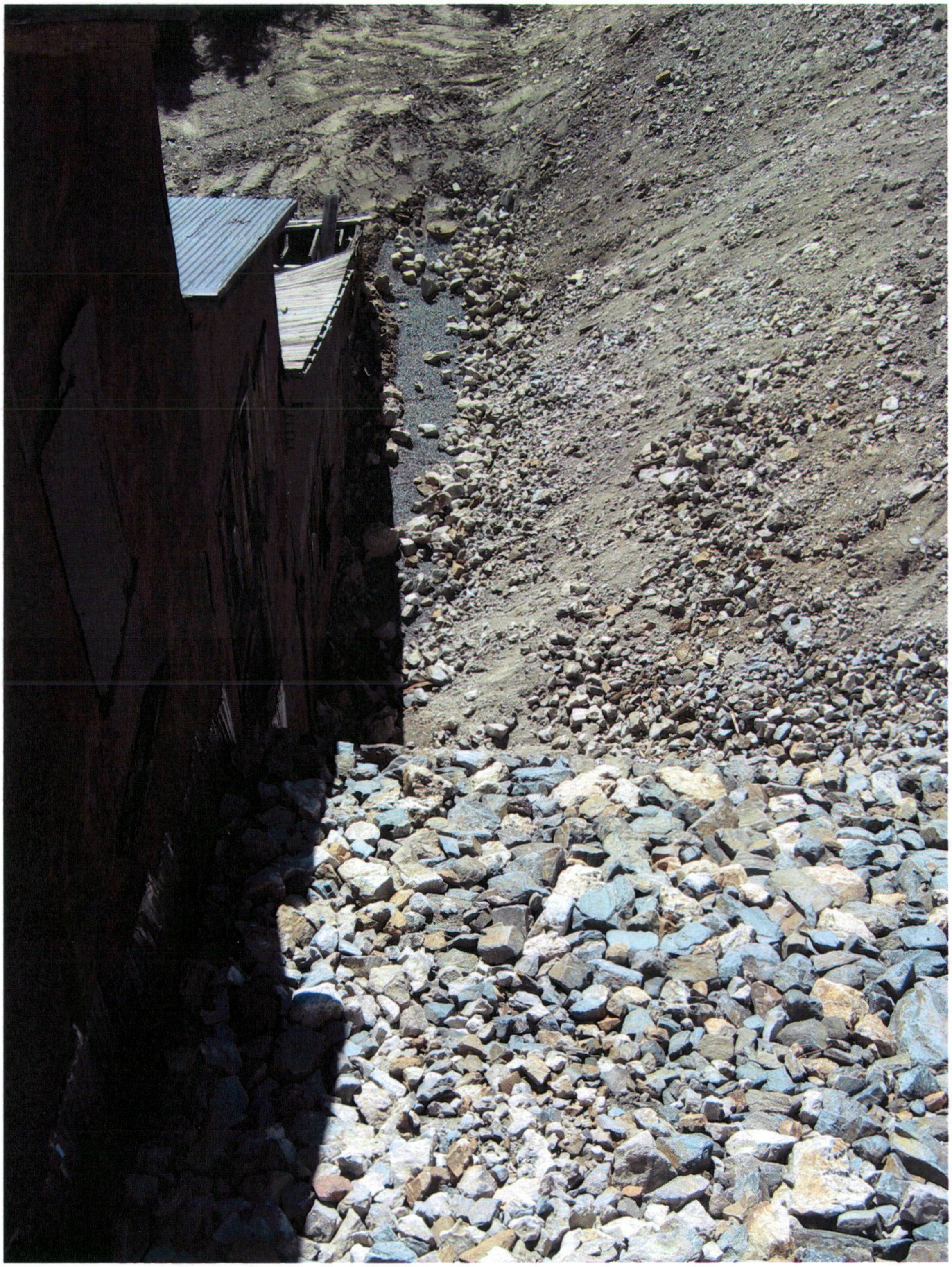
Groundwater seeped into the mill building and pool up in 2-4 foot deep pools in places.

Source: Carol Beam, Boulder County

Groundwater collecting in cleaned trench prior to construction of interceptor drain

Source: Carol Beam, Boulder County

Groundwater inceptor trench with collection pipe being backfilled with gravel, not manhole clean out, next to excavator.



Source Carol Beam: Boulder County

Completed groundwater inceptor drain note light colored gravel next to building.

Source: Dennis Copeland, Loris and Associates

Discharge point from groundwater collection trench.

Source: Dennis Copeland, Loris and Associates

Completed MSE wall.

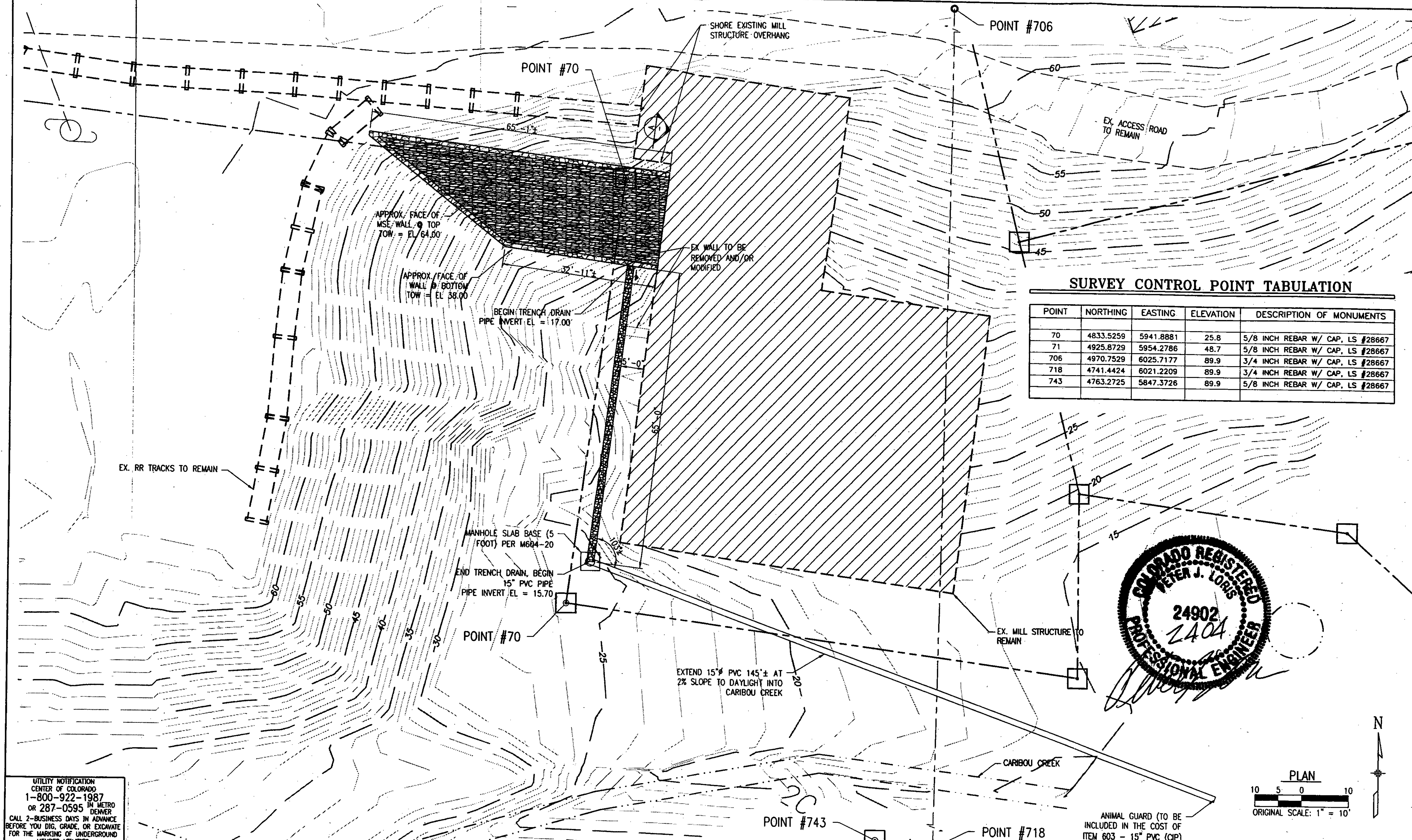
Source: Carol Beam, Boulder County

Completed wall

Source: Carol Beam, Boulder County

View of the completed Project for across the valley.

Scanned 10:56:18 on 11/22/2017



SURVEY CONTROL POINT TABULATION

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION OF MONUMENTS
70	4833.5259	5941.8881	25.8	5/8 INCH REBAR W/ CAP, LS #28667
71	4925.8729	5954.2786	48.7	5/8 INCH REBAR W/ CAP, LS #28667
706	4970.7529	6025.7177	89.9	3/4 INCH REBAR W/ CAP, LS #28667
718	4741.4424	6021.2209	89.9	3/4 INCH REBAR W/ CAP, LS #28667
743	4763.2725	5847.3726	89.9	5/8 INCH REBAR W/ CAP, LS #28667

COMPUTER FILE INFORMATION

CREATION DATE:	9-02-03	INITIALS:	TDB
LAST MODIFICATION DATE:		INITIALS:	
FULL PATH:			
DRAWING FILE NAME:			
ACAD VER: R00	SCALE: AS SHOWN	UNITS: ENGLISH	

SHEET REVISIONS

Loris and Associates, Inc.
5775 Flatiron Pkwy
Suite 207
Boulder, Colorado 80301
303.444.2073

NO REVISIONS:
REVISED:
VOID:

SITE PLAN

ISSUED BY: LORIS AND ASSOCIATES, INC.
REVISED:
SHEET SUBSET:
SUBSET SHEETS:

PROJECT NO/CODE
HMWMD-RP-05
NEW CARDINAL MILL RETAINING WALL
SHEET NUMBER 2

R

LEGAL DESCRIPTION:
MILL SITE LOT

A TRACT OF LAND BEING PORTIONS OF THE BOULDER COUNTY MILL SITE, MINERAL SURVEY NO. 14445B, AND THE CARDINAL MILL SITE, MINERAL SURVEY NO. 16783B, LOCATED IN THE NORTHWEST 1/4 OF SECTION 15, TOWNSHIP 1 SOUTH, RANGE 73 WEST OF THE 6TH P.M., BOULDER COUNTY, COLORADO, DESCRIBED AS FOLLOWS:

BEGINNING AT THE NO. 3 CORNER OF THE SAID BOULDER COUNTY MILL SITE; THENCE S13°41'32"E, 115.56 FEET; THENCE S00°06'15"W, 40.14 FEET; THENCE N82°21'05"W, 111.55 FEET; THENCE N07°16'47"E, 93.44 FEET; THENCE N83°30'17"W, 166.83 FEET; THENCE N04°29'26"W, 73.66 FEET TO CORNER NO. 2 OF THE SAID BOULDER COUNTY MILL SITE; THENCE S78°57'16"E, 247.55 FEET TO THE CORNER NO. 3 OF THE SAID BOULDER COUNTY MILL SITE AND THE POINT OF BEGINNING. AREA = 0.63 ACRES.

LEGAL DESCRIPTION:
LOT 2

A TRACT OF LAND BEING A PORTION OF THE BOULDER COUNTY MILL SITE, MINERAL SURVEY NO. 14445B, LOCATED IN THE NORTHWEST 1/4 OF SECTION 15, TOWNSHIP 1 SOUTH, RANGE 73 WEST OF THE 6TH P.M., BOULDER COUNTY, COLORADO, DESCRIBED AS FOLLOWS:

COMMENCING AT THE NO. 3 CORNER OF THE SAID BOULDER COUNTY MILL SITE; THENCE N78°57'16"W, 247.55 FEET TO CORNER NO. 2 OF THE SAID BOULDER COUNTY MILL SITE; THENCE S81°22'44"W, 132.41 FEET ALONG THE 2-1 LINE OF THE SAID BOULDER COUNTY MILL SITE; THENCE S00°38'17"W, 50.20 FEET TO THE POINT OF BEGINNING; THENCE N84°42'38"E, 37.62 FEET; THENCE S03°26'25"E, 83.72 FEET; THENCE S83°18'21"W, 59.18 FEET; THENCE N03°26'25"W, 85.17 FEET; THENCE N84°42'38"E, 21.49 FEET TO THE POINT OF BEGINNING. AREA = 12306 S.F..

LEGAL DESCRIPTION:
OUTLOT A

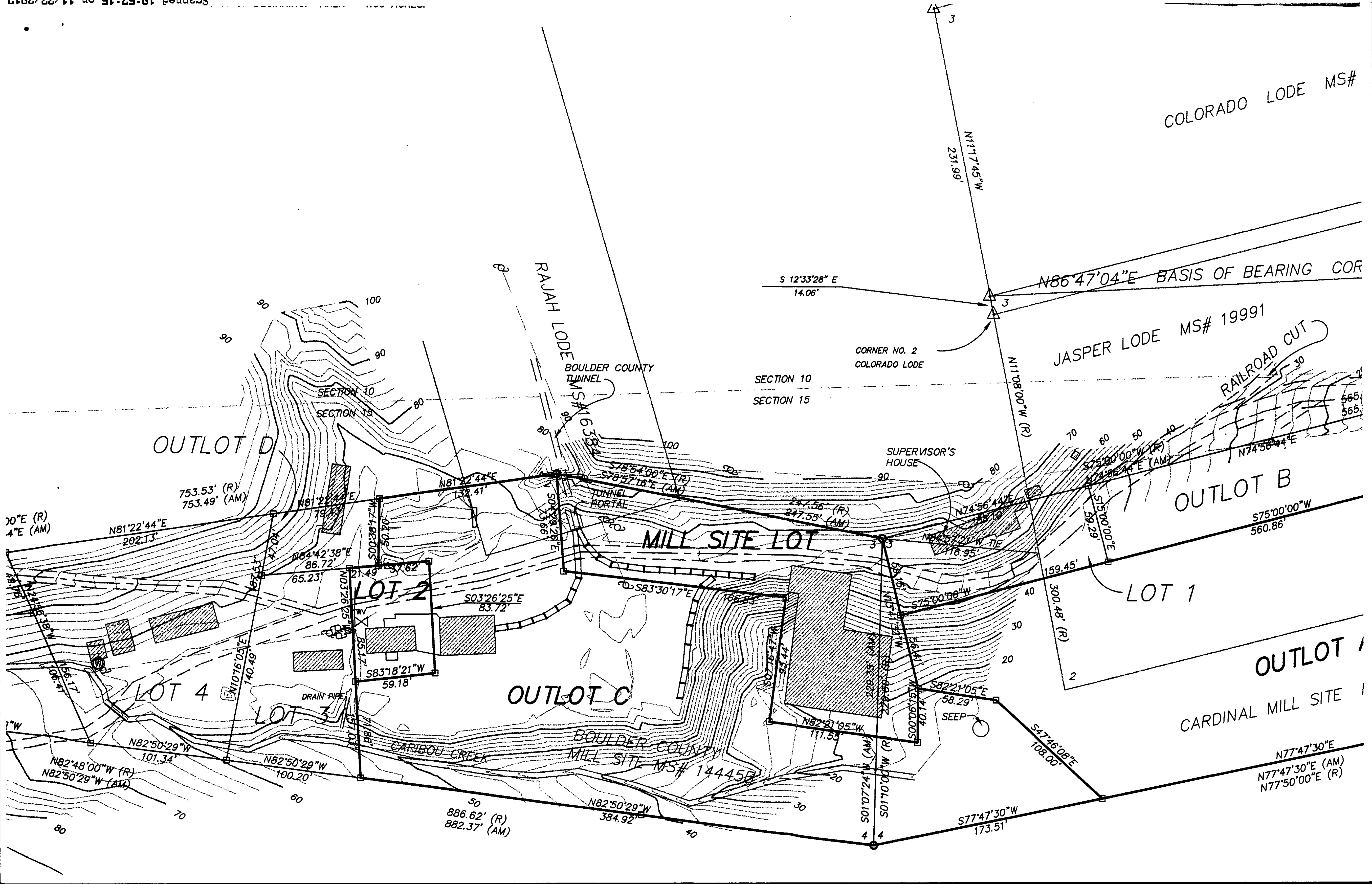
A TRACT OF LAND BEING A PORTION OF THE CARDINAL MILL SITE, MINERAL SURVEY NO. 16783B, LOCATED IN THE NORTH 1/2 OF SECTION 15, TOWNSHIP 1 SOUTH, RANGE 73 WEST OF THE 6TH P.M., BOULDER COUNTY, COLORADO, DESCRIBED AS FOLLOWS:

COMMENCING AT THE NO. 3 CORNER OF THE CARDINAL MILL SITE MINERAL SURVEY NO. 16783B, THENCE S13°41'32"E, 59.15 FEET TO THE POINT OF BEGINNING; THENCE N75°00'00"E, 560.86 FEET; THENCE N87°13'00"E, 301.14 FEET TO A POINT ON THE 4-1 LINE OF THE O & M MILL SITE, MINERAL SURVEY NO. 540B; THENCE ALONG THE SAID 4-1 LINE S00°23'00"E, 141.42 TO CORNER NO. 4 OF SAID O & M MILL SITE; THENCE N87°57'00"E, 17.21 FEET ALONG THE 3-4 LINE OF SAID O & M MILL SITE TO A POINT ON THE 4-5 LINE OF SAID CARDINAL MILL SITE; THENCE S77°47'30"W, 726.02 FEET ALONG SAID 4-5 LINE; THENCE N47°46'08"W, 108.00 FEET; THENCE N82°21'05"W, 58.29 FEET; THENCE N13°41'32"W, 56.41 FEET TO THE POINT OF BEGINNING. AREA = 3.18 ACRES.

