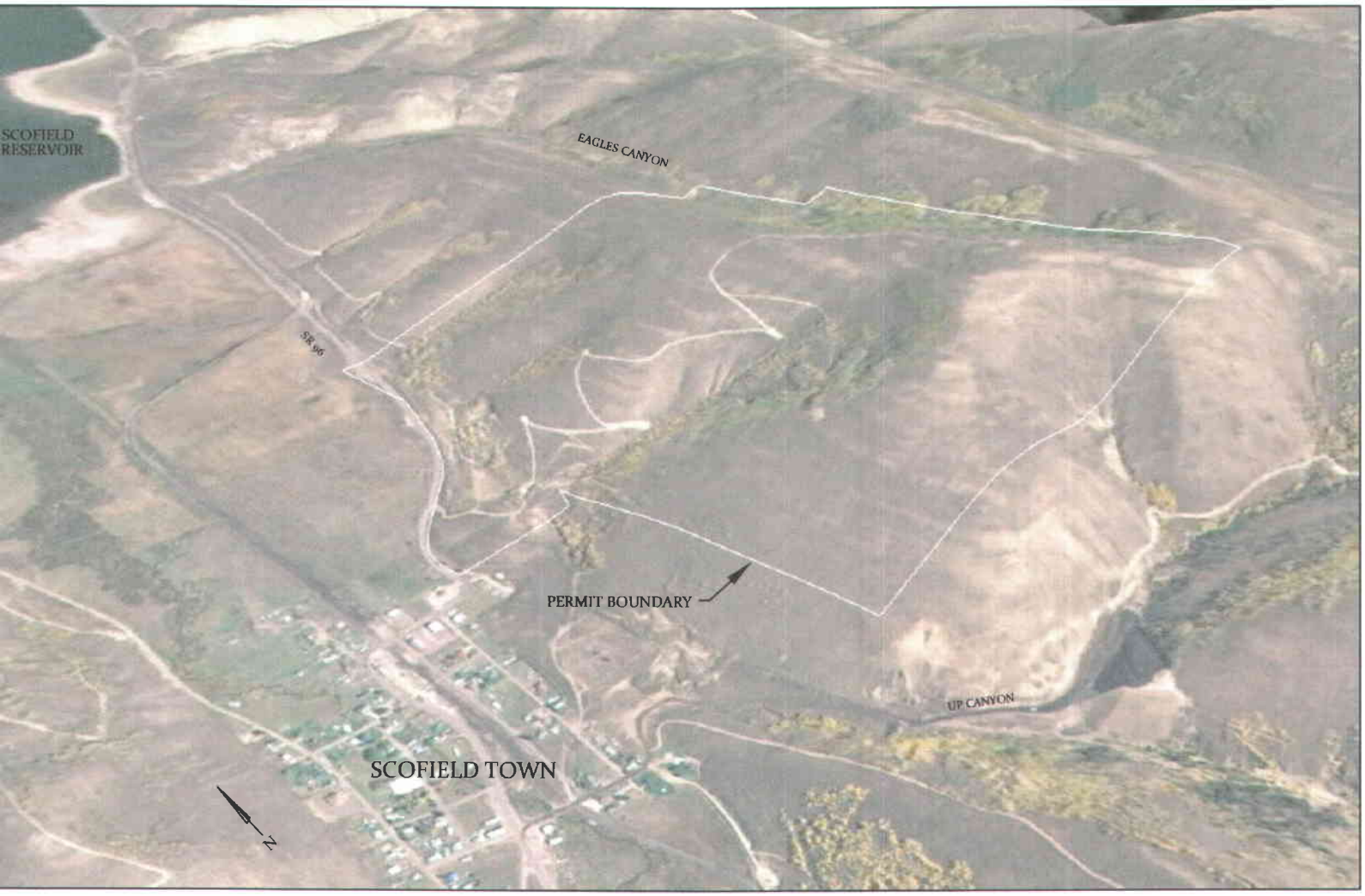
Mining and Reclamation Permit Application
Kinney No. 2 Mine

Volume 4



Carbon Resources
Coal For Carbon County

File in:
☐ Confidential
☒ Shelf
☐ Expandable
Date Folder 10/4/2010 C/ 0070047
See: Sucoming # Confidential For additional information

Carbon Resources LLC
P.O. Box 954
Sandia Park, NM 87047
505-980-1841

C/007/047 Incoming

COPY

#3646

Carbon Resources, LLC
PO Box 954
Sandia Park, NM 87047
Telephone: (505) 980-1841

October 1, 2010

Mr. John Baza, Director
Department of Natural Resources
Utah Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
Salt Lake City, Utah 84116

Dear Mr. Baza,

RE: PERMIT APPLICATION RESUBMISSION FOR KINNEY NO. 2 MINE - PERMIT NO. C/007/0047

In response to the Divisions Technical review deficiencies, Carbon Resources submits the attached permit application and responds to the technical deficiencies outlined in the Division's letter of September 24, 2008. The document has been completely reformatted to address the applicable regulations as directed, and to respond to the technical deficiencies.

Five copies of the application with responses are submitted herewith and they include paper copies of all of background data (lab sheets etc.) supporting determinations reached herein. This includes but not limited to data from water monitoring, soils survey, acid forming potential analyses etc. We understand that you will "stamp received" on all the copies and distribute them, per discussions with Daron Haddock, as follows;

1. Sent to OSM
2. Remains in UDOGM SLC OFFICE for Public Room
3. Remains in UDOGM SLC OFFICE for internal review
4. Sent to UDOGM PRICE OFFICE
5. Returned to Carbon Resources

A comprehensive Suite of Drilling Data, including quality analyses of coal etc., was submitted to UDOGM in February 2007 and is located in the Salt Lake Office Library under "Confidential Information."

This submission is accompanied by Forms C1 and C2 as required.

Please feel free to contact me, Greg Hunt at (970) 856-9477, or Ben Grimes at (435) 653-2304 with any questions regarding this application.

File in:
☐ Confidential
☒ Shelf
☐ Expandable
Date Folder 10042010 C/0070047
See Incoming & Confidential For additional

RECEIVED
OCT 04 2010
DIV. OF OIL, GAS & MINING

COPY

Application Certification

I the undersigned, hereby certify that the material and information contained in this application for a permit to mine coal by underground methods are complete and correct to the best of my knowledge and belief.

Carbon Resources, LLC

By: _____
Clay Wisdom
C.F.O.

State of New Mexico
County of Bernalillo

Subscribed and sworn to and before me this 28th day of September, 2010

OFFICIAL SEAL
SHANNON PARRA
NOTARY PUBLIC
STATE OF NEW MEXICO
My Commission Expires 2/11/2013

Shannon Parra
Notary Public for the State of New Mexico

Residing at: Bernalillo County

My Commission Expires: 2/11/2013

COPY

APPLICATION FOR COAL PERMIT PROCESSING

Permit Change ☐ New Permit ☒ Renewal ☐ Exploration ☐ Bond Release ☐ Transfer ☐

Permittee: Carbon Resources, LLC
Mine: Kinney No. 2 Mine **Permit Number:** C/007/0047
Title: Response to Technical Deficiencies & Reformatted MRP

Description, Include reason for application and timing required to implement:
Responds to Technical Deficiencies and reformats the original application to the regulations - NEW COAL MINE.

Instructions: If you answer yes to any of the first eight questions, this application may require Public Notice publication.

☐ Yes ☒ No 1. Change in the size of the Permit Area? Acres: _____ Disturbed Area: _____ ☐ increase ☐ decrease.
☐ Yes ☒ No 2. Is the application submitted as a result of a Division Order? DO# _____
☐ Yes ☒ No 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?
☐ Yes ☒ No 4. Does the application include operations in hydrologic basins other than as currently approved?
☐ Yes ☒ No 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?
☒ Yes ☐ No 6. Does the application require or include public notice publication?
☒ Yes ☐ No 7. Does the application require or include ownership, control, right-of-entry, or compliance information?
☒ Yes ☐ No 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
☐ Yes ☒ No 9. Is the application submitted as a result of a Violation? NOV # _____
☐ Yes ☒ No 10. Is the application submitted as a result of other laws or regulations or policies?
Explain: _____
☐ Yes ☒ No 11. Does the application affect the surface landowner or change the post mining land use?
☐ Yes ☒ No 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
☒ Yes ☐ No 13. Does the application require or include collection and reporting of any baseline information?
☐ Yes ☒ No 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
☒ Yes ☐ No 15. Does the application require or include soil removal, storage or placement?
☒ Yes ☐ No 16. Does the application require or include vegetation monitoring, removal or revegetation activities?
☒ Yes ☐ No 17. Does the application require or include construction, modification, or removal of surface facilities?
☒ Yes ☐ No 18. Does the application require or include water monitoring, sediment or drainage control measures?
☒ Yes ☐ No 19. Does the application require or include certified designs, maps or calculation?
☐ Yes ☒ No 20. Does the application require or include subsidence control or monitoring?
☐ Yes ☒ No 21. Have reclamation costs for bonding been provided?
☐ Yes ☒ No 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?
☐ Yes ☒ No 23. Does the application affect permits issued by other agencies or permits issued to other entities?
☒ Yes ☐ No 24. Does the application include confidential information and is it clearly marked and separated in the plan?

Please attach three (3) review copies of the application. If the mine is on or adjacent to Forest Service land please submit four (4) copies, thank you. (These numbers include a copy for the Price Field Office)

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein

Clay Wisdom	C.F.O.	09/28/2010	
Print Name	Position	Date	Signature (Right-click above choose certify then have notary sign below)

Subscribed and sworn to before me this 28 day of September, 2010

Notary Public: Shannon Parra, state of ~~Utah~~ NM

My commission Expires: 2/11/2012
Commission Number: _____
Address: 46 Jemez Rd
City: Moriarty State: NM Zip: 87035

OFFICIAL SEAL
SHANNON PARRA
NOTARY PUBLIC
STATE OF NEW MEXICO
My Commission Expires 2/11/2012

For Office Use Only:	Assigned Tracking Number:	Received by Oil, Gas & Mining
		RECEIVED OCT 04 2010 DIV OF OIL, GAS & MINING

Form DOGM- C1 (Revised December 10, 2007)

COPY

APPLICATION FOR COAL PERMIT PROCESSING
Detailed Schedule Of Changes to the Mining And Reclamation Plan

Permittee: Carbon Resources, LLC
Mine: Kinney No. 2 Mine
Permit Number: C/007/0047
Title: Response to Technical Deficiencies & Reformatted MRP

Provide a detailed listing of all changes to the Mining and Reclamation Plan, which is required as a result of this proposed permit application. Individually list all maps and drawings that are added, replaced, or removed from the plan. Include changes to the table of contents, section of the plan, or other information as needed to specifically locate, identify and revise the existing Mining and Reclamation Plan. Include page, section and drawing number as part of the description.

			DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐ Add	☒ Replace	☐ Remove	Replace entire MRP application with reformatted document
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	
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☐ Add	☐ Replace	☐ Remove	

Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.

This application replaces the original MRP application as required by UDOGM, and is reformatted to the regulations. It includes responses to the Technical Review deficiencies.

Received by Oil, Gas & Mining

RECEIVED
OCT 04 2010
DIV. OF OIL, GAS & MINING

Exhibit 13

Water Rights

RECEIVED
OCT 04 2010
DIV. OF OIL, GAS & MINING

WATER RIGHT: **91-5152** APPLICATION/CLAIM NO.: **A1035** CERT. NO.: 2046
CHANGES: t34656 Lapsed

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OWNERSHIP********

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NAME: Price River Water User's Association
ADDR: 375 South Carbon Avenue A-10
Price, Utah 84501
REMARKS: Based on 2 shares / Stock Cert #8289

NAME: Western Reserve Coal Co Inc
ADDR: PO Box 954
Sandia Park, NM 87047

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DATES, ETC.********

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LAND OWNED BY APPLICANT? COUNTY TAX ID#:
FILED: 08/30/1906|PRIORITY: 08/30/1906|PUB BEGAN: |PUB ENDED: |NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION: [Approved]|ActionDate:03/27/1907|PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC: 03/15/1988|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [ ]
PD BOOK: [91-]|MAP: [ ]|PUB DATE:

TYPE -- DOCUMENT -- STATUS----------

Type of Right: Application to Appropriate Source of Info: Ownership
Segregation Status: Certificate

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LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER**********

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FLOW: 2.0 acre-feet SOURCE: Gooseberry Creek
COUNTY: Sanpete COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 810 ft W 990 ft from SE cor, Sec 10, T 12S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

POINTS OF REDIVERSION:
(1) N 900 ft E 100 ft from SW cor, Sec 03, T 12S, R 7E, SLBM

Diverting Works:
Source: Ex.430, Theresa A. Phelps-well
(2) N 1285 ft W 345 ft from SE cor, Sec 04, T 12S, R 7E, SLBM
Diverting Works:
Source: Ex.336, Frank Marrelli-well
(3) N 1420 ft W 480 ft from SE cor, Sec 04, T 12S, R 7E, SLBM
Diverting Works:
Source: Ex.175, Rudy Scartezina-well
(4) S 1400 ft W 20 ft from E4 cor, Sec 04, T 12S, R 7E, SLBM
Diverting Works:
Source: Ex.397,Robt.or Francis Mallard-Well
(5) N 1338 ft E 655 ft from SW cor, Sec 17, T 12S, R 7E, SLBM
Diverting Works:
Source: Ex.178, Catherine Rudman-spring
(6) N 860 ft E 430 ft from S4 cor, Sec 19, T 12S, R 7E, SLBM
Diverting Works:
Source: Ex.375, G. Pete Frandsen-spring
(7) N 30 ft E 465 ft from S4 cor, Sec 32, T 12S, R 7E, SLBM
Diverting Works:
Source: Ex.164, Louis Gorishek-well
(8) N 430 ft W 410 ft from S4 cor, Sec 26, T 12S, R 9E, SLBM
Diverting Works:
Source: Price City Filtering Plant
(9) S 90 ft E 730 ft from N4 cor, Sec 35, T 12S, R 9E, SLBM
Diverting Works:
Source: Power Plant & Coal Company
(10)S 970 ft E 60 ft from W4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source: Ex.452, Robert Radokovich-well
(11)N 900 ft E 980 ft from SW cor, Sec 12, T 13S, R 9E, SLBM
Diverting Works:
Source: Bryner-Hansen Ditch
(12)S 480 ft E 1440 ft from W4 cor, Sec 12, T 13S, R 9E, SLBM
Diverting Works:
Source: Bryner-Ploutz Ditch
(13)S 560 ft W 840 ft from N4 cor, Sec 13, T 13S, R 9E, SLBM
Diverting Works:
Source: Spring Glen Canal
(14)N 1310 ft E 1000 ft from S4 cor, Sec 24, T 13S, R 9E, SLBM
Diverting Works:
Source: Gay Ditch
(15)S 0 ft W 730 ft from NE cor, Sec 24, T 13S, R 9E, SLBM
Diverting Works:
Source: O`Berto Ditch
(16)S 1190 ft W 1490 ft from E4 cor, Sec 24, T 13S, R 9E, SLBM
Diverting Works:
Source: Stowell Ditch
(17)N 560 ft W 240 ft from S4 cor, Sec 36, T 13S, R 9E, SLBM
Diverting Works:
Source: Price-Wellington Canal
(18)N 580 ft W 240 ft from S4 cor, Sec 36, T 13S, R 9E, SLBM
Diverting Works:
Source: Country Club-Cook Ditch
(19)S 560 ft E 680 ft from N4 cor, Sec 01, T 14S, R 9E, SLBM
Diverting Works:
Source: Carbon Canal
(20)N 1410 ft W 535 ft from S4 cor, Sec 08, T 15S, R 11E, SLBM

Diverting Works:
Source: Coal Washing Plant
(21)N 2261 ft W 218 ft from SE cor, Sec 16, T 15S, R 11E, SLBM
Diverting Works:
Source: Coal Washing Plant
(22)S 470 ft W 310 ft from E4 cor, Sec 16, T 15S, R 11E, SLBM
Diverting Works:
Source: Farnham Ditch
(23)S 1925 ft W 811 ft from NE cor, Sec 16, T 15S, R 11E, SLBM
Diverting Works:
Source: Coal Washing Plant

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USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*

==========

SEGREGATION HISTORY********

==========

This Right was Segregated from 91-2, with Appl#: A1035, Approval Date: / /
under which Proof is to be submitted.
This Right as originally filed:

----W A T E R U S E S----------			FLOW IN CFS	QUANTITY IN *---------- ACRE-FEET	IRRIGATED ACREAGE	STOCK (ELUs)
DOMESTIC	MUNICIPAL	MINING	POWER	OTHER		
(FAMILIES)	(*----------ACRE-FEET----------*)					
				2.0	0.6667	

Temporary change to be filed

==========

STOCK COMPANY ASSOCIATED WITH THIS WATER RIGHT:

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Price River Water User`s Assn. -- COMPANY WATER RIGHT

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**********E N D O F D A T A**********

WATER RIGHT: **91-5160** APPLICATION/CLAIM NO.: CERT. NO.: 2046
SHARES OF STOCK: 1.0
CHANGES: a34946 Approved

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OWNERSHIP********

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NAME: Boyd L. Peterson and Peggy Peterson Trust
ADDR: 1363 Sea Pines
Mesquite, NV 87024

NAME: Price River Water User's Association
ADDR: 375 South Carbon Avenue A-10
Price, Utah 84501

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DATES,
ETC.********
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LAND OWNED BY APPLICANT? COUNTY TAX ID#:
FILED: 08/30/1906|PRIORITY: 08/30/1906|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[Approved]|ActionDate:03/27/1907|PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
03/15/1988|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-]|MAP: [ ]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------
----------*
Type of Right: Application to Appropriate Source of Info: Ownership
Segregation Status: Certificate

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LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER**********

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FLOW: 1.0 acre-feet SOURCE: Gooseberry Creek
COUNTY: Sanpete COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 810 ft W 990 ft from SE cor, Sec 10, T 12S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

POINTS OF REDIVERSION:
(1) N 900 ft E 100 ft from SW cor, Sec 03, T 12S, R 7E, SLBM
Diverting Works:
Source: Ex.430, Theresa A. Phelps-well
(2) N 1285 ft W 345 ft from SE cor, Sec 04, T 12S, R 7E, SLBM
Diverting Works:
Source: Ex.336, Frank Marrelli-well
(3) N 1420 ft W 480 ft from SE cor, Sec 04, T 12S, R 7E, SLBM

Diverting Works:
Source: Ex.175, Rudy Scartezina-well
(4) S 1400 ft W 20 ft from E4 cor, Sec 04, T 12S, R 7E, SLBM
Diverting Works:
Source: Ex.397,Robt.or Francis Mallard-Well
(5) N 1338 ft E 655 ft from SW cor, Sec 17, T 12S, R 7E, SLBM
Diverting Works:
Source: Ex.178, Catherine Rudman-spring
(6) N 860 ft E 430 ft from S4 cor, Sec 19, T 12S, R 7E, SLBM
Diverting Works:
Source: Ex.375, G. Pete Frandsen-spring
(7) N 30 ft E 465 ft from S4 cor, Sec 32, T 12S, R 7E, SLBM
Diverting Works:
Source: Ex.164, Louis Gorishek-well
(8) N 430 ft W 410 ft from S4 cor, Sec 26, T 12S, R 9E, SLBM
Diverting Works:
Source: Price City Filtering Plant
(9) S 90 ft E 730 ft from N4 cor, Sec 35, T 12S, R 9E, SLBM
Diverting Works:
Source: Power Plant & Coal Company
(10)S 970 ft E 60 ft from W4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source: Ex.452, Robert Radokovich-well
(11)N 900 ft E 980 ft from SW cor, Sec 12, T 13S, R 9E, SLBM
Diverting Works:
Source: Bryner-Hansen Ditch
(12)S 480 ft E 1440 ft from W4 cor, Sec 12, T 13S, R 9E, SLBM
Diverting Works:
Source: Bryner-Ploutz Ditch
(13)S 560 ft W 840 ft from N4 cor, Sec 13, T 13S, R 9E, SLBM
Diverting Works:
Source: Spring Glen Canal
(14)N 1310 ft E 1000 ft from S4 cor, Sec 24, T 13S, R 9E, SLBM
Diverting Works:
Source: Gay Ditch
(15)S 0 ft W 730 ft from NE cor, Sec 24, T 13S, R 9E, SLBM
Diverting Works:
Source: O`Berto Ditch
(16)S 1190 ft W 1490 ft from E4 cor, Sec 24, T 13S, R 9E, SLBM
Diverting Works:
Source: Stowell Ditch
(17)N 560 ft W 240 ft from S4 cor, Sec 36, T 13S, R 9E, SLBM
Diverting Works:
Source: Price-Wellington Canal
(18)N 580 ft W 240 ft from S4 cor, Sec 36, T 13S, R 9E, SLBM
Diverting Works:
Source: Country Club-Cook Ditch
(19)S 560 ft E 680 ft from N4 cor, Sec 01, T 14S, R 9E, SLBM
Diverting Works:
Source: Carbon Canal
(20)N 1410 ft W 535 ft from S4 cor, Sec 08, T 15S, R 11E, SLBM
Diverting Works:
Source: Coal Washing Plant
(21)N 2261 ft W 218 ft from SE cor, Sec 16, T 15S, R 11E, SLBM
Diverting Works:
Source: Coal Washing Plant
(22)S 470 ft W 310 ft from E4 cor, Sec 16, T 15S, R 11E, SLBM

Diverting Works:
Source: Farnham Ditch
(23)S 1925 ft W 811 ft from NE cor, Sec 16, T 15S, R 11E, SLBM
Diverting Works:
Source: Coal Washing Plant

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USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*

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SEGREGATION HISTORY********

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==========

This Right was Segregated from 91-2, with Appl#: , Approval Date: / /
under which Proof is to be submitted.
This Right as originally filed:

FLOW IN	QUANTITY IN				
----W A T E R U S E S----------					
CFS	ACRE-FEET	IRRIGATED	STOCK		
DOMESTIC	MUNICIPAL	MINING	POWER	OTHER	
				ACREAGE	(ELUs)
(FAMILIES)(*----------ACRE-FEET----------*)					
			1.0	0.2000	

Change to be filed based on share cert. # 7926 1 af per share

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STOCK COMPANY ASSOCIATED WITH THIS WATER RIGHT:
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Price River Water User`s Assn. -- SHARES OF STOCK: 1.0

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****
**********E N D O F D A T A****

WATER RIGHT: **91-3401** APPLICATION/CLAIM NO.: CERT. NO.:

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OWNERSHIP********

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NAME: Waino E. Burton
ADDR: Scofield UT
INTEREST: 100% REMARKS:

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DATES,
ETC.**********
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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1895|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
08/02/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-1]|MAP: [28d]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------
----------*
Type of Right: Diligence Claim Source of Info: Proposed
Determination Status:
==========
==========
LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*******************
==========
==========
FLOW: 0.011 cfs SOURCE: Underground Water
Well
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- UNDERGROUND: (Click Well ID# link for more well data.)
(1) N 625 ft E 710 ft from S4 cor, Sec 32, T 12S, R 7E, SLBM
DIAMETER OF WELL: ins. DEPTH: to
ft.[redacted] YEAR DRILLED: WELL LOG? No WELL ID#:
==========
==========
USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*
==========
==========
SUPPLEMENTAL GROUP NO.: **614798.** Water Rights Appurtenant to the following use(s):
91-3401(DIL),3402(DIL)

.....
.....
STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 4.0000
Div Limit: 0.11 acft. PERIOD OF USE: 01/01 TO 12/31
*==========
==========
==========*
SUPPLEMENTAL GROUP NO.: **614799.**
91-3401(DIL)

.....
.....

DOMESTIC: Sole Supply: UNEVALUATED EDUs Group Total: 1.0000
Div Limit: 0.73 acft. PERIOD OF USE: 01/01 TO 12/31
****
****
**********E N D O F D A T
A******

WATER RIGHT: **91-3402** APPLICATION/CLAIM NO.: CERT. NO.:

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OWNERSHIP********
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NAME: Waino E. Burton
ADDR: Scofield UT
INTEREST: 100% REMARKS:

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DATES,
ETC.********
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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1895|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
08/02/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-1]|MAP: [28d]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------
----------*
Type of Right: Diligence Claim Source of Info: Proposed
Determination Status:

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LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER******************

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==========

FLOW: 0.011 cfs SOURCE: Underground Water
Well
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- UNDERGROUND: (Click Well ID# link for more well data.)
(1) N 570 ft E 690 ft from S4 cor, Sec 32, T 12S, R 7E, SLBM
DIAMETER OF WELL: ins. DEPTH: to
ft.[illegible] YEAR DRILLED: WELL LOG? No WELL ID#:

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USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*

==========
==========
SUPPLEMENTAL GROUP NO.: **614798.** Water Rights Appurtenant to the following use(s):
91-3401(DIL),3402(DIL)

.....
.....
STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 4.0000
Div Limit: 0.11 acft. PERIOD OF USE: 01/01 TO 12/31
*==========
==========
==========*
SUPPLEMENTAL GROUP NO.: **614800.**
91-3402(DIL)

.....
.....
DOMESTIC: Sole Supply: UNEVALUATED EDUs Group Total: 1.0000
Div Limit: 0.73 acft. PERIOD OF USE: 01/01 TO 12/31
****
****
**********E N D O F D A T
A****
EXCHANGE: **E1912 (91-4889)** BASE WATER RIGHT: - STOCK/CONTRACT
NUMBER: COUNTY TAX ID#:
RIGHT EVIDENCED BY: Stock Cert. 4018, Price River Water Users Assoc.
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OWNERSHIP**********
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----------*

NAME: Jim Nicolodemos
ADDR: 1221 South 2820 West
South Jordan UT 84065
==========
==========
DATES,
ETC.**********
****
==========
==========
FILED: 06/11/1981|PRIORITY: 06/11/1981|ADV BEGAN: |ADV ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate:04/30/1982|PROOF DUE:
EXTENSION: |ProofFiled: |CertIssued: |LAP, ETC:
|LAPS LETTR: |RUSH LETTER:
RENOVATE: |RECON REQ: |TYPE: [ ]
Date Verified: Initials: Status: Approved
Related Distribution System: Not part of any Distribution System

****
****
**********C U R R E N T R I G H
T**********
****
****
FLOW: 1.00 acre-feet
SOURCE: Scofield Reservoir
COUNTY: Carbon
POINT OF DIVERSION -- SURFACE:
(1) N 850 ft W 1080 ft from SE cor, Sec 10, T 12S, R 7E, SLBM
*----------
----------*
NATURE OF USE:
.....
.....
  ###IRRIGATION: Total: acres Sole Supply: acres
PERIOD OF USE: 04/01 TO 10/31
****
****
**********P R O P O S E D E X C H A
N G E**********
****
****
FLOW: 1.00 acre-feet PERIOD OF USE: 01/01 TO 12/31
SOURCE: Underground Water Well
COUNTY: Carbon COMMON DESCRIPTION: 12 1/2
Mi. NW of Scofield Dam
*----------
----------*
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==========
LOCATION OF EXCHANGE*(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER**********
==========
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POINT OF EXCHANGE -- UNDERGROUND: (Click link for PLAT data, click Well ID# link for more well data.)
(1) N 2145 ft W 1350 ft from E4 cor, Sec 05, T 13S, R 7E, SLBM
    DIAMETER OF WELL: 6 ins. DEPTH: 100 to 500 ft. YEAR DRILLED:
WELL LOG? NO WELL ID#:
*----------
----------*
POINT OF RELEASE:
FLOW: 1.00 acre-feet PERIOD OF USE: 01/01 TO 12/31
***Location of Release Point(s) is the SAME as Point(s) of Diversion in CURRENT RIGHT above.
*----------
----------*
NATURE OF USE:
SUPPLEMENTAL GROUP NO. 615761.
.....
.....
  DOMESTIC: Sole Supply: UNEVALUATED EDUs Group Total: 1.0000
Div Limit: PERIOD OF USE: 01/01 TO 12/31

.....
.....
###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------*
Section
* NW | NE | SW | SE * NW | NE | SW | SE * NW | NE | SW | SE * NW | NE | SW | SE *
Totals
Sec 05 T 13S R 7E SLBM *_____|_____|_____|_____*X
|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____*
0.0000

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SEGREGATION HISTORY********

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This Exchange as originally filed:

FLOW IN QUANTITY IN *----------
----W A T E R U S E S----------*

CFS ACRE-FEET IRRIGATED STOCK
DOMESTIC MUNICIPAL MINING POWER OTHER
ACREAGE (ELUs)
(FAMILIES) (*----------ACRE-FEET----------*)
1.0
1.0000

****

END OF DATA**

WATER RIGHT: **91-2993** APPLICATION/CLAIM NO.: CERT. NO.:

==========

OWNERSHIP********

==========

NAME: Bill B. and Utahna Pace Jones
ADDR: Palmyra UT
INTEREST: 100% REMARKS:

==========

DATES, ETC.********

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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: / /1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
07/20/1968|LAP, ETC: |LAPS LETTER:

RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-1]|MAP: [28d]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------*
Type of Right: Decree Source of Info: Proposed
Determination Status: Water User's Claim
==========
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LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*******************
==========
==========
FLOW: 4.58 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) S 1200 ft E 800 ft from N4 cor, Sec 32, T 12S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No
==========
==========
USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*
==========
==========
SUPPLEMENTAL GROUP NO.: **614615.**

.....
.....
IRRIGATION: 42.8 acres
Div Limit: 171.2 acft. PERIOD OF USE: 03/01 TO 11/30
.....
.....
###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------* Section
* NW | NE | SW | SE * NW | NE |
SW | SE * NW | NE | SW | SE * NW | NE | SW | SE * Totals
Sec 29 T 12S R 7E SLBM
*_____|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____*18.4000|_____|18.5000|_____* 36.9000
Sec 32 T 12S R 7E SLBM *_____|_____|_____|_____*
5.9000|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____* 5.9000

GROUP ACREAGE TOTAL: 42.8000
****
****
**********E N D O F D A T A****
WATER RIGHT: **91-3665** APPLICATION/CLAIM NO.: CERT. NO.:

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OWNERSHIP********
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NAME: Liodakis Ranch LLC
ADDR: 1411 West Highland Hollow Drive
West Jordan UT 84084
INTEREST: 100% REMARKS:
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DATES,
ETC.********
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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#: 2A-733
FILED: |PRIORITY: / /1869|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
08/31/1971|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [38a]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------
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Type of Right: Diligence Claim Source of Info: Proposed
Determination Status:
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LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER**********
==========
==========
FLOW: SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- POINT TO POINT:
(1)Stockwatering directly on stream from a point at S 660 ft. W 660 ft. from E4 corner, Sec 17, T13S, R7E, SLBM,
to a point at N 1250 ft. W 610 ft. from E4 corner, Sec 17, T13S, R7E, SLBM.
COMMENT: Administratively updated by State Engineer.
==========
==========
USES OF WATER RIGHT********** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*
==========
==========
SUPPLEMENTAL GROUP NO.: **614125.** Water Rights Appurtenant to the following use(s):

91-23(WUC),85(WUC),86(WUC),409(WUC),410(DIL)
411(DIL),412(DIL),413(DIL),414(DIL),415(DIL)
416(DIL),417(DIL),418(DIL),419(DIL),420(DIL)
421(DIL),422(DIL),423(DIL),424(DIL),425(DIL)
426(DIL),427(DIL),428(DIL),429(DIL),430(DIL)
431(DIL),432(DIL),433(DIL),434(DIL),435(DIL)
436(DIL),437(DIL),438(DIL),440(DIL),441(DIL)
443(DIL),444(DIL),445(DIL),446(DIL),447(DIL)
448(DIL),449(DIL),450(DIL),451(DIL),452(DIL)
453(DIL),456(DIL),457(WUC),458(DIL),459(DIL)
460(DIL),461(DIL),462(DIL),463(DIL),464(DIL)
465(DIL),466(DIL),467(DIL),468(DIL),469(DIL)
470(DIL),471(DIL),472(DIL),473(DIL),474(DIL)
475(DIL),476(DIL),477(DIL),478(DIL),479(DIL)
480(DIL),487(DIL),488(DIL),491(WUC),492(WUC)
493(WUC),494(WUC),495(WUC),591(DIL),592(DIL)
593(DIL),604(WUC),605(WUC),606(WUC),607(WUC)
1675(DIL),1676(DIL),2697(DIL),3051(DIL),3052(DIL)
3059(DIL),3060(DIL),3070(DIL),3071(DIL),3665(DIL)
3666(DIL),3669(DIL),3670(DIL),3671(DIL),3672(DIL)
3729(DIL),3730(DIL),3881(DIL)

