COLORADO
Department of Public
Health & Environment

Dedicated to protecting and improving the health and environment of the people of Colorado

May 17, 2018

Mr. Ben Moline
Coors Energy Company
1801 California Street
Suite 4600
Denver, Colorado 80202

Re: Approval with Modifications: Post-closure Care and Groundwater Monitoring Plans
Keenesburg Ash Disposal Facility
SW/WLD/COO 2.4

Dear Mr. Moline,

The Colorado Department of Public Health and Environment (the "Department") Hazardous Materials and Waste Management Division (the "Division") has received the following Post-closure Care Plan with includes a Post-closure Groundwater Monitoring Plan attached as Appendix C, together referenced herein as the "PC Plan", for the Keenesburg Ash Disposal Facility (the "Facility") located at 13495 Weld County Road 61, 7 miles northwest of Keenesburg, Colorado with the Coors Energy Company.

> *"Draft" Post-closure Care Plan, Keenesburg Ash Disposal Site.* Prepared by: Doty and Associates. Document dated: May 7, 2018. Document received: May 7, 2018.
>
> *"Draft" Post-closure Groundwater Monitoring Plan, Keenesburg Ash Disposal Site.* Prepared by: Doty and Associates. Document dated: May 4, 2018. Document received: May 7, 2018.

The Division reviewed the submitted PC Plan pursuant to 6 CCR 1007-2, Part 1, the *Regulations Pertaining to Solid Waste Sites and Facilities* (the "Regulations"). Based on this review the Division approves the PC Plan with modifications as described below.

1) The following language is struck from Section 2.3 (Post-Closure Term):

> "The post-closure care period for both Pit A and B landfill will start as of the date of release for Pit B from DRMS regulatory authority and will start as of the date of release for Pit B from DRMS regulatory authority and will be subject to the requirements of Section 2.6 of 6 CCR 1007-2, Part 1. Pursuant to Section 3.6.3 of 6 CCR 1007-2, Part 1 this post-closure may be increased or decreased after consultation and written approval from both the Colorado Department of Public Health and Environment Hazardous Materials and Solid Waste Division and the local governing authority having jurisdiction."

And replaced with:

> "The post-closure care period for Pit A will start as of the date of approval of this Post-Closure Care Plan as Pit A has been released from DRMS regulatory authority. The post-closure care period will be subject to the requirements of Section 2.6 of 6 CCR 1007-2, Part 1 which states the post-closure care period shall be at least thirty (30) years. The post-closure care period for the Pit B landfill will start as of the date of release from DRMS closure authority and will be subject to the requirements of Section 2.6 of 6 CCR 1007-2, Part 1. Pursuant to Section 3.6.3 of 6 CCR 1007-2, Part 1, this post-closure care period may be increased or decreased after consultation and written approval from both the Colorado Department of Public Health and Environment Hazardous Materials and Solid Waste Division and the local governing body having jurisdiction."

As previously discussed:

a) The area referenced as the Pit A landfill has already been released from the Division of Reclamation, Mining and Safety (DRMS) regulatory authority and is currently a solid waste disposal area in post-closure care pursuant to Section 2.6 and 3.6 of the Regulations.

b) The area referenced as Pit B landfill is currently being closed under DRMS regulatory authority and also currently falls under the authority of the solid waste Regulations.

In discussions with DRMS staff and Facility representatives it was determined that the mining and solid waste regulatory closure and post-closure requirements differed slightly based on differing considerations associated with differing operations and processes. As examples:

i) DRMS requires re-establishing natural gradients for mined sites while not necessarily contemplating final disposition of solid wastes (reference the definition of solid wastes in the Solid Wastes Disposal Sites and Facilities Act (§30-20-101, *et seq.*, C.R.S.)) and the solid waste Regulation requires considerations of shedding water from final landfill covers while preventing erosion using considerations including engineered minimum and maximum grades.

ii) DRMS regulations provide for final covers that are much thicker than solid waste final cover requirements including water balance covers which is essentially what has been contemplated by the DRMS regulatory process.

iii) Post-closure care groundwater monitoring requirements under the Regulations for solid waste facilities differed from DRMS post-closure care groundwater monitoring requirements.

Previous determinations made between DRMS, the Division, and the Facility included:

- the final cover had already been constructed at the Pit A landfill area and therefore no additional construction other than typical maintenance would be required;
- the final cover for the Pit B landfilled area is already approved by DRMS and is currently under construction and based;
- the approved DRMS final cover is compliant with the solid waste water balance cover design criteria;
- the DRMS re-vegetation requirements exceeded those required by the Regulations therefore the solid waste regulatory considerations are met under current permitted activity; and

- the final cover design for this Facility is believed to adequately prevent ponding of storm water and allows for adequate shedding of storm water from the designed final covers, therefore no additional construction requirements are required provided future ponding is not identified through required inspections of the landfilled areas.

Further it appears as if the Pit B landfill area may not receive full regulatory release from DRMS for a significant period of time. Based on these considerations this modification #1 has been applied to the PC Plan.

The Division understands the Facility's desire to have the post-closure care period for the Pits A and B landfilled areas run simultaneously. Therefore should the Facility choose to initiate the post-closure care period for the Pit B landfill along with the Pit A landfill and initiate the requirements of the PC Plan for post-closure care pursuant to the Regulations and the approved PC Plan for the Pit B landfilled area concurrently with the Pit A landfilled area the Division approves this decision provided the Facility clarifies such a decision in writing within two (2) weeks of the date of this letter.

2) The Facility further states in Section 7.2 (New Well Installation) of the Post-closure Groundwater Monitoring Plan that monitoring well installation may be delayed if such installation(s) would impact grading or seeding operations. This language is modified by the Division by a subsequent sentence in this paragraph that states:

> "The CDPHE will be notified in writing of any delay or variance to any well installations."

In such delay or variance to well installation must be reviewed and approved by the Division in writing prior to any deadline defined by the PC Plan language.

For clarity, the previous paragraph stating the following is struck from Section 7.2:

> "Any new groundwater monitoring well required for any area released from DRMS regulatory authority and placed in CDPHE's regulatory authority will be installed within one-hundred eighty (180) days of either approval of the Post-Closure Plan or the date the area was released from DRMS authority, whichever comes first."

and replaced with:

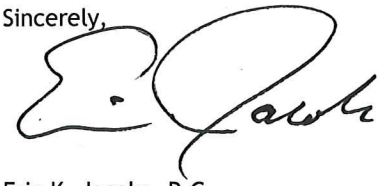
> "Any new groundwater monitoring well required for any area under CDPHE's regulatory authority will be installed within one-hundred eighty (180) days of approval of this Post-Closure Plan."

For convenience the Division has attached to this letter a clean version of the PC Plan. An electronic copy of this clean version will additionally be provided to the Facility.

The Department is authorized to bill for its review of technical submittals pursuant to Section 1.7 of the Regulations Pertaining to Solid Waste Sites and Facilities (6 CCR 1007-2). An invoice for the Division's review of the above referenced documents will be transmitted under separate cover. Our fees and billing ceilings may be viewed online at https://www.colorado.gov/pacific/cdphe/solid-waste-regulations.

Should you have any questions regarding determination made herein contact Eric Jacobs at 303-692-3430 or by email at eric.jacobs@state.co.us.

Sincerely,



Eric K. Jacobs, P.G.
Solid Waste Permitting Unit
Hazardous Materials and Waste Management Division

ec: Ben Frissel, Weld County Department of Health and Environment
Dan Hernandez, Division of Reclamation, Mining, and Safety
Tabetha Lynch, Division of Reclamation, Mining, and Safety
Robin Reilley, Division of Reclamation, Mining, and Safety
Doug Ikenberry, P.E., Solid Waste Compliance Unit
Ben Doty, P.E., Doty and Associates

H:\Working File\Projects\County Weld\Keenesburg Ash Facility\Correspondence\180517 PC and GW Plan Approval with Modifications FINAL.docx.

DOTY & ASSOCIATES, LLC
ENVIRONMENTAL, GROUNDWATER AND WASTE MANAGEMENT ENGINEERS

1440 BRICKYARD ROAD
SUITE 1
GOLDEN, COLORADO 80403-8054

http://www.dotyeng.com
bpdoty@dotyeng.com

VOICE: (303) 279-9181
FAX: (303) 279-9186

POST-CLOSURE CARE PLAN
KEENESBURG ASH DISPOSAL SITE

January 29, 2018
Revision 1: May 7, 2018

Prepared for:

Molson Coors Brewing Company
1801 California Street
Suite 4500
Denver, Colorado 80202

Prepared by:

Doty & Associates, LLC
1440 Brickyard Road
Suite 1
Golden, Colorado 80403-8054

Project No. 302-15

Benjamin P. Doty, P.E.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

Page

LIST OF APPENDICES

1.0 INTRODUCTION

This is the post-closure care plan for the A and B disposal pits at the Keenesburg Ash Disposal Site. The site is located approximately 4.5 miles north of Keenesburg (Figure 1) in portions of Sections 25 and 36, Township 3 North, Range 64 West, Sixth Principal Meridian, Weld County, Colorado (Figure 2). The area included in the permit allowing both mining and disposal operations is approximately 788.5 acres. Only 413 acres were actually disturbed by mining activities. Ash disposal occurred in the two pits (cells) totalling about 65.6 acres (Figure 2).

1.1 DESCRIPTION OF OPERATION

The property was a surface coal mine (with associated support operations) from 1981 through 1987. Disposal of ash began in 1987 as part of the mine reclamation process. The site is permitted to dispose of fly and bottom ash from the coal-fired power plant located at the Molson Coors Brewing complex in Golden, Colorado. The facility can also accept waste rock from other mines on a case-by-case basis. The approved operations plan also allows demolition and disposal of on-site facilities such as the shop/office building.

Ash was brought to the site in over-the-road haul vehicles from 1987 through 2016 and the ash was placed in two disposal cells (the A and B pits). The locations of the A and B pits are shown on Figure 2. Given the available evidence cannot confirm the base elevation of Pits A and B are above pre-mining groundwater elevations based on a lack of as-built construction information, the floors of the A and B disposal areas are reported to consist of compacted clayey spoil material and are presumed to be a minimum of four feet above the pre-mining water table. The ash was covered routinely as it was placed and, when the disposal areas approached final grade, a final cover consisting of six feet of compacted clayey material (spoil) was placed over them. Finally, an uppermost two foot thick layer of topsand was placed and seeded to establish vegetation that is self-supporting under ambient precipitation conditions. After placement, the final cover grade is approximately equivalent to the pre-mining contours.

1.2 TRANSFER OF REGULATORY AUTHORITY

The Keenesburg site has operated under a permit from the Colorado Division of

Reclamation and Mining Safety (DRMS) since 1981 and under a Certificate of Designation for ash disposal issued by Weld County since 1987. As a former mining facility, the Keenesburg Ash Disposal Site has been regulated by the Department of Reclamation and Mining Safety (DRMS). As the bonding requirements pursuant to the regulatory authority of DRMS is released this financial assurance consideration will be transferred to the Department. As discussed in Section 3.6 (Financial Assurance) of this Post-closure Care Plan, the Facility will submit a cost estimate to the Division pursuant to Section 1.8 of the Regulations Pertaining to Solid Waste Sites and Facilities (6 CCR 1007-2, Part 1) within sixty (60) days of any bond releases that effect any aspect of the Post-closure Care Plan that require financial assurance pursuant to 6 CCR 1007-2, Part 1 within sixty (60) days of release from DRMS regulatory authority for Pit B. Any financial assurance required for the Pit A area will be included in the first process associated with Pit B. Consistent with standard DRMS permit practice, portions of the site are released from bonding requirements after grading is complete and revegetation has been proven to be self-sustaining. The A Pit area has been removed from the DRMS permit on this basis. Reclamation work is continuing in the B Pit area and it will be similarly removed from the DRMS permit sometime in the future.