LEGAL DESCRIPTION:
OUTLOT C

A TRACT OF LAND BEING PORTIONS OF THE BOULDER COUNTY MILL SITE, MINERAL SURVEY NO. 14445B AND OF THE CARDINAL MILL SITE, MINERAL SURVEY NO. 16783B, LOCATED IN THE NORTHWEST 1/4 OF SECTION 15, TOWNSHIP 1 SOUTH, RANGE 73 WEST OF THE 6TH P.M., BOULDER COUNTY, COLORADO, DESCRIBED AS FOLLOWS:

COMMENCING AT THE NO. 3 CORNER OF THE SAID BOULDER COUNTY MILL SITE, THENCE S13°41'32"E, 115.56 FEET TO THE POINT OF BEGINNING; THENCE S82°21'05"E, 58.29 FEET; THENCE S47°46'08"E, 108.00 FEET TO A POINT ON THE 4-5 LINE OF THE CARDINAL MILL SITE, MINERAL SURVEY NO. 16783B; THENCE S77°47'30"W, 173.51 FEET TO CORNER NO. 4 OF THE SAID CARDINAL MILL SITE; THENCE N82°50'29"W, 384.92 FEET ALONG THE 4-5 LINE OF THE SAID BOULDER COUNTY MILL SITE; THENCE N03°26'25"W, 71.86 FEET; THENCE N83°18'21"E, 59.18 FEET; THENCE N03°26'25"W, 83.72 FEET; THENCE S84°42'38"W, 37.62 FEET; THENCE N00°38'17"E, 50.20 FEET TO A POINT ON THE 1-2 LINE OF THE SAID BOULDER COUNTY MILL SITE; THENCE N81°22'44"E, 132.41 FEET TO CORNER NO. 2 OF SAID BOULDER COUNTY MILL SITE; THENCE S04°29'26"E, 73.66 FEET; THENCE S83°30'17"E, 166.83 FEET; THENCE S07°16'47"W, 93.44 FEET; THENCE S82°21'05"E, 111.55 FEET; THENCE N00°06'15"E, 40.14 FEET TO THE POINT OF BEGINNING. AREA = 1.66 ACRES.


COLORADO LODE MS#
N11°17'45"W
231.99'
S 12°33'28" E
14.06'
N86°47'04"E BASIS OF BEARING COR
JASPER LODE MS# 19991
CORNER NO. 2
COLORADO LODE
RAILROAD CUT
SECTION 10
SECTION 15
N11°08'00"W (R)
RAJAH LODE MS# 16384
BOULDER COUNTY TUNNEL
OUTLOT D
753.53' (R)
753.49' (AM)
N81°22'44"E
202.13'
N81°22'44"E
79.43'
N81°22'44"E
132.41'
S78°54'00"E (R)
S78°57'16"E (AM)
247.56' (R)
247.55' (AM)
TUNNEL PORTAL
MILL SITE LOT
SUPERVISOR'S HOUSE
N74°56'44"E
S75°00'00"W (R)
N74°56'44"E (AM)
OUTLOT B
S75°00'00"W
560.86'
159.45'
300.48' (R)
LOT 1
N84°57'21"W TIE
116.95'
S75°00'00"W
N84°42'38"E
86.72'
65.23'
LOT 2
S03°26'25"E
83.72'
S83°30'17"E
166.93'
S83°18'21"W
59.18'
N10°16'05"E
140.49'
LOT 4
LOT 3
DRAIN PIPE
OUTLOT C
OUTLOT A
S82°21'05"E
58.29'
SEEP
N82°21'05"W
111.55'
S47°46'08"E
108.00'
CARDINAL MILL SITE
N77°47'30"E
N77°47'30"E (AM)
N77°50'00"E (R)
S77°47'30"W
173.51'
S01°07'24"W (AM)
S01°10'00"W (R)
CARIBOU CREEK
BOULDER COUNTY MILL SITE MS# 14445B
N82°50'29"W
101.34'
N82°50'29"W
100.20'
N82°48'00"W (R)
N82°50'29"W (AM)
886.62' (R)
882.37' (AM)
N82°50'29"W
384.92'

Information To Build On
Engineering • Consulting • Testing

Phase II Environmental Site Assessment/ Limited Risk Assessment

Cardinal Mill
Section 15, Township 1 South, Range 73 West
(167 Bergren Road)
Cardinal, Boulder County, Colorado

Prepared for

Boulder County Parks and Open Space
5201 St. Vrain Road
Longmont, CO 80503

Prepared by

Professional Service Industries, Inc.
451 East 124th Avenue
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April 24, 2008

PSI Project 279-8G0001

Stephen P. Long
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Env. Dept. Mgr.

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APPENDICES

1 EXECUTIVE SUMMARY

Professional Service Industries, Inc. (PSI) has completed a Phase II Environmental Site Assessment (ESA) and a Limited Human Health Risk Assessment for the subject property, known as the Cardinal Mill. The work was completed in substantive accordance with the contract between Boulder County Parks and Open Space and PSI.

1.1 BACKGROUND

The subject property encompasses approximately 0.63 acres of land that is developed with a historic mill. The Boulder County Tunnel portal (the mine entrance) is also located within the subject property, but the remainder of the historic mine is outside the subject property boundary. Drainage from the mine tunnel entrance formerly flowed through the lower level of the mill via sheet flow, but this condition was rectified in 2005 with the construction of a retention wall on the west side of the mill that redirects this drainage to Coon Track Creek, to the immediate south of the site.

PSI previously conducted a Phase I Environmental Site Assessment on the subject property for the purpose of identifying evidence of potential recognized environmental conditions associated with the property. The Phase I ESA also included very limited sampling of soil inside the mill, along with sampling of a green scale on the building timbers and sampling of a soda ash stockpile inside the building. The soil testing indicated the presence of lead concentrations in the soils within the lower level of the mine building that exceeded the Colorado Department of Public Health and Environment's (CDPHE) Soil Cleanup Standards for residential, commercial and industrial direct exposure. It should be noted that lead and arsenic are naturally occurring metals that are present in the rock in this area. However, the arsenic and lead concentrations measured in the soil also exceeded background metals concentrations previously measured in other areas of the site (Walsh, 2000). PSI believed that the soils within the lower level of the mill might be enriched with lead and arsenic due to the previous mine drainage, which ran through this area. PSI also noted that the lead concentrations that were present might cause the soils to be classified as RCRA Hazardous Waste in the event that these soils were removed for off-site disposal. PSI recommended further testing of the soils with analysis for total lead, total arsenic, and leachable lead in order to characterize the soils and determine whether the soils might be classified as hazardous waste. PSI also recommended a limited risk assessment to evaluate potential human health risks associated with worker or public exposure to lead and arsenic impacted soils at the site.

1.2 PHASE II ESA

The Phase II ESA field investigation and sampling activities were directed by Mr. Steve Long of PSI on January 25, 2008. The assessment was performed in general accordance with the authorized scope of work.

PSI collected nine surficial soil samples from within the mill structure, six soil samples from outside the mill along the roadway and parking area, and five samples from the waste rock pile on the east side of the mill. All of these samples were analyzed for lead and arsenic by EPA method 6010. The samples containing the highest lead concentrations were subsequently analyzed by the Toxicity Characteristic Leaching Procedure (TCLP) for hazardous waste characterization. PSI also collected one sample from the soda ash stockpile for TCLP metals (As, Ba, Cd, Cr, Pb, Se, Ag) to determine if the soda ash would be classified as a hazardous waste upon disposal.

A summary of the previous and current soil sampling results is shown in the following table:

TABLE 1
Summary of Metals Concentrations in Soil

Sampling Location	Date	Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Selenium	Silver	Mercury
Previous Phase I Testing Results (mg/kg)										
S1	10/07	**9.4**	299	16.2	10.6	227	**4080**	1.8	68.2	1.6
S2	10/07	**3.0**	25.5	0.87	0.66	749	198	ND	5.2	ND
S3	10/07	ND	ND	ND	ND	**204,000**	86.3	ND	ND	ND
Current Phase II Testing Results (mg/kg)										
SS-1	1/08	**2.1**	NA	NA	NA	NA	228	NA	NA	NA
SS-2	1/08	**6.7**	NA	NA	NA	NA	875	NA	NA	NA
SS-3	1/08	**57.6**	NA	NA	NA	NA	**20,900**	NA	NA	NA
SS-4	1/08	ND	NA	NA	NA	NA	2,780	NA	NA	NA
SS-5	1/08	**17.7**	NA	NA	NA	NA	**7,800**	NA	NA	NA
SS-6	1/08	**15.9**	NA	NA	NA	NA	**12,300**	NA	NA	NA
SS-7	1/08	ND	NA	NA	NA	NA	671	NA	NA	NA
SS-8	1/08	ND	NA	NA	NA	NA	19.7	NA	NA	NA
SS-9	1/08	ND	NA	NA	NA	NA	693	NA	NA	NA
SS-10	1/08	ND	NA	NA	NA	NA	44.4	NA	NA	NA
SS-11	1/08	ND	NA	NA	NA	NA	**3,660**	NA	NA	NA
SS-12	1/08	**11.4**	NA	NA	NA	NA	**5,440**	NA	NA	NA
RD-1	1/08	ND	NA	NA	NA	NA	376	NA	NA	NA
RD-2	1/08	ND	NA	NA	NA	NA	**3,180**	NA	NA	NA
RD-3	1/08	ND	NA	NA	NA	NA	133	NA	NA	NA
WR-1	1/08	ND	NA	NA	NA	NA	6.8	NA	NA	NA
WR-2	1/08	ND	NA	NA	NA	NA	20.1	NA	NA	NA
WR-3	1/08	ND	NA	NA	NA	NA	134	NA	NA	NA
WR-4	1/08	ND	NA	NA	NA	NA	273	NA	NA	NA
WR-5	1/08	ND	NA	NA	NA	NA	228	NA	NA	NA
CDPHE Soil Cleanup Standards for Commercial Land Use (mg/kg)		1.04	NE	1052.46	212.92	41,522	2,920	NE	NE	176.53

The sample results generally confirmed that lead and arsenic concentrations in the soils within the mill are higher than soils outside the mill building. One exception was sample RD-2, which was collected from immediately outside the Boulder County Tunnel entrance and contained elevated lead concentrations.

Arsenic and lead concentrations within the mill building also show a high degree of variance. Arsenic was detected in the mill soils at concentrations ranging from 2.1 mg/kg to 57.6 mg/kg. Lead was detected in the mill soils at concentrations ranging from 228 mg/kg to 20,900 mg/kg. The highest lead concentrations were generally measured in the lower portion of the mill, with 5 of 9 soil samples inside the mill exceeding the CDPHE Cleanup Standard for Commercial Land Use of 2,920 mg/kg.

A summary of the TCLP testing results is shown below:

TABLE 2
Summary of TCLP Testing Results
(all results in mg/L)

Sampling Location	Date	Arsenic	Barium	Cadmium	Chromium	Lead	Selenium	Silver
Soda Ash	1/08	<0.5	0.33	<0.05	<0.1	**12.6**	<0.5	<0.5
SB-3	1/08	<0.5	NA	NA	NA	**224**	NA	NA
WR-3	1/08	NA	NA	NA	NA	<0.5	NA	NA
RCRA Hazardous Waste Threshold	mg/L	5	100	1	5	5	1	5

The TCLP results for the soda ash stockpile exceeded the RCRA threshold for classification as a RCRA hazardous waste. Therefore, the soda ash will require special handling and disposal.

PSI also analyzed one soil sample from inside the mill (SS-3) and one sample from the waste rock pile (WR-3) containing the highest total lead concentrations for TCLP-lead to determine the leachable fraction of lead. The TCLP results for the soil sample from inside the mill exceed the RCRA threshold for classification as a RCRA hazardous waste. However, the TCLP results for the waste rock sample are below the hazardous waste threshold. Therefore, the waste rock would not be classified as a hazardous waste for disposal purposes.

1.3 LIMITED HUMAN HEALTH RISK ASSESSMENT

PSI conducted a limited human health risk assessment to evaluate potential health risks to county personnel and construction workers that might be exposed to the impacted soils within the mill. Since both arsenic and lead were detected in the soil at concentrations exceeding the CDPHE Soil Cleanup Standards for Commercial Land Use, PSI separately evaluated health risks for both of these metals. PSI computed exposure concentrations for each metal by calculating the 95% upper confidence limit (95% UCL) estimate of the mean soil concentration inside the mill building. The 95% UCL for lead is 12,761.4 mg/kg and the 95% UCL for arsenic is 34.5 mg/kg. Both the arsenic and lead risk assessment models consider health risks to adult workers that would be exposed to the soils within the mill during construction work. Since it is not likely that children or the general public would be inside the mill, these groups were not evaluated as potential receptors. Based on the lead and arsenic concentrations present in the soil and the obvious physical hazards inside the building, PSI does not recommend opening the building to the public for tours, etc. unless the soils are covered and the physical hazards are abated.

Since the potential health effects for arsenic and lead differ, PSI utilized different models to evaluate potential health effects for each of these metals. Arsenic is considered by the EPA as a potential carcinogen, and so the risks associated with long term exposure to arsenic-impacted soils are primarily associated with increased risk of developing cancer. The main target for lead toxicity is the nervous system, both in adults and children. Lead is not a known carcinogen. Children and developing fetuses are significantly more sensitive to lead exposure than adults. Lead can be passed from a pregnant female to a developing fetus. Therefore, the model for lead health risk assumes exposure of a pregnant woman worker to lead as a worst-case scenario.