.....
.....
STOCKWATER: Sole Supply: 0.0 ELUs of the Group Total of 810.0000
Div Limit: 22.68 acft. PERIOD OF USE: 01/01 TO 12/31

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PLACE OF USE for STOCKWATERING********
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	NORTH-WEST¼	NORTH-EAST¼	SOUTH-WEST¼	SOUTH-EAST¼
	NW NE SW SE	NW NE SW SE	NW NE SW SE	NW NE SW SE
Sec 17 T 13S R 7E SLBM	* : : : *	* : : : X*	* : : : *	: X: : *

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****
**********END OF DATA**

WATER RIGHT: **91-5069** APPLICATION/CLAIM NO.: CERT. NO.:
CHANGES: a27697 Approved

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OWNERSHIP********
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NAME: Rudman Land & Livestock L.L.C.
ADDR: 1111 East Brickyard Road Suite 106
Salt Lake City UT 84106

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DATES,
ETC.**********
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LAND OWNED BY APPLICANT? COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1869|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-]|MAP: [ ]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------
----------*
Type of Right: Diligence Claim Source of Info: Ownership
Segregation Status:
==========
==========
LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*******************
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FLOW: 1.4 acre-feet SOURCE: Woods Canyon Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- POINT TO POINT:
(1)Stockwatering directly on stream from a point at N 660 ft. E 1980 ft. from W4 corner, Sec 32, T12S, R7E, SLBM,
to a point at S 1980 ft. E 660 ft. from N4 corner, Sec 32, T12S, R7E, SLBM.
COMMENT: Administratively updated by State Engineer.
==========
==========
USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family*
==========
==========
SUPPLEMENTAL GROUP NO.: **615951.**

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.....
STOCKWATER: 50.0000 Stock Units
Div Limit: PERIOD OF USE: 01/01 TO 12/31
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==========
PLACE OF USE for STOCKWATERING********
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                                  NORTH-WEST¼        NORTH-EAST¼        SOUTH-
WEST¼        SOUTH-EAST¼
                                  NW NE SW SE        NW NE SW SE        NW NE SW
SE        NW NE SW SE
Sec 32 T 12S R  7E SLBM        *  :  :  : X*     *  :  : X:  *     *  :  :  :
*     *  :  :  :  *
==================================================================================
==================================================================
SEGREGATION
HISTORY*************************************************************************
****************************************
==================================================================================
==================================================================
This Right was Segregated from 91-3655 , with Appl#: , Approval Date:   /  /
under which Proof is to be submitted.
This Right as originally filed:
                        FLOW IN       QUANTITY IN *-------------------------
----W A T E R   U S E S-----------------------------*
                          CFS          ACRE-FEET   IRRIGATED     STOCK
DOMESTIC  MUNICIPAL    MINING      POWER       OTHER
                                                   ACREAGE      (ELUs)
(FAMILIES)(*-----------------ACRE-FEET------------------*)
                                          1.4                    50.0000
               50 ELU from 91-3655 only.
*****************************************************************************
*****************************************************
*****************************************************E N D   O F   D A T
A****
WATER RIGHT: 91-3648      APPLICATION/CLAIM NO.:          CERT. NO.:
==================================================================================
==================================================================
OWNERSHIP***********************************************************************
****************************************************
==================================================================================
==================================================================

NAME: Bill B. and Utahna Pace Jones
ADDR: 555 W. Front Street
      Scofield UT 84526
INTEREST: 100%       REMARKS:
==================================================================================
==================================================================
DATES,
ETC.****************************************************************************
**********************************************
==================================================================================
==================================================================
LAND OWNED BY APPLICANT? Yes                COUNTY TAX ID#:
FILED:                |PRIORITY:    /  /1869|PUB BEGAN:           |PUB ENDED:
|NEWSPAPER:
ProtestEnd:           |PROTESTED: [No      ]|HEARNG HLD:          |SE ACTION:
[        ]|ActionDate:          |PROOF DUE:
EXTENSION:            |ELEC/PROOF:[        ]|ELEC/PROOF:          |CERT/WUC:
|LAP, ETC:             |LAPS LETTER:
RUSH LETTR:           |RENOVATE:            |RECON REQ:           |TYPE: [
]
```

PD BOOK: [91-1]|MAP: [28d]|PUB DATE:
TYPE -- DOCUMENT -- STATUS--

Type of Right: Diligence Claim Source of Info: Proposed Determination Status: Water User's Claim

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LOCATION OF WATER RIGHT***(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*****************

==

FLOW: SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- POINT TO POINT:
(1)Stockwatering directly on stream from a point at S 660 ft. W 1980 ft. from E4 corner, Sec 32, T12S, R7E, SLBM,
to a point at S 660 ft. W 1980 ft. from E4 corner, Sec 29, T12S, R7E, SLBM.
COMMENT: Administratively updated by State Engineer.

==

USES OF WATER RIGHT****** *ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family*

==

SUPPLEMENTAL GROUP NO.: **614858.** Water Rights Appurtenant to the following use(s):
91-3648(WUC),3655(WUC)

....

STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 150.0000
Div Limit: PERIOD OF USE: 01/01 TO 12/31

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PLACE OF USE for STOCKWATERING*

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	NORTH-WEST¼	NORTH-EAST¼	SOUTH-WEST¼	SOUTH-EAST¼
	NW NE SW SE	NW NE SW SE	NW NE SW SE	NW NE SW SE
Sec 29 T 12S R 7E SLBM	* : : : *	* : : : *	* : : : *	* X: : : *
Sec 32 T 12S R 7E SLBM	* : : : *	* : : : *	* : : : *	* X: : : *

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SEGREGATION HISTORY*

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==========
This Right as originally filed:
FLOW IN QUANTITY IN *----------
----W A T E R U S E S----------*
CFS ACRE-FEET IRRIGATED STOCK
DOMESTIC MUNICIPAL MINING POWER OTHER
ACREAGE (ELUs)
(FAMILIES)(*----------ACRE-FEET----------*)
5.6 200.0000
supplemental with 91-3642, 3655, and 3658
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==========
The following Water Rights have been Segregated from 91-3648:
(1) WRNUM: 91-5069 1.4 50.0000
APPL#:
NAME: Rudman Land & Livestock LLC
FILED: 02/ /2003 STATUS: PERF
APPR:
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==========
CFS ACRE-FEET IRRIGATED STOCK
DOMESTIC MUNICIPAL MINING POWER OTHER
ACREAGE (ELUs)
(FAMILIES)(*----------ACRE-FEET----------*)
91-3648 currently has: 4.2 150.0000
All ACRE-FEET has been SEGREGATED OFF.
****
****
**********E N D O F D A T
A***
WATER RIGHT: **91-2992** APPLICATION/CLAIM NO.: CERT. NO.:
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OWNERSHIP**********
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NAME: Bill B. and Utahna Pace Jones
ADDR: Palmyra UT
INTEREST: 100% REMARKS:
==========
==========
DATES,
ETC.**********
****
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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: / /1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:

ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION: [ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC: 07/20/1968|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [ ]
PD BOOK: [91-1]|MAP: [28d]|PUB DATE:

***TYPE -- DOCUMENT -- STATUS**----------*

Type of Right: Decree Source of Info: Proposed Determination Status: Water User's Claim

==========

LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER*******************

==========

FLOW: 4.58 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) S 120 ft W 2230 ft from E4 cor, Sec 32, T 12S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

==========

USES OF WATER RIGHT******** ***ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family***

==========

SUPPLEMENTAL GROUP NO.: **614613.** Water Rights Appurtenant to the following use(s):
91-2991(WUC),2992(WUC)

.....

IRRIGATION: Sole Supply: UNEVALUATED acres Group Total: 141.5
Div Limit: 566.0 acft. PERIOD OF USE: 03/01 TO 11/30

.....

###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------* Section

	* NW	NE	SW	SE	* NW	NE	SW	SE	* Totals
Sec 28 T 12S R 7E SLBM									
*				*				*	22.2000
	15.0000		*				*		37.2000
Sec 29 T 12S R 7E SLBM									
*				*				*	
		*	4.7000	34.1000	5.7000	40.0000	*		84.5000

```
 Sec 32 T 12S R  7E SLBM *_______|_______|_______|_______*
4.3000|14.2000|_______|_______*_______|_______|_______|_______*_______|_____
_|_______|_______*     18.5000
 Sec 33 T 12S R  7E SLBM *_______|_______|_______|_______*_______|
1.3000|_______|_______*_______|_______|_______|_______*_______|_______|_____
_|_______*      1.3000
```

GROUP ACREAGE TOTAL: 141.5000

*==========
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SUPPLEMENTAL GROUP NO.: **614614.**
91-2992(WUC)

.....
.....
IRRIGATION: Sole Supply: UNEVALUATED acres Group Total: 16.8
Div Limit: 67.2 acft. PERIOD OF USE: 03/01 TO 11/30
.....
.....
###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------
* Section

```
                          *  NW   |  NE   |  SW   |  SE   *  NW   |  NE   |
SW   |  SE   *  NW   |  NE   |  SW   |  SE   *  NW   |  NE   |  SW   |  SE
*   Totals
 Sec 32 T 12S R  7E SLBM *_______|_______|_______|_______*
2.8000|_______|13.8000|_______*_______|_______|_______|_______*
0.2000|_______|_______|_______*      16.8000
```

GROUP ACREAGE TOTAL: 16.8000

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This Right (91-2992) has an evaluated sole-supply total for irrigation of 0.0000 acres.

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This Right (91-2992) is a member of 2 supplemental water right groups with irrigated acreage totaling 158.3000 acres.

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OTHER
COMMENTS**********
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Morse Decree, 1st Class.
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****
**********END OF DATA*****

WATER RIGHT: **91-3588** APPLICATION/CLAIM NO.: CERT. NO.:

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OWNERSHIP**********
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==========

NAME: Clear Creek Home Association
ADDR: P.O. Box 263
Springville UT 84663
INTEREST: 100% REMARKS: a Utah Corporation
==========
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DATES,
ETC.********
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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1869|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
08/11/1969|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [49]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------
----------*
Type of Right: Diligence Claim Source of Info: Proposed
Determination Status:
==========
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LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER**********
==========
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FLOW: SOURCE: Finn Canyon Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- POINT TO POINT:
(1)Stockwatering directly on stream from a point at S 660 ft. W 1980 ft. from E4 corner, Sec 32, T13S, R7E, SLBM,
to a point at S 660 ft. E 660 ft. from W4 corner, Sec 33, T12S, R7E, SLBM.
COMMENT: Administratively updated by State Engineer.
==========
==========

USES OF WATER RIGHT********
*ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family*
==========
==========

SUPPLEMENTAL GROUP NO.: **614837.** Water Rights Appurtenant to the following use(s):
91-3587(DIL),3588(DIL),3589(DIL)

.....
.....

STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 810.0000
Div Limit: 12.14 acft. PERIOD OF USE: 06/01 TO 11/30

PLACE OF USE for
STOCKWATERING

	NORTH-WEST¼	NORTH-EAST¼	SOUTH-WEST¼	SOUTH-EAST¼
	NW NE SW SE	NW NE SW SE	NW NE SW SE	NW NE SW SE
Sec 33 T 12S R 7E SLBM	* : : : *	* : : : *	* X: : : *	* : : : *
Sec 32 T 13S R 7E SLBM	* : : : *	* : : : *	* : : : *	* X: : : *

END OF DATA

THIS RIGHT IS BEING PROTESTED IN A PROPOSED DETERMINATION BOOK!!!

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 09/27/2010

WATER RIGHT: **91-4026** APPLICATION/CLAIM NO.: CERT. NO.:

OWNERSHIP

NAME: George Telonis
ADDR: C/O Luke Pappas
Price UT 84501
INTEREST: 100% REMARKS:

DATES,
ETC.

LAND OWNED BY APPLICANT? COUNTY TAX ID#:
FILED: |PRIORITY: / /1869|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
01/22/1973|LAP, ETC: |LAPS LETTER:

RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-]|MAP: [29c]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**---*

Type of Right: Pending Adjudication Claim Source of Info: Water User's Claim Status:

==

LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*******************

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FLOW: SOURCE: Unnamed Spring
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION:
(1)Stockwatering directly on spring located at S 660 ft. W 1980 ft. from E4 corner, Sec 33, T12S, R7E, SLBM.
COMMENT: Administratively updated by State Engineer.

==

USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family*

==

SUPPLEMENTAL GROUP NO.: **615009.** Water Rights Appurtenant to the following use(s):
91-3640(WUC),4025(PAC),4026(PAC),4027(PAC),4028(PAC)
4029(PAC),4031(PAC),4032(PAC),4033(PAC)

....
STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 510.0000
Div Limit: 10.76 acft. PERIOD OF USE: 03/01 TO 11/30
===

SUPPLEMENTAL GROUP NO.: **615057.** Water Rights Appurtenant to the following use(s):
91-3640(WUC),4025(PAC),4026(PAC),4027(PAC),4028(PAC)
4029(PAC),4030(WUC),4031(PAC),4032(PAC),4033(PAC)
4143(PAC)

....
STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 510.0000
Div Limit: PERIOD OF USE: 05/01 TO 11/30

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PLACE OF USE for STOCKWATERING

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NORTH-WEST¼ NORTH-EAST¼ SOUTH-WEST¼ SOUTH-EAST¼

NW NE SW SE NW NE SW SE NW NE SW SE NW NE SW SE

Sec 33 T 12S R 7E SLBM * : : : * * : : : * * : : : * * X: : : *

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**********END OF DATA**

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 09/27/2010

WATER RIGHT: **91-640** APPLICATION/CLAIM NO.: CERT. NO.:

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OWNERSHIP**********

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NAME: Clarence Anderson Estate

ADDR: Price UT 84501

INTEREST: 100% REMARKS:

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DATES,

ETC.**********

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LAND OWNED BY APPLICANT? COUNTY TAX ID#:

FILED: |PRIORITY: 00/00/1860|PUB BEGAN: |PUB ENDED: |NEWSPAPER:

ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION: [ ]|ActionDate: |PROOF DUE:

EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC: 07/22/1965|LAP, ETC: |LAPS LETTER:

RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [ ]

PD BOOK: [91-1]|MAP: [29]|PUB DATE:

TYPE -- DOCUMENT -- STATUS----------

Type of Right: Diligence Claim Source of Info: Proposed Determination Status:

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LOCATION OF WATER RIGHT***(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER**********

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FLOW: SOURCE: Left hand Fork of Hopkins Creek

COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- POINT TO POINT:

(1)Stockwatering directly on stream from a point at S 660 ft. W 660 ft. from E4 corner, Sec 35, T12S, R7E, SLBM,
to a point at N 660 ft. E 660 ft. from S4 corner, Sec 27, T12S, R7E, SLBM.
COMMENT: Administratively updated by State Engineer.

==========

USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*

==========

SUPPLEMENTAL GROUP NO.: **614017.** Water Rights Appurtenant to the following use(s):
91-352(DIL),640(DIL),740(DIL),1221(DIL),1396(DIL)
1397(DIL),1398(DIL),1399(DIL),1400(DIL),1401(DIL)
1402(DIL)

.....

STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 556.0000
Div Limit: 8.18 acft. PERIOD OF USE: 05/01 TO 11/01

==========

SUPPLEMENTAL GROUP NO.: **614068.** Water Rights Appurtenant to the following use(s):
91-352(DIL),640(DIL),740(DIL),1221(DIL),1396(DIL)
1397(DIL),1398(DIL),1399(DIL),1400(DIL),1401(DIL)
1402(DIL),1403(DIL),1475(DIL),3279(DIL)

.....

STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 556.0000
Div Limit: 8.18 acft. PERIOD OF USE: 05/01 TO 11/01

==========

SUPPLEMENTAL GROUP NO.: **614071.** Water Rights Appurtenant to the following use(s):
91-352(DIL),640(DIL),740(DIL),1221(DIL),1396(DIL)
1397(DIL),1398(DIL),1399(DIL),1400(DIL),1401(DIL)
1402(DIL),1403(DIL)

.....

STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 556.0000
Div Limit: 8.18 acft. PERIOD OF USE: 05/01 TO 11/01

==========

SUPPLEMENTAL GROUP NO.: **614088.** Water Rights Appurtenant to the following use(s):
91-352(DIL),640(DIL),740(DIL),1221(DIL),1396(DIL)
1397(DIL),1398(DIL),1399(DIL),1400(DIL),1401(DIL)
1402(DIL),1475(DIL)

.....
.....
STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 556.0000
Div Limit: 8.18 acft. PERIOD OF USE: 05/01 TO 11/01
*==========
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==========*
SUPPLEMENTAL GROUP NO.: **616022.**
91-640(DIL)

.....
.....
DOMESTIC: Sole Supply: UNEVALUATED EDUs Group Total: 1.0000
Div Limit: PERIOD OF USE: 01/01 TO 12/31
.....
.....
###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------
* Section
* NW | NE | SW | SE * NW | NE | SW | SE
SW | SE * NW | NE | SW | SE * NW | NE | SW | SE
* Totals
Sec 27 T 12S R 7E SLBM
*_____|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____*_____|X |_____* 0.0000
Sec 35 T 12S R 7E SLBM
*_____|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____*_____|X |_____|_____* 0.0000

GROUP ACREAGE TOTAL: 0.0000
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PLACE OF USE for STOCKWATERING********
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	NORTH-WEST¼	NORTH-EAST¼	SOUTH-WEST¼	SOUTH-EAST¼
	NW NE SW SE	NW NE SW SE	NW NE SW SE	NW NE SW SE
Sec 27 T 12S R 7E SLBM	* : : : *	* : : : *	* : : : *	* : : : X: *
Sec 35 T 12S R 7E SLBM	* : : : *	* : : : *	* : : : *	* : X: : *

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**********E N D O F D A T A****
WATER RIGHT: **91-3645** APPLICATION/CLAIM NO.: CERT. NO.:
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==========
OWNERSHIP********
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NAME: Fred and Shelia Jensen
ADDR: UT
INTEREST: 100% REMARKS:

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DATES,
ETC.**********

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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1869|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
07/27/1961|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------*
Type of Right: Diligence Claim Source of Info: Proposed
Determination Status:

==========

LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*******************

==========

FLOW: SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- POINT TO POINT:
(1)Stockwatering directly on stream from a point at S 660 ft. W 1980 ft. from E4 corner, Sec 05, T13S, R7E, SLBM,
to a point at S 1980 ft. E 660 ft. from N4 corner, Sec 05, T13S, R7E, SLBM.
COMMENT: Administratively updated by State Engineer.

==========

USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family*

==========

SUPPLEMENTAL GROUP NO.: **614629.** Water Rights Appurtenant to the following use(s):
91-3011(DIL),3645(DIL)

.....

STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 60.0000
Div Limit: 1.68 acft. PERIOD OF USE: 01/01 TO 12/31

PLACE OF USE for STOCKWATERING

	NORTH-WEST¼	NORTH-EAST¼	SOUTH-WEST¼	SOUTH-EAST¼
	NW NE SW SE	NW NE SW SE	NW NE SW SE	NW NE SW SE
Sec 05 T 13S R 7E SLBM	* : : : *	* : : X: *	* : : : *	* X: : : *

END OF DATA**

WATER RIGHT: **91-3008** APPLICATION/CLAIM NO.: CERT. NO.:

OWNERSHIP

NAME: Fred and Shelia Jensen
ADDR: P.O. Box 113
Goshen UT 84633
INTEREST: 100% REMARKS:

DATES, ETC.

LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1874|PUB BEGAN: |PUB ENDED: |NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION: [ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC: 07/26/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [ ]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:

***TYPE -- DOCUMENT -- STATUS**

Type of Right: Decree Source of Info: Proposed Determination Status:

LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER**********

FLOW: 0.693 cfs SOURCE: Winter Quarters Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 700 ft W 1400 ft from E4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*

SUPPLEMENTAL GROUP NO.: **614626.**

IRRIGATION: 41.6 acres
Div Limit: 166.4 acft. PERIOD OF USE: 03/01 TO 11/30

###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------*

Section	NW	NE	SW	SE	NW	NE	SW	SE	Totals
Sec 05 T 13S R 7E SLBM				32.3000				9.3000	41.6000

GROUP ACREAGE TOTAL: 41.6000

OTHER COMMENTS**********

Morse Decree, 1st Class
****
**********E N D O F D A T A*

WATER RIGHT: **91-3011** APPLICATION/CLAIM NO.: CERT. NO.:

OWNERSHIP**********

NAME: Fred and Shelia Jensen
ADDR: P.O. Box 113
Goshen UT 84633
INTEREST: 100% REMARKS:

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DATES,
ETC.**********
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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1869|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
07/26/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------
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Type of Right: Diligence Claim Source of Info: Proposed
Determination Status:

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LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*******************

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FLOW: SOURCE: Winter Quarters
Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- POINT TO POINT:
(1)Stockwatering directly on stream from a point at N 660 ft. W 660 ft. from E4 corner, Sec 05, T13S, R7E, SLBM,
to a point at S 1980 ft. E 660 ft. from N4 corner, Sec 05, T13S, R7E, SLBM.
COMMENT: Administratively updated by State Engineer.

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USES OF WATER RIGHT******** ***ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family***

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SUPPLEMENTAL GROUP NO.: **614629.** Water Rights Appurtenant to the following use(s):
91-3011(DIL),3645(DIL)

.....
.....
STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 60.0000
Div Limit: 1.68 acft. PERIOD OF USE: 01/01 TO 12/31

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PLACE OF USE for
STOCKWATERING**********
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	NORTH-WEST¼	NORTH-EAST¼	SOUTH-WEST¼	SOUTH-EAST¼
	NW NE SW SE	NW NE SW SE	NW NE SW SE	NW NE SW SE
Sec 05 T 13S R 7E SLBM	* : : : *	* : : X: X*	* : : : *	* : : : *

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**********E N D O F D A T
A**

WATER RIGHT: **91-3644** APPLICATION/CLAIM NO.: CERT. NO.:
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OWNERSHIP**********
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NAME: Carbon Co. Rec. Transportation Special Service Dis
ADDR: a Special Service Dist. created by Co. of Carbon
185 East Main
Price UT 84501
INTEREST: 100% REMARKS:
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DATES,
ETC.**********
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==========
LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1869|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:
*TYPE -- DOCUMENT -- STATUS----------
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Type of Right: Diligence Claim Source of Info: Proposed
Determination Status:
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==========
LOCATION OF WATER RIGHT***(Points of Diversion: Click on Location to access
PLAT Program.)**********MAP VIEWER**********

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==========
FLOW: SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- POINT TO POINT:
(1)Stockwatering directly on stream from a point at N 660 ft. E 660 ft. from S4 corner, Sec 05, T13S, R7E, SLBM,
to a point at N 660 ft. E 660 ft. from S4 corner, Sec 05, T13S, R7E, SLBM.
COMMENT: Administratively updated by State Engineer.
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USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*
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==========
SUPPLEMENTAL GROUP NO.: **614284.** Water Rights Appurtenant to the following use(s):
91-2187(DIL),2974(DEC),2975(DEC),2976(DEC),2978(DEC)
3644(DIL),3742(DIL),3743(DIL),3744(DIL),3749(DIL)
3750(DIL),3751(DIL),3868(DIL)

.....
.....
STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 710.0000
Div Limit: 10.66 acft. PERIOD OF USE: 05/01 TO 11/30
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==========
PLACE OF USE for STOCKWATERING********
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==========
NORTH-WEST¼ NORTH-EAST¼ SOUTH-WEST¼ SOUTH-EAST¼
NW NE SW SE NW NE SW SE NW NE SW SE NW NE SW SE
Sec 05 T 13S R 7E SLBM * : : : * * : : : * * : : : * * : : : X: *
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**********E N D O F D A T A******
WATER RIGHT: **91-2978** APPLICATION/CLAIM NO.: CERT. NO.:
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==========
OWNERSHIP********
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==========

NAME: Carbon Co. Rec. Transportation Special Service Dis
ADDR: a Special Service Dist. created by Co. of Carbon
185 East Main

Price UT 84501
INTEREST: 100% REMARKS:

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DATES,
ETC.********

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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
08/10/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------*
Type of Right: Decree Source of Info: Proposed
Determination Status:

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LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER**********

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FLOW: 0.683 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

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USES OF WATER RIGHT********
ELU -- Equivalent Livestock Unit (cow, horse, etc.) ***** EDU -- Equivalent Domestic Unit or 1 Family***

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SUPPLEMENTAL GROUP NO.: **614284.** Water Rights Appurtenant to the following use(s):
91-2187(DIL),2974(DEC),2975(DEC),2976(DEC),2978(DEC)
3644(DIL),3742(DIL),3743(DIL),3744(DIL),3749(DIL)
3750(DIL),3751(DIL),3868(DIL)

.....
.....
STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 710.0000
Div Limit: 10.66 acft. PERIOD OF USE: 05/01 TO 11/30

*==========
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==========*

SUPPLEMENTAL GROUP NO.: **614598.**
91-2978(DEC)

.....
.....
IRRIGATION: Sole Supply: UNEVALUATED acres Group Total: 4.1
Div Limit: 16.4 acft. PERIOD OF USE: 03/01 TO 11/30
.....
.....
###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------
* Section
* NW | NE | SW | SE * NW | NE | SW | SE
SW | SE * NW | NE | SW | SE * NW | NE | SW | SE
* Totals
Sec 05 T 13S R 7E SLBM
*_____|_____|_____|_____*_____|_____|_____|_____*_____|____
___|_____|_____*_____|_____| 4.1000|_____* 4.1000

GROUP ACREAGE TOTAL: 4.1000
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OTHER
COMMENTS**********
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Morse Decree, 1st Class
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**********E N D O F D A T
A****

WATER RIGHT: **91-2979** APPLICATION/CLAIM NO.: CERT. NO.:
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OWNERSHIP**********
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NAME: Fred and Shelia Jensen
ADDR: P.O. Box 113
Goshen UT 84633
INTEREST: 100% REMARKS:
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DATES,
ETC.**********
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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:

FILED: |PRIORITY: 00/00/1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
07/26/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------*

Type of Right: Decree Source of Info: Proposed
Determination Status:

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LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*******************

==========

FLOW: 0.453 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

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USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ************ *EDU -- Equivalent Domestic Unit or 1 Family*

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SUPPLEMENTAL GROUP NO.: **614599.**

.....

IRRIGATION: 27.2 acres
Div Limit: 108.8 acft. PERIOD OF USE: 03/01 TO 11/30

.....

###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------* Section

* NW | NE | SW | SE * NW | NE | SW | SE * NW | NE | SW | SE * Totals

Sec 05 T 13S R 7E SLBM

								13.7000								
			13.5000													27.2000

GROUP ACREAGE TOTAL: 27.2000

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OTHER
COMMENTS**********
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Morse Decree, 1st Class
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****
**********E N D O F D A T
A****
WATER RIGHT: **91-2980** APPLICATION/CLAIM NO.: CERT. NO.:
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==========
OWNERSHIP**********
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NAME: Frank T. Jr. & Pamela G. Helsten
ADDR: 1339 East 3955 South
Salt Lake City UT 84124
INTEREST: 100% REMARKS:
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==========
DATES,
ETC.**********
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==========
LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
07/26/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------
----------*
Type of Right: Decree Source of Info: Proposed
Determination Status:
==========
==========
LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*******************
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==========
FLOW: 0.1 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*

SUPPLEMENTAL GROUP NO.: **614601.**

IRRIGATION: 0.8 acres
Div Limit: 3.2 acft. PERIOD OF USE: 03/01 TO 11/30

###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------*

Section	NW	NE	SW	SE	NW	NE	SW	SE	NW	NE	SW	SE	Totals
Sec 05 T 13S R 7E SLBM													0.8000

GROUP ACREAGE TOTAL: 0.8000

OTHER COMMENTS**********

Morse Decree, 1st Class

**********END OF DATA****

WATER RIGHT: **91-2981** APPLICATION/CLAIM NO.: CERT. NO.:

OWNERSHIP**********

NAME: Orson Marsing
ADDR: Miller Creek UT
INTEREST: 100% REMARKS:

DATES, ETC.**********

LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
07/03/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------*
Type of Right: Decree Source of Info: Proposed
Determination Status:

LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*******************

FLOW: 0.1 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

USES OF WATER RIGHT******** ***ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family***

SUPPLEMENTAL GROUP NO.: **614602.**

IRRIGATION: 2.2 acres
Div Limit: 8.8 acft. PERIOD OF USE: 03/01 TO 11/30

###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------* Section
* NW | NE | SW | SE * NW | NE | SW | SE * NW | NE | SW | SE * Totals
Sec 05 T 13S R 7E SLBM *_____|_____|_____|_____*
2.2000|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____* 2.2000

GROUP ACREAGE TOTAL: 2.2000

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==========
OTHER
COMMENTS**********
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==========
Morse Decree, 1st Class
****
****
**********E N D O F D A T
A***
WATER RIGHT: **91-2982** APPLICATION/CLAIM NO.: CERT. NO.:
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OWNERSHIP**********
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NAME: Lillie Pearson
ADDR: 315 South 7th East
Salt Lake City UT
INTEREST: 100% REMARKS:
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==========
DATES,
ETC.**********
****
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==========
LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
07/25/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:
*TYPE -- DOCUMENT -- STATUS----------
----------*
Type of Right: Decree Source of Info: Proposed
Determination Status:
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==========
LOCATION OF WATER RIGHT***(Points of Diversion: Click on Location to access
PLAT Program.)**********MAP VIEWER**********
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==========
FLOW: 0.1 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM

Diverting Works:
Source:

Stream Alt Required?: No

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USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*

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SUPPLEMENTAL GROUP NO.: **614603.**

.....
.....
IRRIGATION: 1.2 acres
Div Limit: 4.8 acft. PERIOD OF USE: 03/01 TO 11/30
.....
.....
###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------*
Section

	*	NW	NE	SW	SE	*	NW	NE	SW	SE	*	NW	NE	SW	SE	*	Totals
Sec 32 T 12S R 7E SLBM																	
																1.2000	1.2000

GROUP ACREAGE TOTAL: 1.2000

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OTHER COMMENTS**********

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Morse Decree, 1st Class
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**********E N D O F D A T A**

WATER RIGHT: **91-2983** APPLICATION/CLAIM NO.: CERT. NO.:

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OWNERSHIP**********

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NAME: Thomas Biggs Jr.
ADDR: Columbia UT
INTEREST: 100% REMARKS:

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DATES,
ETC.**********
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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: / /1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
07/05/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------
----------*
Type of Right: Decree Source of Info: Proposed
Determination Status: Water User's Claim

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LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*******************

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FLOW: 0.1 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

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USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*

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SUPPLEMENTAL GROUP NO.: **614604.**

.....
.....
IRRIGATION: 1.1 acres
Div Limit: 4.4 acft. PERIOD OF USE: 03/01 TO 11/30
.....
.....
###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------
* Section
* NW | NE | SW | SE * NW | NE |
SW | SE * NW | NE | SW | SE * NW | NE | SW | SE
* Totals

Sec 32 T 12S R 7E SLBM
*_____|_____|_____|_____*_____|_____|_____|_____*_____|____
___|_____|_____*_____|_____|_____| 1.1000* 1.1000

GROUP ACREAGE TOTAL: 1.1000
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OTHER
COMMENTS**********
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Morse Decree, 1st Class
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**********E N D O F D A T
A***

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 09/27/2010

WATER RIGHT: **91-2984** APPLICATION/CLAIM NO.: CERT. NO.:
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OWNERSHIP**********
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NAME: Waino E. Burton
ADDR: Scofield UT
INTEREST: 100% REMARKS:
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==========
DATES,
ETC.**********
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==========
LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
08/02/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:
*TYPE -- DOCUMENT -- STATUS----------
----------*
Type of Right: Decree Source of Info: Proposed
Determination Status:
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LOCATION OF WATER RIGHT***(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER**********

FLOW: 0.1 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*

SUPPLEMENTAL GROUP NO.: **614605.**

IRRIGATION: 0.6 acres
Div Limit: 2.4 acft. PERIOD OF USE: 03/01 TO 11/30

###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------*
Section

	*	NW	NE	SW	SE	*	NW	NE	SW	SE	*	NW	NE	SW	SE	*	Totals
Sec 32 T 12S R 7E SLBM	*					*					*					*	0.6000

GROUP ACREAGE TOTAL: 0.6000

OTHER COMMENTS**********

Morse Decree, 1st Class
****
**********E N D O F D A T A****

WATER RIGHT: **91-2985** APPLICATION/CLAIM NO.: CERT. NO.:

OWNERSHIP**********

NAME: Phyllis M. Conover
ADDR: 358 South 1st West
Provo UT 84601
INTEREST: 100% REMARKS:

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DATES,
ETC.********
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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
07/28/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------
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Type of Right: Decree Source of Info: Proposed
Determination Status:

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LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*******************

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FLOW: 0.1 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

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USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*

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SUPPLEMENTAL GROUP NO.: **614606.**

.....
.....
IRRIGATION: 0.3 acres
Div Limit: 1.2 acft. PERIOD OF USE: 03/01 TO 11/30
.....
.....

###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------
* Section
* NW | NE | SW | SE * NW | NE | SW | SE * NW | NE | SW | SE * NW | NE | SW | SE *
Totals
Sec 32 T 12S R 7E SLBM
*_____|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____*
| 0.3000|_____* 0.3000

GROUP ACREAGE TOTAL: 0.3000

OTHER COMMENTS**********

Morse Decree, 1st Class

**********E N D O F D A T A*

WATER RIGHT: **91-2986** APPLICATION/CLAIM NO.: CERT. NO.:

OWNERSHIP**********

NAME: James F. Levanger
ADDR: HC-35 Box 250
Helper UT 84526
INTEREST: 100% REMARKS:

DATES, ETC.**********

LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1874|PUB BEGAN: |PUB ENDED: |NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION: [ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC: 06/02/1969|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [ ]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE: .

TYPE -- DOCUMENT -- STATUS----------

Type of Right: Decree Source of Info: Proposed Determination Status:

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LOCATION OF WATER RIGHT***(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER**********
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FLOW: 0.015 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No
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USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*
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==========
SUPPLEMENTAL GROUP NO.: **614607.**

.....
.....
IRRIGATION: 0.9 acres
Div Limit: 3.6 acft. PERIOD OF USE: 03/01 TO 11/01
.....
.....
###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------*
Section
* NW | NE | SW | SE * NW | NE | SW | SE * NW | NE | SW | SE *
Totals
Sec 32 T 12S R 7E SLBM
*_____|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____*_____| 0.9000|_____* 0.9000

GROUP ACREAGE TOTAL: 0.9000
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OTHER COMMENTS**********
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Morse Decree, 1st Class
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**********E N D O F D A T A***

WATER RIGHT: **91-2987** APPLICATION/CLAIM NO.: CERT. NO.:
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OWNERSHIP********

NAME: Leah B. Johnson
ADDR: 273 West Main
Spanish Fork UT 84660
INTEREST: 100% REMARKS:

DATES, ETC.********

LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
08/02/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:

***TYPE -- DOCUMENT -- STATUS**----------*

Type of Right: Decree Source of Info: Proposed
Determination Status:

LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*******************

FLOW: 0.1 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*

SUPPLEMENTAL GROUP NO.: **614608.**

.....

IRRIGATION: 0.7 acres
Div Limit: 2.8 acft. PERIOD OF USE: 03/01 TO 11/30

.....

###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------* Section

	*	NW	NE	SW	SE	*	NW	NE	SW	SE	*	NW	NE	SW	SE	*	Totals
Sec 32 T 12S R 7E SLBM																	
																	0.7000

GROUP ACREAGE TOTAL: 0.7000

OTHER COMMENTS

Morse Decree, 1st Class.

END OF DATA

WATER RIGHT: **91-2988** APPLICATION/CLAIM NO.: CERT. NO.:

OWNERSHIP

NAME: Nolan G. and Larue H. Davis
ADDR: Helper UT 84526
INTEREST: 100% REMARKS:

DATES, ETC.

LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
09/22/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:

TYPE -- DOCUMENT -- STATUS--

Type of Right: Decree Determination   Status: Source of Info: Proposed

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LOCATION OF WATER RIGHT***(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*****************

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FLOW: SOURCE: Clear Creek
COUNTY: Carbon   COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

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USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family*

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SUPPLEMENTAL GROUP NO.: **614609.**

....

IRRIGATION: 0.7 acres
Div Limit: 2.8 acft.   PERIOD OF USE: 03/01 TO 11/30

....

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###PLACE OF USE:     *-------NORTH WEST QUARTER------*-------NORTH EAST
QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------
*   Section
                             *  NW  |  NE  |  SW  |  SE  *  NW  |  NE  |
SW  |  SE  *  NW  |  NE  |  SW  |  SE  *  NW  |  NE  |  SW  |  SE
*   Totals
Sec 32 T 12S R 7E SLBM
*_______|_______|_______|_______*_______|_______|_______|_______*_______|____
___|_______|_______*_______|_______| 0.7000|_______*     0.7000
```

