

Appendix A

7003 Order (amended December 27, 2000)



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 8
999 18TH STREET - SUITE 300
DENVER, CO 80202-2466
<http://www.epa.gov/region08>

DEC 27 2000

Ref: 8ENF-L

Ken Kastner
Bryan Cave LLP
700 Thirteenth Street, NW
Washington, DC 20005-3960

Re: In the Matter of Rhodia, Inc.
RCRA-8-2000-07

Dear Ken:

Enclosed please find an amended order in the above referenced case. This amended order merely incorporates extensions of time previously agreed to by the U.S. Environmental Protection Agency. Section VII, Paragraph F has been amended to include the new due date for the Interim Measures Work Plan (September 18, 2000). Section VII, Paragraph K has also been amended to state that the Waste Plan is now due January 31, 2001.

Please call me at 303-312-7054 if you have any questions.

Sincerely,

A handwritten signature in cursive script that reads "Lauren C. Buehler".

Lauren C. Buehler

cc: Tina Diebold
Dan Bersanti
Ken Platt



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**UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION VIII**

DEC 27 PM 2:42

Docket No. RCRA-8-2000-07

FILED
EPA REGION VIII
HEARING CLERK

IN THE MATTER OF:

Rhodia Inc.
P.O. Box 3146
Butte, MT 59702

EPA ID No. MTD 057 558 546

Respondent.

) AMENDED ADMINISTRATIVE
) ORDER

) Proceeding Under § 7003 of the
) Solid Waste Disposal Act,
) as amended, 42 U.S.C. § 6973

I. JURISDICTION

The United States Environmental Protection Agency Region VIII ("EPA"), has the authority to issue and therefore is issuing this Amended Administrative Order ("Order") pursuant to Section 7003(a) of the Solid Waste Disposal Act, as amended (the "Act"), 42 U.S.C. § 6973(a) ("Section 7003").

II. INTRODUCTION

A. Rhodia Inc. ("Respondent") is a corporation authorized to do business in Montana.

B. Respondent owns the Silver Bow facility which is located off German Gulch Road in Silver Bow County, approximately seven miles west of Butte, Montana and approximately one mile south of Ramsey, Montana

C. Respondent is a "person" within the meaning of Section 1004 (15) of the Act, 42 U.S.C. § 6903(15).

D. Respondent has handled and stored "solid waste" within the meaning of Section 1004(27) of the Act, 42 U.S.C. § 6903(27) at all times relevant to the Order.

E. Based on evidence received, EPA has determined that Respondent's handling of solid waste at the Silver Bow facility may present an imminent and substantial endangerment to health or the environment within the meaning of Section 7003 of the Act, 42 U.S.C. § 6973.

F. Pursuant to Section 7003(a) of the Act, EPA has notified the State of Montana in this matter.

G. EPA hereby takes this action pursuant to Section 7003 having determined that the issuance of this Order is necessary to protect health or the environment.

III. PARTIES BOUND

A. This Order shall apply and be binding upon Respondent, including all agents, employees, firms, corporations, contractors, and consultants acting under or on behalf of Respondent in connection with implementation of this Order.

B. Respondent shall provide a copy of all applicable portions of any plan submitted pursuant to this Order to all contractors, subcontractors, laboratories, and consultants retained to conduct or monitor any portion of the work performed under the Order within seven (7) calendar days of the date of such retention, and shall condition all such contracts on compliance with terms of this Order.

C. Respondent shall give notice to EPA thirty (30) or more days prior to transfer of ownership or operation of the Silver Bow facility.

IV. FINDINGS OF FACT

A. Respondent is a corporation doing business in the State of Montana.

B. At all times pertinent to this Order, Respondent has been duly registered with the Montana Secretary of State.

C. Elemental phosphorous was produced at the Silver Bow facility. In 1997, the Silver Bow facility was shut down for decommissioning and closure.

D. The Silver Bow facility is located in a rural area, with scattered residences within one-half to one mile. Livestock are grazed on adjacent lands. A silicon production plant and the Port of Montana are located on adjacent land. The area is heavily frequented by water fowl.

E. EPA inspected the Silver Bow facility from May 1-4, 2000 ("May 2000 Inspection"). At the time of the inspection, EPA observed a 100' diameter, open-topped, in-ground tank. This tank is known as the clarifier. Calculations indicate that the clarifier contains approximately 500,000 gallons of sludge and a "cap" of several feet of water.

F. Respondent has stated that the sludge is a phosphorous sludge and the water cap is used to prevent the sludge from contacting air.

G. EPA inspectors observed two wet areas of ground adjacent to the above-ground portion of the concrete wall of the 100' diameter tank. At one of the wet areas an inspector dug a hole into the ground and observed infiltration of liquid from the clarifier. Water leaked from the

clarifier in quantities sufficient to lower the level of the clarifier several inches during the May 2000 Inspection.

H. In the process of sampling the leaking clarifier, an inspector inadvertently spilled a small amount of phosphorous sludge on the top edge of the wall of the leaking clarifier. As the phosphorous sludge dried, it spontaneously started to smoke, then ignited, and burned persistently. The inspector doused the fire with several quarts of water. The phosphorous sludge continued to smolder and smoke. The inspector moved on to the adjacent sampling location. While sampling at the new location, the previously spilled phosphorous sludge re-ignited and burst into flame. Repeated dousing with several quarts of water was insufficient to extinguish the flames. The fire ultimately burned out. The ambient air temperature was 57 degrees Fahrenheit at the time of ignition.

I. The inspectors also placed varying quantities of phosphorous sludge, selected from different locations within the leaking clarifier, in three separate metal pans. As the material in each pan dried out, it smoked and spontaneously ignited in the same manner as the spilled sludge described above in paragraph H. The phosphorous sludge burned so persistently that it left scorch marks on the metal pans.

J. Phosphorous, when combined with water, will react to form phosphine gas. Inhalation of phosphine gas is acutely harmful, and is a severe health hazard. Exposure may cause damage to respiratory membranes, resulting in increased bronchial secretions, shortness of breath, weakness, fatigue, dizziness and fainting. Abdominal pain and vomiting may also occur. Phosphine is a central nervous system depressant and is toxic to the kidneys, resulting in albuminuria and hematuria. Lethal exposures result in pulmonary edema, convulsions and coma. Chronic exposures may result in permanent disturbances of sight, speech, motor functions and skeletal injuries. Phosphine is also considered highly flammable and may spontaneously combust in the air.

K. The inspectors utilized phosphine measuring devices above the surface of the leaking clarifier. This sampling indicated that the toxic gas phosphine was present above the surface of the leaking clarifier at concentrations as high as 1.08 parts per million (ppm). The OSHA time weighted average limit is 0.3 ppm. The NIOSH threshold limit value short term exposure limit is 1.00 ppm.

L. The inspectors discovered piles of used furnace brick and carbon furnace liner, also known as refractory, at various locations within the facility. Some of the used brick and furnace liner were located in the slag pile at the facility, and some were agglomerated in a pile south of the leaking clarifier. Brick sizes vary from about the size of a cinder block to as large as a refrigerator. The pile of bricks and furnace liner south of the leaking clarifier is approximately 100' by 30' by 5'. In an effort to gauge the volatility of the used brick, an inspector threw a small stone at a brick. The brick caught fire and burned vigorously and persistently. The inspectors extinguished this fire with sand, for fear the entire pile of used brick and furnace liner, as well as

the surrounding dry grass, might ignite. An inspector turned over a fragment of used brick/refractory. The mere act of overturning the fragment was sufficient to cause the fragment to immediately erupt into flames and burn so vigorously as to approach temperatures of 1,000 degrees Fahrenheit.

M. Respondent does not have a hazardous waste management permit to operate a treatment, storage or disposal facility.

N. As part of its closure activities, Respondent has moved slag from the slag pile to a manmade impoundment of water within the facility boundary that is roughly equivalent to 60 acres. This constant shifting of slag materials may result in a higher incidence of used brick and furnace liner exposure and ignition.

O. As part of its closure activities, Respondent has expressed an intent to the Montana Department of Environmental Quality to bury the leaking clarifier in place.

P. Respondent manages the phosphorous sludges in the 100' diameter leaking clarifier, and the used brick and furnace liner located south of the leaking clarifier and in the slag pile in a manner that presents an imminent and substantial endangerment to health or the environment, as follows:

1. Leaking Clarifier

- (a) The storage of extremely large quantities of ignitable and reactive phosphorous sludge in the 100' leaking clarifier constitutes an imminent hazard to surrounding populations. If the supply of water to the leaking tank is ever interrupted, for whatever reason, the "cap" of water used to maintain a barrier with the air will quickly disappear through the cracks in the leaking tank and through evaporative processes. The entire contents of the leaking tank, hundreds of thousands of gallons of phosphorous sludge, will then be subject to auto-ignition that will emit toxic gaseous compounds that could negatively impact wildlife and the health of nearby populations. A fire in the leaking tank could also ignite a wildfire on adjoining land.
- (b) Even if the water cap on the leaking clarifier is maintained, phosphine gas is constantly exsolved. In the immediate vicinity of the leaking tank, concentrations of phosphine can reach toxic, possibly ignitable levels. Birds and wildlife are unable to differentiate the leaking tank from non-toxic, natural watercourses. If animals stray into the vicinity of the leaking tank, they could succumb to phosphine poisoning.
- (c) The facility maintains no signs warning of the hazardous nature of

the wastes on-site. There is but a single, eight foot, chain-link perimeter fence that is topped with barbed wire. There are only three employees at the site during regular business hours, and no staff after the close of business. Extremely hazardous areas within the perimeter fence are not segregated or distinguished in any way. Thus, a trespasser that climbed the perimeter fence would be in extreme danger from unmarked and unrestricted hazards on-site.

2. Used Brick and Furnace Liner

- (a) The used brick and furnace liner located in the pile south of the leaking clarifier and throughout the slag pile constitute an immediate hazard to surrounding populations. If even casually disturbed (from meteorological, human or animal activities), the refractory is subject to auto-ignition that will emit toxic gaseous compounds that could negatively impact wildlife and the health of nearby populations. A refractory fire could also ignite a wildfire on adjoining land.
- (a) The same lack of security, signage and segregation which cause the leaking clarifier to constitute an exposure risk make the brick pile and slag piles a risk to public health and the environment.

V. CONCLUSIONS OF LAW

- A. Respondent is a "person" within the meaning of Section 1004(15) of the Act, 42 U.S.C. § 6903(15).
- B. Wastes generated, managed, and stored at the Silver Bow facility are solid wastes as defined in Section 1004(27) of the Act, 42 U.S.C. § 6903(27).
- C. Respondent has contributed and/or is contributing to the handling and storage of solid waste at the Silver Bow facility within the meaning of Section 7003 of the Act, 42 U.S.C. § 6973.
- D. Respondent's contribution to and/or handling and storage of solid waste at the Silver Bow facility may present an imminent and substantial endangerment to health or the environment within the meaning of Section 7003 of the Act, 42 U.S.C. § 6973.

VI. ORDER

Based on the foregoing Findings of Fact and Conclusions of Law and other information contained in the administrative record for this order, EPA has determined that the activities required by this Order are necessary to protect health or the environment. EPA, therefore, hereby orders Respondent to undertake and complete the following actions. All work undertaken pursuant to this Order shall be performed in a manner consistent with this Order, including all documents incorporated herein pursuant to this Order, and all applicable laws.

VII. WORK TO BE PERFORMED

A. Within 15 calendar days of the effective date of this Order, Respondent must:

- (1) Install a security fence around the leaking clarifier and the pile of used brick and furnace liner located south of the clarifier; and
- (2) Post signs across the perimeter of the facility and upon the security fences referenced in (1), above, stating "Danger - Unauthorized Personnel Keep Out," which must be legible from a distance of at least 25 feet from each sign. The signs shall be placed at the facility entrance and at a maximum spacing of 750 feet around the perimeter of the facility.

B. Within 30 calendar days of the effective date of this Order, Respondent must assess interim measures necessary to protect public health and the environment, including wildlife, develop an interim measures work plan ("IM Work Plan"), and submit such IM Work Plan to EPA for approval.

C. Interim measures shall include, but not be limited to:

- (1) A method for permanently and continuously eliminating wildlife contact with the solid wastes described above, including covering by netting, or other suitable devices;
- (2) A method for ensuring the maintenance of the water "cap" over the sludge in the 100' leaking clarifier and measuring phosphine gas and capturing or preventing the release of unacceptable levels of phosphine gas; and
- (3) A method of ensuring that operations in the slag pile will not create conditions that could cause used brick and furnace liner to spontaneously ignite.

D. The IM Work Plan shall describe:

- (1) The selected interim measures;
- (2) The procedures and a schedule required for implementation; and

- (3) An operations and maintenance plan and schedule which, if followed, will result in uninterrupted effectiveness of the chosen measure(s) for the scheduled period.

E. EPA shall notify Respondent in writing of any comments it may have on the IM Work Plan which must be incorporated into the IM Work Plan before it can be approved.

F. Respondent must incorporate EPA's comments into the IM Work Plan and resubmit the IM Work Plan ("final submittal") by September 2000.

G. If Respondent fails to timely incorporate EPA's comments and resubmit the IM Work Plan, EPA will either approve, approve with modifications, or disapprove of the IM Work Plan as submitted. If Respondent fails to submit an approvable IM Work Plan by the final submittal date, Respondent shall be in violation of this order.

H. EPA will notify Respondent in writing of its approval, approval with modifications, or disapproval of the IM Work Plan.

I. Within 15 calendar days of receipt of EPA's written approval or approval with modifications, Respondent shall implement the interim measure(s) in accordance with the procedures and schedules contained in the IM Work Plan as approved.

J. Respondent shall include in the IM Work Plan a schedule for providing a written report (Interim Measures Implementation Report) to EPA detailing and confirming the completion of the activities conducted pursuant to the IM Work Plan.

K. Respondent shall submit by January 31, 2001, a written work plan that evaluates alternatives for the lawful disposition of the contents of the leaking clarifier and used brick and furnace liner ("Waste Plan"). The Waste Plan shall include at least one alternative for the lawful removal and disposal of the contents of the leaking clarifier and the used brick and furnace liner.

L. EPA shall notify Respondent in writing of any comments it has on the Waste Plan which must be incorporated in the Waste Plan before it can be approved.

M. Respondent must incorporate EPA's comments into the Waste Plan and resubmit it to EPA within 15 calendar days of receipt of EPA's comments ("final submittal").

N. If Respondent fails to timely incorporate EPA's comments and resubmit the Waste Plan, EPA will either approve, approve with modifications, or disapprove of the Waste Plan as submitted. If Respondent fails to submit an approvable Waste Plan by the final submittal date, Respondent shall be in violation of this Order.

O. EPA will notify Respondent in writing of its approval, approval with modifications, or disapproval of the Waste Plan.

P. Within 15 days of EPA's notification of approval or approval with modifications regarding the Waste Plan, Respondent shall begin implementation of the Waste Plan as approved by EPA in accordance with the procedures and schedules contained in the Waste Plan.

Q. The Respondent shall include in the Waste Plan a schedule for providing a written "Waste Implementation Report" to EPA detailing and confirming the completion of activities conducted pursuant to the Waste Plan.

R. Respondent shall submit three (3) copies of the IM Work Plan and Waste Plan required under this Order for EPA review and approval to:

John Wardell, Office Director
U.S. EPA, Region 8, Montana Office
301 S. Park Ave, DWR 10096-0026
Helena, Montana 59626-0096

VIII. ACCESS

Respondent shall permit full site access as permitted by law to EPA employees, contractors, agents, consultants, designees, representatives, State of Montana and local government representatives, as may be necessary for the purposes of oversight and implementation of this Order.

IX. AVAILABILITY AND RETENTION OF INFORMATION

A. Upon request, Respondent shall make available to EPA, and shall retain, during the pendency of this Order and for a period of five years after its termination, all records and documents in its possession, custody or control, or in the possession, custody or control of its contractors and subcontractors, which relate to the performance of this Order, including but not limited to documents reflecting the results of any sampling, tests, or other data or information generated or acquired by Respondent, or on Respondent's behalf, with respect to the implementation of this Order.

B. After the document retention period, Respondent shall notify EPA at least 90 calendar days prior to the destruction of any such documents, and upon request by EPA, shall deliver the documents to EPA.

X. GENERAL PROVISIONS

A. All plans and documents submitted under any paragraph of this Order shall, upon approval by EPA, be incorporated by reference in this Order as if set forth fully herein.

B. Respondent shall include in the IM Work Plan and Waste Plan the name, title, and qualifications of the personnel to be used in implementing the work required by this Order.

C. Respondent shall obtain any permits or approvals which are necessary to perform work on or outside the Silver Bow facility under applicable law and shall submit timely applications and requests for any such permits and approvals.

XI. FAILURE TO COMPLY

Pursuant to Section 7003(b) and the Federal Civil Penalties Inflation Adjustment Act of 1990, as amended by the Debt Collection Improvement Act of 1996, 31 U.S.C. § 3701, and regulations codified at 40 C.F.R. § 19.4, any failure by Respondent to comply with this Order shall subject Respondent to civil penalties of not more than \$5,500.00 for each day of each failure to comply with this Order.

XII. RESERVATION OF RIGHTS

A. Nothing in this Order shall limit the information gathering, access, and response authority of the United States under any other applicable law, nor shall it limit the authority of EPA to issue additional orders to Respondent as may be necessary.

B. This Order shall not be construed as a waiver or limitation of any rights, remedies, powers and/or authorities which EPA has under the Act, the Comprehensive Environmental Response, Compensation, and Liability Act, or any other applicable law.

C. EPA hereby reserves all of its statutory and regulatory powers, authorities, rights, remedies, both legal and equitable, which may pertain to Respondent's failure to comply with any applicable laws and regulations and with any of the requirements of this Order, including but not limited to, the right to disapprove of work performed by Respondent, to request that Respondent perform additional tasks, and the right to perform any portion of the work herein.

D. Compliance by Respondent with the terms of this Order shall not relieve Respondent of its obligation to comply with the Act and/or any other applicable State or Federal law or regulation including without limitation, Montana Code Annotated Section 75-10-401, *et seq.* and associated Administrative Rules of Montana, and any condition of any permit issued under the Act or any other applicable law or regulation.

E. EPA reserves its right to seek reimbursement from Respondent of its costs to the fullest extent allowed by law.

XIII. OPPORTUNITY TO CONFER AND MODIFICATION

A. Respondent has the opportunity to confer informally with EPA concerning the terms and applicability of this Order. If Respondent desires a conference, Respondent must contact EPA Region VIII to schedule and attend such a conference within fourteen (14) calendar days of receipt of this Order.

B. If EPA determines that any element of this Order, including work to be performed or schedules, warrants modification after a conference is held, EPA will modify the Order in writing, file the modification with the Regional Hearing Clerk and issue a copy to Respondent.

C. Except as otherwise provided in this Order, no modification to this Order shall be effective unless and until it is issued in writing by EPA and filed with the Regional Hearing Clerk.

XIV. NOTICE OF INTENT TO COMPLY

A. Respondent shall provide, within two calendar days of the effective date of this Order, written notice to EPA stating whether Respondent will comply with the terms of the Order. The absence of a response by EPA to the notice required by this paragraph shall not be deemed to be acceptance of any assertions that Respondent may make in their notice(s), and shall not affect Respondent's obligation to implement the Order.

B. Failure of Respondent to provide notification to EPA of intent to comply within this time period shall be deemed a violation of this Order.

XV. EFFECTIVE AND TERMINATION DATES

A. This Order shall become effective on the fifteenth (15) calendar day after the date Respondent receives a copy of the executed Order.

B. Modifications made by EPA to this Order are effective on the date such modification is filed with the Regional Hearing Clerk, so long as Respondent is sent a copy by certified mail or has hand delivered to it a copy of the modification as expeditiously as possible after the modification is filed with the Regional Hearing Clerk.

C. This Order shall terminate upon Respondent's receipt of written notice from EPA that Respondent has demonstrated, to the satisfaction of EPA, that the requirements of this Order, including any additional tasks determined by EPA to be required pursuant to this Order, but not including record retention, have been satisfactorily completed.

XVI. SEVERABILITY

If any provision or authority of this Order or the application of this Order to any party or circumstance is held by any judicial or administrative authority to be invalid, the application of such provision to other parties or circumstances and the remainder of this Order as Modified shall not be affected thereby and shall remain in full force.

IT IS SO ORDERED:

ENVIRONMENTAL PROTECTION AGENCY
REGION VIII

Date: 2/18/00

By: John F. Wardell

John F. Wardell, Director
Montana Office
EPA Region VIII

By: Michael T. Risner 12/27/00

Michael T. Risner
Legal Enforcement Program
EPA Region VIII

IN THE MATTER OF:

Rhodia Inc. and Rhône-Poulenc
Proceeding Under § 7003 of the Solid Waste
Disposal Act, as amended, 42 U.S.C. § 6973

CERTIFICATE OF SERVICE

I hereby certify that the foregoing **Amended Administrative Order** was sent to the following persons in the manner indicated, this **27th day of December, 2000**.

ORIGINAL FILED BY HAND DELIVERY TO:

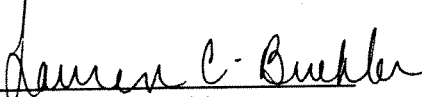
Ms. Tina Artemis
Regional Hearing Clerk
U.S. Environmental Protection Agency, Region VIII
999 18th Street, Suite 500
Denver, CO 80202-2466

COPY BY CERTIFIED MAIL, RETURN RECEIPT REQUESTED TO:

CT Corporation System
40 West Lawrence, Suite A
P.O. Box 1166
Helena, MT 59624

COPY BY REGULAR MAIL TO:

Ken Kastner
Byran Cave LLP
700 Thirteenth Street., NW
Washington, DC 20005-3960
Facsimile No. 202-508-6200


Lauren C. Buehler

Appendix B

3008(h) Order (December 22, 2003)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 8

IN THE MATTER OF:)	
)	
Rhodia Inc.)	DOCKET NO.: RCRA-08-2004-0001
119130 German Gulch Road.)	
Ramsey, Montana)	CORRECTIVE ACTION
59750)	ORDER ON CONSENT
)	
EPA ID No. MTD0575585546)	
)	
Respondent.)	

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I. JURISDICTION

- A. This Corrective Action Order on Consent (“Order”) is issued by the United States Environmental Protection Agency Region 8 (EPA) to Rhodia Inc. (“Respondent” or “Rhodia”), the owner and operator of a former elemental phosphorus facility with the address 119130 German Gulch Rd., located near Butte, in Silver Bow County, Montana. Rhodia SA is also a signatory to this Order as guarantor (hereafter “Guarantor”), as provided for in Section XIII.
- B. This Order is issued pursuant to the authority vested in EPA under Section 3008(h) of the Resource Conservation and Recovery Act (“RCRA”) (42 U.S.C. § 6928(h)).
- C. This authority has been delegated to the EPA signatory below.
- D. The parties to this order understand and agree that the Federal hazardous waste program in Montana is largely embodied in State law and regulations. Because the State regulations incorporate the Federal regulations by reference, and for the convenience of the parties, citations herein to the regulations are to the Code of Federal Regulations (“CFR”).
- E. The parties to this Order understand and agree that Respondent is required to comply with this Order as a condition of probation in the Plea Agreement in United States v. Rhodia Inc. (D. MT) (“Plea Agreement”) during the entire term of Respondent’s probation in that matter. Respondent understands that EPA may refer violations of this Order to the U.S. Probation Office to compel compliance with this Order in and through the U.S. District Court during the period of probation.
- F. Respondent and Guarantor individually consent to and agree not to contest EPA’s jurisdiction to issue this Order or to enforce its terms. Further, Respondent and Guarantor consent to and agree to not contest EPA’s jurisdiction to compel compliance with this Order in any subsequent enforcement proceedings, either administrative or judicial, to require Respondent’s full or interim compliance with the terms of this Order, or to impose sanctions for violations of this Order.

II. APPLICABILITY/PARTIES BOUND

- A. This Order shall apply to and be binding upon Respondent and Guarantor and their respective successors, assigns, heirs, trustees, receivers, and upon EPA.
- B. Respondent shall provide a copy of this Order to all contractors, subcontractors, laboratories, and consultants retained to conduct or monitor any portion of the work performed pursuant to this Order within fourteen (14) days of the effective date of this Order, or within fourteen (14) days after retaining the services of such contractors, subcontractors, laboratories or consultants, whichever is later. Respondent shall require its contractors, subcontractors, laboratories and consultants to perform work which meets the requirements of this Order and Respondent shall be responsible for such work meeting the requirements of this Order.
- C. Respondent will be responsible for and liable for any failure to carry out all activities required of Respondent by the terms and conditions of the Order, regardless of Respondent's use of employees, agents, contractors or consultants to perform any such tasks.
- D. No change in ownership or corporate status relating to the Facility will in any way alter Respondent's responsibility under this Order. Any conveyance of title, easement or other interest in the Facility, or a portion of the Facility, shall not affect Respondent's obligations under this Order.
- E. Respondent shall give written notice of this Order to any successor in interest prior to transfer of ownership or operation of the Facility or any portion thereof, and shall notify EPA at least twenty (20) days prior to any such transfer of ownership or operation.
- F. Respondent agrees to undertake all actions required by this Order, including any portions of this Order incorporated by reference.

III. DEFINITIONS

For purposes of this Order the following definitions shall apply. Unless otherwise expressly provided herein, terms used in this Order shall have the definitions given to them in RCRA or the federal regulations promulgated thereunder.

7003 Order shall mean the Amended Administrative Order issued by EPA Region 8 in RCRA Docket-8-2000-07 to Respondent on June 30, 2000 and amended in December, 2000 under Section of RCRA 7003, 42 U.S.C. § 6973, to address crude phosphorus waste in the clarifier and the spent carbon brick and liner waste from the furnace.

Acceptable shall mean that the quality of submittals or completed work is sufficient in addressing the principle components of the required submittal or work so as to warrant EPA review in order to determine whether the submittal or work meets the terms and conditions of this Order, including all attachments, scopes of work, approved work plans and/or EPA's written comments, and relevant guidance documents. Acceptability of submittals or work, however, does not necessarily imply that they are approvable or will be approved pursuant to this Order. Approval by EPA of submittals or work, however, establishes that those submittals were prepared, or work was completed, in a manner acceptable to EPA.

Additional Work shall mean any activity or requirement that is not expressly covered by this Order or attachments but is determined by EPA to be necessary to fulfill the purposes of this Order, which is to protect human health and the environment considering site-specific factors.

Administrative Record shall mean the record compiled and maintained by EPA in connection with the implementation of this Order.

Advanced Notice of Proposed Rulemaking or ANPR shall mean the body of the Federal Register notice found at 61 Fed. Reg. 19432 (May 1, 1996), which was created to provide a strategy to cleanup solid waste management units at hazardous waste management facilities under RCRA and to provide guidance to the corrective action program. Although the majority of the ANPR was subsequently withdrawn from the rulemaking process (64 Fed. Reg. 54604 (Oct. 7, 1999)), the ANPR continues to be considered the primary corrective action implementation guidance (64 Fed. Reg. at 54607).

Areas of Concern shall mean any area of the Facility at or from which a release to the environment of any hazardous waste or hazardous constituent has occurred, is suspected to have occurred, or may occur, regardless of the time, frequency or duration of the release, and which may present an unacceptable risk to human health or the environment regardless of whether such area meets the definition of a SWMU. The term Areas of Concern includes, but is not limited to, areas and discernible units at which solid wastes have been placed, at any time, irrespective of whether the area or unit was intended for the management of solid or hazardous waste. Examples of Areas of Concern include, but are not limited to, landfills, surface impoundments, pits, waste piles, land treatment units,

incinerators, tank systems (including any storage, treatment, or accumulation tank system), container storage units, waste or wastewater treatment system units, and recycling units, or other areas or systems that received solid or hazardous waste or hazardous constituents, or released hazardous waste or hazardous constituents at any time.

CERCLA shall mean the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9601, *et seq.*

Constituent of Potential Concern ("COPC") shall mean any hazardous constituent that has been released at or from the Facility and which may pose a risk to human health or the environment, as determined in the RFI.

Comply or compliance may be used interchangeably and shall mean completion of work required by this Order including submittal of documents of a quality acceptable to EPA, in accordance with work plans approved by EPA and in the manner and time specified in an approved work plan, this Order or any modification thereof. Respondent must meet both the quality (see definition of acceptable) and timeliness components of a particular requirement to be considered to be in compliance with the terms and conditions of this Order.

Contractor shall mean any person including, but not limited to, any consultant, laboratory or subcontractor retained by Respondent to conduct or monitor any portion of the work performed pursuant to this Order.

Corrective Action Management Unit or CAMU shall mean an area within the Facility that is designated pursuant to 40 C.F.R. 264.552 by EPA for the purpose of implementing corrective action requirements under this Order. A CAMU shall only be used for the management of CAMU-eligible wastes pursuant to implementing such corrective action requirements at the Facility.

Corrective measures shall mean those measures or actions appropriate to control, prevent or mitigate the release, potential release or movement of hazardous waste or hazardous constituents into the environment or within or from one media to another.

Corrective Measures Implementation or CMI shall mean those activities appropriate to initiate, monitor, maintain, and complete the remedies EPA has selected or may select.

Corrective Measures Study or CMS shall mean the investigation and evaluation of potential alternative remedies to protect human health and/or the environment from the release or potential release of hazardous wastes, or hazardous constituents, into the environment from and/or at the Facility.

Day shall mean a calendar day unless expressly stated to be a business day. Business day shall mean a day other than a Saturday, Sunday or Federal Holiday. In computing any period of time under this Order, where the last day would fall on a Saturday, Sunday or Federal Holiday, the period shall run until the end of the next business day.

Decision Document shall mean the document issued by EPA after completion of the CMS setting forth EPA's selection of the corrective measure alternative(s) to be implemented at the Facility to achieve final cleanup objectives.

Environmental Indicators (EI) shall mean the EI for current human exposures and the migration of contaminated groundwater, as described in the EPA Memorandum dated February 5, 1999, entitled "Interim-Final Guidance for RCRA Corrective Action Environmental Indicators", from Elizabeth Cotsworth, Acting Director, Office of Solid Waste.

EPA shall mean the United States Environmental Protection Agency, and any successor departments or agencies of the United States.

Facility shall, for the purposes of this Order, mean the property of Respondent located at 119130 German Gulch Road, in Butte-Silver Bow County, Montana, including all contiguous property under the control of Respondent.

Final Corrective Action Plan or Final CAP shall mean the document (May 1994 OSWER Directive 9902.3-2A with identification no. EPA 520-R-94-004) created to provide guidance which program implementors and facility owners/operators can use to develop and direct site-specific corrective action activities.

Groundwater shall mean the water in the saturated zone beneath the land surface.

Guarantor shall mean Rhodia SA, a corporation incorporated in France, with ADRs traded on the New York Stock Exchange. The authorized representative of Rhodia SA for purposes of this Order is Myron Galuskin.

Hazardous constituents shall mean those constituents listed in Appendix VIII to 40 C.F.R. Part 261 or any constituent identified in Appendix IX to 40 C.F.R. Part 264 or any approved subset of Appendix IX to 40 C.F.R. Part 264.

Hazardous waste shall mean "hazardous waste" as defined Section 1004(5) of RCRA, 42 U.S.C. § 6903(5) and 40 C.F.R. Part 261.

Hazardous Waste Management Unit shall mean “hazardous waste management unit” as that term is defined in 40 C.F.R. 260.10.

Imminent Threat shall mean any release, or threatened release, of hazardous waste or hazardous constituent, on or from the Facility, which may present an imminent endangerment to human health and/or the environment.

Interim Measure or IM shall mean those actions which can be, or are, initiated in advance of implementation of the final corrective action for the Facility and which are designed to achieve stabilization and/or control or abate immediate threats to human health and/or the environment and/or minimize the spread of COPCs.

MDEQ shall mean the Montana Department of Environmental Quality.

Order shall mean this Corrective Action Order on Consent and all attachments hereto, and all specifications, reports, schedules, and work plans approved by EPA pursuant to this Order, and all documents incorporated into this Order, as provided herein.

Receptors shall mean those humans, animals, or plants and their habitats which are or may receive or be affected by releases of hazardous waste or hazardous constituents at, or migrating from, the Facility.

Release shall mean any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, seeping, leaching, dumping, placing, or disposing into the environment of any hazardous waste, hazardous constituents or COPC.

Resource Conservation and Recovery Act or RCRA shall mean the Solid Waste Disposal Act, as amended.

RCRA Facility Investigation or RFI shall mean the investigation and characterization of the source(s) and/or releases of hazardous wastes and hazardous constituents and the nature, extent, direction, rate, movement, and concentration of such releases of hazardous wastes and/or hazardous constituents, that have been, or may be released or may reasonably be expected to be released into the environment from or at and/or to migrate from the Facility.

Solid Waste Management Unit or SWMU shall mean any discernable unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid wastes have been routinely and systematically released.

Stabilization shall mean the actions employed to control or abate releases that pose an actual or potential threat to human health and the environment, to control off-site releases from the migration of contaminated groundwater, and to contain or remove source areas for actual or potential releases.

Submittal shall mean any document Respondent is required to send to EPA and MDEQ pursuant to this Order, including but not limited to all work plans, reports and progress reports.

Violation(s) shall mean any actions, omissions, failures, or refusals to act by Respondent that result in a failure to meet any term or condition of this Order.

Work or obligation shall mean any activity Respondent must perform to comply with the requirements of this Order.

Work plan shall mean the detailed plans prepared by Respondent as required under this Order. All work plans and modifications or amendments thereto are incorporated into this Order and are an enforceable part of this Order when approved in writing by EPA.

IV. FINDINGS OF FACT AND CONCLUSIONS OF LAW

For purposes of this Order, and based on the Administrative Record, EPA makes the following findings of fact and conclusions of law:

- A. Respondent and Guarantor are each a “person” within the meaning of 40 C.F.R. 260.10 and Section 1004(15) of RCRA.
- B. Respondent’s former elemental phosphorus production facility comprises approximately 120 acres, and is located in Sections 23, 24, 25 and 26, Township 3 North, Range 9 West.
- C. At all times relevant, Respondent was and is presently a Delaware corporation registered to conduct business in the State of Montana.
- D. Respondent and its predecessors began manufacturing operations at the facility around 1950. Certain solid wastes and constituents released at the Facility by Respondent are hazardous wastes and/or hazardous constituents.
- E. During the years of operation, a variety of wastes, including but not limited to characteristic hazardous wastes (including D001) were generated, treated, stored, or disposed of.

- F. In 1980, pursuant to Section 3010 of RCRA, Stauffer Chemical Company, a predecessor to Respondent, notified EPA of its hazardous waste activity at the Facility. In its notification, Stauffer Chemical Company identified itself as a generator of hazardous waste.
- G. The principal activities at the plant were the manufacture of elemental phosphorus.
- H. Environmental investigations at the Facility have been undertaken by Respondent and government agencies to assess environmental contamination at the Facility. The data collected in these investigations will be used to identify some of the SWMUs or Areas of Concern requiring further investigation and/or possible interim measures.
- I. Hazardous constituents, including elemental phosphorus, fluoride, arsenic, and cadmium, have been detected at the surface and in the subsurface onsite and/or offsite.
- J. In 2000, Respondent, in response to the 7003 Order issued by U.S. EPA Region 8, installed a series of engineering controls (fencing, netting and other covering, etc.) to restrict access to two unpermitted hazardous waste management units, a 100-foot clarifier containing crude phosphorus and a pile of spent carbon refractory brick. However, decisions regarding the ultimate disposition of the material in the 100-foot clarifier or carbon refractory brick have not occurred as of the date of this Order.
- K. Elemental phosphorus in groundwater and subsurface soils has been detected adjacent to the 100-foot clarifier.
- L. Offsite elemental phosphorus in the sediments of Silver Bow Creek and Sheep Gulch has been reported by EPA.
- M. Certain heavy metals have been detected in groundwater extending northward and westward to Silver Bow Creek and Sheep Gulch.
- N. There has been a release of fluoride from the facility impacting offsite land.
- O. There is or has been a release of hazardous waste into the environment at the Facility.

- P. The actions required by this Order are necessary to protect human health and/or the environment.

V. ORDER

Pursuant to Section 3008(h) of RCRA, Respondent agrees to and is hereby ordered to perform the work required by this Order, in the manner and by the dates specified herein.

VI. STATEMENT OF PURPOSE AND INTEGRATION OF REMEDIAL AUTHORITIES

- A. By entering into this Order, the mutual objectives of EPA and Respondent are for Respondent to perform investigation and, as appropriate, remediation activities in accordance with the requirements of this Order to address releases of hazardous waste and hazardous constituents at and from the Facility as necessary to protect human health and the environment considering site-specific factors.
- B. The Parties acknowledge and agree that investigation and remedial decisions regarding the clarifier, the spent carbon brick and liner material, and remediation of any releases therefrom are expected to be addressed by EPA through and in accordance with the 7003 Order. Further, removal and plugging of the discharge pipe in the non-floodplain portion of Parcel 26 is expected to be undertaken in accordance with an Administrative Order on Consent (AOC) pursuant to Section 7003 of RCRA between EPA and Respondent, which AOC is presently being negotiated by EPA and Respondent. In addition to this provision, the only other provisions of this 3008(h) Order that apply to the 7003 Order are Section XIII -- Financial Assurance, Section XX -- Other Applicable Laws, and Section XXIII -- Dispute Resolution and Judicial Review.

VII. NOTIFICATION, SUBMITTAL AND CERTIFICATION REQUIREMENTS

- A. Unless otherwise specified, reports, notices, approvals, disapprovals, or other submittals relating to or required under this Order shall be in writing and shall be sent to the parties' respective Project Managers, with a copy to MDEQ care of:

Jan Sensibaugh, Director
Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901

- B. One copy of all documents relating to evidence of financial assurance should be sent to:

Ms. Daniela Golden
Mail Code: ENF-T
EPA, Region 8
999 Eighteenth Street, Suite 300
Denver, CO 80202-2466

- C. Any report or other document submitted by Respondent pursuant to this Order which makes any representation concerning Respondent's compliance or noncompliance with any requirement of this Order shall be certified by a responsible corporate officer of Respondent or a duly authorized representative of such responsible corporate officer. A responsible corporate officer may include a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation. Respondent may delegate this requirement to its Project Manager if a responsible corporate official provides EPA a written declaration defining the scope of the Project Manager authority to act on behalf of the corporation.
- D. The certification required by paragraph C. above, shall be in the following form:

"I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to evaluate the information submitted. I certify that the information contained in or accompanying this submittal is true, accurate, and complete, except for the following portions of this submittal which I cannot personally verify: []. As to those identified portions of this submittal which I cannot personally verify the accuracy, I certify that this submittal and all attachments were prepared in accordance with procedures designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those directly responsible for gathering the information, or the immediate supervisor of such person(s), the information submitted is, to the best

of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.”

Signature: _____
Name: _____
Title: _____
Date: _____

- E. Two copies of all documents required to be submitted pursuant to this Order shall be hand delivered, sent by certified mail, return receipt requested, or by overnight express mail or courier to the EPA Project Manager, and one copy to the MDEQ representative, unless the EPA Project Manager approves the submission of fewer documents or a different method of submission.

VIII. WORK TO BE PERFORMED

A. CURRENT CONDITIONS/RELEASE ASSESSMENT

1. Respondent has one hundred and twenty days (120) calendar days from the effective date of this Order to provide a Current Conditions/Release Assessment (“CC/RA”) Report which lists and evaluates all available data relating to the release of hazardous waste or hazardous constituents at or from the Facility.
2. The CC/RA Report shall address the entire Facility and shall meet the requirements for current conditions description and release assessment set forth in the CAP and the ANPR.
3. The purpose of the CC/RA Report is to assess the completeness and quality of the existing data which will be used, in whole or in part, to define the nature and extent of releases of hazardous wastes or hazardous constituents at and/or from the Facility. The CC/RA Report shall also identify potential threats to human health and the environment from releases or potential releases at or from the Facility.
4. Respondent may include within the CC/RA report a Conceptual Site Model.
5. The CC/RA Report shall address:

- a. the identification of COPCs;
- b. the identification of SWMUs or Areas of Concern;
- c. the quality of the existing data used in assessing site conditions or used in a risk assessment;
- d. the areas of the Facility for which existing data are adequate to define releases and supply information for identification and evaluation of interim measures;
- e. the areas of the Facility for which existing data are adequate to demonstrate that there are, or have been, no releases of hazardous waste and/or hazardous constituents above levels of preliminary concern from any source and that no additional consideration is needed; and
- f. the areas of the Facility for which existing data are not adequate.

B. INTERIM MEASURES

1. Respondent may submit any Interim Measures Work Plan at any time during implementation of this Order.

EPA may require Respondent to submit additional Interim Measures Work Plans based on the CC/RA Report or the RFI Summary Report and a determination that the specific interim measure is appropriate to achieve stabilization in order to control or abate threats to human health and the environment from releases of hazardous waste or hazardous constituents while long-term corrective measures alternatives are being evaluated. EPA shall provide written notice of the requirement to submit an Interim Measures Work Plan and explain in such notice its determination. Respondent shall submit Interim Measures Work Plans within thirty (30) days following notification by EPA.

2. Each Interim Measures Work Plan is subject to EPA approval pursuant to the requirements of this Order.
3. Within fifteen (15) calendar days of receipt of EPA's written approval or approval with modifications, Respondent shall begin to implement the interim measure(s) in accordance with the

procedures and schedules contained in the IM Work Plan as approved and shall complete the Interim Measures in accordance with the schedule contained in the Work Plan.

4. Within fifteen (15) calendar days of implementation of the IM Work Plan, Respondent shall provide a written report (Interim Measures Implementation Report) to EPA detailing and confirming the completion of the activities conducted pursuant to the IM Work Plan.
5. Respondent shall make the IM Work Plan available to the public in the local repository established pursuant to this Order.

C. IMMINENT THREAT

1. In the event Respondent identifies a potential imminent threat to human health or the environment at or originating from the Facility, Respondent shall orally notify the EPA Project Manager within twenty four (24) hours of discovery and notify EPA in writing within ten (10) days of such discovery, summarizing the immediacy and magnitude of such threat(s), and proposed appropriate response action(s) on the part of the Respondent to mitigate the threat(s). EPA will review reported potential imminent threats and determine if and when a work plan is necessary.
2. If EPA identifies an imminent threat to human health and/or the environment at or originating from the Facility, EPA will notify Respondent in writing. Within fifteen (15) days of receiving EPA's written notification, Respondent shall submit an IM Work Plan in accordance with the Final CAP that identifies interim measures which will be implemented to mitigate the threat.
3. If EPA determines that immediate action is required, the EPA Project Manager may orally authorize or require Respondent to act prior to Respondent's receipt of EPA's written notification, including the taking of immediate action to abate the threat or harm.
4. Any oral requirements made pursuant to this subsection shall be immediately incorporated into this Order by reference and are immediately enforceable, unless EPA does not provide to

Respondent in writing, a description of such requirements within 72 hours of oral notification.

D. RCRA FACILITY INVESTIGATION (RFI) WORK PLANS

1. If, after reviewing the Final CC/RA Report, EPA determines that an RFI is necessary for one or more COPCs in one or more media, areas of the Facility, or areas beyond the Facility boundaries if there has been migration off-site, within one hundred and twenty (120) days of receipt of EPA's determination, Respondent shall submit to EPA for review and approval a Work Plan for a RCRA Facility Investigation ("RFI Work Plan") for such COPC(s), media and area(s). Any RFI Work Plan shall use the CAP and relevant EPA guidance as a guideline and incorporate any elements noted in the CAP as appropriate for facility-specific conditions.
2. Relevant EPA guidance may include, but is not limited to: the "RCRA Facility Investigation (RFI) Guidance" (Interim Final, May 1989, EPA 530/SW-89-031 (OSWER Directive 9502.00-6D)); and "RCRA Ground-Water Monitoring Technical Enforcement Guidance Document" (OSWER Directive 9950.1, September 1986); the Advanced Notice of Proposed Rulemaking at 61 Fed. Reg. 19432 (May 1, 1996); and "Interim Guidance on Financial Responsibility for Facilities Subject to RCRA Corrective Action" (Sept. 30, 2003).
3. The RFI Work Plan shall document the procedures Respondent will use in conducting investigations necessary to:
 - a. characterize the source(s) of hazardous waste or hazardous constituent releases or potential releases of any hazardous waste or hazardous constituent;
 - b. identify and determine the nature, extent, and the rate of migration of releases of hazardous wastes or hazardous constituents at or from the Facility;
 - c. determine the likely routes of migration of releases of hazardous waste or hazardous constituents, if any, at or from the Facility including characterization of the geology and hydrology of the Facility;

- d. determine the degree and extent of, or threat of, migration of releases of hazardous waste and hazardous constituents at or from the Facility;
 - e. identify actual and potential receptors;
 - f. support the development of corrective measure alternatives; and
 - g. be definitive enough to support the selection of corrective measures.
- 4. In addition to the work required under paragraph VIII.D.3.e. immediately above, the RFI Work Plan may describe the methods to be used to gather information to support a risk assessment of the conditions at the Facility, and to conduct an assessment of risk to identified receptors and their environment.
 - 5. The RFI Work Plan shall address all hazardous waste or hazardous constituents which have been released, or can be expected to have been released at or from the Facility.
 - 6. The RFI Work Plan shall describe the investigation to be done at each SWMU or AOC including an investigation of the complete lateral and vertical extent of any releases of hazardous waste or hazardous constituents from such areas. However, Respondent may propose risk-based concentrations or other investigation endpoints that, if approved by EPA, would be used to limit the scope of the investigation to delineate the extent of contamination at the Facility. EPA's decision to approve the use of such risk-based concentrations or other investigation endpoints shall be based on a demonstration that delineation beyond the risk-based concentrations or other investigation endpoints is not necessary to determine: a) whether corrective measures should be undertaken; or b) what the corrective measures, if any, should be.
 - 7. The RFI Work Plan shall define the methods of analysis to evaluate the presence, magnitude, extent, direction, and rate of migration of any releases of any hazardous waste or hazardous constituents.
 - 8. The RFI Work Plan shall be developed so that, if followed, Respondent can elicit data of adequate technical quality to

support the development and evaluation of corrective measure alternatives during any Corrective Measures Study; and to support a risk assessment.

9. If significant new information relating to hazardous waste or hazardous constituent releases not included in the CC/RA Report is discovered at the Facility, Respondent shall include such information in its next progress report.
10. The RFI Work Plan shall be modified within sixty (60) days of notification from EPA to address newly identified releases, threatened releases, or Areas of Concern.
11. The RFI Work Plan shall include:
 - a. a Project Management Plan;
 - b. a Data Collection Quality Assurance Plan;
 - c. a Data Management Plan for each unit/area or groups of units/areas as appropriate;
 - d. a Health and Safety Plan;
 - e. a Community Relations Plan;
 - f. a Borehole Abandonment Plan; and
 - g. a schedule for implementation of all activities described in the RFI Work Plan, including preparation and submission of preliminary and final reports to EPA.
12. The RFI Work Plan and activities conducted pursuant to the RFI Work Plan are subject to acceptance and approval by EPA based on the criteria identified in this Section VIII. D. Such approval shall not be unreasonably withheld by EPA.

E. RFI Reports

1. In compliance with the schedule developed in the RFI Work Plan, Respondent shall prepare an analysis and summary of the RFI and its results. The objective is to ensure that the investigative data collected pursuant to the RFI Work Plan are sufficient in quality and quantity to describe the nature, extent and rate of releases of hazardous waste or hazardous

constituents, threat(s) to human health and/or the environment (including risk assessment analysis), and to support any Corrective Measures Study.

2. Data Analysis

- a. Respondent shall analyze all data collected pursuant to this Section and prepare reports on whether the gathering and analysis of such data met quality assurance and quality control and other applicable data gathering and analysis procedures.
- i. The reports shall describe the extent of all releases of hazardous wastes or hazardous constituents in relation to site or background levels, or other approved risk-based endpoints, at
 - (A) the source;
 - (B) the boundaries of the Area to be Investigated; and
 - (C) off-site locations, if any, to which the releases have migrated. Background groundwater values for all applicable hazardous constituents described in the RFI Work Plan shall be obtained from analyses of water extracted from appropriate upgradient wells.
- ii. All sampling and analyses shall be conducted in accordance with the Data Collection Quality Assurance Plan included as part of the approved RFI Work Plan.
- iii. All sampling locations, methods and equipment used shall be documented in a field log and all locations shall be identified on detailed site maps.

3. Laboratory, Bench-Scale, and Field Pilot-Scale Studies.

- a. With prior EPA approval, Respondent may conduct laboratory and/or bench-scale studies and field and pilot-scale testing to determine the applicability of a corrective measure technology or technologies to site conditions.
- b. If Respondent proposes to conduct studies pursuant to RFI Work Plan, the Respondent shall provide to and

obtain from EPA approval of a work plan defining proposed laboratory and bench scale studies and field and pilot-scale testing.

- c. If Respondent proposes to conduct studies pursuant to RFI Work Plan, Respondent shall analyze the technologies based on literature review, vendor contacts, and past experience, to determine the testing requirements.

F. CORRECTIVE MEASURES STUDY (CMS) Work Plan

1. Within forty-five (45) calendar days following the receipt of notification in writing by EPA of EPA's approval of the RFI Summary Report, Respondent shall prepare and submit to EPA a Corrective Measure Study ("CMS") Work Plan to evaluate corrective measures for each release of hazardous waste or hazardous constituent that EPA has determined may require a corrective measure based on such being necessary to protect human health and the environment considering site-specific factors. The CMS Work Plan shall use and be in accordance with relevant EPA guidance including: the Final CAP, the ANPR, and the Post Closure Rule.
2. The CMS Work Plan may be divided into a number of sections for logical reasons and analyze different options for different sections. Site-specific corrective measure objectives for the investigation shall be stated in the CMS Work Plan.
3. The CMS Work Plan shall be designed to identify corrective measure alternatives and to provide an evaluative and investigative strategy capable of identifying the effectiveness of each alternative; to recommend and justify the selection of the most effective corrective measure(s) to employ at the Facility over the duration of the cleanup effort; and to obtain all the necessary data needed to compose all of the CMS investigation findings into a CMS Summary Report. The CMS Work Plan is subject to approval by EPA.
4. All corrective measure alternatives shall be developed based upon the results of the CC/RA Report, the RFI Summary Report, and an evaluation of human health and ecological risk existing at the facility.

5. Respondent shall develop, evaluate and propose corrective measure alternatives, and EPA will select the final corrective measure(s) to be implemented at the Facility, in light of site-specific factors and based on consideration of the factors identified in the Final Corrective Action Plan and the ANPR, which are:
 - a. Protect human health and the environment;
 - b. Attain media cleanup standards;
 - c. Control the source of releases so as to reduce or eliminate, to the extent practicable, further releases that may pose a threat to human health and the environment;
 - d. Comply with applicable standards for management of wastes;
 - e. Long-term reliability and effectiveness;
 - f. Reduction of toxicity, mobility, or volume;
 - g. Short term effectiveness;
 - h. Implementability; and
 - i. Costs.
6. Appropriate media cleanup standards shall be selected by EPA for the impacted media. The standards shall:
 - a. reflect actual and potential risks at the Facility by considering hazards, toxicity levels, exposure pathways to the hazards and/or toxicity levels, and fate and transport characteristics;
 - b. consider current and future land use of the Facility and corresponding exposure scenarios;
 - c. be derived based upon existing legal requirements and the results of the RFI Summary Report and an evaluation of human health and ecological risk posed by the Facility.

7. The CMS Work Plan shall describe the strategy Respondent will utilize to evaluate each alternative against the criteria identified in Section VIII.F.5.
8. The CMS Work Plan shall provide a strategy to predict the time frame that each remedial option is capable of meeting protective standards at the points of compliance.
9. The CMS Work Plan shall describe field activities which will be employed to support the findings of the investigation. Such data shall include boring log data, sampling analysis data, contour maps, groundwater elevation data, etc.
10. The CMS Work Plan shall identify remedial options which are capable of successfully satisfying the criteria identified in Section VIII.F.5.
11. Respondent shall make the CMS Work Plan available to the public in the local repository established pursuant to this Order.

G. CMS SUMMARY REPORT

1. Based upon a review of the CC/RA Report, the RFI Report, an evaluation of the human health and ecological risk posed at the Facility and the findings obtained from the implementation of the CMS Work Plan, Respondent shall evaluate each corrective measure alternative and recommend corrective measure alternative(s) which could be implemented at the Facility.
2. Sixty (60) calendar days following the completion of the implementation of the CMS Work Plan, Respondent shall provide a CMS Summary Report for EPA review and acceptance. EPA's written acceptance of the CMS Summary Report does not constitute an approval or selection of the corrective measure alternative(s) proposed and/or recommended in the CMS Summary Report.
3. The CMS Summary Report shall contain the findings of any additional investigations conducted pursuant to the CMS Work Plan, the recommended final corrective measures to be employed, technological limitations posed by utilizing the final remedies for the release of COPCs, and all information used to justify the use of the proposed final corrective measures.

H. CORRECTIVE MEASURES IMPLEMENTATION (CMI) Work Plan

1. After Respondent submits a CMS Summary Report with the proposed final corrective measure alternative(s) to EPA for review, EPA shall tentatively identify the appropriate corrective measure alternative(s) to be implemented based on the evaluation criteria in Section VIII.F.5.
2. Following EPA's tentative identification of the corrective measure(s) to be performed, EPA will conduct a public comment period, in accordance with RCRA and EPA's "RCRA Public Participation Manual", to provide the public with the opportunity to submit comments to EPA regarding the corrective measure(s) identified by EPA. EPA will issue a public notice in a major local newspaper, and, as determined appropriate by EPA, through a radio broadcast, and/or through a notice mailed to the affected community, to notify the public of the comment period. EPA will issue and make available to the public for review and comment a Statement of Basis describing EPA's proposed corrective measure(s) and the rationale and basis for such corrective measure(s). EPA will consider public comments submitted regarding the proposed corrective measure(s).
3. After the public comment period, EPA shall select the corrective measure(s) to be implemented and notify Respondent of EPA's decision in a notification letter, entitled "EPA Decision Document." The EPA Decision Document will describe the rationale and basis for the corrective measure(s) selected with regard to each of the evaluation criteria in Section VIII.F.5, and will include EPA's response to all significant comments made during the public comment period.
4. Respondent shall provide a Corrective Measures Implementation (CMI) Work Plan with implementing schedules after receiving the EPA Decision Document.
 - a. The CMI Work Plan shall be developed in accordance with relevant EPA guidance including, but not limited to, the ANPR and the Final CAP.
 - b. The CMI Work Plan shall be submitted to EPA ninety (90) days following the receipt of the EPA Decision Document. The Work Plan shall contain initial conceptual design plans and specifications. The initial

conceptual design plan with specifications shall clearly describe the size, shape, form, and content of the proposed corrective measure(s); conceptual drawings and schematics; key components required; and the procedures and schedules required to implement the corrective measure(s). The plan shall also contain an operation and maintenance plan, a final design and specification plan, a construction work plan, and a health and safety plan.

- i. The operation and maintenance plan shall contain procedures for performing operations, long term maintenance, and monitoring the performance of the corrective measure(s). The performance monitoring section of the plan shall be designed to identify ways to maximize the efficiency and cost-effectiveness of the corrective measure(s) and to ensure protection of potential human or ecologic receptors. Performance monitoring tasks shall accommodate changing concentrations and distribution of contamination.
- ii. A final design plan with specifications shall contain drawings and specifications needed to construct the corrective measure(s). Some of the elements that may be featured in the plan include: general site plans, process flow diagrams, mechanical drawings, electrical drawings, structural drawings, piping and instrumentation diagrams, excavation and earthwork drawings, equipment lists, site preparation and field work standards, and preliminary specifications for equipment and material.
- iii. The construction plan shall contain procedures that will accommodate seasonal precipitation changes and nearby groundwater usage, etc. for the proposed corrective measures. The plan shall discuss overall management strategies, construction quality assurance/quality control procedures, and contain schedules for constructing the corrective measure(s).
- iv. The health and safety plan must include the following: a description of the goals and objectives of the plan in conjunction with insuring the health and safety of on-site personnel and visitors; a list of COPCs which may be

encountered by field personnel; a description of personal protection/monitoring equipment and procedures; and a list of Facility organization and emergency contacts. EPA will not approve the health and safety plan but will review the plan to confirm that all necessary elements are included.

- c. The CMI Work Plan shall contain a plan to document the achievement of cleanup goals.
- d. The CMI Work Plan shall contain a plan to identify necessary or appropriate future land use restrictions, if any, and the method proposed to achieve and maintain them and to provide ongoing effective public notice of the land use restriction. The Work Plan shall contain a schedule to implement land use restrictions.
- e. Respondent shall make the CMI Work Plans available to the public in the local repository established pursuant to this Order.

I. CMI SUMMARY REPORT

- 1. Respondent shall submit a CMI Summary Report to EPA for review and approval two hundred and seventy (270) days following the completion of the activities provided in the CMI Work Plan and the achievement of clean up goals.
- 2. The CMI Summary Report shall document the criteria used to evaluate the achievement of final cleanup goals.
- 3. The CMI Summary Report shall include a summary of work completed, analytical data, and monitoring results.
- 4. Following EPA's review of the CMI Summary Report a public comment period will be conducted.
- 5. Following EPA's review of the CMI Summary Report and EPA's response to comments made during the public comment period, EPA will provide written comments on the CMI Summary Report to Respondent.

6. Respondent shall modify and resubmit the CMI Summary Report within fifteen (15) days of receipt of EPA's written comments, if necessary.
7. EPA shall provide a written approval/disapproval of the CMI Summary Report to Respondent following the agency's final review of the report.

J. AGENCY APPROVALS

1. EPA will provide Respondent with its written comments or approval, conditional approval, approval with modification, rejection as not acceptable, disapproval with comments and/or modifications, or notice of intent to draft and approve, for any work plan, report (except progress reports), specification or schedule submitted pursuant to or required to be submitted for EPA approval pursuant to this Order.
2. EPA may reject in writing and not comment on any submittal which EPA determines is not acceptable. Submittal of a document which is not acceptable is a violation of this Order, unless such document is resubmitted prior to or on the due date for each submittal and EPA determines that the resubmitted document is acceptable.
3. Respondent shall revise any work plan, report, specification or schedule in accordance with EPA's written comments. Respondent shall submit to EPA any revised submittals within fifteen (15) calendar days upon receipt of EPA written comments or in accordance with a due date specified by EPA. Revised submittals are subject to EPA approval, approval with conditions, rejection as not acceptable, disapproval with comments and/or modifications, or notice of intent to draft and approve.
4. Any report, work plan, specification or schedule approved by EPA, including those drafted by EPA, shall be automatically incorporated into this Order upon written approval.
5. Prior to written approval, no report, work plan, specification or schedule shall be construed as approved and final, except as otherwise expressly provided in the Imminent Threat provisions of this Order. Oral advice, suggestions, or comments given by EPA will not constitute an official approval, nor shall any oral

approval or oral assurance of approval be considered binding on either party, except as otherwise expressly provided for elsewhere in this Order.

6. Within thirty (30) calendar days of Respondent's receipt of written approval, or approval with modifications of any Work Plan, or receipt of a document drafted by EPA after failure by Respondent to draft an approvable document, Respondent shall commence work to implement the tasks required by the Work Plan in accordance with the standards, specifications and schedules set forth in the Work Plan approved by EPA.
7. EPA shall review all draft or final reports or Work Plans, and notify Respondent in writing of EPA's determination regarding the report, work plan or any part thereof. Within thirty (30) calendar days of receipt of EPA's disapproval of a report, Respondent shall amend and submit a revised report, unless an extension is requested by Respondent and granted by EPA.

K. ADDITIONAL WORK

1. Based upon new information and/or changed circumstances, and with regard to releases of hazardous waste or hazardous constituents at or from the Facility, EPA may determine or Respondent may propose that certain tasks, including investigatory work, engineering evaluations, or procedure/methodology modifications, are necessary in addition to or in lieu of the tasks included in any EPA-approved work plan in order to protect human health and the environment, considering site-specific factors.
2. If EPA determines that it is necessary for Respondent to perform additional work, EPA shall specify in writing the technical support and other basis for its determination.
3. Unless Respondent is specifically directed to begin additional work immediately pursuant to the Imminent Threat provisions of this Order, within ten (10) business days of the receipt of such determination, Respondent may request a conference with EPA to discuss the additional work. If Respondent does not request such a meeting, Respondent has waived the right to a meeting. The meeting will be held within ten (10) business days of request.

4. If required by EPA, Respondent shall submit for EPA approval a work plan for additional work or revise an existing work plan. Such work plan(s) shall be submitted within sixty (60) calendar days of receipt of EPA's determination that additional work is to be performed, or according to an alternative schedule established by EPA.
5. Upon approval of a work plan modified to reflect additional work, Respondent shall implement the work plan in accordance with the revised schedule and provisions contained therein.

L. PROPOSED CONTRACTOR/CONSULTANT

1. All work performed pursuant to this Order shall be under the direction and supervision of a professional engineer registered in Montana, hydrogeologist, geologist, or environmental scientist, with expertise in hazardous waste site investigations and remediation. This person shall have the technical expertise sufficient to perform and/or direct all aspects of work for which he or she is responsible.
2. Within fourteen (14) days of retention by Respondent of a contractor different from Barr Engineering, Respondent shall notify EPA in writing of the name, title, and qualifications of the engineer, hydrologist, geologist, or environmental scientist and of any contractors and/or consultants Respondent then plans to use in carrying out the terms of this Order.
3. EPA hereby approves the use of Barr Engineering to undertake the consulting work for Respondent, but reserves the right to disapprove for sufficient cause, any other contractor/consultant that Respondent may identify in the future. If EPA disapproves of an identified contractor/consultant, then Respondent must, within thirty (30) days of receipt of written notice of disapproval, notify EPA, in writing, of the name, title, and qualifications of any replacement.

IX. QUALITY ASSURANCE

- A. All sampling and analytical activities undertaken pursuant to this Order shall follow EPA-approved quality assurance, quality control, and chain-of-custody procedures, which procedures shall be part of the Work Plan.

- B. In addition, Respondent shall, except to the extent alternate arrangements have been made with and approved by EPA:
1. follow EPA QA guidance for sampling and analysis contained in the document entitled "U.S. EPA Region VIII Minimum Requirements for Field Sampling Activities" September 1996;
 2. consult with the EPA Project Manager in advance regarding which laboratories will be used by Respondent and use its best efforts to ensure that EPA personnel and EPA-authorized representatives have reasonable access to the laboratories and personnel used for analyses;
 3. require that laboratories used by Respondent for analyses perform such analyses according to EPA methods as found in "Test Methods for Evaluating Solid Wastes," Third Edition (SW-846), or other methods approved by EPA, which such other methods will be identified in advance and approved in writing by EPA if not addressed in an approved Work Plan. If methods other than SW-846 are proposed, Respondent shall submit all alternative protocols to EPA at least forty five (45) calendar days prior to the commencement of analyses for EPA approval;
 4. require that laboratories used by Respondent for analyses have a quality assurance/quality control program at least equal to that which is followed by EPA. As part of such a program, and upon written request by EPA, Respondent shall cause such laboratories to perform analyses of samples provided by EPA to demonstrate the quality of the analytical data; and
 5. Use EPA guidance to evaluate all data to be collected during the implementation of this Order. This evaluation shall be provided to EPA as part of the sampling plan contained in each Work Plan and shall be updated as necessary.
- C. Existing data may be evaluated by EPA for adequacy based on technical quality, to support all CC/RA and RFI Report analyses and conclusions, and development and evaluation of the corrective measures alternatives. Guidance documents on data quality analysis and data collection methods shall be used as guidelines to assess the quality of existing data, with EPA's best scientific and engineering judgments used as the determining factor on data quality.

X. PUBLIC PARTICIPATION

- A. Respondent shall develop a Public Participation Plan in consultation with EPA and using the “RCRA Public Participation Manual”, September 1996, as guidance and submit the plan to EPA within sixty (60) days of the effective date of this Order. The public participation plan shall assess the community’s concerns, obtained through community interviews and identify ways to address those concerns.
- B. The following activities must be addressed in the Public Participation Plan:
 - 1. Creating, using, and updating a mailing list of the affected community and other stakeholders;
 - 2. Providing the name and telephone number of a person who may be contacted and is responsible for providing information concerning the implementation of this Order to the public;
 - 3. Maintaining an easily accessible repository (such as in a local town hall or public library) for documents relating to the Order, including approved work plans and reports; and
 - 4. Informing the public when substantial decisions are made, and when RFI Summary Reports have been submitted to EPA and placed in the locally established repository and at other important points in the process.
- D. All activities, work products, and information material for public release developed pursuant to this Order, will be submitted by Respondent to EPA for review at least fourteen (14) days prior to public release and implementation. Respondent shall provide information to the public and conduct public activities following the receipt of EPA approval.

XI. QUARTERLY PROGRESS AND NEW INFORMATION REPORTS

- A. The Quarterly Progress Reports deliverable pursuant to this Order shall be sent to EPA no later than the tenth day of the third month of each quarter (March 10, June 10, September 10, December 10) and shall at a minimum:
 - 1. describe the actions, progress, and status of projects which have been undertaken pursuant to this Order;

2. identify any requirements under this Order that were not completed in a timely manner, and problem areas or anticipated problem areas affecting compliance with the Order;
 3. describe projects completed during the prior quarter, as well as the activities scheduled for the next quarter;
 4. describe and estimate the percentage of the studies completed;
 5. include a description and summaries of all findings;
 6. describe actions being taken to address and rectify problems;
 7. identify changes in key personnel during the reporting period; and
 8. include copies of the results of sampling and tests conducted and other data generated pursuant to work performed under this Order since the last Progress Report. Respondent may also submit data that has been validated and confirmed by Respondent to supplement any prior submitted data. Updated, validated, and confirmed data shall be included with the RFI Report if not delivered before.
- B. Respondent shall notify EPA in writing of any newly-identified AOCs, SWMUs, or potential SWMUs, discovered during the course of groundwater monitoring, field investigations, or other means, no later than fifteen (15) calendar days after discovery.
- C. In the event Respondent identifies a potential imminent threat to human health or the environment, Respondent shall comply with the Imminent Threat provisions of this Order.
- D. Respondent's responsibilities regarding information relevant to financial assurance are set forth in Section XIII.

XII. CORRECTIVE ACTION MANAGEMENT UNIT OR CAMU

Respondent may request designation of an area at the Facility to manage CAMU-eligible wastes. Such request shall be submitted to EPA in writing with supporting information as determined necessary by EPA. In accordance with 40 C.F.R. § 264.552, EPA may approve or reject the proposed CAMU designation after reviewing Respondent's written request and other pertinent submittals. EPA will

inform Respondent in writing of its determination regarding any request for a CAMU designation.

XIII. FINANCIAL ASSURANCE AND GUARANTY

A. FINANCIAL ASSURANCE

1. Respondent agrees to provide and maintain during the pendency of this Order financial assurance in an amount equal to the total of all cost estimates for the performance of work to be performed pursuant to this Order and the 7003 Order upon the following schedule:
 - a. With regard to the 3008(h) Order, financial assurance shall be demonstrated within sixty (60) days of EPA's approval of any RFI Work Plan, imminent threat (IT) Work Plan to the extent a work plan is required by EPA and the work is not expected to be completed within sixty (60) days of approval of the IT Work Plan, IM Work Plan, Additional Work Work Plan, CMS Work Plan, and CMI Work Plan in an amount equal to the total of the cost estimate for the work to be performed under such approved Work Plan. If, however, there is dispute resolution or judicial review under Section XXIII of EPA's decision on any of these Work Plans, Respondent shall demonstrate the financial assurance within sixty (60) days of EPA's decisions being upheld or mutually agreed to.
 - b. With regard to remedial work under the 7003 Order, financial assurance shall be demonstrated within ninety (90) days of approval of each Waste Plan remedy under the 7003 Order. If, however, judicial review is had of EPA's decisions under the 7003 Order, Respondent shall demonstrate the financial assurance within ninety (90) days of EPA's decision(s) being upheld or mutually agreed to.
2. Except as allowed under Section XIII. B. 2. below, financial assurance may only be provided by one or more of the following: performance or surety bond, liability insurance, an escrow performance guarantee account, a letter of credit, or trust fund, as these mechanisms generally are described for closure and post-closure financial assurance under 40 C.F.R. Part 264. EPA

will review any submitted financial assurance document and either approve or disapprove such document. Any disapproval will be subject to Section XXIII.

3. Respondent shall develop and maintain a single cost estimate annually for the remaining work to be performed pursuant to this Order. Annual cost estimates after the initial year of the demonstration for each remedy shall include an adjustment for inflation in accordance with 40 C.F.R. 264.142. Annual cost estimates shall be submitted with the first Quarterly Progress Report of the year.
4. In any calendar year, if Respondent can show that the estimated cost to complete the remaining work under any work plan has diminished below the amount calculated at the end of the prior calendar year (or as previously recalculated during the calendar year), Respondent may submit a proposal for reduction to EPA, and may reduce the amount of the financial assurance upon approval by EPA, consistent with 40 C.F.R. Part 264, Subpart H, as if such requirements apply to corrective measures.
5. In any calendar year, if Respondent becomes aware, or should become aware, that the estimated cost to complete the remaining work under any work plan has increased by ten percent (10%) or more above the amount calculated by the end of the prior calendar year, such increase shall be reported and documentation of financial assurance for that increase shall be provided in the next due Quarterly Progress Report.
6. Should any change(s) in circumstances occur which causes, or Respondent anticipates might reasonably cause in the short term, the financial assurance mechanism(s) then in place to fail to meet the requirements of this Section, Respondent shall immediately either begin use of a different means for financial assurance, or upgrade its existing affected mechanism(s) to bring it into compliance. Respondent shall have no more than sixty (60) days from the date on which Respondent became aware or should have become aware of such change(s), to comply with this paragraph. Further, Respondent shall provide notice of such change in circumstances in the next due Quarterly Progress Report, or pursuant to the Imminent Threat provisions of this Order if appropriate.

7. Respondent's inability to maintain financial assurance hereunder at any time during the pendency of this Order shall not excuse or be a defense to allegations of failure to perform any requirements of this Order.
8. In the event of a dispute regarding financial assurance, Respondent may only lower the amount of and/or alter the form of the financial assurance in accordance with determinations made by the ARA and the Court under Section XXIII, or mutually agreed to resolution of the dispute.

B. PARENT GUARANTY

1. By signing below, the Guarantor, which is Rhodia SA the parent of Respondent, represents and warrants that it will be responsible for undertaking and paying for all work under this Order that Respondent is unwilling to undertake or pay for, or unable to undertake or pay for due to insolvency, corporate dissolution, or otherwise. In that event, Respondent's obligations and rights of this Order shall become the obligations and rights of Rhodia SA, and Rhodia SA will thereafter be considered the "Respondent" hereunder. The Guarantor hereby submits to the jurisdiction of the United States District Court for the District of Montana for the purpose of perfecting this Guaranty.
2. At the time the Guarantor assumes the obligations and rights of Rhodia Inc. pursuant to Section XIII.B.1. above, the Guarantor, as Respondent, is expected to and shall cause to be maintained any existing financial assurance obligations, unless and until EPA approves any changes proposed by the Guarantor as Respondent. In addition, subsequent to the Guarantor's assumption of the obligations and rights of Rhodia Inc., the Guarantor as Respondent shall provide any additional financial assurances required under Section XIII.A. above as such obligations thereafter become due pursuant to this Order. After assuming the obligations and rights of Rhodia Inc., the Guarantor, unlike Rhodia Inc., may propose to provide financial assurance based on the financial test and corporate guarantee mechanism.

C. CHANGED FINANCIAL CONDITIONS

1. In the Quarterly Reports required under Section XI, Respondent shall identify any substantial and material change in the financial conditions of itself or the Guarantor that could potentially threaten the ability of Respondent to provide and maintain the financial assurances set forth in Section XIII. A. or of the Guarantor to provide and maintain the guaranty in Section XIII.B. An annual report of the financial condition of Rhodia SA shall also be provided to EPA, which will be considered satisfied by inclusion of Rhodia SA's semi-annual financial statements on its web site ("www.Rhodia.com") and notice to EPA's project manager that such statements have been posted in the prior quarter or will be posted in the future quarter. In addition to the notice required under Section II. E., Respondent shall also notify EPA in the Quarterly Reports of any corporate reorganization or divestiture of Respondent or Rhodia SA that could result in the transfer of Respondent's or Rhodia SA's obligations to another entity.
2. Based on the foregoing information or otherwise, and after conferring with Respondent, EPA may require Respondent to modify the financial assurance and guaranty requirements set forth in Sections XIII. A. and B. above, subject to the provisions of Section XXIII regarding such requirement. Any requirement by EPA to modify the financial assurance and guaranty requirements, and any judicial affirmance of such a modification, shall be based on and consistent with a finding that there has been a substantial and material change in the financial condition of the Respondent, or a substantial and material change in the corporate structure or ownership of either Guarantor or Respondent, that threatens the ability of Respondent to provide and maintain the financial assurances in Section XIII. A. or of the Guarantor to provide and maintain the guaranty in Section XIII. B.

XIV. ON-SITE AND OFF-SITE ACCESS

- A. Upon reasonable notice, and at all reasonable times, EPA, and/or any authorized EPA representative shall be authorized to enter and freely move about all property at the Facility during the effective dates of this Order for the purposes of, inter alia: interviewing Facility personnel and contractors regarding information relevant to the

implementation of this Order; inspecting records, operating logs, and contracts related to this Order; conducting tests, sampling or monitoring; using a camera, sound recording, or other documentary type equipment verifying the reports and data submitted to EPA by Respondent; and any other activities to review the progress of Respondent in carrying out the terms of this Order.

- B. Respondent shall permit such persons to inspect and copy all files, photographs, documents, and other writings, including all sampling and monitoring data, that pertain to work undertaken pursuant to this Order. To the extent that such information is considered by Respondent to be business confidential or proprietary, Respondent shall so advise such persons in writing. Notwithstanding the above, EPA's right to inspect, conduct interviews, etc. under this Section XIV does not extend to materials that are protected by the attorney-client or attorney-work-product privileges. For purposes of the Order, documents prepared by non-lawyers relating to work under this Order will not be considered privileged except for draft documents prepared for the review by Respondent's lawyers in connection with submissions hereunder, and any document when prepared for use in evaluating or presenting Respondent's position in any dispute resolution or judicial review process in Section XXIII or in anticipation of any litigation by a third-party.
- C. EPA shall provide Respondent with split samples of any samples taken by EPA.
- D. To the extent that work required by this Order, or by any approved Work Plans prepared pursuant hereto, must be done on property not owned or controlled by Respondent, Respondent shall use its best efforts to obtain site access agreements from the present owner(s) of such property within thirty (30) days following transmittal of the Work Plan to EPA.
- E. "Best efforts" as used in this Section shall include, at a minimum, a certified letter (showing actual receipt) from Respondent to the present owner(s) of such property requesting the execution of reasonable access agreements to permit Respondent and EPA and their authorized representatives to obtain access to such property.
- F. Any such access agreement shall be submitted to EPA with the next following Quarterly Progress Report.

- G. In the event that agreements for access are not obtained within thirty (30) days of the date of receipt of Respondent's certified letter to the property owner, Respondent shall notify EPA in writing within seven (7) days thereafter regarding both the efforts undertaken to obtain access and its failure to obtain such agreements. EPA may, at its discretion, assist Respondent in obtaining access.
- H. Nothing in this section limits or otherwise affects EPA's right to access and entry pursuant to applicable law.
- I. Nothing in this section shall be construed to limit or otherwise affect Respondent's liability and obligation to perform work required under this Order including such work required beyond the facility boundary, notwithstanding the lack of access.

XV. SAMPLING AND DATA/DOCUMENT AVAILABILITY

- A. Unless notified by EPA in writing, Respondent shall submit to EPA the results of sampling and/or tests or other data generated by, or on behalf of Respondent, in the Quarterly Progress Reports. In addition, Respondent shall submit to EPA the results of all validated and confirmed sampling and/or tests or other data generated by, or on behalf of Respondent performed pursuant to this Order, with the RFI Report, if not before.
- B. Respondent shall notify EPA in writing at least seven (7) calendar days before conducting any well drilling, installation of equipment, or sampling. Respondent shall provide a reasonable amount of, or allow EPA or its authorized representatives to take, split samples of all samples collected by Respondent pursuant to this Order.
- C. Except as noted below, Respondent may assert a business confidentiality claim covering all or part of any information provided to EPA or its representatives pursuant to this Order. Any assertion of confidentiality shall be substantiated by Respondent when the assertion is made, or the right to assert the claim shall be waived. Physical or analytical data either generated and/or submitted pursuant to this Order cannot be claimed confidential and/or privileged.

XVI. RECORD PRESERVATION

During the pendency of this Order and for a minimum of three (3) years from EPA approval of the CMI Summary Report, Respondent shall preserve all

submittals and data generated and/or submitted in its possession or in the possession of its divisions, officers, directors, employees, agents, contractors, attorneys, successors and assigns which relate to performance under this Order or to hazardous waste management at the Facility. For a period of three (3) years from EPA approval of the CMI Summary Report, Respondent shall make such records available to EPA for inspection or copying or shall provide copies of any such records to EPA. Respondent shall notify EPA twenty (20) calendar days prior to the destruction of any such records, and shall provide EPA with the opportunity to take possession of any such records. Preservation and transfer of records under this Section is subject to the same protections for privileged documents as appears in Section XIV. B.

XVII. PROJECT MANAGERS

- A. On or before the effective date of this Order, EPA and Respondent shall designate Project Managers. Each Project Manager shall be responsible for overseeing the implementation of this Order. The EPA Project Manager shall be EPA's designated representative at the Facility. To the maximum extent possible, all communications between Respondent and EPA, and all documents, reports, approvals, and other correspondence concerning the activities performed pursuant to the terms and conditions of this Order, shall be directed to the Project Managers.
- B. The EPA project manager is:
- RCRA Project Manager for Rhodia Inc., Silver Bow Plant
U.S. EPA Region 8, Montana Office
10 West 15th Street, Suite 3200
Helena, MT 59626
- C. The Respondent's Project Manager is:
- Dan Bersanti
Rhodia Inc.
P.O. Box 3146
Butte, MT 59702
- D. The parties agree to provide at least seven (7) calendar days' notice prior to changing Project Managers.
- E. The absence of the EPA Project Manager from the Facility shall not be cause for the stoppage of work unless so directed by the Project Manager pursuant to the Imminent Threat Provisions of this Order.

- F. Pursuant to the Power of Attorney from Rhodia SA, which is Attachment 1 hereto, the Guarantor, Myron Galuskin, President of Rhodia Inc., will act as a contact for Rhodia SA and as a representative of Rhodia SA to accept service of process at the following address:

Myron Galuskin
President
Rhodia Inc.
CN 7500
Cranbury, NJ 08512-7500

XVIII. RESERVATION OF RIGHTS

- A. EPA expressly reserves all rights and defenses that it may have, including the right both to disapprove of work performed by Respondent that is not in compliance with this Order and to require that Respondent perform tasks in addition to those stated in the Work Plans required by this Order in accordance with Section VIII.K. Such disapprovals and requirements to undertake additional work are subject to the provisions set forth in Section XXIII.
- B. All statutory and regulatory powers, authorities, rights, remedies, both legal and equitable, which pertain to Respondent's failure to comply with any of the requirements of this Order, including the assessment of penalties, are reserved. Such determination of failure would be made by the court if judicial review is had under Section XXIII.
- C. Except as provided in Sections IV and XX, this Order shall not be construed as a covenant not to sue, release, waiver or limitation of any rights, remedies, powers and/or authorities, civil or criminal, which EPA has under RCRA or any other statutory, regulatory, or common law authority.
- D. Except as provided in Section XX, compliance by Respondent with the terms of this Order shall not relieve Respondent of its obligations to comply with any other applicable local, state or federal laws and regulations.
- E. This Order shall not limit or otherwise preclude EPA from taking additional action pursuant to Section 7003 of RCRA, 42 U.S.C. § 6973, should EPA determine that such actions are warranted to address an imminent and substantial endangerment not known by EPA at the time of this Order, and such endangerment is not being addressed effectively by this Order or the 7003 Order.

- F. Except as provided in Section XX, this Order is not intended to be nor shall it be construed as a permit, and this Order does not relieve Respondent of any obligation to obtain and comply with any local, state, or Federal permit.
- G. In the event Respondent fails to adequately perform work pursuant to this Order, including the submittal of acceptable documents, EPA reserves the right to perform any portion of the work required hereunder or any additional site characterization, feasibility study, and response or corrective actions as EPA deems necessary or appropriate to protect human health and the environment considering site-specific factors, including drafting final work plans and other documents, which become binding on Respondent upon notice by EPA, subject to the provisions of Section XXIII.

XIX. OTHER CLAIMS AND PARTIES

Except with regard to the protections accorded Respondent under Section VI. -- Statement of Purpose and Integration of Remedial Authorities, and Section XX. -- Other Applicable Laws, nothing in this Order shall constitute or be construed as a release from any claim, cause of action or demand in law or equity, against any person, firm, partnership, or corporation for any liability it may have arising out of or relating in any way to the generation, storage, treatment, handling, transportation, release, management or disposal of any hazardous constituents, hazardous substances, hazardous wastes, hazardous materials, pollutants, or contaminants found at, on, or under, taken to or from, or migrating to, from or through the Facility.

XX. OTHER APPLICABLE LAWS

The Parties recognize and agree that the storage, treatment or disposal of any hazardous waste at the Facility may continue under this Order and the 7003 Order without Respondent having to meet applicable hazardous waste management standards or obtain a hazardous waste management permit, and Respondent shall not be deemed out-of-compliance with any applicable law or regulation relating to hazardous waste, including the requirement to obtain a hazardous waste permit, provided Respondent is otherwise in compliance with this Order, which compliance will be determined pursuant to Section XXIII, and the 7003 Order, which compliance will be determined pursuant to Section XXIII. B. and C.

XXI. INDEMNIFICATION OF THE UNITED STATES

- A. Neither the United States, nor its agencies, departments, agents, or employees, shall be held out or construed to be a party to any contract

entered into by Respondent in carrying out activities pursuant to this Order.

- B. The United States and its agencies, departments, agents, or employees, shall not be liable for any injury or damages to persons or property resulting from acts or omissions of Respondent or its contractor(s) in implementing the requirements of this Order, or any EPA-approved work plans or planning documents submitted pursuant to this Order.
- C. The United States and its agencies, departments, agents, or employees, shall not be considered an agent, independent contractor, receiver, trustee and assign, in carrying out activities required by this Order.

XXII. SUBSEQUENT MODIFICATION

- A. This Order may only be modified or amended in writing signed by the authorized signatories below and each modification shall be effective on the date on which it is signed by EPA.
- B. Any reports, plans, schedules, and attachments required by this Order shall be incorporated into this Order upon written approval by EPA.
- C. If EPA determines that activities in compliance or noncompliance with this Order have caused or may cause a release of hazardous waste or hazardous constituents within or from the Facility, or have caused or may cause a threat to human health or the environment, or if EPA determines that Respondent is not capable of undertaking any studies or corrective measures required pursuant to this Order, EPA may order Respondent to stop further implementation of this Order for such period of time as EPA determines may be needed to abate any such release or threat and/or to undertake any action which EPA determines is necessary to abate such release or threat.
- D. No informal advice, guidance, suggestions, or comments by EPA regarding reports, plans, specifications, schedules, and any other writings submitted by Respondent will be construed as relieving Respondent of its obligations to obtain written approval, if and when required by this Order.

XXIII. DISPUTE RESOLUTION AND JUDICIAL REVIEW

A. DISPUTE RESOLUTION

1. If Respondent disagrees, in whole or in part, with any decision made or action taken pursuant to this Order, Respondent shall notify EPA's Project Manager of the dispute in writing within fourteen (14) days of receipt of the decision or notice of the action.
2. The Project Managers will attempt to resolve the dispute informally within ten (10) business days. If the Project Managers cannot resolve the dispute informally, Respondent may pursue the matter formally by placing its objections in writing and placing them in the mail within fourteen (14) days of the close of business of the tenth business day of informal dispute. The written description must set forth the specific points of the dispute.
3. EPA and Respondent shall then in good faith attempt to resolve the dispute through formal negotiations within fourteen (14) days of EPA receipt, or longer if agreed in writing by EPA. During formal negotiations, either party may request a conference with appropriate senior management to discuss the dispute, which opportunity to confer shall not be unreasonably refused.
4. If the parties are unable to reach agreement within this fourteen (14) day period, Respondent may submit additional written information to the Assistant Regional Administrator for Enforcement, Compliance and Environmental Justice ("ARA") within twenty-one (21) days of the close of the fourteen (14) day period described in Section XXIII.A.3. EPA will maintain a record of the dispute, which will contain all statements of position and any other documentation submitted pursuant to this Section. The ARA may allow submission of relevant supplemental statements of position by Respondent. Based on the record, EPA will respond to Respondent's arguments and evidence and place such response in the record, with a copy to Respondent. After review of the record of dispute as supplemented, the ARA shall provide Respondent with EPA's written decision on the dispute signed by the ARA.

- a. If EPA believes Respondent has undertaken dispute resolution in bad faith and desires a determination of same by the ARA, EPA shall include a statement of position with support regarding bad faith, to which Respondent may respond. When deciding the issues raised under this Section XXIII.A., if requested by EPA, the ARA will also determine whether Respondent's request for dispute resolution, as asserted by EPA, has been in bad faith, and provide such determination in writing to EPA and Respondent.
5. Any agreement or decision made pursuant to this Section by EPA shall be reduced to writing, shall be deemed incorporated into this Order without further order or process, and shall be binding on the parties, subject to the excused performance in Section XXIII.C.2.

B. JUDICIAL REVIEW

1. Judicial review of EPA's decisions and actions pursuant to this Order and the 7003 Order would be on the record and pursuant to 5 U.S.C. § 706, and shall be in the United States District Court for the District of Montana, and if appealed, in the United States Court of Appeals for the Ninth Circuit.
 - a. If EPA determines that Respondent is in violation of a requirement that previously has been the subject of dispute resolution under Section XXIII.A., any review of such EPA determination shall be made solely upon the record made by Respondent and EPA during the dispute resolution proceedings.
2. It is EPA's position that judicial review of any order issued by EPA pursuant to Section 3008(h) or Section 7003 of RCRA is only available when EPA initiates an enforcement action for violation of such orders; it is Respondent's view that such review is available without EPA having to initiate such enforcement action. The Parties reserve their rights to advocate their respective positions on this matter in any proceeding under Section XXIII.B.
3. Respondent agrees that compliance with this Order and the 7003 Order is a condition of probation as set forth in the Plea Agreement in United States v. Rhodia Inc. (D. MT). After

completion of dispute resolution as set forth in Section XXIII.A. for this Order, and judicial review under Section XXIII.B.1 for this Order or the 7003 Order, if EPA determines that Respondent has failed to comply with this Order, EPA may refer the matter to the U.S. Probation Office for the District of Montana. The U.S. Probation Office may then petition the U.S. District Court pursuant to Federal Rule of Criminal Procedure 32.1, to seek revocation or modification of the condition of probation.

C. GENERAL PROVISIONS RELATING TO DISPUTE RESOLUTION AND JUDICIAL REVIEW

1. Within twenty (20) days of receipt by Respondent of the ARA's written decision pursuant to Section XXIII.A. or a written decision under the 7003 Order, Respondent shall advise EPA in writing of its intent to comply or not comply with the decision.
2. During the period of dispute resolution under Section XXIII.A. and judicial review under Section XXIII.B., Respondent shall be excused from performing the requirements, obligations, and deadlines that are the subject of the dispute resolution and judicial review processes, except: (1) regarding the 3008(h) Order, to the extent the District Court affirms any finding by the ARA that Respondent requested dispute resolution in bad faith; or (2) regarding the 7003 Order, to the extent the District Court, on request of EPA, finds that Respondent's refusal to comply in order to expedite judicial review is in bad faith. During the period of dispute resolution under Section XXIII.A. and XXIII.B., Respondent shall not be excused from performing the requirements, obligations or deadlines that are not the subject of the dispute resolution process.

XXIV. FORCE MAJEURE

- A. Respondent shall perform the requirements of this Order within the schedules and time limits set forth herein, unless performance is prevented or delayed by events which constitute a force majeure. A force majeure is defined as any event, arising from causes not reasonably foreseeable and beyond the control of Respondent, which could not be overcome by due diligence and which delays or prevents performance by a date required by this Order. Respondent shall have the burden of raising and of proving such a force majeure.

- B. Within seventy-two (72) hours of the time that Respondent knows or has reason to know of the occurrence of any event which Respondent has reason to believe may prevent Respondent from timely compliance with any requirement under this Order, Respondent shall provide verbal notification to EPA. Within seven (7) calendar days of the time that Respondent knows or has reason to know of the occurrence of such event, Respondent shall submit to EPA a written description of the event causing the delay, the reasons for and the expected duration of the delay, and actions which will be taken to mitigate the duration of the delay.
- C. EPA's decision to agree or disagree that a force majeure has occurred, or the agency's decision to approve or disapprove Respondent's proposed actions for mitigating the delay shall be submitted to the Facility in a written response.

XXV. TERMINATION AND SATISFACTION

The provisions of this Order shall be deemed satisfied upon Respondent's receipt of written notice from EPA that EPA has approved the CMI Summary Report. At that time, this Order shall terminate except the requirements will remain in effect in Section XVI -- Record Preservation.

XXVI. EFFECTIVE DATE

The effective date of this Order shall be the date on which this Order is accepted as a term of probation at the time of sentencing by the United States District Court for the District of Montana.

**FOR THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY,
REGION 8,
CO-COMPLAINANT.**

Date: 12/22/03 By: Eddie A. Sierra for/
Carol Rushin, Assistant Regional Administrator
Office of Enforcement, Compliance and
Environmental Justice

**FOR RHODIA INC.
RESPONDENT.**

Date: 12/18/03 By: SIGNED
Myron Galuskin
President, Rhodia Inc.

**FOR RHODIA SA
GUARANTOR.**

Date: 12/18/04 By: SIGNED
Myron Galuskin
President, Rhodia Inc.
As Authorized Agent for Rhodia SA

**THIS DOCUMENT WAS FILED IN THE REGIONAL HEARING CLERK'S
OFFICE ON DECEMBER 22, 2003.**

Appendix C

Team Members

Appendix C

Team Members

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Fred Ellerbusch – Director, Remediation, Redeployment, and Real Estate

Jeffery Lang – Attorney

Dan Bersanti – Plant Manager

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Appendix D

Short-term Effectiveness – Worker Risk Evaluation

Appendix D

Short-term Effectiveness - Worker Risk Evaluation Supplemental Waste Plan

Inherent in most of the evaluation criteria is the concept of risk. Under short-term effectiveness, the health and safety risks from construction and implementation of the decommissioning alternative are considered. The criterion of reduction of toxicity, mobility and volume considers the risks that may remain from the material of concern after the decommissioning is completed. The criterion of implementability considers how long the current perceived risk of phosphine and fire generation would remain until the decommissioning option is completed.

These risk concepts are considered for each alternative evaluated in this Supplemental Waste Plan. In some cases, just outlining the risk concept relates immediately to common practical experience and enables a simple and obvious choice to emerge. In other cases, the various activities required to implement the alternative and the inherent risk factors involved with each activity are more complex. Nonetheless, in this Supplemental Waste Plan, Solvay identifies the activities associated with each alternative and evaluates the short-term risk of fatality and serious injury for each.

For each remedial alternative, the principal construction activities associated with that alternative are identified based on the collective experience of the Solvay team with other remediation, construction, and decommissioning activities, especially considering sites with phosphorus-bearing materials.

The principal foundation for the risk rates in this Supplemental Waste Plan is derived from a report from the Oak Ridge National Laboratory study entitled: “Methodology for Assessing Worker Risks During Remediation at the United States Department of Energy’s Hazardous Waste Sites” (Datskou & Sutherland, 1995). It describes a case study in which the risk assessment method developed by the Oak Ridge Center for Risk Management is applied to a sample site. The following section provides a brief overview of information used from that study and explains the development of the site-specific risk rates used in the Waste Plan.

1.0 Risk Rate Development

The risk calculations in this Waste Plan focus on the potential risk of either: 1) fatality or long-term disabling injury (hereafter referred to simply as “fatality”), or 2) serious, time-lost injury (hereafter referred to simply as “serious injury”). For this analysis, serious injury is defined as temporary

disability or loss of at least one day of work. Accordingly, calculation of the frequencies of occurrence of the risks associated with the activities required to implement an alternative (*e.g.*, moving materials, filling drums) are subdivided into two categories: one for fatalities and one for serious injuries. The risks for all the activities that make up an alternative are summed for each of these two separate categories to obtain a total risk estimate for each category for the alternative (expressed, for example, as 8.9 E-03, for serious injury and 2.4 E-04 for fatalities).

The development of risk rates for the implementation of remedial alternatives at the Silver Bow Plant involves several assumptions and conventions. Table 1 provides summary documentation of the basis for each of the frequencies of the risks associated with the major component activities of the studied alternatives. This table also includes references for each of the risk rates chosen. The basis for these choices is explained in more detail below.

1.1 Oak Ridge National Laboratories Risk Rates

The risk rates used in this Waste Plan for construction work were based on the rates in a study entitled “Methodology for Assessing Worker Risks during Remediation at the United States Department of Energy’s Hazardous Waste Sites” (Datskou & Sutherland 1995). This study, released June 13, and presented at the July 29-August 2, 1995 Summer National Meeting of the American Institute of Chemical Engineers (Session 15d), is closely related to a study entitled “U.S. Department of Energy Worker Health Risk Evaluation Methodology for Assessing Risks Associated with Environmental Restoration and Waste Management” (Blaylock, *et al* 1995). The Blaylock, *et al.* paper, though not cited directly by Datskou and Sutherland, has J. Sutherland as a coauthor, and appears to be the parent document from which the risk rate information was adopted for their case study at a specific Oak Ridge site.

The Datskou and Sutherland paper selected the risk rates they deemed most appropriate for evaluating remediation construction activities. They condensed the information given in the Blaylock paper into a set of four risk values, two for construction-related accidents and two for heat stress. The first two, for construction-related accidents, were a fatality risk of 1.65 E-7 per person-hour and an injury risk rate of 4.6 E-5 per person-hour. Unlike the evaluation in this Waste Plan that only considers serious injuries involving loss of one day or more of work, injury in the Datskou and Sutherland case study included all reported injuries, without regard to the seriousness of the injury. These rates were applied for all construction and operational activities in the example case study, including work involving earth-moving equipment, electrical work, constructing buildings, and demolishing structures. The study assumed that all operations requiring personal protective

equipment (PPE) would be using it. (The implication is that if the PPE were not used for the more dangerous activities, higher risk rates for the “unprotected” workers would have been appropriate). The second two risk values were for heat stress, are in addition to the construction risk rates, and are applicable when PPE is employed in any portion of the construction work. The risk rates related to heat stress selected by Datskou and Sutherland were a fatality risk of 1.6 E-9 per person-hour and a heat stress illness rate of 2.6 E-7 per person-hour.

The methodologies for computing worker risks are described in detail in the Blaylock, et al. Study (1995). As with the risk analysis methods commonly used by the EPA for evaluating long-term risks of RCRA or CERCLA remediation plans, the Department of Energy site-restoration risk estimation method identifies a risk rate for each short-term worker exposure scenario and then multiplies the rate by the number of person-hours estimated for the subject activity. The total risk is simply the sum of the component exposures for the total construction project. To compare or prioritize remediation options, the total risks for the several alternatives are compared. This procedure has been followed in estimating the remedial construction risks and the operation and maintenance risks for the alternatives in the Waste Plan.

1.2 Site-Specific Risk Rate Development

The risk evaluation conventions and professional judgment applied in the development of the risk rates are presented in this section. The risk evaluations for the remedial alternatives consider two cases: 1) a baseline case, assuming no extra worker protection beyond the normal construction attire of long sleeved shirts, long pants, gloves, hardhat, and steel-toed boots (henceforth referred to as “baseline worker”); and 2) a “protected worker” case which assumes a project health and safety plan (HASP) is designed and implemented to mitigate the special risks associated with working with phosphorus-bearing materials. For example, in situations involving access to phosphorus at distances greater than several feet, protective gear required by the HASP would normally be a respirator for emergency escape use, continuous personal air monitoring for phosphine, and in some cases face shields for splash protection. For situations involving handling of phosphorus-bearing materials (*e.g.*, drum packaging), the protective gear would normally include silvers (fire-resistant suits) and fire-resistant gloves, continuous personal air monitoring for phosphine, a respirator for emergency escape use, and face shields for splash protection as appropriate. The development of the risk rates for the “baseline worker” case is presented below, followed by the adjustments for the “protected worker” case. For situations in which the individual risks for specific activities are extraordinary or unacceptable, special considerations must be applied. One such situation was found: the cleaning of the crude phosphorus residue from the bottom of the clarifier following removal of the clarifier

contents. In that case, no “baseline worker” scenario is developed, as the activity simply would not be performed by a worker with only baseline protections. The “protected worker” scenario is developed, however, that accounts for the level of safety risks and concomitant safety support for the activity.

“Baseline Worker” Risk Rate Basis

The risk rates for the “baseline worker” are summarized and their derivation explained in Table 1, Part A. The rationale for the important judgments and adjustments are also explained here. The baseline worker rates of injury and fatality for construction-type activities are consistent with the Oak Ridge case study (Datskou & Sutherland, 1995). This 1995 case study applied a recordable injury rate based on information from the National Safety Council, 1991. Currently, the Bureau of Labor Statistics tracks and publishes annual reports on occupational fatalities and injuries. The BLS data were used to calculate a fatality rate of $4.8 \text{ E-}8$ fatalities/person-hr (BLS 2013a) and a serious injury rate of $1.6 \text{ E-}6$ serious injuries/person-hr (BLS 2013b) for construction workers. The serious injury rate relied on the data for cases with days away from work, job transfer or restriction (i.e., more “serious injuries” rather than merely “reportable injuries”).

Most of the component activities of the alternatives for the clarifier materials are like typical construction activities. Consequently, as a starting point, a single set of fatality and serious injury rates are used to evaluate all activities that could be described as “construction-like” activities. As explained above, the serious injury risk rate of $1.6 \text{ E-}6$ and the fatality rate of $4.8 \text{ E-}8$ adopted here are based on the Oak Ridge case study and current fatality and injury statistics published by the BLS. These construction risk rates are applied to all activities associated with the alternatives studied in this Waste Plan where the worker would not have access to or directly handle phosphorus-bearing materials that have the potential to generate fire or phosphine gas. The rationale is that in such cases, the activities are essentially like standard construction activities that involve standard construction risks.

For the “baseline worker” version of the risk evaluation, risk rates are increased for situations where there is direct access to phosphorus-bearing materials, with the risk increasing the most for workers who directly handle or work very close to the phosphorus-bearing material. In these situations it is standard practice in the risk management profession to expect the risk of injury would increase due to the potential of these materials to generate fire and phosphine gas at hazardous levels when exposed to air and water (this standard practice is reflected in the “protection factors” attributed to safety gear

that is employed to mitigate these risks). To account for this, two categories of more direct exposure to hazardous materials have been evaluated for the baseline case. In the first the risk rate is multiplied by a factor of 3 to reflect the difference between the risk associated with normal construction activities and those that involve working in the general vicinity of phosphorus-bearing materials in situations where they may ignite or generate phosphine. For example, placement of subgrade material directly in the clarifier increases the risk of phosphine release, and so is assigned a risk rate 3 times higher than general construction work, such as site preparation prior to placement of the subgrade material in the clarifier. In the second category, a risk of more extreme exposure was deemed possible for those situations in which a worker would be directly handling, or working in very close proximity to phosphorus-bearing materials (*e.g.*, within a few feet of such materials). In these cases, the base construction risk rate is increased to 10 times the general construction risk rate. So, for example, drumming the clarifier material will be considered to have 10 times the risk rate of ordinary site preparation. These adjustments are only made for the “baseline worker” scenarios. Reduced risk rates are used for the “protected worker” as discussed separately below.

Not all of the activities involved in the decommissioning would be expected to have as high a set of risk rates as those of “construction-like” activities. Two notable exceptions are the restoration and revegetation task and the monitoring, cap maintenance, and inspection task (associated with alternatives involving capping of materials left in place).

The BLS reports include specific injury rates that are applicable to agricultural workers engaged in crop production. Those rates (2.5 E-6/person-hr serious injury) are similar to the rates presented for general construction (1.6 E-6/person-hr). The fatality risk for agricultural workers engaged in crop production was calculated at 1.1 E-7/person-hrs. These are the serious injury and fatality rates used to represent the risk rates for revegetation and restoration work for all alternatives.

The BLS also presents fatality rates for “services” industries, and includes injury rates for “engineering and management services”. These risk rates appear to be representative for the groundwater monitoring, report writing, cap inspection, operation and maintenance of the cap monitoring systems, and general long-term cap maintenance, required for post-closure care of cap systems. Accordingly, the rates for serious injury (4.5 E-7/person-hr), and fatality (5.7 E-9/person-hr) for post-closure work are based on these risk rates, rather than those typical of the construction industry.

The risk rates for the “baseline worker” scenarios are summarized in Table 1, Part A. The “baseline

worker” scenario risk calculations are in Appendix M. Appendix L provides the development of task durations and construction crew size estimates that are used in Appendix M.

“Protected Worker” Risk Rate Basis

A second set of risk evaluations was performed for the remedial alternatives using risk rates based on a “protected worker.” In contrast with the “baseline worker” cases described above, the “protected worker” scenario assumes that an appropriate HASP has been implemented and will limit the risk to rates similar to those not involving close proximity to hazardous materials like elemental phosphorus that is not under water (see Table 1, Part B). This means, in effect, that the protective measures selected for the workers are assumed to balance the increased risk that would be posed by the hazards of the material and activity. In terms of risk rates, the fatality risk for “protected workers” performing tasks in proximity to phosphorus-bearing materials is therefore $1.4 \text{ E-}7/\text{person-hr}$, and the serious injury risk is $4.7 \text{ E-}6/\text{person-hr}$, the same as the risk rates for “baseline workers” performing general construction. In order to account for some of the effects of using protective equipment on the total risk for implementing an alternative, three adjustments are made to the risks associated with protected worker activities: (1) the time required for task performance was increased; (2) field safety supervision was added; and (3) a risk factor from “heat-stress” was added to the risk rate. These adjustments are discussed below:

First, the length of time it takes to perform tasks using protective gear is adjusted to be greater than that without such gear. Protective gear will be more cumbersome, and the time for completing a particular task will typically increase. In addition, extra time will be needed to suit-up and suit-down at the beginning and end of each shift, meal, and break, to attend daily safety meetings, to maintain their respirators and emergency escape equipment, and to use the personal phosphine monitors. This extra time is estimated at 20 minutes, 4 times a day for suiting up and suiting down, 20 minutes for the daily safety meeting, 20 minutes over the course of the day for phosphine monitoring, and 20 minutes for safety gear maintenance. A factor of 1.4 is applied to the task duration for “protected workers” in “silvers,” workers who are handling phosphorus-bearing materials, to account for this extra time. A factor of 1.1 is applied to the task duration for “protected workers” who are several feet from phosphorus-bearing materials, do not work directly with the material, and do not wear “silvers”. This factor allows 20 minutes daily for phosphine monitoring and 20 minutes for safety meetings and safety gear maintenance. The task duration adjustments for “protected workers” are incorporated in the spreadsheets for calculation of task durations in Appendix M.

Second, safety officers, air monitoring staff, or other additional personnel are needed for HASP implementation. It was assumed this additional safety effort could be met with the equivalent of ½ an additional person per crew for the tasks that would have had a 3x risk rate applied for “baseline workers.” The additional safety effort was expected to require the equivalent of 1 additional person per crew for the tasks that would have had a 10 times risk rate applied for “baseline workers.” The application of these adjustments is shown in the spreadsheets in Appendix M.

Third, workers that wear “silvers” and other protective gear are likely to experience greater heat stress. Thus, the risk rates for “heat stress” are added to the evaluation for all “protected worker” scenarios. The calculations of risk (see Appendix M) under the “protected worker” scenarios explicitly identify the incremental heat stress risk rate. These incremental risk rates are 2.6 E-7/person-hr for serious injury and 1.6 E-9/person-hr for fatality, as presented in the Oak Ridge case study^{1/} (Datskou & Sutherland, 1995). These rates are identified as “incremental” because they are in addition to the normal construction risk rate. The Oak Ridge case study risk rates for heat stress were based on the entire worker population, even though only a portion (about 12 percent) of the workers were in protective gear. Accordingly, consistent with the Oak Ridge methodology, the heat stress increment is applied to all the construction workers in a remedial alternative in order to account for the incremental risk due to heat stress for the “protected worker” scenarios.

In summary, based upon the assumptions discussed above, the risk of implementing each alternative under this Waste Plan has been calculated both in terms of serious injury and fatality. (See Appendix M and Appendix L). One set of total risks, the baseline case, assumes the “baseline worker” scenario. The second set of total risks, for the “protected worker” case, assumes implementation of a HASP which is well-suited to each alternative, and effectively mitigates the extra risk that may otherwise be associated with working in close proximity to, or with close

^{1/} Although the injury risk rates used for this evaluation of remedial actions used serious injury rates one-tenth those for total “reportable” injuries cited by the Oak Ridge case study, an exception from this rationale is made here for the use of “heat stress” injury rates. The serious injury rate used here is the same as the “reportable” heat stress injury rate identified in the Oak Ridge case study. That is because, by their nature, heat stress injuries are more difficult to diagnose and document. Therefore, one has to rely more on practical operational experience from long-term observation of field crew behavior and results obtained from health and safety management programs to assess the likelihood of reporting of minor and major symptoms of heat stress. It is the judgment of the authors of this report that heat stress injury rates are most likely to represent cases in which symptoms were of a serious nature, otherwise the heat stress event may not have been reported. This is because recovery from minor symptoms is sufficiently rapid that the worker is often able to return to work after a short resting period. Thus, the Oak Ridge case study rates, 2.60 E-7/person-hr, were used without adjustment to represent the potential for serious injury. Fatalities are quite rare, and the quoted rate for heat-stress-related fatalities from the Oak Ridge case study, 1.60 E-9/person-hr, was also directly adopted here.

handling of phosphorus-bearing materials. Note that, for purposes of comparing the alternatives and recommending their selection in the Comparative Evaluation and Recommendation Sections of this Waste Plan, we have assumed that the workers will follow the appropriate HASP, and be properly protected for each task. Consequently, only the risks to the protected worker are considered in the Comparative Evaluation and Recommendation Sections. This way, the true risks that would be experienced are not overstated.

1.3 Non-Transportation Risk Rate Frequency Summary

Table 1, Parts A and B, summarizes all of the risk rates assumed for both the “baseline worker” that were derived from the Oak Ridge study, and the alternative set of rates used for the “protected worker” operating under an appropriate health and safety plan to mitigate the special risks associated with working with phosphorus-bearing materials.

Many of the risk rates are the same for the “protected worker” and the “baseline worker” scenarios, except that “heat stress risks are only included in the “protected worker” scenarios. It should also be noted, however, that the heat stress incremental risk is added to all the work in the “protected worker” scenarios, not just the work where protective gear is being worn, in order to be consistent with the Oak Ridge case study and its application of the methodology. That incremental risk is 1.60 E-9/person-hour for fatalities and 2.60 E-7/person-hour for injury that is, in this case, assumed to be serious if reported.

2.0 Transportation Risk Rate Frequency Summary

Three primary sources were used to determine the frequencies of transportation-related risks. The first was a thorough study performed in 1989 for transportation of hazardous waste to the Clean Harbors Rotary Kiln Incinerator facility in Braintree, MA (Battelle, 1989). The second was the U.S. DOT’s Hazardous Material Information System (HMIS), an online data system now used to track reports of hazardous waste spills and consequences (U.S. DOT HMIS 2013). The third was a report entitled Large Truck Crash Overview 2011 (USDOT 2013).

The base rate of hazardous waste shipping incidents identified in the Clean Harbors study was selected for use in the risk evaluations in this Waste Plan, because the study was carefully done to avoid the typical problems associated with self-reporting of transportation incidents that plague many databases. That incident rate of 2.5 E-6 hazardous waste truck spill incidents/mile serves as the foundation for all other transport risk calculations in this evaluation. There is a range of fatality and injury rates reported for the trucking industry. For instance, the latest DOT data indicates a rate of serious injury of 2.0 E-7 for 2010 and a rate of 2.3 E-7 for 2011, both very close to the rate adopted

here.

The Clean Harbors study did not include a rate of serious injury versus a rate of fatality. The U.S. DOT HMIS database, however, is helpful in predicting the rates of fatality and serious injury that might occur for hazardous materials incidents. HMIS contains reports of these accident consequence statistics for a ten-year period (1990-1999). For transportation incidents, we will assume that all injuries reported were potentially serious, since minor injuries would not likely be reported. The database shows that there has been a ratio of injuries to fatalities of approximately 30 to 1 for that period. That ratio was approximately the same as that found for construction-type accidents discussed earlier. For simplicity, the same 30 to 1 ratio will be utilized for all calculations. The final rates are given in Table 1, Part C.

As shown in Table 1, the fatality rate for truck transportation used in this Waste Plan evaluation is 2.5 E-9/mile . The recently available FMCSA report identifies a fatality incidence rate of 2.2 E-8/mile for all large truck crashes (incidents), which is much higher than the fatality rate in Table 1. Other data may indicate an injury to fatality ratio of approximately 25, compared with the factor of 30 noted above. However, since the rates used in Table 1 are based on information specific to the transport of hazardous materials, and reflect the additional training and care enforced for these drivers, the authors of this report believe that the rates presented in Table 1 are most appropriate for the trucks transporting phosphorus-bearing materials and returning.

To promote an easier comparison of stationary facility risk rates with those for transportation of hazardous materials to an off-site location, the published rates, which are on a “per mile” basis, were converted to a “per hour” basis. This has no effect on the risk calculated for the transportation component of the remedial alternatives (the risk is the same whether calculated on a per-mile or per-hour basis). Translating the per-mile risk rate to a per-hour risk rate requires an assumption of a transport speed, however. Since the only transport that is considered in the evaluations presented below is for relatively long distances, an average highway-dominated rate of 50 mph is assumed. This assumption is based on the expectation that the trucks are normally on interstate or other primary roads with truck speed limits ranging from 50 to 70 mph. The lower end of this range was selected to account for some secondary road transportation to and from the origin and destination, truck stops, restaurants, motels, and to account for delays caused by rush hours, accidents, highway construction, and equipment breakdown.

Since implementation of the off-site options will necessitate truck transportation outbound and a

return trip for another load, the risk for the round trip was considered. The risk rate for return empty shipments was assumed to be the same as for loaded outbound shipments. Although this assumption may appear to be counter-intuitive, the evidence given in the FMCSA report would imply that the risk rate for empty shipments is actually somewhat higher than that for the transport of hazardous materials. The returning drivers would, however be more likely to be those with the same training and expected safety performance as those transporting the waste materials off site. Therefore, to simplify the analysis, the same risk rate was applied for outbound and inbound transportation for the evaluation of remedial alternatives in this report.

Comparing adjusted values in Table 1, Part C reveals that the hourly rate of risk to the truck driver is lower than the hourly rates of risk for many of the identified on-site activities. If there is a large volume of material to be shipped, or the distances traveled are large, the total risk from that component can become a significant contribution to the overall risk.

3.0 Assessment of Risks for Incineration Activities

For those options that include shipment to an off-site incinerator, there are incremental risks to workers at the incinerator facility, due to the incremental volume of material that the incinerator workers will have to unload and convey through the incinerator. The present evaluation, therefore, applies the relevant risk rates to the activities of workers during receiving and handling operations for the volume of material that is estimated for shipment under each of the incineration alternatives.

The receiving and handling steps at the incinerator would produce additional worker exposures to risks associated with phosphorus-bearing materials. The number of hours involved in handling Silver Bow Plant shipments at the incinerator and the risk rates will be matched to the facility procedures that would be most appropriate for the clarifier material in drums, or the brick and block material in special bulk containers. Since the TSD personnel will be opening the drums of phosphorus-bearing material and handling those open drums, the risk rate is set at the same rate as that used to characterize drum filling and packaging operations.

The use of an offsite incinerator for final removal of the alleged ignitability and reactivity characteristics also raises an added question of the potential risks to the public associated with products of complete and incomplete combustion. However, Solvay has not added the risks of air emissions from the incinerator to workers or neighbors. Current permitting requirements for these incineration facilities already address compliance with air quality standards, and with allowable risks for commercial combustion facilities. The existing risk guidance requires all such facilities to

demonstrate that the long-term risk levels associated with all of their emissions does not exceed a level of 1 E-5 risk in 30 to 70 years of exposure of surrounding residents. These risk rates are far below the rates of risk under examination here for the decommissioning alternatives. Since the risk from incremental air emissions would make an insignificant contribution, they will not be included in this evaluation. However, the degree of public concern for any new activity that noticeably increases the operational load of the existing facilities can be quite significant, even if the added risks are not.

4.0 Assessment of Risk for Each Alternative

Appendix M contains risk tables, two for each of the alternatives that pass the Phase I screen of being technically and legally feasible. One table estimates the likelihood of fatalities and a second table estimates the likelihood of serious injuries. These tables are developed for both the “baseline worker” and the “protected worker” scenarios. The tables reflect the outcome of this evaluation in that they show the total risk associated with implementation of each remediation option. The tables show the general activities to be performed in completion of each alternative. The details of the construction team crew sizes and task durations for the construction activities are developed in Appendix L. The crew sizes and task durations for each activity, repeated in Appendix M, are multiplied together to arrive at the duration of exposure in person-hours. This duration is multiplied by the estimated risk rate for the activity (in risk/hour), as listed in Table 1, to arrive at the risk product. The risk products for each activity comprising the alternative are then summed to calculate the total risk product for completing the entire option, for each of the two categories: fatalities and serious injuries. Based on the individual tables in Appendix M, summary tables were also prepared, and are referenced in the discussion of the remedial alternatives.

5.0 Risk Characterization

The risk of serious injury and fatality associated with implementation is calculated for each of the alternatives passing the Phase I screening criteria. As an aid in characterizing the risk for each decommissioning alternative, a risk matrix is used to help describe, evaluate, and rank these risks. The matrix is illustrated in Table 2. This matrix method is very similar to the one recommended by the American Institute of Chemical Engineers (AIChE) for application to Process Safety Management and Risk Management Planning programs in the U.S. See Guidelines for Hazard Evaluation Procedures, Center for Chemical Process Safety of the American Institute of Chemical Engineers, Chapter 7 and § 7.1, (AIChE, 1992a); see also Plant Guidelines for Terminal Management of Chemical Process Safety, Center for Chemical Process Safety of the American Institute of Chemical Engineers, Appendix 6B (AIChE, 1992b) A very similar version was also utilized in the

A&W study just mentioned.

The matrix presented in Table 2 shows the relationship among:

- Severity of the potential injury (“minimal”, “minor”, “moderate”, and “severe”);
- Anticipated frequency of occurrence, from “very unlikely” to “very likely”, with quantitative ranges for these categories also indicated (in both absolute risk rate and percent chance of occurrence); and
- Assignment of a descriptive term for the level of risk for each combination of injury severity and frequency of occurrence. The descriptive terms, which characterize the overall risk for each combination, range from “low” to “very high”.

For instance, if the evaluation of an activity concludes that the activity could result in serious short-term injury (defined as a “moderate” risk in the matrix) and the calculated probability of occurrence was between 0.1 to 1 percent (defined as “unlikely” in the matrix), the activity would be described as a “moderately low” risk. The descriptive characterizations in the matrix are intended to be helpful for grouping risk levels, but are not intended to substitute for the quantitative risk evaluation performed for each remedial alternative. This method of cross-tabulation illustrates that the importance of a risk is not merely the frequency of occurrence, nor is it only the severity of the injury; rather, it is a combination of the two.

The frequency ranges utilized in the risk matrix are in steps of a factor of ten. This promotes easier comparisons between events that happen infrequently (“unlikely”), or quite rarely (“very unlikely”), and those that happen quite often (“very likely”). These characterizations of the relative likelihood of each frequency follow conventional approaches presented in the AICHe and A&W references mentioned above.

The risk calculations in this Waste Plan focus on the potential risk of either: 1) fatality or long-term disabling injury or 2) serious, lost-time injury. These are categorized as “severe” and “moderate” respectively in the Table 2 matrix. A quantitative estimate of the risk of fatalities and serious injuries is developed for each retained alternative. As an aid in understanding the general level of risk for construction of that alternative, the risk matrix is reviewed to select which cells of the matrix corresponds to the total risk product (likelihood) for fatalities and for serious injuries for the alternative. Thus, in addition to the quantitative probabilities calculated for fatalities and for serious

injuries the Table 2 descriptive levels of overall risk corresponding to the calculated values (*e.g.*, “very high”, “high”, “medium”, “moderately low”, or “low”) are assigned to the alternative. The outcome of the risk evaluation as reflected in each table is discussed as part of the short-term effectiveness evaluations for each decommissioning alternative later in the Waste Plan. A spreadsheet with the details of these calculations is provided for each alternative in Appendix M.

References

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Tables

Table 1
Basis for Assumptions Utilized in Short-term Risk Evaluation

Including
Part A: Baseline Worker
Part B: Protected Worker
Part C: Transportation

Part A. “Baseline Worker”

Decommissioning Activities/ Exposure Situation	Risk Rates		Reference	Comments
	Fatalities	Serious Injuries		
Site preparation or construction-like activities involving construction equipment, with no expectation of exposure to P4 or PH3	4.7 E-8/hr		Oak Ridge Case Study (Datskou & Sutherland, 1995), Uses BLS (2013) data.	Risks assumed similar to those for general construction workers, including those involved in remediation projects.
		1.6 E-6/hr	Oak Ridge Case Study (Datskou & Sutherland, 1995), Uses BLS (2013) data-(NAICS: 237), decreased by 10x	Same as above, except for a 10 x reduction to reflect difference between “recordable” and serious “lost-time” injury, based upon Silver Bow Plant injury data.
Earth-moving or other construction like activities under circumstances that allow direct access to phosphorus-bearing materials which are likely to be exposed to open air, but work is not proximately handling the material (<i>i.e.</i> , within several feet).	1.4 E-7/hr		Oak Ridge Case Study (Datskou & Sutherland, 1995), Uses BLS (2013) data, increased by 3x	The 3x increase is assumed to represent added risk in situations involving incidental exposure to uncovered phosphorus-contaminated materials and/or fugitive phosphine emissions.
		4.7 E-6/hr	Oak Ridge Case Study (Datskou & Sutherland, 1995), Uses BLS (2013) data-(NAICS: 237), increased by 3x, and decreased 10x	The 3x increase is assumed to represent added risk in situations involving incidental exposure to uncovered phosphorus-contaminated materials and/or fugitive phosphine emissions. The 10x reduction reflects the difference between “recordable” and serious “lost-time” injury rates, based upon Silver Bow Plant injury data.
Removal, handling, or container packaging of phosphorus-bearing materials with high possibility of direct contact (working within distances of several feet)	7.0 E-9/hr		Oak Ridge Case Study (Datskou & Sutherland, 1995), Uses BLS (2013) data)	BLS data: Fatal occupational injuries, total hours worked, and rates of fatal occupational injuries by selected worker characteristics, occupations, and industries, civilian workers, 2013p for the chemical manufacturing industry.
		7.0 E-7/hr	Oak Ridge Case Study (Datskou & Sutherland, 1995), Uses Solvay NA (2014 LTAR data).	Solvay NA lost time accident rate data.

Table 1 (cont.)
Basis for Assumptions Utilized in Short-term Risk Evaluation

Part A. “Baseline Worker” (Continued)

Decommissioning Activities/ Exposure Situation	Risk Rates		Reference	Comments
	Fatalities	Serious Injuries		
Final surface restoration and revegetation, (no heavy construction activity)	1.1 E-7/hr		BLS 2013 Data: Fatalities reported for Crop Production Occupations	For 2013, 210 fatalities and 1,898 million total hours worked were reported for Crop Production occupations.
		2.6 E-6/hr	BLS 2013 data (NAICS: 111), decreased 10x: Industry Injury and Illness Data - 2013: SNR05. Workers engaged in Crop Production	For 2013: the incidence rate for crop production workers was 5.2. The 10x reduction reflects the difference between “recordable” and serious “lost-time” injury rates, based upon Silver Bow Plant injury data.
Long-term monitoring, sampling, and maintenance activities, (no heavy construction activity)	5.7 E-9/hr		BLS 2012 Data: Fatalities reported for Architects and Engineering Occupations	For 2013, 34 fatalities and 5,761 million total hours worked were reported for Architecture and Engineering occupations.
		4.0 E-7/hr	BLS 2013 data (NAICS: 54162), decreased 10x: Industry Injury and Illness Data - 2013: SNR05. Workers engaged in Environmental Engineering Services.	For 2013: the incidence rate for Environmental Engineering Services was 0.8. The 10x reduction reflects the difference between “recordable” and serious “lost-time” injury rates, based upon Silver Bow Plant injury data.
Incineration Operations	5.4 E-8/hr		BLS 2013 data: Fatalities for Waste management and remediation services	For 2013, 49 fatalities and 913 million total hours worked were reported for Waste management and remediation services.
		8.0E-7/hr	BLS 2013 data (NAICS: 562211), decreased 10x:	For 2013: the incidence rate for Hazardous waste treatment and disposal was 1.6. The 10x reduction reflects the difference between “recordable” and serious “lost-time” injury rates, based upon Silver Bow Plant injury data.

Table 1 (cont.)
Basis for Assumptions Utilized in Short-Term Risk Evaluation

Part B: Protected Worker

Decommissioning Activities/ Exposure Situation	Risk Rates		Reference	Comments
	Severe (Fatal)	Moderate (Serious Injury)		
Site preparation or construction-like activities involving construction equipment, with no expectation of exposure to P4 or PH3	4.7 E-8/hr		Oak Ridge Case Study (Datskou & Sutherland, 1995), Uses BLS (2013) data.	Risks assumed similar to those for general construction workers, including those involved in remediation projects.
		1.6 E-6/hr	Oak Ridge Case Study (Datskou & Sutherland, 1995), Uses BLS (2013) data, decreased by 10x	Same as above, except for a 10 x reduction to reflect difference between “recordable” and serious “lost-time” injury, based upon Silver Bow Plant injury data.
Earth-moving or other construction like activities under circumstances that allow direct access to phosphorus-bearing materials which are likely to be exposed to open air, but work is not proximately handling the material (<i>i.e.</i> , within several feet).	1.4 E-7/hr		Oak Ridge Case Study (Datskou & Sutherland, 1995), Uses BLS (2013) data, increased by 3x	The 3x increase is assumed to represent added risk in situations involving incidental exposure to uncovered phosphorus-contaminated materials and/or fugitive phosphine emissions.
		4.7 E-6/hr	Oak Ridge Case Study (Datskou & Sutherland, 1995), Uses BLS (2013) data, increased by 3x, and decreased 10x	The 3x increase is assumed to represent added risk in situations involving incidental exposure to uncovered phosphorus-contaminated materials and/or fugitive phosphine emissions. The 10x reduction reflects the difference between “recordable” and serious “lost-time” injury rates, based upon Silver Bow Plant injury data.
Removal, handling, or container packaging of phosphorus-bearing materials with high possibility of direct contact (working within distances of several feet)	7.0 E-9/hr		Oak Ridge Case Study (Datskou & Sutherland, 1995), Uses BLS (2013) data),	BLS data: Fatal occupational injuries, total hours worked, and rates of fatal occupational injuries by selected worker characteristics, occupations, and industries, civilian workers, 2013p for the chemical manufacturing industry.
		7.0 E-7/hr	Oak Ridge Case Study (Datskou & Sutherland, 1995), Uses Solvay NA (2014 LTAR data).	Solvay NA lost time accident rate data.
Final surface restoration and revegetation, (no heavy construction activity)	1.1 E-7/hr		BLS 2012 Data: Fatalities reported for Crop Production Occupations	For 2012, 204 fatalities and 1,817 million total hours worked were reported for Crop Production occupations.
		2.6 E-6/hr	BLS 2012 Data, decreased 10x: Industry Injury and Illness Data - 2012: SNR05. Workers engaged in Crop Production	For 2012: the incidence rate for crop production workers was 5.0. The 10x reduction reflects the difference between “recordable” and serious “lost-time” injury rates, based upon Silver Bow Plant injury data.

Table 1 (cont.)
Basis for Assumptions Utilized in Short-Term Risk Evaluation

Part B: Protected Worker (Continued)

Decommissioning Activities/ Exposure Situation	Risk Rates		Reference	Comments
	Severe (Fatal)	Moderate (Serious Injury)		
Heat stress for construction work, with a portion of the workers wearing protective clothing such as tyvek.	1.6 E-9/hr		Oak Ridge Case Study (Datskou & Sutherland, 1995)	The Oak Ridge Case Study heat stress risk rates are based on the entire population of workers, about 10% of whom were in Level C protective gear. Accordingly, the heat stress risk rate is applied to all the construction workers, including those not in protective gear, in evaluating the total risk in a protected worker scenario. The heat stress risk rate should not be added to the monitoring and maintenance function, as the Oak Ridge Case Study data are not applicable to that case.
		2.6 E-7/hr	Oak Ridge Case Study (Datskou & Sutherland, 1995)	The Oak Ridge Case Study risk rates for injury are not reduced by a factor of 10, unlike the other serious injury construction rates. It is the judgment of the authors of this Waste Plan that the heat stress injury rates most likely represent cases in which symptoms were of a serious nature, otherwise the heat stress event would not have been reported.
Long-term monitoring, sampling and maintenance activities (no heavy construction activity)	5.9 E-9/hr		BLS 2013 Data: Fatalities reported for Architects and Engineering Occupations	For 2013, 34 fatalities and 5,761 million total hours worked were reported for Architecture and Engineering occupations.
		4.0 E-7/hr	BLS 2013 Data, decreased 10x: Industry Injury and Illness Data - 2013: SNR05. Workers engaged in Environmental Engineering Services.	For 2013: the incidence rate for Environmental Engineering Services was 0.8. The 10x reduction reflects the difference between "recordable" and serious "lost-time" injury rates, based upon Silver Bow Plant injury data.
Incineration Operations	5.4 E-8/hr		BLS 2013 data: Fatalities for Waste management and remediation services	For 2013, 49 fatalities and 913 million total hours worked were reported for Waste management and remediation services.
		8.0 E-7/hr	BLS 2013 data (NAICS: 562211), decreased 10x:	For 2013: the incidence rate for Hazardous waste treatment and disposal was 1.6. The 10x reduction reflects the difference between "recordable" and serious "lost-time" injury rates, based upon Silver Bow Plant injury data.

Table 1 (cont.)
Basis for Assumptions Utilized in Short-Term Risk Evaluation

Part C: Transportation

Decommissioning Activities/ Exposure Situation	Risk Rates		Reference	Comments
	Severe (Fatal)	Moderate (Serious Injury)		
Transportation by truck to TSD classified as "hazardous waste" transport. (Return trip assumed to have same rates)	2.5 E-09/mi.: or 1.3 E-07/hr		"Hazard Identification and Accident Scenario Definition" for the Clean Harbors of Braintree, Inc. Rotary Kiln Incinerator Project (Battelle, 1989), reduced by 1000 x fatality/incident ratio from: U.S. DOT Hazardous Materials Information System Database 1999 (Hourly rate assumes average 50 mph travel rate)	Hazardous waste trucking incident rate based upon study performed for Clean Harbors incinerator in 1989: 2.5 E-6/mile. Adjusted to fatality rate estimate by ratio of fatalities to accidents given in U.S. DOT HMIS Database 1999, 2000. (The latest U.S. DOT data for Large Truck incident rates also give 2.3 E-6/mile for 1997 and 2.1E-6/mile for 1998). To maintain an hourly rate basis for all risk evaluation tables, the equivalent hourly rates assume all transport averages 50 mi/hr. The 1/1000 fatality/incident ratio is derived from the ratio of 107 fatalities in the years 1990-1999, divided by the total number of incidents reported to U.S. DOT for the same years: 111,691. (For large trucks not carrying hazardous waste, the 2000 U.S. DOT fatal incident rates reported for 1997 and 1998 were 2.6E-8/mile and 2.5E-8/mile, respectively—almost exactly a factor of ten higher than that observed within the hazardous waste shipment portion of the DOT database). Data from the hazardous waste shipment database is considered most representative for current use.
		7.5 E-08/mi: or 3.8 E-06/hr	Also from Battelle (1989)-derived fatality rate above, but increased by 30x injury/fatality ratio from U.S. DOT Hazardous Materials Information System Database 1999 (Hourly rate assumes average 50 mph travel rate)	The number of injuries reported for the same 1990-1999 set of 111,691 incidents was 3080, about 30 times the 107 reported fatalities. (This injury/fatality ratio is approximately the same as that estimated for the other classes of accidents identified above for construction and related activities). (For large trucks not carrying hazardous waste, the 2000 U.S. DOT non-fatal incident rates reported for 1997 and 1998 were 5.0 and 4.5E-7/mile, respectively, about 20 times the fatality incidence rate—and about a factor of seven higher than that observed within the hazardous waste shipment portion of the DOT database). Data from the hazardous waste shipment database is considered most representative for current use.

Table 2
Short-Term Risk Evaluation Risk Ranking Description*

		Frequency/Probability of Occurrence			
		Very Unlikely (10 E-4 to 10 E-3 : 0.01 to 0.1 % chance)	Unlikely (10 E-3 to 10 E-2 : 0.1 to 1.% chance)	Likely (10 E-2 to 10 E-1 : 1 to 10 % chance)	Very likely (10 E-1 to >1.0 : 10 to >100 % chance)
Injury Severity	Minimal (No health effects)	<i>Low</i>	<i>Low</i>	<i>Low</i>	<i>Low</i>
	Minor (Temporary effects, may be OSHA recordable for worker)	<i>Low</i>	<i>Low</i>	<i>Moderately Low</i>	<i>Medium</i>
	Moderate (Serious short-term injury, with temporary disability possible, e.g., "lost days")	<i>Low</i>	<i>Moderately Low</i>	<i>Medium</i>	<i>High</i>
	Severe (Fatality, or disabling serious injury)	<i>Low</i>	<i>Medium</i>	<i>High</i>	<i>Very High</i>

* Based upon method recommended by the Center for Chemical Process Safety of the American Institute of Chemical Engineers in Guidelines for Hazard Evaluation Procedures, Chapter 7 and § 7.1, and in Plant Guidelines for Technical Management of Chemical Process Safety, App. 6B, published by AIChE, New York, 1992

Appendix E

Cost Estimate Methodology

Appendix E

Cost Estimate Methodology Supplemental Waste Plan

This appendix describes the general approach that was used to prepare cost estimates for the alternatives that are evaluated in this Supplemental Waste Plan. One of the evaluation criteria that must be considered is relative cost. EPA guidance requires that cost estimates include consideration of capital costs and annual operation, maintenance, and repair costs. These two cost components are to be combined in an estimate of the net present worth for each alternative, which is a way of allowing comparison between alternatives on the basis of a single figure.

The cost estimates for the alternatives were based on the conceptual plans that are described in this Supplemental Waste Plan. Various tasks and quantities in the estimates are not considered final or comprehensive as they are based on the conceptual plans, and it is not possible to identify every work item in this phase of the analysis. The estimates are, however, considered satisfactory for relative cost comparison purposes. Unit prices for each individual task of work item were obtained from various sources including:

- Means Site Work Cost Data;
- conversations with remediation vendors;
- contractor bids on similar work items; and
- engineering experience and judgment.