PSI evaluated potential health risks to adult workers exposed to arsenic in the soils as part of the risk assessment. PSI calculated incremental lifetime cancer risks using conservative exposure assumptions, then subsequently determined that the incremental risk associated with exposure to the site soils within a range that is generally considered acceptable by EPA. The risk assessment for arsenic indicates an incremental lifetime cancer risk on the order of 1.2×10^{-6} (i.e., 1.2 in one million). This level of risk is at the low end of the range of 10^{-4} to 10^{-6}, which is the range of allowable cancer risks that are generally considered acceptable to EPA.

PSI also evaluated potential health risks to adult workers exposed to lead in the soils as part of the risk assessment. Lead risks are typically evaluated by comparing computed blood lead levels for the site-specific exposure to allowable blood lead levels considered acceptable by EPA. EPA has generally attempted to limit the blood lead levels for 95% of the population to less than 10 micrograms per deciliter (ug/dL). The lead risk model evaluates risks to pregnant female workers as the most sensitive receptor group, and calculates potential blood lead levels in the developing fetus. Using the site-specific exposure scenario, PSI computed the geometric mean blood lead level for an adult worker at 9.0 ug/dL, which is below the allowable level. However, the 95th percentile blood lead level in developing fetuses was calculated at 27.9 ug/dL, which exceeds the allowable level of 10 ug/dL. The probability of the lead level in a developing fetus exceeding the allowable level of 10 ug/dL was calculated at 38.6 percent.

1.4 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the Phase II ESA and Limited Risk Assessment, PSI has developed the following conclusions and recommendations:

1.4.1 CONCLUSIONS

- The soils within the mill building appear to be enriched with lead and arsenic at concentrations that exceed background levels outside the building.
- While the building is not likely to be open to the public, some contact with the soils within the building may occur. County workers or construction workers performing structural stabilization inside the building may have short-term exposure to the soils. Arsenic and lead are the primary consituents of concern in the soil.
- The limited risk evaluation for arsenic indicates that incremental lifetime cancer risks associated with exposure to arsenic in the soils inside the mill building are within an acceptable range for construction workers.
- The limited risk evaluation for lead indicates moderate risks to construction workers associated with exposure to lead in the soils within the building. The geometric mean blood lead level for construction workers is within the range considered acceptable by EPA. However, the risks to developing fetuses of pregnant women associated with exposure to these soils are slightly elevated. The lead risk model indicates fetal blood lead levels in 38.6% of the population may exceed the allowable concentration of 10 ug/dL. It should be noted that the risk assessment is based on conservative assumptions and estimates of exposure. Therefore, the model is likely to overestimate the risks to the population. Additionally, protective measures that are recommended in Section 1.4.2 below should reduce risks to construction workers well below the recommended thresholds.
- We understand that the County is planning to conduct work inside the mill, which will include structural stabilization of the south wall of the mill building. This work will likely result in significant disturbance to impacted soils in this area. As long as the protective measures outlined in the recommendations section below are implemented during construction, the work should not result in significant risks to workers or the general public.
- TCLP results for the soda ash and the soils within the mill building indicate that these materials would be considered as a RCRA hazardous waste, if disposed off-site. Leachable lead concentrations are high enough in both of these materials that run-off might be impacted by lead if these materials are exposed to rainfall. Therefore, these materials should not be stored or stockpiled outside, particularly in proximity to the creek.

- Lead concentrations in the waste rock pile are consistent with background concentrations for the surrounding area. TCLP testing indicates that the waste rock would not be classified as a RCRA hazardous waste, in the event that the waste rock is to be disposed off-site. PSI understands that the county may construct a retaining wall in the area of the waste rock pile in the near future. No special precautions appear warranted with regard to the handling of this material.

1.4.2 RECOMMENDATIONS

- Dust levels should be controlled to the maximum extent practicable during construction work. Areas where work is to occur should be wetted on a routine basis to prevent dust.
- Workers should wear dust masks when conducting activities that have the potential to generate significant quantities of dust.
- Pregnant workers should be limited to no more than 30 days inside the building per year.
- A soil management plan should be developed for any proposed construction activities that might result in displacement of the arsenic and lead impacted soils inside the mill building. The plan should include provisions for the handling and disposal of any excess soils that might need to be re-located or disposed due to the project. Any excess soils should be staged inside, or covered to prevent rainwater contact and potential leaching of lead into run-off.
- The soda ash should be transferred into 55-gallon drums for storage until such time as this material can be sold for re-use, or disposed as a RCRA hazardous waste. The soda ash is highly corrosive and contains high levels of leachable lead. Drumming the material would minimize the potential for contact with this material in the short-term.

2 INTRODUCTION

2.1 CONTRACT

The contract between PSI and Client is summarized below:

Summary	
Client	Boulder County Parks and Open Space
Authorizing Party **Title**	Mr. Matt Adeletti Paralegal
Engagement ID, Date	PSI Proposal 552-7G0015 December 17, 2007

2.2 PURPOSE OF SERVICES

PSI understands that Boulder County Parks and Open Space intends to preserve the Cardinal Mill. While the county does envision further structural and architectural work within the building to preserve it, the county does not intend for the interior of the mill to be visited or utilized by the general public. We further understand that the county will construct a retaining wall on the east side of the mill in the vicinity of the waste rock pile in the near future.

PSI has performed both a Phase II ESA and a limited risk assessment to assess the human health risk associated with exposure to metals-impacted soils at the site. The objectives the Phase II ESA –Limited Risk Assessment were as follows:

- Further evaluate the chemical characteristics of the soda ash stockpile to determine whether this material would be classified as RCRA Hazardous Waste if it were to be removed for off-site disposal.
- Determine safe handling procedures for the soda ash.
- Further evaluate the lead and arsenic concentrations in the soils within the mill in order to establish exposure point concentrations for the risk assessment.
- Further evaluate lead and arsenic concentrations in the soils outside the mill for comparison with soil concentrations inside the mill. Establish whether lead and arsenic concentrations inside the mill are statistically higher than surrounding native soils.
- Analysis of select soil samples containing the highest lead concentrations by the TCLP method in order to determine whether any soils requiring off-site disposal might be classified as RCRA hazardous waste.

- Evaluate lead and arsenic concentrations in the waste rock pile on the east side of the mill. Determine safe handling procedures for the waste rock pile for future retaining wall construction in this area.
- Prepare a limited risk assessment to evaluate potential health risks for county workers and contractors associated with potential exposure to lead and arsenic impacted soils at the site.

3 PHASE II ESA

The intent of the Phase II ESA was to address potential environmental concerns identified in the Phase I ESA report by invasive sampling for laboratory analysis in areas of interest throughout the property.

3.1 METHODOLOGY

Field investigation and sampling activities were directed by Mr. Steve Long of PSI on January 25, 2008. The assessment was performed in general accordance with the authorized scope of work. All field sampling activities were performed in accordance with sampling protocols established by EPA and/or the Colorado Department of Public Health and Environment (CDPHE). Laboratory analytical services were provided by Pace Analytical Laboratories.

PSI collected a total of 20 soil samples from the property; nine surficial soil samples from within the mill structure, six soil samples from outside the mill along the roadway and parking area, and five samples from the waste rock pile on the east side of the mill. All of these samples were analyzed for lead and arsenic by EPA method 6010. The samples containing the highest lead concentrations were subsequently analyzed by the Toxicity Characteristic Leaching Procedure (TCLP) for hazardous waste characterization. PSI also collected one sample from the soda ash stockpile for TCLP metals (As, Ba, Cd, Cr, Pb, Se, Ag) to determine if the soda ash would be classified as a hazardous waste upon disposal.

The soil samples were all collected from the upper 4-6 inches of the soil column using a stainless steel spoon. The samples were placed in a mixing bowl and thoroughly homogenized. Rock particles of greater than approximately ¼" were excluded from the sample. The samples were then each placed in a 4 ounce glass container provided by the laboratory for analysis. The sample containers were placed in an iced cooler for shipment to the laboratory under chain of custody protocols.

It should be noted that the waste rock pile samples may not be representative of the entire volume of waste rock. Due to the extreme slope and instability of the pile, only surficial samples could be collected. In general, it is preferable to collect samples from a cross section of a pile for analysis. However, this does not appear to be possible in this instance.

Additionally, it should be noted that PSI intended to collect additional background soil samples from the west, south, and east sides of the mill for comparison purposes. However, heavy snow drifts prevented access to these areas. PSI does not believe that this limitation would affect the conclusions contained in the report.

3.2 REGULATORY GUIDANCE CONCENTRATIONS

Analyte concentrations in all media were compared to applicable or relevant and appropriate requirements, based upon current and future proposed usage of the subject property. These criteria are summarized below.

3.2.1 SOIL CRITERIA

The following human-health based criteria are established by CDPHE for direct exposure to chemicals in soils.

- ***Residential*** – The Soil Cleanup Target Level for direct exposure in a residential setting (SCTL-R) is the default standard for site screening purposes in Colorado, and assumes potential contact with soils on a regular basis by adults and children.
- ***Industrial*** – The Soil Cleanup Target Level for direct exposure in an industrial setting (SCTL-IDE) assumes extensive contact with soils on a daily basis (5 days/week) by adult workers at industrial sites.
- **Commercial** – The The Soil Cleanup Target Level for direct exposure in a commercial setting (SCTL-CDE) assumes more limited contact with soils on a daily basis (5 days/week) by adult workers at commercial sites.

Based on the proposed use of the property, PSI believes that the use of the SCTL-CDE criterion is most appropriate. If the site is to be utilized for residential or industrial purposes, the screening may not be appropriate for these uses.

3.2.2 RCRA HAZARDOUS WASTE CRITERIA

Under the Resource Conservation and Recovery Act (RCRA), EPA established levels for classification of wastes as hazardous wastes. EPA utilizes the Toxicity Characteristic Leaching Procedure (TCLP) to determine wastes which are hazardous due to the toxicity characteristic. TCLP results are compared to the hazardous waste thresholds in 40 CFR Part 261.24. The TCLP test simulates the concentration of a chemical that might leach from the waste under typical landfill conditions. Wastes with high leachable metals concentrations may be classified as RCRA Hazardous Waste due to their potential to leach from unlined landfills. For lead, the TCLP threshold is 5 milligrams per liter (mg/L).

3.3 SAMPLING RESULTS

Laboratory analytical results for the soil samples are summarized on **Table 1** and a complete copy of the laboratory reports is included in **Appendix A**. Soil sampling locations are shown on **Figure 2**. These results have been evaluated by comparison with the appropriate human-health based SCTLs established by CDPHE.

The sample results generally confirmed that lead concentrations in the soils within the mill contain higher lead concentrations than soils outside the mill building. One exception was sample RD-1, which was collected from immediately outside the Boulder County Tunnel entrance. As previously stated, mine run-off from the tunnel once flowed out of the tunnel and into the lower level of the mill. PSI believes that the run-off from the tunnel has enriched the arsenic and lead content of the soils inside the mill. This enrichment is also the likely reason for the higher concentration measured in RD-1. RD-2 is located in the immediate area of the former mine drainage pathway, while the remaining samples outside of the mill were located outside the former drainage pathway.

Arsenic and lead concentrations within the mill building also show a high degree of variance. Arsenic was detected in the mill soils at concentrations ranging from 2.1 mg/kg to 57.6 mg/kg. Lead was detected in the mill soils at concentrations ranging from 228 mg/kg to 20,900 mg/kg. The highest lead concentrations were generally measured in the lower portion of the mill, with 5 of 9 soil samples inside the mill exceeding the CDPHE Cleanup Standard for Commercial Land Use of 2,920 mg/kg.

In response to the detection of arsenic and lead at concentrations exceeding the regulatory criteria, PSI subsequently analyzed one soil sample from the mill and one soil sample from the waste rock pile containing the highest lead concentrations for TCLP-lead. The TCLP-lead results for soil sample SS-3, collected from inside the mill, exceed the RCRA threshold of 5 milligrams per liter (mg/L) for classification as a RCRA hazardous waste. However, the TCLP-lead results for waste rock sample WR-3 are below the threshold for classification as a RCRA hazardous waste. Therefore, the waste rock would not be classified as a hazardous waste for disposal purposes.

The TCLP-lead results for the soda ash stockpile exceeded the RCRA threshold for classification as a RCRA hazardous waste. Therefore, the soda ash will require special handling and disposal as a hazardous waste.

4 LIMITED HUMAN HEALTH RISK ASSESSMENT

4.1 EXPOSURE POINT CONCENTRATIONS

In a risk assessment, the exposure point concentration (EPC) is defined as the average concentration of the chemical of concern to which a person might be exposed. In using the average contaminant concentration, instead of the maximum, the risk assessor assumes that potential receptors will spend equal parts of their exposure period within each part of the site. In the case of this assessment, this assumption appears valid. Construction workers or county personnel are likely to roam freely through the mill during work activities.

In calculating the EPC, the EPA recommends the use of a statistical estimation of the mean or average concentration, which is termed the 95% upper confidence limit (95% UCL). Use of the 95% UCL ensures that we do not underestimate the mean based on our limited data set. By definition, the 95% UCL is a value that we can state with 95% certainty is equal or higher than the true mean concentration of the data set if an infinite number of samples were collected. The 95% UCL is always higher than the calculated mean and the difference between these two values is influenced by the number of samples collected and the variability of the data set (i.e., standard deviation).

The calculated 95% UCL arsenic concentration in the mill soils is 34.5 mg/kg and the calculated 95% UCL lead concentration in the mill soils is 12,761.4 mg/kg. As discussed above, the 95% UCL values for both arsenic and lead are significantly higher than the calculated means due to the high standard deviation of the data sets. In particular, one sample result (SS-3) appears to be a significant outlier for the data set. The highest arsenic and lead concentrations were both reported in this sample. It appears that inclusion of this outlier data point may result in significant overestimation of the mean and 95% UCL for this site. However, inclusion of the data point is the most conservative approach and PSI considered it appropriate given the limited number of samples which have been collected at the site.

4.2 LEAD RISK ASSESSMENT

4.2.1 LEAD RISK ASSESSMENT METHODOLOGY

PSI utilized the EPA Adult Lead Model (ALM) methodology for assessing risks associated with non-residential adult exposures to lead in soil. The approach for assessing nonresidential adult risks utilizes a methodology to relate lead intake from soil to blood lead concentrations in women of child-bearing age, and then subsequently estimating fetal blood lead concentrations in women exposed to lead contaminated soils. The methodology is the product of extensive evaluations by the EPA Technical Review Workgroup for Lead (TRW).

Long-term exposure of adults can result in decreased performance in some tests that measure functions of the nervous system. It may also cause weakness in fingers, wrists, or ankles. Lead exposure also causes small increases in blood pressure, particularly in middle-aged and older people and can cause anemia. Exposure to high lead levels can severely damage the brain and kidneys in adults or children and ultimately cause death. Lead may be transferred from exposed pregnant women to the fetus. High levels of exposure to lead may cause miscarriage. High level exposure in men can damage the organs responsible for sperm production.

The ALM methodology uses a simplified representation of lead biokinetics to predict quasi-steady state blood lead concentrations among adults who have relatively steady patterns of site exposures. The methodology relates soil lead concentrations to blood lead concentrations in the exposed population according to the equations described below.