GROUP ACREAGE TOTAL: 0.7000

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OTHER COMMENTS***

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Morse Decree, 1st Class
END OF DATA*

WATER RIGHT: **91-2989** APPLICATION/CLAIM NO.: CERT. NO.:

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OWNERSHIP********

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NAME: Town of Scofield (Public Water Supplier)
ADDR: Scofield UT
INTEREST: 100% REMARKS:

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DATES, ETC.********

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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
07/26/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------*
Type of Right: Decree Source of Info: Proposed
Determination Status:

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LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER**********

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FLOW: 0.1 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

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USES OF WATER RIGHT********** *ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family*

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SUPPLEMENTAL GROUP NO.: **614610.**
91-2989(DEC)

.....
.....
IRRIGATION: Sole Supply: UNEVALUATED acres Group Total: 3.4
Div Limit: 13.6 acft. PERIOD OF USE: 03/01 TO 11/30
.....
.....
###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST
QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------
* Section
* NW | NE | SW | SE * NW | NE |
SW | SE * NW | NE | SW | SE * NW | NE | SW | SE
* Totals
Sec 32 T 12S R 7E SLBM
*_____|_____|_____|_____*_____|_____|_____|_____*_____|____
___|_____|_____*_____|_____| 1.4000| 2.0000* 3.4000

GROUP ACREAGE TOTAL: 3.4000
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==========*
SUPPLEMENTAL GROUP NO.: **615095.** Water Rights Appurtenant to the following
use(s):
91-830(REJ),2989(DEC),3094(DIL),4195(DEC),E1784(APP)
E2567(APP)

.....
.....
MUNICIPAL: Scofield
PERIOD OF USE: 01/01 TO 12/31
Acre Feet Contributed by this Right for this Use: Unevaluated
.....
.....
###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST
QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------
* Section
* NW | NE | SW | SE * NW | NE |
SW | SE * NW | NE | SW | SE * NW | NE | SW | SE
* Totals
Sec 17 T 13S R 7E SLBM *_____|X
|_____|_____*_____|_____|_____|_____*_____|_____|_____|____
___*_____|_____|_____|_____* 0.0000

GROUP ACREAGE TOTAL: 3.4000
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OTHER
COMMENTS**********
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Morse Decree, 1st Class
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**********E N D O F D A T
A***
WATER RIGHT: **91-2990** APPLICATION/CLAIM NO.: CERT. NO.:

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OWNERSHIP********
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NAME: Della L. Madsen
ADDR: Meadow UT 84644
INTEREST: 100% REMARKS:
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==========
DATES, ETC.********
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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
09/11/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------
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Type of Right: Decree Source of Info: Proposed
Determination Status:
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LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER**********
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FLOW: 1.166 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No
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USES OF WATER RIGHT********** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*
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SUPPLEMENTAL GROUP NO.: **614611.**

.....
.....

IRRIGATION: 70.0 acres
Div Limit: 280.0 acft. PERIOD OF USE: 03/01 TO 11/30
.....
.....
###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------
* Section
                  * NW | NE | SW | SE * NW | NE |
SW | SE * NW | NE | SW | SE * NW | NE | SW | SE
* Totals
Sec 32 T 12S R 7E SLBM *_____|_____|_____|_____*_____|_____|
6.3000|37.7000*_____|_____|_____|_____*
6.1000|19.9000|_____|_____* 70.0000

GROUP ACREAGE TOTAL: 70.0000
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OTHER
COMMENTS**********
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Morse Decree, 1st Class
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**********END OF DAT
A****

WATER RIGHT: **91-2991** APPLICATION/CLAIM NO.: CERT. NO.:
CHANGES: a11884 Withdrawn
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==========
OWNERSHIP**********
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NAME: John B. Jones
ADDR: Rt. 2 Box 96
Spanish Fork UT 84660
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==========
DATES,
ETC.**********
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LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: / /1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
07/20/1967|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-]|MAP: [28d]|PUB DATE:

*TYPE -- DOCUMENT -- STATUS----------
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Type of Right: Decree Source of Info: Water User's Claim Status: Water User's Claim

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LOCATION OF WATER RIGHT***(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER**********

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==========

FLOW: SOURCE: Clear Creek

COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:

(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM

Diverting Works:

Source:

Stream Alt Required?: No

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==========

USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*

==========
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SUPPLEMENTAL GROUP NO.: **614612.**

91-2991(WUC)

.....
.....

IRRIGATION: Sole Supply: UNEVALUATED acres Group Total: 66.9

Div Limit: 267.6 acft. PERIOD OF USE: 03/01 TO 11/30

.....
.....

###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------*

Section * NW | NE | SW | SE * NW | NE | SW | SE * NW | NE | SW | SE * Totals

Sec 32 T 12S R 7E SLBM *_____|_____|_____|_____* 1.8000|23.8000|7.4000|_____*_____|_____|_____|_____*26.6000|_____|1.9000|_____* 61.5000

Sec 33 T 12S R 7E SLBM *5.4000|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____* 5.4000

GROUP ACREAGE TOTAL: 66.9000

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SUPPLEMENTAL GROUP NO.: **614613.** Water Rights Appurtenant to the following use(s):

91-2991(WUC),2992(WUC)

.....
.....
IRRIGATION: Sole Supply: UNEVALUATED acres Group Total: 141.5
Div Limit: 566.0 acft. PERIOD OF USE: 03/01 TO 11/30
.....
.....
###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------*
Section * NW | NE | SW | SE * NW | NE | SW | SE * NW | NE | SW | SE * Totals

Sec 28 T 12S R 7E SLBM
*_____|_____|_____|_____*_____|_____|_____|_____*22.2000|_____|15.0000|_____*_____|_____|_____|_____* 37.2000

Sec 29 T 12S R 7E SLBM
*_____|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____* 4.7000|34.1000| 5.7000|40.0000* 84.5000

Sec 32 T 12S R 7E SLBM *_____|_____|_____|_____*
4.3000|14.2000|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____* 18.5000

Sec 33 T 12S R 7E SLBM *_____|_____|_____|_____*_____|
1.3000|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____* 1.3000

GROUP ACREAGE TOTAL: 141.5000
==========
==========
This Right (91-2991) has an evaluated sole-supply total for irrigation of 0.0000 acres.
==========
==========
This Right (91-2991) is a member of 2 supplemental water right groups with irrigated acreage totaling 208.4000 acres.
==========
==========
OTHER COMMENTS**********
****
==========
==========
Morse Decree - 1st Class.
WUCs 91-2991, 2992, 2993 are limited to the irrigation requirements of 267.5
acres and 4.458 cfs.
****
****
**********E N D O F D A T A**

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 09/27/2010

WATER RIGHT: **91-3622** APPLICATION/CLAIM NO.: CERT. NO.:
==========
==========
OWNERSHIP**********
****

==========
==========

NAME: Mae Nicolodemas
ADDR: Scofield UT 84538
INTEREST: 100% REMARKS:

==========
==========

DATES,
ETC.**********
****

==========
==========

LAND OWNED BY APPLICANT? Yes COUNTY TAX ID#:
FILED: |PRIORITY: / /1874|PUB BEGAN: |PUB ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC:
08/13/1969|LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
PD BOOK: [91-2]|MAP: [28d]|PUB DATE:
***TYPE -- DOCUMENT -- STATUS**----------
----------*
Type of Right: Decree Source of Info: Proposed
Determination Status: Water User's Claim

==========
==========

LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*******************

==========
==========

FLOW: 0.016 cfs SOURCE: Clear Creek
COUNTY: Carbon COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

==========
==========

USES OF WATER RIGHT******** *ELU -- Equivalent Livestock Unit (cow, horse, etc.)* ******** *EDU -- Equivalent Domestic Unit or 1 Family*

==========
==========

SUPPLEMENTAL GROUP NO.: **614843.**

.....
.....
IRRIGATION: 1.0 acres
Div Limit: 4.0 acft. PERIOD OF USE: 03/01 TO 11/30
.....
.....

```
  ###PLACE OF USE:        *-------NORTH WEST QUARTER------*-------NORTH EAST
QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------
*   Section
                          *  NW   |  NE   |  SW   |  SE   *  NW   |  NE   |
SW   |  SE   *  NW   |  NE   |  SW   |  SE   *  NW   |  NE   |  SW   |  SE
*   Totals
 Sec 05 T 13S R  7E SLBM *_______|_______|_______|_______*
1.0000|_______|_______|_______*_______|_______|_______|_______*_______|_______
_|_______|_______*      1.0000

GROUP ACREAGE TOTAL:      1.0000
==================================================================================
==================================================================
OTHER
COMMENTS*************************************************************************
************************************************
==================================================================================
==================================================================
     Morse Decree, 1st Class
**********************************************************************************
*****************************************************
*****************************************************E N D   O F   D A T
A***
WATER RIGHT: 91-4195      APPLICATION/CLAIM NO.:          CERT. NO.:
==================================================================================
==================================================================
OWNERSHIP************************************************************************
****************************************************
==================================================================================
==================================================================

NAME: Scofield Town (Public Water Supplier)
ADDR: Scofield UT 84538
INTEREST: 100%       REMARKS:
==================================================================================
==================================================================
DATES,
ETC.*****************************************************************************
*********************************************
==================================================================================
==================================================================
LAND OWNED BY APPLICANT? Yes                 COUNTY TAX ID#:
FILED:                |PRIORITY:  00/00/1874|PUB BEGAN:           |PUB ENDED:
|NEWSPAPER:
ProtestEnd:           |PROTESTED: [No      ]|HEARNG HLD:          |SE ACTION:
[        ]|ActionDate:          |PROOF DUE:
EXTENSION:            |ELEC/PROOF:[        ]|ELEC/PROOF:          |CERT/WUC:
05/08/1979|LAP, ETC:            |LAPS LETTER:
RUSH LETTR:           |RENOVATE:            |RECON REQ:           |TYPE: [
]
PD BOOK: [  91-     ]|MAP:  [28d          ]|PUB DATE:
*TYPE -- DOCUMENT -- STATUS-------------------------------------------------------
-----------------------------------------------------*
Type of Right: Decree                        Source of Info: Water User's
Claim            Status:
```

==========
==========
LOCATION OF WATER RIGHT*(Points of Diversion: Click on Location to access PLAT Program.)***********MAP VIEWER*******************
==========
==========
FLOW: 0.1 cfs SOURCE: Mud Creek & Green Canyon Springs
COUNTY: Carbon COMMON DESCRIPTION:

POINTS OF DIVERSION -- SURFACE:
(1) N 310 ft E 510 ft from S4 cor, Sec 05, T 13S, R 7E, SLBM
Diverting Works:
Source:
(2) S 546 ft W 285 ft from N4 cor, Sec 17, T 13S, R 7E, SLBM
Diverting Works:
Source:

Stream Alt Required?: No

POINT OF DIVERSION:
(1)Municipal directly on spring located at S 660 ft. W 660 ft. from N4 corner, Sec 17, T13S, R7E, SLBM.
COMMENT: Administratively updated by State Engineer.
==========
==========
USES OF WATER RIGHT******** ***ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family***
==========
==========
SUPPLEMENTAL GROUP NO.: **615095.** Water Rights Appurtenant to the following use(s):
91-830(REJ),2989(DEC),3094(DIL),4195(DEC),E1784(APP)
E2567(APP)

.....
.....
MUNICIPAL: Scofield
PERIOD OF USE: 01/01 TO 12/31
Acre Feet Contributed by this Right for this Use: Unevaluated
.....
.....
###PLACE OF USE: *-------NORTH WEST QUARTER------*-------NORTH EAST QUARTER------*-------SOUTH WEST QUARTER------*-------SOUTH EAST QUARTER------* Section
* NW | NE | SW | SE * NW | NE | SW | SE * NW | NE | SW | SE * Totals
Sec 17 T 13S R 7E SLBM *_____|X
|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____*_____|_____|_____|_____* 0.0000

GROUP ACREAGE TOTAL: 0.0000
==========
==========

OTHER
COMMENTS**********
****
==========
==========
Morse Decree 1st Class
****
****
**********E N D O F D A T
A****
EXCHANGE: **E1934 (91-4891)** BASE WATER RIGHT: - STOCK/CONTRACT
NUMBER: COUNTY TAX ID#:
RIGHT EVIDENCED BY: Price River Water Users Association Stock Certific
ate # 4035
==========
==========
OWNERSHIP**********
****
==========
==========
*----------
----------*

NAME: UCO Incorporated
ADDR: 1580 Lincoln Suite 530
Denver UT 80203
==========
==========
DATES,
ETC.**********
****
==========
==========
FILED: 06/29/1981|PRIORITY: 06/29/1981|ADV BEGAN: |ADV ENDED:
|NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION:
[ ]|ActionDate:01/21/1983|PROOF DUE:
EXTENSION: |ProofFiled: |CertIssued: |LAP, ETC:
|LAPS LETTR: |RUSH LETTER:
RENOVATE: |RECON REQ: |TYPE: [ ]
Date Verified: Initials: Status: Approved
Related Distribution System: Not part of any Distribution System
****
****
**********C U R R E N T R I G H
T**********
****
****
FLOW: 20.00 acre-feet
SOURCE: Scofield Reservoir
COUNTY: Carbon
POINT OF DIVERSION -- SURFACE:
(1) N 810 ft W 1000 ft from SE cor, Sec 10, T 12S, R 7E, SLBM
Diverting Works: Source: Scofield
Reservoir

*----------
----------*
NATURE OF USE:
.....
.....
  ###OTHER Irrigation under Wellington Canal System.
PERIOD OF USE: 01/01 TO 12/31
****
****
**********P R O P O S E D E X C H A
N G E**********
****
****
FLOW: 20.00 acre-feet PERIOD OF USE: 01/01 TO 12/31
SOURCE: Underground Water Well
COUNTY: Carbon COMMON DESCRIPTION: 1.5 - 2.5
mi. W. Scofield Town
*----------
----------*
==========
==========
LOCATION OF EXCHANGE*(Points of Diversion: Click on Location to access PLAT Program.)**********MAP VIEWER**********
==========
==========

POINT OF EXCHANGE -- UNDERGROUND: (Click link for PLAT data, click Well ID# link for more well data.)
(1) N 1320 ft 0 ft from S4 cor, Sec 21, T 12S, R 7E, SLBM
    DIAMETER OF WELL: ins. DEPTH: to ft. YEAR DRILLED:
WELL LOG? NO WELL ID#:
(2) N 1771 ft E 210 ft from S4 cor, Sec 21, T 12S, R 7E, SLBM
    DIAMETER OF WELL: ins. DEPTH: to ft. YEAR DRILLED:
WELL LOG? NO WELL ID#:
(3) N 2220 ft E 420 ft from S4 cor, Sec 21, T 12S, R 7E, SLBM
    DIAMETER OF WELL: ins. DEPTH: to ft. YEAR DRILLED:
WELL LOG? NO WELL ID#:
(4) N 2640 ft E 630 ft from S4 cor, Sec 21, T 12S, R 7E, SLBM
    DIAMETER OF WELL: ins. DEPTH: to ft. YEAR DRILLED:
WELL LOG? NO WELL ID#:
(5) S 2200 ft W 700 ft from NE cor, Sec 01, T 13S, R 6E, SLBM
    DIAMETER OF WELL: ins. DEPTH: to ft. YEAR DRILLED:
WELL LOG? NO WELL ID#:
(6) S 2000 ft W 2300 ft from NE cor, Sec 01, T 13S, R 6E, SLBM
    DIAMETER OF WELL: ins. DEPTH: to ft. YEAR DRILLED:
WELL LOG? NO WELL ID#:
(7) S 1300 ft W 2200 ft from NE cor, Sec 12, T 13S, R 6E, SLBM
    DIAMETER OF WELL: ins. DEPTH: to ft. YEAR DRILLED:
WELL LOG? NO WELL ID#:
(8) S 2100 ft E 2500 ft from NW cor, Sec 06, T 13S, R 7E, SLBM
    DIAMETER OF WELL: ins. DEPTH: to ft. YEAR DRILLED:
WELL LOG? NO WELL ID#:
(9) S 2100 ft E 1000 ft from NW cor, Sec 06, T 13S, R 7E, SLBM
    DIAMETER OF WELL: ins. DEPTH: to ft. YEAR DRILLED:
WELL LOG? NO WELL ID#:

*----------
----------*
POINT OF RELEASE:
FLOW: 20.00 acre-feet PERIOD OF USE: 01/01 TO 12/31
***Location of Release Point(s) is the SAME as Point(s) of Diversion in CURRENT RIGHT above.
*----------
----------*
NATURE OF USE:
SUPPLEMENTAL GROUP NO. 615764.
==========
==========
SEGREGATION HISTORY********
****
==========
==========
This Exchange as originally filed:

FLOW IN	QUANTITY IN			
----W A T E R U S E S----------				
CFS	ACRE-FEET	IRRIGATED	STOCK	
DOMESTIC	MUNICIPAL	MINING	POWER	OTHER
				ACREAGE
(ELUs)				
(FAMILIES)	(*----------ACRE-FEET----------*)			
			20.0	

****
****
**********E N D O F D A T A**

*----------
----------*
POINT OF RELEASE:
FLOW: 20.00 acre-feet PERIOD OF USE: 01/01 TO 12/31
***Location of Release Point(s) is the SAME as Point(s) of Diversion in CURRENT RIGHT above.
*----------
----------*
NATURE OF USE:
SUPPLEMENTAL GROUP NO. 615764.
==========
==========
SEGREGATION
HISTORY**********
****
==========
==========
This Exchange as originally filed:

FLOW IN	QUANTITY IN				
----W A T E R U S E S----------					
DOMESTIC	MUNICIPAL	CFS MINING	ACRE-FEET POWER	IRRIGATED OTHER ACREAGE	STOCK (ELUs)
(FAMILIES)	(*----------ACRE-FEET----------*)				
			20.0		

****
****
**********E N D O F D A T A**

CHANGE: **a28898** WATER RIGHT: 91-5083 CERT. NO.: COUNTY
TAX ID#: AMENDATORY? No
BASE WATER RIGHTS: 91-5083
RIGHT EVIDENCED BY: 91-5083(A1035)
91-2 Price River Water User`s Association Stock Certificates #8171 and #8172
CHANGES: Point of Diversion [X], Place of Use [X], Nature of Use [X], Reservoir Storage [X].
*----------
NAME: Tom F. & Kim Kreek
ADDR: 233 East 3000 South
Price UT 84501
REMARKS:

NAME: Price River Water User's Association
ADDR: 375 South Carbon Avenue A-10
Price, Utah 84501
REMARKS:
*----------
FILED: 04/09/2004|PRIORITY: 04/09/2004|ADV BEGAN: 05/13/2004|ADV ENDED: 05/20/2004|NEWSPAPER: Sun Advocate
ProtestEnd:06/09/2004|PROTESTED: [No]|HEARNG HLD: |SE ACTION: [Approved]|ActionDate:08/06/2004|PROOF DUE: 08/31/2009
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC: |LAP, ETC: 08/31/2009|LAPS LETTER:09/15/2009

RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [
]
Status: Lapsed
**********H E R E T O F O R E**********
**********H E R E A F T E R**********
|FLOW: 2.0 acre-feet ||FLOW:
2.0 acre-feet |
|----------||----------
|SOURCE: Gooseberry Creek ||SOURCE:
Underground Water Well |
|----------||----------
|COUNTY: Carbon ||COUNTY:
Carbon COM DESC: 2 miles North of Scofield Town |
|----------||----------
| HERETOFORE PLACE OF USE: Delivery ||
HEREAFTER PLACE OF USE: Lots #1 and #2 |
| through Carbon Canal ||
in
Scofield Lakeside Subdivision. |
| ||
HERETOFORE: |
| ||
Diversion: 0.40 acs x 5 af/ac/yr |
| ||
= 2
af/year |
| ||
Depletion: 2.52 af/ac/yr x 0.40 = |
| ||
1.008
af/year |
| ||
HEREAFTER: |
| ||
Diversion: 2 families x 0.25 |
| ||
af/family/yr = 0.50 af/year |
| ||
Depletion: 0.50 af/yr x 0.20 = |
| ||
0.1
af/year |
| ||
Diversion: 0.50 ac x 3 af/ac = |
| ||
1.5
af/year |
| ||
Depletion: 1.29 af/ac/yr x 0.50 |
| ||
ac =
0.645 af/year |
| ||
Total Depletion: 0.745 af/year |
Consumptive use data was taken from Research Report #145 Consumptive Use of
|
| ||
Irrigated Crops in Utah. Heretofore |
| ||
from
Castle Dale Station page 158. |
| ||
Hereafter from the Scofield Station |

324. page

POINT(S) OF DIVERSION ------> **MAP VIEWER** CHANGED AS FOLLOWS: (Click Location link for WRPLAT)

Point Surface:

(1) N 810 ft W 990 ft from SE cor, Sec 10, T 12S, R 7E, SLBM

Dvrting Wks:

Source:

Point Underground:

UNDERGROUND: (Click Link for PLAT data, Well ID# link for data.)

(1) N 1050 ft W 360 ft from S4 cor, Sec 21, T 12S, R 7E, SLBM

Diameter: 6 ins. Depth: 0 to 300 ft. WELL ID#: 34697

Point Rediversion:

(1) N 900 ft E 100 ft from SW cor, Sec 03, T 12S, R 7E, SLBM
Dvrting Wks:
Source: Ex.430, Theresa A. Phelps-well

(2) N 1420 ft W 480 ft from SE cor, Sec 04, T 12S, R 7E, SLBM
Dvrting Wks:
Source: Ex.175, Rudy Scartezina-well

(3) N 1285 ft W 345 ft from SE cor, Sec 04, T 12S, R 7E, SLBM
Dvrting Wks:
Source: Ex.336, Frank Marrelli-well

(4) S 1400 ft W 20 ft from E4 cor, Sec 04, T 12S, R 7E, SLBM
Dvrting Wks:
Source: Ex.397,Robt.or Francis Mallard-Well

(5) N 1338 ft E 655 ft from SW cor, Sec 17, T 12S, R 7E, SLBM
Dvrting Wks:
Source: Ex.178, Catherine Rudman-spring

(6) N 860 ft E 430 ft from S4 cor, Sec 19, T 12S, R 7E, SLBM
Dvrting Wks:
Source: Ex.375, G. Pete Frandsen-spring

(7) N 30 ft E 465 ft from S4 cor, Sec 32, T 12S, R 7E, SLBM
Dvrting Wks:
Source: Ex.164, Louis Gorishek-well

(8) N 430 ft W 410 ft from S4 cor, Sec 26, T 12S, R 9E, SLBM
Dvrting Wks:
Source: Price City Filtering Plant

(9) S 90 ft E 730 ft from N4 cor, Sec 35, T 12S, R 9E, SLBM
Dvrting Wks:
Source: Power Plant & Coal Company

(10) S 970 ft E 60 ft from W4 cor, Sec 05, T 13S, R 7E, SLBM
Dvrting Wks:
Source: Ex.452, Robert Radokovich-well

(11) N 900 ft E 980 ft from SW cor, Sec 12, T 13S, R 9E, SLBM
Dvrting Wks:
Source: Bryner-Hansen Ditch

(12) S 480 ft E 1440 ft from W4 cor, Sec 12, T 13S, R 9E, SLBM
Dvrting Wks:
Source: Bryner-Ploutz Ditch

(13) S 560 ft W 840 ft from N4 cor, Sec 13, T 13S, R 9E, SLBM	
Dvrting Wks:	
Source: Spring Glen Canal	
(14) N 1310 ft E 1000 ft from S4 cor, Sec 24, T 13S, R 9E, SLBM	
Dvrting Wks:	
Source: Gay Ditch	
(15) S 0 ft W 730 ft from NE cor, Sec 24, T 13S, R 9E, SLBM	
Dvrting Wks:	
Source: O`Berto Ditch	
(16) S 1190 ft W 1490 ft from E4 cor, Sec 24, T 13S, R 9E, SLBM	
Dvrting Wks:	
Source: Stowell Ditch	
(17) N 580 ft W 240 ft from S4 cor, Sec 36, T 13S, R 9E, SLBM	
Dvrting Wks:	
Source: Country Club-Cook Ditch	
(18) N 560 ft W 240 ft from S4 cor, Sec 36, T 13S, R 9E, SLBM	
Dvrting Wks:	
Source: Price-Wellington Canal	
(19) S 560 ft E 680 ft from N4 cor, Sec 01, T 14S, R 9E, SLBM	
Dvrting Wks:	
Source: Carbon Canal	
(20) N 1410 ft W 535 ft from S4 cor, Sec 08, T 15S, R 11E, SLBM	
Dvrting Wks:	
Source: Coal Washing Plant	
(21) S 1925 ft W 811 ft from NE cor, Sec 16, T 15S, R 11E, SLBM	
Dvrting Wks:	
Source: Coal Washing Plant	
(22) S 470 ft W 310 ft from E4 cor, Sec 16, T 15S, R 11E, SLBM	
Dvrting Wks:	
Source: Farnham Ditch	
(23) N 2261 ft W 218 ft from SE cor, Sec 16, T 15S, R 11E, SLBM	
Dvrting Wks:	
Source: Coal Washing Plant	

|PLACE OF USE ------> ||CHANGED as follows:

```
|-----------------------------------------------------------------||----------
|                                --NW¼--  --NE¼--  --SW¼--  --SE¼-- ||
--NW¼--  --NE¼--  --SW¼--  --SE¼-- |
|                               |N N S S||N N S S||N N S S||N N S S|||
|N N S S||N N S S||N N S S||N N S S||
|                               |W E W E||W E W E||W E W E||W E W E|||
|W E W E||W E W E||W E W E||W E W E||
|                                                                  ||Sec 21 T
12S R 7E SLBM     * : : : ** : : : ** : : :X** : : : *|
```

|NATURE OF USE ------> ||CHANGED as follows:

```
|-----------------------------------------------------------------||----------
|IRR  = values are in acres.                                       ||
|
|STK  = values are in ELUs meaning Cattle or Equivalent.           ||
|
|DOM  = values are in EDUs meaning Equivalent Domestic Units (F    ||
|
|-----------------------------------------------------------------||----------
-------------------------------------------------------|
```

```
|SUPPLEMENTAL to Other Water Rights: No
||SUPPLEMENTAL to Other Water Rights: No                          |
|-----------------------------------------------------------------||----------
|IRR:  18904.8200 acres.                        USED 04/01 - 10/31||IRR:
and       .5000 Supp acres   USED 04/01 - 10/31|
|.................................................................||..........
|                                                                  ||DOM:
2.0000 Equivalent Domestic Units.   USED 01/01 - 12/31|
```

```
|RESERVOIR STORAGE -->                                             ||CHANGED as
follows:                                                  |
|-----------------------------------------------------------------||----------
|Storage 01/01 to 12/31, in Scofield Reservoir                     ||
| with a maximum capacity of 73600.000 acre-feet, located in:      ||
|                              --NW¼--  --NE¼--  --SW¼--  --SE¼-- ||
|  Height of Dam:     125 ft |N N S S||N N S S||N N S S||N N S S|||
|  Area Inundat  2000.000 acs|W E W E||W E W E||W E W E||W E W E|||
|Sec 33 T 11S R  7E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||
|Sec 03 T 12S R  7E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||
|Sec 04 T 12S R  7E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||
|Sec 08 T 12S R  7E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||
|Sec 09 T 12S R  7E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||
|Sec 10 T 12S R  7E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||
|Sec 15 T 12S R  7E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||
|Sec 16 T 12S R  7E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||
|Sec 17 T 12S R  7E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||
|Sec 18 T 12S R  7E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||
|Sec 20 T 12S R  7E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||
|Sec 21 T 12S R  7E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||
|Sec 28 T 12S R  7E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||
|Sec 29 T 12S R  7E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||
|-----------------------------------------------------------------||----------
****************************E N D   O F   D A T A****
```

Exhibit 14

Geotechnical Investigations

Exhibit 14

Geotechnical Investigations

KINNEY MINE
Scofield, Utah

Geotechnical Investigation
November 26, 2007

RB&G
ENGINEERING, INC.