Mobilization and contingencies were applied to the capital costs for project systems as a percent of the subtotal estimated cost. Contingencies, which represent costs for items not detailed in these estimates, were applied to the operation, maintenance and monitoring costs for the alternatives as a percent of the subtotal estimated cost. Engineering and administration costs were represented by an estimated duration and monthly unit cost for the mud still alternative, rather than a percentage of construction cost. For the enhanced RCRA cap and incineration alternatives, engineering and administration costs were represented as a percentage of construction costs.

Present worth was calculated for all tasks that included long-term operation and maintenance, or monitoring. Except for financial assurance purposes discussed later, a maximum of 30 years was assumed for each present worth determination. The value of any work completed more than 30 years into the future is considered insignificant within the accuracy of these estimates compared to the costs incurred in the first 30 years. An interest rate of 5 percent was used to return future operation, maintenance, and monitoring costs to a present worth.

For cost estimation purposes, the duration of each alternative was estimated according to a reasonable time line. The estimates of capital cost included in this Supplemental Waste Plan are tied to the estimated time or quantity of work and associated unit cost.

The operation, maintenance, and monitoring cost estimates included in this Supplemental Waste Plan are presented as net present worth. The present worth estimates are based on 30 years and a net discount rate of 5 percent annually. That discount rate is consistent with EPA's guidance and the value used in this Supplemental Waste Plan. However, caution must be exercised in using net present worth cost estimates as economic forecasts. The discount rate is used here only for producing net present worth estimates that are commensurate for comparison purposes.

Post-closure care costs have been estimated consistent with 40 CFR Part 265, Subpart H. Under RCRA at 40 CFR §265.117, the post-closure period is 30 years, and the financial assurance must cover this post-closure period. *See* 40 CFR § 265.145. This time period can be shortened or extended through a permit modification process based on a demonstration and finding that the hazardous waste management unit is secure. Conversely, the time period can be extended based on a finding that after the 30 years, there is a continuing potential for migration of hazardous wastes at levels that may be harmful. *See* 40 CFR §264.17(a)(1) and (2)(i) and (ii). Solvay expects that within a few years after completion of the cap, the groundwater and phosphine monitoring data will demonstrate that the unit is secure and continued monitoring would not be necessary.

In the May 17, 2001 meeting, Solvay suggested to EPA and MDEQ that in light of this regulatory structure, it would be appropriate to base that financial assurance on a 30-year period, which could be shortened or extended pursuant to the regulations. Solvay noted that in the FMC Consent Decree, EPA adopted a 30-year post-closure to monitor its capped phosphorus-containing ponds. Indeed, EPA rejected the Shoshonee Bannock Tribe's suggestion for a longer period, noting that the period could be extended if necessary per 40 CFR § 265.117. *See U.S. v. FMC Corporation, Inc.*, Proposed Consent Decree, Response to Public Comments p.16 (3/29/99) (see Attachment 1). Therefore, Solvay

proposed to maintain financial assurance based on a 30-year post-closure monitoring period for the *in situ* decommissioning options. At the request of the EPA, however, Solvay has also estimated the cost of financial assurance for 100 years of maintenance and monitoring of the caps.

The post-closure cost estimate includes groundwater monitoring, phosphine monitoring, and maintenance operations for the alternatives involving capping of the clarifier. Note that the “representative” cost estimates assume five years of groundwater monitoring occurring each quarter, except the winter quarter (as is typical for northern climates), and then annual groundwater monitoring for years 6 through 30. Cap inspection and maintenance would continue through year 100. These post-closure costs estimates are included in Appendix N.

The “representative cost” scenarios are based on data and assumptions that appear to represent the conditions currently known or expected at the site. We have used the assumptions of quantity and tasks that underlie the “representative” evaluation for purposes of other evaluations in this Supplemental Waste Plan, such as short-term risk and time-to-complete, *i.e.*, implementation time. As a result, the “risk” and “implementation time” calculations are based on the most reasonable known or expected assumptions at the time of this submission.

Order-of-magnitude cost estimates are prepared. This evaluation considers the capital and general operation and maintenance costs associated with the alternative. Consistent with standard practice for a feasibility-level cost estimate, where very little of the detailed design is typically completed, the cost estimates are considered to be order of magnitude estimates and are expected to provide an accuracy of plus 50 to minus 30 percent for the described scope of the alternative.

The estimated costs for the capping and off-site incineration alternatives were presented in the Waste Plan (Barr 2001). In 2003, updated cost estimates for these alternatives were provided with a revised enhanced cap proposal (Rhodia 2003). The incineration cost estimate was updated to include larger drum sizes, smaller building, and reduced transportation trips. The capping costs estimates were scaled-up to account for a larger cap area. These cost estimates were then adjusted to 2013 dollars using the Engineering News-Record’s Construction Cost Index History (CCI) to adjust for inflation (Attachment 2). The value from November 2013 in the CCI (9666) was divided by the value from November 2003 (6794) to create the multiplier value of approximately 1.4, which represents an increase in cost of approximately 40 percent.

Solvay developed the cost estimate for construction and operation of the mud still. The cost estimate was based on the results of the treatability study, the conceptual design presented on Figures 3-7

through 3-9 of this Supplemental Waste Plan, and their professional experience and expertise. The costs to construct the evapotranspiration cap over the clarifier following completion of the mud still operation and the costs associated with long-term operations and monitoring were added to the mud still alternative cost estimate using the same methodology as described above (i.e., based on the estimates in the Waste Plan (Barr 2001) scaled to current dollars).

The cost of financial assurance was estimated for each alternative based on the respective detailed cost estimates. The cost of financial assurance estimates identify the activity, year, annual expense, estimated total amount for a financial assurance document, typical cost for financial assurance, and the annual cost of financial assurance. The initial total amount of financial assurance is equal to the total estimated relative cost of each alternative. The total amount of financial assurance is adjusted each year to account for the cost of the remaining activities. The annual cost of financial assurance column is summed to generate the total cost of financial assurance. The value of the elemental product product that would be recovered by the mud still alternative was not included in the cost of financial assurance. The cost of financial assurance estimates are presented in Appendix N.

The financial assurance document was assumed to be a letter of credit, but alternative documentation may be considered after the alternative is selected.

References

Barr 2001. Waste Plan. Prepared for Rhodia Inc., Submitted to EPA Region 8, November 16, 2001.

Attachment 1

Proposed Consent Decree (U.S. v. FMC Corporation) Response to Public Comments



U.S. v. FMC CORPORATION, INC.

PROPOSED CONSENT DECREE:

RESPONSE TO PUBLIC COMMENTS

Regardless of what technology is selected for the treatment plant, the treated waste must meet the strict performance standards for gas emissions, leachability of metals and permanence in the Consent Decree. FMC must demonstrate that its design can meet these performance requirements before EPA will allow it to start up the plant. Continuing operation of the LDR treatment plant will include monitoring to ensure all wastes generated meet these requirements. EPA will continue to work with FMC to ensure that the system is designed and constructed so that it will meet the performance standards specified in the Consent Decree and can be operated in a safe and protective manner. EPA also will provide the public with an opportunity to comment on the design and operating plans before approving them. The plant will not be allowed to operate unless it meets the performance requirements.

As described in the United States' Response to Comment I(A), EPA worked extensively with FMC to set the shortest possible schedule for completing the treatment plant that allows adequate time for design and construction and public input, and believes that the schedule cannot be accelerated. The Tribes were represented during these meetings.

C. Summary of Comment - Pond Closure:

The Consent Decree allows FMC to cap its hazardous waste ponds without deactivating and stabilizing the waste material. This does not meet RCRA capping requirements, which require FMC to minimize long term maintenance and to prevent to the greatest extent practicable releases to the environment. Over the past 50 years, FMC has created approximately 28 ponds filled with ignitable or reactive waste covering approximately 123 acres. Contaminants from these ponds within the soil column will continue to migrate into the aquifer. Capping the waste will not prevent contaminants from migrating into the aquifer. In addition, the Consent Decree only requires monitoring of the caps for thirty years, while the hazardous phosphorus bearing waste under these caps will remain reactive and ignitable for up to 10,000 years. Although the wastes in ponds 18A and 18B eventually will be excavated, deactivated and stabilized once FMC's treatment plant is constructed, the settlement gives FMC until 2007 to do this. Excavation, deactivation through treatment and stabilization of waste in all ponds, and certainly in active ponds 16S and 17S should occur prior to disposal.

Shoshone-Bannock Comments at pp. 13-15.

Response:

RCRA regulations give a facility the option at closure of either removing the waste from surface impoundments OR leaving the waste in place and capping the unit as a landfill. 40 C.F.R. § 265.228. Nevertheless, and at the Tribes' request, EPA went to considerable effort to determine whether the risks

associated with leaving the waste in place were sufficient to justify seeking a court order to compel FMC to remove and treat the waste. In light of the option provided at 40 C.F.R. § 265.228 to close with the waste in place and the considerable cost and technical difficulties of removing and treating waste already disposed of in the ponds, FMC made clear that it would not agree to remove and treat the waste. The Tribes were represented at a series of meetings with FMC over a period of several months during which this issue was addressed.

In evaluating the risks associated with leaving the waste in place, EPA sampled the groundwater to see if elemental phosphorus was moving into the groundwater from the ponds. To obtain analytical data regarding the mobility of phosphorus to the groundwater, EPA sampled wells at the facility for elemental phosphorus. The objectives of the sampling were 1) to determine whether the groundwater at the facility is contaminated with site related phosphorus compounds and characterize the contamination if present, and 2) determine whether the related phosphorus compounds are being discharged to the Portneuf River. The concentration of elemental phosphorus adjacent to and down gradient from Pond 8S was of specific interest as this Pond is unlined and has resulted in metal contamination of the groundwater. To achieve these objectives, on January 1 through January 15, 1998, EPA collected groundwater samples from 21 wells and a sediment sample and surface water samples from two springs down gradient. The groundwater samples were analyzed for field parameters, including dissolved oxygen, pH, temperature, specific conductivity, and oxidation reduction potential (Eh). Groundwater samples were also analyzed at the laboratory for orthophosphorous, total phosphorus, white phosphorus, nitrite and nitrate. Four samples were analyzed for total dissolved solids (TDS) and anions (chloride, fluoride, and sulfate). Spring water samples were analyzed for orthophosphorous, total phosphorus, orthophosphorous, white phosphorus, nitrate and nitrite, and Eh. Sediment samples were analyzed for total phosphorus, orthophosphorous and white phosphorus. The results of these analyses indicate that elemental phosphorus has not migrated into the groundwater as a result of releases from 8S. It appears that elemental phosphorus is relatively immobile under these conditions. These sampling results were shared with the Tribes.

In addition, because sediments in the ponds may be ignitable, reactive or radioactive, EPA determined that it would not be safe or practical to ship the waste off-site for treatment. Due to the great volume of sediment in the ponds, and the technical difficulty of removing it, treatment on-site after the treatment plant was designed and built would take many years. The cost of such on-site treatment, in excess of \$75 million, was also relevant, in that FMC would not agree to this option in settlement and the prospect of obtaining this type of injunctive relief in litigation was not assured. See Weinberger v. Romero-Barcelo, 456 U.S. 305 (1982). However, as explained below, EPA is confident

that the pond capping requirements of the Consent Decree will protect human health and the environment.

Under the Consent Decree, wastes in Pond 18 must be removed and treated in the LDR Treatment plant within 5 years after the treatment plant begins operation. This schedule was negotiated with FMC, with participation by Tribal representatives. FMC sought a longer schedule. Any acceleration of the schedule would require design and construction of a larger treatment plant, which FMC objected to. Given the extensive leak and toxic gas detection and pond management requirements for Pond 18, EPA is confident that this schedule is protective.

Also, in the event that FMC deposits in Pond 17 any phosphy waste other than precipitator slurry treated using the NOSAP process and meeting the criteria for NOSAP waste set forth in the Pond Management Plan, Pond 17 shall be subject to the same sediment removal and treatment requirements as Pond 18.

All other ponds will be closed with wastes left in place in accordance with RCRA closure regulations. The Phase IV Ponds and Ponds 15S and 16 will be closed using techniques developed by FMC for closure of pond 8S. Caps for these ponds will be more protective than what is normally required for RCRA closure and will include, in addition to a geosynthetic barrier, a seven foot capillary barrier composed of soils and sands to enhance evapotranspiration. This cap design is comparable to one being designed for radioactive waste landfills which may be dangerous for thousands of years. This is a durable largely soil based cap that promotes evapotranspiration to minimize migration of precipitation through the cap and requires little maintenance other than maintaining the vegetative cover. In addition, a leak detection and removal system will be placed between the capillary barrier and the geosynthetic to assure that the capillary barrier is minimizing migration of liquids to the geosynthetics and underlying wastes. This minimizes the potential for groundwater contamination. Long term maintenance and monitoring will be required.

Most of the waste placed in Pond 8E has been treated using the NOSAP process. Most of the waste placed in Pond 9E has been removed. These ponds do not pose the same kinds of risks that the Phase IV Ponds and Pond 15S do. Nevertheless, the Consent Decree requires a RCRA cap for these ponds which includes soil and geosynthetic components. The requirements are the same as for the Phase IV Ponds and Pond 15S except the capillary barrier is not required. The Consent Decree does not allow FMC to create new ponds which would then be closed without waste treatment.

Removal of water from the ponds is expected to significantly reduce any migration of contamination from the ponds to the groundwater by minimizing hydrostatic pressure. Capping the units will minimize the amount of precipitation

which could infiltrate the waste and carry hazardous constituents from the surface impoundments to the groundwater.

Because phosphine, hydrogen and hydrogen cyanide could be created by waste decomposition or other reactions, temperature and pressure under the caps will be measured and recorded continuously. If gases are generated at levels of concern, the gas will be collected and treated.

These features of the caps to be installed over the waste ponds are designed to minimize the need for further maintenance, and to minimize, eliminate or control releases as necessary to protect public health and the environment, and to meet other applicable RCRA requirements. FMC is required to maintain the integrity and effectiveness of the final cover. Under RCRA, post closure care must continue for 30 years. EPA may extend the post closure period as necessary to protect human health and the environment. There is no limit on extensions to the post closure period. The post closure period will be specified in the permit for the FMC facility. The public will be provided an opportunity to comment on the post closure requirements of the permit. The permit requirements for post closure will be renewed and remain in effect so long as necessary to be protective.

Under the closure and post-closure plans for the ponds, FMC will continue to analyze the monitoring wells around the ponds for elemental phosphorus after closure to ensure that phosphorus is not contaminating the ground water. In addition, sumps at each of the operating ponds will be checked weekly for the presence of leachate and the flow rate from the leachate collection wells will be evaluated to determine if it exceeds 50% of the EPA approved action leakage rate. If it does, further investigations to determine whether there are any impacts to groundwater below the pond will begin. All of these actions are described in detail in the Response Action Plans for Operating Ponds (Appendix O of the Pond Management Plan).

EPA believes that the cap construction, operation and monitoring requirements required by the Decree are protective of human health and the environment. All information obtained or developed during the course of negotiations relating to cap requirements was shared with the Tribe.

There are other ponds at the FMC facility that are not subject to RCRA hazardous waste closure requirements; these are being addressed in the CERCLA Record of Decision issued for the Eastern Michaud Flats Superfund Site ("ROD"). The Superfund program primarily focuses on cleanup of past releases of hazardous substances, and defers to RCRA to address ongoing releases of hazardous waste that are subject to RCRA regulations. The Eastern Michaud Flats Superfund Record of Decision requires the closure of older, unused ponds at the site, and is consistent with current RCRA pond closure requirement.

Attachment 2

Construction Cost Index History Engineering News-Record

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CTDOT Seeks Qualified Construction Manager/General Contractor (CM/GC) for the Norwalk River 'Walk' Bridge Replacement Project in Norwalk, CT

A "Request for Statements of Qualifications" (RSO) will be issued in the near future. Please contact Mr. John D. Hanifin, Project Manager, CTDOT, at John.Hanifin@ct.gov for information regarding the RSO.


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HOW ENR BUILDS THE INDEX: 200 hours of common labor at the 20-city average of common labor rates, plus 25 cwt of standard structural steel shapes at the mill price prior to 1996 and the fabricated 20-city price from 1996, plus 1,128 tons of portland cement at the 20-city price, plus 1,088 board ft of 2 x 4 lumber at the 20-city price.

ENR'S CONSTRUCTION COST INDEX HISTORY (1908-2014)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVG.
2014	9664	9681	9702	9750	9796	9800	9835	9846					
2013	9437	9453	9456	9484	9516	9542	9552	9545	9552	9689	9666	9668	9547
2012	9176	9198	9268	9273	9290	9291	9324	9351	9341	9376	9398	9412	9308
2011	8938	8998	9011	9027	9035	9053	9080	9088	9116	9147	9173	9172	9070
2010	8660	8672	8671	8677	8761	8805	8844	8837	8836	8921	8951	8952	8799
2009	8549	8533	8534	8528	8574	8578	8566	8564	8586	8596	8592	8641	8570
2008	8090	8094	8109	8112	8141	8185	8293	8362	8557	8623	8602	8551	8310
2007	7880	7880	7856	7865	7942	7939	7959	8007	8050	8045	8092	8089	7966
2006	7660	7689	7692	7695	7691	7700	7721	7722	7763	7883	7911	7888	7751
2005	7297	7298	7309	7355	7398	7415	7422	7479	7540	7563	7630	7647	7446
2004	6825	6862	6957	7017	7065	7109	7126	7188	7298	7314	7312	7308	7115
2003	6581	6640	6627	6635	6642	6694	6695	6733	6741	6771	6794	6782	6694
2002	6462	6462	6502	6480	6512	6532	6605	6592	6589	6579	6578	6563	6538
2001	6281	6272	6279	6286	6288	6318	6404	6389	6391	6397	6410	6390	6343
2000	6130	6160	6202	6201	6233	6238	6225	6233	6224	6259	6266	6283	6221
1999	6000	5992	5986	6008	6006	6039	6076	6091	6128	6134	6127	6127	6059
1998	5852	5874	5875	5883	5881	5895	5921	5929	5963	5986	5995	5991	5920
1997	5765	5769	5759	5799	5837	5860	5863	5854	5851	5848	5838	5858	5826
1996	5523	5532	5537	5550	5572	5597	5617	5652	5683	5719	5740	5744	5620
1995	5443	5444	5435	5432	5433	5432	5484	5506	5491	5511	5519	5524	5471
1994	5336	5371	5381	5405	5405	5408	5409	5424	5437	5437	5439	5439	5408
1993	5071	5070	5106	5167	5262	5260	5252	5230	5255	5264	5278	5310	5210
1992	4888	4884	4927	4946	4965	4973	4992	5032	5042	5052	5058	5059	4985
1991	4777	4773	4772	4766	4801	4818	4854	4892	4891	4892	4896	4889	4835
1990	4680	4685	4691	4693	4707	4732	4734	4752	4774	4771	4787	4777	4732

SOURCE FOR THE DATA HERE

ANNUAL AVERAGE

YEAR	AVG	YEAR	AVG	YEAR	AVG	YEAR	AVG
1989	4615	1988	4519	1987	4406	1986	4295

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Video

Appendix F

Letter from Dan Bersanti, Plant Manager



Silver Bow Plant

P.O. Box 3146
Butte, MT 59702
406-782-1215
406-782-4498 (FAX)

Re: Rhodia--Silver Bow Plant Operations

To Whom It May Concern:

My name is Dan Bersanti, and I am the Plant Manager of the Rhodia, Silver Bow plant. I have held this position since 1996. Before that, I held a variety of positions at the Silver Bow site. Initially hired as a process engineer, I worked in this capacity and as a production engineer until 1986. At that time, I took over responsibilities for the Maintenance Department. In 1987, I was promoted to Maintenance and Operations Manager and was responsible for all plant operations needed to produce and ship phosphorus to our downstream plants. In 1991, I became the Technical Manager for the site, responsible for all process and production engineering and all capital improvement projects. In 1996, I became Plant Manager, a position which I still hold.

The purpose of this letter is to explain the nature of the material in the clarifier and how it was processed in the roaster at the Rhodia, Silver Bow plant during its years of operation. I will also describe several technologies that were tested in the early 1980's that were designed to reduce the concentration of phosphorus in the crude phosphorus prior to the roaster operation.

The product that was produced at the Rhodia, Silver Bow plant through March of 1997 was elemental phosphorus, P₄. In simple terms, as the attached Process Flow Diagram shows, phosphate ore was nodulized (calcined) in one of two rotary kilns to produce nodules, which are a baseball sized pieces of agglomerated phosphate ore. The nodules were proportionally mixed with silica and coke and were placed into the electric arc furnaces. Electric arc furnaces, which operated at temperatures over 2500 ° F, would cause the phosphate in the nodule to be reduced to elemental phosphorus. This process resulted in a vapor stream consisting of elemental phosphorus and carbon monoxide. Calcium silicate slag and ferrophosphorus, a phosphorus and iron compound, were co-products that were either sold or stockpiled on site. The vaporized elemental phosphorus stream was condensed and called crude phosphorus (a mixture of phosphorus, water, and small particles of the furnace burden). This crude phosphorus was collected in condensers, one condenser for each furnace. The crude phosphorus material in the condenser was then moved into two large process tanks called receiving tanks. There were two receiving tanks for each condenser to allow the material in one of the receiving tanks to be filtered and moved while the other receiving tank was receiving material from the condenser.

When the crude phosphorus material was moved from the receiving tank, it was filtered using a vertical tube filter. The elemental phosphorus that could be separated from the crude phosphorus material by filtering was sent to an elemental phosphorus product storage tank. The remaining crude phosphorus material was sent to another process tank where the material

was stored and filtered again at a later time. The crude phosphorus material was stored in several different process tanks and was filtered two or three times. After no more product phosphorus could be removed by filtering, the crude phosphorus material was moved to the roaster for processing or the 100-foot clarifier for storage while waiting for further processing. This remaining crude phosphorus was essentially an emulsion of elemental phosphorus, water and solids, such as phosphate dust, silica dust and coke dust. Despite numerous efforts by Rhodia to break this emulsion to recover more phosphorus (*e.g.*, centrifugation, filtration, flocculation, dilution, etc.), more phosphorus could only be effectively recovered through heating. In our case, we used the roaster technology. Below is a summary of each technology designed to break this emulsion that was tested and the outcome of the test.

- Centrifugation: Several types of centrifuges were tested with the expectation that the crude phosphorus could be subjected to high centrifugal forces. These forces, similar to gravity, would accelerate and enhance the separation rate of phosphorus in the crude phosphorus and thereby increase recovery rates. Although partially successful, continuous and economical operation was not possible. Because the crude phosphorus had high solids content, steady flow conditions within the centrifuge could not be maintained. This caused the machine to become out of mechanical balance and it had to be shut down and cleaned. Additionally, the solids cause extensive wear within the centrifuge and the resulting high maintenance costs. Ultimately, this process was discontinued.
- Filtration: In addition to the vertical tube filter that was used, a high pressure, horizontal rotating filter assembly was also tested. This filter, manufactured by Artisan Filters, has a series of circular flat filter plates that used a filter cloth coated with diatomaceous earth. Between each filter plate was a rotating plate that continuously removed the filter cake. Crude phosphorus was continuously fed to this filter at pressures near 200 p.s.i. Phosphorus contained in the crude phosphorus would pass through the filter cloth and be collected in a storage tank. The remaining filter cake was collected in another tank. Again, solids concentration in the crude phosphorus made continuous operation impossible. Close mechanical tolerances within the filter could not be maintained and the filter had to be shut down and repaired. This process was also discontinued.
- Flocculation: Several different types of flocculating agents were tried to enhance separation of phosphorus from crude phosphorus. None were found that increase phosphorus recovery.
- Dilution: After the crude phosphorus had been filtered as much as possible, a technology referred to as "Washing" was used to increase phosphorus recovery. Based on discussions with colleagues in the phosphorus industry, washing was carried out on plant scale trials where hot water was bubbled up through the crude phosphorus in the settling tanks using sparging rings placed in the bottom of the tanks. The bubbling water washed and lowered or diluted the phosphorus concentrations in the P4 residue layer by promoting both cleanup of the elemental phosphorus stream and enhancing the settling action in the settling tanks. This technology had some success but did not remove all the phosphorus present. Additional processing was required to remove the remaining phosphorus in the crude phosphorus.

Before being transferred to the roaster or the 100-foot clarifier, the crude phosphorus had been moved from one tank to another tank several times. During this process, very good mixing took place. Once the crude phosphorus was placed in the large, poorly heated 100-foot clarifier, the phosphorus in the mixture partially froze (phosphorus has a freezing point of 111° F) and the mixture solidified. When there was capacity available in a roaster feed tank, the crude phosphorus in the 100-foot clarifier was heated and pumped to a roaster feed tank.

The roaster process was the final step in phosphorus production at the Silver Bow Plant. This process consisted of an externally heated, airtight stainless steel rotary kiln. A temperature of 550° C (1020° F) was maintained on the roaster shell as it rotated at approximately 20 rpm. Crude phosphorus at roughly 60° C (140° F) and nodule fines (the finer material screened during nodule production) were introduced into the feed end of the roaster. The nodule fines helped to distribute the mixture evenly within the roaster and aided in heat transfer. These nodule fines also prevented material build-up on the inside of the roaster shell.

Crude phosphorus was introduced using one of three 10,000 gallon feed tanks. The feed tank was pressurized with water and the crude phosphorus was forced out of the tank and into the roaster at a feed rate of approximately 300 gallons/hour. Nodule fines were introduced using a feed screw mounted on the feed end of the roaster at a rate of roughly (2) tons/hour. This process continued until the feed tank was empty, at which time the process was stopped and a new feed tank was put into service. Typically, the crude phosphorus fed to the roaster contained roughly 20% phosphorus. This was calculated by measuring the volume in the feed tank and phosphorus product tank before and after each batch.

The remaining phosphorus in the crude phosphorus was vaporized in the roaster. The phosphorus vapor was directed to a water-quenching spray tower and condensing system where the elemental phosphorus was condensed and collected as a liquid in a tank at the bottom of the tower. This recovered product phosphorus was filtered, loaded in railroad tank cars and shipped to other phosphorus utilization facilities for use in their processes.

The surface of the nodule fines would collect the non-phosphorus containing materials as they migrated to the discharge end of the roaster. At the discharge end, these nodule fines, now called roaster solids, were removed with a screw conveyor and stockpiled in 25-ton stockpiles. At times, roaster solids were used instead of nodule fines and reintroduced to the roaster.

Roaster operations were discontinued in 1997 due to operational problems encountered while attempting to process material from the clarifier. Detailed below are descriptions of the operational difficulties that prevented Rhodia from processing the material remaining in the clarifier.

Crude phosphorus was introduced to the roaster using a specially-designed feed system. This system consisted of feed pumps, piping, tanks, tank agitators, a flow measuring device, and a feed temperature control system. The purpose of this feed system was to insure that the crude phosphorus was introduced to the roaster at a constant rate and as a liquid slurry mixture. This allowed the roaster to operate under steady state conditions for both operating

temperature and pressure. If these conditions were met, the roaster efficiently removed the phosphorus contained in the feed stream. If not met, temperature and pressure fluctuations in the roaster appeared which made operation nearly impossible. These fluctuations in operation parameters reduced efficiency and increased emissions at the discharge. Feed rate and feed temperature, the only design variables, were varied in an attempt to continue operations but no suitable combination was found that allowed steady state roaster operation. In addition to the operational difficulties caused by these clarifier materials, processing this material also increased the safety risk to maintenance and operational personnel. When the feed system plugged, it was necessary to manually clean the piping system. This involved breaking into phosphorus lines and physically washing the crude phosphorus from the lines. Although the personnel utilized for this task were trained in these procedures, the risk increased due to the increased number of time the procedures had to be performed.

Although the roaster technology was utilized in the past, processing crude phosphorus from the clarifier created operational and safety issues that made continued roaster processing untenable after March of 1997.

The material that remains in the clarifier is estimated to have about 20% elemental phosphorus. The most relevant evidence of this is the attached record from the "Plantwide Meeting" on February 19, 1997, which is shortly before the clarifier material ceased to be processed. The record shows that of the 10,033 gallons of crude phosphorus sludge that had been processed during that month, 1,841 gallons or 18.3% was recovered as product P_4 . The crude phosphorus sludge in the clarifier would be expected to have a very similar percentage of elemental phosphorus since the material that was processed in February 1997 is the same material in the clarifier today. Since the P_4 in the clarifier will stay with the solids and slurry material, I would expect that if the water were removed for capping, the P_4 concentration of the remaining solids would increase slightly. But a reasonable estimate is that the clarifier material that would be capped would contain about 20% elemental phosphorus.

Sincerely,



Dan Bersanti

Attachment

PLANTWIDE MEETING

19-Feb-97

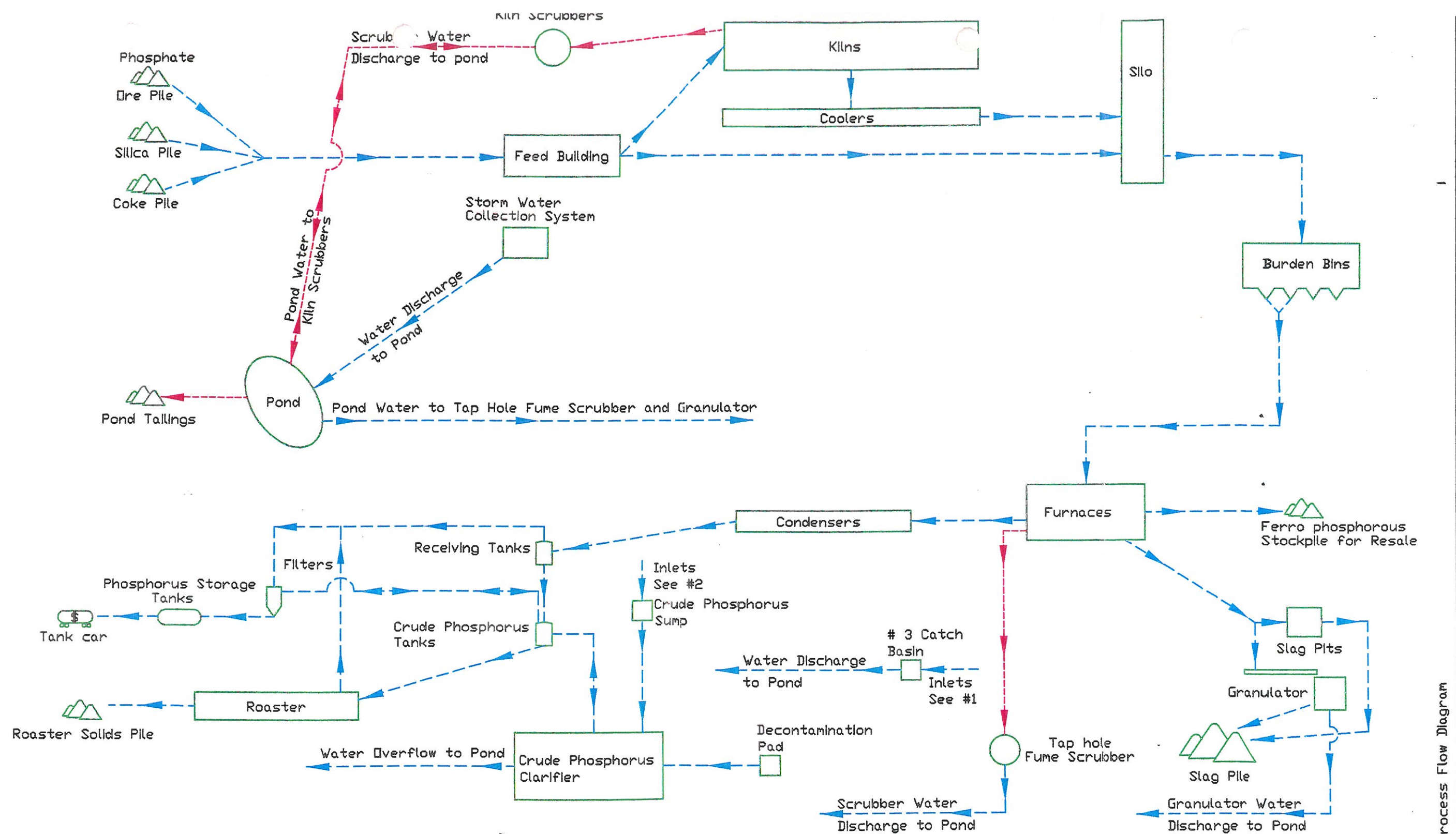
	February MTD Actual	1997 YTD-Actual
Sludge Recovered From 100' Clarifier (gallons)	952	13,488
Sludge Processed in Roaster (gallons)	10,033	10,033
P4 Yield From Roaster Processing-BC (gallons)	1,841	1,841
P4 Yield Direct From 100' Clarifier (gallons)	0	0
Roaster Onstream Time (%)**	20	10
Current Sludge Inventory: 18,541 gallons		

Ron Smith by Tom Goody
Ron Smith

Posting Responsibility

Main Office: Cheryl Bolton
Operations: Tom Goody
Maintenance: Tom Goody
Clock Alley: Teri Tregear
Lab: Lisa Palmer
~~File Copy: Teri Tregear~~
CC: Dan Bersanti




Post: February 21, 1997
Remove: February 28, 1997



Process Flow Diagram

- #1 No. 3 Catch Basin: Overflow water from Condensers, Receiving tanks, Crude Phosphorus tanks and Crude Phosphorus Clarifier.
- #2 Crude Phosphorus Sump: Overflow water from Condensers, Receiving tanks and Crude Phosphorus tanks.

KEY

	Process Steps
	Pollution Control Device
	Stockpile

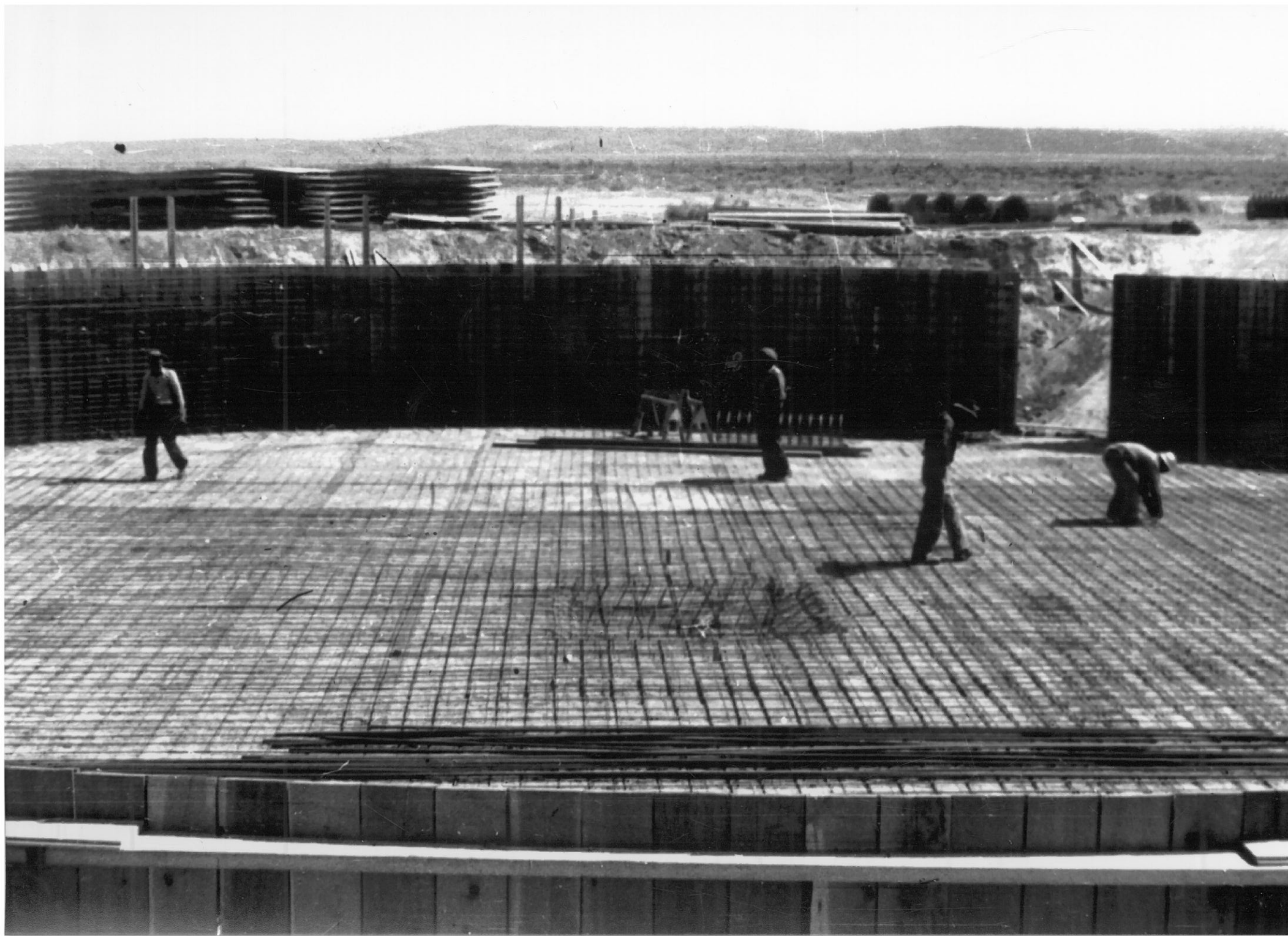
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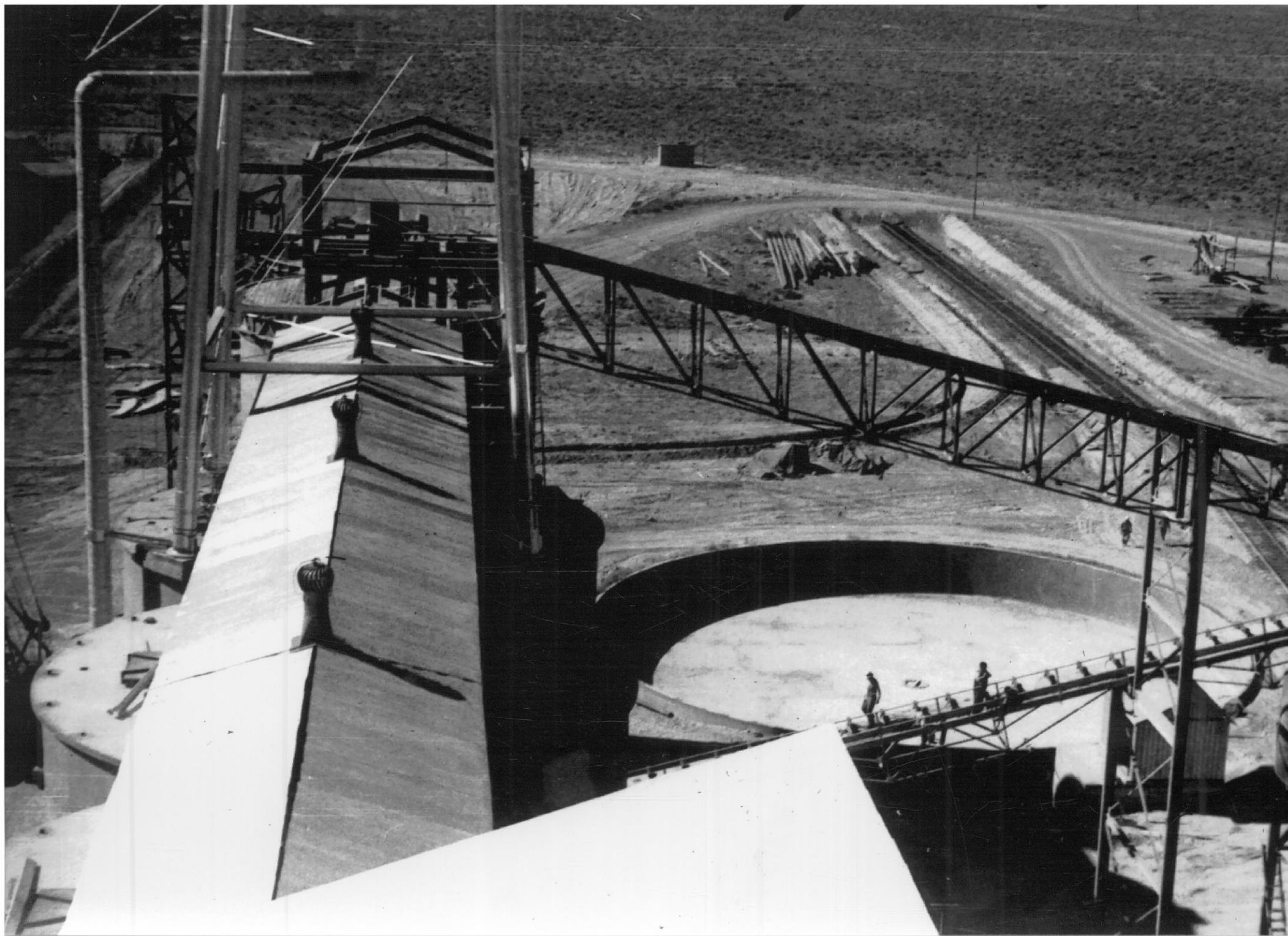
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Appendix G

Clarifier – Construction Photos, Sampling and Analysis Plan, and TCLP Analytical Data







100-Foot Clarifier Sampling and Analysis Plan for February 1997

1. Introduction

The 100-foot clarifier, located near the roaster, was used for surge capacity during phosphorus production. Crude phosphorus coming from the phosphorus-handling department for processing in the roaster that could not be stored in the roaster feed tanks was sent to the clarifier. When space was available in the feed tanks, material was pumped from the clarifier to these tanks and processed in the roaster.

In 1997, closing the 100-foot clarifier in place was an option that was considered. In order to evaluate this option, representative samples of the material in the clarifier were taken and analyzed for TCLP metals.

A sampling program was designed to fulfill data objectives that included:

- The samples collected were representative of the materials sampled;
- Sample integrity was maintained and documented;
- Proper measurements and information were recorded;
- Sample volumes were sufficient for the required analytical procedures;
- Analytical results adequately characterized the clarifier material; and
- The sampling protocol was efficient and relatively uncomplicated.

2. Data Quality Objectives

The purpose of data quality assessment is to assure that data generated under this program is reconciled, accurate and consistent with program data quality objectives. The quality of the data will be assessed based on precision, accuracy, and completeness. Percent precision is the degree to which a measurement is reproducible and will be assessed by a comparison of duplicate sample results. A relative percent difference (RPD) of 35% for the duplicate samples is the precision goal. Percent accuracy is a determination of how close the measurement is to the true value and will be assessed via spike recovery in sample matrices. The laboratory as part of their QA/QC procedures will perform this. Spike recoveries reported by the laboratory needs to be within $\pm 20\%$ of the spiked amount. Completeness is a measure of the amount of valid data obtained, compared to the amount that was expected under normal conditions. Ninety percent (90%) completeness is the goal of the Sampling Plan. Resolution of data discrepancies will be conducted as outlined in Section 4 of this document.

Material from the clarifier will be analyzed for concentrations of Resource Conservation Recovery Act (RCRA) eight metals (silver, arsenic, barium, cadmium, chromium, mercury, lead, and selenium).

3. Sampling Procedures

The following section outlines the sampling procedures used to collect samples from the 100-foot clarifier.

3.1. Sample Collection

During routine processing of clarifier material, a clamshell attached to a crane was used to move material from various locations in the clarifier to a pumping station. The crane was set southwest of the clarifier wall where it was able to access all locations within the clarifier. For 2 ½ days prior to sampling, the crane operator took material from all locations and moved it to the pumping station. Because the clarifier was heated and the material was only partially frozen, the clamshell was able to gather material from various depths within the clarifier. The material in the pumping station was heated with a steam lance to thaw the frozen phosphorus in the material, which enabled it to be pumped to the roaster feed tanks where the samples were taken.

3.2. Generation of Composite

Once in the feed tanks, the material was agitated with a mechanical, paddle-type, agitator used to agitate and mix the contents of the tank. After agitation, a sample jar was lowered to the middle of the material and a sample was taken. This sample was placed in a cold water bucket and allowed to cool below the freezing point of phosphorus. It was then transported to the laboratory for packaging and shipment. This process was repeated on a second tank and another sample was obtained.

3.3. Sampling Sequence

The following sampling sequence was used to obtain representative samples from the 100-foot clarifier:

- Clamshell material from locations within the 100-foot clarifier to the pumping station.
- Heat the material in the pumping station.
- Pump the material to the roaster feed tanks.
- Agitate the material in the feed tanks.
- Sample the material in the tanks in the center of the mixture.
- Cool the sample.
- Transport to the laboratory for packaging and shipment.

3.4. Analytical Methods

The samples were analyzed for TCLP metals using EPA SW-846 Method 1311. The results are attached. The plant Laboratory Manager was present and supervised the analytical work for these samples.

4. Data Validation

Data from the sampling event will be reviewed and evaluated based on the data quality objectives. This review includes:

- A comparison of duplicate samples.
- A check of laboratory quality control information.

The analytical results of the duplicate samples will be compared by calculating the RPD. The data quality objective for this comparison is $\pm 35\%$. The RPD is defined by the following equation:

$$RPD = (A1 - A2) / ((A1 + A2) / 2) * 100$$

Where: A1 = Analytical result from one duplicate sample

A2 = Analytical result from the other duplicate sample

Laboratory quality control information will be reviewed for every sample. The quality information that will be reviewed is the matrix spike sample results. The percent recovery must be within $\pm 20\%$ of the spiked amount.

If the QC results detect conditions or data that do not meet the data quality requirements, corrective action will be initiated. The nature of the action will depend on the circumstances unique to each situation and may include:

Reanalyzing the samples, if holding time criteria permit;
Re-sampling and analyzing;
Evaluating and amending sampling and analytical procedures;
Accepting data, acknowledging the level of uncertainty; and
Conducting a laboratory audit.

The following is a data review and validation of the 100' clarifier sampling data. This review and validation is based on the Data Quality Objectives described in the 100-Foot Clarifier Sampling Plan.

Data Validation

	A1 (mg/l)	A2 (mg/l)	RPD (%)	Spike Recovery A1	Spike Recovery
arsenic	0.5	0.5	0	0	2
barium	10	10	0	-9	-10
cadmium	0.1	0.1	0	3	1
chromium	0.5	0.5	0	-8	-9
lead	0.5	0.5	0	-4	-7
mercury	0.02	0.02	0	6	7
selenium	0.1	0.1	0	-9	-9
silver	0.5	0.5	0	-5	-8

A1 = Sludge #01

A2 = Sludge #02

In conclusion, the clarifier sampling data was well within the data quality objectives established in the 100-Foot Clarifier Sampling Plan. Therefore, the clarifier sampling data is considered to be valid under these conditions.

**ENERGY LABORATORIES, INC.**P.O. BOX 30916 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0916 • PHONE (406) 262-6325
FAX (406) 262-6059 • 1-800-735-4489**LABORATORY REPORT**TO:
ADDRESS:Lisa L. Palmer
Rhône-Poulenc
P.O. Box 3146
Butte, MT 59702LAB NO.: 97-18565
DATE: 03/03/97 kr

REC'D MAR 4 1997

WASTE ANALYSISSludge #01
Submitted 02/27/97
Extracted 02/27/97TOXICITY CHARACTERISTIC LEACHING PROCEDURE
EPA SW-846 METHOD 1311

Metals	CAS No.	Regulatory Limit, mg/l	Minimum Reporting Limit, mg/l	Result, mg/l in Extract	Spike Percent Recovery	Date Analyz
Arsenic	7440-38-2	5.0	0.5	<0.5	100	02/28/97
Barium	7440-39-3	100.0	10.0	<10	91	02/28/97
Cadmium	7440-43-9	1.0	0.1	<0.1	103	02/28/97
Chromium	7440-47-3	5.0	0.5	<0.5	92	02/28/97
Lead	7439-92-1	5.0	0.5	<0.5	96	02/28/97
Mercury	7439-97-6	0.2	0.02	<0.02	106	03/03/97
Selenium	7782-49-2	1.0	0.1	<0.1	91	03/03/97
Silver	7440-22-4	5.0	0.5	<0.5	95	02/28/97

**ENERGY LABORATORIES, INC.**P.O. BOX 30918 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0918 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4469**LABORATORY REPORT****TO:**
ADDRESS:Lisa L. Palmer
Rhone-Poulenc
P.O. Box 3146
Butte, MT 59702**LAB NO.:** 97-18566
DATE: 03/03/97 kr**WASTE ANALYSIS**Sludge #02
Submitted 02/27/97
Extracted 02/27/97**TOXICITY CHARACTERISTIC LEACHING PROCEDURE
EPA SW-846 METHOD 1311**

Metals	CAS No.	Regulatory Limit, mg/l	Minimum Reporting Limit, mg/l	Result, mg/l In Extract	Spike Percent Recovery	Date Analy.
Arsenic	7440-38-2	5.0	0.5	<0.5	102	02/28
Barium	7440-39-3	100.0	10.0	<10	90	02/28
Cadmium	7440-43-9	1.0	0.1	<0.1	101	02/28
Chromium	7440-47-3	5.0	0.5	<0.5	91	02/28
Lead	7439-92-1	5.0	0.5	<0.5	93	02/28
Mercury	7439-97-6	0.2	0.02	<0.02	107	03/03
Selenium	7782-49-2	1.0	0.1	<0.1	91	03/03
Silver	7440-22-4	5.0	0.5	<0.5	92	02/28

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FAX (406) 252-6069 • 1-800-735-4469**LABORATORY REPORT****TO:**
ADDRESS:Lisa L. Palmer
Rhône-Poulenc
P.O. Box 3148
Butte, MT 59702**LAB NO.:** Blank
DATE: 03/03/97 kr**WASTE ANALYSIS**Method Blank
Extracted 02/27/97**TOXICITY CHARACTERISTIC LEACHING PROCEDURE
EPA SW-846 METHOD 1311**

Metals	CAS No.	Regulatory Limit, mg/l	Minimum Reporting Limit, mg/l	Result, mg/l In Extract	Spike Percent Recovery	Date Analyz
Arsenic	7440-38-2	5.0	0.5	<0.5	103	02/28/97
Barium	7440-39-3	100.0	10.0	<10	93	02/28/97
Cadmium	7440-43-9	1.0	0.1	<0.1	104	02/28/97
Chromium	7440-47-3	5.0	0.5	<0.5	96	02/28/97
Lead	7439-92-1	5.0	0.5	<0.5	98	02/28/97
Mercury	7439-97-6	0.2	0.02	<0.02	82	03/03/97
Selenium	7782-49-2	1.0	0.1	<0.1	105	03/03/97
Silver	7440-22-4	5.0	0.5	<0.5	101	02/28/97

Appendix H

RFI Report Section 5.5.2 – SWMU 2 Clarifier

SWMU 2 – Clarifier

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5.5.2 SWMU 2 - Clarifier

The location of Solid Waste Management Unit (SWMU) 2 is shown on Figure 5.5.2-1a and SWMU 2 monitoring stations and sample locations are provided on Figure 5.5.2-1b. The clarifier is a 100-foot diameter concrete unit partially recessed in the ground that contains approximately 500,000 gallons of crude phosphorus covered by a water cap. Crude phosphorus is the filter cake from the filtration operations used to purify the elemental phosphorus. The crude phosphorus consists of elemental phosphorus (about 20% volume/volume [v/v]); water (about 30% v/v); and solids (about 50% v/v) such as phosphate dust, coke dust and silica dust. Until March 1997, the crude phosphorus was further processed in the Plant's roaster to produce P4 product.

5.5.2.1 RCRA 7003 Order

During an inspection at the Silver Bow Plant in May 2000, the EPA inspectors collected samples of crude phosphorus and placed the material in separate metal pans. As the material in the pans dried, it began smoking and spontaneously ignited. EPA Region 8 issued an Administrative Order (7003 Order), Docket No. RCRA-8-2000-07, under § 7003 of the Solid Waste Disposal Act, as amended (42 U.S.C. § 6973). This Order was issued on June 12, 2000 and amended on December 27, 2000 and required Rhodia to undertake immediate and interim measures to protect public health and the environment, including wildlife. The immediate and interim measures included fencing the clarifier area, installing a wind sock, installing Bird Balls™ to camouflage its surface and eliminate wildlife contact with the clarifier contents, installing a float valve to maintain the water cap over the crude phosphorus and installing a continuous phosphine gas monitoring system. These immediate and interim measures were completed before the respective deadlines under the 7003 Order.

Elemental phosphorus may generate some phosphine gas when it is in contact with water at high pH, temperature and agitation conditions. Rhodia installed the continuous phosphine monitoring system around the clarifier as required by the RCRA § 7003 Order and submits annual phosphine monitoring reports¹ to EPA. The time-weighted average values reported from the continuous monitoring for phosphine are typically 0.0 parts per million by volume (ppmv), below the EPA-approved action levels of 0.3 ppmv (8-hour time-weighted average) or 1.0 ppmv (15-minute short-term exposure limit). The detection limit is around 0.03 ppmv.

¹ Monthly reports were submitted to U.S. EPA until the submittal schedule was changed to annual reporting as provided in the U.S. EPA's March 14, 2009 letter to Rhodia.

Phosphine has only been detected in these monitors on two occasions. The first event occurred when drums of soil cuttings containing elemental phosphorus were located near the northwest phosphine monitor immediately after installing monitoring well MW-01-3 in 2001. The second event occurred when crude phosphorus was being excavated from the clarifier for use in the pilot scale testing in 2011. The excavation operations were stopped and the phosphine concentrations decreased immediately.

The 7003 Order remains in effect, since, as stated in Section VI.B. of the 3008(h) Order, the 7003 Order is the mechanism to address investigation and closure matters regarding the clarifier. As such, this RFI Report will summarize the corrective measures that were completed and the environmental data that was collected under the 7003 Order, as well as the plan for follow-up data collection as part of the RFI.

5.5.2.2 Corrective Measures

The 7003 Order required Rhodia to develop a Waste Plan that evaluated alternatives for the lawful disposition of the contents of the clarifier, and at least one alternative that evaluated the lawful removal and disposal of the clarifier contents. The final Waste Plan was submitted to EPA on November 16, 2001 (Barr, 2001b). The Waste Plan identified three options that were considered feasible and were fully evaluated in the Waste Plan. The feasible options were: (1) a soil cap; (2) an enhanced cap with a multi-layer and multi-material cover; and (3) off-site incineration. The Waste Plan also identified processes that had been used to process similar materials at other elemental phosphorus production facilities, but the process equipment was not available. The production facilities had been shut down and the process equipment was demolished.

Rhodia and EPA agreed to further evaluate management options for the crude phosphorus through a multi-step treatability study process. The first step involved gathering all existing information for treatment of crude phosphorus solids. The second step involved developing a short list of technologies from Step 1 that are potentially feasible and merit further evaluation. The third step involved evaluation of the selected technology.

Rhodia submitted the report titled “Clarifier Waste Treatability Study, Phase 1 – Information Gathering” (Franklin Engineering Group, 2007) to EPA in October 2007. The report described several treatment and disposal options for the management of crude phosphorus, many of which were evaluated in the Waste Plan. Based on this report Rhodia, the Montana State Department of Environmental Quality (MDEQ), and the EPA agreed to further evaluate batch still technology

similar to that developed by Albright and Wilson for evaporation and subsequent recovery of the elemental phosphorus. This technology was chosen because it:

- Has proven to be effective in processing similar materials
- Allows Rhodia to recover the elemental phosphorus contained in the clarifier
- Could be evaluated with pilot-scale equipment
- Reduces total volume of waste

The Clarifier Waste Treatability Study, Phase 2 Report, Pilot Plant Design and Testing describes the design of the pilot plant, and initial testing that was conducted to evaluate whether the system could volatilize the elemental phosphorus from the crude phosphorus and render the solids free of elemental phosphorus (Franklin Engineering Group, 2011a).

The initial testing conducted in 2010 demonstrated that the basic process, as designed, demonstrated a capability to safely vaporize and condense the elemental phosphorus contained in the clarifier material. Visually good elemental phosphorus was recovered from all three batches. The non-ignitable residue produced by one batch (run #2) remained hazardous due to leachable cadmium present in the still residue. The report concluded that additional evaluation was needed to evaluate whether the process can render the crude phosphorus residue to be non-hazardous.

Additional testing was conducted in 2011 as detailed in the report titled Clarifier Material Treatability Study, Phase 3 Report, Pilot Plant Operations describes the improvements to the system and the testing protocols that were conducted (Franklin Engineering Group, 2011b). The pilot plant demonstrated the ability to treat clarifier material and recover elemental phosphorus of useful quality from a variety of feed compositions. However, the solid residue in eight of the twelve tests was determined to be hazardous for cadmium. Therefore, additional treatment would be needed to render the solid residue non-hazardous for final disposal.

The next step in the process is to evaluate the overall feasibility of the distillation process including cost effectiveness of the process system. This information will be incorporated into a revised Waste Plan which will be submitted to EPA by the end of 2013.

5.5.2.3 Crude Phosphorus Characteristics

Crude phosphorus consists of elemental phosphorus (about 20% volume/volume [v/v]); water (about 30% [v/v]); and solids (about 50% [v/v]) such as phosphate dust, coke dust and silica dust. Two samples of crude phosphorus were analyzed for TCLP metals in February 1997. The analytical

results are summarized in Table 5.5.2-1. The TCLP results indicate that the bulk crude phosphorus is not a characteristic waste for metals.

A sample of crude phosphorus was collected by EPA's contractor in 2003 and analyzed for metals, fluoride, elemental phosphorus, phosphorus (ortho and total), and gross alpha and beta. The analytical data is summarized in Tables 5.5.2-2 through 5.5.2-4 and the data is plotted on Figures 5.5.2-2 through 5.5.2-4. Data from SWMU 2 were compared to the background/reference area concentrations. Concentrations above the 95% upper confidence limit of the mean background/reference area concentrations are highlighted on the constituent delineation figures presented in this section. Where a 95% upper limit could not be calculated, the maximum detected concentration or the maximum detection limit was selected.

The crude phosphorus sample contained approximately 6.4% elemental phosphorus. This concentration is lower than Rhodia's estimated concentration likely because the sample was obtained from the upper level material overlying the solidified crude phosphorus in the clarifier. The concentration of elemental phosphorus is expected to be higher in the solidified portion of the clarifier. Gross alpha and gross beta were found at 720 pCi/g and 570 pCi/g, respectively (*see* Figure 5.5.2-3). Metals were also detected in the crude phosphorus sample (*see* Figure 5.5.2-4). Cadmium, chromium, lead and selenium were found at concentrations in excess of 20 times the respective hazardous characteristic standard.

The EPA also collected a sample of the water covering the crude phosphorus and analyzed this water sample for metals, fluoride, elemental phosphorus, phosphorus (ortho and total), and gross alpha and beta. The analytical data is summarized in Tables 5.5.2-5 through 5.5.2-7.

Phosphorus compounds including elemental phosphorus were reported in the water cap sample. Metals and radionuclides were present, but the concentrations are below drinking water levels.

5.5.2.4 Groundwater Monitoring Results

There is a documented release of water from the clarifier. The 7003 Order described a "leaking clarifier" based on an observation that water from the clarifier infiltrated into a hole dug in a wet area adjacent to the clarifier. After plant operations ceased in the late 1990s, groundwater has been added to maintain the water cap.

EPA required Rhodia to conduct pre-closure groundwater monitoring of the area near the clarifier under the 7003 Order. A Field Sampling Plan and Quality Assurance Project Plan (Sampling Plan)

(Barr, 2001a) for pre-closure groundwater monitoring at the clarifier was approved by EPA in a letter dated September 6, 2001. Three water table monitoring wells were installed at the clarifier in accordance with the Sampling Plan. MW-01-2 was installed upgradient (i.e., south) of SWMU 2, and MW-01-3 and MW-01-6 were installed downgradient of SWMU 2. Two additional wells (MW-02-1 and MW-02-2) were installed further downgradient of the clarifier to evaluate the potential transport of elemental phosphorus via groundwater. The monitoring well locations are shown in Figure 5.5.2-1b and the Monitoring Well Construction Logs are provided in Appendix 5.5.2-A. The Final Pre-closure Groundwater Monitoring Report (Barr 2002) provides the details of the groundwater monitoring program and the analytical laboratory reports prior to the RFI.

Three rounds of groundwater samples were collected during the pre-closure groundwater monitoring program and analyzed for general and site-specific parameters, metals, VOCs, SVOCs, and radionuclides. The results were summarized in the Final Pre-Closure Groundwater Monitoring Report (Barr 2002) and are also summarized in this report.

The SWMU 2 monitoring wells were included in the site-wide groundwater quality monitoring program included in the RFI Work Plan (Barr, 2009). A detailed and comprehensive discussion of site-wide groundwater quality is discussed in the Groundwater Quality Section (Section 5.3). Constituents of interest were outlined in Section 5.3 and only those with a potential source as the clarifier or TBWR areas will be discussed in this SWMU. The analytical results for the groundwater samples from SWMU 2 monitoring wells are summarized in Tables 5.5.2-8 through 5.5.2-13. Additionally, Figures 5.5.2-6 through 5.5.2-41 display the groundwater quality time-series plots for the general and site-specific parameters, metals and radionuclides. These parameters will be discussed in detail below.

5.5.2.4.1 General and Site-Specific Parameters

Fluoride

Non-detect values were recorded at two of the five wells, MW-01-6 and MW-02-1, surrounding SWMU 2. At all of the wells, except for MW-02-1, concentrations of fluoride have increased with time (*see* Figure 5.5.2-6). At MW-01-2, fluoride increased from 4.06 mg/L in 2001 to 7.8 mg/L in 2008. At MW-01-3, fluoride increased from 0.75 mg/L in 2001 to 1.2 mg/L in 2008. At MW-01-6, fluoride increased from 0.73 mg/L in 2001 to 2.2 mg/L in 2008. At MW-02-2, fluoride increased from 5.14 mg/L in 2002 to 7.6 mg/L in 2008. SWMU 2 may be an ongoing source of fluoride to groundwater, or it is possible that increasing fluoride concentrations may be a function of the dissolution of soluble fluoride complexes, as discussed in Section 5.3.2.2.1.

Elemental Phosphorus

Elemental phosphorus was not detected in MW-01-2, MW-02-1, and MW-02-2, except in September of 2002, when concentrations of 0.00045 J mg/L and 0.00019 J mg/L were reported at MW-02-1 and MW-02-2, respectively. These data points were “J”-qualified, indicating that the value is less than the stated laboratory quantification limit and are considered estimated values. Elemental phosphorus was detected at MW-01-3 and MW-01-6 with average concentrations of 0.791 mg/L and 0.002 mg/L, respectively. The highest elemental phosphorus concentration (i.e., 1.6 mg/L) was found in a sample collected from MW-01-3 in 2002 (*see* Figure 5.5.2-7). Elemental phosphorus concentrations MW-01-6 do not indicate increasing or decreasing trend, however elemental phosphorus concentrations at MW-01-3 are strongly decreasing with time.

Total Phosphorus

Total phosphorus was detected in groundwater sampled from all of the wells around SWMU 2. Of those, four wells indicate decreasing concentrations with time. At MW-01-2, total phosphorus decreased from 25.3 mg/L in 2001 to 17.0 mg/L in 2008. At MW-01-3, total phosphorus decreased from 128 mg/L in 2001 to 68.6 mg/L in 2008. At MW-01-6, total phosphorus decreased from 234 mg/L in 2001 to 91.4 mg/L in 2008. At MW-02-1, total phosphorus decreased from 17.6 mg/L in 2002 to 1.3 mg/L in 2008. Concentrations of total phosphorus at MW-02-2 are generally stable from 2002 to 2008 (*see* Figure 5.5.2-8). SWMU 2 is a likely source of total phosphorus to the groundwater: total phosphorus concentrations are higher downgradient of the clarifier and the total phosphorus analysis of groundwater samples likely detects the presence of phosphates resulting from the attenuation of elemental phosphorus in groundwater (*see* Appendix 5.3-C).

Sulfate

Sulfate concentrations were detected in all of the samples collected at SWMU 2. Sulfate concentrations in groundwater are slightly higher in the downgradient wells (MW-01-03, MW-01-6, and MW-02-2) than the upgradient well (MW-01-2). Sulfate concentrations are decreasing in four of the wells. At MW-01-2, sulfate decreased from 403 mg/L in 2001 to 238 mg/L in 2008. At MW-01-3, sulfate decreased from 486 mg/L in 2001 to 246 mg/L in 2008. At MW-01-6, sulfate decreased from 482 mg/L in 2001 to 271 mg/L in 2008. At MW-02-2, sulfate decreased from 392 mg/L in 2002 to 240 mg/L in 2008. However, sulfate concentrations increased at MW-02-1 from 984 mg/L in 2002 to 1350 mg/L in 2008 (*see* Figure 5.5.2-9). As MW-02-1 is located farther downgradient of SWMU-2, this increase in sulfate may be to another source within the phosphorus production area, rather than SWMU 2.

5.5.2.4.2 Metals

Antimony

Total antimony was detected in nine of the 17 samples with concentrations ranging from not detected at 0.0005 mg/L to 0.003 mg/L. The detection limits from the 2001 and 2002 analyses are much higher than the more recent detected concentrations, making time series evaluation of the data difficult (*see* Figures 5.5.2-10 and 5.5.2-11).

Arsenic

Total and dissolved arsenic were detected in groundwater samples from the five wells surrounding SWMU 2. Generally, intra-well total and dissolved arsenic concentrations appear stable (*see* Figures 5.5.2-12 and 5.5.2-13). It is possible that the clarifier has impacted downgradient arsenic concentrations; however, the groundwater data do not indicate attenuation of impacted groundwater.

Barium

Total and dissolved barium were detected in groundwater from all five wells. The highest detected concentration for dissolved barium was 0.082 mg/L at MW-02-1. The highest total concentration was 0.0425 mg/L at MW-02-1, as well. Both total and dissolved barium concentrations appear to be stable or decreasing with time (*see* Figures 5.5.2-14 and 5.5.2-15).

Beryllium

Total beryllium was detected in groundwater samples from all five wells. Of the 10 dissolved and 15 total samples analyzed, beryllium was not detected in eight of the dissolved samples and four of the total samples. The highest dissolved concentration was 0.002 mg/L and the highest total concentration was 0.03 mg/L, both from MW-01-3. No trend is visible for dissolved or total beryllium due to limited detected concentrations (*see* Figures 5.5.2-16 and 5.5.2-17).

Cadmium

Total and dissolved cadmium were detected in groundwater samples from the five wells. Concentrations were below the limits of detection in 15 of the 27 samples. Generally, intra-well total and dissolved cadmium concentrations appear to be stable (*see* Figures 5.5.2-18 and 5.5.2-19).

Chromium

Total and dissolved chromium were detected in groundwater samples from all five wells. Chromium was not detected in seven of ten samples analyzed for the dissolved fraction and six of fifteen samples analyzed for total concentrations. The highest dissolved chromium concentration was 0.005 mg/L and the highest total chromium concentration was 0.008 mg/L, both at MW-01-3. Total chromium concentrations at MW-01-2 and MW-01-6 appear to be decreasing or stable, while it is

difficult to discern trends in chromium concentrations at the other wells due to limited detected concentrations (*see* Figures 5.5.2-20 and 5.5.2-21).

Cobalt

Total cobalt was detected in groundwater samples from all five wells. Dissolved cobalt was detected in groundwater samples MW-01-3 and MW-01-6. Although the total cobalt concentration increased from the upgradient well (MW-01-2) to the wells immediately downgradient of the clarifier (MW-01-6, MW-01-3, and MW-02-2), the intra-well total cobalt concentrations are decreasing over time, most notably in the downgradient wells MW-01-6 and MW-01-3 (*see* Figures 5.5.2-22 and 5.5.2-23).

Manganese

Total and dissolved manganese were detected in groundwater samples from all five wells. Manganese concentrations are higher in wells downgradient of SWMU 2 than in the upgradient well. The highest dissolved concentration was 12.5 mg/L and the highest total concentration was 13.1 mg/L, both at MW-01-3. These concentrations are generally an order of magnitude higher than the other wells at SWMU 2. In general, both total and dissolved manganese concentrations have decreased in time at the SWMU 2 wells (*see* Figures 5.5.2-24 and 5.5.2-25).

Nickel

Total and dissolved nickel was detected in groundwater samples from all five wells. The highest dissolved nickel concentration was 0.0436 mg/L at MW-02-1, which was a “BQQ”-qualified value. The next highest dissolved concentration without a BQQ qualification was 0.02 mg/L at MW-01-6. The highest total nickel concentration was 0.0420 mg/L at MW-02-1. Samples were not analyzed for dissolved nickel in 2008, so it is difficult to assess trends in those data. However, concentrations of total nickel at MW-01-2, MW-01-3, MW-01-6, and MW-02-1 appear to be decreasing over time (*see* Figures 5.5.2-26 and 5.5.2-27).

Selenium

Total and dissolved selenium were detected in groundwater samples from all five wells. Two of 13 samples analyzed for dissolved selenium and nine of 15 samples analyzed for total selenium had concentrations below the detection limit. The highest dissolved concentration was 0.009 mg/L and the highest total concentration was 0.0149 mg/L, both at MW-02-2. Samples were not analyzed for dissolved selenium in 2008, so it is difficult to assess trends in those data. However, total selenium concentrations appear to be stable. Samples were not analyzed for dissolved selenium in 2008, so it is difficult to assess trends in those data (*see* Figures 5.5.2-28 and 5.5.2-29).

Silver

Total and dissolved silver were rarely detected in groundwater samples from these wells, and were never detected at concentrations higher than the detection limits at MW-01-3 and MW-01-6. The highest detected total silver concentration was 0.0001 mg/L at MW-02-2. Dissolved silver was not analyzed in MW-02-2. Because silver was rarely detected at concentration exceeding the detection limits, trends in the data are not apparent (*see* Figures 5.5.2-30 and 5.5.2-31).

Thallium

Total thallium was detected in groundwater sampled from all five wells, while dissolved thallium was not detected above detection limits at MW-01-3, MW-01-6, or MW-02-1 (dissolved thallium was not analyzed on samples from MW-02-2). Dissolved thallium was only detected in samples from MW-01-2 and were “J”-qualified; the highest concentration was 0.00007 mg/L. The highest detected concentration for total thallium was 0.0001 mg/L at MW-01-6. As thallium concentrations were rarely recorded above the detection limits, no trends are apparent in the data (*see* Figures 5.5.2-32 and 5.5.2-33).

Uranium

Total uranium was detected in groundwater samples from all five wells, while dissolved uranium was not detected above detection limits at MW-01-3, MW-01-6, or MW-01-2 (dissolved uranium was not analyzed on samples from MW-02-2). The highest detected concentration for dissolved uranium was 0.0047 mg/L at MW-02-1, and the highest concentration of total uranium was 0.00455 mg/L, also at MW-02-1. Trends within these data are not apparent due to limited detected concentrations (*see* Figures 5.5.2-34 and 5.5.2-35).

Vanadium

Total vanadium was detected in groundwater samples from MW-01-2, MW-01-3, MW-01-6, and MW-02-2. Dissolved vanadium concentrations were not detected above the detection limits at any wells, except at MW-01-2, where samples had “BQQ” qualified values of 0.0045 mg/L. No trends are apparent in the vanadium data set (*see* Figures 5.5.2-36 and 5.5.2-37).

Zinc

Total and dissolved zinc were detected in groundwater samples from all five wells. The highest dissolved zinc concentration was 0.99 mg/L and the highest total zinc concentration was 0.902 mg/L, both at MW-01-6. Samples were not analyzed for dissolved zinc in 2008, so it is difficult to assess trends in those data. Total zinc concentrations are variable with respect to zinc concentrations (*see* Figures 5.5.2-38 and 5.5.2-39).

5.5.2.4.3 SVOCs

The analytical results for the SVOCs included in the SWMU 2 data set are summarized in Table 5.5.3-10. The majority of SVOCs detected in the SWMU 2 groundwater samples belong to a subgroup of SVOCs known as polynuclear aromatic hydrocarbons (PAHs). These multi-benzene-ringed compounds are naturally present in coke, which was used in the furnaces to scavenge oxygen and creating the reducing environment necessary to generate elemental phosphorus. Crude phosphorus contains some fraction of coke fines. The SVOC concentrations were not plotted on maps because the SVOCs were not detected in sufficient samples to gain any insight from a graphical presentation.

PAHs compounds were routinely detected in samples collected immediately downgradient of the clarifier (i.e., MW-01-3 and MW-01-6). The detected concentrations are J-qualified indicating that the concentrations are below the method reporting limit, but above the method detection limit. PAH compounds were not detected in samples collected from the next downgradient well (i.e., MW-02-2) indicating that these PAH compounds are attenuated along the groundwater flow path.

Common lab contaminants (bis(2-ethylhexyl)phthalate and diethyl phthalate) were also detected in a few groundwater samples from SWMU 2.

O-cresol and p-cresol were detected in samples from MW-01-6 and pentachlorophenol was detected in one of two samples from MW-02-2. These parameters were not detected in the further down gradient well (MW-02-1).

Inspection of the data suggests that the detected concentrations are not above drinking water standards. The data will be evaluated in the risk assessment in order to draw conclusions whether these constituents require further evaluation.

5.5.2.4.4 VOCs

The analytical results for the VOCs included in the SWMU 2 data set are summarized in Table 5.5.2-11. The majority of the VOCs detected in the groundwater samples are J-qualified indicating that the concentrations are below the method reporting limit, but above the method detection limit. The VOC concentrations were not plotted on maps because the VOCs were not detected in sufficient samples to gain any insight from a graphical presentation.

1,2,4-trimethylbenzene was detected in two of two samples from MW-01-6. 1,2,4-trimethylbenzene was not detected in the samples collected in 2008 from the further downgradient wells (MW-02-2

and MW-01-2). 1,2,4-trimethylbenzene was reported at 0.012 mg/L in the January 2002 sample from MW-01-2, but was not detected (DL = 0.00037 mg/L) in the samples collected in 2008.

Samples from MW-02-1 contain other VOCs that are commonly associated with petroleum such as 1,3,5-trimethylbenzene, butylbenzene, sec-butylbenzene, tert-butylbenzene, isopropyl benzene, propyl benzene. These VOCs were only detected in samples from MW-02-1 and indicate a source other than the clarifier. These VOCs are related to a release from an above-ground diesel storage tank that was located north of the clarifier (*see* Section 5.5.28.1).

VOCs detected in more than one sample from the wells at the downgradient edge of the clarifier include acetone, benzene, chloromethane, ethylbenzene, toluene, and o-, m-, & p- xylenes. These compounds were not detected in samples from the further downgradient wells. These VOCs are not migrating a significant distance from the clarifier and are attenuated along the groundwater flow path. Inspection of the data suggests that the detected concentrations are not above drinking water standards. The data will be evaluated in the risk assessment in order to draw conclusions whether these constituents require further evaluation.

5.5.2.4.5 Radionuclides

Gross Alpha

Gross alpha activities were detected in 17 of the 25 groundwater samples with activities ranging from not detected at 1 pCi/L to 6.5 ± 1.9 pCi/L. Concentrations are variable at the well locations, and significant trends are not evident in the gross alpha data set (*see* Figure 5.5.2-40).

Gross Beta

In general, gross beta activities immediately downgradient of the clarifier are decreasing over time (*see* Figure 5.5.2-41). At MW-01-3, gross beta decreases from 50 ± 5.0 pCi/L in 2001 to 33 ± 4.6 pCi/L in 2008 and at MW-01-6, gross beta decreases from 63 ± 6.3 pCi/L in 2001 to 39 ± 5.6 pCi/L in 2008. Gross beta activities upgradient (MW-01-2) and further downgradient (MW-02-2 and MW-02-1) are appear to be stable.

5.5.2.4.6 PCBs

The analytical results for the PCBs included in the data set are summarized in Table 5.5.2-13. PCBs were not detected in any groundwater samples from the SWMU 2 monitoring wells.

5.5.2.5 Conclusions

The clarifier is a 100-foot diameter concrete unit partially recessed in the ground that contains approximately 500,000 gallons of crude phosphorus covered by a water cap. The crude phosphorus consists of elemental phosphorus (about 20% v/v); water (about 30% v/v); and solids (about 50% v/v) such as phosphate dust, coke dust and silica dust.

Rhodia has conducted pilot scale testing to evaluate the technical feasibility of a distillation process to volatilize the elemental phosphorus from the crude phosphorus and render the solids free of elemental phosphorus. The initial testing demonstrated that the basic process, as designed, demonstrated a capability to vaporize and condense the elemental phosphorus contained in the clarifier material. Visually good elemental phosphorus was recovered. The non-ignitable residue produced by some batches remained hazardous due to leachable cadmium present in the residue. The next step in the treatability process is to evaluate the overall feasibility of the distillation process including cost effectiveness of the process system.

Although it is clear that process water has leaked from the clarifier, no distinct trends in groundwater parameter concentrations are observed at this site over time. Only fluoride concentrations appear to be increasing over time. Alternatively, total phosphorus, sulfate, total and dissolved barium, total cobalt, total and dissolved manganese, and total nickel exhibit decreasing trends over time.

PAH compounds were routinely detected in samples collected immediately downgradient of the clarifier (i.e., MW-01-3 and MW-01-6). These compounds were not detected in samples collected from the next downgradient well (i.e., MW-02-2) indicating that these PAH compounds are attenuated along the groundwater flow path.

As with the PAH compounds, certain VOCs were detected in samples collected immediately downgradient of the clarifier (i.e., MW-01-3 and MW-01-6). These compounds were not detected in samples from the further downgradient wells. These VOCs are not migrating a significant distance from the clarifier and are attenuated along the groundwater flow path.

VOCs detected at the furthest downgradient well (MW-02-1) are related to a release from an above-ground diesel storage tank that was located north of the clarifier.

There is sufficient information to conduct the risk assessment for this SWMU. The risk assessment will identify which parameters, if any, are present at concentrations that warrant corrective measures.

The dataset would be reviewed at that time and additional sampling may be necessary to inform the corrective measures study or later during the corrective measures design phase.

5.5.2.6 References

Barr Engineering Co. 2001a. Field Sampling Plan, Pre-closure Groundwater Monitoring Program. Rhodia Silver Bow Plant. Butte, Montana. August 2001

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Barr Engineering Co. 2002. Final Pre-closure Groundwater Monitoring Report, Rhodia Silver Bow Plant. December 2002.

Barr Engineering Co. 2009. Final Phase 1 RCRA Facility Investigation Work Plan, Corrective Action Order on Consent, Docket No. RCRA-08-2004-0001 Rhodia Silver Bow Plant Butte, Montana March 25, 2009.

Franklin Engineering Group, 2007. Clarifier Waste Treatability Study, Phase 1 – Information Gathering. Prepared for Rhodia Inc., Silver Bow, Butte, Montana. October, 2007.

Franklin Engineering Group, 2011a. Clarifier Waste Treatability Study, Phase 2 Report, Pilot Plant Design and Testing. Prepared for Rhodia Inc., Silver Bow, Butte, Montana. February, 2011.

Franklin Engineering Group, 2011b. Clarifier Material Treatability Study, Phase 3 Report, Pilot Plant Operations. Prepared for Rhodia Inc., Silver Bow, Butte, Montana. December, 2011.

Tables

Table 5.5.2-1

Crude Phosphorus TCLP Data Summary
Rhodia Silver Bow Plant
[concentrations in mg/L]

Station ID: Crude P4									
Dates	Sample ID	Arsenic, TCLP	Barium, TCLP	Cadmium, TCLP	Chromium, TCLP	Lead, TCLP	Mercury, TCLP	Selenium, TCLP	Silver, TCLP
2/27/1997	Sludge #1	0.5 U	10 U	0.1 U	0.5 U	0.5 U	0.02 U	0.1 U	0.5 U
2/27/1997	Sludge #2	0.5 U	10 U	0.1 U	0.5 U	0.5 U	0.02 U	0.1 U	0.5 U

Table 5.5.2-2
Crude Phosphorus Data - General and Site-Specific Parameters
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/kg]

Chemical Name			Fluoride	Orthophosphate as P	Phosphorus, elemental (white)	Phosphorus, total
Location ID	Sample Date	Sample Type				
ESI-CLW-1	07/15/2003	N	600	2300	6460 J	360000

Table 5.5.2-3
Crude Phosphorus Data - Metals
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/kg]

Chemical Name Analysis Location			Aluminum Lab	Antimony Lab	Arsenic Lab	Barium Lab	Beryllium Lab	Cadmium Lab	Calcium Lab	Chromium Lab	Cobalt Lab	Copper Lab	Iron Lab	Lead Lab	Magnesium Lab	Manganese Lab	Mercury Lab	Nickel Lab	Potassium Lab	Selenium Lab	Silver Lab	Sodium Lab	Thallium Lab	Vanadium Lab	Zinc Lab
Location ID	Sample Date	Sample Type																							
ESI-CLW-1	07/15/2003	N	445	201 *	86.2 *	10.4 B	< 0.21	271 *	15100 *	499 *	45.9	290 *	3900 *	1050 *	202 B	43.0 *	1.8	2790	627 B	29.1 *	275	284 B	33.0	98.1 *	16200 *

Table 5.5.2-4
Crude Phosphorus Data - Radionuclides
SWMU 2
Rhodia Silver Bow Plant
[concentrations in pCi/g]

Chemical Name			Gross Alpha (radiation)	Gross Beta (radiation)
Location ID	Sample Date	Sample Type		
ESI-CLW-1	07/15/2003	N	720 +/- 20	570 +/- 8.9

Table 5.5.2-5
Clarifier Water Cap Data - General and Site-Specific Parameters
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name			Fluoride	Phosphate as P	Phosphorus, elemental (white)	Phosphorus, total
Location ID	Sample Date	Sample Type				
ESI-CLWC-1	07/15/2003	N	1.7	1.6	0.0452	4.9

Table 5.5.2-6
Clarifier Water Cap Data - Metals
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name Analysis Location			Aluminum Lab	Antimony Lab	Arsenic Lab	Barium Lab	Beryllium Lab	Cadmium Lab	Calcium Lab	Chromium Lab	Cobalt Lab	Copper Lab	Iron Lab	Lead Lab	Magnesium Lab	Manganese Lab	Mercury Lab	Nickel Lab	Potassium Lab	Selenium Lab	Silver Lab	Sodium Lab	Thallium Lab	Vanadium Lab	Zinc Lab
Location ID	Sample Date	Sample Type																							
ESI-CLWC-1	07/15/2003	N	< 0.0278	< 0.0314	0.0058 B	0.0151 B	< 0.00033	0.0010 B	136	< 0.0034	< 0.0080	0.0087 B	0.0676 B	< 0.0029	25.7	0.0116 B	< 0.00010	< 0.0108	16	0.0043 B	< 0.0043 *	50.7	0.0050 BQQ	0.0050 B	0.0344

Table 5.5.2-7
Clarifier Water Cap Data - Radionuclides
SWMU 2
Rhodia Silver Bow Plant
[concentrations in pCi/l]

Chemical Name			Cesium 137	Gross Alpha (radiation)	Gross Beta (radiation)	Radium 226
Location ID	Sample Date	Sample Type				
ESI-CLWC-1	07/15/2003	N	< 60.1	< 3.44	13.5 +/- 38.0	< 1.45

Table 5.5.2-8
Groundwater Quality - General and Site Specific Parameters
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

			2-Ethylhexanoic acid	Alkalinity, bicarbonate, as CaCO3	Alkalinity, carbonate, as CaCO3	Chloride	Fluoride	Nitrate + Nitrite, as N	Nitrogen, ammonia (NH3), as N	Orthophosphate, as PO4	Phosphate, as P	Phosphorus, elemental (white)	Phosphorus, total	Sulfate
Location ID	Sample Date	Sample Type												
MW-01-2	10/9/2001	N	--	--	--	107	4.06	1.61	1.20	24.3 h	--	< 0.000004	25.3	403
MW-01-2	1/16/2002	N	--	--	--	115	3.74	--	--	29.8	--	< 0.0000040	26.0 h	417
		SPLIT	--	--	--	--	4.09	3.02	1.3	23	--	< 0.00050	32	473
MW-01-2	9/4/2002	N	--	--	--	--	5.56	--	--	15.8	--	< 0.0005	16.3	342
MW-01-2	7/22/2003	N	--	--	--	--	6.7	--	--	--	22	< 0.0001	13	--
		FD	--	--	--	--	6.7	--	--	--	23	< 0.0001	12	--
MW-01-2	5/19/2008	N	--	44	< 2	82	10.5	1.89	0.43	--	--	< 0.0000234	18.7	257
MW-01-2	9/22/2008	N	--	53	< 2	112	7.8	1.95	0.31	--	--	0.000441 R	17.0	238
MW-01-2	12/16/2008	N	--	--	--	--	--	--	--	--	--	< 0.0000234	--	--
MW-01-3	10/9/2001	N	--	--	--	126	0.75	< 0.01	1.01	97.4 h	--	0.403	128	486
MW-01-3	1/22/2002	N	--	--	--	133	0.98	< 0.05	1.0	66.3	--	0.250	54 h	489
		FD	--	--	--	131	0.98	< 0.05	1.0	64.3	--	0.3710	58 h	490
		SPLIT	--	--	--	--	1.09	--	--	36	--	1.600	71	524
		FD SPLIT	--	--	--	--	1.00	--	--	36	--	1.610	70	520
		FDD SPLIT	523	--	--	--	1.14	--	--	36	--	--	84	--
MW-01-3	9/5/2002	N	--	--	--	--	0.90	--	--	55.0	--	1.21	59	412
		FD	--	--	--	--	0.90	--	--	55.7	--	1.3	61	411
MW-01-3	5/19/2008	N	--	28	< 2	68	1.1	0.74	0.70	--	--	0.513	94.5	227
MW-01-3	9/19/2008	N	--	28	< 2	69.2	1.2	0.82	0.74	--	--	0.290	68.6	246
MW-01-3	12/16/2008	N	--	--	--	--	--	--	--	--	--	0.366	--	--
MW-01-6	10/9/2001	N	--	--	--	126	0.73	< 0.01	3.79	84.5 h	--	0.00250	234	482
MW-01-6	1/17/2002	N	--	--	--	134	1.32	< 0.05	3.8	134	--	< 0.000660	271 h	443
		SPLIT	--	--	--	--	1.59	--	--	120	--	0.00272	420	503
MW-01-6	9/5/2002	N	--	--	--	--	1.64	--	--	131	--	0.00413	238	450
MW-01-6	5/19/2008	N	--	< 2	< 2	77	< 10	< 0.05	2.85	--	--	0.00121	169	249
MW-01-6	9/18/2008	N	--	2	< 2	78.7	2.2	< 0.05	2.71	--	--	< 0.0000234	91.4	271
MW-02-2	9/5/2002	N	--	--	--	--	5.14	--	--	32.5	--	0.00019 J	36.0	392
MW-02-2	5/19/2008	N	--	21	< 2	76	7.9	1.29	0.06	--	--	< 0.0000234	42.1	240
MW-02-2	9/22/2008	N	--	21	< 2	83	7.6	1.48	< 0.05	--	--	0.000382 R	54.5	240
MW-02-2	12/15/2008	N	--	--	--	--	--	--	--	--	--	< 0.0000234	--	--
MW-02-1	1/17/2002	N	--	--	--	237	0.19	0.06	< 0.1	28.5	--	< 0.0000040	17.6 h	984
		SPLIT	--	--	--	--	0.24	--	--	17	--	< 0.00050	19	1030
MW-02-1	9/4/2002	N	--	--	--	--	0.20	--	--	17.4	--	0.00045 J	19.2	1020
MW-02-1	7/22/2003	N	--	--	--	--	< 1.0	--	--	--	4.1	< 0.0001	7.9	--
MW-02-1	5/29/2008	N	--	222	< 2	251	< 1.0	< 0.05	< 0.05	--	--	< 0.0000234	4.56	1200
		FD	--	223	< 2	251	< 1.0	< 0.05	0.05	--	--	< 0.0000234	4.41	1210
MW-02-1	9/26/2008	N	--	218	< 2	308	< 1.0	< 0.05	< 0.05	--	--	< 0.0000234	1.30	1350

Table 5.5.2-9
Groundwater Quality - Metals
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name Analysis			Aluminum Dissolved	Aluminum Total	Antimony Dissolved	Antimony Total	Arsenic Dissolved	Arsenic Total	Barium Dissolved	Barium Total	Beryllium Dissolved	Beryllium Total	Cadmium Dissolved	Cadmium Total	Calcium Dissolved	Calcium Total	Chromium Dissolved	Chromium Total	Cobalt Dissolved	Cobalt Total	Copper Dissolved	Copper Total	Iron Dissolved	Iron Total
Location ID	Sample Date	Sample Type																						
MW-01-2	10/9/2001	N	--	--	< 0.003	< 0.003	0.019	0.019	0.026	0.030	< 0.001	< 0.001	0.0009	0.0014	134	152	0.001	0.002	< 0.01	< 0.01	0.004	0.005	< 0.01	< 0.01
MW-01-2	10/10/2001	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-01-2	1/16/2002	N	--	--	< 0.003	--	0.023	--	0.032	--	< 0.001	--	< 0.001	--	148	--	< 0.001	--	< 0.01	--	0.003	--	< 0.03	--
		SPLIT	--	--	< 0.003	--	0.021	--	0.029	--	< 0.001	--	0.0007	--	--	--	< 0.001	--	< 0.01	--	< 0.001	--	< 0.01	--
MW-01-2	9/4/2002	N	--	--	--	--	0.015	--	< 0.1	--	--	--	< 0.001	--	--	--	--	--	--	--	--	--	< 0.03	--
MW-01-2	7/22/2003	N	0.419 BQQ	0.64	0.00044 J	< 0.0020	0.0137 BQQ	0.0136	0.0204 BQQ	0.0256	0.00049 J	0.00062 J	0.0011 BQQJ	0.0010	--	--	< 0.0020	0.0014 J	0.0037 BQQ	0.0034	0.0026 BQQJ	0.0030 J	--	--
		FD	0.418 BQQ	0.715	0.00039 J	< 0.0020	0.0134 BQQ	0.0123	0.0202 BQQ	0.0259	0.00057 J	0.00047 J	0.00094 J	0.00081 J	--	--	< 0.0020	0.00062 J	0.0035 BQQ	0.0033	0.0026 BQQJ	0.0052 J	--	--
MW-01-2	5/19/2008	N	--	--	--	0.00036	--	0.0206	--	0.0145	--	0.00061	--	0.00101	--	104	--	< 0.0002	--	0.00261	--	0.0030 J	--	0.02
MW-01-2	9/22/2008	N	--	--	--	0.00026	--	0.0191	--	0.01892	--	0.00036	--	0.00138	--	103	--	0.0003	--	0.00217	--	0.0026	--	0.320
MW-01-3	10/9/2001	N	--	--	< 0.003	< 0.003	0.030	0.037	0.073	0.100	0.002	0.003	0.0009	0.0010	185	192	0.005	0.008	0.08	0.10	0.002	0.010	7.61	10.0
MW-01-3	1/22/2002	N	--	--	< 0.003	--	0.016	--	0.064	--	< 0.001	--	0.0006	--	174	--	< 0.001	--	0.05	--	0.001	--	3.30	--
MW-01-3	1/22/2002	FD	--	--	< 0.003	--	0.016	--	0.065	--	< 0.001	--	0.0005	--	173	--	< 0.001	--	0.05	--	0.001	--	3.34	--
		SPLIT	--	--	< 0.003	--	0.014	--	0.053	--	< 0.001	--	0.0005	--	--	--	< 0.001	--	0.04	--	< 0.001	--	3.08	--
		FD SPLIT	--	--	< 0.003	--	0.014	--	0.055	--	< 0.001	--	0.0011	--	--	--	< 0.001	--	0.04	--	< 0.001	--	3.02	--
		FDD SPLIT	--	--	< 0.003	--	0.014	--	0.054	--	< 0.001	--	0.0006	--	--	--	< 0.001	--	0.04	--	< 0.001	--	3.03	--
MW-01-3	9/5/2002	N	--	--	--	--	0.015	--	< 0.1	--	--	--	< 0.001	--	--	--	--	--	--	--	--	--	1.97	--
		FD	--	--	--	--	0.015	--	< 0.1	--	--	--	< 0.001	--	--	--	--	--	--	--	--	--	1.96	--
MW-01-3	5/19/2008	N	--	--	--	0.00014	--	0.0166	--	0.0339	--	0.00006	--	0.00020	--	107	--	0.0002	--	0.0188	--	0.0034 J	--	1.02
MW-01-3	9/19/2008	N	--	--	--	0.00017	--	0.0177	--	0.0305	--	0.000099	--	0.00018	--	103	--	< 0.00020	--	0.0154	--	0.015536	--	0.67
MW-01-6	10/9/2001	N	--	--	< 0.003	< 0.003	0.009	0.009	0.009	0.017	< 0.001	< 0.001	< 0.0006	< 0.0006	212	229	< 0.001	0.001	0.04	0.04	0.004	0.005	15.9	18.0
MW-01-6	10/10/2001	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-01-6	1/17/2002	N	--	--	< 0.003	--	0.012	--	0.008	--	< 0.001	--	< 0.001	--	231	--	< 0.001	--	0.02	--	< 0.001	--	33.7	--
		SPLIT	--	--	< 0.003	--	0.011	--	0.007	--	< 0.001	--	< 0.0001	--	--	--	< 0.001	--	0.02	--	< 0.001	--	36.6	--
MW-01-6	9/5/2002	N	--	--	--	--	0.009	--	< 0.1	--	--	--	< 0.001	--	--	--	--	--	--	--	--	--	36.0	--
MW-01-6	5/19/2008	N	--	--	--	< 0.00005	--	0.0112	--	0.00980	--	0.00006	--	< 0.00002	--	134	--	< 0.0002	--	0.0116	--	0.0086 J	--	23.2
MW-01-6	9/18/2008	N	--	--	--	0.00005	--	0.0115	--	0.0166	--	0.000176	--	0.00002	--	127	--	< 0.00031	--	0.0087	--	0.061445	--	23.4
MW-02-2	9/5/2002	N	--	--	--	--	0.031	--	< 0.1	--	--	--	0.005	--	--	--	--	--	--	--	--	--	< 0.03	--
MW-02-2	5/19/2008	N	--	--	--	0.00013	--	0.0453	--	0.0186	--	0.00039	--	0.00371	--	102	--	0.0003	--	0.00753	--	0.0016 J	--	0.527
MW-02-2	9/22/2008	N	--	--	--	0.00012	--	0.0515	--	0.02268	--	0.00034	--	0.00353	--	111	--	0.0003	--	0.00705	--	0.0021	--	0.91
MW-02-1	1/17/2002	N	--	--	< 0.003	--	0.008	--	0.082	--	< 0.001	--	< 0.001	--	265	--	0.003	--	< 0.01	--	< 0.001	--	0.16	--
		SPLIT	--	--	< 0.003	--	0.008	--	0.075	--	< 0.001	--	< 0.0001	--	--	--	0.002	--	< 0.01	--	< 0.001	--	0.13	--
MW-02-1	9/4/2002	N	--	--	--	--	0.007	--	< 0.1	--	--	--	< 0.001	--	--	--	--	--	--	--	--	--	0.80	--
MW-02-1	7/22/2003	N	< 0.0300	0.0162 J	0.00016 J	< 0.0020	0.0025 BQQ	0.0039	0.0403 BQQ	0.0425	< 0.0010	< 0.0010	< 0.0010	0.00012 J	--	--	< 0.0020	0.00063 J	0.0076 BQQ	0.0066	0.0046 BQQJ	0.0059 J	--	--
MW-02-1	5/29/2008	N	--	--	--	< 0.00005	--	0.0044	--	0.0293	--	0.00004	--	0.00003	--	324	--	< 0.0002	--	0.00185	--	< 0.0030	--	2.29
		FD	--	--	--	0.00005	--	0.0047	--	0.0286	--	0.00005	--	< 0.00002	--	325	--	< 0.0002	--	0.00194	--	< 0.0026	--	2.41
MW-02-1	9/26/2008	N	--	--	--	< 0.00025	--	0.0055	--	0.0339	--	< 0.00010	--	< 0.00010	--	376	--	< 0.0010	--	0.0025	--	0.0087	--	9.51

Table 5.5.2-9
Groundwater Quality - Metals
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name Analysis			Lead Dissolved	Lead Total	Magnesium Dissolved	Magnesium Total	Manganese Dissolved	Manganese Total	Mercury Dissolved	Mercury Total	Nickel Dissolved	Nickel Total	Potassium Dissolved	Potassium Total	Selenium Dissolved	Selenium Total	Silver Dissolved	Silver Total	Sodium Dissolved	Sodium Total	Strontium Lab	Thallium Dissolved	Thallium Total
Location ID	Sample Date	Sample Type																					
MW-01-2	10/9/2001	N	< 0.002	< 0.002	25	28	2.73	3.06	< 0.0006	< 0.0006	< 0.01	< 0.01	29	35	0.006	0.007	< 0.003	< 0.003	43	47	--	< 0.002	< 0.002
MW-01-2	10/10/2001	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-01-2	1/16/2002	N	< 0.002	--	27	--	3.37	--	< 0.0001	--	0.007	--	34	--	0.006	--	< 0.003	--	44	--	--	< 0.001	--
		SPLIT	< 0.002	--	--	--	3.37	--	< 0.0006	--	0.01	--	--	--	0.007	--	< 0.003	--	--	--	--	< 0.002	--
MW-01-2	9/4/2002	N	--	--	--	--	2.67	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-01-2	7/22/2003	N	< 0.0010	0.00027 J	--	--	2.01 BQQ	2.000	< 0.00020	< 0.00020	0.0231 BQQ	0.0219	--	--	0.0073 BQQ	0.0060	0.000020 J	< 0.0010	--	--	--	0.000048 J	0.00012 J
		FD	< 0.0010 J	0.00037 J	--	--	1.97 BQQ	2.01	< 0.00020	< 0.00020	0.0225 BQQ	0.0222	--	--	0.0059 BQQ	0.0058	0.000020 J	< 0.0010	--	--	--	0.000070 J	0.00012 J
MW-01-2	5/19/2008	N	--	0.00014	--	19 R	--	1.55	--	< 0.0002	--	0.0044	--	23.9	--	0.0121	--	0.00003	--	46.9	--	--	0.00004
MW-01-2	9/22/2008	N	--	0.00028	--	19.2	--	1.18	--	< 0.0002	--	0.0032	--	25.9	--	0.010	--	< 0.00002	--	51.8	--	--	0.00004
MW-01-3	10/9/2001	N	< 0.002	< 0.002	41	44	11.6	13.1	< 0.0006	< 0.0006	0.02	0.03	36	40	0.003	0.003	< 0.003	< 0.003	50	53	--	< 0.002	< 0.002
MW-01-3	1/22/2002	N	< 0.002	--	44	--	12.2	--	< 0.0001	--	0.012	--	39	--	0.002	--	< 0.003	--	51	--	--	< 0.003	--
MW-01-3	1/22/2002	FD	< 0.002	--	44	--	12.4	--	< 0.0001	--	0.012	--	39	--	0.002	--	< 0.003	--	51	--	0.9	< 0.003	--
		SPLIT	< 0.002	--	--	--	12.0	--	< 0.0006	--	0.01	--	--	--	0.004	--	< 0.003	--	--	--	0.9	< 0.002	--
		FD SPLIT	0.003	--	--	--	12.5	--	< 0.0006	--	0.01	--	--	--	0.004	--	< 0.003	--	--	--	--	< 0.002	--
		FDD SPLIT	< 0.002	--	--	--	11.4	--	< 0.0006	--	0.01	--	--	--	0.004	--	< 0.003	--	--	--	--	< 0.002	--
MW-01-3	9/5/2002	N	--	--	--	--	10.1	--	--	--	--	--	--	--	< 0.005	--	--	--	--	--	--	--	--
		FD	--	--	--	--	10.6	--	--	--	--	--	--	--	< 0.005	--	--	--	--	--	--	--	--
MW-01-3	5/19/2008	N	--	0.00013	--	29.1 R	--	8.47	--	< 0.0002	--	0.0057	--	33.7	--	0.0015	--	< 0.00002	--	42.7	--	--	0.00005
MW-01-3	9/19/2008	N	--	0.000423	--	28.3	--	8.36	--	< 0.00020	--	0.0049	--	34.2	--	0.0020	--	< 0.000020	--	44.0	--	--	0.000060
MW-01-6	10/9/2001	N	< 0.002	< 0.002	43	47	4.83	5.36	< 0.0006	< 0.0006	0.01	0.02	55	60	0.002	0.002	< 0.003	< 0.003	69	76	--	< 0.002	< 0.002
MW-01-6	10/10/2001	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-01-6	1/17/2002	N	< 0.002	--	42	--	3.17	--	< 0.0001	--	0.012	--	54	--	0.003	--	< 0.003	--	66	--	--	< 0.001	--
		SPLIT	< 0.002	--	--	--	3.10	--	< 0.0006	--	0.02	--	--	--	0.005	--	< 0.003	--	--	--	--	< 0.002	--
MW-01-6	9/5/2002	N	--	--	--	--	2.39	--	--	--	--	--	--	--	< 0.005	--	--	--	--	--	--	--	--
MW-01-6	5/19/2008	N	--	0.00011	--	22.5 R	--	1.24	--	< 0.0002	--	0.0063	--	42.2	--	0.0012	--	< 0.00002	--	52.2	--	--	0.00010
MW-01-6	9/18/2008	N	--	0.000707	--	21.0	--	0.965	--	< 0.00020	--	0.0053	--	41.6	--	0.0029	--	< 0.000020	--	53.9	--	--	0.000098
MW-02-2	9/5/2002	N	--	--	--	--	1.97	--	--	--	--	--	--	--	0.009	--	--	--	--	--	--	--	--
MW-02-2	5/19/2008	N	--	0.00042	--	18.8 R	--	1.03	--	< 0.0002	--	0.0271	--	18.3	--	0.0149	--	0.00010	--	44.6	--	--	0.00003
MW-02-2	9/22/2008	N	--	0.00075	--	20.9	--	1.14	--	< 0.0002	--	0.0239	--	19.6	--	0.015	--	0.00005	--	47.8	--	--	0.00003
MW-02-1	1/17/2002	N	< 0.002	--	53	--	2.92	--	< 0.0001	--	0.008	--	23	--	0.005	--	< 0.003	--	236	--	--	< 0.001	--
		SPLIT	< 0.002	--	--	--	2.72	--	< 0.0006	--	0.01	--	--	--	0.006	--	< 0.003	--	--	--	--	< 0.002	--
MW-02-1	9/4/2002	N	--	--	--	--	3.17	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-02-1	7/22/2003	N	0.000030 J	0.00028 J	--	--	1.85 BQQ	1.76	< 0.00020	< 0.00020	0.0436 BQQ	0.0420	--	--	0.00087 J	0.0026 J	0.000020 J	< 0.0010	--	--	--	< 0.0010	0.00044 J
MW-02-1	5/29/2008	N	--	< 0.00030	--	--	62.7	--	--	< 0.0002	--	0.0048	--	28.8	--	0.0045	--	0.00002	--	306	--	--	< 0.00002
		FD	--	< 0.00033	--	--	63.4	--	--	< 0.0002	--	0.0050	--	28.9	--	0.0054	--	0.00002	--	308	--	--	< 0.00002
MW-02-1	9/26/2008	N	--	0.00082	--	71.5	--	2.14000	--	< 0.0002	--	0.0057	--	30.1	--	0.0070	--	< 0.00010	--	338	--	--	< 0.00010

Table 5.5.2-9
Groundwater Quality - Metals
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name Analysis			Uranium Dissolved	Uranium Total	Vanadium Dissolved	Vanadium Total	Zinc Dissolved	Zinc Total
Location ID	Sample Date	Sample Type						
MW-01-2	10/9/2001	N	--	< 0.0003	< 0.1	< 0.1	0.20	0.28
MW-01-2	10/10/2001	N	--	--	--	--	--	--
MW-01-2	1/16/2002	N	< 0.0002	--	< 0.01	--	0.091	--
		SPLIT	< 0.0003	--	< 0.1	--	0.10	--
MW-01-2	9/4/2002	N	--	--	--	--	0.25	--
MW-01-2	7/22/2003	N	--	--	0.0045 BQQ	0.0045	0.388 BQQ	0.327
		FD	--	--	0.0045 BQQ	0.0050	0.399 BQQ	0.321
MW-01-2	5/19/2008	N	--	0.000022	--	0.0064	--	0.222
MW-01-2	9/22/2008	N	--	0.00004	--	0.0062	--	0.2124
MW-01-3	10/9/2001	N	--	0.0007	< 0.1	< 0.1	0.47	0.60
MW-01-3	1/22/2002	N	< 0.001	--	< 0.1	--	0.09	--
MW-01-3	1/22/2002	FD	< 0.001	--	< 0.1	--	0.10	--
		SPLIT	< 0.0003	--	< 0.1	--	0.09	--
		FD SPLIT	< 0.0003	--	< 0.1	--	0.09	--
		FDD SPLIT	< 0.0003	--	< 0.1	--	0.09	--
MW-01-3	9/5/2002	N	--	--	--	--	0.23	--
		FD	--	--	--	--	0.23	--
MW-01-3	5/19/2008	N	--	0.000027	--	0.0011	--	0.0080
MW-01-3	9/19/2008	N	--	0.000036	--	0.000903	--	0.0129
MW-01-6	10/9/2001	N	--	< 0.0003	< 0.1	< 0.1	0.320	0.350
MW-01-6	10/10/2001	N	--	--	--	--	--	--
MW-01-6	1/17/2002	N	< 0.0002	--	< 0.01	--	0.873	--
		SPLIT	< 0.0003	--	< 0.1	--	0.97	--
MW-01-6	9/5/2002	N	--	--	--	--	0.99	--
MW-01-6	5/19/2008	N	--	< 0.000020	--	< 0.0002	--	0.902
MW-01-6	9/18/2008	N	--	0.000096	--	0.000500	--	0.6957
MW-02-2	9/5/2002	N	--	--	--	--	1.34	--
MW-02-2	5/19/2008	N	--	0.000059	--	0.0045	--	0.524
MW-02-2	9/22/2008	N	--	0.00008	--	0.0042	--	0.4973
MW-02-1	1/17/2002	N	0.0047	--	< 0.01	--	0.004	--
		SPLIT	0.0022	--	< 0.1	--	< 0.01	--
MW-02-1	9/4/2002	N	--	--	--	--	0.01	--
MW-02-1	7/22/2003	N	--	--	< 0.0010	< 0.0010	0.0030 BQQJ	0.0032 J
MW-02-1	5/29/2008	N	--	0.0035	--	< 0.0004	--	< 0.0016
		FD	--	0.0034	--	< 0.0003	--	< 0.0020
MW-02-1	9/26/2008	N	--	0.00455	--	< 0.0010	--	0.0143

Table 5.5.2-10
Groundwater Quality - SVOCs
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name			1,2,4,5- Tetrachlorobenzene	1,2,4- Trichlorobenzene	1,2- Dichlorobenzene	1,3- Dichlorobenzene	1,4- Dichlorobenzene	1- Methylnaphthalene	2,4,5- Trichlorophenol	2,4,6- Trichlorophenol	2,4- Dichlorophenol	2,4- Dimethylphenol	2,4- Dinitrophenol	2,4- Dinitrotoluene	2,6- Dinitrotoluene	2- Chloronaphthalene
Location ID	Sample Date	Sample Type														
MW-01-2	10/9/2001	N	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	--	< 0.01	< 0.01	< 0.01	< 0.01	< 0.05	< 0.01	< 0.01	< 0.01
MW-01-2	5/19/2008	N	--	< 0.000016	< 0.000022	< 0.000021	< 0.000029	--	< 0.000031	< 0.000058	< 0.000047	< 0.0022	< 0.00017	< 0.000018	< 0.000033	< 0.000041
MW-01-2	9/22/2008	N	--	< 0.000016	< 0.000022	< 0.000021	< 0.000029	--	< 0.000031	< 0.000058	< 0.000047	< 0.0022	< 0.00017 R	< 0.000018	< 0.000033	< 0.000041
MW-01-3	10/9/2001	N	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	--	< 0.01	< 0.01	< 0.01	< 0.01	< 0.05	< 0.01	< 0.01	< 0.01
MW-01-3	5/19/2008	N	--	< 0.000016	< 0.000022	< 0.000021	< 0.000029	--	< 0.000031	< 0.000058	< 0.000047	< 0.0022	< 0.00017	< 0.000018	< 0.000033	< 0.000041
MW-01-3	9/19/2008	N	--	< 0.000016	< 0.000022	< 0.000021	< 0.000029	--	< 0.000031	< 0.000058	< 0.000047	< 0.0022	< 0.00017 R	< 0.000018	< 0.000033	< 0.000041
MW-01-6	10/9/2001	N	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	--	< 0.01	< 0.01	< 0.01	< 0.01	< 0.05	< 0.01	< 0.01	< 0.01
MW-01-6	5/19/2008	N	--	< 0.000016	< 0.000022	< 0.000021	< 0.000029	--	< 0.000031	< 0.000058	< 0.000047	< 0.0022	< 0.00017	< 0.000018	< 0.000033	< 0.000041
MW-01-6	9/18/2008	N	--	< 0.000016	< 0.000022	< 0.000021	< 0.000029	--	< 0.000031	< 0.000058	< 0.000047	< 0.0022	< 0.00017 R	< 0.000018	< 0.000033	< 0.000041
MW-02-2	5/19/2008	N	--	< 0.000016	< 0.000022	< 0.000021	< 0.000029	--	< 0.000031	< 0.000058	< 0.000047	< 0.0022	< 0.00017	< 0.000018	< 0.000033	< 0.000041
MW-02-2	9/22/2008	N	--	< 0.000016	< 0.000022	< 0.000021	< 0.000029	--	< 0.000031	< 0.000058	< 0.000047	< 0.0022	< 0.00017 R	< 0.000018	< 0.000033	< 0.000041
MW-02-1	1/17/2002	N	--	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.05	< 0.01	< 0.01	< 0.01
		SPLIT	--	< 0.011	< 0.011	< 0.011	< 0.011	--	< 0.021	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011
MW-02-1	5/29/2008	N	--	< 0.00016	< 0.00022	< 0.00021	< 0.00029	--	< 0.00031	< 0.00058	< 0.00047	< 0.022 R	< 0.0017	< 0.00018	< 0.00033	< 0.00041
		FD	--	< 0.00032	< 0.00044	< 0.00042	< 0.00058	--	< 0.00062	< 0.0012	< 0.00094	< 0.044 R	< 0.0034	< 0.00036	< 0.00066	< 0.00082
MW-02-1	9/26/2008	N	--	< 0.000016	< 0.000022	< 0.000021	< 0.000029	--	< 0.000031	< 0.000058	< 0.000047	< 0.0022 R	< 0.00017	< 0.000018	< 0.000033	< 0.000041

Table 5.5.2-10
Groundwater Quality - SVOCs
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name			2-Chlorophenol	2-Methyl-4,6-dinitrophenol	2-Methylnaphthalene	2-Nitroaniline	2-Nitrophenol	3,3'-Dichlorobenzidine	3-Nitroaniline	4-Bromophenyl phenyl ether	4-Chloro-3-methylphenol	4-Chloroaniline	4-Chlorophenol	4-Chlorophenyl phenyl ether	4-Nitroaniline	4-Nitrophenol	Acenaphthene	Acenaphthylene
Location ID	Sample Date	Sample Type																
MW-01-2	10/9/2001	N	< 0.01	< 0.05	< 0.01	--	< 0.01	< 0.02	--	< 0.01	< 0.01	--	--	< 0.01	--	< 0.05	< 0.01	< 0.01
MW-01-2	5/19/2008	N	< 0.000054	< 0.000025	< 0.000026	< 0.000024	< 0.000063	< 0.00043 R	< 0.000029	< 0.000026	< 0.000037	< 0.000025 R	--	< 0.000027	< 0.000019	< 0.00028	< 0.000026	< 0.000015
MW-01-2	9/22/2008	N	< 0.000054	< 0.000025	< 0.000026	< 0.000024	< 0.000063	< 0.00043	< 0.000029	< 0.000026	< 0.000037	< 0.000025	--	< 0.000027	< 0.000019	< 0.00028	< 0.0000044	< 0.0000034
MW-01-3	10/9/2001	N	< 0.01	< 0.05	< 0.01	--	< 0.01	< 0.02	--	< 0.01	< 0.01	--	--	< 0.01	--	< 0.05	< 0.01	< 0.01
MW-01-3	5/19/2008	N	< 0.000054	< 0.000025	< 0.000026	< 0.000024	< 0.000063	< 0.00043 R	< 0.000029	< 0.000026	< 0.000037	< 0.000025 R	--	< 0.000027	< 0.000019	< 0.00028	0.000032 J	0.000018 J
MW-01-3	9/19/2008	N	< 0.000054	< 0.000025	< 0.000026	< 0.000024	< 0.000063	< 0.00043	< 0.000029	< 0.000026	< 0.000037	< 0.000025	--	< 0.000027	< 0.000019	< 0.00028	0.000075	< 0.0000035
MW-01-6	10/9/2001	N	< 0.01	< 0.05	< 0.01	--	< 0.01	< 0.02	--	< 0.01	< 0.01	--	--	< 0.01	--	< 0.05	0.0057 J	< 0.01
MW-01-6	5/19/2008	N	< 0.000054	< 0.000025	0.000082 J	< 0.000024	< 0.000063	< 0.00043 R	< 0.000029	< 0.000026	< 0.000037	< 0.000025 R	--	< 0.000027	< 0.000019	< 0.00028	0.00036	0.000045 J
MW-01-6	9/18/2008	N	< 0.000054	< 0.000025	0.000095 J	< 0.000024	< 0.000063	< 0.00043	< 0.000029	< 0.000026	< 0.000037	< 0.000025	--	< 0.000027	< 0.000019	< 0.00028	0.00062	0.000010 J
MW-02-2	5/19/2008	N	< 0.000054	< 0.000025	< 0.000026	< 0.000024	< 0.000063	< 0.00043 R	< 0.000029	< 0.000026	< 0.000037	< 0.000025 R	--	< 0.000027	< 0.000019	< 0.00028	< 0.000026	< 0.000015
MW-02-2	9/22/2008	N	< 0.000054	< 0.000025	< 0.000026	< 0.000024	< 0.000063	< 0.00043	< 0.000029	< 0.000026	< 0.000037	< 0.000025	--	< 0.000027	< 0.000019	< 0.00028	< 0.000026	< 0.000015
MW-02-1	1/17/2002	N	< 0.01	< 0.05	< 0.01	--	< 0.01	< 0.02	--	< 0.01	< 0.01	--	< 0.01	< 0.01	--	< 0.05	< 0.01	< 0.01
		SPLIT	< 0.011	< 0.021	< 0.011	< 0.011	< 0.011	< 0.021	< 0.011	< 0.011	< 0.011	< 0.021	--	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011
MW-02-1	5/29/2008	N	< 0.00054	< 0.00025	< 0.00026	< 0.00024	< 0.00063	< 0.0043	< 0.00029	< 0.00026	< 0.00037	< 0.00025	--	< 0.00027	< 0.00019	< 0.0028	< 0.00026	< 0.00015
		FD	< 0.0011	< 0.00050	< 0.00052	< 0.00048	< 0.0013	< 0.0086	< 0.00058	< 0.00052	< 0.00074	< 0.00050	--	< 0.00054	< 0.00038	< 0.0056	< 0.00052	< 0.00030
MW-02-1	9/26/2008	N	< 0.000054	< 0.000025	< 0.00022	< 0.000024	< 0.000063	< 0.00043	< 0.000029	< 0.000026	< 0.000037	< 0.000025	--	< 0.000027	< 0.000019	< 0.00028	0.00046	< 0.000015

Table 5.5.2-10
Groundwater Quality - SVOCs
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name			Anthracene	Azobenzene	Benzidine	Benzo(a) anthracene	Benzo(a) pyrene	Benzo(b) fluoranthene	Benzo(g,h,i) perylene	Benzo(k) fluoranthene	Benzoic acid	BenzyI alcohol	Bis(2-chloroethoxy) methane	Bis(2- chloroethyl)ether	Bis(2-chloroisopropyl) ether	Bis(2-ethylhexyl) phthalate	Butyl benzyI phthalate	Carbazole	Chrysene
Location ID	Sample Date	Sample Type																	
MW-01-2	10/9/2001	N	< 0.01	--	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	--	--	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	--	< 0.01
MW-01-2	5/19/2008	N	< 0.000024	< 0.000021	--	< 0.000018	< 0.000031	< 0.000017	< 0.000019	< 0.000024	< 0.0011 R	< 0.000073	< 0.000024	< 0.000035	< 0.000026	0.00052 J	< 0.000018	< 0.000018	< 0.000028
MW-01-2	9/22/2008	N	< 0.0000036	< 0.000021	--	< 0.0000026	< 0.0000043	< 0.0000023	< 0.0000029	< 0.0000025	0.0016 R	< 0.000073	< 0.000024	< 0.000035	< 0.000026	< 0.00018	< 0.000056	< 0.000018	< 0.0000034
MW-01-3	10/9/2001	N	< 0.01	--	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	--	--	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	--	< 0.01
MW-01-3	5/19/2008	N	0.000025 J	< 0.000021	--	0.000026 J	< 0.000031	< 0.000017	< 0.000019	< 0.000024	< 0.0011 R	< 0.000073	< 0.000024	< 0.000035	< 0.000026	0.00079 J	< 0.000018	0.000019 J	0.000032 J
MW-01-3	9/19/2008	N	0.000018 J	< 0.000021	--	0.000021 J	< 0.0000044	0.0000027 J	< 0.0000030	< 0.0000026	0.0015 R	< 0.000073	< 0.000024	< 0.000035	< 0.000026	< 0.00021	< 0.000037	0.000029 J	0.000033
MW-01-6	10/9/2001	N	< 0.01	--	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	--	--	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	--	< 0.01
MW-01-6	5/19/2008	N	0.000084 J	< 0.000021	--	< 0.000018	< 0.000031	< 0.000017	< 0.000019	< 0.000024	0.0011 R	< 0.000073	< 0.000024	< 0.000035	< 0.000026	0.0026	< 0.000018	0.00031	< 0.000028
MW-01-6	9/18/2008	N	0.000025	< 0.000021	--	0.0000049 J	< 0.0000043	< 0.0000023	< 0.0000029	< 0.0000025	< 0.0011 R	< 0.000073	< 0.000024	< 0.000035	< 0.000026	< 0.00025	< 0.000062	0.00061	< 0.0000034
MW-02-2	5/19/2008	N	< 0.000024	< 0.000021	--	< 0.000018	< 0.000031	< 0.000017	< 0.000019	< 0.000024	< 0.0011 R	< 0.000073	< 0.000024	< 0.000035	< 0.000026	0.0019	< 0.000018	< 0.000018	< 0.000028
MW-02-2	9/22/2008	N	< 0.000024	< 0.000021	--	< 0.000018	< 0.000031	< 0.000017	< 0.000019	< 0.000024	0.0022 R	< 0.000073	< 0.000024	< 0.000035	< 0.000026	< 0.00025	< 0.000018	< 0.000018	< 0.000028
MW-02-1	1/17/2002	N	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	--	--	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	--	< 0.01
		SPLIT	< 0.011	--	--	< 0.011	< 0.021	< 0.011	< 0.011	< 0.011	< 0.053	< 0.021	< 0.011	< 0.021 *	< 0.011	< 0.021	< 0.011	< 0.032	< 0.011
MW-02-1	5/29/2008	N	< 0.00024	< 0.00021	--	< 0.00018	< 0.00031	< 0.00017	< 0.00019	< 0.00024	< 0.011 R	< 0.00073	< 0.00024	< 0.00035	< 0.00026	1.4 J	< 0.00018	< 0.00018	< 0.00028
		FD	< 0.00048	< 0.00042	--	< 0.00036	< 0.00062	< 0.00034	< 0.00038	< 0.00048	< 0.022 R	< 0.0015	< 0.00048	< 0.00070	< 0.00052	22 J	< 0.00036	< 0.00036	< 0.00056
MW-02-1	9/26/2008	N	< 0.000024	< 0.000021	--	< 0.000018	< 0.000031	< 0.000017	< 0.000019	< 0.000024	< 0.0011	< 0.000073	< 0.000024	< 0.000035	< 0.000026	< 0.16	< 0.000018	< 0.000018	< 0.000028

Table 5.5.2-10
Groundwater Quality - SVOCs
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name			Dibenz(a,h) anthracene	Dibenzofuran	Diethyl phthalate	Dimethyl phthalate	Di-n-butyl phthalate	Di-n-octyl phthalate	Fluoranthene	Fluorene	Hexachlorobenzene	Hexachlorobutadiene	Hexachlorocyclopentadiene	Hexachloroethane	Indeno(1,2,3-cd) pyrene	Isophorone	m,p- cresols	Naphthalene
Location ID	Sample Date	Sample Type																
MW-01-2	10/9/2001	N	< 0.01	--	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
MW-01-2	5/19/2008	N	< 0.000017	< 0.000018	< 0.000033	< 0.000021	< 0.000044	< 0.000018	< 0.000020	< 0.000027	< 0.000022	< 0.000027 R	< 0.00019 R	< 0.000024	< 0.000021	< 0.000016	--	0.000069 J
MW-01-2	9/22/2008	N	< 0.0000025	< 0.000018	< 0.000042	< 0.000021	< 0.000088	< 0.000018	< 0.0000044	< 0.0000038	< 0.000022	< 0.000027	< 0.00019 R	< 0.000024	< 0.0000026	< 0.000016	--	< 0.000011
MW-01-3	10/9/2001	N	< 0.01	--	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01	0.015
MW-01-3	5/19/2008	N	< 0.000017	< 0.000018	< 0.000055	< 0.000021	< 0.000053	< 0.000018	0.00031	< 0.000027	< 0.000022	< 0.000027 R	< 0.00019 R	< 0.000024	< 0.000021	< 0.000016	--	0.000024 J
MW-01-3	9/19/2008	N	< 0.0000026	0.000031 J	< 0.000069	< 0.000021	< 0.000083	< 0.000018	0.00049	0.0000085 J	< 0.000022	< 0.000027 R	< 0.00019 R	< 0.000024 R	< 0.0000027	< 0.000016	--	< 0.000036
MW-01-6	10/9/2001	N	< 0.01	--	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01	0.015
MW-01-6	5/19/2008	N	< 0.000017	0.00014 J	0.00020	< 0.000021	< 0.000043	< 0.000018	0.00019 J	0.00014 J	< 0.000022	< 0.000027 R	< 0.00019 R	< 0.000024	< 0.000021	< 0.000016	--	0.00032
MW-01-6	9/18/2008	N	< 0.0000025	0.00030	< 0.00015	< 0.000021	< 0.000080	< 0.000018	0.00031	0.00017	< 0.000022	< 0.000027 R	< 0.00019 R	< 0.000024 R	< 0.0000026	< 0.000016	--	< 0.00030
MW-02-2	5/19/2008	N	< 0.000017	< 0.000018	< 0.000023	< 0.000021	< 0.000043	< 0.000018	< 0.000020	< 0.000027	< 0.000022	< 0.000027 R	< 0.00019 R	< 0.000024	< 0.000021	< 0.000016	--	< 0.000022
MW-02-2	9/22/2008	N	< 0.000017	< 0.000018	< 0.000039	< 0.000021	< 0.000090	< 0.000018	< 0.000020	< 0.000027	< 0.000022	< 0.000027	< 0.00019 R	< 0.000024	< 0.000021	< 0.000016	--	< 0.000022
MW-02-1	1/17/2002	N	< 0.01	--	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
		SPLIT	< 0.021	< 0.011	< 0.032	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011	--	< 0.011
MW-02-1	5/29/2008	N	< 0.00017	< 0.00018	< 0.00012	< 0.00021	< 0.00023	< 0.00018	< 0.00020	< 0.00027	< 0.00022	< 0.00027 R	< 0.0019 R	< 0.00024 R	< 0.00021	< 0.00016	--	< 0.00022
		FD	< 0.00034	< 0.00036	< 0.00024	< 0.00042	< 0.00046	< 0.00036	< 0.00040	< 0.00054	< 0.00044	< 0.00054 R	< 0.0038 R	< 0.00048 R	< 0.00042	< 0.00032	--	< 0.00044
MW-02-1	9/26/2008	N	< 0.000017	0.00070	< 0.000012	< 0.000021	< 0.000023	< 0.000018	< 0.000020	0.00064	< 0.000022	< 0.000027	< 0.00019 R	< 0.000024	< 0.000021	< 0.000016	--	< 0.000022

Table 5.5.2-10
Groundwater Quality - SVOCs
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name			Nitrobenzene	N-Nitrosodimethylamine	N-Nitrosodi-n-propylamine	N-Nitrosodiphenylamine	N-Nitrosopyrrolidine	o-Cresol	p-cresol	Pentachlorobenzene	Pentachlorophenol	Phenanthrene	Phenol	Pyrene	Pyridine
Location ID	Sample Date	Sample Type													
MW-01-2	10/9/2001	N	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	--	< 0.01	< 0.05	< 0.01	< 0.01	< 0.01	< 0.02
MW-01-2	5/19/2008	N	0.000099 J	< 0.00042	< 0.000037	< 0.000048	--	< 0.00011	< 0.00012	--	< 0.00034	< 0.000022	0.0017	< 0.000019	--
MW-01-2	9/22/2008	N	< 0.000028	< 0.00042	< 0.000037	< 0.000048	--	< 0.00011	< 0.00012	--	< 0.00034	< 0.0000050	0.00019 J	< 0.0000035	< 0.0014 R
MW-01-3	10/9/2001	N	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	--	< 0.01	< 0.05	< 0.01	< 0.01	< 0.01	< 0.02
MW-01-3	5/19/2008	N	< 0.000028	< 0.00042	< 0.000037	< 0.000048	--	< 0.00011	< 0.00012	--	< 0.00034	0.000072 J	0.0018	0.00021	--
MW-01-3	9/19/2008	N	< 0.000028	< 0.00042	< 0.000037	< 0.000048	--	< 0.00011	< 0.00012	--	< 0.00034	0.000074	< 0.000063	0.00033	< 0.0014 R
MW-01-6	10/9/2001	N	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	--	< 0.01	< 0.05	< 0.01	< 0.01	< 0.01	< 0.02
MW-01-6	5/19/2008	N	< 0.000028	< 0.00042	< 0.000037	< 0.000048	--	0.00020 J	0.00039 J	--	< 0.00034	0.00037	0.0062	0.00012 J	--
MW-01-6	9/18/2008	N	< 0.000028	< 0.00042	< 0.000037	< 0.000048	--	0.00011 J	< 0.00012	--	< 0.00034	0.00051	< 0.000063	0.00020	< 0.0014 R
MW-02-2	5/19/2008	N	< 0.000028	< 0.00042	< 0.000037	< 0.000048	--	< 0.00011	< 0.00012	--	< 0.00034	< 0.000022	0.0014	< 0.000019	--
MW-02-2	9/22/2008	N	< 0.000028	< 0.00042	< 0.000037	< 0.000048	--	< 0.00011	< 0.00012	--	0.00080 J	< 0.000022	< 0.000063	< 0.000019	< 0.0014 R
MW-02-1	1/17/2002	N	< 0.01	< 0.01	< 0.01	< 0.01	--	< 0.01	--	--	< 0.05	< 0.01	< 0.01	< 0.01	< 0.02
		SPLIT	< 0.011	< 0.011 *	< 0.011	< 0.011	--	< 0.011	< 0.011	--	< 0.011	< 0.011	< 0.011 *	< 0.011	< 0.011
MW-02-1	5/29/2008	N	< 0.00028	< 0.0042	< 0.00037	< 0.00048	--	< 0.0011	< 0.0012	--	< 0.0034	< 0.00022	< 0.013	< 0.00019	--
		FD	< 0.00056	< 0.0084	< 0.00074	< 0.00096	--	< 0.0022	< 0.0024	--	< 0.0068	< 0.00044	< 0.015	< 0.00038	--
MW-02-1	9/26/2008	N	< 0.000028	< 0.00042	< 0.000037	< 0.000048	--	< 0.00011	< 0.00012	--	< 0.00034	0.00056	0.0020	< 0.000019	< 0.0014 R

Table 5.5.2-11
Groundwater Quality - VOCs
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name			1,1,1,2-Tetrachloroethane	1,1,1-Trichloroethane	1,1,1,2,2-Tetrachloroethane	1,1,2-Trichloroethane	1,1-Dichloro-1-propene	1,1-Dichloroethane	1,1-Dichloroethylene	1,2,3-Trichlorobenzene	1,2,3-Trichloropropane	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,2-Dibromo-3-chloropropane	1,2-Dibromoethane	1,2-Dichlorobenzene
Location ID	Sample Date	Sample Type														
MW-01-2	10/9/2001	N	< 0.0010	< 0.0010	< 0.0010	< 0.0010	--	< 0.0010	< 0.0010	--	< 0.0010	--	--	< 0.0010	< 0.0010	--
MW-01-2	5/19/2008	N	< 0.000047	< 0.000050	< 0.000064	< 0.000061	< 0.000051	< 0.000042	< 0.00010	< 0.00010	< 0.00014	< 0.00013	< 0.000037	< 0.00022	< 0.000084	< 0.000044
MW-01-2	9/22/2008	N	< 0.000047	< 0.000050	< 0.000064	< 0.000061	< 0.000051	< 0.000042	< 0.00010	< 0.00010	< 0.00014	< 0.00013	< 0.000037	< 0.00022 J	< 0.000084	< 0.000044
MW-01-3	10/9/2001	N	< 0.0010	< 0.0010	< 0.0010	< 0.0010	--	< 0.0010	< 0.0010	--	< 0.0010	--	--	< 0.0010	< 0.0010	--
MW-01-3	5/19/2008	N	< 0.000047	< 0.000050	< 0.000064	< 0.000061	< 0.000051	< 0.000042	< 0.00010	< 0.00010	< 0.00014	< 0.00013	< 0.000037	< 0.00022	< 0.000084	< 0.000044
MW-01-3	9/19/2008	N	< 0.000047	< 0.000050	< 0.000064	< 0.000061	< 0.000051	< 0.000042	< 0.00010	< 0.00010	< 0.00014	< 0.00013	< 0.000037	< 0.00022 J	< 0.000084	< 0.000044
MW-01-6	10/9/2001	N	< 0.0010	< 0.0010	< 0.0010	< 0.0010	--	< 0.0010	< 0.0010	--	< 0.0010	--	--	< 0.0010	< 0.0010	--
MW-01-6	5/19/2008	N	< 0.000047	< 0.000050	< 0.000064	< 0.000061	< 0.000051	< 0.000042	< 0.00010	< 0.00010	< 0.00014	< 0.00013	0.00010 J	< 0.00022	< 0.000084	< 0.000044
MW-01-6	9/18/2008	N	< 0.000047	< 0.000050	< 0.000064	< 0.000061	< 0.000051	< 0.000042	< 0.00010	< 0.00010	< 0.00014	< 0.00013	0.000090 J	< 0.00022	< 0.000084	< 0.000044
MW-02-2	5/19/2008	N	< 0.000047	< 0.000050	< 0.000064	< 0.000061	< 0.000051	< 0.000042	< 0.00010	< 0.00010	< 0.00014	< 0.00013	< 0.000037	< 0.00022	< 0.000084	< 0.000044
MW-02-2	9/22/2008	N	< 0.000047	< 0.000050	< 0.000064	< 0.000061	< 0.000051	< 0.000042	< 0.00010	< 0.00010	< 0.00014	< 0.00013	< 0.000037	< 0.00022 J	< 0.000084	< 0.000044
MW-02-1	1/17/2002	N	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.012	< 0.0010	< 0.0010	< 0.0010
		SPLIT	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.014	< 0.005	< 0.001	< 0.001
MW-02-1	5/29/2008	N	< 0.000047	< 0.000050	< 0.000064	< 0.000061	< 0.000051	< 0.000042	< 0.00010	< 0.00010	< 0.00014	< 0.00013	< 0.000037	< 0.00022	< 0.000084	< 0.000044
		FD	< 0.000047	< 0.000050	< 0.000064	< 0.000061	< 0.000051	< 0.000042	< 0.00010	< 0.00010	< 0.00014	< 0.00013	< 0.000037	< 0.00022	< 0.000084	< 0.000044
MW-02-1	9/26/2008	N	< 0.000047	< 0.000050	< 0.000064	< 0.000061	< 0.000051	< 0.000042	< 0.00010	< 0.00010	< 0.00014	< 0.00013	< 0.000037	< 0.00022 J	< 0.000084	< 0.000044