Equation 1:

$$PbB_{adult,central} = PbB_{adult,0} + \frac{PbS \cdot BKSF \cdot IR_S \cdot AF_S \cdot EF_S}{AT}$$

where:

- **PbS** = 95% UCL estimate of mean soil lead concentration (mg/kg) at the site.
- **PbB_{adult}, central** = Central estimate of blood lead concentrations (ug/dL) in adults (i.e., women of child-bearing age) that have site exposures to soil lead at concentration, PbS.
- **PbB_{adult}, 0** = Typical background blood lead concentration (ug/dL) in adults (i.e., women of child-bearing age) in the absence of exposures to the site that is being assessed.
- **BKSF** = Biokinetic slope factor relating (quasi-steady state) increase in typical adult blood lead concentration to average daily lead uptake (ug/dL blood lead increase per ug/day lead uptake).
- **IR_S** = Intake rate of soil, including both outdoor soil and indoor soil-derived dust (g/day).
- **AF_S** = Absolute gastrointestinal absorption fraction for ingested lead in soil and lead in dust derived from soil (dimensionless).

- **EF_S** = Exposure frequency for contact with assessed soils and/or dust derived in part from these soils (days of exposure during the averaging period); may be taken as days per year for continuing, long term exposure.
- **AT** = Averaging time; the total period during which soil contact may occur; 365 days/year for continuing long term exposures.

Equation 2 below describes the estimated relationship between the blood lead concentration in adult women and the corresponding 95th percentile fetal blood lead concentration ($PbB_{fetal,\ 0.95}$), assuming that $PbB_{adult,\ central}$ reflects the geometric mean of a lognormal distribution of blood lead concentrations in women of child-bearing age. As a health-based goal, EPA has sought to limit the risk to young children of having elevated blood lead concentrations. Current Office of Solid Waste and Emergency Response (OSWER) guidance calls for the establishment of cleanup goals to limit the probability of blood lead levels exceeding 10 micrograms per deciliter (ug/dL) in children and developing fetuses to 5% (U.S. EPA, 1994a).

Equation 2:

$$PbB_{fetal,0.95} = PbB_{adult,central} \cdot GSD_{i,adult}^{1.645} \cdot R_{fetal/maternal} \qquad \text{(Equation 2)}$$

Where:

$PbB_{fetal,\ 0.95}$ = The 95th percentile blood lead concentration (ug/dL) among fetuses born to women having exposures to the specified site soil concentration. The 95th percentile is interpreted to mean that there is a 95% likelihood that a fetus, in a woman who experiences such exposures, would have a blood lead concentration no greater than 10 ug/dL.

$PbB_{adult,\ central}$ = Central estimate of blood lead concentrations (ug/dL) in adults (i.e., women of child-bearing age) that have site exposures to soil lead at concentration, PbS.

$GSDi_{adult}$ = Estimated value of the individual geometric standard deviation (dimensionless); the GSD among adults (i.e., women of child-bearing age) that have exposures to similar on-site lead concentrations, but that have non-uniform response (intake, biokinetics) to site lead and non-uniform off-site lead exposures.

R fetal/maternal = Constant of proportionality between fetal blood lead concentration at birth and maternal blood lead concentration (dimensionless).

The model is based on the following assumptions:

- Blood lead concentrations for exposed adults can be estimated as the sum of an expected starting blood lead concentration in the absence of site exposure ($PbB_{adult,\,0}$) and an expected site-related increase.
- The site-related increase in blood lead concentrations can be estimated using a linear biokinetic slope factor (BKSF) which is multiplied by the estimated lead uptake.
- Lead uptake can be related to soil lead levels using the estimated soil lead concentration (PbS), the overall rate of daily soil ingestion (IRS), and the estimated fractional absorption of ingested lead (AFS). The term "soil" is used to refer to that portion of the soil to which adults are most likely to be exposed. Exposure is assumed to be predominantly to the top layers of the soil which gives rise to transportable soil-derived dust. Derived dust occurs both in outdoor and indoor environments, the latter occurring where soil-derived dust has been transported indoors. Exposure to soil-derived dust can contribute to adult lead exposure and may even predominate in the occupational setting; these include dust generated from manufacturing processes (e.g., grinding, milling, packaging of lead-containing material), road dust, pavement dust, and paint dust.
- In most cases, the toxicity of an ingested chemical depends, in part, on the degree to which it is absorbed from the gastrointestinal tract into the body. Because oral reference doses (RfDs) are generally expressed in terms of ingested dose (rather than absorbed dose), accounting for potential differences in absorption between different exposure media can be important to site risk assessments. This is true for all chemicals, but is of special importance for metals. This is because metals can exist in a variety of chemical and physical forms, and not all forms of a given metal are absorbed to the same extent. For example, a metal in contaminated soil may be absorbed to a greater or lesser extent than when ingested in drinking water or food. Thus, if the oral RfD for a metal is based on studies using the metal administered in water or food, risks from ingestion of the metal in soil might be underestimated or overestimated. Even a relatively small adjustment in oral bioavailability can have significant impacts on estimated risks and cleanup goals.

4.2.2 LEAD RISK MODELING RESULTS

The lead risk model calculations are presented in **Appendix B**. The limited risk evaluation for lead indicates moderate risks to construction workers associated with exposure to lead in the soils within the building. The geometric mean blood lead level for construction workers is predicted to be 9.0 ug/dL, which is less than the EPA recommended blood lead level of 10 ug/dL. However, the risks to developing fetuses of pregnant women associated with exposure to these soils are slightly elevated. The lead risk model indicates developing fetal blood lead levels in 38.6% of the population may exceed the allowable concentration of 10 ug/dL. It should be noted that the risk assessment is based on conservative assumptions and estimates of exposure. Therefore, the model is likely to overestimate the risks to the population.

4.3 ARSENIC RISK ASSESSMENT

4.3.1 ARSENIC RISK ASSESSMENT METHODOLOGY

Exposure estimates represent the daily dose of arsenic taken into the body for the receptor group, averaged over the appropriate period of time. Exposure estimates are normally presented in milligrams of arsenic per kilogram of body weight per day (mg/kg-day). The EPA Risk Assessment Guidance for Superfund (RAGS) was the primary source of exposure assumptions utilized in this risk assessment. The generalized equation to evaluate intake is shown below:

$$I = \frac{EPC \times CR \times EF \times ED}{BW \times AT}$$

Where:

I =	Intake, chemical amount at the body entrance point (mg/kg body wt – day)
EPC =	Exposure Point Concentration, average arsenic concentration in soil (mg/kg)
CR =	Contact Rate, amount of media contacted per unit of time
EF =	Exposure Frequency, frequency of exposure or contact (days/yr)
ED =	Exposure Duration (yr)
BW =	Body Weight, average weight of receptor group (kg)
AT =	Averaging Time, the period over which exposure is averaged (days)

Although arsenic is capable of producing a wide variety of health effects, the most significant concern associated with chronic, long-term exposure to arsenic impacted soils is carcinogeneity. Ingestion of arsenic in drinking water is a common problem in many parts of the world and has been associated with an increased risk of cancer to the skin, bladder, lung, liver, kidney, and prostate (Chen, et. al., 1988; Chen and Wang, 1990). The EPA has classified arsenic as a Group A human carcinogen – known to produce cancer in humans. The EPA has used data from a large Tiawanese skin cancer study (Tseng, 1968, 1977) to derive an oral cancer slope factor for arsenic. This slope factor is utilized to derive slope factors for all media.

Arsenic may be present in the soil in both inorganic and organic forms; however, in most regulatory jurisdictions, both inorganic and organic forms are summed and regulated as total arsenic. Some studies have indicated that organic forms of arsenic are less acutely toxic than inorganic forms. However, arsenic is reactive in the soil and may cycle between organic and inorganic forms. Inorganic arsenic is typically present as either arsenate or arsenite. Arsenate is typically considered to be less toxic than arsenite, but again arsenic may cycle between each form depending upon subsurface conditions. In some cases, attempts have been made to speciate the form of arsenic present in the soil in order to characterize the risks associated with only the form of arsenic that is most prevalent at a site. PSI does not consider this a valid approach since arsenic may cycle between states in the environment in responses to changes in subsurface conditions (e.g., redox potential). For this risk assessment, it is assumed that all arsenic is present in its most toxic form. This assumption is conservative and would tend to result in overestimation of the risk in many cases.

Potential health affects and cancer slope factors were obtained from the EPA Integrated Risk Information System (IRIS). Cancer risks are characterized as the incremental probability that an individual will develop cancer in his/her lifetime due to chemical exposure under the specific scenarios that were evaluated. ILCR values for the exposure pathways (oral ingestion, dermal adsorption, and inhalation) that were evaluated in this risk assessment were calculated using intake estimates (average daily dose over the exposure period) that were calculated as part of the exposure assessment and cancer slope factors (CSFs) for each exposure pathway. The overall excess cancer risk was calculated by summing the risks from all three exposure pathways (oral, dermal, inhalation) using the following equation:

$$ILCR = \frac{EPC * EF * ED * FC * \left[(CSF_o * IR_o * CF) + (CSF_d * SA * AF * DA * CF) + \left(CSF_i * IR_i * \left(\frac{1}{VF} + \frac{1}{PEF} \right) \right) \right]}{BW * AT * RBA}$$

Where the variables are described as follows:

Variable	**Description**	**Units**
EPC	Exposure Point Concentration	mg/kg
BW	Body Weight	kg
AT	Carcinogenic Averaging Time	days
EF	Exposure Frequency	days/yr.
ED	Exposure Duration	years
FC	Fraction from Contaminated Source	unitless
RBA	Relative Bioavailability Factor	unitless
CSFo	Oral Cancer Slope Factor	1/mg/kg-day
CSFd	Dermal Cancer Slope Factor	1/mg/kg-day
CSFi	Inhalation Cancer Slope Factor	1/mg/kg-day
CF	Correction Factor	kg/mg
SA	Skin Surface Area	cm2/day
AF	Adherence Factor	mg/cm2
DA	Dermal Adsorption	unitless
IRo	Ingestion Rate	mg/day
IRi	Inhalation Rate	m3/day
VF	Volatilization Factor	m3/kg
PEF	Particulate Emission Factor	m3/kg

4.3.2 ARSENIC RISK MODELING RESULTS

Calculation spreadsheets for incremental lifetime cancer risks for the construction worker exposure scenario are included in **Appendix C**. The potential incremental lifetime cancer risks were summed for each route of exposure and the total risk for each medium and each exposure scenario also are presented. This is a conservative approach since risk may not necessarily be additive.

The calculated incremental lifetime cancer risk (ILCR) is calculated at 1.2×10^{-6} for the construction worker exposure scenario. The calculated ILCR for this exposure scenario is within the EPA allowable range of 1×10^{-4} to 1×10^{-6}. It should be noted that the cancer risk is dominated by exposure through oral ingestion of soil particles. Risks associated with dermal contact and inhalation of windblown dust are one or more orders of magnitude lower than the oral ingestion risk. Therefore, limiting ingestion of soil or dust particles during construction activities would further limit the risk.

4.4 UNCERTAINTY

There are uncertainties which are inherent in the risk assessment process. The calculations and conclusions which are presented in this report include uncertainties which may arise from assumptions used in several steps of this assessment. The factors which may lead to either an overestimation or an underestimation of the potential adverse human health effects and associated environmental risks posed by exposures to arsenic and lead impacted soils at the Cardinal Mill, depending on the relationship of actual conditions to the assumptions employed in the calculations, include the following:

- Statistical analysis of the mean and 95% UCL values for lead and arsenic concentrations were positively skewed due to the presence of one data outlier (SS-3) and the resulting elevated standard deviation for the data sets. While inclusion of the outlier in the data set may result in overestimation of the mean and 95% UCL for arsenic and lead concentrations in the site soils, this is standard practice to maintain conservatism in the calculations, and it is unlikely to result in underestimation of the true risk from exposure under the conditions that were assumed;
- Assumptions regarding, for example, body weight, average human lifetime, and other factors were based on reasonable estimates from available sources and may not be accurate for specific individuals whose characteristics may vary from the conservative general conditions which were assumed. However, standard assumptions were employed in those cases where they were available and professional judgment was applied elsewhere. References are included for all values used;
- Factors which affect the disposition of absorbed arsenic and lead, such as metabolism, distribution, bio-concentration and excretion, were not explicitly

considered in detail in the intake and risk calculations. Rather, reasonable and conservative assumptions were employed which are unlikely to underestimate the true exposure conditions. Corrections regarding route-of-exposure were made to reflect such conditions;

- The mechanism of action for toxicity of arsenic is not taken into account, and is not known with certainty in many cases, particularly regarding its putative carcinogenic effects. The rather specific nature of the carcinogenic effects in animal studies suggests that any extrapolation to humans will be heavily dependent on the assumption of equivalent response in man, an assumption which often is not supported by the epidemiological data. Extrapolation of dose-response curves from high to low dose, from animals to humans and from one exposure route to another introduce uncertainty, albeit in ways which are intended to be conservative, at each step in the calculated results. The use in this document of established Unit Cancer Risk values (i.e., Carcinogenic Slope Factors) for arsenic, which have been calculated by conservative methods (e.g., the linearized multistage model) is unlikely to underestimate the true risk and may overestimate it by a margin which is not quantifiable at present. Consistent with standard risk assessment practice, the U.S. EPA Carcinogenic Slope Factors (CSFs) were used to reflect toxicity endpoints of interest;
- The intake and risk calculations assume that the exposure conditions can be represented by a deterministic approach which views each variable separately and may result in inappropriate targets because conservative assumptions are "layered" on top of one another. Probabilistic methods are available for such evaluations, but were not employed in this stage of the risk assessment activities;
- Since the overall risks for both arsenic and lead were determined to be dominated by the oral ingestion route, the model is most sensitive to changes in the assumptions made to quantify risk through this route. The most important of these factors include ingestion rate, exposure frequency, and exposure duration. The modeled risks are relatively insensitive to changes in input parameters used to estimate the risks associated with dermal exposure and inhalation of wind blown particles (e.g., adsorption factor, PEF, skin surface area, etc.).

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Based on the findings of this Phase II ESA and Limited Human Health Risk Assessment, PSI has developed the following conclusions:

- The soils within the mill building appear to be enriched with lead and arsenic at concentrations that exceed background levels outside the building.
- While the building is not likely to be open to the public, some contact with the soils within the building may occur. County workers or construction workers performing structural stabilization inside the building may have short-term exposure to the soils. Arsenic and lead are the primary consituents of concern in the soil.
- The limited risk evaluation for arsenic indicates that incremental lifetime cancer risks associated with exposure to arsenic in the soils inside the mill building are within an acceptable range for construction workers.
- The limited risk evaluation for lead indicates moderate risks to construction workers associated with exposure to lead in the soils within the building. The geometric mean blood lead level for construction workers is within the allowable range allowed by EPA. However, the risks to developing fetuses of pregnant women associated with exposure to these soils are slightly elevated. The lead risk model indicates blood lead levels in 38.6% of the population may exceed the allowable concentration of 10 ug/dL. It should be noted that the risk assessment is based on conservative assumptions and estimates of exposure. Therefore, the model is likely to overestimate the risks to the population. Additionally, protective measures that are recommended in Section 5.2 below should reduce risks to construction workers well below the recommended thresholds.
- We understand that the County is planning to conduct work inside the mill, which will include structural stabilization of the south wall of the mill building. This work will likely result in significant disturbance to impacted soils in this area. As long as the protective measures outlined in the recommendations section below are implemented during construction, the work should not result in significant risks to workers or the general public.
- TCLP results for the soda ash and the soils within the mill building indicate that these materials would be considered as a RCRA hazardous waste, if disposed off-site. Leachable lead concentrations are high enough in both of these materials that run-off might be impacted by lead if these materials are exposed to rainfall. Therefore, these materials should not be stored or stockpiled outside, particularly in proximity to the creek.

- Lead concentrations in the waste rock pile are consistent with background concentrations for the surrounding area. TCLP testing indicates that the waste rock would not be classified as a RCRA hazardous waste, in the event that the waste rock is to be disposed off-site. PSI understands that the county may construct a retaining wall in the area of the waste rock pile in the near future. No special precautions appear warranted with regard to the handling of this material.