Thus, regulatory authority is gradually being relinquished to Weld County and the Colorado Department of Public Health & Environment (CDPHE). The A Pit is already solely subject to the Colorado solid waste regulations and this will be the case for the B Pit in the relatively near future. The owner will update CDPHE and Weld County on the status of the DRMS permit for the B Pit area on an annual basis.

1.3 OWNER/OPERATOR INFORMATION

The owner and operator of the Keenesburg Ash Disposal site and the contact during the post-closure care period is as follows.

Molson Coors Brewing Company
Attn: Mr. Benjamin M. Moline, P.E.
1801 California Street
Suite 4600
Denver, Colorado 80202

Phone: (303) 927-3680

FAX: (303) 927-3700
Email: ben.moline@molsoncoors.com

2.0 POST-CLOSURE USES, CONTROLS & TERM

2.1 POST-CLOSURE USES

The post-closure use of the A and B Pit areas is non-irrigated rangeland. Other uses or disturbance of the A and B Pit areas may be proposed provided that these other uses do not disturb the integrity of the final cover, liner, or any other components of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements in the CDPHE regulations. CDPHE may approve any other disturbance if the owner or operator demonstrates that disturbance of the final cover, liner or other component of the containment system, including any removal of waste, will not increase the potential threat to human health or the environment. Approval for other uses or disturbance must also be obtained from Weld County. Any land use changes for any area regulated by the Post-closure Care Plan must be approved in writing by both the Colorado Department of Public Health and Environment and the local governing agency having jurisdiction.

No drilling of any kind will be allowed within the surveyed boundaries of the A and B Pits unless specific approval is obtained from CDPHE and Weld County.

2.2 POST-CLOSURE CONTROLS

The owner will determine the limits of the areas used for ash disposal by survey or photogrammetric methods. These limits will be used in the institutional controls described below and also will define the areas for which post-closure care is required. The limits of ash disposal will be provided to CDPHE and Weld County within sixty days of approval of the post-closure care plan. The facility will be responsible for assuring accurate coordinate identifying the solid waste boundaries of Pits A and B are provided to the Division and that such coordinates are certified by a Professional Land Surveyor.

The owner will record a notation on the deed to the facility property, or on another instrument that is normally examined during title search, that will in perpetuity notify any potential purchaser of the property that: (1) the land specific to the areas of Pits A and B has been used as a landfill facility and (2) the use of the land is restricted under Section 3.6.1(7) of the solid waste regulations. The owner will also notify the CDPHE and Weld County that the notation has been recorded and that a copy has been placed in the

operating record. CDPHE, after consultation with Weld County, may grant permission to remove the notation from the deed if all wastes are removed from the facility. Pursuant to the Colorado Environmental Covenants Law, § 25-15-317-327, C.R.S., either an Environmental Covenant (EC) or Notice of Environmental Use Restrictions (RN) is required on the property, outlining specifically the areas associated with Pits A and B. The Facility owner will initiate the Division's process for implementing either an EC or RN on the property within sixty (60) days from the date of this letter.

2.3 POST-CLOSURE TERM

The post-closure care period for Pit A will start as of the date of approval of this Post-Closure Care Plan as Pit A has been released from DRMS regulatory authority. The post-closure care period will be subject to the requirements of Section 2.6 of 6 CCR 1007-2, Part 1 which states the post-closure care period shall be at least thirty (30) years. The post-closure care period for the Pit B landfill will start as of the date of release from DRMS closure authority and will be subject to the requirements of Section 2.6 of 6 CCR 1007-2, Part 1. Pursuant to Section 3.6.3 of 6 CCR 1007-2, Part 1, this post-closure care period may be increased or decreased after consultation and written approval from both the Colorado Department of Public Health and Environment Hazardous Materials and Solid Waste Division and the local governing body having jurisdiction.

Prior to release from post-closure care obligations, the owner must demonstrate that the potentiometric surface has returned to pre-mining levels, with consideration of any potential groundwater system changes due to natural activities, seasonal effects or Colorado water policy. Stable water levels must be evidenced in quarterly monitoring data collected over two years. In addition, the owner must provide sufficient monitoring data after pre-mining water levels have been achieved to demonstrate the absence of water quality impacts from the ash disposal areas.

3.0 CARE & MAINTENANCE

3.1 NUISANCE CONDITIONS

Of the nuisance conditions listed in Section 1.2 of the solid waste regulations, the only nuisance conditions with potential to develop at the site are those resulting from windblown solid wastes, exposure of any solid wastes, and water pollution. The inspection program described in Section 3.2 and groundwater monitoring program described in Section 3.3 are intended to prevent these potential nuisance conditions.

3.2 FINAL COVER INTEGRITY

3.2.1 Site Inspection

Conditions in the A and B Pit areas will be inspected annually during the post-closure care period. The inspections will include drainage structures, erosion control measures, covered areas and vegetation. The check-list attached to this plan (or a similar check-list) will be used for this purpose. The results of the site condition inspection (and any corrective measures undertaken) will be documented in an annual report to CDPHE and Weld County. The report will be submitted on or before March 31 to document work performed in the preceding year.

3.2.2 Repairs

Any repairs to the final cover will utilize on-site soil or imported soil if necessary. The soil will be spread in loose lifts not exceeding 8 inches and lightly compacted using the tracks of a dozer or similar equipment. All areas of cover repair will be revegetated using a seed mix similar to that previously used at the site. Revegetation will be accomplished in the fall or spring after the cover repair is complete.

Cover and drainage system repairs will be undertaken as soon as possible after identifying a problem and completed in an expeditious manner, considering such factors as weather and the availability of suitable soil. All such repairs will be completed within 180 days of need identification. Longer times to complete repairs may be allowed by CDPHE on request.

Maintenance requiring repairs will include any areas where:

a) ponding is identified on the final landfill cap; or
b) an inspection provides evidence of solid wastes exposed at the surface

Any repairs conducted will assure surface water is shed from the capped areas of the landfilled areas.

3.3 GROUNDWATER

Groundwater monitoring will be performed for the duration of the post-closure care period as described in the groundwater monitoring plan presented in Appendix C.

3.4 LEACHATE COLLECTION SYSTEM

The facility does not have a leachate collection system.

3.5 EXPLOSIVE GAS

The material placed in the A and B Pits is non-putrescible and not subject to decomposition. Therefore, explosive gas will not be generated and explosive gas monitoring is not required (Section 2.3 of the solid waste regulations).

3.6 FINANCIAL ASSURANCE

The owner will provide a financial assurance cost estimate to CDPHE within sixty (60) days of approval of this plan. The cost estimate (in current dollars) will be for hiring a third party to conduct post-closure care of the facility. The owner will establish financial assurance sufficient to ensure payment of such costs using one of the mechanisms specified in the regulations when released from the DRMS bonding requirements. Financial assurance coverage will be provided continuously until a release is granted by the Department.

The post-closure financial assurance cost estimate will be adjusted annually to account for inflation or deflation by using the implicit price deflator for the gross domestic product or its successor as published by the U.S. Department of Commerce. In addition, the original cost estimate will be replaced with a new cost estimate every five years unless otherwise required or approved by CDPHE. The owner will notify CDPHE when the required cost

estimates have been placed in the operating record.

4.0 COMPLETION

At the conclusion of the post-closure care period, a certification verifying that post-closure care has been completed in accordance with this plan will be prepared and signed by an independent Colorado registered professional engineer. The certification will be placed in the operating record and forwarded to CDPHE and Weld County.

5.0 REPORTING

5.1 WASTE LIMITS

As discussed in Section 2.2 of this plan, the operator will determine the limits of the areas used for ash disposal by survey or photogrammetric methods. These limits will be provided to CDPHE and Weld County within sixty days of approval of the post-closure care plan.

5.2 FINANCIAL ASSURANCE

A financial assurance cost estimate for post-closure care will be provided to CDPHE within sixty days of approval of this plan. The owner will establish financial assurance in the amount of the cost estimate using one of the mechanisms specified in the regulations when released from the bonding requirements of the DRMS permit.

A revised post-closure financial assurance cost estimate adjusted to account for inflation will be submitted to CDPHE annually. In addition, a wholly new cost estimate will be submitted every five years unless otherwise required or approved by CDPHE.

5.3 DRMS PERMIT STATUS

An update on the status of the DRMS permit for the B Pit area will be provided to CDPHE and Weld County on an annual basis. The updates will be provided on March 31 of each calendar year until the B Pit is fully released from the DRMS permit.

5.4 MONITORING REPORTS

This and the attached groundwater monitoring plan include requirements for two annual reports, as follows.

- Site inspection & monitoring report - due March 31 for work performed in the preceding year.
- Groundwater monitoring report - due March 31 for work performed in the preceding year.

These reports may be submitted separately or combined into a single report. The reports will be submitted to both CDPHE and Weld County.

The owner will also submit groundwater monitoring reports prepared under the DRMS permit on an annual basis. The reports will be submitted to CDPHE within 90 days of their submittal to DRMS.

5.5 END OF POST-CLOSURE CARE

As described in Section 4.0 of this plan, a certification verifying that post-closure care has been completed in accordance with this plan will be prepared and signed by an independent Colorado registered professional engineer. The certification will be placed in the operating record and forwarded to CDPHE and Weld County at the end of the post-closure care period. The Facility must obtain written approval for release from post-closure care from both the Department and the local governing authority having jurisdiction.