Table 5.5.2-11
Groundwater Quality - VOCs
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name			1,2-Dichloroethane	1,2-Dichloroethylene, cis	1,2-Dichloroethylene, trans	1,2-Dichloropropane	1,3,5-Trimethylbenzene	1,3-Dichloro-1-propene, cis	1,3-Dichloro-1-propene, trans	1,3-Dichlorobenzene	1,3-Dichloropropane	1,4-Dichlorobenzene	2,2-Dichloropropane	2-Chloroethyl vinyl ether	2-Hexanone	Acetone	Acrolein
Location ID	Sample Date	Sample Type															
MW-01-2	10/9/2001	N	< 0.0010	< 0.0010	< 0.0010	< 0.0010	--	< 0.0010	< 0.0010	--	--	--	--	--	< 0.02	< 0.02	--
MW-01-2	5/19/2008	N	< 0.000073	< 0.000045	< 0.000048	< 0.000042	< 0.000042	< 0.000038	< 0.000041	< 0.000041	< 0.000032	< 0.000054	< 0.000050	< 0.00019 R	< 0.0029	< 0.0025	< 0.0020
MW-01-2	9/22/2008	N	< 0.000073	< 0.000045	< 0.000048	< 0.000042	< 0.000042	< 0.000038	< 0.000041	< 0.000041	< 0.000032	< 0.000054	< 0.000050	< 0.00019 R	< 0.0029	< 0.0051	< 0.0020
MW-01-3	10/9/2001	N	< 0.0010	< 0.0010	< 0.0010	< 0.0010	--	< 0.0010	< 0.0010	--	--	--	--	--	< 0.02	0.012 J	--
MW-01-3	5/19/2008	N	< 0.000073	< 0.000045	< 0.000048	< 0.000042	< 0.000042	< 0.000038	< 0.000041	< 0.000041	< 0.000032	< 0.000054	< 0.000050	< 0.00019 R	< 0.0029	0.0084 J	< 0.0020
MW-01-3	9/19/2008	N	< 0.000073	< 0.000045	< 0.000048	< 0.000042	< 0.000042	< 0.000038	< 0.000041	< 0.000041	< 0.000032	< 0.000054	< 0.000050	< 0.00019 R	< 0.0029	< 0.023	< 0.0020
MW-01-6	10/9/2001	N	< 0.0010	< 0.0010	< 0.0010	< 0.0010	--	< 0.0010	< 0.0010	--	--	--	--	--	< 0.02	< 0.02	--
MW-01-6	5/19/2008	N	< 0.000073	< 0.000045	< 0.000048	< 0.000042	< 0.000042	< 0.000038	< 0.000041	< 0.000041	< 0.000032	< 0.000054	< 0.000050	< 0.00019 R	< 0.0029	< 0.0025	< 0.0020
MW-01-6	9/18/2008	N	< 0.000073	< 0.000045	< 0.000048	< 0.000042	< 0.000042	< 0.000038	< 0.000041	< 0.000041	< 0.000032	< 0.000054	< 0.000050	< 0.00019 R	< 0.0029	< 0.017	< 0.0020
MW-02-2	5/19/2008	N	< 0.000073	< 0.000045	< 0.000048	< 0.000042	< 0.000042	< 0.000038	< 0.000041	< 0.000041	< 0.000032	< 0.000054	< 0.000050	< 0.00019 R	< 0.0029	< 0.0025	< 0.0020
MW-02-2	9/22/2008	N	< 0.000073	< 0.000045	< 0.000048	< 0.000042	< 0.000042	< 0.000038	< 0.000041	< 0.000041	< 0.000032	< 0.000054	< 0.000050	< 0.00019 R	< 0.0029	< 0.0046	< 0.0020
MW-02-1	1/17/2002	N	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.0058	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.02	< 0.02	< 0.02
		SPLIT	< 0.001	< 0.001	< 0.001	< 0.001	0.007	--	--	< 0.001	< 0.001	< 0.001	< 0.001	--	--	--	--
MW-02-1	5/29/2008	N	< 0.000073	< 0.000045	< 0.000048	< 0.000042	0.00078	< 0.000038	< 0.000041	< 0.000041	< 0.000032	< 0.000054	< 0.000050	< 0.00019 R	< 0.0029	< 0.0025	< 0.0020 J
		FD	< 0.000073	< 0.000045	< 0.000048	< 0.000042	0.00032 J	< 0.000038	< 0.000041	< 0.000041	< 0.000032	< 0.000054	< 0.000050	< 0.00019 R	< 0.0029	< 0.0025	< 0.0020 J
MW-02-1	9/26/2008	N	< 0.000073	< 0.000045	< 0.000048	< 0.000042	0.00031 J	< 0.000038	< 0.000041	< 0.000041	< 0.000032	< 0.000054	< 0.000050	< 0.00019 R	< 0.0029	< 0.0025	< 0.0020

Table 5.5.2-11
Groundwater Quality - VOCs
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name			Acrylonitrile	Benzene	Bromobenzene	Bromochloromethane	Bromodichloromethane	Bromoform	Bromomethane	Butyl benzene	Butylbenzene, sec	Butylbenzene, tert	Carbon disulfide	Carbon tetrachloride	Chlorobenzene	Chlorodibromomethane	Chloroethane
Location ID	Sample Date	Sample Type															
MW-01-2	10/9/2001	N	--	< 0.0010	--	--	< 0.0010	< 0.0010	< 0.0010	--	--	--	0.00030 J*	< 0.0010	< 0.0010	< 0.0010	< 0.0010
MW-01-2	5/19/2008	N	< 0.00031	< 0.000045	< 0.000027	< 0.000091	< 0.000036	< 0.000080	< 0.000072	< 0.000056	< 0.000036	< 0.000038	< 0.000080	< 0.000068	< 0.000045	< 0.000057	< 0.00013
MW-01-2	9/22/2008	N	< 0.00031	< 0.000045	< 0.000027	< 0.000091	< 0.000036	< 0.000080 J	< 0.000072	< 0.000056	< 0.000036	< 0.000038	< 0.000045	< 0.000068	< 0.000045	< 0.000057	< 0.00013
MW-01-3	10/9/2001	N	--	< 0.0010	--	--	< 0.0010	< 0.0010	< 0.0010	--	--	--	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
MW-01-3	5/19/2008	N	< 0.00031	0.00027 J	< 0.000027	< 0.000091	< 0.000036	< 0.000080	< 0.000072	< 0.000056	< 0.000036	< 0.000038	< 0.000045	< 0.000068	< 0.000045	< 0.000057	< 0.00013
MW-01-3	9/19/2008	N	< 0.00031	< 0.000045	< 0.000027	< 0.000091	< 0.000036	< 0.000080 J	< 0.000072	< 0.000056	< 0.000036	< 0.000038	< 0.000045	< 0.000068	< 0.000045	< 0.000057	< 0.00013
MW-01-6	10/9/2001	N	--	0.00070 J	--	--	< 0.0010	< 0.0010	< 0.0010	--	--	--	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
MW-01-6	5/19/2008	N	< 0.00031	0.00060	< 0.000027	< 0.000091	< 0.000036	< 0.000080	< 0.000072	< 0.000056	< 0.000036	< 0.000038	< 0.000045	< 0.000068	< 0.000045	< 0.000057	< 0.00013
MW-01-6	9/18/2008	N	< 0.00031	0.00048 J	< 0.000027	< 0.000091	< 0.000036	< 0.000080 J	< 0.000072	< 0.000056	< 0.000036	< 0.000038	< 0.000045	< 0.000068	< 0.000045	< 0.000057	< 0.00013
MW-02-2	5/19/2008	N	< 0.00031	< 0.000045	< 0.000027	< 0.000091	< 0.000036	< 0.000080	< 0.000072	< 0.000056	< 0.000036	< 0.000038	< 0.000060	< 0.000068	< 0.000045	< 0.000057	< 0.00013
MW-02-2	9/22/2008	N	< 0.00031	< 0.000045	< 0.000027	< 0.000091	< 0.000036	< 0.000080 J	< 0.000072	< 0.000056	< 0.000036	< 0.000038	< 0.000045	< 0.000068	< 0.000045	< 0.000057	< 0.00013
MW-02-1	1/17/2002	N	< 0.02	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.0047	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
		SPLIT	--	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	0.005	0.004	--	< 0.001	< 0.001	< 0.001	< 0.001
MW-02-1	5/29/2008	N	< 0.00031	< 0.000045	< 0.000027	< 0.000091	< 0.000036	< 0.000080	< 0.000072	< 0.000072	0.0029	0.00013 J	< 0.000045	< 0.000068	< 0.000045	< 0.000057	< 0.00013
		FD	< 0.00031	< 0.000045	< 0.000027	< 0.000091	< 0.000036	< 0.000080	< 0.000072	< 0.000056	0.00069 J	0.000050 J	< 0.000045	< 0.000068	< 0.000045	< 0.000057	0.00022 J
MW-02-1	9/26/2008	N	< 0.00031	0.00012 J	< 0.000027	< 0.000091	< 0.000036	< 0.000080 J	< 0.000072	0.00035 J	0.0016 J	0.000060 J	< 0.00028	< 0.000068	< 0.000045	< 0.000057	< 0.00013

Table 5.5.2-11
Groundwater Quality - VOCs
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name			Chloroform	Chloromethane	Chlorotoluene o-	Chlorotoluene p-	Cumene (isopropyl benzene)	Cymene p- (Toluene isopropyl p-)	Dibromomethane (methylene bromide)	Dichlorodifluoromethane (CFC-12)	Ethyl benzene	Hexachlorobutadiene	Iodomethane	Isopropyl toluene	Methyl ethyl ketone	Methyl isobutyl ketone
Location ID	Sample Date	Sample Type														
MW-01-2	10/9/2001	N	< 0.0010	< 0.0010	--	--	--	--	--	< 0.0010	< 0.0010	--	< 0.0010	--	< 0.02	< 0.02
MW-01-2	5/19/2008	N	< 0.000042	< 0.000053	< 0.000035	< 0.000025	< 0.000031	< 0.000044	< 0.000089	< 0.000083	< 0.000042	< 0.00019	< 0.00027	--	< 0.0038	< 0.0030
MW-01-2	9/22/2008	N	< 0.000042	< 0.000053	< 0.000035	< 0.000025	< 0.000031	< 0.000044	< 0.000089	< 0.000083	< 0.000042	< 0.00019	< 0.00027	--	< 0.0038	< 0.0030
MW-01-3	10/9/2001	N	< 0.0010	< 0.0010	--	--	--	--	--	< 0.0010	< 0.0010	--	< 0.0010	--	< 0.02	< 0.02
MW-01-3	5/19/2008	N	< 0.000042	< 0.000053	< 0.000035	< 0.000025	< 0.000031	< 0.000044	< 0.000089	< 0.000083	< 0.000042	< 0.00019	< 0.00027	--	< 0.0038	< 0.0030
MW-01-3	9/19/2008	N	< 0.000042	0.00016 J	< 0.000035	< 0.000025	< 0.000031	< 0.000044	< 0.000089	< 0.000083	< 0.000042	< 0.00019	< 0.00027	--	< 0.0038	< 0.0030
MW-01-6	10/9/2001	N	< 0.0010	< 0.0010	--	--	--	--	--	< 0.0010	< 0.0010	--	< 0.0010	--	< 0.02	< 0.02
MW-01-6	5/19/2008	N	< 0.000042	0.000090 J	< 0.000035	< 0.000025	0.000040 J	< 0.000044	< 0.000089	< 0.000083	0.000070 J	< 0.00019	< 0.00027	--	< 0.0038	< 0.0030
MW-01-6	9/18/2008	N	< 0.000042	< 0.000053	< 0.000035	< 0.000025	< 0.000031	< 0.000044	< 0.000089	< 0.000083	0.000060 J	< 0.00019	< 0.00027	--	< 0.0038	< 0.0030
MW-02-2	5/19/2008	N	< 0.000042	< 0.000053	< 0.000035	< 0.000025	< 0.000031	< 0.000044	< 0.000089	< 0.000083	< 0.000042	< 0.00019	< 0.00027	--	< 0.0038	< 0.0030
MW-02-2	9/22/2008	N	< 0.000042	< 0.000053	< 0.000035	< 0.000025	< 0.000031	< 0.000044	< 0.000089	< 0.000083	< 0.000042	< 0.00019	< 0.00027	--	< 0.0038	< 0.0030
MW-02-1	1/17/2002	N	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.0016	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	--	< 0.02	< 0.02
		SPLIT	< 0.001	< 0.001	< 0.001	< 0.001	0.002	--	< 0.001	< 0.001	< 0.001	< 0.001	--	< 0.001	--	--
MW-02-1	5/29/2008	N	< 0.000042	< 0.000053	< 0.000035	< 0.000025	0.00034 J	0.0014 J	< 0.000089	< 0.000083	< 0.000042	< 0.00019	< 0.00027	--	< 0.0038	< 0.0030
		FD	< 0.000042	< 0.000053	< 0.000035	< 0.000025	0.00016 J	< 0.000044	< 0.000089	< 0.000083	< 0.000042	< 0.00019	< 0.00027	--	< 0.0038	< 0.0030
MW-02-1	9/26/2008	N	< 0.000042	< 0.000053	< 0.000035	< 0.000025	0.00017 J	< 0.000044	< 0.000089	< 0.000083	< 0.000042	< 0.00019	< 0.00027	--	< 0.0038	< 0.0030

Table 5.5.2-11
Groundwater Quality - VOCs
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name			Methyl tertiary butyl ether (MTBE)	Methylene chloride	Naphthalene	Propylbenzene	Styrene	Tetrachloroethylene	Toluene	Trichloroethylene	Trichlorofluoromethane	Vinyl acetate	Vinyl chloride	Xylene, m & p	Xylene, o	Xylenes, total
Location ID	Sample Date	Sample Type														
MW-01-2	10/9/2001	N	--	< 0.0010	--	--	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
MW-01-2	5/19/2008	N	< 0.000070	< 0.00023	< 0.00010	< 0.000037	< 0.000039	0.00030 J	< 0.00023	< 0.000061	< 0.000086	< 0.00091	< 0.000071	< 0.000078	< 0.000037	--
MW-01-2	9/22/2008	N	< 0.000070	< 0.00023	< 0.00010	< 0.000037	< 0.000039	0.00030 J	< 0.00050	< 0.000061	< 0.000086	< 0.00091	< 0.000071	< 0.000078	< 0.000037	--
MW-01-3	10/9/2001	N	--	< 0.0010	--	--	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
MW-01-3	5/19/2008	N	< 0.000070	< 0.00023	< 0.00010	< 0.000037	< 0.000039	< 0.000077	< 0.000060	< 0.000061	< 0.000086	< 0.00091	< 0.000071	< 0.000078	< 0.000037	--
MW-01-3	9/19/2008	N	< 0.000070	< 0.00023	< 0.00010	< 0.000037	< 0.000039	< 0.000077	< 0.00046	< 0.000061	< 0.000086	< 0.00091	< 0.000071	< 0.000078	< 0.000037	--
MW-01-6	10/9/2001	N	--	< 0.0010	--	--	< 0.0010	< 0.0010	0.00020 J	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.00024 J	< 0.0010	0.00024 J
MW-01-6	5/19/2008	N	< 0.000070	< 0.00023	< 0.00031	< 0.000037	< 0.000039	< 0.000077	0.00041 J	< 0.000061	< 0.000086	< 0.00091	< 0.000071	0.00027 J	0.00011 J	--
MW-01-6	9/18/2008	N	< 0.000070	< 0.00023	0.00023 J	< 0.000037	0.000050 J	< 0.000077	< 0.00011	< 0.000061	< 0.000086	< 0.00091	< 0.000071	0.00015 J	0.000090 J	--
MW-02-2	5/19/2008	N	< 0.000070	< 0.00023	< 0.00010	< 0.000037	< 0.000039	< 0.000077	< 0.00012	< 0.000061	< 0.000086	< 0.00091	< 0.000071	< 0.000078	< 0.000037	--
MW-02-2	9/22/2008	N	< 0.000070	< 0.00023	< 0.00010	< 0.000037	< 0.000039	< 0.000077	< 0.000090	< 0.000061	< 0.000086	< 0.00091	< 0.000071	< 0.000078	< 0.000037	--
MW-02-1	1/17/2002	N	< 0.0010	< 0.0010	< 0.0010	0.00086 J	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
		SPLIT	< 0.001	< 0.005	< 0.005	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	--	< 0.001	--	--	< 0.002
MW-02-1	5/29/2008	N	< 0.000070	< 0.00023	< 0.00053	0.00018 J	< 0.000039	< 0.000077	< 0.000060	< 0.000061	< 0.000086	< 0.00091	< 0.000071	< 0.000078	< 0.000037	--
		FD	< 0.000070	< 0.00023	< 0.00038	0.000070 J	< 0.000039	< 0.000077	< 0.00020	< 0.000061	< 0.000086	< 0.00091	< 0.000071	< 0.000078	< 0.000037	--
MW-02-1	9/26/2008	N	< 0.000070	< 0.00023	< 0.00010	0.000080 J	0.000060 J	< 0.000077	< 0.00015	< 0.000061	< 0.000086	< 0.00091	< 0.000071	< 0.000078	< 0.000037	--

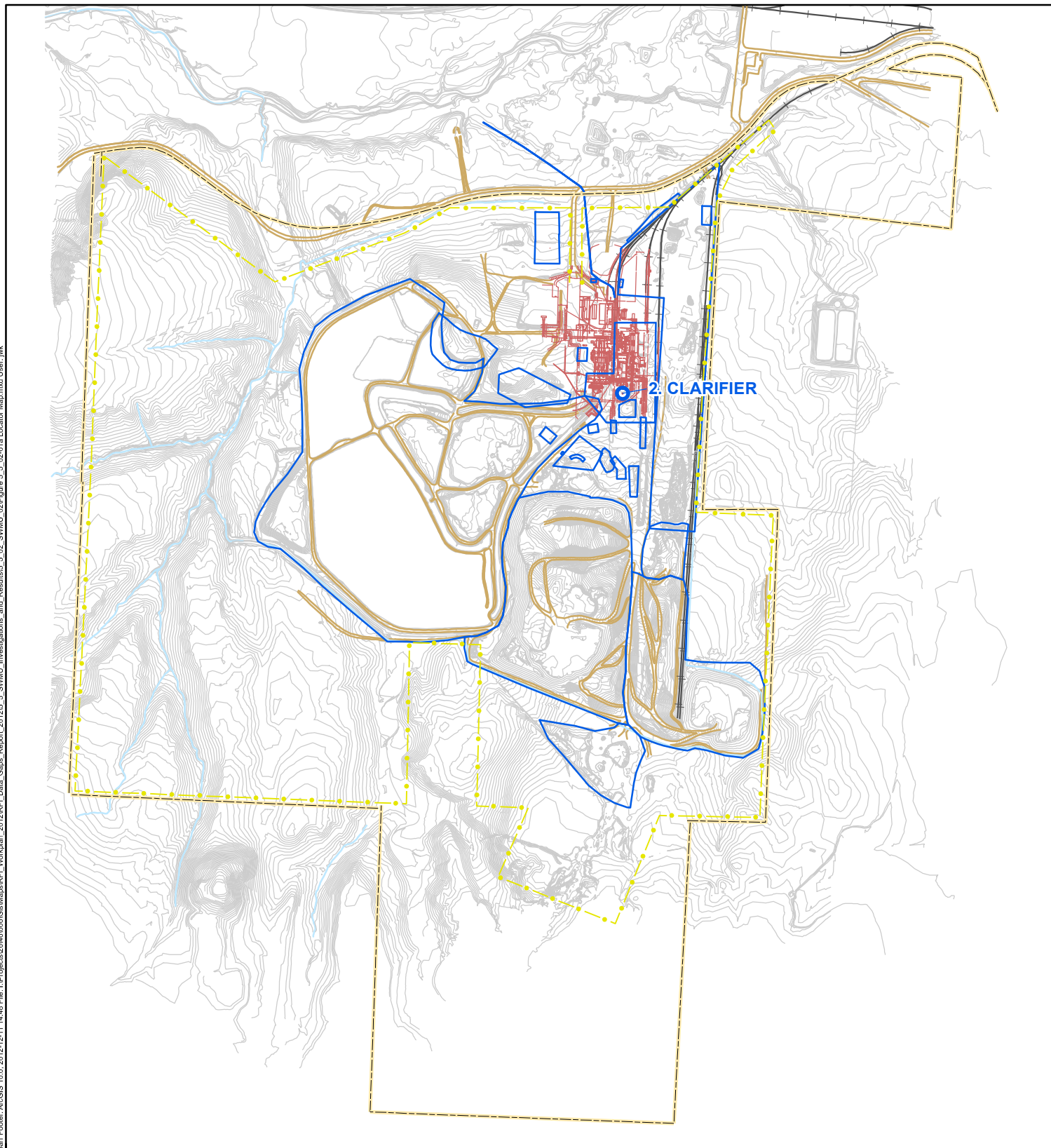
Table 5.5.2-12
Groundwater Quality - Radionuclides
SWMU 2
Rhodia Silver Bow Plant
[concentrations in pCi/l]

Chemical Name			Cesium 137	Gross Alpha (radiation)	Gross Beta (radiation)	Radium 226	Radium 228	Radium, total	Strontium 90
Location ID	Sample Date	Sample Type							
MW-01-2	10/9/2001	N	--	< 1	31 +/- 5.0	0.30 +/- 0.2	< 1	--	< 10
MW-01-2	1/16/2002	N	--	< 1.0	33 +/- 4.5	< 0.20	1.5 +/- 1	--	< 10
		SPLIT	--	0.7	32	--	0.5	--	--
MW-01-2	9/4/2002	N	--	1.4 +/- 1.2	17.6 +/- 2.7	< 0.2	< 1.0	< 0.2	--
MW-01-2	7/22/2003	N	< 49.1	5.68 +/- 2.34 J	23.8 +/- 9.41	< 1.56	--	--	--
		FD	< 40.1	< 3.55	27.3 +/- 19.8	< 1.76	--	--	--
MW-01-2	5/19/2008	N	--	< 2.3	24 +/- 4.3	< 0.32	< 0.71	--	--
MW-01-2	9/22/2008	N	--	2.1 +/- 2.4	27 +/- 4.5	< 0.3	0.82 +/- 0.26	--	--
MW-01-3	10/9/2001	N	--	6.5 +/- 1.9	50 +/- 5.0	1.0 +/- 0.20	< 1	--	< 10
		N	--	3.1 +/- 2.5	46 +/- 4.9	< 0.20	< 1.0	--	< 10
MW-01-3	1/22/2002	FD	--	< 1.0	45 +/- 4.9	< 0.20	< 1.0	--	< 10
		SPLIT	--	4.8	32	0.2	--	--	--
		FD SPLIT	--	8.1	29	0.5	--	--	--
MW-01-3	9/5/2002	N	--	< 1.0	42.2 +/- 4.1	< 0.2	< 1.0	< 0.2	--
		FD	--	< 1.0	41.3 +/- 4.1	< 0.2	< 1.0	< 0.2	--
MW-01-3	5/19/2008	N	--	2.7 +/- 2.6	35 +/- 4.9	< 0.32	< 0.73	--	--
MW-01-3	9/19/2008	N	--	< 2.1	33 +/- 4.6	< 0.35	< 0.72	--	--
MW-01-6	10/9/2001	N	--	2.2 +/- 2.3	63 +/- 6.3	0.70 +/- 0.2	< 1	--	< 10
MW-01-6	1/17/2002	N	--	< 1.0	67 +/- 5.6	< 0.20	3.4 +/- 3	--	< 10
		SPLIT	--	5	29	--	0.5	--	--
MW-01-6	9/5/2002	N	--	< 1.0	49.2 +/- 6.1	< 0.2	2.2 +/- 1.1	2.2 +/- 1.1	--
MW-01-6	5/19/2008	N	--	< 3.3	41 +/- 6.4	< 0.2	< 0.72	--	--
MW-01-6	9/16/2008	N	--	< 2.7	39 +/- 5.6	< 0.21	2.5 +/- 0.7	--	--
MW-02-2	9/5/2002	N	--	< 1.0	23.5 +/- 3.5	< 0.2	< 1.0	< 0.2	--
MW-02-2	5/19/2008	N	--	< 2	25 +/- 4.2	< 0.59	< 4	--	--
MW-02-2	9/22/2008	N	--	4.9 +/- 2.9	21 +/- 3.9	< 0.31	< 0.7	--	--
MW-02-1	1/17/2002	N	--	< 1.0	22 +/- 7.5	0.80 +/- 0	1.9 +/- 1	--	< 10
		SPLIT	--	4	5	0.4	1.2	--	0.1
MW-02-1	9/4/2002	N	--	7.1 +/- 3.6	< 2.0	0.5	< 1.0	0.5 +/- 0.3	--
MW-02-1	7/22/2003	N	< 56.5	< 9.40	21.9 +/- 77.9	< 1.82	--	--	--
MW-02-1	5/29/2008	N	--	< 6.3	24 +/- 11	< 0.17	1.1 +/- 0.32	--	--
		FD	--	< 6.9	27 +/- 11	< 0.35	1.2 +/- 0.32	--	--
MW-02-1	9/26/2008	N	--	< 7.6	37 +/- 12	0.6 +/- 0.16	< 1.4	--	--

Table 5.5.2-13
Groundwater Quality - PCBs
SWMU 2
Rhodia Silver Bow Plant
[concentrations in mg/l]

Chemical Name			Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1262	Aroclor 1268
Location ID	Sample Date	Sample Type									
MW-01-2	05/19/2008	N	< 0.0000094	< 0.000020	< 0.000023	< 0.000013	< 0.0000054	< 0.0000070	< 0.0000031	< 0.0000048	< 0.0000065
MW-01-3	05/19/2008	N	< 0.000016	< 0.000020	< 0.000047	< 0.000040	< 0.0000054	< 0.0000070	< 0.0000031	< 0.0000048	< 0.0000065
MW-01-6	05/19/2008	N	< 0.000033	< 0.000020	< 0.000023	< 0.000013	< 0.0000054	< 0.0000070	< 0.0000031	< 0.0000048	< 0.0000065
MW-02-2	05/19/2008	N	< 0.000012	< 0.000020	< 0.000023	< 0.000013	< 0.0000054	< 0.0000070	< 0.0000031	< 0.0000048	< 0.0000065
MW-02-1	01/17/2002	N	< 0.00050	< 0.0010	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050
		SPLIT	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	--	--
		FD SPLIT	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	--	--
MW-02-1	05/29/2008	N	< 0.0000094	< 0.000020	< 0.000023	< 0.000013	< 0.0000054	< 0.0000070	< 0.0000031	< 0.0000048	< 0.0000065
		FD	< 0.0000094	< 0.000020	< 0.000023	< 0.000013	< 0.0000054	< 0.0000070	< 0.0000031	< 0.0000048	< 0.0000065

Figures












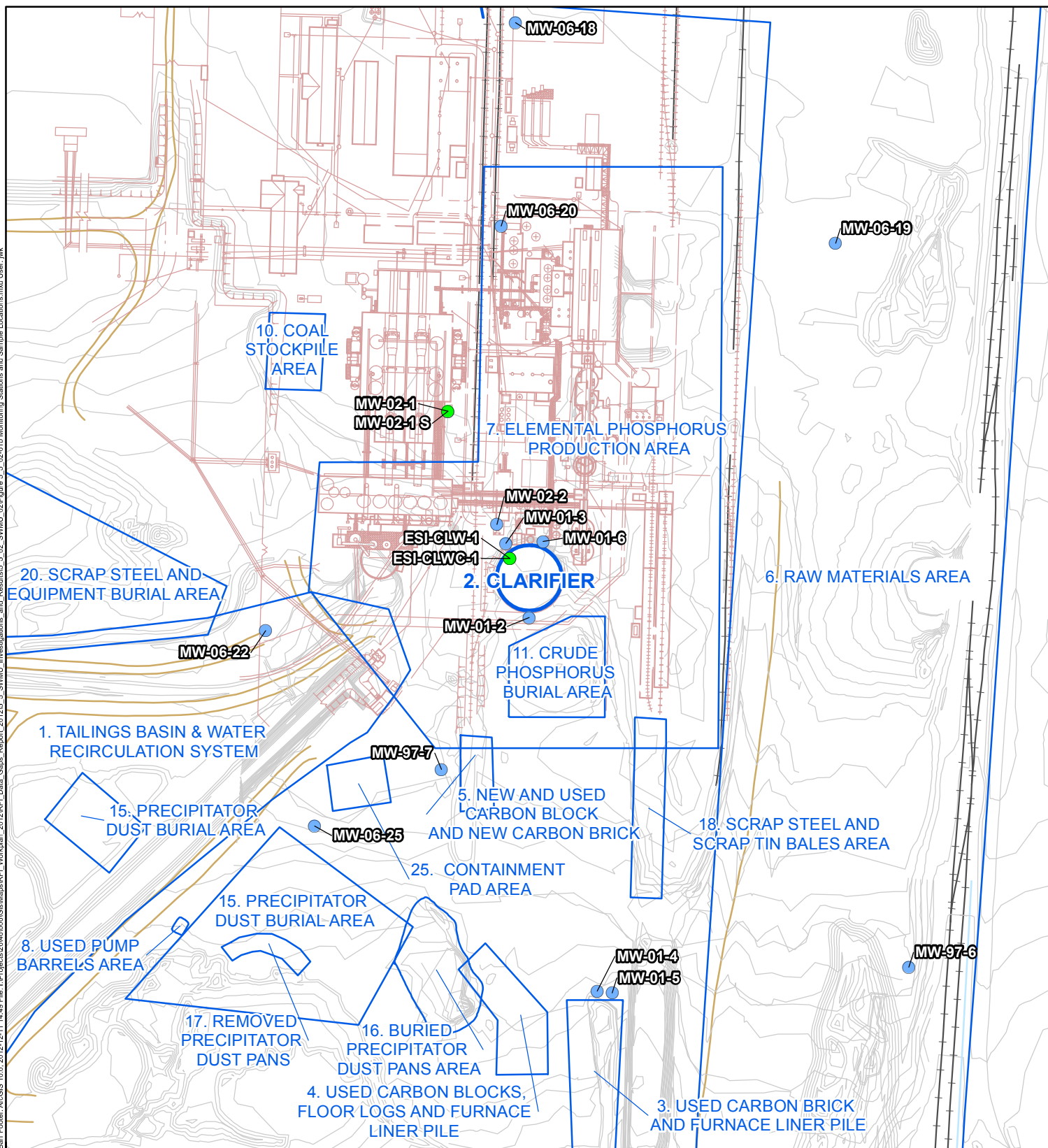
- | | | | |
|--|-------------------------|---|-------------------|
|  | SWMU 2 |  | Property Boundary |
|  | Other SWMUs |  | Fence Line |
|  | Elevation Contour | | |
|  | Drainage | | |
|  | Railroad | | |
|  | Road | | |
|  | Former Plant Structures | | |

Figure 5.5.2-1a

SWMU 2 LOCATION
Rhodia Silver Bow Plant
Montana

Bar Footer: ArcGIS 10.0, 2012-12-11 14:49 File: I:\Projects\2646\066\GIS\MapServer\Worldpin_2012\Figure 5.5.2-1b Monitoring Stations and Sample Locations.mxd User: jwk



- Monitoring Well
- Soil Sample
- SWMU 2
- Other SWMUs
- Elevation Contour
- Drainage
- Railroad
- Road
- Former Plant Structures

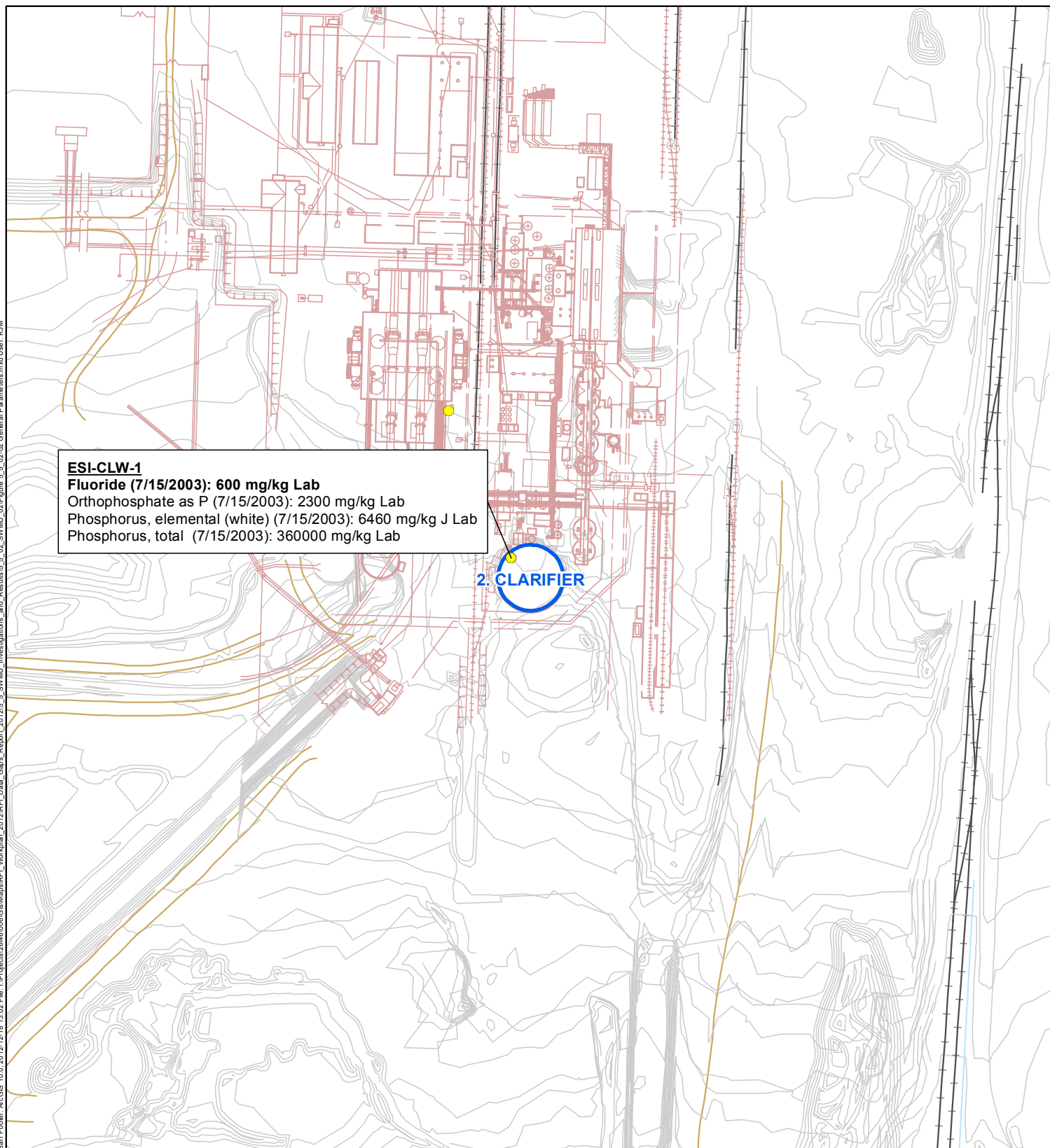


200 0 200
Feet

Figure 5.5.2-1b

SWMU 2
MONITORING STATIONS
AND SAMPLE LOCATIONS
Rhodia Silver Bow Plant
Montana

Barri Footer: ArcGIS 10.0, 2012-12-18 13:02 File: I:\Projects\2646\006\Gis\MapInfo\Workplan_2012\5_SWMU_Investigations_and_Results\5_02_SWMU_02\Figure 5.5.02-02 General Parameters.mxd User: KJM



- Sample Location
- SWMU 2
- Elevation Contour
- Drainage
- + + Railroad
- Road
- Former Plant Structures

Bold font indicates that sample concentration is greater than the 95% UCL of mean Reference Area Concentration.

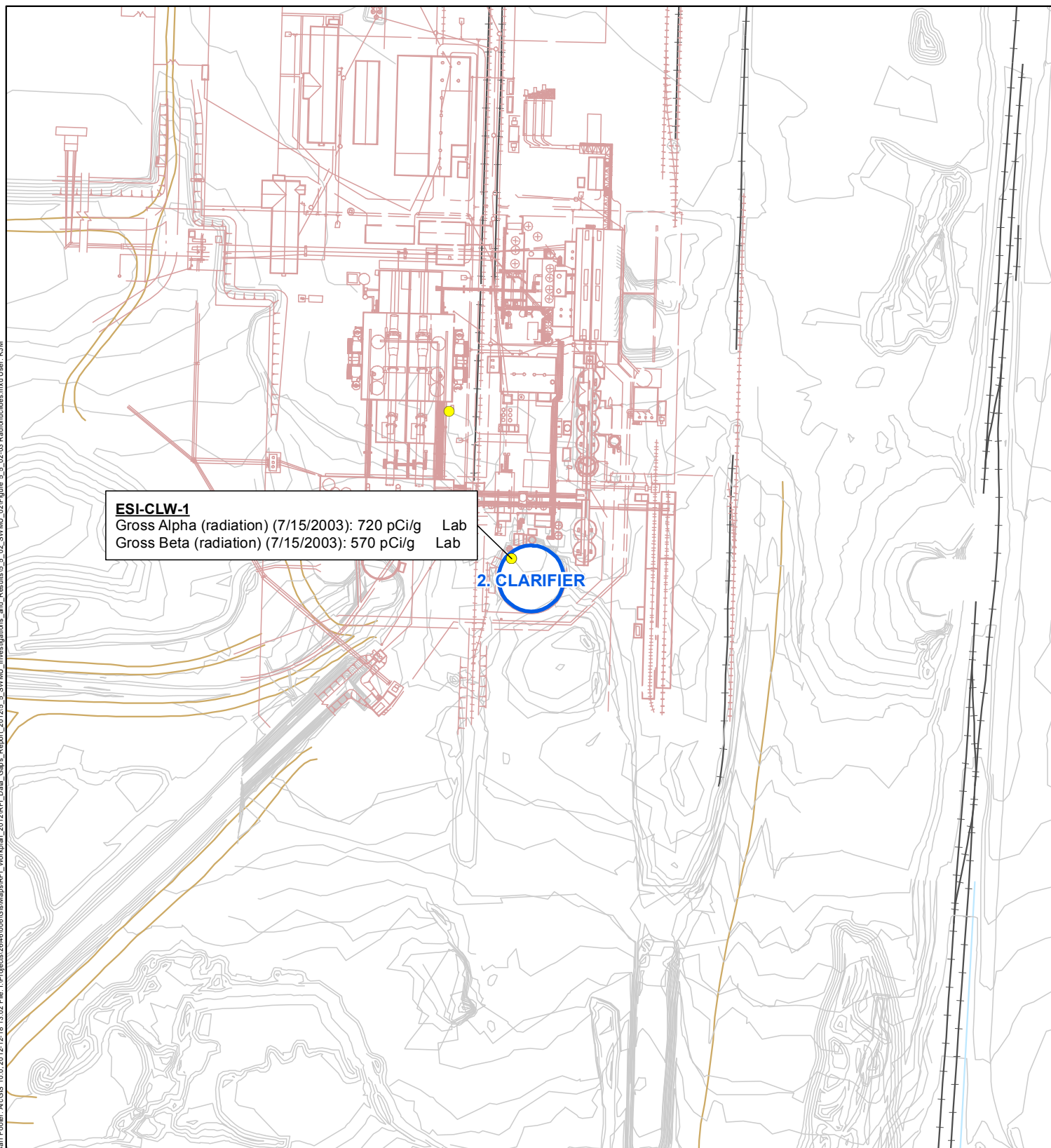
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Feet



Figure 5.5.2-2

SWMU 2
GENERAL PARAMETERS
Rhodia Silver Bow Plant
Montana

Barri Footer: ArcGIS 10.0, 2012-12-18 13:02 File: I:\Projects\2646\006\Gis\MapInfo\Workplan_2012\Figure 5.5.2-3 SWMU 02\Figure 5.5.2-3 Radionuclides.mxd User: KJM



- Sample Location
- SWMU 2
- Elevation Contour
- Drainage
- + + Railroad
- Road
- Former Plant Structures

Bold font indicates that sample concentration is greater than the 95% UCL of mean Reference Area Concentration.

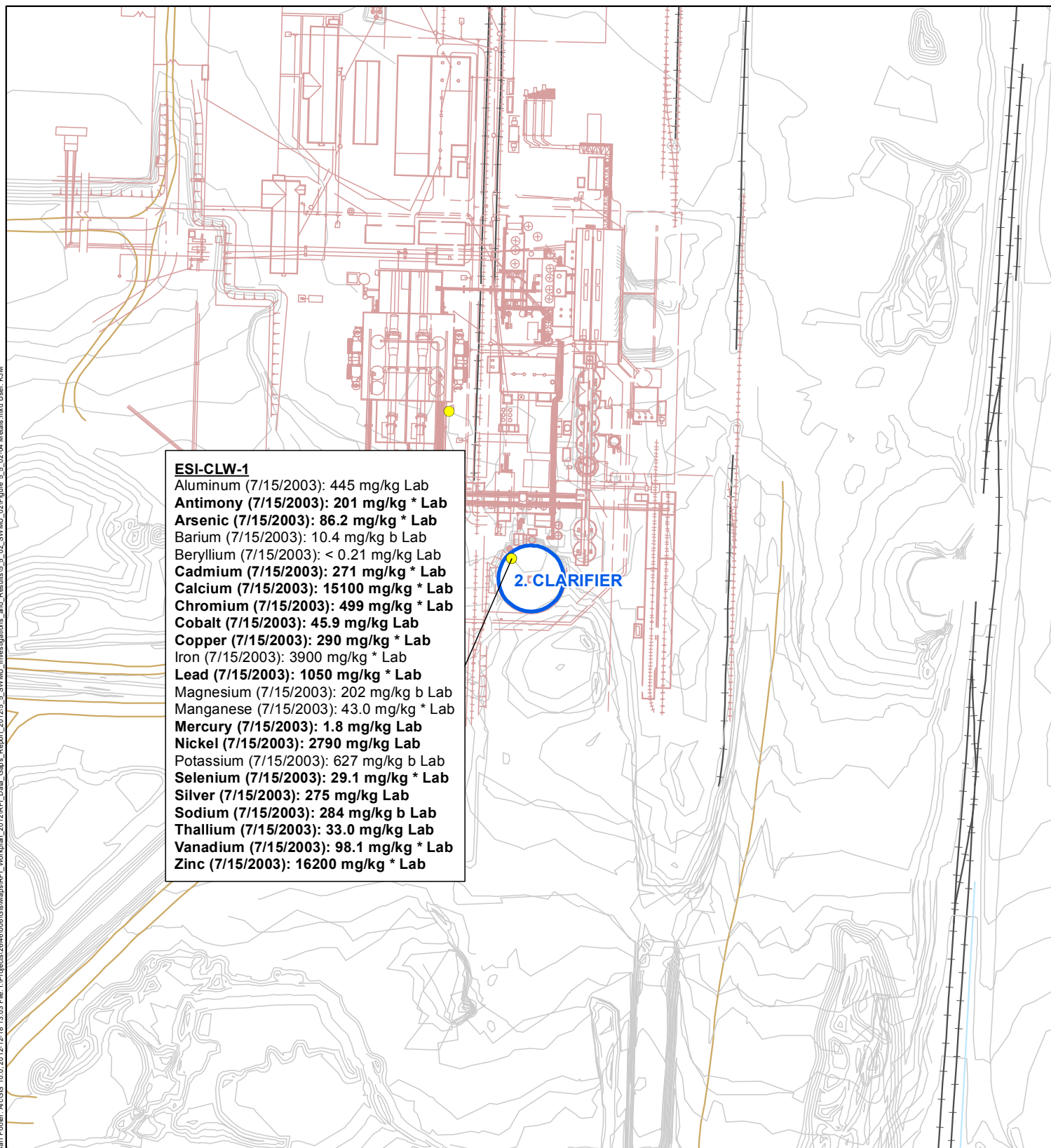
200 Feet 200
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Figure 5.5.2-3

**SWMU 2
RADIONUCLIDES
Rhodia Silver Bow Plant
Montana**

Barri Footer: ArcGIS 10.0, 2012-12-18 13:03 File: I:\Projects\2646\006\GMap\MapRF1_Workplan_2012\FI Data_Gaps_Report_2012\5_SWMU_Investigations_and_Results\5_02_SWMU_02\Figure 5.5.02-04 Metals and User: KJM



ESI-CLW-1
Aluminum (7/15/2003): 445 mg/kg Lab
Antimony (7/15/2003): 201 mg/kg * Lab
Arsenic (7/15/2003): 86.2 mg/kg * Lab
Barium (7/15/2003): 10.4 mg/kg b Lab
Beryllium (7/15/2003): < 0.21 mg/kg Lab
Cadmium (7/15/2003): 271 mg/kg * Lab
Calcium (7/15/2003): 15100 mg/kg * Lab
Chromium (7/15/2003): 499 mg/kg * Lab
Cobalt (7/15/2003): 45.9 mg/kg Lab
Copper (7/15/2003): 290 mg/kg * Lab
Iron (7/15/2003): 3900 mg/kg * Lab
Lead (7/15/2003): 1050 mg/kg * Lab
Magnesium (7/15/2003): 202 mg/kg b Lab
Manganese (7/15/2003): 43.0 mg/kg * Lab
Mercury (7/15/2003): 1.8 mg/kg Lab
Nickel (7/15/2003): 2790 mg/kg Lab
Potassium (7/15/2003): 627 mg/kg b Lab
Selenium (7/15/2003): 29.1 mg/kg * Lab
Silver (7/15/2003): 275 mg/kg Lab
Sodium (7/15/2003): 284 mg/kg b Lab
Thallium (7/15/2003): 33.0 mg/kg Lab
Vanadium (7/15/2003): 98.1 mg/kg * Lab
Zinc (7/15/2003): 16200 mg/kg * Lab

- Sample Location
- SWMU 2
- Elevation Contour
- Drainage
- Railroad
- Road
- Former Plant Structures

Bold font indicates that sample concentration is greater than the 95% UCL of mean Reference Area Concentration.

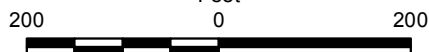
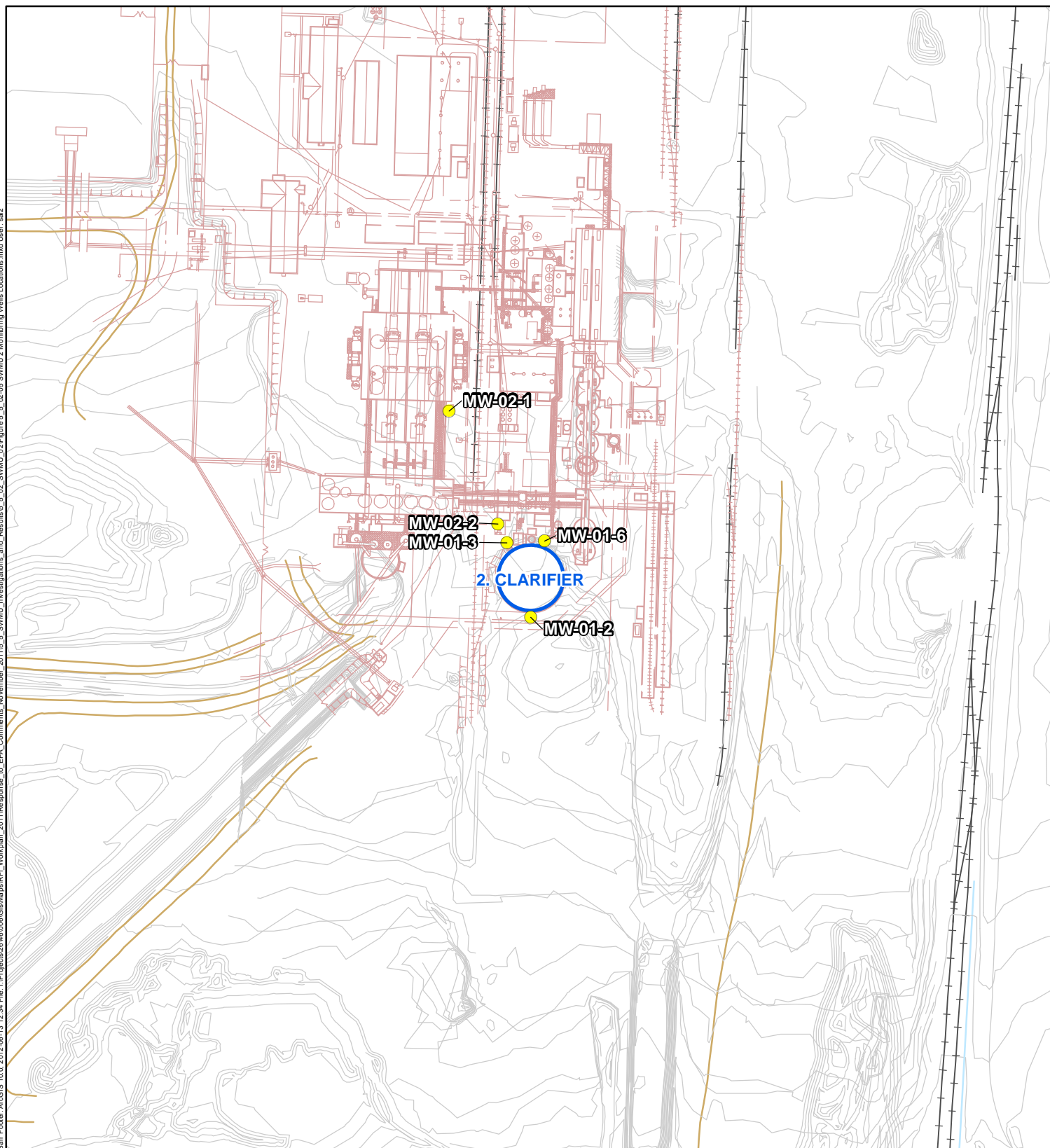


Figure 5.5.2-4

SWMU 2
METALS
Rhodia Silver Bow Plant
Montana

Bar Footer ArcGIS 10.0, 2012-06-13 12:34 File: I:\Project\26146\000\GIS\Map\pREFI_Workplan_2011\Report\5_02_SWMU_02\Figure 5_02-05 SWMU 2 Monitoring Wells Locations.mxd User: ad2



- Monitoring Well
- SWMU 2
- Elevation Contour
- Drainage
- Railroad
- Road
- Former Plant Structures

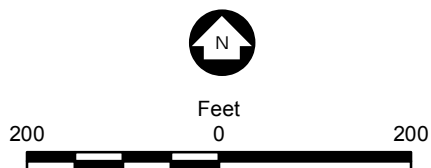
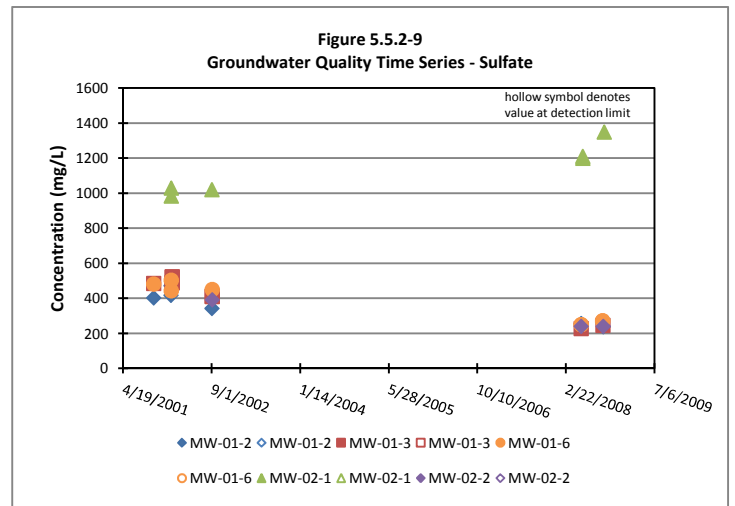
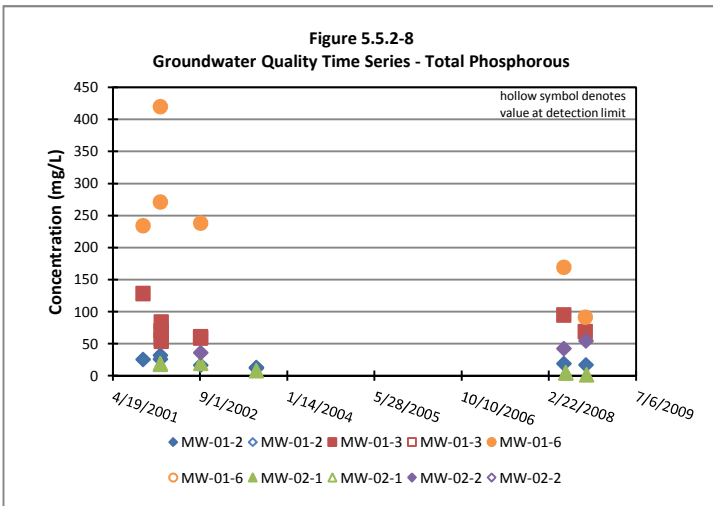
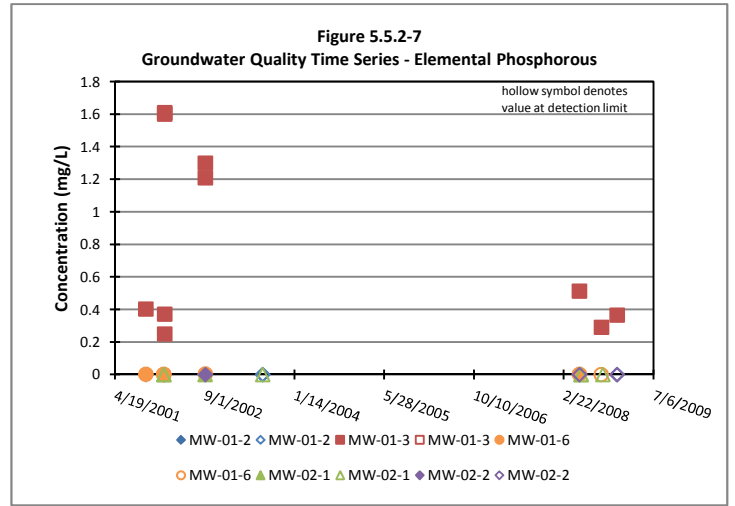
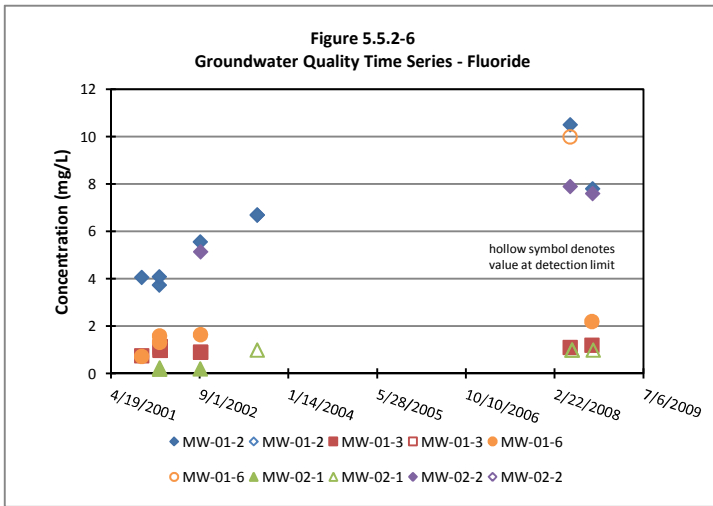


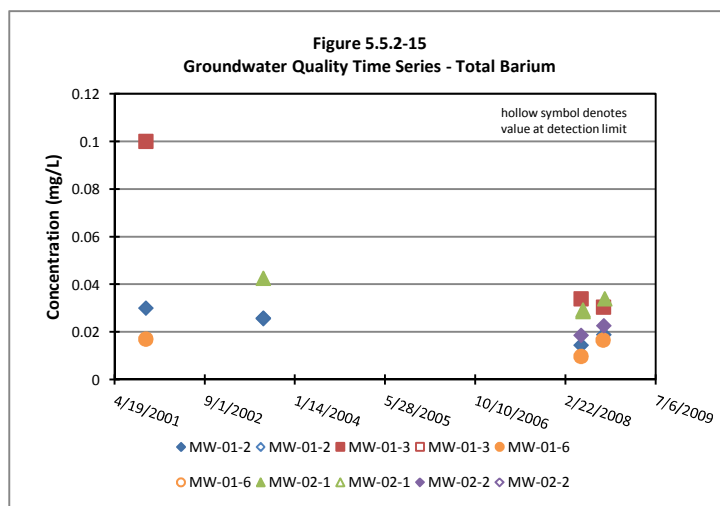
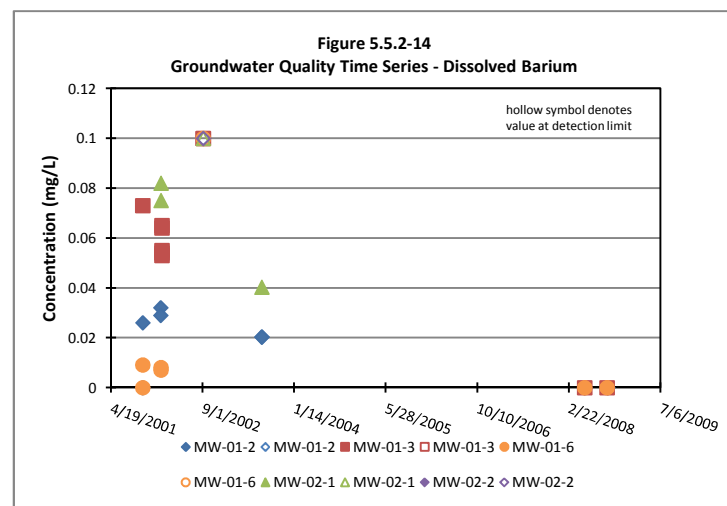
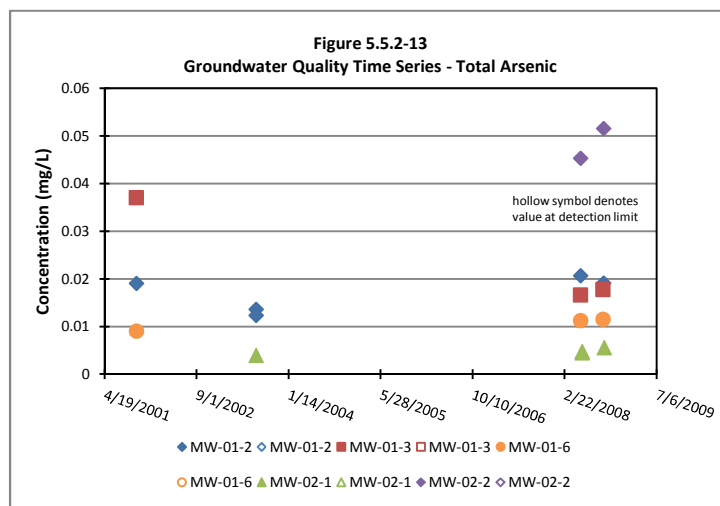
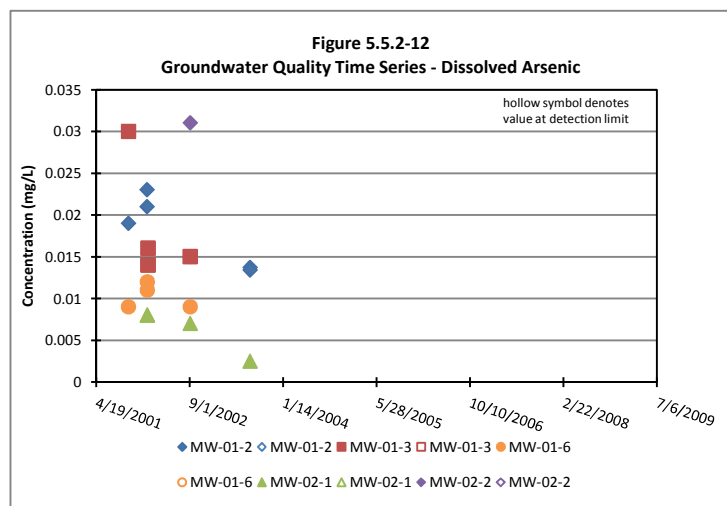
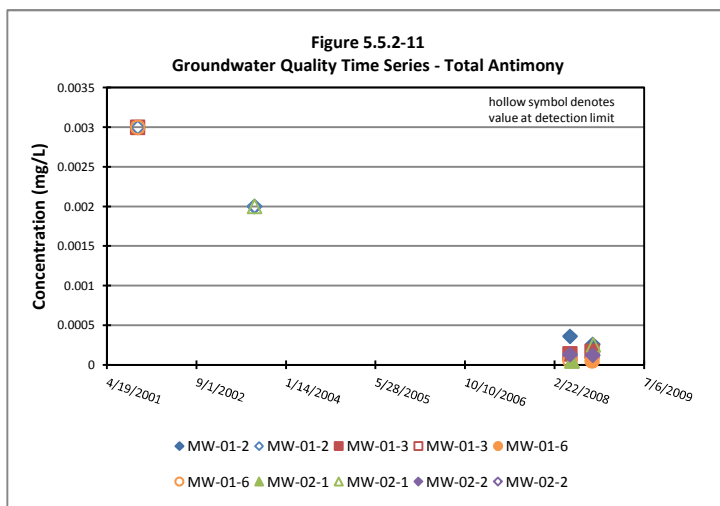
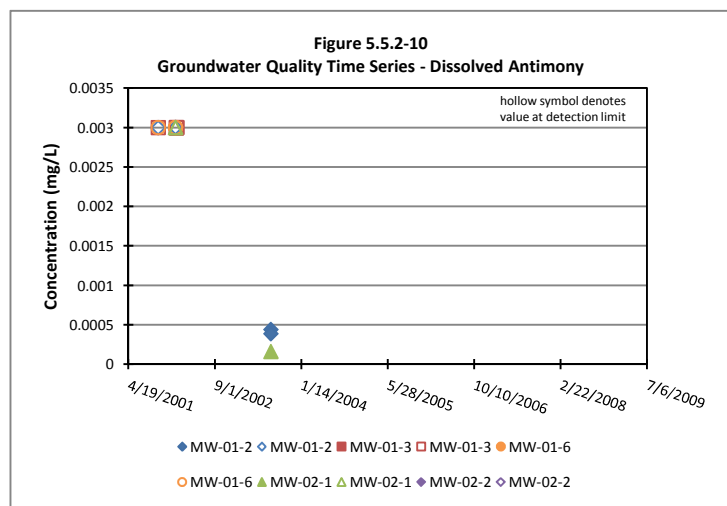
Figure 5.5.2-5

SWMU 2
MONITORING WELL
LOCATIONS
Rhodia Silver Bow Plant
Montana

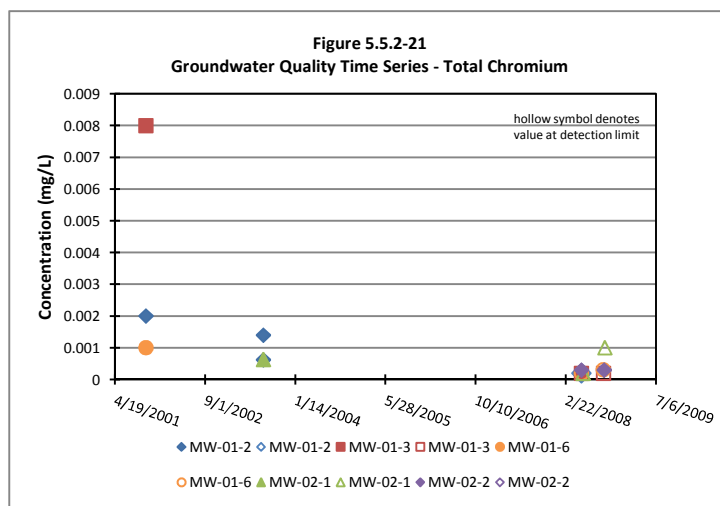
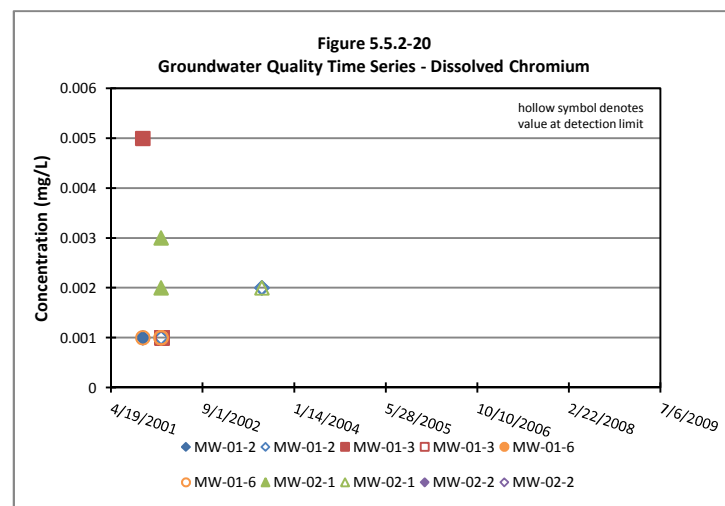
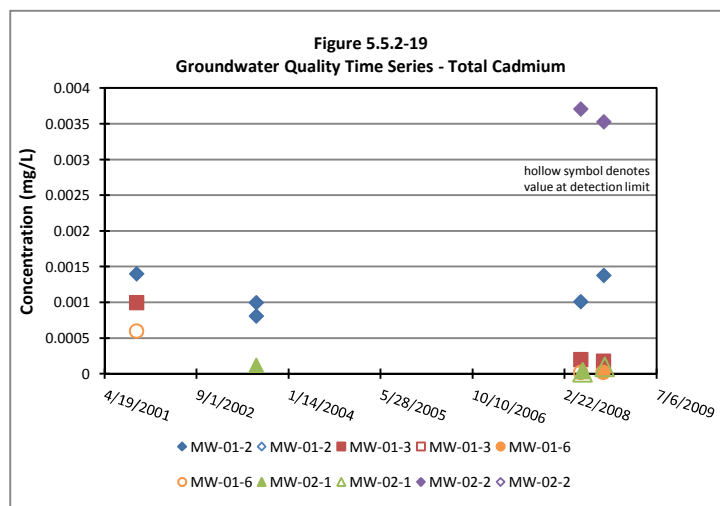
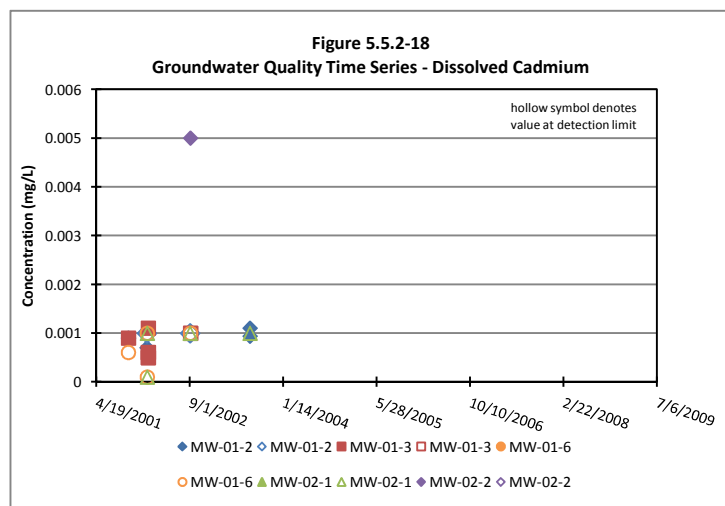
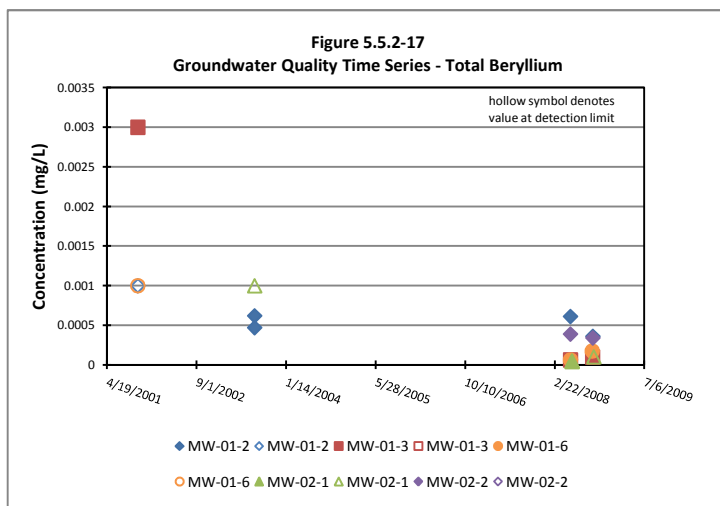
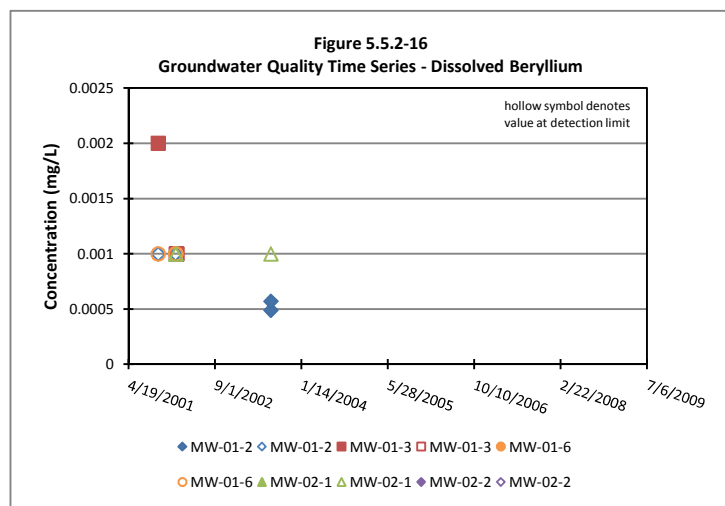
Figures 5.5.2-6 - 5.5.2-9
Groundwater Quality - General and Site Specific Parameters
SWMU 2



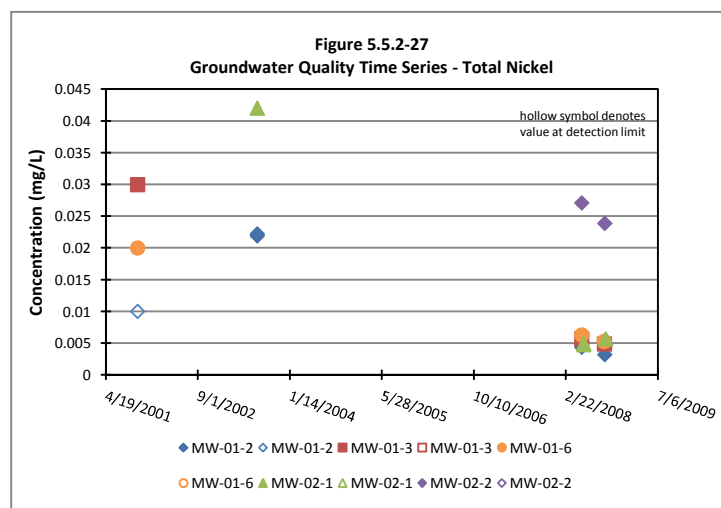
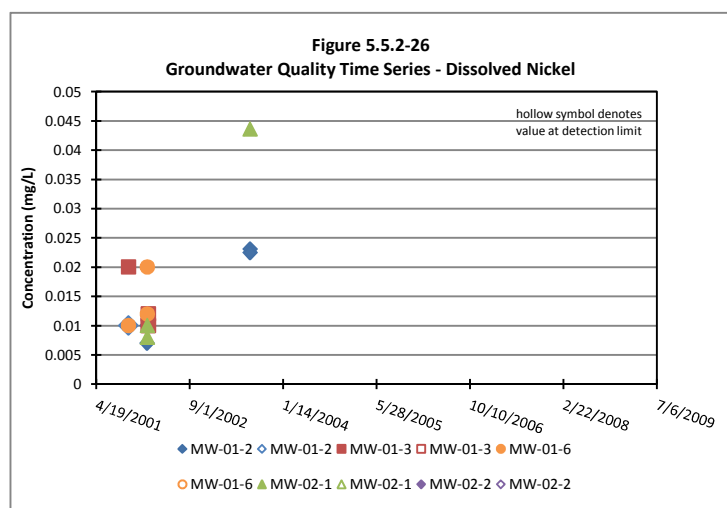
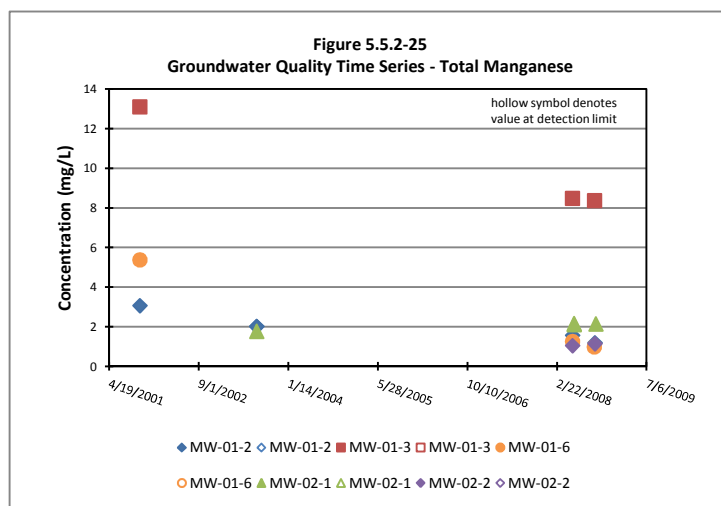
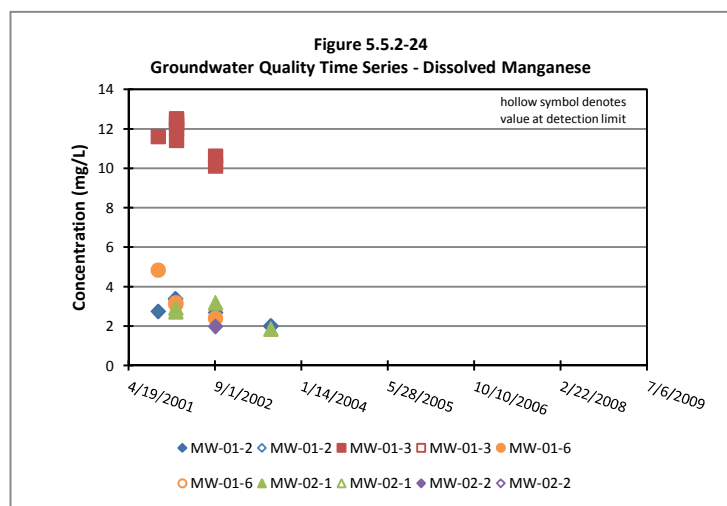
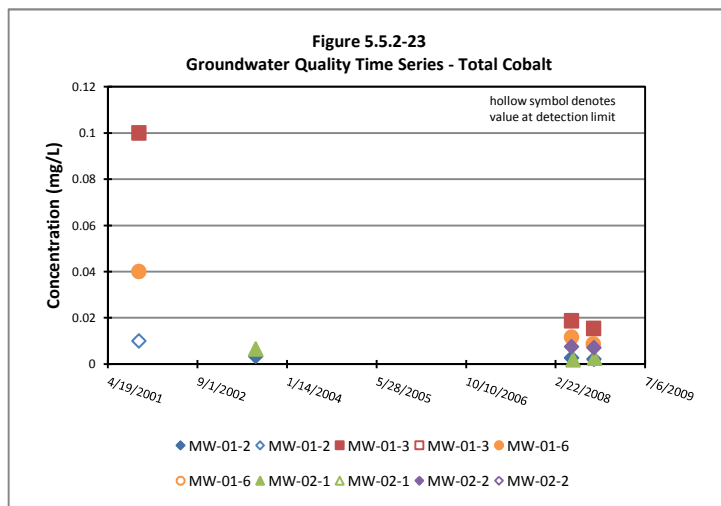
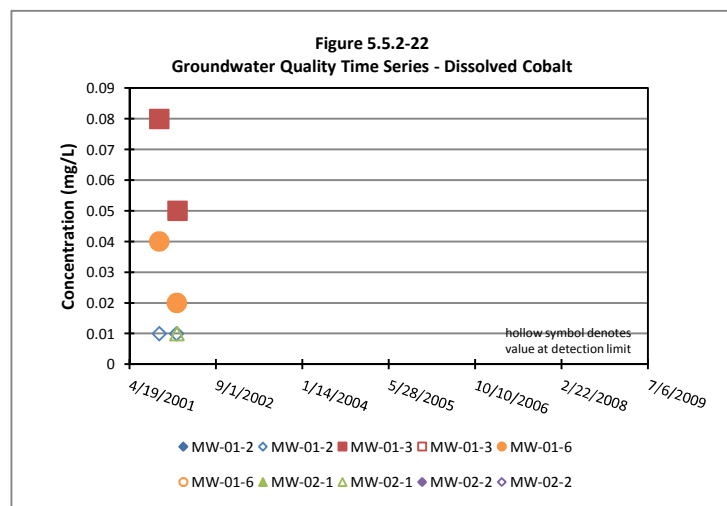
Figures 5.5.2-10 - 5.5.2-39
Groundwater Quality - Metals
SWMU 2



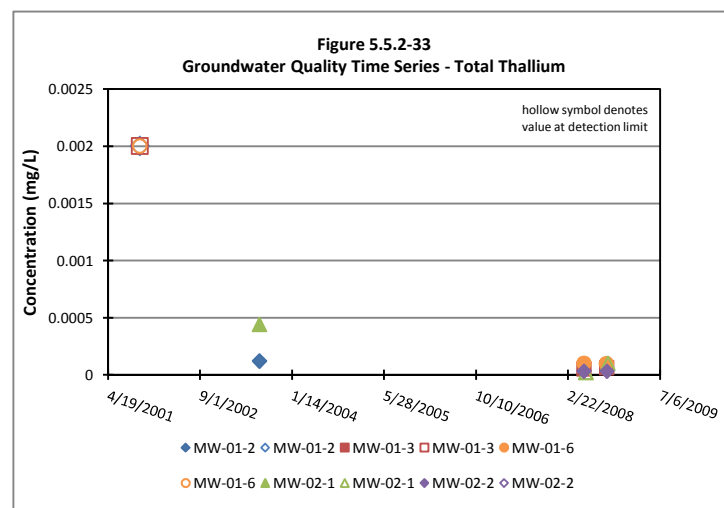
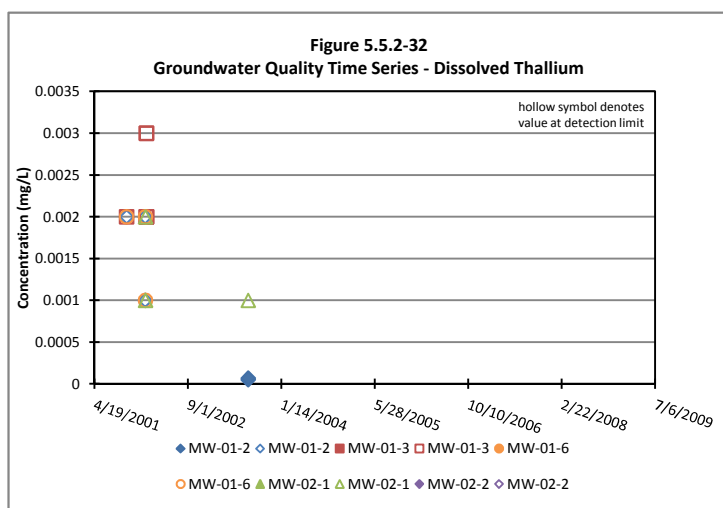
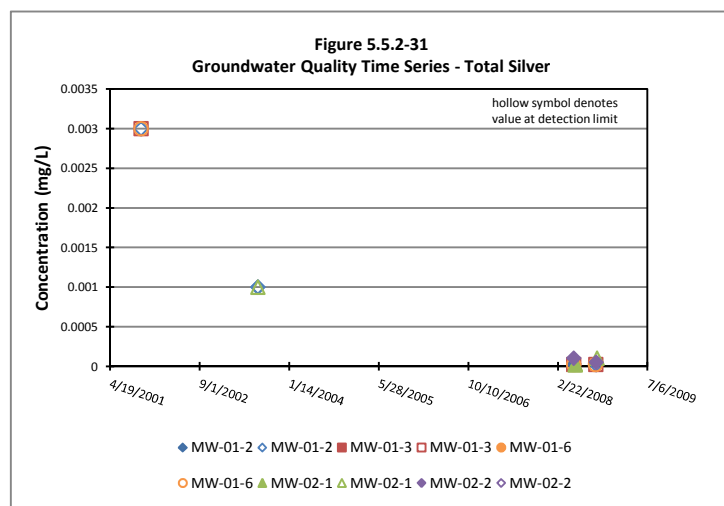
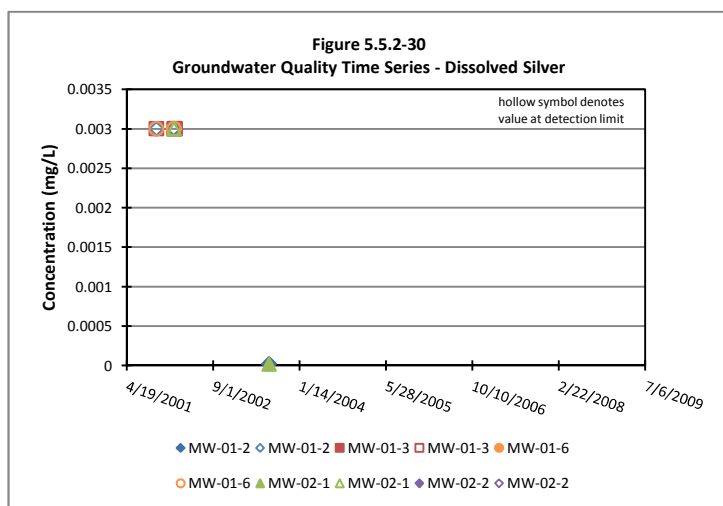
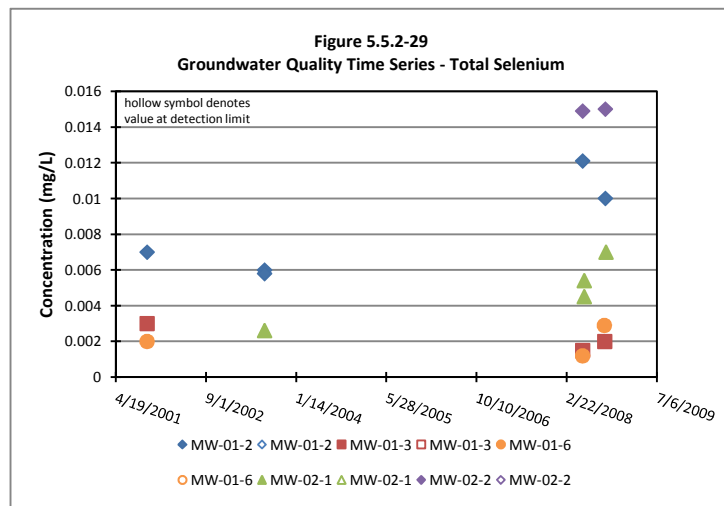
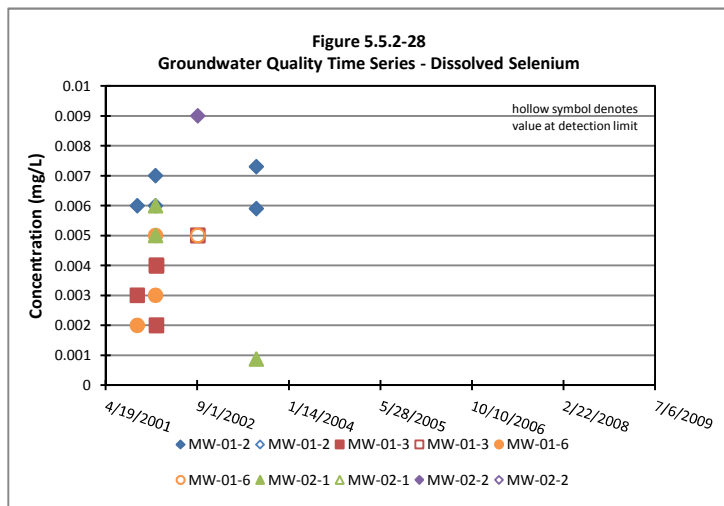
Figures 5.5.2-10 - 5.5.2-39
Groundwater Quality - Metals
SWMU 2



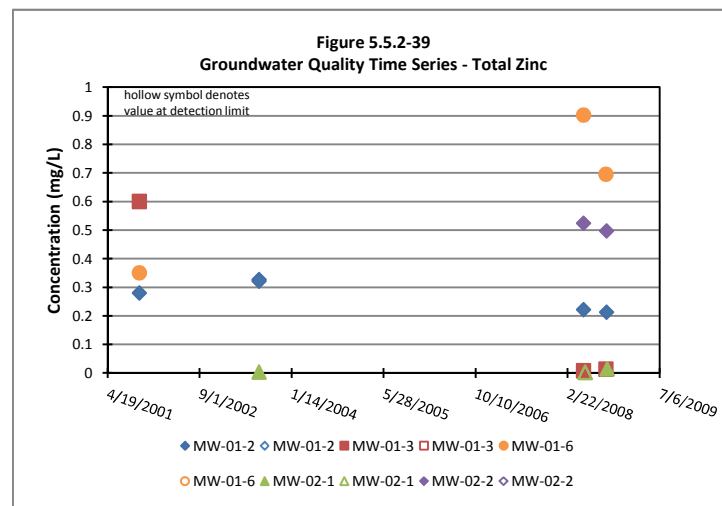
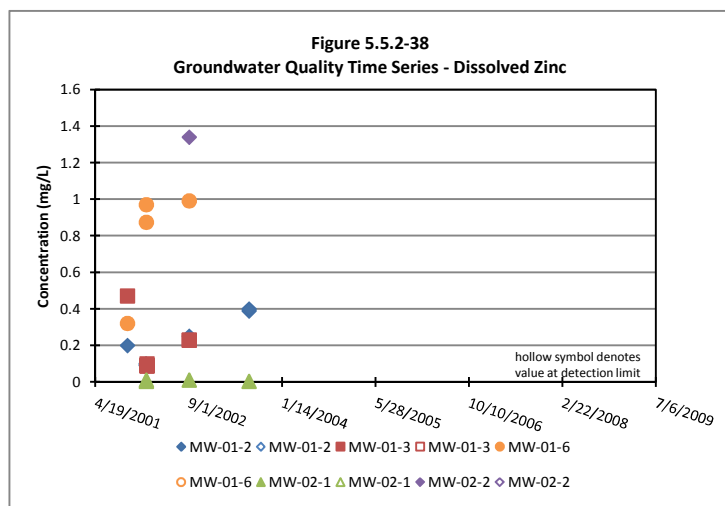
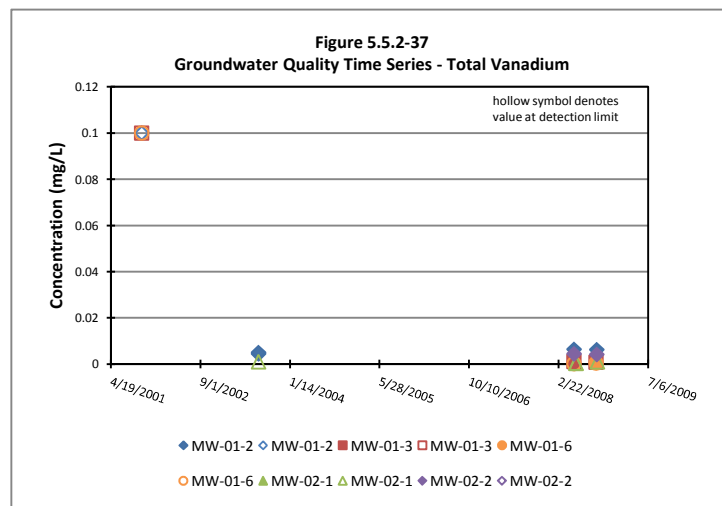
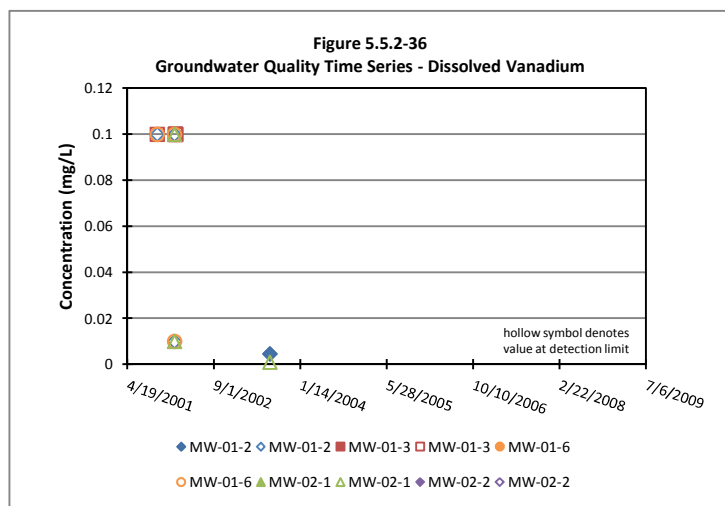
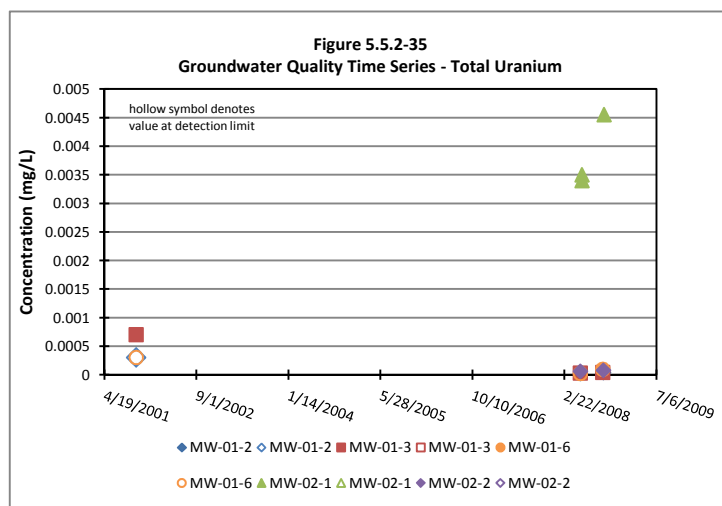
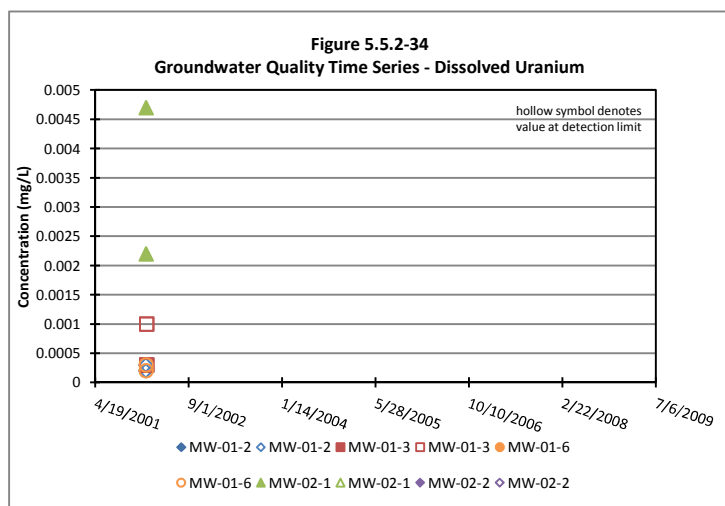
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Groundwater Quality - Metals
SWMU 2



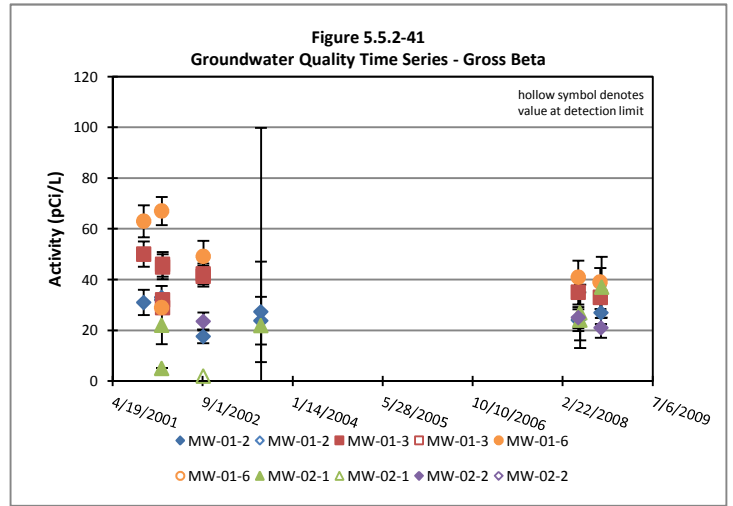
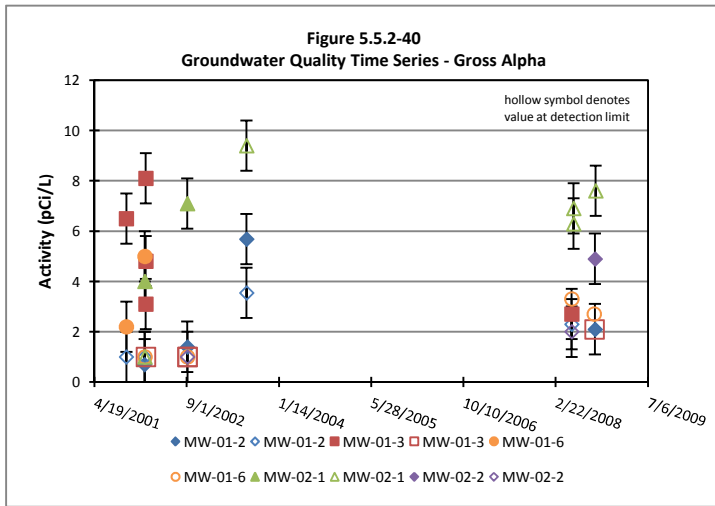
Figures 5.5.2-10 - 5.5.2-39
Groundwater Quality - Metals
SWMU 2



Figures 5.5.2-10 - 5.5.2-39
Groundwater Quality - Metals
SWMU 2



Figures 5.5.2-40 - 5.5.2-41
Groundwater Quality - Radionuclides
SWMU 2



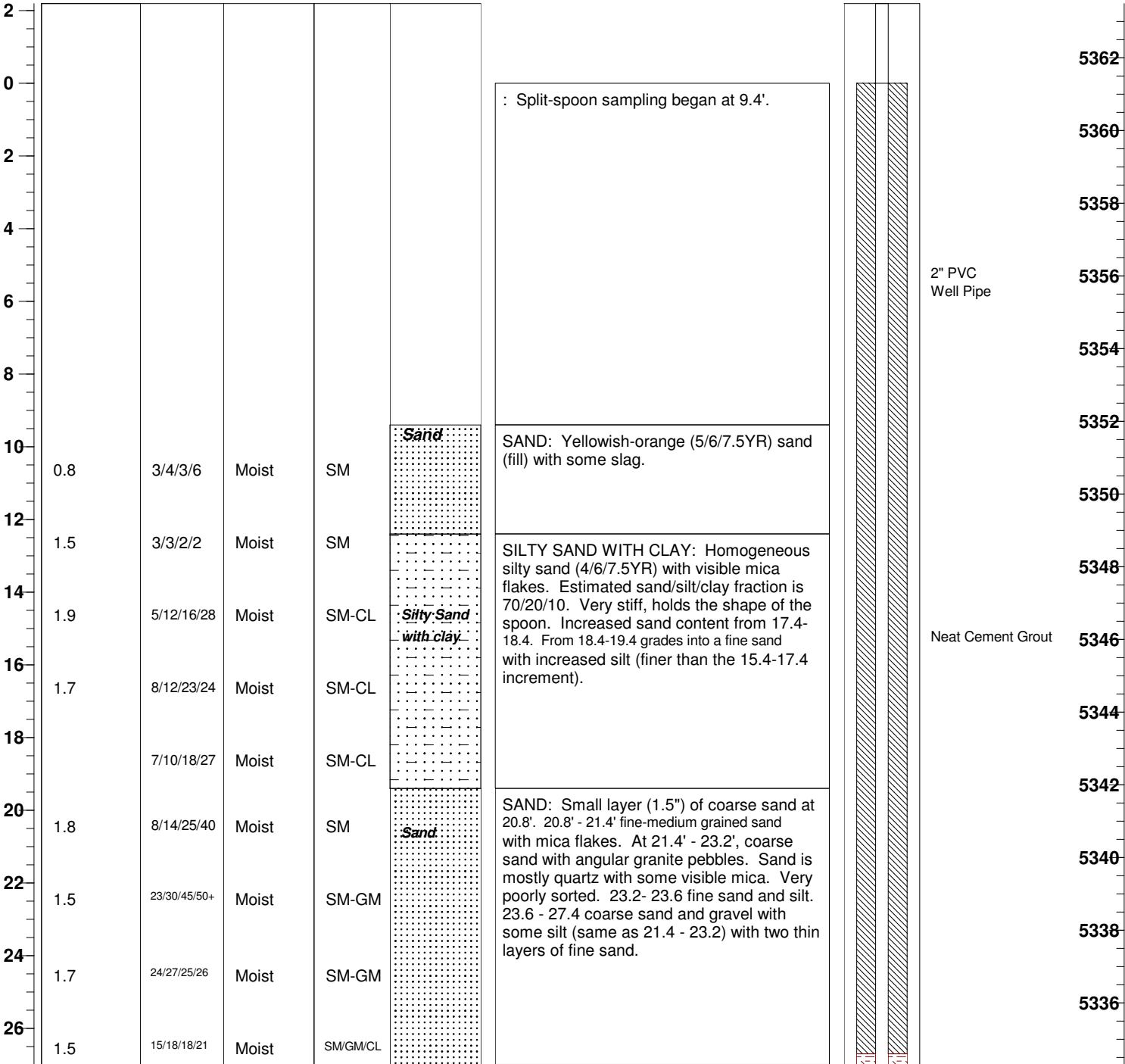
Appendices

Appendix 5.5.2-A

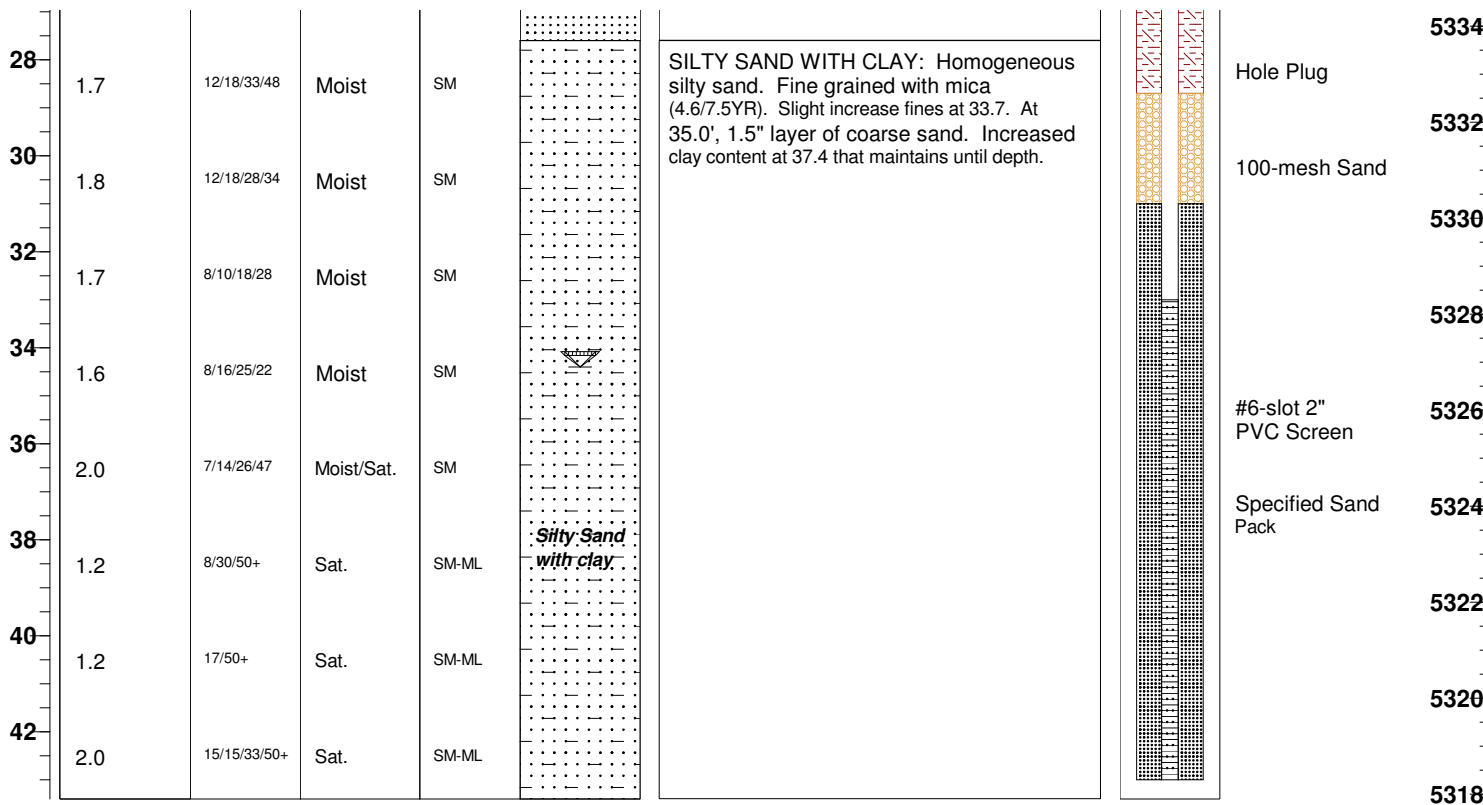
Boring/Monitoring Well Logs

P:\2625\001\Well Logs\mw_01_2.dat

Barr Engineering Company		Ref. Boring # n/a		Well # MW-01-2				
Project: Pre-Closure Groundwater Monitoring Program								
Project Number: 26/25/001-JSL-021		Total Drilled Depth (ft): 43.4						
Boring Location: Rhodia Silver Bow Plant - Butte, Montana		Ground Surface Elevation (ft): 5361.3						
Drilling Contractor: O'Keefe Drilling		Depth to Groundwater (ft): 36.59						
Drilling Method: Hollow Stemmed Auger		Riser Elevation (ft): 5363.47						
Driller: Steve Malkovich		Date Started: 9/18/01						
Geologist: Sheryl Filby		Date Completed: 9/18/01						
Page 1 of 2								
Depth (ft. bgs)	Split spoon Recovery (ft)	Blow Count	Moisture/W.L.	ASTM	Lithologic Unit	Material Descriptions and Remarks	Well Construction/ Comments	Elevation



Depth (ft. bgs)	Sample Type/ Recovery (ft.)	Blow Count	Moisture\W.L.	ASTM	Lithologic Unit	Material Descriptions and Remarks	Page 2 of 2	
							Well Construction/ Comments	Elevation

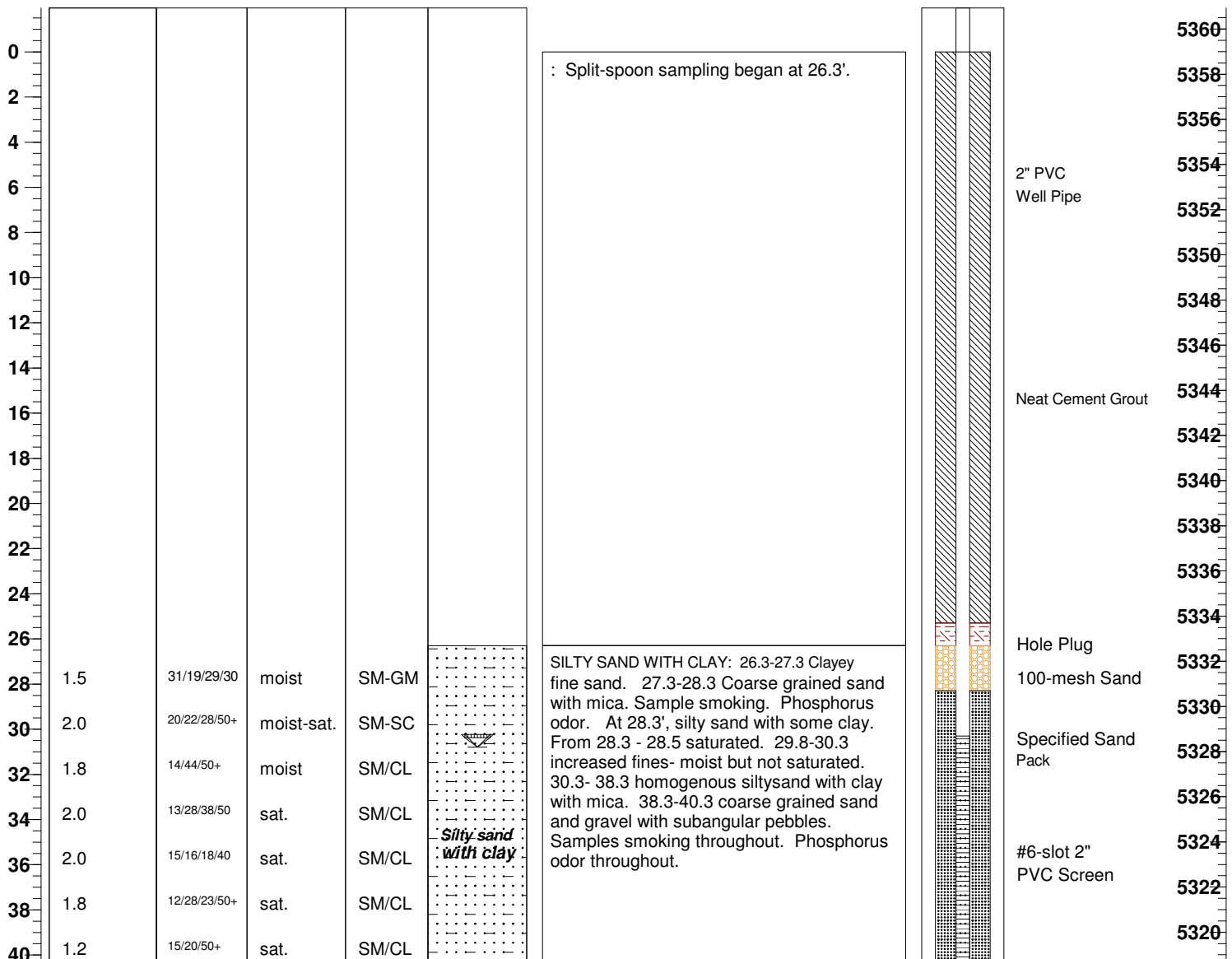


Total Drilled Depth (ft):	40.3
Ground Surface Elevation (ft):	5357.0
Depth to Groundwater (ft):	32.74
Riser Elevation (ft):	5358.99
Date Started:	9/19/01
Date Completed:	9/21/01

Project Number: 26/25/001-JSL-021
Boring Location: Rhodia Silver Bow Plant - Butte, Montana
Drilling Contractor: O'Keefe Drilling
Drilling Method: Hollow Stemmed Auger
Driller: Steve Malkovich
Geologist: Sheryl Filby

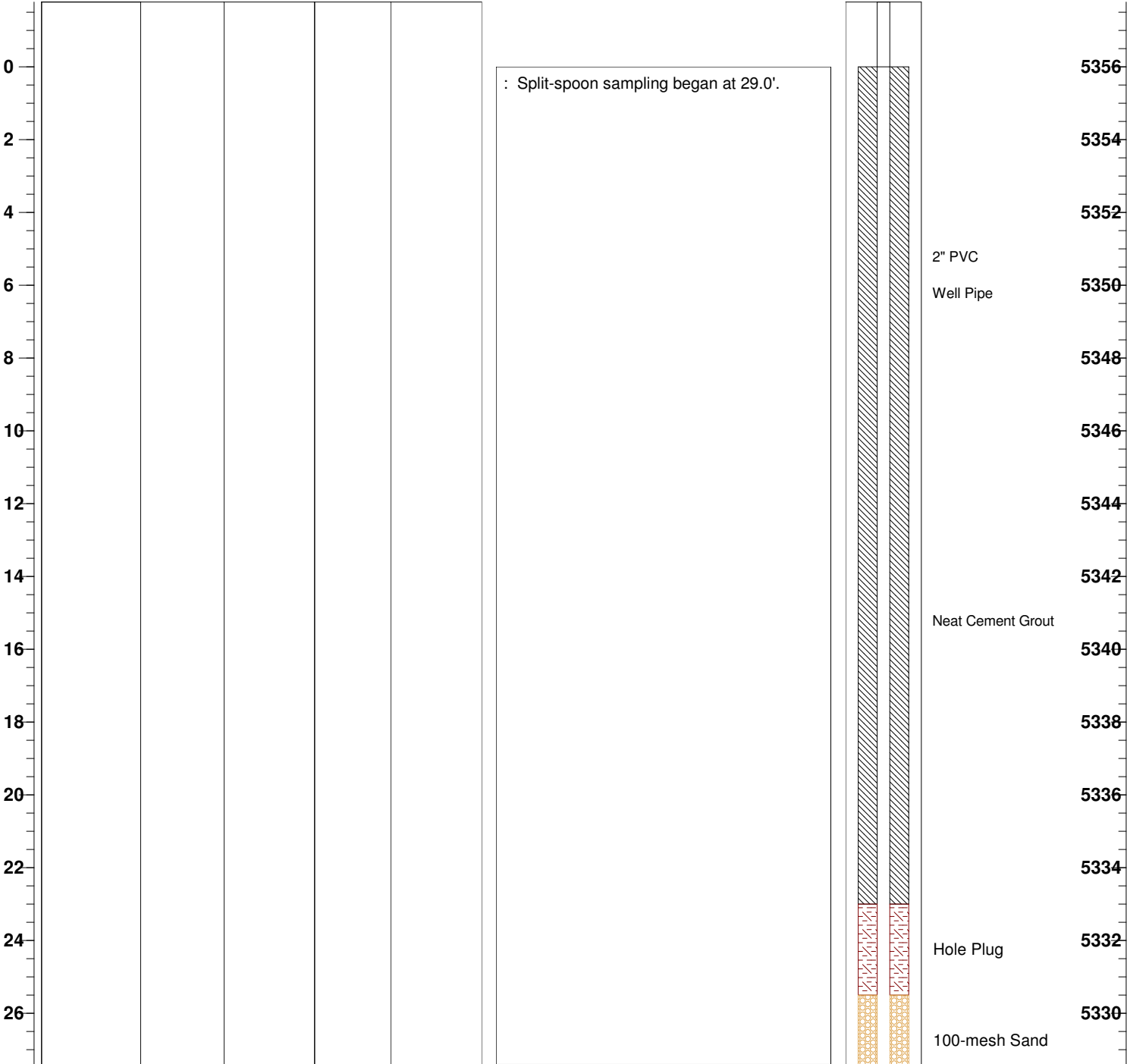
Ground Surface Elevation (ft):	5357.0
Depth to Groundwater (ft):	32.74
Riser Elevation (ft):	5358.99
Date Started:	9/19/01
Date Completed:	9/21/01

Depth (ft. bgs)	Split spoon Recovery (ft)	Blow Count	Moisture/W.L.	ASTM	Lithologic Unit	Material Descriptions and Remarks	Page 1 of 1	
							Well Construction/ Comments	Elevation

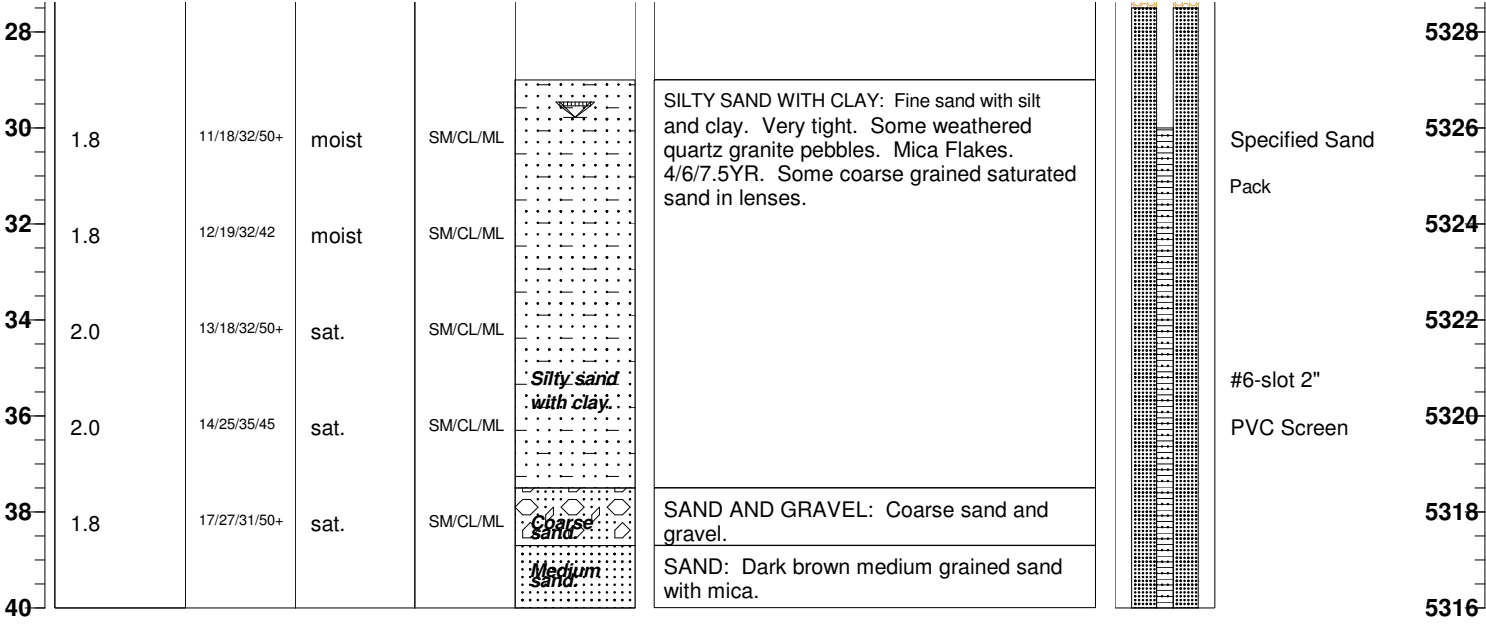


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Barr <i>Engineering Company</i>				Ref. Boring # n/a				Well # MW-01-6	
Project: Pre-Closure Groundwater Monitoring Program									
Project Number: 26/25/001-JSL-021				Total Drilled Depth (ft): 40.3					
Boring Location: Rhodia Silver Bow Plant - Butte, Montana				Ground Surface Elevation (ft): 5356.0					
Drilling Contractor: O'Keefe Drilling				Depth to Groundwater (ft): 31.56					
Drilling Method: Hollow Stemmed Auger				Riser Elevation (ft): 5357.75					
Driller: Steve Malkovich				Date Started: 9/21/01					
Geologist: Sheryl Filby				Date Completed: 9/21/01					
Depth (ft. bgs)	Split spoon Recovery (ft)	Blow Count	Moisture/W.L.	ASTM	Lithologic Unit	Material Descriptions and Remarks	Page 1 of 2		
							Well Construction/ Comments	Elevation	



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Depth (ft. bgs)	Sample Type/ Recovery (ft.)	Blow Count	Moisture\W.L.	ASTM	Lithologic Unit	Material Descriptions and Remarks	Page 2 of 2	
							Well Construction/ Comments	Elevation



Total Drilled Depth (ft):	38.0 (bgs)
Ground Surface Elevation (ft):	5357.10
Depth to Groundwater (ft):	34.94 (bgs)
Riser Elevation (ft):	5358.81
Date Started:	8/19/02
Date Completed:	8/20/02

Project Number: 26/25/001-JSL-035
Boring Location: Rhodia Silver Bow Plant - Butte, Montana
Drilling Contractor: O'Keefe Drilling
Drilling Method: Hollow Stem Auger
Driller: Steve Malkovich
Geologist: Karma Geiger

Depth (ft. bgs)	Split spoon Recovery (ft)	Blow Count	Moisture/W.L.	ASTM	Odor/PH3 Reading	Lithologic Unit	Material Descriptions and Remarks	Page 1 of 1	
								Well Construction/ Comments	Elevation

Depth (ft)	Diameter (in)	Date	Moisture	Soil Type	Grain Size	Description
0						FILL: Concrete and fill.
2	1.6	156	dry	SM	No/0.00	SILTY SAND: Yellowish-brown (7.5YR5/4), homogenous, very dense, silty sand. Sand is mostly fine grained but includes medium to coarse sand as well as trace fine gravel. Sand is predominantly golden-colored mica and subrounded to subangular quartz. Silt fraction is 30%.
4	1.6	18/26/30/31	dry	SM	No/0.00	
6	1.9	15/24/34/38	dry	SM	No/0.00	
8	1.6	12/24/32/41	dry	SM	No/0.00	
10	1.6	16/27/41/49	dry	SM	No/0.00	
12	1.6	21/32/34/36	dry	SP	No/0.00	SAND: Light gray (10YR7/2), loose fine to coarse sand with trace silt.
14	1.6	13/20/33/40	dry	SM	No/0.00	SILTY SAND: Homogenous, dark yellowish brown (10YR4/4), very dense silty fine sand with trace gravel. Sand includes 20% medium to coarse grained sand with fine gravel. Silt fraction is approximately 40%. Sand is golden-colored mica (possible iron pyrite), quartz and igneous.
16	1.7	11/15/22/29	moist	SM	No/0.00	
18	1.9	10/19/30/50	moist	SM	No/0.00	
20	1.8	10/21/33/54	dry	SM	No/0.00	
22	1.8	11/17/36/48	dry	SM	No/0.00	
24	1.8	8/22/37/38	dry	SM-ML	No/0.00	SILTY SAND TO SILT: Dark yellowish brown silty very fine sand.
26	1.8	8/21/38/45	moist	SM	No/0.00	SILTY SAND: Homogenous, dark yellowish brown, homogenous silty sand. Sand is mostly very fine to fine grained but includes up to approximately 15% medium to coarse sand and trace fine gravel. Sand is quartz, mica and igneous-rich. Silt fraction is 35 to 40%.
28	1.7	8/20/28/48	moist	SM	No/0.00	
30	1.8	13/42/68/91	moist	SM	No/0.00	
32	1.8	12/24/30/52	dry moist	SM	No/0.00	
34	1.8	10/24/43/74	saturated	SM	No/0.00	
36	1.9	11/24/42/63	saturated	SM	No/0.00	
38						
40						

P:\26\25\001\Well Logs\mw_02_1.dat

Project: Pre-Closure Groundwater Monitoring Program

Project Number: 26/25/001-JSL-031

Boring Location: Rhodia Silver Bow Plant - Butte, Montana

Drilling Contractor: O'Keefe Drilling

Drilling Method: Hollow Stemmed Auger

Driller: Steve Malkovich

Geologist: Sheryl Filby

Total Drilled Depth (ft): 42.0

Ground Surface Elevation (ft): 5356.54

Depth to Groundwater (ft): 32.8

Riser Elevation (ft): 5358.70

Date Started: 1/14/02

Date Completed: 1/15/02

Depth (ft. bgs)	Split spoon Recovery (ft)	Blow Count	Moisture/W.L.	ASTM	Odor/PH3 Reading	Lithologic Unit	Material Descriptions and Remarks	Page 1 of 1	
								Well Construction/Comments	Elevation

2									5358
0									5356
2	2.0	frozen	none	SM	N/0.0				5354
4	1.5	10/10/12/14	none	SM	N/0.0				5352
6	1.7	23/30/33/46	none	SM	N/0.0				5350
8	1.7	23/44/57/58	none	SM	N/0.0				5348
10	1.6	21/38/64/71	none	SM	N/0.0				5346
12	1.6	31/51/73/90	none	SM	N/0.0				5344
14	1.6	26/37/64/78	none	SM	N/0.0				5342
16	1.6	30/46/53/57	none	SM-ML	N/0.0				5340
18	1.7	22/31/50/61	none	SM-ML	N/0.0				5338
20	1.7	16/19/30/46	none	SM-ML	N/0.0				5336
22	1.7	22/34/54/71	none	SM-ML	N/0.0				5334
24	1.6	32/56/87/116	moist	SM-ML	N/0.0				5332
26	1.7	30/36/62/75	moist	SM-ML	N/0.0				5330
28	1.7	28/57/83/105	moist	SM-ML	N/0.0				5328
30	1.8	30/44/68/74	moist	SM-ML	N/0.0				5326
32	1.8	23/50/55/73	moist	SM-ML	N/0.0				5324
34	1.8	22/36/48/63	moist	SM-ML	N/0.0				5322
36	1.8	12/32/50/67	moist-wet	SM-ML	N/0.0				5320
38	1.8	?12/22/41/52?	moist-wet	SM-ML	N/0.0				5318
40	1.8	17/63/74/101	moist-wet	SM-ML	N/0.0				5316
42	2.0	31/49/73/112	moist-wet	SM-ML	SL/0.0				

Sand

Silty sand
with clay

SAND: 0-0.3', sand and gravel. 0.3-0.4', slag. 0.4-0.6' brown (2.5/3 7.5YR) organic-rich soil. 0.6-4' light brown (7/4 10YR) silty sand with some small angular pebbles. At 6', color grades into 6/6 10yr. 8-12', increased fines. 12-14.5, fine grained sand with some medium grained sand, sand/silt/clay 70/30/0. 14.5-14.7', pocket of medium grained sand. 14.7-16', silty sand with mica. 16-16.5', as 14.7-16' with some medium sand.

SILTY SAND WITH CLAY: 16.5-17.8, fine grained sand and silt with some clay. Mica and small sub-angular pebbles present. Color 5/6/7.5YR. 17.8-18.4', increased silt (55/40/5). 18.4-19.3, thin layer of medium-coarse sand. 19.3-19.5, clean fine sand with some silt (8/1 10YR). 19.5-42', silty fine grained sand with clay (65/30/5). Includes mica and small sub-angular pebbles. Reddish color (5/6/7.5 YR).

37.6-37.7', thin layer of black stained soil. No noticeable odor. Sheen observed on drill bit.

41.6-41.7', thin layer of black stained soil. Slight petroleum odor.

2" PVC
Well Pipe

Neat Cement

Hole Plug

Grout

Specified
Pack#6-slot 2"
PVC Screen
Sand

Appendix I

**July 31, 2003 Letter
Enhanced RCRA Cap Alternative**

July 31, 2003

Mr. John F. Wardell
Director, Montana Office
U.S. EPA, Region 8
Federal Building
10 West 15th Street, Suite 3200
Helena, MT 59626

Re: Preliminary Decision on Draft Waste Plan
Rhodia – Silver, Bow, Montana

Dear Mr. Wardell:

In your June 27, 2003 letter, you asked Rhodia to identify issues we would like to discuss with you regarding the Focused Feasibility Study (FFS) prepared by Booz Allen Hamilton (BAH), and EPA Region 8's preliminary conclusion that off-site incineration is the best option for management of the clarifier wastes. The main issue we would like to discuss is an alternative capping option that we will summarize below.

We have developed this alternative to address what we understand is the Region's principle concern with a capping option—that the capped material could become a hazard in the future. The new option addresses this concern by, among other things, using the advanced "Astaris-type cap" design for Ponds 8S and 15S at the FMC/Astaris plant that EPA Region 10 recently approved after our Waste Plan was submitted. This is also the cap design your consultant BAH has recommended for the clarifier material. In addition, the groundwater around the cap will be monitored. Phosphine generated under the cap will also be monitored, collected and treated, again as BAH has recommended. Institutional controls, layered in the manner suggested in EPA's guidance, will be established to prevent future disturbance of the cap and exposure to affected groundwater, and to require future owners to maintain the cap, groundwater and phosphine monitoring systems. Rhodia will also provide long-term financial assurance to inspect, monitor and maintain these systems.

This package of cap design enhancements, the institutional controls, the monitoring and maintenance of the cap, groundwater and phosphine systems,

and the financial assurances exceeds by far the protections normally associated with approved caps of similar waste. This new proposal would likely cost Rhodia over 75% more than the enhanced cap that Rhodia proposed in the Waste Plan. And unlike incineration, capping is well-supported by the many other caps that have routinely and successfully been used to close elemental phosphorus units at over a dozen facilities. Indeed, as recently as January 2002, EPA Region 10 selected a capping remedy for Pond 18 Cell A at FMC's Pocatello facility.¹

We would like to discuss this new capping option in a meeting with you in the near future. We would also be pleased to discuss at this meeting any of our over 30 comments on BAH's assumptions and conclusions in the FFS. Many of our comments on the FFS identify shortcomings in the BAH analysis that Region 8 should consider before it seeks public comment on remedial options. We ask that these comments on the FFS, which are Attachment A hereto, as well as this entire letter and all of its other attachments, be included in the administrative record for the 7003 order. We will describe and discuss the new capping option in the remainder of this letter.

I. New Cap Proposal

A. Design

Rhodia would install a cap over the clarifier material that meets or exceeds the design that EPA Region 10 recently approved for closure of Ponds 8S and 15S at the FMC/Astaris facility. See Attachments B, C, D and E. The Astaris-type cap will provide about 16 feet of cover material over the crude phosphorus in the clarifier. The cap includes a 60 mil flexible membrane liner, a geosynthetic clay liner, and a biotic protection layer. BAH recommended in its FFS that Rhodia use this Astaris-type cap.

When all phases of the cap are completed and adequately sloped to promote proper run-off, the Astaris-type cap will necessarily extend beyond the clarifier and cover other nearby production areas shown on Attachment B, including a currently-capped burial area, which contains the same type of crude phosphorus

¹ Pond 18 Cell A has approximately 15% elemental phosphorus in the capped solids, which is comparable to the estimated 20% elemental phosphorus in the clarifier. The 15% is based on the total slurry having 0.75% elemental phosphorus content, and the slurry being 5% solids and 95% water. See Volume 2, Section 7 of the "Engineering Package Update for the LDR Waste Treatment System," Astaris, Pocatello, ID (September 2001).

material as the clarifier. As a result, this larger cap will provide additional environmental benefit beyond the clarifier material.²

The construction cost alone for this Astaris-type cap is estimated to be about \$2.5 million, which is over \$1.4 million more expensive than the enhanced cap and almost \$2 million more expensive than the soil cap that Rhodia proposed in the Waste Plan.³

The Astaris-type cap would be inspected twice a year (after the spring snow melt and before significant snow in the fall) and after precipitation events that exceed the 25-year 24-hour storm design criteria. The cover would be maintained (e.g., mowing), and repairs would be made whenever necessary to correct the effects of settling, erosion or other relevant events. A 10 foot fence and signage, which would warn not to dig or trespass and identify the hazards and a contact telephone number, would be maintained around the cap and repaired and replaced whenever necessary. Rhodia would maintain the cap, fencing and signage for as long as it owns the property, and require its successors, through a combination of contractual obligations and institutional controls, similarly to maintain the cap, fence and signage. For purposes of cost estimates and financial assurances, Rhodia has assumed a 50 year maintenance period.

A groundwater monitoring program would be implemented around the cap that meets the substantive requirements of RCRA post-closure groundwater monitoring at 40 CFR § 265.90 through § 265.94. The approximate locations of the proposed upgradient and downgradient wells are shown on Attachment B. The groundwater monitoring wells would be maintained and repaired, as necessary.

² Prior to construction of the cap, additional sampling will be conducted in the areas beyond the clarifier and the burial area that will be under the cap. The objective of this sampling is to characterize the constituents of concern in the soil in this area. After this sampling is completed, Rhodia would construct all phases of the cap, or if EPA and MDEQ prefer, we would construct the cap in phases that are consistent with timelines that may otherwise be established for remediation of other plant areas beyond the clarifier that may require a cap. For example, Rhodia could first install all of the subgrade up to the flexible membrane liner, and, at a later time, install the liner and complete the remainder of the cap when instructed to do so by the Region.

³ See Attachment F hereto and "Representative Cost Estimate Summary," Appendix G to Waste Plan (Nov. 16, 2001).

It is expected that 30 years of groundwater monitoring will be more than adequate to establish groundwater quality trends and demonstrate the protectiveness of the cap. Current data show that elemental phosphorus in the groundwater degrades to non-toxic compounds and concentrations within 30 feet of the clarifier, as would be expected based on the chemistry of this element.⁴ Modeling discussed in the Waste Plan (pages 76-78) shows that once the clarifier is capped with an enhanced cap, the incremental risk level to humans of cancer from the potential leaching from the capped clarifier is 10^{-7} (1 in 10 million) for arsenic and 10^{-9} (1 in 1 billion) or lower for other heavy metals. These risks are well below EPA's typical 10^{-4} to 10^{-6} drinking water standards. In light of this, and so as not to inflate the expected cost of this groundwater measure, Rhodia has estimated the groundwater monitoring and maintenance costs over a 30 year period. The RCRA regulations allow the Regional Administrator or state authority to require longer term groundwater monitoring, and Rhodia would undertake such longer-term monitoring, if it is determined to be necessary.

Rhodia would also monitor, and as necessary, collect and treat with a carbon system any phosphine gas that is generated from under the cap. A system of pipes will be installed under the cap to collect any gas, and it will be sealed to prevent emissions to the atmosphere and air entering the subgrade. This proposal includes BAH's recommendation to include in the cost estimate the expected costs for a carbon treatment system, which is the same type of system Region 10 approved for FMC at Pocatello. The phosphine monitoring and collection systems would also be inspected routinely and maintained as necessary. Since little phosphine generation is expected based both on the subsurface conditions (neutral pH, about 60°F, and no agitation) and FMC's experience with not seeing appreciable phosphine in the monitoring systems under its completed caps, Rhodia has estimated phosphine collection and treatment for five years to avoid overstatement of those costs. Rhodia would monitor for ten years, *i.e.*, five more years after collection and treatment, to establish that longer term collection and treatment is not necessary. If a longer period of collection and treatment is determined to be necessary, Rhodia would continue to operate and maintain the phosphine system.