5.2 RECOMMENDATIONS

- The soda ash should be transferred into 55-gallon drums for storage until such time as this material can be sold for re-use, or disposed as a RCRA hazardous waste. The soda ash is highly corrosive and contains high levels of leachable lead. Drumming the material would minimize the potential for contact with this material in the short-term.
- Dust levels should be controlled to the maximum extent practicable during construction work. Areas where work is to occur should be wetted on a routine basis to prevent dust.
- Workers should wear dust masks when conducting activities that have the potential to generate significant quantities of dust.
- A soil management plan should be developed for any proposed construction activities that might result in displacement of the arsenic and lead impacted soils inside the mill building. The plan should include provisions for the handling and disposal of any excess soils that might need to be re-located or disposed due to the project. Any excess soils should be staged inside, or covered to prevent rainwater contact and potential leaching of lead into run-off.
- Pregnant workers should be limited to no more than 30 days inside the building per year.

6 STANDARD OF CARE AND WARRANTIES

Our services were not intended to be technically exhaustive. There is a possibility that with the proper application of methodologies, conditions may exist on the property that could not be identified within the scope of the assessment(s) or that were not reasonably identifiable from the available information.

Our report is based on commonly known and reasonably ascertainable information. Findings and conclusions derived from the methodologies described in the report contain all of the inherent limitations in the methodologies that are referred to in thereport. No other warranties are implied or expressed.

PSI warrants that the findings contained in this report have been prepared in general conformance with accepted professional practices at the time of report preparation as applied by similar professionals. Future changes in standards, practices, or regulations cannot be anticipated and have not been addressed. The observations and recommendations presented in this report are time dependent, and conditions will change. This report speaks only as of its date.

7 REFERENCES

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TABLES

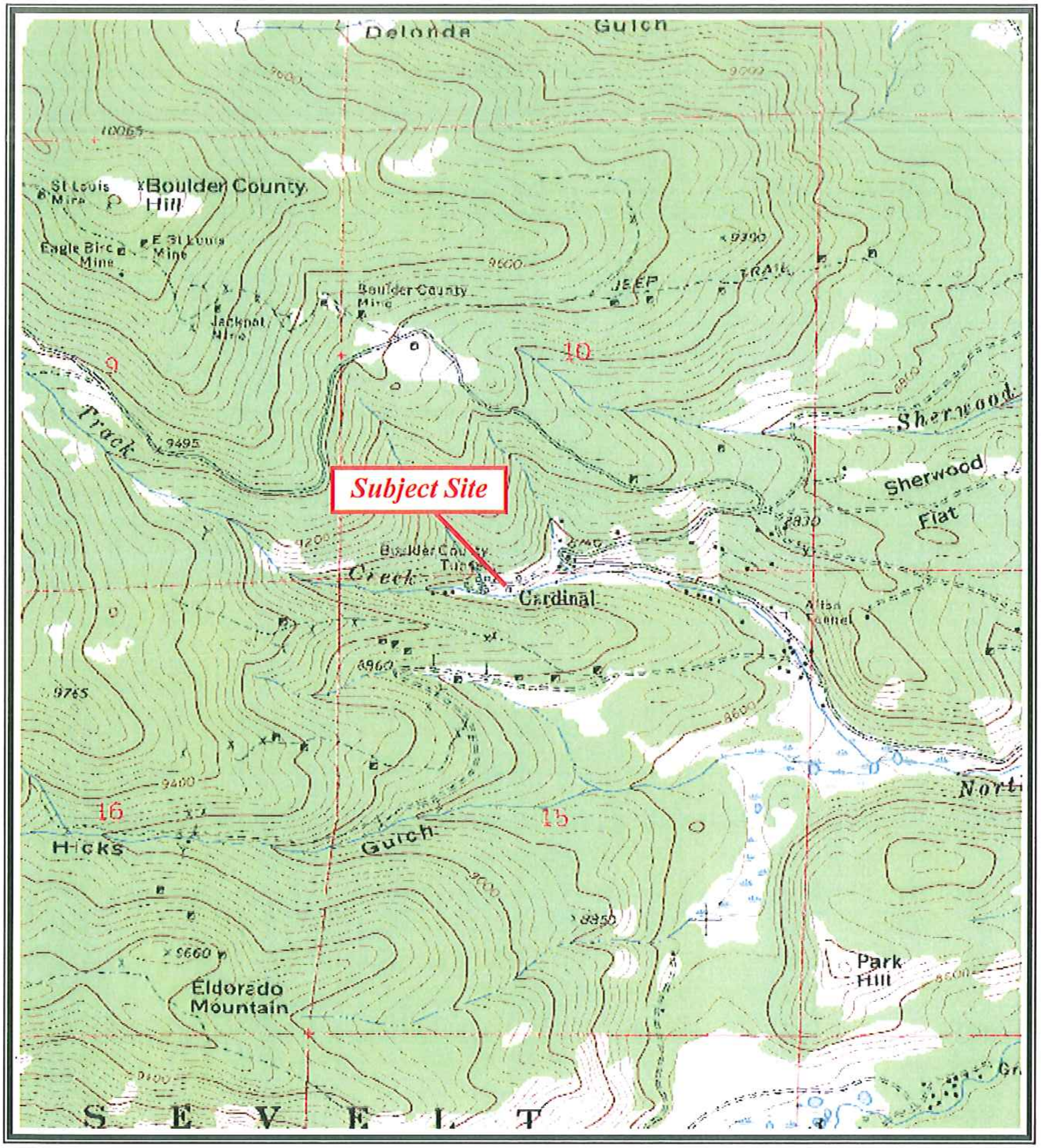
TABLE 1
Summary of Metals Concentrations in Soil

Sampling Location	Date	Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Selenium	Silver	Mercury
Previous Phase I Testing Results (mg/kg)										
S1	10/07	**9.4**	299	16.2	10.6	227	**4080**	1.8	68.2	1.6
S2	10/07	**3.0**	25.5	0.87	0.66	749	198	ND	5.2	ND
S3	10/07	ND	ND	ND	ND	**204,000**	86.3	ND	ND	ND
Current Phase II Testing Results (mg/kg)										
SS-1	1/08	**2.1**	NA	NA	NA	NA	228	NA	NA	NA
SS-2	1/08	**6.7**	NA	NA	NA	NA	875	NA	NA	NA
SS-3	1/08	**57.6**	NA	NA	NA	NA	**20,900**	NA	NA	NA
SS-4	1/08	ND	NA	NA	NA	NA	2,780	NA	NA	NA
SS-5	1/08	**17.7**	NA	NA	NA	NA	**7,800**	NA	NA	NA
SS-6	1/08	**15.9**	NA	NA	NA	NA	**12,300**	NA	NA	NA
SS-7	1/08	ND	NA	NA	NA	NA	671	NA	NA	NA
SS-8	1/08	ND	NA	NA	NA	NA	19.7	NA	NA	NA
SS-9	1/08	ND	NA	NA	NA	NA	693	NA	NA	NA
SS-10	1/08	ND	NA	NA	NA	NA	44.4	NA	NA	NA
SS-11	1/08	ND	NA	NA	NA	NA	**3,660**	NA	NA	NA
SS-12	1/08	**11.4**	NA	NA	NA	NA	**5,440**	NA	NA	NA
RD-1	1/08	ND	NA	NA	NA	NA	376	NA	NA	NA
RD-2	1/08	ND	NA	NA	NA	NA	**3,180**	NA	NA	NA
RD-3	1/08	ND	NA	NA	NA	NA	133	NA	NA	NA
WR-1	1/08	ND	NA	NA	NA	NA	6.8	NA	NA	NA
WR-2	1/08	ND	NA	NA	NA	NA	20.1	NA	NA	NA
WR-3	1/08	ND	NA	NA	NA	NA	134	NA	NA	NA
WR-4	1/08	ND	NA	NA	NA	NA	273	NA	NA	NA
WR-5	1/08	ND	NA	NA	NA	NA	228	NA	NA	NA
CDPHE Soil Cleanup Standards for Commercial land use in mg/kg		1.04	NE	1052.46	212.92	41,522	2,920	NE	NE	176.53

TABLE 2
Summary of TCLP Testing Results

Sampling Location	Date	Arsenic	Barium	Cadmium	Chromium	Lead	Selenium	Silver
Soda Ash	1/08	<0.5	0.33	<0.05	<0.1	**12.6**	<0.5	<0.5
SB-3	1/08	<0.5	NA	NA	NA	**224**	NA	NA
WR-3	1/08	NA	NA	NA	NA	<0.5	NA	NA
RCRA Hazardous Waste Threshold		5	100	1	5	5	1	5

FIGURES



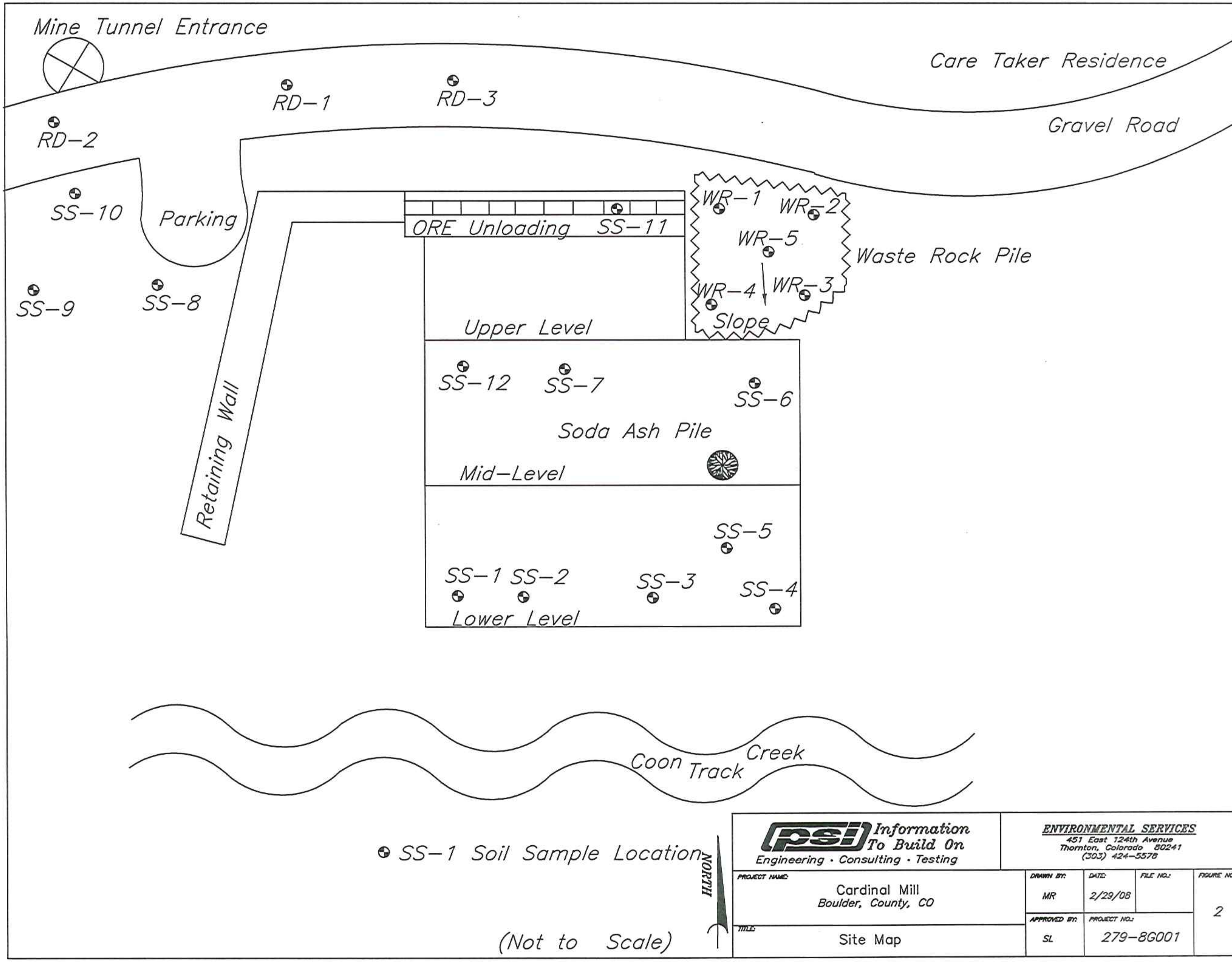
"Nederland, CO"
Quadrangle

1000 0 1000 2000 3000 4000 5000 6000 7000

Scale 1" = 24,000"

N

psi Information To Build On	***Boulder County Parks and Open Space*** ***Cardinal Millsite Property*** ***Cardinal, Colorado***	***Figure 1*** ***Phase I ESA*** ***PSI Project 279-7E029***



psi Information To Build On Engineering · Consulting · Testing	ENVIRONMENTAL SERVICES 451 East 124th Avenue Thornton, Colorado 80241 (303) 424-5578			
PROJECT NAME: Cardinal Mill Boulder, County, CO	DRAWN BY: MR	DATE: 2/29/08	FILE NO.:	FIGURE NO.: 2
TITLE: Site Map	APPROVED BY: SL	PROJECT NO.: 279-8G001		

APPENDIX A – LABORATORY REPORTS

Pace Analytical®
www.pacelabs.com

Pace Analytical Services, Inc.
9608 Loiret Blvd.
Lenexa, KS 66219
(913)599-5665

February 15, 2008

Nancy Otterstrom
PSI, Inc
451 E. 124th Ave
Denver, CO 80241

RE: Project: Cardinal Mill
Pace Project No.: 6034611 Amended report 02/15/08. rev_1 Added TCLP Pb, As

Dear Nancy Otterstrom:
Enclosed are the analytical results for sample(s) received by the laboratory on January 29, 2008. The results relate only to the samples included in this report. Results reported herein conform to the most current NELAC standards, where applicable, unless otherwise narrated in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Colleen Koporc

colleen.koporc@pacelabs.com
Project Manager

A2LA Certification Number: 2456.01
Arkansas Certification Number: 05-008-0
Illinois Certification Number: 001191
Iowa Certification Number: 118
Kansas/NELAP Certification Number: E-10116
Louisiana Certification Number: 03055
Oklahoma Certification Number: 9205/9935
Utah Certification Number: 9135995665

Enclosures

cc: Steve Long, PSI, Inc

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SAMPLE SUMMARY

Project: Cardinal Mill
Pace Project No.: 6034611

Lab ID	Sample ID	Matrix	Date Collected	Date Received
6034611001	SB-1	Solid	01/25/08 09:00	01/29/08 09:00
6034611002	SB-2	Solid	01/25/08 09:05	01/29/08 09:00
6034611003	SB-3	Solid	01/25/08 09:15	01/29/08 09:00
6034611004	SB-4	Solid	01/25/08 09:20	01/29/08 09:00
6034611005	SB-5	Solid	01/25/08 09:30	01/29/08 09:00
6034611006	SB-6	Solid	01/25/08 09:40	01/29/08 09:00
6034611007	SB-7	Solid	01/25/08 09:00	01/29/08 09:00
6034611008	SB-8	Solid	01/25/08 10:35	01/29/08 09:00
6034611009	SB-9	Solid	01/25/08 10:45	01/29/08 09:00
6034611010	SB-10	Solid	01/25/08 10:55	01/29/08 09:00
6034611011	SB-11	Solid	01/25/08 11:00	01/29/08 09:00
6034611012	SB-12	Solid	01/25/08 11:05	01/29/08 09:00
6034611013	WR-1	Solid	01/25/08 10:10	01/29/08 09:00
6034611014	WR-2	Solid	01/25/08 10:15	01/29/08 09:00
6034611015	WR-3	Solid	01/25/08 10:20	01/29/08 09:00
6034611016	WR-4	Solid	01/25/08 10:25	01/29/08 09:00
6034611017	WR-5	Solid	01/25/08 10:30	01/29/08 09:00
6034611018	RD-1	Solid	01/25/08 10:00	01/29/08 09:00
6034611019	RD-2	Solid	01/25/08 10:10	01/29/08 09:00
6034611020	RD-3	Solid	01/25/08 10:15	01/29/08 09:00
6034611021	SODA ASH	Solid	01/25/08 10:00	01/29/08 09:00