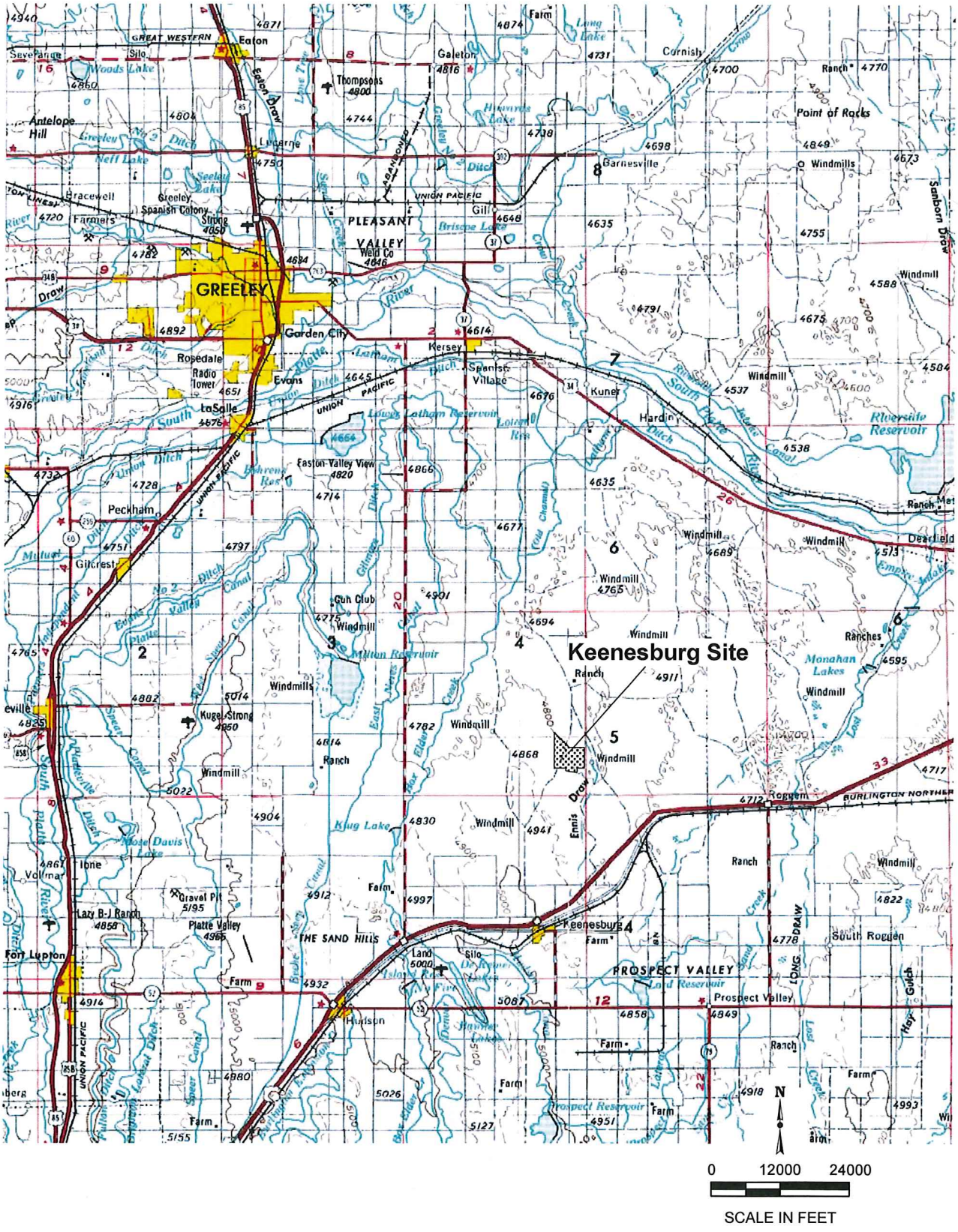
APPENDIX A

FIGURES

Figure 1. Regional Location

FIGURE 1

REGIONAL LOCATION

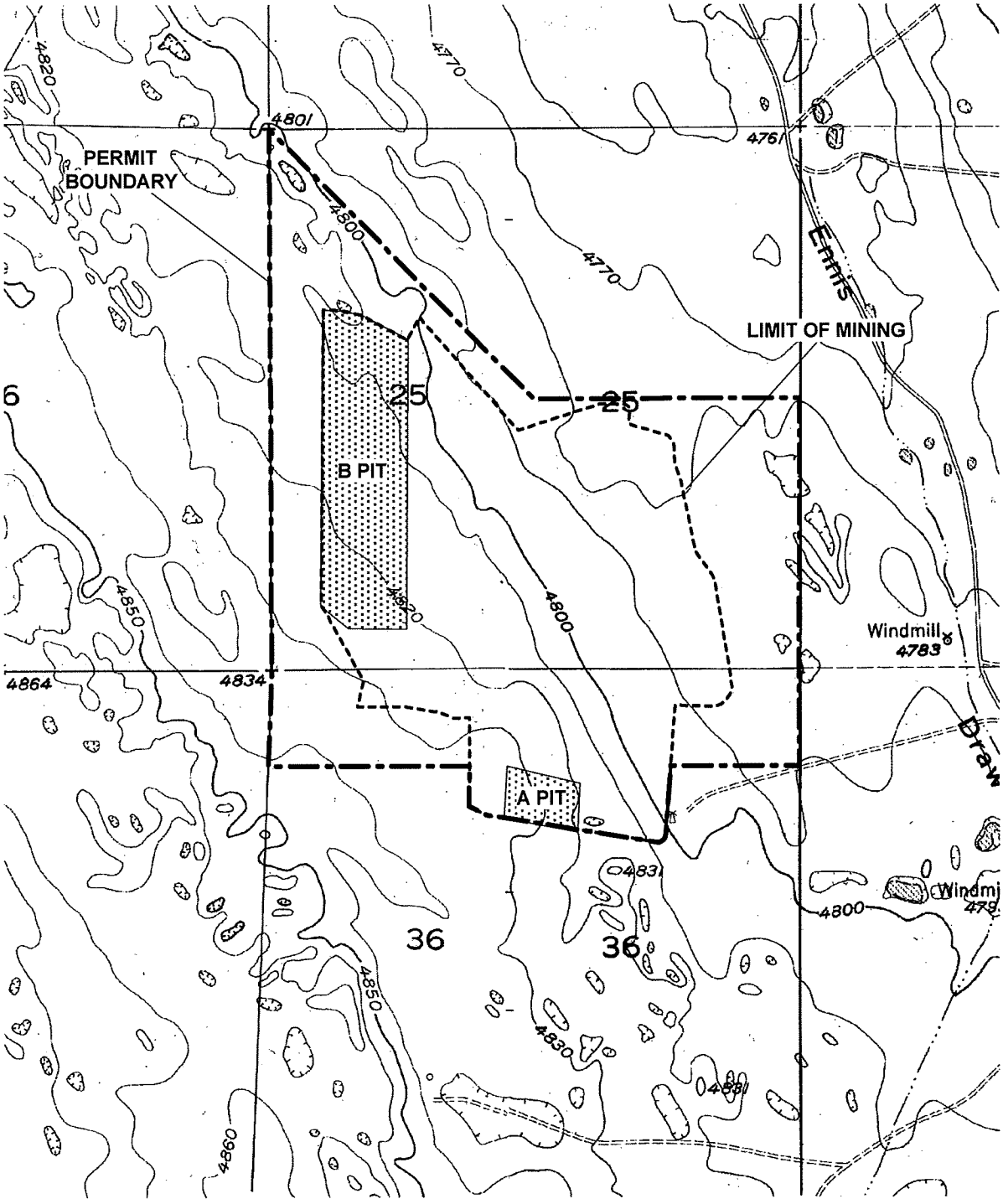


DOTY & ASSOCIATES, LLC | 302-15 | 01/24/2018

Figure 2. Detailed Location

FIGURE 2

DETAILED LOCATION



A and B Pits are ash disposal areas.

DOTY & ASSOCIATES, LLC | 302-15 | 01/24/2018

APPENDIX B

BLANK INSPECTION FORM

KEENESBURG ASH DISPOSAL SITE

ANNUAL INSPECTION
POST-CLOSURE CARE

_____
Inspection Date

Erosional Features	A Pit Area	B Pit Area
Rills/Gullies	☐ yes ☐ no	☐ yes ☐ no
Sparse Vegetation	☐ yes ☐ no	☐ yes ☐ no
Erosion at Limits	☐ yes ☐ no	☐ yes ☐ no
Wind Damage	☐ yes ☐ no	☐ yes ☐ no
Burrows	☐ yes ☐ no	☐ yes ☐ no
Comments		

Structural Issues	A Pit Area	B Pit Area
Settlement	☐ yes ☐ no	☐ yes ☐ no
Closed Depressions	☐ yes ☐ no	☐ yes ☐ no
Cracks	☐ yes ☐ no	☐ yes ☐ no
Seepage	☐ yes ☐ no	☐ yes ☐ no
Others	☐ yes ☐ no	☐ yes ☐ no
Comments		

Site Access	
Main Gate needs Repair	☐ yes ☐ no
Other Fencing needs Repair	☐ yes ☐ no
Evidence of Unauthorized Access	☐ yes ☐ no
Comments	

_____ Signature

_____ Printed Name & Title

_____ Date

APPENDIX C

POST-CLOSURE
GROUNDWATER MONITORING PLAN

DOTY & ASSOCIATES, LLC
ENVIRONMENTAL, GROUNDWATER AND WASTE MANAGEMENT ENGINEERS

1440 BRICKYARD ROAD
SUITE 1
GOLDEN, COLORADO 80403-8054

http://www.dotyeng.com
bpdoty@dotyeng.com

VOICE: (303) 279-9181
FAX: (303) 279-9186

POST-CLOSURE GROUNDWATER MONITORING PLAN KEENESBURG ASH DISPOSAL SITE

March 3, 2017
Revision 1: May 4, 2018

Prepared for:

Molson Coors Brewing Company
1801 California Street
Suite 4500
Denver, Colorado 80202

Prepared by:

Doty & Associates, LLC
1440 Brickyard Road
Suite 1
Golden, Colorado 80403-8054

Project No. 302-15

Benjamin P. Doty, P.E.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF ATTACHMENTS

Attachment I. Figures

Attachment II. Tables

Attachment III. Example Field Forms

Attachment IV. Well Logs & Completion Diagrams

1.0 INTRODUCTION

This is the groundwater monitoring plan for the Keenesburg Ash Disposal Site. The site is located approximately 4.5 miles north of Keenesburg (Figure 1) in portions of Sections 25 and 36, Township 3 North, Range 64 West, Sixth Principal Meridian, Weld County, Colorado (Figure 2). The area included in the permit allowing both mining and disposal operations is approximately 788.5 acres. Only 413 acres were actually disturbed by mining activities. Ash disposal occurred in two pits (cells) totalling about 65.6 acres.

The property was a surface coal mine (with associated support operations) from 1981 through 1987. Disposal of ash began in 1987 as part of the mine reclamation process. The site is permitted to dispose of fly and bottom ash from the coal-fired power plant located at the Molson Coors Brewing complex in Golden, Colorado. The facility can also accept waste rock from other mines on a case-by-case basis. The approved operations plan also allows demolition and disposal of on-site facilities such as the shop/office building.

Ash was brought to the site in over-the-road haul vehicles from 1987 through 2016 and the ash was placed in two disposal cells (the A and B pits). The locations of the A and B pits are shown on Figure 2. The floors of the A and B disposal areas consist of replaced compacted clayey spoil material and are a minimum of four feet above the pre-mining water table. The ash was covered routinely as it was placed and, when the disposal areas approached final grade, a final cover consisting of six feet of compacted clayey material (spoil) was placed over them. Finally, an uppermost two foot thick layer of topsand was placed and seeded to establish vegetation that is self-supporting under ambient precipitation conditions. After placement, the final cover grade is approximately equivalent to the pre-mining contours.

This plan is intended to comply with the requirements of RCRA Subtitle D (40 CFR Part 258) and the State of Colorado Regulations Pertaining to Solid Waste Disposal Sites and Facilities (6 CCR 1007-2). The monitoring program has been designed to monitor conditions in the uppermost aquifer at the relevant point of compliance at the Pit A and Pit B disposal areas.

2.0 HYDROGEOLOGIC CONDITIONS

A deposit of eolian sand covers the area in the vicinity of the Keenesburg site to depths varying from eight to twenty feet. In the western and southwestern portions of the site, the eolian sand is underlain by about twenty feet of clay (possibly weathered bedrock) and then by Laramie Formation claystones, sandstones and coals. In the eastern and northeastern portions of the site, the eolian sand is underlain by approximately 40 feet of alluvial sand (the Ennis Draw Alluvium). The depth to Laramie Formation bedrock in Ennis Draw is approximately 57 feet. In the center of the site (inside the limit of mining), there is a plug of clayey replaced overburden extending to the depth of mining (ranging from about 100 to 150 feet below ground). The hydrogeologic characteristics of these materials are as follows.

1. Soils. Both the eolian sand that blankets the region and the alluvial materials in Ennis Draw are relatively permeable. IC (1992) reports an eolian sand hydraulic conductivity of $1x10^{-3}$ centimeters per second (cm/s), although the material is dry at their site and at the Keenesburg facility.

   The Ennis Draw Alluvium is saturated and produces water to several wells and windmills in the general area. McWhorter and Ortiz (1978) report a conductivity of $1x10^{-4}$ cm/s for a single slug test in this material. Data are too limited to define the direction of flow in the Ennis Draw Alluvium; however, flow is expected to parallel the axis of the spatial distribution of the material (north to slightly northwest).

2. Overburden. The silty claystones and sandstones above the coal in the upper portion of the Laramie Formation are known locally as the overburden. Groundwater occurs in these materials under both confined and unconfined conditions and flow is generally to the northeast (McWhorter and Ortiz, 1978). Also according to McWhorter and Ortiz (1978), groundwater in the overburden is in good connection with and discharges to the Ennis Draw alluvium. Based on hydraulic testing described in McWhorter and Ortiz (1978), the overburden has a geometric mean hydraulic conductivity of $3x10^{-5}$ cm/s.