RB&G Response to Comment R645-301-242.110 and R645-301-553.130

The comment states:

'.....No specific recommendations for fill slopes were made, except that the sandy lean clay soils are collapsible and have a friction angle of 20 degrees.....'

The reviewer is referred to the second paragraph of Page 17, which reads:

'It is anticipated that fill slopes will be created with on-site material. If this material is placed and compacted in accordance with recommendations provided in Section IV, fill slopes as steep as 1.5H:1V will have a factor of safety of at least 1.3 if constructed of the native clayey soils. Fill slopes shown on Sections A-A, B-B, and F-F will likely be constructed of this clayey on-site fill. Test pits in the vicinity of the fill areas shown on Sections C-C, D-D, and E-E encountered significant amounts of medium-dense silty sand. Fill slopes as steep as 1.8H:1V constructed of this silty sand material have a computed factor of safety of at least 1.3. Plots of stability analyses for typical fill slopes are included in the appendix.'

Note that the Direct Shear test on the sample of sandy lean clay which had a friction angle of 20 degrees also had cohesion of 15 psi. Two Triaxial Shear tests performed on samples of the lean clay had total stress friction angles of 29.6 and 32.5 degrees with 2 psi cohesion and effective stress friction angles of 36.0 and 36.7 degrees with 2 psi cohesion.

RB&G Response to Comment R645-301-534.130 and R645-301-121.200

The comment states:

'The Applicant must address the safety factor for roads within the text of the MRP.'

Recommendations provided in Section VI. SLOPE STABILITY of the Geotechnical Report are applicable to roadway cut and fills.

RB&G Response to Comment R645-301-533.100 and 533.110

The comment states:

'The Applicant did not specifically state the safety factor for Sediment Pond 1.'

See Addendum No. 1 to the Geotechnical Report, attached hereto.

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RB&G
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KINNEY MINE
Scofield, Utah

Geotechnical Investigation
November 26, 2007

ADDENDUM NO. 1
September 28, 2010

Add the following to the end of Section VI. SLOPE STABILITY

Stability analyses were performed for the proposed Detention Pond for both Steady State and Sudden Drawdown conditions. The below ground pond was modeled with cut slopes of 3 horizontal to 1 vertical, extending 15 feet below the existing ground surface. It was assumed that the foundation soils will consist of native lean sandy clay. If fill is encountered in the excavation, it has been assumed that the cut will be over-excavated a distance of at least 10 feet into the side slope, and that this zone will be replaced with engineered fill as recommended in *Section V.I. – Detention Pond*. For the sudden drawdown condition, the phreatic surface was modeled to be within one foot of the slope surface 10 feet down-slope of the crest, exiting at the toe of the slope after full drawdown.

A factor of safety of 3.37 was obtained for the Steady State condition. For the Sudden Drawdown condition, the factor of safety reduces to 2.30.

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November 26, 2007

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RB&G Response to Comment R645-301-242.110 and R645-301-553.130

The comment states:

'.....No specific recommendations for fill slopes were made, except that the sandy lean clay soils are collapsible and have a friction angle of 20 degrees.....'

The reviewer is referred to the second paragraph of Page 17, which reads:

'It is anticipated that fill slopes will be created with on-site material. If this material is placed and compacted in accordance with recommendations provided in Section IV, fill slopes as steep as 1.5H:1V will have a factor of safety of at least 1.3 if constructed of the native clayey soils. Fill slopes shown on Sections A-A, B-B, and F-F will likely be constructed of this clayey on-site fill. Test pits in the vicinity of the fill areas shown on Sections C-C, D-D, and E-E encountered significant amounts of medium-dense silty sand. Fill slopes as steep as 1.8H:1V constructed of this silty sand material have a computed factor of safety of at least 1.3. Plots of stability analyses for typical fill slopes are included in the appendix.'

Note that the Direct Shear test on the sample of sandy lean clay which had a friction angle of 20 degrees also had cohesion of 15 psi. Two Triaxial Shear tests performed on samples of the lean clay had total stress friction angles of 29.6 and 32.5 degrees with 2 psi cohesion and effective stress friction angles of 36.0 and 36.7 degrees with 2 psi cohesion.

RB&G Response to Comment R645-301-534.130 and R645-301-121.200

The comment states:

'The Applicant must address the safety factor for roads within the text of the MRP.'

Recommendations provided in Section VI. SLOPE STABILITY of the Geotechnical Report are applicable to roadway cut and fills.

RB&G Response to Comment R645-301-533.100 and 533.110

The comment states:

'The Applicant did not specifically state the safety factor for Sediment Pond 1.'

See Addendum No. 1 to the Geotechnical Report, attached hereto.

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November 26, 2007

ADDENDUM NO. 1
September 28, 2010

Add the following to the end of Section VI. SLOPE STABILITY

Stability analyses were performed for the proposed Detention Pond for both Steady State and Sudden Drawdown conditions. The below ground pond was modeled with cut slopes of 3 horizontal to 1 vertical, extending 15 feet below the existing ground surface. It was assumed that the foundation soils will consist of native lean sandy clay. If fill is encountered in the excavation, it has been assumed that the cut will be over-excavated a distance of at least 10 feet into the side slope, and that this zone will be replaced with engineered fill as recommended in *Section V.I. – Detention Pond*. For the sudden drawdown condition, the phreatic surface was modeled to be within one foot of the slope surface 10 feet down-slope of the crest, exiting at the toe of the slope after full drawdown.

A factor of safety of 3.37 was obtained for the Steady State condition. For the Sudden Drawdown condition, the factor of safety reduces to 2.30.

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GEOTECHNICAL INVESTIGATION

KINNEY MINE

Scofield, Utah

Prepared for:
Carbon Resources LLC,
a New Mexico Limited Liability Company

November 2007

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200701-045

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ENGINEERING, INC.

November 26, 2007

Carbon Resources LLC,
a New Mexico Limited Liability Company
c/o Greg Hunt
Geo-Hunt Consulting, Inc.
16577 Columbine Lane
Cedarredge, CO 81413

Subject: Kinney Mine, Scofield, Utah
Geotechnical Investigation

Gentlemen:

A Geotechnical Investigation has been completed for the proposed Kinney Mine in Scofield, Utah. The results of the study are summarized in the report transmitted herewith.

We appreciate the opportunity of providing this service for you. If there are any questions relating to the information contained herein, please call.

Sincerely,

RB&G ENGINEERING, INC.

REGISTERED PROFESSIONAL ENGINEER
NO.162291
BRADFORD E.
PRICE
12/17/07
STATE OF UTAH

Bradford E. Price, P.E.

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Geotechnical Investigation

Kinney Mine

Scofield, Utah

Prepared for:
Carbon Resources LLC,
a New Mexico Limited Liability Company

November 2007

RB&G ENGINEERING, INC.

RB&G
ENGINEERING, INC.

KINNEY MINE
Scofield, Utah

Geotechnical Investigation

INTRODUCTION

This report outlines the results of a geotechnical investigation performed for the proposed Kinney Mine surface facilities to be located north-northeast of Scofield, Utah at the approximate location shown in Figure 1. The purpose of this investigation was to determine the characteristics of the subsurface material throughout the site so that satisfactory substructures and slopes can be designed to support the proposed facilities. The results of the investigation, along with pertinent recommendations for design, are outlined in the following sections of this report.

The information contained in the report is discussed under the following headings: (1) Geologic Setting and Existing Site Conditions, (2) Field and Laboratory Testing Procedures, (3) Subsurface Soil and Water Conditions, (4) Site Preparation and Compacted Fill Requirements, (5) Foundation Considerations and Recommendations, and (6) Slope Stability Analyses.

I. GEOLOGIC SETTING AND EXISTING SITE CONDITIONS

The regional and site geology is being prepared by others and will be submitted under separate cover. The area is located in Seismic Zone 2B according to the 1997 edition of the Uniform Building Code. The site is located on the east side of Highway 96, rising to the east with the elevation ranging from about 7700 to 7900 feet. Adjacent to Highway 96, the southerly half of the site is relatively flat for a few hundred feet before rising to the east. This area has been used for mining activities in the past and has been reclaimed with topsoil overlying approximately 2 to 6 feet of coal and soil fill. The vegetative cover across the site consists of native grass and sagebrush with some aspen trees.

Scofield Reservoir is located 0.5 to 1 mile northwest of the site at about elevation 7620 feet. No major water conveyance facilities or other water bodies exist in the immediate vicinity, which would influence the groundwater level at this site. Other than the information provided above, no conditions appear to exist at this site which would adversely affect foundation performance.

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II. FIELD AND LABORATORY TESTING PROCEDURES

The subsurface investigation was performed with borings and test pits. The borings were drilled using a Simco 2800 drill rig and continuous flight auger to advance the boring, and a Longyear 44 with H.Q. core to advance the boring. Where coring was performed in overburden, split spoon samples were obtained at select intervals. Sampling was generally performed in the overburden at five-foot intervals throughout the depth investigated. Disturbed samples were obtained by driving a 2-inch split spoon sampling tube through a distance of 18 inches using a 140-pound weight dropped from a distance of 30 inches. The number of blows to drive the sampling spoon through each 6 inches of penetration is shown on the boring logs. The sum of the last two blow counts, which represents the number of blows to drive the sampling spoon through 12 inches, is defined as the standard penetration value. The standard penetration value, corrected for overburden and hammer energy, provides a good indication of the in-place density of sandy material; however, it only provides an indication of the relative stiffness of the cohesive material, since the penetration resistance of materials of this type is a function of the moisture content. Considerable care must be exercised in interpreting the standard penetration value in gravelly-type soils, particularly where the size of the granular particle exceeds the inside diameter of the sampling spoon. If the spoon can be driven through the full 18 inches with a reasonable core recovery, the standard penetration value provides a good indication of the in-place density of gravelly-type material.

It will be noted that it was not possible to drive the sampling spoon through the full 18 inches at some sampling locations. Where the sampling tube could not be driven through the full 18 inches, the number of blows to drive the spoon through a given depth of penetration is shown on the boring logs.

Miniature vane shear tests, which provide an indication of the undrained shearing strength of cohesive materials, were performed on samples of the clay soil during the field investigations. The results of these tests are shown on the boring logs as the torvane value in tsf.

The test pits were excavated using a John Deere 160 trackhoe. During the subsurface investigation, the test pits were logged and sampling was performed at about three-foot intervals throughout the depth investigated. Both disturbed and undisturbed samples were obtained during the field investigations. The in-place dry unit weight and the natural moisture content was determined in the field using a Troxler nuclear density gauge at select sample locations with the samples delivered to the laboratory to verify moisture content. Undisturbed samples were obtained by trimming block samples of the cohesive material encountered in the soil profile.

Each sample obtained in the field was classified in the laboratory according to the Modified Unified Soil Classification System. The symbol designating the soil type according to this system, is presented on the logs. A description of the Modified Unified Soil Classification System is presented in the appendix, and the meaning of the various symbols, shown on the logs, can be obtained from this figure.

Laboratory tests performed during this investigation to define the characteristics of the subsurface material throughout the proposed site included in-place dry unit weight, natural moisture content, Atterberg Limits, mechanical analyses, unconfined compressive strength, pH, resistivity, sulfate, direct shear, triaxial shear, and consolidation tests. Testing was performed following procedures outlined in the American Society for Testing and Materials (ASTM) standards.

III. SUBSURFACE SOIL AND WATER CONDITIONS

The characteristics of the subsurface material throughout the site were evaluated by drilling 6 borings to depths of between 25 and 76.5 feet and excavating 14 test pits to depths of between 8 and 19.5 feet at the approximate locations shown in Figure 2. The logs for the borings and test pits are presented in the appendix and the subsurface profile at each test hole location is included on the logs. Also included in the appendix are photos of the cores obtained in the borings.

No groundwater was encountered within the depth investigated at the time the field investigation was performed (August/September 2007).

The results of classification, density and moisture tests are presented on the test hole logs, and the results of all laboratory tests, with exception of the consolidation tests, are summarized in Tables 1 and 2 in the appendix. It will be noted from Table 1 that the in-place dry unit weight of the subsurface material varies from 86.6 to 118.5 pcf and that the natural moisture content of the cohesive soil ranges from 4.5 to 17.5%. The cohesive soil has 15 to 34% gravel, 19 to 42% sand, and 27 to 66% clay. The liquid limit of the lean clay and silt ranges from 19 to 42 and the plasticity index varies from 4 to 26. The non-plastic silty sand has 15 to 38% gravel size particles, 38 to 61% sand, and 9 to 28% silt. The gravelly material has 55 to 64% gravel, 23% sand, and 13 to 22% silt size particles. The unconfined compressive strength of the lean clay ranges from 2080 to 8280 psf.

One direct shear test was performed on a sample of the sandy lean clay obtained from Test Pit CV-5-1 at a depth of 12 feet. The results of this test are included in the appendix and summarized on Table 2. It will be noted that this sample has a friction angle of 20 degrees and a cohesion of 15 psi.

Two triaxial shear tests were performed on samples of the lean clay obtained from Boring CV-4-1 at a depth of 20 to 21.5 feet and from Boring SC-2 at 23 to 24 feet. The results of this test are also included in the appendix and summarized on Table 2. It will be observed that a friction angle of 29.6 and 32.5 degrees with 2 psi cohesion was obtained for the total stress envelopes.

In order to obtain an indication of the corrosive nature of the subsurface material at this site, four resistivity, pH, and sulfate tests were performed on samples obtained throughout the site. The results of these tests are presented on Table 2. It will be noted that the soils tested have relatively low corrosive characteristics. It is recommended that Type II cement be used for concrete in contact with soil.

The compressibility characteristics of the subsurface material were evaluated by performing eleven consolidation tests, and the results of these tests are also presented in the appendix. During the performance of the consolidation tests, each sample was loaded at the natural moisture content until a load intensity of 0.58 tsf had been reached. At this point in the loading cycle, each sample was permitted to absorb water without any increase in the load intensity. Soils having collapsible characteristics always settle without any increase in the load when they become wet or saturated, and expansive soils experience an increase in void ratio on absorbing water. It will be observed from these tests that five of the samples tested exhibited collapsible characteristics and that three of the samples showed expansive characteristics.

IV. SITE PREPARATION AND COMPACTED FILL REQUIREMENTS

Included on Figure 2 are the location of preliminary cut and fill sections. These sections are presented in Figures 3 through 8. In areas where structures will be located, it is recommended that clearing and grubbing be performed to remove excess organic matter. It is anticipated that this will require stripping of the upper 6 inches and grubbing of tree and sagebrush roots. This action should also be performed in parking areas and borrow areas. Where cut and fill operations will take place, it is recommended that the excavated material be moisture conditioned to within 2% of optimum moisture content, placed in 8 inch (maximum) lifts and compacted to an in-place unit weight equal to at least 92% of the maximum laboratory density as determined by ASTM D 1557 for fills outside of building areas and 95% for fills where structures will be located. A sheeps-foot or tamping-type roller should be used for compacting the clay soils.

V. FOUNDATION CONSIDERATIONS AND RECOMMENDATIONS

It is recommended that exterior structural foundations be located at a depth below finished grade sufficient to provide frost protection, which is about 4.5 feet in this area. If the foundations for

the proposed facilities are designed in accordance with the recommendations outlined below, the maximum settlement of any footing should not exceed one inch and differential settlement throughout the structure should not exceed 0.5 inch. It is generally recognized that the tolerable differential settlement for steel and concrete structures is about 0.002 times the column spacing. This criterion is tantamount to a differential settlement of about 0.5 inch for column spacings of 20 feet and 0.7 inch for column spacings of 30 feet. Since it is not anticipated that the column spacing for this structure will be less than 20 feet, a differential settlement of 0.5 inch should be satisfactory for the proposed facility. Additional potential settlement associated with collapsible type soil layers is discussed where applicable.

A. MINE DRY / OFFICE – (Test Pits MDF-1, MDF-2, & MDF-3)

Test Pits MDF-1, 2 and 3 define the characteristics of the subsurface profile in the vicinity of the Mine Dry / Office facility. It will be noted from the test pit logs that the soil profile for Test Pit MDF-1 consists of stiff lean clay throughout the depth investigated (15 feet). Test Pit MDF-2 encountered clayey sand with gravel and silty sand with gravel, cobbles and boulders to a depth of 9 feet, followed by stiff lean clay to a depth of 18 feet. Test Pit MDF-3 encountered 3 feet of coal fill, followed by silty sand and gravel with cobbles and boulders to a depth of 15 feet. Lean clay with sand was encountered from 15 feet to the bottom of the test pit at 20 feet.

It is our understanding that the floor level for this structure will be at about elevation 7727 feet. Tabulated below is the ground elevation at the three test pit locations:

MDF-1	7720.4 feet
MDF-2	7729.6 feet
MDF-3	7744.0 feet

It is apparent that about 7 feet of fill will be required to meet final grade on the westerly side of the building site (MDF-1), and that 17 feet of cut will be required on the easterly side of the building site (MDF-3). The native lean clay has relatively high dry strength; however, this material has collapsible characteristics and will experience significant settlement if it becomes wet.

Options for foundation support include (1) supporting the structure on spread footings and providing partial mitigation against settlement associated with collapsible soils, and (2) supporting the structure on deep foundations extending below the collapsible lean clay layers.

(1) Spread Footings

As indicated above, the native lean clay has relatively high dry strength. If these soils become wet, the soil matrix will collapse and settlement will occur. Up to 20 inches of settlement is possible under saturated conditions. If precautions are taken to prevent the native lean clay from becoming wet, the structure can be supported on spread footings. These precautions should include providing positive drainage away from the building and installing an impervious membrane extending at least 6 feet beyond the outside footings. While this action will reduce the risk of moisture entering the subgrade clay, the owner should be made aware that significant settlement will occur if these soils become wet.

An allowable soil bearing capacity of 2500 psf can be used for spread footings supported on the native lean clay and fill compacted to the recommendations outlined in Section IV. Shallow foundation support will be satisfactory provided that the native lean clay does not become wet during the design life of the structure.

(2) Deep Foundations

It is our opinion that drilled shafts represent the most efficient deep foundation option for this structure. To minimize downdrag forces if the collapsible soils become wet, it is recommended that 2 foot diameter drilled shafts be used with the ends belled for increased capacity. It is recommended that the shafts extend to elevation 7700 feet. Shown in the following table are allowable capacities for end bearing drilled shafts terminating in the stiff lean clay at a depth of about 27 feet below the finished pad level.

Procedures outlined in FHWA-H1-88-042, "*Drilled Shafts: Construction Procedures and Design Methods*" have been used to determine size and load capacities. It has been assumed that high quality construction, good specifications and excellent inspection will exist for the structure. The capacities are based upon end bearing only, and it is, therefore, essential that the base of the shafts be cleaned to remove all loose debris.

Based upon these assumptions, a factor of safety of 2.5 has been selected. The shafts can be belled to achieve the required base diameter.

Tabulated below are capacities for compression loading for various diameters of shafts.

Shaft Diameter (ft)	Total Compressive Capacity (kips)	Allowable Compressive Capacity (kips) – f.s. = 2.5
2	40	16
3	89	35
4	158	63
5	247	99

The design of rebar and concrete should follow established guidelines. If this option is used, it is recommended that inspection of the shaft excavations be made by the soils engineer prior to placement of concrete.

B. SHOP / WAREHOUSE – (Test Pits WSF-1, WSF-2, & WSF-3)

Test Pits WSF-1, 2 and 3 define the characteristics of the subsurface profile in the vicinity of the proposed Shop / Warehouse structure. It will be noted from the test pit logs that the soil profile includes a 1 foot sandy lean clay layer underlain by 3 to 5 feet of coal fill. In Test Pit WSF-1 a 2 foot layer of sandy clay was encountered below the coal fill, followed by highly weathered sandstone to the bottom of the test hole at 13 feet. Test Pit WSF-2 encountered loose silty sand with gravel below the coal fill from 3.5 to 8.5 feet. The silty sand was followed by layers of sandy clay and clayey sand from 8.5 to 12 feet, then gravel with cobbles and boulders to the bottom of the test pit at 16 feet. The profile in Test Pit WSF-3 consists of loose silty sand with gravel below the coal fill from 3 to 9 feet, followed by a 2.5 foot layer of sandy clay to 11.5 feet, then medium dense silty sand from 11.5 to 15 feet.

It is our understanding that the floor level for this structure will be at about elevation 7728 feet. Tabulated below is the ground elevation at the three test pit locations:

MSF-1	7719.5 feet
MSF-2	7721.6 feet
MSF-3	7718.7 feet

It is apparent that 6 to 9.5 feet of fill will be required to meet final grade throughout the building site. It is recommended that the loose coal fill be removed from beneath the building area prior to placement of fill. Assuming that the native soils (including lean clay, sand, and gravel) are used to establish final grade, and that compaction requirements outlined in Section IV are complied with, footings can be designed using an allowable soil bearing capacity of 3500 psf, except that in no case should the width of any footing be less than 2 feet.

Up to 3 feet of collapsible soils were encountered in Test Pits WSF-2 and 3. The sample from 9 feet in Test Pit WSF-3 experienced about 3% settlement upon wetting. It is estimated that 1 inch of additional settlement may occur if these soils become saturated.

C. COVERED STORAGE AND FUEL STRUCTURE – (Test Pits CS-1 and F-1)

Test Pits CS-1 and F-1 define the characteristics of the subsurface profile in the vicinity of the proposed Covered Storage and Fuel Structure sites. It will be noted from the test pit logs that the soil profile includes a 0.5 to 1 foot sandy lean clay layer underlain by 7 to 8.5 feet of loose fill consisting of coal, and layers of coal and clayey sand with gravel. In Test Pit CS-1, sandy lean clay was encountered below the coal fill, extending from 8.5 to 16 feet, followed by a 2 foot layer of sandy gravel. The lean clay exhibits collapse characteristics. Test Pit F-1 encountered 4 feet of sandy clay and clayey sand layers below the 7 feet of loose fill, followed by sand and gravel from 11 to 16 feet.

It is our understanding that the floor level for these structures will be at about elevation 7728 feet. Tabulated below is the ground elevation at the two test pit locations:

CS-1	7716.6 feet
F-1	7724.0 feet

It is apparent that 4 to 11 feet of fill will be required to meet final grade throughout the building sites. It is recommended that the loose coal fill be removed from beneath the building areas prior to placement of fill. Assuming that the native soils (including lean clay, sand, and gravel) are used to establish final grade, and that compaction requirements outlined in Section IV are complied with, footings can be designed using an allowable soil bearing capacity of 3500 psf, except that in no case should the width of any footing be less than 2 feet.

Up to 5 feet of collapsible soils were encountered in Test Pit CS-1 between 10 and 16 feet below the existing ground surface. It is estimated that up to 2 inches of additional settlement may occur if these soils become saturated. Since the moisture sensitive soils will be about 20 feet below final grade, it is our opinion that the risk of saturation and collapse of this layer once the structures are in place is relatively low.

D. CONVEYOR SECTION–1 (Boring Portal 1 and Test Pit TT-1-2)

Boring Portal-1 and Test Pit TT-1-2 were placed along the alignment for Conveyor Section-1. It will be noted from the boring log that the subsurface profile in the portal area consists of interbedded siltstone and sandstone gravels and cobbles in a sandy silt matrix with occasional clay layers to a depth of about 18 feet (elev. 7873'). A 4 foot coal layer was encountered between elevation 7873 and 7869 feet, followed by 6 inches of highly weathered mudstone; then relatively competent sandstone to the bottom of the boring at 25 feet (elev. 7865').

The ground elevation at Test Pit TT-1-2 was 7873.1 feet, and the profile consists predominantly of silty clay with gravel to a depth of 4 feet (elev. 7869'), followed by clayey gravel with cobbles to the bottom of the test pit at a depth of 8 feet (elev. 7865').

It is our understanding that the portal pad elevation will be at 7869 feet. Structures contemplated along this section include the portal entrance, conveyor supports and the transfer tower. At elevation 7869 feet, the portal excavation will extend into bedrock. It is recommended that supports not be founded on the coal or the highly weathered mudstone. We recommend that foundation support areas extend through these materials and into the underlying sandstone. It is recommended that the sandstone be treated as a very dense sand to evaluate allowable bearing capacity for footings. For footings located on the sandstone or granular fill overlying the sandstone and compacted to an in-place density equal to at least 95% of the maximum laboratory density as determined by ASTM D 1557, we recommend that footings be designed using the allowable bearing capacities shown in the following table:

FOOTING WIDTH (ft)	ALLOWABLE BEARING CAPACITY (psf) (assumes factor of safety = 2.5)
2	5800
3	6900
4	7950
5	9050
6	10,100
7	9,800
8	9,500
12	8,800
16	8,500

The above capacities assume a minimum embedment depth of 2 feet and a maximum total settlement of 1 inch with differential settlement less than 0.5 inch.

The clay encountered in Test Pit TT-1-2 to elevation 7869 feet has collapsible characteristics and we recommend that no foundations be supported on this material. It appears that foundations for the conveyor section will extend into the gravelly clay and clayey gravel with cobbles and boulders below an elevation of 7869 feet. If the conveyor is supported using spread footings, it is recommended that an allowable bearing capacity of 2500 psf be used for the clay soils.

For this conveyor section, capacities for drilled shafts extending 8 to 10 feet into the gravelly clay and clayey gravel are shown in the following table:

Shaft Diameter (ft)	Total Compressive Capacity (kips)	Allowable Compressive Capacity (kips) – f.s. = 2.5
2	42	17
3	84	34
4	141	56
5	211	84

It is recommended that lateral bearing be determined using procedures outlined in Section 1804 and 1805 of the 2006 edition of the International Building Code (IBC). It is recommended that Material Class 5 (CL) be used with a lateral bearing of 100 psf per foot. L-Pile Parameters can be provided upon request for specific locations.

It is apparent from Figures 2 and 8 that the transfer tower will be located on compacted fill. It is anticipated that the collapsible clay layer, which extended to a depth of about 4 feet, will also exist in the area where the transfer tower is planned. If the transfer tower is supported on spread footings, it is recommended that the collapsible clay layer be excavated prior to placement of fill. Under this scenario, the footings placed on compacted fill can be designed using an allowable bearing capacity of 3500 psf, following recommendations outlined in Section V.B.

E. CONVEYOR SECTION–2 (Test Pit CV-2-1, Boring CV-2-2, & Test Pit CV-2-3)

Test Pit CV-2-1, Boring CV-2-2, and Test Pit CV-2-3 were placed along the alignment for Conveyor Section-2. The soil profile for each of these test holes is discussed separately below:

Test Pit CV-2-1

This test pit encountered stiff lean clay with gravel and cobbles to a depth of 3.5 feet, followed by 6 inches of coal. Below the coal, the profile consists of cobbles and boulders in a silty sand matrix to a depth of 14 feet, followed by competent sandstone to the bottom of the boring at 19 feet.

Boring CV-2-2

The boring encountered sandy clay to a depth of 3 feet, followed by medium dense to dense silty sand with gravel to 24 feet. A layer of lean clay was encountered between 24 and 30 feet. The clay was underlain by dense silty sand with gravel to the bottom of the boring at 32 feet.

Test Pit CV-2-3

This test pit encountered stiff sandy lean clay with gravel fill to a depth of 6.5 feet, underlain by 6 inches of coal. Native very stiff sandy clay with gravel was encountered between a depth of 6 and 11 feet, followed by sandstone to the bottom of the test pit at 15 feet.

Foundations for this conveyor section can be designed using the recommendations provided for Conveyor Section 1 in Section V., except that no footings should be located on the existing clay fill. Where fill is encountered, it is recommended that the foundations either extend below the fill, or that the fill be excavated and replaced as compacted fill under controlled conditions.

F. CONVEYOR SECTION–3 (Borings NS-1 and S-1)

Borings NS-1 and S-1 were placed along the alignment for Conveyor Section-3. It will be noted from the boring logs that the subsurface profile at each of these locations consists predominantly of very stiff sandy lean clay with some gravel and occasional cobbles and boulders lower in the profile. The borings extended to a depth of about 50 feet, terminating at elevation 7735 feet.

It will be noted from Figure 4 that a significant excavation will be required on the westerly side of the stockpile area and that some filling will be required on the easterly side to provide the pad elevation at 7780 feet. The ground elevation at the boring locations is at about 7785 feet. Some samples of the clay in the upper 5 feet have a pinhole type structure characteristic of collapsible soils. Samples deeper in the profile between elevation 7730 and 7715 feet exhibited expansive characteristics for load intensities less than about 2 tsf. The allowable bearing capacity for spread footings located between elevation 7775 and 7755 feet will be controlled by the stiff lean clay.

It is recommended that spread footings be designed using an allowable bearing capacity of 2500 psf. The magnitude of large area loads associated with the coal stockpiles are not known as of the preparation of this report. If the area loads exceed 500 psf, it is recommended that an analysis be performed to evaluate the settlement associated with large area loads.

G. CONVEYOR SECTION–4 (Borings CV-4-1 and SC-2)

Borings CV-4-1 and SC-2 were placed along the alignment for Conveyor Section-4, with SC-2 located at the location of the proposed screening and crushing facility. Boring CV-4-1 was

located at elevation 7776 feet and encountered lean clay with gravel and occasional cobbles and boulders throughout the depth investigated, terminating at a depth of 71 feet (elev. 7705'). Boring SC-2 was located at ground elevation 7741 feet and extended to a depth of about 31 feet (elev. 7710'). It will be noted from the boring log that no sampling was performed in the upper 19 feet. At the time drilling was performed, it was assumed that this material would be removed.

It will be noted from Figure 2 that the pad elevation for the Screening and Crushing facility is at 7742 feet. It is recommended that this structure be supported on drilled shafts extending to a depth of at least 25 feet. Recommendations provided in Section V.A. Mine Dry / Office *(2) Deep Foundations* are applicable to this site.

It is recommended that foundations for the conveyor along this section also be supported on drilled shafts extending to a depth of 8 to 10 feet in the vicinity of Boring CV-4-1 and 25 feet in Boring SC-2. Foundations for this conveyor section can be designed using the recommendations provided for Conveyor Section 1 in Section V., except that no footings should be located on the existing clay fill.

H. CONVEYOR SECTION–5 (Test Pits CV-5-1 and CV-5-2)

Test Pits CV-5-1 and CV-5-2 were placed along the alignment for Conveyor Section-5. Each of the test pits encountered fill consisting of lean clay with layers of coal and silt to a depth of 5 feet in Test Pit CV-5-1 and 11.5 feet in Test Pit CV-5-2. The fill was underlain by sandy lean clay which exhibited a pinhole structure characteristic of collapsible-type soils. The sample obtained at a depth of 9 feet in Test Pit CV-5-1 settled approximately 8% when saturated. The sample obtained at a depth of 12 feet in Test Pit CV-5-2 exhibited a 2% swell when saturated.