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SAMPLE ANALYTE COUNT

Project: Cardinal Mill
Pace Project No.: 6034611

Lab ID	Sample ID	Method	Analysts	Analytes Reported
6034611001	SB-1	EPA 6010	TJG	2
6034611002	SB-2	EPA 6010	TJG	2
6034611003	SB-3	EPA 6010	SMW	2
		EPA 6010	SMW, TJG	2
6034611004	SB-4	EPA 6010	SMW, TJG	2
6034611005	SB-5	EPA 6010	SMW, TJG	2
6034611006	SB-6	EPA 6010	TJG	2
6034611007	SB-7	EPA 6010	TJG	2
6034611008	SB-8	EPA 6010	TJG	2
6034611009	SB-9	EPA 6010	TJG	2
6034611010	SB-10	EPA 6010	TJG	2
6034611011	SB-11	EPA 6010	TJG	2
6034611012	SB-12	EPA 6010	TJG	2
6034611013	WR-1	EPA 6010	SMW	2
6034611014	WR-2	EPA 6010	TJG	2
6034611015	WR-3	EPA 6010	SMW	1
		EPA 6010	TJG	2
6034611016	WR-4	EPA 6010	TJG	2
6034611017	WR-5	EPA 6010	TJG	2
6034611018	RD-1	EPA 6010	TJG	2
6034611019	RD-2	EPA 6010	TJG	2
6034611020	RD-3	EPA 6010	TJG	2
6034611021	SODA ASH	EPA 6010	TJG	7

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: SB-1 **Lab ID: 6034611001** Collected: 01/25/08 09:00 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	**2.1**	mg/kg	0.81	1	01/31/08 00:00	02/05/08 15:53	7440-38-2	
Lead	**228**	mg/kg	0.40	1	01/31/08 00:00	02/05/08 15:53	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: SB-2 **Lab ID: 6034611002** Collected: 01/25/08 09:05 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	**6.7**	mg/kg	0.72	1	01/31/08 00:00	02/05/08 15:59	7440-38-2	
Lead	**875**	mg/kg	0.36	1	01/31/08 00:00	02/05/08 15:59	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: SB-3 **Lab ID: 6034611003** Collected: 01/25/08 09:15 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	**57.6**	mg/kg	8.8	10	01/31/08 00:00	02/07/08 13:51	7440-38-2	
Lead	**20900**	mg/kg	43.9	100	01/31/08 00:00	02/05/08 16:21	7439-92-1	
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010							
Arsenic	ND	mg/L	0.50	1	02/12/08 00:00	02/13/08 10:32	7440-38-2	
Lead	**224**	mg/L	0.50	1	02/12/08 00:00	02/13/08 10:32	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: SB-4 **Lab ID: 6034611004** Collected: 01/25/08 09:20 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	ND	mg/kg	9.3	10	01/31/08 00:00	02/07/08 13:56	7440-38-2	
Lead	**2780**	mg/kg	46.3	100	01/31/08 00:00	02/05/08 16:25	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: SB-5 **Lab ID: 6034611005** Collected: 01/25/08 09:30 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	**17.7**	mg/kg	8.7	10	01/31/08 00:00	02/07/08 14:01	7440-38-2	
Lead	**7800**	mg/kg	43.5	100	01/31/08 00:00	02/05/08 16:29	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: SB-6 **Lab ID: 6034611006** Collected: 01/25/08 09:40 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	**15.9**	mg/kg	7.6	10	01/31/08 00:00	02/05/08 17:00	7440-38-2	
Lead	**12300**	mg/kg	3.8	10	01/31/08 00:00	02/05/08 17:00	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: SB-7 **Lab ID: 6034611007** Collected: 01/25/08 09:00 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	ND	mg/kg	7.2	10	01/31/08 00:00	02/05/08 17:04	7440-38-2	
Lead	**671**	mg/kg	3.6	10	01/31/08 00:00	02/05/08 17:04	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: SB-8 **Lab ID: 6034611008** Collected: 01/25/08 10:35 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	ND	mg/kg	8.7	10	01/31/08 00:00	02/05/08 17:09	7440-38-2	
Lead	**19.7**	mg/kg	4.3	10	01/31/08 00:00	02/05/08 17:09	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: SB-9 **Lab ID: 6034611009** Collected: 01/25/08 10:45 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	ND	mg/kg	7.8	10	01/31/08 00:00	02/05/08 17:13	7440-38-2	
Lead	**693**	mg/kg	3.9	10	01/31/08 00:00	02/05/08 17:13	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: SB-10 **Lab ID: 6034611010** Collected: 01/25/08 10:55 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	ND	mg/kg	8.1	10	01/31/08 00:00	02/05/08 17:17	7440-38-2	
Lead	**44.4**	mg/kg	4.1	10	01/31/08 00:00	02/05/08 17:17	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: SB-11 **Lab ID: 6034611011** Collected: 01/25/08 11:00 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	ND	mg/kg	7.8	10	01/31/08 00:00	02/05/08 17:21	7440-38-2	
Lead	**3660**	mg/kg	3.9	10	01/31/08 00:00	02/05/08 17:21	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: SB-12 **Lab ID: 6034611012** Collected: 01/25/08 11:05 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	**11.4**	mg/kg	8.0	10	01/31/08 00:00	02/05/08 17:25	7440-38-2	
Lead	**5440**	mg/kg	4.0	10	01/31/08 00:00	02/05/08 17:25	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: WR-1 **Lab ID: 6034611013** Collected: 01/25/08 10:10 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	ND	mg/kg	1.6	2	01/31/08 00:00	02/07/08 14:06	7440-38-2	
Lead	**6.8**	mg/kg	0.79	2	01/31/08 00:00	02/07/08 14:06	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: WR-2 **Lab ID: 6034611014** Collected: 01/25/08 10:15 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	ND	mg/kg	8.4	10	01/31/08 00:00	02/05/08 17:33	7440-38-2	
Lead	**20.1**	mg/kg	4.2	10	01/31/08 00:00	02/05/08 17:33	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: WR-3 **Lab ID: 6034611015** Collected: 01/25/08 10:20 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	ND	mg/kg	7.6	10	01/31/08 00:00	02/05/08 17:37	7440-38-2	
Lead	**134**	mg/kg	3.8	10	01/31/08 00:00	02/05/08 17:37	7439-92-1	
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010							
Lead	ND	mg/L	0.50	1	02/12/08 00:00	02/13/08 10:47	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: WR-4 **Lab ID: 6034611016** Collected: 01/25/08 10:25 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	ND	mg/kg	9.4	10	01/31/08 00:00	02/05/08 17:53	7440-38-2	
Lead	**273**	mg/kg	4.7	10	01/31/08 00:00	02/05/08 17:53	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: WR-5 **Lab ID: 6034611017** Collected: 01/25/08 10:30 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	ND	mg/kg	7.0	10	01/31/08 00:00	02/05/08 17:57	7440-38-2	
Lead	**228**	mg/kg	3.5	10	01/31/08 00:00	02/05/08 17:57	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: RD-1 **Lab ID: 6034611018** Collected: 01/25/08 10:00 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	ND	mg/kg	8.3	10	01/31/08 00:00	02/05/08 18:01	7440-38-2	
Lead	**376**	mg/kg	4.1	10	01/31/08 00:00	02/05/08 18:01	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: RD-2 **Lab ID: 6034611019** Collected: 01/25/08 10:10 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	ND	mg/kg	7.6	10	01/31/08 00:00	02/05/08 18:05	7440-38-2	
Lead	**3180**	mg/kg	3.8	10	01/31/08 00:00	02/05/08 18:05	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: RD-3 **Lab ID: 6034611020** Collected: 01/25/08 10:15 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050							
Arsenic	ND	mg/kg	9.3	10	01/31/08 00:00	02/05/08 18:09	7440-38-2	
Lead	**133**	mg/kg	4.7	10	01/31/08 00:00	02/05/08 18:09	7439-92-1	

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ANALYTICAL RESULTS

Project: Cardinal Mill
Pace Project No.: 6034611

Sample: SODA ASH **Lab ID: 6034611021** Collected: 01/25/08 10:00 Received: 01/29/08 09:00 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010							
Arsenic	ND	mg/L	0.50	1	01/31/08 00:00	02/01/08 14:18	7440-38-2	
Barium	**0.33**	mg/L	0.20	1	01/31/08 00:00	02/01/08 14:18	7440-39-3	
Cadmium	ND	mg/L	0.050	1	01/31/08 00:00	02/01/08 14:18	7440-43-9	
Chromium	ND	mg/L	0.10	1	01/31/08 00:00	02/01/08 14:18	7440-47-3	
Lead	**12.6**	mg/L	0.50	1	01/31/08 00:00	02/01/08 14:18	7439-92-1	
Selenium	ND	mg/L	0.50	1	01/31/08 00:00	02/01/08 14:18	7782-49-2	
Silver	ND	mg/L	0.10	1	01/31/08 00:00	02/01/08 14:18	7440-22-4	

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QUALITY CONTROL DATA

Project: Cardinal Mill
Pace Project No.: 6034611

QC Batch: MPRP/5603 — Analysis Method: EPA 6010
QC Batch Method: EPA 3050 — Analysis Description: 6010 MET
Associated Lab Samples: 6034611001, 6034611002, 6034611003, 6034611004, 6034611005, 6034611006, 6034611007, 6034611008, 6034611009, 6034611010, 6034611011, 6034611012, 6034611013, 6034611014, 6034611015, 6034611016, 6034611017, 6034611018, 6034611019, 6034611020

METHOD BLANK: 281083
Associated Lab Samples: 6034611001, 6034611002, 6034611003, 6034611004, 6034611005, 6034611006, 6034611007, 6034611008, 6034611009, 6034611010, 6034611011, 6034611012, 6034611013, 6034611014, 6034611015, 6034611016, 6034611017, 6034611018, 6034611019, 6034611020

Parameter	Units	Blank Result	Reporting Limit	Qualifiers
Arsenic	mg/kg	ND	1.0	
Lead	mg/kg	ND	0.50	

LABORATORY CONTROL SAMPLE: 281084

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	mg/kg	50	50.5	101	80-120	
Lead	mg/kg	50	49.8	100	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 281085 281086

Parameter	Units	6034611001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic	mg/kg	2.1	38.8	39.4	38.7	38.6	94	93	75-125	0	14	
Lead	mg/kg	228	38.8	39.4	359	276	338	122	75-125	26	20	M0,R1

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QUALITY CONTROL DATA

Project: Cardinal Mill
Pace Project No.: 6034611

QC Batch: MPRP/5608 Analysis Method: EPA 6010
QC Batch Method: EPA 3010 Analysis Description: 6010 MET TCLP
Associated Lab Samples: 6034611021

METHOD BLANK: 281374
Associated Lab Samples: 6034611021

Parameter	Units	Blank Result	Reporting Limit	Qualifiers
Arsenic	mg/L	ND	0.50	
Barium	mg/L	ND	0.20	
Cadmium	mg/L	ND	0.050	
Chromium	mg/L	ND	0.10	
Lead	mg/L	ND	0.50	
Selenium	mg/L	ND	0.50	
Silver	mg/L	ND	0.10	

LABORATORY CONTROL SAMPLE: 281375

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	mg/L	1	1.0	104	80-120	
Barium	mg/L	1	0.98	98	80-120	
Cadmium	mg/L	1	1.0	103	80-120	
Chromium	mg/L	1	0.98	98	80-120	
Lead	mg/L	1	1.0	101	80-120	
Selenium	mg/L	1	0.98	98	80-120	
Silver	mg/L	.5	0.48	96	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 281376 281377

Parameter	Units	6034440001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic	mg/L	ND	10	10	10.6	10.8	105	106	75-125	2	20	
Barium	mg/L	ND	10	10	10.0	10.0	99	99	75-125	0	20	
Cadmium	mg/L	ND	10	10	10.4	10.5	104	105	75-125	0	20	
Chromium	mg/L	ND	10	10	9.8	9.9	98	98	75-125	0	20	
Lead	mg/L	ND	10	10	10.3	10.4	102	103	75-125	1	20	
Selenium	mg/L	ND	10	10	9.9	10.0	98	99	75-125	1	20	
Silver	mg/L	ND	5	5	4.9	4.9	97	97	75-125	0	20	

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QUALITY CONTROL DATA

Project: Cardinal Mill
Pace Project No.: 6034611

QC Batch: MPRP/5684 — Analysis Method: EPA 6010
QC Batch Method: EPA 3010 — Analysis Description: 6010 MET TCLP
Associated Lab Samples: 6034611003, 6034611015

METHOD BLANK: 285626
Associated Lab Samples: 6034611003, 6034611015

Parameter	Units	Blank Result	Reporting Limit	Qualifiers
Arsenic	mg/L	ND	0.50	
Barium	mg/L	ND	0.20	
Cadmium	mg/L	ND	0.050	
Chromium	mg/L	ND	0.10	
Lead	mg/L	ND	0.50	
Selenium	mg/L	ND	0.50	
Silver	mg/L	ND	0.10	

LABORATORY CONTROL SAMPLE: 285627

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	mg/L	1	1.0	102	80-120	
Barium	mg/L	1	1.0	104	80-120	
Cadmium	mg/L	1	1.1	107	80-120	
Chromium	mg/L	1	1.1	106	80-120	
Lead	mg/L	1	1.1	107	80-120	
Selenium	mg/L	1	1.1	113	80-120	
Silver	mg/L	.5	0.52	104	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 285628 285629

Parameter	Units	6034611003 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic	mg/L	ND	10	10	9.8	9.7	97	96	75-125	1	20	
Barium	mg/L	0.38	10	10	10.1	10.0	98	96	75-125	1	20	
Cadmium	mg/L	ND	10	10	10.1	10.1	101	100	75-125	1	20	
Chromium	mg/L	ND	10	10	10.0	9.9	100	99	75-125	1	20	
Lead	mg/L	224	10	10	229	226	46	19	75-125	1	20	M0
Selenium	mg/L	ND	10	10	10.9	10.7	109	107	75-125	1	20	
Silver	mg/L	ND	5	5	4.9	4.9	98	97	75-125	1	20	

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QUALIFIERS

Project: Cardinal Mill
Pace Project No.: 6034611

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to changes in sample preparation, dilution of the sample aliquot, or moisture content.

ND - Not Detected at or above adjusted reporting limit.

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

S - Surrogate

1,2-Diphenylhydrazine (8270 listed analyte) decomposes to Azobenzene.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

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ANALYTE QUALIFIERS

M0	Matrix spike recovery was outside laboratory control limits.
R1	RPD value was outside control limits.