3. Coal. Groundwater also occurs in the coal under confined conditions and probably had little or no communication with the overlying water in the overburden (McWhorter and Ortiz, 1978). Ground-water flow in the coal prior to its removal

was mostly to the east. Based on testing described in McWhorter and Ortiz (1978), the coal has a geometric mean hydraulic conductivity of $9x10^{-5}$ cm/s.

4. Clayey Backfill. The clayey backfill consists of excavated overburden (known locally as spoil) that was placed back into the mining pit. Given the degree of comminution and mixing produced by the excavation and replacement process, it is likely that the hydraulic conductivity of the replaced overburden is low and may be similar to that of the undisturbed overburden (McWhorter and Ortiz, 1978). No data are available to quantify the as-placed hydraulic conductivity.

Prior to mining, flow in the overburden was generally to the northeast to its point of discharge into the alluvium and flow in the alluvium was also believed to be to the northeast, although there is probably also a northwest component following the alignment of the draw. Based on measurements made over the past twenty-four years, water levels have generally been steady at all points monitored, with the exception of AMW-2 and SMW-2. The AMW-2 and SMW-2 data demonstrate fairly linear rising water level trends of about 1 foot per year. The rising water levels in these wells are believed to result from gradual resaturation of the formerly dewatered mining pit. The water level in SMW-2 is currently approximately 10 feet lower than the pre-mining level. Potentiometric conditions in September 2017 and the existing well locations are shown on Figure 3.

Thus, the uppermost aquifer for the ash disposal cells consists of the Clayey Backfill, Overburden and Ennis Draw Alluvium, all of which form a single interconnected system. Currently, flow is toward the center of the site as the former mining pit resaturates. Ultimately, flow will be to the northeast toward Ennis Draw and then to the north along Ennis Draw.

3.0 MONITORING SYSTEM

The groundwater monitoring system consists of nine wells in locations capable of yielding samples representative of water quality at the point of compliance. Three of the wells are existing wells and six are new wells that will be installed within 180 days of approval of the post-closure care plan. The well locations are shown on Figure 4 and well details are presented in Table 1. The wells are completed in the overburden or backfill materials.

Prior to constructing the new wells, the operator will determine the limits of the areas used for ash disposal by survey or photogrammetric methods. These limits will be used in the institutional controls and also will define the areas for which post-closure care is required. As part of this effort, the locations and elevations of the existing wells will be re-surveyed. If the existing well or disposal area locations are significantly different than shown on Figure 4, a revised monitoring network map will be prepared and submitted to CDPHE and Weld County for review and approval.

In general, the existing monitoring wells have been designed and constructed in accordance with the State of Colorado Water Well and Pump Installation Contractors Act, Title 37-91-1, C.R.S. 1973, as amended. Well logs and completion diagrams for the existing wells are presented in Attachment IV.

As stated earlier, the new wells will be installed within 180 days of approval of the post-closure care plan. They also will be constructed in accordance with the rules and regulations developed under the Water Well and Pump Installation Contractor's Act. The wells will extend approximately ten feet below the current water level. Borings will be advanced using solid stem augers and samples of the subsurface materials will be collected at least every five feet by driving a split-spoon sampler following the standard penetration test procedure. The samples will be visually classified in the field by a qualified hydrogeologist using the Unified Soil Classification System. These classifications will be noted on a log as drilling progresses. In addition, the samples will be carefully inspected for and notes will be kept on the log regarding material strength and consistency, grain size, moisture content, color, degree of fracturing and weathering, fracture orientation, staining, mineralogy of the sample and any fracture/vug fillings, and depositional features.

The wells will be constructed in boreholes of at least 4 inch diameter and will be cased with

2 inch diameter flush-jointed polyvinyl chloride (PVC) casing. The bottom portion of the casing string will consist of 10 feet of machine slotted pipe (0.010 inch slots) and the upper portion will consist of solid pipe. The bottom of the casing will be capped with a perforated slip-on cap and approximately 2.5 feet of the solid pipe will extend above ground. The annulus between the casing and borehole wall will be packed with 10-20 silica sand from total depth to 1 foot above the slotted interval. A 2 foot thick hydrated bentonite seal will be placed above the sand pack. The interval above the bentonite seal will be backfilled with additional bentonite or with cement grout. A locking steel surface casing will be placed over the PVC casing and a concrete pad will be poured at the surface to hold it in place. A generalized completion diagram is provided as Figure 5. The as-built construction details of the new wells will be documented in a report that will be placed in the operating record and submitted to CDPHE and Weld County.

4.0 FIELD METHODS

4.1 WELL INSPECTION

The condition of the wells will be inspected each time a water sample is collected and will be documented on a field data sheet or in a field book. The inspection will consist of an evaluation of the following.

- Is the well number clearly labeled on outer casing or lid?
- Is protective casing intact and not bent or excessively corroded?
- Is inner casing intact?
- Is inner casing properly capped?
- Is there any evidence to suggest unauthorized access to the well has occurred?

Any damage or degradation will be repaired, if possible. If the well cannot be repaired and the integrity of samples or water level measurements may be impaired, the well will be decommissioned and replaced following the rules and regulations of the Colorado State Engineer.

4.2 WATER LEVEL MEASUREMENTS

The depth to water will be measured in all of the wells in the monitoring network prior to initiation of sampling activities. The water level measurements will be made with an electronic depth-indicating meter. The electronic depth-indicating meter is used by lowering the probe into the well until the meter indicates that water has been contacted by the probe. The probe is then raised above the water level and slowly lowered again until water is indicated. The cable is held against the side of the inner casing at the point designated for water level measurements (north side) and a depth reading recorded to the nearest 0.01 feet. The electronic depth measurement probe is rinsed with distilled water before and after use in each well.

4.3 WELL PURGING

All monitoring wells will be adequately purged such that the sample collected is representative of subsurface conditions at the well location. Purging may be accomplished using bailers (disposable or dedicated) or pumps (dedicated or non-dedicated). If the same non-dedicated purging and sampling equipment is used in more than one well, it must be thoroughly decontaminated between uses and an equipment blank must be collected (see discussion of quality control samples later in this plan). Sampling personnel must wear new powderless vinyl gloves while purging each well.

In general, three wellbore storage volumes will be purged prior to sample collection. The wellbore storage volume (volume of water standing in the well) will be calculated using the measured depth to water, the known well depth and the well diameter. Purge volume calculation factors based on well diameters are presented in Table 2. Well depth data from the well completion records are generally sufficiently precise for calculating purge volumes. If a well purges dry prior to producing three wellbore storage volumes, the well will be sampled as soon as practical and no later than 24 hours after being purged dry.

Purge water will be disposed of on the ground surface near the well from which it came. Collection, containerization, and treatment of purge water will only be required if the purge water is known to contain high concentrations of contaminants and the discharge of purge water to the ground surface would cause contamination of previously uncontaminated soils or groundwater.

4.4 FIELD PARAMETER MEASUREMENTS

During purging and immediately prior to filling the sample bottles, temperature, pH and specific conductance will be measured using appropriate field meters. Both the specific conductance and pH probes are calibrated immediately prior to making the field parameter measurements. All probes are rinsed with distilled water before and after making the measurements. Measurements are to be made after purging each wellbore volume.

4.5 SAMPLE COLLECTION

The actual samples are to be produced from the wells with the same device used for purging. If pumped during purging, the flow from the pump can be reduced to a rate convenient for filling the sample bottles. Sampling personnel must wear new powderless vinyl gloves while sampling each well. The sample is bottled at the wellhead directly from the pump discharge tubing or the bailer. The sample bottles should be labelled and placed in insulated coolers containing ice essentially immediately after they are filled.

The portion of the sample for dissolved metals analysis will be filtered in the field or at the laboratory. If filtered in the field, the sample will be placed in a polyethylene beaker and pumped from the beaker through a 0.45 micron in-line disposable filter (Voss Single-Sample, or equal) using medical grade silicon tubing and a peristaltic pump. A new length of tubing and a new filter will be used for each sample. Alternatively, the filter may be attached directly to the pump discharge tube, if a pump is used for sample collection. Approximately 50 to 100 ml of sample will be flushed through the system and discarded prior to filling the sample bottles. The dissolved metals sample bottles will be filled directly from the discharge end of the filter.

4.6 FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Quality assurance/quality control (QA/QC) samples will be collected so that bias from laboratory procedures, sampling, and transport activities can be evaluated. Trip blanks, equipment blanks and field duplicates will be prepared and analyzed as described below to provide a quantitative basis for validating the analytical data.

Trip Blanks - A trip blank consisting of an analyte-free water sample prepared by the laboratory will accompany the sample container shipment from the laboratory to the field and back. Trip blanks will be analyzed only for volatile organic compounds. Trip blanks will be collected at a rate of one per monitoring event that samples are collected for volatile organic analyses.

Equipment Blanks - Equipment blanks will consist of analyte-free water (commercially available distilled or deionized water) that is poured over precleaned non-dedicated sampling equipment (excluding disposable bailers). One equipment blank will be collected each monitoring event that an item of non-dedicated equipment is used to purge or

sample more than one well.

Field Duplicates - Field duplicates will consist of an extra full sample collected from one of the monitoring wells. The sample will be submitted to the laboratory and analyzed as any other sample. The sample will not be identified as a duplicate; thus, it will be a blind duplicate. Field duplicates will be collected and analyzed as needed to address quality control concerns.

4.7 SAMPLE PRESERVATION & SHIPMENT

4.7.1 Containers & Preservatives

The sample containers and associated preservatives will be selected following applicable EPA and state guidance. The containers and preservatives are normally, but not always, supplied by the laboratory. The sample containers will be organized and inventoried several days prior to initiation of sampling in order to provide sufficient time to rectify any problems, should they occur.

4.7.2 Labels

Pre-printed sample labels will be placed on all sample containers for the primary purpose of sample identification. Field data need not be recorded on the labels because they will be recorded on field data sheets. The sample labels will contain the following information.

- Sample or location identification number (i.e., well name or other sample number)
- Analysis to be performed
- Preservative (as appropriate)
- Date and time of sample collection
- Initials of sampler

4.7.3 Shipment/Delivery

All samples will be promptly shipped or delivered to the analytical laboratory. The samples will be properly packaged in order to protect the sample containers, to maintain the samples as nearly as possible at a temperature of 4°C, and to comply with applicable transportation regulations.

In general, the samples will be transported using packaging supplied by the analytical laboratory. The packaging normally includes a shippable insulated box (e.g., an ice cooler) and contains protective internal packaging material such as foam sleeves. Some laboratories use proprietary sample packaging with integral internal packaging. In either case, the temperature of the samples will be maintained by the use of ice packs or ice. The shipment of environmental samples is not regulated under 40 CFR 261.40(d); therefore, no special shipping procedures are required. However, sample containers will be properly packed such that inadvertent spillage does not occur during shipment.

4.8 CHAIN-OF-CUSTODY

Chain-of-custody procedures will be used to track the sample from the time of collection until it and its derived data are used. A sample is considered "in custody" under the following conditions.

- It is in personal possession.
- It is in personal view after being in personal possession.
- It was in personal possession when it was properly secured.
- It is in a designated secure area.

A chain-of-custody form will be completed before the sample containers leave the site at which they were filled. Field personnel will complete all applicable sections of the form. The chain-of-custody forms will be placed in the shipping containers and accompany the containers during transport to the laboratory. Field personnel collecting the samples will be responsible for sample custody until the samples are relinquished to the laboratory or a common carrier. Sample transfer requires the individuals relinquishing and receiving the samples to sign and note the date and time of transfer on the chain-of-custody forms. Common carriers (e.g., Federal Express) are not expected to sign the chain-of-custody form; however, the bill of lading or airbill becomes part of the chain-of-custody record. The chain-of-custody is considered complete after the sample has been received and signed in at the analytical laboratory. A copy of the chain-of-custody record will be retained by field personnel along with other field records.