The proposed pad elevation for this area is at 7232 feet. The elevation of the two test pits are as follows:

CV-5-1	7737.7 feet
CV-5-2	7749.8 feet

It will be noted that Test Pit CV-5-2 located near the Truck Loadout only extended to elevation 7730 feet, 2 feet below the pad level. It is recommended that foundations for the Truck Loadout facility bypass the moisture sensitive clay in the upper portion of the soil profile. Based upon the two test pits, it appears that these clays extend to at least elevation 7715 feet. We recommend that the structure be supported on drilled shafts extending to an estimated depth of 30 feet below the pad level, to about elevation 7702 feet. We recommend

that an additional boring be located at the Truck Loadout site to evaluate the characteristics of the subsurface soil. We recommend that the conveyor system also be supported on drilled shafts extending to a depth of 8 to 10 feet below the pad level.

Recommendations provided in Section V.A. Mine Dry / Office (2) Deep Foundations are applicable to this area.

I. DETENTION POND

It is our understanding that a below ground detention pond is planned at the north side of the property at the approximate location shown in Figure 2. We understand that the pond will be sized to hold between 2.5 and 2.7 acre feet with the bottom 12 to 15 feet below the existing ground surface. No test holes were located in the detention pond area; however, test pits CV-5-1 and CV-5-2 located a few hundred feet south of the area both encountered fill to depths varying from 5 to 12 feet. The fill has interbedded layers of coal, sandy gravel and lean clay. It is recommended that the excavation side slopes be cut at 3 horizontal to 1 vertical. If fill is encountered, it is recommended that the cut be over-excavated a distance of at least 10 feet into the side slope, and that this zone be replaced with engineered fill. On site material can be used as engineered fill provided that it is placed in lifts not exceeding 8 inches, moisture conditioned and compacted in accordance with the recommendations provided in Section IV of this report. It is also recommended that the detention pond be lined with 18 inches of compacted lean clay obtained from on-site excavations and that a 6 inch layer of sandy gravel be placed over the liner to protect the clay from cracking.

J. ROADWAYS

The project will require cuts and fills for roadway construction throughout the development. For shallow cuts less than 20 feet in the native clayey soils, we recommend that slopes of 1.25H:1V or flatter be used. Fill slopes less than 20 feet high and constructed of clayey soils may slope as steeply at 1.5H:1V. Fill slopes constructed of sandy soils should be sloped at 1.8H:1V or flatter. Slopes for roadway fills and cuts with heights or depths greater than 20 feet should be designed in conformance with the slope stability recommendations in Section VI of this report.

K. SEISMIC CONSIDERATIONS

As indicated earlier in this report, the site is located in Seismic Zone 2B according to the 1997 edition of the Uniform Building Code. Soil profile type S_D should be used for structural

seismic design, with the Uniform Building Code. The site is classified as Site Class D, as per Section 1613 of the 2006 International Building Code.

The site is located at latitude 39.7330° North and longitude 111.1535° West. Probabilistic peak ground acceleration (PGA) values are tabulated below:

Probabilistic ground motion values in %g.

	10%PE in 50 yr	2%PE in 50 yr
PGA	12.19	27.94
0.2 sec SA	28.21	64.33
1.0 sec SA	9.46	21.94

The allowable soil bearing pressure indicated above may be increased by one-third where seismic forces are involved in the structural loads. If the passive pressures associated with footings and walls are used to resist seismic forces, and if backfilling is performed using granular material, we recommend that the passive pressures be calculated from the lateral earth pressure equation using an earth pressure coefficient of 2.0. If the frictional resistance of the footings and floor slabs are used to resist seismic forces, we recommend a coefficient of friction of 0.40 be used to calculate these forces.

Since the groundwater level is at a substantial depth below the ground surface and since the subsurface soil profile consists predominantly of lean clay and gravel, problems associated with liquefaction during a seismic event are unlikely at this location, and no special mitigation of the foundation soils is required.

VI. SLOPE STABILITY

The proposed development will require earthwork to establish roadways, level structure areas, and a detention basin on the hillside. Figures 3 through 8 show sections cut at locations as shown in Figure 2. The purpose of these sections is to evaluate the stability of the proposed cut and fill slopes.

It will be noted from the section drawings that the proposed fill slopes range from about 1.5H:1V to 2H:1V. The proposed cut slopes are steeper, varying from about 0.8H:1V to 1.4H:1V. The section drawings also show the locations of test holes performed in the vicinity of the section lines. The holes applicable to each section are summarized on the table below, along with the predominant soil types and brief descriptions of the proposed earthwork in the area.

Section	Earthwork Description (as shown on sections)	Test Hole No.	Depth (ft)	Soil / Rock Description
A-A	Cut Slopes 0.8H:1V to 1.4H1V Fill Slope 1.5H:1V	CV-5-1 TH	19.5	Stiff Sandy Lean Clay
		CV-4-1 DRL	71.5	Stiff Sandy and Gravelly Lean Clay
		SC-2 DRL	30.5	Stiff Sandy Lean Clay (not sampled above 19')
B-B	Cut Slope 0.8H:1V File Slope 1.5H:1V	NS-1 DRL	50	Stiff Lean Clay, with some dense Sand and Gravel layers
		S-1 DRL	76.5	Stiff Sandy Lean Clay
C-C	Cut Slope 0.8H:1V Fill Slope 1.8H:1V	CV-2-2 DRL	31.5	Silty Clay to 3', Silty Sand from 3' to 24' Stiff Lean Clay from 24' to 30.5', then Sand
D-D	Cut Slope 1.25H:1V Fill Slope 2H:1V	WSF-3 TH	19.5	Silty Sand and Lean Clay layers, some coal in upper 3'
		WSF-2 TH	16	Silty Sand and Lean Clay layers, some coal in upper 3', gravel below 12'
E-E	Cut Slope 1H:1V Fill Slopes 2H:1V	MDF-1 TH	19.5	Stiff Sandy Lean Clay
		MDF-2 TH	19.5	Stiff Sandy Lean Clay with Silty Sand layer
		MDF-3 TH	19.5	Silty Sand, Gravel and Lean Clay layers, some coal in upper 2'
F-F	Cut Slope 0.8H:1V Fill Slope 1.8H:1V	TT-1-2 TH	8	Silty Clay to 4', then Gravel with Clay
		Portal-1 DRL	25	Silty Gravel with some Clay layers to 14' Sandstone, Mudstone, Coal from 14' to 25'

Stability analyses were performed using the computer program Slope/W. Spencer's method, which satisfies both force and moment equilibrium requirements, was used to compute factors of safety. Potential circular failure surfaces were evaluated using a grid and radius approach.

Stability analyses were performed primarily for Sections A-A, B-B and F-F. At Sections A-A and B-B, the predominant soil type was assumed to be stiff lean clay. Based on the results of field and laboratory testing, this material was assigned an internal friction angle of 30 degrees with cohesion of 250 psf. At Section F-F, the portal drill hole encountered gravelly material in a silty matrix in the upper 10 to 15 feet, underlain by lean clay and rock. This gravelly material was modeled using a friction angle of 35 degrees and 100 psf cohesion.

At Sections A-A, B-B and F-F, the cut slopes were initially modeled as shown on the section drawings, with slopes as steep as 0.8H:1V. For these slopes, the computed factors of safety were in the range of 1.0 to 1.2. Following the initial stability analyses, additional calculations were performed to estimate factors of safety for flatter cut slopes. A summary of computed factors of safety is shown below, and the critical failure surfaces are shown in the appendix.

Section	Cut Slope	Approximate Depth of Cut (ft)	Factor of Safety
A-A	0.8H:1V	35	1.17
	1H:1V	39	1.24
	1.25H:1V	44	1.35
	1.5H:1V	56	1.41
	1.75H:1V	67	1.50
B-B	0.8H:1V	69	0.91
	1H:1V	75	1.00
	1.25H:1V	88	1.10
	1.5H:1V	113	1.19
	1.75H:1V	153	1.29
F-F	0.8H:1V	23	1.07
	1H:1V	30	1.19
	1.25H:1V	35	1.32
	1.5H:1V	40	1.45
	1.75H:1V	45	1.57

The acceptable factor of safety for a given slope depends upon several factors, including the level of certainty and conservatism of model parameters, as well as the nature of the slope and potential consequences of failure. For static, long-term conditions, required minimum factors of safety typically range from about 1.3 to 1.5, with the 1.5 factor used for more critical facilities. For Sections A-A and F-F, an estimated factor of safety of 1.3 or better is achieved for slopes of 1.25H:1V. To achieve an estimated factor of safety of 1.5, the slopes would have to be flattened to about 1.75H:1V. It will be noted that the deep cut on Section B-B has a factor of safety of almost 1.3 only if flattened to 1.75H:1V.

We recommend that permanent cut slopes greater than 10 feet deep in the native silty gravel and lean clay materials be no steeper than 1.25H:1V, in order to provide an estimated factor of safety of 1.3. A greater factor of safety may be required by regulatory agencies, policies, or the facility owner, and can be achieved by further flattening the cut slopes.

It is likely that cut slopes for the pads on the easterly side of the development will be located on the upthrown side of the fault which runs through the site. It appears that the borings throughout this area were located on the downthrown side of the fault. The geology report for the project (prepared by others) references sandstone outcrops and prior boring logs which show a dominance of sandstone to be the norm in the area. Near-vertical sandstone outcrops were observed east of the borings on the north end of the site by RB&G's geologist during field exploration work.

Where the proposed cuts encounter bedrock, they can be performed at near vertical angles in sandstone, and at relatively steep overall angles in interbedded sandstone/mudstone without jeopardizing overall slope stability. Problems associated with the interbedded degradable clay/mudstone layers limit the steepness of the cut, however. It is recommended that the overall

cut slope at these locations be no steeper than 0.8H:1V. It is also recommended that horizontal benches be constructed at the top of degradable clay and mudstone layers, such that a resultant slope in these layers of 1.5H:1V can be achieved without undercutting the overlying ledge rock. If the horizontal benches are not feasible, long term maintenance associated with ledge rock fall should be planned as the mudstone weathers and degrades, resulting in undercutting of the ledges.

It is anticipated that fill slopes will be created with on-site material. If this material is placed and compacted in accordance with recommendations provided in Section IV, fill slopes as steep as 1.5H:1V will have a factor of safety of at least 1.3 if constructed of the native clayey soils. Fill slopes shown on Sections A-A, B-B, and FF will likely be constructed of this clayey on-site fill. Test pits in the vicinity of the fill areas shown on Sections C-C, D-D, and E-E encountered significant amounts of medium-dense silty sand. Fill slopes as steep as 1.8H:1V constructed of this silty sand material have a computed factor of safety of at least 1.3. Plots of stability analyses for typical fill slopes are included in the appendix.

Cut and fill slopes will be susceptible to erosion and shallow surficial failures – particularly for slopes steeper than 2H:1V. We recommend that soil slopes be seeded and erosion control blankets provided where necessary to minimize such problems on bare slopes.

VII. LIMITATIONS

The conclusions and recommendations presented in this report are based upon the results of the field and laboratory tests. It should be recognized that soil materials are inherently heterogeneous and that conditions may exist throughout this site which could not be defined during this investigation. Since the bearing capacity for foundation design and slope stability are dependent upon adequate compaction of fill, it is requested that testing of the fill be performed under the direct supervision of the soils engineer.

It is recommended that a soils engineer observe the foundation excavations prior to placement of footings. If during construction, conditions are encountered which appear to be different than those presented in this report, it is requested that we be advised in order that appropriate action may be taken.