APPENDIX B – LEAD RISK ASSESSMENT CALCULATIONS

UCL Calculator Version 1.0

3/10/08

Summary Statistics for	
Number of Samples	12
Number of Censored Data	0
Minimum	86.3
Maximum	20900
Mean	4918.192
Median	3220
Standard Deviation	6233.015
Variance	38850472
Coefficient of Variation	1.267339
Skewness	1.816478

95% UCL (Assuming Normal Data)	
Student's-t	8149.557

95% UCL (Adjusted for Skewness)	
Adjusted-CLT	8886.374
Modified-t	8306.809

95% Non-parametric UCL	
CLT	7878.067
Jackknife	NA
Standard Bootstrap	8148.768
Bootstrap-t	11025.85
Chebyshev (Mean, Std)	12761.41

Summary Statistics for ln()	
Minimum	4.457829
Maximum	9.947504
Mean	7.486332
Standard Deviation	1.765914
Variance	3.118453

Goodness-of-Fit Results	
Distribution Recommended	Lognormal
Distribution Used	Lognormal

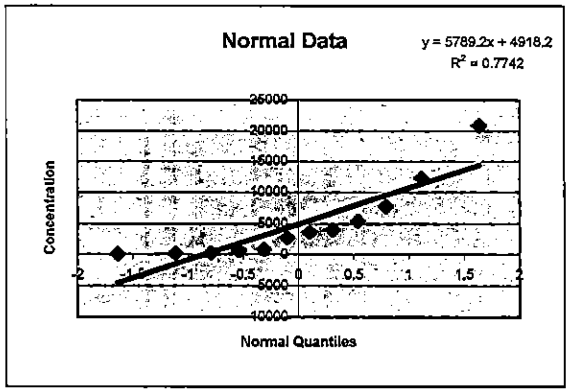
Estimates Assuming Lognormal Distribution	
MLE Mean	8480.784
MLE Standard Deviation	39425.49
MLE Median	1783.498
MLE Coefficient of Variation	4.648802
MVUE Estimate of Mean	6560.63
MVUE Estimate of Std. Dev.	14860.49
MVUE Estimate of SE	3657.363
MVUE Coefficient of Variation	2.265101

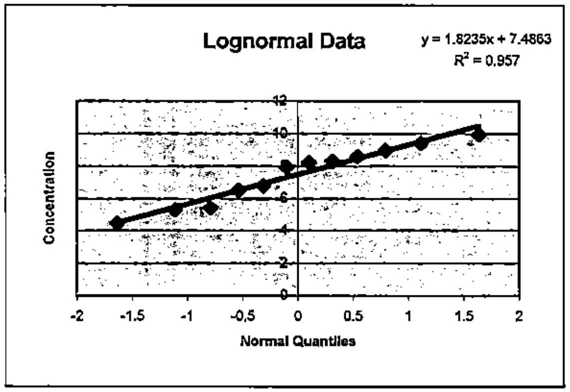
UCL Assuming Lognormal Distribution	
95% H-UCL	102135.9
95% Chebyshev (MVUE) UCL	22502.71
99% Chebyshev (MVUE) UCL	42951.03

Recommended UCL to Use:
12761.41
LEAD

UCL Calculator Version 1.0

Goodness-of-fit test results





Shapiro-Francia Results (Adjust for Censoring)

SF for Normal Distribution	0.7742
SF for LogNormal Distribution	0.957
Shapiro-Francia critical value for $p<0.05$	NA

Test stat > critical value indicates a reasonable fit

Shapiro-Wilk's Test Results for All Data (BDL replaced with 1/2 DL)

SW test statistic for Normal Distribution	0.782
SW test statistic for LogNormal Distribution	0.944
Shapiro-Wilk's critical value for $p<0.05$	0.859

Test stat > critical value indicates a reasonable fit

Based on the results of the Shapiro-Wilk's test
Distribution is best described as: Lognormal

Lognormal

Calculations of Preliminary Remediation Goals (PRGs)

Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 05/19/05 **EDIT RED CELLS**

Exposure Variable	Description of Exposure Variable	Units	
PbS	Soil lead concentration	ug/g or ppm	12761.4
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	2.1
PbB_0	Baseline PbB	ug/dL	1.4
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
$AF_{S,D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S,D}$	Exposure frequency (same for soil and dust)	days/yr	90
$AT_{S,D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	ug/dL	**9.0**
$PbB_{fetal,0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	27.5
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	%	**38.6%**

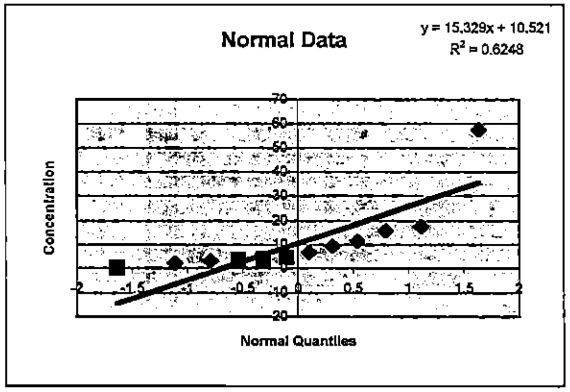
[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}).
When $IR_S = IR_{S+D}$ and $W_S = 1.0$, the equations yield the same $PbB_{fetal,0.95}$.

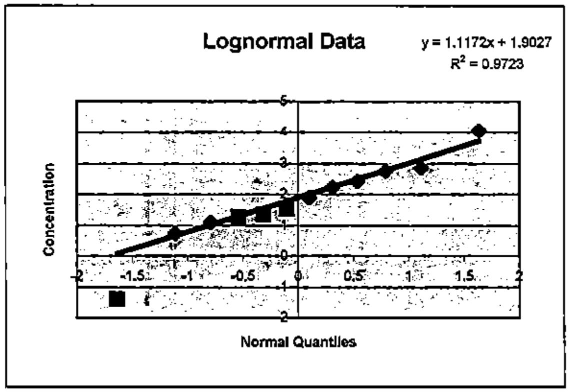
Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

APPENDIX C – ARSENIC RISK CALCULATIONS

FDEP UCL Calculator Version 1.0

Goodness-of-fit test results





Shapiro-Francia Results (Adjust for Censoring)

SF for Normal Distribution	0.6248
SF for LogNormal Distribution	0.9723
Shapiro-Francia critical value for $p<0.05$	0.921591

Test stat > critical value indicates a reasonable fit

Shapiro-Wilk's Test Results for All Data (BDL replaced with 1/2 DL)

SW test statistic for Normal Distribution	0.644
SW test statistic for LogNormal Distribution	0.946
Shapiro-Wilk's critical value for $p<0.05$	0.859

Test stat > critical value indicates a reasonable fit

Based on the results of the Shapiro-Francia test
Distribution is best described as: Lognormal

Lognormal

UCL Calculator Version 1.0 3/10/08

Note: Results reflect censored parameter estimations based on distributional assumptions.

Censor Estimated Statistics for	
Number of Samples	12
Number of Censored Data	4
Minimum Non-censored	3.9
Maximum	57.6
Mean	NA
Median	NA
Standard Deviation	NA
Variance	NA
Coefficient of Variation	NA
Skewness	NA

95% UCL (Assuming Normal Data)	
Student's-t	NA

95% UCL (Adjusted for Skewness)	
Adjusted-CLT	NA
Modified-t	NA

95% Non-parametric UCL	
CLT	NA
Jackknife	NA
Standard Bootstrap	NA
Bootstrap-t	NA
Chebyshev (Mean, Std)	30.93416

Censor Estimated Statistics for ln()	
Minimum	-1.386294
Maximum	4.053523
Mean	1.802014
Standard Deviation	1.26008
Variance	1.587801
Fit	0.966311

Goodness-of-Fit Results	
Distribution Recommended	Lognormal
Distribution Used	Lognormal

Estimates Assuming Lognormal Distribution	
MLE Mean	13.40884
MLE Standard Deviation	26.45649
MLE Median	6.061845
MLE Coefficient of Variation	1.973062
MVUE Estimate of Mean	11.59472
MVUE Estimate of Std. Dev.	15.47383
MVUE Estimate of SE	5.256292
MVUE Coefficient of Variation	1.334559

UCL Assuming Lognormal Distribution	
95% H-UCL	52.16857
95% Chebyshev (MVUE) UCL	34.50637
99% Chebyshev (MVUE) UCL	63.8943

Recommended UCL to Use:
34.5
ARSENIC

Calculation of Incremental Lifetime Cancer Risk for Direct Exposure to Soil

Chemical: Arsenic
Scenario: Construction Worker

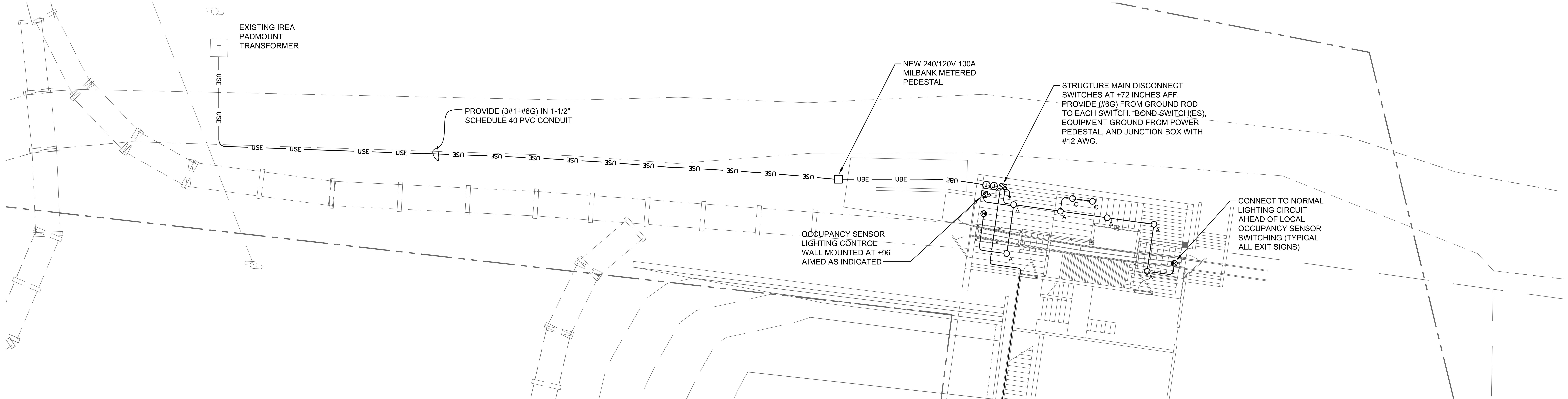
VARIABLE	DESCRIPTION	VALUE	UNIT
Co	Exposure Point Concentration	**34.5**	mg/kg
BW	Body Weight	76.1	kg
AT	Carcinogenic Averaging Time	25550	days
EF	Exposure Frequency	90	days/yr.
ED	Exposure Duration	30	years
FC	Fraction from Contaminated Source	1	unitless
RBA	Relative Bioavailability Factor	3	unitless
CSFo	Oral Cancer Slope Factor	1.50E+00	1/mg/kg-day
CSFd	Dermal Cancer Slope Factor	1.579E+00	1/mg/kg-day
CSFi	Inhalation Cancer Slope Factor	1.500E+00	1/mg/kg-day
CF	Correction Factor	1.00E-06	kg/mg
SA	Skin Surface Area	3500	cm2/day
AF	Adherence Factor	0.1	mg/cm2
DA	Dermal Adsorption	0.001	unitless
IRo	Ingestion Rate	50	mg/day
IRi	Inhalation Rate	20	m3/day
VF	Volatilization Factor	4.20.E+07	m3/kg
PEF	Particulate Emission Factor	4.60E+09	m3/kg
Q/C	Inverse of Mean Concentration	32.68	g/m2-sec
Da	Apparent Diffusivity	2.0E-12	cm2/sec
T	Exposure Interval	946080000	sec
rb	Soil Bulk Density	1.5	g/cm3

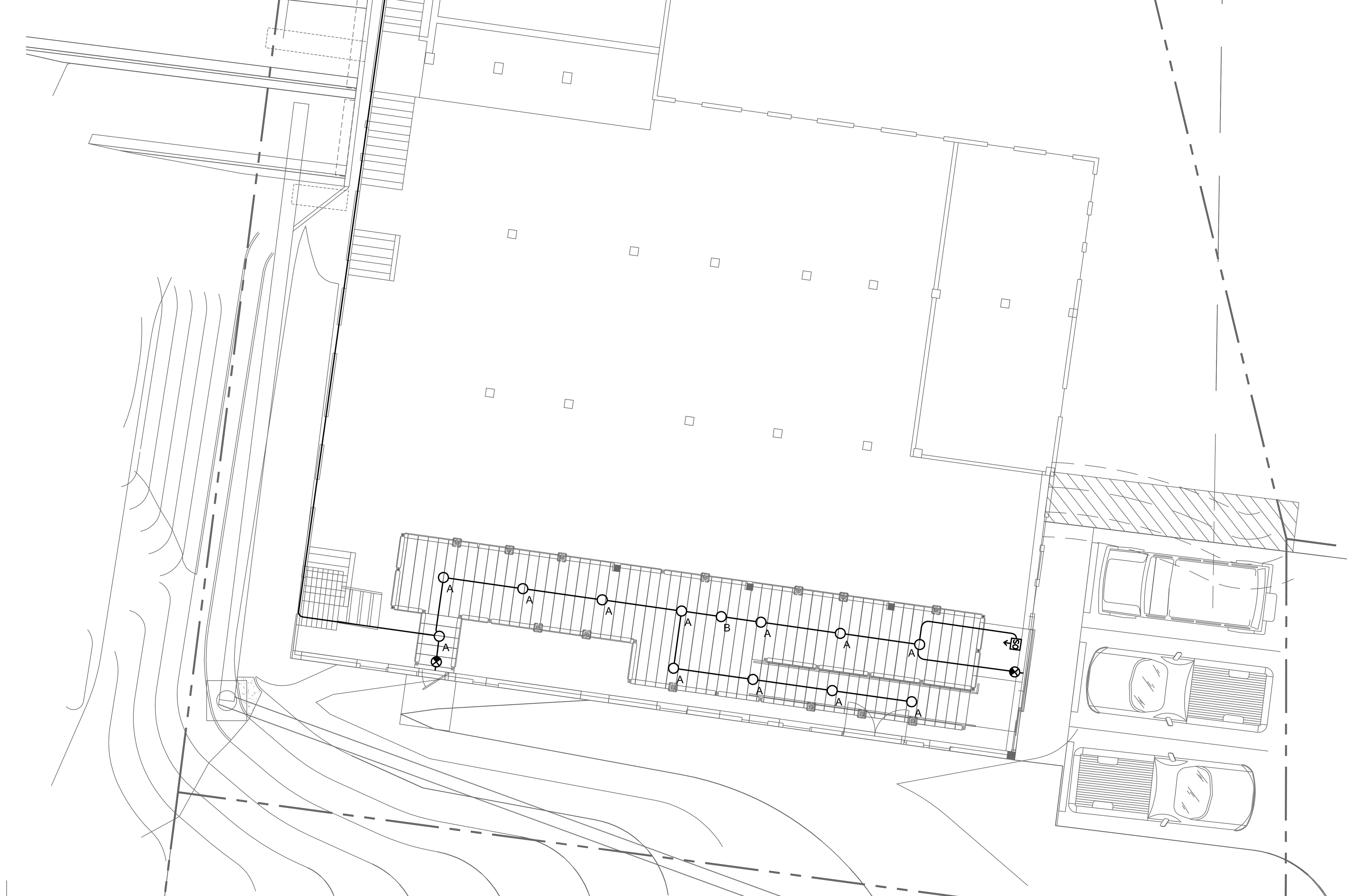
The following equation is used to calculate the Incremental Lifetime Cancer Risk (ILCR) associated with exposure to the soils under the scenario shown above.