4.9 RECORDKEEPING

Field records that are both technically and legally defensible will be maintained for all aspects of groundwater sampling. These records include sample identification labels, chain-of-custody information, and technical field data. Sample labels and chain-of-custody records have already been discussed. Records of technical field data will be kept on preprinted groundwater sampling field data sheets. Preprinted forms will be used because of the prompting provided, the ease of use, and the consistent format. The field sampling records will include the following information.

- Sampling location
- Date and time
- Condition of the well
- Static water level (depth to water)
- Depth to the bottom of the well
- Calculated well volume
- Purging method
- Actual purged volume
- Sample collection method
- Sample description
- Field meter calibration data (as appropriate)
- General comments (weather conditions, etc.)

Data entries will be made using black indelible ink and will be written legibly. Entry errors will be crossed out with a single line, dated, and initialed by the person making the correction.

5.0 SCHEDULES & ANALYTES

5.1 ROUTINE MONITORING SCHEDULE

5.1.1 Water Levels

Water levels will be measured in the post-closure monitoring network on a quarterly basis. These data will be used to prepare quarterly potentiometric surface maps that will be included in the annual groundwater monitoring report.

5.1.2 Water Quality

Groundwater samples will be collected from the monitoring wells on a semi-annual basis. The analytical results will be statistically evaluated within 30 days of receiving the laboratory report. Monitoring of the new wells described in this plan will commence in the calendar quarter following their construction. Semi-annual monitoring will continue for the duration of the post-closure care period.

If verification resampling is undertaken as described in Section 6.3.2 of this plan, the first verification resample must be collected within 180 days of the date of the laboratory report containing the apparent exceedance result.

5.2 ANALYTES

The analytical program was developed by the Colorado Department of Public Health & Environment (CDPHE). The routine analyte list (detection monitoring) is presented on Table 3. If statistically significant increases are evidenced in the data, analysis for a larger list of compounds (assessment monitoring) may be required. The assessment monitoring analytes are listed on Table 4. Analytical methods will be as specified in EPA SW-846 or other appropriate sources. As allowed under the regulations, a petition may be made in the future to reduce the routine analyte list.

5.3 RESPONSE TO SIGNIFICANT CHANGES

If a statistically significant increase over background is indicated using the methodology specified in Section 6.3 of this plan, the operator will do the following.

- Within 14 days of confirming a statistically significant increase based on resample results, documentation will be placed in the operating record indicating which constituents have shown statistically significant changes from background levels and the documentation will be forwarded to CDPHE and Weld County.

- Within 90 days of confirming a statistically significant increase based on resample results and if appropriate, a demonstration will be prepared showing that a source other than the solid waste disposal site and facility caused the contamination, that the statistically significant increase resulted from an error in sampling, analysis, or statistical evaluation, or that the statistically significant increase resulted from natural variation in groundwater quality. The demonstration must be certified by a qualified groundwater scientist, placed in the operating record, and approved by CDPHE and Weld County.

If a successful demonstration is made and documented, detection monitoring will continue. If a successful demonstration is not made within 90 days, an assessment monitoring program will be initiated in accordance with the regulations.

6.0 DATA EVALUATION

6.1 GROUNDWATER FLOW DIRECTION & RATE

The direction and rate of groundwater flow will be evaluated quarterly. The direction of flow will be based on a potentiometric map prepared for the uppermost aquifer. The map will be constructed by plotting the groundwater elevation at each well and drawing lines representing equal groundwater elevations (potentiometric contour lines) based on the groundwater elevation data. Arrows may be drawn perpendicular to the potentiometric contour lines to indicate the general direction of groundwater flow.

The rate of groundwater flow will be calculated using the seepage velocity equation (Equation 6-1).

$$V_s = (2830 \times K)i/n_e \qquad (6\text{-}1)$$

Where:

V_s	=	groundwater seepage velocity (ft/day)
K	=	hydraulic conductivity (cm/s)
i	=	hydraulic gradient (dimensionless)
n_e	=	effective porosity (dimensionless)
2830	=	unit conversion factor (s-ft/cm-day)

Hydraulic conductivity values are presented earlier in this plan ($3x10^{-5}$ cm/s for both the overburden and the backfill). A value of 0.1 will be assumed for the effective porosity. This is at the lower end of typical total porosities (0.1 to 0.3) and predicts faster travel times.

The hydraulic gradient will be estimated from the potentiometric map. This will be accomplished by measuring the distance (on the potentiometric map) between one or more potentiometric contour lines. The change in head is the difference in elevation between the two potentiometric contour lines used in the distance determination. The

hydraulic gradient will be calculated using Equation 6-2.

$$i = d_h/d_L \quad (6\text{-}2)$$

Where: i = hydraulic gradient (dimensionless)
d_h = change in head (feet)
d_L = horizontal distance (feet)

If the gradient is relatively uniform, a typical gradient will be calculated. If the hydraulic gradient varies significantly across the site, a range of hydraulic gradients and seepage velocities may be calculated.

6.2 DATA MANAGEMENT

The groundwater data will be maintained in both hard-copy and in a commercially available computer data management system. The data management system will allow flexibility in data presentation, including the production of tabular and graphical data reports, and make the data readily accessible for investigating trends and general evaluation. The data management system will also offer several data reporting options. Standard outputs will include tabulated data summaries, line graphs, and appropriate file output for use in statistical, contouring and graphics software packages.

6.3 STATISTICS

6.3.1 Methods & Analytes

The groundwater monitoring data will be statistically evaluated using interwell prediction limits. The Sanitas Technologies statistical software package with the default unified guidance settings will be used for this purpose. The background pool will be updated annually. As directed by CDPHE, the analytes listed on Table 5 will be statistically evaluated. Other statistical methods may be proposed by the operator when the nature of the post-closure monitoring data becomes clear. In addition, the operator may propose a shortened analyte list for statistical evaluation limited to analytes likely to be derived from the ash.

6.3.2 Verification Sampling

At least one verification sample is required to maintain the false positive rate at an acceptable level. The verification resampling program is as follows. If an analytical result is found to be statistically significant, it will be considered an apparent statistical exceedance pending the results of a verification resample to be collected during the next regularly scheduled monitoring event, or within 180 days of the date on the analytical report that identified the requirement for verification sampling, whichever comes first. The facility will be considered in compliance if the original result is not confirmed by the verification resample (i.e., the resample result is less than the statistical limit). However, if the verification resample confirms the apparent exceedance, a final verification resample will be collected immediately for the analyte in question (within 7 days of completing the statistical evaluation). If this final verification resample does not confirm the two prior results, the facility will be considered in compliance and detection monitoring will continue. This "pass one of two resamples" approach is one of the preferred methods described in Section 5.1.3.4 of ASTM (2005). If the final verification resample confirms the apparent exceedance, the procedure specified in Section 5.3 of this plan will be implemented.

Results will not be rejected on the basis of verification resampling. Instead, non-verified exceedances will be included in the background pool annually, unless the result is shown to be a laboratory, field or other error. Results that are errors will be R-qualified to remove them from future statistical evaluations. A table will be maintained identifying all rejected results and the table will be included in the annual monitoring report.

7.0 REPORTING

7.1 WASTE LIMITS

As discussed in Section 3.0 of this plan, the operator will determine the limits of the areas used for ash disposal by survey or photogrammetric methods. These limits will be provided to CDPHE and Weld County within sixty days of approval of the post-closure care plan. If the existing well or disposal area locations are significantly different than shown on Figure 4, a revised monitoring network map will be prepared and submitted within ninety days of post-closure care plan approval for review and approval by CDPHE and Weld County.

7.2 NEW WELL INSTALLATION

Any new groundwater monitoring well required for any area under CDPHE's regulatory authority will be installed within one-hundred eighty (180) days of the approval of this Post-Closure Plan.

Well installation may be delayed if installation would impact the grading or seeding operations. The CDPHE will be notified in writing of any delay or variance to any well installations. If the well installation is delayed, well installation will occur within sixty (60) days after grading and seeding operations are completed, weather permitting. All wells for both Pits A and B will be installed at the same time.

The as-built construction details of the new wells described in Section 3.0 of this plan will be documented in a report that will be placed in the operating record and submitted to CDPHE and Weld County. This report will be submitted within ninety days of completing the well construction project.

7.3 WATER LEVEL MONITORING

As discussed in Section 5.1.1 of this plan, water levels will be measured on a quarterly basis. A figure showing the potentiometric surface will be prepared for each dataset. The four quarterly potentiometric surface maps will be included in the annual groundwater monitoring report described below. The maps will not be reported separately.

7.4 WATER QUALITY MONITORING

During the post-closure care period, an annual report will be submitted to CDPHE and Weld County by March 31 discussing groundwater monitoring completed in the preceding calendar year. The report will document field procedures, statistical evaluations, the system inspection and any maintenance performed. The laboratory reports and field sheets will be attached to the report for documentation purposes. The report will include the four quarterly potentiometric surface maps and a table of all rejected values in the database.

7.5 STATISTICAL EXCEEDANCES

Within 14 days of confirming a statistically significant increase based on resample results, documentation will be placed in the operating record indicating which constituents have shown statistically significant changes from background levels and the documentation will be forwarded to CDPHE and Weld County.

Within 90 days of confirming a statistically significant increase based on resample results and if appropriate, a demonstration will be prepared showing that a source other than the solid waste disposal site and facility caused the contamination, that the statistically significant increase resulted from an error in sampling, analysis, or statistical evaluation, or that the statistically significant increase resulted from natural variation in groundwater quality. The demonstration will be submitted to CDPHE and Weld County for review and approval.

8.0 CERTIFICATION

This certifies that, in my opinion, the number, spacing and depths of the wells in the groundwater monitoring system described in this plan are adequate to yield groundwater samples from the uppermost aquifer that:

1. represent the quality of background groundwater that has not been affected by leakage from a solid waste unit, and

2. represent the quality of groundwater passing the relevant point of compliance (as identified in the plan).

I am qualified to make this certification by virtue of undergraduate and graduate level education in geological engineering, groundwater hydrology, and geotechnical engineering, as well as more than twenty-five years of work experience in these fields.

Benjamin P. Doty, P.E.
Name

19649 Colorado
Registration No. State

9.0 REFERENCES

ASTM, 2005, Standard Guide for Developing Appropriate Statistical Approaches for Ground-Water Detection Monitoring Programs, ASTM Designation D 6312-98 (reapproved 2005).

IC, 1992, Design and Operations Plan for the East Weld Sanitary Landfill, Weld County, Colorado, prepared for Waste Services Company, Industrial Compliance Project Number 2-3716, February 7, revised December 10.

McWhorter, D.B., and N. Ortiz, 1978, Water Resources and Impact Evaluation for a Proposed Mining Site, Weld County, Colorado, submitted to Adolph Coors Company, Agricultural and Chemical Engineering Department, Colorado State University, November.