The total operation, monitoring and repair costs, hereafter referred to as "post-closure" costs, are estimated to be about \$1.4 million. This is based on: (1) monitoring, maintaining and repairing the cap for 50 years; (2) monitoring the groundwater and maintaining the monitoring wells for 30 years; (3) monitoring phosphine gas for 10 years, collecting and treating gas for five years, and maintaining these systems for those periods of time; and (4) related administration,

⁴ See Pre-Closure Groundwater Monitoring Report, page 32 (December, 2002).

inspection and reporting for up to 50 years. See Attachment F. These periods could be extended or shortened as actual events and observations unfold in the future, but these time frames were chosen to reflect reasonable worst case scenarios that do not unreasonably inflate the future expected costs of this option.

Combining both the \$2.5 million construction and the \$1.4 million post-closure costs, Rhodia would expect to spend a total of \$3.9 million on this new Astaris-type cap option and the post-closure care. The comparable construction and 50-year post-closure cost estimates for the caps Rhodia evaluated in the Waste Plan are \$1.7 million for the soil cap, and \$2.2 million for the enhanced cap.⁵

B. Financial Assurances

To ensure the long-term reliability of the cap and the groundwater and phosphine systems, Rhodia would provide financial assurance for the approximate \$1.4 million post-closure costs in accordance with the substantive financial assurance rules at 40 CFR § 265.145. As noted above, this cost estimate covers the inspection, maintenance and repair of the cap for 50 years, sampling and maintaining the groundwater monitoring system for 30 years, and monitoring and maintaining the phosphine collection and treatment system for 10 years. In the unexpected event that the data show a need to extend these time periods, the Regional Administrator or state authority may require an extension. In that event, Rhodia would maintain financial assurance during the extended period.

The RCRA §7003 order could obligate Rhodia and its successors to undertake the post-closure care (monitoring, maintenance, repair, inspections, reporting, etc.) and to maintain the financial assurances noted above. Since financial assurances are based on the costs of third-parties doing the work, and since the Region and/or state would be the designated beneficiaries of the financial assurance mechanism, e.g., letters of credit, trust or insurance, there will be ample money available to the Region and/or state to ensure that any necessary maintenance tasks are completed in the unlikely event that Rhodia or its successors were to become insolvent.

⁵ To compare "apples and apples," Rhodia has calculated the 50 Year Post-Closure Cost amounts for the soil and enhanced caps. This calculation is the 50-year present worth, at a zero percent interest rate, of the operation, maintenance, and repair costs shown in Appendix G "Representative" Cost Estimate tables in the November 16, 2001 Waste Plan.

C. Institutional Controls

Institutional controls would also be put into place to protect the cap from unauthorized disturbance, to ensure that groundwater associated with the capped area is not consumed, and to require cap maintenance. As discussed in EPA's institutional controls guidance documents,⁶ these institutional controls would be "layered" to provide redundant assurances that the capped material will not pose a future risk. All of the institutional controls are based on Montana law authorizing the controls, and in most cases, on specific situations where the controls have been used at similar sites in Montana. The specific types of controls and the precedent for them are briefly noted below:

- Governmental Controls – Rhodia would work with the Silver Bow County and/or state authorities to develop and have adopted prohibitions on disturbance of the capped area and the drilling of drinking water wells in the upper aquifer downgradient from the clarifier up to the Streamside Tailing Operable Unit. For example, authority for adoption of such prohibitions appears at Mont. Code Ann. 85-2-506.
- Private Property Law Restrictions – Rhodia would place on the title and other land use records land use restrictions that prevent disturbance of the capped area and use of contaminated groundwater for drinking water purposes. In addition, Rhodia would ensure that the title would provide for an easement that would allow access to Rhodia, its successors, and third-parties, including governmental agencies, to conduct the monitoring and maintenance of the cap, the groundwater wells, and the phosphine system. A covenant would also be placed on the land requiring perpetual care and maintenance of the cap, fence and signage by Rhodia and future owners. Montana Code Annotated § 75-10-727 expressly authorizes the establishment of these covenants and easements in the land records, and they can be established at any time, i.e., they need not be associated with a property conveyance.

⁶ See "Institutional Controls: A Guide to Implementing, Monitoring and Enforcing Institutional Controls ...," pp. 3-4 (EPA, Draft 2003) and "Institutional Controls" A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups," OSWER 9355.0-74FS-P, p. 2 (Sept., 2000).

- Informational Devices – Rhodia would also place in the land records a notice identifying the fact that the clarifier material has been capped in place, that the cap should not be disturbed, and that groundwater downgradient from the capped area should not be consumed so long as it exceeds drinking water standards.
- Enforcement Tools – The RCRA §7003 order could require Rhodia to have included in the appropriate land records the covenants, easement, and notices noted above, and to use best efforts to obtain enactment by the County and/or the state of the governmental controls noted above. In addition, Rhodia and its successors could be ordered to provide notice to EPA Region 8 and MDEQ of any land transfer involving the capped clarifier area.

Note that similar types of institutional controls have been established at the Montana Pole and Treating Plant Superfund site in Butte (see September 3, 1993 ROD), in the Streamside Tailings Operable Unit Consent Decree (see subparagraph 40.a. and b.), and at the Anaconda Company Smelter (see 1994 ROD and Land Use Master Plan).

II. Evaluation of New Cap Proposal

A. Evaluation Criteria

As BAH notes in the FFS at page 9, Rhodia evaluated the various options using Phase I threshold criteria that are based on the requirements of the RCRA §7003 order: (1) will the alternative abate the alleged characteristics of fire and phosphine gas generation; and (2) will the alternative comply with applicable regulations under federal, state and international law. We used these criteria because the Agency's authority for all Waste Plan requirements is RCRA §7003. We evaluated the options that passed the Phase I criteria using the five criteria that are typically employed in evaluating corrective measures at RCRA sites that are subject to corrective action. BAH employed the same Phase II criteria in its evaluation of the options. See FFS, pp. 9-12.

We understand that the Region would like Rhodia in this letter to evaluate the new proposed capping option and the off-site incineration option based on the CERCLA evaluation criteria.⁷ We seriously question whether the CERCLA evaluation criteria are applicable to this Waste Plan determination. CERCLA is not the underlying authority for this RCRA §7003 order. Under RCRA, it is common to

⁷ See 40 CFR § 300.430(e)(9)(iii) and (f).

allow RCRA units to be closed with waste left in place. Specifically, under 40 CFR § 264.197 and § 265.197, units may be closed by removing all waste or by leaving waste in place and conducting post-closure care. EPA has expressly relied on this in-place closure authority to support its decision in the FMC Consent Decree to cap the elemental phosphorus ponds.⁸ Similarly, since the Government has insisted in the past that Rhodia's clarifier must be closed according to RCRA's substantive requirements under the assumption that it contains a hazardous waste, closure of the clarifier waste in place with a cap followed by RCRA post-closure care should be an entirely acceptable alternative for closing this alleged RCRA unit. In any event, in light of the Region's request, we will evaluate the capping options against the CERCLA criteria.

In evaluating remedies under CERCLA, one is to apply two threshold criteria: overall protection of human health and the environment and compliance with applicable or relevant and appropriate requirements (ARARs).⁹ Remedies that do not provide "adequate protection" or comply with ARARs, are screened out and are not further evaluated under the "five balancing criteria."¹⁰ The five balancing criteria are:

1. long-term effectiveness and permanence;
2. reduction of toxicity, mobility or volume;
3. short-term effectiveness;
4. implementability; and
5. cost.

As EPA explains, the "*five primary balancing criteria are used to identify major trade offs between remedial alternatives. These trade offs are ultimately balanced to identify the preferred alternative and to select a final remedy.*"¹¹

⁸ See Government's "Memorandum in Support of Motion for Entry of Proposed Consent Decree," U.S. v. FMC Corporation, Civil No. 98-0406-E-BLW, page 20 (March 29, 1999).

⁹ See "A Guide to Selecting Superfund Remedial Actions," Publication No. 9355.0-27FS (April 1990).

¹⁰ Id. at Exhibit 3, page 3.

¹¹ Id.

B. Threshold Criteria

As noted earlier, the incremental risk level to human health from potential leaching of metals into drinking water from the clarifier material under an enhanced cap would be several orders of magnitude below EPA's safe 10^{-4} to 10^{-6} levels. The institutional controls we propose will also prevent placement of drinking water wells in any area where there might be contaminated groundwater. Potential disturbance or failure of the cap and consequent direct exposure to the phosphorus-bearing materials should be virtually eliminated by the very protective design of the Astaris-type cap, and the proposed institutional controls, post-closure care, and financial assurance. Thus, there is little question that the proposed Astaris-type cap and the post-closure care could pass the initial threshold criteria of adequately protecting human health and the environment and complying with ARARs.¹² The principle question you have raised is whether this remedy will be effective in providing such protection in the long-term. This long-term effectiveness issue is discussed below, along with the other balancing criteria.

C. Balancing Criteria

1. Long-Term Effectiveness

The Astaris-type cap is the most protective design ever approved by the Agency for capping elemental phosphorus-bearing materials. The Astaris-type cap would provide approximately 16 feet of cover, including two very low permeability synthetic layers, over the crude phosphorus solid material in the clarifier. This will prevent air and water from seeping into the phosphorus-bearing material and causing a threat of fire or significant phosphine generation. Indeed, modeling of the Astaris cap that Region 10 approved at Pocatello for Pond 18 Cell A concluded that only 0.00002 inches of rainwater per year would infiltrate the cap.¹³

This very thick cap should also provide cover even in the event of the worst earthquake ever recorded in this Earthquake Zone 3 area. The cap also has a

¹² BAH raised one question regarding compliance with ARARs. It asks whether capping would comply with the RCRA land disposal restriction requirements and the Subtitle C prohibition against co-disposal of ignitable and reactive waste. See FFS at 15. As explained in our Comment # 35 in Attachment A, closure in place of hazardous waste does not trigger land disposal restriction requirements or other Subtitle C regulations.

¹³ See Section 7.1.2 of Pond 18 Cell A Closure Plan, Astaris, Pocatello, ID, (August 2001).

self-healing geosynthetic clay liner that can tolerate differential settlement better than a simple synthetic membrane liner. The 3.5 feet of top soil is reinforced with pea gravel to resist wind erosion, and will support vegetation that will resist rain erosion. The 100-year, 24-hour rainfall for this area of 3.2 inches will not impair the integrity of this Astaris-type cap. The cap would also not be located in a floodplain. The 2.5 foot biotic protection layer of slag below the 4.5 feet of top soil and sand will protect the underlying liner from intrusion by vegetation, burrowing animals or excavation activities. The integrity of the cap will be further ensured by Rhodia's proposal to provide long-term financial assurance to pay for a third party (if Rhodia is unable) to inspect, maintain and repair the cap, the groundwater monitoring system, the phosphine monitoring, collection and treatment systems, and the fence and signage, in the event Rhodia or its successors become insolvent or refuse to do this work.

Rhodia's proposal to put into place layered institutional controls should greatly reduce the Region's concerns that someone might dig into the cap and potentially expose the clarifier material. Prospective purchasers of this property will be on notice, by virtue of several layered and enforceable institutional controls, that the cap cannot be disturbed, groundwater associated with the cap cannot be consumed, and the cap must be maintained. In sum, the Astaris-type design, as well as the institutional controls, post-closure care and financial assurance that Rhodia proposes should together provide a high degree of comfort that the capping remedy will be effective in the long-term.

Of course, the off-site incineration option also will be effective in the long-term if it can be completed as described. But it is important to recognize that even with the incineration option, your consultant BAH estimates that approximately 5,000 gallons of crude phosphorus will not be able to be removed from the clarifier, and it will have to be capped in place. (FFS, page 33). This 5,000 gallons of crude phosphorus will contain approximately 1,000 gallons of elemental phosphorus, as well as trace metals. The infiltration rate through the cap and the leachability of this residual 5,000 gallons of crude phosphorus would not be less than the infiltration rate and leachability of the 500,000 gallons of crude phosphorus that would be capped in place under Rhodia's proposal. The only theoretical difference is that the 5,000 gallons of capped material would probably be exhausted as a source for leaching contaminants in relatively less time (2,000 to 3,000 years¹¹) than it would take to exhaust the source if all of the material

¹¹ The duration of leaching was calculated using information published in the November 2001 Waste Plan: the soil cap infiltration rate of 0.013 inches per year, the leachate concentrations shown in Table 3-3, Partitioning Model section, and the concentrations of metals calculated by mass balance in Section 3.1.1.2 (pages 38-42).

currently in the clarifier were capped. Thus, there would be no less leachate moving through the capped clarifier and into groundwater for centuries if 5,000 gallons rather than 500,000 gallons of crude phosphorus are capped in place. Similarly, whether there are 5,000 or 500,000 gallons of phosphorus left in place, disturbance of the cap could lead to the same exposure concerns.

In reality, these exposure and leachability concerns are insignificant whether all or a portion of the clarifier material is capped. They should not drive the Region's decision at all. But whatever significance the Agency places on the long-term groundwater impacts, the concerns should be essentially the same for hundreds of years to come whether all of the crude phosphorus is capped in place or just 5,000 gallons. As such, the Region cannot legitimately point to concerns over long-term groundwater impacts as a justification for requiring incineration.

2. Reduction in Toxicity, Mobility and Volume

The cap will reduce the mobility of the waste since it will be effective in reducing the quantity of leachate that will migrate from the clarifier. Rhodia demonstrated in the Waste Plan that there would be only about 0.00002 inches of water infiltrating each year through the enhanced cap.¹⁵ This infiltration rate was shown to result in an incremental risk level in drinking water of 10^{-7} for arsenic and 10^{-9} or below for other heavy metals. Modeling of the Astaris-type cap at the Silver Bow Plant location confirms that the infiltration rate is likely to be even less than 0.00002 inches per year.¹⁶ Thus, the cap reduces mobility and protects groundwater.

The incineration option reduces the toxicity, mobility and volume of the crude phosphorus that is removed from the clarifier and incinerated, but that which cannot be removed will not have reduced toxicity or volume. There will still be approximately 1,000 gallons of elemental phosphorus as well as other constituents of concern under a cap after incineration.

The calculated leaching duration for most of the TCLP metals is in the 2,000 to 3,000 year range.

¹⁵ See Waste Plan, page 73 and Attachment 3 of Appendix D.

¹⁶ This result is consistent with the modeling of the cap for the Pocatello, Idaho area, which also showed an annual infiltration rate of 0.00002 inches per year. See Section 7.1.2 Pond 18 Cell A Closure Plan, Astaris, Pocatello, ID, August 2001.

3. Short-Term Effectiveness

The short-term risks involved in implementing the incineration option (remove, package, transport and incinerate the estimated 25,000 drums of frozen crude phosphorus) were projected in the Waste Plan to be 1.4% risk of fatality and 41% risk of serious injury. This is for a trained worker with full protective gear. While BAH brushes these estimates aside saying Rhodia has experience handling crude phosphorus materials, the fact is that these estimates were calculated based on Rhodia's actual incident experience while the plant was being operated, and the estimates are in line with other industrial safety studies. These short-term risks of serious injury and death are 29 times greater for the incineration option than are the short-term risks of constructing and maintaining the enhanced cap.¹⁷

These are alarmingly high risks for a remedial project. The Agency cannot justify incineration with its very high 41 in 100 risk of serious injury and 1.4 in 100 risk of death on the grounds of trying to avoid the insignificant 1 in 10 million and 1 in 1 billion long-term incremental risks of cancer from groundwater exposure.

4. Implementability

Construction of the Astaris-type cap is readily implementable, uses standard materials and construction techniques, and can be completed in one to two years. In contrast, removal, packaging and incineration of this very large volume of frozen crude phosphorus raises serious feasibility questions. Under the incineration option, several years will be required to design, build and put into effective operation the new facilities that will be needed to remove the frozen crude phosphorus from the clarifier and package it at Silver Bow. If tank trucks or railcars are used, as BAH suggests, the receiving incineration facilities will also have to design an effective removal and gas collection system for the crude phosphorus and off-gases, and they will need to obtain permits or permit modifications for these facilities. These upfront efforts are likely to take at least two to three years. The actual removal, packaging, transportation, and incineration of the clarifier material, as well as the capping of the residual 5,000 gallons of crude

¹⁷ See Waste Plan, pages 131-132. The risks for construction of the Astaris-type cap were calculated in the same manner as those risks were calculated for the enhanced cap in the Waste Plan. Since the Astaris-type cap is about twice as large as the enhanced cap, the work will take longer, and the associated risks will be roughly twice the enhanced cap construction risks. Even so, the incineration risks are still dramatically higher – more than 14 times greater than the Astaris-type cap risks.

phosphorus that cannot be effectively removed from the clarifier, will take at least another two to four years assuming both incineration facilities are available for use. Thus, Rhodia's proposed capping will likely take one to two years to complete, while the incineration option will likely take at least four to seven years to complete.

5. Cost

Rhodia has, in good faith, re-evaluated the cost for the incineration option to address BAH's questions and suggestions, and to identify a "best case" cost that assumes that the material can be fairly easily removed from the clarifier and packaged. Rhodia believes that the "best case" cost is \$39.1 million.¹⁸ This is still ten times higher and over \$35 million more costly than the \$3.9 million estimated cost of the proposed Astaris-type cap and its associated post-closure care.

III. Summary

Choosing incineration, with its dramatically higher cost, is not justified based on the CERCLA evaluation criteria. Although the incineration option will reduce the volume and toxicity of the waste more than Rhodia's cap proposal, the issue is whether the greater volume of crude phosphorus (about 500,000 gallons) that will remain and be capped under Rhodia's proposal or the smaller volume (5,000 gallons) that will be capped under the incineration option will be secure over the long-term. Rhodia's proposal for an Astaris-type cap over the clarifier material, coupled with the institutional controls, post-closure care and financial assurances that Rhodia will commit to, would provide a secure and effective means of closing the clarifier in an environmentally protective manner for the long-term. In reality, the long-term risks are miniscule whether capping all the material or just 5,000 gallons and incinerating the rest.

Regarding the other three balancing criteria, construction of the Astaris-type cap is far superior in terms of short-term risk. A requirement to incinerate this material runs a 41% risk of serious injury and a 1.4% risk of a fatality, which is 14 times higher than the Astaris-type cap. These are very high risks that far outweigh the long-term risks. This is precisely the type of situation that EPA regards as inappropriate for a treatment remedy since "*implementation of treatment-based remedy would result in greater overall risk to human health and the environment due to risks posed to workers or the surrounding community during implementation.*"¹⁹ The incineration option will also take at least four to

¹⁸ See Comment #32 and #33 in Attachment A

¹⁹ "A Guide to Selecting Superfund Remedial Actions," Publication No. 9355.0-27FS, page 3 (April 1990).

Mr. John F. Wardell

July 31, 2003

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seven years to complete, and its cost is ten times higher than capping. Further, capping has been demonstrated to be reliable at every one of the more than a dozen facilities where it has been used to cap elemental phosphorus wastes. And finally, Rhodia would agree to an Astaris-type capping requirement in the RCRA §7003 Order, and move forward constructively with the Region to implement it as soon as possible.

We look forward to an opportunity to discuss this new capping option with you, answer questions you might have about it, and attempt to resolve any concerns you might have. Please let me know when a meeting would be convenient for you and your colleagues. We will do our best to make ourselves available at your earliest convenience.

Sincerely,

Dan Bersanti

Enclosure

cc: Chuck Figur
Rebecca Holmes
Rosemary Rowe

Attachment A

REDACTED

Xrefs in Drawing - M:\cad\2625001\16381_1.DWG

rlg M:\CAD\2625001\18569_1.dwg Plot at 200 07/29/2003 09:23:57

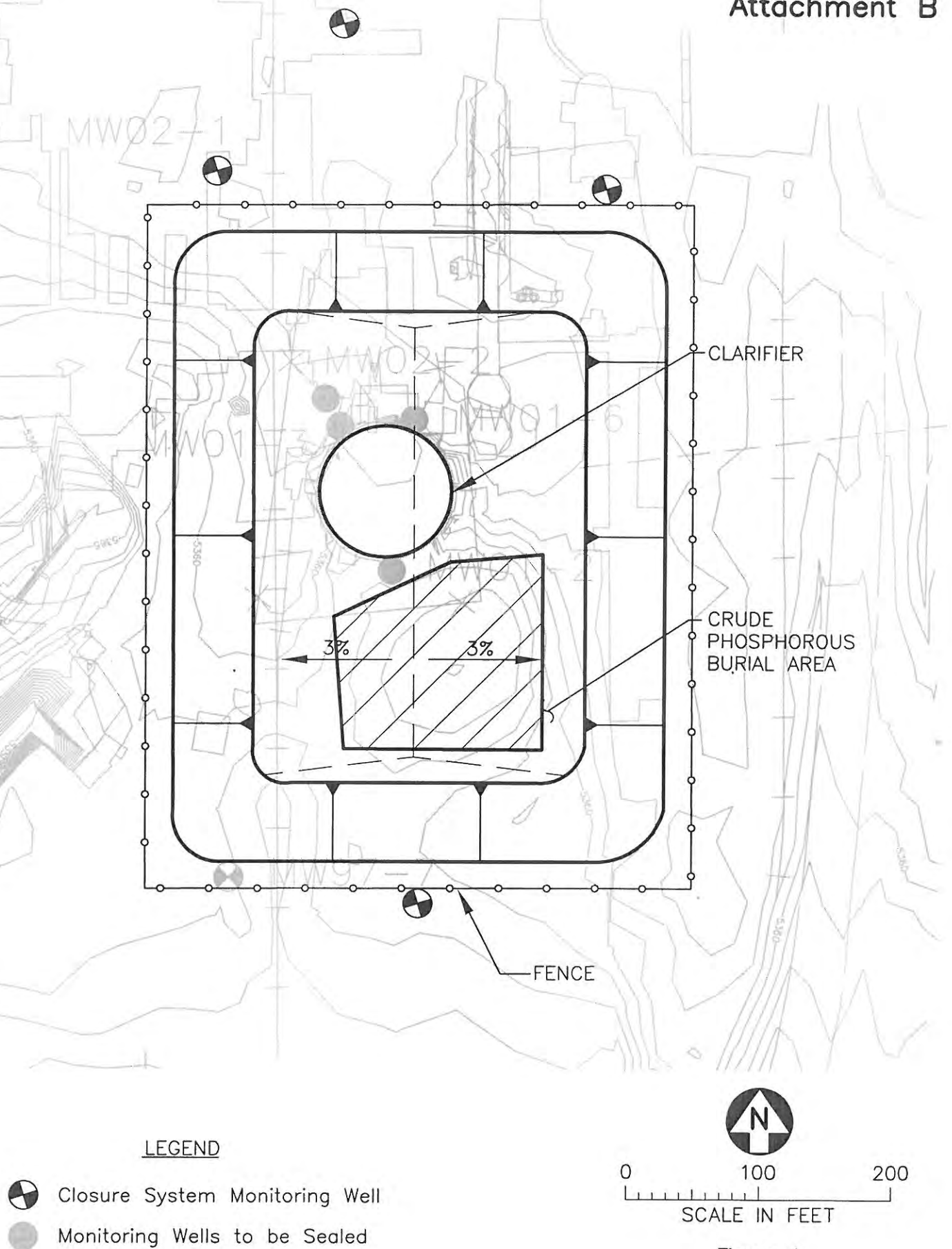


Figure 1

GENERAL LOCATION
OF COVERED AREA

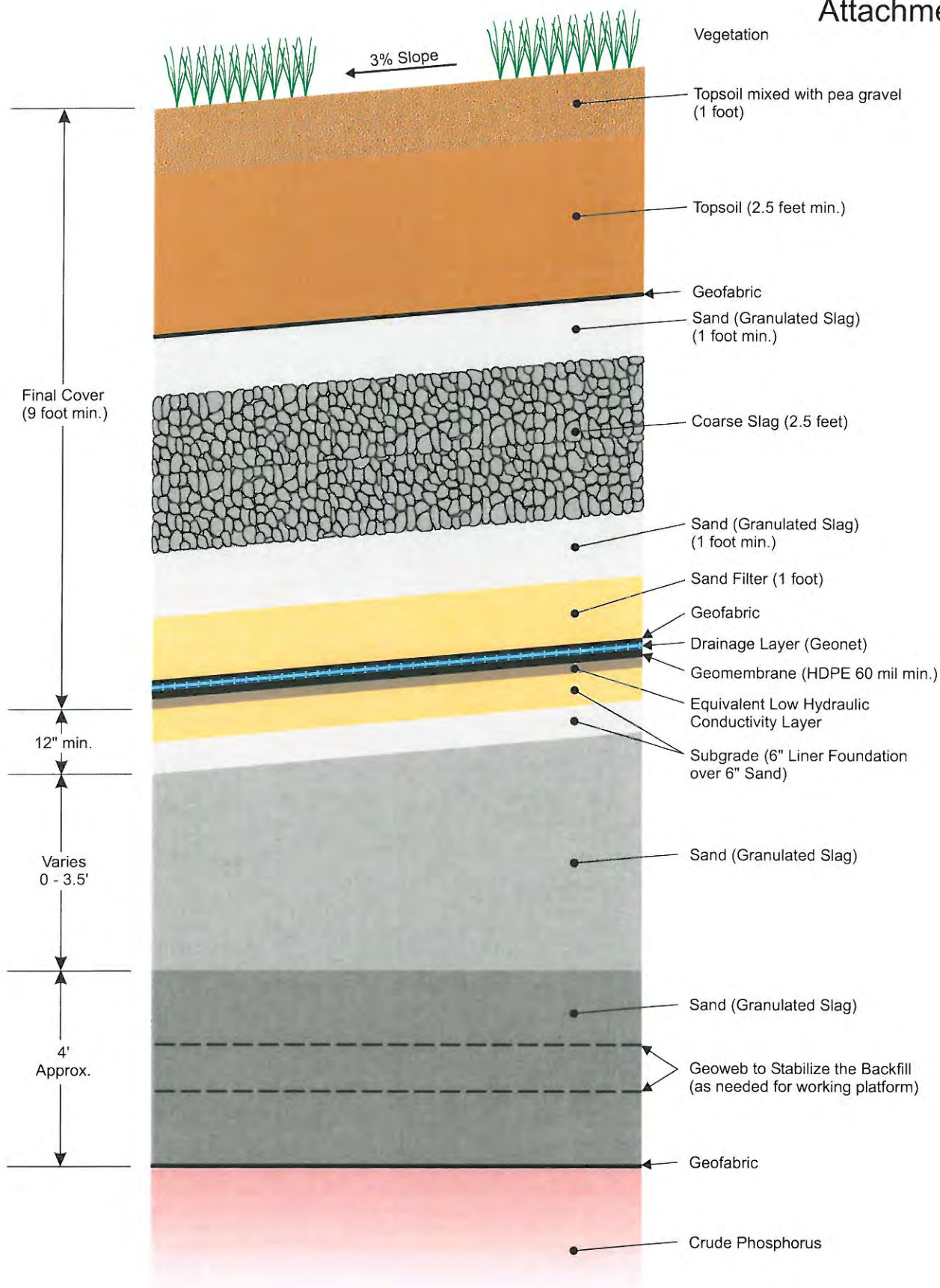
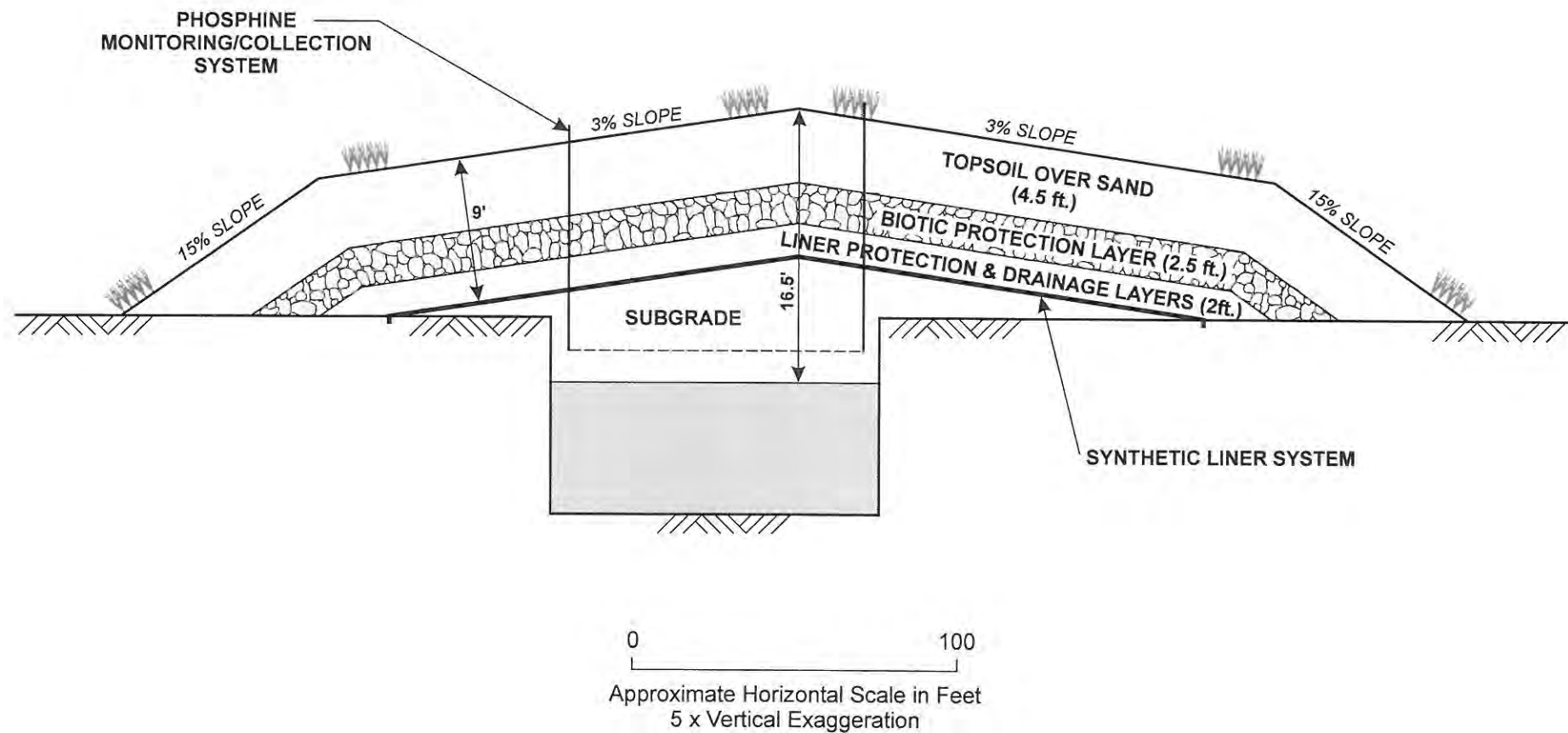


Figure 2

TYPICAL SECTION OF
ASTARIS-TYPE CAP SYSTEM
Rhodia, Inc.
Silver Bow, Montana



See Figure 2 for detailed depiction of Cover System.

Figure 3
ASTARIS-TYPE CAP
CROSS SECTION
Rhodia, Inc.
Silver Bow, Montana

Comparison of Cap System Designs

Layer	Rhodia Proposed Astaris-Type Cap			Astaris Pond 18 Final Cap ¹			Difference
	Thickness	Description	Details	Thickness	Description	Details	
16	1 foot	Topsoil mixed with 15% pea gravel	Native vegetation cover (See Section 3.5.3 of Waste Plan Appendix D) over 3.5 feet of topsoil classified as SM/SC/ML/CL per ASTM D2487 with the top foot of topsoil mixed with pea gravel; poor vegetation coverage was assumed considering the site climatic conditions.	1 foot	Topsoil mixed with 15% pea gravel	Native vegetation cover over 3.5 feet of topsoil classified as ML/SM per ASTM D2487 with the top foot of topsoil mixed with pea gravel; poor vegetation coverage was assumed considering the site climatic conditions.	Rhodia's design also allows soil classified as SC or CL per ASTM D2487. These soils have a higher proportion of fines to hold soil moisture.
15	2.5 feet	Topsoil		2.5 feet	Topsoil		
14	---	Geofabric	A commercial synthetic filter fabric.	---	---	---	Rhodia's design provides an additional filter fabric to maintain separation of topsoil and underlying coarser material layers.
13	1 foot	Sand	Sand. Granulated slag classified as poorly graded sand (SP) per ASTM Standard D2487.	0.5 feet	Sand filter	Coarse sand.	
				0.5 feet	Gravel filter	4-inch minus, graded, crushed and screened slag; or gravel.	Astaris's design uses specific particle size materials to maintain separation of topsoil layers and the underlying coarse material layers.
12	2.5 feet	Coarse slag (1½ to 12 inches) Biotic Protection Layer	Coarse Slag (1½ to 12 inches in diameter) and granulated slag. The coarse slag and granulated slag will be placed in lifts such that the interstices in the coarse slag are filled with granular slag to minimize settling of overlying layers.	1.5 feet	Coarse Slag (1½ to 12 inches)	Coarse Slag (1½ to 12 inches in diameter).	Rhodia's design includes an extra 1 foot of coarse slag. Granulated slag and installation methods will be used to fill any void space between the cobbles.
11	1 foot	Sand	Sand. Granulated slag classified as SP per ASTM Standard D2487.	---	---	---	Rhodia's design provides an additional 1 foot of sand to protect the underlying flexible membrane and geosynthetic clay layers during construction.
10	1 foot	Sand Filter	Sand rounded to sub-rounded (< or = 3/8 inches in diameter) classified as SP or SW per ASTM Standard D2487.	1 foot	Sand Filter	Sand all classified as SP or GW per ASTM Standard D2487.	Same, except that Astaris allows gravel as the sand filter.
9	---	Geofabric	A commercial synthetic filter fabric.		Geofabric	A commercial synthetic filter fabric.	Same
8	---	Drainage layer	Geonet (GN) drainage layer, a commercial synthetic drainage net, having a performance equivalent to a one foot thick layer of granular material which has a hydraulic conductivity of 10 ⁻² cm/sec or higher.	---	Drainage layer	Geonet (GN) drainage layer, a commercial synthetic drainage net, having a performance equivalent to a one foot thick layer of granular material which has a hydraulic conductivity of 10 ⁻² cm/sec or higher.	Same

¹ Pond 18 Closure Plan, Volume 1-Cell A. Astaris Idaho, LLC, Pocatello, Idaho, August 2001.

Comparison of Cap System Designs (cont.)

Layer	Rhodia Proposed Astaris-Type Cap			Astaris Pond 18 Final Cap ¹			Difference
	Thickness	Description	Details	Thickness	Description	Details	
7	60 mil	Geomembrane	Durable commercial synthetic liner, HDPE (60 mil min.).	60 mil	Geomembrane	Durable commercial synthetic liner, HDPE (60 mil min.).	Same
6	---	Equivalent Low Hydraulic Conductivity Layer	Geosynthetic Clay Liner (GCL), a commercial synthetic HDPE/Bentonite composite liner, having a hydraulic conductivity of 5×10^{-9} cm/sec or less, hydraulically equivalent to a 2-foot thick layer of fine clayey material with a hydraulic conductivity of 1×10^{-7} cm/sec.	---	Equivalent Low Hydraulic Conductivity Layer	Geosynthetic Clay Liner (GCL), a commercial synthetic HDPE/Bentonite composite liner, having a hydraulic conductivity of 5×10^{-9} cm/sec or less, hydraulically equivalent to a 2-foot thick layer of fine clayey material with a hydraulic conductivity of 1×10^{-7} cm/sec.	Same
Subgrade							
5	0.5 feet	Subgrade (6" Liner Foundation material)	Sand rounded to sub-rounded ($< \text{ or } = 3/8$ inches in diameter). Sand subgrade will serve as a leveling course to provide proper bedding for the overlying geosynthetic clay liner.	0.5 feet	Subgrade (6" Liner Foundation material).	Sand subgrade will serve as a leveling course to provide proper bedding for the overlying geosynthetic clay liner.	Same, but Rhodia would use rounded sand to protect the overlying liners.
4	0.5 feet	Subgrade (6" sand)	Sand. Granulated slag classified as SP per ASTM Standard D2487.	0.5 feet	Sand Filter (6" sand).	Sand filter between overlying liner foundation and underlying slag.	Rhodia does not need the filter function because Rhodia's layer 3 is sand, not coarse slag.
3	Varies (0–3.5 feet)	Sand	Sand. Granulated slag classified as SP per ASTM Standard D2487. The thickness of this layer represents fill above the top of the clarifier wall Graded to form the shape of the cap.	Varies	Backfill, slag (12" max size).	Locally borrowed sand and slag material. Graded to form the shape of the cap.	Rhodia's design specifies granulated slag which is a superior foundation material.
2	4 feet (approx.)	Sand with Geoweb layers (to stabilize backfill for working platform, as needed)	Sand. Granulated slag classified as SP per ASTM Standard D2487. The thickness of this layer is based on filling to the top of the clarifier wall. Geoweb, a commercial synthetic fabric.	Varies	Sand with Geoweb to stabilize the backfill (as needed for working platform).	Locally borrowed sand and slag material. Geoweb, a commercial synthetic fabric.	Rhodia's design specifies granulated slag which is a superior foundation material.
1	---	Geofabric filter	A commercial synthetic filter fabric.	---	Geofabric filter	A commercial synthetic filter fabric.	Same
---	---	Crude phosphorus	---	---	Pond Material	---	---

Table 1
Astaris-Type Cap
Representative Cost Estimate of Cap Installation
Rhodia Silver Bow Plant

Attachment F

ITEM	ESTIMATED QUANTITY	UNIT	UNIT COST [1]	ITEM TOTAL COST	WORK SUBDIVISION TOTAL COST	SOURCE	COMMENTS
SOIL SAMPLING							
Sampling and Analysis	24	SAMPLE	\$2,500	\$60,000		Barr	12 soil borings in cap area, 2 samples per boring
Reporting	1	LS	\$15,000	\$15,000		Barr	Soil sampling report
SUBTOTAL SOIL SAMPLING					\$75,000		
GENERAL REQUIREMENTS							
Mobilization/Demob./Submittals							The amount is shown under Estimated Subtotal Field Cost, below
Health & Safety	1	LS	\$50,000	\$50,000		Barr	Training and field support
Equipment and Personnel Decon. Facilities	7	MO	\$10,000	\$70,000		Barr	
Sitework							
Clear and Grade	5	ACRE	\$2,000	\$10,000		Barr	
Fence Removal	800	LF	\$2	\$1,600		Barr	
SUBTOTAL GENERAL REQUIREMENTS					\$131,600		
CAP CONSTRUCTION							
Geofabric Filter	15,000	SF	\$1.50	\$22,500		Barr	Cover the clarifier contents with geotextile (higher cost for install)
Sand (Granulated Slag) Subgrade	1,500	CY	\$6	\$9,000		Barr/Rhodia	4 ft thick, 10,000 sq ft area; assume on-site source, careful placement
Geoweb	30,000	SF	\$1.00	\$30,000		Barr	2 layers in clarifier
Gas Collection System	1	LS	\$4,000	\$4,000		Barr	Piping and fittings within clarifier, enclosure,
Gas Treatment System	1	LS	\$4,500	\$4,500		Barr	Enclosure, 20 cfm blower, 3 - 55 gallon drums, piping, fittings
Placement and Grading - Coarse & Granulated Slag	14,800	CY	\$3	\$44,400		Barr/Rhodia	4 ft thick, 100,000 sq ft area; assume on-site source (outside clarifier)
Sand (Granulated Slag) Surcharge	15,000	CY	\$5	\$75,000		Barr/Rhodia	Place and remove surcharge; assume on-site source
Sand (Granulated Slag)	1,900	CY	\$3	\$5,700		Barr/Rhodia	0.5 ft thick, 100,000 sq ft area; assume on-site source
Sand Filter - Rounded to Subrounded	1,900	CY	\$20	\$38,000		Barr	0.5 ft thick, 100,000 sq ft area; assume off-site source
Geosynthetic Clay Liner (GCL)	100,000	SF	\$2	\$200,000		Barr	100,000 sq ft area (furnished and installed cost)
HDPE - 60 mil	100,000	SF	\$1.60	\$160,000		Barr	100,000 sq ft area (furnished and installed cost)
Drainage Layer - Geonet	100,000	SF	\$1.00	\$100,000		Barr	100,000 sq ft area (furnished and installed cost)
Geofabric Filter	100,000	SF	\$0.50	\$50,000		Barr	Geotextile 100,000 sq ft area
Sand Filter - Rounded to Subrounded	3,700	CY	\$20	\$74,000		Barr	1 ft thick, 100,000 sq ft area; assume off-site source
Sand (Granulated Slag)	6,700	CY	\$3	\$20,100		Barr/Rhodia	1 ft thick, 180,000 sq ft area; assume on-site source
Biotic Protection Layer - Coarse Slag	16,700	CY	\$6	\$100,200		Barr	2.5 ft thick, 180,000 sq ft area; assume on-site source, and screening
Sand (Granulated Slag)	6,700	CY	\$3	\$20,100		Barr/Rhodia	1 ft thick, 180,000 sq ft area; assume on-site source
Geofabric Filter	180,000	SF	\$0.50	\$90,000		Barr	Geotextile 180,000 sq ft area
Topsoil	16,700	CY	\$8	\$133,600		Barr/Rhodia	2.5 ft thick, 180,000 sq ft area; assume on-site source
Pea Gravel for Topsoil Mixing	1,000	CY	\$20	\$20,000		Barr/Rhodia	15% of 1 ft thick, 180,000 sq ft area; assume off-site source
Topsoil for Pea Gravel	5,700	CY	\$12	\$68,400		Barr/Rhodia	85% of 1 ft thick, 180,000 sq ft area; assume on-site source; mixing
SUBTOTAL CAP CONSTRUCTION					\$1,269,500		
SITE RESTORATION							
Site Restoration/Revegetation	10	ACRE	\$5,000	\$50,000		Barr	Includes seeding, mulching, fertilizing, watering
Install Perimeter Fence	1,900	LF	\$12	\$22,800		Barr	520 ft x 420 ft
SUBTOTAL SITE RESTORATION					\$72,800		
ESTIMATED SUBTOTAL FIELD COST					\$1,549,000		
Mobilization/Demob./Submittals					\$155,000	Barr	10% of Estimated Subtotal Field Cost
ESTIMATED TOTAL FIELD COST					\$1,704,000		
Contingency (20%) [2]					\$341,000		20% of Estimated Total Field Cost
Engineering/Administration	9	MO	\$50,000	\$450,000		Barr	2 months design, 7 months construction
ESTIMATED TOTAL CONSTRUCTION COST					\$2,495,000		
NOTES:							
[1] Unit cost includes labor, materials, equipment, overhead, and profit.							
[2] Calculated as Contingency Multiplier times Estimated Total Field Cost.							

Table 1 (Cont.)
Astaris-Type Cap
Representative Post-Closure Cost Estimate of
Operation, Maintenance, Repair, and Administration
Rhodia Silver Bow Plant

Attachment F

ITEM	ESTIMATED QUANTITY	UNIT	UNIT DIRECT COST [1]	ANNUAL ITEM TOTAL DIRECT COST	NUMBER OF YEARS	POST-CLOSURE COST	COMMENTS
Admin., Inspection, Reporting (Years 1 to 5)	1	LS	\$25,000	\$25,000	5	\$125,000	
Admin., Inspection, Reporting (Years 6 to 10)	1	LS	\$15,000	\$15,000	5	\$75,000	
Admin., Inspection, Reporting (Years 11 to 50)	1	LS	\$10,000	\$10,000	40	\$400,000	
Groundwater Monitoring (Years 1 to 5)	3	QTR	\$5,000	\$15,000	5	\$75,000	1 upgradient, 3 downgradient wells
Groundwater Monitoring (Years 6 to 30)	1	QTR	\$5,000	\$5,000	25	\$125,000	1 upgradient, 3 downgradient wells
Cap Maintenance (Years 1 to 30)	1	LS	\$6,000	\$6,000	30	\$180,000	
Cap Maintenance (Years 31 to 50)	1	LS	\$5,000	\$5,000	20	\$100,000	
Phosphine Monitoring (Years 1 to 10)	1	LS	\$5,000	\$5,000	10	\$50,000	
Phosphine Collection/Treatment System Maintenance (Years 1 to 5)	1	LS	\$2,500	\$2,500	5	\$12,500	120 lbs of Centaur Carbon per year, includes labor for change-out, piping and blower repair
SUBTOTAL OMR COSTS						\$1,142,500	
Contingency (20%) [2]						\$228,500	
ESTIMATED TOTAL OMR COSTS						\$1,371,000	

NOTES:

- [1] Lump sum costs include labor, materials, equipment, profit and overhead. Costs in 2003 dollars.
[2] Calculated as Contingency Multiplier times subtotal OMR costs.
[3] Groundwater compliance monitoring is not included in this estimate.

Table 1 (Cont.)
Astaris-Type Cap
Representative Cost Estimate Summary
Rhodia Silver Bow Plant

Attachment F

Closure				Post-Closure	Total
Estimated Field Cost	Contingency	Engineering/ Administration	Total Estimated Closure Cost	Financial Assurance Cost	Estimated Closure and Post-Closure Cost
\$1,700,000	\$341,000	\$450,000	\$2,500,000	\$1,400,000	\$3,900,000

Table 1 (cont.)
Astaris-Type Cap
Representative Post-Closure Cost Estimate of
Operation, Maintenance, Repair, and Administration
Notes
Rhodia Silver Bow Plant

Administration, Inspection, Reporting

This work includes cap inspections 2 times per year, surveying settling markers on the cap, and all reporting and project administration. The reporting includes review and reporting of cap inspection results, any maintenance performed on the cap, groundwater data, phosphine monitoring data, any changes to or problems with the phosphine treatment system, and any recommended changes to the inspection, monitoring, or maintenance programs.

The estimated cost steps down at year 6, corresponding to the change from quarterly to annual groundwater monitoring and the assumed end of gas collection activities. The cost steps down again in year 11, corresponding to the end of routine phosphine monitoring activities. There are sufficient resources, between the stated budget and contingencies, to support occasional monitoring of the groundwater and the phosphine monitoring/collection/treatment system for the period after the end of routine monitoring.

Cap Maintenance

This work includes mowing the cap, topsoil addition as needed, gully repair, seeding, and fence and signage maintenance. With the annual attention to cap repair, topsoil addition, and seeding, and this very thick 3.5 foot topsoil cap, it is not anticipated that major topsoil restoration and re-seeding will be necessary at longer-interval periods, like the 40 and 80 years BAH suggested in the FFS. The \$5,000 and \$6,000 annual budgets include \$2,000 per year that is to be set aside for occasional capital expenses, like fence and signage replacement. The budget steps down slightly at year 31, by which time the cap vegetation and cap erosion resistance should be well established.

Appendix J

HELP Modeling for Enhanced RCRA Cap

HELP Modeling Enhanced RCRA Cap

Introduction

The HELP (Hydrologic Evaluation of Landfill Performance) model (Version 3.07, U.S. Army Corps of Engineers, November 1997) was used to project long-term infiltration through the proposed enhanced cap system.

The HELP model tracks the water budget for the cap system. The water enters as precipitation (including snowmelt) less the runoff, and exits via evapotranspiration (ET), percolation, and drainage, or it is held in storage in the pore spaces. The amount of water percolating through the capped material is of particular interest because it can leach contaminants and may impact the underlying groundwater.

The summary model output for the proposed cap system is attached. It includes data inputs and summary results for 30 years of model simulation.

Input

The input values used were those recommended in the HELP guidance and documentation for this climate and this type of application. Site-specific parameters such as soil characteristics were used to select reasonably similar HELP soil textures. The inputs and rationales for their selection are explained below.

Climate Data: 30 years of precipitation data were synthetically generated from monthly total precipitation data from the Butte, Montana airport and the Helena, Montana coefficients. The Helena coefficients are a default data set available with the HELP model. The average annual precipitation at Helena and Butte and the monthly distribution of precipitation were nearly identical, so the Helena coefficients were considered suitable for this model. The attached table of weather information for Butte and Helena illustrate the similarities in their climates. Temperature data were generated synthetically by the HELP model using Helena coefficients and monthly averages for Butte. The latitude was adjusted to 45.8E for the solar radiation and the Helena values were used for the relative humidity. The growing season for Helena was used: 128 days.

Cover Design: The layers that comprise the cover are shown in the attached figure (Figure J-1). This multi-layer cover system is a combination of locally available soil and slag, along with multiple types of geosynthetics.

Topsoil and common fill will be obtained locally. The attached soil test data is for a borrow source available at the Silver Bow Plant property. The soil was compacted to approximately 90 percent of standard proctor maximum density for the permeability testing. The borrow soil is expected to function similarly to HELP soil Texture 12, based on the similar soil type (silty clay loam) and identical hydraulic conductivities (4.2×10^{-5} cm/s). The borrow soil may have an ability to store more water than the HELP Texture 12 soil, which would only improve the effectiveness of the cap. Local sand and granulated slag available at the plant would be used for granular filter layers.

Geosynthetic layers including geofabric, geonet, geomembrane, geosynthetic clay liner (GCL), and geoweb are part of this multi-layer cover system. Geofabric is assumed to aid in filtering between

soil layers. Geonet is used as a lateral drainage layer beneath a minimum 9 feet thick soil cover. Geomembrane and an underlying GCL layer are the barrier layer underlying the geonet drainage layer. Geoweb is used to stabilize the backfill above the crude phosphorus waste.

General Design and Evapotranspiration Parameters: The input and HELP-computed parameters for runoff and evapotranspiration are as follows:

Cover slope: 3%
 Cover slope length: 50 feet
 SCS runoff curve number: 83.50 (computed by HELP)
 Evaporative zone depth: 24.0 inches
 Maximum leaf area index: 2.00

Results

Summary output for the HELP model is attached.

The annual average values for the 30-year simulation are as follows:

Precipitation: 12.55 inches
 Runoff: 0.469 inches
 Evapotranspiration: 12.085 inches
 Lateral drainage: 0.30824 inches (collected from the geonet drainage layer)
 Percolation through cap: 0.00000306 inches (0.002 ft³)

Model Sensitivity

Model sensitivity was tested on 5 parameters:

1. Evaporative zone depth
2. Leaf index
3. Pinhole density
4. Liner defects
5. Liner soil

The summary outputs for the HELP model runs are attached. The effect on average annual percolation for the sensitivity cases are summarized in the following table. The representative case using the inputs described earlier is listed first, followed by the sensitivity cases where one or more parameters were varied.

Sensitivity Case

Parameter	Representative	Deep Evap. Zone	Shallow Evap. Zone	High Leaf Area	High Liner Defects	Ineffective Liner Soil
Evaporative zone depth (in)	24	42	14	24	24	24
Maximum leaf area index	2	2	2	3	2	2
FML pinhole density (hole/acre)	1	1	1	1	2	1
FML installation	15	15	15	15	30	15

defects (holes/acre)						
Liner soil hydraulic conductivity (10^{-9} cm/s)	3	3	3	3	3	100
Acreage annual percolation through cap (10^{-6} in/yr)	3.06	3.06	3.06	3.06	3.06	6.12
Acreage annual percolation through cap (10^{-3} ft ³ /yr)	2	2	2	2	2	4

The range of annual average percolation is 0.002 cubic feet to 0.004 cubic feet (3.06×10^{-6} in/year to 6.12×10^{-6} in/year) for the representative and sensitivity cases, as shown in the last line of the above table. This result strongly suggests that this form of cap is insensitive to variations in the cover vegetation, liner defects, and even the permeability of the liner material below the HDPE geomembrane. Based on these sensitivity results and the very low percolation rates through the cap system, the enhanced RCRA cap is a very robust design for this climate and this application.

Monthly Climate Summary
Butte FAA Airport, Montana: (Weather Station 241318)
Compared to HELP Helena Climate Data

Month	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Butte													
Average Maximum Temperature, °F	29.8	34.3	40.6	51.1	60.5	69.3	79.5	78.0	66.9	55.5	40.5	31.7	53.2
Butte													
Average Minimum Temperature, °F	7.4	10.9	17.7	27.0	34.9	42.0	47.1	45.3	36.9	28.7	18.2	10.0	27.2
Butte													
Average Total Precipitation, Inches	0.61	0.56	0.81	1.03	1.89	2.27	1.30	1.11	1.12	0.80	0.62	0.59	12.71
Butte													
Average Total Snowfall, Inches	8.6	7.7	10.3	7.5	3.7	0.5	0.0	0.1	1.1	3.6	6.6	8.3	57.9
Butte													
Average Snow Depth, Inches	4.0	4.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.0	1.0
Butte													
Average Wind Speed, mph **	14.9	14.1	3.6	0.8	2.3	2.6	5.1	4.3	6.5	5.9	15.5	2.5	6.3
Helena													
Average Mean Temperature, °F	18.1	26.0	31.6	42.3	52.2	60.1	67.9	65.9	55.6	45.1	31.4	23.5	43.3
Helena													
Average Total Precipitation, Inches	0.66	0.44	0.69	1.01	1.72	2.01	1.04	1.18	0.83	0.65	0.54	0.60	11.4
Helena													
Average Wind Speed, mph													7.8

Notes: Data were based on a record period of 104 years, 1894 to 1998, for Butte FAA Airport unless noted otherwise

* Indicates data are based on a record period of 1 year, 1996, from onsite weather station

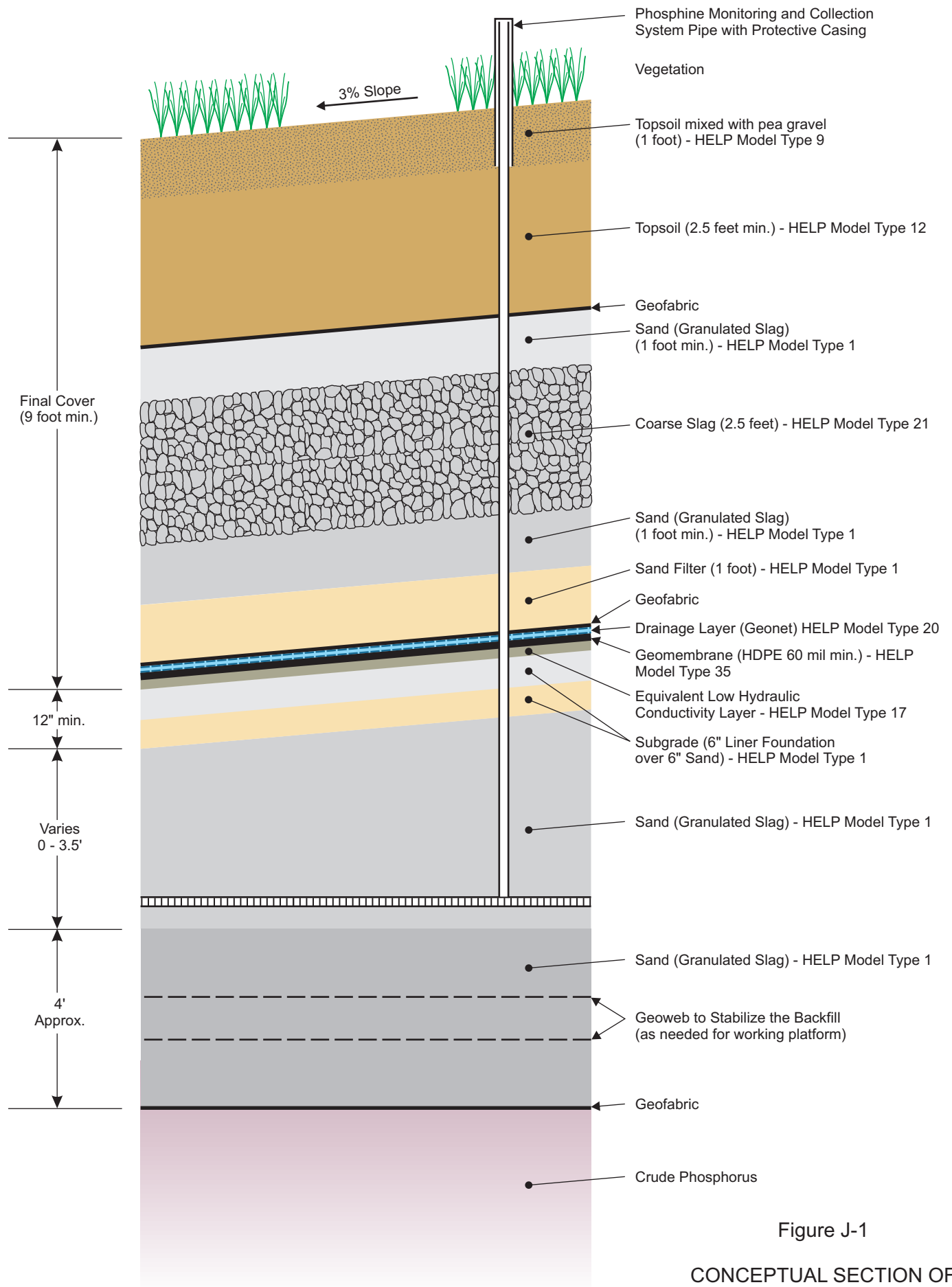


Figure J-1

CONCEPTUAL SECTION OF
ENHANCED RCRA CAP
Silver Bow Plant
Butte, Montana

Project: RHODIA SILVER BOW - # 26/46-004 JSL 200 Date: 7-30-99

Reported To: BARN ENGINEERING COMPANY Job No.: 3604

Boring No.	99-10	99-10	99-10		
Sample No.					
Depth (Ft)	1/2 - 6	1/2 - 6	6 - 12		
Type of Sample	BULK	BULK	BULK		
Soil Classification (ASTM: D2487/2488)	CLAYEY SAND w/ A TRACE OF GRAVEL (SC)				
Mechanical Analysis					
Dry Weight (Grams)					
Percent Passing					
Gravel 3"					
2"					
1"					
3/4"					
Sand #4					
#10					
#40					
#100					
#200					
Atterberg Limits					
Liquid Limit					
Plastic Limit					
Plasticity Index					
Moisture - Density					
Water Content (%)	3.6 *	25.8 **	33.2		
Dry Density (PCF)		100.6 #			
Unconfined Compression					
Maximum Load (psf)					
Hand Penetrometer (tsf)					
Organic Content (%)					
pH (Meter Method)					
Specific Gravity					
Resistivity (ohm-cm)					

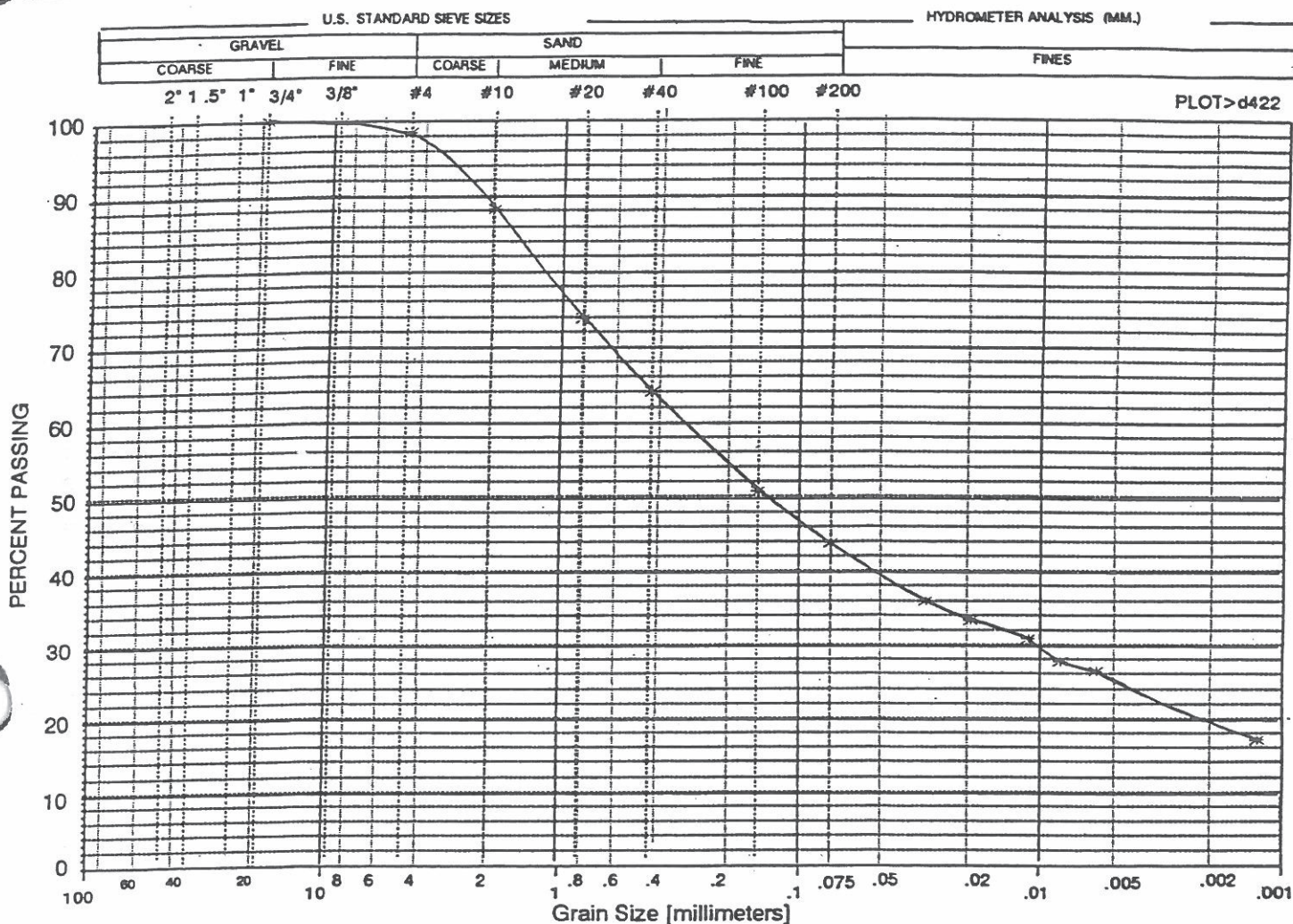
* AIR DRIED TO CONSTANT WEIGHT
FOR TWO WEEKS

** WATER HOLDING CAPACITY
INITIAL DRY DENSITY AT 12.4% W.C.
BEFORE SOAKING & GRAVITY DRAINING

REPORTED TO: Rhodia Silver Bow

Date: 7-19-99

Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
99-10		0.5-6.0	Bulk	Clayey sand w/a trace of gravel (SC)



OTHER TESTS

	x	+	□
Liquid Limit (%)	46.5		
Plastic Limit (%)	20.1		
Plasticity Index	26.4		
Water Content (%)	12.3		
Dry Density [pcf]			
Specific Gravity (°)	2.67*		
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

* Assumed Value

PERCENT PASSING

	x	+	□
Mass [gm]			
2"			
1-1/2"			
1"			
3/4"	100.0		
3/8"	99.7		
#4	98.5		
#10	88.3		
#20	73.8		
#40	64.1		
#100	50.7		
#200	43.9		

ASTM: D422 Sieve Set

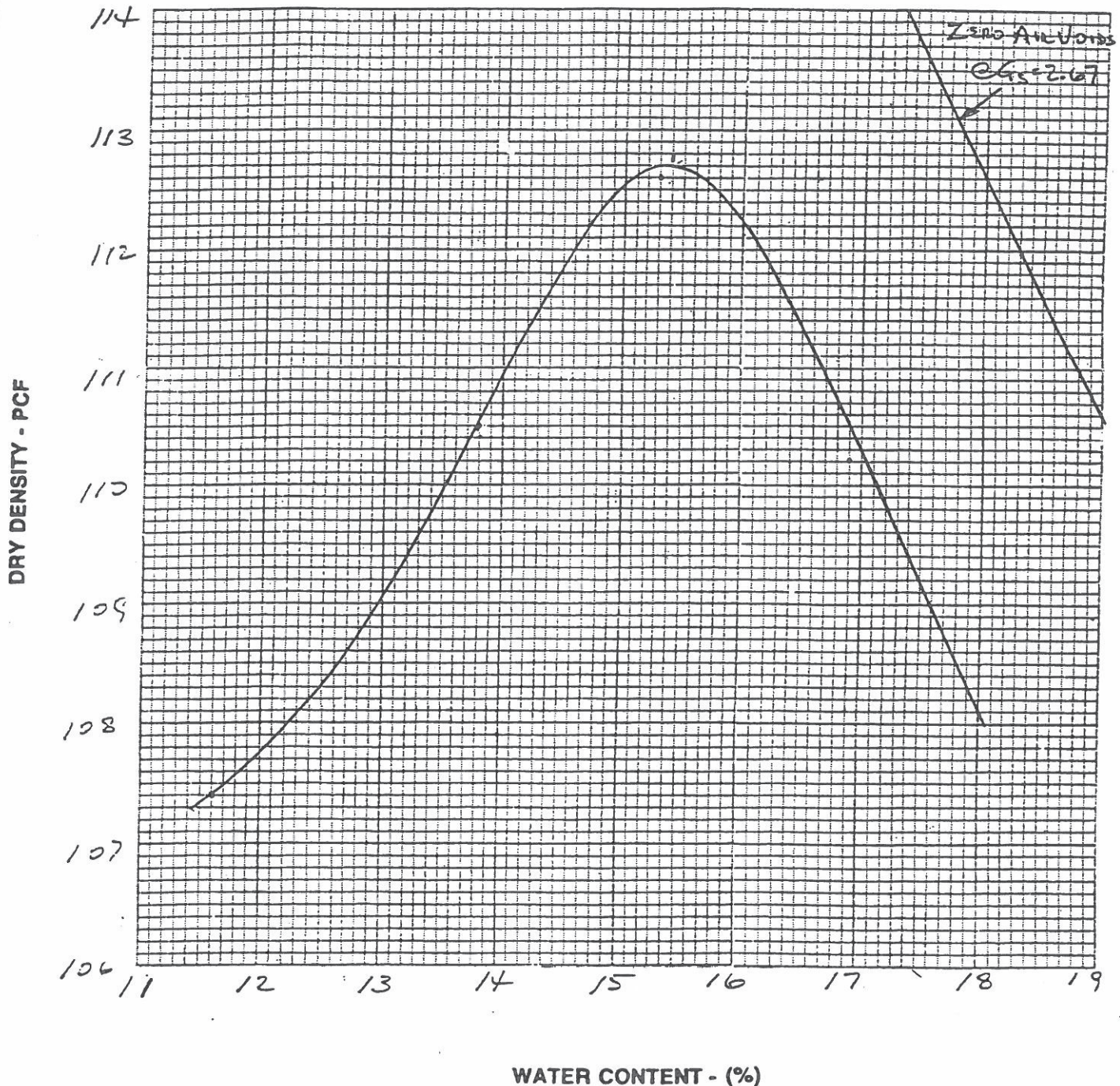
	x	+	□
D ₆₀			
D ₃₀			
D ₁₀			
C _u			
C _c			

Remarks:



MOISTURE - DENSITY CURVE

Project RHODIA SILVER BOW - #26/46-004 JSL 200 Date 7-16-99
 Reported To BAER ENGINEERING COMPANY Job No. 3604
 Boring No. 99-10 Sample No. _____ Depth (ft.) 1/2 - 6 Location _____
 Test Method ASTM: D 698, Procedure B
 Soil Description CLAYEY SAND w/ A TRACE OF GRAVEL (SC)
AS RECEIVED WATER CONTENT: 12.3% LL=46.5% PL=20.1% PI=26.4
 Maximum Dry Density 112.7 pcf Optimum Water Content 15.4 %



Permeability Test Data (Compacted Specimens)

Project: RHODIA SILVER BOW - # 26/46-004 JSL 200

Date: 7-23-99

Reported To: BARB ENGINEERING COMPANY

Job No.: 3604

Sample No./Designation	99-10				
Sample Type, Location Elevation or Depth	0 1/2' - 6'				
Soil Classification	CLAYY SAND W/ A TRACE OF GRAVEL (SC)				
In-Place Water Content (%)	12.3				
Moisture - Density Relation (ASTM: D698)					
Max Dry Density (PCF)	112.7				
Opt. Water Content (%)	15.4				
Atterberg Limits					
Liquid Limit	46.5				
Plastic Limit	20.1				
Plasticity Index	26.4				
Permeability Test					
% Saturation (After Test)	87.5*	* LOST WATER AFTER DISASSEMBLING DUE TO GRAVITY DRAINAGE			
Specimen Height (Inches)	3.00				
Specimen Diameter (Inches)	2.86				
Dry Density (PCF)	101.9				
% of Max. Density	90.4				
Water Content (%)	12.3				
Type of Test (Head)	Falling				
Max. Head Differential (Ft)	1.1				
Confining Pressure (Effective-PSI)	2.0				
Trial No.	12-16				
Water Temp. (°C)	23				
Coefficient of Permeability					
K @ 20°C (Cm/Sec)	4.2 x 10 ⁻⁵				
K @ 20°C (Ft/Min)	8.3 x 10 ⁻⁵				

Representative HELP Model

```
*****
*****
**
**
**
**      HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**      HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**      DEVELOPED BY ENVIRONMENTAL LABORATORY
**      USAE WATERWAYS EXPERIMENT STATION
**      FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
**
**
*****
*****
```

```
PRECIPITATION DATA FILE:  C:\HELP3\silver1.D4
TEMPERATURE DATA FILE:   C:\HELP3\silver2.D7
SOLAR RADIATION DATA FILE: C:\HELP3\silver3.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\silver4.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\silver7.D10
OUTPUT DATA FILE:        C:\HELP3\silver8.OUT
```

TIME: 14:23 DATE: 4/16/2015

```
*****
TITLE: Silver Bow Plant - Enhanced RCRA Cover
*****
```

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9
THICKNESS           = 12.00 INCHES
POROSITY             = 0.5010 VOL/VOL
FIELD CAPACITY       = 0.2840 VOL/VOL
WILTING POINT       = 0.1350 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2840 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.190000006000E-03 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 12
THICKNESS           = 30.00 INCHES
POROSITY             = 0.4710 VOL/VOL
FIELD CAPACITY       = 0.3420 VOL/VOL
WILTING POINT       = 0.2100 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3420 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.419999997000E-04 CM/SEC
```

LAYER 3 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS           = 12.00 INCHES
```

POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 30.00 INCHES
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3200 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000012000 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 12.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 12.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20
THICKNESS = 0.20 INCHES
POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC
SLOPE = 3.00 PERCENT
DRAINAGE LENGTH = 50.0 FEET

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY = 1.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 15.00 HOLES/ACRE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17
THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 6.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 11

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 6.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 12

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 42.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 13

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 48.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
FAIR STAND OF GRASS, A SURFACE SLOPE OF 3. %
AND A SLOPE LENGTH OF 50. FEET.

SCS RUNOFF CURVE NUMBER	=	83.50	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	0.180	ACRES
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	7.512	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	11.664	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	4.140	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	29.657	INCHES
TOTAL INITIAL WATER	=	29.657	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
HELENA MONTANA

STATION LATITUDE	=	45.82	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	138	
END OF GROWING SEASON (JULIAN DATE)	=	266	
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.61	0.56	0.81	1.03	1.89	2.27
1.30	1.11	1.12	0.80	0.62	0.59

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.60	22.60	29.20	39.10	47.70	55.70
63.30	61.70	51.90	42.10	29.40	20.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA
AND STATION LATITUDE = 45.82 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 8
DRAIN #1: LATERAL DRAINAGE FROM LAYER 7 (RECIRCULATION AND COLLECTION)

LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 9
LEAK #2: PERCOLATION OR LEAKAGE THROUGH LAYER 13

DAILY OUTPUT FOR YEAR 1

DAY	A	S O I I L	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.	HEAD #2 IN.	DRAIN #2 IN.	LEAK #2 IN.
1	*	*	0.00	0.000	0.000	0.3130	3.2905	3.980	.7552E-05	0.0000	.0000E+00	.7552E-05
2	*	*	0.00	0.000	0.000	0.3130	0.0175	.5933	.2439E-07	0.0000	.0000E+00	.3877E-05
3	*	*	0.00	0.000	0.000	0.3130	0.0096	.3263	.1704E-07	0.0000	.0000E+00	.4261E-05
4	*	*	0.00	0.000	0.000	0.3130	0.0066	.2239	.1408E-07	0.0000	.0000E+00	.0000E+00
5	*	*	0.00	0.000	0.000	0.3130	0.0050	.1693	.1246E-07	0.0000	.0000E+00	.0000E+00
6	*	*	0.00	0.000	0.000	0.3130	0.0040	.1354	.1142E-07	0.0000	.0000E+00	.0000E+00
7	*	*	0.00	0.000	0.000	0.3130	0.0033	.1124	.1071E-07	0.0000	.0000E+00	.0000E+00
8	*	*	0.00	0.000	0.000	0.3130	0.0028	.9571E-01	.1018E-07	0.0000	.0000E+00	.0000E+00
9	*	*	0.00	0.000	0.000	0.3130	0.0024	.8316E-01	.9780E-08	0.0000	.0000E+00	.0000E+00
10	*	*	0.00	0.000	0.000	0.3130	0.0022	.7337E-01	.9462E-08	0.0000	.0000E+00	.0000E+00
11	*	*	0.00	0.000	0.000	0.3130	0.0019	.6553E-01	.9205E-08	0.0000	.0000E+00	.0000E+00
12	*	*	0.00	0.000	0.000	0.3130	0.0017	.5912E-01	.8992E-08	0.0000	.0000E+00	.0000E+00
13	*	*	0.00	0.000	0.000	0.3130	0.0016	.5378E-01	.8813E-08	0.0000	.0000E+00	.0000E+00
14	*	*	0.03	0.000	0.015	0.3130	0.0015	.4928E-01	.8661E-08	0.0000	.0000E+00	.0000E+00
15	*	*	0.00	0.000	0.012	0.3130	0.0013	.4543E-01	.8530E-08	0.0000	.0000E+00	.0000E+00
16	*	*	0.00	0.000	0.002	0.3130	0.0012	.4211E-01	.8415E-08	0.0000	.0000E+00	.0000E+00
17	*	*	0.00	0.000	0.000	0.3130	0.0012	.3921E-01	.8315E-08	0.0000	.0000E+00	.0000E+00
18	*	*	0.00	0.000	0.000	0.3130	0.0011	.3666E-01	.8226E-08	0.0000	.0000E+00	.0000E+00
19	*	*	0.00	0.000	0.000	0.3130	0.0010	.3440E-01	.8147E-08	0.0000	.0000E+00	.0000E+00
20	*	*	0.01	0.000	0.007	0.3131	0.0010	.3239E-01	.8076E-08	0.0000	.0000E+00	.0000E+00
21	*	*	0.00	0.000	0.000	0.3131	0.0009	.3059E-01	.8012E-08	0.0000	.0000E+00	.0000E+00
22	*	*	0.00	0.000	0.000	0.3131	0.0009	.2896E-01	.7954E-08	0.0000	.0000E+00	.0000E+00
23	*	*	0.06	0.000	0.014	0.3150	0.0008	.2749E-01	.7901E-08	0.0000	.0000E+00	.0000E+00
24	*	*	0.11	0.004	0.015	0.3188	0.0008	.2615E-01	.7853E-08	0.0000	.0000E+00	.0000E+00
25	*	*	0.00	0.000	0.000	0.3188	0.0007	.2493E-01	.7809E-08	0.0000	.0000E+00	.0000E+00
26	*	*	0.00	0.000	0.000	0.3188	0.0007	.2381E-01	.7768E-08	0.0000	.0000E+00	.0000E+00
27	*	*	0.00	0.000	0.000	0.3188	0.0007	.2278E-01	.7730E-08	0.0000	.0000E+00	.0000E+00
28	*	*	0.00	0.000	0.000	0.3188	0.0006	.2183E-01	.7695E-08	0.0000	.0000E+00	.0000E+00
29	*	*	0.09	0.000	0.030	0.3188	0.0006	.2095E-01	.7663E-08	0.0000	.0000E+00	.0000E+00
30	*	*	0.01	0.000	0.036	0.3188	0.0006	.2013E-01	.7633E-08	0.0000	.0000E+00	.0000E+00
31	*	*	0.00	0.000	0.035	0.3188	0.0006	.1937E-01	.7604E-08	0.0000	.0000E+00	.0000E+00
32	*	*	0.00	0.000	0.000	0.3188	0.0005	.1867E-01	.7578E-08	0.0000	.0000E+00	.0000E+00
33	*	*	0.00	0.000	0.000	0.3188	0.0005	.1800E-01	.7553E-08	0.0000	.0000E+00	.0000E+00
34	*	*	0.02	0.000	0.020	0.3188	0.0005	.1739E-01	.7530E-08	0.0000	.0000E+00	.0000E+00
35	*	*	0.00	0.000	0.000	0.3188	0.0005	.1681E-01	.7508E-08	0.0000	.0000E+00	.0000E+00
36	*	*	0.00	0.000	0.000	0.3188	0.0005	.1626E-01	.7487E-08	0.0000	.0000E+00	.0000E+00
37	*	*	0.11	0.000	0.026	0.3188	0.0005	.1575E-01	.7468E-08	0.0000	.0000E+00	.0000E+00
38	*	*	0.00	0.001	0.039	0.3207	0.0004	.1526E-01	.7450E-08	0.0000	.0000E+00	.0000E+00
39	*	*	0.00	0.000	0.000	0.3207	0.0004	.1481E-01	.7432E-08	0.0000	.0000E+00	.0000E+00
40	*	*	0.00	0.000	0.000	0.3207	0.0004	.1437E-01	.7415E-08	0.0000	.0000E+00	.0000E+00
41	*	*	0.00	0.000	0.000	0.3207	0.0004	.1396E-01	.7400E-08	0.0000	.0000E+00	.0000E+00
42	*	*	0.05	0.000	0.014	0.3222	0.0004	.1358E-01	.7385E-08	0.0000	.0000E+00	.0000E+00
43	*	*	0.00	0.000	0.000	0.3222	0.0004	.1321E-01	.7371E-08	0.0000	.0000E+00	.0000E+00
44	*	*	0.00	0.000	0.000	0.3222	0.0004	.1286E-01	.7357E-08	0.0000	.0000E+00	.0000E+00
45	*	*	0.00	0.000	0.000	0.3222	0.0004	.1252E-01	.7344E-08	0.0000	.0000E+00	.0000E+00
46	*	*	0.00	0.000	0.000	0.3222	0.0004	.1220E-01	.7332E-08	0.0000	.0000E+00	.0000E+00
47	*	*	0.05	0.000	0.039	0.3222	0.0004	.1190E-01	.7320E-08	0.0000	.0000E+00	.0000E+00
48	*	*	0.00	0.000	0.011	0.3222	0.0003	.1161E-01	.7308E-08	0.0000	.0000E+00	.0000E+00
49	*	*	0.00	0.000	0.000	0.3222	0.0003	.1133E-01	.7298E-08	0.0000	.0000E+00	.0000E+00
50	*	*	0.00	0.000	0.000	0.3222	0.0003	.1107E-01	.7287E-08	0.0000	.0000E+00	.0000E+00
51	*	*	0.00	0.000	0.000	0.3222	0.0003	.1082E-01	.7277E-08	0.0000	.0000E+00	.0000E+00
52	*	*	0.00	0.000	0.000	0.3222	0.0003	.1057E-01	.7268E-08	0.0000	.0000E+00	.0000E+00
53	*	*	0.00	0.000	0.000	0.3222	0.0003	.1034E-01	.7258E-08	0.0000	.0000E+00	.0000E+00
54	*	*	0.05	0.000	0.027	0.3222	0.0003	.1012E-01	.7250E-08	0.0000	.0000E+00	.0000E+00
55	*	*	0.06	0.000	0.034	0.3222	0.0003	.9902E-02	.7241E-08	0.0000	.0000E+00	.0000E+00
56	*	*	0.13	0.000	0.028	0.3222	0.0003	.9695E-02	.7233E-08	0.0000	.0000E+00	.0000E+00
57	*	*	0.00	0.000	0.040	0.3222	0.0003	.9496E-02	.7225E-08	0.0000	.0000E+00	.0000E+00
58	*	*	0.00	0.000	0.052	0.3222	0.0003	.9305E-02	.7217E-08	0.0000	.0000E+00	.0000E+00
59	*	*	0.00	0.000	0.052	0.3222	0.0003	.9121E-02	.7210E-08	0.0000	.0000E+00	.0000E+00
60	*	*	0.05	0.000	0.037	0.3222	0.0003	.8943E-02	.7203E-08	0.0000	.0000E+00	.0000E+00
61	*	*	0.03	0.000	0.027	0.3222	0.0003	.8772E-02	.7196E-08	0.0000	.0000E+00	.0000E+00
62	*	*	0.00	0.000	0.022	0.3222	0.0003	.8607E-02	.7189E-08	0.0000	.0000E+00	.0000E+00
63	*	*	0.00	0.000	0.000	0.3222	0.0002	.8447E-02	.7183E-08	0.0000	.0000E+00	.0000E+00
64	*	*	0.00	0.000	0.000	0.3222	0.0002	.8293E-02	.7176E-08	0.0000	.0000E+00	.0000E+00
65	*	*	0.02	0.000	0.020	0.3222	0.0002	.8144E-02	.7170E-08	0.0000	.0000E+00	.0000E+00
66	*	*	0.00	0.000	0.000	0.3222	0.0002	.8000E-02	.7164E-08	0.0000	.0000E+00	.0000E+00
67	*	*	0.00	0.000	0.000	0.3222	0.0002	.7860E-02	.7159E-08	0.0000	.0000E+00	.0000E+00
68	*	*	0.00	0.000	0.000	0.3222	0.0002	.7725E-02	.7153E-08	0.0000	.0000E+00	.0000E+00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
	-----	-----	-----	-----	-----	-----

PRECIPITATION

TOTALS	0.65 1.31	0.48 0.98	0.85 1.27	1.11 0.83	1.92 0.57	2.04 0.54
STD. DEVIATIONS	0.36 0.67	0.31 0.47	0.46 0.68	0.58 0.42	0.84 0.35	0.73 0.36

RUNOFF

TOTALS	0.021 0.000	0.068 0.000	0.143 0.000	0.169 0.000	0.039 0.024	0.000 0.005
STD. DEVIATIONS	0.063 0.001	0.139 0.000	0.224 0.001	0.195 0.000	0.101 0.052	0.000 0.015

EVAPOTRANSPIRATION

TOTALS	0.460 2.075	0.401 0.970	0.456 0.861	0.843 0.558	2.294 0.325	2.510 0.332
STD. DEVIATIONS	0.182 1.024	0.192 0.432	0.159 0.315	0.292 0.230	0.402 0.142	0.560 0.161

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	0.2220 0.0065	0.0165 0.0067	0.0122 0.0061	0.0093 0.0050	0.0083 0.0041	0.0072 0.0044
STD. DEVIATIONS	1.1891 0.0127	0.0655 0.0144	0.0398 0.0125	0.0261 0.0077	0.0204 0.0058	0.0161 0.0062

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 13

TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.0036 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0198 0.0000	0.0001 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30				
	INCHES		CU. FEET	PERCENT
PRECIPITATION	12.55	(1.640)	8200.6	100.00
RUNOFF	0.469	(0.2806)	306.59	3.739
EVAPOTRANSPIRATION	12.085	(1.4404)	7896.15	96.287
LATERAL DRAINAGE COLLECTED FROM LAYER 7	0.30824	(1.39636)	201.407	2.45600
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000	(0.00000)	0.002	0.00002
AVERAGE HEAD ON TOP OF LAYER 8	0.000	(0.002)		
PERCOLATION/LEAKAGE THROUGH LAYER 13	0.00000	(0.00000)	0.002	0.00002
CHANGE IN WATER STORAGE	-0.312	(2.0617)	-203.54	-2.482

PEAK DAILY VALUES FOR YEARS	1 THROUGH	30
	(INCHES)	(CU. FT.)
PRECIPITATION	1.15	751.410
RUNOFF	0.708	462.3551
DRAINAGE COLLECTED FROM LAYER 7	3.97996	2600.50635
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000008	0.00493
AVERAGE HEAD ON TOP OF LAYER 8	3.291	
MAXIMUM HEAD ON TOP OF LAYER 8	2.906	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	12.2 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 13	0.000008	0.00493
SNOW WATER	1.84	1201.1409
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3474
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1725

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	3.9454	0.3288
2	8.9878	0.2996
3	0.5400	0.0450
4	0.9600	0.0320
5	0.5400	0.0450
6	0.5695	0.0475
7	0.0020	0.0100
8	0.0000	0.0000
9	0.1770	0.7500
10	0.2700	0.0450
11	0.2700	0.0450
12	1.8900	0.0450
13	2.1600	0.0450
SNOW WATER	0.000	

Deep Evapotranspiration Zone HELP Model

```
*****
*****
**
**
**
**      HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**      HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**      DEVELOPED BY ENVIRONMENTAL LABORATORY
**      USAE WATERWAYS EXPERIMENT STATION
**      FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
**
**
*****
*****
```

```
PRECIPITATION DATA FILE:  C:\HELP3\silver1.D4
TEMPERATURE DATA FILE:   C:\HELP3\silver2.D7
SOLAR RADIATION DATA FILE: C:\HELP3\silver3.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\silver4.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\silver7.D10
OUTPUT DATA FILE:        C:\HELP3\silver8.OUT
```

TIME: 14:32 DATE: 4/16/2015

```
*****
TITLE: Silver Bow Plant - Enhanced RCRA Cover
*****
```

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9
THICKNESS      = 12.00 INCHES
POROSITY       = 0.5010 VOL/VOL
FIELD CAPACITY = 0.2840 VOL/VOL
WILTING POINT  = 0.1350 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2840 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.190000006000E-03 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 12
THICKNESS      = 30.00 INCHES
POROSITY       = 0.4710 VOL/VOL
FIELD CAPACITY = 0.3420 VOL/VOL
WILTING POINT  = 0.2100 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3420 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.419999997000E-04 CM/SEC
```

LAYER 3 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS      = 12.00 INCHES
```

POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 30.00 INCHES
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3200 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000012000 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 12.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 12.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20
THICKNESS = 0.20 INCHES
POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC
SLOPE = 3.00 PERCENT
DRAINAGE LENGTH = 50.0 FEET

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL

POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 21

THICKNESS = 30.00 INCHES
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3200 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000012000 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 1

THICKNESS = 12.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 1

THICKNESS = 12.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER

MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 INCHES
POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC
SLOPE = 3.00 PERCENT
DRAINAGE LENGTH = 50.0 FEET

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY = 1.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 15.00 HOLES/ACRE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17
THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 6.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 11

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 6.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 12

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 42.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 13

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 48.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
FAIR STAND OF GRASS, A SURFACE SLOPE OF 3. %
AND A SLOPE LENGTH OF 50. FEET.

SCS RUNOFF CURVE NUMBER	=	83.50	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	0.180	ACRES
EVAPORATIVE ZONE DEPTH	=	42.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	13.668	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	20.142	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	7.920	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	29.657	INCHES
TOTAL INITIAL WATER	=	29.657	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
HELENA MONTANA

STATION LATITUDE	=	45.82 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
EVAPORATIVE ZONE DEPTH	=	42.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.61	0.56	0.81	1.03	1.89	2.27
1.30	1.11	1.12	0.80	0.62	0.59

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.60	22.60	29.20	39.10	47.70	55.70
63.30	61.70	51.90	42.10	29.40	20.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA
AND STATION LATITUDE = 45.82 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 8
DRAIN #1: LATERAL DRAINAGE FROM LAYER 7 (RECIRCULATION AND COLLECTION)

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
	-----	-----	-----	-----	-----	-----

PRECIPITATION

TOTALS	0.65 1.31	0.48 0.98	0.85 1.27	1.11 0.83	1.92 0.57	2.04 0.54
STD. DEVIATIONS	0.36 0.67	0.31 0.47	0.46 0.68	0.58 0.42	0.84 0.35	0.73 0.36

RUNOFF

TOTALS	0.019 0.000	0.060 0.000	0.128 0.000	0.137 0.000	0.032 0.022	0.000 0.004
STD. DEVIATIONS	0.056 0.001	0.123 0.000	0.210 0.001	0.171 0.000	0.083 0.048	0.000 0.014

EVAPOTRANSPIRATION

TOTALS	0.460 2.121	0.401 1.037	0.458 0.892	0.832 0.548	2.246 0.311	2.589 0.332
STD. DEVIATIONS	0.182 1.055	0.193 0.507	0.158 0.332	0.276 0.214	0.396 0.135	0.527 0.162

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	0.2227 0.0066	0.0170 0.0070	0.0125 0.0059	0.0095 0.0045	0.0084 0.0042	0.0073 0.0050
STD. DEVIATIONS	1.1890 0.0130	0.0657 0.0155	0.0401 0.0113	0.0264 0.0065	0.0207 0.0060	0.0164 0.0083

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 13

TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.0036 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0198 0.0000	0.0001 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30				
	INCHES		CU. FEET	PERCENT
PRECIPITATION	12.55	(1.640)	8200.6	100.00
RUNOFF	0.402	(0.2506)	262.80	3.205
EVAPOTRANSPIRATION	12.229	(1.6251)	7990.46	97.437
LATERAL DRAINAGE COLLECTED FROM LAYER 7	0.31040	(1.39695)	202.813	2.47315
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000	(0.00000)	0.002	0.00002
AVERAGE HEAD ON TOP OF LAYER 8	0.000	(0.002)		
PERCOLATION/LEAKAGE THROUGH LAYER 13	0.00000	(0.00000)	0.002	0.00002
CHANGE IN WATER STORAGE	-0.391	(2.4267)	-255.47	-3.115

PEAK DAILY VALUES FOR YEARS	1 THROUGH	30
	(INCHES)	(CU. FT.)
PRECIPITATION	1.15	751.410
RUNOFF	0.656	428.8822
DRAINAGE COLLECTED FROM LAYER 7	3.97996	2600.50635
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000008	0.00493
AVERAGE HEAD ON TOP OF LAYER 8	3.291	
MAXIMUM HEAD ON TOP OF LAYER 8	2.906	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	12.2 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 13	0.000008	0.00493
SNOW WATER	1.84	1201.1409
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3453
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1886

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	3.9837	0.3320
2	6.5839	0.2195
3	0.5400	0.0450
4	0.9600	0.0320
5	0.5400	0.0450
6	0.5508	0.0459
7	0.0020	0.0100
8	0.0000	0.0000
9	0.1770	0.7500
10	0.2700	0.0450
11	0.2700	0.0450
12	1.8900	0.0450
13	2.1600	0.0450
SNOW WATER	0.000	

Shallow Evapotranspiration Zone HELP Model

```
*****
*****
**
**
**
**      HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**      HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**      DEVELOPED BY ENVIRONMENTAL LABORATORY
**      USAE WATERWAYS EXPERIMENT STATION
**      FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
**
**
*****
*****
```

```
PRECIPITATION DATA FILE:  C:\HELP3\silver1.D4
TEMPERATURE DATA FILE:   C:\HELP3\silver2.D7
SOLAR RADIATION DATA FILE: C:\HELP3\silver3.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\silver4.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\silver7.D10
OUTPUT DATA FILE:        C:\HELP3\silver8.OUT
```

TIME: 14:34 DATE: 4/16/2015

```
*****
TITLE: Silver Bow Plant - Enhanced RCRA Cover
*****
```

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1 -----

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9

```
THICKNESS      = 12.00 INCHES
POROSITY       = 0.5010 VOL/VOL
FIELD CAPACITY = 0.2840 VOL/VOL
WILTING POINT  = 0.1350 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2840 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.190000006000E-03 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
      FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2 -----

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 12

```
THICKNESS      = 30.00 INCHES
POROSITY       = 0.4710 VOL/VOL
FIELD CAPACITY = 0.3420 VOL/VOL
WILTING POINT  = 0.2100 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3420 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.419999997000E-04 CM/SEC
```

LAYER 3 -----

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

```
THICKNESS      = 12.00 INCHES
```

POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 30.00 INCHES
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3200 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000012000 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 12.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 12.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20
THICKNESS = 0.20 INCHES
POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC
SLOPE = 3.00 PERCENT
DRAINAGE LENGTH = 50.0 FEET

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY = 1.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 15.00 HOLES/ACRE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17
THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 6.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 11

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 6.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 12

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 42.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 13

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 48.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
FAIR STAND OF GRASS, A SURFACE SLOPE OF 3. %
AND A SLOPE LENGTH OF 50. FEET.

SCS RUNOFF CURVE NUMBER	=	83.50	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	0.180	ACRES
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	4.092	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	6.954	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.040	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	29.657	INCHES
TOTAL INITIAL WATER	=	29.657	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
HELENA MONTANA

STATION LATITUDE	=	45.82 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
EVAPORATIVE ZONE DEPTH	=	14.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.61	0.56	0.81	1.03	1.89	2.27
1.30	1.11	1.12	0.80	0.62	0.59

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.60	22.60	29.20	39.10	47.70	55.70
63.30	61.70	51.90	42.10	29.40	20.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA
AND STATION LATITUDE = 45.82 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 8
DRAIN #1: LATERAL DRAINAGE FROM LAYER 7 (RECIRCULATION AND COLLECTION)

LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 9
LEAK #2: PERCOLATION OR LEAKAGE THROUGH LAYER 13

DAILY OUTPUT FOR YEAR 1

DAY	A	S	RAIN	RUNOFF	ET	E. ZONE	HEAD	DRAIN	LEAK	HEAD	DRAIN	LEAK
	I	I				WATER	#1	#1	#1	#2	#2	#2
	L	L	IN.	IN.	IN.	IN./IN.	IN.	IN.	IN.	IN.	IN.	IN.
1	*	*	0.00	0.000	0.000	0.2923	3.2905	3.980	.7552E-05	0.0000	.0000E+00	.7552E-05
2	*	*	0.00	0.000	0.000	0.2923	0.0175	.5933	.2439E-07	0.0000	.0000E+00	.3877E-05
3	*	*	0.00	0.000	0.000	0.2923	0.0096	.3263	.1704E-07	0.0000	.0000E+00	.4261E-05
4	*	*	0.00	0.000	0.000	0.2923	0.0066	.2239	.1408E-07	0.0000	.0000E+00	.0000E+00
5	*	*	0.00	0.000	0.000	0.2923	0.0050	.1693	.1246E-07	0.0000	.0000E+00	.0000E+00
6	*	*	0.00	0.000	0.000	0.2923	0.0040	.1354	.1142E-07	0.0000	.0000E+00	.0000E+00
7	*	*	0.00	0.000	0.000	0.2923	0.0033	.1124	.1071E-07	0.0000	.0000E+00	.0000E+00
8	*	*	0.00	0.000	0.000	0.2923	0.0028	.9571E-01	.1018E-07	0.0000	.0000E+00	.0000E+00
9	*	*	0.00	0.000	0.000	0.2923	0.0024	.8316E-01	.9780E-08	0.0000	.0000E+00	.0000E+00
10	*	*	0.00	0.000	0.000	0.2923	0.0022	.7337E-01	.9462E-08	0.0000	.0000E+00	.0000E+00
11	*	*	0.00	0.000	0.000	0.2923	0.0019	.6553E-01	.9205E-08	0.0000	.0000E+00	.0000E+00
12	*	*	0.00	0.000	0.000	0.2923	0.0017	.5912E-01	.8992E-08	0.0000	.0000E+00	.0000E+00
13	*	*	0.00	0.000	0.000	0.2923	0.0016	.5378E-01	.8813E-08	0.0000	.0000E+00	.0000E+00
14	*	*	0.03	0.000	0.015	0.2923	0.0015	.4928E-01	.8661E-08	0.0000	.0000E+00	.0000E+00
15	*	*	0.00	0.000	0.012	0.2923	0.0013	.4543E-01	.8530E-08	0.0000	.0000E+00	.0000E+00
16	*	*	0.00	0.000	0.002	0.2923	0.0012	.4211E-01	.8415E-08	0.0000	.0000E+00	.0000E+00
17	*	*	0.00	0.000	0.000	0.2923	0.0012	.3921E-01	.8315E-08	0.0000	.0000E+00	.0000E+00
18	*	*	0.00	0.000	0.000	0.2923	0.0011	.3666E-01	.8226E-08	0.0000	.0000E+00	.0000E+00
19	*	*	0.00	0.000	0.000	0.2923	0.0010	.3440E-01	.8147E-08	0.0000	.0000E+00	.0000E+00
20	*	*	0.01	0.000	0.007	0.2925	0.0010	.3239E-01	.8076E-08	0.0000	.0000E+00	.0000E+00
21	*	*	0.00	0.000	0.000	0.2925	0.0009	.3059E-01	.8012E-08	0.0000	.0000E+00	.0000E+00
22	*	*	0.00	0.000	0.000	0.2925	0.0009	.2896E-01	.7954E-08	0.0000	.0000E+00	.0000E+00
23	*	*	0.06	0.000	0.012	0.2959	0.0008	.2749E-01	.7901E-08	0.0000	.0000E+00	.0000E+00
24	*	*	0.11	0.004	0.012	0.3026	0.0008	.2615E-01	.7853E-08	0.0000	.0000E+00	.0000E+00
25	*	*	0.00	0.000	0.000	0.3026	0.0007	.2493E-01	.7809E-08	0.0000	.0000E+00	.0000E+00
26	*	*	0.00	0.000	0.000	0.3026	0.0007	.2381E-01	.7768E-08	0.0000	.0000E+00	.0000E+00
27	*	*	0.00	0.000	0.000	0.3026	0.0007	.2278E-01	.7730E-08	0.0000	.0000E+00	.0000E+00
28	*	*	0.00	0.000	0.000	0.3026	0.0006	.2183E-01	.7695E-08	0.0000	.0000E+00	.0000E+00
29	*	*	0.09	0.000	0.030	0.3026	0.0006	.2095E-01	.7663E-08	0.0000	.0000E+00	.0000E+00
30	*	*	0.01	0.000	0.036	0.3026	0.0006	.2013E-01	.7633E-08	0.0000	.0000E+00	.0000E+00
31	*	*	0.00	0.000	0.035	0.3026	0.0006	.1937E-01	.7604E-08	0.0000	.0000E+00	.0000E+00
32	*	*	0.00	0.000	0.000	0.3026	0.0005	.1867E-01	.7578E-08	0.0000	.0000E+00	.0000E+00
33	*	*	0.00	0.000	0.000	0.3026	0.0005	.1800E-01	.7553E-08	0.0000	.0000E+00	.0000E+00
34	*	*	0.02	0.000	0.020	0.3026	0.0005	.1739E-01	.7530E-08	0.0000	.0000E+00	.0000E+00
35	*	*	0.00	0.000	0.000	0.3026	0.0005	.1681E-01	.7508E-08	0.0000	.0000E+00	.0000E+00
36	*	*	0.00	0.000	0.000	0.3026	0.0005	.1626E-01	.7487E-08	0.0000	.0000E+00	.0000E+00
37	*	*	0.11	0.000	0.026	0.3026	0.0005	.1575E-01	.7468E-08	0.0000	.0000E+00	.0000E+00
38	*	*	0.00	0.001	0.039	0.3058	0.0004	.1526E-01	.7450E-08	0.0000	.0000E+00	.0000E+00
39	*	*	0.00	0.000	0.000	0.3058	0.0004	.1481E-01	.7432E-08	0.0000	.0000E+00	.0000E+00
40	*	*	0.00	0.000	0.000	0.3058	0.0004	.1437E-01	.7415E-08	0.0000	.0000E+00	.0000E+00
41	*	*	0.00	0.000	0.000	0.3058	0.0004	.1396E-01	.7400E-08	0.0000	.0000E+00	.0000E+00
42	*	*	0.05	0.000	0.012	0.3085	0.0004	.1358E-01	.7385E-08	0.0000	.0000E+00	.0000E+00
43	*	*	0.00	0.000	0.000	0.3085	0.0004	.1321E-01	.7371E-08	0.0000	.0000E+00	.0000E+00
44	*	*	0.00	0.000	0.000	0.3085	0.0004	.1286E-01	.7357E-08	0.0000	.0000E+00	.0000E+00
45	*	*	0.00	0.000	0.000	0.3085	0.0004	.1252E-01	.7344E-08	0.0000	.0000E+00	.0000E+00
46	*	*	0.00	0.000	0.000	0.3085	0.0004	.1220E-01	.7332E-08	0.0000	.0000E+00	.0000E+00
47	*	*	0.05	0.000	0.039	0.3085	0.0004	.1190E-01	.7320E-08	0.0000	.0000E+00	.0000E+00
48	*	*	0.00	0.000	0.011	0.3085	0.0003	.1161E-01	.7308E-08	0.0000	.0000E+00	.0000E+00
49	*	*	0.00	0.000	0.000	0.3085	0.0003	.1133E-01	.7298E-08	0.0000	.0000E+00	.0000E+00
50	*	*	0.00	0.000	0.000	0.3085	0.0003	.1107E-01	.7287E-08	0.0000	.0000E+00	.0000E+00
51	*	*	0.00	0.000	0.000	0.3085	0.0003	.1082E-01	.7277E-08	0.0000	.0000E+00	.0000E+00
52	*	*	0.00	0.000	0.000	0.3085	0.0003	.1057E-01	.7268E-08	0.0000	.0000E+00	.0000E+00
53	*	*	0.00	0.000	0.000	0.3085	0.0003	.1034E-01	.7258E-08	0.0000	.0000E+00	.0000E+00
54	*	*	0.05	0.000	0.027	0.3085	0.0003	.1012E-01	.7250E-08	0.0000	.0000E+00	.0000E+00
55	*	*	0.06	0.000	0.034	0.3085	0.0003	.9902E-02	.7241E-08	0.0000	.0000E+00	.0000E+00
56	*	*	0.13	0.000	0.028	0.3085	0.0003	.9695E-02	.7233E-08	0.0000	.0000E+00	.0000E+00
57	*	*	0.00	0.000	0.040	0.3085	0.0003	.9496E-02	.7225E-08	0.0000	.0000E+00	.0000E+00
58	*	*	0.00	0.000	0.052	0.3085	0.0003	.9305E-02	.7217E-08	0.0000	.0000E+00	.0000E+00
59	*	*	0.00	0.000	0.052	0.3085	0.0003	.9121E-02	.7210E-08	0.0000	.0000E+00	.0000E+00
60	*	*	0.05	0.000	0.037	0.3085	0.0003	.8943E-02	.7203E-08	0.0000	.0000E+00	.0000E+00
61	*	*	0.03	0.000	0.027	0.3085	0.0003	.8772E-02	.7196E-08	0.0000	.0000E+00	.0000E+00
62	*	*	0.00	0.000	0.022	0.3085	0.0003	.8607E-02	.7189E-08	0.0000	.0000E+00	.0000E+00
63	*	*	0.00	0.000	0.000	0.3085	0.0002	.8447E-02	.7183E-08	0.0000	.0000E+00	.0000E+00
64	*	*	0.00	0.000	0.000	0.3085	0.0002	.8293E-02	.7176E-08	0.0000	.0000E+00	.0000E+00
65	*	*	0.02	0.000	0.020	0.3085	0.0002	.8144E-02	.7170E-08	0.0000	.0000E+00	.0000E+00
66	*	*	0.00	0.000	0.000	0.3085	0.0002	.8000E-02	.7164E-08	0.0000	.0000E+00	.0000E+00
67	*	*	0.00	0.000	0.000	0.3085	0.0002	.7860E-02	.7159E-08	0.0000	.0000E+00	.0000E+00
68	*	*	0.00	0.000	0.000	0.3085	0.0002	.7725E-02	.7153E-08	0.0000	.0000E+00	.0000E+00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
	-----	-----	-----	-----	-----	-----

PRECIPITATION

TOTALS	0.65 1.31	0.48 0.98	0.85 1.27	1.11 0.83	1.92 0.57	2.04 0.54
STD. DEVIATIONS	0.36 0.67	0.31 0.47	0.46 0.68	0.58 0.42	0.84 0.35	0.73 0.36

RUNOFF

TOTALS	0.024 0.001	0.077 0.000	0.157 0.000	0.210 0.000	0.048 0.026	0.000 0.006
STD. DEVIATIONS	0.077 0.003	0.157 0.000	0.231 0.001	0.230 0.000	0.120 0.057	0.000 0.017

EVAPOTRANSPIRATION

TOTALS	0.460 1.770	0.399 0.922	0.446 0.916	0.963 0.709	2.195 0.409	2.383 0.340
STD. DEVIATIONS	0.182 0.836	0.192 0.476	0.160 0.420	0.402 0.288	0.574 0.136	0.610 0.159

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	0.2249 0.0102	0.0191 0.0104	0.0151 0.0094	0.0127 0.0079	0.0119 0.0070	0.0109 0.0075
STD. DEVIATIONS	1.1885 0.0136	0.0652 0.0153	0.0395 0.0125	0.0259 0.0082	0.0207 0.0072	0.0167 0.0079

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 13

TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.0036 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0198 0.0000	0.0001 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30				
	INCHES		CU. FEET	PERCENT
PRECIPITATION	12.55	(1.640)	8200.6	100.00
RUNOFF	0.549	(0.3125)	358.58	4.373
EVAPOTRANSPIRATION	11.912	(1.4294)	7783.11	94.909
LATERAL DRAINAGE COLLECTED FROM LAYER 7	0.34693	(1.38970)	226.683	2.76423
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000	(0.00000)	0.002	0.00002
AVERAGE HEAD ON TOP OF LAYER 8	0.000	(0.002)		
PERCOLATION/LEAKAGE THROUGH LAYER 13	0.00000	(0.00000)	0.002	0.00002
CHANGE IN WATER STORAGE	-0.257	(1.7698)	-167.77	-2.046

PEAK DAILY VALUES FOR YEARS	1 THROUGH	30
	(INCHES)	(CU. FT.)
PRECIPITATION	1.15	751.410
RUNOFF	0.741	484.0527
DRAINAGE COLLECTED FROM LAYER 7	3.97996	2600.50635
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000008	0.00493
AVERAGE HEAD ON TOP OF LAYER 8	3.291	
MAXIMUM HEAD ON TOP OF LAYER 8	2.906	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	12.2 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 13	0.000008	0.00493
SNOW WATER	1.84	1201.1409
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3481
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1457

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	3.9195	0.3266
2	9.9817	0.3327
3	0.6764	0.0564
4	1.1944	0.0398
5	0.7106	0.0592
6	0.7026	0.0585
7	0.0020	0.0100
8	0.0000	0.0000
9	0.1770	0.7500
10	0.2700	0.0450
11	0.2700	0.0450
12	1.8900	0.0450
13	2.1600	0.0450
SNOW WATER	0.000	

High Leaf Area HELP Model

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*****
**
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**
**      HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**      HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**      DEVELOPED BY ENVIRONMENTAL LABORATORY
**      USAE WATERWAYS EXPERIMENT STATION
**      FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
**
**
*****
*****
```

```
PRECIPITATION DATA FILE:  C:\HELP3\silver1.D4
TEMPERATURE DATA FILE:   C:\HELP3\silver2.D7
SOLAR RADIATION DATA FILE: C:\HELP3\silver3.D13
EVAPOTRANSPIRATION DATA:  C:\HELP3\silver4.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\silver7.D10
OUTPUT DATA FILE:        C:\HELP3\silver8.OUT
```

TIME: 14:36 DATE: 4/16/2015

```
*****
TITLE: Silver Bow Plant - Enhanced RCRA Cover
*****
```

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9
THICKNESS           = 12.00 INCHES
POROSITY             = 0.5010 VOL/VOL
FIELD CAPACITY       = 0.2840 VOL/VOL
WILTING POINT       = 0.1350 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2840 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.190000006000E-03 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.20
      FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 12
THICKNESS           = 30.00 INCHES
POROSITY             = 0.4710 VOL/VOL
FIELD CAPACITY       = 0.3420 VOL/VOL
WILTING POINT       = 0.2100 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3420 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.419999997000E-04 CM/SEC
```

LAYER 3 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS           = 12.00 INCHES
```


POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 30.00 INCHES
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3200 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000012000 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 12.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 12.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20
THICKNESS = 0.20 INCHES
POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC
SLOPE = 3.00 PERCENT
DRAINAGE LENGTH = 50.0 FEET

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY = 1.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 15.00 HOLES/ACRE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17
THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 6.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 11

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 6.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 12

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 42.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 13

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 48.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
FAIR STAND OF GRASS, A SURFACE SLOPE OF 3. %
AND A SLOPE LENGTH OF 50. FEET.

SCS RUNOFF CURVE NUMBER	=	83.50	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	0.180	ACRES
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	7.512	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	11.664	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	4.140	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	29.657	INCHES
TOTAL INITIAL WATER	=	29.657	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
HELENA MONTANA

STATION LATITUDE	=	45.82 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.00
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
EVAPORATIVE ZONE DEPTH	=	24.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.61	0.56	0.81	1.03	1.89	2.27
1.30	1.11	1.12	0.80	0.62	0.59

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.60	22.60	29.20	39.10	47.70	55.70
63.30	61.70	51.90	42.10	29.40	20.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA
AND STATION LATITUDE = 45.82 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 8
DRAIN #1: LATERAL DRAINAGE FROM LAYER 7 (RECIRCULATION AND COLLECTION)

LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 9
LEAK #2: PERCOLATION OR LEAKAGE THROUGH LAYER 13

DAILY OUTPUT FOR YEAR 1

DAY	A	S	RAIN	RUNOFF	ET	E. ZONE	HEAD	DRAIN	LEAK	HEAD	DRAIN	LEAK
	I	I				WATER	#1	#1	#1	#2	#2	#2
	R	L	IN.	IN.	IN.	IN./IN.	IN.	IN.	IN.	IN.	IN.	IN.
1	*	*	0.00	0.000	0.000	0.3130	3.2905	3.980	.7552E-05	0.0000	.0000E+00	.7552E-05
2	*	*	0.00	0.000	0.000	0.3130	0.0175	.5933	.2439E-07	0.0000	.0000E+00	.3877E-05
3	*	*	0.00	0.000	0.000	0.3130	0.0096	.3263	.1704E-07	0.0000	.0000E+00	.4261E-05
4	*	*	0.00	0.000	0.000	0.3130	0.0066	.2239	.1408E-07	0.0000	.0000E+00	.0000E+00
5	*	*	0.00	0.000	0.000	0.3130	0.0050	.1693	.1246E-07	0.0000	.0000E+00	.0000E+00
6	*	*	0.00	0.000	0.000	0.3130	0.0040	.1354	.1142E-07	0.0000	.0000E+00	.0000E+00
7	*	*	0.00	0.000	0.000	0.3130	0.0033	.1124	.1071E-07	0.0000	.0000E+00	.0000E+00
8	*	*	0.00	0.000	0.000	0.3130	0.0028	.9571E-01	.1018E-07	0.0000	.0000E+00	.0000E+00
9	*	*	0.00	0.000	0.000	0.3130	0.0024	.8316E-01	.9780E-08	0.0000	.0000E+00	.0000E+00
10	*	*	0.00	0.000	0.000	0.3130	0.0022	.7337E-01	.9462E-08	0.0000	.0000E+00	.0000E+00
11	*	*	0.00	0.000	0.000	0.3130	0.0019	.6553E-01	.9205E-08	0.0000	.0000E+00	.0000E+00
12	*	*	0.00	0.000	0.000	0.3130	0.0017	.5912E-01	.8992E-08	0.0000	.0000E+00	.0000E+00
13	*	*	0.00	0.000	0.000	0.3130	0.0016	.5378E-01	.8813E-08	0.0000	.0000E+00	.0000E+00
14	*	*	0.03	0.000	0.015	0.3130	0.0015	.4928E-01	.8661E-08	0.0000	.0000E+00	.0000E+00
15	*	*	0.00	0.000	0.012	0.3130	0.0013	.4543E-01	.8530E-08	0.0000	.0000E+00	.0000E+00
16	*	*	0.00	0.000	0.002	0.3130	0.0012	.4211E-01	.8415E-08	0.0000	.0000E+00	.0000E+00
17	*	*	0.00	0.000	0.000	0.3130	0.0012	.3921E-01	.8315E-08	0.0000	.0000E+00	.0000E+00
18	*	*	0.00	0.000	0.000	0.3130	0.0011	.3666E-01	.8226E-08	0.0000	.0000E+00	.0000E+00
19	*	*	0.00	0.000	0.000	0.3130	0.0010	.3440E-01	.8147E-08	0.0000	.0000E+00	.0000E+00
20	*	*	0.01	0.000	0.008	0.3131	0.0010	.3239E-01	.8076E-08	0.0000	.0000E+00	.0000E+00
21	*	*	0.00	0.000	0.000	0.3131	0.0009	.3059E-01	.8012E-08	0.0000	.0000E+00	.0000E+00
22	*	*	0.00	0.000	0.000	0.3131	0.0009	.2896E-01	.7954E-08	0.0000	.0000E+00	.0000E+00
23	*	*	0.06	0.000	0.018	0.3148	0.0008	.2749E-01	.7901E-08	0.0000	.0000E+00	.0000E+00
24	*	*	0.11	0.004	0.019	0.3185	0.0008	.2615E-01	.7853E-08	0.0000	.0000E+00	.0000E+00
25	*	*	0.00	0.000	0.000	0.3185	0.0007	.2493E-01	.7809E-08	0.0000	.0000E+00	.0000E+00
26	*	*	0.00	0.000	0.000	0.3185	0.0007	.2381E-01	.7768E-08	0.0000	.0000E+00	.0000E+00
27	*	*	0.00	0.000	0.000	0.3185	0.0007	.2278E-01	.7730E-08	0.0000	.0000E+00	.0000E+00
28	*	*	0.00	0.000	0.000	0.3185	0.0006	.2183E-01	.7695E-08	0.0000	.0000E+00	.0000E+00
29	*	*	0.09	0.000	0.030	0.3185	0.0006	.2095E-01	.7663E-08	0.0000	.0000E+00	.0000E+00
30	*	*	0.01	0.000	0.036	0.3185	0.0006	.2013E-01	.7633E-08	0.0000	.0000E+00	.0000E+00
31	*	*	0.00	0.000	0.035	0.3185	0.0006	.1937E-01	.7604E-08	0.0000	.0000E+00	.0000E+00
32	*	*	0.00	0.000	0.000	0.3185	0.0005	.1867E-01	.7578E-08	0.0000	.0000E+00	.0000E+00
33	*	*	0.00	0.000	0.000	0.3185	0.0005	.1800E-01	.7553E-08	0.0000	.0000E+00	.0000E+00
34	*	*	0.02	0.000	0.020	0.3185	0.0005	.1739E-01	.7530E-08	0.0000	.0000E+00	.0000E+00
35	*	*	0.00	0.000	0.000	0.3185	0.0005	.1681E-01	.7508E-08	0.0000	.0000E+00	.0000E+00
36	*	*	0.00	0.000	0.000	0.3185	0.0005	.1626E-01	.7487E-08	0.0000	.0000E+00	.0000E+00
37	*	*	0.11	0.000	0.026	0.3185	0.0005	.1575E-01	.7468E-08	0.0000	.0000E+00	.0000E+00
38	*	*	0.00	0.001	0.039	0.3203	0.0004	.1526E-01	.7450E-08	0.0000	.0000E+00	.0000E+00
39	*	*	0.00	0.000	0.000	0.3203	0.0004	.1481E-01	.7432E-08	0.0000	.0000E+00	.0000E+00
40	*	*	0.00	0.000	0.000	0.3203	0.0004	.1437E-01	.7415E-08	0.0000	.0000E+00	.0000E+00
41	*	*	0.00	0.000	0.000	0.3203	0.0004	.1396E-01	.7400E-08	0.0000	.0000E+00	.0000E+00
42	*	*	0.05	0.000	0.018	0.3217	0.0004	.1358E-01	.7385E-08	0.0000	.0000E+00	.0000E+00
43	*	*	0.00	0.000	0.000	0.3217	0.0004	.1321E-01	.7371E-08	0.0000	.0000E+00	.0000E+00
44	*	*	0.00	0.000	0.000	0.3217	0.0004	.1286E-01	.7357E-08	0.0000	.0000E+00	.0000E+00
45	*	*	0.00	0.000	0.000	0.3217	0.0004	.1252E-01	.7344E-08	0.0000	.0000E+00	.0000E+00
46	*	*	0.00	0.000	0.000	0.3217	0.0004	.1220E-01	.7332E-08	0.0000	.0000E+00	.0000E+00
47	*	*	0.05	0.000	0.039	0.3217	0.0004	.1190E-01	.7320E-08	0.0000	.0000E+00	.0000E+00
48	*	*	0.00	0.000	0.011	0.3217	0.0003	.1161E-01	.7308E-08	0.0000	.0000E+00	.0000E+00
49	*	*	0.00	0.000	0.000	0.3217	0.0003	.1133E-01	.7298E-08	0.0000	.0000E+00	.0000E+00
50	*	*	0.00	0.000	0.000	0.3217	0.0003	.1107E-01	.7287E-08	0.0000	.0000E+00	.0000E+00
51	*	*	0.00	0.000	0.000	0.3217	0.0003	.1082E-01	.7277E-08	0.0000	.0000E+00	.0000E+00
52	*	*	0.00	0.000	0.000	0.3217	0.0003	.1057E-01	.7268E-08	0.0000	.0000E+00	.0000E+00
53	*	*	0.00	0.000	0.000	0.3217	0.0003	.1034E-01	.7258E-08	0.0000	.0000E+00	.0000E+00
54	*	*	0.05	0.000	0.027	0.3217	0.0003	.1012E-01	.7250E-08	0.0000	.0000E+00	.0000E+00
55	*	*	0.06	0.000	0.034	0.3217	0.0003	.9902E-02	.7241E-08	0.0000	.0000E+00	.0000E+00
56	*	*	0.13	0.000	0.028	0.3217	0.0003	.9695E-02	.7233E-08	0.0000	.0000E+00	.0000E+00
57	*	*	0.00	0.000	0.040	0.3217	0.0003	.9496E-02	.7225E-08	0.0000	.0000E+00	.0000E+00
58	*	*	0.00	0.000	0.052	0.3217	0.0003	.9305E-02	.7217E-08	0.0000	.0000E+00	.0000E+00
59	*	*	0.00	0.000	0.052	0.3217	0.0003	.9121E-02	.7210E-08	0.0000	.0000E+00	.0000E+00
60	*	*	0.05	0.000	0.037	0.3217	0.0003	.8943E-02	.7203E-08	0.0000	.0000E+00	.0000E+00
61	*	*	0.03	0.000	0.027	0.3217	0.0003	.8772E-02	.7196E-08	0.0000	.0000E+00	.0000E+00
62	*	*	0.00	0.000	0.022	0.3217	0.0003	.8607E-02	.7189E-08	0.0000	.0000E+00	.0000E+00
63	*	*	0.00	0.000	0.000	0.3217	0.0002	.8447E-02	.7183E-08	0.0000	.0000E+00	.0000E+00
64	*	*	0.00	0.000	0.000	0.3217	0.0002	.8293E-02	.7176E-08	0.0000	.0000E+00	.0000E+00
65	*	*	0.02	0.000	0.020	0.3217	0.0002	.8144E-02	.7170E-08	0.0000	.0000E+00	.0000E+00
66	*	*	0.00	0.000	0.000	0.3217	0.0002	.8000E-02	.7164E-08	0.0000	.0000E+00	.0000E+00
67	*	*	0.00	0.000	0.000	0.3217	0.0002	.7860E-02	.7159E-08	0.0000	.0000E+00	.0000E+00
68	*	*	0.00	0.000	0.000	0.3217	0.0002	.7725E-02	.7153E-08	0.0000	.0000E+00	.0000E+00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.65 1.31	0.48 0.98	0.85 1.27	1.11 0.83	1.92 0.57	2.04 0.54
STD. DEVIATIONS	0.36 0.67	0.31 0.47	0.46 0.68	0.58 0.42	0.84 0.35	0.73 0.36
RUNOFF						
TOTALS	0.021 0.000	0.067 0.000	0.142 0.000	0.168 0.000	0.038 0.024	0.000 0.005
STD. DEVIATIONS	0.065 0.001	0.137 0.000	0.222 0.001	0.194 0.000	0.099 0.051	0.000 0.015
EVAPOTRANSPIRATION						
TOTALS	0.460 1.785	0.401 0.976	0.458 0.850	0.844 0.545	2.311 0.313	2.812 0.333
STD. DEVIATIONS	0.182 0.931	0.193 0.450	0.158 0.317	0.291 0.218	0.380 0.132	0.637 0.162
LATERAL DRAINAGE COLLECTED FROM LAYER 7						
TOTALS	0.2222 0.0066	0.0166 0.0069	0.0122 0.0059	0.0094 0.0047	0.0082 0.0042	0.0071 0.0046
STD. DEVIATIONS	1.1891 0.0130	0.0655 0.0150	0.0398 0.0114	0.0261 0.0069	0.0204 0.0058	0.0160 0.0067
PERCOLATION/LEAKAGE THROUGH LAYER 9						
TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 13						
TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)						
DAILY AVERAGE HEAD ON TOP OF LAYER 8						
AVERAGES	0.0036 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0198 0.0000	0.0001 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

```

*****
      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS      1 THROUGH  30
-----
              INCHES              CU. FEET              PERCENT
-----
PRECIPITATION      12.55      (  1.640)      8200.6      100.00
RUNOFF              0.465      (  0.2789)      303.94      3.706
EVAPOTRANSPIRATION  12.088      (  1.4317)      7898.10      96.311
LATERAL DRAINAGE COLLECTED
FROM LAYER  7      0.30868 (  1.39612)      201.691      2.45946
PERCOLATION/LEAKAGE THROUGH
LAYER  9          0.00000 (  0.00000)          0.002      0.00002
AVERAGE HEAD ON TOP
OF LAYER  8          0.000 (    0.002)
PERCOLATION/LEAKAGE THROUGH
LAYER 13          0.00000 (  0.00000)          0.002      0.00002
CHANGE IN WATER STORAGE      -0.311      (  2.0405)      -203.12      -2.477
*****

```

PEAK DAILY VALUES FOR YEARS	1 THROUGH	30
	(INCHES)	(CU. FT.)
PRECIPITATION	1.15	751.410
RUNOFF	0.703	459.0752
DRAINAGE COLLECTED FROM LAYER 7	3.97996	2600.50635
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000008	0.00493
AVERAGE HEAD ON TOP OF LAYER 8	3.291	
MAXIMUM HEAD ON TOP OF LAYER 8	2.906	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	12.2 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 13	0.000008	0.00493
SNOW WATER	1.84	1201.1409
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3465
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1725

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	3.8817	0.3235
2	9.0396	0.3013
3	0.5400	0.0450
4	0.9600	0.0320
5	0.5437	0.0453
6	0.5969	0.0497
7	0.0020	0.0100
8	0.0000	0.0000
9	0.1770	0.7500
10	0.2700	0.0450
11	0.2700	0.0450
12	1.8900	0.0450
13	2.1600	0.0450
SNOW WATER	0.000	

High Liner Defects HELP Model

```
*****
*****
**
**
**
**      HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**      HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**      DEVELOPED BY ENVIRONMENTAL LABORATORY
**      USAE WATERWAYS EXPERIMENT STATION
**      FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
**
**
*****
*****
```

```
PRECIPITATION DATA FILE:  C:\HELP3\silver1.D4
TEMPERATURE DATA FILE:   C:\HELP3\silver2.D7
SOLAR RADIATION DATA FILE: C:\HELP3\silver3.D13
EVAPOTRANSPIRATION DATA:  C:\HELP3\silver4.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\silver7.D10
OUTPUT DATA FILE:        C:\HELP3\silver8.OUT
```

TIME: 14:40 DATE: 4/16/2015

```
*****
TITLE: Silver Bow Plant - Enhanced RCRA Cover
*****
```

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9
THICKNESS           = 12.00 INCHES
POROSITY             = 0.5010 VOL/VOL
FIELD CAPACITY       = 0.2840 VOL/VOL
WILTING POINT       = 0.1350 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2840 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.190000006000E-03 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 12
THICKNESS           = 30.00 INCHES
POROSITY             = 0.4710 VOL/VOL
FIELD CAPACITY       = 0.3420 VOL/VOL
WILTING POINT       = 0.2100 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3420 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.419999997000E-04 CM/SEC
```

LAYER 3 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS           = 12.00 INCHES
```

POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 30.00 INCHES
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3200 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000012000 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 12.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 12.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20
THICKNESS = 0.20 INCHES
POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC
SLOPE = 3.00 PERCENT
DRAINAGE LENGTH = 50.0 FEET

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 30.00 HOLES/ACRE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17
THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 6.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 11

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 6.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 12

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 42.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 13

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 48.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
 SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
 FAIR STAND OF GRASS, A SURFACE SLOPE OF 3. %
 AND A SLOPE LENGTH OF 50. FEET.