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Figures

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Provo, Utah

Figure 1 VICINITY MAP

Kinney Mine

Scofield, Utah

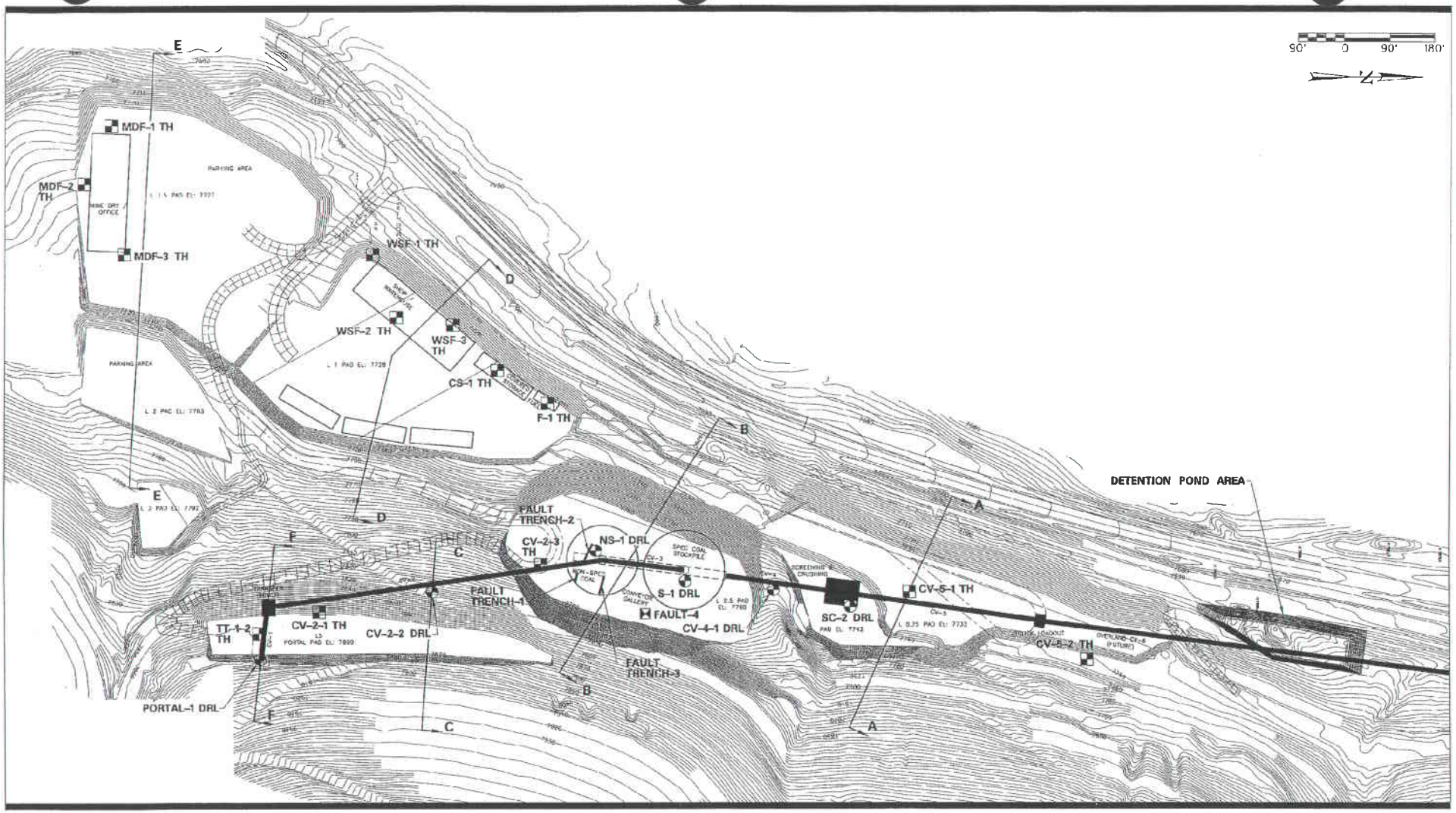

Figure 2

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KINNEY MINE
Scofield, Utah

Site Plan Wth Test Hole & Section Locations

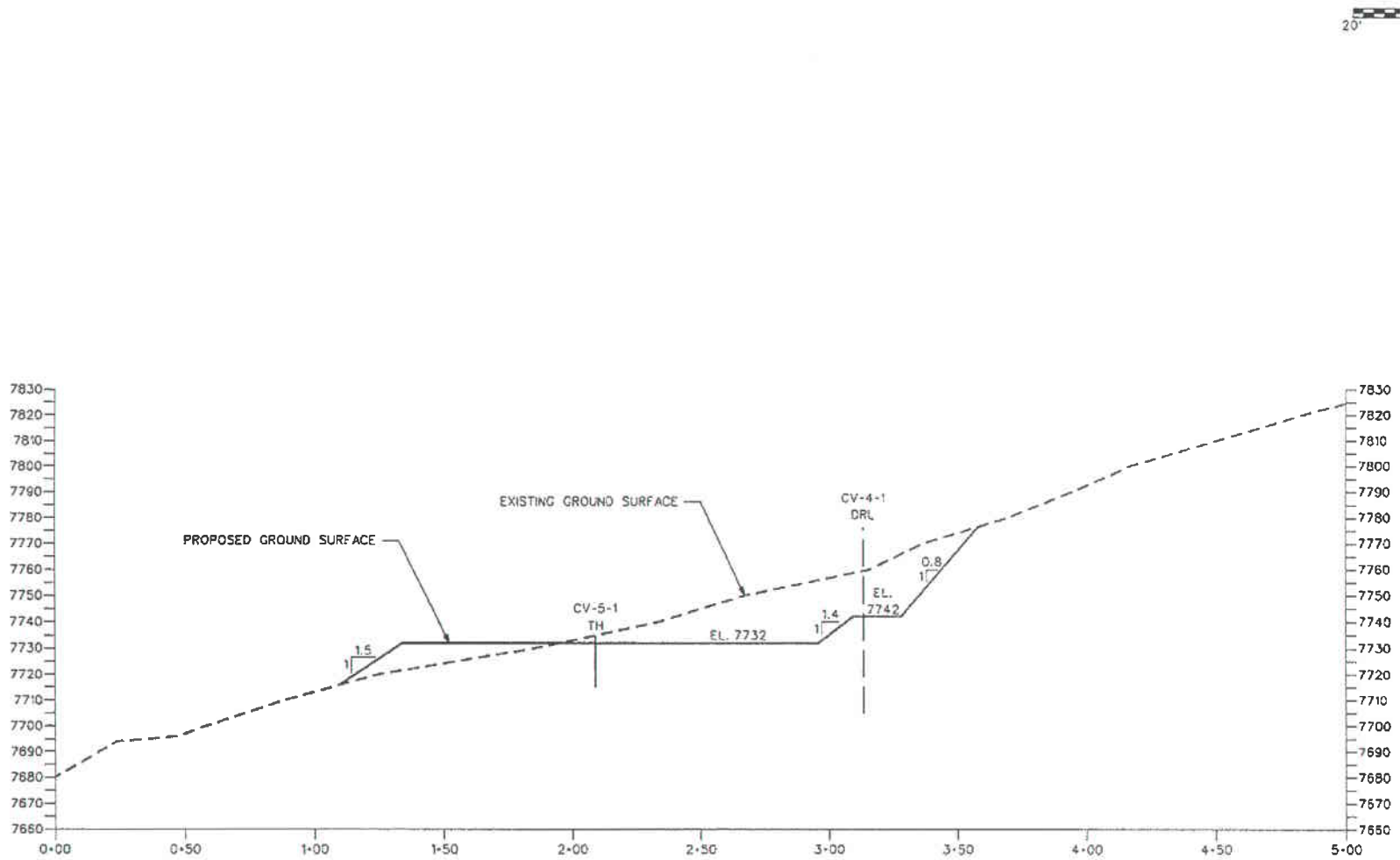

Figure 3

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Kinney Mine
Scofield, Utah

Section A–A

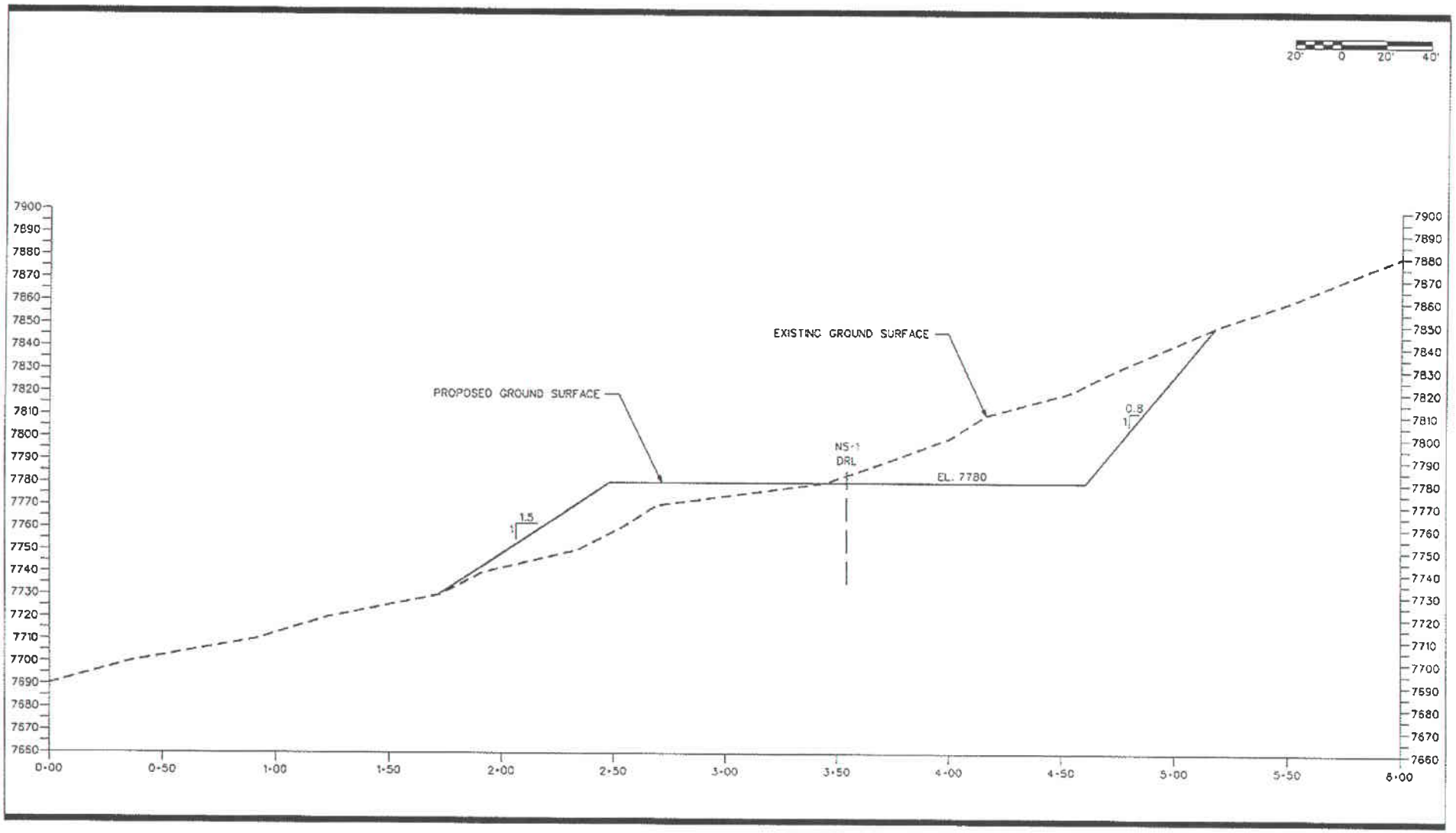

Figure 4

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Kinney Mine
Scofield, Utah

Section B-B

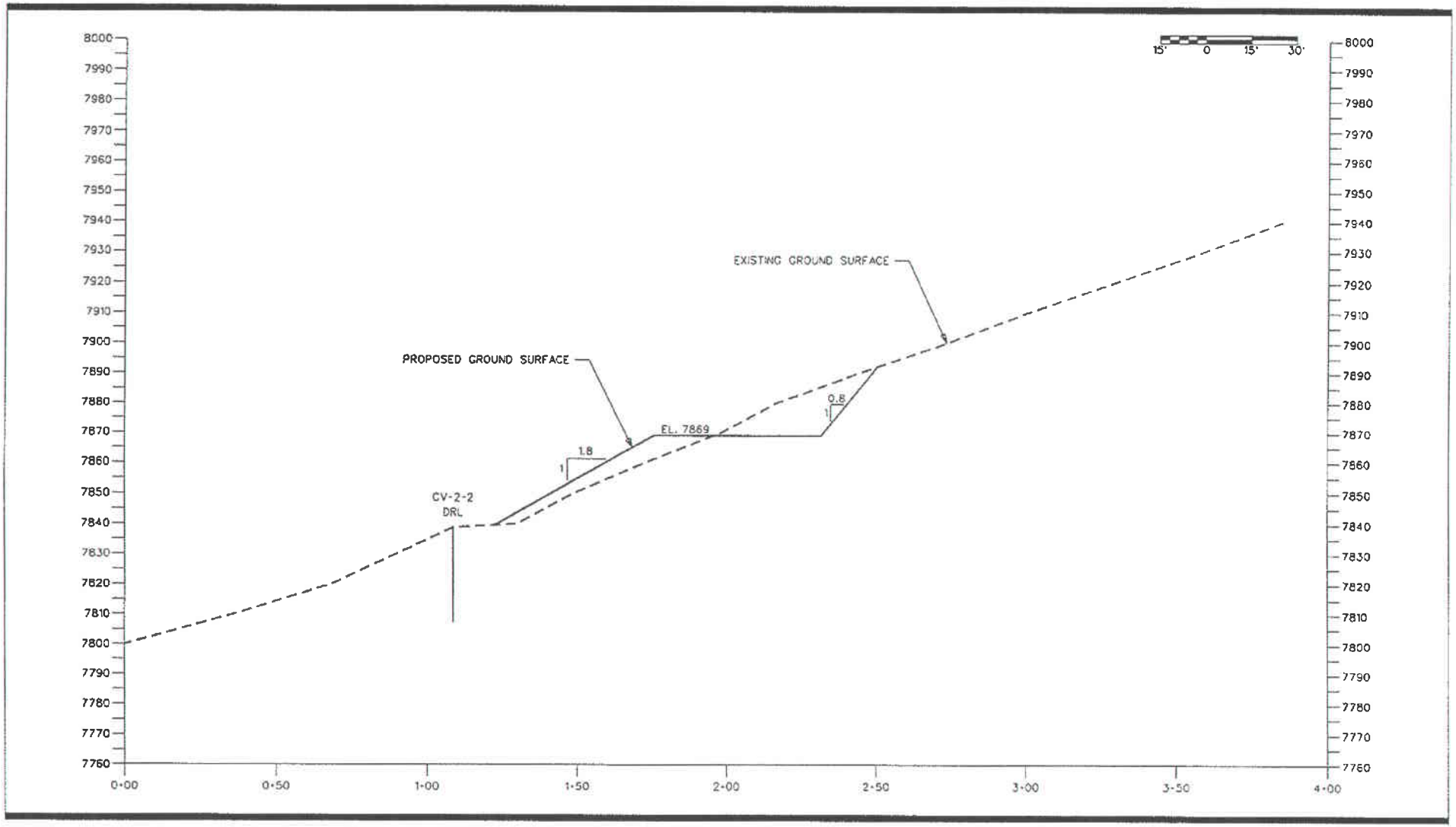

Figure 5

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Kinney Mine
Scofield, Utah

Section C–C

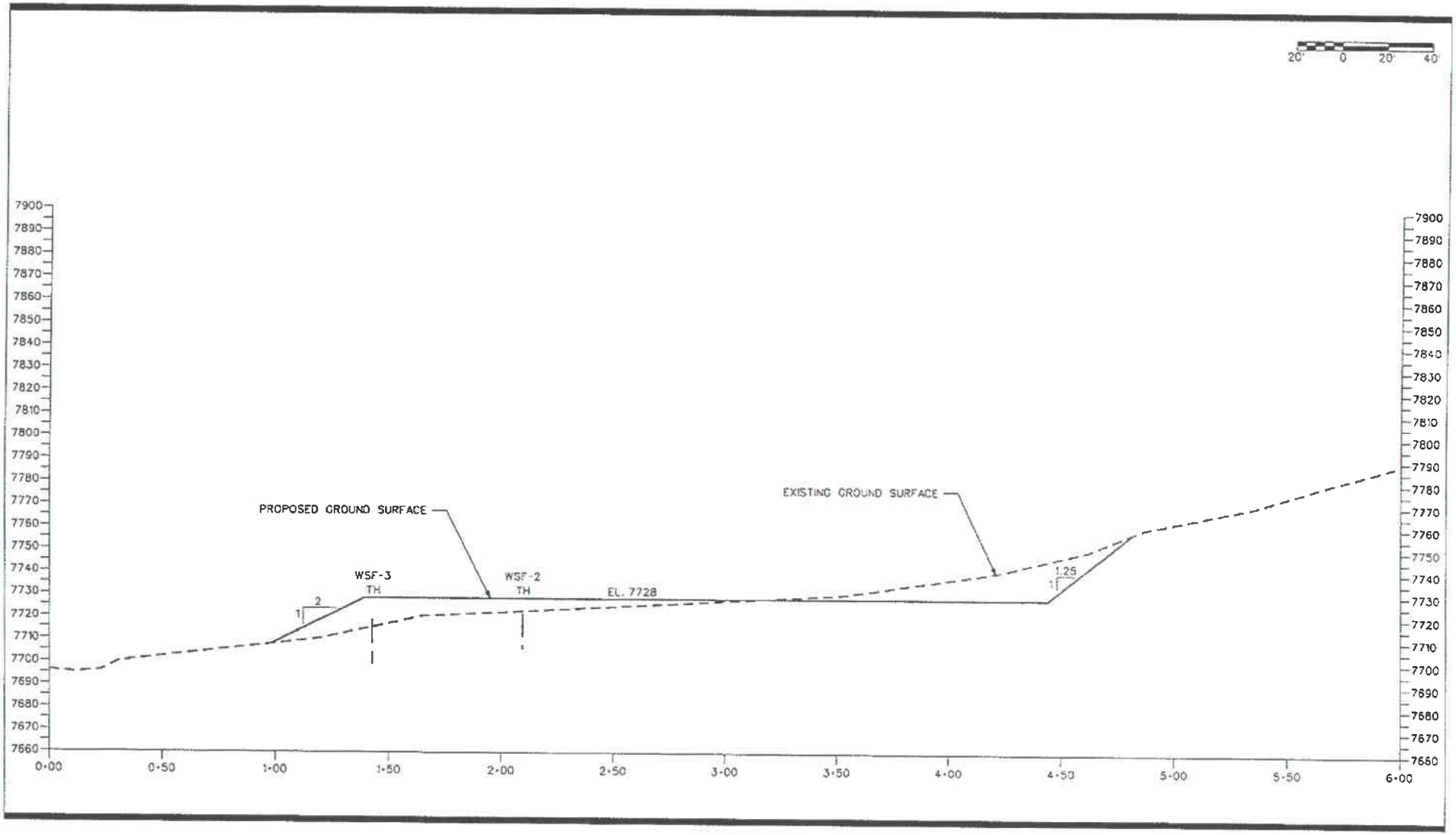

Figure 6

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Kinney Mine
Scofield, Utah

Section D–D

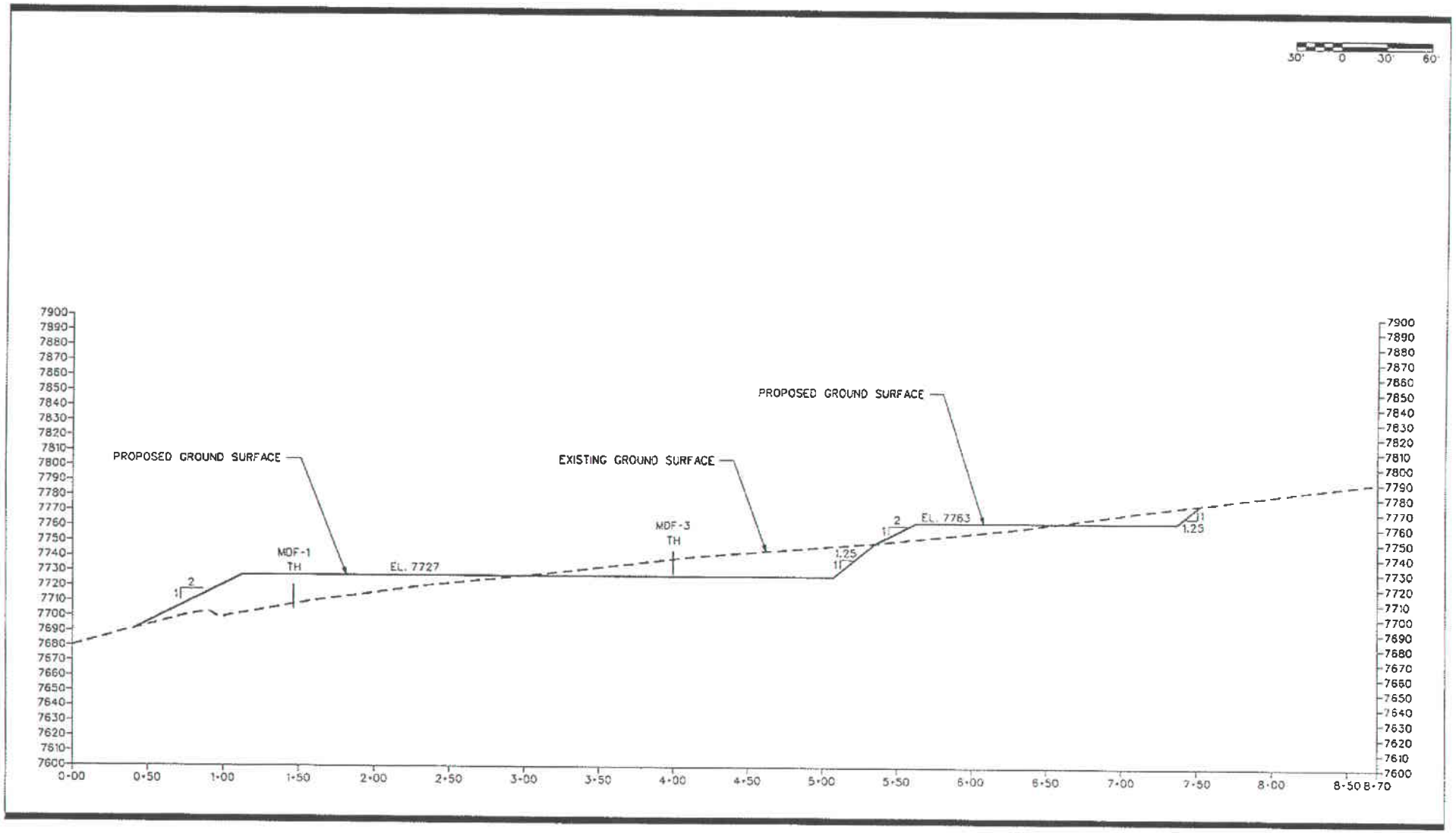

Figure 7

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Kinney Mine
Scofield, Utah

Section E-E

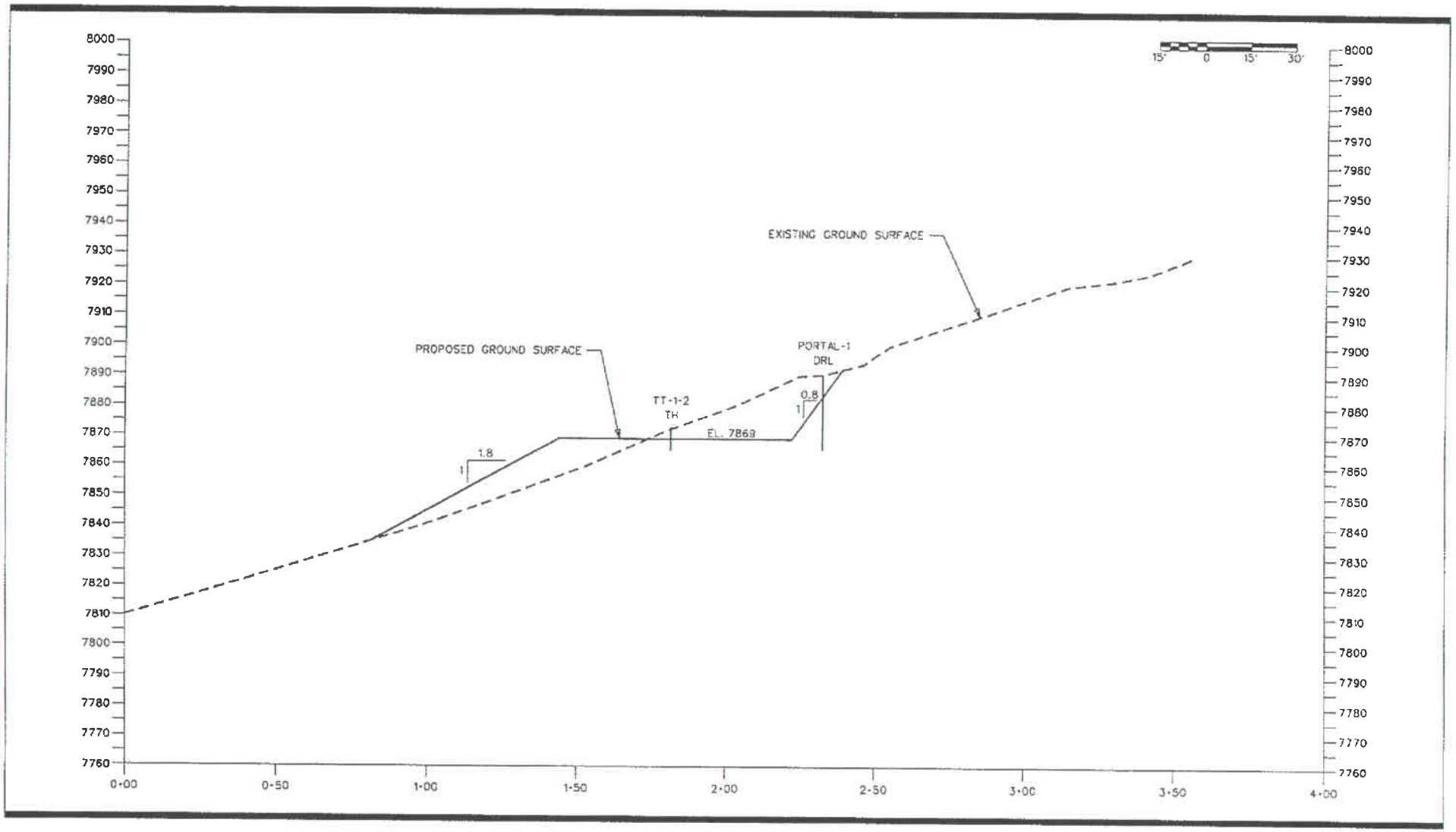

Figure 8

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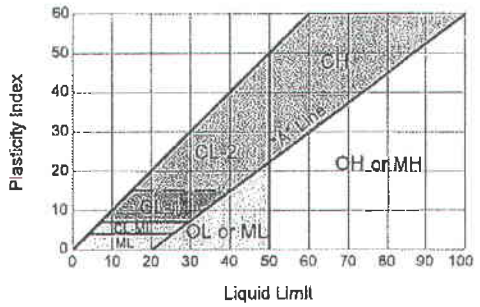
Kinney Mine
Scofield, Utah

Section F-F

Appendix

Unified Soil Classification System

Major Divisions			Group Symbols	Typical Names	Laboratory Classification Criteria		
COARSE-GRAINED SOILS *more than half of material is larger than No. 200 sieve*	Gravels *more than half of coarse fraction is larger than No. 4 sieve size*	Clean Gravels *little or no fines*	GW	Well graded gravels, gravel-sand mixtures, little or no fines	*For laboratory classification of coarse-grained soils* Determine percentage of gravel and sand from grain-size curve. Depending on percentage of fines (*fraction smaller than No. 200 sieve size*), coarse-grained soils are classified as follows: Less than 5% GW, GP, SW, SP More than 12% GM, GC, SM, SC 5% to 12% Borderline cases requiring use of dual symbols**	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels With Fines *appreciable amount of fines*	GM* d / u	Silty gravels, poorly graded gravel-sand-silt mixtures		Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring uses of dual symbols
			GC	Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, or PI greater	
	Sands *more than half of coarse fraction is smaller than No. 4 sieve size*	Clean Sands *little or no fines*	SW	Well graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with Fines *appreciable amount of fines*	SM* d / u	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring uses of dual symbols
			SC	Clayey sands, poorly graded sand-clay mixtures		Atterberg limits above "A" line, or PI greater	
FINE-GRAINED SOILS *more than half of material is smaller than No. 200 sieve*	Silts and Clays *liquid limit is less than 50*		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	*For laboratory classification of fine-grained soils*		
			CL 1 / 2	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silt-clays of low plasticity			
	Silts and Clays *liquid limit is greater than 50*		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity, organic silts			
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils			



Plasticity Chart

NOTE: USCS Modified to include CL-type subcategories

*Division of GM and SM groups into subdivisions of d and u for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when liquid limit is 28 or less and the PI is 6 or less, the suffix u used when liquid limit is greater than 28.

***Borderline classification*: Soils possessing characteristics of two groups are designated by combinations of group symbols. (For example GW-GC, well graded gravel-sand mixture with clay binder.)

MINE DRY / OFFICE

TEST PITS MDF-1, MDF-2 & MDF-3

TEST PIT LOG

TEST PIT NO. MDF-1 TH

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: MINE DRY FACILITY / N:73,774 E:37,860
DIGGING METHOD: JOHN DEERE 160 TRACKHOE
OPERATOR:
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/6/07
DATE COMPLETED: 9/6/07
GROUND ELEVATION: 7720.4'
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
7720						CL	brown, dry	SANDY LEAN CLAY								
			X			CL-ML	brown, slightly moist	GRAVELLY SILTY CLAY W/SAND	102.7	4.9	20	4				CT
7715	5		X		0.70	CL	brown, slightly moist, stiff		94.8	9.9						
			X		0.81	CL-1	brown, slightly moist, stiff		86.6	8.4	25	11				CT
7710	10							LEAN CLAY W/SAND pinhole structure, ~10% cobbles								
			X		0.95	CL	brown, moist, stiff									
7705	15		X		0.87	CL	brown, moist, stiff									
			X		0.69	CL-1	brown, moist, stiff	SANDY LEAN CLAY pinhole structure	108.7	10.8	23	10				CT

TP_LOGV1 KINNEYMINE_TP.GPJ US EVAL.GDT 10/29/07

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LEGEND:
DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)
UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

TEST PIT LOG

TEST PIT NO. MDF-2 TH

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: MINE DRY FACILITY / N:73,721 E:37,976
DIGGING METHOD: JOHN DEERE 160 TRACKHOE
OPERATOR:
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/6/07
DATE COMPLETED: 9/6/07
GROUND ELEVATION: 7729.6'
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
						CL	brown, dry	SANDY LEAN CLAY W/GRAVEL								
			■			SC-SM	brown, slightly moist	SILTY CLAYEY SAND W/GRAVEL >20% cobbles	108.6	4.6	20	5	34	38	28	
7725	5															
			■			SM	brown, slightly moist, med. dense	SILTY SAND W/GRAVEL >30% cobbles & boulders	118.5	3.8		NP	38	47	15	
7720	10															
			⊠		0.95	CL	lt. brown, slightly moist, stiff									
7715	15							SANDY LEAN CLAY gravel seams, pinhole structure								
			⊠		0.88	CL-1	lt. brown, moist, stiff		94.8	9.3	23	9	6	38	56	CT
			⊠		0.85	CL	lt. brown, slightly moist, stiff									
7710																

TP_LOGV1 KINNEYMINE_TP.GPJ US EVAL.GDT 10/29/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:
DISTURBED SAMPLE ■ Bucket ← Type of Sample
0.45 ← Torvane (tsf)
UNDISTURBED SAMPLE ⊠

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

TEST PIT LOG

TEST PIT NO. MDF-3 TH

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: MINE DRY FACILITY / N:73,800 E:38,115
DIGGING METHOD: JOHN DEERE 160 TRACKHOE
OPERATOR:
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/6/07
DATE COMPLETED: 9/6/07
GROUND ELEVATION: 7744.0'
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
						CL	brown, dry	GRAVELLY LEAN CLAY W/SAND								
								COAL (fill)								
						CL	brown, dry, very stiff	LEAN CLAY W/SAND								
						SM	brown, slightly moist		106.5	6.1						
7740																
	5							SILTY SAND W/GRAVEL >30% cobbles & boulders								
						SM	brown, slightly moist		102.9	5.8		NP	34	39	27	
7735																
	10					GP-GM	brown, dry									
								GRAVEL W/SILT & SAND >50% cobbles & boulders								
						GP-GM	brown, dry									
7730																
	15				0.99+	CL-1	lt. brown, slightly moist, stiff			7.5	22	10				
								LEAN CLAY W/SAND slight pinhole structure								
7725					0.99+	CL-1	lt. brown, slightly moist to dry, stiff			5.3	21	8				

TP_LOGV1 KINNEYMINE_TP.GPJ US EVAL.GDT 10/29/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

Table 1

SUMMARY OF TEST DATA

PROJECT LOCATION: Kinney Mine, Scofield, Utah

PROJECT NO.: 200701-045

FEATURE: Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE		UNCONFINED COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM (modified)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
CV-2-1 TH	3	Grab	95.0	9.0		32	15	17				CL-2
	6	Grab		3.1				NP	64	23	13	GM
CV-2-3 TH	3	Grab	106.1	7.6	4000+*	25	13	12				CL-1
	6	Grab	88.6	6.5	4000+*	23	17	6				CL-ML
	9	Grab	97.1	4.8	4000+*	19	15	4				CL-ML / SC-SM
CV-5-1 TH	3	Grab	89.8	5.8	4000+*	22	15	7				CL-1
	9	Grab	90.7	7.1	4000+*	21	17	4				CL-ML
	12	Grab	95.8	9.7	4000+*	22	12	10				CL-1
	19	Grab		9.6	4000+*	23	13	10				CL-1
CL-5-2 TH	12	Grab	112.7	13.8	4000+*	42	16	26				CL-2
	15	Grab		14.1	4000+*	33	15	18				CL-2
WSF-1 TH	6	Grab	97.9	4.5	2827	21	16	5				CL-ML
WSF-2 TH	3	Grab	91.0	4.6				NP	29	45	26	SM
	9	Grab		4.7		19	15	4				CL-ML / SC-SM
WSF-3 TH	6	Grab	89.6	4.6				NP	34	38	28	SM
	9	Grab	96.3	10.1	3000*	22	14	8				CL-1
	12	Grab		6.1	3320*			NP	34	38	28	SM
MDF-1 TH	3	Grab	102.7	4.9		20	16	4				CL-ML / SC-SM
	9	Grab	86.6	8.4	3240*	25	14	11				CL-1
	18.5	Grab	108.7	10.8	2760*	23	13	10				CL-1
MDF-2 TH	3	Grab	108.6	4.6		20	15	5	34	38	28	SC-SM
	6	Grab	118.5	3.8				NP	38	47	15	SM
	15	Grab	94.8	9.3	3520*	23	14	9				CL-1
MDF-3 TH	6	Grab	102.9	5.8				NP	34	39	27	SM
	15	Grab		7.5	4000+*	22	12	10				CL-1
	18	Grab		5.3	4000+*	21	13	8				CL-1
CS-1 TH	6	Grab										Coal
	9	Grab		8.8	2080*	23	14	9				CL-1
	12	Grab		15.5	2240*	24	16	8				CL-1
F-1 TH	6	Grab	91.3	5.6		22	18	4	18	42	40	SC-SM
	9	Grab		6.1		21	16	5				CL-ML / SC-SM

NP=Nonplastic

*Toravne value used to estimate unconfined compressive Strength.

OTHER LABORATORY TESTING

PROJECT Kinney Mine
LOCATION Scofield, Utah

PROJECT NO. 200701-045
FEATURE

CHEMICAL TESTS					
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	pH	RESISTIVITY (ohm-cm)	SULFATE (%)	USCS (MODIFIED) / AASHTO CLASSIFICATION
3-NS-1	6-7.5	8.0	6761	0.0031	CL-1
11-MDF-2	3	8.2	7202	0.0064	SC-SM
9-WSF-1	6	7.3	3322	0.0195	CL-ML
13-WSF-2	3	7.8	6502	0.0315	SM

DIRECT SHEAR TESTS CONSOLIDATED DRAINED					
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	DRY DENSITY (pcf)	FRICTION ANGLE Φ (degrees)	COHESION c (psi)	USCS (MODIFIED) / AASHTO CLASSIFICATION
07-CV-5-1 TH	12	95.8	20	15	CL-1

TRIAXIAL SHEAR TESTS MULTI-STAGE CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENTS						
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	TOTAL STRESS		EFFECTIVE STRESS		USCS (MODIFIED) / AASHTO CLASSIFICATION
		FRICTION ANGLE $\Phi_{(cu)}$ (degrees)	COHESION $c_{(cu)}$ (psi)	FRICTION ANGLE Φ (degrees)	COHESION c (psi)	
CV-4-1 DRL	20-21.5	29.6	2	36.0	2	CL
SC-2 DRL	23-24	32.5	2	36.7	2	CL-1

* Visual Classification
**Bulk Sample

RB&G ENGINEERING INC.
1435 West 820 North, Provo, Utah 84601
801 374-5771 Provo
801 521-5771 Salt Lake City

PROJECT NO.	200701.045
REPORT NO.	-

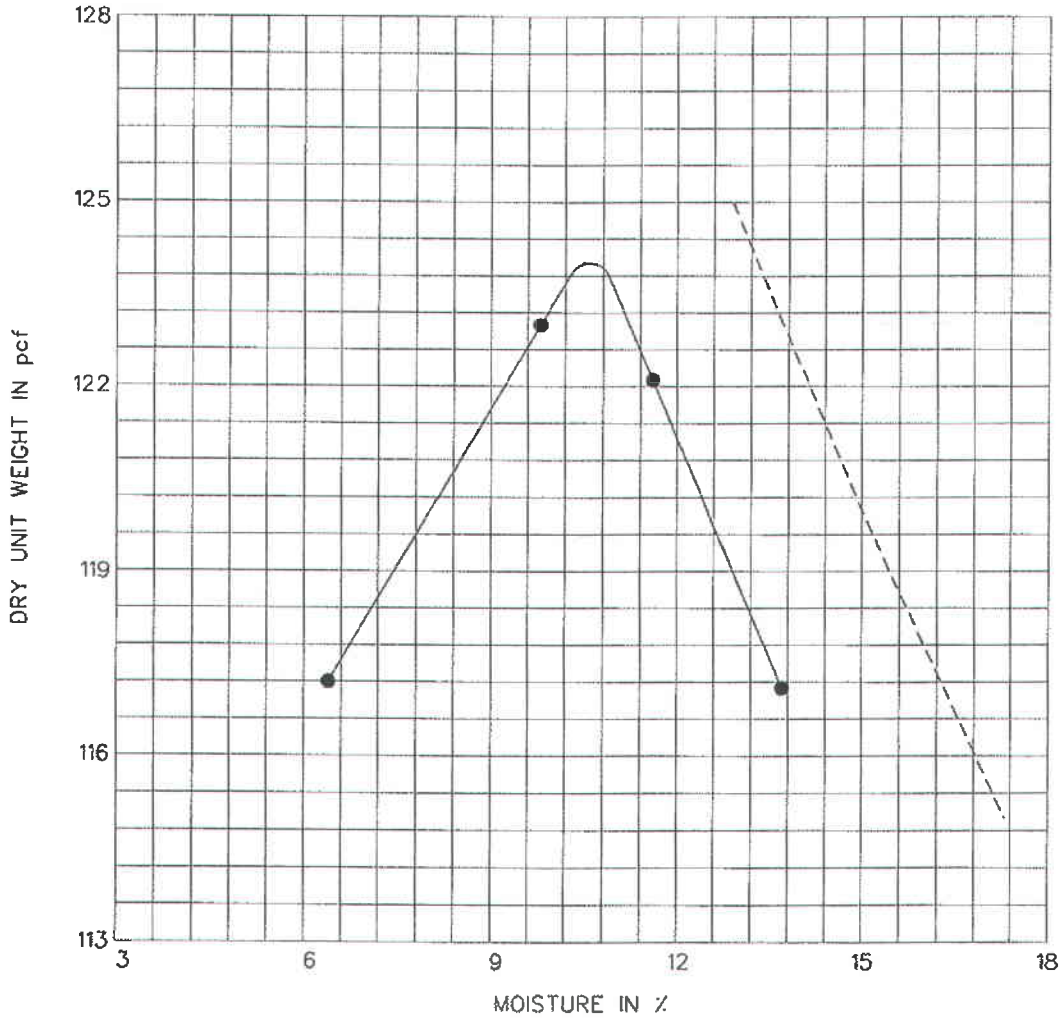
MOISTURE-DENSITY RELATION (PROCTOR)

Project	KINNEY MINE			Date	9/6/07
Location / No.	SCOFIELD, UTAH / MDF-1 TH AT 3'-10'			Technician	G. PEASLEE
Material Description	BROWN SANDY LEAN CLAY	USCS	CL	Method	ASTM D 1557

Procedure Used[1]	B
Classification Procedure[2]	Visual

[1] A-No. 4 Sieve, B-3/8" Sieve, C-3/4" Sieve
[2] Visual as per ASTM D 2488, Test as per ASTM D 2487

Preparation Method	Moist
Rammer Used	Manual
As-Received Moisture Content (%)	6.0



Maximum Dry Density (pcf)	124.0
Optimum Moisture Content (%)	10.5
Corrected Maximum Density (pcf)	124.0
Corrected Optimum Moisture Content (%)	10.5

- - - - - 100% Saturation Curve

Specific Gravity of Soil	2.70	Est.

OVERSIZE CORRECTION-ASTM D 4718

Specific Gravity of Soil +3/4	2.70	Est.
Percent Oversize	0.0	

Type of Specific Gravity is BULK Unless Otherwise Indicated

RB&G ENGINEERING INC.
1435 West 820 North, Provo, Utah 84601
801 374-5771 Provo
801 521-5771 Salt Lake City

PROJECT NO.	200701.045
REPORT NO.	-

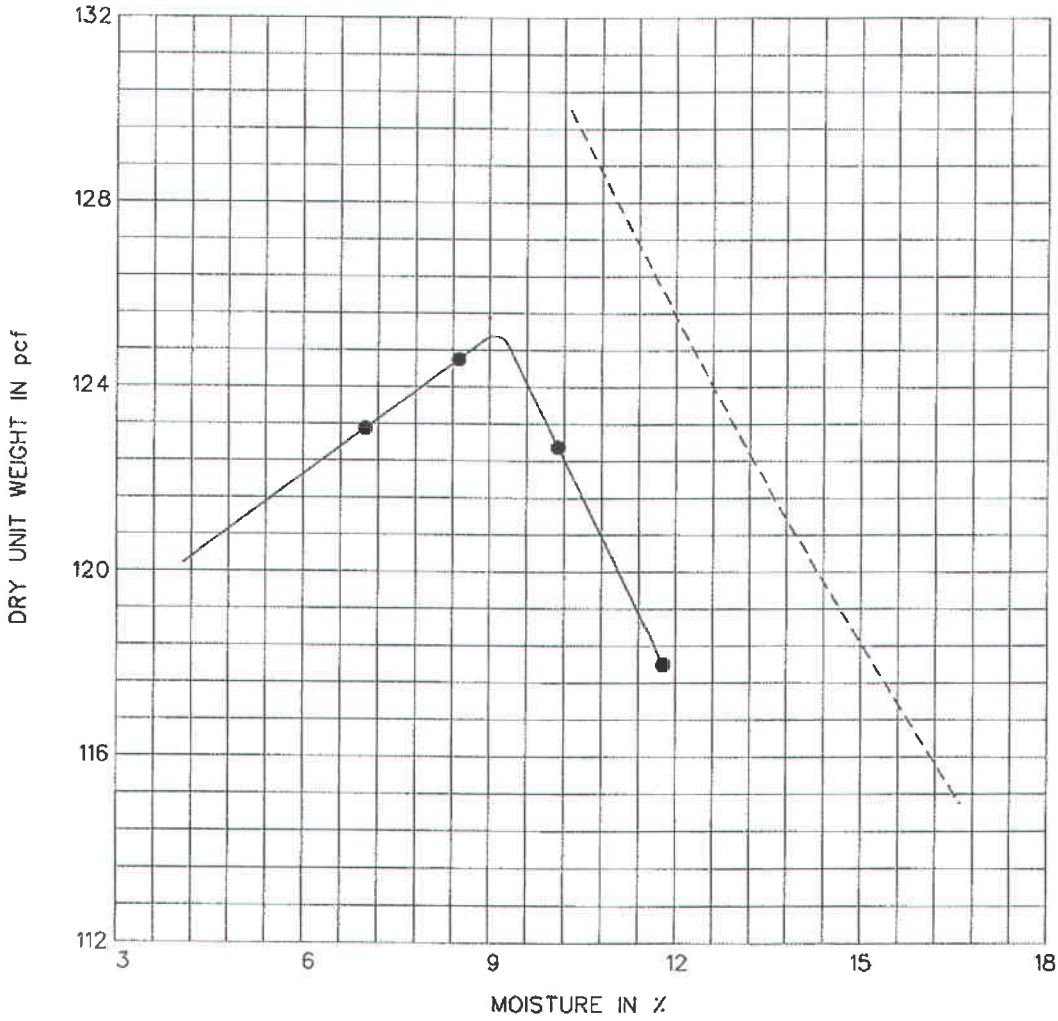
MOISTURE-DENSITY RELATION (PROCTOR)

Project	KINNEY MINE			Date	9/6/07
Location / No.	SCOFIELD, UTAH / WSF-2 TH AT 3'-8'			Technician	G. PEASLEE
Material Description	LT. BROWN SILTY SAND W/GRAVEL	USCS	SM	Method	ASTM D 1557

Procedure Used[1]	C
Classification Procedure[2]	Visual

[1] A-No. 4 Sieve, B-3/8" Sieve, C-3/4" Sieve
[2] Visual as per ASTM D 2488, Test as per ASTM D 2487

Preparation Method	Moist
Rammer Used	Manual
As-Received Moisture Content (%)	5.0



Maximum Dry Density (pcf)	125.5
Optimum Moisture Content (%)	9.0
Corrected Maximum Density (pcf)	128.0
Corrected Optimum Moisture Content (%)	8.5

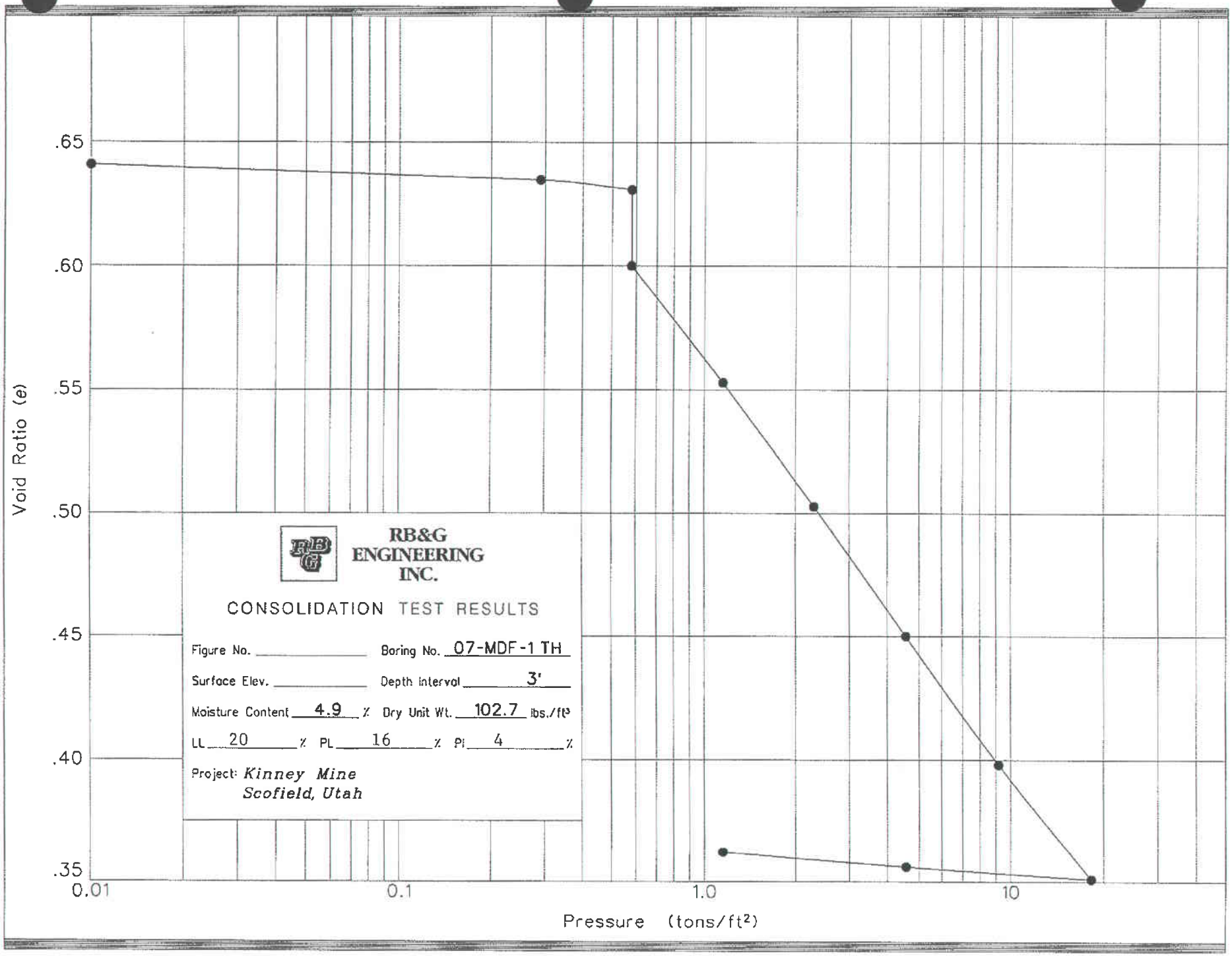
----- 100% Saturation Curve

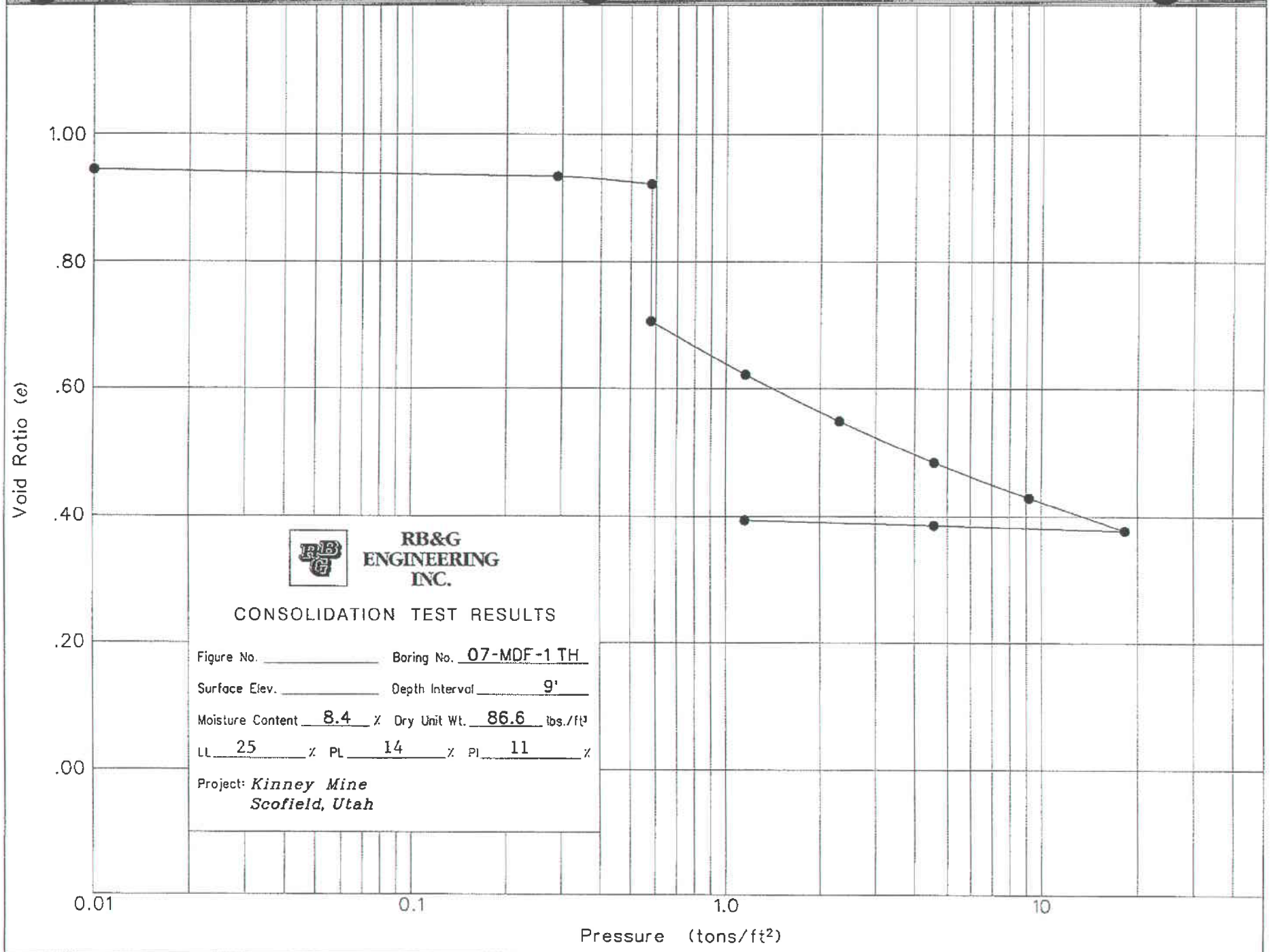
Specific Gravity of Soil	2.65	Est.