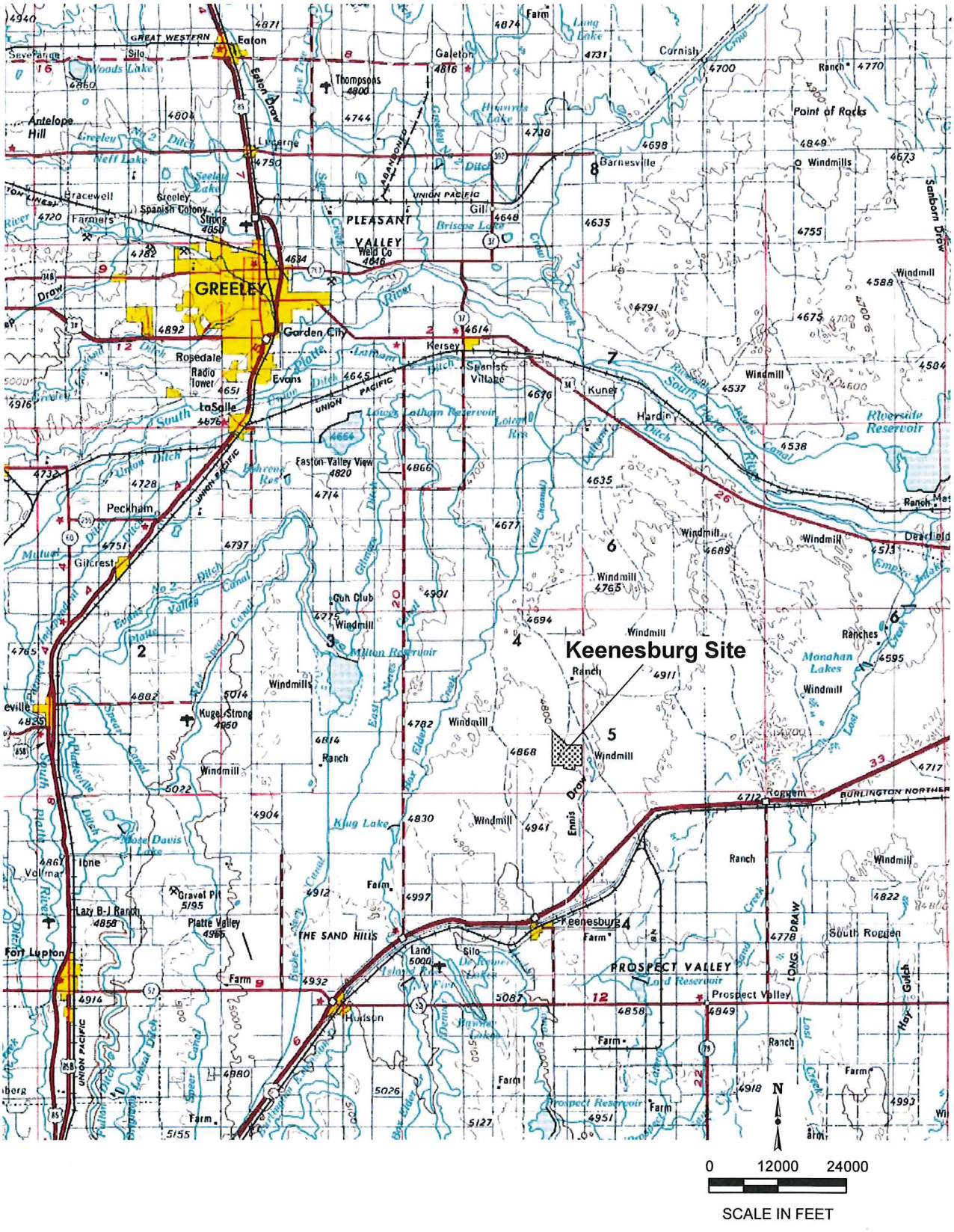
ATTACHMENT I

FIGURES

Figure 1. Regional Location

FIGURE 1

REGIONAL LOCATION

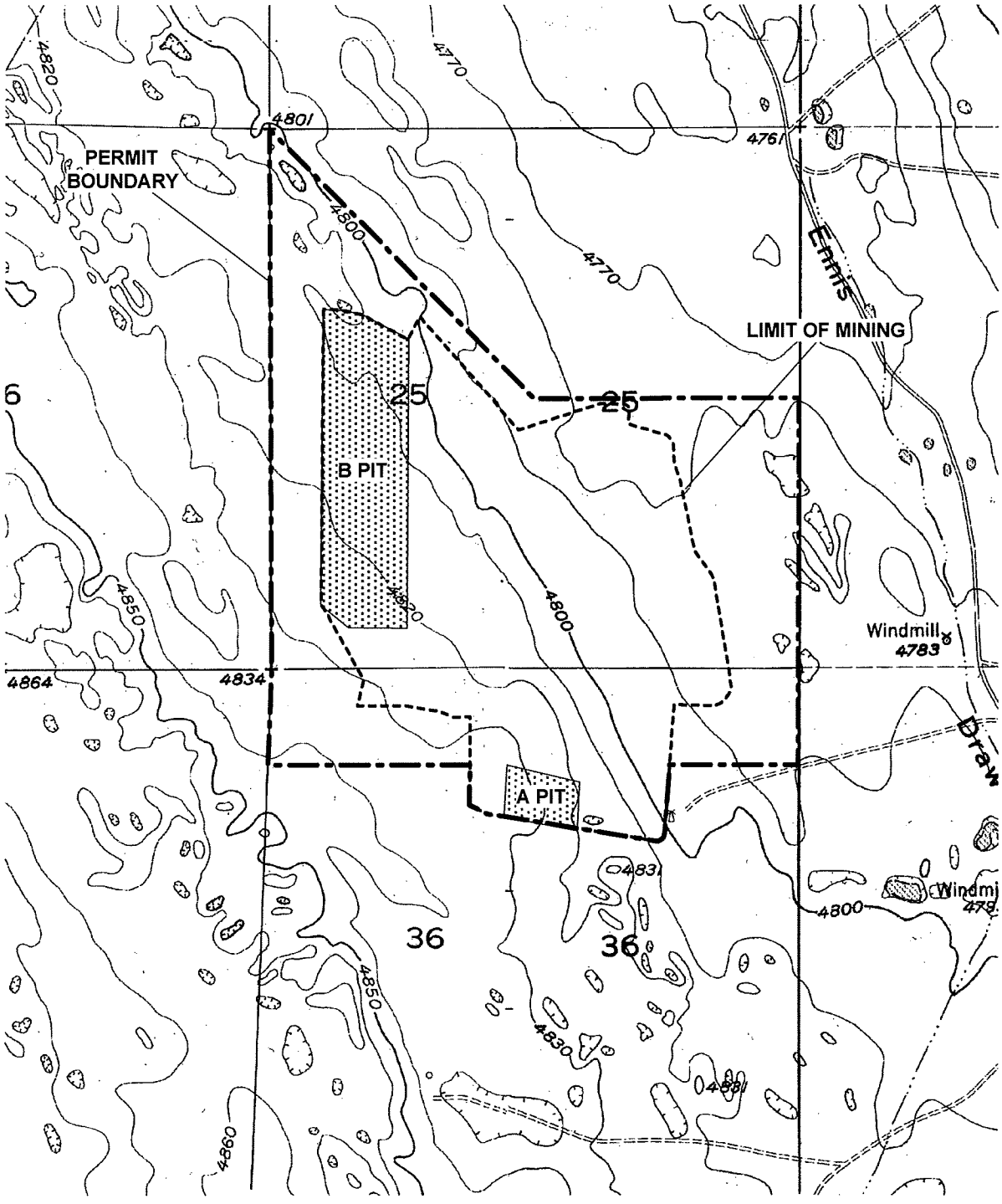


DOTY & ASSOCIATES, LLC | 302-15 | 01/24/2018

Figure 2. Detailed Location

FIGURE 2

DETAILED LOCATION



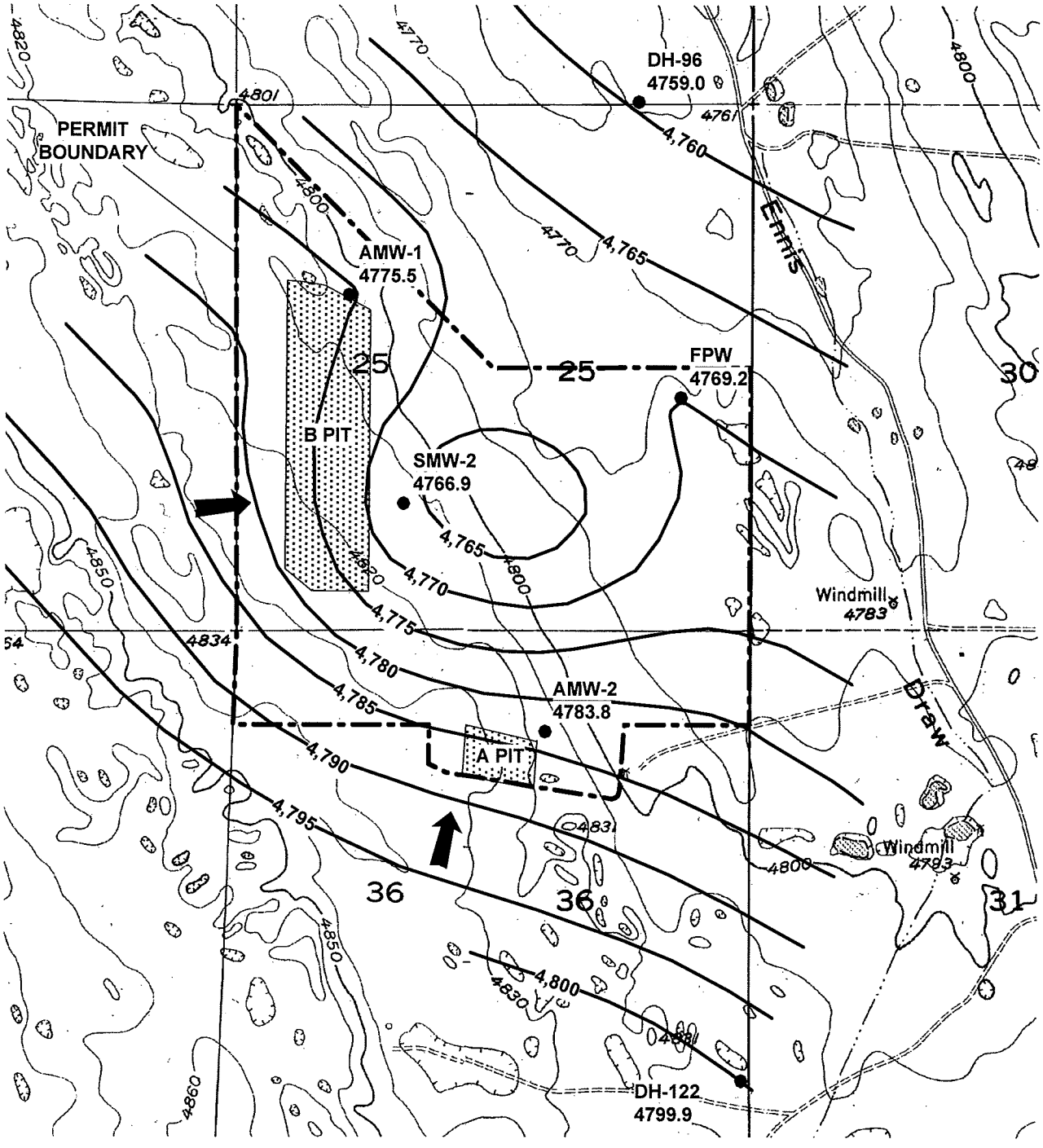
A and B Pits are ash disposal areas.