SCS RUNOFF CURVE NUMBER	=	83.50	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	0.180	ACRES
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	7.512	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	11.664	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	4.140	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	29.657	INCHES
TOTAL INITIAL WATER	=	29.657	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
 HELENA MONTANA

STATION LATITUDE	=	45.82 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
EVAPORATIVE ZONE DEPTH	=	24.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.61	0.56	0.81	1.03	1.89	2.27
1.30	1.11	1.12	0.80	0.62	0.59

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.60	22.60	29.20	39.10	47.70	55.70
63.30	61.70	51.90	42.10	29.40	20.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR HELENA MONTANA
 AND STATION LATITUDE = 45.82 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 8
 DRAIN #1: LATERAL DRAINAGE FROM LAYER 7 (RECIRCULATION AND COLLECTION)

LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 9
LEAK #2: PERCOLATION OR LEAKAGE THROUGH LAYER 13

DAILY OUTPUT FOR YEAR 1

DAY	A	S	RAIN	RUNOFF	ET	E. ZONE	HEAD	DRAIN	LEAK	HEAD	DRAIN	LEAK
	I	I				WATER	#1	#1	#1	#2	#2	#2
	L	L	IN.	IN.	IN.	IN./IN.	IN.	IN.	IN.	IN.	IN.	IN.
1	*	*	0.00	0.000	0.000	0.3130	3.2905	3.980	.1473E-04	0.0000	.0000E+00	.3816E-05
2	*	*	0.00	0.000	0.000	0.3130	0.0175	.5933	.4198E-07	0.0000	.0000E+00	.4305E-05
3	*	*	0.00	0.000	0.000	0.3130	0.0096	.3263	.2727E-07	0.0000	.0000E+00	.0000E+00
4	*	*	0.00	0.000	0.000	0.3130	0.0066	.2239	.2136E-07	0.0000	.0000E+00	.0000E+00
5	*	*	0.00	0.000	0.000	0.3130	0.0050	.1693	.1811E-07	0.0000	.0000E+00	.3947E-05
6	*	*	0.00	0.000	0.000	0.3130	0.0040	.1354	.1605E-07	0.0000	.0000E+00	.5810E-05
7	*	*	0.00	0.000	0.000	0.3130	0.0033	.1124	.1461E-07	0.0000	.0000E+00	.5658E-05
8	*	*	0.00	0.000	0.000	0.3130	0.0028	.9571E-01	.1356E-07	0.0000	.0000E+00	.0000E+00
9	*	*	0.00	0.000	0.000	0.3130	0.0024	.8316E-01	.1276E-07	0.0000	.0000E+00	.0000E+00
10	*	*	0.00	0.000	0.000	0.3130	0.0022	.7337E-01	.1212E-07	0.0000	.0000E+00	.0000E+00
11	*	*	0.00	0.000	0.000	0.3130	0.0019	.6553E-01	.1161E-07	0.0000	.0000E+00	.0000E+00
12	*	*	0.00	0.000	0.000	0.3130	0.0017	.5912E-01	.1118E-07	0.0000	.0000E+00	.0000E+00
13	*	*	0.00	0.000	0.000	0.3130	0.0016	.5378E-01	.1082E-07	0.0000	.0000E+00	.0000E+00
14	*	*	0.03	0.000	0.015	0.3130	0.0015	.4928E-01	.1052E-07	0.0000	.0000E+00	.0000E+00
15	*	*	0.00	0.000	0.012	0.3130	0.0013	.4543E-01	.1026E-07	0.0000	.0000E+00	.0000E+00
16	*	*	0.00	0.000	0.002	0.3130	0.0012	.4211E-01	.1003E-07	0.0000	.0000E+00	.0000E+00
17	*	*	0.00	0.000	0.000	0.3130	0.0012	.3921E-01	.9827E-08	0.0000	.0000E+00	.0000E+00
18	*	*	0.00	0.000	0.000	0.3130	0.0011	.3666E-01	.9649E-08	0.0000	.0000E+00	.0000E+00
19	*	*	0.00	0.000	0.000	0.3130	0.0010	.3440E-01	.9491E-08	0.0000	.0000E+00	.0000E+00
20	*	*	0.01	0.000	0.007	0.3131	0.0010	.3239E-01	.9349E-08	0.0000	.0000E+00	.0000E+00
21	*	*	0.00	0.000	0.000	0.3131	0.0009	.3059E-01	.9221E-08	0.0000	.0000E+00	.0000E+00
22	*	*	0.00	0.000	0.000	0.3131	0.0009	.2896E-01	.9105E-08	0.0000	.0000E+00	.0000E+00
23	*	*	0.06	0.000	0.014	0.3150	0.0008	.2749E-01	.8999E-08	0.0000	.0000E+00	.0000E+00
24	*	*	0.11	0.004	0.015	0.3188	0.0008	.2615E-01	.8902E-08	0.0000	.0000E+00	.0000E+00
25	*	*	0.00	0.000	0.000	0.3188	0.0007	.2493E-01	.8814E-08	0.0000	.0000E+00	.0000E+00
26	*	*	0.00	0.000	0.000	0.3188	0.0007	.2381E-01	.8732E-08	0.0000	.0000E+00	.0000E+00
27	*	*	0.00	0.000	0.000	0.3188	0.0007	.2278E-01	.8657E-08	0.0000	.0000E+00	.0000E+00
28	*	*	0.00	0.000	0.000	0.3188	0.0006	.2183E-01	.8587E-08	0.0000	.0000E+00	.0000E+00
29	*	*	0.09	0.000	0.030	0.3188	0.0006	.2095E-01	.8522E-08	0.0000	.0000E+00	.0000E+00
30	*	*	0.01	0.000	0.036	0.3188	0.0006	.2013E-01	.8462E-08	0.0000	.0000E+00	.0000E+00
31	*	*	0.00	0.000	0.035	0.3188	0.0006	.1937E-01	.8405E-08	0.0000	.0000E+00	.0000E+00
32	*	*	0.00	0.000	0.000	0.3188	0.0005	.1867E-01	.8353E-08	0.0000	.0000E+00	.0000E+00
33	*	*	0.00	0.000	0.000	0.3188	0.0005	.1800E-01	.8303E-08	0.0000	.0000E+00	.0000E+00
34	*	*	0.02	0.000	0.020	0.3188	0.0005	.1739E-01	.8257E-08	0.0000	.0000E+00	.0000E+00
35	*	*	0.00	0.000	0.000	0.3188	0.0005	.1681E-01	.8213E-08	0.0000	.0000E+00	.0000E+00
36	*	*	0.00	0.000	0.000	0.3188	0.0005	.1626E-01	.8172E-08	0.0000	.0000E+00	.0000E+00
37	*	*	0.11	0.000	0.026	0.3188	0.0005	.1575E-01	.8133E-08	0.0000	.0000E+00	.0000E+00
38	*	*	0.00	0.001	0.039	0.3207	0.0004	.1526E-01	.8096E-08	0.0000	.0000E+00	.0000E+00
39	*	*	0.00	0.000	0.000	0.3207	0.0004	.1481E-01	.8061E-08	0.0000	.0000E+00	.0000E+00
40	*	*	0.00	0.000	0.000	0.3207	0.0004	.1437E-01	.8028E-08	0.0000	.0000E+00	.0000E+00
41	*	*	0.00	0.000	0.000	0.3207	0.0004	.1396E-01	.7996E-08	0.0000	.0000E+00	.0000E+00
42	*	*	0.05	0.000	0.014	0.3222	0.0004	.1358E-01	.7966E-08	0.0000	.0000E+00	.0000E+00
43	*	*	0.00	0.000	0.000	0.3222	0.0004	.1321E-01	.7938E-08	0.0000	.0000E+00	.0000E+00
44	*	*	0.00	0.000	0.000	0.3222	0.0004	.1286E-01	.7911E-08	0.0000	.0000E+00	.0000E+00
45	*	*	0.00	0.000	0.000	0.3222	0.0004	.1252E-01	.7885E-08	0.0000	.0000E+00	.0000E+00
46	*	*	0.00	0.000	0.000	0.3222	0.0004	.1220E-01	.7860E-08	0.0000	.0000E+00	.0000E+00
47	*	*	0.05	0.000	0.039	0.3222	0.0004	.1190E-01	.7836E-08	0.0000	.0000E+00	.0000E+00
48	*	*	0.00	0.000	0.011	0.3222	0.0003	.1161E-01	.7814E-08	0.0000	.0000E+00	.0000E+00
49	*	*	0.00	0.000	0.000	0.3222	0.0003	.1133E-01	.7792E-08	0.0000	.0000E+00	.0000E+00
50	*	*	0.00	0.000	0.000	0.3222	0.0003	.1107E-01	.7771E-08	0.0000	.0000E+00	.0000E+00
51	*	*	0.00	0.000	0.000	0.3222	0.0003	.1082E-01	.7751E-08	0.0000	.0000E+00	.0000E+00
52	*	*	0.00	0.000	0.000	0.3222	0.0003	.1057E-01	.7732E-08	0.0000	.0000E+00	.0000E+00
53	*	*	0.00	0.000	0.000	0.3222	0.0003	.1034E-01	.7714E-08	0.0000	.0000E+00	.0000E+00
54	*	*	0.05	0.000	0.027	0.3222	0.0003	.1012E-01	.7696E-08	0.0000	.0000E+00	.0000E+00
55	*	*	0.06	0.000	0.034	0.3222	0.0003	.9902E-02	.7679E-08	0.0000	.0000E+00	.0000E+00
56	*	*	0.13	0.000	0.028	0.3222	0.0003	.9695E-02	.7662E-08	0.0000	.0000E+00	.0000E+00
57	*	*	0.00	0.000	0.040	0.3222	0.0003	.9496E-02	.7646E-08	0.0000	.0000E+00	.0000E+00
58	*	*	0.00	0.000	0.052	0.3222	0.0003	.9305E-02	.7631E-08	0.0000	.0000E+00	.0000E+00
59	*	*	0.00	0.000	0.052	0.3222	0.0003	.9121E-02	.7616E-08	0.0000	.0000E+00	.0000E+00
60	*	*	0.05	0.000	0.037	0.3222	0.0003	.8943E-02	.7602E-08	0.0000	.0000E+00	.0000E+00
61	*	*	0.03	0.000	0.027	0.3222	0.0003	.8772E-02	.7588E-08	0.0000	.0000E+00	.0000E+00
62	*	*	0.00	0.000	0.022	0.3222	0.0003	.8607E-02	.7575E-08	0.0000	.0000E+00	.0000E+00
63	*	*	0.00	0.000	0.000	0.3222	0.0002	.8447E-02	.7562E-08	0.0000	.0000E+00	.0000E+00
64	*	*	0.00	0.000	0.000	0.3222	0.0002	.8293E-02	.7550E-08	0.0000	.0000E+00	.0000E+00
65	*	*	0.02	0.000	0.020	0.3222	0.0002	.8144E-02	.7537E-08	0.0000	.0000E+00	.0000E+00
66	*	*	0.00	0.000	0.000	0.3222	0.0002	.8000E-02	.7526E-08	0.0000	.0000E+00	.0000E+00
67	*	*	0.00	0.000	0.000	0.3222	0.0002	.7860E-02	.7514E-08	0.0000	.0000E+00	.0000E+00
68	*	*	0.00	0.000	0.000	0.3222	0.0002	.7725E-02	.7503E-08	0.0000	.0000E+00	.0000E+00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
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PRECIPITATION

TOTALS	0.65 1.31	0.48 0.98	0.85 1.27	1.11 0.83	1.92 0.57	2.04 0.54
STD. DEVIATIONS	0.36 0.67	0.31 0.47	0.46 0.68	0.58 0.42	0.84 0.35	0.73 0.36

RUNOFF

TOTALS	0.021 0.000	0.068 0.000	0.143 0.000	0.169 0.000	0.039 0.024	0.000 0.005
STD. DEVIATIONS	0.063 0.001	0.139 0.000	0.224 0.001	0.195 0.000	0.101 0.052	0.000 0.015

EVAPOTRANSPIRATION

TOTALS	0.460 2.075	0.401 0.970	0.456 0.861	0.843 0.558	2.294 0.325	2.510 0.332
STD. DEVIATIONS	0.182 1.024	0.192 0.432	0.159 0.315	0.292 0.230	0.402 0.142	0.560 0.161

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	0.2220 0.0065	0.0165 0.0067	0.0122 0.0061	0.0093 0.0050	0.0083 0.0041	0.0072 0.0044
STD. DEVIATIONS	1.1891 0.0127	0.0655 0.0144	0.0398 0.0125	0.0261 0.0077	0.0204 0.0058	0.0161 0.0062

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 13

TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.0036 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0198 0.0000	0.0001 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30				
	INCHES		CU. FEET	PERCENT
PRECIPITATION	12.55	(1.640)	8200.6	100.00
RUNOFF	0.469	(0.2806)	306.59	3.739
EVAPOTRANSPIRATION	12.085	(1.4404)	7896.15	96.287
LATERAL DRAINAGE COLLECTED FROM LAYER 7	0.30824	(1.39636)	201.407	2.45600
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000	(0.00000)	0.002	0.00002
AVERAGE HEAD ON TOP OF LAYER 8	0.000	(0.002)		
PERCOLATION/LEAKAGE THROUGH LAYER 13	0.00000	(0.00000)	0.002	0.00003
CHANGE IN WATER STORAGE	-0.312	(2.0617)	-203.54	-2.482

PEAK DAILY VALUES FOR YEARS	1 THROUGH	30
	(INCHES)	(CU. FT.)
PRECIPITATION	1.15	751.410
RUNOFF	0.708	462.3551
DRAINAGE COLLECTED FROM LAYER 7	3.97995	2600.50146
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000015	0.00963
AVERAGE HEAD ON TOP OF LAYER 8	3.291	
MAXIMUM HEAD ON TOP OF LAYER 8	2.906	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	12.2 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 13	0.000006	0.00380
SNOW WATER	1.84	1201.1409
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3474
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1725

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	3.9454	0.3288
2	8.9878	0.2996
3	0.5400	0.0450
4	0.9600	0.0320
5	0.5400	0.0450
6	0.5695	0.0475
7	0.0020	0.0100
8	0.0000	0.0000
9	0.1770	0.7500
10	0.2700	0.0450
11	0.2700	0.0450
12	1.8900	0.0450
13	2.1600	0.0450
SNOW WATER	0.000	

Ineffective Liner Soil HELP Model

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**      HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**      HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**      DEVELOPED BY ENVIRONMENTAL LABORATORY
**      USAE WATERWAYS EXPERIMENT STATION
**      FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
**
**
*****
*****
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```
PRECIPITATION DATA FILE:  C:\HELP3\silver1.D4
TEMPERATURE DATA FILE:   C:\HELP3\silver2.D7
SOLAR RADIATION DATA FILE: C:\HELP3\silver3.D13
EVAPOTRANSPIRATION DATA:  C:\HELP3\silver4.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\silver9.D10
OUTPUT DATA FILE:        C:\HELP3\silver8.OUT
```

TIME: 14:46 DATE: 4/16/2015

```
*****
TITLE: Silver Bow Plant - Enhanced RCRA Cover
*****
```

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9
THICKNESS           = 12.00 INCHES
POROSITY             = 0.5010 VOL/VOL
FIELD CAPACITY       = 0.2840 VOL/VOL
WILTING POINT       = 0.1350 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2840 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.190000006000E-03 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 12
THICKNESS           = 30.00 INCHES
POROSITY             = 0.4710 VOL/VOL
FIELD CAPACITY       = 0.3420 VOL/VOL
WILTING POINT       = 0.2100 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3420 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.419999997000E-04 CM/SEC
```