OVERSIZE CORRECTION-ASTM D 4718

Specific Gravity of Soil +3/4	2.65	Est.
Percent Oversize	10.0	

Type of Specific Gravity is BULK Unless Otherwise Indicated


.65
.60
.55
.50
.45
.40
.35
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G
ENGINEERING
INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. 07-MDF-1 TH
Surface Elev.
Depth Interval 3'
Moisture Content 4.9 %
Dry Unit Wt. 102.7 lbs./ft³
LL 20 %
PL 16 %
PI 4 %
Project: Kinney Mine
Scofield, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

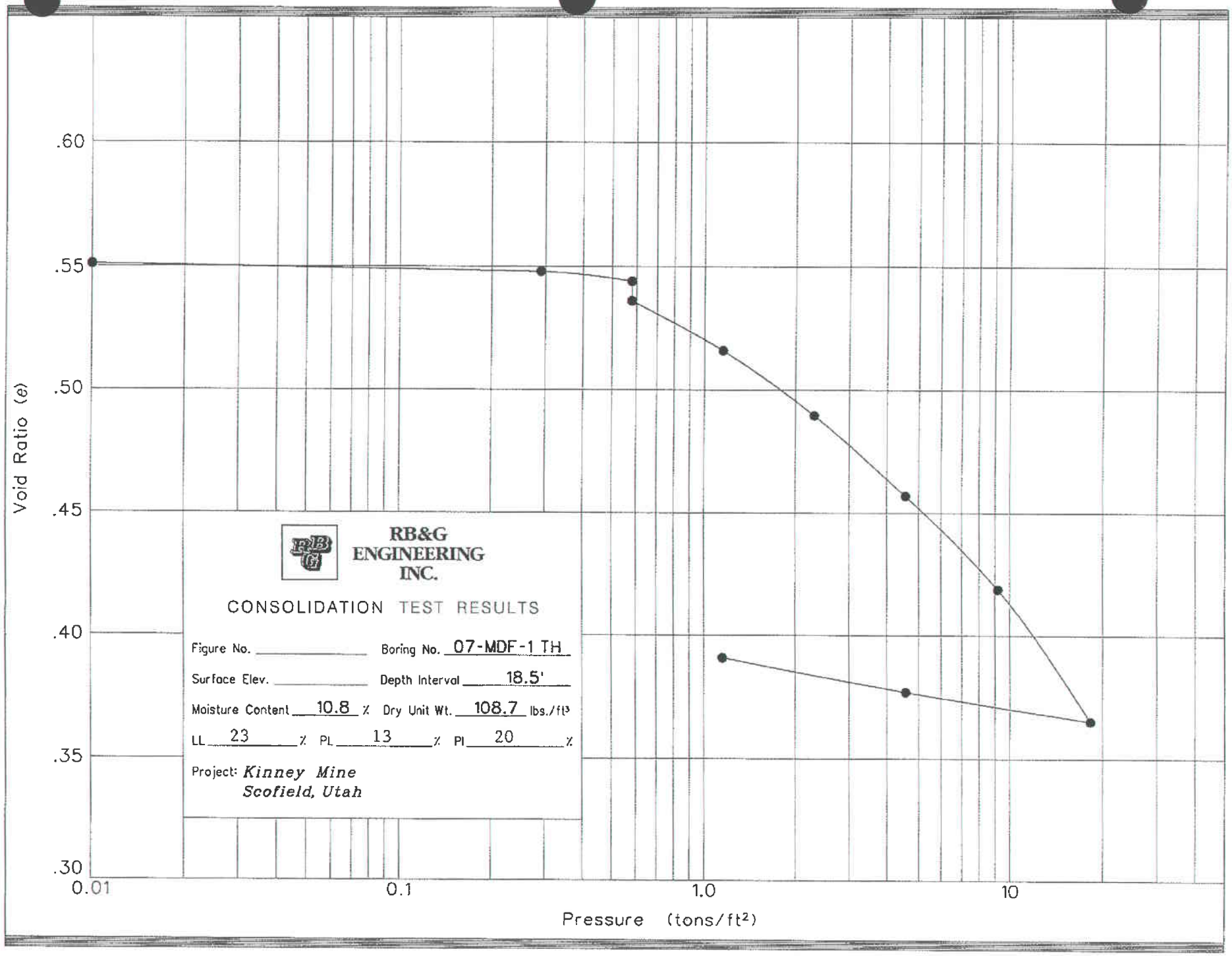
Figure No. _____ Boring No. 07-MDF-1 TH

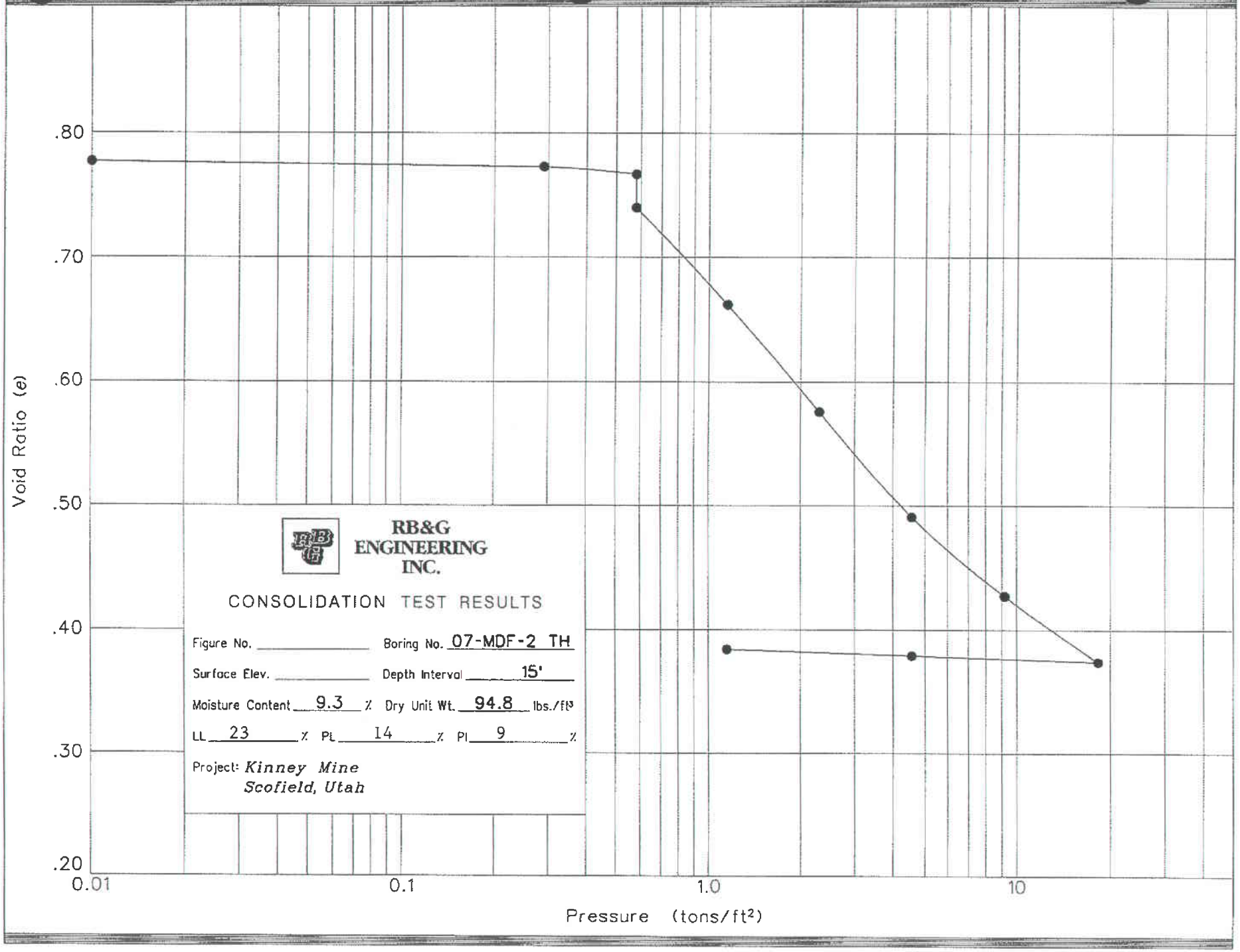
Surface Elev. _____ Depth Interval 9'

Moisture Content 8.4 % Dry Unit Wt. 86.6 lbs./ft³

LL 25 % PL 14 % PI 11 %

Project: *Kinney Mine*
Scofield, Utah


.60
.55
.50
.45
.40
.35
.30
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G
ENGINEERING
INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. 07-MDF-1 TH
Surface Elev.
Depth Interval 18.5'
Moisture Content 10.8 %
Dry Unit Wt. 108.7 lbs./ft³
LL 23 %
PL 13 %
PI 20 %
Project: Kinney Mine
Scofield, Utah


.80
.70
.60
.50
.40
.30
.20
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G
ENGINEERING
INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. 07-MDF-2 TH
Surface Elev.
Depth Interval 15'
Moisture Content 9.3 %
Dry Unit Wt. 94.8 lbs./ft³
LL 23 %
PL 14 %
PI 9 %
Project: Kinney Mine
Scofield, Utah

SHOP / WAREHOUSE

TEST PITS WSF-1, WSF-2 & WSF-3

TEST PIT LOG

TEST PIT NO. WSF-1 TH

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: WARWEHOUSE & SHOP FACILITY / N:74,287 E:38,116
DIGGING METHOD: JOHN DEERE 160 TRACKHOE
OPERATOR:
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/6/07
DATE COMPLETED: 9/6/07
GROUND ELEVATION: 7719.5'
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
						CL-ML	brown, dry — SILTY SANDY CLAY (fill)								
							COAL (fill)								
7715	5						SANDY SILTY CLAY								
			☒		+1.00	CL-ML	brown, dry, hard	97.9	4.5	21	5				UC
							ll. brown, dry, dense — SANDSTONE very weathered, more competent w/depth								
7710	10														
							Trackhoe unable to excavate deeper								
7705	15														
7700															

TP_LOGV1 KINNEYMINE_TP.GPJ US EVAL.GDT 10/29/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:
DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)
UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

TEST PIT LOG

TEST PIT NO. WSF-2 TH

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: WARWEHOUSE & SHOP FACILITY / N:74,287 E:38,116
DIGGING METHOD: JOHN DEERE 160 TRACKHOE
OPERATOR:
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/7/07
DATE COMPLETED: 9/7/07
GROUND ELEVATION: 7721.6'
LOGGED BY: J. LINDO

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
						CL	dk. brown, dry	SANDY LEAN CLAY								
7720						-	black, dry	COAL (fill)								
						SM	dk. brown, slightly moist, loose		91	4.6		NP	29	45	26	
	5							SILTY SAND W/GRAVEL occasional cobbles								
7715						SM	dk. brown, slightly moist, loose		89.4	6.5						
	10					CL-ML/ SC-SM	brown, slightly moist	SANDY SILTY CLAY TO SILTY CLAYEY SAND slight pinhole structure		4.7	19	4				
7710						GM	lt. brown, dry	SILTY GRAVEL W/SAND cobbles & boulders increasing w/depth								
	15					GM	lt. brown, dry									
7705								Bottom of excavation very rocky, trackhoe unable to excavate deeper								

TP_LOGV1 KINNEYMINE_TP.GPJ US EVAL.GDT 10/29/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:
DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)
UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

TEST PIT LOG

TEST PIT NO. WSF-3 TH

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: WARWEHOUSE & SHOP FACILITY / N:74,287 E:38,116
DIGGING METHOD: JOHN DEERE 160 TRACKHOE
OPERATOR:
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/7/07
DATE COMPLETED: 9/7/07
GROUND ELEVATION: 7718.7'
LOGGED BY: J. LINDO

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
						CL	dk. brown, dry	SANDY LEAN CLAY								
						-	black, dry	COAL (fill)								
7715						SM	dk. brown, very moist, loose		84.7	18						
	5							SILTY SAND W/GRAVEL								
						SM	dk. brown, slightly moist, loose		89.6	4.6		NP	34	38	28	
7710					0.75	CL-1	lt. brown, slightly moist, stiff	SANDY LEAN CLAY W/GRAVEL slight pinhole structure	96.3	10.1	22	8				CT
	10															
					0.83	SM	lt. brown, moist, med. dense	SILTY SAND clay layers to 4" thick		6.1		NP	34	38	28	
7705																
	15				0.70	CL	lt. brown, moist, stiff	SANDY LEAN CLAY W/GRAVEL >20% cobbles & boulders								
7700					+1.00	CL	lt. brown, moist, very stiff									

TP_LOGV1 KINNEYMINE_TP.GPJ US EVAL.GDT 10/29/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

Table 1

SUMMARY OF TEST DATA

PROJECT Kinney Mine
LOCATION Scofield, Utah

PROJECT NO. 200701-045
FEATURE Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE		UNCONFINED COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM (modified)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
CV-2-1 TH	3	Grab	95.0	9.0		32	15	17				CL-2
	6	Grab		3.1				NP	64	23	13	GM
CV-2-3 TH	3	Grab	106.1	7.6	4000+*	25	13	12				CL-1
	6	Grab	88.6	6.5	4000+*	23	17	6				CL-ML
	9	Grab	97.1	4.8	4000+*	19	15	4				CL-ML / SC-SM
CV-5-1 TH	3	Grab	89.8	5.8	4000+*	22	15	7				CL-1
	9	Grab	90.7	7.1	4000+*	21	17	4				CL-ML
	12	Grab	95.8	9.7	4000+*	22	12	10				CL-1
	19	Grab		9.6	4000+*	23	13	10				CL-1
CL-5-2 TH	12	Grab	112.7	13.8	4000+*	42	16	26				CL-2
	15	Grab		14.1	4000+*	33	15	18				CL-2
WSF-1 TH	6	Grab	97.9	4.5	2827	21	16	5				CL-ML
WSF-2 TH	3	Grab	91.0	4.6				NP	29	45	26	SM
	9	Grab		4.7		19	15	4				CL-ML / SC-SM
WSF-3 TH	6	Grab	89.6	4.6				NP	34	38	28	SM
	9	Grab	96.3	10.1	3000*	22	14	8				CL-1
	12	Grab		6.1	3320*			NP	34	38	28	SM
MDF-1 TH	3	Grab	102.7	4.9		20	16	4				CL-ML / SC-SM
	9	Grab	86.6	8.4	3240*	25	14	11				CL-1
	18.5	Grab	108.7	10.8	2760*	23	13	10				CL-1
MDF-2 TH	3	Grab	108.6	4.6		20	15	5	34	38	28	SC-SM
	6	Grab	118.5	3.8				NP	38	47	15	SM
	15	Grab	94.8	9.3	3520*	23	14	9				CL-1
MDF-3 TH	6	Grab	102.9	5.8				NP	34	39	27	SM
	15	Grab		7.5	4000+*	22	12	10				CL-1
	18	Grab		5.3	4000+*	21	13	8				CL-1
CS-1 TH	6	Grab										Coal
	9	Grab		8.8	2080*	23	14	9				CL-1
	12	Grab		15.5	2240*	24	16	8				CL-1
F-1 TH	6	Grab	91.3	5.6		22	18	4	18	42	40	SC-SM
	9	Grab		6.1		21	16	5				CL-ML / SC-SM

NP=Nonplastic
*Toravne value used to estimate unconfined compressive Strength.

OTHER LABORATORY TESTING

PROJECT Kinney Mine
LOCATION Scofield, Utah

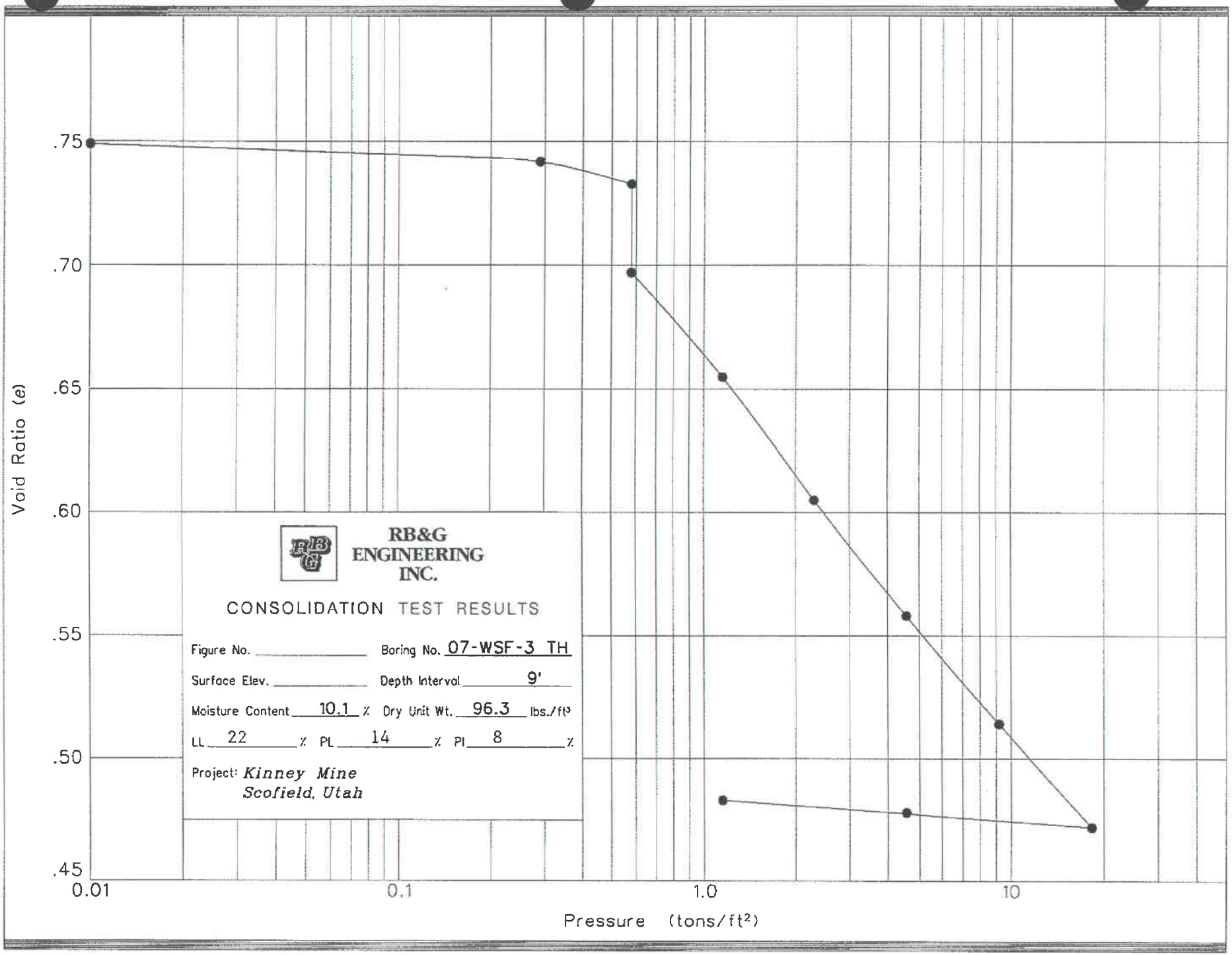
PROJECT NO. 200701-045
FEATURE

CHEMICAL TESTS					
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	pH	RESISTIVITY (ohm-cm)	SULFATE (%)	USCS (MODIFIED) / AASHTO CLASSIFICATION
3-NS-1	6-7.5	8.0	6761	0.0031	CL-1
11-MDF-2	3	8.2	7202	0.0064	SC-SM
9-WSF-1	6	7.3	3322	0.0195	CL-ML
13-WSF-2	3	7.8	6502	0.0315	SM

DIRECT SHEAR TESTS CONSOLIDATED DRAINED					
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	DRY DENSITY (pcf)	FRICTION ANGLE Φ (degrees)	COHESION c (psi)	USCS (MODIFIED) / AASHTO CLASSIFICATION
07-CV-5-1 TH	12	95.8	20	15	CL-1

TRIAXIAL SHEAR TESTS MULTI-STAGE CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENTS						
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	TOTAL STRESS		EFFECTIVE STRESS		USCS (MODIFIED) / AASHTO CLASSIFICATION
		FRICTION ANGLE $\Phi_{(cu)}$ (degrees)	COHESION $c_{(cu)}$ (psi)	FRICTION ANGLE Φ (degrees)	COHESION c (psi)	
CV-4-1 DRL	20-21.5	29.6	2	36.0	2	CL
SC-2 DRL	23-24	32.5	2	36.7	2	CL-1

* Visual Classification
**Bulk Sample


.75
.70
.65
.60
.55
.50
.45
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G
ENGINEERING
INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. 07-WSF-3 TH
Surface Elev.
Depth Interval 9'
Moisture Content 10.1 %
Dry Unit Wt. 96.3 lbs./ft³
LL 22 %
PL 14 %
PI 8 %
Project: Kinney Mine
Scofield, Utah

COVERED STORAGE & FUEL STRUCTURE

TEST PITS CS-1 & F-1

TEST PIT LOG

TEST PIT NO. CS-1 TH

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: COVERED STORAGE / N:74,530 E:38,348
DIGGING METHOD: JOHN DEERE 160 TRACKHOE
OPERATOR:
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/6/07
DATE COMPLETED: 9/6/07
GROUND ELEVATION: 7716.6'
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
						CL	dk. brown, dry	SANDY LEAN CLAY W/GRAVEL								
7715																
						-	black, dry									
	5							COAL fine grained, occasional gravel layer (fill)								
7710						-	black, dry									
					0.52	CL-1	dk. brown, slightly moist, stiff	SANDY LEAN CLAY (fill?)		8.8	23	9				
	10															
7705					0.56	CL-1	orange-brown, moist, stiff	SANDY LEAN CLAY W/GRAVEL pinhole structure		15.5	24	8				
	15				0.55	CL	orange-brown, moist, stiff									
7700						GM	orange-brown, moist	SILTY GRAVEL W/SAND								
					0.85	CL	lt. brown, moist, stiff	LEAN CLAY W/SAND								

TP_LOGV1 KINNEYMINE_TP.GPJ US EVAL.GDT 10/29/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:
DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)
UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

TEST PIT LOG

TEST PIT NO. F-1 TH

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: FUEL / N:74,629 E:38,415
DIGGING METHOD: JOHN DEERE 160 TRACKHOE
OPERATOR:
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/7/07
DATE COMPLETED: 9/7/07
GROUND ELEVATION: 7724.0'
LOGGED BY: J. LINDO

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
						CL	dk. brown, dry	SANDY LEAN CLAY								
7720	5					SC-SM	brown, slightly moist, loose	SILTY CLAYEY SAND W/GRAVEL coal layers (fill)	89.3	6.2						
						SC-SM	brown, slightly moist, loose		91.3	5.6	22	4	18	42	40	
7715	10					CL-ML/ SC-SM	dk. brown, slightly moist	SANDY SILTY CLAY TO SILTY CLAYEY SAND		6.1	21	5				
7710						SM	lt. brown, slightly moist	SILTY SAND W/GRAVEL more gravel w/depth								
	15					GM	lt. brown, slightly moist, dense	SILTY GRAVEL W/SAND								
7705																

TP_LOGV1 KINNEYMINE TP.GPJ US EVAL.GDT 10/29/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:
DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)
UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

Table 1

SUMMARY OF TEST DATA

PROJECT LOCATION: Kinney Mine, Scofield, Utah

PROJECT NO.: 200701-045

FEATURE: Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE		UNCONFINED COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM (modified)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
CV-2-1 TH	3	Grab	95.0	9.0		32	15	17				CL-2
	6	Grab		3.1				NP	64	23	13	GM
CV-2-3 TH	3	Grab	106.1	7.6	4000+*	25	13	12				CL-1
	6	Grab	88.6	6.5	4000+*	23	17	6				CL-ML
	9	Grab	97.1	4.8	4000+*	19	15	4				CL-ML / SC-SM
CV-5-1 TH	3	Grab	89.8	5.8	4000+*	22	15	7				CL-1
	9	Grab	90.7	7.1	4000+*	21	17	4				CL-ML
	12	Grab	95.8	9.7	4000+*	22	12	10				CL-1
	19	Grab		9.6	4000+*	23	13	10				CL-1
CL-5-2 TH	12	Grab	112.7	13.8	4000+*	42	16	26				CL-2
	15	Grab		14.1	4000+*	33	15	18				CL-2
WSF-1 TH	6	Grab	97.9	4.5	2827	21	16	5				CL-ML
WSF-2 TH	3	Grab	91.0	4.6				NP	29	45	26	SM
	9	Grab		4.7		19	15	4				CL-ML / SC-SM
WSF-3 TH	6	Grab	89.6	4.6				NP	34	38	28	SM
	9	Grab	96.3	10.1	3000*	22	14	8				CL-1
	12	Grab		6.1	3320*			NP	34	38	28	SM
MDF-1 TH	3	Grab	102.7	4.9		20	16	4				CL-ML / SC-SM
	9	Grab	86.6	8.4	3240*	25	14	11				CL-1
	18.5	Grab	108.7	10.8	2760*	23	13	10				CL-1
MDF-2 TH	3	Grab	108.6	4.6		20	15	5	34	38	28	SC-SM
	6	Grab	118.5	3.8				NP	38	47	15	SM
	15	Grab	94.8	9.3	3520*	23	14	9				CL-1
MDF-3 TH	6	Grab	102.9	5.8				NP	34	39	27	SM
	15	Grab		7.5	4000+*	22	12	10				CL-1
	18	Grab		5.3	4000+*	21	13	8				CL-1
CS-1 TH	6	Grab										Coal
	9	Grab		8.8	2080*	23	14	9				CL-1
	12	Grab		15.5	2240*	24	16	8				CL-1
F-1 TH	6	Grab	91.3	5.6		22	18	4	18	42	40	SC-SM
	9	Grab		6.1		21	16	5				CL-ML / SC-SM

NP=Nonplastic

*Toravne value used to estimate unconfined compressive Strength.

CONVEYOR SECTION-1

BORING PORTAL-1 & TEST PIT TT-1-2

DRILL HOLE LOG

BORING NO. PORTAL-1 DRL

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: TRANSFER TOWER / N:74,072 E:38,924
DRILLING METHOD: SIMCO 2800 / C.F. AUGER & H.Q. CORE W/AIR
DRILLER: S. MCCRAKEN
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 8/31/07
DATE COMPLETED: 8/31/07
GROUND ELEVATION: 7890.6'
LOGGED BY: M. HANSEN

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	Sample USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
7890				10	6,10	CL-ML	lt. brown, dry	SANDY SILTY CLAY								
						GM	lt. brown, dry									
	5			13	Core 55,0	GM	yellow & lt. brown, dry									
7885								INTERBEDDED SILTSTONE & SANDSTONE GRAVELS & COBBLES IN A SANDY SILT MATRIX occasional clay layers to 1" thick								
				13	Core 28,0	GM	yellow & lt. brown, dry									
	10															
7880				10	5,10,7	GM	yellow & lt. brown, dry, loose			5		NP	55	23	22	
				0	Core 0,0	-										
				9	9,5,2 0.39	CL	gray-brown, slightly moist, firm	LEAN CLAY W/SAND								
	15			0	Core 0,0	-										
7875								SILTY SANDSTONE VERY HIGHLY WEATHERED								
				2	14,11,10	GM	yellow, dry									
					1.88	CL	dk. brown, very stiff	LEAN CLAY								
				18	Core 100,0	OH	black, dry									
	20			11	4,6,10	OH	black, dry, med. dense	COAL very highly weathered		72	78	4	0	41	59	
7870				0	Core 0,0	-										
								CLAYEY MUDSTONE very highly weathered								
				42	Core 117,50	GM	lt. brown, dry	SANDSTONE more competent w/depth								

DH LOGV3 KINNEYMINE_DH.GPJ US EVAL.GDT 11/1/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE — 2,3,2 ← Blow Count per 6"; 0.45 ← Torvane (tsf)
CORE — CORE 95,60 ← Rock Quality Designation (% RQD); Percent Sample Recovery
UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

TEST PIT LOG

TEST PIT NO. TT-1-2 TH

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: TRANSFER TOWER / N:74,070 E:38,873
DIGGING METHOD: JOHN DEERE 160 TRACKHOE
OPERATOR:
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/5/07
DATE COMPLETED: 9/5/07
GROUND ELEVATION: 7873.1'
LOGGED BY: M.N.H.

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
						ML	lt. brown w/some green, dry	SANDY SILT W/ORGANICS								
						CL-ML	lt. brown, dry	SILTY CLAY W/GRAVEL some pinhole structure, flagstone cobbles of sandstone								
7870																
						GC	dry	COBBLES & GRAVEL W/CLAY								
						CL/GC	lt. brown, dry	GRAVELLY CLAY TO CLAYEY GRAVEL								
	5					CL-ML	dk. brown, dry	SILTY CLAY W/GRAVEL								
						GC	lt. brown, dry	GRAVEL W/CLAY cobbles & boulders								
7865																

TP_LOGV1 KINNEYMINE_TP.GPJ US EVAL.GDT 10/29/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:
DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)
UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

TT-1-DH

Table 1

SUMMARY OF TEST DATA

PROJECT Kinney Mine
LOCATION Scofield, Utah

PROJECT NO. 200701-045
FEATURE Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE		UNCONFINED COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM (modified)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
Portal 1-DRL	10-11.5	17		5.0				NP	55	23	22	GM
	19-20.5	16		72.0		78	74	4	0	41	59	OH
CV-2-2 DRL	3-4.5	52		3.6				NP	15	59	26	SM
	9-10.5	11		4.9				NP	17	61	22	SM
	15-16.5	19		4.4				NP	42	49	9	SP-SM
	25-26.5	19		10.7		31	15	16				CL-2
NS-1 DRL	6-7.5	28		5.3		22	13	9				CL-1
	9-10.5	52		6.1		26	13	13				CL-1
	15-16.5	46		5.3				NP	6	25	69	ML
	22.5-24	23		11.8		26	13	13				CL-1
	31.5-31.9		109.6	18.8								CL
S-1 DRL	10-11.5	23		7.8		28	14	14				CL-1
	20-21.5	19		12.9		24	14	10				CL-1
	30-31.5	27		12.8		26	14	12				CL-1
	40-41.5	25		17.5	6280*	28	15	13				CL-1
	50-51.5	29		16.2	5840*	34	15	19				CL-2
	57		113.9	16.3								
	66		103.4	18.1								CL
	70-71.5	35		17.2	8280*	35	14	21				CL-2
CV-4-1 DRL	5-6.5	21		10.0		25	18	7				CL-1
	10.5-15	Core		9.2		20	13	7	24	24	52	CL-1
	15-16.5	55		10.2		21	11	10				CL-1
	21.5-25	Core		11.9	3600*	22	12	10				CL-1
	25-26.5	22		13.8	2240*	26	10	16				CL-2
	31.5-35	Core		10.5	2220*	21	10	11				CL-1
	35-36.5	9		17.1	3200*	21	11	10				CL-1
	41.5-45	Core		17.1		29	13	16				CL-2
	45-46.5	74		14.6	3320*	30	14	16				CL-2
	55-60	Core		12.6	4000*	21	14	7				CL-1
	66.5-70	Core		12.6	4000*	29	11	18	15	19	66	CL-2
SC-2 DRL	23-24					24	12	12				CL-1

NP=Nonplastic
*Torvane value used to estimate unconfined compressive strength.