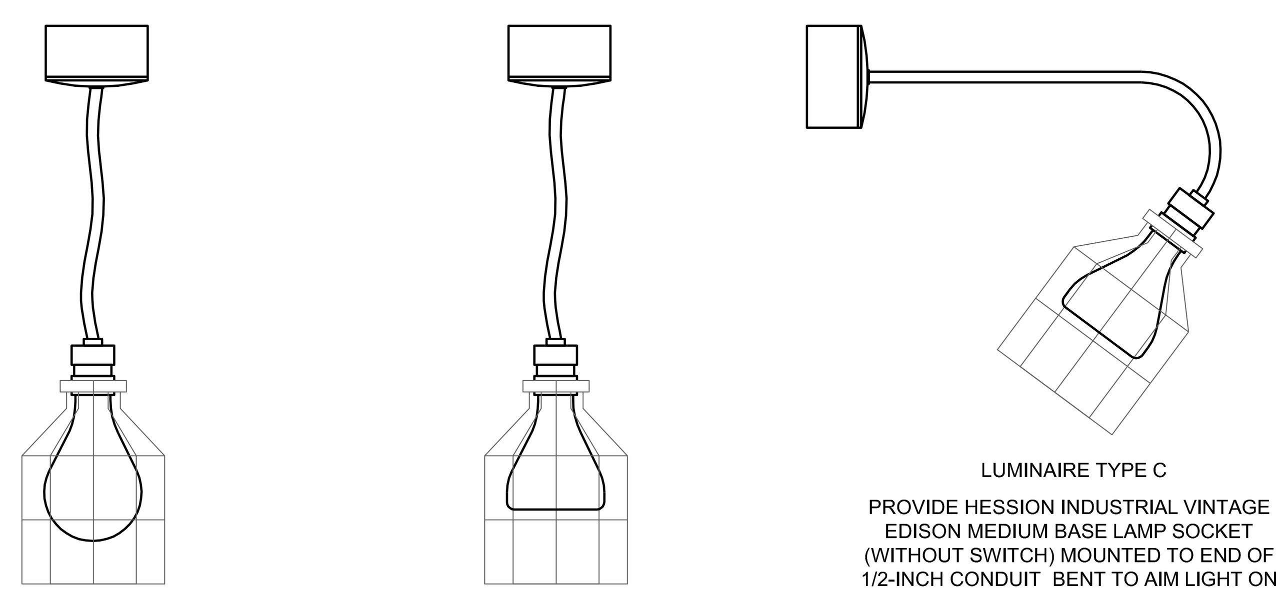
$$ILCR = \frac{Co * EF * ED * FC * \left[(CSF_o * IR_o * CF) + (CSF_d * SA * AF * DA * CF) + \left(CSF_i * IR_i * \left(\frac{1}{VF} + \frac{1}{PEF} \right) \right) \right]}{BW * AT}$$

CALCULATED VALUES:

ILCR= **1.2E-06**







LUMINAIRE TYPE A

PROVIDE HESSION INDUSTRIAL VINTAGE EDISON MEDIUM BASE LAMP SOCKET (WITHOUT SWITCH), 36-INCH BLACK (3#12) SO CORD, AND BLACK 4-INCH DIAMETER BACK-BOX DROP-CORD CANOPY. INSTALL 13WATT WARM/SOFT WHITE A-19 LED LAMP AND NEWHOUSE LIGHTING BLACK METAL 5-INCH DIAMETER LAMP WIRE GUARD

LUMINAIRE TYPE B

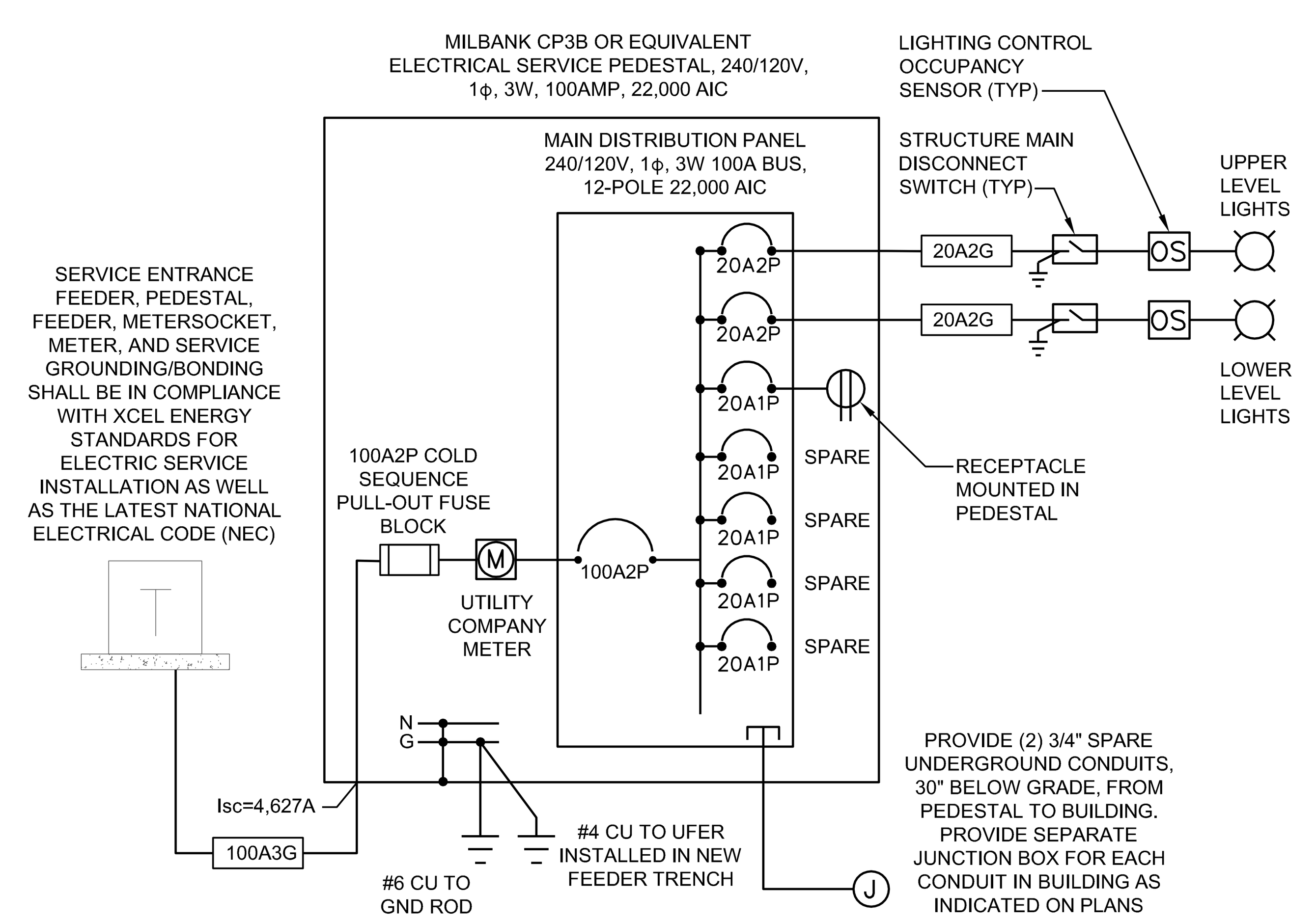
PROVIDE HESSION INDUSTRIAL VINTAGE EDISON MEDIUM BASE LAMP SOCKET (WITHOUT SWITCH), 36-INCH BLACK (3#12) SO CORD, AND BLACK 4-INCH DIAMETER BACK-BOX DROP-CORD CANOPY. INSTALL 8WATT WARM/SOFT WHITE R-20 LED LAMP AND NEWHOUSE LIGHTING BLACK METAL 5-INCH DIAMETER LAMP WIRE GUARD

LUMINAIRE TYPE C

PROVIDE HESSION INDUSTRIAL VINTAGE EDISON MEDIUM BASE LAMP SOCKET (WITHOUT SWITCH) MOUNTED TO END OF 1/2-INCH CONDUIT BENT TO AIM LIGHT ON SHELF (PAINT BLACK). INSTALL 8WATT WARM/SOFT WHITE R-20 LED LAMP AND NEWHOUSE LIGHTING BLACK METAL 5-INCH DIAMETER LAMP WIRE GUARD

Luminaire Configuration Types

Scale: NTS



Electrical One-Line Diagram

Scale: NTS

FEEDER SCHEDULE

ALL WIRE SHALL BE COPPER UNLESS NOTED OTHERWISE

Feeder Key	# of Runs	Wire Size	Ground	Conduit	Notes
20A.3G	1 Set	3#12	+1#12G	3/4"C	
20A.4G	1 Set	4#12	+1#12G	3/4"C	
30A.3G	1 Set	3#10	+1#10G	3/4"C	
30A.4G	1 Set	4#10	+1#10G	3/4"C	
40A.3G	1 Set	3#8	+1#8G	3/4"C	
40A.4G	1 Set	4#8	+1#8G	3/4"C	
50A.3G	1 Set	3#6	+1#8G	1"C	
50A.4G	1 Set	4#6	+1#8G	1"C	
60A.3G	1 Set	3#4	+1#8G	1 1/4"C	
60A.4G	1 Set	4#4	+1#8G	1 1/4"C	
70A.3G	1 Set	3#4	+1#8G	1 1/4"C	
70A.4G	1 Set	4#4	+1#8G	1 1/4"C	
80A.3G	1 Set	3#3	+1#8G	1 1/4"C	
80A.4G	1 Set	4#3	+1#8G	1 1/4"C	
100A.3G	1 Set	3#1	+1#8G	1 1/2"C	
100A.4G	1 Set	4#1	+1#8G	1 1/2"C	
125A.3G	1 Set	3#1	+1#6G	1 1/2"C	
125A.4G	1 Set	4#1	+1#6G	1 1/2"C	
150A.3G	1 Set	3#1/0	+1#6G	2"C	
150A.4G	1 Set	4#1/0	+1#6G	2"C	

Volt: **240/120** Bus Rating: **100**
Ph: **1** Main Breaker: **100**
Wire: **3** AIC Rating: **22,000**

	Code	Description	Load	Bkr	P	Ph	Ph	P	Bkr	Load	Description	Code	
			VA			A	B			VA			
1	1	Mill Lighting - Upper	104	20	1	*		1	20	180	Recept Pedestal	2	2
3	1	Mill Lighting - Lower	169	20	1		*	1	20		Spare		4
5		Spare		20	1	*		1	20		Spare		6
7		Space		-			*		-		Space		8
9		Space		-		*			-		Space		10
11		Space		-			*		-		Space		12

Code	Description	Load VA	Dem
1	Lighting	**273**	125%
2	Rec up to 10,000	**180**	100%
	Rec over 10,000		50%
3	Motor		100%
	Largest Motor		125%
4	Heater		100%
5	Kitchen		100%
6	Miscellaneous		100%
7	Sub Panel		100%

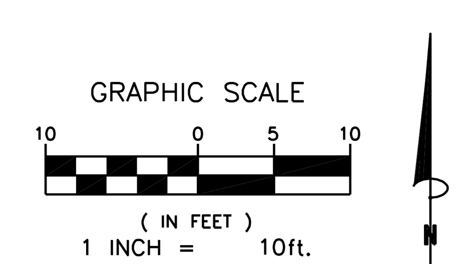
Load Summary

Per Phase
Ph A **284** VA
Ph B **169** VA

Connected **453** VA
Code Demand **521** VA

Code Demand **2.17** Amps

1 / EP **ELECTRICAL PLAN**



Boulder County

Boulder County Parks & Open Space

5201 Saint Vrain Road
Longmont, CO 80503

Phone: (303) 678-6200
Fax: (303) 678-6180
www.BoulderCounty.org

Cardinal Mill

167 Bergren Road, Nederland, Colorado 80466

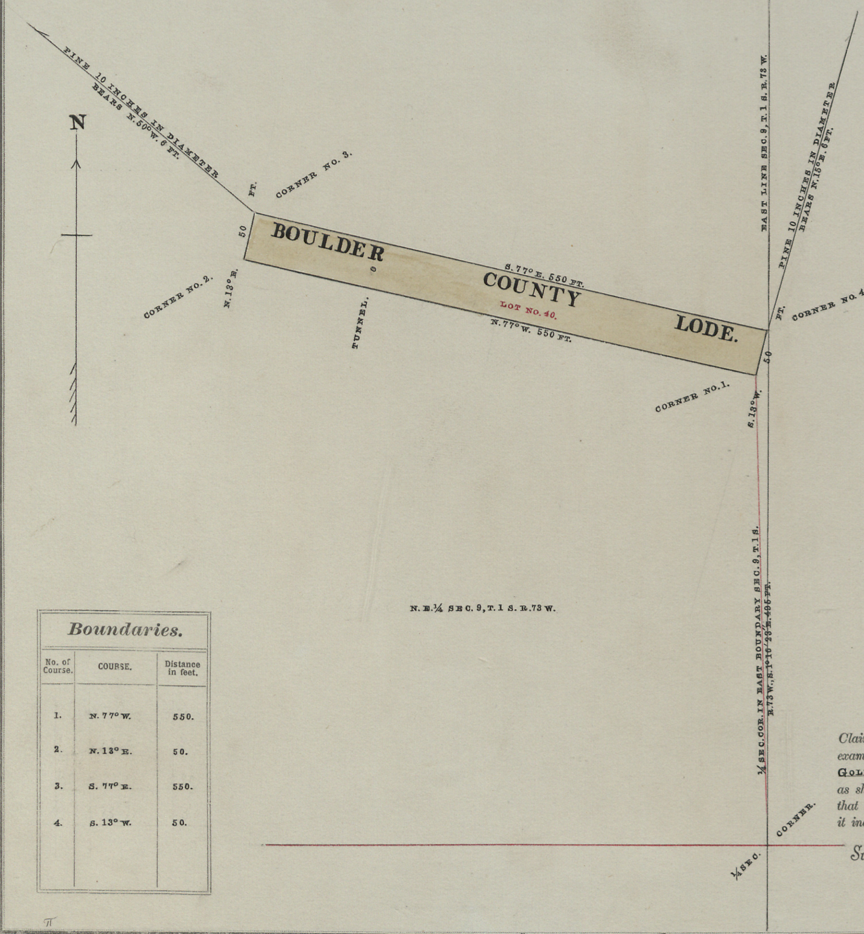
Public Access Electrical Plan

DATE:	February 24, 2017
SCALE:	1"=10'
DRAWN BY:	AEI
DESIGNED BY:	DJA
CHECKED BY:	DJA

REVISIONS: DATE

SHEET: 10 OF 10

ELP



SURVEY No. 40.

Mineral District No. 4.

PLAT
OF THE
CONGER & SANDERS CLAIM
UPON THE
BOULDER COUNTY LODE

Grand Island Mining District, Boulder County, Colorado.

Surveyed by J. DARTT, U. S. DEPUTY SURVEYOR.

Containing 0.6314 *Acres.*

Scale of 100 *Feet to an Inch.*

Variation. 14° EAST.

Boundaries.

No. of Course.	COURSE.	Distance in feet.
1.	N. 77° W.	550.
2.	N. 13° E.	50.
3.	S. 77° E.	550.
4.	S. 13° W.	50.

The Field Notes of Survey of the CONGER & SANDERS *Claim, upon the* BOULDER COUNTY *Lode from which this Plat has been made, have been examined and approved, and are on file in this office. And I hereby Certify that the Lode claimed is of* GOLD & SILVER *and the value of the labor and improvements thereon, exceed one thousand dollars, as shown by the report of the Deputy Surveyor, and the testimony of two witnesses; and I further Certify that this claim is not embraced either wholly or partially within the exterior lines of any other claim, nor does it include any portion of any other claim.*

Surveyor General's Office,
Denver, Colorado,
June 6th 1872
9 o'clock A.M.

W. N. Lessig
U. S. Surveyor General of Colorado.