LAYER 3 -----

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS           = 12.00 INCHES
```

POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 30.00 INCHES
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3200 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000012000 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 12.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 12.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.99999978000E-02 CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20
THICKNESS = 0.20 INCHES
POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC
SLOPE = 3.00 PERCENT
DRAINAGE LENGTH = 50.0 FEET

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY = 1.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 15.00 HOLES/ACRE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16
THICKNESS = 0.24 INCHES
POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000001000E-06 CM/SEC

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 6.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 11

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 6.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 12

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 42.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

LAYER 13

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1
THICKNESS = 48.00 INCHES
POROSITY = 0.4170 VOL/VOL
FIELD CAPACITY = 0.0450 VOL/VOL
WILTING POINT = 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
FAIR STAND OF GRASS, A SURFACE SLOPE OF 3. %
AND A SLOPE LENGTH OF 50. FEET.

SCS RUNOFF CURVE NUMBER	=	83.50	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	0.180	ACRES
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	7.512	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	11.664	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	4.140	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	29.581	INCHES
TOTAL INITIAL WATER	=	29.581	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
HELENA MONTANA

STATION LATITUDE	=	45.82 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
EVAPORATIVE ZONE DEPTH	=	24.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.61	0.56	0.81	1.03	1.89	2.27
1.30	1.11	1.12	0.80	0.62	0.59

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.60	22.60	29.20	39.10	47.70	55.70
63.30	61.70	51.90	42.10	29.40	20.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA
AND STATION LATITUDE = 45.82 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 8
DRAIN #1: LATERAL DRAINAGE FROM LAYER 7 (RECIRCULATION AND COLLECTION)

LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 9
LEAK #2: PERCOLATION OR LEAKAGE THROUGH LAYER 13

DAILY OUTPUT FOR YEAR 1

DAY	A	S	RAIN	RUNOFF	ET	E. ZONE	HEAD	DRAIN	LEAK	HEAD	DRAIN	LEAK
	I	I				WATER	#1	#1	#1	#2	#2	#2
	L	L	IN.	IN.	IN.	IN./IN.	IN.	IN.	IN.	IN.	IN.	IN.
1	*	*	0.00	0.000	0.000	0.3130	3.2905	3.980	.1026E-03	0.0000	.0000E+00	.3817E-05
2	*	*	0.00	0.000	0.000	0.3130	0.0175	.5933	.2429E-06	0.0000	.0000E+00	.0000E+00
3	*	*	0.00	0.000	0.000	0.3130	0.0096	.3263	.1441E-06	0.0000	.0000E+00	.0000E+00
4	*	*	0.00	0.000	0.000	0.3130	0.0066	.2239	.1044E-06	0.0000	.0000E+00	.0000E+00
5	*	*	0.00	0.000	0.000	0.3130	0.0050	.1693	.8261E-07	0.0000	.0000E+00	.0000E+00
6	*	*	0.00	0.000	0.000	0.3130	0.0040	.1354	.6875E-07	0.0000	.0000E+00	.0000E+00
7	*	*	0.00	0.000	0.000	0.3130	0.0033	.1124	.5915E-07	0.0000	.0000E+00	.0000E+00
8	*	*	0.00	0.000	0.000	0.3130	0.0028	.9571E-01	.5210E-07	0.0000	.0000E+00	.0000E+00
9	*	*	0.00	0.000	0.000	0.3130	0.0024	.8316E-01	.4671E-07	0.0000	.0000E+00	.0000E+00
10	*	*	0.00	0.000	0.000	0.3130	0.0022	.7337E-01	.4244E-07	0.0000	.0000E+00	.0000E+00
11	*	*	0.00	0.000	0.000	0.3130	0.0019	.6553E-01	.3899E-07	0.0000	.0000E+00	.0000E+00
12	*	*	0.00	0.000	0.000	0.3130	0.0017	.5912E-01	.3614E-07	0.0000	.0000E+00	.0000E+00
13	*	*	0.00	0.000	0.000	0.3130	0.0016	.5378E-01	.3374E-07	0.0000	.0000E+00	.0000E+00
14	*	*	0.03	0.000	0.015	0.3130	0.0015	.4928E-01	.3170E-07	0.0000	.0000E+00	.0000E+00
15	*	*	0.00	0.000	0.012	0.3130	0.0013	.4543E-01	.2994E-07	0.0000	.0000E+00	.0000E+00
16	*	*	0.00	0.000	0.002	0.3130	0.0012	.4211E-01	.2841E-07	0.0000	.0000E+00	.0000E+00
17	*	*	0.00	0.000	0.000	0.3130	0.0012	.3921E-01	.2706E-07	0.0000	.0000E+00	.0000E+00
18	*	*	0.00	0.000	0.000	0.3130	0.0011	.3666E-01	.2587E-07	0.0000	.0000E+00	.0000E+00
19	*	*	0.00	0.000	0.000	0.3130	0.0010	.3440E-01	.2481E-07	0.0000	.0000E+00	.0000E+00
20	*	*	0.01	0.000	0.007	0.3131	0.0010	.3239E-01	.2386E-07	0.0000	.0000E+00	.0000E+00
21	*	*	0.00	0.000	0.000	0.3131	0.0009	.3059E-01	.2300E-07	0.0000	.0000E+00	.0000E+00
22	*	*	0.00	0.000	0.000	0.3131	0.0009	.2896E-01	.2222E-07	0.0000	.0000E+00	.3974E-05
23	*	*	0.06	0.000	0.014	0.3150	0.0008	.2749E-01	.2152E-07	0.0000	.0000E+00	.0000E+00
24	*	*	0.11	0.004	0.015	0.3188	0.0008	.2615E-01	.2087E-07	0.0000	.0000E+00	.0000E+00
25	*	*	0.00	0.000	0.000	0.3188	0.0007	.2493E-01	.2027E-07	0.0000	.0000E+00	.0000E+00
26	*	*	0.00	0.000	0.000	0.3188	0.0007	.2381E-01	.1973E-07	0.0000	.0000E+00	.0000E+00
27	*	*	0.00	0.000	0.000	0.3188	0.0007	.2278E-01	.1922E-07	0.0000	.0000E+00	.0000E+00
28	*	*	0.00	0.000	0.000	0.3188	0.0006	.2183E-01	.1875E-07	0.0000	.0000E+00	.0000E+00
29	*	*	0.09	0.000	0.030	0.3188	0.0006	.2095E-01	.1832E-07	0.0000	.0000E+00	.0000E+00
30	*	*	0.01	0.000	0.036	0.3188	0.0006	.2013E-01	.1792E-07	0.0000	.0000E+00	.0000E+00
31	*	*	0.00	0.000	0.035	0.3188	0.0006	.1937E-01	.1754E-07	0.0000	.0000E+00	.0000E+00
32	*	*	0.00	0.000	0.000	0.3188	0.0005	.1867E-01	.1718E-07	0.0000	.0000E+00	.0000E+00
33	*	*	0.00	0.000	0.000	0.3188	0.0005	.1800E-01	.1685E-07	0.0000	.0000E+00	.0000E+00
34	*	*	0.02	0.000	0.020	0.3188	0.0005	.1739E-01	.1654E-07	0.0000	.0000E+00	.0000E+00
35	*	*	0.00	0.000	0.000	0.3188	0.0005	.1681E-01	.1625E-07	0.0000	.0000E+00	.3032E-05
36	*	*	0.00	0.000	0.000	0.3188	0.0005	.1626E-01	.1597E-07	0.0000	.0000E+00	.3700E-05
37	*	*	0.11	0.000	0.026	0.3188	0.0005	.1575E-01	.1571E-07	0.0000	.0000E+00	.3756E-05
38	*	*	0.00	0.001	0.039	0.3207	0.0004	.1526E-01	.1546E-07	0.0000	.0000E+00	.1502E-04
39	*	*	0.00	0.000	0.000	0.3207	0.0004	.1481E-01	.1523E-07	0.0000	.0000E+00	.1501E-04
40	*	*	0.00	0.000	0.000	0.3207	0.0004	.1437E-01	.1501E-07	0.0000	.0000E+00	.1500E-04
41	*	*	0.00	0.000	0.000	0.3207	0.0004	.1396E-01	.1480E-07	0.0000	.0000E+00	.1499E-04
42	*	*	0.05	0.000	0.014	0.3222	0.0004	.1358E-01	.1460E-07	0.0000	.0000E+00	.4396E-05
43	*	*	0.00	0.000	0.000	0.3222	0.0004	.1321E-01	.1441E-07	0.0000	.0000E+00	.0000E+00
44	*	*	0.00	0.000	0.000	0.3222	0.0004	.1286E-01	.1422E-07	0.0000	.0000E+00	.0000E+00
45	*	*	0.00	0.000	0.000	0.3222	0.0004	.1252E-01	.1405E-07	0.0000	.0000E+00	.1049E-08
46	*	*	0.00	0.000	0.000	0.3222	0.0004	.1220E-01	.1388E-07	0.0000	.0000E+00	.6572E-08
47	*	*	0.05	0.000	0.039	0.3222	0.0004	.1190E-01	.1372E-07	0.0000	.0000E+00	.1260E-07
48	*	*	0.00	0.000	0.011	0.3222	0.0003	.1161E-01	.1357E-07	0.0000	.0000E+00	.5110E-05
49	*	*	0.00	0.000	0.000	0.3222	0.0003	.1133E-01	.1343E-07	0.0000	.0000E+00	.1502E-04
50	*	*	0.00	0.000	0.000	0.3222	0.0003	.1107E-01	.1329E-07	0.0000	.0000E+00	.5212E-05
51	*	*	0.00	0.000	0.000	0.3222	0.0003	.1082E-01	.1315E-07	0.0000	.0000E+00	.0000E+00
52	*	*	0.00	0.000	0.000	0.3222	0.0003	.1057E-01	.1303E-07	0.0000	.0000E+00	.0000E+00
53	*	*	0.00	0.000	0.000	0.3222	0.0003	.1034E-01	.1290E-07	0.0000	.0000E+00	.0000E+00
54	*	*	0.05	0.000	0.027	0.3222	0.0003	.1012E-01	.1278E-07	0.0000	.0000E+00	.0000E+00
55	*	*	0.06	0.000	0.034	0.3222	0.0003	.9902E-02	.1267E-07	0.0000	.0000E+00	.0000E+00
56	*	*	0.13	0.000	0.028	0.3222	0.0003	.9695E-02	.1256E-07	0.0000	.0000E+00	.0000E+00
57	*	*	0.00	0.000	0.040	0.3222	0.0003	.9496E-02	.1245E-07	0.0000	.0000E+00	.0000E+00
58	*	*	0.00	0.000	0.052	0.3222	0.0003	.9305E-02	.1235E-07	0.0000	.0000E+00	.0000E+00
59	*	*	0.00	0.000	0.052	0.3222	0.0003	.9121E-02	.1225E-07	0.0000	.0000E+00	.0000E+00
60	*	*	0.05	0.000	0.037	0.3222	0.0003	.8943E-02	.1215E-07	0.0000	.0000E+00	.0000E+00
61	*	*	0.03	0.000	0.027	0.3222	0.0003	.8772E-02	.1206E-07	0.0000	.0000E+00	.0000E+00
62	*	*	0.00	0.000	0.022	0.3222	0.0003	.8607E-02	.1197E-07	0.0000	.0000E+00	.0000E+00
63	*	*	0.00	0.000	0.000	0.3222	0.0002	.8447E-02	.1189E-07	0.0000	.0000E+00	.0000E+00
64	*	*	0.00	0.000	0.000	0.3222	0.0002	.8293E-02	.1180E-07	0.0000	.0000E+00	.0000E+00
65	*	*	0.02	0.000	0.020	0.3222	0.0002	.8144E-02	.1172E-07	0.0000	.0000E+00	.0000E+00
66	*	*	0.00	0.000	0.000	0.3222	0.0002	.8000E-02	.1164E-07	0.0000	.0000E+00	.0000E+00
67	*	*	0.00	0.000	0.000	0.3222	0.0002	.7860E-02	.1157E-07	0.0000	.0000E+00	.0000E+00
68	*	*	0.00	0.000	0.000	0.3222	0.0002	.7725E-02	.1149E-07	0.0000	.0000E+00	.0000E+00

MONTHLY TOTALS (IN INCHES) FOR YEAR 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.37 1.27	0.30 1.98	1.01 1.65	1.01 1.24	1.64 1.31	3.48 0.59
RUNOFF	0.000 0.000	0.000 0.000	0.080 0.000	0.235 0.000	0.000 0.149	0.001 0.029
EVAPOTRANSPIRATION	0.420 2.494	0.301 1.933	0.550 0.943	0.595 0.605	2.112 0.353	2.883 0.444
LATERAL DRAINAGE COLLECTED FROM LAYER 7	0.0009 0.0008	0.0008 0.0008	0.0008 0.0008	0.0008 0.0004	0.0007 0.0003	0.0007 0.0004
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 13	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 8	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 8	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000

ANNUAL TOTALS FOR YEAR 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.85	10356.391	100.00
RUNOFF	0.494	322.693	3.12
EVAPOTRANSPIRATION	13.633	8907.828	86.01
DRAINAGE COLLECTED FROM LAYER 7	0.0082	5.367	0.05
PERC./LEAKAGE THROUGH LAYER 9	0.000002	0.002	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
PERC./LEAKAGE THROUGH LAYER 13	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	1.715	1120.498	10.82
SOIL WATER AT START OF YEAR	18.470	12067.989	
SOIL WATER AT END OF YEAR	20.235	13221.851	
SNOW WATER AT START OF YEAR	0.051	33.364	0.32
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.004	0.00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
	-----	-----	-----	-----	-----	-----

PRECIPITATION

TOTALS	0.65 1.31	0.48 0.98	0.85 1.27	1.11 0.83	1.92 0.57	2.04 0.54
STD. DEVIATIONS	0.36 0.67	0.31 0.47	0.46 0.68	0.58 0.42	0.84 0.35	0.73 0.36

RUNOFF

TOTALS	0.021 0.000	0.068 0.000	0.143 0.000	0.169 0.000	0.039 0.024	0.000 0.005
STD. DEVIATIONS	0.063 0.001	0.139 0.000	0.224 0.001	0.195 0.000	0.101 0.052	0.000 0.015

EVAPOTRANSPIRATION

TOTALS	0.460 2.075	0.401 0.970	0.456 0.861	0.843 0.558	2.294 0.325	2.510 0.332
STD. DEVIATIONS	0.182 1.024	0.192 0.432	0.159 0.315	0.292 0.230	0.402 0.142	0.560 0.161

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	0.2219 0.0065	0.0165 0.0067	0.0122 0.0061	0.0093 0.0050	0.0083 0.0041	0.0072 0.0044
STD. DEVIATIONS	1.1891 0.0127	0.0655 0.0144	0.0398 0.0125	0.0261 0.0077	0.0204 0.0058	0.0161 0.0062

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 13

TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.0036 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0198 0.0000	0.0001 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30				
	INCHES		CU. FEET	PERCENT
PRECIPITATION	12.55	(1.640)	8200.6	100.00
RUNOFF	0.469	(0.2806)	306.59	3.739
EVAPOTRANSPIRATION	12.085	(1.4404)	7896.15	96.287
LATERAL DRAINAGE COLLECTED FROM LAYER 7	0.30824	(1.39634)	201.405	2.45597
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00001	(0.00002)	0.004	0.00005
AVERAGE HEAD ON TOP OF LAYER 8	0.000	(0.002)		
PERCOLATION/LEAKAGE THROUGH LAYER 13	0.00001	(0.00002)	0.004	0.00005
CHANGE IN WATER STORAGE	-0.312	(2.0617)	-203.54	-2.482

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30		
	(INCHES)	(CU. FT.)
PRECIPITATION	1.15	751.410
RUNOFF	0.708	462.3551
DRAINAGE COLLECTED FROM LAYER 7	3.97987	2600.44458
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000103	0.06704
AVERAGE HEAD ON TOP OF LAYER 8	3.290	
MAXIMUM HEAD ON TOP OF LAYER 8	2.906	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	12.2 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 13	0.000015	0.00981
SNOW WATER	1.84	1201.1409
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3474
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1725

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

FINAL WATER STORAGE AT END OF YEAR 30		
LAYER	(INCHES)	(VOL/VOL)

-----	-----	-----
1	3.9454	0.3288
2	8.9878	0.2996
3	0.5400	0.0450
4	0.9600	0.0320
5	0.5400	0.0450
6	0.5695	0.0475
7	0.0020	0.0100
8	0.0000	0.0000
9	0.1008	0.4270
10	0.2700	0.0450
11	0.2700	0.0450
12	1.8900	0.0450
13	2.1600	0.0450
SNOW WATER	0.000	

Appendix K

Predictive Groundwater Quality Evaluation

Appendix K

Predictive Groundwater Quality Evaluation Supplemental Waste Plan

Three approaches to the evaluation are presented in order to provide a more comprehensive picture than any single approach would provide. The three approaches are: 1) Partition Model - modeling using estimated leachate quality based on the constituent concentrations calculated for the clarifier material; 2) Leachate Model - modeling using leachate quality estimates based on measured data (TCLP); and 3) Solids Concentration – modeling using target groundwater quality to estimate the acceptable concentrations in the crude phosphorus. All three approaches have two elements in common. The first common element is use of the HELP model to estimate the rate of infiltration/percolation through the enhanced cap. The HELP model results for the enhanced cap and evapotranspiration cap are presented in Appendix J and Appendix Q, respectively. The second common element is use of an EPA screening model to represent the interactions between infiltration/percolation and groundwater. The EPA model is presented in “Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites,” peer review draft, dated March 2001, p. 4-24 (EPA 2001). For simplicity, this model will be referred to as the SSL model, or more generically as predictive groundwater modeling calculations.

Crude Phosphorus

This section describes the three approaches regarding leaching of metals from crude phosphorus.

Partition Model

The partition model involves two steps:

- 1) Estimating the concentrations of metals in the clarifier materials. The mass balance is summarized in Table K-1 and additional information concerning the mass balance analysis is presented in Attachment 1. The calculated crude phosphorus concentrations are shown in Table K-2, and repeated for the reader’s convenience in Table K-3 and K-4.
- 2) Applying the SSL model to estimate leachate concentrations and resultant groundwater concentrations.

In this application, the SSL model uses total metals concentrations to produce a conservative equilibrium estimate of leachate quality. The model then blends the leachate with the groundwater

flow beneath the clarifier. The model makes conservative simplifying assumptions. The SSL guidance identifies a number of simplifying assumptions for the migration to groundwater pathway calculation. Some of the simplifying assumptions of note for this application include:

- Infinite source (the source is not diminished over time as mass leaches out, and the model is two-dimensional, so the source is considered to be infinitely wide)
- Uniformly distributed contamination from the surface to the top of the aquifer
- No contaminant attenuation in soil
- Instantaneous and linear equilibrium soil/water partitioning.

Because the SSL model is two-dimensional it provides an estimate of the conditions along the widest point of the clarifier, rather than accounting for its circular shape. The model uses a simple linear equilibrium solid/liquid partition equation to estimate the equilibrium leachate concentrations (SSL Equation 10 [EPA 2001]). The equation is as follows:

$$C_L = \frac{C_{CP}}{K_D + \frac{\Theta_w + \Theta_a H^1}{\rho_b}}$$

Where: C_L = Equilibrium leachate concentration [mg/L]

C_{CP} = Concentration in crude phosphorus [mg/kg]

K_D = Soil-water partition coefficient [L/kg]

Θ_w = Water-filled soil porosity

Θ_a = Air-filled soil porosity

H^1 = Dimensionless Henry's Law constant

ρ_b = Bulk density of crude phosphorus

For most constituents, the SSL model guidance provides the necessary partition coefficients. In the case of lead, a supplementary document "Understanding Variation in Partition Coefficient, K_d , Values" (EPA, 1999) was used for this modeling. A pH of 6.0 was used in selecting partition coefficients for the SSL model because elemental phosphorus in water naturally tends to that pH.

The equilibrium leachate concentrations calculated from the crude phosphorus metals concentrations for the enhanced RCRA cap and the evapotranspiration cap are shown in the third column of Table K-3 and Table K-4, respectively.

These equilibrium leachate concentrations can then be used in the groundwater mixing model to estimate the potential groundwater concentrations. A site-specific dilution and attenuation (DAF) factor is applied to the leachate concentration to reflect the mixing with the underlying groundwater unit. The site-specific DAF was calculated according to the following equation (Equation 4-11 in EPA 2001):

Where: DAF = Dilution attenuation factor (unitless)

$$DAF = 1 + \frac{K \times i \times d}{I \times L}$$

- K = Aquifer hydraulic conductivity (1 ft/day); based on the geometric mean of the slug test results for the monitoring wells near the clarifier (Barr 2013)
- i = Hydraulic gradient (0.006 ft/ft); based on groundwater levels in nearby well in fall 2013.
- d = mixing zone depth (11 ft)
- I = Infiltration Rate (enhanced cap: 0.000006 inches/yr; evapotranspiration cap: 0.014 inches/yr)
- L = Source length parallel to groundwater flow (100 ft)

Equation 12 (EPA 2001) was used to estimate the mixing zone depth (d) based on the site-specific groundwater parameters:

$$d = \sqrt{0.112 L^2} + d_a(1 - e^{\left(\frac{-L \times I}{K \times i \times d_a}\right)})$$

- Where: d = Mixing zone depth (ft)
- L = Source length parallel to groundwater flow (100 ft)
- I = Infiltration rate (same as above)
- K = Aquifer hydraulic conductivity (same as above)
- i = Hydraulic gradient (same as above)
- d_a = Aquifer Thickness (300 ft)

The predicted groundwater concentrations based on the enhanced cap and evapotranspiration cap are shown in the fourth column of Table K-3 and Table K-4, respectively. These concentrations can be compared to MCLs or to DEQ-7 Montana groundwater standards, shown in the fifth and sixth columns of the respective tables. This comparison confirms that there would be no exceedances of groundwater quality due to leachate from the crude phosphorus contained in a capped clarifier.

The SSL groundwater concentration estimates, based on the conservative simplifying assumptions of the SSL model, are generally more than a factor of 10 lower than groundwater quality standards. The estimated concentrations for many of the parameters are more than a factor of 100 lower than groundwater quality standards.

Leachate Model

Another way to apply the SSL model is to use measured leachate quality rather than the very conservative linear estimation methods supplied with the model. The SSL guidance suggests the synthetic precipitation leaching procedure (SPLP) can be used to estimate the concentration in the leachate (EPA, 2001). This approach of measuring the quality of a laboratory-generated leachate can be a better indicator of actual leachate constituent concentrations in that it inherently accounts for natural mechanisms that inhibit dissolution and tests the leaching behavior of the actual material in question.

Although SPLP data is not available for the clarifier contents, data from another leaching procedure, the Toxicity Characteristic Leaching Procedure (TCLP) (EPA Method 1311), is available. It is reasonable to use TCLP to represent a conservative estimate of leachate quality for the crude phosphorus material. TCLP was designed by EPA to determine the leachability of organic and inorganic analytes present in liquid, solid and multiphasic wastes. See e.g., 51 FR at 21653 (June 13, 1986,) (proposed TCLP Rule). The TCLP method uses an aggressive, low pH-leaching agent (typically pH 4.93) that simulates waste leaching from a municipal landfill. This is a more aggressive (*i.e.*, more conservative) approach than use SPLP or other procedures that simulate more neutral pH environments. It should be noted that leachate from the crude phosphorus is expected to be on the acidic side of neutral because the pH naturally tends to 6.0 when water is in contact with elemental phosphorus.

TCLP results represent a high-end dissolved concentration for the crude phosphorus, for the primary parameters of concern, except chromium. Solvay conducted a sensitivity analysis using the SSL model equilibrium relationships for the metals parameters. This was done by varying the pH between

5.0 and 8.0 and calculating change in equilibrium concentrations. This analysis is presented in Attachment 1 of this appendix. The sensitivity analysis demonstrates that arsenic, barium, cadmium, lead and silver concentrations should increase as the pH is lowered (i.e., more acidic conditions). Conversely, chromium and selenium concentrations are expected to decrease as the pH is lowered. Of those two metals, chromium but not selenium has been identified as a potential contaminant of concern. The sensitivity analysis results mean that groundwater modeling based on TCLP results would potentially over-predict potential groundwater contamination for arsenic, barium, cadmium, lead and silver. The TCLP results could potentially underestimate potential groundwater concentrations for chromium and selenium. However, as seen in the results in Table K-3, the SSL model chromium and selenium concentrations are about a factor of 100 below the groundwater standards, so some underestimation of their concentrations can be tolerated without compromising the conclusions from the analysis.

Thus, because TCLP uses an extraction fluid of pH less than 6.0, using TCLP values in the predictive modeling in this Supplemental Waste Plan should result in a high-end estimate of potential contamination for all the metals except chromium and selenium. In fact, EPA said when it proposed use of the TCLP,

[T]he Agency believes that the predicted degree of contaminant concentration in leachate could reasonably occur in the course of other types of land based waste management (e.g., surface impoundments). The TCLP, as well as the EP, basically involve mixing the waste with an aqueous leaching media, and seeing if certain contaminants can migrate from the waste to a significant degree.^{1/}

It is precisely for that purpose that Solvay proposes to use the TCLP.

Using the TCLP data in the SSL model produces the predicted groundwater concentrations shown in the eighth column of Table K-3 and K-4. The TCLP results for the crude phosphorus samples did not detect any of the metal constituents, at a detection limit one-tenth of the TCLP regulatory limits. (See seventh column of the respective tables). These detection limits were used as the leachate metals concentrations in the SSL modeling, even though the actual concentrations may be significantly lower.

The predicted groundwater concentrations using the measured leachate quality approach can be compared to MCLs or to DEQ-7 Montana groundwater standards in Table K-3 and K-4. This

^{1/} 51 FR at 21655 (June 13, 1986).

comparison confirms that there would be no exceedances of groundwater quality due to leachate from the crude phosphorus contained in a capped clarifier. In fact, the SSL groundwater concentration estimates are generally more than a factor of 100 lower than groundwater quality standards. These values are especially significant given the conservative simplifying assumptions of the SSL model, the conservative over-estimate of leachate concentrations from the TCLP testing, and the conservative use of detection limits.

Solids Concentration

The third way of using the SSL model is to calculate the minimum metals concentrations in the solid phase (in the crude phosphorus) in order for there to be the potential for leachate to cause groundwater to exceed drinking water quality standards.

The model uses the same equations described earlier for the SSL model, but starts from the desired water quality, calculates a corresponding leachate quality, and finally solves the partitioning equations for the metals concentrations in the solid phase. This is a “totals” concentration which can be directly compared to the crude phosphorus metals concentrations (see second column of the respective table). The SSL model solids metals concentrations are shown on the final column of Table K-3 and K-4.

Conclusion

The predictive groundwater quality evaluations indicate that either cap design would remain protective even if the metals concentrations in the crude phosphorus were underestimated by more than one order of magnitude.

Crude Phosphorus Distillation Residues

As part of the on-site phosphorus recovery alternative, a CAMU would be designated for the clarifier (SWMU 2). This CAMU would be the long-term disposal unit for the mud still solid residues, which would be placed back into the clarifier and the crude phosphorus that cannot be safely and practicably removed from the clarifier or that is entrained in the crevices of the clarifier. The CAMU would be covered with an evapotranspiration cap that meets the requirements of 40 CFR 264.552(e)(6)(iv). The leachability of crude phosphorus closed with an evapotranspiration cap was evaluated in the crude phosphorus section, which demonstrated that the evapotranspiration cap would be protective of groundwater based on metals concentrations in crude phosphorus.

This section describes the three approaches regarding leaching of metals from crude phosphorus distillation residues that would be placed back into the clarifier. Mud still residue was not analyzed for total metals, only for TCLP leachable levels of metals. Roaster residue is, however, very similar to the mud still residue. Roaster residue was generated from the same feedstock (i.e., crude phosphorus sludge from the clarifier) using a very similar distillation process at about the same temperature. Neither distillation process would add or remove metals from the residue. As such, sample results on roaster residue are very good surrogates for the mud still residue.

Table K-5 shows the predicted groundwater concentrations from the various leachate models as follows:

- Column 4 - Partitioning Model using the total metals concentrations for the roaster residue samples from Table K-1.
- Column 8- Leachate Model using the SPLP data for the roaster residue samples from Table 5.5.14-9 of the RFI Report (Barr 2013). The higher concentration of the two samples was selected for this evaluation.
- Column 10- Leachate Model using the TCLP data for the mud still residue analyzed during the treatability study (Franklin 2012). A summary of the TCLP data and statistical evaluation is in Attachment 2. This data indicates that the mud still residue could be a characteristic hazardous waste for cadmium, but no other metals exceeded the regulatory level. The mud still residue TCLP concentrations shown in Table K-5 are the regulatory levels for the metals except for cadmium. The 95% UCL of the mean, based on a normal distribution, was calculated for cadmium using ProUCL version 5.00.

The sensitivity analysis (Table 4 and Figure 4 of Attachment 1) demonstrates that cadmium concentrations should increase as the pH of the leaching solution is lowered (i.e., more acidic conditions). As such, the leachate model using the TCLP data overestimates the leachate concentrations and still does not predict an exceedance of groundwater criteria, even if the leachate concentrations are added to the crude phosphorus leachate concentrations in Table K-4.

This evaluation demonstrates that the evapotranspiration cap would be protective of groundwater quality based on metals concentrations in crude phosphorus distillation residues.

Conclusions

The predictive groundwater quality evaluations indicate that either cap design would remain protective even if the metals concentrations in the crude phosphorus were underestimated by more than one order of magnitude. The evapotranspiration cap would also be protective of groundwater based on modeled leaching from mud still residue.

References:

- Barr 2013. RCRA Facility Investigation Report. Prepared for Rhodia Inc., Submitted to EPA Region 8, May 1, 2013.
- EPA 1999. Understanding Variation in Partition Coefficient, K_d , Values. U.S. EPA Radiation Protection Programs Remediation Technology and Tools, EPA 402-R-99-004A&B. August 1999.
- EPA 2001. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, March 2001.
- Franklin 2012. Clarifier Material Treatability Study; Phase 3 Report – Pilot Plant Operation. Prepared for Rhodia, Inc. February 2012.

Tables

Table K-1

**Analytical Data for Inputs and Outputs
Mass Balance Roaster Process**

Silver Bow Plant

Parameters	Roaster Residue						Average [mg/Kg]
	RR001-97 [mg/Kg]	RR002-97 [mg/Kg]	RS-03 [mg/Kg]	RS-04 [mg/Kg]	RS-05 [mg/Kg]		
As	<5	<5	1.93	3.17	2.27		2.5
Ba	39	42	55.3	55.4	49.1		48
Cd	20	21	R	R	R		21
Cr	250	270	388	381	327		320
Pb	65	70	108	134	81.1		92
Hg	N/A	N/A	<0.002	0.007	0.004		0.006
Se	<5	5	4.5	4.2	2.4		4.0
Ag	31	34	45.2	50.2	37.4		40

Parameters	Nodule Fines			Average [mg/Kg]
	NF003-97 [mg/Kg]	NF004-97 [mg/Kg]		
As	<5	<5		5
Ba	35	39		37
Cd	1	1		1
Cr	210	190		200
Pb	<5	<5		5
Hg	N/A	N/A		N/A
Se	<5	<5		5
Ag	7	7		7

Parameters	P4 Product - Solution Analysis						Average [mg/Kg]
	SB001-97 [mg/L]	SB002-97 [mg/L]	SB003-97 [mg/L]	SB004-97 [mg/L]	SB005-97 [mg/L]	SB006-97 [mg/L]	
P4 Mass [g]	22.981	19.900	21.321	22.281	21.286	0.000	
Solvent Volume [mL]	200.0	200.0	200.0	200.0	200.0	200.0	
As	4.3	3.5	3.6	3.8	3.4	<0.1	
Ba	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Cd	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Cr	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Pb	1.5	1.2	1.3	1.8	2	1.2	
Hg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Se	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Ag	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	

Parameters	P4 Product ¹						Average [mg/Kg]
	SB001-97 [mg/kg]	SB002-97 [mg/kg]	SB003-97 [mg/kg]	SB004-97 [mg/kg]	SB005-97 [mg/kg]	SB006-97 [mg/kg]	
As	37	35	34	34	32	--	34.5
Ba	0.87	1.01	0.94	0.90	0.94	--	0.93
Cd	0.87	1.01	0.94	0.90	0.94	--	0.93
Cr	4.4	5.0	4.7	4.5	4.7	--	4.7
Pb ²	3	0.0	1	5	8	--	3.3
Hg	0.0087	0.010	0.0094	0.0090	0.0094	--	0.0093
Se	0.87	1.01	0.94	0.90	0.94	--	0.93
Ag	0.87	1.01	0.94	0.90	0.94	--	0.93

¹ P4 Product concentrations = (P4 Solution concentration) * (Solvent Volume) / (P4 Mass)

² The lead concentration in the blank (BB006-97) was subtracted.

Table K-2

**Mass Balance Roaster Process
Silver Bow Plant**

Parameter	Outputs		Inputs	
	Roaster Residue	P4 Product	Nodule Fines ²	Crude Phosphorus
Volume Basis [gal]	--	1,840	--	10,000
Density ¹ [lbs/gal]	--	15.2	--	10.5
Mass Basis [lbs]	130,000	27,900	52,500	105,000
Source	Table 1	Table 1	Table 1	Calculated
Units	[mg/Kg]	[mg/Kg]	[mg/Kg]	[mg/Kg]
As	2.5	34	5	9.8
Ba	48	0.93	37	41
Cd	21	0.93	1	26
Cr	320	4.7	200	300
Pb	92	3.3	5	110
Hg	0.006	0.0093	N/A	--
Se	4	0.93	5	2.7
Ag	40	0.93	7	46

¹ Specific Gravity of P4 Product is 1.82. Density = 1.82 X 8.34 lbs/gal = 15.2 lbs/gal.

² Feed ratio [2:1] was described in Appendix F of the Waste Plan.

Table K-3

Enhanced RCRA Cap - Clarifier
Estimated Groundwater Concentration and
Comparison to Groundwater Standards

Parameter	Partitioning Model			Drinking Water Standards		Leachate (TCLP) Model		Solids Conc.
	Crude Phosphorus [mg/Kg]	Leachate ² [pH = 6.0] [mg/L]	Predicted Groundwater Concentration ³ [mg/l]	MDEQ DEQ-7 ¹ [mg/l]	MCL [mg/l]	Crude Phosphorus [mg/l TCLP]	Predicted Groundwater Concentration ³ [mg/l]	Metals Concentration to equal DEQ-7 [mg/Kg]
Arsenic	9.8	0.36	7.2E-07	1.0E-02	1.0E-02	<0.5	1.0E-06	139,000
Barium	41	1.4	2.7E-06	1.0E+00	2.0E+00	<10	2.0E-05	15,400,000
Cadmium	26	0.69	1.4E-06	5.0E-03	5.0E-03	<0.1	2.0E-07	94,000
Chromium	300	13	2.6E-05	1.0E-01	1.0E-01	<0.5	1.0E-06	1,190,000
Lead	110	0.067	1.3E-07	1.5E-02	1.5E-02	<0.5	1.0E-06	12,300,000
Mercury	--	--	--	2.0E-03	2.0E-03	<0.02	4.0E-08	4,350
Selenium	2.7	0.31	6.1E-07	5.0E-02	5.0E-02	<0.1	2.0E-07	233,000
Silver	46	30	6.0E-05	1.0E-01	--	<0.5	1.0E-06	101,000

Partitioning Equation Inputs		Parameter	K _D ⁴ @ pH = 6.0		DAF Inputs	
θ _w =	0.3	Arsenic	27	L/Kg	I =	6.E-06 inches/yr
θ _a =	0.117	Barium	30	L/Kg	K =	1 ft/day
n =	0.417	Cadmium	37	L/Kg	i =	0.006 ft/ft
ρ [Kg/L]	1.26	Chromium	23	L/Kg	L =	100 ft
H' =	0	Lead ⁵	1,639	L/Kg	d _a =	300 ft
H' (Mercury) =	4.67E-01	Mercury	3.5	L/Kg	Calculated Values	
		Selenium	8.6	L/Kg	d ⁶ =	11 ft
		Silver	1.3	L/Kg	DAF ⁷ =	500,000

Notes:¹ DEQ-7 Effective Date: October 2012.² Equation 4-10, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA OSWER 9355.4-24³ Predicted Groundwater Concentration = C_{Leachate} / DAF⁴ K_D values from Exhibit C-4 (EPA 2001)⁵ K_D value for Lead from Appendix F (EPA 1999)⁶ Equation 4-12, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA OSWER 9355.4-24⁷ Equation 4-11, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA OSWER 9355.4-24

Table K-4

Evapotranspiration Cap (Crude Phosphorus) - Clarifier
Estimated Groundwater Concentration and
Comparison to Groundwater Standards

Parameter	Partitioning Model			Drinking Water Standards		Leachate (TCLP) Model		Solids Conc.
	Crude Phosphorus [mg/Kg]	Leachate ² [pH = 6.0] [mg/L]	Predicted Groundwater Concentration ³ [mg/l]	MDEQ DEQ-7 ¹ [mg/l]	MCL [mg/l]	Crude Phosphorus [mg/l TCLP]	Predicted Groundwater Concentration ³ [mg/l]	Metals Concentration to equal DEQ-7 [mg/Kg]
Arsenic	9.8	0.36	6.0E-04	1.0E-02	1.0E-02	<0.5	8.3E-04	170
Barium	41	1.4	2.3E-03	1.0E+00	2.0E+00	<10	1.7E-02	18,000
Cadmium	26	0.69	1.2E-03	5.0E-03	5.0E-03	<0.1	1.7E-04	110
Chromium	300	13	2.2E-02	1.0E-01	1.0E-01	<0.5	8.3E-04	1,400
Lead	110	0.067	1.1E-04	1.5E-02	1.5E-02	<0.5	8.3E-04	15,000
Mercury	--	--	--	2.0E-03	2.0E-03	<0.02	3.3E-05	5.2
Selenium	2.7	0.31	5.1E-04	5.0E-02	5.0E-02	<0.1	1.7E-04	280
Silver	46	30	5.0E-02	1.0E-01	--	<0.5	8.3E-04	121

Partitioning Equation Inputs		Parameter	K _D ⁴ @ pH = 6.0		DAF Inputs	
theta w =	0.3	Arsenic	27	L/Kg	I =	0.014 inches/yr
theta a =	0.117	Barium	30	L/Kg	K =	1 ft/day
n =	0.417	Cadmium	37	L/Kg	i =	0.006 ft/ft
Bulk Density [Kg/L]	1.26	Chromium	23	L/Kg	L =	100 ft
H' =	0	Lead ⁵	1,639	L/Kg	d _a =	300 ft
H' (Mercury) =	4.67E-01	Mercury	3.5	L/Kg	Calculated Values	
		Selenium	8.6	L/Kg	d ⁶ =	29 ft
		Silver	1.3	L/Kg	DAF ⁷ =	600

Notes:¹ DEQ-7 Effective Date: October 1999.² Equation 4-10, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA OSWER 9355.4-24³ Predicted Groundwater Concentration = C_{Leachate} / DAF⁴ K_D values from Exhibit C-4 (EPA 2001)⁵ K_D value for Lead from Appendix F (EPA 1999)⁶ Equation 4-12, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA OSWER 9355.4-24⁷ Equation 4-11, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA OSWER 9355.4-24

Table K-5

**Evapotranspiration Cap (Residue) - Clarifier
Estimated Groundwater Concentration and
Comparison to Groundwater Standards**

Parameter	Partitioning Model			Drinking Water Standards		Leachate (SPLP) Model		Leachate (TCLP) Model	
	Roaster Residue [mg/Kg]	Leachate ² [pH = 6.0] [mg/L]	Predicted Groundwater Concentration ³ [mg/l]	MDEQ DEQ-7 ¹ [mg/l]	MCL [mg/l]	Roaster Residue [mg/l SPLP]	Predicted Groundwater Concentration ³ [mg/l]	Mud Still Residue [mg/l TCLP]	Predicted Groundwater Concentration ³ [mg/l]
Arsenic	2.5	0.09	1.5E-04	1.0E-02	1.0E-02	0.0009	1.5E-06	<0.5	8.3E-04
Barium	48	1.6	2.6E-03	1.0E+00	2.0E+00	0.082	1.4E-04	<0.5	8.3E-04
Cadmium	21	0.56	9.4E-04	5.0E-03	5.0E-03	0.028	4.7E-05	2.1	3.5E-03
Chromium	320	14	2.3E-02	1.0E-01	1.0E-01	0.039	6.5E-05	<0.5	8.3E-04
Lead	92	0.056	9.4E-05	1.5E-02	1.5E-02	0.09	1.5E-04	2.0	3.3E-03
Mercury	--	--	--	2.0E-03	2.0E-03	0.001	1.7E-06	0.11	1.8E-04
Selenium	4.0	0.45	7.5E-04	5.0E-02	5.0E-02	0.001	1.7E-06	<0.5	8.3E-04
Silver	40	26	4.3E-02	1.0E-01	--	0.03	5.0E-05	<0.5	8.3E-04

Partitioning Equation Inputs		Parameter	K_D^4 @ pH = 6.0		DAF Inputs	
theta w =	0.3	Arsenic	27	L/Kg	I =	0.014 inches/yr
theta a =	0.117	Barium	30	L/Kg	K =	1 ft/day
n =	0.417	Cadmium	37	L/Kg	i =	0.006 ft/ft
Bulk Density [Kg/L]	1.26	Chromium	23	L/Kg	L =	100 ft
H' =	0	Lead ⁵	1,639	L/Kg	d _a =	300 ft
H' (Mercury) =	4.67E-01	Mercury	3.5	L/Kg	Calculated Values	
		Selenium	8.6	L/Kg	d ⁶ =	29 ft
		Silver	1.3	L/Kg	DAF ⁷ =	600

Notes:¹ DEQ-7 Effective Date: October 2012.² Equation 4-10, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA OSWER 9355.4-24³ Predicted Groundwater Concentration = $C_{Leachate} / DAF$ ⁴ K_D values from Exhibit C-4 (EPA 2001)⁵ K_D value for Lead from Appendix F (EPA 1999)⁶ Equation 4-12, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA OSWER 9355.4-24⁷ Equation 4-11, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA OSWER 9355.4-24

Attachment 1

Sensitivity Analysis of Predictive Groundwater Modeling Calculations

Memorandum

To: Solvay File
From: Tom Mattison
Subject: Sensitivity of Predictive Groundwater Modeling Calculations
Project: Supplemental Waste Plan – Clarifier Materials
c:

This memorandum evaluates the sensitivity of the mass balance calculations to the various input parameters used in the calculations. The sensitivity to changes in infiltration, hydraulic conductivity, and mixing zone depth were evaluated as described below.

Infiltration

The infiltration rate was obtained from the HELP model (version 3.07) presented in Appendix J of the Supplemental Waste Plan. The model indicates that the infiltration rate should be approximately 0.000003 inches/year through the enhanced cap. This value was varied between –50% (0.000002 inches per year) and +100% (0.000006 inches per year) of the value from the HELP model and the potential maximum groundwater concentration was calculated for each varied value. The percent change in maximum groundwater concentration was then computed from the base case calculation (0.000003 inches /yr).

Table 1 summarizes the sensitivity calculations for changes to infiltration rates. Figure 1 shows a graph of the relationship between changes in infiltration rate and changes in maximum groundwater concentrations. This evaluation indicates a linear relationship between infiltration rate and maximum groundwater concentrations.

Hydraulic Conductivity

The hydraulic conductivity value was obtained from the geometric mean of the slug test results for the monitoring wells near the clarifier. This value was varied between –50% (0.5 ft/day) and +50% (1ft/day) based on the geometric mean of the slug test results for the monitoring wells near the clarifier (Barr 2013).

The potential maximum groundwater concentration was calculated, varying only the K value in the DAF equation of the SSL model, for each sensitivity value, and the percent change in maximum groundwater concentration was then computed from the base case calculation (1 ft/day).

Table 2 summarizes the sensitivity calculations for changes to hydraulic conductivity. Figure 2 shows a graph of the relationship between changes in hydraulic conductivity and changes in maximum groundwater concentrations. This evaluation indicates an inverse relationship between hydraulic conductivity and maximum groundwater concentrations. Lower hydraulic conductivities result in higher maximum groundwater concentrations in that a 200% reduction in hydraulic conductivity causes the maximum groundwater concentration to double.

Mixing Zone Depth

The leachate mixing zone depth value was obtained from the EPA's SSL model. For the clarifier, this depth was very similar to the length of the monitoring well screens installed at the clarifier as part of the preclosure groundwater monitoring program, 10 feet. During the October 17, 2001 meeting, the EPA requested that a 50-foot mixing zone depth also be evaluated. This sensitivity analysis includes the 50-foot and also a 100-foot depth. The potential maximum groundwater concentration was calculated for each depth value and the percent change in maximum groundwater concentration was then computed from the base case calculation (10 feet).

Table 3 summarizes the sensitivity calculations for changes to mixing zone depth. Figure 3 shows a graph of the relationship between changes in mixing zone depth and changes in maximum groundwater concentrations. A greater mixing zone depth significantly decreases the maximum groundwater concentration especially in the top 50 feet.

pH

The pH value of the crude phosphorus was varied between 5 and 8 to evaluate the effect of differing leaching solutions on the resulting equilibrium leachate concentrations. The pH values correspond to the pH ranges on "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites" peer review draft, March 2001, Exhibit C-4 (EPA 2001). The pH-dependent partition coefficient (K_d) values used to calculate the equilibrium leachate concentration for the respective metal species, except for lead, were taken from that same Exhibit C-4. The pH-dependent K_d value

for lead was obtained from a correlation presented in “Understanding Variation in Partition Coefficient, K_d , Values” (EPA 1999).

Table 4 summarizes the sensitivity calculations for changes to pH. Figure 4 shows a graph of the relationship between changes in pH and percent change in the corresponding equilibrium leachate concentration. This evaluation indicates that leachate concentrations of arsenic, barium, cadmium, lead, and silver should decrease as the pH is raised between pH = 5 and pH = 8. The leachate concentrations chromium and selenium should increase as the as the pH is raised between pH = 5 and pH = 8.

The figure 4 graph is normalized to pH = 6, so parameters whose graphs slope up to the left (arsenic, barium, cadmium, lead, and silver) are metals whose equilibrium leachate concentration increases with decreasing pH. The 2 metals whose graphs slope up to the right, chromium and selenium, have increasing equilibrium leachate concentrations with increasing pH.

References:

- Barr 2013. RCRA Facility Investigation Report. Prepared for Rhodia Inc., Submitted to EPA Region 8, May 1, 2013.
- EPA 1999. *Understanding Variation in Partition Coefficient, K_d , Values*. U.S. EPA Radiation Protection Programs Remediation Technology and Tools, EPA 402-R-99-004A&B. August 1999.
- EPA 2001. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*, OSWER 9355.4-24, March 2001.

Table 1

**Sensitivity to Changes in Infiltration
Estimated Groundwater Concentration**

Mass Balance Inputs		
I	inches/yr	0.000003
K	ft/day	1
i	ft/ft	0.006
L	ft	100
d _a	ft	300
d	ft	11
DAF		900,000

Sensitivity Summary		
% Change Inf	Inf	% Change GW Prediction
-50%	0.000002	-50%
-25%	0.000002	-25%
0%	0.000003	0%
25%	0.000004	25%
50%	0.000005	50%
75%	0.000005	75%
100%	0.000006	100%

Figure 1 - Sensitivity to Changes in Infiltration

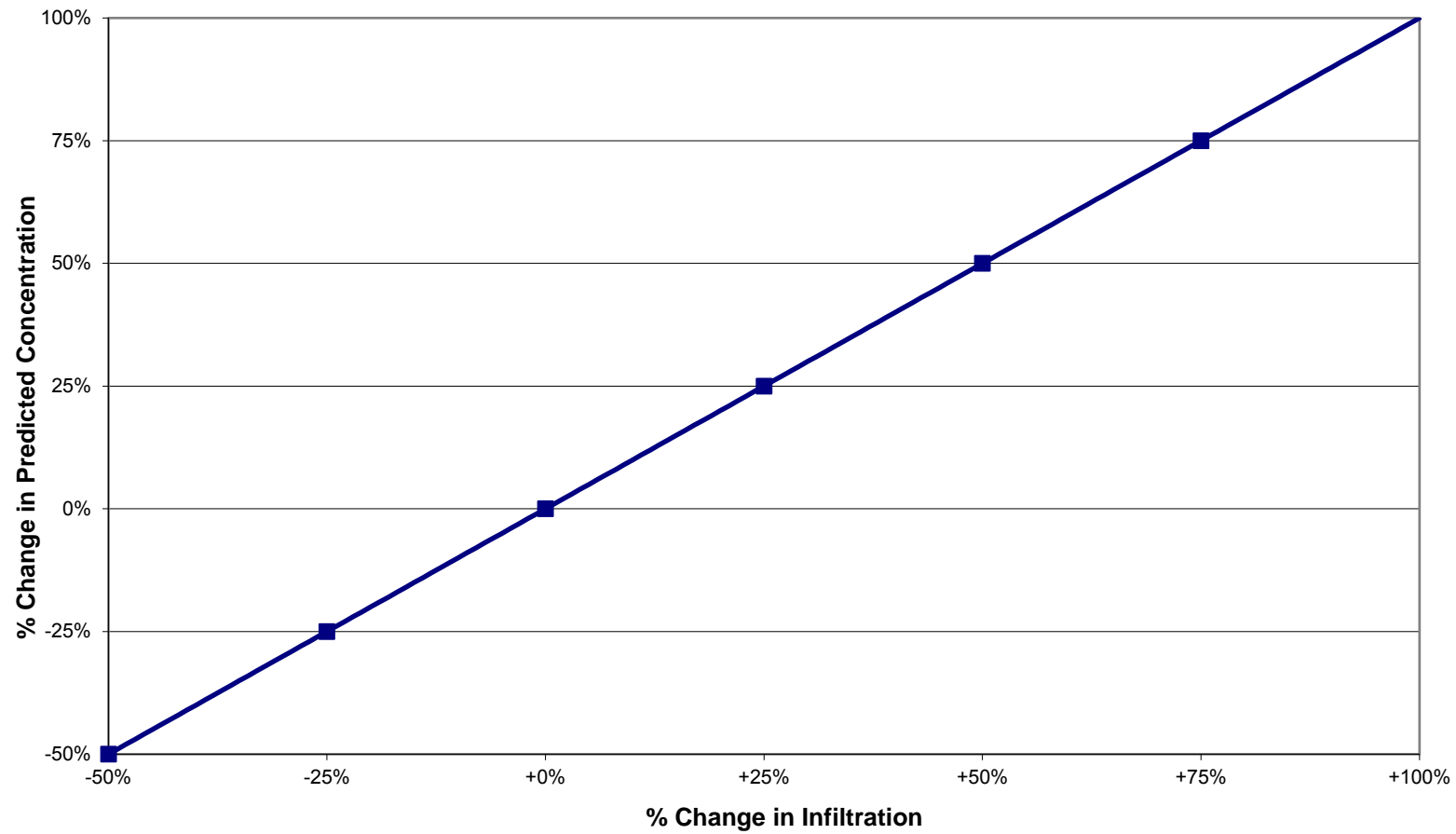


Table 2

**Sensitivity to Changes in Hydraulic Conductivity
Estimated Groundwater Concentration**

Mass Balance Inputs		
I	inches/yr	0.00002
K	ft/day	1
i	ft/ft	0.006
L	ft	100
d _a	ft	300
d	ft	11
DAF		100,000

Sensitivity Summary		
% Change K	K	% Change GW Prediction
-50%	0.5	100%
-25%	0.8	33%
0%	1.0	0%
25%	1.3	-20%
50%	1.5	-33%

Figure 2 - Sensitivity to Changes in Hydraulic Conductivity

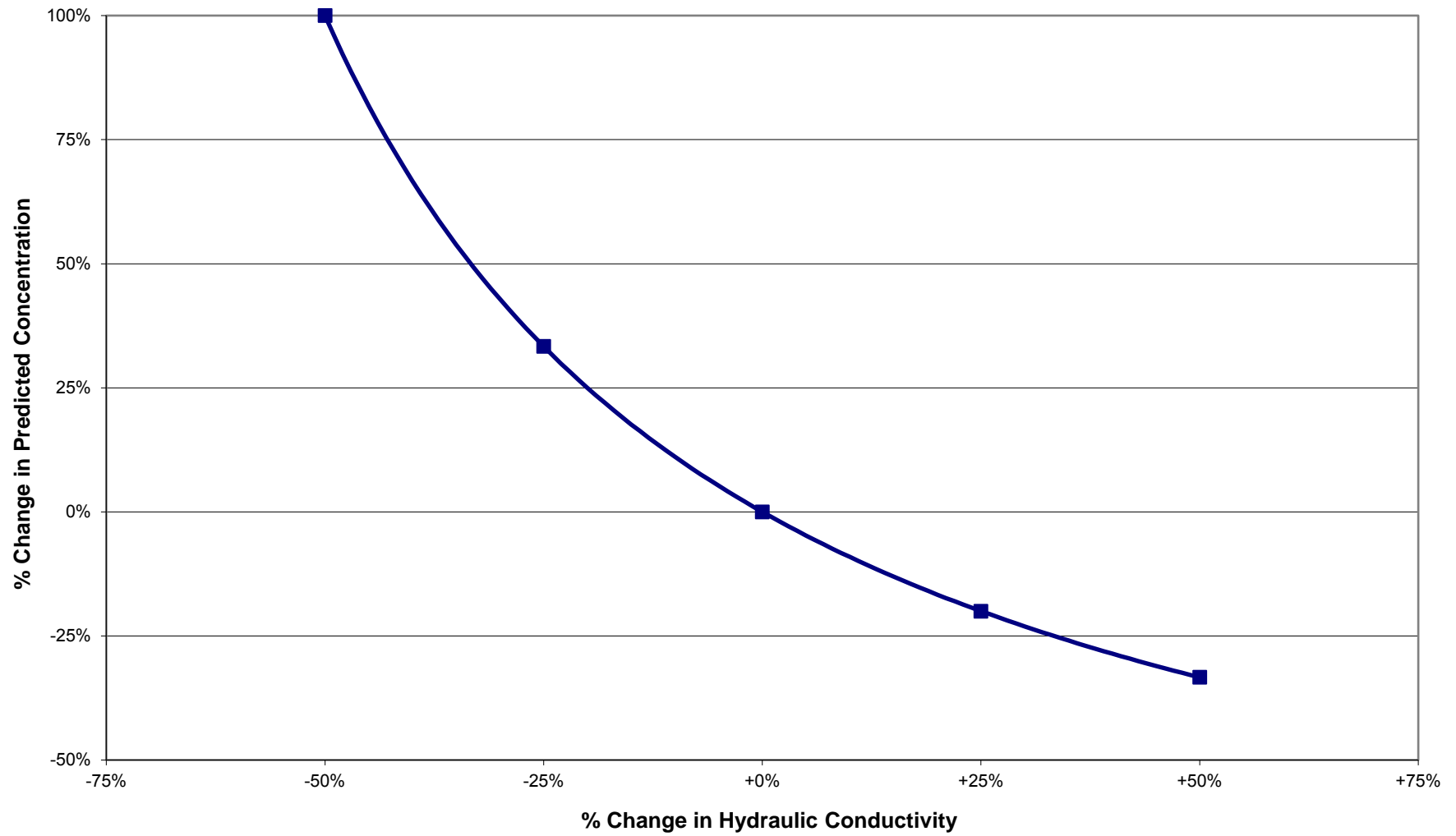


Table 3

**Sensitivity to Mixing Zone Depth
Estimated Groundwater Concentration**

Mass Balance Inputs		
I	inches/yr	0.00002
K	ft/day	1
i	ft/ft	0.006
L	ft	100
d _a	ft	300
d	ft	11
DAF		100,000
Sensitivity Summary		
Penetration Depth	% Change GW Prediction	
10	0%	
50	-80%	
100	-90%	

Figure 3 - Sensitivity to Changes in Mixing Zone Depth

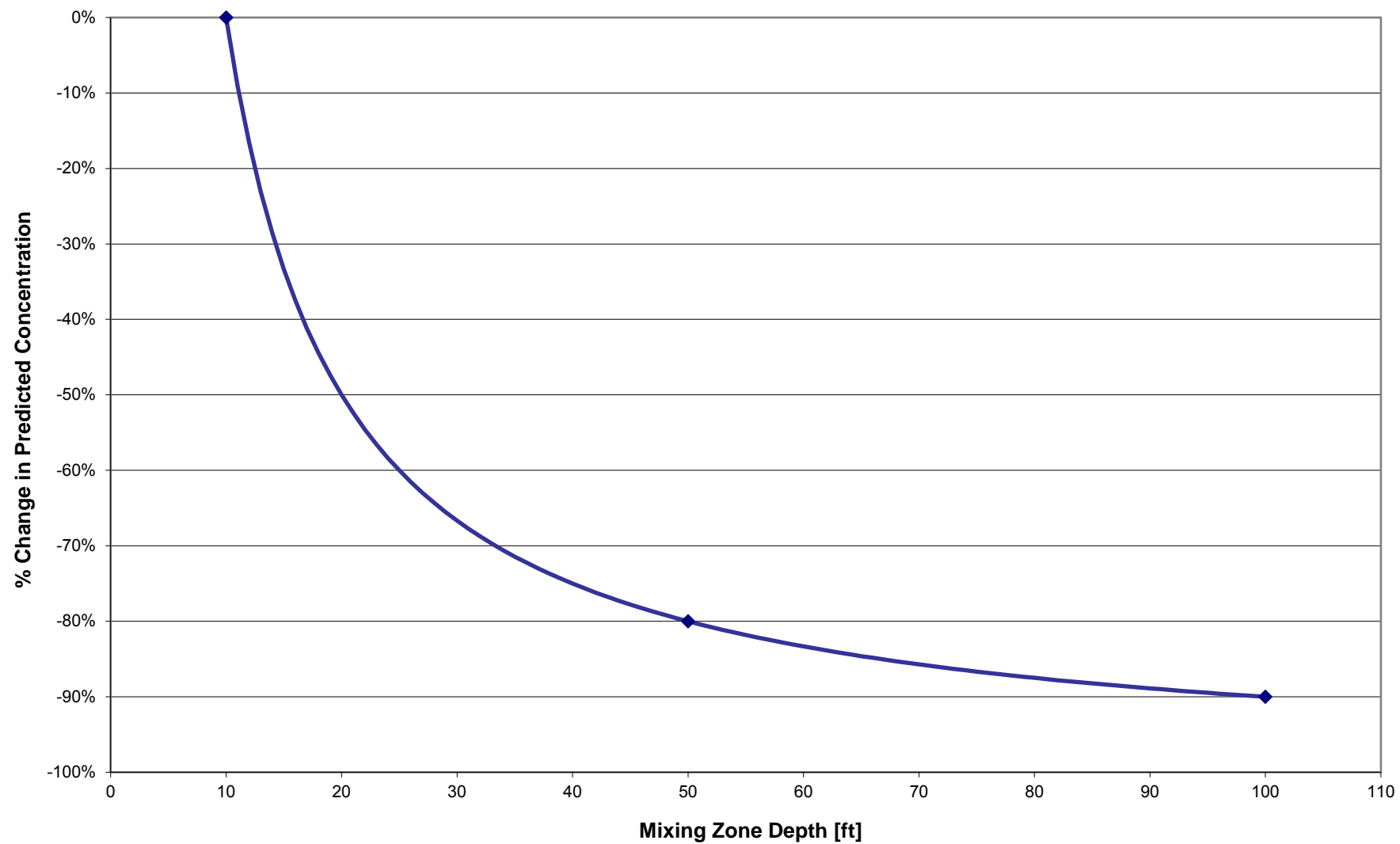
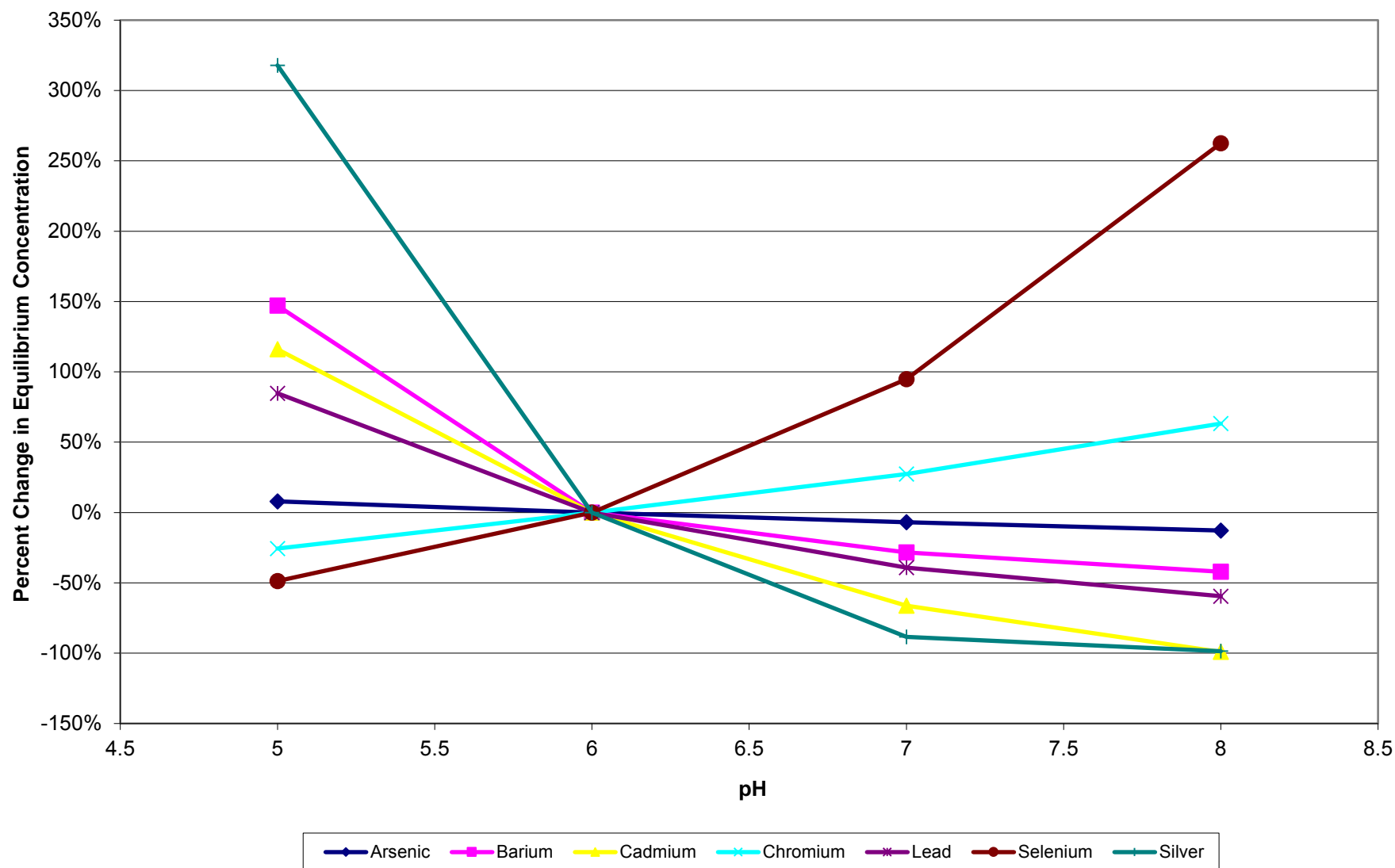


Table 4

**Sensitivity to Changes in pH
Estimated Groundwater Concentration**

Partitioning Equation Inputs								
Θ_W	0.3							
Θ_A	0.117							
n	0.417							
ρ_B	1.26							
H'	0							
Parameter	Crude Phosphorus [mg/Kg]							
Arsenic	9.8							
Barium	41							
Cadmium	26							
Chromium	300							
Lead	110							
Mercury	--							
Selenium	2.7							
Silver	46							
Parameter	K_D							
	pH = 5.0 [L/Kg]	pH = 6.0 [L/Kg]	pH = 7.0 [L/Kg]	pH = 8.0 [L/Kg]				
Arsenic	25	27	29	31				
Barium	12	30	42	52				
Cadmium	17	37	110	4300				
Chromium	31	23	18	14				
Lead ¹	887	1,639	2,692	4,045				
Mercury	0.06	3.5	82	200				
Selenium	17	8.6	4.3	2.2				
Silver	0.13	1.3	13	110				
Sensitivity of pH	Equilibrium Concentration							
	Arsenic [mg/L]	Barium [mg/L]	Cadmium [mg/L]	Chromium [mg/L]	Lead [mg/L]	Mercury [mg/L]	Selenium [mg/L]	Silver [mg/L]
5	0.39	3.36	1.49	9.60	0.12	--	0.16	124.97
6	0.36	1.36	0.69	12.91	0.07	--	0.31	29.91
7	0.33	0.97	0.23	16.45	0.04	--	0.59	3.47
8	0.31	0.79	0.01	21.07	0.03	--	1.11	0.42
Sensitivity of pH	Percent Change in Equilibrium Concentration							
	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
5	8%	147%	116%	-26%	85%	--	-49%	318%
6	0%	0%	0%	0%	0%	--	0%	0%
7	-7%	-28%	-66%	27%	-39%	--	95%	-88%
8	-13%	-42%	-99%	63%	-59%	--	263%	-99%

Figure 4 - Sensitivity to Changes to pH

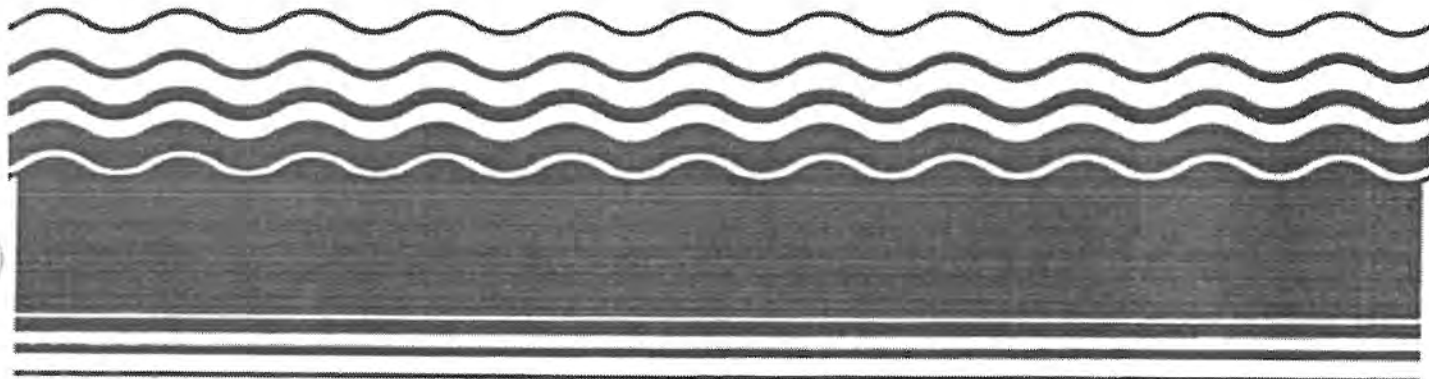


Superfund



SUPPLEMENTAL GUIDANCE FOR DEVELOPING SOIL SCREENING LEVELS FOR SUPERFUND SITES

Peer Review Draft



SUPPLEMENTAL GUIDANCE FOR DEVELOPING SOIL SCREENING LEVELS FOR SUPERFUND SITES

Peer Review Draft

**Office of Emergency and Remedial Response
U.S. Environmental Protection Agency
Washington, DC 20460**

Disclaimer

This document provides guidance to EPA Regions concerning how the Agency intends to exercise its discretion in implementing one aspect of the CERCLA remedy selection process. The guidance is designed to implement national policy on these issues.

The statutory provisions and EPA regulations described in this document contain legally binding requirements. However, this document does not substitute for those provisions or regulations, nor is it a regulation itself. Thus, it cannot impose legally-binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. Any decisions regarding a particular remedy selection decision will be made based on the statute and regulations, and EPA decisionmakers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance where appropriate. EPA may change this guidance in the future.

Migration to Ground Water.

This guidance calculates commercial/industrial SSLs for the ingestion of leachate-contaminated ground water using the same set of equations and default input values presented in the 1996 SSG. Thus, the generic SSLs for this pathway are the same under commercial/industrial and residential land use scenarios.

EPA has adopted this approach for two reasons. First, it protects off-site receptors, including residents, who may ingest contaminated ground water that migrates from the site. Second, it protects potentially potable ground water aquifers that may exist beneath commercial/ industrial properties (see text box for EPA's policy on ground water classification). Thus, this approach is appropriate for protecting ground water resources and human health; however, it may necessitate that sites meet stringent SSLs if the migration to ground water pathway applies, regardless of future land use.

The simple site-specific ground water approach consists of two steps. First, it employs a simple linear equilibrium soil/water partition equation to estimate the contaminant concentration in soil leachate. Alternatively, the synthetic precipitation leachate procedure (SPLP) can be used to estimate this concentration. Next, a simple water balance equation is used to calculate a dilution factor to account for reduction of soil leachate concentration from mixing in an aquifer. This calculation is based on conservative, simplified assumptions about the release and transport of contaminants in the subsurface (see Exhibit 4-3). These assumptions should be reviewed for consistency with the CSM to determine the applicability of SSLs to the migration to ground water pathway.

Equation 4-10 is the soil/water partition equation; it is appropriate for calculating SSLs corresponding to target leachate contaminant concentrations in the zone of contamination. Equations 4-11 and 4-12 are appropriate for determining the dilution attenuation factor (DAF) by which concentrations are reduced when leachate mixes with a clean aquifer. Because of the wide variability in subsurface conditions that affect contaminant migration in ground water, default

Ground Water Classification

In order to demonstrate that the ingestion of ground water exposure pathway is not applicable for a site, site managers may either perform a detailed fate and transport analysis (as discussed in the TBD to the 1996 SSG), or may show that the underlying ground water has been classified as non-potable. EPA's current policy regarding ground water classification for Superfund sites is outlined in an OSWER directive (U.S. EPA, 1997e). EPA evaluates ground water at a site according to the federal ground water classification system, which includes four classes:

- 1 - sole source aquifers;
- 2A - currently used for drinking water;
- 2B - potentially usable for drinking water; and
- 3 - not usable for drinking water.

Generally, this pathway applies to all potentially potable water (i.e., classes 1, 2A, and 2B), unless the state has made a different determination through a process analogous to the Comprehensive State Ground Water Protection Plan (CSGWPP). Through this process, ground water classification is based on an aquifer or watershed analysis of relevant hydrogeological information, with public participation, in consultation with water suppliers, and using a methodology that is consistently applied throughout the state. If a state has no CSGWPP or similar plan, EPA will defer to the state's ground water classification only if it is more protective than EPA's. As of February 2001, 11 states (AL, CT, DE, GA, IL, MA, NH, NV, OK, VT, and WI) have approved CSGWPP plans.

values are not provided for input parameters for these dilution equations. Instead, EPA has developed two possible default DAFs (DAF=20 and DAF=1) that are appropriate for deriving generic SSLs for this pathway. The selection of a default DAF is discussed in Appendix A, and the derivation of these defaults is described in the *TBD* to the 1996 *SSG*. The default DAFs also can be used for calculating simple site-specific SSLs, or the site manager can develop a site-specific DAF using equations 4-11 and 4-12.

To calculate SSLs for the migration to ground water pathway, the acceptable ground water concentration is multiplied by the DAF to obtain a target soil leachate concentration (C_w).²⁰ For example, if the DAF is 20 and the acceptable ground water concentration is 0.05 mg/L, the target soil leachate concentration would be 1.0 mg/L. Next, the partition equation is used to calculate the total soil concentration (i.e., SSL) corresponding to this soil leachate concentration. Alternatively, if a leach test is used, the target soil leachate concentration is compared directly to extract concentrations from the leach tests.

For more information on the development of SSLs for this pathway, please consult the 1996 *SSG*.

Mass-Limit SSLs. Equations 4-13 and 4-14 present models for calculating mass-limit SSLs for the outdoor inhalation of volatiles and migration to ground water pathways, respectively. These models can be used only if the depth and area of contamination are known or can be estimated with confidence. These equations are identical to those in the 1996 *SSG*. Please consult that guidance for information on using mass-limit SSL models.

Exhibit 4-3

Simplifying Assumptions for the SSL Migration to Ground Water Pathway

- Infinite source (i.e., steady-state concentrations are maintained over the exposure period)
- Uniformly distributed contamination from the surface to the top of the aquifer
- No contaminant attenuation (i.e., adsorption, biodegradation, chemical degradation) in soil
- Instantaneous and linear equilibrium soil/water partitioning
- Unconfined, unconsolidated aquifer with homogeneous and isotropic hydrologic properties
- Receptor well at the downgradient edge of the source and screened within the plume
- No contaminant attenuation in the aquifer
- No NAPLs present (if NAPLs are present, the SSLs do not apply)

²⁰ The acceptable ground water concentration is, in order of preference: a non-zero Maximum Contaminant Level Goal (MCLG), a Maximum Contaminant Level (MCL), or a health-based level (HBL) calculated based on an ingestion rate of 2L/day and a target cancer risk of 1×10^{-6} or an HQ of 1. These values are presented in Appendix C.

Equation 4-10
Soil Screening Level Partitioning Equation for Migration to Ground Water

$$\text{Screening Level in Soil (mg/kg)} = C_w \left[K_D + \frac{(\theta_w + \theta_a H')}{\rho_b} \right]$$

Parameter/Definition (units)	Default
C_w /target soil leachate concentration (mg/L)	(nonzero MCLG, MCL, or HBL) ^a × dilution factor
K_d /soil-water partition coefficient (L/kg)	for organics: $K_d = K_{oc} \times f_{oc}$ for inorganics: see Appendix C ^b
K_{oc} /soil organic carbon/water partition coefficient (L/kg)	chemical-specific ^c
f_{oc} /fraction organic carbon in soil (g/g)	0.002 (0.2%)
θ_w /water-filled soil porosity (L_{water}/L_{soil})	0.3
θ_a /air-filled soil porosity (L_{air}/L_{soil})	$n - \theta_w$
ρ_b /dry soil bulk density (kg/L)	1.5
n /soil porosity (L_{pore}/L_{soil})	$1 - (\rho_b/\rho_s)$
ρ_s /soil particle density (kg/L)	2.65
H' /dimensionless Henry's law constant	chemical-specific ^c (assume to be zero for inorganic contaminants except mercury)

^a Chemical-specific (see Appendix C).

^b Assume a pH of 6.8 when selecting default K_d values for metals.

^c See Appendix C.

Equation 4-11
Derivation of Dilution Attenuation Factor

$$\text{Dilution Attenuation Factor (DAF)} = 1 + \frac{K \times i \times d}{l \times L}$$

Parameter/Definition (units)	Default
DAF/dilution attenuation factor (unitless)	20 or 1 (0.5-acre source)
K /aquifer hydraulic conductivity (m/yr)	Site-specific
i /hydraulic gradient (m/m)	Site-specific
l /infiltration rate (m/yr)	Site-specific
d /mixing zone depth (m)	Site-specific
L /source length parallel to ground water flow (m)	Site-specific

Equation 4-12
Estimation of Mixing Zone Depth

$$d = (0.0112L^2)^{0.5} + d_a(1 - \exp[(-L \times I)/(K \times i \times d_a)])$$

Parameter/Definition (units)	Default
d/mixing zone depth (m)	Site-specific
L/source length parallel to ground water flow (m)	Site-specific
I/infiltration rate (m/yr)	Site-specific
K/aquifer hydraulic conductivity (m/yr)	Site-specific
i/hydraulic gradient (m/m)	Site-specific
d _a /aquifer thickness (m)	Site-specific

Equation 4-13
Mass-Limit Volatilization Factor
- Commercial/Industrial Scenario

$$VF = Q/C_{vol} \times \frac{[T \times (3.15 \times 10^7 \text{s/yr})]}{(\rho_b \times d_s \times 10^6 \text{g/Mg})}$$

Parameter/Definition (units)	Default
d _s /average source depth (m)	site-specific
T/exposure interval (yr)	30
Q/C _{vol} /inverse of mean conc. at center of a square source (g/m ² -s per kg/m ³)	68.18 (for 0.5 acre source)
ρ _b /dry soil bulk density (kg/L or Mg/m ³)	1.5

Equation 4-14
Mass-Limit Soil Screening Level for Migration to
Ground Water

$$\text{Screening Level in Soil (mg/kg)} = \frac{(C_w \times I \times ED)}{\rho_b \times d_s}$$

Parameter/Definition (units)	Default
C _w /target soil leachate concentration (mg/L)	(nonzero MCLG, MCL, or HBL) ^a × dilution factor
d _s /depth of source (m)	site-specific
I/infiltration rate (m/yr)	0.18
ED/exposure duration (yr)	70
ρ _b /dry soil bulk density (kg/L)	1.5

^a Chemical-specific, see Appendix C.

APPENDIX C

Chemical Properties and Regulatory/Human Health Benchmarks for SSL Calculations

This appendix provides the chemical properties and regulatory and human health benchmarks necessary to calculate SSLs for 110 chemicals commonly found at NPL sites. It consists of the following exhibits:

- Exhibit C-1 provides chemical-specific organic carbon-water partition coefficients (K_{oc}), air and water diffusivities (D_a and D_w), water solubilities (S), and dimensionless Henry's law constants (H').
- Exhibit C-2 provides pH-specific K_{oc} values for nine organic contaminants that ionize under natural pH conditions. Site-specific soil pH measurements (see EPA's 1996 SSG, Section 2.3.5) can be used to select appropriate K_{oc} values for these contaminants. Where site-specific soil pH values are not available, values corresponding to a pH of 6.8 should be used. Note that K_{oc} values presented in Exhibit C-1 for these contaminants are based on a default pH of 6.8).
- Exhibit C-3 provides the physical state (liquid or solid) for organic contaminants. This information is needed to apply and interpret soil saturation limit (C_{sat}) results when calculating SSLs for the inhalation of volatiles in outdoor air pathway.
- Exhibit C-4 provides pH-specific soil-water partition coefficients (K_d) for metals. Site-specific soil pH measurements (see 1996 SSG, Section 2.3.5) can be used to select appropriate K_d values for these metals. Where site-specific soil pH values are not available, values corresponding to a pH of 6.8 should be used.
- Exhibit C-5 provides chemical-specific regulatory and human health benchmarks for organic and inorganic contaminants. The chemical-specific Maximum Contaminant Level Goal (MCLG), Maximum Contaminant Level (MCL), Water Health Based Limit (HBL), Cancer Slope Factor (CSF), Unit Risk Factor (URF), Reference Dose (RfD), and Reference Concentration (RfC) values presented in this exhibit are used as inputs in the SSL equations in Sections 3, 4, and 5 of this document.
- Exhibit C-6 presents chemical-specific absorption percentages for dermal contact (ABS_d) for all contaminants for which this pathway is relevant. The values presented represent the average dermal absorption values across a range of soil types, loading rates, and chemical concentrations for these contaminants.
- Exhibit C-7 provides gastrointestinal absorption factors (ABS_{GI}) for contaminants of concern for the dermal pathway. These values are used for route-to-route extrapolation of toxicity values. Specifically, these factors are used to adjust the oral reference dose (RfD) and cancer slope factor (SF) for a contaminant, which is based

on administered dose, to more accurately reflect the dermal dose, which is an absorbed dose. Where there is greater than 50 percent gastrointestinal absorption (e.g., $ABS_{GI} > .5$), no adjustment is made.

With the exception of values for air diffusivity (D_a), water diffusivity (D_w), and certain K_{oc} values, all of the chemical properties used to calculate SSLs are also reported in the Superfund Chemical Data Matrix (SCDM). Water and air diffusivities were obtained from EPA's CHEMDAT8 and WATER8 models. For more information on the derivation of K_{oc} values, or for a more detailed discussion of the chemical properties presented in Exhibits C-1 through C-4, please refer to the *Technical Background Document* for the 1996 *Soil Screening Guidance* (SSG).

The sources for the regulatory and human health benchmarks include the list of National Primary Drinking Water Regulations (NPDWRs), maintained by EPA's Office of Ground Water and Drinking Water, and EPA's *Integrated Risk Information System* (IRIS). The full list of sources for the regulatory and chronic human health benchmarks is presented at the end of Exhibit C-5. Chemical-specific dermal and gastro-intestinal absorption fractions for the dermal contact pathway were obtained from EPA's *RAGS, Part E, Supplemental Guidance for Dermal Risk Assessment* (U.S. EPA, in press).

All of the sources of the values listed in Exhibits C-1 through C-5 are regularly updated by EPA. In addition, the information in Exhibits C-6 and C-7 was obtained from *RAGS, Part E*. Therefore, prior to calculating SSLs for a site, regulatory/health benchmarks and chemical properties should be checked against the most recent versions of the appropriate sources to ensure that they are up to date. These sources may also be useful for identifying properties and benchmarks for additional contaminants of concern not included in this appendix. Several of these sources are available on-line at the following EPA web sites:

IRIS:	http://www.epa.gov/ngispgm3/iris/
NPDWRs:	http://www.epa.gov/safewater/mcl.html
SCDM:	http://www.epa.gov/superfund/resources/scdm/index.htm
CHEMDAT8:	http://www.epa.gov/ttn/chief/software.html
WATER8:	http://www.epa.gov/ttn/chief/software.html

Exhibit C-4

METAL K_d VALUES (L/kg) AS A FUNCTION OF pH*

pH	Arsenic	Barium	Beryllium	Cadmium	Chromium (+III)	Chromium (+VI)	Mercury	Nickel	Silver	Selenium	Thallium	Zinc
4.9	2.5E+01	1.1E+01	2.3E+01	1.5E+01	1.2E+03	3.1E+01	4.0E-02	1.6E+01	1.0E-01	1.8E+01	4.4E+01	1.6E+01
5.0	2.5E+01	1.2E+01	2.6E+01	1.7E+01	1.9E+03	3.1E+01	6.0E-02	1.8E+01	1.3E-01	1.7E+01	4.5E+01	1.8E+01
5.1	2.5E+01	1.4E+01	2.8E+01	1.9E+01	3.0E+03	3.0E+01	9.0E-02	2.0E+01	1.6E-01	1.6E+01	4.6E+01	1.9E+01
5.2	2.6E+01	1.5E+01	3.1E+01	2.1E+01	4.9E+03	2.9E+01	1.4E-01	2.2E+01	2.1E-01	1.5E+01	4.7E+01	2.1E+01
5.3	2.6E+01	1.7E+01	3.5E+01	2.3E+01	8.1E+03	2.8E+01	2.0E-01	2.4E+01	2.6E-01	1.4E+01	4.8E+01	2.3E+01
5.4	2.6E+01	1.9E+01	3.8E+01	2.5E+01	1.3E+04	2.7E+01	3.0E-01	2.6E+01	3.3E-01	1.3E+01	5.0E+01	2.5E+01
5.5	2.6E+01	2.1E+01	4.2E+01	2.7E+01	2.1E+04	2.7E+01	4.6E-01	2.8E+01	4.2E-01	1.2E+01	5.1E+01	2.6E+01
5.6	2.6E+01	2.2E+01	4.7E+01	2.9E+01	3.5E+04	2.6E+01	6.9E-01	3.0E+01	5.3E-01	1.1E+01	5.2E+01	2.8E+01
5.7	2.7E+01	2.4E+01	5.3E+01	3.1E+01	5.5E+04	2.5E+01	1.0E+00	3.2E+01	6.7E-01	1.1E+01	5.4E+01	3.0E+01
5.8	2.7E+01	2.6E+01	6.0E+01	3.3E+01	8.7E+04	2.5E+01	1.6E+00	3.4E+01	8.4E-01	9.8E+00	5.5E+01	3.2E+01
5.9	2.7E+01	2.8E+01	6.9E+01	3.5E+01	1.3E+05	2.4E+01	2.3E+00	3.6E+01	1.1E+00	9.2E+00	5.6E+01	3.4E+01
6.0	2.7E+01	3.0E+01	8.2E+01	3.7E+01	2.0E+05	2.3E+01	3.5E+00	3.8E+01	1.3E+00	8.6E+00	5.8E+01	3.6E+01
6.1	2.7E+01	3.1E+01	9.9E+01	4.0E+01	3.0E+05	2.3E+01	5.1E+00	4.0E+01	1.7E+00	8.0E+00	5.9E+01	3.9E+01
6.2	2.8E+01	3.3E+01	1.2E+02	4.2E+01	4.2E+05	2.2E+01	7.5E+00	4.2E+01	2.1E+00	7.5E+00	6.1E+01	4.2E+01
6.3	2.8E+01	3.5E+01	1.6E+02	4.4E+01	5.8E+05	2.2E+01	1.1E+01	4.5E+01	2.7E+00	7.0E+00	6.2E+01	4.4E+01
6.4	2.8E+01	3.6E+01	2.1E+02	4.8E+01	7.7E+05	2.1E+01	1.6E+01	4.7E+01	3.4E+00	6.5E+00	6.4E+01	4.7E+01
6.5	2.8E+01	3.7E+01	2.8E+02	5.2E+01	9.9E+05	2.0E+01	2.2E+01	5.0E+01	4.2E+00	6.1E+00	6.6E+01	5.1E+01
6.6	2.8E+01	3.9E+01	3.9E+02	5.7E+01	1.2E+06	2.0E+01	3.0E+01	5.4E+01	5.3E+00	5.7E+00	6.7E+01	5.4E+01
6.7	2.9E+01	4.0E+01	5.5E+02	6.4E+01	1.5E+06	1.9E+01	4.0E+01	5.8E+01	6.6E+00	5.3E+00	6.9E+01	5.8E+01
6.8	2.9E+01	4.1E+01	7.9E+02	7.5E+01	1.8E+06	1.9E+01	5.2E+01	6.5E+01	8.3E+00	5.0E+00	7.1E+01	6.2E+01
6.9	2.9E+01	4.2E+01	1.1E+03	9.1E+01	2.1E+06	1.8E+01	6.6E+01	7.4E+01	1.0E+01	4.7E+00	7.3E+01	6.8E+01
7.0	2.9E+01	4.2E+01	1.7E+03	1.1E+02	2.5E+06	1.8E+01	8.2E+01	8.8E+01	1.3E+01	4.3E+00	7.4E+01	7.5E+01
7.1	2.9E+01	4.3E+01	2.5E+03	1.5E+02	2.8E+06	1.7E+01	9.9E+01	1.1E+02	1.6E+01	4.1E+00	7.6E+01	8.3E+01
7.2	3.0E+01	4.4E+01	3.8E+03	2.0E+02	3.1E+06	1.7E+01	1.2E+02	1.4E+02	2.0E+01	3.8E+00	7.8E+01	9.5E+01
7.3	3.0E+01	4.4E+01	5.7E+03	2.8E+02	3.4E+06	1.6E+01	1.3E+02	1.8E+02	2.5E+01	3.5E+00	8.0E+01	1.1E+02
7.4	3.0E+01	4.5E+01	8.6E+03	4.0E+02	3.7E+06	1.6E+01	1.5E+02	2.5E+02	3.1E+01	3.3E+00	8.2E+01	1.3E+02
7.5	3.0E+01	4.6E+01	1.3E+04	5.9E+02	3.9E+06	1.6E+01	1.6E+02	3.5E+02	3.9E+01	3.1E+00	8.5E+01	1.6E+02
7.6	3.1E+01	4.6E+01	2.0E+04	8.7E+02	4.1E+06	1.5E+01	1.7E+02	4.9E+02	4.8E+01	2.9E+00	8.7E+01	1.9E+02
7.7	3.1E+01	4.7E+01	3.0E+04	1.3E+03	4.2E+06	1.5E+01	1.8E+02	7.0E+02	5.9E+01	2.7E+00	8.9E+01	2.4E+02
7.8	3.1E+01	4.9E+01	4.6E+04	1.9E+03	4.3E+06	1.4E+01	1.9E+02	9.9E+02	7.3E+01	2.5E+00	9.1E+01	3.1E+02
7.9	3.1E+01	5.0E+01	6.9E+04	2.9E+03	4.3E+06	1.4E+01	1.9E+02	1.4E+03	8.9E+01	2.4E+00	9.4E+01	4.0E+02
8.0	3.1E+01	5.2E+01	1.0E+05	4.3E+03	4.3E+06	1.4E+01	2.0E+02	1.9E+03	1.1E+02	2.2E+00	9.6E+01	5.3E+02

* Non pH-dependent inorganic K_d values for antimony, cyanide, and vanadium are 45, 9.9, and 1,000 (L/kg), respectively.



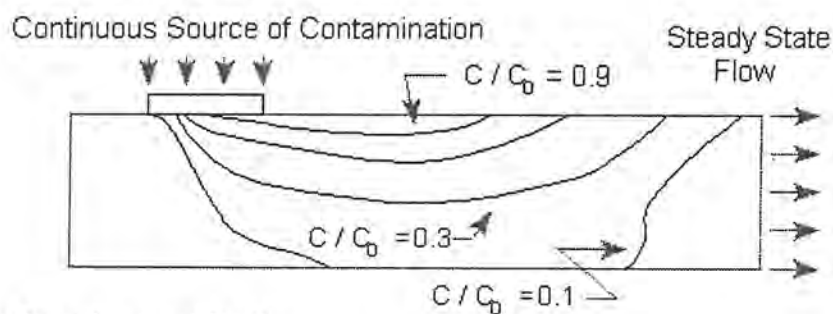
UNDERSTANDING VARIATION IN PARTITION COEFFICIENT, K_d , VALUES



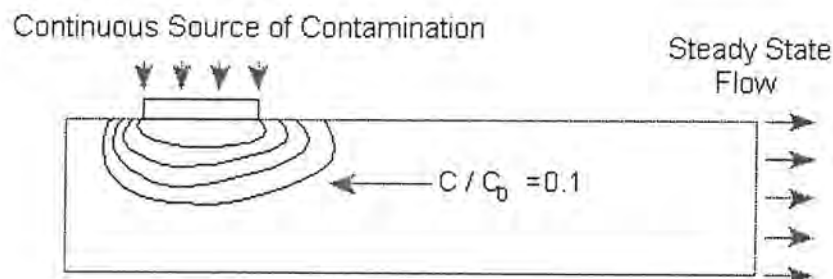
Volume II:

Review of Geochemistry and Available K_d Values for Cadmium, Cesium, Chromium, Lead, Plutonium, Radon, Strontium, Thorium, Tritium (^3H), and Uranium

Case I: $K_d = 1 \text{ ml/g}$



Case II: $K_d = 10 \text{ ml/g}$



UNDERSTANDING VARIATION IN PARTITION COEFFICIENT, K_d , VALUES

Volume II:

**Review of Geochemistry and Available K_d Values
for Cadmium, Cesium, Chromium, Lead, Plutonium,
Radon, Strontium, Thorium, Tritium (^3H), and Uranium**

August 1999

A Cooperative Effort By:

**Office of Radiation and Indoor Air
Office of Solid Waste and Emergency Response
U.S. Environmental Protection Agency
Washington, DC 20460**

**Office of Environmental Restoration
U.S. Department of Energy
Washington, DC 20585**

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FOREWORD

Understanding the long-term behavior of contaminants in the subsurface is becoming increasingly more important as the nation addresses groundwater contamination. Groundwater contamination is a national concern as about 50 percent of the United States population receives its drinking water from groundwater. It is the goal of the Environmental Protection Agency (EPA) to prevent adverse effects to human health and the environment and to protect the environmental integrity of the nation's groundwater.

Once groundwater is contaminated, it is important to understand how the contaminant moves in the subsurface environment. Proper understanding of the contaminant fate and transport is necessary in order to characterize the risks associated with the contamination and to develop, when necessary, emergency or remedial action plans. The parameter known as the partition (or distribution) coefficient (K_d) is one of the most important parameters used in estimating the migration potential of contaminants present in aqueous solutions in contact with surface, subsurface and suspended solids.

This two-volume report describes: (1) the conceptualization, measurement, and use of the partition coefficient parameter; and (2) the geochemical aqueous solution and sorbent properties that are most important in controlling adsorption/retardation behavior of selected contaminants. Volume I of this document focuses on providing EPA and other environmental remediation professionals with a reasoned and documented discussion of the major issues related to the selection and measurement of the partition coefficient for a select group of contaminants. The selected contaminants investigated in this two-volume document include: chromium, cadmium, cesium, lead, plutonium, radon, strontium, thorium, tritium (^3H), and uranium. This two-volume report also addresses a void that has existed on this subject in both this Agency and in the user community.

It is important to note that soil scientists and geochemists knowledgeable of sorption processes in natural environments have long known that generic or default partition coefficient values found in the literature can result in significant errors when used to predict the absolute impacts of contaminant migration or site-remediation options. Accordingly, one of the major recommendations of this report is that for site-specific calculations, partition coefficient values measured at site-specific conditions are absolutely essential.

For those cases when the partition coefficient parameter is not or cannot be measured, Volume II of this document: (1) provides a "thumb-nail sketch" of the key geochemical processes affecting the sorption of the selected contaminants; (2) provides references to related key experimental and review articles for further reading; (3) identifies the important aqueous- and solid-phase parameters controlling the sorption of these contaminants in the subsurface environment under oxidizing conditions; and (4) identifies, when possible, minimum and maximum conservative partition coefficient values for each contaminant as a function of the key geochemical processes affecting their sorption.

APPENDIX F

Partition Coefficients For Lead

Appendix F

Partition Coefficients For Lead

F.1.0 Background

The review of lead K_d data reported in the literature for a number of soils led to the following important conclusions regarding the factors which influence lead adsorption on minerals, soils, and sediments. These principles were used to evaluate available quantitative data and generate a look-up table. These conclusions are:

- Lead may precipitate in soils if soluble concentrations exceed about 4 mg/l at pH 4 and about 0.2 mg/l at pH 8. In the presence of phosphate and chloride, these solubility limits may be as low as 0.3 mg/l at pH 4 and 0.001 mg/l at pH 8. Therefore, in experiments in which concentrations of lead exceed these values, the calculated K_d values may reflect precipitation reactions rather than adsorption reactions.
- Anionic constituents such as phosphate, chloride, and carbonate are known to influence lead reactions in soils either by precipitation of minerals of limited solubility or by reducing adsorption through complex formation.
- A number of adsorption studies indicate that within the pH range of soils (4 to 11), lead adsorption increases with increasing pH.
- Adsorption of lead increases with increasing organic matter content of soils.
- Increasing equilibrium solution concentrations correlates with decreasing lead adsorption (decrease in K_d).

Lead adsorption behavior on soils and soil constituents (clays, oxides, hydroxides, oxyhydroxides, and organic matter) has been studied extensively. However, calculations by Rickard and Nriagu (1978) show that the solution lead concentrations used in a number of adsorption studies may be high enough to induce precipitation. For instance, their calculations show that lead may precipitate in soils if soluble concentrations exceed about 4 mg/l at pH 4 and about 0.2 mg/l at pH 8. In the presence of phosphate and chloride, these solubility limits may be as low as 0.3 mg/l at pH 4 and 0.001 mg/l at pH 8. Therefore, in experiments in which concentrations of lead exceed these values, the calculated K_d values may reflect precipitation reactions rather than adsorption reactions.

Based on lead adsorption behavior of 12 soils from Italy, Soldatini *et al.* (1976) concluded that soil organic matter and clay content were 2 major factors which influence lead adsorption. In these experiments, the maximum adsorption appeared to exceed the cation exchange capacity

(CEC) of the soils. Such an anomaly may have resulted from precipitation reactions brought about by high initial lead concentrations used in these experiments (20 to 830 mg/l).

Lead adsorption characteristics of 7 alkaline soils from India were determined by Singh and Sekhon (1977). The authors concluded that soil clay, organic matter, and the calcium carbonate influenced lead adsorption by these soils. However, the initial lead concentrations used in these experiments ranged from 5 to 100 mg/l, indicating that in these alkaline soils the dominant lead removal mechanism was quite possibly precipitation.

In another adsorption study, Abd-Elfattah and Wada (1981) measured the lead adsorption behavior of 7 Japanese soils. They concluded that soil mineral components which influenced lead adsorption ranged in the order: iron oxides>halloysite>imogolite, allophane>humus, kaolinite>montmorillonite. These data may not be reliable because high lead concentrations (up to 2,900 mg/l) used in these experiments may have resulted in precipitation reactions dominating the experimental system.

Anionic constituents, such as phosphate, chloride, and carbonate, are known to influence lead reactions in soils either by precipitation of minerals of limited solubility or by reducing adsorption through complex formation (Rickard and Nriagu, 1978). A recent study by Bargar *et al.* (1998) showed that chloride solutions could induce precipitation of lead as solid $PbOHCl$. Presence of synthetic chelating ligands such as ethylenediaminetetraacetic acid (EDTA) has been shown to reduce lead adsorption on soils (Peters and Shem, 1992). These investigators showed that the presence of strongly chelating EDTA in concentrations as low as 0.01 M reduced K_d for lead by about 3 orders of magnitude. By comparison quantitative data is lacking on the effects of more common inorganic ligands (phosphate, chloride, and carbonate) on lead adsorption on soils.

A number of adsorption studies indicate that within the pH range of soils (4 to 11), lead adsorption increases with increasing pH (Bittel and Miller, 1974; Braids *et al.*, 1972; Griffin and Shimp, 1976; Haji-Djafari *et al.*, 1981; Hildebrand and Blum, 1974; Overstreet and Krishnamurthy, 1950; Scrudato and Estes, 1975; Zimdahl and Hassett, 1977). Griffin and Shimp (1976) also noted that clay minerals adsorbing increasing amounts of lead with increasing pH may also be attributed to the formation of lead carbonate precipitates which was observed when the solution pH values exceeded 5 or 6.

Solid organic matter such as humic material in soils and sediments are known to adsorb lead (Rickard and Nriagu, 1978; Zimdahl and Hassett, 1977). Additionally, soluble organic matter such as fulvates and amino acids are known to chelate soluble lead and affect its adsorption on soils (Rickard and Nriagu, 1978). Gerritse *et al.* (1982) examined the lead adsorption properties of soils as a function of organic matter content of soils. Initial lead concentrations used in these experiments ranged from 0.001 to 0.1 mg/l. Based on adsorption data, the investigators expressed K_d value for a soil as a function of organic matter content (as wt.%) and the distribution coefficient of the organic matter. The data also indicated that irrespective of soil organic matter content, lead adsorption increased with increasing soil pH (from 4 to 8). In certain soils, lead is

also known to form methyl- lead complexes (Rickard and Nriagu, 1978). However, quantitative relationship between the redox status of soils and its effect on overall lead adsorption due to methylation of lead species is not known.

Tso (1970), and Sheppard *et al.* (1989) studied the retention of ^{210}Pb in soils and its uptake by plants. These investigators found that lead in trace concentrations was strongly retained on soils (high K_d values). Lead adsorption by a subsurface soil sample from Hanford, Washington was investigated by Rhoads *et al.* (1992). Adsorption data from these experiments showed that K_d values increased with decreasing lead concentrations in solution (from 0.2 mg/l to 0.0062 mg/l). At a fixed pH of 8.35, the authors found that K_d values were log-linearly correlated with equilibrium concentrations of lead in solution. Calculations showed that if lead concentrations exceeded about 0.207 mg/l, lead-hydroxycarbonate (hydrocerussite) would probably precipitate in this soil.

The K_d data described above are listed in Table F.1.

F.2.0 Approach

The initial step in developing a look-up table consisted of identifying the key parameters which were correlated with lead adsorption (K_d values) on soils and sediments. Data sets developed by Gerritse *et al.* (1982) and Rhoads *et al.* (1992) containing both soil pH and equilibrium lead concentrations as independent variables were selected to develop regression relationships with K_d as the dependent variable. From these data it was found that a polynomial relationship existed between K_d values and soil pH measurements. This relationship (Figure F.1) with a correlation coefficient of 0.971 (r^2) could be expressed as:

$$K_d \text{ (ml/g)} = 1639 - 902.4(\text{pH}) + 150.4(\text{pH})^2 \quad (\text{F.1})$$

The relationship between equilibrium concentrations of lead and K_d values for a Hanford soil at a fixed pH was expressed by Rhoads *et al.* (1992) as:

$$K_d \text{ (ml/g)} = 9,550 C^{-0.335} \quad (\text{F.2})$$

where C is the equilibrium concentration of lead in $\mu\text{g/l}$. The look-up table (Table F.2) was developed from using the relationships F.1 and F.2. Four equilibrium concentration and 3 pH categories were used to estimate the maximum and minimum K_d values in each category. The relationship between the K_d values and the 2 independent variables (pH and the equilibrium concentration) is shown as a 3-dimensional surface (Figure F.2). This graph illustrates that the highest K_d values are encountered under conditions of high pH values and very low equilibrium lead concentrations and in contrast, the lowest K_d values are encountered under lower pH and higher lead concentrations. The K_d values listed in the look-up table encompasses the ranges of pH and lead concentrations normally encountered in surface and subsurface soils and sediments.

Table F.1. Summary of K_d values for lead adsorption on soils.

Soil Description	Clay Content (wt.%)	Organic Carbon (wt.%)	Iron Oxide content (wt.%)	pH	CEC (meq/100g)	K_d (ml/g)	Experimental Parameters	Reference
Sediment, Split Rock Formation, Wyoming	--	--	--	2.0	--	20	--	Haji-Djafari <i>et al.</i> , 1981
	--	--	--	4.5	--	100	--	
	--	--	--	5.75	--	1,500	--	
	--	--	--	7.0	--	4,000	--	
Sand (Soil C) Sand (Soil C) Sandy Loam (Soil D) Sandy Loam (Soil D)	0	--	--	4.5	22	280	Batch Experiment	Gerritse <i>et al.</i> (1982)
	0	--	--	5.0	22	1295	Batch Experiment	
	2	--	--	7.5	16	3,000	Batch Experiment	
	2	--	--	8.0	16	4,000	Batch Experiment	
Loam (Soil 2) Medium Sand (Soil 3) Organic soil (Soil 4) Fine Sandy Loam (Soil 6)	15	--	--	7.3	17	21,000	Batch Experiment	Sheppard <i>et al.</i> (1989)
	2	--	--	4.9	5.8	19	Batch Experiment	
	<1	--	--	5.5	120	30,000	Batch Experiment	
	11	--	--	7.4	8.7	59,000	Batch Experiment	
Sand (Hanford)	0.06	<0.01	0.41	8.35	5.27	13,000 - 79,000	Batch tracer studies (Initial activities 2.38 - 23.4 μ Ci/l)	Rhoads <i>et al.</i> (1992)

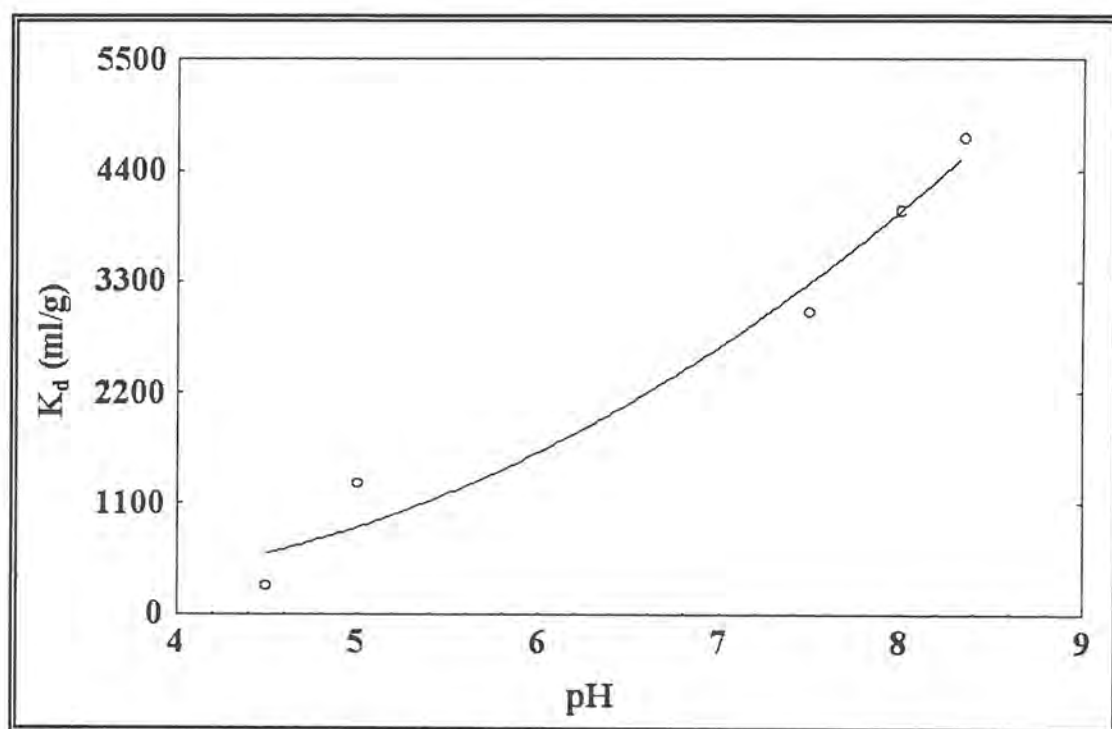


Figure F.1. Correlative relationship between K_d and pH.

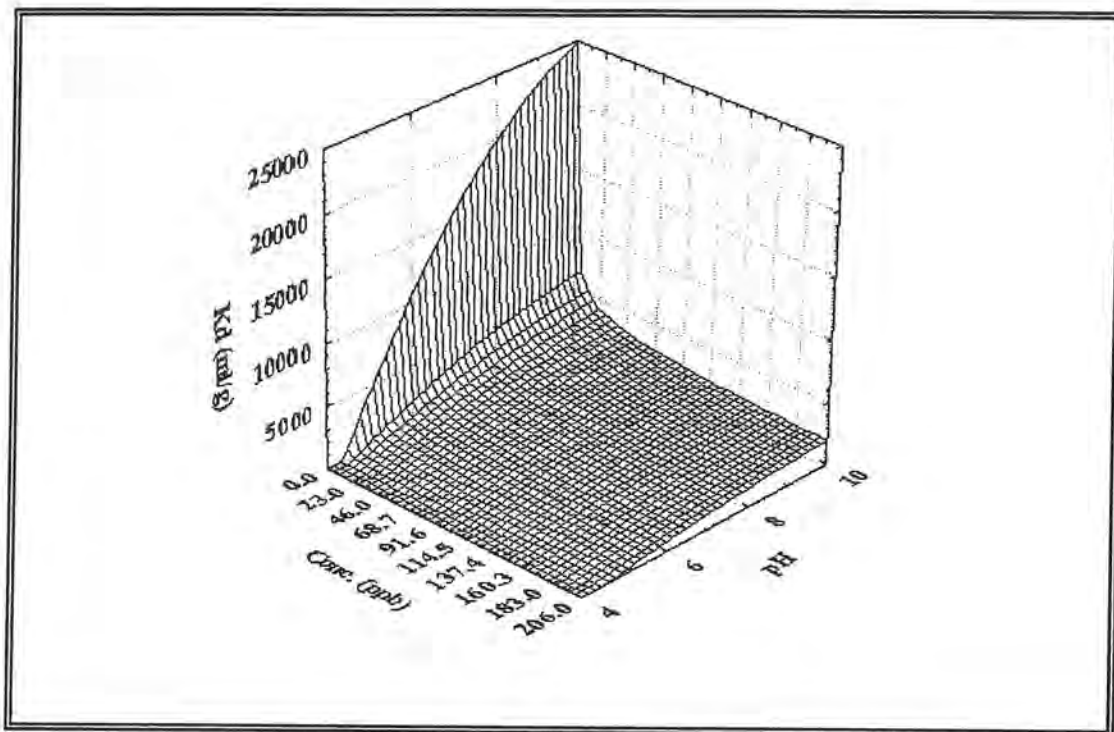


Figure F.2. Variation of K_d as a function of pH and the equilibrium lead concentrations.

F.3.0 Data Set for Soils

The data sets developed by Gerritse *et al.* (1982) and Rhoads *et al.* (1992) were used to develop the look-up table (Table F.2). Gerritse *et al.* (1982) developed adsorption data for 2 well-characterized soils using a range of lead concentrations (0.001 to 0.1 mg/l) which precluded the possibility of precipitation reactions. Similarly, adsorption data developed by Rhoads *et al.* (1992) encompassed a range of lead concentrations from 0.0001 to 0.2 mg/l at a fixed pH value. Both these data sets were used for estimating the range of K_d values for the range of pH and lead concentration values found in soils.

Table F.2. Estimated range of K_d values for lead as a function of soil pH, and equilibrium lead concentrations.

Equilibrium Lead Concentration ($\mu\text{g/l}$)	K_d (ml/g)	Soil pH		
		4.0 - 6.3	6.4 - 8.7	8.8 - 11.0
0.1 - 0.9	Minimum	940	4,360	11,520
	Maximum	8,650	23,270	44,580
1.0 - 9.9	Minimum	420	1,950	5,160
	Maximum	4,000	10,760	20,620
10 - 99.9	Minimum	190	900	2,380
	Maximum	1,850	4,970	9,530
100 - 200	Minimum	150	710	1,880
	Maximum	860	2,300	4,410

F.4.0 References

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Attachment 2

Mud Still Residue Data – TCLP And Statistical Analysis

Attachment 2

Mud Still Residue - TCLP Metals

Silver Bow Plant

[concentration in mg/l]

Run #	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
1	<0.5	<0.5	0.269	<0.5	0.66	<0.1	<0.5	<0.5
2	<0.5	<0.5	0.72	<0.5	1.07	0.11	<0.5	<0.5
2 Reanalysis	<0.05	0.05	1.86	0.11	1.12	0.03	<0.05	<0.05
3	<0.5	<0.5	2.03	<0.5	1.79	<0.01	<0.5	<0.5
2 Reanalysis	<0.05	<0.05	3.06	<0.01	1.33	0.02	<0.05	<0.05
4	<0.5	0.13	0.43	<0.05	0.83	<0.01	<0.05	<0.05
5	<0.5	0.08	1.56	<0.05	3.05	<0.01	<0.05	<0.05
6	<0.5	0.06	2.53	0.15	3.15	0.06	<0.05	<0.05
7	--	--	--	--	--	--	--	--
8	--	--	--	--	--	--	--	--
9	<0.5	<0.5	2.65	<0.5	1.31	<0.1	<0.5	<0.5
10	<0.5	<0.5	1.45	<0.5	<0.5	<0.1	<0.5	<0.5
11	<0.5	<0.5	<0.5	<0.5	1.4	<0.1	<0.5	<0.5
12	--	--	--	--	--	--	--	--
Concentration Rationale	0.5 Detection Limit	0.5 Detection Limit	2.1 95% KM(t) UCL ProUCL V5.0	0.5 Detection Limit	2.0 95% KM(t) UCL ProUCL V5.0	0.11 Maximum	0.5 Detection Limit	0.5 Detection Limit

Source: Clarifier Material Treatability Study; Phase 3 Report – Pilot Plant Operation (Franklin 2012).

UCL Statistics for Data Sets with Non-Detects				
User Selected Options				
Date/Time of Computation	10/10/2014 12:17:32 PM			
From File	Mud Still Residue TCLP Summary.xls			
Full Precision	OFF			
Confidence Coefficient	95%			
Number of Bootstrap Operations	2000			
Cd				
General Statistics				
Total Number of Observations	11	Number of Distinct Observations	11	
Number of Detects	10	Number of Non-Detects	1	
Number of Distinct Detects	10	Number of Distinct Non-Detects	1	
Minimum Detect	0.269	Minimum Non-Detect	0.5	
Maximum Detect	3.06	Maximum Non-Detect	0.5	
Variance Detects	0.918	Percent Non-Detects	9.091%	
Mean Detects	1.656	SD Detects	0.958	
Median Detects	1.71	CV Detects	0.579	
Skewness Detects	-0.136	Kurtosis Detects	-1.179	
Mean of Logged Detects	0.268	SD of Logged Detects	0.824	
Normal GOF Test on Detects Only				
Shapiro Wilk Test Statistic	0.951	Shapiro Wilk GOF Test		
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Normal at 5% Significance Level		
Lilliefors Test Statistic	0.136	Lilliefors GOF Test		
5% Lilliefors Critical Value	0.28	Detected Data appear Normal at 5% Significance Level		
Detected Data appear Normal at 5% Significance Level				
Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs				
Mean	1.537	Standard Error of Mean	0.3	
SD	0.945	95% KM (BCA) UCL	2.019	
95% KM (t) UCL	2.082	95% KM (Percentile Bootstrap) UCL	2.03	
95% KM (z) UCL	2.031	95% KM Bootstrap t UCL	2.042	
90% KM Chebyshev UCL	2.438	95% KM Chebyshev UCL	2.847	
97.5% KM Chebyshev UCL	3.413	99% KM Chebyshev UCL	4.526	
Gamma GOF Tests on Detected Observations Only				
A-D Test Statistic	0.445	Anderson-Darling GOF Test		
5% A-D Critical Value	0.735	Detected data appear Gamma Distributed at 5% Significance Level		
K-S Test Statistic	0.212	Kolmogrov-Smirnoff GOF		
5% K-S Critical Value	0.269	Detected data appear Gamma Distributed at 5% Significance Level		
Detected data appear Gamma Distributed at 5% Significance Level				
Gamma Statistics on Detected Data Only				
k hat (MLE)	2.269	k star (bias corrected MLE)	1.655	
Theta hat (MLE)	0.73	Theta star (bias corrected MLE)	1.001	
nu hat (MLE)	45.37	nu star (bias corrected)	33.1	

MLE Mean (bias corrected)	1.656	MLE Sd (bias corrected)	1.287
Gamma Kaplan-Meier (KM) Statistics			
k hat (KM)	2.647	nu hat (KM)	58.24
Approximate Chi Square Value (58.24, α)	41.7	Adjusted Chi Square Value (58.24, β)	39.43
95% Gamma Approximate KM-UCL (use when $n \geq 50$)	2.147	95% Gamma Adjusted KM-UCL (use when $n < 50$)	2.271
Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detected data is small such as < 0.1			
For such situations, GROS method tends to yield inflated values of UCLs and BTVs			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	0.269	Mean	1.552
Maximum	3.06	Median	1.56
SD	0.972	CV	0.627
k hat (MLE)	2.097	k star (bias corrected MLE)	1.586
Theta hat (MLE)	0.74	Theta star (bias corrected MLE)	0.979
nu hat (MLE)	46.13	nu star (bias corrected)	34.88
MLE Mean (bias corrected)	1.552	MLE Sd (bias corrected)	1.232
		Adjusted Level of Significance (β)	0.0278
Approximate Chi Square Value (34.88, α)	22.37	Adjusted Chi Square Value (34.88, β)	20.75
95% Gamma Approximate UCL (use when $n \geq 50$)	2.419	95% Gamma Adjusted UCL (use when $n < 50$)	2.608
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statistic	0.874	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.25	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.28	Detected Data appear Lognormal at 5% Significance Level	
Detected Data appear Lognormal at 5% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	1.544	Mean in Log Scale	0.166
SD in Original Scale	0.982	SD in Log Scale	0.852
95% t UCL (assumes normality of ROS data)	2.08	95% Percentile Bootstrap UCL	1.99
95% BCA Bootstrap UCL	2.06	95% Bootstrap t UCL	2.102
95% H-UCL (Log ROS)	3.536		
UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed			
KM Mean (logged)	0.146	95% H-UCL (KM -Log)	3.395
KM SD (logged)	0.843	95% Critical H Value (KM-Log)	2.707
KM Standard Error of Mean (logged)	0.269		
DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.528	Mean in Log Scale	0.118
SD in Original Scale	1.003	SD in Log Scale	0.927
95% t UCL (Assumes normality)	2.076	95% H-Stat UCL	4
DL/2 is not a recommended method, provided for comparisons and historical reasons			

Nonparametric Distribution Free UCL Statistics							
Detected Data appear Normal Distributed at 5% Significance Level							
Suggested UCL to Use							
95% KM (t) UCL	2.1	95% KM (Percentile Bootstrap) UCL					2.0
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.							
Recommendations are based upon data size, data distribution, and skewness.							
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).							
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.							

UCL Statistics for Data Sets with Non-Detects				
User Selected Options				
Date/Time of Computation	10/10/2014 12:18:21 PM			
From File	Mud Still Residue TCLP Summary.xls			
Full Precision	OFF			
Confidence Coefficient	95%			
Number of Bootstrap Operations	2000			
Pb				
General Statistics				
Total Number of Observations	11	Number of Distinct Observations	11	
Number of Detects	10	Number of Non-Detects	1	
Number of Distinct Detects	10	Number of Distinct Non-Detects	1	
Minimum Detect	0.66	Minimum Non-Detect	0.5	
Maximum Detect	3.15	Maximum Non-Detect	0.5	
Variance Detects	0.746	Percent Non-Detects	9.091%	
Mean Detects	1.571	SD Detects	0.864	
Median Detects	1.32	CV Detects	0.55	
Skewness Detects	1.242	Kurtosis Detects	0.404	
Mean of Logged Detects	0.332	SD of Logged Detects	0.505	
Normal GOF Test on Detects Only				
Shapiro Wilk Test Statistic	0.821	Shapiro Wilk GOF Test		
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level		
Lilliefors Test Statistic	0.278	Lilliefors GOF Test		
5% Lilliefors Critical Value	0.28	Detected Data appear Normal at 5% Significance Level		
Detected Data appear Approximate Normal at 5% Significance Level				
Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs				
Mean	1.474	Standard Error of Mean	0.267	
SD	0.84	95% KM (BCA) UCL	1.901	
95% KM (t) UCL	1.957	95% KM (Percentile Bootstrap) UCL	1.917	
95% KM (z) UCL	1.913	95% KM Bootstrap t UCL	2.388	
90% KM Chebyshev UCL	2.274	95% KM Chebyshev UCL	2.637	
97.5% KM Chebyshev UCL	3.141	99% KM Chebyshev UCL	4.13	
Gamma GOF Tests on Detected Observations Only				
A-D Test Statistic	0.494	Anderson-Darling GOF Test		
5% A-D Critical Value	0.729	Detected data appear Gamma Distributed at 5% Significance Level		
K-S Test Statistic	0.229	Kolmogrov-Smirnoff GOF		
5% K-S Critical Value	0.268	Detected data appear Gamma Distributed at 5% Significance Level		
Detected data appear Gamma Distributed at 5% Significance Level				
Gamma Statistics on Detected Data Only				
k hat (MLE)	4.321	k star (bias corrected MLE)	3.091	
Theta hat (MLE)	0.364	Theta star (bias corrected MLE)	0.508	
nu hat (MLE)	86.42	nu star (bias corrected)	61.83	

MLE Mean (bias corrected)	1.571	MLE Sd (bias corrected)	0.894
Gamma Kaplan-Meier (KM) Statistics			
k hat (KM)	3.078	nu hat (KM)	67.72
Approximate Chi Square Value (67.72, α)	49.78	Adjusted Chi Square Value (67.72, β)	47.28
95% Gamma Approximate KM-UCL (use when $n \geq 50$)	2.005	95% Gamma Adjusted KM-UCL (use when $n < 50$)	2.111
Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detected data is small such as < 0.1			
For such situations, GROS method tends to yield inflated values of UCLs and BTVs			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	0.044	Mean	1.432
Maximum	3.15	Median	1.31
SD	0.94	CV	0.656
k hat (MLE)	1.609	k star (bias corrected MLE)	1.231
Theta hat (MLE)	0.89	Theta star (bias corrected MLE)	1.163
nu hat (MLE)	35.4	nu star (bias corrected)	27.08
MLE Mean (bias corrected)	1.432	MLE Sd (bias corrected)	1.291
		Adjusted Level of Significance (β)	0.0278
Approximate Chi Square Value (27.08, α)	16.21	Adjusted Chi Square Value (27.08, β)	14.86
95% Gamma Approximate UCL (use when $n \geq 50$)	2.392	95% Gamma Adjusted UCL (use when $n < 50$)	2.61
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statistic	0.934	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.196	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.28	Detected Data appear Lognormal at 5% Significance Level	
Detected Data appear Lognormal at 5% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	1.465	Mean in Log Scale	0.22
SD in Original Scale	0.891	SD in Log Scale	0.605
95% t UCL (assumes normality of ROS data)	1.952	95% Percentile Bootstrap UCL	1.9
95% BCA Bootstrap UCL	1.972	95% Bootstrap t UCL	2.296
95% H-UCL (Log ROS)	2.333		
UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed			
KM Mean (logged)	0.238	95% H-UCL (KM -Log)	2.159
KM SD (logged)	0.543	95% Critical H Value (KM-Log)	2.234
KM Standard Error of Mean (logged)	0.173		
DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.451	Mean in Log Scale	0.175
SD in Original Scale	0.911	SD in Log Scale	0.705
95% t UCL (Assumes normality)	1.949	95% H-Stat UCL	2.654
DL/2 is not a recommended method, provided for comparisons and historical reasons			

Nonparametric Distribution Free UCL Statistics							
Detected Data appear Approximate Normal Distributed at 5% Significance Level							
Suggested UCL to Use							
95% KM (t) UCL	2.0	95% KM (Percentile Bootstrap) UCL					1.9
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.							
Recommendations are based upon data size, data distribution, and skewness.							
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).							
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.							

Appendix L

Assumptions for Crew Size and Exposure Duration

Table L-1

**Crew Size and Task Duration Assumptions
Clarifier Materials**

Enhanced RCRA Cap

Risk - Contributing Exposure	Baseline Worker Scenario						Protected Worker Scenario				
	Crew			Crew Size (persons)	Task Duration (hours)	Duration Assumption	Assumed Level of Protection	Incremental Addition to:		Crew Size (persons)	Task Duration (hours)
	Forman	Operator	Laborer					Crew Size (persons)	Task Duration Factor		
A	B	C	D	E=(B+C+D)	F	G	H	I	J	K = (E + I)	L = (F X J)
Site Preparation	1	1	1	3	20	1/2 week	1	--	1.0	3	20
Subgrade Placement	1	4	1	6	80	2 weeks	2	0.5	1.1	6.5	88
Surcharge Placement/Removal	1	4	1	6	80	2 weeks	1	--	1.0	6	80
Consolidation Monitoring	1	--	1	2	20	1 hr/ week for 20 weeks	1	--	1.0	2	20
Gas Collection System Installation	1	1	2	4	20	1/2 week	2	0.5	1.1	4.5	22
Subgrade Placement	1	9	2	12	40	1 week	1	--	1.0	12	40
Subgrade Regrading	1	1	--	2	60	1.5 weeks	1	--	1.0	2	60
Liner Placement	1	4	1	6	100	2.5 weeks	1	--	1.0	6	100
Cover Soil Placement/Grading	1	4	1	6	500	12.5 weeks	1	--	1.0	6	500
Restoration/Revegetation/Fencing	1	1	--	2	140	3.5 weeks	1	--	1.0	2	140
Maintenance & Monitoring				1.9	484	Total Maintenance and Monitoring	1	--	1.0	1.9	484
Year 1 to 5	1	--	1	2	200	40 hr/yr for 5 yrs	1	--	1	2	200
Years 6 to 30	1	--	1	2	225	9 hr/yr for 25 yrs	1	--	1	2	225
Years 31 to 100	1	--	--	1	70	1 hr/yr for 70 yrs	1	--	1	1	70
Estimated Duration of Exposure [person-hrs]				6,540						6,651	

Table L-2

Crew Size and Task Duration Assumptions Clarifier Materials

On-site Phosphorus Recovery (Mud Still)

Risk - Contributing Exposure	Baseline Worker Scenario						Protected Worker Scenario				
	Crew			Crew Size (persons)	Task Duration (hours)	Duration Assumption	Assumed Level of Protection	Incremental Addition to:		Crew Size (persons)	Task Duration (hours)
	Foreman	Operator	Laborer					Crew Size (persons)	Task Duration Factor		
A	B	C	D	E=(B+C+D)	F	G	H	I	J	K = (E + I)	L = (F X J)
Removal Operations											
Site Preparation	1	1	1	3	20	1/2 week	1	--	1.0	3	20
Mud Still Preparation											
Construct/Test Feed System	2	4	10	16	500	1/4 year	1	1	1.0	17	500
Construct/Test Mud Still	2	4	10	16	2000	1/2 year	1	1	1.0	17	2,000
Construct/Test Offgas System	2	4	10	16	1000	1/2 year	1	1	1.0	17	1,000
Test Burn	2	2	4	8	24	24 hr	1	1	1.0	9	24
Mud Still Operations (24 hr/day; 7 days/wk; 5 batches/wk; 71% Onstream time)											
Excavate CP and Load Skips	2	2	2	6	4,760	4 hr/day; 7 days/wk; 170 wks	3	1	1.4	7	6,664
Water Cap Control/Maintenance	--	--	1	1	595	1/2 hr/day; 7 days/wk, 170 wks	2	0.5	1.1	1.5	655
Open Skip and Remove Residue	2	2	2	6	2,380	2 hr/day; 7 days/wk; 170 wks	3	1	1.4	7	3,332
Transfer P4 product	2	2	2	6	2,380	2 hr/day; 7 days/wk; 170 wks	3	1	1.4	7	3,332
System Maintenance	2	2	2	6	3,600	40 hr/week; 90 weeks	1	0	1.0	6	3,600
Transport (via truck) to P4 facility *	--	1	--	1	1,120	38 - 20 Tons loads	1	--	1.0	1	1,120
Transport (Truck returns to site) *	--	1	--	1	1,120	38 return trips	1	--	1.0	1	1,120
Transfer P4 product to P4 facility tanks	1	1	1	3	76	2 hr/load	3	1	1.0	4	76
P4 use at P4 facility	1	1	1	3	76	2 hr/load	3	1	1.0	4	76
Closure Operations											
Decontaminate & Decommission Facilities	1	2	6	9	320	8 - 40 hr weeks	3	1	1.4	10	448
Place Residue in Clarifier	1	1	1	3	16	2 days	1	1	1.4	4	22
Backfill/ Compaction	1	4	1	6	40	1 week	1	--	1.0	6	40
Evapotranspiration Cap	--	--	--	--	2,620	Table L-4	--	--	--	--	2,731
Maintenance & Monitoring				1.9	484	Total Maintenance and Monitoring	1	--	1.0	1.9	484
Year 1 to 5	1	--	1	2	200	40 hr/yr for 5 yrs	1	--	1	2	200
Years 6 to 30	1	--	1	2	225	9 hr/yr for 25 yrs	1	--	1	2	225
Years 31 to 100	1	--	--	1	70	1 hr/yr for 70 yrs	1	--	1	1	70
Estimated Duration of Exposure [person-hrs]				123,370						165,362	

Table L-3

**Crew Size and Task Duration Assumptions
Clarifier Materials**

Off-site Incineration

Risk - Contributing Exposure	Baseline Worker Scenario						Protected Worker Scenario				
	Crew			Crew Size (persons)	Task Duration (hours)	Duration Assumption	Assumed Level of Protection	Incremental Addition to:		Crew Size (persons)	Task Duration (hours)
	Forman	Operator	Laborer					Crew Size (persons)	Task Duration Factor		
A	B	C	D	E=(B+C+D)	F	G	H	I	J	K = (E + I)	L = (F X J)
Removal Operations											
Site Preparation	1	1	1	3	20	1/2 week	1	--	1.0	3	20
Water Cap Control/Maintenance	--	--	1	1	360	1/2 hr / day	2	0.5	1.1	1.5	396
Removal Operations (Clarifier to Drum)	1	4	3	8	5,750	Removal rate is 16 drums / 8 hr (day)	1	1	1.4	9	8,050
Drum Transfer to Storage	1	1	1	3	720	1 hr/day	3	1	1.4	4	1,008
Drum Inspection and pH adjustment	--	1	--	1	11,680	2 hr /day; 16 yrs	1	--	1.0	1	11,680
Transportation Operations											
Drum Transfer (Storage to Truck)	1	1	--	2	288	2 hrs / load	1	--	1.0	2	288
Transport (via truck) to TSD facility *	--	1	--	1	4,320	Sauget, IL	1	--	1.0	1	4,320
Transport (Truck returns to site) *	--	1	--	1	4,320		1	--	1.0	1	4,320
Incineration Operations											
Receive/unload truck at TSD facility	1	1	--	2	288	2 hrs / load	1	1	1.4	3	403
Transfer to Incinerator Unit	--	1	--	1	2,920	0.5 hr / day; 16 yrs	3	1	1.4	2	4,088
Stabilize ash and waste residue from air cleaning system for final landfill disposal	1	1	--	2	1600	2 hr/wk; 50 wks/yr; 16 yrs	1	--	1.0	2	1,600
Closure Operations											
Backfill/ Compaction	1	4	1	6	40	1 week	1	--	1.0	6	40
Evapotranspiration Cap	--	--	--	--	2,620	Table J-4	--	--	--	--	2,731
Maintenance & Monitoring				1.9	484	Total Maintenance and Monitoring	1	--	1.0	1.9	484
Estimated Duration of Exposure [person-hrs]				79,951						114,508	

Table L-4

**Crew Size and Task Duration Assumptions
Clarifier Materials**

Evapotranspiration Cap

Risk - Contributing Exposure	Baseline Worker Scenario						Protected Worker Scenario				
	Crew			Crew Size (persons)	Task Duration (hours)	Duration Assumption	Assumed Level of Protection	Incremental Addition to:		Crew Size (persons)	Task Duration (hours)
	Forman	Operator	Laborer					Crew Size (persons)	Task Duration Factor		
A	B	C	D	E=(B+C+D)	F	G	H	I	J	K = (E + I)	L = (F X J)
Site Preparation	1	1	1	3	20	1/2 week	1	--	1.0	3	20
Subgrade Placement	1	4	1	6	80	2 weeks	2	0.5	1.1	6.5	88
Surcharge Placement/Removal	1	4	1	6	40	1 week	1	--	1.0	6	40
Consolidation Monitoring	1	--	1	2	20	1 hr/ week for 20 weeks	1	--	1.0	2	20
Gas Collection System Installation	1	1	2	4	20	1/2 week	2	0.5	1.1	4.5	22
Subgrade Regrading	1	1	--	2	20	1/2 week	1	--	1.0	2	20
Cover Soil Placement/Grading	1	4	1	6	120	3 weeks	1	--	1.0	6	120
Restoration/Revegetation	1	1	--	2	20	1/2 week	1	--	1.0	2	20
Maintenance & Monitoring				1.9	484	Total Maintenance and Monitoring	1	--	1.0	1.9	484
Year 1 to 5	1	--	1	2	200	40 hr/yr for 5 yrs	1	--	1	2	200
Years 6 to 30	1	--	1	2	225	9 hr/yr for 25 yrs	1	--	1	2	225
Years 31 to 100	1	--	--	1	70	1 hr/yr for 70 yrs	1	--	1	1	70
Estimated Duration of Exposure [person-hrs]				2,620						2,731	

Appendix M

Risk Calculations for Short-term Risk Scenarios

Table M-1

Short term Worker Risk Scenarios and Estimated Probability of Fatality
Baseline Worker Scenario
Clarifier Materials

Enhanced RCRA Cap

Risk - Contributing Exposure	Crew Size¹ (persons)	Task Duration¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Risk Factor	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D = (B X C)	E	F	G = (E X F)	H = (D X G)	
Site Preparation	3	20	60	4.7E-08	1	4.7E-08	2.8E-06	
Subgrade Placement	6	80	480	4.7E-08	3	1.4E-07	6.8E-05	
Surcharge Placement/Removal	6	80	480	4.7E-08	1	4.7E-08	2.3E-05	
Consolidation Monitoring	2	20	40	4.7E-08	1	4.7E-08	1.9E-06	
Gas Collection System Installation	4	20	80	4.7E-08	3	1.4E-07	1.1E-05	
Subgrade Placement	12	40	480	4.7E-08	1	4.7E-08	2.3E-05	
Subgrade Regrading	2	60	120	4.7E-08	1	4.7E-08	5.6E-06	
Liner Placement	6	100	600	4.7E-08	1	4.7E-08	2.8E-05	
Cover Soil Placement/Grading	6	500	3,000	4.7E-08	1	4.7E-08	1.4E-04	
Restoration/Revegetation/Fencing	2	140	280	1.1E-07	1	1.1E-07	3.1E-05	
Maintenance & Monitoring	1.9	484	920	5.9E-09	1	5.9E-09	5.4E-06	
TOTAL (Sum of column)			6,540				3.4E-04	Low
Probability of Worker Fatality							0.0007%	

¹ See Appendix L for estimated crew size and task duration.

Table M-2

Short term Worker Risk Scenarios and Estimated Probability of Fatality
Protected Worker Scenario
Clarifier Materials

Enhanced RCRA Cap

Risk - Contributing Exposure	Assumed Level of Protection¹	Crew Size¹ (persons)	Task Duration¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Heat Stress Risk Rate (risk/hr)	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D	E = (C X D)	F	G	H = (F + G)	I = (E X H)	
Site Preparation	1	3	20	60	4.7E-08	1.6E-09	4.9E-08	2.9E-06	
Subgrade Placement	2	6.5	88	572	4.7E-08	1.6E-09	4.9E-08	2.8E-05	
Surcharge Placement/Removal	1	6	80	480	4.7E-08	1.6E-09	4.9E-08	2.3E-05	
Consolidation Monitoring	1	2	20	40	4.7E-08	1.6E-09	4.9E-08	1.9E-06	
Gas Collection System Installation	2	4.5	22	99	4.7E-08	1.6E-09	4.9E-08	4.8E-06	
Subgrade Placement	1	12	40	480	4.7E-08	1.6E-09	4.9E-08	2.3E-05	
Subgrade Regrading	1	2	60	120	4.7E-08	1.6E-09	4.9E-08	5.8E-06	
Liner Placement	1	6	100	600	4.7E-08	1.6E-09	4.9E-08	2.9E-05	
Cover Soil Placement/Grading	1	6	500	3,000	4.7E-08	1.6E-09	4.9E-08	1.5E-04	
Restoration/Revegetation/Fencing	1	2	140	280	1.1E-07	1.6E-09	1.1E-07	3.1E-05	
Maintenance and Monitoring	1	1.9	484	920	5.9E-09	--	5.9E-09	5.4E-06	
TOTAL (Sum of column)				6,651				3.0E-04	Low
Probability of Worker Fatality								0.0006%	

¹ See Appendix L for assumed level of protection, crew size and task duration.

Table M-3

Short term Worker Risk Scenarios and Estimated Probability of Serious Injury
Baseline Worker Scenario
Clarifier Materials

Enhanced RCRA Cap

Risk - Contributing Exposure	Crew Size ¹ (persons)	Task Duration ¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Risk Factor	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D = (B X C)	E	F	G = (E X F)	H = (D X G)	
Site Preparation	3	20	60	1.6E-06	1	1.6E-06	9.3E-05	
Subgrade Placement	6	80	480	1.6E-06	3	4.7E-06	2.2E-03	
Surcharge Placement/Removal	6	80	480	1.6E-06	1	1.6E-06	7.4E-04	
Consolidation Monitoring	2	20	40	1.6E-06	1	1.6E-06	6.2E-05	
Gas Collection System Installation	4	20	80	1.6E-06	3	4.7E-06	3.7E-04	
Subgrade Placement	12	40	480	1.6E-06	1	1.6E-06	7.4E-04	
Subgrade Regrading	2	60	120	1.6E-06	1	1.6E-06	1.9E-04	
Liner Placement	6	100	600	1.6E-06	1	1.6E-06	9.3E-04	
Cover Soil Placement/Grading	6	500	3,000	1.6E-06	1	1.6E-06	4.7E-03	
Restoration/Revegetation/Fencing	2	140	280	2.6E-06	1	2.6E-06	7.3E-04	
Maintenance and Monitoring	1.9	484	920	4.0E-07	1	4.0E-07	3.7E-04	
TOTAL (Sum of column)			6,540				1.1E-02	Medium
Probability of Serious Injury							0.02%	

¹ See Appendix L for estimated crew size and task duration.

Table M-4

Short term Worker Risk Scenarios and Estimated Probability of Serious Injury
Protected Worker Scenario
Clarifier Materials

Enhanced RCRA Cap

Risk - Contributing Exposure	Assumed Level of Protection¹	Crew Size¹ (persons)	Task Duration¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Heat Stress Risk Rate (risk/hr)	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D	E = (D X C)	F	G	H = (F + G)	I = (E X H)	
Site Preparation	1	3	20	60	1.6E-06	2.6E-07	1.8E-06	1.1E-04	
Subgrade Placement	2	6.5	88	572	1.6E-06	2.6E-07	1.8E-06	1.0E-03	
Surcharge Placement/Removal	1	6	80	480	1.6E-06	2.6E-07	1.8E-06	8.7E-04	
Consolidation Monitoring	1	2	20	40	1.6E-06	2.6E-07	1.8E-06	7.2E-05	
Gas Collection System Installation	2	4.5	22	99	1.6E-06	2.6E-07	1.8E-06	1.8E-04	
Subgrade Placement	1	12	40	480	1.6E-06	2.6E-07	1.8E-06	8.7E-04	
Subgrade Regrading	1	2	60	120	1.6E-06	2.6E-07	1.8E-06	2.2E-04	
Liner Placement	1	6	100	600	1.6E-06	2.6E-07	1.8E-06	1.1E-03	
Cover Soil Placement/Grading	1	6	500	3,000	1.6E-06	2.6E-07	1.8E-06	5.4E-03	
Restoration/Revegetation/Fencing	1	2	140	280	2.6E-06	2.6E-07	2.9E-06	8.0E-04	
Maintenance and Monitoring	1	1.9	484	920	4.0E-07	2.6E-07	6.6E-07	6.1E-04	
TOTAL (Sum of column)				6,651				1.1E-02	Medium
Probability of Serious Injury								0.02%	

¹ See Appendix L for assumed level of protection, crew size and task duration.

Table M-5

Short term Worker Risk Scenarios and Estimated Probability of Fatality
Baseline Worker Scenario
Clarifier Materials

On-site Phosphorus Recovery (Mud Still)

Risk - Contributing Exposure	Crew Size ¹ (persons)	Task Duration ¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Risk Factor	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D = (B X C)	E	F	G = (E X F)	H = (D X G)	

Removal Operations

Site Preparation	3	20	60	4.7E-08	1	4.7E-08	2.8E-06
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Mud Still Preparation

Construct/Test Feed System	16	500	8,000	4.7E-08	1	4.7E-08	3.8E-04
Construct/Test Mud Still	16	2,000	32,000	4.7E-08	1	4.7E-08	1.5E-03
Construct/Test Offgas System	16	1,000	16,000	4.7E-08	1	4.7E-08	7.5E-04
Test Burn	8	24	192	4.7E-08	1	4.7E-08	9.0E-06

Mud Still Operations (24 hr/day; 7 days/wk; 5 batches/wk; 71% Onstream time)

Transfer Operations (Clarifier to Skip)	6	4,760	28,560	7.0E-09	10	7.0E-08	2.0E-03
Water Cap Control/Maintenance	1	595	595	7.0E-09	1	7.0E-09	4.1E-06
Open Skip and Remove Residue	6	2,380	14,280	7.0E-09	1	7.0E-09	9.9E-05
Transfer P4 product to ISO containers	6	2,380	14,280	7.0E-09	1	7.0E-09	9.9E-05
System Maintenance	6	3,600	21,600	7.0E-09	1	7.0E-09	1.5E-04
Transport (via truck) to P4 facility ²	1	1,120	1,120	1.3E-07	1	1.3E-07	1.4E-04
Transport (Truck returns to site) ²	1	1,120	1,120	1.3E-07	1	1.3E-07	1.4E-04
Transfer P4 product to P4 facility tanks	3	76	228	7.0E-09	1	7.0E-09	1.6E-06
P4 use at P4 facility	3	76	228	7.0E-09	1	7.0E-09	1.6E-06

Closure Operations

Decontaminate & Decommission Facilities	9	320	2,880	7.0E-09	10	7.0E-08	2.0E-04
Place Residue in Clarifier	3	16	48	7.0E-09	1	7.0E-09	3.3E-07
Backfill/ Compaction	6	40	240	7.0E-09	1	7.0E-09	1.7E-06

Evapotranspiration Cap (see Table M-13)	--	--	2,620	--	--	--	1.4E-04
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Maintenance & Monitoring	1.9	484	920	5.9E-09	1	5.9E-09	5.4E-06
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TOTAL (Sum of column)			144,970				5.6E-03	Medium
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Probability of Worker Fatality							0.005%	
---------------------------------------	--	--	--	--	--	--	---------------	--

¹ See Appendix L for estimated crew size and task duration.

² Truck transport fatality risk calculated from risk/mile rate of 2.5×10^{-9} / mile (assuming 50 mi/hr)

Table M-6

Short term Worker Risk Scenarios and Estimated Probability of Fatality
Protected Worker Scenario
Clarifier Materials

On-site Phosphorus Recovery (Mud Still)

Risk - Contributing Exposure	Assumed Level of Protection ¹	Crew Size ¹ (persons)	Task Duration ¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Heat Stress Risk Rate (risk/hr)	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D	E = (C X D)	F	G	H = (F + G)	I = (E X H)	

Removal Operations

Site Preparation	1	3	20	60	4.7E-08	1.6E-09	4.9E-08	2.9E-06
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Mud Still Preparation

Construct/Test Feed System	1	17	500	8,500	4.7E-08	1.6E-09	4.9E-08	4.1E-04
Construct/Test Mud Still	1	17	2,000	34,000	4.7E-08	1.6E-09	4.9E-08	1.6E-03
Construct/Test Offgas System	1	17	1,000	17,000	4.7E-08	1.6E-09	4.9E-08	8.2E-04
Test Burn	1	9	24	216	4.7E-08	1.6E-09	4.9E-08	1.0E-05

Mud Still Operations (24 hr/day; 7 days/wk; 5 batches/wk; 71% Onstream time)

Transfer Operations (Clarifier to Skip)	3	7	6,664	46,648	7.0E-09	1.6E-09	8.6E-09	4.0E-04
Water Cap Control/Maintenance	2	1.5	655	982	7.0E-09	1.6E-09	8.6E-09	8.4E-06
Open Skip and Remove Residue	3	7	3,332	23,324	7.0E-09	1.6E-09	8.6E-09	2.0E-04
Transfer P4 product	3	7	3,332	23,324	7.0E-09	1.6E-09	8.6E-09	2.0E-04
System Maintenance	1	6	3,600	21,600	7.0E-09	1.6E-09	8.6E-09	1.8E-04
Transport (via truck) to P4 facility ²	1	1	1,120	1,120	1.3E-07	--	1.3E-07	1.4E-04
Transport (Truck returns to site) ²	1	1	1,120	1,120	1.3E-07	--	1.3E-07	1.4E-04
Transfer P4 product to P4 facility tanks	3	4	76	304	7.0E-09	1.6E-09	8.6E-09	2.6E-06
P4 use at P4 facility	3	4	76	304	7.0E-09	1.6E-09	8.6E-09	2.6E-06

Closure Operations

Decontaminate & Decommission Facilities	3	10	448	4,480	7.0E-09	1.6E-09	8.6E-09	3.8E-05
Place Residue in Clarifier	1	4	22	90	7.0E-09	1.6E-09	8.6E-09	7.7E-07
Backfill/ Compaction	1	6	40	240	7.0E-09	1.6E-09	8.6E-09	2.1E-06

Evapotranspiration Cap (see Table M-14)	--	0	0	2,731	--	--	--	9.6E-05
---	----	---	---	-------	----	----	----	---------

Maintenance & Monitoring	1	1.9	484	920	5.9E-09	--	5.9E-09	5.4E-06
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TOTAL (Sum of column)**186,962****4.3E-03****Medium****Probability of Worker Fatality****0.003%**¹ See Appendix L for assumed level of protection, crew size and task duration.² Truck transport fatality risk calculated from risk/mile rate of 2.5×10^{-9} / mile (assuming 50 mi/hr)

Table M-7

Short term Worker Risk Scenarios and Estimated Probability of Serious Injury
Baseline Worker Scenario
Clarifier Materials

On-site Phosphorus Recovery (Mud Still)

Risk - Contributing Exposure	Crew Size ¹ (persons)	Task Duration ¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Risk Factor	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D = (B X C)	E	F	G = (E X F)	H = (D X G)	

Removal Operations

Site Preparation	3	20	60	1.6E-06	1	1.6E-06	9.3E-05
------------------	---	----	----	---------	---	---------	---------

Mud Still Preparation

Construct/Test Feed System	16	500	8,000	1.6E-06	1	1.6E-06	1.2E-02
Construct/Test Mud Still	16	2,000	32,000	1.6E-06	1	1.6E-06	5.0E-02
Construct/Test Offgas System	16	1,000	16,000	1.6E-06	1	1.6E-06	2.5E-02
Test Burn	8	24	192	1.6E-06	1	1.6E-06	3.0E-04

Mud Still Operations (24 hr/day; 7 days/wk; 5 batches/wk; 71% Onstream time)

Excavate CP and Load Skips	6	4,760	28,560	7.0E-07	10	7.0E-06	2.0E-01
Water Cap Control/Maintenance	1	595	595	7.0E-07	1	7.0E-07	4.2E-04
Open Skip and Remove Residue	6	2,380	14,280	7.0E-07	1	7.0E-07	1.0E-02
Transfer P4 product to ISO containers	6	2,380	14,280	7.0E-07	1	7.0E-07	1.0E-02
System Maintenance	6	3,600	21,600	7.0E-07	1	7.0E-07	1.5E-02
Transport (via truck) to P4 facility ²	1	1,120	1,120	3.8E-06	1	3.8E-06	4.2E-03
Transport (Truck returns to site) ²	1	1,120	1,120	3.8E-06	1	3.8E-06	4.2E-03
Transfer P4 product to P4 facility tanks	3	76	228	7.0E-07	1	7.0E-07	1.6E-04
P4 use at P4 facility	3	76	228	7.0E-07	1	7.0E-07	1.6E-04

Closure Operations

Decontaminate & Decommission Facilities	9	320	2,880	1.6E-06	10	1.6E-05	4.5E-02
Place Residue in Clarifier	3	16	48	1.6E-06	1	1.6E-06	7.4E-05
Backfill/ Compaction	6	40	240	1.6E-06	1	1.6E-06	3.7E-04

Evapotranspiration Cap (see Table M-15)	--	--	2,620	--	--	--	4.8E-03
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Maintenance & Monitoring	1.9	484	920	4.0E-07	1	4.0E-07	3.7E-04
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TOTAL (Sum of column)			144,970				3.8E-01	High
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Probability of Serious Injury							0.34%	
--------------------------------------	--	--	--	--	--	--	--------------	--

¹ See Appendix L for estimated crew size and task duration.

² Truck transport fatality risk calculated from risk/mile rate of 2.5×10^{-9} / mile (assuming 50 mi/hr)

Table M-8

Short term Worker Risk Scenarios and Estimated Probability of Serious Injury
Protected Worker Scenario
Clarifier Materials

On-site Phosphorus Recovery (Mud Still)

Risk - Contributing Exposure	Assumed Level of Protection ¹	Crew Size ¹ (persons)	Task Duration ¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Heat Stress Risk Rate (risk/hr)	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D	E = (D X E)	F	G	H = (F + G)	I = (E X H)	
Removal Operations									
Site Preparation	1	3	20	60	1.6E-06	2.6E-07	1.8E-06	1.1E-04	
Mud Still Preparation									
Construct/Test Feed System	1	17	500	8,500	1.6E-06	2.6E-07	1.8E-06	1.5E-02	
Construct/Test Mud Still	1	17	2,000	34,000	1.6E-06	2.6E-07	1.8E-06	6.2E-02	
Construct/Test Offgas System	1	17	1,000	17,000	1.6E-06	2.6E-07	1.8E-06	3.1E-02	
Test Burn	1	9	24	216	1.6E-06	2.6E-07	1.8E-06	3.9E-04	
Mud Still Operations (24 hr/day; 7 days/wk; 5 batches/wk; 71% Onstream time)									
Excavate CP and Load Skips	3	7	6,664	46,648	7.0E-07	2.6E-07	9.6E-07	4.5E-02	
Water Cap Control/Maintenance	2	1.5	655	982	7.0E-07	2.6E-07	9.6E-07	9.4E-04	
Open Skip and Remove Residue	3	7	3,332	23,324	7.0E-07	2.6E-07	9.6E-07	2.2E-02	
Transfer P4 product to ISO containers	3	7	3,332	23,324	7.0E-07	2.6E-07	9.6E-07	2.2E-02	
System Maintenance	1	6	3,600	21,600	7.0E-07	2.6E-07	9.6E-07	2.1E-02	
Transport (via truck) to P4 facility *	1	1	1,120	1,120	3.8E-06	--	3.8E-06	4.2E-03	
Transport (Truck returns to site) *	1	1	1,120	1,120	3.8E-06	--	3.8E-06	4.2E-03	
Transfer P4 product to P4 facility tanks	3	4	76	304	7.0E-07	2.6E-07	9.6E-07	2.9E-04	
P4 use at P4 facility	3	4	76	304	7.0E-07	2.6E-07	9.6E-07	2.9E-04	
Closure Operations									
Decontaminate & Decommission Facilities	3	10	448	4,480	1.6E-06	2.6E-07	1.8E-06	8.1E-03	
Package removable materials in drums	1	4	22	90	1.6E-06	2.6E-07	1.8E-06	1.6E-04	
Backfill/ Compaction	1	6	40	240	1.6E-06	2.6E-07	1.8E-06	4.3E-04	
Evapotranspiration Cap (see Table M-16)	--	--	--	2730.6	--	--	--	3.7E-03	
Maintenance & Monitoring	1	1.9	484	920	4.0E-07	--	4.0E-07	3.7E-04	
TOTAL (Sum of column)				186,962				2.4E-01	High
Probability of Serious Injury								0.2%	

¹ See Appendix L for assumed level of protection, crew size and task duration.

² Truck transport fatality risk calculated from risk/mile rate of 2.5×10^{-9} / mile (assuming 50 mi/hr)

Table M-9

Short term Worker Risk Scenarios and Estimated Probability of Fatality
Baseline Worker Scenario
Clarifier Materials

Off-site Incineration

Risk - Contributing Exposure	Crew Size ¹ (persons)	Task Duration ¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Risk Factor	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D = (B X C)	E	F	G = (E X F)	H = (D X G)	

Removal Operations

Site Preparation	3	20	60	4.7E-08	1	4.7E-08	2.8E-06	
Water Cap Control/Maintenance	1	360	360	7.0E-09	1	7.0E-09	2.5E-06	
Removal Operations (Clarifier to Drums)	8	5750	46,000	7.0E-09	10	7.0E-08	3.2E-03	
Drum Transfer to Storage	3	720	2,160	7.0E-09	1	7.0E-09	1.5E-05	
Drum Inspection and pH adjustment	1	11680	11,680	7.0E-09	1	7.0E-09	8.1E-05	

Transportation Operations

Drum Transfer (Storage to Truck)	2	288	576	7.0E-09	1	7.0E-09	4.0E-06	
Transport (via truck) to TSD facility ²	1	4320	4,320	1.3E-07	1	1.3E-07	5.4E-04	
Transport (Truck returns to site) ²	1	4320	4,320	1.3E-07	1	1.3E-07	5.4E-04	

Incineration Operations

Receive/unload truck at TSD facility	2	288	576	5.4E-08	1	5.4E-08	3.1E-05	
Transfer to Incinerator Unit	1	2920	2,920	5.4E-08	10	5.4E-07	1.6E-03	
Stabilize ash and waste residue from air cleaning system for final landfill disposal	2	1600	3,200	5.4E-08	1	5.4E-08	1.7E-04	

Closure Operations

Backfill/ Compaction	6	40	240	4.7E-08	1	4.7E-08	1.1E-05	
Evapotranspiration Cap (see Table M-13)	--	--	2,620	--	--	--	1.4E-04	
Maintenance and Monitoring	1.9	484	920	5.9E-09	1	5.9E-09	5.4E-06	

TOTAL (Sum of column) **79,951** **6.3E-03** **Medium**

Probability of Worker Fatality**0.02%**

¹ See Appendix L for estimated crew size and task duration.

² Truck transport fatality risk calculated from risk/mile rate of 2.5×10^{-9} / mile (assuming 50 mi/hr)

Table M-10

Short term Worker Risk Scenarios and Estimated Probability of Fatality
Protected Worker Scenario
Clarifier Materials

Off-site Incineration

Risk - Contributing Exposure	Assumed Level of Protection ¹	Crew Size ¹ (persons)	Task Duration ¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Heat Stress Risk Rate (risk/hr)	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D	E = (C X D)	F	G	H = (F + G)	I = (E X H)	

Removal Operations

Site Preparation	1	3	20	60	4.7E-08	1.6E-09	4.9E-08	2.9E-06	
Water Cap Control/Maintenance	2	1.5	396	594	7.0E-09	1.6E-09	8.6E-09	5.1E-06	
Removal Operations (Clarifier to Drums)	1	9	8,050	72,450	7.0E-09	1.6E-09	8.6E-09	6.2E-04	
Drum Transfer to Storage	3	4	1,008	4,032	7.0E-09	1.6E-09	8.6E-09	3.4E-05	
Drum Inspection and pH adjustment	1	1	11,680	11,680	7.0E-09	1.6E-09	8.6E-09	1.0E-04	

Transportation Operations

Drum Transfer (Storage to Truck)	1	2	288	576	7.0E-09	1.6E-09	8.6E-09	4.9E-06	
Transport (via truck) to TSD facility ²	1	1	4,320	4,320	1.3E-07	--	1.3E-07	5.4E-04	
Transport (Truck returns to site) ²	1	1	4,320	4,320	1.3E-07	--	1.3E-07	5.4E-04	

Incineration Operations

Receive/unload truck at TSD facility	1	3	403	1,210	5.4E-08	1.6E-09	5.5E-08	6.7E-05	
Transfer to Incinerator Unit	3	2	4,088	8,176	5.4E-08	1.6E-09	5.5E-08	4.5E-04	
Stabilize ash and waste residue from air cleaning system for final landfill disposal	1	2	1,600	3,200	5.4E-08	1.6E-09	5.5E-08	1.8E-04	

Closure Operations

Backfill/ Compaction	1	6	40	240	4.7E-08	1.6E-09	4.9E-08	1.2E-05	
Evapotranspiration Cap (see Table M-14)	1	1	1	2,731	--	--	--	9.6E-05	
Maintenance and Monitoring	1	1.9	484	920	5.9E-09	--	5.9E-09	5.4E-06	

TOTAL (Sum of column)**114,508****2.7E-03****Medium****Probability of Worker Fatality****0.007%**¹ See Appendix L for assumed level of protection, crew size and task duration.² Truck transport fatality risk calculated from risk/mile rate of 2.5×10^{-9} / mile (assuming 50 mi/hr)

Table M-11

Short term Worker Risk Scenarios and Estimated Probability of Serious Injury
Baseline Worker Scenario
Clarifier Materials

Off-site Incineration

Risk - Contributing Exposure	Crew Size ¹ (persons)	Task Duration ¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Risk Factor	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D = (B X C)	E	F	G = (E X F)	H = (D X G)	
Removal Operations								
Site Preparation	3	20	60	1.6E-06	1	1.6E-06	9.3E-05	
Water Cap Control/Maintenance	1	360	360	7.0E-07	1	7.0E-07	2.5E-04	
Removal Operations (Clarifier to Drum)	8	5750	46,000	7.0E-07	10	7.0E-06	3.2E-01	
Drum Transfer to Storage	3	720	2,160	7.0E-07	1	7.0E-07	1.5E-03	
Drum Inspection & pH adjustment	1	11680	11,680	7.0E-07	1	7.0E-07	8.2E-03	
Transportation Operations								
Drum Transfer (Storage to Truck)	2	288	576	7.0E-07	1	7.0E-07	4.0E-04	
Transport (via truck) to TSD facility ²	1	4320	4,320	3.8E-06	1	3.8E-06	1.6E-02	
Transport (Truck returns to site) ²	1	4320	4,320	3.8E-06	1	3.8E-06	1.6E-02	
Incineration Operations								
Receive/unload truck at TSD facility	2	288	576	8.0E-07	1	8.0E-07	4.6E-04	
Transfer to Incinerator Unit	1	2920	2,920	8.0E-07	10	8.0E-06	2.3E-02	
Stabilize ash and waste residue from air cleaning system for final landfill disposal	2	1600	3,200	8.0E-07	1	8.0E-07	2.6E-03	
Closure Operations								
Backfill/ Compaction	6	40	240	1.6E-06	1	1.6E-06	3.7E-04	
Evapotranspiration Cap (see Table M-15)	--	--	2,620	--	--	--	4.8E-03	
Maintenance and Monitoring	1.9	484	920	4.0E-07	1	4.0E-07	3.7E-04	
TOTAL (Sum of column)			79,951				4.0E-01	High
Probability of Serious Injury							1.2%	

¹ See Appendix L for estimated crew size and task duration.

² Truck transport fatality risk calculated from risk/mile rate of 2.5×10^{-9} / mile (assuming 50 mi/hr)

Table M-12

Short term Worker Risk Scenarios and Estimated Probability of Serious Injury
Protected Worker Scenario
Clarifier Materials

Off-site Incineration

Risk - Contributing Exposure	Assumed Level of Protection ¹	Crew Size ¹ (persons)	Task Duration ¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Heat Stress Risk Rate (risk/hr)	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D	E = (D X E)	F	G	H = (F + G)	I = (E X H)	

Removal Operations

Site Preparation	1	3	20	60	1.6E-06	2.6E-07	1.8E-06	1.1E-04
Water Cap Control/Maintenance	2	1.5	396	594	7.0E-07	2.6E-07	9.6E-07	5.7E-04
Removal Operations (Clarifier to Drum)	1	9	8,050	72,450	7.0E-07	2.6E-07	9.6E-07	7.0E-02
Drum Transfer to Storage	3	4	1,008	4,032	7.0E-07	2.6E-07	9.6E-07	3.9E-03
Drum Inspection and pH adjustment	1	1	11,680	11,680	7.0E-07	2.6E-07	9.6E-07	1.1E-02

Transportation Operations

Drum Transfer (Storage to Truck)	1	2	288	576	7.0E-07	2.6E-07	9.6E-07	5.5E-04
Transport (via truck) to TSD facility ²	1	1	4,320	4,320	3.8E-06	--	3.8E-06	1.6E-02
Transport (Truck returns to site) ²	1	1	4,320	4,320	3.8E-06	--	3.8E-06	1.6E-02

Incineration Operations

Receive/unload truck at TSD facility	1	3	403	1,210	8.0E-07	2.6E-07	1.1E-06	1.3E-03
Transfer to Incinerator Unit	3	2	4,088	8,176	8.0E-07	2.6E-07	1.1E-06	8.7E-03
Stabilize ash and waste residue from air cleaning system for final landfill disposal	1	2	1,600	3,200	8.0E-07	2.6E-07	1.1E-06	3.4E-03

Closure Operations

Backfill/ Compaction	1	6	40	240	1.6E-06	2.6E-07	1.8E-06	4.3E-04
Evapotranspiration Cap (see Table M-16)	--	--	--	2,731	--	--	--	3.7E-03
Maintenance and Monitoring	1	1.9	484	920	4.0E-07	--	4.0E-07	3.7E-04

TOTAL (Sum of column)**114,508****1.4E-01****High****Probability of Serious Injury****0.4%**¹ See Appendix L for assumed level of protection, crew size and task duration.² Truck transport fatality risk calculated from risk/mile rate of 2.5×10^{-9} / mile (assuming 50 mi/hr)

Table M-13

Short term Worker Risk Scenarios and Estimated Probability of Fatality
Baseline Worker Scenario
Clarifier Materials

Evapotranspiration Cap

Risk - Contributing Exposure	Crew Size ¹ (persons)	Task Duration ¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Risk Factor	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D = (B X C)	E	F	G = (E X F)	H = (D X G)	
Site Preparation	3	20	60	4.7E-08	1	4.7E-08	2.8E-06	
Subgrade Placement	6	80	480	4.7E-08	3	1.4E-07	6.8E-05	
Surcharge Placement/Removal	6	40	240	4.7E-08	1	4.7E-08	1.1E-05	
Consolidation Monitoring	2	20	40	4.7E-08	1	4.7E-08	1.9E-06	
Gas Collection System Installation	4	20	80	4.7E-08	3	1.4E-07	1.1E-05	
Subgrade Regrading	2	20	40	4.7E-08	1	4.7E-08	1.9E-06	
Cover Soil Placement/Grading	6	120	720	4.7E-08	1	4.7E-08	3.4E-05	
Restoration/Revegetation	2	20	40	1.1E-07	1	1.1E-07	4.4E-06	
Maintenance & Monitoring	1.9	484	920	5.9E-09	1	5.9E-09	5.4E-06	
TOTAL (Sum of column)			2,620				1.4E-04	Low

Probability of Worker Fatality**0.0004%**¹ See Appendix L for estimated crew size and task duration.

Table M-14

Short term Worker Risk Scenarios and Estimated Probability of Fatality
Protected Worker Scenario
Clarifier Materials

Evapotranspiration Cap

Risk - Contributing Exposure	Assumed Level of Protection¹	Crew Size¹ (persons)	Task Duration¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Heat Stress Risk Rate (risk/hr)	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D	E = (C X D)	F	G	H = (F + G)	I = (E X H)	
Site Preparation	1	3	20	60	4.7E-08	1.60E-09	4.85E-08	2.91E-06	
Subgrade Placement	2	6.5	88	572	4.7E-08	1.60E-09	4.85E-08	2.77E-05	
Surcharge Placement/Removal	1	6	40	240	4.7E-08	1.60E-09	4.85E-08	1.16E-05	
Consolidation Monitoring	1	2	20	40	4.7E-08	1.60E-09	4.85E-08	1.94E-06	
Gas Collection System Installation	2	4.5	22	99	4.7E-08	1.60E-09	4.85E-08	4.80E-06	
Subgrade Regrading	1	2	20	40	4.7E-08	1.60E-09	4.85E-08	1.94E-06	
Cover Soil Placement/Grading	1	6	120	720	4.7E-08	1.60E-09	4.85E-08	3.49E-05	
Restoration/Revegetation	1	2	20	40	1.1E-07	1.60E-09	1.12E-07	4.49E-06	
Maintenance and Monitoring	1	1.9	484	920	5.9E-09	--	5.90E-09	5.43E-06	
TOTAL (Sum of column)				2,731				9.6E-05	Very Low

Probability of Worker Fatality**0.0003%**¹ See Appendix L for assumed level of protection, crew size and task duration.

Table M-15

Short term Worker Risk Scenarios and Estimated Probability of Serious Injury
Baseline Worker Scenario
Clarifier Materials

Evapotranspiration Cap

Risk - Contributing Exposure	Crew Size ¹ (persons)	Task Duration ¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Risk Factor	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D = (B X C)	E	F	G = (E X F)	H = (D X G)	
Site Preparation	3	20	60	1.6E-06	1	1.6E-06	9.30E-05	
Subgrade Placement	6	80	480	1.6E-06	3	4.7E-06	2.23E-03	
Surcharge Placement/Removal	6	40	240	1.6E-06	1	1.6E-06	3.72E-04	
Consolidation Monitoring	2	20	40	1.6E-06	1	1.6E-06	6.20E-05	
Gas Collection System Installation	4	20	80	1.6E-06	3	4.7E-06	3.72E-04	
Subgrade Regrading	2	20	40	1.6E-06	1	1.6E-06	6.20E-05	
Cover Soil Placement/Grading	6	120	720	1.6E-06	1	1.6E-06	1.12E-03	
Restoration/Revegetation	2	20	40	2.6E-06	1	2.6E-06	1.04E-04	
Maintenance and Monitoring	1.9	484	920	4.0E-07	1	4.0E-07	3.68E-04	
TOTAL (Sum of Column)			2,620				4.8E-03	
Probability of Serious Injury							0.01%	

¹ See Appendix L for estimated crew size and task duration.

Table M-16

Short term Worker Risk Scenarios and Estimated Probability of Serious Injury
Protected Worker Scenario
Clarifier Materials

Evapotranspiration Cap (Options 2 & 3)

Risk - Contributing Exposure	Assumed Level of Protection ¹	Crew Size ¹ (persons)	Task Duration ¹ (hours)	Duration of Exposure to risk (person-hrs)	Baseline Risk Rate (risk/hr)	Heat Stress Risk Rate (risk/hr)	Estimated Risk Rate (risk/hr)	Risk Product Due to Element (risk)	Qualitative (Total Risk)
A	B	C	D	E = (D X C)	F	G	H = (F + G)	I = (E X H)	
Site Preparation	1	3	20	60	1.6E-06	2.6E-07	1.8E-06	1.1E-04	
Subgrade Placement	2	6.5	88	572	1.6E-06	2.6E-07	1.8E-06	1.0E-03	
Surcharge Placement/Removal	1	6	40	240	1.6E-06	2.6E-07	1.8E-06	4.3E-04	
Consolidation Monitoring	1	2	20	40	1.6E-06	2.6E-07	1.8E-06	7.2E-05	
Gas Collection System Installation	2	4.5	22	99	1.6E-06	2.6E-07	1.8E-06	1.8E-04	
Subgrade Regrading	1	2	20	40	1.6E-06	2.6E-07	1.8E-06	7.2E-05	
Cover Soil Placement/Grading	1	6	120	720	1.6E-06	2.6E-07	1.8E-06	1.3E-03	
Restoration/Revegetation	1	2	20	40	2.6E-06	2.6E-07	2.9E-06	1.1E-04	
Maintenance and Monitoring	1	1.9	484	920	4.0E-07	--	4.0E-07	3.7E-04	
TOTAL (Sum of column)				2,731				3.7E-03	

Probability of Serious Injury

0.01%

¹ See Appendix L for assumed level of protection, crew size and task duration.

Appendix N

Cost Estimates for Retained Alternatives

**"Representative" Cost Estimate Summary
Supplemental Waste Plan - Clarifier
Silver Bow Plant**

Alternatives	Closure					Cost of Financial Assurance	Post-closure Financial Assurance	
	Estimated Capital Cost	Contingency	Estimated Engineering/ Administration	30 Years Present Worth OMR ⁴	Total Estimated Relative Cost		30 Years Post-Closure Cost (no discount)	100 Years Post-Closure Cost (no discount)
Enhanced RCRA Cap ¹	\$2,400,000	\$480,000	\$640,000	\$1,500,000	\$5,000,000	\$430,000	\$1,500,000	\$3,500,000
Off-site Incineration ²	\$36,000,000	\$7,800,000	\$3,800,000	\$1,500,000	\$49,000,000	\$5,300,000	\$1,500,000	\$3,500,000

Alternative	Estimated Mud Still Capital, Contingency & Engineering/ Administration Cost	Estimated Evapotranspiration Cap Cost	30 Years Present Worth OMR	Total Estimated Relative Cost	Cost of Financial Assurance	30 Years Post-Closure (no discount) Cost	100 Years Post-Closure (no discount) Cost
Mud Still ³	\$21,000,000	\$1,000,000	\$1,500,000	\$24,000,000	\$1,400,000	\$1,500,000	\$3,500,000

Cost Estimate Details

- 1 - Estimated costs from 2003 Astaris Cap proposal, multiplied by CCI index (see Appendix E for cost estimate methodology)
- 2 - Estimated capital, contingency, and engineering/admin costs from original waste plan, multiplied by CCI index (see Appendix E for cost estimate methodology).
- 3 - Estimated capital construction, contingency, engineering, administration and operation costs provided by Solvay. Estimated evapotranspiration cap costs from original waste plan, adjusted for size, multiplied by CCI index (see Appendix E for cost estimate methodology).
- 4 - OMR and post-closure costs assumed to be the same for each alternative (costs based on 2003 Astaris Cap proposal; see Appendix E for cost estimate methodology).

**Enhanced RCRA Cap
Representative Cost Estimate
Silver Bow Plant**

DRAFT

ITEM	2003 ORIGINAL ESTIMATED QUANTITY	UNIT	UNIT COST [1]	ITEM TOTAL COST 2003	ITEM ADJUSTED FOR INFLATION 2013	
SOIL SAMPLING						
Sampling and Analysis	24	SAMPLE	\$2,500	\$60,000	\$85,400	*
Reporting	1	LS	\$15,000	\$15,000	\$21,300	*
				2003 Cost	2013 Cost	
SUBTOTAL SOIL SAMPLING				\$75,000	\$106,700	
GENERAL REQUIREMENTS						
Mobilization/Demob./Submittals	1	LS	\$155,000	\$155,000	\$220,500	*
Health & Safety	1	LS	\$50,000	\$50,000	\$71,100	*
Equipment and Personnel Decon. Facilities	7	MO	\$10,000	\$70,000	\$99,600	*
Sitework						
Clear and Grade	5	ACRE	\$2,000	\$10,000	\$14,200	*
Fence Removal	800	LF	\$2	\$1,600	\$2,300	*
SUBTOTAL GENERAL REQUIREMENTS				\$286,600	\$407,700	
CAP CONSTRUCTION						
Geofabric Filter	15,000	SF	\$1.50	\$22,500	\$32,000	*
Sand (Granulated Slag) Subgrade	1,500	CY	\$6	\$9,000	\$12,800	*
Geoweb	30,000	SF	\$1.00	\$30,000	\$42,700	*
Gas Collection System	1	LS	\$4,000	\$4,000	\$5,700	*
Gas Treatment System	1	LS	\$4,500	\$4,500	\$6,400	*
Placement and Grading - Coarse & Granulated Slag	14,800	CY	\$3	\$44,400	\$63,200	*
Sand (Granulated Slag) Surcharge	15,000	CY	\$5	\$75,000	\$106,700	*
Sand (Granulated Slag)	1,900	CY	\$3	\$5,700	\$8,100	*
Sand Filter - Rounded to Subrounded	1,900	CY	\$20	\$38,000	\$54,100	*
Geosynthetic Clay Liner (GCL)	100,000	SF	\$2	\$200,000	\$284,500	*
HDPE - 60 mil	100,000	SF	\$1.60	\$160,000	\$227,600	*
Drainage Layer - Geonet	100,000	SF	\$1.00	\$100,000	\$142,300	*
Geofabric Filter	100,000	SF	\$0.50	\$50,000	\$71,100	*
Sand Filter - Rounded to Subrounded	3,700	CY	\$20	\$74,000	\$105,300	*
Sand (Granulated Slag)	6,700	CY	\$3	\$20,100	\$28,600	*
Biotic Protection Layer - Coarse Slag	16,700	CY	\$6	\$100,200	\$142,600	*
Sand (Granulated Slag)	6,700	CY	\$3	\$20,100	\$28,600	*
Geofabric Filter	180,000	SF	\$0.50	\$90,000	\$128,000	*
Topsoil	16,700	CY	\$8	\$133,600	\$190,100	*
Pea Gravel for Topsoil Mixing	1,000	CY	\$20	\$20,000	\$28,500	*
Topsoil for Pea Gravel	5,700	CY	\$12	\$68,400	\$97,300	*
				2003 Cost	2013 Cost	
SUBTOTAL CAP CONSTRUCTION				\$1,269,500	\$1,806,200	
SITE RESTORATION						
Site Restoration/Revegetation	10	ACRE	\$5,000	\$50,000	\$71,100	
Install Perimeter Fence	1,900	LF	\$12	\$22,800	\$32,400	
				2003 Cost	2013 Cost	
SUBTOTAL SITE RESTORATION				\$72,800	\$103,500	
ESTIMATED TOTAL FIELD COST				\$1,703,900	\$2,424,100	
Contingency (20%) [2]				\$340,780	\$484,820	
Engineering/Administration	9	MO	\$50,000	\$450,000	\$640,200	
			Year	2003 Cost	2013 Cost	
ESTIMATED TOTAL CONSTRUCTION COST				\$2,494,700	\$3,550,000	
NOTES:						
[1] Unit cost includes labor, materials, equipment, overhead, and profit.						
[2] Calculated as Contingency Multiplier times Estimated Total Field Cost.						

Mud Still Representative Cost Estimate Silver Bow Plant							
MUD STILL	ITEM	MATERIAL		LABOR	TOTAL		
	MUD STILL CONSTRUCTION (MATERIAL AND LABOR)						
	Primary Equipment	\$2,858,000		\$574,400	\$3,432,400		
	Piping	\$458,500		\$851,500	\$1,310,000		
	Instrumentation	\$792,180		\$674,820	\$1,467,000		
	Electrical	\$507,750		\$1,015,500	\$1,523,250		
	Site Development	\$65,000		\$325,000	\$390,000		
	Fire Protection	\$20,000		\$200,000	\$220,000		
	Concrete	\$66,600		\$321,900	\$388,500		
	Structural Steel	\$200,100		\$147,900	\$348,000		
	Buildings	\$162,000		\$243,000	\$405,000		
	Insulation	\$235,000		\$141,000	\$376,000		
	Painting	\$53,000		\$79,500	\$132,500		
	Demolition	\$28,500		\$190,000	\$218,500		
	Indirect Costs (Engineering, Supervision)	\$0		\$2,518,682	\$2,518,682		
	SUBTOTAL MUD STILL CONSTRUCTION (MATERIAL AND LABOR)		\$5,446,630	\$7,283,202	\$12,729,832		
ESTIMATED QUANTITY		UNIT	UNIT COST [1]	ITEM TOTAL COST			
MUD STILL OPERATIONS							
Consumables	5,674,232	lb. crude P4	\$0.40	\$2,269,693			
Electric	5,674,232	lb. crude P4	\$0.11	\$612,817			
Labor	5,674,232	lb. crude P4	\$0.91	\$5,140,708			
Residue Disposal	5,674,232	lb. crude P4	\$0.25	\$422,497			
SUBTOTAL MUD STILL OPERATIONS				\$8,445,714			
ESTIMATED QUANTITY		UNIT	UNIT COST [1]	ITEM TOTAL COST			
P4 PRODUCT VALUE							
P4 Product Value	1,418,558	lb. P4 Product	\$1.70	\$2,411,549			
SUBTOTAL MUD STILL COSTS				\$21,200,000			
EVAPOTRANSPIRATION CAP	2003 ESTIMATED ORIGINAL QUANTITY		CAP SIZE QUANTITY (FOR 2013)	UNIT	UNIT DIRECT COST [1]	ITEM TOTAL COST 2003	ITEM ADJUSTED FOR CAP SIZE + INFLATION 2013
	ITEM						
	SOIL SAMPLING						
	Sampling and Analysis	24	36	SAMPLE	\$2,500	\$60,000	\$128,000
	Reporting	1	1	LS	\$15,000	\$15,000	\$21,300
	SUBTOTAL SOIL SAMPLING					\$75,000	\$149,300
	GENERAL REQUIREMENTS						
	Mobilization/Demob./Submittals	1	1	LS	\$20,280	\$20,280	\$28,900
	Health & Safety	1	1	LS	\$40,000	\$40,000	\$56,900
	Equipment and Personnel Decon. Facilities	4	4	MO	\$10,000	\$40,000	\$56,900
	Sitework						
	Clear and Grade	1	1	ACRE	\$2,000	\$2,000	\$2,800
	Fence Removal	800	800	LF	\$2	\$1,600	\$2,300
	SUBTOTAL GENERAL REQUIREMENTS					\$103,880	\$147,800
	CAP CONSTRUCTION						
	Demolition	1	1	LS	\$10,000	\$10,000	\$14,200
	Geotextile	20,000	20,000	SF	\$1.50	\$30,000	\$42,700
	Granular Slag Fill	3,000	3,000	CY	\$3	\$9,000	\$12,800
	Sand/Granular Slag Subgrade	700	3,200	CY	\$3	\$2,100	\$13,700
	Borrow Soil - Clay	2,200	1,600	CY	\$7	\$15,400	\$15,900
	Topsoil	700	500	CY	\$8	\$5,600	\$5,700
	SUBTOTAL CAP CONSTRUCTION					\$72,100	\$105,000
	SITE RESTORATION						
	Site Restoration/Revegetation	5	10	ACRE	\$5,000	\$25,000	\$71,100
	Install Perimeter Fence	1,600	800	LF	\$8	\$12,800	\$9,100
	SUBTOTAL SITE RESTORATION					\$37,800	\$80,200
	ESTIMATED TOTAL FIELD COST					\$288,780	\$482,300
Contingency (20%) [2]					\$57,756	\$96,460	
Engineering/Administration	5	6	MO	\$50,000	\$250,000	\$426,800	
SUBTOTAL CAP COSTS					\$600,000	\$1,010,000	
TOTAL ESTIMATED COST (MUD STILL + CAP)					\$22,210,000		

Estimated Mud Still Construction Costs (Equipment and Labor)

Prepared by Solvay

10' Dia Skip-Scrubber Building option

REV. 4

1/14/2012

Description	Cost Each	Qty	Usual factor Fraction of Equipment		
			Material	Labor	Total
Direct Costs					
Equipment	2118000	20	2,118,000	706,000	2,824,000
Skip Bottom vessels (10' D x 2.5'H)	25,000	6	150,000	1,000	151,000
Skip Top (weather cover) 10' D x1')	10,000	6	60,000	1,000	61,000
Still (Oven) with top	750,000	1	750,000	225,000	975,000
Condensor SS, 39" D X 18' H	70,000	1	70,000	21,000	91,000
SS Sump Tank w/jacket heater	21,000	1	21,000	6,300	27,300
Recirc. Pump	10,000	2	20,000	6,000	26,000
Sump Level Buffer Tank	12,000	1	12,000	3,600	15,600
Waste Water collection tank	10,000	1	10,000	3,000	13,000
Sump Transfer Pump	10,000	1	10,000	3,000	13,000
Hot water Distrib.Pump	10,000	1	10,000	3,000	13,000
Recirc. Air cooler	50,000	1	50,000	15,000	65,000
P4 Collection tank, CS 6K gal	60,000	1	60,000	18,000	78,000
Truck scale (w/output to control system)	60,000	1	60,000	18,000	78,000
ISO access platform	30,000	1	30,000	9,000	39,000
Vapor Combustor	150,000	1	150,000	45,000	195,000
Scrubber- 4,000 cfm, FRP	60,000	1	60,000	18,000	78,000
Scrubber Recirc Pump	10,000	2	20,000	6,000	26,000
Scrubber Fan	15,000	1	15,000	4,500	19,500
Bridge Crane (15 Ton)	100,000	1	100,000	30,000	130,000
Evaporator pond (dam and line)	200,000	1	200,000		200,000
Waste water transfer pump	10,000	1	10,000	3,000	13,000
N2 TK (rented cryo/vaporizer) 120K scf	25,000	1	25,000	7,500	32,500
Hot water heater system	250,000	1	250,000	75,000	325,000
Hot Water Tank	8,000	1	8,000	2,400	10,400
Hot water recirc pump	6,000	2	12,000	3,600	15,600
Water conditioning/softener	25,000	1	25,000	7,500	32,500
Caustic tank-SS 300 gal	8,000	1	8,000	2,400	10,400
Caustic pump	10,000	1	10,000	3,000	13,000
Spill pan	10,000	1	10,000	3,000	13,000
Phossey Water Buffer tank-850gal	7,000	1	7,000	2,100	9,100
Phossey Water Trans. Pump	10,000	1	10,000	3,000	13,000
Residual silo Cyclone Separator	10,000	1	10,000	3,000	13,000
Silo Baghouse	10,000	1	10,000	3,000	13,000
Residual material silo 200 ft3	15,000	1	15,000	4,500	19,500
Vacuum system water separator	10,000	1	10,000	3,000	13,000
Vacuum system Demister	5,000	1	5,000	1,500	6,500
Vacuum system Fan	10,000	1	10,000	3,000	13,000
Fork truck (min 24K lbs)	20,000	1	20,000	-	20,000
Flatbed truck	20,000	1	20,000		20,000
Track Hoe-50 ft reach	80,000	1	80,000	-	80,000
ISO Containers	70,000	6	420,000	-	420,000
Jump Tank (heated)	10,000	1	10,000	3,000	13,000
Supersack Feeder	15,000	1	15,000	4,500	19,500
Subtotal			2,858,000	574,400	3,432,400

Piping	60-160	100	741,300	1,835,600	2,576,900
Vent piping from Still	80	18" X 10'	28,000	52,000	80,000
N2 lines to Still	70	1" X 100'	24,500	45,500	70,000
Recirc to condenser thru cooler (4"-CS)	65	4" X 200'	22,750	42,250	65,000
Phossey water to piping system	150	1"X 175'	52,500	97,500	150,000
P4 Piping to Reciever Tank	14	3" X 3'	4,900	9,100	14,000
Phossey water to P4 collection tank	50	2" X 75'	17,500	32,500	50,000
P4 from tank to Truck (jacketed)	150	1.5" 75'	52,500	97,500	150,000
Phossey H2O, ISO to Buffer, P4 recov'y Tk	60	2"X 100'	21,000	39,000	60,000
Vents for system	30	2"X 100'	10,500	19,500	30,000
Phossey H2O to/from sump level buffer tank	20	2" X 40'	7,000	13,000	20,000
Transfer piping for residual skip mat'l	25	6" X 25'	8,750	16,250	25,000
Overflow to waste water tank	10	2" X 70'	3,500	6,500	10,000
Blowdown to Evap Pond (e traced)	25	1.5" X 200'	8,750	16,250	25,000
Waste water Tank to Clarifier (SS)	25	1.5" X 200'	8,750	16,250	25,000
Sump vent to FA and combustor (SS)	25	6" X 40'	8,750	16,250	25,000
Combustor to Scrubber (SS)	15	6" X 25'	5,250	9,750	15,000
Scrubber to fan (FRP)	10	6" X 25'	3,500	6,500	10,000
Residual vacuum line-skip to cyclone-SS Duct	11	3" X 50'	3,850	7,150	11,000
Liquid vacuum line-skip to separator-SS Duct	11	3" X 50'	3,850	7,150	11,000
Blower inlet-SS Duct	12	4" X 60'	4,200	7,800	12,000
Blower discharge-SS Duct	12	4" X 60'	4,200	7,800	12,000
Water within process area-CS	45	2" X 400'	15,750	29,250	45,000
Misc Process lines	50		17,500	32,500	50,000
Utilities			-	-	-
Process Water tie In	20	6" X 150'	7,000	13,000	20,000
Process water to clarifier (SS) e-traced	10	1.5" X 200'	3,500	6,500	10,000
Hot water system	80	2" X 200'	28,000	52,000	80,000
N2 for instruments	50	1" X 200'	17,500	32,500	50,000
Gas to combustor,Boiler and heaters	85	1" X 800'	29,750	55,250	85,000
Misc, steam water, Safety showers etc	100		35,000	65,000	100,000
Subtotal			458,500	851,500	1,310,000
Instrumen	20-70	40	571,860	357,120	938,980
Skip Bottom vessels (10' D x 2.5'H)			-	-	-
Skip Top (weather cover) 10' D x1')			-	-	-
Still (Oven) with top	300	1	81,000	69,000	150,000
Condensor SS, 39" D X 18' H	300	1	81,000	69,000	150,000
SS Sump Tank w/jacket heater	100	1	27,000	23,000	50,000
Recirc. Pump	50	2	27,000	23,000	50,000
Sump Level Buffer Tank	50	1	13,500	11,500	25,000
Waste Water collection tank	70	1	18,900	16,100	35,000
Sump Transfer Pump	50	1	13,500	11,500	25,000
Hot water Distrib.Pump	50	1	13,500	11,500	25,000
Recirc. Air cooler	100	1	27,000	23,000	50,000
P4 Collection tank, CS 6K gal	200	1	54,000	46,000	100,000
Truck scale (w/output to control system)	150	1	40,500	34,500	75,000
ISO access platform	-	1	-	-	-
Vapor Combustor	200	1	54,000	46,000	100,000
Scrubber- 4,000 cfm, FRP	200	1	54,000	46,000	100,000
Scrubber Recirc Pump	50	2	27,000	23,000	50,000
Scrubber Fan	50	1	13,500	11,500	25,000
Bridge Crane (15 Ton)		1	-	-	-
Evaporator pond (dam and line)		1	-	-	-
Waste water transfer pump	50	1	13,500	11,500	25,000
N2 TK (rented cryo/vaporizer) 120K scf		1	-	-	-
Hot water heater system	100	1	27,000	23,000	50,000
Hot Water Tank	70	1	18,900	16,100	35,000
Hot water recirc pump	25	2	13,500	11,500	25,000
Water conditioning/softener	100	1	27,000	23,000	50,000
Caustic tank-SS 300 gal	70	1	18,900	16,100	35,000
Caustic pump	25	1	6,750	5,750	12,500
Spill pan		1	-	-	-
Phossey Water Buffer tank-850gal	70	1	18,900	16,100	35,000
Phossey Water Trans. Pump	25	1	6,750	5,750	12,500
Residual silo Cyclone Separator	15	1	4,050	3,450	7,500
Silo Baghouse	10	1	2,700	2,300	5,000
Residual material silo 200 ft3	20	1	5,400	4,600	10,000
Vacuum system water separator	10	1	2,700	2,300	5,000
Vacuum system Demister	5	1	1,350	1,150	2,500
Vacuum system Fan	10	1	2,700	2,300	5,000
Fork truck (min 24K lbs)		1	-	-	-
Flatbed truck		1	-	-	-
Track Hoe-50 ft reach		1	-	-	-
ISO Containers		6	-	-	-
Jump Tank (heated)	30	1	8,100	6,900	15,000
Supersack Feeder	30	1	8,100	6,900	15,000
Autovalves for P4 and steam coils	80	1	21,600	18,400	40,000
Phosphine monitoring- 12 units	12	12	38,880	33,120	72,000
Subtotal			792,180	674,820	1,467,000

Electrical	25-60	40	317,700	706,000	1,023,700
Skip Bottom vessels (10' D x 2.5'H)	-	6	-	-	-
Skip Top (weather cover) 10' D x1')	-	6	-	-	-
Still (Oven) with top	600	1	90,000	180,000	270,000
Condensor SS, 39" D X 18' H	-	1	-	-	-
SS Sump Tank w/jacket heater	-	1	-	-	-
Recirc. Pump	30	2	9,000	18,000	27,000
Sump Level Buffer Tank	-	1	-	-	-
Waste Water collection tank	-	1	-	-	-
Sump Transfer Pump	30	1	4,500	9,000	13,500
Hot water Distrib.Pump	30	1	4,500	9,000	13,500
Recirc. Air cooler	100	1	15,000	30,000	45,000
P4 Collection tank, CS 6K gal	-	1	-	-	-
Truck scale (w/output to control system)	30	1	4,500	9,000	13,500
ISO access platform	-	1	-	-	-
Vapor Combustor	75	1	11,250	22,500	33,750
Scrubber- 4,000 cfm, FRP	75	1	11,250	22,500	33,750
Scrubber Recirc Pump	30	2	9,000	18,000	27,000
Scrubber Fan	75	1	11,250	22,500	33,750
Bridge Crane (15 Ton)	150	1	22,500	45,000	67,500
Evaporator pond (dam and line)	-	1	-	-	-
Waste water transfer pump	30	1	4,500	9,000	13,500
MCC Sections and feed wiring	550	1	82,500	165,000	247,500
N2 TK (rented cryo/vaporizer) 120K scf	50	1	7,500	15,000	22,500
Hot water heater system	125	1	18,750	37,500	56,250
Water conditioning/softener	50	1	7,500	15,000	22,500
Caustic tank-SS 300 gal	-	1	-	-	-
Caustic pump	30	1	4,500	9,000	13,500
Spill pan	-	1	-	-	-
Phossey Water Buffer tank-850gal	-	1	-	-	-
Phossey Water Trans. Pump	30	1	4,500	9,000	13,500
Residual silo Cyclone Separator	-	1	-	-	-
Silo Baghouse	75	1	11,250	22,500	33,750
Residual material silo 200 ft3	10	1	1,500	3,000	4,500
Vacuum system water separator	-	1	-	-	-
Vacuum system Demister	-	1	-	-	-
Vacuum system Fan	25	1	3,750	7,500	11,250
Fork truck (min 24K lbs)	-	1	-	-	-
Flatbed truck	-	1	-	-	-
Track Hoe-50 ft reach	-	1	-	-	-
ISO Containers	-	6	-	-	-
Jump Tank (heated)	10	1	1,500	3,000	4,500
Supersack Feeder	10	1	1,500	3,000	4,500
Electric Tracing	500	1	75,000	150,000	225,000
Oven Building- lighting, misc	150	1	22,500	45,000	67,500
ISO Loading Building- lighting, misc	50	1	7,500	15,000	22,500
Utility Building- lighting, misc	70	1	10,500	21,000	31,500
MCC Building- lighting, misc	25	1	3,750	7,500	11,250
Outside and Clarifier	300	1	45,000	90,000	135,000
Subtotal			507,750	1,015,500	1,523,250
Site Devel	4-8	6	21,180	141,200	162,380
Roads/paving (14,000 sf asphalt)	6,000	1	60,000	300,000	360,000
Fencing misc repairs	100	1	1,000	5,000	6,000
Excavation for lines to remote area	250	1	2,500	12,500	15,000
Misc gravel drives etc	150	1	1,500	7,500	9,000
Subtotal			65,000	325,000	390,000

Fire Protection	5-15	10		105,900	141,200	247,100
Building Fire Protection		300	1	15,000	150,000	165,000
Tie in to main lines		100	1	5,000	50,000	55,000
Subtotal				20,000	200,000	220,000
Concrete	12-55	35		127,080	818,960	946,040
Skip Staging Building (25' X 26' X 40'H)		220	1	13,200	63,800	77,000
ISO Loading Building (14' X 28' X 18'H)		120	1	7,200	34,800	42,000
Utility Bldg extension (24' X 28' X 30'H)		240	1	14,400	69,600	84,000
Scrubber pad-12' X 30' open		80	1	4,800	23,200	28,000
Residual Bin/fan found 12' X 12' open		60	1	3,600	17,400	21,000
N2 Tank Foundation 12' X12' open		60	1	3,600	17,400	21,000
Over Foundation (Fire Brick)		200	1	12,000	58,000	70,000
Misc		130	1	7,800	37,700	45,500
Subtotal				66,600	321,900	388,500
Structural	25-50	40		487,140	480,080	967,220
Oven Level platform-25' X 25' X 11'H		240	1	55,200	40,800	96,000
Condensor structure-12' X 8' X 20'H		120	1	27,600	20,400	48,000
Oven Support platform-12'X 12' X 8'H		80	1	18,400	13,600	32,000
Silo access platform-3' X 15' X 16'H		100	1	23,000	17,000	40,000
Silo Baghouse platform-6' X 10' X 26'H		80	1	18,400	13,600	32,000
Pipe supports bridges		100	1	23,000	17,000	40,000
Misc walkways, stairs etc		150	1	34,500	25,500	60,000
Subtotal				200,100	147,900	348,000
Buildings	1-15	10		84,720	169,440	254,160
Break room (Prefab indust. unit.)		700	1	28,000	42,000	70,000
Revamp Change House facilities		500	1	20,000	30,000	50,000
Control room in Skip staging area (6' X 12')		200	1	8,000	12,000	20,000
MCC Building repairs		150	1	6,000	9,000	15,000
Skip staging extension-25' X 26' X 40'		800	1	32,000	48,000	80,000
Utility extension-25' X 26' X 30' H		750	1	30,000	45,000	75,000
ISO Loading building-14' X 28' X 18' H		450	1	18,000	27,000	45,000
Misc		500	1	20,000	30,000	50,000
Subtotal				162,000	243,000	405,000
Insulation	5-15	8		105,900	84,720	190,620
P4 piping		650	1	32,500	19,500	52,000
Sump Tank		400	1	20,000	12,000	32,000
Scrubber piping		300	1	15,000	9,000	24,000
P4 Recovery Tank		800	1	40,000	24,000	64,000
Lines to clarifier(2) and evap pond(1)		1,000	1	50,000	30,000	80,000
Hot water tank and piping		800	1	40,000	24,000	64,000
Misc heating		750	1	37,500	22,500	60,000
Subtotal				235,000	141,000	376,000
Painting	3-8	5		42,360	84,720	127,080
Structure		1,900	1	38,000	57,000	95,000
Misc		750	1	15,000	22,500	37,500
Subtotal				53,000	79,500	132,500
Demolition	5-15	8		13,500	90,000	103,500
East Tower (crane cost in Mt'l)		900	1	13,500	90,000	103,500
Water distr. Building		200	1	3,000	20,000	23,000
Interior structures (crane cost in Mt'l)		600	1	9,000	60,000	69,000
Misc around clarifier		200	1	3,000	20,000	23,000
Subtotal				28,500	190,000	218,500
				5,446,630	4,764,520	10,211,150

Indirect Costs

766	Eng. Days (\$100/hr)	612,669
1,489	Eng. Days (\$120/hr)	1,429,561
794	Constr. Supervision (\$65/hr)	476,452

Total Indirect Costs (X 1.21) 19.8% of total project **2,518,682**

TOTAL INSTALLED COST (X 5.35) 11,331,300 REF only (standard factors) **12,729,832**

Proj Range: \$ 8,910,882 to approx. \$ 16,548,782

Desired field rate: **75**

Estimated Operating Costs-Full Scale Mud Still

Prepared by Solvay

Assumptions

Electricity Cost (\$/Kw-Hr)	\$	0.12
Labor Cost (Including Fringes-\$/Hr)	\$	60.00
Oven Primary Heat- Kw-Hr/# Batch		0.6
Auxilliary Equipment - Kw-Hr/# Batch		0.3
Estimated Consumables (\$/# Batch)	\$	0.40
Estimated P4 %		25.0%
Estimated Residue %		30.0%
Estimated Residue Disposal (\$/#)	\$	0.25
Labor 3 man crews operating 2 - 12 hour shifts		
Operating Time	24 Hours/Batch	
Operating Batch Size(lbs)	6,676	
Total Material in Clarifier (gallons)	500,000	
Total Material in Clarifier (lbs)	5,674,232	
Skip Capacity (10' Diam x 1') (gallons)	588.25	
Batches per week (71% Onstream Time)	5	
Time to empty clarifier (Weeks)	170.00	

Heated Area	Diameter (feet)	Wall Height (ft) (feet)	Top Area (sq. feet)	Walls Area (sq. feet)	Bottom Area (sq. feet)	Total Area (sq. feet)	KW per Square Foot	Furnace Size KW
Pilot Still	2	1.25	3.1415	3.926875	3.1415	10.209875	3.134	32
10' Diameter Still	10	1.25	78.5375	19.634375	78.5375	176.709375	3.134	554

Total Gallons Per Batch	Total Batch Weight (lbs)	Hours Per Batch	Processed lbs.Per Hour	Estimated Aux. Equip. Kw-Hr/lb of Batch	Estimated Aux. Equip. Total KW-Hr Used/Batch	Primary Heat Kw-Hr/lb of Batch	Primary Heat Total KW-Hr Used/Batch	Total KW-Hr Used/Batch
668	6676	24.00	278	0.30	2002.71	0.60	4005	6008

Total P4 Produced lbs/batch	Estimated Labor-Per Week Man-Hrs	Total Labor Cost - Inc. Fringes (\$/Hr)	Total Labor Cost - Inc. Fringes (\$/Week)	Total Labor Cost - Inc. Fringes (\$/Year)	Total Residue Produced lbs/batch	Residue Disposal \$/batch
1669	504	\$60	\$30,240	\$1,572,480	2003	\$ 497

Estimated consumables \$/lb of Batch	Total Electric Costs \$/lb of Batch	Total Labor Cost 5 Batches Per Week \$/lb of Batch	Residue Disposal \$/lb of Batch	Total Cost \$/lb of Batch	Total P4 Revenue @ \$2/lb Per Batch	Total P4 Revenue @ \$2/lb \$/lb of Batch	Net Cost \$/lb of Batch
\$0.40	\$0.11	\$0.91	\$ 0.07	\$1.49	\$3,337.84	\$0.50	\$0.99

Residue Disposal Costs - Using Heritage Environmental Estimates

Assumptions		Pound of Residue Per Truck Load	Disposal Cost (\$/#)	Landfill Surcharge (\$/#)	Freight Cost (\$/#)	Fuel Surcharge (\$/#)	Total Cost (\$/#)
Supersack - Disposal Cost	150	41580	\$ 0.16	\$ 0.02	\$ 0.06	\$ 0.01	\$ 0.25
Local Landfill Surcharge	0.12						
Freight Charge per Load	2400						
Fuel Surcharge per Load	0.22						
Supersack Capacity - Cubic Feet	27						
Bulk Density of residue - #/Cubic Foot	35						
Supersacks Per Load	44						

***Need to add ISO leasing costs and diesel fuel costs

Consumables
Natural Gas
Heating
Process
Nitrogen
Fuel
Supplies

Utilities Usage Estimate		and Estimated Cost	
Based on lbs/batch of:		6,715 # mud and	2,155 lb P4
		and	24 hrs/batch
Electricity:			
This is based on the Portishead process energy balance, 1976 report.			
It shows that about 50% of energy was used to make-up for losses (other than needed for distillation).			
6,000 kWh per batch or per day for 24 hr cycle.	Cost per same:	\$	720
1.01 kWh/lb P4 @32% weight P4 in mud (average of 2011 pilot run)			\$0.121
0.32 kWh/lb mud			\$0.038
Monthly cost:			\$21,600.00
Nitrogen:			
Gas cost estimated at 20% higher than UP costs. Lease about 46.7% as UP			
UP N2 cost	\$0.335 per 100scf plus \$1,500/mo on a 13,000 gal tank		
	\$0.402 per 100 scf	Use a 6,000 gal tank:	\$900 est/month
UP usage is estimated to 12,000,000 scf / month. SB rated monthly usage:			890,000 scf/mo
That means tank size of 1,500 gal would be adequate.			86.4 scf/gal liquid
			5,127 gal/mo
SB monthly costs expected about:			\$1,781 for gas. Gas + lease =
14,766 scf/batch or per day for 24 hr cycle.	Monthly usage, scf =		\$2,681 /month
6.85 scf/lb P4 @32% weight P4 in mud (average of 2011 pilot run)			442,980 scf/mo
2.20 scf/lb mud			\$0.041 /lb P4
			\$0.013 /lb mud
Natural Gas (space heat excluded). Assumes non-insulated Condenser and top of Sump			
Heat losses to make-up, BTU/h			
	97,000 based on 120°F differential air to jackets and 1½" insulation. Includes condenser losses		
	2,328,000 BTU/day or BTU/24hr-batch		
	82% Boiler efficiency (Miura Specs)		
	2,839,024 BTU fuel needed		
	100,000 BTU/therm. 1 therm = 100 cuft nat gas.		
28.39 therms/day or per 24 hr batch	Cost per same:		\$14.20 /day
0.01317 therms/lb P4			\$398 /lb P4
0.00423 therms/lb mud			\$128 /lb mud
	Monthly:		\$425.85
Space Heating			
100.0 therms/day or per 24 hr batch	Cost per same:		\$50.00 /day
	Monthly:		\$1,500.00
Utilities Rates			
Electricity:	\$0.12 per kWh - (Dec 2011 NW Energy rates Montana)		
Natural Gas:	\$0.50 per therm --- per Dan Bersanti		
Nitrogen	See estimate above, based on UP rates		
Totalutilities (operating):	\$26,207	Note, \$900/mo lease applies also for winter	
Utility Costs - \$/#Batch	\$ 0.18		

Capping Alternatives
Operation, Maintenance, and Repair Costs
Cost Estimate Details

ITEM	ESTIMATED QUANTITY	UNIT	2003 ANNUAL UNIT DIRECT COST [1]	2003 ANNUAL ITEM TOTAL DIRECT COST	2013 ADJUSTED ANNUAL ITEM DIRECT COST	30 YEAR PRESENT WORTH OF DIRECT COST [2] 2013	30 YEAR POST-CLOSURE (NO DISCOUNT) 2013	100 YEAR POST- CLOSURE COST 2003	100 YEAR POST- CLOSURE COST 2013	COMMENTS
Admin., Inspection, Reporting (Years 1 to 5)	1	LS	\$25,000	\$25,000	\$ 35,600.00	\$ 150,000.00	\$178,000	\$125,000	\$178,000	
Admin., Inspection, Reporting (Years 6 to 10)	1	LS	\$15,000	\$15,000	\$ 21,300.00	\$ 260,000.00	\$106,500	\$75,000	\$106,500	
Admin., Inspection, Reporting (Years 11 to 100)	1	LS	\$10,000	\$10,000	\$ 14,200.00	\$ 330,000.00	\$284,000	\$900,000	\$1,278,000	
Groundwater Monitoring (Years 1 to 5)	1	YR	\$6,250	\$6,250	\$ 8,900.00	\$ 40,000.00	\$44,500	\$31,250	\$44,500	1 upgradient, 4 downgradient wells
Groundwater Monitoring (Years 6 to 30)	1	YR	\$6,250	\$6,250	\$ 8,900.00	\$ 180,000.00	\$222,500	\$156,250	\$222,500	1 upgradient, 4 downgradient wells
Cap Maintenance (Years 1 to 30)	1	LS	\$6,000	\$6,000	\$ 8,500.00	\$ 130,000.00	\$255,000	\$180,000	\$255,000	
Cap Maintenance (Years 31 to 100)	1	LS	\$5,000	\$5,000	\$ 7,100.00	\$ -	\$0	\$350,000	\$497,000	
Phosphine Monitoring (Years 1 to 30)	1	LS	\$5,000	\$5,000	\$ 7,100.00	\$ 110,000.00	\$71,000	\$150,000	\$213,000	
Phosphine Collection/Treatment System Maintenance (Years 1 to 30)	1	LS	\$2,500	\$2,500	\$ 3,600.00	\$ 60,000.00	\$18,000	\$75,000	\$108,000	120 lbs of Centaur Carbon per year, includes labor for change-out, piping and blower repair
SUBTOTAL OMR COSTS						\$1,260,000	\$1,179,500	\$2,042,500	\$2,902,500	
Contingency (20%) [2]						\$252,000	\$235,900	\$408,500	\$580,500	
ESTIMATED TOTAL OMR COSTS						\$1,512,000	\$1,415,400	\$2,451,000	\$3,483,000	
NOTES: [1] Lump sum costs include labor, materials, equipment, profit and overhead. Costs in 2003 dollars. [2] Calculated as Contingency Multiplier times subtotal OMR costs. [3] Groundwater compliance monitoring is not included in this estimate.										

Silver Bow Plant
Off-site Incineration - Clarifier
Cost Estimate Details

ITEM	ESTIMATED QUANTITY	REDUCED CAP SIZE		UNIT	UNIT DIRECT COST [1]	2003 ITEM TOTAL DIRECT COST	2013 ITEM TOTAL DIRECT COST	ITEM ADJUSTED FOR CAP SIZE + INFLATION 2013	SOURCE	COMMENTS
		QUANTITY (FOR 2013)								
GENERAL REQUIREMENTS										
Mobilization/Demob./Submittals	1	1	LS		\$519,650	\$519,650	\$739,300	\$739,300	Barr	10% of total field cost, excluding T& D
Health & Safety	1	1	LS		\$100,000	\$100,000	\$142,300	\$142,300	Barr	Training, refresher training, and field support
Equipment and Personnel Decon. Facilities	24	24	MO		\$10,000	\$240,000	\$341,500	\$341,500	Barr	
Sitework										
Clear and Grade	1	5	ACRE		\$2,000	\$2,000	\$2,800	\$14,200	Barr	
Fence Removal	800	800	LF		\$2	\$1,600	\$2,300	\$2,300	Barr	
SUBTOTAL GENERAL REQUIREMENTS						\$863,250	\$1,228,200	\$1,239,600		
PHOSPHORUS REMOVAL, TREATMENT, AND DISPOSAL										
Phosphorus Removal Operations										
Agitation Chamber	650	650	VLF		\$1,500	\$975,000	\$1,387,200	\$1,387,200	Means	Means (1999) (I.e. Caisson drill and operator)
Backhoe and Operator	104	104	WK		\$6,000	\$624,000	\$887,800	\$887,800	Barr	\$150/hr @ 40 h/wk
Transfer pump and screen	1	1	LS		\$20,000	\$20,000	\$28,500	\$28,500	Master Sales	Master Sales
Double Walled Stainless Steel Tank	1	1	LS		\$250,000	\$250,000	\$355,700	\$355,700	Tanks Direct	30,000 gallon capacity tank + \$7000 transportation, Tanks Direct
Steam Sparge and Steam Plant	1	1	LS		\$400,000	\$400,000	\$569,100	\$569,100	Barr	
Additional Labor and operators	104	104	WK		\$7,200	\$748,800	\$1,065,300	\$1,065,300	Barr	4 people, 40h/wk @ \$45/h, for 2 years
Phosphorus Packing System	1	1	LS		\$1,000,000	\$1,000,000	\$1,422,700	\$1,422,700	Barr	
Drums for packing and transportation	11,500	11,500	DRUM		\$100		\$1,150,000	\$1,150,000	Barr	55 gallon steel drum (UN1A2/X400/S), as advertised on www.newpig.com 1/20/2014
Drum Storage Building	9,600	9,600	SF		\$42	\$403,200	\$573,600	\$573,600	Means	60' x 160' building w/plumbing, HVAC, and electrical, Means (1998)
Concrete Slab for Drum Storage Building	600	600	CY		\$120	\$72,000	\$102,400	\$102,400	Means	6 inch slab with 2 ft curbed edges to contain water, 15,000 square feet, Means (1999)
Decommission/Decon	1	1	LS		\$250,000	\$250,000	\$355,700	\$355,700	Barr	Decommissioning and decontamination of phosphorus removal and packing system
Transportation	437,000	437,000	MI		\$5	\$2,185,000	\$3,108,700	\$3,108,700	Barr	assume 50 drums per load; total of 230 loads X 1900 miles @ \$5 / loaded mile
Incineration/Disposal	11,500	11,500	DRUM		\$1,455	\$16,736,000	\$23,811,000	\$23,811,000	TWI	TWI at \$3.15/lb, 462 lbs crude phosphorus/drum
SUBTOTAL PHOSPHORUS REMOVAL, TREATMENT, AND DISPOSAL						\$23,664,000	\$34,817,700	\$34,817,700		
CLARIFIER DEMOLITION AND CAP CONSTRUCTION										
Demolition	1	1	LS		\$10,000	\$10,000	\$14,200	\$14,200	Barr	Demolition of above-ground concrete clarifier wall, misc.
Geotextile	20,000	20,000	SF		\$1.50	\$30,000	\$42,700	\$42,700	Barr	Cover the clarifier contents
Granular Slag Fill	3,000	3,000	CY		\$3	\$9,000	\$12,800	\$12,800	Barr	Subgrade fill
Sand/Granular Slag Subgrade	700	3,200	CY		\$3	\$2,100	\$3,000	\$13,700	Barr	Fill up to top of clarifier: 3 ft over 29,000 sq ft area; assumes on-site source
Borrow Soil - Clay	2,200	1,600	CY		\$7	\$15,400	\$21,900	\$15,900	Barr	1.5 ft over 29,000 sq ft area; assume on-site source
Topsoil	700	500	CY		\$8	\$5,600	\$8,000	\$5,700	Barr	0.5 ft over 29,000 sq ft area; assume off-site source
SUBTOTAL CLARIFIER DEMOLITION AND CAP CONSTRUCTION						\$72,100	\$102,600	\$105,000		
SITE RESTORATION										
Site Restoration/Revegetation	5	10	ACRE		\$5,000	\$25,000	\$35,600	\$71,100	Barr	Includes seeding, mulching, fertilizing
Install Perimeter Fence	1,600	800	LF		\$8	\$12,800	\$18,200	\$9,100	Barr	
SUBTOTAL SITE RESTORATION						\$37,800	\$53,800	\$80,200		
ESTIMATED TOTAL FIELD COST						\$24,637,150	\$36,202,300	\$36,242,500		
Contingency (40%) [2]						\$2,286,460	\$3,713,040	\$3,800,000		
						\$2,838,150	\$4,037,955	\$4,037,955		
Engineering/Administration						\$2,286,460	\$3,713,040	\$3,800,000	Barr	40% of Estimated Total Field Cost, excluding T & D
ESTIMATED TOTAL CONSTRUCTION COST						\$33,000,000	\$48,000,000	\$47,900,000		

NOTES:
[1] Unit direct cost includes labor, materials, equipment, overhead, and profit.
[2] Calculated as Contingency Multiplier times Estimated Total Field Cost.

**Cost of Financial Assurance
Enhanced RCRA Cap**

Activity	Year	Annual Expense	Total Amount of Financial Assurance	Typical Cost	Annual Cost
Cap Construction	2015	\$2,000,000	\$5,240,000	1.35%	\$70,740
	2016	\$1,520,000	\$3,240,000	1.35%	\$43,740
30 Year Post Closure Care	2017	\$91,000	\$1,720,000	1.35%	\$23,220
	2018	\$91,000	\$1,629,000	1.35%	\$21,992
	2019	\$91,000	\$1,538,000	1.35%	\$20,763
	2020	\$91,000	\$1,447,000	1.35%	\$19,535
	2021	\$91,000	\$1,356,000	1.35%	\$18,306
	2022	\$57,000	\$1,265,000	1.35%	\$17,078
	2023	\$57,000	\$1,208,000	1.35%	\$16,308
	2024	\$57,000	\$1,151,000	1.35%	\$15,539
	2025	\$57,000	\$1,094,000	1.35%	\$14,769
	2026	\$57,000	\$1,037,000	1.35%	\$14,000
	2027	\$49,000	\$980,000	1.35%	\$13,230
	2028	\$49,000	\$931,000	1.35%	\$12,569
	2029	\$49,000	\$882,000	1.35%	\$11,907
	2030	\$49,000	\$833,000	1.35%	\$11,246
	2031	\$49,000	\$784,000	1.35%	\$10,584
	2032	\$49,000	\$735,000	1.35%	\$9,923
	2033	\$49,000	\$686,000	1.35%	\$9,261
	2034	\$49,000	\$637,000	1.35%	\$8,600
	2035	\$49,000	\$588,000	1.35%	\$7,938
	2036	\$49,000	\$539,000	1.35%	\$7,277
	2037	\$49,000	\$490,000	1.35%	\$6,615
	2038	\$49,000	\$441,000	1.35%	\$5,954
	2039	\$49,000	\$392,000	1.35%	\$5,292
	2040	\$49,000	\$343,000	1.35%	\$4,631
	2041	\$49,000	\$294,000	1.35%	\$3,969
	2042	\$49,000	\$245,000	1.35%	\$3,308
	2043	\$49,000	\$196,000	1.35%	\$2,646
	2044	\$49,000	\$147,000	1.35%	\$1,985
	2045	\$49,000	\$98,000	1.35%	\$1,323
	2046	\$49,000	\$49,000	1.35%	\$662
Cost of Financial Assurance					\$430,000

**Cost of Financial Assurance
On-site Phosphorus Recovery**

Activity	Year	Annual Expense	Total Amount of Financial Assurance	Typical Cost	Annual Cost
Mud Still Constuction	2015	\$8,000,000	\$24,020,000	1.35%	\$324,270
	2016	\$4,800,000	\$16,020,000	1.35%	\$216,270
Mud Still Operation	2017	\$1,700,000	\$11,220,000	1.35%	\$151,470
	2018	\$1,700,000	\$9,520,000	1.35%	\$128,520
	2019	\$1,700,000	\$7,820,000	1.35%	\$105,570
	2020	\$1,700,000	\$6,120,000	1.35%	\$82,620
	2021	\$1,700,000	\$4,420,000	1.35%	\$59,670
Cap Construction	2022	\$1,000,000	\$2,720,000	1.35%	\$36,720
30 Year Post Closure Care	2023	\$91,000	\$1,720,000	1.35%	\$23,220
	2024	\$91,000	\$1,629,000	1.35%	\$21,992
	2025	\$91,000	\$1,538,000	1.35%	\$20,763
	2026	\$91,000	\$1,447,000	1.35%	\$19,535
	2027	\$91,000	\$1,356,000	1.35%	\$18,306
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	2031	\$57,000	\$1,094,000	1.35%	\$14,769
	2032	\$57,000	\$1,037,000	1.35%	\$14,000
	2033	\$49,000	\$980,000	1.35%	\$13,230
	2034	\$49,000	\$931,000	1.35%	\$12,569
	2035	\$49,000	\$882,000	1.35%	\$11,907
	2036	\$49,000	\$833,000	1.35%	\$11,246
	2037	\$49,000	\$784,000	1.35%	\$10,584
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	2039	\$49,000	\$686,000	1.35%	\$9,261
	2040	\$49,000	\$637,000	1.35%	\$8,600
	2041	\$49,000	\$588,000	1.35%	\$7,938
	2042	\$49,000	\$539,000	1.35%	\$7,277
	2043	\$49,000	\$490,000	1.35%	\$6,615
	2044	\$49,000	\$441,000	1.35%	\$5,954
	2045	\$49,000	\$392,000	1.35%	\$5,292
	2046	\$49,000	\$343,000	1.35%	\$4,631
	2047	\$49,000	\$294,000	1.35%	\$3,969
	2048	\$49,000	\$245,000	1.35%	\$3,308
	2049	\$49,000	\$196,000	1.35%	\$2,646
	2050	\$49,000	\$147,000	1.35%	\$1,985
	2051	\$49,000	\$98,000	1.35%	\$1,323
	2052	\$49,000	\$49,000	1.35%	\$662
Cost of Financial Assurance					\$1,400,000

**Cost of Financial Assurance
Off-site Incineration**

Activity	Year	Annual Expense	Total Amount of Financial Assurance	Typical Cost	Annual Cost
Site Construction	2015	\$11,000,000	\$46,020,000	1.35%	\$621,270
	2016	\$2,018,750	\$35,020,000	1.35%	\$472,770
	2017	\$2,018,750	\$33,001,250	1.35%	\$445,517
	2018	\$2,018,750	\$30,982,500	1.35%	\$418,264
	2019	\$2,018,750	\$28,963,750	1.35%	\$391,011
	2020	\$2,018,750	\$26,945,000	1.35%	\$363,758
	2021	\$2,018,750	\$24,926,250	1.35%	\$336,504
	2022	\$2,018,750	\$22,907,500	1.35%	\$309,251
	2023	\$2,018,750	\$20,888,750	1.35%	\$281,998
	2024	\$2,018,750	\$18,870,000	1.35%	\$254,745
	2025	\$2,018,750	\$16,851,250	1.35%	\$227,492
	2026	\$2,018,750	\$14,832,500	1.35%	\$200,239
	2027	\$2,018,750	\$12,813,750	1.35%	\$172,986
	2028	\$2,018,750	\$10,795,000	1.35%	\$145,733
	2029	\$2,018,750	\$8,776,250	1.35%	\$118,479
Packaging and Incineration Operations	2030	\$2,018,750	\$6,757,500	1.35%	\$91,226
	2031	\$2,018,750	\$4,738,750	1.35%	\$63,973
	2032	\$1,000,000	\$2,720,000	1.35%	\$36,720
	2033	\$91,000	\$1,720,000	1.35%	\$23,220
	2034	\$91,000	\$1,629,000	1.35%	\$21,992
	2035	\$91,000	\$1,538,000	1.35%	\$20,763
	2036	\$91,000	\$1,447,000	1.35%	\$19,535
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	2041	\$57,000	\$1,094,000	1.35%	\$14,769
	2042	\$57,000	\$1,037,000	1.35%	\$14,000
	2043	\$49,000	\$980,000	1.35%	\$13,230
	2044	\$49,000	\$931,000	1.35%	\$12,569
30 Year Post Closure Care	2045	\$49,000	\$882,000	1.35%	\$11,907
	2046	\$49,000	\$833,000	1.35%	\$11,246
	2047	\$49,000	\$784,000	1.35%	\$10,584
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	2052	\$49,000	\$539,000	1.35%	\$7,277
	2053	\$49,000	\$490,000	1.35%	\$6,615
	2054	\$49,000	\$441,000	1.35%	\$5,954
	2055	\$49,000	\$392,000	1.35%	\$5,292
	2056	\$49,000	\$343,000	1.35%	\$4,631
	2057	\$49,000	\$294,000	1.35%	\$3,969
	2058	\$49,000	\$245,000	1.35%	\$3,308
	2059	\$49,000	\$196,000	1.35%	\$2,646
	2060	\$49,000	\$147,000	1.35%	\$1,985
	2061	\$49,000	\$98,000	1.35%	\$1,323
	2062	\$49,000	\$49,000	1.35%	\$662
Cost of Financial Assurance					\$5,300,000

Appendix O

History of Operation of Mud Distillation Units within A&W/Rhodia

History of Operation of Mud Distillation Units within A&W/Rhodia

By Kevin Ryan, former Manager of Phosphorus Technology, Rhodia, October 8, 2014

Introduction: In the early 1970s, particularly at two Albright and Wilson locations in Canada (Long Harbour, Newfoundland and Varennes, Quebec) it had become an increasing priority to address the generation and accumulation of large volumes of materials containing residual elemental phosphorus. These residues were defined either as a phosphorus/water/solids emulsion (typically containing approximately 30% elemental phosphorus) called Phosphorus Mud, or a more dilute residue stream typically containing 1-3% elemental phosphorus called Phosphorus Sludge.

To address the significant accumulations of these materials especially at the two phosphorus manufacturing sites in Canada, key Albright and Wilson (A&W) corporate phosphorus technology personnel, based in the company's technical headquarters in the UK, were assigned to assess alternative means of treating and/or recovering the elemental phosphorus from these streams. As a result of this technical activity a new mud distillation process was developed and patented. Over time, and based upon the success of this process development, a total of nine distillation trains were built and successfully operated at two separate locations in the UK, at two different locations in Canada, and at one location in the US. Below is a listing of the operating experience at these various sites as well as a general description of the process.

Description of the process: The A&W distillation process, which was patented in 1978, provided a distillation apparatus comprising a furnace adapted to receive a skip containing phosphorus mud or sludge. The furnace top was provided with an aperture through which the skips could be inserted or removed as well as a means for closing the aperture with a vapor tight seal. A pool of molten lead, capable of transferring heat from the inner surface of the furnace to the base of the skip, was provided within the furnace. A means of heating the furnace electrically was also provided, as well as ductwork designed to carry the phosphorus vapor from the furnace to the condensing stream. A means of removing the recovered elemental phosphorus, as well as a means of disposing of the residual phosphorus free solids left in the bottom of the skips at the end of

each distillation batch were also provided. A key advantage of the process was that it permitted the skip of phosphorus mud residue to be removed quickly from the furnace as soon as the distillation had been completed, without the need to allow the furnace to cool. This capability converted what was essentially a batch process into a semi-continuous process.

Over a period of approximately twenty years, nine individual distillation trains were constructed at five separate sites. The two initial installations were smaller trains, which were constructed at two separate locations in the UK, where the process was piloted and developed. Later, at three different locations in North America, seven trains were constructed and successfully and safely operated. Below is a listing of the operations of these various plants.

3. The Three Foot Diameter Pilot Plant – Oldbury, UK (~1974/1975): The initial pilot plant for the process was constructed at Oldbury in the UK, the location of A&W's process development facility. A total of 74 batches were run in this unit of several different charge materials and the operating parameters were varied in order to determine the limitations and capability of the process. At the end of the development, the Oldbury pilot plant demonstrated the practical feasibility of mud distillation as a method of recovery of phosphorus of useful quality from a variety of muds with the formation of a residue that can be disposed of safely. The pilot activity also demonstrated there were limitations to the amount or depth of charge that could be processed. Too large a charge resulted in either too long a distillation time or incomplete removal of phosphorus from the charge.

However, encouraged by the overall success of this unit, a larger seven foot diameter plant was constructed at Portishead in the UK.

4. The Seven Foot Diameter Prototype Plant – Portishead UK (~1975-1979): The larger seven foot diameter unit also operated successfully for over 400 runs during the process development stage and for a period of time after the development work was completed to recover phosphorus from contaminated residues in the UK. Based upon the success of this prototype plant, construction was begun on a larger plant at the A&W phosphorus manufacturing plant in Long Harbour, Newfoundland, Canada,

5. Two Ten Foot Diameter Mud Still Trains in Long Harbour, Newfoundland, Canada (1978-~1993): Prior to the construction of the mud processing plant in

1978, P4 mud produced at Long Harbour was stored in tanks or in P4 mud storage holes. From 1978 until the closure of the plant in 1989, most of the P4 mud produced was successfully processed in the two ten foot diameter mud still trains.

After the Long Harbour phosphorus plant had been shut down, the mud stills continued to operate for ~three-four years in an attempt to recover mud from various large storage tanks on the site. The operation of the mud plants at a shutdown site proved much more difficult than at a fully operational site.

Especially in winter and in part because the utility plants (steam etc) were not designed to operate at such a lower requirement, numerous facility breakdowns etc. rendered the continued operation of this process unfeasible. Hence in ~1993 the plants were shut down and decommissioned and the remaining mud was disposed of in a landfill at the site.

6. Four Ten Foot Diameter Mud Still Trains Varennes, Quebec (~ 1981 and 1983 to ~1993): Based upon the success of the Long Harbour units, and compelled by the need to treat the mud and sludge generations at the Varennes plant, initially two mud stills were installed in ~1981 and later two additional still trains were installed in ~1983. All four of these units operated safely and successfully and recovered all the fresh arisings of mud and sludge at the Varennes site until the closure of that phosphorus plant in 1993. In 1993, when the Varennes plant was shut down, these units were also shut down and decommissioned as part of that site's remediation program.

7. Single ten foot diameter still, Colombia, Tennessee (~1987 - ~1992): In 1987 or thereabouts a seventh ten foot diameter phosphorus mud distillation system of similar design was constructed and installed at the Monsanto former elemental phosphorus manufacturing site in Colombia, Tennessee, USA. Monsanto entered an agreement with A&W to purchase and utilize this technology to process and treat the mud remaining at the Colombia Tennessee phosphorus manufacturing site after the shutdown of this facility. This plant also operated successfully for ~5-6 years into the early 1990s and recovered elemental phosphorus from the P4 rich residues at that site. After successful completion of the remediation activity at that site, the distillation plant was also shut down and decommissioned.

8. Summary: In summary, a total of nine P4 mud distillation plants were constructed and successfully operated over ~20 years from 1974 – ~1993. The

first two of these plants were smaller (three and seven foot diameter) and used to pilot and develop the process. The next seven plants were all ten foot diameter units that were successfully operated at three different sites in North America. All seven plants have since been shut down and decommissioned. The units are more difficult to operate in winter conditions, and especially as standalone operations, where the potential for freezing of mud and phosphorus lines and also water and steam lines is greater.

Appendix P

Residue Testing Summary – Clarifier Material Treatability Study, Phase 3 Report

Rhodia Phosphorus Recovery Pilot Plant 2011 Residue Summary

Residue Collection Date	Test Number	Drum Number	A/B Sample	Field Flammability Test	Field Test for PH3 Generation	EPA 1030 Ignitability Test	Burn Rate Test	Residue Density	TCLP Sample to Lab	TCLP Results	Sample Residue Disposal Location
6/15/2011	Test 1	12	A	Negative	Negative	Negative	Not Req'd.	30.41	6/28/2011	Failed for Cadmium - 2.69 mg/L	Clarifer
6/22/2011	Test 2	5	B	Negative	Negative	Negative	Not Req'd.	30.76	6/28/2011	Passed all TCLP analysis	Clarifer
6/22/2011	Test 2 Re-run	5	B	Negative	Negative	Negative	Not Req'd.	30.76	7/22/2011	Failed for Cadmium - 1.86 mg/L	Clarifer
6/24/2011	Test 3	5	B	Negative	Negative	Negative	Not Req'd.	30.76	7/7/2011	Failed for Cadmium - 2.03 mg/L	Residue Drum 1
6/24/2011	Test 3 Re-run	5	B	Negative	Negative	Negative	Not Req'd.	30.76	7/22/2011	Failed for Cadmium - 3.06 mg/L	Residue Drum 1
6/29/2011	Test 4	7	A	Negative	Negative	Negative	Not Req'd.	31.69	7/7/2011	Passed all TCLP analysis	Residue Drum 2
7/13/2011	Test 5	8	A	Negative	Negative	Negative	Not Req'd.	34.05	7/22/2011	Failed for Cadmium - 1.86 mg/L	Residue Drum 3
7/20/2011	Test 6	10	A	Negative	Negative	Negative	Not Req'd.	31.49	7/22/2011	Failed for Cadmium - 2.53 mg/L	Residue Drum 4
	Test 7	7	A	Negative	Negative	Negative	Not Req'd.	33.47		Residue contaminated - No TCLP Analysis	Clarifer
	Test 8	11	A	Residue contaminated with RAP. Unable to obtain samples.						Residue contaminated - No TCLP Analysis	Clarifer
8/10/2011	Test 9	1	A	Negative	Negative	Negative	Not Req'd.	34.00	8/19/2011	Failed for Cadmium - 2.65 mg/L	Clarifier
8/16/2011	Test 10	9	A	Negative	Negative	Negative	Not Req'd.	30.87	8/19/2011	Failed for Cadmium - 1.45 mg/L	Clarifier
8/24/2011	Test 11	3	A	Negative	Negative	Negative	Not Req'd.	30.95	8/19/2011	Passed all TCLP analysis	Residue Drum 5
	Test 12	2	A	Negative	Negative	Negative	Not Req'd.	31.56		Residue contaminated - No TCLP Analysis	Clarifier

Appendix Q

HELP Modeling for Evapotranspiration Cap

HELP Modeling Soil Cap

Introduction

The HELP (Hydrologic Evaluation of Landfill Performance) model (Version 3.07, U.S. Army Corps of Engineers, November 1997) was used to project long-term infiltration through the soil cap system.

The HELP model tracks the water budget for the cap system. The water enters as precipitation (including snowmelt) less the runoff, and exits via evapotranspiration (ET), percolation, and drainage, or it is held in storage in the pore spaces. The amount of water percolating through the capped material is of particular interest because it can leach contaminants and may impact the underlying groundwater.

The summary model output for the soil cap system is attached. It includes data inputs and summary results for 30 years of model simulation.

Input

The input values used were those recommended in the HELP guidance and documentation for this climate and this type of application. Site-specific parameters such as soil characteristics were used to select a reasonably similar HELP soil textures. The inputs and rationales for their selection are explained below.

Climate Data: 30 years of precipitation data were synthetically generated from monthly total precipitation data from the Butte, Montana airport and the Helena, Montana coefficients. The Helena coefficients are a default data set available with the HELP model. The average annual precipitation at Helena and Butte and the monthly distribution of precipitation were nearly identical, so the Helena coefficients were considered suitable for this model. The attached table of weather information for Butte and Helena illustrate the similarities in their climates. Temperature data were generated synthetically by the HELP model using Helena coefficients and monthly averages for Butte. The latitude was adjusted to 45.8° for the solar radiation and the Helena values were used for the relative humidity. The growing season for Helena was used: 128 days.

Cover Design: The layers that comprise the cover are 6 inches of topsoil, 18 inches of native soil borrow, and a cushion of granulated slag over the crude phosphorus. The corresponding HELP soil types are Texture 9 for the topsoil, Texture 12 for the native soil borrow, and Texture 1 for the granulated slag. This cover assumes that the topsoil and common fill will be obtained locally. The attached soil test data is for a borrow source available at the Silver Bow Plant property. The soil was compacted to approximately 90 percent of standard proctor maximum density for the permeability testing. The borrow soil is expected to function similarly to HELP soil Texture 12, based on the similar soil type (silty clay loam) and identical hydraulic conductivities (4.2×10^{-5} cm/s). The borrow soil may have an ability to store more water than the HELP Texture 12 soil, which would only improve the effectiveness of the cap. The granulated slag available at the plant would be used for the granular subgrade for the cap.

General Design and Evapotranspiration Parameters: The input and HELP-computed parameters for runoff and evapotranspiration are as follows:

Cover slope: 3%
Cover slope length: 50 feet
SCS runoff curve number: 83.50 (computed by HELP)
Evaporative zone depth: 24.0 inches
Maximum leaf area index: 2.00

Results

Summary output for the HELP model is attached.

The annual average values for the 30-year simulation are as follows:

Precipitation: 12.55 inches
Runoff: 0.475 inches
Evapotranspiration: 12.074 inches
Percolation through cap: 0.01272 inches

Model Sensitivity

Model sensitivity was tested on 2 parameters:

1. Evaporative zone depth
2. Leaf index

The summary outputs for the HELP model runs are attached. The effect on average annual percolation for this sensitivity case is summarized in the following table. The representative case using the inputs described earlier is listed first, followed by the sensitivity cases where one or more parameters were varied.

Sensitivity Cases

Parameter	Representative	Deep Evap. Zone	Shallow Evap. Zone	High Leaf Area
Evaporative zone depth (in)	24	42	14	24
Maximum leaf area index	2	2	2	3
Acreage annual percolation through cap (in/yr)	0.013	0.070	0.089	0.015

The range of annual average percolation is 0.013 inches to 0.089 inches for the representative and sensitivity cases, as shown in the last line of the above table. This result suggests that this form of cap is sensitive to variations in the cover vegetation and the depth of the evaporative zone, although the estimated percolation is still small, less than 0.1 inches per year. Based on these sensitivity results the soil cap design may benefit from optimization of the cap thickness, assuming a slightly thicker cap would reduce the variability in percolation due to these sensitivity factors.

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 1

THICKNESS = 72.00 INCHES
 POROSITY = 0.4170 VOL/VOL
 FIELD CAPACITY = 0.0450 VOL/VOL
 WILTING POINT = 0.0180 VOL/VOL
 INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
 EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
 SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
 FAIR STAND OF GRASS, A SURFACE SLOPE OF 3. %
 AND A SLOPE LENGTH OF 50. FEET.

SCS RUNOFF CURVE NUMBER = 83.50
 FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE = 0.180 ACRES
 EVAPORATIVE ZONE DEPTH = 24.0 INCHES
 INITIAL WATER IN EVAPORATIVE ZONE = 7.860 INCHES
 UPPER LIMIT OF EVAPORATIVE STORAGE = 11.484 INCHES
 LOWER LIMIT OF EVAPORATIVE STORAGE = 4.590 INCHES
 INITIAL SNOW WATER = 0.000 INCHES
 INITIAL WATER IN LAYER MATERIALS = 11.100 INCHES
 TOTAL INITIAL WATER = 11.100 INCHES
 TOTAL SUBSURFACE INFLOW = 0.00 INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
 HELENA MONTANA

STATION LATITUDE = 45.82 DEGREES
 MAXIMUM LEAF AREA INDEX = 2.00
 START OF GROWING SEASON (JULIAN DATE) = 138
 END OF GROWING SEASON (JULIAN DATE) = 266
 EVAPORATIVE ZONE DEPTH = 24.0 INCHES
 AVERAGE ANNUAL WIND SPEED = 7.80 MPH
 AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 63.00 %
 AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 54.00 %
 AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 49.00 %
 AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.61	0.56	0.81	1.03	1.89	2.27
1.30	1.11	1.12	0.80	0.62	0.59

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
---------	---------	---------	---------	---------	---------

18.60	22.60	29.20	39.10	47.70	55.70
63.30	61.70	51.90	42.10	29.40	20.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR HELENA MONTANA
 AND STATION LATITUDE = 45.82 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

PRECIPITATION						

TOTALS	0.65 1.31	0.48 0.98	0.85 1.27	1.11 0.83	1.92 0.57	2.04 0.54
STD. DEVIATIONS	0.36 0.67	0.31 0.47	0.46 0.68	0.58 0.42	0.84 0.35	0.73 0.36
RUNOFF						

TOTALS	0.021 0.000	0.068 0.000	0.145 0.000	0.171 0.000	0.040 0.024	0.000 0.005
STD. DEVIATIONS	0.063 0.001	0.141 0.000	0.224 0.001	0.195 0.000	0.102 0.053	0.000 0.015
EVAPOTRANSPIRATION						

TOTALS	0.460 2.092	0.401 0.969	0.456 0.857	0.841 0.547	2.286 0.322	2.510 0.333
STD. DEVIATIONS	0.182 0.996	0.192 0.433	0.159 0.315	0.293 0.223	0.397 0.141	0.554 0.161
PERCOLATION/LEAKAGE THROUGH LAYER 3						

TOTALS	0.0011 0.0012	0.0009 0.0012	0.0010 0.0011	0.0010 0.0011	0.0010 0.0011	0.0011 0.0011
STD. DEVIATIONS	0.0007 0.0008	0.0006 0.0008	0.0007 0.0007	0.0007 0.0007	0.0007 0.0007	0.0007 0.0007

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	12.55	(1.640)	8200.6	100.00
RUNOFF	0.475	(0.2803)	310.31	3.784
EVAPOTRANSPIRATION	12.074	(1.4376)	7889.23	96.203
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.01272	(0.00818)	8.311	0.10135
CHANGE IN WATER STORAGE	-0.011	(0.9869)	-7.25	-0.088

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	1.15	751.410
RUNOFF	0.705	460.7727
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000070	0.04546
SNOW WATER	1.84	1201.1409
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3614	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1912	

 FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.3158	0.3860
2	4.9099	0.2728
3	3.5412	0.0492
SNOW WATER	0.000	

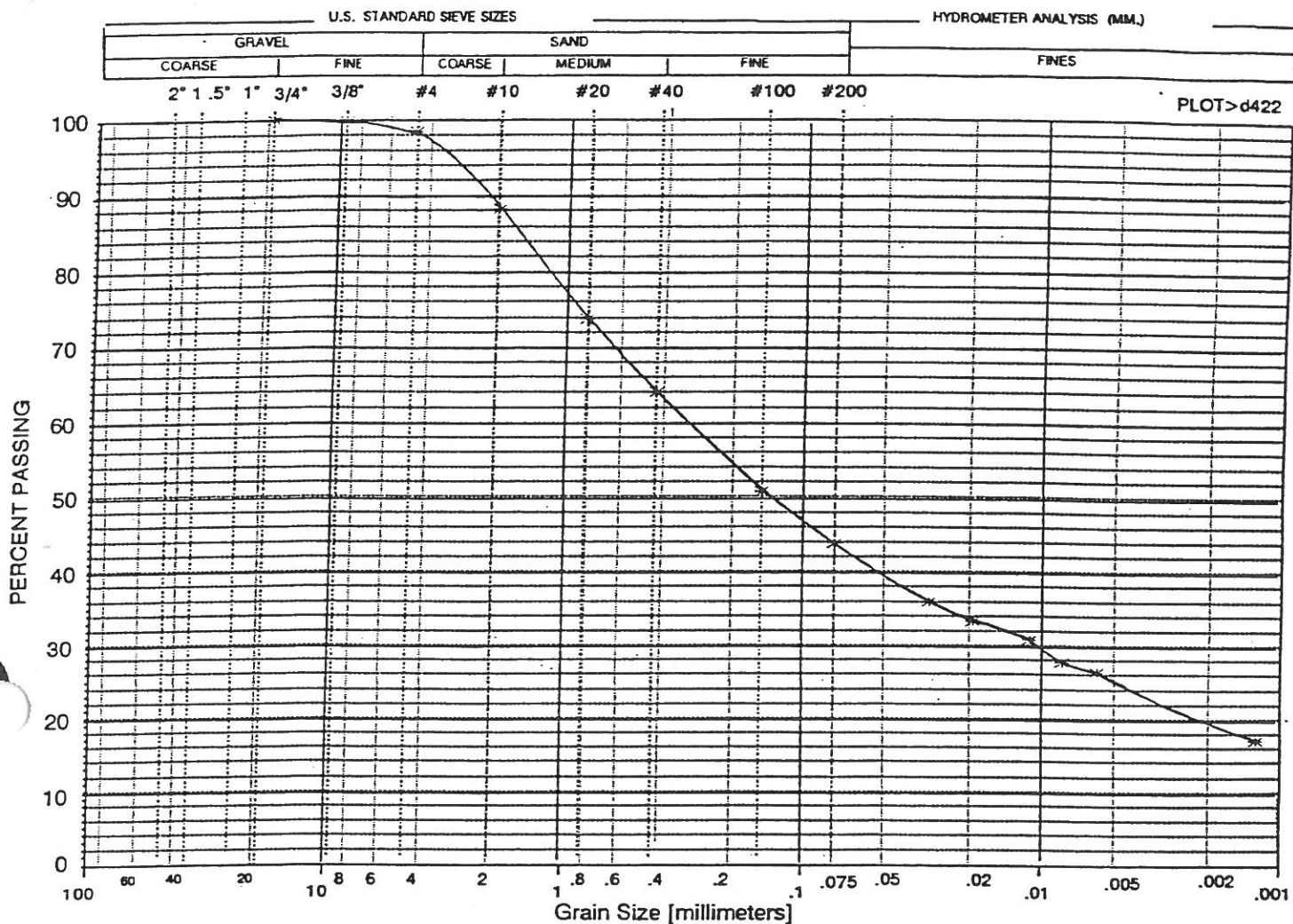
Monthly Climate Summary
Butte FAA Airport, Montana: (Weather Station 241318)
Compared to HELP Helena Climate Data

Month	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Butte													
Average Maximum Temperature, °F	29.8	34.3	40.6	51.1	60.5	69.3	79.5	78.0	66.9	55.5	40.5	31.7	53.2
Butte													
Average Minimum Temperature, °F	7.4	10.9	17.7	27.0	34.9	42.0	47.1	45.3	36.9	28.7	18.2	10.0	27.2
Butte													
Average Total Precipitation, inches	0.61	0.56	0.81	1.03	1.89	2.27	1.30	1.11	1.12	0.80	0.62	0.59	12.71
Butte													
Average Total Snowfall, inches	8.6	7.7	10.3	7.5	3.7	0.5	0.0	0.1	1.1	3.6	6.6	8.3	57.9
Butte													
Average Snow Depth, inches	4.0	4.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.0	1.0
Butte													
Average Wind Speed, mph **	14.9	14.1	3.6	0.8	2.3	2.6	5.1	4.3	6.5	5.9	15.5	2.5	6.3
Helena													
Average Mean Temperature, °F	18.1	26.0	31.6	42.3	52.2	60.1	67.9	65.9	55.6	45.1	31.4	23.5	43.3
Helena													
Average Total Precipitation, inches	0.66	0.44	0.69	1.01	1.72	2.01	1.04	1.18	0.83	0.65	0.54	0.60	11.4
Helena													
Average Wind Speed, mph													7.8

Notes: Data were based on a record period of 104 years, 1894 to 1998, for Butte FAA Airport unless noted otherwise

* Indicates data are based on a record period of 1 year, 1996, from onsite weather station

Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
99-10		0.5-6.0	Bulk	Clayey sand w/a trace of gravel (SC)



OTHER TESTS

	x	+	□
Liquid Limit (%)	46.5		
Plastic Limit (%)	20.1		
Plasticity Index	26.4		
Water Content (%)	12.3		
Dry Density [pcf]			
Specific Gravity (G)	2.67*		
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

PERCENT PASSING

	x	+	□
Mass [gm]			
2"			
1-1/2"			
1"			
3/4"	100.0		
3/8"	99.7		
#4	98.5		
#10	88.3		
#20	73.8		
#40	64.1		
#100	50.7		
#200	43.9		

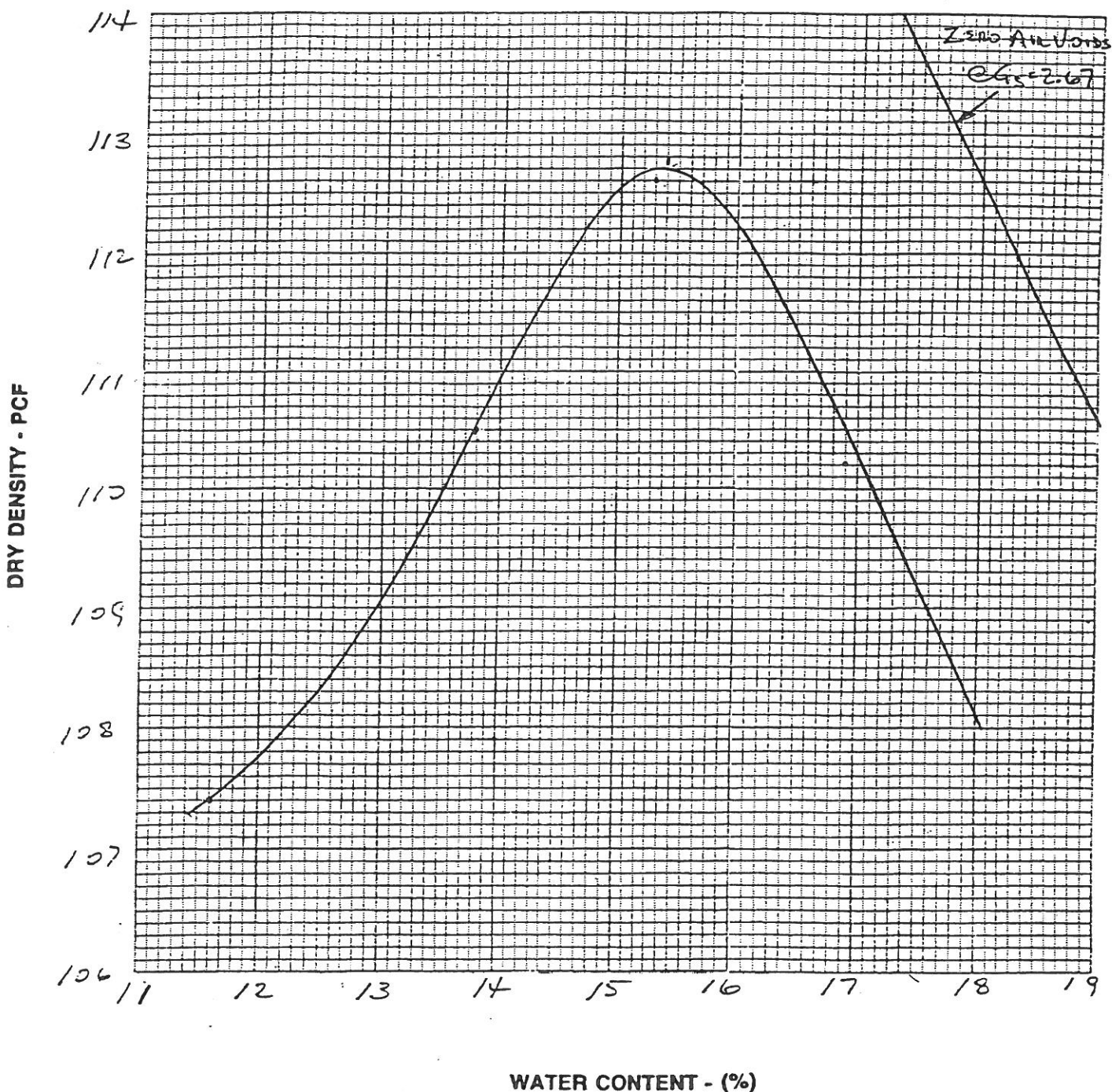
	x	+	□
D ₆₀			
D ₃₀			
D ₁₀			
C _u			
C _c			

Remarks:

ASTM: D422 Sieve Set

MOISTURE - DENSITY CURVE

Project RHODIA SILVER BOW - #26/46-004 JSL 200 Date 7-16-99
 Reported To BAR ENGINEERING COMPANY Job No. 3604
 Boring No. 99-10 Sample No. _____ Depth (ft.) 1/2-6 Location _____
 Test Method ASTM: D698, PROCEDURE B
 Soil Description CLAYEY SAND w/ A TRACE OF GRAVEL (SC)
AS RECEIVED WATER CONTENT: 12.3% LL=46.5% PL=20.1% PI=26.4
 Maximum Dry Density 112.7 pcf Optimum Water Content 15.4 %



Project: RHODIA SILVER BOW - # 26/46-004 JSL200 Date: 7-30-99

Reported To: BARN ENGINEERING COMPANY Job No.: 3604

Boring No.		99-10	99-10	99-10		
Sample No.						
Depth (Ft)		1/2 - 6	1/2 - 6	6 - 12		
Type of Sample		BULK	BULK	BULK		
Soil Classification (ASTM: D2487/2488)		CLAYEY SAND w/ A TRACE OF GILGAISS (SC)	→			
Mechanical Analysis						
Dry Weight (Grams)						
Percent Passing						
Gravel	3"					
	2"					
	1"					
	3/4"					
Sand	#4					
	#10					
	#40					
	#100					
	#200					
Atterberg Limits						
Liquid Limit						
Plastic Limit						
Plasticity Index						
Moisture - Density						
Water Content (%)		3.6 *	25.8 **	33.2		
Dry Density (PCF)			100.6 #			
Unconfined Compression						
Maximum Load (psf)						
Hand Penetrometer (tsf)						
Organic Content (%)						
pH (Meter Method)						
Specific Gravity						
Resistivity (ohm-cm)						

* AIR DRIED TO CONSTANT WEIGHT
FOR TWO WEEKS

** WATER HOLDING CAPACITY
INITIAL DRY DENSITY AT 12.4% W.C.
BEFORE SOAKING & GRAVITY DRAINING

Permeability Test Data (Compacted Specimens)

Project: RHODIA SILVER BOW - # 26146-004 JSL200

Date: 7-23-99

Reported To: BARR ENGINEERING COMPANY

Job No.: 3604

Sample No./Designation	99-10					
Sample Type, Location Elevation or Depth	2 1/2' - 6'					
Soil Classification	CLAYEY SAND W/A TRACE OF GRAVEL (SC)					
In-Place Water Content (%)	12.3					
Moisture - Density Relation (ASTM: D698)						
Max Dry Density (PCF)	112.7					
Opt. Water Content (%)	15.4					
Atterberg Limits						
Liquid Limit	46.5					
Plastic Limit	20.1					
Plasticity Index	26.4					
Permeability Test						
% Saturation (After Test)	87.5*	* LOST WATER AFTER DISSASSEMBLING DUE TO GRAVITY DRAINAGE				
Specimen Height (Inches)	3.00					
Specimen Diameter (Inches)	2.86					
Dry Density (PCF)	101.9					
% of Max. Density	90.4					
Water Content (%)	12.3					
Type of Test (Head)	Falling					
Max. Head Differential (Ft)	1.1					
Confining Pressure (Effective-PSI)	2.0					
Trial No.	12-16					
Water Temp. (°C)	23					
Co-efficient of Permeability						
K @ 20°C (Cm/Sec)	4.2×10^{-5}					
K @ 20°C (F/Min)	8.3×10^{-5}					

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4710	VOL/VOL
FIELD CAPACITY	=	0.3420	VOL/VOL
WILTING POINT	=	0.2100	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3420	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.419999997000E-04	CM/SEC

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 1

THICKNESS = 72.00 INCHES
 POROSITY = 0.4170 VOL/VOL
 FIELD CAPACITY = 0.0450 VOL/VOL
 WILTING POINT = 0.0180 VOL/VOL
 INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
 EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
 SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
 FAIR STAND OF GRASS, A SURFACE SLOPE OF 3. %
 AND A SLOPE LENGTH OF 50. FEET.

SCS RUNOFF CURVE NUMBER = 83.50
 FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE = 0.180 ACRES
 EVAPORATIVE ZONE DEPTH = 42.0 INCHES
 INITIAL WATER IN EVAPORATIVE ZONE = 8.670 INCHES
 UPPER LIMIT OF EVAPORATIVE STORAGE = 18.990 INCHES
 LOWER LIMIT OF EVAPORATIVE STORAGE = 4.914 INCHES
 INITIAL SNOW WATER = 0.000 INCHES
 INITIAL WATER IN LAYER MATERIALS = 11.100 INCHES
 TOTAL INITIAL WATER = 11.100 INCHES
 TOTAL SUBSURFACE INFLOW = 0.00 INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
 HELENA MONTANA

STATION LATITUDE = 45.82 DEGREES
 MAXIMUM LEAF AREA INDEX = 2.00
 START OF GROWING SEASON (JULIAN DATE) = 138
 END OF GROWING SEASON (JULIAN DATE) = 266
 EVAPORATIVE ZONE DEPTH = 42.0 INCHES
 AVERAGE ANNUAL WIND SPEED = 6.30 MPH
 AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 63.00 %
 AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 54.00 %
 AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 49.00 %
 AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.61	0.56	0.81	1.03	1.89	2.27
1.30	1.11	1.12	0.80	0.62	0.59

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
---------	---------	---------	---------	---------	---------

18.60	22.60	29.20	39.10	47.70	55.70
63.30	61.70	51.90	42.10	29.40	20.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR HELENA MONTANA
 AND STATION LATITUDE = 45.82 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.65 1.31	0.48 0.98	0.85 1.27	1.11 0.83	1.92 0.57	2.04 0.54
STD. DEVIATIONS	0.36 0.67	0.31 0.47	0.46 0.68	0.58 0.42	0.84 0.35	0.73 0.36
RUNOFF						
TOTALS	0.023 0.000	0.084 0.000	0.143 0.000	0.144 0.000	0.034 0.024	0.000 0.007
STD. DEVIATIONS	0.061 0.001	0.159 0.000	0.223 0.001	0.176 0.000	0.091 0.052	0.000 0.019
EVAPOTRANSPIRATION						
TOTALS	0.414 2.063	0.370 0.986	0.432 0.919	0.844 0.565	2.280 0.301	2.554 0.300
STD. DEVIATIONS	0.154 0.983	0.162 0.438	0.144 0.351	0.304 0.234	0.388 0.143	0.518 0.138
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0051 0.0074	0.0045 0.0082	0.0050 0.0071	0.0050 0.0067	0.0049 0.0059	0.0049 0.0056
STD. DEVIATIONS	0.0046 0.0054	0.0043 0.0061	0.0045 0.0052	0.0044 0.0048	0.0044 0.0042	0.0044 0.0044

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.55 (1.640)	8200.6	100.00
RUNOFF	0.459 (0.2806)	299.96	3.658
EVAPOTRANSPIRATION	12.027 (1.4373)	7858.68	95.831
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.07028 (0.05110)	45.918	0.55994
CHANGE IN WATER STORAGE	-0.006 (0.9773)	-3.96	-0.048

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	1.15	751.410
RUNOFF	0.737	481.3681
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000846	0.55257
SNOW WATER	1.91	1248.5452
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.2282
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1170

 FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.3220	0.3870
2	4.6315	0.2573
3	3.9646	0.0551
SNOW WATER	0.000	


```
PRECIPITATION DATA FILE: P:\26\46\004\HELPMODE\HELP307\data4-3.D4
TEMPERATURE DATA FILE: p:\26\46\004\Helpmode\help307\data7-3.D7
SOLAR RADIATION DATA FILE: p:\26\46\004\helpmode\help307\data13-3.D13
EVAPOTRANSPIRATION DATA: p:\26\46\004\helpmode\help307\DATA11-5.D11
SOIL AND DESIGN DATA FILE: p:\26\46\004\helpmode\help307\soilcap2.D10
OUTPUT DATA FILE: p:\26\46\004\helpmode\help307\slcap2c.OUT
```

TITLE: Silver Bow - Soil Cap (24" soil cover, ⁷/₂' E.Z. Depth)

LAYER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.5010	VOL/VOL
FIELD CAPACITY	=	0.2840	VOL/VOL
WILTING POINT	=	0.1350	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2840	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.190000006000E-03	CM/SEC

LAYER 2

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4710	VOL/VOL
FIELD CAPACITY	=	0.3420	VOL/VOL
WILTING POINT	=	0.2100	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3420	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.419999997000E-04	CM/SEC

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 1

THICKNESS = 72.00 INCHES
 POROSITY = 0.4170 VOL/VOL
 FIELD CAPACITY = 0.0450 VOL/VOL
 WILTING POINT = 0.0180 VOL/VOL
 INITIAL SOIL WATER CONTENT = 0.0450 VOL/VOL
 EFFECTIVE SAT. HYD. COND. = 0.999999978000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
 SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
 FAIR STAND OF GRASS, A SURFACE SLOPE OF 3. %
 AND A SLOPE LENGTH OF 50. FEET.

SCS RUNOFF CURVE NUMBER = 83.50
 FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE = 0.180 ACRES
 EVAPORATIVE ZONE DEPTH = 14.0 INCHES
 INITIAL WATER IN EVAPORATIVE ZONE = 4.440 INCHES
 UPPER LIMIT OF EVAPORATIVE STORAGE = 6.774 INCHES
 LOWER LIMIT OF EVAPORATIVE STORAGE = 2.490 INCHES
 INITIAL SNOW WATER = 0.000 INCHES
 INITIAL WATER IN LAYER MATERIALS = 11.100 INCHES
 TOTAL INITIAL WATER = 11.100 INCHES
 TOTAL SUBSURFACE INFLOW = 0.00 INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
 HELENA MONTANA

STATION LATITUDE = 45.82 DEGREES
 MAXIMUM LEAF AREA INDEX = 2.00
 START OF GROWING SEASON (JULIAN DATE) = 138
 END OF GROWING SEASON (JULIAN DATE) = 266
 EVAPORATIVE ZONE DEPTH = 14.0 INCHES
 AVERAGE ANNUAL WIND SPEED = 6.30 MPH
 AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 63.00 %
 AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 54.00 %
 AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 49.00 %
 AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.61	0.56	0.81	1.03	1.89	2.27
1.30	1.11	1.12	0.80	0.62	0.59

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
---------	---------	---------	---------	---------	---------

18.60	22.60	29.20	39.10	47.70	55.70
63.30	61.70	51.90	42.10	29.40	20.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR HELENA MONTANA
 AND STATION LATITUDE = 45.82 DEGREES

 AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.65 1.31	0.48 0.98	0.85 1.27	1.11 0.83	1.92 0.57	2.04 0.54
STD. DEVIATIONS	0.36 0.67	0.31 0.47	0.46 0.68	0.58 0.42	0.84 0.35	0.73 0.36
RUNOFF						
TOTALS	0.030 0.001	0.106 0.000	0.176 0.000	0.227 0.000	0.051 0.028	0.000 0.009
STD. DEVIATIONS	0.088 0.003	0.196 0.000	0.245 0.001	0.245 0.000	0.128 0.061	0.000 0.025
EVAPOTRANSPIRATION						
TOTALS	0.413 1.698	0.367 0.953	0.414 0.940	0.996 0.702	2.256 0.407	2.326 0.309
STD. DEVIATIONS	0.155 0.811	0.161 0.497	0.145 0.472	0.459 0.314	0.583 0.121	0.629 0.137
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0072 0.0085	0.0068 0.0077	0.0075 0.0071	0.0072 0.0070	0.0082 0.0065	0.0087 0.0070
STD. DEVIATIONS	0.0086 0.0087	0.0087 0.0082	0.0099 0.0075	0.0096 0.0075	0.0095 0.0071	0.0094 0.0072

 AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.55 (1.640)	8200.6	100.00
RUNOFF	0.627 (0.3479)	409.90	4.998
EVAPOTRANSPIRATION	11.779 (1.4470)	7696.50	93.853
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.08947 (0.09880)	58.463	0.71291
CHANGE IN WATER STORAGE	0.055 (0.8099)	35.75	0.436

PEAK DAILY VALUES FOR YEARS	1 THROUGH	30
	(INCHES)	(CU. FT.)
PRECIPITATION	1.15	751.410
RUNOFF	0.832	543.4906
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.001477	0.96500
SNOW WATER	1.91	1248.5452
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3768
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1779

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.3083	0.3847
2	5.7103	0.3172
3	4.7227	0.0656
SNOW WATER	0.000	