DOTY & ASSOCIATES, LLC | 302-15 | 01/24/2018

Figure 3. Potentiometric Surface

FIGURE 3

POTENTIOMETRIC SURFACE

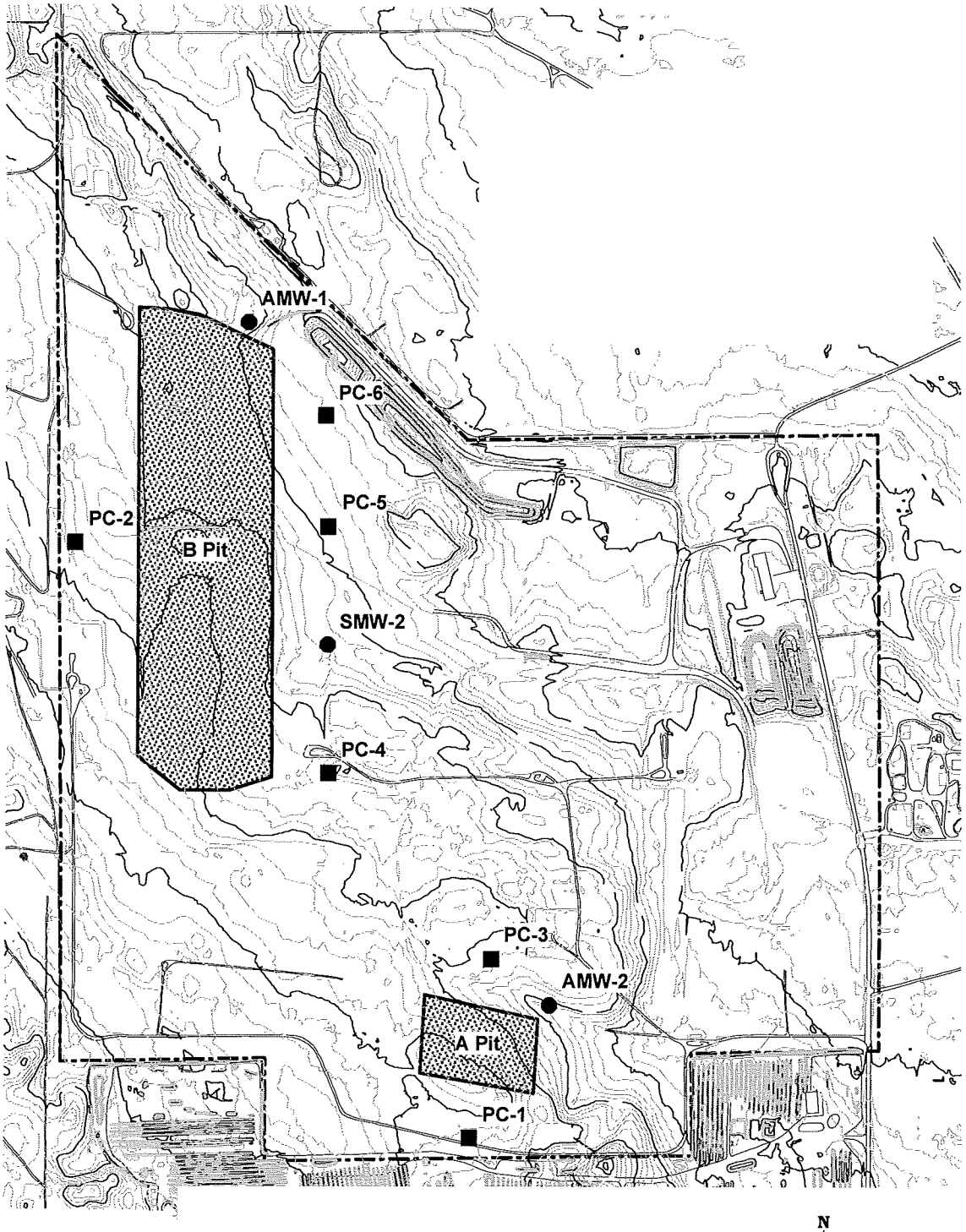


DOTY & ASSOCIATES, LLC | 302-17 | 01/24/2018

Figure 4. Groundwater Monitoring System

FIGURE 4

GROUNDWATER MONITORING SYSTEM

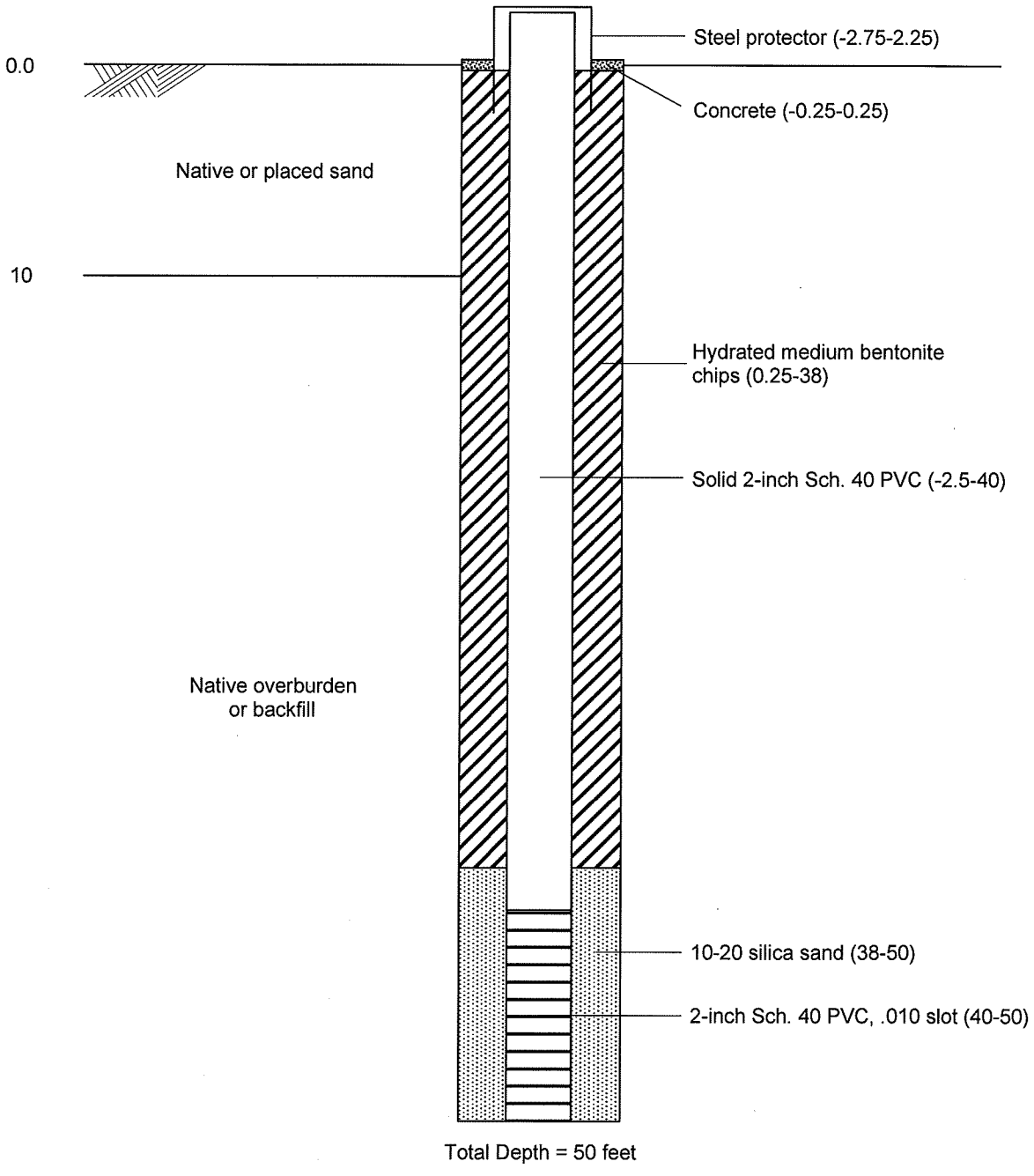


DOTY & ASSOCIATES, LLC | 302-15 | 01/26/2018

Figure 5. Generalized Completion Diagram

FIGURE 5

GENERALIZED COMPLETION DIAGRAM



All depths are in feet and reference ground surface
Depths shown are for illustration purposes only

DOTY & ASSOCIATES, LLC | 302-15 | 01/26/2018

ATTACHMENT II

TABLES

Table 1. Groundwater Monitoring System

Well	Approx-imate Ground Eleva-tion (feet)	Refer-ence Eleva-tion (feet)	Total Depth (feet)	Depth to Water (feet)	Casing Diameter (inches)	Casing Type	Completion Material
AMW-1	4801	4804	61	27	4.5	PVC	Overburden
AMW-2	4809	4811	51	26	6	PVC	Backfill
SMW-2	4801	4803	97	34	6	PVC	Backfill
PC-1	4827	-	49	39	2	PVC	Overburden
PC-2	4817	-	47	37	2	PVC	Overburden
PC-3	4818	-	51	41	2	PVC	Backfill
PC-4	4813	-	54	44	2	PVC	Backfill
PC-5	4799	-	39	29	2	PVC	Backfill
PC-6	4794	-	27	17	2	PVC	Backfill

Notes:

Total Depth and Depth to Water reference ground surface.

AMW-1, AMW-2 and SMW-2 are existing wells.

The PC-series wells are proposed.

Table 2. Purge Volume Calculation Factors

Casing Diameter (inches)	Wellbore Storage Volume (gallons per foot)
1	0.041
1.25	0.064
2	0.16
3	0.37
4	0.65
4.5	0.83
5	1.0
6	1.5
8.625	3.0

Table 3. Detection Monitoring Analytes

Analyte
temperature (field)
pH (field)
specific conductance (field)
total dissolved solids
hardness (as CaC03)
sodium adsorption ratio
calcium, dissolved
magnesium, dissolved
sodium, dissolved
potassium, dissolved
chloride
sulfate
carbonate
bicarbonate
fluoride
antimony, dissolved
arsenic, dissolved
barium, dissolved
boron, dissolved
cadmium, dissolved
iron, dissolved
lead, dissolved
manganese, dissolved
molybdenum, dissolved
selenium, dissolved

Table 4. Assessment Monitoring Analytes

Analyte	
temperature (field)	antimony, dissolved
pH (field)	arsenic, dissolved
sp. conductance (field)	barium, dissolved
total dissolved solids	beryllium, dissolved
calcium, dissolved	boron, dissolved
magnesium, dissolved	cadmium, dissolved
sodium, dissolved	chromium, dissolved
potassium, dissolved	cobalt, dissolved
chloride	iron, dissolved
sulfate	lead, dissolved
carbonate	lithium, dissolved
bicarbonate	manganese, dissolved
total alkalinity	mercury, dissolved
hydroxide alkalinity	molybdenum, dissolved
fluoride	selenium, dissolved
	silver, dissolved
	thallium, dissolved
	radium 226/228

Table 5. Statistical Evaluation Analytes

Analytes
Calcium, dissolved
Magnesium, dissolved
Sodium, dissolved
Potassium, dissolved
Chloride
Sulfate
Carbonate
Bicarbonate
Fluoride
Arsenic, dissolved
Barium, dissolved
Boron, dissolved
Cadmium, dissolved
Iron, dissolved
Lead, dissolved
Manganese, dissolved
Molybdenum, dissolved
Selenium, dissolved

ATTACHMENT III

EXAMPLE FIELD FORMS

COORS ENERGY COMPANY

Sheet ____ of ____

WATER LEVEL FIELD SHEET

Date: _____ Location: _____

Instrument: _____ (make & model)

Measurement Point: _____ Job No.: _____

Weather: _____

Well	Time	Depth to Water (feet)	Comments

Other Instrument : _____ (make & model)

Other Instrument : _____ (make & model)

_____ _____

Name Signature

FIELD WATER QUALITY SHEET

COORS ENERGY COMPANY

Well No.:	Weather:
Date:	Well Depth (ft):
Project No.:	Depth to Water (ft):
Site: Keenesburg	Casing Volume (gals):

Condition of Well : (describe any problems w/ surface casing, caps or other items)

Purge Method:

Time	Temperature (oC)	pH (s.u.)	Specific Conductance (umhos/cm)	Purge Volume (gals)	Description of Sample

Sampling Method:

Containers Filled/Analyses:

- ☐ 1 500-ml PE bottle (unpreserved), anions & indicators
- ☐ 1 500-ml PE bottle (unpreserved), lab filtered for dissolved metals
- ☐
- ☐
- ☐
- ☐

Field Instrument (make & model):

Notes:

Sampler's Signature: _____

ATTACHMENT IV

WELL LOGS & COMPLETION DIAGRAMS

DRILL HOLE LOG

CI-3770

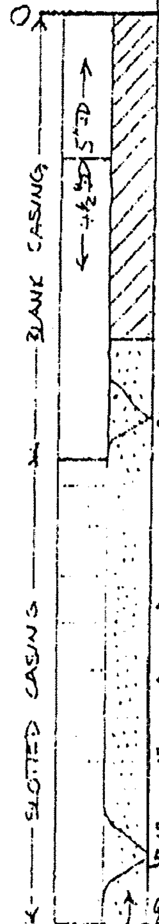
HOLE NO.	TOTAL DEPTH (FT.)	COMPLETION DATE
AMW-1	61	9-24-87

DRILLED BY	LOGGED BY
CHRISTEN	TROUSIL

COORDINATES:	NORTH	EAST	COLLAR ELEVATION	GROUND ELEVATION
	34640	37550	4804	4801

SAMPLED: ☐ YES ☒ NO

CORE HOLE DIA.: 7 7/8"



ELEV.	DEPTH	DESCRIPTION
	0–15	sand, med-coarse grained, eolian, mod well sorted, angular to sub rounded, brown, poorly cemented.
	15–17	sand, fine grained, gray, silty.
	17–38	clay, gray w/ yellow clay clasts (brown-orange clay 33-36')
	38–61	clay, gray, w/ brown clays upper zone, firm w/ carbonaceous shale (interbeds)
	61	TD = 61'

Depth marks: 5, 10, 15, 17, 20, 23, 25, 28, 30, 35, 40, 45, 50, 55, 58, 60, 61, 65, 70, 75, 80; 85, 90, 95, 100, 105, 110, 115, 120, 125, 130, 135, 140, 145, 150, 155, 160

ELEV.	DEPTH	DESCRIPTION

COAL CORE DESCRIPTION

1 2 3 4 5 6 7 8 9 10 11 12

COMMENTS

CORE RECOVERY

COMMENTS
- Casing extends 3.5' above ground surface.
- slotted casing 32/1000", 4½ ID
- blank casing 4½" ID
- centralizers 1 @ 28' & 58'
- cement grout 0-23'

Industrial Compliance Inc.

JOB NAME Coors Energy WELL NUMBER AMW-2

JOB NUMBER 06104270 INSTALLATION DATE 4-26-93 LOCATION Keenesburg, Colorado

DATUM FOR WATER LEVEL MEASUREMENT ground surface

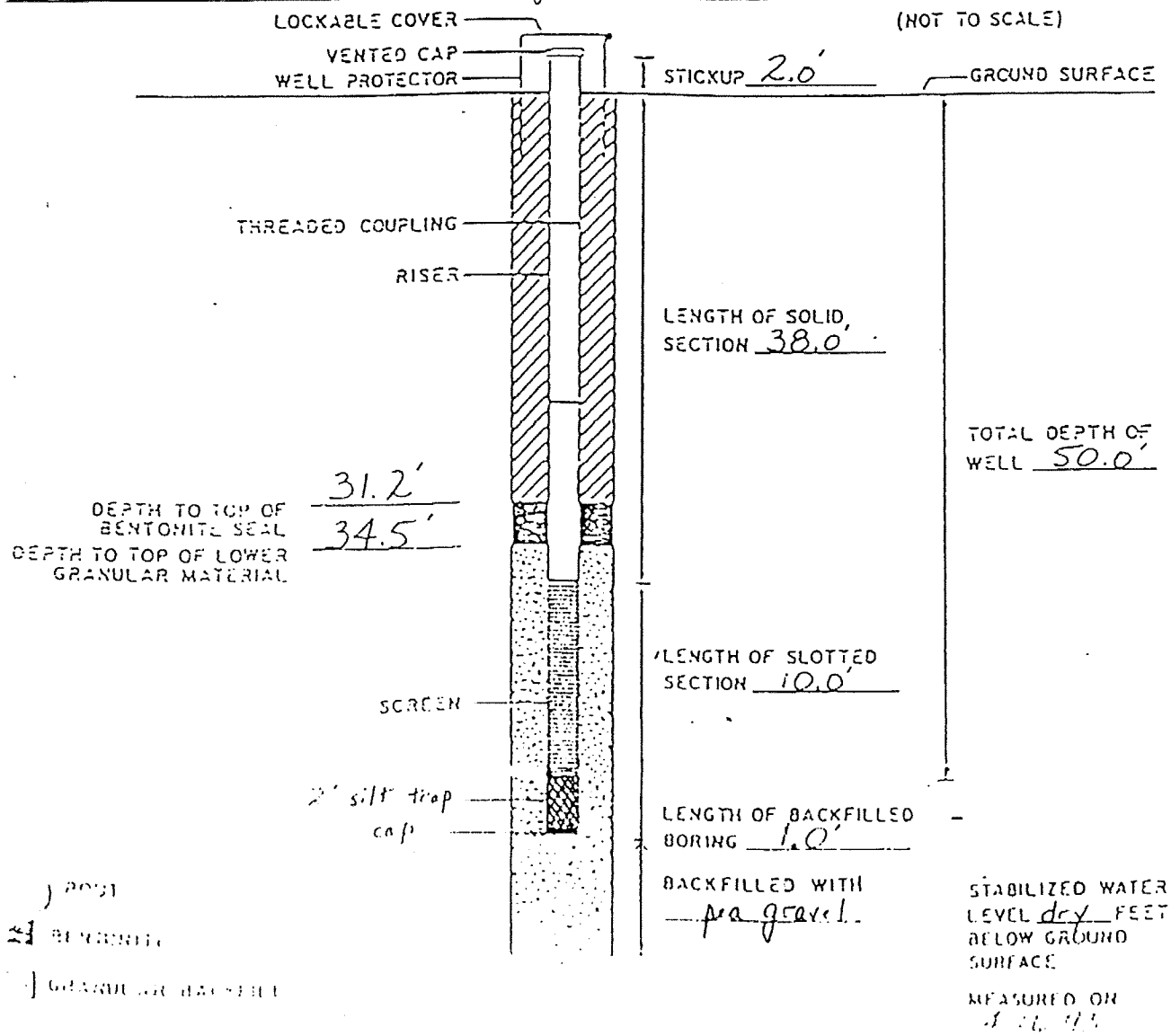
DATUM ELEVATION _____ GROUND SURFACE ELEVATION _____

SCREEN DIAMETER AND MATERIAL 6" PVC SLOT SIZE 0.032

RISER DIAMETER AND MATERIAL 6" PVC BOREHOLE DIAMETER 13.6"

GRANULAR BACKFILL MATERIAL pea gravel REPRESENTATIVE Unger

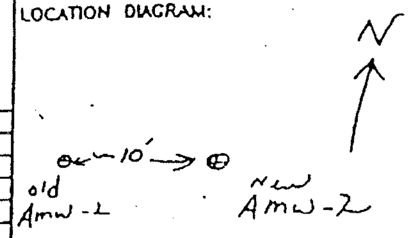
DRILLING TECHNIQUE Hollow Stem Auger DRILLING CONTRACTOR Layne



INDUSTRIAL COMPLIANCE
AN SP ENVIRONMENTAL SYSTEMS COMPANY
1746 COLE BLVD.
BLDG. 21 SUITE 300
GOLDEN, COLORADO 80401
(303)277-1400
FAX (303)277-1405

LOG OF BORING NUMBER: AMW-2
SHEET NUMBER: 1 OF 3

LOCATION DIAGRAM:



CLIENT: Coors Energy
PROJECT NAME: AMW-2 replacement
PROJECT NUMBER: 06104270
PROJECT LOCATION: Keenesburg Coors Energy Facility
BORING LOCATION:

DRILLING METHOD: 10¼" I.D. H.S. augers
SAMPLING METHOD: 3" split spoon (SS)
SURFACE ELEVATION:
WATER LEVEL: dry
TIME: 1:30
DATE: 4-26-93

START DATE: 4-23-93 FINISH DATE: 4-26-93
START TIME: 11:00 FINISH TIME: 3:30

SAMPLER TYPE	SAMPLE NO. & DEPTH	OVA READING	SPT	DEPTH IN FEET	SOIL GRAPH	SOIL DESCRIPTION AND DRILLING CONDITIONS
				1	SP/SW	sand, v.f.-c - m.g., silty, clayey, brown, sl. moist to moist, Bennett, mining spoils
				2		
				3		
				4		
				5		
				6		
				7	CL	Clay, silty, sandy, brown, med. moist, [illegible], mining spoils
				8		
				9		
				10	CL/SW	clay and sand lenses, interbedded, med. moist, v.f.-c.-m.g., brown to gray (clay/[illegible] formation), some [illegible] crystals
SS			14/12	11		
				12		
				13		
				14		
				15		
				16		
				17		
				18		
				19		
				20		

LOGGED BY: [illegible]
CHECKED BY:
DRILLING CONTRACTOR: Layne
DATE: 4-23-93

INDUSTRIAL COMPLIANCE
AN SP ENVIRONMENTAL SYSTEMS COMPANY
1746 COLE BLVD.
BLDG. 21 SUITE 300
GOLDEN, COLORADO 80401
(303)277-1400
FAX (303)277-1405

LOG OF BORING NUMBER: AMW-2
SHEET NUMBER: 2 OF 3

WATER LEVEL:			
TIME:			
DATE:			

SAMPLER TYPE	SAMPLE NO. & DEPTH	OVA READING	SPT	DEPTH IN FEET	GRAPH	SOIL DESCRIPTION AND DRILLING CONDITIONS
SS			9/12	21	CL	clay, silty, sli. sandy to sandy, l. brown to dk. gray, md. moist, clay stone fragments, some lignite/coal fragments, mining spoils,
				22		
				23		
				24		
				25		
				26		
				27		
				28		
				29		
				30	CL/SW	interbedded clay & sand lenses, brown to dk. gray, md. moist, mining spoils
			11/12	31		
				32		
				33		
				34		
				35		
				36		
				37		
				38		
				39		
				40	CL/SW	interbedded clay & sand lenses, some clay mining spoils
			21/12	41		
				42		
				43		

LOGGED BY [illegible]
DRILLING CONTRACTOR [illegible]
DATE 4/23/91

INDUSTRIAL COMPLIANCE
AN SP ENVIRONMENTAL SYSTEMS COMPANY
1746 COLE BLVD.
BLDG. 21 SUITE 300
GOLDEN, COLORADO 80401
(303)277-1400
FAX (303)277-1405

LOG OF BORING NUMBER: Amw-2
SHEET NUMBER: 3 OF 3

WATER LEVEL: dry
TIME: 1:00
DATE: 4-26-93

SAMPLER TYPE	SAMPLE NO. & DEPTH	OVA READING	SPT	DEPTH IN FEET	GRAPH	SOIL DESCRIPTION AND DRILLING CONDITIONS
				44	CL/SW	interbedded clay and sand lenses, brown to gray, med. moist, mining spoils
				45		
				46		
				47		4-23-93
				48		rig down @ 48' 12:00
				49		
				50		no drive at 50' - mining spoils
				51		51' T.D.
				52		
				53		
				54		cement grout: 0 - 31.2
						bentonite: 31.2 - 34.5
				55		pea gravel pack: 34.5' - 50.5'
						6" PVC sch 40 solid: 0 - 38
						screen: 38 - 48
						trap: 48 - 50
						2' stickup
						35 bags (100 lbs) cement
						1 bag bentonite

GEOLOGIST: [illegible]
CHECKED BY:
DRILLING CONTRACTOR: [illegible]
DATE: 4-23-93 / 4-26-93
[illegible]

WELL CONSTRUCTION DIAGRAM FOR SPOIL MONITORING WELL NO. 2 (SMW-2)
COORS ENERGY COMPANY, KEENESBURG MINE.
LOCATION: 32463.17N - 38234.10E ELEV 4804.06