```

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 12
THICKNESS              =      18.00    INCHES
POROSITY                =      0.4710  VOL/VOL
FIELD CAPACITY          =      0.3420  VOL/VOL
WILTING POINT          =      0.2100  VOL/VOL
INITIAL SOIL WATER CONTENT =    0.3420  VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.419999997000E-04 CM/SEC

```


LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER	1
THICKNESS	= 72.00 INCHES
POROSITY	= 0.4170 VOL/VOL
FIELD CAPACITY	= 0.0450 VOL/VOL
WILTING POINT	= 0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT	= 0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND.	= 0.999999978000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 50. FEET.

SCS RUNOFF CURVE NUMBER	= 83.50
FRACTION OF AREA ALLOWING RUNOFF	= 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	= 0.180 ACRES
EVAPORATIVE ZONE DEPTH	= 24.0 INCHES
INITIAL WATER IN EVAPORATIVE ZONE	= 7.860 INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	= 11.484 INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	= 4.590 INCHES
INITIAL SNOW WATER	= 0.000 INCHES
INITIAL WATER IN LAYER MATERIALS	= 11.100 INCHES
TOTAL INITIAL WATER	= 11.100 INCHES
TOTAL SUBSURFACE INFLOW	= 0.00 INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM HELENA MONTANA

STATION LATITUDE	= 45.82 DEGREES
MAXIMUM LEAF AREA INDEX	= 3.00
START OF GROWING SEASON (JULIAN DATE)	= 138
END OF GROWING SEASON (JULIAN DATE)	= 266
EVAPORATIVE ZONE DEPTH	= 24.0 INCHES
AVERAGE ANNUAL WIND SPEED	= 6.30 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	= 63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	= 54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	= 49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	= 63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.61	0.56	0.81	1.03	1.89	2.27
1.30	1.11	1.12	0.80	0.62	0.59

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
---------	---------	---------	---------	---------	---------

18.60	22.60	29.20	39.10	47.70	55.70
63.30	61.70	51.90	42.10	29.40	20.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR HELENA MONTANA
 AND STATION LATITUDE = 45.82 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.65 1.31	0.48 0.98	0.85 1.27	1.11 0.83	1.92 0.57	2.04 0.54
STD. DEVIATIONS	0.36 0.67	0.31 0.47	0.46 0.68	0.58 0.42	0.84 0.35	0.73 0.36
RUNOFF						
TOTALS	0.027 0.000	0.095 0.000	0.162 0.000	0.182 0.000	0.042 0.026	0.000 0.008
STD. DEVIATIONS	0.072 0.001	0.177 0.000	0.238 0.001	0.203 0.000	0.109 0.058	0.000 0.022
APOTRANSPIRATION						
TOTALS	0.414 1.842	0.370 0.977	0.433 0.843	0.829 0.514	2.300 0.283	2.889 0.300
STD. DEVIATIONS	0.154 0.923	0.162 0.451	0.143 0.315	0.286 0.202	0.361 0.111	0.566 0.139
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0012 0.0014	0.0011 0.0013	0.0012 0.0013	0.0012 0.0013	0.0012 0.0013	0.0013 0.0013
STD. DEVIATIONS	0.0009 0.0010	0.0008 0.0010	0.0009 0.0009	0.0008 0.0009	0.0008 0.0009	0.0009 0.0009

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.55 (1.640)	8200.6	100.00
RUNOFF	0.542 (0.3122)	354.41	4.322
POTRANSPIRATION	11.994 (1.4021)	7836.89	95.565
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.01517 (0.01037)	9.915	0.12091
CHANGE IN WATER STORAGE	-0.001 (0.9566)	-0.61	-0.007

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30.

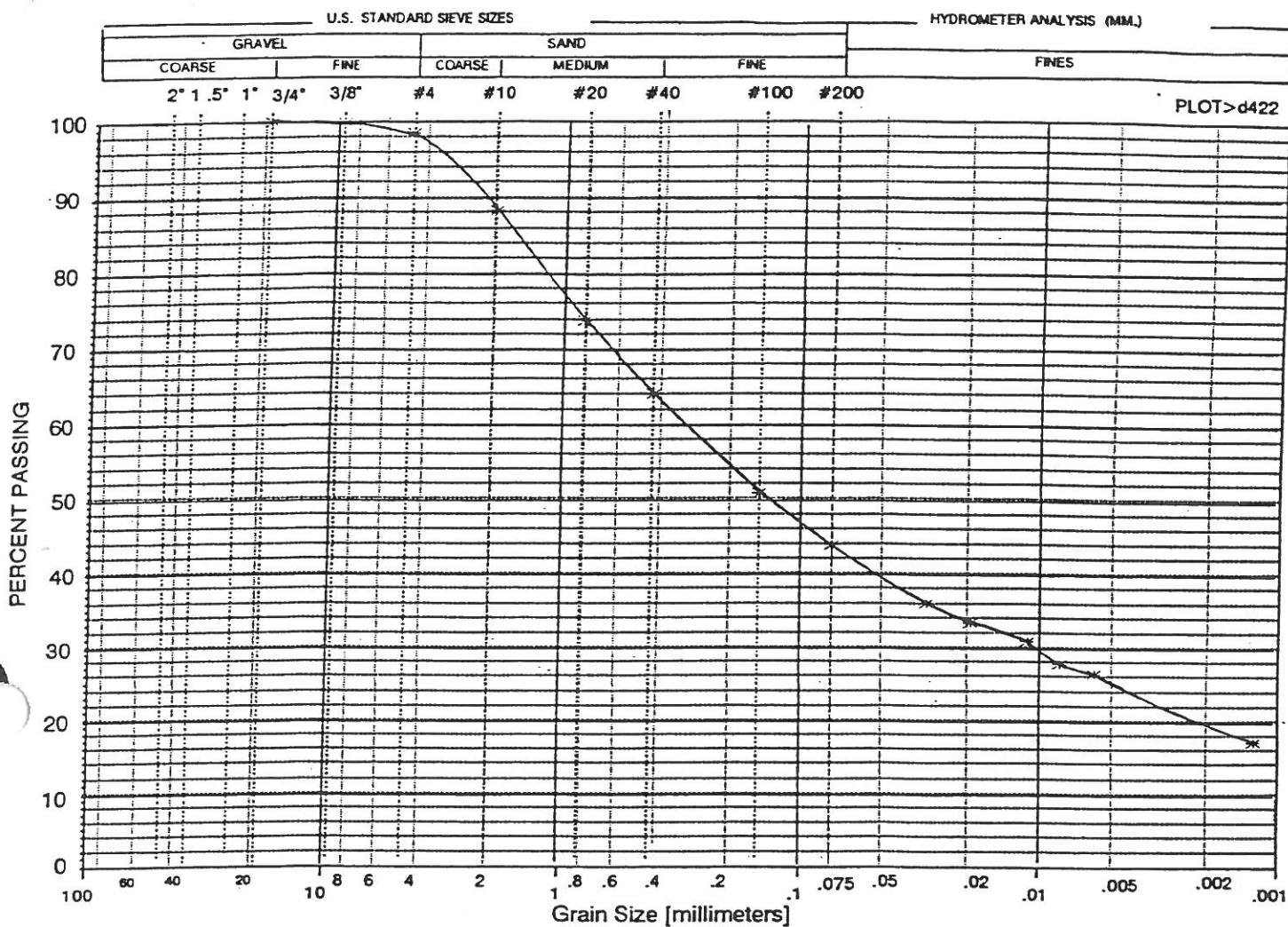
	(INCHES)	(CU. FT.)
PRECIPITATION	1.15	751.410
RUNOFF	0.794	518.8820
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000124	0.08134
SNOW WATER	1.91	1248.5452
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3623
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1912

 FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
-----	-----	-----
1	2.3246	0.3874
2	4.9748	0.2764
3	3.7727	0.0524
SNOW WATER	0.000	

Appendix R
Soil Test Report

Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
99-10		0.5-6.0	Bulk	Clayey sand w/a trace of gravel (SC)



OTHER TESTS

	x	+	□
Liquid Limit (%)	46.5		
Plastic Limit (%)	20.1		
Plasticity Index	26.4		
Water Content (%)	12.3		
Dry Density [pcf]			
Specific Gravity (*)	2.67*		
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

* Assumed Value

PERCENT PASSING

	x	+	□
Mass [gm]			
2"			
1-1/2"			
1"			
3/4"	100.0		
3/8"	99.7		
#4	98.5		
#10	88.3		
#20	73.8		
#40	64.1		
#100	50.7		
#200	43.9		

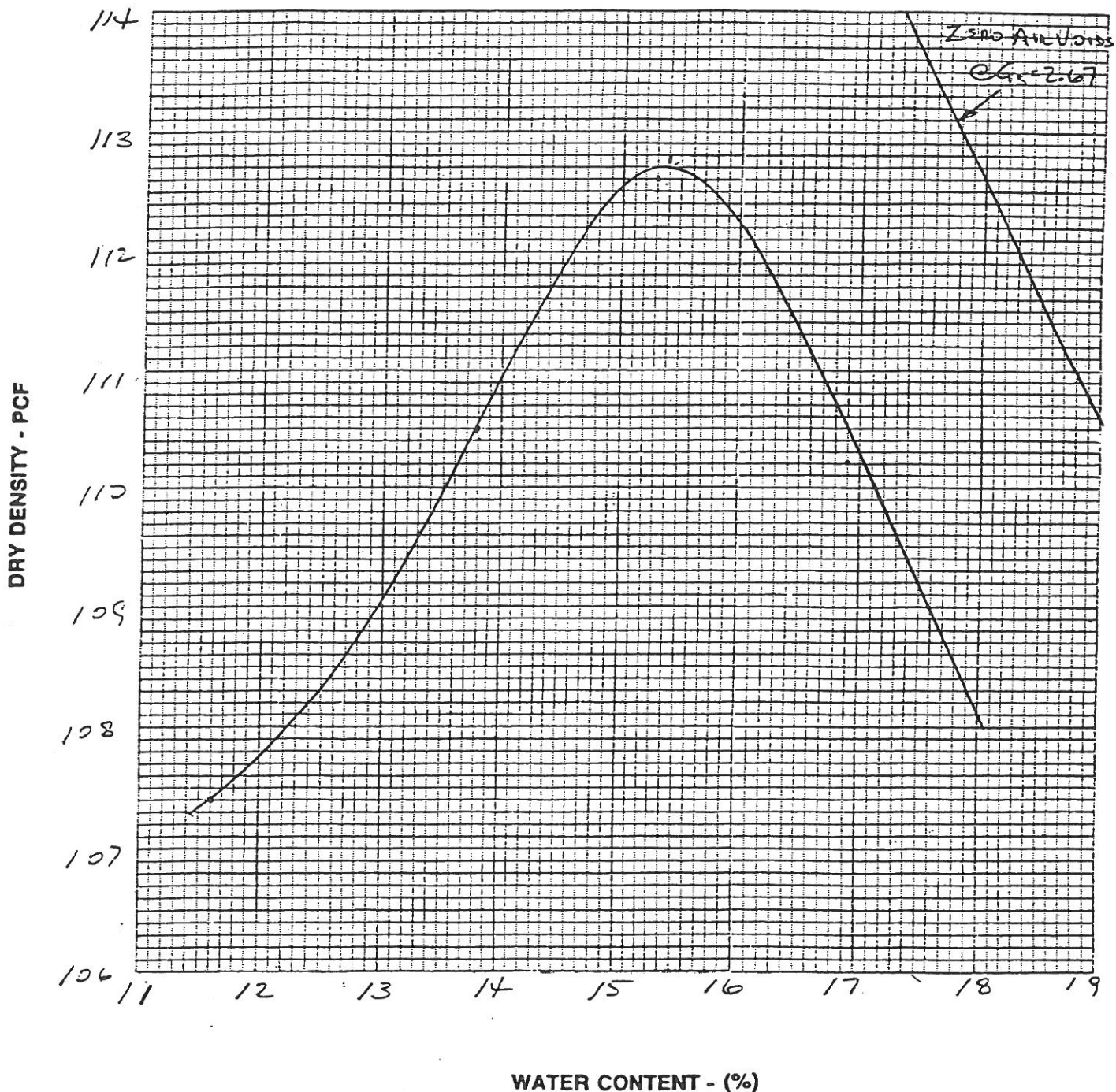
ASTM: D422 Sieve Set

	x	+	□
D ₆₀			
D ₃₀			
D ₁₀			
C _u			
C _c			

Remarks:

MOISTURE - DENSITY CURVE

Project RHODIA SILVER BOW - #26/46-004 JSL 200 Date 7-16-99
 Reported To BAHL ENGINEERING COMPANY Job No. 3604
 Boring No. 99-10 Sample No. _____ Depth (ft.) 1/2-6 Location _____
 Test Method ASTM: D698, Procedure B
 Soil Description CLAYEY SAND w/ A TRACE OF GRAVEL (SC)
AS RECEIVED WATER CONTENT: 12.3% LL=46.5% PL=20.1% PI=26.4
 Maximum Dry Density 112.7 pcf Optimum Water Content 15.4 %



Project: RHODIA SILVER BOW - # 26/46-004 JSL200 Date: 7-30-99

Reported To: BARN ENGINEERING COMPANY Job No.: 3604

Core No.	99-10	99-10	99-10		
Sample No.					
Depth (Ft)	1/2 - 6	1/2 - 6	6 - 12		
Type of Sample	BULK	BULK	BULK		
Soil Classification (ASTM: D2487/2488)	CLAYED SAND w/ A TRACE OF GRAVEL (SC)	→			
Mechanical Analysis					
Dry Weight (Grams)					
Percent Passing					
Gravel 3"					
2"					
1"					
3/4"					
Sand #4					
#10					
#40					
#100					
#200					
Atterberg Limits					
Liquid Limit					
Plastic Limit					
Plasticity Index					
Moisture - Density					
Water Content (%)	3.6 *	25.8 **	33.2		
Dry Density (PCF)		100.6 #			
Unconfined Compression					
Maximum Load (psf)					
Hand Penetrometer (tsf)					
Organic Content (%)					
pH (Meter Method)					
Specific Gravity					
Resistivity (ohm-cm)					

* AIR DRIED TO CONSTANT WEIGHT
FOR TWO WEEKS

** WATER HOLDING CAPACITY
INITIAL DRY DENSITY AT 12.4% W.C.
BEFORE SOAKING & GRAVITY DRAINING

Permeability Test Data (Compacted Specimens)

Project: RHODIA SILVER BOW - # 26/46-004 JSL 200

Date: 7-23-99

Reported To: BARL ENGINEERING COMPANY

Job No.: 3604

Sample No./Designation	99-10				
Sample Type, Location Elevation or Depth	0.2' - 6'				
Soil Classification	CLAYEY SAND W/A TRACE OF GRAVEL (SC)				
In-Place Water Content (%)	12.3				
Moisture - Density Relation (ASTM: D698)					
Max Dry Density (PCF)	112.7				
Opt. Water Content (%)	15.4				
Atterberg Limits					
Liquid Limit	46.5				
Plastic Limit	20.1				
Plasticity Index	26.4				
Permeability Test					
% Saturation (After Test)	87.5*	* LOST WATER AFTER DISASSEMBLING DUE TO GRAVITY DRAINAGE			
Specimen Height (Inches)	3.00				
Specimen Diameter (Inches)	2.86				
Dry Density (PCF)	101.9				
% of Max. Density	90.4				
Water Content (%)	12.3				
Type of Test (Head)	Falling				
Max. Head Differential (Ft)	1.1				
Confining Pressure (Effective-PSI)	2.0				
Trial No.	12-16				
Water Temp. (°C)	23				
Co-efficient of Permeability					
K @ 20°C (Cm/Sec)	4.2×10^{-5}				
K @ 20°C (Ft/Min)	8.3×10^{-5}				

Appendix S

Required Permits and Rationale Document for Mud Still Technology



Rhodia Inc., Member of the Solvay Group

Silver Bow Plant

P.O. Box 3146
Butte, MT 59702
406-782-1215
406-782-4498 (FAX)

June 18, 2013

Larry Kimmel
RCRA Project Manager
U.S. EPA Region 8
1595 Wynkoop Street
Mail Code: 8P-HW
Denver, CO 80202-1129

**Re: Mud Still Recovery of Elemental Phosphorus—Required
Permits and Rationale**

Dear Mr. Kimmel:

As a result of our meeting in Denver on April 12, 2013, and consistent with the draft schedule I sent you on June 14, 2013, Rhodia has prepared a document that outlines the permit issues associated with the Mud Still Process and our interpretation of the Federal and State Regulations that would be relevant (Rationale Document - attached). The Rationale Document was prepared by Hogan Lovells US LLP at Rhodia's request and is being shared with EPA as a continuation of the dialogue that was started at the April meeting. Rhodia needs EPA's input and hopefully concurrence with our approach before a revision to the Waste Plan can be prepared and submitted, as the details in the Rationale Document impact the design and feasibility of the proposed Mud Still facility.

The attached Rationale Document contains much information about the proposed process and the applicability of Federal and State regulations. We realize a decision cannot be made quickly and another meeting may be required to more fully explain our rationale and discuss it with you. We would be happy to meet in Denver whenever you think it would be appropriate.

Thank you for your consideration of this document, and we look forward to achieving a mutual understanding on these important issues.

Sincerely,

Dan Bersanti

MUD STILL RECOVERY OF ELEMENTAL PHOSPHORUS - - REQUIRED PERMITS AND RATIONALE - -

The purpose of this document is to identify and explain the rationale for the permits and other major regulatory programs that Rhodia, Inc. (Rhodia) believes will apply if a mud still is used to process and recover elemental phosphorus (P4) during remediation of the clarifier at Rhodia's Silver Bow, Montana site and during potential future commercial use of the mud still for P4-rich materials sent to Rhodia by other entities. Rhodia is presenting this information to continue the discussion with EPA and MDEQ on these issues that are critical to the feasibility of the mud still option, and to obtain EPA's concurrence with Rhodia's permitting and regulatory conclusions, all of which are summarized in the Conclusions Section 6 at the end of this document.

BACKGROUND

When Rhodia's elemental phosphorus plant at Silver Bow was actively producing P4, one step in the process involved placing material from the clarifier into a roaster. The roaster heated the material and produced P4 from it. When the roaster operation was ended in 1997, an estimated 500,000 gallons of this material rich in P4 was left in the clarifier under a water cap. This material has been referred to as the "clarifier sludge," and it is a D001 ignitable hazardous waste. This clarifier sludge on average has about 20% P4 and the remainder consists of wet solids, (*e.g.*, dirt, stones, grit, etc.) mostly from the phosphate rock, silica and coke that were the raw materials used to produce P4.

CONCEPTUAL PROCESS

One remediation option for the clarifier sludge would involve building a mud still facility on-site. About 500 gallons of clarifier sludge would be placed in the mud still on a batch basis, and the mud still would heat the clarifier sludge under pressure to the point where the P4 would be driven off as a vapor and then condensed into a marketable P4 product. The P4 recovery system would consist of three primary parts: (1) a stainless steel pan still with a separate electric furnace to heat the sludge and vaporize the phosphorus; (2) a stainless steel condenser to condense and accumulate the recovered phosphorus; and (3) a stainless steel recirculation tank

and pump to capture the overflow water from the condenser and recirculate it back to the condenser. The process will result in a large amount (about 60% by volume of the initial mass) of solid residuals (*i.e.*, the dirt, stone, grit, etc.). The solid residuals will not spontaneously ignite because the P4 would have been removed, but they will contain some metals, including cadmium which will sometimes exceed the hazardous waste toxicity characteristic. After each batch, the residual solids would be removed and stockpiled near the clarifier. At the end of the entire phosphorus recovery operation using the mud still, which would take several years, the residual solids will be moved from the stockpile and placed into the clarifier for disposal. It is also expected that some sludge that is deep in the clarifier or embedded in cracks and corners of the clarifier cannot be safely removed from the clarifier. Such sludge, with EPA approval, would also be allowed to remain in the clarifier and disposed with the residual solids. After all residual solids have been placed back into the clarifier, the above ground portion on the clarifier walls would be pushed into the clarifier, the clarifier would be brought up to surface grade with a fill material, and finally capped using an EPA-approved cap design. The cap would extend beyond the clarifier and cover the adjacent areas where phosphorus sludge was buried pre-RCRA.

It is expected that the mud still operation will generate emissions with low concentrations of phosphorus pentoxide (P_2O_5) and phosphine (PH_3). The phosphine would be combusted in a flare-like unit, and the off gas from the combustion process and the vent gas from the mud still would be sent to a wet scrubber to remove the P_2O_5 . Additionally, the physical process of removing material from the clarifier and placing this material into the mud still pans would generate some low level fugitive P_2O_5 emissions that would be released to the atmosphere.

The water that currently covers the clarifier sludge and the scrubber water will be reused in the recovery operations as cover water, clean-up water, and carrier water in the clarifier and in the process equipment, pipes, and any holding tanks or containers. Additional water will be added for these purposes from plant water wells. Any water that comes in contact with phosphorous-bearing material could pick-up small particles of P4, and therefore, is referred to as “phossy water.” Phossy water should not flame, but occasionally it could smoke. We expect that all the phossy water will be used up in these processes, but if any is left at the end of the project, its pH, which usually ranges about 2.3 to 2.5, would be adjusted with lime in a tank and then the treated water would be evaporated on-site in a lined pond. There would be no discharge

of the water, in any event. All wastewater should be nonhazardous both before and after the pH adjustment.

ANALYSIS OF PERMITTING/REGULATORY ISSUES

1. Hazardous Waste Permits and Regulation

A. The Mud Still

The mud still operation would be conducted pursuant to the RCRA Section 7003 Order, which was amended and issued to Rhodia on December 27, 2000 by EPA Region 8 (the “7003 Order”). See §VI.K of 7003 Order. In addition, certain selected sections of the RCRA Section 3000(h) Order issued to Rhodia by EPA Region 8 on December 2003 (the “3008(h) Order”) apply to the management of the clarifier sludge. See Section VI.B. of 3008(h) Order. Most pertinent here is that Section XX of the 3008(h) Order—Other Applicable Laws—specifically will apply to work conducted under the 7003 Order, such as recovery of P4 from the clarifier. Section XX provides:

The Parties recognize and agree that the storage, treatment or disposal of any hazardous waste at the Facility may continue under this [3008(h)] Order and the 7003 Order without Respondent having to meet applicable hazardous waste management standards or obtain a hazardous waste management permit, and Respondent shall not be deemed out-of-compliance with any applicable law or regulation relating to hazardous waste, including the requirement to obtain a hazardous waste permit provided Respondent is otherwise in compliance with this [3008(h)] Order, which compliance will be determined pursuant to Section XXIII, and the 7003 Order, which compliance will be determined pursuant to Section XXIII.B. and C.

This Section XX provides considerable flexibility to fashion a remedy for the clarifier that involves storage, treatment, and disposal of the sludge and its residue without a RCRA permit and other RCRA hazardous waste management requirements applying.

Although normal RCRA permitting and treatment, storage and disposal requirements would not apply based on this Section XX of the 3000(h) Order, Rhodia intends to conduct the

mud still operation in an environmentally responsible manner. Material from the clarifier would be placed in the mud still pan using a long reach backhoe. While the mud still pans are being loaded and transported to the furnace, they would be placed in a larger containment pan that will collect any material that is spilled during loading and transport. Any material that is spilled can then be washed back into the clarifier for further processing.

Please note that these procedures that Rhodia will follow actually exceed the hazardous waste requirements that would otherwise apply if the mud still operation were not subject to Section XX of the 3008(h) Order. Specifically, the mud still would be a recycling process under 40 CFR §261.6(c) because it will recover a valuable product from the clarifier sludge, which is a hazardous waste recyclable material. See 40 CFR §261.6(a)(1). ^{1/} Under 40 CFR §261.6(c)(1), the “recycling process itself,” in this case the mud still, “is exempt from regulation except as provided in §261.6(d).” Note that 40 CFR §261.6(d) only imposes additional requirements on RCRA permitted facilities, and since the Silver Bow plant is not RCRA permitted, no additional requirements would apply. In summary, because the mud still is recovering valuable P4 from the clarifier sludge, we believe its operation would not be subject to hazardous waste management requirements.

B. The Solid Residuals from the Mud Still

We now turn to the hazardous waste regulatory issues associated with the solid residue that will remain after the P4 is recovered from the clarifier sludge. Based on the pilot test wherein the sampled solid residue regularly exhibited the toxicity characteristic for cadmium, it is expected that much of the solid residue will be hazardous due to its cadmium concentration. (The toxicity characteristic level for cadmium is 1.0 mg/l and the samples ranged from 0.43mg/l to 3.06 mg/l.) Although treatment of the solids that are hazardous to meet 40 CFR Part 268 land disposal restriction (LDR) standards prior to land disposal would normally be required under hazardous waste rules, disposal of the residual solids in the clarifier without further treatment is allowed under Section XX of the 3000(h) Order, which permits the treatment and disposal of hazardous waste from the clarifier without having to meet RCRA requirements.

^{1/} Montana incorporates by reference all of EPA’s 40 CFR Part 261 regulations cited herein. See ARM 17.53.501.

In addition, such would also be allowed if the clarifier and its immediate surrounding area where P4 sludge had historically (pre-RCRA) been buried or released are designated by EPA as a corrective action management unit (CAMU). By designating the clarifier and its surrounding P4 sludge burial area as a CAMU, disposal of any hazardous waste residues can occur without the residue first having to be treated to meet the LDR treatment standards. See 40 CFR §264.552(a)(4). ^{2/} Placement of any hazardous waste residue in a CAMU also does not trigger the requirement that the CAMU meet minimum technological requirements of a double liner and a leachate collection system. See 40 CFR §264.552(a)(5).

Designation of an area as a CAMU is expressly identified as an option for remediation in Section XII of the 3008(h) Order. (“Respondent may request designation of an area at the Facility to manage CAMU-eligible wastes.”) In this case, designating the clarifier and its nearby P4 sludge burial area as a CAMU would be consistent with the applicable regulations and appropriate for the following reasons: First, the material that would be disposed in the CAMU would meet the requirements in Section XII of the 3008(h) Order and at 40 CFR 264.552(a) that it be “CAMU-eligible waste” in that it is the residue from the remedy for the clarifier. See 40 CFR §264.552(a)(1)(i). Second, the sample data indicate that the level of cadmium in the solid residue would not exceed a level that would cause the disposed material to have in it “principal hazards constituents” as defined in 40 CFR §264.552(e)(4)(i). ^{3/} As such, additional treatment of the solid residue would not be required prior to its disposal in the clarifier at the end of the project. See 40 CFR §264.552(a)(4) and (e)(4)(i). Third, the CAMU would be capped in a manner that meets the standards specified in 40 CFR §552(e)(6)(iv). Fourth, groundwater monitoring would be placed around the CAMU in accordance with 40 CFR §552(e)(5). Finally, the CAMU would meet the closure and post-closure care standards in 40 CFR §552(e)(6).

^{2/} Montana has incorporated by reference most of the federal 40 CFR Part 264 rules, including the CAMU rule. See ARM 17.53.801.

^{3/} Carcinogens are generally to be identified as “principle hazardous constituents” if their risk level is at or above 10^{-3} . See 40 CFR § 264.552(e)(4)(i)(A)(1). The toxicity characteristic (TC) was set at a 10^{-5} risk level for carcinogens. See 55 Fed. Reg. at 11814 March 29, 1990). The 10^{-5} TC level for cadmium, a suspected carcinogen, is 1.0 mg/l. Therefore, cadmium would have to exceed 100 mg/l to be at or above the 10^{-3} risk level and be a “principle hazardous constituent.” The sample results have never exceeded 3.06 mg/l. Thus, the cadmium in the solid residues will not be a “principle hazardous constituent.”

In summary, either by relying on Section XX of the 3008(h) Order or by designating the clarifier and nearby P4 sludge burial area as a CAMU, the solid residues from the mud still operation could be disposed of on-site in the clarifier without additional treatment to meet LDR treatment standards.

2. Solid Waste Permits and Regulation

As noted earlier, the phosphy water is not a hazardous wastewater, but it is a nonhazardous wastewater. If any wastewater remains after its use, it would be pH adjusted with lime in a tank and then conveyed into an earthen evaporation pond. There, the water would be completely evaporated, so there would be no need to discharge or dispose any water.

If evaporation of pH adjusted water in an earthen pond is needed, Rhodia proposes to apply for a solid waste management system license under ARM 17.50.508. Specifically, under ARM 17.50.508(1), Rhodia would need this license to construct and operate a solid waste management system. An earthen pond would likely be a “surface impoundment,” which is defined under Montana rules as “a natural topographic depression, human made excavation, or diked area formed primarily of earthen materials (although it may be lined with human made materials), that is designed to hold an accumulation of liquid wastes or wastes containing free liquids and is not an injection well. Examples of surface impoundments are holding, storage, settling, and aeration pits, ponds, and lagoons.” ARM 17.50.502(39). This surface impoundment/evaporation pond would also likely be a “solid waste management system” defined as “a system which controls the storage, treatment, recycling, recovery or disposal of solid waste.” ARM 17.50.502(37). “Solid wastes” include nonhazardous wastewaters that are not industrial wastewater effluents. See Montana Code Annotated, 75-10-103(7). In light of these state rules, it appears that a state solid waste management system license would be needed to construct and operate an evaporation pond for the phosphy water, and Rhodia would obtain this license if any phosphy water needs to be evaporated in a pond.

3. Air Permits and Regulation

Operation of the mud still will result in phosphorus pentoxide (P₂O₅), phosphine (PH₃), and nitrogen oxide (NO_x) emissions. Specifically, PH₃ from the condenser would be sent to a

controlled flare combustion unit that will flare combust the PH_3 and destroy it. The off-gas from the combustion process as well as the vent gas from the mud still, which are almost entirely P_2O_5 , would be sent to a wet scrubber. In addition, the physical process of removing material from the clarifier and placing the material into the mud still pans will generate some low level fugitive P_2O_5 emissions. Low levels of NO_x will also be emitted from the combustion process.

As discussed in more detail below, under the federal Clean Air Act, a permit is not required for the construction and operation of the mud still because it is not a “major” source of air pollution and there are no applicable New Source Performance Standards (“NSPS”) or National Emissions Standards of Hazardous Air Pollutants (“NESHAPs”). In addition, no permit is required under Montana law because the mud still is not subject to the federal Clean Air Act requirements and the combustor is not an “incinerator.”

A. Federal Clean Air Act

Phosphine is listed as a hazardous air pollutant (“HAP”) under the federal Clean Air Act. 42 U.S.C. § 7412(b)(1). Phosphorus pentoxide is not a HAP. “Major” sources of HAPs must obtain a permit. In order to be a “major” source of HAPs, a source must emit ten tons per year of a single HAP or 25 tons per year of any HAPs combined. The maximum potential emissions of PH_3 from the operation of the mud still are well below these thresholds and, as a result, the mud still would not be a “major” source for HAPs.

NO_x is a criteria pollutant. Emissions of NO_x will be well below the major source threshold for criteria pollutants from this type of source (100 tons per year). 42 U.S.C. § 7602(j).

Minor sources of air pollutants may still be subject to regulation under the federal Clean Air Act if an NSPS or NESHAP applies to that source. Here, there are no applicable NSPS or NESHAPs. The phosphine is not a “contained gaseous material” because it is not in a container when combusted, and therefore, not a “solid waste” subject to regulation under the commercial and industrial solid waste incineration (CISWI) rule. See 42 U.S.C. § 7429(g)(6) (defining “solid waste” to include only “contained gaseous materials”). See 76 Fed. Reg. at 80,472-73 (Dec. 23, 2011) (“[B]urning of gaseous material, such as in fume incinerators (as well as other combustion units, including air pollution control devices that may combust gaseous material)

does not involve treatment or other management of a solid waste.”); 54 Fed. Reg. at 50,973, n. 5 (Dec. 11, 1989) (fume incinerators that are used to destroy gaseous emissions from various industrial processes are not subject to RCRA incinerator standards because the input (an uncontainerized gas) is not a solid waste). EPA made clear in its CISWI rule preamble discussion that combustion of uncontained gases is not subject to the CISWI rule. See 78 Fed. Reg. at 9,128 (Feb. 7, 2013). Similarly, because the uncontained gas that is combusted is not a solid waste, it cannot be a hazardous waste, and consequently, the NESHAP for hazardous waste combustors at 40 CFR Part 63, Subpart EEE does not apply.

B. State Air Permitting Program

A Montana air quality permit is required when, among other things, the source (1) is a “major” source under the federal Clean Air Act; (2) has the potential to emit 25 tons per year of any airborne pollutant; or (3) is regulated under sections 111, 112, or 129 of the federal Clean Air Act. See ARM § 17.8.743(1); ARM § 17.8.1204. As explained above, the mud still is not a “major” source because emissions of PH₃ and P₂O₅, NO_x from the operation of the mud still (including the combustion unit) are expected to be well below the relevant thresholds, and is also not subject to sections 111 (NSPS), 112 (NESHAPs), or 129 (CISWI) of the federal Clean Air Act.

In addition, an air permit would be required if the combustion unit is an incinerator that both (1) meets the definition of an incinerator under Montana’s air law at 75-2-103(11) MCA, and (2) is subject to the requirements of 75-2-215 MCA, which in turn means that the combustion unit must be subject to the Montana hazardous waste provisions for incinerators at 75-2-406 MCA. See ARM §17.8.743(i)(c). The combustion unit meets neither of these criteria, (and both must be met for an air permit to be required). First, the combustion unit is not an incinerator as defined under the Montana air law at 75-2-103(11) MCA. That law defines “incinerator” as any single- or multiple-chambered combustion device that burns combustible material, alone or with a supplemental fuel or with catalytic combustion assistance, primarily for the purpose of removal, destruction, disposal, or volume reduction of any portion of the input material.” MCA §75-2-103(11). Excluded from this definition, however, are “safety flares used to combust or dispose of hazardous or toxic gases at industrial facilities . . . such as . . .

elemental phosphorus plants.” Id. § 11(b)(i). The combustor functions as a safety flare and is used to combust hazardous toxic gases (here, PH₃) at an industrial facility. As such, it can be interpreted not to be an “incinerator” under Montana’s air law. Second, the combustion unit is not the type of incinerator that is subject to regulation under Montana’s hazardous waste law at 75-10-406 MCA. Fume incinerators that are used to destroy gaseous emissions from various industrial processes are not regulated under the hazardous waste law as incinerators because the input (an uncontainerized gas) is not a solid waste, and therefore, the gases cannot be a hazardous waste subject to regulation. See 54 Fed. Reg. at 50,973, n. 5 (Dec. 11, 1989). The combustion unit will only receive and destroy fumes, *i.e.*, off-gases from the mud still, and therefore, is not regulated as an incinerator under Montana’s hazardous waste law. Because the combustion unit is not both an incinerator as defined under Montana’s air law and as regulated under Montana’s hazardous waste law, a state air quality permit is not required. See ARM § 17.8.743(1)(c).

In summary, after review of the relevant federal and state regulations, we believe that the construction and operation of the mud still does not require a construction or operating permit under the federal Clean Air Act or state air permitting program. Notwithstanding, the air emissions would be controlled through the proposed operation of the controlled flare combustion unit and the wet scrubber.

4. Future Commercial Operation

Construction and use of the mud still process to recover P4 from only the clarifier, by itself, would be cost-prohibitive and very difficult to justify. To garner support for the mud still internally within Rhodia, it is important that there be a reasonable regulatory path and supportive regulators that would enable Rhodia, after it completes processing of the clarifier sludge, to use the mud still to receive and recover P4 on a commercial basis from other generators and suppliers of phosphorus rich material. Potential customers might include other elemental phosphorus manufacturers who are dismantling and/or remediating their plants, some pursuant to EPA or state orders, and potentially other entities who generate or produce phosphorus rich solid streams. Our review of the applicable regulations for a commercial mud still operation follows, and we request EPA’s confirmation of our conclusions.

With regard to air regulation and permits, there is no difference between Rhodia's non-commercial use of the mud still to process the clarifier sludge and Rhodia's use of the mud still commercially. No air permits are triggered by either the non-commercial or commercial operation.

Similarly, the handling of any remaining phosphy wastewater would be subject to the same solid waste management system license whether the mud still is used non-commercially to recover P4 from the clarifier sludge or to recover P4 from other generators on a commercial basis. All remaining water, if any, from the non-commercial and commercial operations would be similarly pH adjusted with lime in tank units and then evaporated in a pond, and the evaporation pond would require a solid waste management system license under ARM 17.50.508(1).

The regulatory analysis regarding storage of the phosphorus-rich material prior to its processing in the mud still, however, would be different for the non-commercial versus the commercial operation of the mud still. This is because when Rhodia is recovering P4 non-commercially solely from the clarifier sludge, it is subject to Section XX of the 3008(h) Order, which expressly allows the storage, treatment or disposal of any hazardous waste to occur without meeting applicable hazardous waste management standards or obtaining a hazardous waste management permit. That flexibility is not available to Rhodia for commercial processing of P4-rich material from other generators.

The permit analysis will depend on whether the phosphorus rich material that is being brought to the Silver Bow site for P4 recovery is considered a hazardous waste recyclable material or an intermediate product that is being further processed to recover P4. If the material is an intermediate, it would not be subject to waste regulation at all. It could be brought to the Rhodia facility, stored in tanks, and processed in the mud still to recover P4 without a RCRA permit. If the material being sent to Rhodia for P4 recovery is a waste, and assuming it is hazardous due to its potential to ignite, Rhodia would also need to meet hazardous waste requirements for management of the incoming P4-rich hazardous waste prior to its P4 recovery. Specifically, if the incoming hazardous waste needs to be stored prior to being placed in the mud still for P4 recovery, such storage would require a hazardous waste permit. See 40 CFR

§261.6(c)(1). As discussed above, the mud still recovery operation itself would not be subject to RCRA permitting since it is an exempt recycling unit recovering P4 from, in this case, recyclable material, *i.e.*, a hazardous waste rich in P4. Id.

Regarding the solid residuals that remain after the mud still processing, they would need to be characterized to determine if they are hazardous whether the material brought to the Rhodia site for mud still processing is an intermediate product or a hazardous waste recyclable material. The solid residuals would be a solid waste, *i.e.*, a material intended for discard, in either case. If the solid residuals contain cadmium or some other RCRA metal above the hazardous waste toxicity characteristic level, the residues would have to be treated to meet LDR treatment standards prior to disposal, and they cannot be stored on Rhodia's site for more than 90 days without a RCRA permit. See 40 CFR §268.40(a) and §262.34(a). Further, the solid residues (treated or untreated) cannot be placed into an on-site CAMU since a CAMU at Rhodia's plant site cannot be used for disposal of residues from the processing of an off-site, third party's material. See 40 CFR §264.552(a) and 58 Fed. Reg. at 8664 (February 16, 1993).

Given these limitations, Rhodia's first option would be to collect the solid residuals, store them for up to 90 days in a tank, containers or a containment building, and send them off-site for LDR treatment and disposal, all of which could be done without Rhodia having to obtain a hazardous waste permit. Alternatively, Rhodia could obtain a hazardous waste permit that would allow it to store the solid residuals for more than 90 days and/or treat the residuals on-site to meet LDR treatment standards. Presumably the treatment would render the waste nonhazardous, and in that case, they could be disposed of in an on-site or off-site authorized nonhazardous waste landfill, which in Montana would require a state solid waste management system license under ARM 17.50.508.

In sum, the hazardous waste permit and LDR requirements for the commercial operation of the mud still would be more extensive than for non-commercial operations.

CONCLUSIONS

With regard to the non-commercial recovery of P4 from the clarifier sludge using the mud still, Rhodia believes, and requests EPA's concurrence, that:

- A hazardous waste permit is not required and other hazardous waste regulations will not apply to the operation of the mud still unit itself, although Rhodia plans to operate it to minimize and capture any releases;
- The storage and disposal of the solid residue from the mud still recovery operation that exhibits a hazardous waste characteristic, such as for cadmium, also would not be subject to hazardous waste permitting or other hazardous waste regulations based on Section XX of the 3008(h) Order. Alternatively, a CAMU would provide the same relief, and if EPA chooses not to rely on Section XX, we request EPA and MDEQ confirm that they will designate a CAMU covering the clarifier and the nearby P4 sludge pre-RCRA burial area;
- Any phossey water that remains after the mud still operation that is treated with lime in a tank-based system may be disposed into a pond for evaporation on-site if a solid waste management system license is obtained from the state; and
- No air permit is required for the phosphine and phosphorus pentoxide emissions from the mud still operation. Notwithstanding, Rhodia will control the, emissions through the controlled flare combustion unit and the wet scrubber.

With regard to commercial operation of the mud still to recover P4 from material brought to the site from other entities, Rhodia believes, and requests EPA's concurrence, that:

- The air permitting issues are the same for commercial versus non-commercial operations, *i.e.*, no air permits are required;
- The phossey water issues are the same for commercial and non-commercial operation of the mud still, *i.e.*, any remaining phossey water that is placed into a pond for evaporation will require a state solid waste management system license;
- All residual solids from commercial P4 recovery, assuming they have hazardous waste levels of cadmium or other constituents, will need to be treated to meet LDR treatment standards prior to disposal. Rhodia would need a hazardous waste permit to store or treat such residuals for more than 90 days. Assuming the solid residuals after treatment no longer exhibit a

hazardous waste characteristic, the treated solid residuals could be sent off-site for disposal in a nonhazardous waste landfill, or disposed on-site in a nonhazardous waste landfill if Rhodia obtains a state solid waste management system license;

- If the P4-rich material Rhodia receives from off-site entities is an intermediate product and not a solid or hazardous waste, Rhodia may receive it, store it prior to the mud still recovery, and use the mud still to recover the valuable P4, all without a hazardous waste permit. If, however, the P4 rich material is a solid and hazardous waste, it can only be received and stored by Rhodia if Rhodia has a hazardous waste permit. The mud still recovery operation, in any case however, would be a recycling unit that is exempt from permitting and other RCRA requirements; and
- Finally, Rhodia requests confirmation from MDEQ, and concurrence by EPA Region 8, that they will support the permitting and licensing required for commercial operation of a mud still at the Silver Bow plant.



Rhodia Inc., Member of the Solvay Group

Silver Bow Plant

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July 3, 2013

Larry Kimmel
RCRA Project Manager
U.S. EPA Region 8
1595 Wynkoop Street
Mail Code: 8P-HW
Denver, CO 80202-1129

Re: Supplement to Mud Still Recovery of Elemental
Phosphorus Required Permits and Rationale

Dear Mr. Kimmel:

In the Rationale Document that I sent you on June 21, 2013, we explained that there are two independent bases that support EPA fashioning a remedy for the clarifier that allows storage, treatment and disposal of the sludge and its residue without Rhodia having to obtain a RCRA permit or meet otherwise applicable hazardous waste management standards. The first basis is Section XX of the 3008(h) Order which expressly waives such RCRA requirements. The second basis is if EPA were to designate the clarifier and the surrounding area where P4 sludge has historically been buried as a corrective action management unit (CAMU) under the CAMU rules at 40 CFR § 264.552. There is a third independent basis for such flexibility, which we failed to mention in the Rationale Document.

Specifically, EPA has long recognized that "[u]nder Section 7003, EPA has the discretion to waive any RCRA requirements at a site where appropriate to implementing remedial actions." 58 Fed. Reg. at 8679 (Feb. 16, 1993). EPA further explained that when the remediation occurs under a 7003 Order, EPA can allow use of a CAMU without following its CAMU rules and regardless of the RCRA permit status of the facility. *Id.* EPA reiterated this authority in its October 1997 "Guidance on the Use of Section 7003 of RCRA" at page 4, where it said "persons complying with a RCRA Section 7003 Order under EPA's direction may treat, store, or dispose of waste without securing a RCRA permit for the actions required by that Order." As EPA explained in OSWER Policy Directive Number 9522.00-2 (November 16, 1987), such flexibility stems from the language of RCRA Section 7003, 42 USC §6973, which begins "Notwithstanding any other provision of this chapter,...".

In summary, even if there were no Section XX in the 3008(h) Order, and even if EPA does not want to go through the formal process of designating a CAMU at the site pursuant to 40 CFR § 264.552, because the clarifier remedy is being done under the 7003 Order, EPA can waive the hazardous waste storage, treatment and disposal requirements, including permits and land disposal restriction treatment standards, in connection with the mud still operation and disposal of the residues therefrom. Please let me know if you have any questions regarding this, or desire additional information.

Sincerely,

Dan Bersanti

Appendix T

Analysis of Air Quality Permitting Requirements for On-site Phosphorus Recovery

Technical Memorandum

To: Montana Department of Environmental Quality – Air Resources Management Bureau
(Department)
From: Barr Engineering Company
Subject: Analysis of Air Quality Permitting Requirements for On-site Phosphorus Recovery Alternative
(i.e., Mud Still Operations)
Date: November 25, 2013
Project: 26460006

Solvay is evaluating alternatives for the management and final disposition of the contents of the Silver Bow facility's clarifier to fulfill the requirements of the Amended Administrative Order under RCRA § 7003 ("7003 Order") that was issued to Solvay's (f.k.a., Rhodia) Silver Bow facility near Butte, Montana by Environmental Protection Agency (EPA), Region 8 on June 29, 2000, and amended on December 27, 2000. One alternative involves on-site phosphorus recovery using the mud still technology that was the subject of the extensive treatability studies conducted at the Silver Bow Plant. The treatability studies included construction and operation of a pilot-scale mud still. The Department determined that the equipment associated with the pilot-scale mud still did not have the potential to emit more than 25 tons per year (TPY) of any regulated airborne pollutant, and the predicted emissions of phosphorus are expected to be less than 10 TPY. Therefore, the pilot-scale mud still did not require a Montana Air Quality Permit (MAQP) or a Title V Operating Permit. A copy of the Department's letter is provided in Attachment 1.

This memorandum evaluates the potential to emit from a production-scale mud still that would be constructed at the Silver Bow Plant, should EPA select this alternative for the final disposition of the clarifier contents and concludes that a MAQP or Title V Operating Permit would not be required for the same reasons identified above. Solvay is seeking concurrence from the Department as to the need for MAQP or Title V Operating Permit.

Process Description

A production-scale mud still would be constructed at the Silver Bow Plant to vaporize elemental phosphorus from the crude phosphorus and recover the phosphorus as a useable product. This alternative

To: Montana Department of Environmental Quality – Air Resources Management Bureau (Department)
From: Barr Engineering Company
Subject: Analysis of Air Quality Permitting Requirements for On-site Phosphorus Recovery Alternative (i.e., Mud Still)
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Project: 26460006

consists of excavation of the crude phosphorus and transfer to a metal skip (the metal skip would be placed in the furnace), an electric roasting furnace, a condenser, an oxidation chamber and a wet scrubber. The furnace would be continuously purged with nitrogen to maintain the necessary reducing atmosphere and to drive the water and phosphorus vapors through the process. Residues that remain in the skip after the phosphorus has been vaporized would be transferred to the residue silo via vacuum system with a cyclone separator and a bag filter to control particulate emissions. The conceptual process flow diagram is depicted on Figures 1 and 2.

The production-scale mud still would be designed to process five batches over seven days with continuous operations (i.e., 24-hours per day; 7-days per week). Each batch would process about 6,700 pounds of crude phosphorus (about 25 percent elemental phosphorus by weight). The condenser in the pilot-scale plant had an average phosphorus recovery rate of greater than 98 percent based on the batches that were run to completion (FEG 2012).

Potential Emission Sources

The MDEQ identified two potential sources of air pollutant emissions based on the Clarifier Waste Treatability Study Phase 2 Report – Pilot Plant Design and Testing (FEG 2011) (i.e., phosphorus vapors at the condenser vent and combustion emissions from the propane burner utilized in one of three potential still designs. Note: the propane burner option was not selected for the pilot-scale system). The production-scale mud still would have the same emission sources as the pilot-scale mud still (i.e., phosphorus vapors at the condenser vent). However, the production-scale plant would vent the condenser gases to an oxidation chamber. The oxidation chamber was considered integral to the process for safety reasons because it provides a controlled environment for oxidation of reduced phosphorus compounds that could be in the condenser exhaust. These reactions are spontaneous and would occur whether the condenser exhaust were vented directly to atmosphere or routed through the oxidation chamber; therefore, the oxidation chamber does not materially affect emissions to the atmosphere. A wet scrubber would be used to control particulate emissions; however, use of the wet scrubber was not considered in the permit applicability analysis.

Other sources of fugitive particulate emissions include residue management, and crude phosphorus excavation and handling. Mobile diesel-powered equipment would be used to excavate the crude phosphorus and transfer the skip to the furnace area. Particulate emissions from crude phosphorus

To: Montana Department of Environmental Quality – Air Resources Management Bureau (Department)
From: Barr Engineering Company
Subject: Analysis of Air Quality Permitting Requirements for On-site Phosphorus Recovery Alternative (i.e., Mud Still)
Date: November 25, 2013
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excavation and handling would be negligible because the sludge would be maintained in a wet condition to prevent oxidation reactions. Some visible emissions may be present during crude phosphorus excavation and transfer to the skip. The skip would be covered once it is fully loaded and during transport to the mud still.

Potential to Emit Regulated Air Pollutants

On-site phosphorus recovery would result in emissions of regulated air pollutants. However, air emissions from the project would be less than any amount which would trigger requirements to obtain air quality construction and/or operating permits under Administrative Rules of Montana (ARM) 17.8.743, ARM 17.8.904 or ARM 17.8.1204.

Potential pollutants include elemental phosphorus (P_4), phosphine (PH_3), phosphorus pentoxide (P_4O_{10}) and lead (Pb). P_4 and PH_3 are classified as Hazardous Air Pollutants (HAPs). Emissions of these compounds would also be counted as particulate emissions. To be conservative in the particulate emissions calculation, it was assumed that all phosphorus compounds emitted were in the form of P_4O_{10} .

Calculated uncontrolled emissions from the proposed project at potential to emit are as follows:

Total Particulates (PM):	10.2 tons/yr
Particulates less than ten microns (PM_{10})	10.0 tons/yr
Particulates less than two point five microns ($PM_{2.5}$)	9.9 tons/yr
Lead	0.5 ton/yr
Hazardous Air Pollutants (HAPs)	4.8 tons/yr

No emissions of sulfur dioxide, nitrogen oxides, carbon monoxide, or volatile organic compounds are expected to occur.

Emission calculations are located in Attachment 2 to this technical memorandum.

Based on potential emissions, the requirements for a new source to obtain an air quality permit under the State of Montana regulations are summarized in Table 1 on the following page. In addition, the mud still

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does not meet the definitions of any of the source categories that are required to obtain permits. These regulations and conclusions are summarized in Attachment 3.

Table 1

MT Air Quality Permit Requirements by Emission Rate

Regulation	Applies To:	Applicable	Reason
17.8.743(a)	Construction of new sources with a potential to emit of more than 5 tons per year of lead.	No	The mud still would not emit more than 5 tons of lead per year. Maximum potential emissions of lead were estimated at 0.5 tons per year.
17.8.743(e)	Construction of sources with a potential to emit of more than 25 tons per year of any air pollutant, other than lead.	No	The mud still would be a source of particulate emissions, but potential emissions of particulates (PM, PM ₁₀ and PM _{2.5}) were estimated to be < 10.2 tons per year.
17.8.904	Major new stationary sources of air pollution	No	The mud still would not be a major new source of particulate emissions (>100 ton/yr any FCAA air pollutant or > 70 ton/yr PM ₁₀ in a non-attainment area) because potential emissions of particulates (PM, PM ₁₀ and PM _{2.5}) were estimated to be ≤ 10.2 tons per year.
17.8.1204(1)(a)	An operating permit is required for major sources. A major source has the potential to emit 100 tons or more per year of any air pollutant.	No	The mud still would be a source of particulate emissions, but potential emissions of particulates (PM, PM ₁₀ and PM _{2.5}) were estimated to be ≤ 10.2 tons per year.
17.8.1204(1)(a)	An operating permit is required for a major source of hazardous air pollutants (HAPs) because it has potential emissions of more than 10 tons per year of a single HAP or the total of all HAPs emitted exceeds 25 tons per year.	No	The mud still would be a source of HAPs (e.g., P ₄ , PH ₃). The potential emissions of P ₄ and/or PH ₃ as a single HAP or as total HAPs would be less than 4.8 tons per year. Potential emissions of PH ₃ are based on the very conservative assumption that all elemental phosphorus would be emitted as PH ₃ .

The uncontrolled emission rates in the potential to emit calculations are based on the batch processing of the crude phosphorus with an average recovery rate of 98% and 6,670 lbs per batch of a sludge containing 25wt% elemental phosphorus. The potential to emit calculations assume continuous operations (24-hours per day; 7 days per week). The potential to emit calculations for HAPs assume as a worst case that all elemental phosphorus would be emitted as PH₃. In reality, the majority of phosphorus would be emitted as oxidized phosphorus compounds and only a small fraction would be emitted as PH₃.

The scrubber would be considered emission control equipment, and was not included in the assessment of the uncontrolled potential to emit emission rate for the permitting applicability analysis, which demonstrates that a MAQP or Title V Operating Permit would not be required. However, Solvay would operate the scrubber to further reduce air emissions from the elemental phosphorus recovery operations. The elemental phosphorus recovery operations (including the operation of the scrubber) would be

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conducted in accordance with the 7003 Order, which could give regulators the equivalent of federally enforceable permit conditions requiring operation of the wet scrubber whenever the phosphorus recovery system were operated. The controlled emissions estimates are included on Table 1 of Attachment 2. The controlled emissions assume that the wet scrubber would have a 90% removal efficiency.

After each roasting cycle was completed, the skip would be cleaned out by a vacuum system and the material would be pneumatically transferred to a storage silo. Solids would be transferred by gravity from the silo into “super sacks” for final disposal. No controls were assumed in the potential to emit calculation for either material handling operation. EPA emission factors for uncontrolled material handling operations were used to calculate these emissions. For the pneumatic transfer, the AP-42 calculation procedures for conveyor drops in Chapter 13.2.4 were used. This approach was taken to account for particulates entrained in the air used for pneumatic transport. The velocity of the pneumatic transfer air exiting the storage silo vent pipe was used for the wind velocity in emission calculations. Air velocities within the silo where the actual material drop occurs would be much lower. As noted above, the silo would be equipped with a cyclone and a baghouse or bin vent filter for material recovery and for particulate control. For the gravity transfer of material to the super sacks, emission factors for conveyor transfers of crushed and pulverized stone and minerals from AP-42 Chapter 11.19.2 were used based on the assumption that the residual material would be similar in nature to pulverized stone or pulverized minerals. The uncontrolled conveyor drop emission factor for PM_{2.5} was listed as “non-detect”. So, to be conservative, PM_{2.5} emissions were assumed to be equal to PM₁₀.

Moving the skips filled with crude phosphorus from the clarifier to the mud still and returning the empty skips to the clarifier would generate a small amount of fugitive dust emissions associated with the movement of heavy equipment on unpaved plant roads. Emission calculation procedures for unpaved roads from AP-42 Chapter 13.2.2 were used to calculate fugitive emissions from unpaved roads.

Conclusion

This memorandum evaluated the potential to emit from a production-scale mud still that would be constructed at the Silver Bow Plant, should EPA select this alternative for the final disposition. The equipment associated with the production-scale mud still does not have the potential to emit more than 25 TPY of any regulated airborne pollutant, and the predicted emissions of hazardous air pollutants were

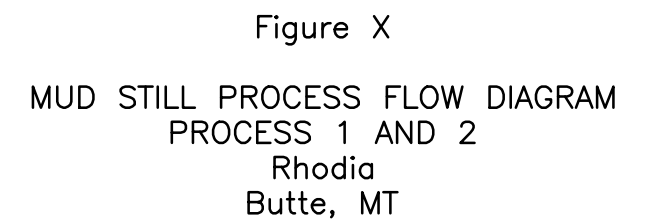
To: Montana Department of Environmental Quality – Air Resources Management Bureau (Department)
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estimated to be less than 10 TPY. As such, the On-site Phosphorus Recovery Alternative would not require a MAQP or Title V Operating Permit.

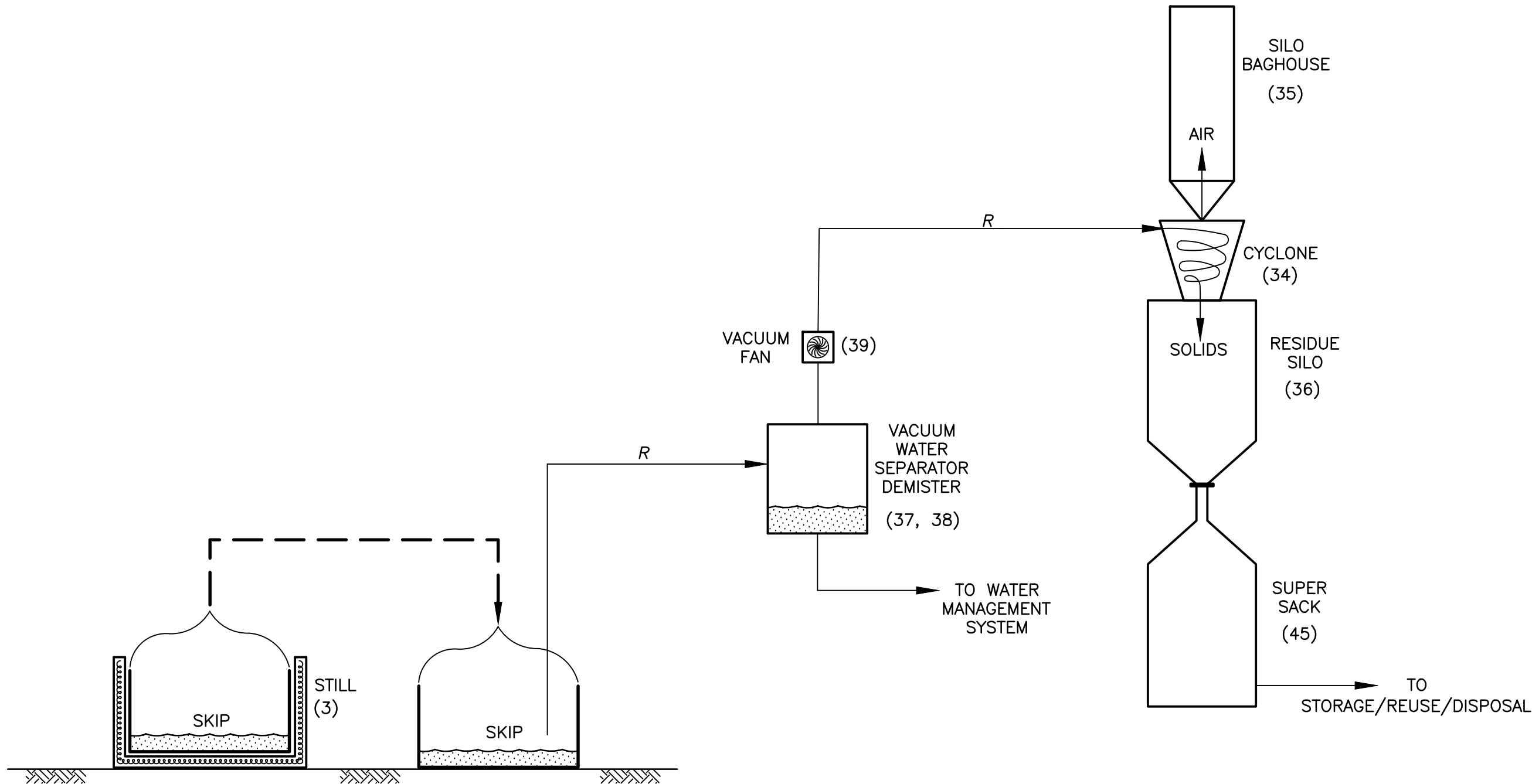
References

- FEG 2011. Clarifier Waste Treatability Study Phase 2 Report – Pilot Plant Design and Testing. Prepared for Rhodia Inc. by Franklin Engineering Group Inc. February 2011.
- FEG 2012. Clarifier Material Treatability Study, Phase 3 Report, Pilot Plant Operation. Prepared for Rhodia Inc. by Franklin Engineering Group Inc. February 2012.
- US EPA AP-42, Fifth Edition from US EPA's Clearinghouse for Inventories and Emission Factors (CHIEF) <http://www.epa.gov/ttn/chief/ap42/index.html>

Figures



PROCESS 3: PROCESS RESIDUE MANAGEMENT



(4) - EQUIPMENT LIST ITEM #
CP - CRUDE PHOSPHOROUS
N₂ - NITROGEN (SWEEP GAS)
P₄ - PHOSPHORUS
R - RESIDUALS
V - VAPOR
W - WATER

Figure X
MUD STILL PROCESS FLOW DIAGRAM
PROCESS 3
Rhodia
Butte, MT

Attachment 1

**Permit Determination Letter – Pilot-scale Mud Still
Montana Department of Environmental Quality
Air Resources Management Bureau (Dec 2009)**



**Montana Department of
ENVIRONMENTAL QUALITY**

Brian Schweitzer, Governor

P. O. Box 200901

Helena, MT 59620-0901

(406) 444-2544

Website: www.deq.mt.gov

December 28, 2009

Dan Bersanti
Rhodia, Inc.
119130 German Gulch Road
Butte, MT 59570

Dear Mr. Bersanti:

The Montana Department of Environmental Quality – Air Resources Management Bureau (Department) has completed its Montana Air Quality Permit (MAQP) determination for the Clarifier Waste Treatability Study Phase 2 – Batch Still Technology Testing that Rhodia, Inc. (Rhodia) is proposing at their Silver Bow, Montana facility. Rhodia proposes to recover phosphorus from the clarifier sludge at the former Rhodia phosphorus manufacturing facility. The sludge contains approximately 500,000 gallons of solidified phosphorus-rich waste. The Department was supplied a batch still technology evaluation report prepared by Franklin Engineering Group, Inc. (FEG) which described this phase of the project as a pilot study to evaluate the performance of three different types of vessels (stills) and associated heating systems used to heat batches of the clarifier sludge and vaporize the phosphorus. The phosphorus vapor would be routed to a condenser system which utilizes water to condense the phosphorus for recovery. All three still designs would utilize the same condenser system.

After reviewing the FEG report, the Department noted two potential sources of air pollutant emissions. These sources include escaping phosphorus vapor at the condenser vent (proposed to be used in all three still designs) and combustion emissions from the propane burner utilized in the third still design (with a rated capacity of 0.525 million British Thermal units per hour (MMBtu/hr)). Phosphorus is designated by the Environmental Protection Agency as a hazardous air pollutant (HAP). According to the FEG report, the mass balance indicates that approximately 0.09 pounds of phosphorus vapor per batch run would be vented to the atmosphere through the condenser vent based on the vapor pressure of phosphorus at the venting temperature at vapor-liquid equilibrium. This calculation does not account for any additional phosphorus entrainment in the gas stream vented to the atmosphere that may be encountered due to condenser inefficiency. Rhodia was unable to provide an accurate condenser efficiency value; however, they did predict that the vast majority of the phosphorus vapor would be recovered within the condenser. The Department believes that because the condenser would be designed to recover the maximum amount of phosphorus as possible that a high degree of efficiency can be expected.

Pursuant to the Administrative Rules of Montana (ARM) 17.8.743, any facility or emitting unit that has the potential to emit more than 25 tons per year (TPY) of any airborne pollutant is required to have an MAQP. Additionally, ARM 17.8.1201(23) states that any source with the potential to emit more than 10 TPY of an individual HAP is considered a major source of air pollutants and therefore required to have a Title V Operating Permit. While the Department acknowledges that the pilot study will consist of only 10 to 15 batch tests, the total potential emissions are calculated based on continuous operation during a year (8,760 hours per year). Upon review of the information provided by Rhodia and the FEG report, the Department has determined that the equipment associated with this pilot study does not exhibit the potential to emit more than 25 TPY of any regulated airborne pollutant and therefore does not require an MAQP. Predicted emissions of phosphorus are expected to be less than 10 TPY and therefore do not require a Title V Operating Permit. These conclusions pertain only to the proposed pilot study and do not

represent a permit determination for a production-scale system. The following information summarizes the Department's determination.

Potential Emissions from Condenser Vent:

Mass Balance indicates 0.09 pounds of phosphorus vented per batch run (lb/batch) (Rhodia information)

Length of batch run = 5 hours (Rhodia information)

Phosphorus emissions = (0.09 lb/batch) / (5 hours/batch) = 0.018 lb/hr (based on mass balance)

Phosphorus condensed under ideal conditions = 93 lb/batch (Rhodia information)

Condenser efficiency = 90% (assumption)

Phosphorus vented based on condenser efficiency = (1-90%) * (93 lb/batch) / (5 hours/batch) = 1.86 lb/hr

Total phosphorus emissions = (0.018 lb/hr + 1.86 lb/hr) * (8760 hours/year) / (2000 lb/ton) = 8.2 TPY

Potential Emissions from Propane Combustion:

Propane burner capacity = 0.525 MMBtu/hr (Rhodia information)

Propane heat content = 91.5 MMBtu/10³ gallons propane (AP-42, Section 1.5, Table 1.5-1, 7/08)

Propane burner capacity = (0.525 MMBtu/hr) / (91.5 MMBtu/10³ gallons) = 5.74E-3 10³ gal/hr

Particulate Matter with an Aerodynamic Diameter of 10 microns or less (PM₁₀) Emissions:

Assume all particulate matter is PM₁₀ (AP-42, Sec. 1.5, Table 1.5-1, 7/08)

Emission Factor = 0.7 lb/10³ gal (AP-42, Sec. 1.5, Table 1.5-1, 7/08)

Calculation: (8760 hrs/yr) * (5.74E-3 10³ gal/hr) * (0.7 lb/10³ gal) * (ton/2000 lb) = 0.02 TPY

Oxides of Nitrogen (NO_x) Emissions:

Emission Factor = 13 lb/10³ gal (AP-42, Sec. 1.5, Table 1.5-1, 7/08)

Calculation: (8760 hrs/yr) * (5.74E-3 10³ gal/hr) * (13 lb/10³ gal) * (ton/2000 lb) = 0.36 TPY

Carbon Monoxide (CO) Emissions:

Emission Factor = 7.5 lb/10³ gal (AP-42, Sec. 1.5, Table 1.5-1, 7/08)

Calculation: (8760 hrs/yr) * (5.74E-3 10³ gal/hr) * (7.5 lb/10³ gal) * (ton/2000 lb) = 0.19 TPY

Volatile Organic Compounds (VOC) Emissions:

Emission Factor = 0.8 lb/10³ gal (VOC = TOC – CH₄, AP-42, Sec. 1.5, Table 1.5-1, 7/08)

Calculation: (8760 hrs/yr) * (5.74E-3 10³ gal/hr) * (0.8 lb/10³ gal) * (ton/2000 lb) = 0.02 TPY

Oxides of Sulfur (SO_x) Emissions:

Emission Factor = 0.10S lb/10³ gal (S = sulfur content in gr/100 ft², AP-42, Sec. 1.5, Table 1.5-1, 7/08)

S = 50 gr/100 ft² (ARM 17.8.322(5), highest content allowable by ARM)

Emission Factor = 0.10 * 50 = 0.50 lb/10³ gal

Calculation: (8760 hrs/yr) * (5.74E-3 10³ gal/hr) * (0.5 lb/10³ gal) * (ton/2000 lb) = 0.01 TPY

If you have any questions regarding this determination or any other permitting questions concerning your facility, please contact me at (406) 444-2467.

Sincerely,



Ed Warner

Environmental Engineer

Montana Department of Environmental Quality – Air Resources Management Bureau

ewarner@mt.gov

Attachment 2

Emission Calculations On-site Phosphorus Recovery Alternative

Attachment 2 Table 1

Solvay (Rhodia- Silver Bow, MT)

Phosphorus Recovery Project Emissions Summary

11/19/2013

Uncontrolled Emissions

	PM	PM10	PM2.5	HAPs (PH3)	Lead (Pb)
Mud Still	9.9	9.9	9.9	4.8	0.50
Residue Handling	0.09	0.03	0.005	n/a	n/a
Fugitive Dust	0.15	0.04	0.004		n/a
Total	10.2	10.0	9.9	4.8	0.5

Controlled Emissions

	PM	PM10	PM2.5	HAPs (PH3)	Lead (Pb)
Mud Still with wet scrubber	0.99	0.99	0.99	0.48	0.05
Residue Handling	0.09	0.03	0.005	n/a	n/a
Fugitive Dust	0.15	0.04	0.004	n/a	n/a
Total	1.23	1.06	1.00	0.48	0.1
Wet Scrubber Control Efficiency	90%	90%	90%	90%	90%

Attachment 2 Table 2
Solvay (Rhodia- Silver Bow, MT)
Mud Still Operations Emissions Estimate
11/19/2013

Particulate and Phosphorus Compound Emissions

Loaded Skip per Batch (wet)	6,675.7 lbs		Total P4 at	
Wt % P4	25% Per Mass Balance		170 Batches	
Wt % Residue	30% Per Mass Balance		1,418,584	
Recovery Efficiency	98% Per Pilot Testing			
P4 Recovered per Batch	1,635.5 lbs			
P4 to Ox Chamber per Batch	33.4 lbs			
Batch Cycle Time	33.6 Hrs			
Batches per Week	5			
Weeks per Year	52			
Annual P4 to Ox Chamber	4.34 t/yr	assumes all P4 is emitted as P ₄	123.92 lb/mol	P ₄
Annual P4 Emitted as PH ₃	4.76 t/yr	assumes all P4 is emitted as PH ₃	283.89 lb/mol	P ₄ O ₁₀
Annual P4 Emitted at P ₄ H ₁₀	9.94 t/yr	assumes all P ₄ is emitted as P ₄ O ₁₀		
Residue Per Batch	2,003 lbs			
Annual Residue	260.4 t/yr			

Lead Emissions

Loaded Skip per Batch (wet)	6,675.7 lbs	
Wt % P4	25% Per Mass Balance	
Wt % Residue	30% Per Mass Balance	
Crude P4 per Batch	3,671.6 lbs	
Lead ¹	1050 mg/kg crude phosphorus	0.11% wt%
Lead Emitted per Batch	3.86 lbs	
Batches per Year	260	
Lead Emitted per Year	1002.4 lbs	
Lead Emitted per Year	0.50 tons	

1. A sample of crude phosphorus analyzed by EPA reported a lead concentration of 1050 mg/kg.

Attachment 2 Table 3
Solvay (Rhodia- Silver Bow, MT)
Residual Material Handling Emissions
11/19/2013

Use AP-42 Factors for Conveyor Drops Chapter 13.2.4 for pneumatic transfer and
Crushed Stone Processing Chapter 11.19 for filling super sacks

Pneumatic transfer from skip to silo; assume wind velocity equals speed of air in exhaust pipe

Exhaust Flow Rate Calculations

4 in	diameter exhaust pipe
0.26 ft ²	opening
585 ft ³ /min	Air flow rate for pneumatic transfer

$$\frac{585 \text{ ft}^3}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} \times \frac{1}{0.26 \text{ ft}^2} \times \frac{1 \text{ mi}}{5280 \text{ ft}} = \frac{25.4 \text{ mi}}{\text{hr}}$$

Residue	260.4	tons/yr	
k _{PM2.5}	0.053		
k _{PM10}	0.35		
k _{PM}	1		
U	25.4 mph		
M	0.2 % Moisture		
E _{PM2.5} =	0.035 lb PM _{2.5} /ton	0.0046 ton/yr PM _{2.5}	
E _{PM10} =	0.233 lb PM ₁₀ /ton	0.0303 ton/yr PM ₁₀	
E _{PM} =	0.665 lb PM/ton	0.0865 ton/yr PM	

Gravity transfer from silo to supersack

Residue Processed	260.4 tons/yr	260.4 tons/yr	260.4 tons/yr
Emission Factor Uncontrolled Conveyor Transfer Point	0.0030 PM lb/ton processed	0.00110 PM ₁₀ lb/ton processed	Non-Detect PM _{2.5} lb/ton processed
AP-42 Table 11.19.2-2	0.78 lb/yr	0.29 lb/yr	0.29 lb/yr
	0.0004 T/yr	0.0001 T/yr	0.0001 T/yr
			(Assume PM _{2.5} = PM ₁₀)

Totals Transfer to Silo and Super Sack

Particle Size	T/Yr
PM _{2.5}	0.005
PM ₁₀	0.030
PM	0.087

Attachment 2 Table 4
Solvay (Rhodia- Silver Bow, MT)
Fugitive Emissions Calculations from Sludge and Mud Still Residuals Transport
11/19/2013

Calculations

Average Vehicle wgt. (W)	26.1
Miles traveled (VMT)	42.5
Silt content, % (s)	5.1

Uncontrolled Fugitive Dust Emissions

Emission Factor, E (lb PM _{2.5} /vehicle-mile traveled) ¹	0.18
Emission Factor, E (lb PM ₁₀ /vehicle-mile traveled) ²	1.84
Emission Factor, E (lb TSP/vehicle-mile traveled) ²	7.13

Emissions (lb PM _{2.5} /yr)	8
Emissions (lb PM ₁₀ /yr)	78
Emissions (lb TSP/yr)	303
Emissions (ton PM _{2.5} /yr)	0.00
Emissions (ton PM ₁₀ /yr)	0.04
Emissions (ton TSP/yr)	0.15

Assumed % Silt Content ³	5.1
Vehicle Weight	
Spec Sheet Catapiller 966H Wheeled Loader	52,254 lbs 26.1 tons

Annual Vehicle Miles Traveled

Calrifier Sludge Processing	
Distance Clarifier to Still	300 ft
Trips per Batch	2
Batches per week	5
Annual # of batches	260
Allowance for travel in/out processing area	20%
Annual VMT for Sludge Processing	187,200 ft 35.5 mi

"Super Sack" Transport	
Distance Silo to Clarifier	300 ft
Trips per Batch	2
Super sack loads per week	1
Annual # of loads	52
Allowance for travel in/out processing area	20%
Annual VMT for Sludge Processing	37,440 ft 7.1 mi

Total annual VMT	42.5 mi
------------------	---------

Empirical Constants ¹	TSP	PM ₁₀	PM _{2.5}
k (lb/VMT)	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

¹ Empirical Constants from AP-42 5th Ed. (11/06), 13.2.2 Unpaved Roads, Table 13.2.2-2 for Equation 1a

² Formula for emission factor from AP-42 5th Ed. (11/06), 13.2.2 Unpaved Roads, Equation 1a

$E = k (s/12)^a (W/3)^b$

Where:

k, a, and b are empirical constants

E = size-specific emission factor (lb/VMT)

s = surface material silt content (%)

W = mean vehicle weight (tons)

³ Western surface coal mining, plant road AP-42 Table 13.2.2-1

Attachment 3

Air Quality Permit Applicability Summary

MT Air Quality Permit Requirements by Emission Rate and Source Category

Regulation	Applies To:	Applicable	Reason
17.8.743(a)	Construction of new sources with a potential to emit of more than 5 tons per year of lead.	No	The mud still would not emit more than 5 tons of lead per year. Maximum potential emissions of lead were estimated at 0.5 tons per year.
17.8.743(b)	Asphalt concrete plant, mineral crusher or mineral screen with a potential to emit of more than 15 tons per year of any air pollutant, other than lead.	No	The mud still would not be an asphalt concrete plant, mineral crusher or mineral screen.
17.8.743(c)	An incinerators as defined under Montana statute 75-2-103(11).	No	The oxidizer for the mud still condenser exhaust would meet the definition of a flare under MCA 75—2-103(13)(b)(i) because it would be used to combust a toxic or hazardous gas. Therefore, it is not an incinerator and a permit would not be required.
17.8.743(d)	Modification of existing sources	No	The mud still would be a new source.
17.8.743(e)	Construction of sources with a potential to emit of more than 25 tons per year of any air pollutant, other than lead.	No	The mud still would be a source of particulate emissions, but potential emissions of particulates (PM, PM ₁₀ and PM _{2.5}) were estimated to be ≤ 10.2 tons per year.
17.8.904	Major new stationary sources of air pollution	No	The mud still would not be a major new source of particulate emissions (>100 ton/yr any FCAA air pollutant or > 70 ton/yr PM ₁₀ in a non-attainment area) because potential emissions of particulates (PM, PM ₁₀ and PM _{2.5}) were estimated to be ≤ 10.2 tons per year.
17.8.1204(1)(a)	An operating permit is required for major sources. A major source is one that potential emissions of 100 tons or more per year of any air pollutant.	No	The mud still would be a source of particulate emissions, but potential emissions of particulates (PM, PM ₁₀ and PM _{2.5}) were estimated to be ≤ 10.2 tons per year.
17.8.1204(1)(a)	An operating permit is required for a major source of hazardous air pollutants (HAPs) because it has potential emissions of more than 10 tons per year of a single HAP or the total of all HAPs emitted exceeds 25 tons per year.	No	The mud still would be a source of HAPs (e.g., P ₄ , PH ₃). The potential emissions of P ₄ and/or PH ₃ as a single HAP or as total HAPs would be less than 4.8 tons per year. Potential emissions of PH ₃ are based on the very conservative assumption that all elemental phosphorus would be emitted as PH ₃ .
17.8.1204(1)(b)	Any source subject to new source performance standards under section 111 of the FCAA	No	The mud still would not be subject to any standards under section 111 of the FCAA. Section 111 standards related to phosphorus production only apply to phosphate rock processing, fertilizer and phosphoric acid production. In addition, the mud still would be exempt from permitting under 17.8.1204(c) because it would not be a major source.
17.8.1204(1)(c)	Any source subject to standards for control of HAPS under section 112 of the FCAA	No	The mud still would not be subject to any standards under section 112 of the FCAA. Section 112 standards for area sources related to phosphorus production have been issued to date. In addition, the mud still would be exempt from permitting under 17.8.1204(c) because it would not be a major source.
17.8.1204(1)(d)	Any affected source subject to the acid rain control requirements under Title IV of the FCAA	No	The mud still would not emit SO ₂ or NO _x and would not be a coal fired electric utility or any other large emission source of acid rain precursors meeting the definition of an affected source under Title IV of the FCAA.
17.8.1204(e)	Any source required to get a permit under section 129(e) of the FCAA	No	The mud still would not be a solid waste combustor.
17.8.1204(f)	Any source in a category designated by the US EPA administrator required to obtain a permit under 40 CFR 60 70.3	No	Categories requiring permits are listed above under 17.8.1204(1)(a)-(e). None of these categories apply to the proposed mud still.
17.8.1204(g)	Any source required to obtain a permit under Title V of the FCAA	No	Categories requiring permits are listed above under 17.8.1204(1)(a)-(e). None of these categories apply to the proposed mud still.

Appendix U

Commercial TSD Facility Survey and Responses

Work Plan



Barr Engineering Company
4700 West 77th Street • Minneapolis, MN 55435-4803
Phone: 952-832-2600 • Fax: 952-832-2601

Minneapolis, MN • Hibbing, MN • Duluth, MN • Ann Arbor, MI • Jefferson City, MO

October 18, 2000

Ms. Tina Diebold
U.S. EPA, Region 8, Montana Office
301 S. Park St., DWR 10096-0026
Helena, MT 59626-0096

**Re: TSD Facility Survey Work Plan
Rhodia Silver Bow Plant
Docket No. RCRA-8-2000-07**

Dear Ms. Diebold:

Rhodia plans to conduct a survey of commercial hazardous waste treatment, storage, and disposal (TSD) facilities concerning their ability to receive, treat and dispose of two materials from the Rhodia Silver Bow Plant. This survey is in addition to Rhodia's efforts to identify treatment options for phosphorus recovery for the materials in the clarifier.

This work plan describes the process to be used to conduct the TSD facility survey. This information will be incorporated into the Waste Plan that will be prepared pursuant to the Amended Administrative Order under RCRA § 7003 ("7003 Order") that was issued to Rhodia Inc. by EPA, Region 8, on June 29, 2000. The 7003 Order requires Rhodia to evaluate alternatives for the lawful removal and disposal of the crude phosphorus and used carbon brick and furnace liner materials. Accordingly, the survey is intended to identify commercial TSD facilities with the ability to treat and dispose of these materials.

Scope of Work

The overall scope of the survey involves:

1. Identification of commercial TSD facilities;
2. Screening to eliminate facilities that do not have appropriate treatment technologies to manage the phosphorus-containing materials;

3. Screening of facilities based on their response to FMC Corporation's TSD Facility Survey conducted in 1999.
4. Contacting each facility (i.e., questionnaire) that was retained in the screening process to inquire about their ability to receive, treat and dispose of the phosphorus-containing materials.
5. Follow-up contacts with all facilities that indicate they have the ability to receive, treat and dispose of the phosphorus-containing materials. Retain facilities that can demonstrate their ability to handle phosphorus-containing materials.
6. Obtain cost and scheduling requirements for the facilities that have demonstrated their ability to handle these materials.

The results of each step will be summarized and maintained in a spreadsheet for inclusion in the Waste Plan.

Step 1

Commercial TSD Facilities

The Resource Conservation and Recovery Information System (RCRIS) database was accessed from the EPA WebPage {<http://www.epa.gov/epaoswer/hazwaste/data/tsd.htm>}. This database was last updated on April 4, 2000 and identifies 3,083 hazardous waste TSD facilities throughout the United States. The RCRIS database provides the EPA identification number, company name, address, and contact for each TSD facility. "The Hazardous Waste Consultant" publishes a survey of commercial TSD facilities. The last survey results were published in 1998 (Volume 16, Issue 2, March/April 1998). The commercial TSD facility list was referenced to the RCRIS database to develop Table 1. Table 1 identifies 151 commercial TSD facilities by EPA Identification number, company name, and the onsite treatment and disposal methods identified in the "Hazardous Waste Consultant" Annual TSD Survey.

FMC Surveys

FMC Corporation explored nation-wide for treatment and disposal capacity for materials containing elemental phosphorus. FMC documented a lack of available treatment capacity for their waste streams in 1995 and again in 1999. Treatment, storage, and disposal (TSD) facilities surveyed by FMC cited a number of factors in declining to manage these waste streams, including the presence of

elemental phosphorus, the potential for generation of phosphine gas, levels of naturally occurring radioactive materials (NORM), and the volume of wastes to be managed.

In 1995, FMC surveyed 168 treatment, storage, and disposal facilities (TSDs) throughout the nation, in an effort to locate commercial treatment or disposal capacity. Not one of the surveyed facilities was able or willing to provide treatment or disposal capacity for the FMC Pocatello waste streams. Likewise, EPA was not aware of any available capacity for these waste streams. As such, EPA granted a national capacity variance for the FMC Pocatello waste streams, extending the LDR effective date for these waste streams to May 26, 2000. [See 63 FR 28556, May 26, 1998]

In support of its request for this case-by-case extension of the LDR effective date, FMC performed another survey in February--May 1999 that supplemented the initial 1995 survey of available commercial treatment capacity. This supplemental survey was designed to focus on those facilities likely to have developed additional or new capacity since the 1995 survey. The results of this survey were obtained from the Federal Register Docket Number F-2000-FMCP-FFFFF; S0011.C & S0012.B. All but three facilities surveyed by FMC are listed in the "Hazardous Waste Consultant" Annual TSD Survey. These three facilities were added at the end of Table 1 along with the respective survey results (i.e., basis for rejecting FMC's wastestream).

FMC Corporation is currently designing a wastewater treatment process to treat their waste streams to render them non-ignitable and non-reactive, and to remove other identified hazardous characteristics. The process reacts the elemental phosphorus to generate phosphine. The phosphine is then thermally oxidized to phosphorus pentoxide (i.e., P_2O_5) which is recovered as a product. Since FMC is planning to construct a hazardous waste treatment facility for processing phosphorus-containing materials, FMC Corporation was added at the end of Table 1, even though we have no information to suggest the FMC facility intends to receive materials on a commercial basis.

The one hundred fifty five (155) commercial TSD facilities identified during Step 1 are listed in Table 1.

Step 2

This step involves screening to retain facilities with potentially appropriate treatment technologies for the proper management of the phosphorus-containing materials. EPA has indicated they believe these materials should be managed as D001 and D003 hazardous wastes.

According to the land disposal restriction identified in 40 CFR 268.40, D001 non-wastewater wastestreams must be treated according to the following technology codes: DEACT and meet universal treatment standards (40 CFR 268.48); or RORGs; or CMBST. Non-wastewater wastestreams with the D003 code must be treated according to the following technology codes: DEACT and meet universal treatment standards (40 CFR 268.48). Table 2 explains the technology codes and describes the treatment technologies that EPA has recommended under 40 CFR 268, Appendix VI.

In addition, under 40 CFR 268.40, D001 and D003 hazardous waste may be treated and disposed of in a surface impoundment that meets minimum technology requirements (MTR). This treatment option was retained, but no commercial facilities were identified that provide these services. Also, EPA has recognized that deactivation for phosphorus-containing materials includes mixing with water [see Exhibit to Final Report to BDAT Related Comments Documents - D001 Characteristic Ignitable Wastes, pp. 170-173, Volume 1-B (May, 1990)]. Because this is the current management strategy at the site, no further inquiry was made of offsite facilities.

These recommended treatment technologies were further evaluated for applicability to the phosphorus-containing materials from the Rhodia facility. The results of this evaluation are summarized in Table 3.

The applicable technologies were used to evaluate whether a TSD facility's treatment technology was appropriate for the phosphorus-containing materials. Facilities with appropriate treatment technologies (i.e., incineration, BIF, or similar) were retained for further evaluation. The results of Step 2 are summarized on Table 1.

Step 3

The results of FMC's most recent survey of TSD facilities are summarized on Table 1. All of the facilities surveyed by FMC were unable or unwilling to treat the FMC Pocatello waste streams for one or more of the following reasons:

- Elevated levels of naturally occurring radioactive materials (NORM);
- Presence of elemental phosphorus;
- Volume of wastes to be managed; and
- Potential for generation of phosphine gas.

Because the material volume for Rhodia is less than that for FMC, facilities were retained for further evaluation if the only reason they rejected the FMC waste streams was due to the excessive volume. All other facilities were eliminated from further consideration since the Rhodia and FMC materials have similarities in phosphorus content and possibly NORM.

Step 4

Facilities that were retained through the screening process will be contacted to inquire about their ability to receive, treat, and dispose of the phosphorus-containing materials. Forty (40) facilities with potentially appropriate technologies are included on the questionnaire list (Table 4).

A cover letter, material descriptions, and a brief questionnaire will be mailed to each facility with a request to complete and return the questionnaire within one week. Facility name, mailing address, and EPA identification number were obtained from the RCRIS database. The cover letter, material descriptions and questionnaire are contained in Attachment 1.

The responses to the questionnaire will be summarized on Table 4.

Step 5

Follow-up discussions will be held with each facility that indicates they are able to treat and dispose of the materials. The purpose of the follow-up discussions is to evaluate whether the facility is knowledgeable about managing phosphorus-containing materials and whether the facility has experience. A script for these conversations may be prepared to assure consistent relay of

information to the TSD facilities. Follow-up discussion will be documented in phone memos and will be summarized on Table 4.

Step 6

If the TSD Facility can demonstrate they are capable of treating and disposing of the materials, a price quote and scheduling information will be requested from the facility and summarized for the Waste Plan.

Conclusion

Rhodia plans to mail the surveys to the identified TSD facilities on October 23, 2000. If you have any comments or suggestions, please contact me by October 20, 2000.

Sincerely,

Dan Bersanti
Plant Manager – Silver Bow
Rhodia, Inc.

Tables

Identification and Screening of Commercial TSD Facilities Phosphorus-containing Materials

Commercial TSD	EPA ID #	Company	Retained Technologies					Inappropriate Technologies							FMC Survey Results							Retained Commercial TSD Facilities (Yes or No)			
			CMBST					WTRX	CHOXD/CHRED	STABL	Distillation	HTMR	Biological/Chemical/Thermal	GAC Regeneration	Landfill	Other (See Annual TSD Survey)	Elevated NORM Levels	Elemental P	Large Volumes	Potential Ignitability	Hazardous Waste		Pyrophoric Materail	Composition (Metals)	
1	ALD0031498833	Allied Signal Inc Fairfield Tar																							N
2	ALD000622464	Chemical Waste Management																							N
3	ALD981019045	Systech Environmental Corporation/Medusa Cement Company																							Y
4	AKD983068685	Alaska Pollution Control																							N
5	AZD009015389	Romic Environmental Technologies Inc																							N
6	AZD982441263	Westates Carbon Arizona Inc Pk																							N
7	AZD980735500	World Resources Co																							N
8	ARD981512270	Ash Grove Cement Co-Foreman																							N
9	ARD069748192	ENSCO Inc																							Y
10	ARD006354161	Reynolds Metals Co Gum Springs Plant																							N
11	CAT080022148	Denova Environmental Inc																							Y
12	CAT000646117	Chemical Waste Mgmt Inc																							Y
13	CAT080033681	Chem Tech Systems Inc																							N
14	CAD028409019	Crosby & Overton Plt No 1																							N
15	CAT080013352	Demunno/Kerdoon																							N
16	CAD000633164	Safety Kleen Westmorland Inc																							N
17	CAD980675276	Safety Kleen Inc																							N
18	CAD050806850	Safety Kleen Inc																							N
19	CAD008488025	Phibro Tech Inc																							N
20	CAD009452657	Romic Environmentaltechnologies Corp																							N
21	CAD0940303993	U.S. Filter Recovery Services																							N
22	COD980591184	Oil & Solvent Process Company (Osco)																							N
23	COD991300484	Safety-Kleen (Deer Trail) Inc																							N
24	CTD000604488	Clean Harbors Of Connecticut Inc																							N
25	GAD096629282	Onyx Environmental Services (Former Cwm)																							N
26	GAD000616367	MKC Enterprises Inc																							N
27	IDD073114654	Envirosafe Svcs Of Idaho Site B																							N
28	ILD000716894	American Waste Processing Ltd																							N
29	ILD098642424	Trade Waste Incinerator Inc																							N
30	ILD000608471	Clean Harbors Of Chicago																							N

Table 1

**Identification and Screening of Commercial TSD Facilities
Phosphorus-containing Materials**

Commercial TSD	EPA ID #	Company	Retained Technologies					Inappropriate Technologies								FMC Survey Results						Retained Commercial TSD Facilities (Yes or No)		
			CMBST	Incineration	Detonation/Open Burning	Cement Kiln	Aggregate Kiln	WTRX	CHOXD/CHRED	STABL	Distillation	HTMR	Biological/Chemical/Thermal	GAC Regeneration	Landfill	Other (See Annual TSD Survey)	Elevated NORM Levels	Elemental P	Large Volumes	Potential Ignitability	Hazardous Waste		Pyrophoric Material	Composition (Metals)

31	ILD000666206	Envirite Of Illinois Inc																							N
32	ILD085349264	Heritage Environmental Services																							N
33	ILD040891368	Horeshead Resource Development Company, Inc.																							N
34	ILD984766279	Hydromet Environmental Usa Inc																							N
35	ILD000805812	Peoria Disposal Co																							N
36	ILD062480850	Phibro Tech Inc																							N
37	IND078911146	Chemical Waste Mgmt Of Indiana Lic																							N
38	IND005081542	Essroc Cement Corp																							N
39	IND093219012	Heritage Environmental Svcs Lic																							Y
40	IND006419212	Lone Star Greencastle Wdf																							N
41	IND001859032	Rhodia Inc		X																					Y
42	IAD005289806	John Deere Waterloo Works																							N
43	KSD981506025	Safety Klean Sys Inc Argonite		X																					Y
44	KSD031203318	Ash Grove Cement Plant																							Y
45	KSD980739999	Heartland Cement Co																							Y
46	KSD980633259	Systech Environmental Corp																							Y
47	KYD000770313	Environmental Conservation Systems																							Y
48	KYD088438817	LWD Inc Calvert City		X																					Y
49	LAD000777201	Chemical Waste Management Inc																							Y
50	LAD981055791	Safety Klean Colfax Inc																							N
51	LAD008161234	Rhodia Inc		X																					Y
52	LAD010395127	Safety Klean Baton Rouge Inc																							Y
53	LAD000778514	Safety Klean Plaquemine Inc		X																					Y
54	MED019051069	Environmental Compliance Corp																							N
55	MDD980555189	Clean Harbors Of Baltimore Inc																							N
56	MAD053452637	Clean Harbors Of Braintree Inc																							N
57	MAD062179890	Environmental Compliance Corp																							N
58	MID096963194	Chem Met Services Inc																							N
59	MID054683479	City Environmental And Disposal Sys																							N
60	*"ID092947928	Drug And Laboratory Disposal Inc																							N

Identification and Screening of Commercial TSD Facilities Phosphorus-containing Materials

Commercial TSD	EPA ID #	Company	Retained Technologies					Inappropriate Technologies							FMC Survey Results							Retained Commercial TSD Facilities (Yes or No)		
			CMBST	WTRRX	Aggregate Kiln	Cement Kiln	Detonation/Open Burning	Incineration	CHOXD/CHRED	STABL	Distillation	HTMR	Biological/Chemical/Thermal	GAC Regeneration	Landfill	Other (See Annual TSD Survey)	Elevated NORM Levels	Elemental P	Large Volumes	Potential Ignitability	Hazardous Waste		Pyrophoric Material	Composition (Metals)

61	MID074259565	Dynecol Inc							X								X							N
62	MID000724831	Michigan Disposal Waste Treatment Plant							X								X							N
63	MID098011992	Cyanokem Inc							X								X							N
64	MID981200835	Systech Environmental Corp				X																		Y
65	MID048090633	Wayne Disposal Inc Site #2													X									N
66	MN0000903468	Recyclights Inc																						N
67	MND981098478	U S Filter Recovery Svcs Inc							X							X								N
68	MSD077655876	Holnam, Inc. Artesia Plant				X																		N
69	MOD980962849	West Star Environmental Inc								X														Y
70	MOR000001230	Frontier Technologies, Inc.									X													N
71	MOD981505555	Heritage Environmental Svcs Llc										X												N
72	MOD029729688	Holnam Inc Safety Klean Corp				X										X								N
73	MOD985798164	I C I Explosives Environmental Co						X																Y
74	MOD069277549	Laidlaw Environmental Services														X								Y
75	MOD981127319	Lone Star Ind Inc				X																		Y
76	MOD054018288	Continental Cement Co Llc				X																		Y
77	NED981723513	Clean Harbors Env Services Inc						X																Y
78	NVD980895338	21St Century Emi Dba Transporter															X							N
79	NVT330010000	US Ecology Inc																X						N
80	NJD002200046	Cycle Chem Inc																						N
81	NJD002385730	Dupont E I De Nemours & Co - Deepwater																						N
82	NJD002141950	C P Chemicals Inc																						N
83	NJD053288239	Safety Klean Bridgeport Inc																						N
84	NJD991291105	S & W Waste Inc						X											X					Y
85	NYD049836679	C W M Chemical Services LLC																						N
86	NYD000632372	Safety-Klean Bdt Inc Clarence						X										X						N
87	NYD048148175	Mercury Refining Co Formerly Mws Ny Inc																						Y
88	NYD080469935	Norlite Corp																						N
89	NCD121700777	Heritage Environmental Services Inc															X							Y
90	NCD000773655	Giant Resource Recovery Inc																						N
																								Y

Table 1

**Identification and Screening of Commercial TSD Facilities
Phosphorus-containing Materials**

Commercial TSD	EPA ID #	Company	Retained Technologies					Inappropriate Technologies							FMC Survey Results							Retained Commercial TSD Facilities (Yes or No)							
			CMBST					WTRX	Aggregate Kiln	Cement Kiln	Detonation/Open Burning	Incineration	CHOXD/CHRED	STABL	Distillation	HTMR	Biological/Chemical/Thermal	GAC Regeneration	Landfill	Other (See Annual TSD Survey)	Elevated NORM Levels		Elemental P	Large Volumes	Potential Ignitability	Hazardous Waste	Pyrophoric Material	Composition (Metals)	
91	OH020273819	Waste Management Of Ohio																			X								N
92	OH0000816629	Spring Grove Resource Recovery																											N
93	OH0000724153	Clean Harbors Environmental Services, Inc.																											N
94	OH0093945293	Chemical Waste Mgmt Resource Recovery In																											N
95	OH0980568992	Envirite Of Ohio Inc																											N
96	OH083377010	Environmental Enterprises Inc																											N
97	OH045243706	Envirosafe Services Otter Creek Rd																											N
98	OH081290611	Laidlaw Environmental Services, Inc.																											N
99	OH055522429	Republic Environmental Systems																											N
100	OH0004178612	Pure Tech Systems Inc																											N
101	OH0048415665	Ross Incineration Services Inc																											N
102	OH0980587364	Safety Kleen Systems Inc																											N
103	OH0005048947	Systech Environmental Corporation																											N
104	OH0980613541	Waste Technologies Industries																											Y
105	OKD065438376	Lone Mountain Facility																											N
106	OKD000402396	Perma-Fix Treatment Svcs Inc																											N
107	ORD089452353	Chemical Waste Management of the NW																											N
108	PAD002390961	Bethlehem Apparatus Co Inc																											N
109	PAD010154045	Envirite Of Pa Inc																											N
110	PAD980707087	Envirotrol Inc Beaver Falls																											N
111	PAD002395887	Horsehead Resource Dev Co Inc																											N
112	PAD002389559	Keystone Cement Co																											N
113	PAD004835146	Mill Svc Inc Yukon Plt																											Y
114	PAD085690592	Republic Environmental Sys																											N
115	PAD083965897	Southdown Inc																											N
116	RID040098352	Northland Environmental Inc																											Y
117	RID980906986	21st Century Environmental Mgmt Inc																											N
118	SCD003351699	Giant Cement Company																											Y
119	SCD070375985	Safety Kleen Pinewood Inc																											N
120	SCD981467616	Safety Kleen Roebuck Inc																											Y

Identification and Screening of Commercial TSD Facilities Phosphorus-containing Materials

Commercial TSD	EPA ID #	Company	Retained Technologies					Inappropriate Technologies							FMC Survey Results							Retained Commercial TSD Facilities (Yes or No)			
			CMBST					WTRRX	CHOXD/CHRED	STABL	Distillation	HTMR	Biological/Chemical/Thermal	GAC Regeneration	Landfill	Other (See Annual TSD Survey)	Elevated NORM Levels	Elemental P	Large Volumes	Potential Ignitability	Hazardous Waste		Pyrophoric Materail	Composition (Metals)	
121	SCD070371885	Phibro-Tech Inc																							N
122	SCD003368891	Holnam Inc Safety Klean Systems Inc																							Y
123	TND982109142	Diversified Scientific Services Inc (Dss																							Y
124	TND982144099	Horsehead Resource Dev Co Inc																							N
125	TND000772277	Safety Klean (Wt) Inc																							N
126	TXD000838896	Chemical Waste Mgmt																							N
127	TXD000761254	Chemical Waste Mgmt Of Corpus Christi																							N
128	TXD074196338	Philip Reclamation Services																							N
129	TXD097673149	Empak Inc Deer Park																							N
130	TXD008117186	Encycle Texas Inc																							N
131	TXD000719518	Disposal Systems Inc																							N
132	TXD982560294	Nssl/Recovery Services Inc																							N
133	TXD008097487	Arch Chemicals Inc																							N
134	TXD047823265	Phibro-Tech Inc																							N
135	TXD008099079	Rhodia Inc																							Y
136	TXD055141378	Safety Klean Deer Park Inc																							N
137	TXD069452340	Texas Ecologists Inc																							N
138	TXD007349327	TXI Midlothian Cement Plant																							Y
139	TXD055135388	Treatment One Div Of Set Environmental																							N
140	TXD988088464	Waste Control Specialists Lic																							N
141	UTD982598898	Envirocare Of Utah Inc																							N
142	UTD981552177	Safety-Kleen (Aragonite)																							Y
143	UTD991301748	Safety-Kleen (Lone & Grassy)																							N
144	VAD988175055	Clean Harbors Env Svcs Inc																							N
145	VAD098443443	Giant Resource Recovery Inc																							Y
146	VAD077942266	Giant Resource Recovery																							Y
147	WAD000812909	Burlington Environmental Inc George																							N
148	WAD991281767	Burlington Environmental Inc Kent																							N
149	WAD020257945	Burlington Environmental Inc Tacoma																							N
150	WID003967148	Controlled Waste Division																							N

Table 1

**Identification and Screening of Commercial TSD Facilities
Phosphorus-containing Materials**

Commercial TSD	EPA ID #	Company	Retained Technologies					Inappropriate Technologies								FMC Survey Results							Retained Commercial TSD Facilities (Yes or No)				
			CMBST	Incineration	Detonation/Open Burning	Cement Kiln	Aggregate Kiln	WTRRX	CHOXD/CHRED	STABL	Distillation	HTMR	Biological/Chemical/Thermal	GAC Regeneration	Landfill	Other (See Annual TSD Survey)	Elevated NORM Levels	Elemental P	Large Volumes	Potential Ignitability	Hazardous Waste	Pyrophoric Materail		Composition (Metals)			
151	WID990829475	WRR Environmental Services Co Inc																									Y
152		EnviroSource																			X						N
153	CAD076180843	McWhorter Technologies																					X				N
154	GAD033582461	Alternate Energy Resources																				X					N
155	IDD070929518	FMC Corp Phosphorus Chemicals Group																									Y
			21	2	18	5	1	33	22	15	6	1	2	16	10	15	13	7	3	2	0	4				155	
Number of facilities retained for Rhodia Survey																										40	

Table 2

**Recommended Treatment Technologies
D001/D003 Hazardous Wastes**

Waste Code	Subcategory	Technology Code [40 CFR 268.40]	Description of Technology-Based Standard [40 CFR 268.42]	Recommended Technology [40 CFR 268, Appendix VI]
D001	Ignitable Reactives based on 40 CFR 261.21(a)(2).	DEACT	Deactivation to remove the hazardous characteristics of a waste due to its ignitability, corrosivity, and/or reactivity.	WTTRX
				CHOXD
				CHRED
				STABL
				INCIN
			Recovery of organics utilizing one or more of the following technologies: (1) Distillation; (2) thin film evaporation; (3) steam stripping; (4) carbon precipitation/crystallization (including freeze); or (8) chemical phase separation techniques (i.e., addition of acids, bases, demulsifiers, or similar chemicals);-- Note: this does not preclude the use of other physical phase separation techniques such as a decantation, filtration (including ultrafiltration), and centrifugation, when used in conjunction with the above listed recovery technologies.	These treatment technologies are not appropriate for inorganic material streams.
		RORGS		
		CMBST	High temperature organic destruction technologies, such as combustion in incinerators, boilers, or industrial furnaces operated in accordance with the applicable requirements of 40 CFR part 264, subpart O, or 40 CFR part 265, subpart O, or 40 CFR part 266, subpart H, and in other units operated in accordance with applicable technical operating requirements; and certain non-combustive technologies, such as the Catalytic Extraction Process.	INCIN
				BIF Boiler or Industrial Furnace
D003	Other Reactives based on 40 CFR 261.23(a)(3).	DEACT	Deactivation to remove the hazardous characteristics of a waste due to its ignitability, corrosivity, and/or reactivity.	INCIN
				CHOXD
				CHRED
D003	Water Reactives based on 40 CFR 261.23(a)(2),(3), and (4)	DEACT	Deactivation to remove the hazardous characteristics of a waste due to its ignitability, corrosivity, and/or reactivity.	INCIN
				WTTRX
				CHOXD
				CHRED

Table 3

Evaluation of Recommended Treatment Technologies Phosphorus-containing Materials

Recommended Technology [40CFR 268, Appendix VI]	Technology Description [40 CFR 268.42]	Applicability to Phosphorus- containing Materials
WTTX	Controlled reaction with water for highly reactive inorganic or organic chemicals with precautionary controls for protection of workers from potential violent reactions as well as precautionary controls for potential emissions of toxic/ignitable levels of gases released during the reaction.	Yes – Phosphorus-containing materials will react to form highly toxic phosphine gas under aqueous and alkaline conditions. Upon generation, the phosphine can be thermally oxidized to form P ₂ O ₅ that can be recovered as a product. This technology system will be constructed at the FMC facility to treat its wastewater streams.
CHOXD	Chemical or electrolytic oxidation utilizing the following oxidation reagents (or waste reagents) or combinations of reagents: (1) Hypochlorite (e.g., bleach); (2) chlorine; (3) chlorine dioxide; (4) ozone or UV (ultraviolet light) assisted ozone; (5) peroxides; (6) persulfates; (7) perchlorates; (8) permanganates; and/or (9) other oxidizing of equivalent efficiency, performed in units operated such that a surrogate compound or indicator parameter has been substantially reduced in concentration in the residuals (e.g., Total Organic Carbon can often be used as an indicator parameter for the oxidation of many organic constituents that cannot be directly analyzed in wastewater residues). Chemical oxidation specifically includes what is commonly referred to as alkaline chlorination.	No – Treatment via chemical oxidation is not a proven technology for treatment of phosphorus containing materials.
CHRED	Chemical reduction utilizing the following reducing reagents (or waste reagents) or combinations of reagents: (1) Sulfur dioxide; (2) sodium, potassium, or alkali salts or sulfites, bisulfites, metabisulfites, and polyethylene glycols (e.g., NaPEG and KPEG); (3) sodium hydrosulfide; (4) ferrous salts; and/or (5) other reducing reagents of equivalent efficiency, performed in units operated such that a surrogate compound or indicator parameter has been substantially reduced in concentration in the residuals (e.g., Total Organic Halogens can often be used as an indicator parameter for the reduction of many halogenated organic constituents that cannot be directly analyzed in wastewater residues). Chemical reduction is commonly used for the reduction of hexavalent chromium to the trivalent state.	No – Treatment via chemical reduction is not a proven technology for treatment of phosphorus containing materials.
STABL	Stabilization with the following reagents (or waste reagents) or combinations of reagents: (1) Portland cement; or (2) lime/pozzolans (e.g., fly ash and cement kiln dust) – this does not preclude the addition of reagents (e.g., iron salts, silicates, and clays) designed to enhance the set/cure time and/or compressive strength, or to overall reduce the leachability of the metal or inorganic.	No – Treatment via stabilization is not a proven technology for treatment of Phosphorus-containing materials. Stabilization is not demonstrated to alter the D001 or D003 characteristics.
INCIN	Incineration in units operated in accordance with the technical operating requirements of 40 CFR part 264 subpart O and part 265 subpart O.	Yes
BIF (i.e., Cement or Aggregate Kilns)	Combustion in boilers, or industrial furnaces operated in accordance with the applicable requirements of 40 CFR part 264, subpart O, or 40 CFR part 265, subpart O, or 40 CFR part 266, subpart H, and in other units operated in accordance with applicable technical operating requirements.	Yes
Other Technologies		
Surface Impoundment (MTR)	Phosphorus-containing materials are mixed with and covered by water.	Yes - EPA considers this technology as BDAT for phosphorus-containing materials.

Retained Commercial TSD Facilities

RCRIS Database						
EPA ID #	Company	Address1	Address2	City	State	PostalCode
ALD000622464	Chemical Waste Management	Hwy 17 N/Mi Marker 163	P O Box 55	Emelle	AL	35459
ALD981019045	Systech Environmental Corporation (Closed Facility)	P.O. Box 1097, Arcola Rd		Demopolis	AL	36732
ARD981512270	Ash Grove Cement Co-Foreman	4457 Hwy 108		Foreman	AR	71836
ARD069748192	ENSCO Inc	309 American Circle	309 American Circle	El Dorado	AR	71730-6555
ARD006354161	Reynolds Metals Co Gum Springs Plant	500 E Reynolds Rd		Arkadelphia	AR	71923-0520
CAT080022148	Denova Environmental Inc	2610 N Alder	2824 N Locust Ave	Rialto	CA	92377
ILD098642424	Trade Waste Incinerator Inc	7 Mobile Ave Site B		Sauget	IL	62201
IND005081542	Essroc Cement Corp	Sr 25 S 3084 W Cr 225 S		Logansport	IN	46947
IND006419212	Lone Star Greencastle Wdf	3301 S Cr 150 W	PO Box 486	Greencastle	IN	46135
IND001859032	Rhodia Inc	2000 Michigan St		Hammond	IN	46320
KSD981506025	Safety Kleen Sys Inc Argonite	Hwy 169 N Industrial Park	PO Box 1328	Coffeyville	KS	67337
KSD031203318	Ash Grove Cement Plant	1801 N Santa Fe	PO Box 519	Chanute	KS	66720
KSD980739999	Heartland Cement Co	1765 Limestone Ln	PO Box 428	Independence	KS	67301
KSD980633259	Systech Environmental Corp	Cement Plant Rd	PO Box 111	Fredonia	KS	66736
KYD000770313	Environmental Conservation Systems	Highway 1020	PO Box 7	Brooks	KY	40109
KYD088438817	LWD Inc Calvert City	Ky Hwy 1523, 2475 Indust. Pkwy	PO Box 327	Calvert City	KY	42029
LAD000777201	Chemical Waste Management Inc	7170 John Brannon Rd		Sulphur	LA	70665
LAD981055791	Safety Kleen Colfax Inc	3763 Hwy 471		Colfax	LA	71417-5614
LAD008161234	Rhodia Inc	1275 Airline Hwy	PO Box 828	Baton Rouge	LA	70805
LAD010395127	Safety Kleen Baton Rouge Inc	13351 Scenic Hwy Id127	PO Box 74137	Baton Rouge	LA	70807-1021
MID981200835	Systech Environmental Corp (Closed Facility)	1480 Ford Ave	245 N Valley Rd	Alpena	MI	49707
MSD077655876	Holham, Inc. Artesia Plant	8677 Hwy 45 South Alternate		Artesia	MS	39736
MOD029729688	Holham Inc Safety Kleen Corp	N Hwy 79	PO Box 67	Clarksville	MO	63336
MOD985798164	I C I Explosives Environmental Co	3078A County Rd 180	PO Box 1386	Joplin	MO	64801
MOD981127319	Lone Star Ind Inc	2524 S Sprigg St	PO Box 988	Cape Girardeau	MO	63701
MOD054018288	Continental Cement Co Llc	10107 Hwy 79	PO Box 71	Hannibal	MO	63401-0071
NED981723513	Clean Harbors Env Services Inc	Highway 71, 5 Mi S Of Town		Kimball	NE	69145
NJD053288239	Safety Kleen (Bridgeport) Inc	Us Rte 322 & I 295	PO Box 337	Bridgeport	NJ	08014
NYD000632372	Safety-Kleen Bdt Inc Clarence	4255 Research Pkwy		Clarence	NY	14031
NYD080469935	Norlite Corp	628 S Saratoga St	PO Box 694	Cohoes	NY	12047
NCD000773655	Giant Resource Recovery Inc	12423 Old Aquadale Rd	PO Box 987	Norwood	NC	28128-9550
OHD005048947	Systech Environmental Corporation	11397 County Road 176	PO Box 266	Paulding	OH	45879
OHD980613541	Waste Technologies Industries	1250 St George Street	PO Box 919	East Liverpool	OH	43920
PAD002389559	Keystone Cement Co	Route 329	PO Drawer A	Bath	PA	18014
PAD083965897	Southdown Inc	2001 Portland Park		Wampum	PA	16157
SCD003351699	Giant Cement Company	654 Judge St	PO Box 354	Harleyville	SC	29448
SCD981467616	Safety Kleen Roebuck Inc	301 Railroad Street		Roebuck	SC	29376
SCD003368891	Holham Inc Safety Kleen Systems Inc	2175 Gardner Blvd		Holly Hill	SC	29059
TND982109142	Diversified Scientific Services Inc (Dss)	657 Gallaher Rd		Kingston	TN	37763
TXD000838896	Chemical Waste Mgmt	Hwy 73 W 3M	PO Box 2563	Port Arthur	TX	77640
TXD008099079	Rhodia Inc	8615 Manchester Boulevard	PO Box 5275	Houston	TX	77012

Table 4

Retained Commercial TSD Facilities

RCRIS Database						
EPA ID #	Company	Address1	Address2	City	State	PostalCode
TXD007349327	TXI Midlothian Cement Plant	245 Ward Rd		Midlothia	TX	76065
UTD981552177	Safety-Kleen (Aragonite)	11373 N 29527 W Aragonite	7050 Union Park Cntr, Suite 680	Aragonite	UT	84047
VAD098443443	Giant Resource Recovery Inc	Rt 1 St Rd 652	PO Box 68	Arvonita	VA	23004
VAD077942266	Giant Resource Recovery	Solite Rd		Cascade	VA	24069-9701
WID990829475	WRR Environmental Services Co Inc	5200 St Rd 93		Eau Claire	WI	54701
IDD070929518	FMC Corp Phosphorus Chemicals Group	HWY 30	Box 4111	Pocatello	ID	83202
47 Facilities Included in TSD Survey						

Attachment 1

*TSD Facility Survey
Cover Letter, Materials Description,
and Questionnaire*



Barr Engineering Company
4700 West 77th Street • Minneapolis, MN 55435-4803
Phone: 952-832-2600 • Fax: 952-832-2601

Minneapolis, MN • Hibbing, MN • Duluth, MN • Ann Arbor, MI • Jefferson City, MO

October 26, 2000

«Name»
«Company»
«Address1»
«Address2»
«City», «State» «PostalCode»

**Re: Phosphorus-containing Materials
Rhodia Silver Bow Plant
Butte, Montana**

«Name»:

Rhodia, Inc. is evaluating alternatives for the lawful removal and disposal of two materials that are located at a closed elemental phosphorus facility near Butte, Montana. Rhodia, Inc. is inquiring about your ability to receive, treat and dispose of these phosphorus-containing materials. The materials are (1) crude phosphorus and (2) used carbon brick and furnace liner. Crude phosphorus contains elemental phosphorus; elevated levels of naturally occurring radioactive material (NORM); and has the potential to generate phosphine gas. The used carbon brick and furnace liner contains forms of phosphorus, may have elevated levels of NORM, and has the potential to generate oxides of phosphorus. In addition, EPA has expressed concern that elemental phosphorus could have saturated the carbon brick and furnace liner while they were in service, although Rhodia has seen no evidence to substantiate this concern.

The U.S. EPA believes that the crude phosphorus should be characterized as D001 and D003 hazardous waste, and that the used carbon brick and furnace liner should be characterized as D001 hazardous waste. For purposes of this request, please assume that the materials will be shipped to you as such. Under the land disposal restriction (LDR) requirements, D001 hazardous wastes will have to be treated so that they are nonignitable and D003 hazardous wastes will have to be treated so that they are nonreactive (do not generate toxic gases) before land disposal. The materials are not known to contain underlying hazardous constituents that exceed their Universal Treatment Standards. However, EPA believes the materials should be assumed to contain metals that do not meet their universal treatment standards.

Special handling requirements for these materials are identified in the detailed material descriptions that are attached to this letter. A brief questionnaire regarding these materials is also attached. Please review the material descriptions, respond to the specific questions and return the completed questionnaire by Friday, November 3, 2000 in the stamped, self-addressed envelope.

Please direct any questions concerning these materials to me at (952)832-2600 or email (tmattison@barr.com). Thank you for your time and consideration.

Sincerely,

Thomas D. Mattison
Senior Chemical Engineer

Material Description Crude Phosphorus

Generator Name and Location				
Rhodia, Inc. Silver Bow Plant 119130 German Gulch Road Silver Bow, Montana 59750				
General Description				
Crude Phosphorus (<i>i.e.</i> , Phosphorus-containing material)				
Process Description				
This material is crude phosphorus from a closed elemental phosphorus production facility. The crude phosphorus that remains in a 100-foot diameter clarifier would be removed from the clarifier, packaged in appropriate containers and shipped for treatment and disposal.				
Generation Amount				
500,000 gallons; one-time only.				
Material Characteristics				
Color:	Brown to Tan			
pH:	6 - 7 (aqueous extract)			
Physical State:	Solid under water			
Material Composition				
	<u>Range</u>	<u>Typical</u>		
Elemental Phosphorus	5 to 50	20 wt%		
Other solids (<i>i.e.</i> , phosphate ore, coke, silica, etc.)	20 to 80	50 wt%		
Water	15 to 75	30 wt%		
TOTAL		100 wt%		
Material Safety Data Sheet (MSDS) and Analytical Data				
The following data is attached to this Material Description				
1) MSDS for Phosphorus				
2) TCLP Metal Data (attached)				
		<u>Reg. Limit</u>	<u>Sample 01</u>	<u>Sample 02</u>
Arsenic	[mg/l]	5.0	<0.5	<0.5
Barium	[mg/l]	100.0	<10.0	<10.0
Cadmium	[mg/l]	1.0	<0.1	<0.1
Chromium	[mg/l]	5.0	<0.5	<0.5
Lead	[mg/l]	5.0	<0.5	<0.5
Mercury	[mg/l]	0.2	<0.02	<0.02
Selenium	[mg/l]	1.0	<0.1	<0.1
Silver	[mg/l]	5.0	<0.5	<0.5
RCRA Classification				
EPA has indicated they believe the following codes are applicable: D001 D003				
DOT Requirements				
Proper Shipping Name:	Phosphorus, yellow, under water		<u>Packaging Requirements:</u>	
Hazard Class:	4.2		Closed head drums:	
UN/NA Number:	UN 1381		55 gallon drum; 1A1/X1.8/300	
Packing Group:	I		30 gallon drum; 1A1/X1.3/250	
Label:	SPONTANEOUSLY COMBUSTIBLE; POISON		or	
Reportable Quantity:	1 lb		Open head drums:	
			30 gallon drum; 1A2/X160/S	

Material Description

Crude Phosphorus

Additional Information

Special handling is required for this material due to the presence of elemental phosphorus. Upon exposure to air, concentrated phosphorus may spontaneously ignite and form oxides of phosphorus (mainly P_2O_5 ; a dense white acrid fume). To prevent spontaneous oxidation, crude phosphorus must be handled under water or in another manner that prevents oxygen from contacting the elemental phosphorus. Rhodia intends to package the crude phosphorus under water for shipping, consistent with 49 CFR 173.188(a)(2).

The material is naturally occurring radioactive material (NORM) due to it deriving from phosphate ore. A radiation survey at the Silver Bow Plant found gamma radiation ranging from 17 to 170 microRoentgens per hour. The survey included measurements near the 100' diameter clarifier (*i.e.*, where the crude phosphorus is stored).

Elemental phosphorus has the potential to generate phosphine gas when in contact with water. The crude phosphorus will be shipped under water. Higher temperature and higher pH typically increase the generation of phosphine. Phosphine is highly toxic and may be fatal if inhaled at high concentrations. Effects may include dizziness, headache, nausea, vomiting, abdominal and chest pain, difficulty with breathing, diarrhea and collapse. Phosphine inhalation at excess concentrations causes irritation of the respiratory tract and lungs and pulmonary edema may occur 1 to 2 days after exposure. Repeated exposure may result in anemia, bronchitis, gastrointestinal disturbances, and visual, speech and motor disturbances. Central nervous system depression, heart, liver and kidney damage, and cerebral edema may occur from overexposure.

In order to handle this material, particular attention to temperature and pH is needed. Generally phosphorus containing materials should be maintained at temperatures above 60 degrees C during handling to ensure that the phosphorus is in the liquid state. During transport, solids in phosphorus-containing material will settle to the bottom of the container and the residual phosphorus will solidify. In order to unload a typical container, it will be necessary reheat the contents to above the melting point of phosphorus and provide agitation to suspend the liquid phosphorus and contained solids. Otherwise, phosphorus-containing solids will remain in the bottom of the shipping container.

During any operations involving the storage and handling of phosphorus-containing materials, pH must be carefully controlled to avoid high alkaline conditions, and adequate ventilation should be provided to prevent excessive generation and buildup of phosphine gas.

Based on process knowledge, the material **does not** contain any of the following substances:

- DOT Radioactive, Explosives, or materials forbidden from transport.
- TSCA regulated materials, Chlorinated biphenyls (PCB) or Brominated biphenyls (PBB), Chlorinated dibenzodioxins or furans.
- Products used as pesticides, herbicides, or by-products of pesticide manufacture.
- Human carcinogens above exclusion levels as defined by OSHA (Ref. 29CFR1910.1001)
- Sulfides, Cyanides, Shock sensitive materials.
- Biological hazards (such as Pathogenic materials, infectious agents, etiologic agents, USEPA Medical Waste).
- Water or amine-reactive components (such as unreacted isocyanate monomers and resins, Acid chlorides, Anhydrides, Epoxides).

RHONE-POULENC BASIC CHEMICALS CO.
1 Corporate Drive Box 881 Shelton, CT. 06484 (203)925-3300
24-HOUR EMERGENCY TELEPHONE CHEMTREC 1-800-424-9300

PRODUCT NAME:

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PHOSPHORUS

Effective Date: JUNE 9, 1992
Supersedes: APRIL 17, 1990

I. IDENTIFICATION

CHEMICAL NAME OF PRIMARY COMPONENT(S): Phosphorus
FORMULA: P_4 FORMULA WEIGHT: 123.9
SYNONYMS: White Phosphorus; WP; Yellow Phosphorus; Phosphorus, elemental, white;
CAS# & NAME: 7723-14-0 Phosphorus

II. INGREDIENTS/SUMMARY OF HAZARDS

<u>INGREDIENT(S)</u>	<u>CAS NUMBER</u>	<u>OSHA HAZARDOUS (H)/ NON-HAZARDOUS (NH)</u>	<u>PERCENT</u>
Phosphorus	7732-14-0	H	100

WARNING STATEMENTS:

DANGER! EXTREMELY FLAMMABLE - CATCHES FIRE IF EXPOSED TO AIR · CAUSES SEVERE BURNS TO SKIN AND EYES · MAY BE FATAL IF SWALLOWED · SMOKE AND FUMES FROM BURNING PHOSPHORUS ARE EXTREMELY IRRITATING TO EYES, NOSE, THROAT AND LUNGS · POSSIBLE HAZARD TO WOMEN OF CHILD-BEARING POTENTIAL, BASED ON ANIMAL DATA ·

Contents packed under water and will ignite if water is removed · Container headspace may contain toxic and flammable phosphine gas · Store in a cool place · Do not get in eyes, on skin or on clothing · Avoid breathing vapors or dust · Wear appropriate protective clothing, NIOSH/MSHA approved respirator, goggles, face shield, and heavy rubber gloves when handling · Use only with adequate ventilation · Never use welding or cutting torch on or near any container (even empty) - explosions can result.

(See Section VI for complete Health Hazard Data)

**NATIONAL FIRE PROTECTION ASSOCIATION RATING
HAZARDOUS MATERIALS IDENTIFICATION SYSTEM**

(4=Extreme/Severe, 3=High/Serious,
2=Moderate, 1=Slight, 0=Minimum)

	NFPA	HMIS
HEALTH	3	3
FIRE	3	3
REACTIVITY	1	1

SARA TITLE III HAZARD CLASSIFICATION

IMMEDIATE (ACUTE) HEALTH	YES
DELAYED (CHRONIC) HEALTH	YES
FIRE	YES
SUDDEN RELEASE OF PRESSURE	NO
REACTIVE	YES

MATERIAL SAFETY DATA SHEET

RHONE-POULENC BASIC CHEMICALS CO.

PRODUCT NAME:

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PHOSPHORUS

Effective Date: JUNE 9, 1992

III. PHYSICAL DATA

SPECIFIC GRAVITY:	1.82 @ 20 °C
BULK DENSITY:	70 LBS/FT ³
BOILING POINT, 760 mm Hg, °C (°F):	280.5°C (536°F)
MELTING POINT, °C (°F):	44.1°C (111°F)
VAPOR PRESSURE, @ 20°C	0.026 mm Hg
pH :	6 (aqueous extract)
SOLUBILITY IN WATER (%/wt @ 20°C):	0.0003%
APPEARANCE AND ODOR:	White to yellow, soft, waxy solid; garlic odor

(For additional technical information call 1-800-642-4200)

IV. FIRE AND EXPLOSION HAZARD DATA

FLAMMABLE SOLID as defined in the OSHA Hazard Communication Standard, 29 CFR 1910.1200(c).

FLASH POINT [°C (°F)]:	Ignites spontaneously on contact with air.
FLAMMABLE LIMITS IN AIR:	Not applicable
AUTOIGNITION TEMPERATURE [°C (°F)]:	30°C (86°F)

EXTINGUISHING MEDIA: Deluge with water spray, being careful not to scatter material until fire is extinguished and phosphorus has solidified. Cover with wet sand or dirt.

SPECIAL FIRE FIGHTING PROCEDURES:

Provide for the protection of employees and residents:

- Evacuate residents who are downwind of fire.
- Prevent unauthorized entry to fire area.
- Persons who may have been exposed to contaminated smoke should be examined by a physician and treated appropriately.
- Dike area to prevent runoff and contamination of water sources.
- Cool exposed containers with water spray.

Notify local authorities that firemen should:

- Wear flame-retardant full protective clothing and use self-contained breathing apparatus.
- Be immediately relieved from duty, if exposed to contaminated smoke and checked for symptoms of overexposure. These should not be mistaken for heat exhaustion or smoke inhalation. See section VI, Health Hazard Data for symptoms of overexposure, first aid procedures, and notes to physician.

UNUSUAL FIRE AND EXPLOSION HAZARDS:

Phosphorus burns rapidly, releasing dense, white fumes (smoke) that are highly irritating. Hazardous combustion products include phosphoric acid and phosphorus pentoxide and may also contain highly toxic phosphorus vapor or phosphine gas. The combustion of phosphorus in a closed space will lead to rapid oxygen depletion.

This product will reignite itself after fire is extinguished unless covered with water, sand or earth.

Avoid contact with potassium chlorate, potassium permanganate, peroxides and other oxidizing agents. Explosions may result on contact or friction.

Elemental phosphorus reacts slowly with water to produce phosphine, especially at high (alkaline) pH. Hot water or steam may accelerate the reaction.

MATERIAL SAFETY DATA SHEET

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V. REACTIVITY DATA

STABILITY: Stable in the absence of air. Ignites spontaneously upon exposure to air.

CONDITIONS TO AVOID:

FLAMMABLE SOLID: Keep away from heat, sparks, open flame, and other ignition sources.
Light causes discoloration.
Protect from air.

MATERIALS TO AVOID:

AIR: Ignites spontaneously.
OXIDIZERS: Explosive.
STRONG BASES: Releases highly toxic phosphine gas which may spontaneously ignite.
NOTE: Elemental phosphorus reacts slowly with water to form phosphine, especially at high (alkaline) pH. Hot water or steam may accelerate the reaction.

HAZARDOUS DECOMPOSITION PRODUCTS:

Thermal decomposition produces toxic or irritating materials such as phosphoric acid and phosphorus pentoxide. Phosphine gas is released when reacted with bases, hot water or steam.

HAZARDOUS POLYMERIZATION:

Above 200°C (392°F), phosphorus polymerizes exothermically to red phosphorus. It may then heat uncontrollably, developing vapor pressures above the tank-bursting pressure.

VI. HEALTH HAZARD DATA/FIRST AID PROCEDURES

EXPOSURE LIMITS:

<u>Chemical Name(s)</u>	<u>ACGIH (TWA)</u>	<u>OSHA (TWA)</u>
Phosphorus (yellow)	0.1 mg/m ³ , (0.02 ppm)	0.1 mg/m ³

HEALTH EFFECTS SUMMARY:

The following information presents both human experience and the result of scientific experiments used by qualified experts to assess the effects of phosphorus on the health of industrially exposed individuals and to support the Precautionary Statements and Occupational Control Procedures recommended in this document. To avoid misunderstanding, the data provided in this section should be interpreted by individuals trained in the evaluation of this type of information.

ROUTES OF ENTRY:

DERMAL CONTACT AND INHALATION are expected to be the primary routes of occupational exposure to phosphorus. Phosphorus can be absorbed through the skin, respiratory tract and gastrointestinal tract. Phosphorus ignites and burns spontaneously when exposed to air and the gas, vapor or fume produced is irritating to the eyes, nose, throat and lungs. The solid in contact with the skin or eyes produces severe burns.

INGESTION: The acute lethal oral dose of phosphorus for an adult is reported to be about 1 mg/kg, with adverse effects reported at 0.1 mg/kg. Acute oral phosphorus intoxication is usually described as having three stages. In the initial phase, gastrointestinal effects, characterized by nausea, vomiting, belching, and severe abdominal pain predominate. Death from cardiovascular collapse can occur in about 12 hours. In stage two, symptoms may regress with an apparent recovery lasting approximately two days.

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VI. HEALTH HAZARD DATA/FIRST AID PROCEDURES (Continued)

The third stage is characterized by return of gastrointestinal distress with signs of hepatic, cardiovascular and renal involvement, including jaundice, oliguria (diminished urine production), pitting edema, increased pulse rate, low blood pressure and coma.

CHRONIC SYSTEMIC SYMPTOMS: Early signs of chronic systemic intoxication by phosphorus are reported to include anemia, loss of appetite, gastrointestinal distress, chronic cough, a garlic-like odor of the breath, and pallor (paleness). A response to severe chronic poisoning which was seen in the past is "phossy jaw". The first indications of "phossy jaw" are toothache and excessive salivation, followed by loosening of the teeth, severe pain, and swelling of the jaw. Ulcerations can develop which may invade the bone. (4)

ANIMAL TOXICOLOGY DATA

Oral LD50 (rats):	3.03 mg/kg body weight	(1)
Dermal LD50 (rabbits):	No information available	
Inhalation LC50 (rats):	No information available	
Skin Effects (rabbits):	Corrosive, causes severe burns	(2)
Eye Effects (rabbits):	Corrosive	(3)

SHORT-TERM EXPOSURE:

Bone changes were reported in female rats (23 days old) given phosphorus at a dietary level of 1.30 mg/kg/day for 8 or 16 days. In the animals treated for 16 days, the bone changes were reversed following withdrawal of the test diet.

SUB-CHRONIC EXPOSURE:

Depressed growth was reported in a 22 week feeding study in young female rats fed diets containing phosphorus at median daily dosage levels of 0.0032, 0.018, and 0.072 mg/kg/day. A recovery in growth occurred at the mid-dose level following withdrawal of phosphorus from the diet; no recovery in growth was reported at the high-dose level. Old male rats fed diets containing 0.0027 mg/kg/day displayed no overt effects. Pathology and bone studies were not performed.

In a sub-chronic toxicity study, female dogs were injected subcutaneously with 0.1, 0.2, or 0.4 mg phosphorus/kg/day. Mortality resulted within 6 days with animals given 0.4 mg/kg. The one animal given 0.2 mg/kg developed severe kidney hemorrhage and died by day 12. Fatty livers, hydropic degeneration in the kidneys, body weight loss, and changes in blood chemistry parameters were reported in dogs surviving treatment with 0.1 mg/kg/day for 116 days.

Retardation of longitudinal bone growth and body weight gain were reported in rabbits given 0.6 mg phosphorus/day orally via capsule for periods of 13 to 117 days. Similar effects were noted in rats treated for 22 to 57 days with cod liver oil containing 0.1% phosphorus mixed in the diet. Disturbance of dentin calcification in the teeth of rats was also reported.

CHRONIC EXPOSURE:

Phosphorus was administered to rats by subcutaneous injection of oil solutions at dosages ranging from 0.05 to 3.2 mg/kg/day twice weekly for periods up to 610 days. Guinea pigs were injected subcutaneously with similar solutions at dosages of 0.05 to 0.4 mg/kg/day twice weekly for up to 720 days. In the rats, mortality was reported to increase with increasing dosage. Bone pathology (reported to be more marked in rats than in guinea pigs) was observed in an apparent dose-related fashion. Less conspicuous bone changes were noted in rats fed for 174 to 512 days. Mortality was reported to increase in these rats with increase in the total amount of phosphorus administered. The decreased growth rate observed in rats fed phosphorus in the diet was attributed to decreased food consumption. (4)

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VI. HEALTH HAZARD DATA/FIRST AID PROCEDURES (Continued)

CARCINOGENICITY:

This product does not contain any ingredient designated by IARC, NTP, ACGIH OR OSHA as a probable human carcinogen.

TERATOGENICITY:

Phosphorus in corn oil was administered by gavage to female rats at dosages of 0, 0.1, 0.3 or 0.75 mg/kg/day on days 6 through 19 of gestation. A second, satellite study was conducted in which rats received either 0.6 mg phosphorus /kg/day in corn oil or corn oil (control) on a comparable regimen. Due to significant maternal mortality (84%), at 0.75 mg/kg, no fetal evaluations were performed at this dosage. Decreased mean body weights were noted in surviving dams at 0.75 mg/kg. No teratogenic or fetotoxic effects were observed at dosages of 0.6 mg/kg or lower. Mortality and decreased mean body weight were noted in dams at 0.6 mg/kg.

REPRODUCTIVE TOXICITY:

In a one generation reproduction study, male and female rats were dosed orally with phosphorus (0.005, 0.015, 0.075 mg/kg/day) throughout premating, mating, pregnancy and lactation periods (males were dosed only through mating). An increased incidence of mortality at the end of pregnancy (days 21 and 22) and a decrease in the number of live pups were observed among high-dose females. The no-observable-effect-level (NOEL) for males and females was considered to be 0.075 and 0.015 mg/kg/day, respectively. No effects on reproductive function or fertility were found in males or females. In a second study, increased late-pregnancy mortality was observed in females treated with 0.075 mg/kg/day either throughout pre-mating and the first two trimesters of pregnancy (to day 15).

METABOLISM:

Following administration of single oral doses (0.3 mg/kg) of phosphorus to rats, elimination of phosphorus or its metabolites was reported to occur primarily in urine and feces. Approximately 46.7% and 33% of the absorbed radioactivity was excreted in the urine and feces, respectively, of rats dosed within five days. Increases in total body burden were noted in rats dosed once. (4)

EFFECTS OF SINGLE OVEREXPOSURE:

Swallowing:

MAY BE FATAL IF SWALLOWED. Symptoms of acute poisoning develop in three stages. First, ingestion produces a sensation of warmth or burning pain in the throat and abdomen with intense thirst followed by nausea, vomiting, diarrhea and severe abdominal pain. The breath has a garlic odor. Shock may be severe enough to cause death in 24-48 hours. The second stage is a period of several days which may be symptom free. Third, symptoms of systemic toxicity from absorbed poison develop including nausea, protracted vomiting, diarrhea, massive hematemesis (vomiting blood), liver tenderness and enlargement, jaundice, pruritus (severe itching), hemorrhages into the skin, mucous membranes and viscera, renal damage, cardiovascular collapse and central nervous system involvement resulting in convulsions, confusion and coma. Death usually occurs in 4 to 8 days.

Skin Absorption:

Phosphorus is readily absorbed through the skin when present in an oil solution or when burning on the skin. If burning phosphorus is not rapidly cleansed from the skin, severe effects including hypocalcemia, shock and fatal cardiac arrest can occur. Severe liver and kidney damage may occur.

Inhalation:

CORROSIVE. Breathing of concentrated gas, vapor, or fume may cause severe damage to the respiratory tract and lungs. Systemic effects as described under swallowing may also occur.

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VI. HEALTH HAZARD DATA/FIRST AID PROCEDURES (Continued)

Skin Contact: CORROSIVE. Ignites on contact with air which causes severe second and third degree burns which are necrotic, yellowing, and fluorescent under UV light. (2) Phosphorus may be absorbed by damaged skin and cause systemic toxicity.

Eye Contact: CORROSIVE. Causes irreversible eye damage, seen as corneal opacity.

EFFECTS OF REPEATED OVEREXPOSURE:

Chronic overexposure to elemental phosphorus by inhalation or ingestion has been reported to produce a form of generalized weakness, accompanied by anemia, loss of appetite, gastrointestinal complaints, chronic cough and paleness. Chronic poisoning may also cause changes in bones, especially the jawbones, known as "phossy jaw".

OTHER EFFECTS OF OVEREXPOSURE: See Notes to Physician.

EXISTING MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE:

Skin irritation may be aggravated in persons with existing skin lesions. Smoke from burning phosphorus may aggravate acute or chronic asthma and other chronic pulmonary disease.

EMERGENCY AND FIRST AID PROCEDURES:

**** POISON **** GET IMMEDIATE MEDICAL HELP ****

If contact with this material occurs or is suspected, DO NOT WAIT FOR SYMPTOMS TO DEVELOP!! Immediately initiate the recommended procedures below and simultaneously contact a Poison Control Center, a physician or the nearest hospital.

PRECAUTION:

Persons attending the patient should avoid direct contact with heavily contaminated clothing and vomitus. Wear impervious gloves while decontaminating skin and hair.

Remove the patient from the source of exposure and confirm that the individual is breathing. If not breathing, use artificial respiration or cardiopulmonary resuscitation (CPR). GET IMMEDIATE MEDICAL ATTENTION.

Swallowing: If patient is conscious and alert, give large quantities of water or milk to drink and induce vomiting immediately. Give one tablespoon of Syrup of Ipecac. If vomiting has not occurred in 20 minutes, the same dose of Syrup of Ipecac may be repeated one additional time. Alternatively, induce vomiting by touching the back of the throat with a finger. NEVER give anything by mouth to an unconscious or convulsing person or make an unconscious person vomit. GET IMMEDIATE MEDICAL ATTENTION.

Skin: Immediately wash skin with a large volume of water (preferably cold) while removing contaminated clothing and shoes. Solutions of 5% sodium bicarbonate can then be used if readily available. Keep burned area submerged in water or 5% sodium bicarbonate solution or wrapped in dressings, towels, bandages, etc. soaked in water or bicarbonate solution until medical attention is available. Water gel wraps or water gel blankets can also be used. GET MEDICAL ATTENTION.
Shoes and clothing contaminated by phosphorus should be placed under water in closed containers and discarded in a safe manner with due consideration of possible ignition and contamination.

RHONE-POULENC BASIC CHEMICALS CO.

PRODUCT NAME:

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PHOSPHORUS

Effective Date: JUNE 9, 1992

VI. HEALTH HAZARD DATA/FIRST AID PROCEDURES (Continued)

Inhalation: Remove patient to fresh air. If not breathing administer cardiopulmonary resuscitation or artificial respiration. If breathing is difficult administer oxygen. GET MEDICAL ATTENTION.

WARNING! If phosphorus has been ingested, administration of mouth-to-mouth resuscitation may expose the first aid provider to the chemical. In these situations, use of a pocket mask or Ambu bag is recommended.

Eyes: Hold eyelids open and flush with a steady, gentle stream of water for at least 15 minutes. GET MEDICAL ATTENTION, PREFERABLY AN OPHTHALMOLOGIST.

NOTES TO PHYSICIANS:

WARNING! Patient and attendants must be protected from contact with residual phosphorus, vomitus, and gastric washing.

All treatments should be based on observed signs and symptoms of distress in the patient. Consideration should be given to the possibility that overexposure to materials other than this product may have occurred.

TREATMENT FOR INGESTION:

1. Immediate gastric lavage with potassium permanganate solution (1:5000). Lavage volume is 4 liters for an adult. Use half normal saline if permanganate solution is not immediately available. Also, follow permanganate lavage with half normal saline. Lavage with 0.2% cupric sulfate solution is recommended in some poison texts but carries a risk of copper poisoning.
2. Instill activated charcoal through lavage tube.
3. An initial dose of 200 - 250 ml of mineral oil as a cathartic and to prevent absorption, followed by 30 - 40 ml every 3 hours for the first 48 hours. Avoid digestible fats and oils.
4. Treatment of severe shock.
5. Control of convulsions by rapid-acting barbiturates or diazepam.
6. Vitamin K₁, IV to combat hypoprothrombinemia. Fresh blood transfusions may be necessary.
7. Hospitalization for observation to ascertain possible liver and kidney damage.
8. EKG monitoring to detect hypocalcemia (prolonged QT interval) and to evaluate possible myocardial damage.

TREATMENT FOR EYE EXPOSURES:

1. Continue irrigation of eyes.
2. If available, instill several drops of 3% cupric sulfate solution which will turn phosphorus particles dark and reduce the potential for continued burning.
3. Mechanically remove embedded particles.

TREATMENT FOR INHALATION:

1. Prolonged inhalation of high vapor levels of phosphorus can lead to delayed onset pulmonary edema.
2. Treat pulmonary edema the same as for other corrosive gas overexposure.
3. Consider the need for same measures as noted in 4.- 8. under TREATMENT FOR INGESTION.

RHONE-POULENC BASIC CHEMICALS CO.

PRODUCT NAME:

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PHOSPHORUS

Effective Date: JUNE 9, 1992

VI. HEALTH HAZARD DATA/FIRST AID PROCEDURES (Continued)

TREATMENT OF DERMAL PHOSPHORUS BURNS:

1. Flood with large quantities of water or 5% sodium bicarbonate solution if not already done.
2. Keep burn areas covered with saline soaked dressings.
3. Remove all particles of phosphorus using forceps or sharp dissection if necessary. Ultraviolet light should be used to help identify phosphorus particles which fluoresce under UV. A Woods lamp is satisfactory.
4. Some poison texts recommend use of 1% cupric sulfate solutions or 2 - 3% silver nitrate solutions to coat phosphorus particles which reduces burning and allows easier identification for removal. Use of cupric sulfate solutions has the risk of copper poisoning and intravascular hemolysis especially if burns are extensive. Silver nitrate solutions presumably present less risk of poisoning. Some authorities feel removal under UV light is preferable to copper or silver solutions. If the latter are used they should be thoroughly rinsed away with saline and used cautiously in patients with large burn areas.
5. Consider need for the same measures as noted in 4. - 8. under TREATMENT FOR INGESTION, especially for more extensive burns.
6. Observe and treat for possible systemic effects.

References: 2,7,8,9,10

VII. PRECAUTIONS FOR SAFE HANDLING AND USE

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:

Persons involved in clean-up must wear appropriate protective equipment (see section VIII). Ventilate spill area.

Do not touch spilled material; stop leak if you can do so without risk. Water spray may reduce vapor, but it may not prevent ignition in closed spaces.

For small spills: Contain all spilled material by diking with earth or sand and apply a low pressure, cold water spray to extinguish fire and freeze contents. Cover with water, sand or earth. Shovel into a metal container and keep material under water. Residual spillage that cannot be removed by shovelling should be cleaned from hard surfaces as appropriate.

Do not flush material to public sewer systems or any waterways. Ensure adequate decontamination of tools and equipment following clean up.

Large spills should be handled according to a predetermined plan. For assistance in developing a plan, contact the Technical Service Department, 1-800-642-4200.

WASTE DISPOSAL METHOD:

Dispose of in accordance with Local, State and Federal regulations.

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

Do not breathe vapor or fume. Do not swallow. Do not get in eyes or on skin and clothing.

FLAMMABLE SOLID: Will spontaneously ignite on contact with air. Never use welding or cutting torch on or near any container (even empty). Explosion can result.

Product should be stored in a cool, dry, well-ventilated area in tightly closed containers away from all sources of ignition. Protect from light and air. Do not store near food or feedstuffs. Keep away from oxidizing materials. Contents are packed under water and will ignite if water is removed.

RHONE-POULENC BASIC CHEMICALS CO.

PRODUCT NAME:

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PHOSPHORUS

Effective Date: JUNE 9, 1992

VII. PRECAUTIONS FOR SAFE HANDLING AND USE

Phosphine may be present in the headspace of the containers. Extreme care must be exercised during loading and unloading. Follow Rhone-Poulenc Basic Chemicals Company procedures and only use trained personnel.

Do not eat, drink or smoke in the area where material is handled, processed or stored. Wash thoroughly after handling. Shower at the end of each workday. Wear clean work clothes every day.

VIII. SPECIAL PROTECTION INFORMATION

PROTECTIVE EQUIPMENT SHOULD BE USED DURING THE FOLLOWING PROCEDURES:

- Manufacture or formulation of this product
- Repair and maintenance of contaminated equipment
- Clean up of leaks and spills
- Any activity with potential for hazardous overexposure.

RESPIRATORY PROTECTION:

Use NIOSH/MSHA approved full-facepiece positive pressure supplied-air equipment. Use positive-pressure self-contained breathing apparatus for emergency conditions. If airborne concentrations of phosphorus vapors and phosphine gas are known to be well below the permissible limits, an air-purifying respirator equipped with a fume or high-efficiency filter may be used to protect against exposure to phosphorus pentoxide and phosphoric acid.

VENTILATION: Use local exhaust ventilation to control exposure levels below airborne exposure limits.

PROTECTIVE CLOTHING: Full-body flame-retardant protective clothing, heavy rubber gloves and boots.

EYE PROTECTION: When small quantities are handled, wear face shield with splash-proof goggles. When bulk quantities are handled, a fire-resistant face shield integrated with a whole head hood is recommended.

OTHER PROTECTIVE EQUIPMENT:

Maintain a sink, safety shower, eyewash fountain and submersion tub in the work area. Have oxygen readily available.

IX. REGULATORY STATUS

TSCA Inventory: This product is listed on the TSCA inventory.

Transportation Status: DOT

Proper shipping name: Phosphorus, yellow, under water

Hazard Class: 4.2

Packing Group: I

ID Number: UN 1381

Label: SPONTANEOUSLY COMBUSTIBLE; POISON

Reportable Quantity under 49 CFR 172.101 Appendix 1 : 1 lb

MATERIAL SAFETY DATA SHEET

RHONE-POULENC BASIC CHEMICALS CO.

PRODUCT NAME:

Page: 10 of 10

PHOSPHORUS

Effective Date: JUNE 9, 1992

IX. REGULATORY STATUS, (Continued)

SARA Title III

Section 302 Extremely Hazardous Substance List: YES
Section 313 Toxic Chemicals: YES

Reportable Quantity (RQ) under US EPA CERCLA: RQ = 1 lb
TPQ = 100 lbs

State/International Right-to-Know Regulations:

California:	Not listed
Connecticut:	Survey
Florida:	Toxic
Illinois:	Toxic, Chemical
Louisiana:	RTK, Spill RQ=1 lb
Massachusetts:	RTK, EHS (E), Spill RQ = 1 lb
New Jersey:	ID# 1534, RTK, Spec. Haz. (F3), TAX
New York:	Spill RQ=1 lb (air), 1 lb (l/w)
Pennsylvania:	RTK, ENV
Rhode Island:	HAZ, Note TF
Canada:	List, 1%, No. 1295

X. REFERENCES

- (1) RTECS, 62963, 12/87
- (2) Gosselin, Clinical Toxicology of Commercial Products, 5th ed.
- (3) NIOSH Pocket Guide to Chemical Hazards, Sept. 1985.
- (4) Monsanto MSDS for Phosphorus.
- (5) Sax, Dangerous Properties of Industrial Materials, 6th ed.
- (6) Sittig, Handbook of Toxic and Hazardous Chemicals and Carcinogens, 2nd ed.
- (7) Proctor, Chemical Hazards in the Workplace, 2nd ed.
- (8) Arena, Poisoning, 5th ed.
- (9) Ellenhorn, Barceloux, Medical Toxicology - Diagnosis and Treatment of Human Poisoning, 1988.
- (10) Grant, Toxicology of the Eye, 2nd ed.

The information herein is given in good faith
but no warranty, expressed or implied, is made.

**ENERGY LABORATORIES, INC.**

P.O. BOX 30916 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325

FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

ADDRESS:

Lisa L. Palmer
Rhone-Poulenc
P.O. Box 314C
Butte, MT 59702LAB NO.: 97-18565
DATE: 03/03/97 krWASTE ANALYSISSludge #01
Submitted 02/27/97
Extracted 02/27/97*crude phosphorous***TOXICITY CHARACTERISTIC LEACHING PROCEDURE
EPA SW-846 METHOD 1311**

Metals	CAS No.	Regulatory Limit, mg/l	Minimum Reporting Limit, mg/l	Result, mg/l in Extract	Spike Percent Recovery	Date Analyzed
Arsenic	7440-38-2	5.0	0.5	<0.5	100	02/28/97
Barium	7440-39-3	100.0	10.0	<10	91	02/28/97
Cadmium	7440-43-9	1.0	0.1	<0.1	103	02/28/97
Chromium	7440-47-3	5.0	0.5	<0.5	92	02/28/97
Lead	7439-92-1	5.0	0.5	<0.5	96	02/28/97
Mercury	7439-97-6	0.2	0.02	<0.02	106	03/03/97
Selenium	7782-49-2	1.0	0.1	<0.1	91	03/03/97
Silver	7440-22-4	5.0	0.5	<0.5	95	02/28/97

**ENERGY LABORATORIES, INC.**P.O. BOX 30916 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489**LABORATORY REPORT**Lisa L. Palmer
Rhone-Poulenc
P.O. Box 3146
Butte, MT 59702**LAB NO.:** 97-18566
DATE: 03/03/97 kr**WASTE ANALYSIS**Sludge #02
Submitted 02/27/97
Extracted 02/27/97Crude
phosphorous**TOXICITY CHARACTERISTIC LEACHING PROCEDURE
EPA SW-846 METHOD 1311.**

Metals	CAS No.	Regulatory Limit, mg/l	Minimum Reporting Limit, mg/l	Result, mg/l in Extract	Spike Percent Recovery	Date Analyzed
Arsenic	7440-38-2	5.0	0.5	<0.5	102	02/28/97
Barium	7440-39-3	100.0	10.0	<10	90	02/28/97
Cadmium	7440-43-9	1.0	0.1	<0.1	101	02/28/97
Chromium	7440-47-3	5.0	0.5	<0.5	91	02/28/97
Lead	7439-92-1	5.0	0.5	<0.5	93	02/28/97
Mercury	7439-97-6	0.2	0.02	<0.02	107	03/03/97
Selenium	7782-49-2	1.0	0.1	<0.1	91	03/03/97
Silver	7440-22-4	5.0	0.5	<0.5	92	02/28/97

**ENERGY LABORATORIES, INC.**P.O. BOX 30916 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489**LABORATORY REPORT**

ADDRESS:

Lisa L. Palmer
Rhone-Poulenc
P.O. Box 3146
Butte, MT 59702LAB NO.: Blank
DATE: 03/03/97 kr**WASTE ANALYSIS**Method Blank
Extracted 02/27/97**TOXICITY CHARACTERISTIC LEACHING PROCEDURE
EPA SW-846 METHOD 1311**

Metals	CAS No.	Regulatory Limit, mg/l	Minimum Reporting Limit, mg/l	Result, mg/l in Extract	Spike Percent Recovery	Date Analyzed
Arsenic	7440-38-2	5.0	0.5	<0.5	103	02/28/97
Barium	7440-39-3	100.0	10.0	<10	93	02/28/97
Cadmium	7440-43-9	1.0	0.1	<0.1	104	02/28/97
Chromium	7440-47-3	5.0	0.5	<0.5	96	02/28/97
Lead	7439-92-1	5.0	0.5	<0.5	98	02/28/97
Mercury	7439-97-6	0.2	0.02	<0.02	82	03/03/97
Selenium	7782-49-2	1.0	0.1	<0.1	105	03/03/97
Silver	7440-22-4	5.0	0.5	<0.5	101	02/28/97

Material Description
Used Carbon Brick and Furnace Liner

Generator Name and Location			
Rhodia, Inc. Silver Bow Plant 119130 German Gulch Road Silver Bow, Montana 59750			
General Description			
Used carbon brick and furnace liner			
Process Description			
The used brick and furnace liner is an inert; carbon refractory lining that was removed from electric arc furnaces that were used to convert phosphate ore into elemental phosphorus. The brick and furnace liner material ranges in size from cinder block size to as large as a refrigerator. A small fraction of the used brick and furnace liner surfaces contain a thin veneer of amorphous phosphorus (a flammable solid).			
Generation Amount			
Case 1: Approximately 2,000 Tons; one-time only.			
Case 2: Approximately 100 Tons; one-time only. Rhodia may be able to reduce the volume by segregating and packaging only the carbon bricks that have the veneer of amorphous phosphorus.			
Material Characteristics			
Color:	Black		
pH:	Solid		
Physical State:	Solid		
Material Composition			
	<u>Range</u>	<u>Typical</u>	
Phosphorus amorphous	Trace	Trace	
Used Carbon Brick and Furnace Liner	99 to 100	>99 wt%	
TOTAL		100 wt%	
Material Safety Data Sheet (MSDS) and Analytical Data			
The following data is attached to this Material Description			
1) MSDS for Phosphorus amorphous			
2) MSDS for Carbon Block and Brick			
3) TCLP Metal Data (Sample is labeled Spent Furnace Brick in the attached report.)			
		<u>Reg. Limit</u>	<u>Results</u>
Arsenic	[mg/l]	5.0	<0.015
Barium	[mg/l]	100.0	0.205
Cadmium	[mg/l]	1.0	0.022
Chromium	[mg/l]	5.0	0.156
Lead	[mg/l]	5.0	<0.040
Mercury	[mg/l]	0.2	<0.0003
Selenium	[mg/l]	1.0	<0.02
Silver	[mg/l]	5.0	<0.006
4) Method 8270B Semi-Volatile and 8260A Volatile Data (Sample is labeled "SCB: Spent Carbon Brick in the attached report.) All results were below detection limits.			
RCRA Classification			
EPA has indicated they believe the following code is applicable: D001			

Material Description

Used Carbon Brick and Furnace Liner

DOT Requirements		
Proper Shipping Name:	Phosphorus, amorphous	<u>Packaging Requirements:</u>
Hazard Class:	4.1	Tri-wall cubic yard box; 11G/1Y
UN/NA Number:	UN 1338	or
Packing Group:	III	55-gallon drum; 1A2/Y1.8/200
Label:	FLAMMABLE SOLID	
Reportable Quantity:	1 lb	
Additional Information		
<p>Special handling is required for this material due to the presence of elemental phosphorus in a thin veneer of amorphous phosphorus on some areas of some of the carbon brick and furnace liner. The veneer of amorphous phosphorus does not spontaneously react with air, but may ignite if sufficient friction is applied to its surface. Upon ignition, phosphorus will form oxides of phosphorus (mainly P_2O_5; a dense white acrid fume). The material safety data sheet indicates that the carbon brick and furnace liner is noncombustible; only the veneer of phosphorus would burn. EPA has expressed concern that elemental phosphorus could have saturated the carbon brick and furnace liner while they were in service, although Rhodia has seen no evidence to substantiate this concern.</p> <p>The used carbon brick and furnace liner has been in the presence of material derived from phosphate ore. Phosphate ore is a naturally occurring radioactive material (NORM). A radiation survey at the Silver Bow Plant found gamma radiation ranging from 17 to 170 microRoentgens per hour.</p> <p>Phosphorus has the potential to generate phosphine gas in the presence of water. Higher temperature and higher pH typically increase the general of phosphine when phosphorus is in contact with water. The used carbon brick and furnace liner will be packaged consistent with 40 CFR 173.213 and may be packaged under water.</p> <p>Phosphine is highly toxic and may be fatal if inhaled at high concentrations. Effects may include dizziness, headache, nausea, vomiting, abdominal and chest pain, difficulty with breathing, diarrhea and collapse. Phosphine inhalation at excess concentrations causes irritation of the respiratory tract and lungs and pulmonary edema may occur 1 to 2 days after exposure. Repeated exposure may result in anemia, bronchitis, gastrointestinal disturbances, and visual, speech and motor disturbances. Central nervous system depression, heart, liver and kidney damage, and cerebral edema may occur from overexposure.</p> <p>Based on process knowledge, the material does not contain any of the following substances:</p> <ul style="list-style-type: none"> • DOT Radioactive, Explosives, or materials forbidden from transport. • TSCA regulated materials, Chlorinated biphenyls (PCB) or Brominated biphenyls (PBB), Chlorinated dibenzodioxins or furans. • Products used as pesticides, herbicides, or by-products of pesticide manufacture. • Human carcinogens above exclusion levels as defined by OSHA (Ref. 29CFR1910.1001) • Sulfides, Cyanides, Shock sensitive materials. • Biological hazards (such as Pathogenic materials, infectious agents, Etiologic agents, USEPA Medical Waste). • Water or amine-reactive components (such as unreacted isocyanate monomers and resins, Acid chlorides, Anhydrides, Epoxides). 		

MSDS

Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

MALLINCKRODT



24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-998-6666

Outside U.S. and Canada
Chemtrec: 202-483-7616

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

PHOSPHORUS AMORPHOUS

MSDS Number: P4017 — *Effective Date: 11/17/99*

1. Product Identification

Synonyms: Red Phosphorus; Phosphorus Amorphous Red

CAS No.: 7723-14-0

Molecular Weight: 30.97

Chemical Formula: P

Product Codes:

J.T. Baker: 9358

Mallinckrodt: 6620

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Phosphorus	7723-14-0	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

WARNING! FLAMMABLE SOLID. MAY IGNITE FROM FRICTION OR ROUGH HANDLING. CAUSES EYE IRRITATION. MAY BE HARMFUL IF SWALLOWED OR INHALED.

J.T. Baker SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

Health Rating: 0 - None

Flammability Rating: 2 - Moderate

Reactivity Rating: 2 - Moderate

Contact Rating: 2 - Moderate

Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES;
CLASS D EXTINGUISHER

Storage Color Code: Red Stripe (Store Separately)

Potential Health Effects

Inhalation:

Not considered highly toxic but acute exposure may cause coughing, bronchitis, possible liver or kidney impairment if contaminated with yellow phosphorus.

Ingestion:

Red phosphorus is not readily absorbed and, in pure form, is considered non-poisonous. However, possible contamination with the yellow form must be considered, and symptoms such as nausea, vomiting, abdominal pain or garlic odor on breath will indicate poisoning by the latter. The estimated lethal adult human dose for white phosphorus is 50 - 100 mg.

Skin Contact:

Red phosphorous is not harmful to skin. If contaminated with white phosphorus, however, contact may cause deep, slow healing burns.

Eye Contact:

Red phosphorus causes eye irritation. If contaminated with yellow phosphorus, eye contact can cause severe irritation and burns.

Chronic Exposure:

Chronic ingestion or inhalation may induce systemic phosphorous poisoning. Liver damage, kidney damage, jaw/tooth abnormalities, blood disorders and cardiovascular effects can result.

Aggravation of Pre-existing Conditions:

Persons with pre-existing skin disorders or eye problems, jaw/tooth abnormalities, or impaired liver, kidney or respiratory function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Ingestion:

If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention immediately. Get medical attention.

Skin Contact:

Wash exposed area with soap and water. Get medical advice if irritation develops.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:

Autoignition temperature: 260C (500F)

Flammable solid. May ignite from friction or rough handling.

Explosion:

May form explosive mixtures with oxidizing materials. Sensitive to static discharge.

Fire Extinguishing Media:

Water flooding followed by covering with wet sand, clay, ground limestone until clean-up.

Special Information:

Burning phosphorus produces irritating but not highly toxic oxides. Flame-retardant full protective clothing and full breathing apparatus should be worn with phosphorus fires. The red form can convert to the more readily-flammable yellow form at high temperatures.

6. Accidental Release Measures

Moisten the spilled phosphorus as a precaution and keep it under wet sand or the like until it can be collected and placed in a closed container for recovery or disposal. Remove all sources of ignition. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Clean up spills in a manner that does not disperse dust into the air. Use non-sparking tools and equipment. Reduce airborne dust and prevent scattering by moistening with water. Pick up spill for recovery or disposal and place in a closed container. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Protect from light. Avoid dust formation and control ignition sources. Employ grounding, venting and explosion relief provisions in accord with accepted engineering practices in any process capable of generating dust and/or static electricity. Empty only into inert or non-flammable atmosphere. Emptying contents into a non-inert atmosphere where flammable vapors may be present could cause a flash fire or explosion due to electrostatic discharge. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings

and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

None established.

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):

For conditions of use where exposure to the dust or mist is apparent, a half-face dust/mist respirator may be worn. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. **WARNING:** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear protective gloves and clean body-covering clothing.

Eye Protection:

Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

Other Control Measures:

Presence of yellow phosphorous as an impurity will change necessary protective equipment.

9. Physical and Chemical Properties

Appearance:

Red to violet powder.

Odor:

Odorless.

Solubility:

Insoluble in water.

Specific Gravity:

2.34 @ 20C/4C

pH:

No information found.

% Volatiles by volume @ 21C (70F):

0

Boiling Point:

No information found.

Melting Point:

No information found.

Vapor Density (Air=1):

No information found.

Vapor Pressure (mm Hg):

No information found.

Evaporation Rate (BuAc=1):

No information found.

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

White phosphorous, oxides of phosphorous, phosphine, and phosphoric acid (if water is present) may be released if this material is heated to decomposition.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

Halogens, halides, sulfur, oxidizing materials and alkalis (forms phosphine).

Conditions to Avoid:

Heat, flame, ignition sources, shock, friction, incompatibles.

11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure.

-----\Cancer Lists\-----			
Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Phosphorus (7723-14-0)	No	No	None

12. Ecological Information

Environmental Fate:

No information found.

Environmental Toxicity:

No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this

product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: RQ, PHOSPHORUS, AMORPHOUS

Hazard Class: 4.1

UN/NA: UN1338

Packing Group: III

Information reported for product/size: 500G

International (Water, I.M.O.)

Proper Shipping Name: PHOSPHORUS, AMORPHOUS

Hazard Class: 4.1

UN/NA: UN1338

Packing Group: III

Information reported for product/size: 500G

International (Air, I.C.A.O.)

Proper Shipping Name: PHOSPHORUS, AMORPHOUS

Hazard Class: 4.1

UN/NA: UN1338

Packing Group: III

Information reported for product/size: 500G

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\-----
Ingredient TSCA EC Japan Australia

Phosphorus (7723-14-0) Yes Yes No Yes

-----\Chemical Inventory Status - Part 2\-----
Ingredient Korea --Canada-- DSL NDSL Phil.

Phosphorus (7723-14-0) Yes Yes No Yes

-----\Federal, State & International Regulations - Part 1\-----
Ingredient -SARA 302- -SARA 313-
RQ TPQ List Chemical Catg.

Phosphorus (7723-14-0) 1 100 Yes No

-----\Federal, State & International Regulations - Part 2\-----			
Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Phosphorus (7723-14-0)	1	No	Yes

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: Yes Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: 2WE

Poison Schedule: S7

WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 1 Flammability: 1 Reactivity: 1

Label Hazard Warning:

WARNING! FLAMMABLE SOLID. MAY IGNITE FROM FRICTION OR ROUGH HANDLING. CAUSES EYE IRRITATION. MAY BE HARMFUL IF SWALLOWED OR INHALED.

Label Precautions:

Keep away from heat, sparks and flame.

Avoid breathing dust.

Avoid contact with eyes.

Keep container closed.

Use with adequate ventilation.

Wash thoroughly after handling.

Label First Aid:

If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. In all cases, get medical attention.

Product Use:

Laboratory Reagent.

Revision Information:

No changes.

Disclaimer:

Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by

a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.

Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

UCAR CARBON COMPANY
MATERIAL SAFETY DATA SHEET

UCAR CARBON REQUESTS THE USERS OF THIS PRODUCT TO STUDY THIS MATERIAL SAFETY DATA SHEET (MSDS) AND BECOME AWARE OF PRODUCT HAZARDS AND SAFETY INFORMATION. TO PROMOTE SAFE USE OF THIS PRODUCT, USERS SHOULD NOTIFY THEIR EMPLOYEES, AGENTS AND CONTRACTORS OF THE INFORMATION ON THIS MSDS AND ANY PRODUCT HAZARDS AND SAFETY INFORMATION.

UCAR CARBON COMPANY INC
39 OLD RIDGEBURY ROAD, DANBURY, CT 06817-0001

EMERGENCY TELEPHONE NUMBER
1-800-822-4357 (24 HOURS)

TRADE NAME
UCAR(R) CARBON BLOCK AND BRICK, GRADE D,
AND GRADE CJD

MSDS NUMBER
4014

CHEMICAL NAME
CARBON BLOCK AND BRICK

SYNONYMS
CARBON

ACGIH TLV - 1992-1993
OSHA PEL - 1989

DATE OF ISSUE / REVISION
1/93 2/94

1. HAZARDOUS INGREDIENTS

MATERIAL	PERCENT	ACGIH (TLV)	OSHA (PEL)
1. COAL (NO CAS NUMBER)	65-85	2. MG/M3 RESPIRABLE	2.4 MG/M3 RESPIRABLE
2. GRAPHITE (CAS #7782-42-5)	3-20	2.0 MG/M3 RESPIRABLE	5.0 MG/M3 RESPIRABLE
3. CARBON (CAS #7440-44-0)	11.6	10. MG/M3	15 MG/M3
4. CRYSTALLINE SILICA (CAS #14808-60-7)	< 3.0	0.1 MG/M3 RESPIRABLE	0.1 MG/M3 RESPIRABLE

2. PHYSICAL DATA

APPEARANCE BLACK SHAPES	ODOR NONE	MELT POINT > 5000 DEGREES F	SPECIFIC GRAVITY NOT APPLICABLE
VAPOR DENSITY (AIR=1) NOT APPLICABLE	% VOLATILE BY VOLUME NOT VOLATILE	BULK DENSITY 1.6 - 1.8 G/CC	BOILING POINT NOT APPLICABLE
VAPOR PRESSURE NOT APPLICABLE	% SOLUBILITY (H2O) NEGLECTIBLE	EVAPORATION RATE (HUCAC=1) NOT APPLICABLE	OTHER NOT APPLICABLE

3. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT & METHOD NOT APPLICABLE	
FLAMMABLE LIMITS LEL : NOT APPLICABLE	UEL : NOT APPLICABLE
EXTINGUISHING MEDIA BULK MATERIAL IS NONCOMBUSTIBLE. DUSTS ARE COMBUSTIBLE - USE WATER, CARBON DIOXIDE, DRY CHEMICAL OR FOAM.	

SPECIAL FIRE FIGHTING PROCEDURES
MATERIAL IN OR NEAR FIRES SHOULD BE COOLED WITH A WATER SPRAY OR FOG. A SELF-CONTAINED BREATHING APPARATUS, OPERATING IN THE POSITIVE PRESSURE MODE, AND FULL FIRE-FIGHTING PROTECTIVE CLOTHING SHOULD BE WORN FOR COMBATING FIRES.

UNUSUAL FIRE AND EXPLOSION HAZARDS

THERMAL DECOMPOSITION OR COMBUSTION MAY PRODUCE DENSE SMOKE, OXIDES OF CARBON AND SILICA. AS WELL AS LOW MOLECULAR WEIGHT ORGANIC COMPOUNDS WHOSE COMPOSITIONS HAVE NOT BEEN CHARACTERIZED. DIVIDED CARBON DUSTS FORM POTENTIALLY EXPLOSIVE MIXTURES IN AIR AT CONCENTRATIONS EXCEEDING 100 G/M3.

HEALTH HAZARD DATA

LD50 ORAL (INGESTION)	LD50 DERMAL (SKIN CONTACT)	LD50 (INHALATION)
NOT ESTABLISHED FOR PRODUCT	NOT ESTABLISHED FOR PRODUCT	NOT ESTABLISHED FOR PRODUCT
PRIMARY ROUTE OF EXPOSURE		THRESHOLD LIMIT VALUES (TLV)
INHALATION OF DUSTS GENERATED DURING PROCESSING		NOT ESTABLISHED FOR PRODUCT -
AND HANDLING AND DERMAL AND OCULAR CONTACT.		SEE SECTIONS 1 AND 11

EFFECTS OF OVEREXPOSURE

ACUTE

HIGH CONCENTRATIONS OF CARBON AND/OR CRYSTALLINE SILICA DUSTS MAY BE IRRITATING TO THE EYES, SKIN, MUCOUS MEMBRANES AND RESPIRATORY TRACT.

CHRONIC

INHALATION OF HIGH CONCENTRATIONS OF CARBON DUSTS OVER PROLONGED PERIODS OF TIME MAY CAUSE CARBON PNEUMOCONIOSIS. SYMPTOMS CAN INCLUDE COUGH, SHORTNESS OF BREATH AND A DECREASE IN PULMONARY FUNCTION.

INHALATION OF HIGH CONCENTRATIONS OF CRYSTALLINE SILICA DUSTS OVER PROLONGED PERIODS OF TIME MAY CAUSE SILICOSIS, A PROGRESSIVELY DEBILITATING LUNG DISEASE. THE SYMPTOMS ARE SIMILAR TO THOSE CITED ABOVE FOR CARBON PNEUMOCONIOSIS. INHALATION OF HIGH CONCENTRATIONS OF CRYSTALLINE SILICA OVER PROLONGED PERIODS OF TIME HAS ALSO BEEN LINKED TO AN INCREASED INCIDENCE OF LUNG CANCER.

PREEXISTING PULMONARY DISORDERS SUCH AS EMPHYSEMA MAY POSSIBLY BE AGGRAVATED BY PROLONGED EXPOSURES TO HIGH CONCENTRATIONS OF CARBON AND/OR CRYSTALLINE SILICA DUSTS.

SEE SECTION 11.

5. EMERGENCY AND FIRST AID PROCEDURES

FOR OVEREXPOSURE TO PARTICULATE MATTER, MOVE THE EXPOSED PERSON TO FRESH AIR. IF BREATHING IS DIFFICULT, OXYGEN MAY BE ADMINISTERED. IF BREATHING HAS STOPPED, ARTIFICIAL RESPIRATION SHOULD BE STARTED IMMEDIATELY. SEEK MEDICAL ATTENTION.

IF THE MATERIAL ENTERS THE EYES, FLUSH WITH WATER FOR AT LEAST 15 MINUTES. SEEK MEDICAL ATTENTION IF IRRITATION DEVELOPS OR PERSISTS.

IF THE MATERIAL GETS ON THE SKIN, WASH THOROUGHLY WITH MILD SOAP AND WATER. SEEK MEDICAL ATTENTION IF IRRITATION DEVELOPS OR PERSISTS. DERMATITIS SHOULD BE TREATED SYMPTOMATICALLY BY A PHYSICIAN.

INGESTION IS NOT EXPECTED TO BE AN IMPORTANT ROUTE OF ENTRY INTO THE BODY. IF, HOWEVER, THE MATERIAL IS INGESTED, GIVE TWO GLASSES OF WATER AND INDUCE VOMITING. NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON. SEEK MEDICAL ATTENTION.

6. PHYSICAL HAZARDS

CARBON DUSTS ARE ELECTRICALLY CONDUCTIVE. ACCUMULATIONS OF DUST MAY CAUSE SHORTING OF ELECTRICAL CIRCUITS. CARE SHOULD BE TAKEN TO SEAL ELECTRICAL CIRCUITS AND SWITCHES THAT MAY BE AFFECTED. DUSTS SHOULD NOT BE EMITTED INTO THE ATMOSPHERE WHERE THEY MAY SETTLE ON AND CAUSE SHORTING OF OTHER ELECTRICAL EQUIPMENT.

VENTILATION

IF DUSTS ARE GENERATED DURING PROCESSING OR USE, LOCAL EXHAUST VENTILATION SHOULD BE PROVIDED TO MAINTAIN EXPOSURES BELOW THE LIMITS CITED IN SECTION 1. DESIGN DETAILS FOR LOCAL EXHAUST VENTILATION SYSTEMS MAY BE FOUND IN THE LATEST EDITION OF "INDUSTRIAL VENTILATION: A MANUAL OF RECOMMENDED PRACTICES" PUBLISHED BY THE ACGIH COMMITTEE ON INDUSTRIAL VENTILATION, P. O. BOX 16153, LANSING, MI 48910. THE NEED FOR LOCAL EXHAUST VENTILATION SHOULD BE EVALUATED BY A PROFESSIONAL INDUSTRIAL HYGIENIST. LOCAL EXHAUST VENTILATION SYSTEMS SHOULD BE DESIGNED BY A PROFESSIONAL ENGINEER.

RESPIRATORY

IF EXPOSURES EXCEED THE LIMITS CITED IN SECTION 1 BY LESS THAN A FACTOR OF 10, USE AS A MINIMUM A NIOSH APPROVED 1/2 FACEPIECE RESPIRATOR EQUIPPED WITH CARTRIDGES APPROVED FOR PARTICULATE MATTER WITH AN EXPOSURE LIMIT OF NOT LESS THAN 0.05 MG/M3. IF EXPOSURES EXCEED 10 TIMES THE LIMITS CITED IN SECTION 1, CONSULT A PROFESSIONAL INDUSTRIAL HYGIENIST OR YOUR RESPIRATORY PROTECTIVE EQUIPMENT SUPPLIER FOR SELECTION OF THE PROPER EQUIPMENT. THE EVALUATION OF THE NEED FOR RESPIRATORY PROTECTION SHOULD BE DETERMINED BY A PROFESSIONAL INDUSTRIAL HYGIENIST.

EYE PROTECTION

PROTECTIVE GLASSES WITH SIDESHIELDS SHOULD BE WORN TO PREVENT EYE CONTACT WITH PARTICULATE MATTER.

PROTECTIVE GLOVES:

PROTECTIVE GLOVES ARE RECOMMENDED TO PREVENT CUTS, ABRASIONS AND IRRITATION DURING HANDLING AND PROCESSING.

OTHER:

WHERE NORMAL WORK CLOTHES MAY BECOME SOILED WITH DUSTS, COVERALLS ARE RECOMMENDED. WASH SOILED CLOTHING BEFORE REUSE.

ALL CHEMICALS SHOULD BE HANDLED SO AS TO PREVENT EYE CONTACT AND EXCESSIVE OR REPEATED SKIN CONTACT. APPROPRIATE EYE AND SKIN PROTECTION SHOULD BE EMPLOYED. INHALATION OF DUSTS AND VAPORS SHOULD BE AVOIDED.

8. CHEMICAL REACTIVITY

CONDITION CAUSING INSTABILITY

NONE THAT ARE KNOWN. MATERIAL IS STABLE. HAZARDOUS POLYMERIZATION WILL NOT OCCUR.

INCOMPATIBILITY (MATERIALS TO AVOID)

AVOID CONTACT WITH STRONG OXIDIZING AND REDUCING AGENTS.

HAZARDOUS DECOMPOSITION PRODUCTS

SEE SECTION 3 FOR POSSIBLE COMBUSTION AND/OR THERMAL DECOMPOSITION PRODUCTS. THESE WOULD BE EXPECTED ONLY DURING EMERGENCY CONDITIONS.

SPECIAL SENSITIVITY

NONE THAT ARE KNOWN.

9. STORAGE INFORMATION

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

STORE AWAY FROM HEAT, SPARKS, OPEN FLAMES AND OTHER SOURCES OF IGNITION. DO NOT STORE WITH OR NEAR INCOMPATIBLE CHEMICALS CITED IN SECTION 8. DO NOT LET MATERIAL ACCUMULATE IN THE WORKPLACE. PROMPTLY CLEAN UP ANY SPILLS THAT MAY OCCUR. ANY DUSTS GENERATED DURING HANDLING OR PROCESSING SHOULD BE CLEANED UP BY WET MOPPING OR VACUUMING WITH A HEPA FILTER. DRY SWEEPING CAN RESUSPEND PARTICULATE MATTER INTO THE ATMOSPHERE.

10. SPILL, LEAK, AND DISPOSAL INFORMATION

STEPS TO BE TAKEN IN CASE MATERIAL IS SPILLED OR RELEASED

SPILLED OR RELEASED MATERIAL SHOULD BE PICKED UP WITH A SUITABLE IMPLEMENT. IF NOT REUSABLE, THE MATERIAL SHOULD BE PLACED IN DOT APPROVED CONTAINERS FOR DISPOSAL. PERSONNEL INVOLVED IN THE CLEANUP SHOULD WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT. SEE SECTION 7. UNAUTHORIZED PERSONNEL SHOULD BE KEPT CLEAR OF THE AREA OF SPILLS OR RELEASES. DO NOT ALLOW MATERIAL TO ENTER STORM OR SANITARY SEWERS, GROUNDWATER OR SOIL. RELEASES MAY BE REPORTABLE TO LOCAL, STATE OR FEDERAL AUTHORITIES.

EPA RCRA ID NUMBER
NOT APPLICABLE.

WASTE DISPOSAL METHOD

MATERIAL SHOULD BE DISPOSED OF IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS. DISPOSAL IN AN EPA APPROVED LANDFILL IS RECOMMENDED.

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EPA RCRA ID NUMBER

NOT APPLICABLE.

WASTE DISPOSAL METHOD

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1. NOTICE FROM UCAR CARBON COMPANY INC.: THE DATA IN THIS MATERIAL SAFETY DATA SHEET RELATES ONLY TO THE SPECIFIC MATERIAL DESIGNATED HEREIN AND DOES NOT RELATE TO USE IN COMBINATION WITH ANY OTHER MATERIAL OR IN ANY PROCESS. THE OPTIONS EXPRESSED HEREIN ARE THOSE OF QUALIFIED EXPERTS WITHIN UCAR CARBON COMPANY INC. WE BELIEVE THAT THE INFORMATION CONTAINED HEREIN IS CURRENT AS TO THE DATE OF ISSUE OF THIS MATERIAL SAFETY DATA SHEET. SINCE THE USE OF THIS INFORMATION AND THESE OPTIONS AND THE CONDITIONS OF USE OF THE PRODUCT ARE NOT WITHIN THE CONTROL OF UCAR CARBON COMPANY INC., IT IS THE USER'S OBLIGATION TO DETERMINE THE CONDITIONS OF SAFE USE OF THIS PRODUCT.
2. THE CRYSTALLINE SILICA (14808-60-7) COMPONENT OF THIS FORMULATION IS LISTED AS AN ANIMAL CARCINOGEN AND A PROBABLE HUMAN CARCINOGEN BY THE INTERNATIONAL AGENCY FOR RESEARCH ON CANCER (IARC). IT HAS NOT BEEN LISTED AS A CARCINOGEN OR POTENTIAL CARCINOGEN BY THE NATIONAL TOXICOLOGY PROGRAM (NTP) OR THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA).
3. WARNING: THE CRYSTALLINE SILICA COMPONENT OF THIS FORMULATION HAS BEEN IDENTIFIED AS A "CHEMICAL KNOWN TO CAUSE CANCER" BY THE STATE OF CALIFORNIA.

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LABORATORY ANALYSIS

TOXICITY CHARACTERISTICS LEACHING PROCEDURE (TCLP)

RHONE-POULENC
BASIC CHEMICAL
119130 GERMAN GULCH RD
BUTTE, MT 59750

EXTRACTION METHOD: TCLP, 40CFR, Pt. 268, App 1
LAB SAMPLE NO.: 8880-1
SAMPLE DESCRIPT.: SPENT FURNACE CARBON BRICK
MATRIX: OTHER
DATE SUBMITTED: 1/22/92
DATE EXTRACTED: 1/22/92
DATE ANALYZED: 1/23/92
DISCARD DATE: 3/22/92
COLLECTED BY: CAM BALENTINE

ANALYSIS METHOD NUMBER	CONSTITUENT	SAMPLE CONC.*	METHOD DETECTION LIMIT	MAXIMUM ALLOWABLE CONC.	UNITS	PERCENT RECOVERY**
EPA 7060	ARSENIC	N.D.	0.015	5.0	mg/l	96.0%
EPA 6010	BARIUM	0.205	0.015	100	mg/l	120.0%
EPA 7130	CADMIUM	0.022	0.004	1.0	mg/l	96.0%
EPA 7190	CHROMIUM	0.156	0.020	5.0	mg/l	104.0%
EPA 7420	LEAD	N.D.	0.040	5.0	mg/l	88.0%
EPA 7470	MERCURY	N.D.	0.0003	0.2	mg/l	88.5%
EPA 7740	SELENIUM	N.D.	0.02	1.0	mg/l	105.0%
EPA 7760	SILVER	N.D.	0.006	5.0	mg/l	97.0%

*N.D. means "not detected."

**Percent Recovery values were within established control limits.

CENTURY TESTING LABORATORIES, INC.

Reviewed and approved by:

Bruce H. Bale
Quality Assurance Manager

01/24/92

**ENERGY LABORATORIES, INC.**P.O. BOX 30916 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489 • E-MAIL eli@energylab.com

Client: MSE-HKM, Inc.

Date Sampled: 22-MAR-99 15:35

Date Received: 24-MAR-99

Analysis Date: 29-MAR-1999 22:44

Project Info: RHODIA, INC.

Sample Info: SCB-1

Lab No.: 003-99-50887

Report Date: 03/31/99 15:51

Extraction Method: EPA 5030

Sample Matrix: SOIL; Moisture=7%

EPA METHOD 8260A: VOLATILE ORGANICS ANALYSIS REPORT

COMPOUNDS	CONCENTRATION UNITS = ug/g (ppm)		QUALIFIER
	CAS NO.	RESULT	
Acetone	67-64-1	<10	U
Acrolein	107-02-8	<4.0	U
Acrylonitrile	107-13-1	<4.0	U
Benzene	71-43-2	<0.20	U
Bromobenzene	108-86-1	<0.20	U
Bromochloromethane	74-97-5	<0.20	U
Bromodichloromethane	75-27-4	<0.20	U
Bromoform	75-25-2	<0.20	U
Bromomethane	74-83-9	<0.20	U
n-Butylbenzene	104-51-8	<0.20	U
sec-Butylbenzene	135-98-8	<0.20	U
tert-Butylbenzene	98-06-6	<0.20	U
Carbon disulfide	75-15-0	<0.20	U
Carbon tetrachloride	56-23-5	<0.20	U
Chlorobenzene	108-90-7	<0.20	U
Chloroethane	75-00-3	<0.20	U
2-Chloroethylvinyl ether	110-75-8	<0.20	U
Chloroform	67-66-3	<0.20	U
Chloromethane	74-87-3	<0.20	U
2-Chlorotoluene	95-49-8	<0.20	U
4-Chlorotoluene	106-43-4	<0.20	U
Chlorodibromomethane	124-48-1	<0.20	U
1,2-Dibromo-3-chloropropane	96-12-8	<0.20	U
1,2-Dibromoethane	106-93-4	<0.20	U
Dibromomethane	74-95-3	<0.20	U
1,2-Dichlorobenzene	95-50-1	<0.20	U
1,3-Dichlorobenzene	541-73-1	<0.20	U
1,4-Dichlorobenzene	106-46-7	<0.20	U
Dichlorodifluoromethane	75-71-8	<0.20	U
1,1-Dichloroethane	75-34-3	<0.20	U
1,2-Dichloroethane	107-06-2	<0.20	U
1,1-Dichloroethene	75-35-4	<0.20	U
cis-1,2-Dichloroethene	156-59-2	<0.20	U
trans-1,2-Dichloroethene	156-60-5	<0.20	U
1,2-Dichloropropane	78-87-5	<0.20	U
1,3-Dichloropropane	142-28-9	<0.20	U
2,2-Dichloropropane	594-20-7	<0.20	U
1,1-Dichloropropene	563-58-6	<0.20	U
cis-1,3-Dichloropropene	10061-01-5	<0.20	U
trans-1,3-Dichloropropene	10061-02-6	<0.20	U
Ethylbenzene	100-41-4	<0.20	U
Hexachlorobutadiene	87-68-3	<0.20	U
2-Hexanone	591-78-6	<4.0	U
Iodomethane	74-88-4	<0.20	U
Methyl-t-butyl ether	1634-04-4	<0.20	U
Methyl isobutyl ketone	108-10-1	<4.0	U

(report continued on page 2)

SB 20153

Lab No.: 003-99-50887

Page 2

Sample Info: SCB-1

EPA METHOD 8260A: VOLATILE ORGANICS ANALYSIS REPORT

CONCENTRATION UNITS = ug/g (ppm)			
COMPOUNDS	CAS NO.	RESULT	QUALIFIER
Methylene chloride	75-09-2	<0.20	U
Methyl ethyl ketone	78-93-3	<4.0	U
Naphthalene	91-20-3	<0.20	U
Isopropylbenzene	98-82-8	<0.20	U
n-Propylbenzene	103-65-1	<0.20	U
p-Isopropyltoluene	99-87-6	<0.20	U
Styrene	100-42-5	<0.20	U
1,1,1,2-Tetrachloroethane	630-20-6	<0.20	U
1,1,2,2-Tetrachloroethane	79-34-5	<0.20	U
Tetrachloroethene	127-18-4	<0.20	U
Toluene	108-88-3	<0.20	U
1,2,3-Trichlorobenzene	87-61-6	<0.20	U
1,2,4-Trichlorobenzene	120-82-1	<0.20	U
1,1,1-Trichloroethane	71-55-6	<0.20	U
1,1,2-Trichloroethane	79-00-5	<0.20	U
Trichloroethene	79-01-6	<0.20	U
Trichlorofluoromethane	75-69-4	<0.20	U
1,2,3-Trichloropropane	96-18-4	<0.20	U
1,3,5-Trimethylbenzene	108-67-8	<0.20	U
1,2,4-Trimethylbenzene	95-63-6	<0.20	U
Vinyl acetate	108-05-4	<0.20	U
Vinyl chloride	75-01-4	<0.20	U
m+p-Xylenes	108383/106423	<0.20	U
o-Xylene	95-47-6	<0.20	U

SURROGATE RECOVERY REPORT


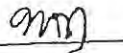
Surrogate Compound	Added-ug/g	Measured-ug/g	%Rec	QC Limits
1,2-Dichloroethane d4	2.00	2.15	108	80--120
Toluene d8	2.00	1.91	96	80--120
p-Bromofluorobenzene	2.00	1.64	82	80--120

QUALIFIER CODE EXPLANATIONS AND NOTES:

Note: Results are reported on a wet weight basis. To convert a result to dry weight basis divide by 0.93.

U= Indicates compound was analyzed for but not detected.

REPORT COMMENTS: None

Analyst: Reviewing Supervisor: 

/IONTRAP1.i/vb032999.b/09mar29.d

SB 20154

**ENERGY LABORATORIES, INC.**

P.O. BOX 30916 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489 • E-MAIL eli@energylab.com

Client: MSE-HKM, Inc.

Date Sampled: 22-MAR-99 15:35

Date Received: 24-MAR-99

Extraction Date: 30-MAR-1999

Analysis Date: 31-MAR-1999 15:47

Project Info: RHODIA, INC.

Sample Info: SCB-1

Lab No.: 003-99-50887

Report Date: 04/01/99 10:03

Sample Matrix: SOIL; Moisture=7%

Extraction Method: EPA 3550

Prep Info: 30g to 1ml

EPA METHOD 8270B: SEMI-VOLATILE ORGANICS ANALYSIS REPORT

COMPOUNDS	CONCENTRATION UNITS = ug/g (ppm)		QUALIFIER
	CAS NO.	RESULT	
Acenaphthene	83-32-9	<0.33	U
Acenaphthylene	208-96-8	<0.33	U
Anthracene	120-12-7	<0.33	U
Azobenzene	103-33-3	<0.33	U
Benzidine	92-87-5	<0.67	U
Benzo(a)Anthracene	56-55-3	<0.33	U
Benzo(b)fluoranthene	205-99-2	<0.33	U
Benzo(k)fluoranthene	207-08-9	<0.33	U
Benzo(g,h,i)perylene	191-24-2	<0.33	U
Benzo(a)pyrene	50-32-8	<0.33	U
4-Bromophenyl-phenylether	101-55-3	<0.33	U
Butylbenzylphthalate	85-68-7	<0.33	U
4-Chloro-3-Methylphenol	59-50-7	<0.33	U
bis(-2-Chloroethoxy)Methane	111-91-1	<0.33	U
bis(-2-Chloroethyl)Ether	111-44-4	<0.33	U
bis(2-Chloroisopropyl)ether	108-60-1	<0.33	U
2-Chloronaphthalene	91-58-7	<0.33	U
2-Chlorophenol	95-57-8	<0.33	U
4-Chlorophenol	106-48-9	<0.33	U
4-Chlorophenyl-phenylether	7005-72-3	<0.33	U
Chrysene	218-01-9	<0.33	U
Dibenzo(a,h)anthracene	53-70-3	<0.33	U
1,2-Dichlorobenzene	95-50-1	<0.33	U
1,3-Dichlorobenzene	541-73-1	<0.33	U
1,4-Dichlorobenzene	106-46-7	<0.33	U
3,3'-Dichlorobenzidine	91-94-1	<0.67	U
2,4-Dichlorophenol	120-83-2	<0.33	U
Diethylphthalate	84-66-2	<0.33	U
Dimethyl Phthalate	131-11-3	<0.33	U
2,4-Dimethylphenol	105-67-9	<0.33	U
Di-n-Butylphthalate	84-74-2	<0.33	U
4,6-Dinitro-2-methylphenol	534-52-1	<1.7	U
2,4-Dinitrophenol	51-28-5	<1.7	U
2,4-Dinitrotoluene	121-14-2	<0.33	U
2,6-Dinitrotoluene	606-20-2	<0.33	U
Di-n-octyl Phthalate	117-84-0	<0.33	U
bis(2-ethylhexyl)Phthalate	117-81-7	<0.33	U
Fluoranthene	206-44-0	<0.33	U
Fluorene	86-73-7	<0.33	U
Hexachlorobenzene	118-74-1	<0.33	U
Hexachlorobutadiene	87-68-3	<0.33	U
Hexachlorocyclopentadiene	77-47-4	<0.33	U
Hexachloroethane	67-72-1	<0.33	U

(report continued on page 2)

SB 20135

Lab No.: 003-99-50887

Sample Info: SCB-1

EPA METHOD 8270B: SEMI-VOLATILE ORGANICS ANALYSIS REPORT

COMPOUNDS	CONCENTRATION UNITS = ug/g (ppm)		
	CAS NO.	RESULT	QUALIFIER
Indeno(1,2,3-c,d)pyrene	193-39-5	<0.33	U
Isophorone	78-59-1	<0.33	U
1-Methylnaphthalene	90-12-0	<0.33	U
2-Methylnaphthalene	91-57-6	<0.33	U
2-Methylphenol	95-48-7	<0.33	U
4Methylphenol/3Methylphenol	106445/108394	<0.33	U
Naphthalene	91-20-3	<0.33	U
Nitrobenzene	98-95-3	<0.33	U
2-Nitrophenol	88-75-5	<0.33	U
4-Nitrophenol	100-02-7	<1.7	U
N-Nitrosodimethylamine	62-75-9	<0.33	U
N-nitroso-Di-n-propylamine	621-64-7	<0.33	U
N-nitrosodiphenylamine	86-30-6	<0.33	U
Pentachlorophenol	87-86-5	<1.7	U
Phenanthrene	85-01-8	<0.33	U
Phenol	108-95-2	<0.33	U
Pyrene	129-00-0	<0.33	U
Pyridine	110-86-1	<0.67	U
1,2,4-Trichlorobenzene	120-82-1	<0.33	U
2,4,5-Trichlorophenol	95-95-4	<0.33	U
2,4,6-Trichlorophenol	88-06-2	<0.33	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added-ug/g	Measured-ug/g	%Rec	QC Limits
2-Fluorophenol	6.67	3.77	57	25--121
Phenol-d5	6.67	3.92	59	24--113
Nitrobenzene-d5	3.33	2.07	62	23--120
2-Fluorobiphenyl	3.33	2.16	65	30--115
2,4,6-Tribromophenol	6.67	6.09	91	19--122
Terphenyl-d14	3.33	1.74	52	18--137

QUALIFIER CODE EXPLANATIONS AND NOTES:

Note: Results are reported on a wet weight basis. To convert a result to dry weight basis divide by 0.93.

U= Indicates compound was analyzed for but not detected.

REPORT COMMENTS: None

Analyst:

Reviewing Supervisor:

/disk3/SV5972.i/sb033199.b/31mar0901009.d

SB 20136

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: «Company»

Location: «Address1»

 «Address2»

 «City», «State» «PostalCode»

EPA ID#: «EPA_ID_»

Individual:

Name: _____

Title: _____ Phone Number: _____

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No _____

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____ No _____

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No _____

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No _____

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No _____

(B) At what capacity or rate: _____(Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No _____

(D) At what capacity or rate: _____(Units)

(E) What is the treatment method (Describe in detail):

*Completed Questionnaire Forms
and Nonresponse Followup*

#2

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: Chemical Waste Management

Location: Hwy 17 N/Mi Marker 163

P O Box 55

Emelle, AL 35459

EPA ID#: ALD000622464

Individual:

Name: John O Hanley

Title: Environmental Mgr

Phone Number: 205/652-8203

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No ✓

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____ No ✓

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

#2

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No _____

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No ☒

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No _____

(B) At what capacity or rate: _____ (Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No _____

(D) At what capacity or rate: _____ (Units)

(E) What is the treatment method (Describe in detail):



Telephone Memo

Date: 11/7/00
Time: 10:55

JMS of Barr Engineering Company

☒ placed a call to

☐ received a call from

☒ received a voice
mail from

☒ left message/voice
mail to

Name

Position

Company

Telephone

Erica Hawk

Operator

Systech Env. Corp

800 538-6003

EPA ID # ALD981019045 ← facility closed 1998 - -
MID981200835 ← facility closed 2000 - -

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials?

☐ Yes ☐ No

Not sure

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

resend to Erica Hawk - call first

Fax Number: 937-643-1203

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☒ No

Fuels to waste Company
handle liquid & sludge fuel quality waste - oils, solvents, paints

2.

I

E

Laidlaw

Open burning permits

10:22 AM

11/14/00

the resp

systech

phosphorus

D003 - no Paulding

3.

W

LA or AL

Fredonia D003 Cyanide
& sulfide only
phosphorus attacks film
bricks



- Company Information
- Fuels Group
- Contact
- Systech Digest Newsletter
- What's New
- Home

Systech Locations

Plant	Bulk Truck Liquid or Sludge	Rail Liquid or Sludge	Drum/Container	Tires
Paulding, OH	X	X		
Fredonia, KS	X	X	X	
Alpena, MI	X			
Whitehall, PA				X

Contact Systech at the following locations:

Systech Environmental Corporation
 3085 Woodman Drive, Suite 300
 Dayton, OH 45420-1159
 Phone: 937-643-1240
 Fax: 937-643-1203

Systech Environmental Corporation
 South Cement Road, P.O. Box 111
 Fredonia, KS 66736
 Phone: 316-378-4451 or
 800-778-7224
 Fax: 316-378-4505

Systech Environmental Corporation *closed 2000*
 1480 Ford Avenue, P.O. Box 588
 Alpena, MI 49707
 Phone: 517-354-3122
 Fax: 517-356-4592

Systech Environmental Corporation
 11397 County Road 176, P.O. Box 266
 Paulding, OH 45879
 Phone: 419-399-4835 or 800-266-3089
 Fax: 419-399-4876

Systech Environmental Corporation
 5160 Main Street
 Whitehall, PA 18052
 Phone: 610-261-3450
 Fax: 610-262-5375

Email: ericah@xenia.sysenv.com

Systech Environmental Corporation
 3085 Woodman Drive, Suite 300
 Dayton, OH 45420-1159
 Phone: 937-643-1240
 Fax: 937-643-1203



Telephone Memo

Date: 11/7/00
Time: 12:00

JMS of Barr Engineering Company

☒ placed a call to ☐ received a call from ☐ received a voice mail from ☐ left message/voice mail to

Name

Position

Company

Telephone

Bill Dugan

Cadence Env. Energy, Inc./
Ash Grove Cement Co.
Foreman, Arkansas

870-542-7278

EPA ID #ARD981512270

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26/25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☒ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Bill Dugan
870-542-7278

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes ☒ No

no reactive mat'ls in their permit

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: ENSCO Inc

Location: 309 American Circle

El Dorado, AR 71730-6555

EPA ID#: ARD069748192

Individual:

Name: TREASA EVANS

Title: Dir. Regulatory Affairs Phone Number: 870-864-3680

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No X

If Yes:

(A) What levels are acceptable: N/A (Units)

Crude Phosphorus (No, since they can not manage NORM material)

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes X No _____

If Yes:

(A) At what capacity or rate: Variable (Units)

(B) What is the treatment method (Describe in detail):

Incineration (rotary kiln) in 30 gal poly
containers by direct drop chute.

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No X - incineration residues (Ash) goes to Class C landfill for final treatment of metals
Used Carbon Brick and Furnace Liner sent to landfill.

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes X No _____

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes X No _____

(B) At what capacity or rate: variable (Units) depending on size/hardness and packaging constraints

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes X No _____

(D) At what capacity or rate: variable (Units)

(E) What is the treatment method (Describe in detail):

Rotary kiln incineration - in-line shredder
drop chute



Telephone Memo

Date: 11/7/00
Time: 12:10

JMS of Barr Engineering Company

☒ placed a call to ☐ received a call from ☒ received a voice mail from ☒ left message/voice mail to

Name	Position	Company	Telephone
Elaine Butler		Ensco, Inc.	870 863-7173
	EPA ID #		- -
			- -
			- -

Re: Project Name:
Rhodia - TSD Facility Survey

Project Number:
26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No
not sure
(If no, we will verify the mailing address and obtain fax number).
Mailing Address:

Fax Number: 870-864-3674

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☐ No

Completed waste material data sheet needed

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?



Telephone Memo

Date: 11/7/00

Time: 12:25

JMS of Barr Engineering Company

☐ placed a call to
 ☒ received a call from
 ☐ received a voice mail from
 ☒ left message/voice mail to

Name

Lyn Shepherd

Position

Company

Reynolds Metals Co
Gem Springs Plant

Telephone

870 - 242 2720

EPA ID # ARD006354161

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes ☒ No

only
LCFE waste code

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?



Telephone Memo

Date: 11/10/00

Time: 2:30

JMS of Barr Engineering Company

☒ placed a call to ☐ received a call from ☐ received a voice mail from ☐ left message/voice mail to

Name	Position	Company	Telephone
Colleen		Denova Environmental, Inc.	909-350-0580
		EPA ID # CAT080022148	- -
			- -
			- -

Re: Project Name:
Rhodia - TSD Facility Survey

Project Number:
26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☒ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☒ Yes ☐ No

cannot take NORM

2. Do you plan to respond to the questionnaire? ☐ Yes ☒ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

Denova Environmental, Inc.
2824 North Locust Ave
Rialto, CA 92377

909-350-0580

#29

**TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant**

RECEIVED

NOV 02 2000

TO BARR
ENGINEERING

Location Information (Please make corrections to the facility address, if appropriate)

Company: Trade Waste Incinerator Inc

Location: 7 Mobile Ave Site B

Sauget, IL 62201

EPA ID#: ILD098642424

Individual:

Name: Craig Zagland

Title: Thermal Product Manager Phone Number: 618-271-2804

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes X No _____

If Yes:

(A) What levels are acceptable: < 0.5 millirads/hr (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes X No _____

If Yes:

(A) At what capacity or rate: 1800 lbs/day (Units) (packaged in 15 lb containers)

(B) What is the treatment method (Describe in detail):

Incineration

#22

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes ☒ No ☒ Ash stabilized at Landfill,

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes ☒ No ☐

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes ☒ No ☐

(B) At what capacity or rate: 20 Tons/day (Units) (must be sized < 6")

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes ☒ No ☐

(D) At what capacity or rate: 20 Tons/day (Units) (must be sized < 6")

(E) What is the treatment method (Describe in detail):

Incineration

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: Essroc Cement Corp
Location: Sr 25 S 3084 W Cr 225 S
Logansport, IN 46947
EPA ID#: IND005081542
Individual:

Name: GRANT MEEKS
Title: CUST. SERV. MNGR. Phone Number: 219-753-2675

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No ☒

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____ No ☒

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No ☒

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No ☒

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No ☒

(B) At what capacity or rate: _____ (Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No ☒

(D) At what capacity or rate: _____ (Units)

(E) What is the treatment method (Describe in detail):



Telephone Memo

Date: 12/13/00

Time: 1:25

12/28/00
3:00 follow up

JMS of Barr Engineering Company

☐ placed a call to

☐ received a call from

☒ received a voice
mail from

☐ left message/voice
mail to

Name

Position

Company

Telephone

Tony Bannon

LoneStar

765 - 653 8816

EPA ID# IND 006419212

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Not sure if they can help us with the waste materials

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☐ No

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?



Telephone Memo

Date: 11/10/00

Time: 2:40

Follow-up 11/27/00
1:55

JMS of Barr Engineering Company

☐ placed a call to ☒ received a call from ☐ received a voice mail from ☒ left message/voice mail to

Name	Position	Company	Telephone
Krista Russell		Lone Star	317-706-3300
Carlos Beckelaw	site manager	sales office	-
		Lone Star - Greencastle	-

Re:

Project Name:

Rhodia - TSD Facility Survey

EPA ID# INB006419212

Project Number:

26/25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Tony Bennett - production & site manager

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes ☐ No

D003 except under limited basis

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

Lone Star Industries
Sales Office
8902 Vincennes Circle
Suite A
PO Box 681250
Indianapolis IN 46260-1250

Lone Star Industries
3301 S Country Rd 150 W
PO Box 482
Greencastle, IN 46135
(765) 653-9766

#41

**TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant**

RECEIVED

NOV 02 2000

TO BARR
ENGINEERING

Location Information (Please make corrections to the facility address, if appropriate)

Company: Rhodia Inc

Location: 2000 Michigan St
Hammond, IN 46320

EPA ID#: IND001859032

Individual:

Name: R. Eicke

Title: Ops. Supt. Phone Number: 219-932-7651, x277

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No X

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____ No X

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

#41
(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No X

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No X

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No X

(B) At what capacity or rate: _____ (Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No X

(D) At what capacity or rate: _____ (Units)

(E) What is the treatment method (Describe in detail):

#43



Telephone Memo

Date: 11/7/00

Time: 12:40

JMS of Barr Engineering Company

☒ placed a call to☐ received a call from☐ received a voice
mail from☒ left message/voice
mail to

Name

Position

Company

Telephone

Debbie Z
Bill WattrippSafety Kleen Sys
Inc. Argonite

316 251-6380

EPA ID# KSD981506025

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No
 Incinerator is shut down - permanently
 (If no, we will verify the mailing address and obtain fax number).
 Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☒ No

closing facility

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

#44

**TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant**

Location Information (Please make corrections to the facility address, if appropriate)

Company: Ash Grove Cement Plant

Location: 1801 N Santa Fe

PO Box 519

Chanute, KS 66720

EPA ID#: KSD031203318

Individual:

Name: Drew Hoisington

Title: Risk Services

Phone Number: 316 431 4500 x338

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No X

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____ No X

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

*8

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No _____ *NA*

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No *X* - *Inadequate Btu/lb.*

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No _____

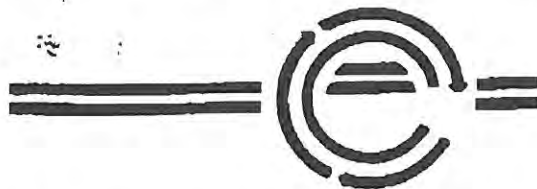
(B) At what capacity or rate: _____ (Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

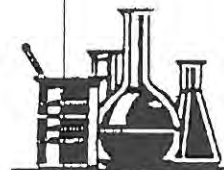
Yes _____ No _____

(D) At what capacity or rate: _____ (Units)

(E) What is the treatment method (Describe in detail):

**CADENCE ENVIRONMENTAL ENERGY****FAX COVER SHEET**TO: Julie Sullivan 952 832 2601FROM: Drew HoisingtonDATE: 11-8-02Number of pages including this cover sheet: three

Please call Drew Hoisington at (316) 431-4122 x338 if there are any problems with this communication.





Telephone Memo

Date: 11/8/00

Time: 10:55

JMS of Barr Engineering Company

☒ placed a call to ☐ received a call from ☐ received a voice mail from ☐ left message/voice mail to

Name	Position	Company	Telephone
Drew Hoisington		Ash Grove Cement Plant Chanute, KS EPA ID # KSD031203318	316 -431- 4500 - - - - - -

Re: Project Name:
Rhodia - TSD Facility Survey

Project Number:
26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes ☒ No
no reactive wastes

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire? - will fax back

Probably needs 50% carbon base
Only way we can take solids → 6 gal pails

75% < 1 inch size

BTUs? If it does not have any cannot take it

#45



Telephone Memo

Date: 11/7/00

Time: 3:35

Follow-up 11/27/00
2:00

JMS of Barr Engineering Company

☒ placed a call to ☐ received a call from ☐ received a voice mail from ☒ left message/voice mail to

Name	Position	Company	Telephone
Bill Birdie		Heartland Cement Co	316 - 331 - 0200
		EPA ID # KSD980739999	- - -

Re:	Project Name:	Project Number:
	Rhodia - TSD Facility Survey	26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☒ No

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

Closure on waste facility currently
→ sent on info to Steve Majors

#46

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: Systech Environmental Corp

Location: Cement Plant Rd

PO Box 111

Fredonia, KS 66736

EPA ID#: KSD980633259

Individual:

Name:

Pam Colvin

Title:

Customer Service Mgr

Phone Number:

800-778-7224 ext. 115

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____

No X _____

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____

No X _____

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

#46

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No _____

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No X _____

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No _____

(B) At what capacity or rate: _____(Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No _____

(D) At what capacity or rate: _____(Units)

(E) What is the treatment method (Describe in detail):

#47

LWD, INC.

P.O. BOX 327 • CALVERT CITY, KENTUCKY 42029
PH.: 270-395-8313 FAX: 270-395-8153

November 1, 2000

Mr. Thomas D. Mattison
Senior Chemical Engineer
Barr Engineering Company
4700 W. 77th. Street
Minneapolis, MN 55435-4803

RE: PHOSPHORUS-CONTAINING MATERIALS
RHODIA SILVER BOW PLANT
BUTTE, MONTANA

Dear Mr. Mattison:

Thank you for considering LWD for your waste treatment needs. At this time we must decline to bid on the above referenced materials because LWD can not accept NORM material. We do not feel we can handle the used carbon brick and furnace liner due to its reactivity and the dimensions of the material.

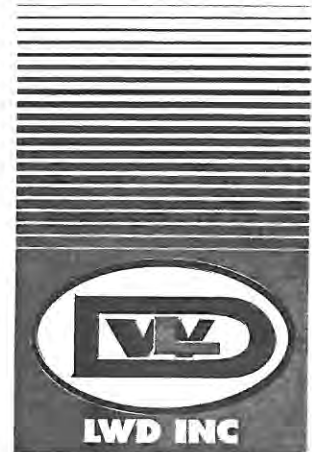
Thanks again for your interest. If we can be of further assistance please contact us at 270-395-8313.

Sincerely,

Allan R. Orth

Allan R. Orth

ARO:bkb





Telephone Memo

Date: 11/1/00

Time: 2:30 pm

49

LAD 000777207

TDM of Barr Engineering Company

☐ placed a call to

☒ received a call from

☐ received a voice
mail from

☐ left message/voice
mail to

Name

Anita

Position

Company

Chemical Waste Management,
Sulphur, LA

Telephone

- -

- -

- -

- -

Re:

Project Name:

Rhodia Silver Bow

Project Number:

26 / 25 - 001 JSL 020

Notes: Chemical Waste Management located in Sulphur, LA cannot accept D001 or D003 wastes at their facility. They can stabilize other hazardous waste prior to landfilling.



Telephone Memo

Date: 11/8/00
Time: 8:10

JMS of Barr Engineering Company

☒ placed a call to ☒ ^{11/10 9:50} received a call from ☐ received a voice mail from ☒ left message/voice mail to

Name

Position

Company

Telephone

Ken Michaels

Receptionist

Safety Kleen
Cofax Inc.
Cofax, LA

318 -627- 3443

EPA ID# LAD 981055791

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

→ Ken Michaels, Operations Manager - back on Friday

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☐ No

Cannot accept radioactive materials

Jim Gallion? talked w/someone previously

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

#51

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: Rhodia Inc
Location: 1275 Airline Hwy
PO Box 828
Baton Rouge, LA 70805
EPA ID#: LAD008161234

Individual:

Name: Anne A. Adelman
Title: Env. Eng. ITH Phone Number: 225 359 3410

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No ☒

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____ No ☒

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

#51

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No ☒

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No ☒

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No ☒

(B) At what capacity or rate: _____ (Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No ☒

(D) At what capacity or rate: _____ (Units)

(E) What is the treatment method (Describe in detail):

Rhodia's Baton Rouge site only handles
bulk liquid materials that are not
HWM containing

#5



Telephone Memo

Date: 11/8/00
Time: 8:18

JMS of Barr Engineering Company

☐ placed a call to ☒ received a call from ☐ received a voice mail from ☒ left message/voice mail to

Name	Position	Company	Telephone
Scott Gendron	Haz waste Mn.	Rhodia, Inc. Baton Rouge, LA	225-356-7111
		EPA ID# LAD008161234	- -

Re: Project Name:
Rhodia - TSD Facility Survey

Project Number:
26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☒ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Scott Gendron

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes ☒ No

Not at that particular site - (only liquid injection)

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

Rhodia has purchased → Heat Energy Dallas TX Bryan Kutz (home office sales)
225-654-7100



Telephone Memo

Date: 11/15
Time: 2:47

JMS of Barr Engineering Company

☐ placed a call to ☐ received a call from ☒ received a voice mail from ☐ left message/voice mail to

Name	Position	Company	Telephone
Bryan Kutz		Rhodia	225 454 7100
			- - -
			- - -
			- - -

Re: Project Name:
Rhodia - TSD Facility Survey

Project Number:
26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☐ No

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

cannot take because of radioactivity



Telephone Memo

Date: 12/8/00

Time: 9:30

JMS of Barr Engineering Company

☐ placed a call to

☐ received a call from

☐ received a voice
mail from

☐ left message/voice
mail to

Name

Position

Company

Telephone

Bill Kestick

Safety Klen
Baton Rouge

225 - 778 3584

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☒ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Processing Rate & Size limitations? 120 tons/wk - yes
~3 loads
Receive - Roll off boxes or dump trucks

Fax Number:

- Can you manage phosphorus-containing materials with D001 and D003 Codes? ☒ Yes ☐ No

Process: wet brick to remove residual

2. Do you plan to respond to the questionnaire? ☒ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?



FAX COVER SHEET

FAX RECEIVED

NOV 15 2000

TO BARR

DATE: 11/15/00

TO: JULIE SULLIVAN

FAX NO:

FROM: BILL KESICK

FAX NO: 225 778 3510

PHONE NO: 11 3584

NUMBER OF PAGES INCLUDING COVER SHEET (2)

RE: RHODIA

JULIE, HERE IS PG 2. ALSO,
AFTER FURTHER REVIEW WE CAN
HANDLE NORM @ 25 micro roentgens
AND OR LESS. IF IT IS NATURALLY
OCCURRING / exempt the action.
levels are higher - please
CHANGE FROM 7 ON ORIGINAL form (pg 1)
per me.

BILL

13351 Scenic Highway, Baton Rouge, LA 70807-1021
Post Office Box 74137, Baton Rouge, LA 70874-4137

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No X TRANSFERRED TO OUR INCINERATOR

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes X No _____ MAY NEED MORE INFO ON HISTORY (SAMPLE)

If Yes:

BUT WE CAN OXIDIZE THE
RED PHOSPHOROUS FOR TRANSFER

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes X No _____ MAY NEED MORE INFO (SAMPLE)

(B) At what capacity or rate: _____ (Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)? AS ABOVE

Yes X No _____

(D) At what capacity or rate: VARIES (Units) 120 TONS / WEEK

(E) What is the treatment method (Describe in detail):

SK (BATON ROUGE) HAS AN ENCLOSED BUILDING
UNDER NEGATIVE PRESSURE. REACTIONS ARE (VAPORS).
VENTED TO A THERMAL OXIDATION UNIT. SINCE
THE FURNACE LINER IS REASONABLY LOW IN CONC.
WE COULD OXIDIZE WITH WATER, CAPTURE
FUMES AND TRANSFER AT GENERATOR'S DESIRED
TREATMENT FACILITY.

**FAX COVER SHEET**

DATE: 11/9/00

TO: Julie Sullivan

FAX NO:

FROM: Bill Kestick

FAX NO:

PHONE NO: 225-778-3584

NUMBER OF PAGES INCLUDING COVER SHEET ()

RE: Phosphorous / TSD Survey

13351 Scenic Highway, Baton Rouge, LA 70807-1021
Post Office Box 74137, Baton Rouge, LA 70874-4137

#52

**TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant**

Location Information (Please make corrections to the facility address, if appropriate)

Company: Safety Kleen Baton Rouge Inc

Location: 13351 Scenic Hwy Id127

PO Box 74137

Baton Rouge, LA 70807-1021

EPA ID#: LAD010395127

Individual:

Name: BILL KESLICK

Title: LAB MANAGER Phone Number: 225-778-3584

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes X No

If Yes:

(A) What levels are acceptable: 25 (Units) or if specifically
exempt. gamma

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes No X (see below)

If Yes:

(A) At what capacity or rate: (Units)

(B) What is the treatment method (Describe in detail):

SK (BATON ROUGE) CAN MANAGE LOW PERCENTAGES OF
ELEMENTAL PHOSPHOROUS INTO INCINERABLE PACKAGES.
THE CONTAINERS ARE THEN TRANSFERRED TO THE SAFETY
KLEEN INCINERATOR, DEER PARK, TX. WHERE THE
MATERIAL IS RENDERED NON-IGNITABLE/NON-REACTIVE.

- 1 of 2 -



Telephone Memo

Date: 11/8/00
Time: 8:24

JMS of Barr Engineering Company

☒ placed a call to ☐ received a call from ☐ received a voice mail from ☐ left message/voice mail to

Name	Position	Company	Telephone
Bill Keslick		Safety Kleen Baton Rouge, Inc.	225 - 778 - 1234
			- -
			- -
			- -

EPA ID # LAD010395127

Re: Project Name:
Rhodia - TSD Facility Survey

Project Number:
26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No

not sure, fax again
(If no, we will verify the mailing address and obtain fax number).
Mailing Address:

Fax Number: 225-778-3510

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☐ No

they have

2. Do you plan to respond to the questionnaire? ☒ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

#68



Telephone Memo

Date: 11/10/00
Time: 3:00

JMS of Barr Engineering Company

☒ placed a call to ☐ received a call from ☐ received a voice mail from ☐ left message/voice mail to

Name	Position	Company	Telephone
Kieth Brown	Superintendent	Holnam, Inc. Artesia Plant	662 - 272 5121
		EPA ID # MSD077655876	- -

Re: Project Name:
Rhodia - TSD Facility Survey

Project Number:
26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No ?

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes ☒ No

Cannot manage haz solids
only haz liquids & non-haz solids

2. Do you plan to respond to the questionnaire? ☐ Yes ☒ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

#38
#72



Telephone Memo

Date: 11/8/00
Time: 10:25

JMS of Barr Engineering Company

☒ placed a call to ☐ received a call from ☐ received a voice mail from ☐ left message/voice mail to

Name	Position	Company	Telephone
Don Jones		Holnam Inc / Safety Kleen Corp	573 - 242-357T - - 3585 - - - -
EPA ID # MOB029729688			

Re: Project Name: Project Number:
Rhodia - TSD Facility Survey 26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Bob Adams 636 - 625 8956 sales
may be able to find outlet

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☒ No
no, cannot accept reactive

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?



Telephone Memo

Date: 12/8/00

Time: 9:05 AM

12/12/00
8:50 AM

JMS of Barr Engineering Company

☐ placed a call to

☐ received a call from

☐ received a voice
mail from

☒ left message/voice
mail to

Name

Position

Company

Telephone

James Kilpatrick

mgr

ICI Explosives

417 - 624 0212 ext. 412

-
-
-

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials?

☐ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

What processing rate for brick & amorphous phosphorus?

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☐ No

2. Do you plan to respond to the questionnaire?

☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

What temp was kiln operated at during processing?
During kiln shut down was it operated empty, if so, what temp?

Will 850° be sufficient to deactivate?

temp. in line Temp = 500°F



Telephone Memo

Date: 11/8/00

Time: 11:20

Called back 11/9/00
1:40

JMS of Barr Engineering Company

☐ placed a call to☐ received a call from11:20
11/9/00
☒ received a voice
mail from☒ left message/voice
mail to

Name

Position

Company

Telephone

Pat Moss

Rhonda

James Kilpatrick

Willie Roy

Manager

Tech mgr

ICI Explosives
Env. Co. Joplin MO

417 -624 0212 ext. 409

- - ext. 400

- - ext. 403

- - ext. 405

Re:

Project Name:

Rhodia - TSD Facility Survey

EPA ID # MOD985798164

Project Number:

26/25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials?

☒ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☒ No

2. Do you plan to respond to the questionnaire?

☒ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

possibly can manage the brick

3. When can we expect the completed questionnaire? will fax

Waste Approval process takes several weeks

**BARR**

Barr Engineering Company
4700 West 77th Street • Minneapolis, MN 55435-4803
Phone: 612-832-2600 • Fax: 612-832-2601

Minneapolis, MN • Hibbing, MN • Duluth, MN • Ann Arbor, MI • Jefferson City, MO

#75

October 26, 2000

Waste Acceptance Coordinator
Lone Star Ind Inc
2524 S Sprigg St
PO Box 968
Cape Girardeau, MO 63701

**Re: Phosphorus-containing Materials
Rhodia Silver Bow Plant
Butte, Montana**

10/20/00
LONE STAR HAS
NO INTEREST IN
THIS MATERIAL.

Waste Acceptance Coordinator:

Rhodia, Inc. is evaluating alternatives for the lawful removal and disposal of two materials that are located at a closed elemental phosphorus facility near Butte, Montana. Rhodia, Inc. is inquiring about your ability to receive, treat and dispose of these phosphorus-containing materials. The materials are (1) crude phosphorus and (2) used carbon brick and furnace liner. Crude phosphorus contains elemental phosphorus; elevated levels of naturally occurring radioactive material (NORM); and has the potential to generate phosphine gas. The used carbon brick and furnace liner contains forms of phosphorus, may have elevated levels of NORM, and has the potential to generate oxides of phosphorus. In addition, EPA has expressed concern that elemental phosphorus could have saturated the carbon brick and furnace liner while they were in service, although Rhodia has seen no evidence to substantiate this concern.

The U.S. EPA believes that the crude phosphorus should be characterized as D001 and D003 hazardous waste, and that the used carbon brick and furnace liner should be characterized as D001 hazardous waste. For purposes of this request, please assume that the materials will be shipped to you as such. Under the land disposal restriction (LDR) requirements, D001 hazardous wastes will have to be treated so that they are nonignitable and D003 hazardous wastes will have to be treated so that they are nonreactive (do not generate toxic gases) before land disposal. The materials are not known to contain underlying hazardous constituents that exceed their Universal Treatment Standards. However, EPA believes the materials should be assumed to contain metals that do not meet their universal treatment standards.

Special handling requirements for these materials are identified in the detailed material descriptions that are attached to this letter. A brief questionnaire regarding these materials is also attached. Please review the material descriptions, respond to the specific questions and return the completed questionnaire by Friday, November 3, 2000 in the stamped, self-addressed envelope.

Please direct any questions concerning these materials to me at (952)832-2600 or email (tmattison@barr.com). Thank you for your time and consideration.

Sincerely,



Thomas D. Mattison
Senior Chemical Engineer

76

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

ENGINEERED TO GO

Location Information (Please make corrections to the facility address, if appropriate)

Company: Continental Cement Co Llc

Location: 10107 Hwy 79

PO Box 71

Hannibal, MO 63401-0071

EPA ID#: MOD054018288

Individual:

Name: RALPH A. FREAD

Title: SALES REPRESENTATIVE Phone Number: 573-271-6262 EXT. 204

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No X

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____ No X

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

#76

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No ☒

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No ☒

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No _____

(B) At what capacity or rate: _____(Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No _____

(D) At what capacity or rate: _____(Units)

(E) What is the treatment method (Describe in detail):

#77

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: Clean Harbors Env Services Inc

Location: Highway 71, 5 Mi S Of Town
Kimball, NE 69145

EPA ID#: NED981723513

Individual:

Name: Carol Schaefer
Title: Lab Manager Phone Number: (308) 235-8265

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No ✓

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____ No ✓

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

#17

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No _____

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No ☒

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No _____

(B) At what capacity or rate: _____ (Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No _____

(D) At what capacity or rate: _____ (Units)

(E) What is the treatment method (Describe in detail):

#83

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: Safety Kleen (Bridgeport) Inc

Location: Us Rte 322 & I 295

PO Box 337

Bridgeport, NJ ~~8014~~ 08014

EPA ID#: NJD053288239

Individual:

Name: _____

Title: _____ Phone Number: _____

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No ☒

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____ No ☒

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

#83

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No ☒

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No ☒

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No ☒

(B) At what capacity or rate: _____ (Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No ☒

(D) At what capacity or rate: _____ (Units)

(E) What is the treatment method (Describe in detail):

#86



Telephone Memo

Date: 11/8/00
Time: 12:30follow-up 11/27/00
2:05

JMS of Barr Engineering Company

☒ placed a call to☐ received a call from☐ received a voice
mail from☐ left message/voice
mail to

Name	Position	Company	Telephone
Sharon Wienckowski		Safety-Kleen Bkt Inc. Clarence	716 - 759-2868
			- -
			- -
			- -

EPA ID # NYD000632372

Re: Project Name:
Rhodia - TSD Facility SurveyProject Number:
26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☒ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number: 716 - 759-6034

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☒ Yes. ☐ No

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

#88

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: Norlite Corp

Location: 628 S Saratoga St

PO Box 694

Cohoes, NY 12047

EPA ID#: NYD080469935

Individual:

Name: Charles Story
Title: V.P. Business Development Phone Number: 518-235-0401 x 4044

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No X

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____ No X

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No _____

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No X _____

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No _____

(B) At what capacity or rate: _____ (Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No _____

(D) At what capacity or rate: _____ (Units)

(E) What is the treatment method (Describe in detail):



Telephone Memo

Date: 11/8/00
Time: 12:33

JMS of Barr Engineering Company

☒ placed a call to ☐ received a call from ☐ received a voice mail from ☐ left message/voice mail to

Name	Position	Company	Telephone
	Receptionist	Giant Resource Recovery, Inc.	704 - 474- 3165
		EPA ID# NCD 000 773655	- -

Re: Project Name: Project Number:
Rhodia - TSD Facility Survey 26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☒ No

This facility no longer burns haz. waste

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

#103



Telephone Memo

Date: 11/8/00

Time:

JMS of Barr Engineering Company

☒ placed a call to
 ☐ received a call from
 ☐ received a voice mail from
 ☐ left message/voice mail to

Name	Position	Company	Telephone
Terri Kanouse		Systech Env. Corp. Paulding OH	419 - 399-4835
		EPA ID # OH D 005048947	- -
			- -

Re: **Project Name:**
 Rhodia - TSD Facility Survey

Project Number:
 26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☒ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☒ No

3 issues

- [D003 code
 Phosphorus - problem for cement process
 do not put ~~the~~ haz mat' in cold end of kiln
2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

#104

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: Waste Technologies Industries

Location: 1250 St George Street

PO Box 919

East Liverpool, OH 43920

EPA ID#: OHD980613541

Individual:

Name: Stephen Lora

Title: Materials Processing Mgr Phone Number: (330) 385-7336

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes ☒ No ☐

If Yes:

(A) What levels are acceptable: < 5 mRem/hr (Units) need isotopic specific info.

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes ☒ No ☐

If Yes:

(A) At what capacity or rate: 3000 lbs/hr (Units)

(B) What is the treatment method (Describe in detail):

Incineration in Drums. Drums must be
open topped metal drums. Phosphorus must
have a minimum of 2 inches of water covering.

#104

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

* Yes ☒ No ☐

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes ☒ No ☐

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes ☒ No ☐

(B) At what capacity or rate: ~3000 lbs/hr (Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes ☒ No ☐

(D) At what capacity or rate: ~3000 lbs/hr (Units)

(E) What is the treatment method (Describe in detail):

Incineration in Drums. Due to phosphorus
phosphorus contamination, material must be shipped
in Drums.

* If residues exceed LDR for metals, stabilization is performed at another facility.

#42



Telephone Memo

Date: 11/6/00

Time: 12:47

follow-up 11/27/00
2106

JMS of Barr Engineering Company

☐ placed a call to

☐ received a call from

☐ received a voice
mail from

☒ left message/voice
mail to

Name

Position

Company

Telephone

Mike Luybli

Keystone Cement Co
direct

610 - 837-1881
610 - 557-2229
- -
- -

EPA ID # PAD002389559

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☐ No

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?



Telephone Memo

Date: 11/10/00
Time: 3:03

JMK of Barr Engineering Company

☒ placed a call to ☐ received a call from ☐ received a voice mail from ☐ left message/voice mail to

Name

Position

Company

Telephone

Southdown Inc.

800 451-6771

EPA ID # PAD083965897

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☒ No

Do not accept hazardous waste

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

#119



Telephone Memo

Date: 1/18/00
Time: 12:52

JMS of Barr Engineering Company

☒ placed a call to ☐ received a call from ☐ received a voice mail from ☐ left message/voice mail to

Name	Position	Company	Telephone
Guy Mobley	Sales	Giant Resource Recovery Inc. / Giant Cement Co.	803 - 496-5033
		EPA ID # SCD003351699	- -
			- -

Re: Project Name:
Rhodia - TSD Facility Survey

Project Number:
26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☒ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes ☒ No

no fuel value > 5000 lbs
phosphorus inhibits cement

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

#122

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: Holnam Inc Safety Kleen Systems Inc

Location: 2175 Gardner Blvd
Holly Hill, SC 29059

EPA ID#: SCD003368891

Individual:

Name: S. Lea Simmons

Title: Environmental Mgr. Phone Number: 803/496-733 ext. 24

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No X

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____ No X

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

#122

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No _____

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No X _____

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No _____

(B) At what capacity or rate: _____ (Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No _____

(D) At what capacity or rate: _____ (Units)

(E) What is the treatment method (Describe in detail):



Telephone Memo

Date: 11/8/00

Time: 1:00

JMS of Barr Engineering Company

☐ placed a call to

☒ received a call from 11/9/00 10:50 AM

☒ received a voice mail from 11/10/00 10:00 AM

☒ left message/voice mail to

Name

Position

Company

Telephone

Larry Hembree

no longer w/company

DSSI

865 - 376-8714

- -8746

Paul Hickman

EPA ID # TND982109142

- -

- -

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials?

☐ Yes ☒ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address: Subsidiary of Permatix
657 Gallaher Rd
Kingsport TN 37763

Fax Number: 865-376-0087

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes ☒ No

liquids processor, no heavy amounts of solids allowed, especially phosphorus

2. Do you plan to respond to the questionnaire?

☐ Yes ☒ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

126



Telephone Memo

Date: 11/8/00

Time: 1:21

Follow-up

JLS of Barr Engineering Company

☒ placed a call to ☐ received a call from ☐ received a voice mail from

☒ left message/voice mail to

Name	Position	Company	Telephone
Jennifer Edwards		onyx Env. Services	409-736-4133
		EPA ID # TXD000838896	

Re: Project Name:
Rhodia - TSD Facility Survey

Project Number:
26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☒ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

jedwards@onyxes.com

Fax Number: 409-736-1636

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☒ Yes ☐ No

Does not appear to be a problem
Need additional info

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

From: "Jennifer Edwards" <jedwards@onyxes.com>
To: Julie Sullivan <jsullivan@barr.com>
Date: Thu, Nov 9, 2000 12:16 PM
Subject: Re: Rhodia - TSD Facility Survey

I received your fax and we aer currently reviewing it.

From: "Jennifer Edwards" <jedwards@onyxes.com>
To: Julie Sullivan <jsullivan@barr.com>
Date: Thu, Nov 9, 2000 7:56 AM
Subject: Re: Rhodia - TSD Facility Survey

I have forward the survey to the appropriate people here at the facility. I should have it completed shortly. I will also include our audit package for your information and overnight it to you.

#135



Telephone Memo

Date: 11/8/00

Time: 1:33

JMS of Barr Engineering Company

☒ placed a call to☐ received a call from☐ received a voice
mail from☐ left message/voice
mail to

Name

Position

Company

Telephone

Rhodia Inc.
Houston TX

713 - 928 - 3411

EPA ID # TXD008099079

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials?

☐ Yes ☐ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Diana Nunez → Rosemary Quintanilla
manifest clerk talked w/ Ken Evans? sales
or Rich Jones

Fax Number: 713-928-3431 — 713-996-5407

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes. ☒ No

do not take elemental phosphorus

2. Do you plan to respond to the questionnaire?

☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?



Telephone Memo

Date: 11/8/00
Time: 1:38
Called back 11/9/00
1:35 PM

JMS of Barr Engineering Company

11/8/00
2:07

☒ placed a call to ☐ received a call from ☒ received a voice mail from ☒ left message/voice mail to

Name	Position	Company	Telephone
Kay Osborn		TXI Midlothian	972-647-6701
Rita Burge		Cement Plant Resource Recovery Dept	972-647-4942

Re: Project Name: EPA ID # TXD007349327 Project Number: 26/25-001 JSL 020
Rhodia - TSD Facility Survey

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☒ No

(If no, we will verify the mailing address and obtain fax number).
Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes ☒ No
cannot accept D003 waste

2. Do you plan to respond to the questionnaire? ☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

42

Telephone Memo

BARR

Date: 11/8/00

Time: 1:46

11/15/00

11:30

JMS of Barr Engineering Company

☐ placed a call to

☒ received a call from

☐ received a voice
mail from

☒ left message/voice
mail to

Name

Position

Company

Telephone

Steve ~~Simons~~
Symonds

Safety Kleen (Aragonite),
Inc.

801-323-8100

EPA ID # VTD981552177

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26/25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☒ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number: 801 - 322 - 9877

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes ☒ No

Cannot accept pyrophorics - (white & yellow phosphorus)
DOT 4.2 packing --- not permitted

2. Do you plan to respond to the questionnaire? ☐ Yes ☒ No

If yes, what is the outstanding issue that is delaying the response?

3. When can we expect the completed questionnaire?

Brick - red phosphorus
can take in lab pack quantities, under oil

#145

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: Giant Resource Recovery Inc

Location: Rt 1 St Rd 652

PO Box 68

Arvonion, VA 23004

EPA ID#: VAD098443443

Individual:

Name: Cynthia Turk

Title: marketing mgr. Phone Number: 804-673-8630

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No ☒

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____ No ☒

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

#145

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No _____

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No ☒

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No _____

(B) At what capacity or rate: _____(Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No _____

(D) At what capacity or rate: _____(Units)

(E) What is the treatment method (Describe in detail):

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

RECEIVED
JUN 20 2000
ENGINEERING CO.

Location Information (Please make corrections to the facility address, if appropriate)

Company: Giant Resource Recovery

Location: ~~1 Mi S Of Cascade VA on Rt 859~~

~~Rt 1 Box 101~~ Solite Rd.

Cascade, VA 24069-9701

EPA ID#: VAD077942266

Individual:

Name:

Lori Baulch

Title:

Manifest Coord

Phone Number:

804-685-3564

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____

No ☒

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____

No ☒

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No _____

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No ☒

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No _____

(B) At what capacity or rate: _____ (Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No _____

(D) At what capacity or rate: _____ (Units)

(E) What is the treatment method (Describe in detail):

Our process is fueled by
waste flammable liquids only

#151

JAN 20 2001
ENGINEERING CO

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: WRR Environmental Services Co Inc

Location: 5200 St Rd 93

Eau Claire, WI 54701

EPA ID#: WID990829475

Individual:

Name: Steve STOKKE

Title: VP Op. Support Phone Number: 715-834-9624

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No X

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____ No X

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

#15

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No X

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No X

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No X

(B) At what capacity or rate: _____(Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No X

(D) At what capacity or rate: _____(Units)

(E) What is the treatment method (Describe in detail):

#155

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: FMC Corp Phosphorus Chemicals Group

Location: HWY 30

Box 4111

Pocatello, ID 83202

EPA ID#: IDD070929518

Individual:

Name: ROB J. HARTMAN

Title: Remediation Project Mgr Phone Number: 208 - 236 - 8658

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No X

If Yes:

(A) What levels are acceptable: _____ (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes _____ No X

If Yes:

(A) At what capacity or rate: _____ (Units)

(B) What is the treatment method (Describe in detail):

#155

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No X

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes _____ No X

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes _____ No _____

(B) At what capacity or rate: _____(Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes _____ No _____

(D) At what capacity or rate: _____(Units)

(E) What is the treatment method (Describe in detail):



Telephone Memo

Date: 11/14/00

Time: 1:10

JMS of Barr Engineering Company

☐ placed a call to

☒ received a call from

☐ received a voice
mail from

☐ left message/voice
mail to

Name

Kieth Gehring

Position

Service Rep

Company

Safety Kleen
Seattle WA

Telephone

253 288-2814

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials?

☐ Yes ☒ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes ☐ No

2. Do you plan to respond to the questionnaire?

☐ Yes ☐ No

If yes, what is the outstanding issue that is delaying the response?

Checking into all their facilities

3. When can we expect the completed questionnaire?

Aragonite, IL cannot accept large quantity bulk 2003 wastes

Roebuck, SC liquid incinerator



Telephone Memo

Date: 11/10/00
Time: 3:08

JMS of Barr Engineering Company

☐ placed a call to

☒ received a call from

☐ received a voice
mail from

☒ left message/voice
mail to

Name

Position

Company

Telephone

Eric Nielsen

Safety-Kleen
Sales
(Corporate office)

888-217-7859
803-231-3790

Re:

Project Name:

Rhodia - TSD Facility Survey

Project Number:

26 / 25 - 001 JSL 020

Notes:

1. Have you received the questionnaire and supporting materials? ☐ Yes ☒ No

(If no, we will verify the mailing address and obtain fax number).

Mailing Address:

will contact local sales person to call me & discuss

Fax Number:

Can you manage phosphorus-containing materials with D001 and D003 Codes? ☐ Yes ☐ No

2. Do you plan to respond to the questionnaire?

If yes, what is the outstanding issue that is delaying the response?

Safety-Kleen
1301 Gervais Street
Columbia, SC 29202

Sales

1-888-217-7859

3. When can we expect the completed questionnaire?

*Followup Contacts with
Candidate Facilities*



Telephone Memo

Date: 12/6/00

Time: 9:00 AM

RTR/TDM of Barr Engineering Company

☒ placed a call to ☐ received a call from ☐ received a voice mail from ☐ left message/voice mail to

Name	Position	Company	Telephone
Steve Lorah	Materials Processing MGR	WTI	330-385-7336
Doug Smith		ENSR	- -
Dan Bersanti		Rhodia	- -
Arnie Feldman		JJDS Environmental	- -

Re:	Project Name:	Project Number:
	Rhodia - TSD Facility Survey - Candidate Facility Follow-up Plan	26 / 25 - 001 JSL 020

Notes:

Do you have any preliminary questions?

1. Do you have previous experience processing with phosphorus-containing materials?
Provide reference for each stream.
 - Waste Technologies Inc. (WTI) has previously completed 6 projects consisting of 10-20 drums per project.
 - They just completed a small (6? drums) white phosphorus drum disposal project for the Aberdeen Proving Ground.
 - Other clients included FMC and others who he said were confidential at this time.
2. Do you have a heated facility for the temporary storage of the phosphorus-containing materials prior to treatment ?
(If yes , what is the capacity?)
 - Steve said that the normal procedure for managing the phosphorus would be to not store the drums, the drums are processed directly off of the truck. He said that the waste acceptance procedure would take 45 minutes to 1 hour and then they would begin burning the drums.
 - He thought that it may be possible to store the drums containing the bricks. They would set up a segregated storage area for the drums containing the bricks.

3. What are your management requirements for elevated NORM materials?
-See the notes on the next set of questions.

4. How will emissions from the phosphorus processing be managed at your facility?
-See the notes on the next set of questions.

5. Do you have written procedures for handling phosphorus-containing materials? (If yes, please provide a copy.)
-See the notes on the next set of questions.

6. What are your procedures for personal air monitoring as it related to phosphine and worker protection?
-See the notes on the next set of questions.

7. What are your fire-fighting capabilities as it relates to a phosphorus fire?
-See the notes on the next set of questions.

8. Can you provide material packaging services in addition to off-site treatment and disposal services?
- Not discussed

9. Who may I contact at the state or federal regulatory agency that is most familiar with your

operations?

- Federal Contacts - Gary Victorine - 312-886-1479

Tim Fields

- Ohio Contacts - Steve said that the State of Ohio has people on-site daily that approve waste stream profiles and review daily operations for compliance. He will provide their names to us.

10. Do you have a current Facility Audit Package? Can you provided a copy for our review?.

- Yes, he will forward the current package to us.

11. Do you continue to believe that your facility is capable of receiving and safely managing the crude phosphorus? How about the used carbon brick and furnace liner?

Rhodia will continue to evaluate your facility and may request a price quote for these services. Thank you for your cooperation.

COMMERCIAL INCINERATOR

QUESTIONS/ISSUES

1. What is your limit on rads? Are you permitted to accept NORM? How do you test; pre-shipment and shipment? What do you do if an incoming load exceeds your permitted level?

- The facility permit restricts the acceptance of NORM waste to below the naturally occurring background levels in the lab on-site (<5 mRem/hour).
- The facility does not require a pre-shipment acceptance sample.
- The shipment acceptance sample will consist of a surface dose (3 cm from the drum) measurement on the exterior of the drum. The drum will not be opened prior to incineration, only the drum ring will be dropped off of the drum.
- The facility only measures gamma radiation with it's radiation meter. Alpha and beta are not measured. A comment was made that alpha and beta most likely would not be detected through the metal drum.
- If the shipment acceptance measurement for radiation exceeds the permitted level the facility will work through the Ohio EPA to see if the material can be accepted at the facility.
- The facility does not require isotopic specific information, they are looking for the activity level of the material.
- The comment was made that P40 would be the main isotope that would be an issue.

2. What is your permit limitation on reactive wastes, if any? Can you accept all D003 categories [reference to 261.23(a)(1)-(8)]?

- The facility has no limitations on reactive D003 wastes. All are acceptable, they have some restrictions on explosives.
- They have burned 450 lbs. of phosphorus in a shot.

3. What is your permit limitation on ignitable wastes, if any? Can you accept ignitable non liquids [reference to 261.21(a)(2)]?

- The facility does not have any permit limit on incineration of ignitable wastes, the feed limit for phosphorus is limited by opacity. Opacity is an issue for phosphorus.
- The facility will not store phosphorus, the drums will be burned with limited handling from the trucks with out being put into storage.
- The facility will accept one truck a day or 80 drums per day. The truck will be held at the facility until all of the drums are burned. It will take 8-10 hours to burn the drums.

4. How does your P&P and Contingency Plan address wastes that if spilled will spontaneously combust? Will you need a permit modification? If so, which Class? How long to obtain the modification?

- The facility requires 3-inches of water be placed on-top of the phosphorus in the drums.
- The facility verifies/inspects the drums for water content by pinging the drums.
- The facility has a material specific spill plan for phosphorus.
- The facility personnel were trained on phosphorus emergency response/spill cleanup procedures by FMC in 1999. No additional training has been conducted in 2000.
- The facility controls phosphorus spills by using sand and/or water. The facility has set-up garden hoses around the facility for control of phosphorus spills and fires. Spilled materials would be disposed of in the incinerator.

5. Does your fire-fighting equipment include equipment used for fighting phosphorous fires ("silver suits")? Have your personnel been trained in such? Part of your RCRA and OSHA programs or will you have to retrain? Are your fire-fighting respirators good for P2O5 and PH3 or will you have to obtain? Will this require a permit modification?

- The facility has purchased flash suits that fit over level-A suits.

6. Are the respirators that your operations personnel use good for PH3 and P2O5? Will you have to obtain

new ones? Will you need a permit modification?

- The facility uses 3M Super Cartridges.
- Emergency response activities would be done in SCBA or supplied air.
- The facility has supplied air throughout the facility.

7. What is your training program in regards to phosphorous wastes and specifically handling procedures, spill response and cleanup? What does your training state specific to P₂O₅ and PH₃ releases? Will you need a permit modification? If so, what Class? How long to obtain?

- The facility has a material specific spill plan for phosphorus.
- The facility personnel were trained on phosphorus emergency response/spill cleanup procedures by FMC in 1999.
- The facility environmental staff could better answer this question.

8. Have your operators been trained in wearing and working in "silver suits"? Will they require retraining and certification? Will this require a permit modification? Class and how long to obtain?

- The facility has purchased flash suits that fit over level-A suits.
- Training question was not specifically answered.

9. Can your scrubbing systems handle P₂O₅ which is a fine aerosol mist and still stay within the MACT limit for particulate's? P₂O₅ will hydrolyze to phosphoric acid which is a micron/sub-micron particle?

- The facility has a four stage scrubber system that is the best system at any incinerator in the country.
- The scrubber system consists of a spray dryer, an electrostatic precipitator, a three stage packed bed scrubber and a venturi scrubber.
- The facility has a 0.015 ?not sure of this number? particulate limit (Permit said 0.08 grains per dry standard cubic foot)
- During actual incineration of drums of phosphorus at the facility, the highest particulate level measurement was said to be 12% of the permitted particulate limit.

10. Can you repack large containers of slurry or will the shipping containers have to be a maximum size?

- Question not asked.

11. The slurry will contain trace organics below the UHC level including SVOC's and PAH's [Ed. Note: comes in with the coke]. Will this impact your risk assessments including your PIC's analysis? Will you have to rerun? Cost; who pays? Timing?

- Trace organic in the PPB or PPM are not a problem.

12. What is the maximum size piece of brick you can receive? What is the maximum size brick you can put in the kiln? Can your sizing equipment (shredders) handle hardened carbon block?

- The facility does not have a shredder.
- The facility could accept the bricks in a 55 gallon drum.

13. Does your shredding equipment include fire suppression and gas collection systems? If not, how will you handle phosphorous fires and P₂O₅/PH₃ releases during shredding?

- The facility does not have a shredder.



Telephone Memo

Date: 11/20/00

Time: 3 PM

TDM, RTR of Barr Engineering Company

☒ placed a call to ☐ received a call from ☐ received a voice mail from ☐ left message/voice mail to

Name	Position	Company	Telephone
Craig Ragland	Thermal Products Manager	Trade Waste Incinerator, Inc./Onyx	618-271-2804
Doug Bushey	Materials Manager	Trade Waste Incinerator, Inc./Onyx	618-271-2804

Re:	Project Name: Rhodia - TSD Facility Survey - Candidate Facility Follow-up Plan	Project Number: 26 / 25 - 001 JSL 020
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Notes:

Do you have any preliminary questions?

1. Do you have previous experience processing with phosphorus-containing materials?
Provide reference for each stream.
 - TWI worked on a phosphorus project for Rhodia that had to do with phosphorus in a sewer, but TWI was not able to accept the waste due to PCB contamination identified in the material.
 - TWI has completed projects for the military involving incineration of hundreds of missile heads each containing 25lbs of phosphorus.
2. Do you have a heated facility for the temporary storage of the phosphorus-containing materials prior to treatment ?
(If yes , what is the capacity?)
 - TWI said that they could store 90-days of material, or about 4-trucks worth of storage.
 - The facility's feed rate is 1,800 lbs per day (1,800 x 90 = 162,000 lbs)
 - The facility is permitted to store 11,000 drums.
 - Some of the storage is heated.
 - It was suggested that glycols could be added to the drums to serve as anti-freeze during the winter.

Follow-up Phone notes: I asked Doug Bushey to clarify the 1,800 lbs/day feed rate, was this the feed rate for pure phosphorus or crude phosphorus containing 20% phosphorus? He said that TWI had taken into account the 20% phosphorus concentration in the crude phosphorus when they came up with their best guess at the feed rate of 1,800 lbs/day. This feed rate is based on the phosphorus pentoxide scrubbing capability of the incinerator. He further stated that the crude phosphorus waste stream could be further limited by the BTU value of the other materials (debris, plastic, etc.) in the crude phosphorus waste stream. If the debris/plastic content has a high BTU value the feed rate/charge limit could be adjusted.

3. What are your management requirements for elevated NORM materials?

- The facility can not accept radioactive materials.
- Waste analysis plan requires that all materials be screened and if radioactivity is detected at > 0.5 millirad/hour the waste will be rejected.

4. How will emissions from the phosphorus processing be managed at your facility?

- Facility began operations in 1989, DRE is 99.99 %.
- The facility operates a rotary kiln with a dry scrubber system
- Lime is used to scrub the stack gas in the scrubber system.
- Ash goes to a subpart C landfill.
- The landfill stabilizes the ash prior to landfilling.
- Currently the facility uses: Peoria Disposal Co. Peoria, IL, WM in Model City, NY, EQ in Detroit, MI or WM in Lake Charles, LA.

5. Do you have written procedures for handling phosphorus-containing materials? (If yes, please provide a copy.)

- The facility has a reactive procedure for phosphorus. (They will send the procedure with the audit package).
- 15 lb charge limit for phosphorus (plus water).
- Waste acceptance personnel will open each container.

6. What are your procedures for personal air monitoring as it related to phosphine and worker protection?

- PPE is material specific.
- Phosphine air sampling could be done.

7. What are your fire-fighting capabilities as it relates to a phosphorus fire?

- 400,000 gallon tank.

8. Can you provide material packaging services in addition to off-site treatment and disposal services?

- TWI/Onyx does provide on-site packaging services.

9. Who may I contact at the state or federal regulatory agency that is most familiar with your operations?

- We can contact all regulatory agencies.

- IL-EPA contact is Mike Grant.

- Additional contact names are listed in the facility audit package.

10. Do you have a current Facility Audit Package? Can you provide a copy for our review?

- Yes, they will send us an audit package.

11. Do you continue to believe that your facility is capable of receiving and safely managing the crude phosphorus? How about the used carbon brick and furnace liner?

- Will accept phosphorus at a feed rate of 1,800 lbs/hr.

- The brick can be handled as a bulk solid, the facility has no shredder.

- Bulk solids have a six inch size limitation.

- Wash water from bricks is acceptable, the water must be filtered and have a fluorine content of <2% and a total halogen content of <5%.

Rhodia will continue to evaluate your facility and may request a price quote for these services. Thank you for your cooperation.

Follow-up Phone notes are from a telephone interview with Doug Bushey, TWI Inc. conducted by Ron Reding, Barr Engineering Company on December 14, 2000.

TSD Facility Questionnaire
Phosphorus-containing Materials
Rhodia Silver Bow Plant

Location Information (Please make corrections to the facility address, if appropriate)

Company: ENSCO Inc.

Location: 309 American Circle
El Dorado, AR 71730-6555

EPA ID#: ARD069748192

Individual:

Name: Treasa Evans

Title: Dir. Regulatory Affairs Phone Number: 870-864-3680

Naturally Occurring Radioactive Materials (NORM)

Can your facility manage materials that contain NORM?

Yes _____ No X _____

Phone Notes: The facility does not accept NORM waste at all.

Follow-up Phone Notes: The facility waste analysis plan requires all wastes be surveyed for radioactivity and the facility does not accept waste above background levels which is 50 microcuries. The waste can not be classified as NORM waste.

If Yes:

(A) What levels are acceptable: N/A (Units)

Crude Phosphorus

Does your facility at this location have the ability and capacity to treat the crude phosphorus material to render it nonignitable and nonreactive?

Yes X _____ No _____

If Yes:

(A) At what capacity or rate: Variable (Units)

(B) What is the treatment method (Describe in detail):

Incineration (rotary kiln) via 30 gal poly containers by direct drop chute.

Phone Notes: She did not provide a charge/pack limit rather she stated that there is a 1.7MBTU/charge limit. As for the requirement for poly drums she said that the facility does have depacking capabilities for removing fiber containers from metal drums.

Follow-up Phone Notes: She restated that the 30 gal ploy drum is the charge limit for phosphorus. I asked if we could place 150 lbs of material in a 30 gallon poly drum and that that would be the approved charge size? She said that it would, but stated the DOT packaging requirements for metal drums. I asked what the BTU value of phosphorus would be? She said that phosphorus would have a BTU value of around 10,000 BTU/lb. and that the 1.7 MBTU/charge is the charge limit. I asked what the charge limit is for pure phosphorus and she thought it would be 25lbs/charge. I asked what the charge limit would be for crude phosphorus, based on a concentration of 20% phosphorus? Would it be around 100 lbs.? She said again that they could accept the crude phosphorus in 100 lb. charges. (Note that a 125lb charge would contain 25 lbs. of phosphorus using a 20% concentration).

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No X -Incinerator residues (ash) goes to Class C landfill for final treatment of metals prior to landfill.

Phone Note: The ENSCO facility treats the ash to the organic standard.

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes X No _____

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes X No _____

(B) At what capacity or rate: Variable (Units) – Depending on size/hardness and packaging constraints.

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)?

Yes X No

(D) At what capacity or rate: Variable (Units)

(E) What is the treatment method (Describe in detail):

Rotary kiln incinerator – In-line shredders to drop chute.

Phone Notes: The shredder size limitation is 12 inches x 6 inches.

- Furnace liner brick is acceptable at the facility, hardness is not a problem.

- Treasa also suggested that we contact the Waste Management landfill in LA, she said that the facility provides treatment on reactive bulk solids prior to landfill. (Note: Barr Engineering Company has contacted the WM facility in Lake Charles/Sulphur LA and they no longer provide treatment of D001 and D003 reactive wastes).

Phone notes are from telephone interviews with Treasa Evans, ENSCO Inc. conducted by Ron Reding, Barr Engineering Company on October 16, 2000 and December 14, 2000.



FAX COVER SHEET

FAX RECEIVED

NOV 15 2000

TO BARR

DATE: 11/15/00

TO: JULIE SULLIVAN

FAX NO:

FROM: BILL KESICK

FAX NO: 225 778 3510

PHONE NO: 11 3584

NUMBER OF PAGES INCLUDING COVER SHEET (2)

RE: RHODIA

JULIE, HERE IS PG 2. ALSO,
AFTER FURTHER REVIEW WE CAN
HANDLE NORM @ 25 micro roentgens
AND OR LESS. IF IT IS NATURALLY
OCCURRING / exempt the action.
levels are higher - please
CHANGE FROM 7 ON original form (pg 1)
per me.

BILL

13351 Scenic Highway, Baton Rouge, LA 70807-1021
Post Office Box 74137, Baton Rouge, LA 70874-4137

(C) Does your facility at this location have the capacity (e.g., stabilization) to treat the residue to meet the Universal Treatment Standards (UTS) specified in 40 CFR 268.48 for metals?

Yes _____ No X TRANSFERRED TO OUR INCINERATOR

Used Carbon Brick and Furnace Liner

Does your facility at this location have the ability and capacity to treat the used carbon brick and furnace liner to render it nonignitable?

Yes X No _____ MAY NEED MORE INFO ON HISTORY (SAMPLE)
BUT WE CAN OXIDIZE THE
RED PHOSPHOROUS FOR TRANSFER

If Yes:

(A) Can you manage the Case 1 amount (i.e., approximately 2,000 tons)?

Yes X No _____ MAY NEED MORE INFO (SAMPLE)

(B) At what capacity or rate: _____ (Units)

(C) Can you manage the Case 2 amount (i.e., approximately 100 tons)? AS ABOVE

Yes X No _____

(D) At what capacity or rate: VARIES (Units) 120 TONS / WEEK

(E) What is the treatment method (Describe in detail):

SK (BATON ROUGE) HAS AN ENCLOSED BUILDING
UNDER NEGATIVE PRESSURE. REACTIONS ARE (VAPORS).
VENTED TO A THERMAL OXIDATION UNIT. SINCE
THE FURNACE LINER IS REASONABLY LOW IN CONC.
WE COULD OXIDIZE WITH WATER, CAPTURE
FINES AND TRANSFER AT GENERATOR'S DESIRED
TREATMENT FACILITY.



Telephone Memo

Date: 1/11/01

Time: 1:30 PM

TDM/RTR of Barr Engineering Company

☒ placed a call to ☐ received a call from ☐ received a voice mail from ☐ left message/voice mail to

Name	Position	Company	Telephone
Mark Zaugg	Sales	ICI Environmental	- -
Willie Roy	Technical Manager	ICI Environmental	- -
			- -
			- -

Re:	Project Name:	Project Number:
	Rhodia - TSD Facility Survey - Candidate Facility Follow-up Plan	26 / 25 - 001 JSL 020

Notes:

Do you have any preliminary questions?

The discussions are applicable to incineration of brick only.

ICI operates a car bottom furnace, where the materials are placed on a mobile car that connects to incinerator's bottom. Then the heat (i.e., gas fired) is applied to incinerate the materials. The car is removed when the internal temperature falls to 300 degrees C and the next car load is placed in the incinerator for processing.

ICI stated that incinerating the brick be a very slow process.

1. Do you have previous experience processing with phosphorus-containing materials?
Provide reference for each stream.

ICI has very limited experience processing phosphorus materials. (Military - M825 Rounds). ICI stated that large quantities of phosphorus may be too corrosive for their system. Additional information would be needed to evaluate this concern before acceptance.

Personnel have worked on projects involving incineration of phosphorus. Helped design phosphoric acid plant at Crane Munitions, Fort Wingate.

2. What are your management requirements for elevated NORM materials?

Shipments are screened and materials above background at the facility are questioned.

3. How will emissions from the phosphorus processing be managed at your facility?

Off gas controls included an acid gas scrubber. Solids from this pollution control equipment are landfilled.

4. Do you have written procedures for handling phosphorus-containing materials? (If yes, please provide a copy.)

No. The facility develops plans for each material accepted.

5. What are your fire-fighting capabilities as it relates to a phosphorus fire?

Would be developed.

6. Who may I contact at the state or federal regulatory agency that is most familiar with your operations?

Missouri DNR - Randy Kixmuller - Jefferson City, (573)751-2930

7. Do you have a current Facility Audit Package? Can you provide a copy for our review?

Yes, Yes.

8. Do you continue to believe that your facility is capable of receiving and safely managing the crude phosphorus? How about the used carbon brick and furnace liner?

Facility could potentially hold 3 to 4 truck loads in one of their (magazine) storage cells. However, materials would need to be scheduled and the logistics worked out in advance.

COMMERCIAL INCINERATOR QUESTIONS/ISSUES

9. What is your limit on rads? Are you permitted to accept NORM? How do you test; pre-shipment and shipment? What do you do if an incoming load exceeds your permitted level?

NA

10. What is your permit limitation on ignitable wastes, if any? Can you accept ignitable non liquids [reference to 261.21(a)(2)]?

Yes

11. How does your P&P and Contingency Plan address wastes that if spilled will spontaneously combust? Will you need a permit modification? If so, which Class? How long to obtain the modification?

NO. The plan would be developed specific to materials accepted for processing.

12. Does your fire-fighting equipment include equipment used for fighting phosphorous fires ("silver suits")? Have your personnel been trained in such? Part of your RCRA and OSHA programs or will you have to retrain? Are your fire-fighting respirators good for P2O5 or will you have to obtain? Will this require a permit modification?

No. The plan would be developed specific to materials accepted for processing.

13. Are the respirators that your operations personnel use good for P2O5? Will you have to obtain new ones? Will you need a permit modification?

Not asked.

14. What is your training program in regards to phosphorous wastes and specifically handling procedures, spill response and cleanup? What does your training state specific to P2O5 releases? Will you need a permit modification? If so, what Class? How long to obtain?

Would be developed.

15. Have your operators been trained in wearing and working in "silver suits"? Will they require retraining and certification? Will this require a permit modification? Class and how long to obtain?

No

16. Can your scrubbing systems handle P2O5 which is a fine aerosol mist and still stay within the MACT limit for particulate's? P2O5 will hydrolyze to phosphoric acid which is a micron/sub-micron particle?

Not asked.

17. What is the maximum size piece of brick you can receive? What is the maximum size brick you can put in the kiln? Can your sizing equipment (shredders) handle hardened carbon block?

9' x 6' x 5'.

18. Does your shredding equipment include fire suppression and gas collection systems? If not, how will you handle phosphorous fires and P₂O₅ releases during shredding?

No Entire block would be fed to the incinerator.

Rhodia will continue to evaluate your facility and may request a price quote for these services. Thank you for your cooperation.

Permit limitation = 250 pounds of combustible material per hour.

Facility operates 24 hours per day, 5 days/week.

Cant' stop the incineration process once started. Can't open furnace until internal temperature is less than 300 degrees C.

Appendix V

DOT-SP 13552 (May 5, 2009)

May 5, 2009



U.S. Department
of Transportation

**Pipeline and Hazardous
Materials Safety Administration**

East Building, PHH - 30
1200 New Jersey Avenue, Southeast
Washington, D.C. 20590

DOT-SP 13552
(FIFTH REVISION)

(FOR RENEWAL, SEE 49 CFR § 107.109)

1. GRANTEE: (See individual authorization letter)
2. PURPOSE AND LIMITATION:
 - a. This special permit authorizes the transportation in commerce of Phosphorus, white dry or Phosphorus, white, under water or Phosphorus white, in solution, or Phosphorus, yellow dry or Phosphorus, yellow, under water or Phosphorus, yellow, in solution in alternate packaging. This special permit provides no relief from the Hazardous Materials Regulations (HMR) other than as specifically stated herein. The most recent revision supersedes all previous revisions.
 - b. The safety analyses performed in development of this special permit only considered the hazards and risks associated with transportation in commerce.
 - c. Unless otherwise stated herein, this special permit consists of the special permit authorization letter issued to the grantee together with this document.
3. REGULATORY SYSTEM AFFECTED: 49 CFR Parts 106, 107 and 171-180.
4. REGULATIONS FROM WHICH EXEMPTED: 49 CFR § 173.188 in that alternative packaging is authorized as provided herein.
5. BASIS: This special permit is based on the Pipeline and Hazardous Materials Safety Administration's (PHMSA) editorial review under § 107.121 initiated on December 4, 2008.

6. HAZARDOUS MATERIALS (49 CFR § 172.101):

Hazardous Materials Description			
Proper Shipping Name	Hazard Class/ Division	Identification Number	Packing Group
Phosphorus, white dry or Phosphorus, white, under water or Phosphorus white, in solution, or Phosphorus, yellow dry or Phosphorus, yellow, under water or Phosphorus, yellow, in solution	4.2	UN1381	I

7. SAFETY CONTROL MEASURES:a. PACKAGING - Prescribed packaging is:

(1) A 55-gallon UN 1A2 steel drum certified to the PG I performance level for solids and the PG II performance level for liquids and dual marked to a minimum of UN1A2 X/400/S and UN1A2 Y/1.2/150; or

(2) A 30-gallon UN 1A2 steel drum certified to the PG I performance level for solids and the PG II performance level for liquids and dual marked to a minimum of UN1A2 X/235/S and UN1A2 Y/1.2/150.

b. OPERATIONAL CONTROLS:

(1) Transportation is authorized by private or contract carrier only.

(2) Transportation is authorized one-time, one-way, only from the generator of the waste material to the hazardous waste treatment facility where it must be unloaded by the consignee for disposal.

(3) Sufficient water must be present in each drum to ensure that the waste phosphorous is covered during transportation, in any orientation of the drum.

(4) Drums must be held and observed for a minimum of 24-hours before transportation. Any leaking or

otherwise unsuitable drums must be replaced prior to transportation.

(5) Packages must be destroyed at the disposal site and may not be reused.

(6) The net mass of the waste material and water, in kilograms, must not exceed the mass that would be permitted by calculating the volume of the packaging in liters multiplied by the specific gravity indicated on the package certification.

8. SPECIAL PROVISIONS:

(1) A current copy of this special permit must be maintained at each facility where the package is offered or reoffered for transportation.

(2) A person who is not a holder of this special permit who receives a package covered by this special permit may reoffer it for transportation provided no modification or change is made to the package and it is reoffered for transportation in conformance with this special permit and the HMR.

9. MODES OF TRANSPORTATION AUTHORIZED: Motor vehicle.

10. MODAL REQUIREMENTS: A current copy of this special permit must be carried aboard each motor vehicle used to transport packages covered by this special permit.

11. COMPLIANCE: Failure by a person to comply with any of the following may result in suspension or revocation of this special permit and penalties prescribed by the Federal hazardous materials transportation law, 49 U.S.C. 5101 et seq:

- o All terms and conditions prescribed in this special permit and the Hazardous Materials Regulations, 49 CFR Parts 171-180.
- o Persons operating under the terms of this special permit must comply with the security plan requirement in Subpart I of Part 172 of the HMR, when applicable.
- o Registration required by § 107.601 et seq., when applicable.

Each "Hazmat employee", as defined in § 171.8, who performs a function subject to this special permit must receive training on the requirements and conditions of this special permit in addition to the training required by §§ 172.700 through 172.704.

No person may use or apply this special permit, including display of its number, when this special permit has expired or is otherwise no longer in effect.

Under Title VII of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) - 'The Hazardous Materials Safety and Security Reauthorization Act of 2005' (Pub. L. 109-59), 119 Stat. 1144 (August 10, 2005), amended the Federal hazardous materials transportation law by changing the term "exemption" to "special permit" and authorizes a special permit to be granted up to two years for new special permits and up to four years for renewals.

12. REPORTING REQUIREMENTS: Shipments or operations conducted under this exemption are subject to the Hazardous Materials Incident Reporting requirements specified in 49 CFR 171.15 - Immediate notice of certain hazardous materials incidents, and 171.16 - Detailed hazardous materials incident reports. In addition, the grantee(s) of this exemption must notify the Associate Administrator for Hazardous Materials Safety, in writing, of any incident involving a package, shipment or operation conducted under terms of this exemption.

Issued in Washington, D.C.:

Diane LaValle

for Theodore L. Willke
Associate Administrator for Hazardous Materials Safety

Address all inquiries to: Associate Administrator for Hazardous Materials Safety, Pipeline and Hazardous Materials Safety Administration, Department of Transportation, Washington, D.C. 20590. Attention: PHH-31.

Copies of this special permit may be obtained by accessing the Hazardous Materials Safety Homepage at http://hazmat.dot.gov/sp_app/special_permits/spec_perm_index.htm
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PO: DL/AM



Transportation Safety & Security – NA HSE Services

May 21, 2010

Associate Administrator for Hazardous Materials Safety
Research and Special Programs Administration
U.S. Department of Transportation
400 7th Street, SW
Washington, DC 20590-0001

Attention: Exemptions, DHM-31

RE: Request for Renewal of Party Status to DOT Special Permit 13552

Dear Sir/Madam:

This is to request renewal of Rhodia Inc.'s party status to DOT SP-13552 in accordance with 49 CFR §107.109. This exemption authorizes the transportation in commerce of waste phosphorus in alternate packaging.

This request for renewal is for:

Rhodia Inc.	Contact: Donna Edminster
CN 7500	Phone: 609-860-4085
8 Cedarbrook Drive	Fax: 609-860-2478
Cranbury, NJ 08512	E-mail: donna.edminster@us.rhodia.com

The 5th revision of this special permit is the current version and is accurate and complete. Since 2006 when Rhodia last renewed this special permit, six (6) shipments of waste phosphorous have been made, involving a total of 112 drums. Rhodia certifies that they are not aware of any incidents involving the inadvertent release of any hazardous material while shipping material authorized under terms of this special permit. Rhodia also certifies that, to the best of our knowledge and belief, we are in compliance with applicable federal security laws and regulations that apply to its transportation operations.

We believe this application is complete to the best of our ability and conforms to the requirements of 49 CFR §107.109. Please contact me should you require additional information.

Sincerely,

A handwritten signature in black ink that reads "Donna Edminster".

Donna Edminster
Manager, Transportation Safety & Security
Rhodia Inc.