CONVEYOR SECTION-2

TEST PIT CV-2-1, BORING CV-2-2, & TEST PIT CV-2-3

TEST PIT LOG

TEST PIT NO. CV-2-1 TH

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: CONVEYOR BENT / N:74,184 E:38,833
DIGGING METHOD: JOHN DEERE 160 TRACKHOE
OPERATOR:
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/5/07
DATE COMPLETED: 9/5/07
GROUND ELEVATION: 7862.7'
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
							SANDY LEAN CLAY W/GRAVEL ~30% cobbles & boulders								
7860			X			CL-2	brown, slightly moist, stiff	95	9	32	17				
							COAL								
	5		■			GM	lt. brown, dry, dense		3.1		NP	64	23	13	
7855							COBBLES & BOULDERS IN SILTY SAND MATRIX >80% gravel, cobbles & boulders; fractured & weathered sandstone								
	10		■			GM	lt. brown, dry, dense								
7850															
	15		■			-	lt. brown, dry								
7845							SANDSTONE competent, trackhoe able to excavate w/difficulty								

TP_LOGV1 KINNEYMINE_TP.GPJ US EVAL.GDT 10/29/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE ■ Bucket ← Type of Sample
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

DRILL HOLE LOG

BORING NO. CV-2-2 DRL

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: CONVEYOR BENT / N:74,404 E:38,793
DRILLING METHOD: SIMCO 2800 / C.F. AUGER
DRILLER: S. MCCRAKEN
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/1/07
DATE COMPLETED: 9/1/07
GROUND ELEVATION: 7841.2'
LOGGED BY: M. HANSEN

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
7840				18	4,5,5	CL-ML	gray-brown, dry, firm	SANDY SILTY CLAY								
						CL-ML	lt. brown, dry									
				16	9,27,25	SM	yellow-brown, dry, very dense			3.6		NP	15	59	26	
	5															
7835				12	30,21,12	SM	yellow-brown, dry, dense									
								SILTY SAND W/GRAVEL very highly weathered sandstone								
	10			18	4,5,6	SM	yellow-brown, dry, med. dense			4.9		NP	17	61	22	
7830																
				11	3,6,7	SM	yellow-brown, dry, med. dense									
	15															
7825				12	11,9,10	SP-SM	lt. brown, dry, med. dense			4.4		NP	42	49	9	
								SAND W/SILT & GRAVEL very highly weathered sandstone								
	20															
7820				11	4,5,7	SP-SM	lt. brown, dry, med. dense									
	25															
7815				15	4,7,12	CL-2	gray-brown, slightly moist, stiff			10.7	31	16				
								LEAN CLAY W/SAND very highly weathered mudstone								
	30					CL	yellow-brown, slightly moist, stiff									
7810				12	7,11,36	SM	yellow-brown	SILTY SAND W/GRAVEL very highly weathered sandstone								

DH LOGV3 KINNEYMINE DH.GPJ US EVAL.GDT 11/1/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE — 2,3,2 ← Blow Count per 6"; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

TEST PIT LOG

TEST PIT NO. CV-2-3 TH

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: CONVEYOR BENT / N:74,617 E:38,738
DIGGING METHOD: JOHN DEERE 160 TRACKHOE
OPERATOR:
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/5/07
DATE COMPLETED: 9/5/07
GROUND ELEVATION: 7805.2'
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	Sample USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
7805																
			■		+1.00	CL-1	dk. brown, dry to slightly moist, very stiff	SANDY LEAN CLAY W/GRAVEL (fill)	106.1	7.6	25	12				
7800	5															
								COAL & ORGANIC LAYER								
			■		+1.00	CL-ML	lt. brown, dry, very stiff	SANDY SILTY CLAY W/GRAVEL very blocky	88.6	6.5	23	6				
			⊠		+1.00	CL-ML/ SC-SM	lt. brown, dry, very stiff	SANDY SILTY CLAY TO SILTY CLAYEY SAND pinhole structure	97.1	4.8	19	4				
7795	10															
			■			-	lt. brown, dry, dense	SANDSTONE weathered, becomes more competent w/depth								
7790	15															

TP_LOGV1 KINNEYMINE_TP.GPJ US EVAL.GDT 10/29/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE ■ Bucket ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ⊠

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

SIUFF
25.0
25.5
DH-2
Soils
26.0
26.5

SIUFF
29.5
Kinney
DH. 2
Soils
31.0
31.5

CV-2

Table 1

SUMMARY OF TEST DATA

PROJECT Kinney Mine
LOCATION Scofield, Utah

PROJECT NO. 200701-045
FEATURE Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE		UNCONFINED COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM (modified)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
Portal 1-DRL	10-11.5	17		5.0				NP	55	23	22	GM
	19-20.5	16		72.0		78	74	4	0	41	59	OH
CV-2-2 DRL	3-4.5	52		3.6				NP	15	59	26	SM
	9-10.5	11		4.9				NP	17	61	22	SM
	15-16.5	19		4.4				NP	42	49	9	SP-SM
	25-26.5	19		10.7		31	15	16				CL-2
NS-1 DRL	6-7.5	28		5.3		22	13	9				CL-1
	9-10.5	52		6.1		26	13	13				CL-1
	15-16.5	46		5.3				NP	6	25	69	ML
	22.5-24	23		11.8		26	13	13				CL-1
	31.5-31.9		109.6	18.8								CL
S-1 DRL	10-11.5	23		7.8		28	14	14				CL-1
	20-21.5	19		12.9		24	14	10				CL-1
	30-31.5	27		12.8		26	14	12				CL-1
	40-41.5	25		17.5	6280*	28	15	13				CL-1
	50-51.5	29		16.2	5840*	34	15	19				CL-2
	57		113.9	16.3								
	66		103.4	18.1								CL
	70-71.5	35		17.2	8280*	35	14	21				CL-2
CV-4-1 DRL	5-6.5	21		10.0		25	18	7				CL-1
	10.5-15	Core		9.2		20	13	7	24	24	52	CL-1
	15-16.5	55		10.2		21	11	10				CL-1
	21.5-25	Core		11.9	3600*	22	12	10				CL-1
	25-26.5	22		13.8	2240*	26	10	16				CL-2
	31.5-35	Core		10.5	2220*	21	10	11				CL-1
	35-36.5	9		17.1	3200*	21	11	10				CL-1
	41.5-45	Core		17.1		29	13	16				CL-2
	45-46.5	74		14.6	3320*	30	14	16				CL-2
	55-60	Core		12.6	4000*	21	14	7				CL-1
	66.5-70	Core		12.6	4000*	29	11	18	15	19	66	CL-2
SC-2 DRL	23-24					24	12	12				CL-1

NP=Nonplastic
*Torvane value used to estimate unconfined compressive strength.

Table 1

SUMMARY OF TEST DATA

PROJECT Kinney Mine
LOCATION Scofield, Utah

PROJECT NO. 200701-045
FEATURE Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE		UNCONFINED COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM (modified)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
CV-2-1 TH	3	Grab	95.0	9.0		32	15	17				CL-2
	6	Grab		3.1				NP	64	23	13	GM
CV-2-3 TH	3	Grab	106.1	7.6	4000+*	25	13	12				CL-1
	6	Grab	88.6	6.5	4000+*	23	17	6				CL-ML
	9	Grab	97.1	4.8	4000+*	19	15	4				CL-ML / SC-SM
CV-5-1 TH	3	Grab	89.8	5.8	4000+*	22	15	7				CL-1
	9	Grab	90.7	7.1	4000+*	21	17	4				CL-ML
	12	Grab	95.8	9.7	4000+*	22	12	10				CL-1
	19	Grab		9.6	4000+*	23	13	10				CL-1
CL-5-2 TH	12	Grab	112.7	13.8	4000+*	42	16	26				CL-2
	15	Grab		14.1	4000+*	33	15	18				CL-2
WSF-1 TH	6	Grab	97.9	4.5	2827	21	16	5				CL-ML
WSF-2 TH	3	Grab	91.0	4.6				NP	29	45	26	SM
	9	Grab		4.7		19	15	4				CL-ML / SC-SM
WSF-3 TH	6	Grab	89.6	4.6				NP	34	38	28	SM
	9	Grab	96.3	10.1	3000*	22	14	8				CL-1
	12	Grab		6.1	3320*			NP	34	38	28	SM
MDF-1 TH	3	Grab	102.7	4.9		20	16	4				CL-ML / SC-SM
	9	Grab	86.6	8.4	3240*	25	14	11				CL-1
	18.5	Grab	108.7	10.8	2760*	23	13	10				CL-1
MDF-2 TH	3	Grab	108.6	4.6		20	15	5	34	38	28	SC-SM
	6	Grab	118.5	3.8				NP	38	47	15	SM
	15	Grab	94.8	9.3	3520*	23	14	9				CL-1
MDF-3 TH	6	Grab	102.9	5.8				NP	34	39	27	SM
	15	Grab		7.5	4000+*	22	12	10				CL-1
	18	Grab		5.3	4000+*	21	13	8				CL-1
CS-1 TH	6	Grab										Coal
	9	Grab		8.8	2080*	23	14	9				CL-1
	12	Grab		15.5	2240*	24	16	8				CL-1
F-1 TH	6	Grab	91.3	5.6		22	18	4	18	42	40	SC-SM
	9	Grab		6.1		21	16	5				CL-ML / SC-SM

NP=Nonplastic
*Toravne value used to estimate unconfined compressive Strength.

CONVEYOR SECTION-3

BORINGS NS-1 & S-1

DRILL HOLE LOG

BORING NO. NS-1 DRL

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: NON-SPEC COAL STOCKPILE / N:74,729 E:74,72938,707
DRILLING METHOD: SIMCO 2800 / C.F. AUGER & H.Q. CORE
DRILLER: S. MCCRAKEN
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 8/30/07
DATE COMPLETED: 9/1/07
GROUND ELEVATION: 7785.2'
LOGGED BY: M.N.H., G.L.H.

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
				11	13,16,16	CL-ML	gray-brown, dry, very stiff	SANDY SILTY CLAY occasional cobbles								
				13	7,7,10	CL-ML	dk. brown, dry, stiff, slight pinhole structure									
7780	5			11	11,13,15	CL-1	mottled rust & brown, dry, very stiff	SANDY LEAN CLAY		5.3	22	9				
7775	10			15	9,24,28	CL-1	mottled gray-brown, dry, hard			6.1	26	13				
				9	32,50/3"	GC-GM	gray-brown, dry, dense	SILTY CLAYEY GRAVEL W/SAND possible cobbles								
7770	15			13	11,19,27	OH ML	black, dry lt. brown, dry, dense	COAL very highly weathered SANDY SILT very highly weathered siltstone		5.3		NP	6	25	69	
				5	19,50/3"	SM	lt. brown, dry, dense	SILTY SAND W/GRAVEL very highly weathered sandstone, more competent w/depth								
7765	20			6	Core 50,30	SM	lt. brown, dry									
				0	Core 0,0	-										
				0	Core 0,0	-										
				15	7,10,13 0.80	CL-1	brown, slightly moist, stiff			11.8	26	13				
7760	25			2	10,10,14	CL	brown, slightly moist, stiff	SANDY LEAN CLAY W/GRAVEL								
7755	30			18	5,10,12 0.90+	CL	lt. brown, yellow-brown & gray, moist, very stiff		109.6	18.8						CT
				0	Core 0,0	-										
7750	35			30	Core 1.78 50,0	CL	lt. brown & yellow-brown, moist, very stiff									
				42	Core 100,0	CL,GM	tan, dk. gray & yellow-brown, slightly moist, very stiff									
7745	40			35	Core 100,0	CL,GM	lt. brown & yellow-brown, slightly moist	SANDY LEAN CLAY W/GRAVEL sandstone cobbles and/or boulders								
				25	Core 72,0	CL,GM	lt. brown, gray & yellow-brown, slightly moist									
7740	45			19	Core 76,0	CL,GM	lt. brown, rust & gray, slightly moist									
				36	Core 97,0	CL,GM	lt. brown, gray & yellow-brown, slightly moist									

DH_LOGV3_KINNEYMINE_DH.GPJ US EVAL.GDT 12/13/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE — 2,3,2 ← Blow Count per 6"; 0.45 ← Torvane (tsf)
CORE — CORE 95,60 ← Rock Quality Designation (% RQD); ← Percent Sample Recovery
UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

DRILL HOLE LOG

BORING NO. S-1 DRL

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: SPEC COAL STOCKPILE / N:74,730 E:38,707
DRILLING METHOD: LONGYEAR 44 & CME-2800 / C.F. AUGER & H.Q. CORE
DRILLER: S. MCCRAKEN
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/2/07
DATE COMPLETED: 9/12/07
GROUND ELEVATION: 7784.6'
LOGGED BY: G.L.H., M.N.H

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
				12	12,16,21	CL-ML	dk. brown to black, dry, very stiff								
				18	10,11,15	CL-ML	brown, dry, very stiff, slight pinhole structure								
7780	5						SANDY SILTY CLAY coal & sandstone gravels, occasional cobbles								
7775	10			18	10,13,26	CL-1	dk. gray to brown, dry to slightly moist, hard		7.8	28	14				
7770	15			13	10,16,20	CL	dk. gray to lt. gray-brown, dry to slightly moist, hard								
7765	20			18	7,10,9	CL-1	lt. brown to gray, slightly moist, very stiff		12.9	24	10				
7760	25			18	13,10,10	CL	dk. gray to brown, slightly moist, very stiff								
							SANDY LEAN CLAY W/GRAVEL sandstone cobbles & boulders, sand layers to 3" thick								
7755	30			18	7,10,17	CL-1	lt. brown, slightly moist, very stiff		12.8	26	12				
				34	Core 2.20 100,0	CL	lt. orange-brown, slightly moist, very stiff								
7750	35			0	Core	-									
				2	0,0 14,10,11	CL	rust-brown, very moist, very stiff								
				22	Core 1.45 51,29	CL	gray-brown, moist, very stiff								
7745	40			8	7,13,12 1.57	CL-1	orange-brown, moist, very stiff		17.5	28	13				
				41	Core 1.63 97,86	CL	gray-brown, moist, very stiff								
7740	45			2	4,6,7 0.91	CL	gray, moist, stiff								
				24	Core 0.85 57,57	CL	gray to lt. brown, moist, stiff to very stiff								
7735															

DH_LOGV3 KINNEYMINE_DH.GPJ US EVAL.GDT 12/13/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE — 2,3,2 ← Blow Count per 6"; 0.45 ← Torvane (tsf)
CORE — CORE 95,60 ← Rock Quality Designation (% RQD); Percent Sample Recovery
UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

DRILL HOLE LOG

BORING NO. S-1 DRL

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: SPEC COAL STOCKPILE / N:74,730 E:38,707
DRILLING METHOD: LONGYEAR 44 & CME-2800 / C.F. AUGER & H.Q. CORE
DRILLER: S. MCCRAKEN
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/2/07
DATE COMPLETED: 9/12/07
GROUND ELEVATION: 7784.6'
LOGGED BY: G.L.H., M.N.H

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	Sample USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
				18	8,13,16 *1.46*	CL-2	lt. gray-brown, moist, very stiff		16.2	34	19				
				42	Core *100,0*	CL	lt. orange-brown, moist, very stiff — SANDY LEAN CLAY W/GRAVEL sandstone cobbles & boulders, sand layers to 3" thick								
7730	55			18	8,19,24 *0.90+*	CL	lt. brown, moist, very stiff to hard								
				42	Core *1.37* *100,63*	CL	gray to rusty-brown & lt. brown, moist, hard	113.9	16.3						CT
7725	60			22	Core *0.90* *36,0*	CL	yellow-brown to brown, moist, stiff								
7720	65			62	Core *2.37* *104,100*	CL	gray-brown & yellow-brown, moist, hard — SANDY LEAN CLAY W/GRAVEL sandstone & mudstone cobbles & boulders	103.4	18.1						CT
7715	70			18	10,17,18 *2.07*	CL-2	brown, moist, hard		17.2	35	21				
				42	Core *2.14* *100,100*	CL	brown, moist, hard								
7710	75			18	10,19,20 *0.90+*	CL	brown to lt. brown, moist, hard								
7705	80														
7700	85														
7695	90														
7690	95														
7685															

DH_LOGV3 KINNEYMINE_DH.GPJ US EVAL.GDT 12/13/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE — 2,3,2 ← Blow Count per 6"; 0.45 ← Torvane (tsf)

CORE — CORE 95,60 ← Rock Quality Designation (% RQD); Percent Sample Recovery

UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

Photo Loss

NS-1 Page 1

1F
Kinney Soil of
3-NS-1

2F
3F
47.0
Kinney
soil of
3-NS-1
48.0

3F
4F
48.0
Kinney
soil of
3-NS-1
49.0

4F
5F
9.0
Kinney
soil of
3-NS-1
50.0

1.0
Kinney Soil 07 4-S-1
2.0
Kinney Soil 07 4-S-1
3.0
10.0
Kinney Soil 07 4-S-1
11.0
15.0
Kinney Soil 07
16.0
16.0
16.5

S-1 Page 1

1F
2F
20.0
Kinney
Soil 07
4-S-1
21.0
21.5
1F
2F
25.0
Kinney
Soil 07
4-S-1
26.0
26.5
1F
2F
30.0
Kinney
Soil 07
4-S-1
31.0
31.5

S-1 Page 2

40.0 - 41.5 Core Loss

Core Loss

Core Loss

51.0
1F
2F
3F
52.0
53.0

3F
4F
5F
53.0
54.0
55.0

Core
Loss

1F
1F
2F
56.5
57.0
57.0
58.0
4-S-1

2F
3F
58.0
4-S-1
59.0

3F
4F
59.0
4-S-1
60.0

1F
60.0
4-S-1
61.0

1F
2F
61.0
4-S-1
61.8
Missing
61.8-6

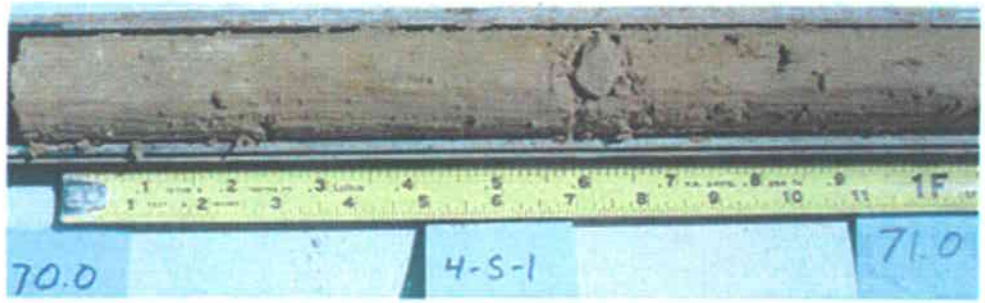
1F
65.0
66.0

1F
2F
66.0
67.0

2F
3F
67.0
4-S-1

3F
4F
68.0
69.0

4F
5F
69.0


1F
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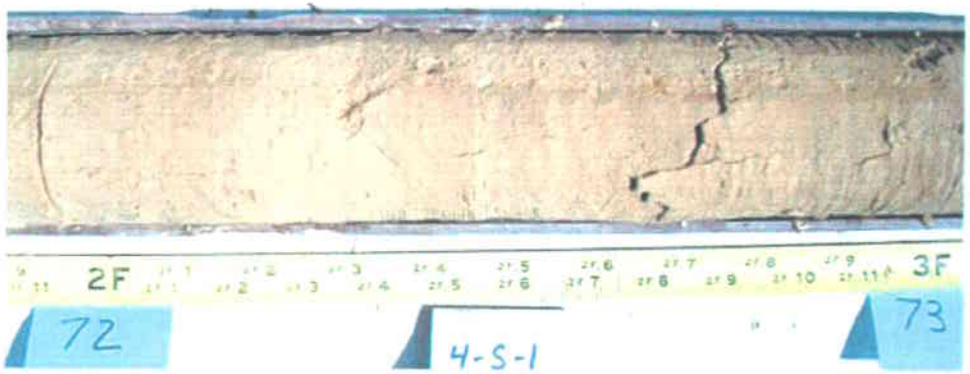
4-S-1
71.0

1F
71.0
4-S-1
71.5

2F
71.5
72


2F
3F
72
4-S-1
73

3F
4F
73
4-S-1
74

4F
5F
74
4-S-1
75.0

1F
75.0
4-S-1
76.0

1F
76.0
4-S-1
76.5

TD

Table 1

SUMMARY OF TEST DATA

PROJECT Kinney Mine
LOCATION Scofield, Utah

PROJECT NO. 200701-045
FEATURE Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE		UNCONFINED COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM (modified)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
Portal 1-DRL	10-11.5	17		5.0				NP	55	23	22	GM
	19-20.5	16		72.0		78	74	4	0	41	59	OH
CV-2-2 DRL	3-4.5	52		3.6				NP	15	59	26	SM
	9-10.5	11		4.9				NP	17	61	22	SM
	15-16.5	19		4.4				NP	42	49	9	SP-SM
	25-26.5	19		10.7		31	15	16				CL-2
NS-1 DRL	6-7.5	28		5.3		22	13	9				CL-1
	9-10.5	52		6.1		26	13	13				CL-1
	15-16.5	46		5.3				NP	6	25	69	ML
	22.5-24	23		11.8		26	13	13				CL-1
	31.5-31.9		109.6	18.8								CL
S-1 DRL	10-11.5	23		7.8		28	14	14				CL-1
	20-21.5	19		12.9		24	14	10				CL-1
	30-31.5	27		12.8		26	14	12				CL-1
	40-41.5	25		17.5	6280*	28	15	13				CL-1
	50-51.5	29		16.2	5840*	34	15	19				CL-2
	57		113.9	16.3								
	66		103.4	18.1								CL
	70-71.5	35		17.2	8280*	35	14	21				CL-2
CV-4-1 DRL	5-6.5	21		10.0		25	18	7				CL-1
	10.5-15	Core		9.2		20	13	7	24	24	52	CL-1
	15-16.5	55		10.2		21	11	10				CL-1
	21.5-25	Core		11.9	3600*	22	12	10				CL-1
	25-26.5	22		13.8	2240*	26	10	16				CL-2
	31.5-35	Core		10.5	2220*	21	10	11				CL-1
	35-36.5	9		17.1	3200*	21	11	10				CL-1
	41.5-45	Core		17.1		29	13	16				CL-2
	45-46.5	74		14.6	3320*	30	14	16				CL-2
	55-60	Core		12.6	4000*	21	14	7				CL-1
	66.5-70	Core		12.6	4000*	29	11	18	15	19	66	CL-2
SC-2 DRL	23-24					24	12	12				CL-1

NP=Nonplastic
*Torvane value used to estimate unconfined compressive strength.

Table 2
Page 1 of 1

OTHER LABORATORY TESTING

PROJECT Kinney Mine
LOCATION Scofield, Utah

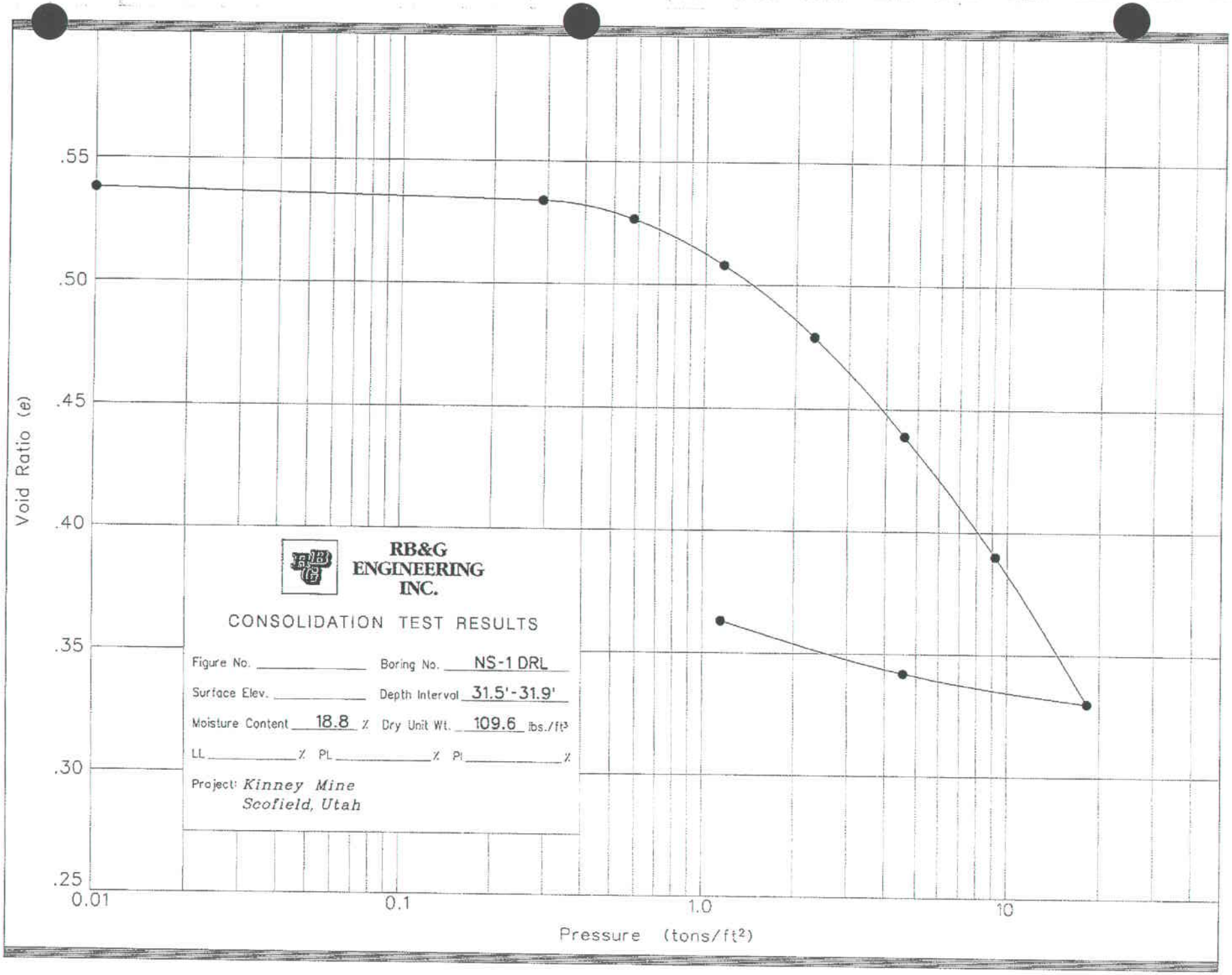
PROJECT NO. 200701-045
FEATURE

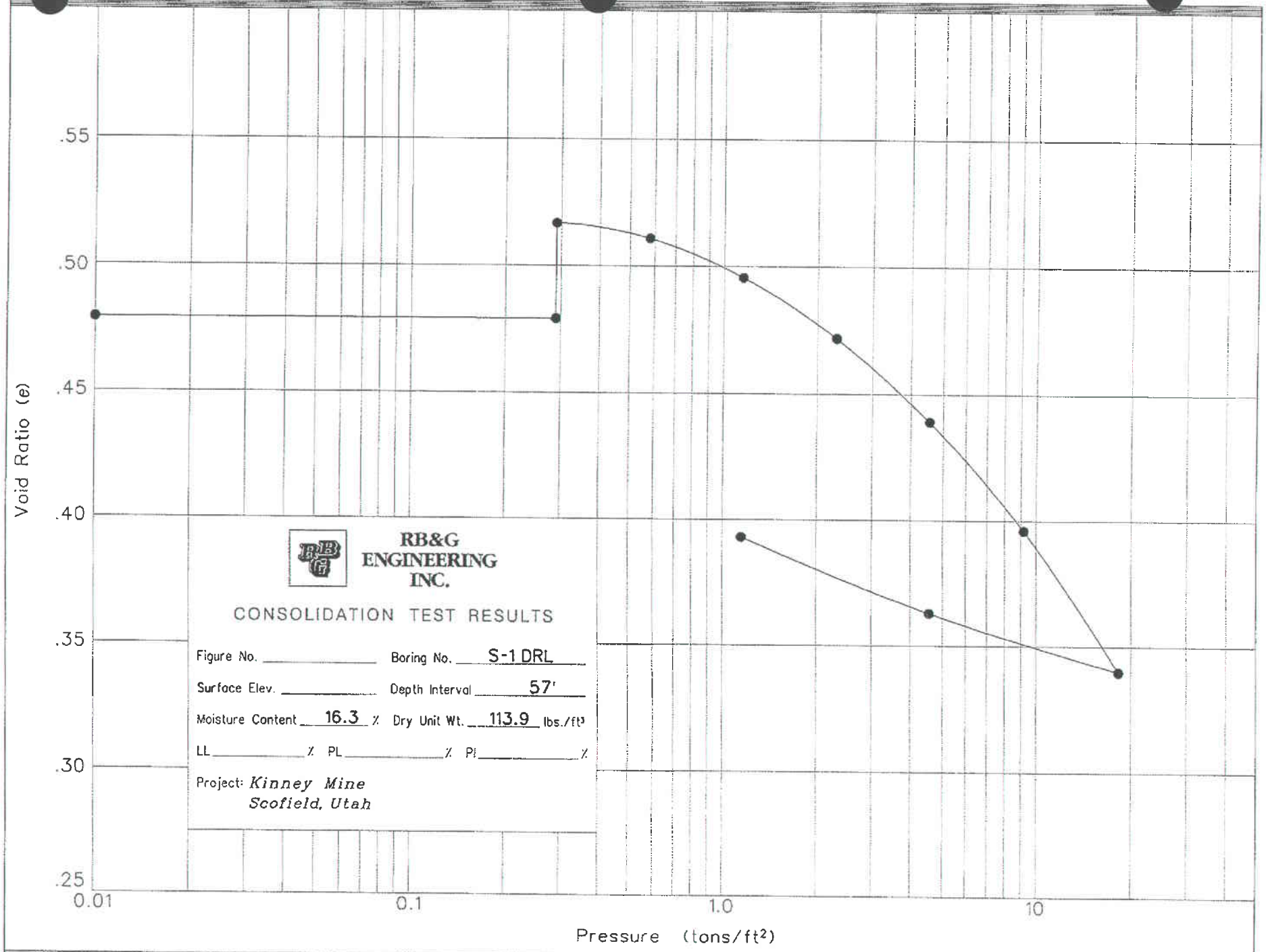
CHEMICAL TESTS					
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	pH	RESISTIVITY (ohm-cm)	SULFATE (%)	USCS (MODIFIED) / AASHTO CLASSIFICATION
3-NS-1	6-7.5	8.0	6761	0.0031	CL-1
11-MDF-2	3	8.2	7202	0.0064	SC-SM
9-WSF-1	6	7.3	3322	0.0195	CL-ML
13-WSF-2	3	7.8	6502	0.0315	SM

DIRECT SHEAR TESTS CONSOLIDATED DRAINED					
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	DRY DENSITY (pcf)	FRICTION ANGLE Φ (degrees)	COHESION c (psi)	USCS (MODIFIED) / AASHTO CLASSIFICATION
07-CV-5-1 TH	12	95.8	20	15	CL-1

TRIAXIAL SHEAR TESTS MULTI-STAGE CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENTS						
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	TOTAL STRESS		EFFECTIVE STRESS		USCS (MODIFIED) / AASHTO CLASSIFICATION
		FRICTION ANGLE $\Phi_{(cu)}$ (degrees)	COHESION $c_{(cu)}$ (psi)	FRICTION ANGLE Φ (degrees)	COHESION c (psi)	
CV-4-1 DRL	20-21.5	29.6	2	36.0	2	CL
SC-2 DRL	23-24	32.5	2	36.7	2	CL-1

* Visual Classification
**Bulk Sample


.55
.50
.45
.40
.35
.30
.25
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G
ENGINEERING
INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. NS-1 DRL
Surface Elev.
Depth Interval 31.5'-31.9'
Moisture Content 18.8 %
Dry Unit Wt. 109.6 lbs./ft³
LL % PL % PI %
Project: Kinney Mine
Scofield, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

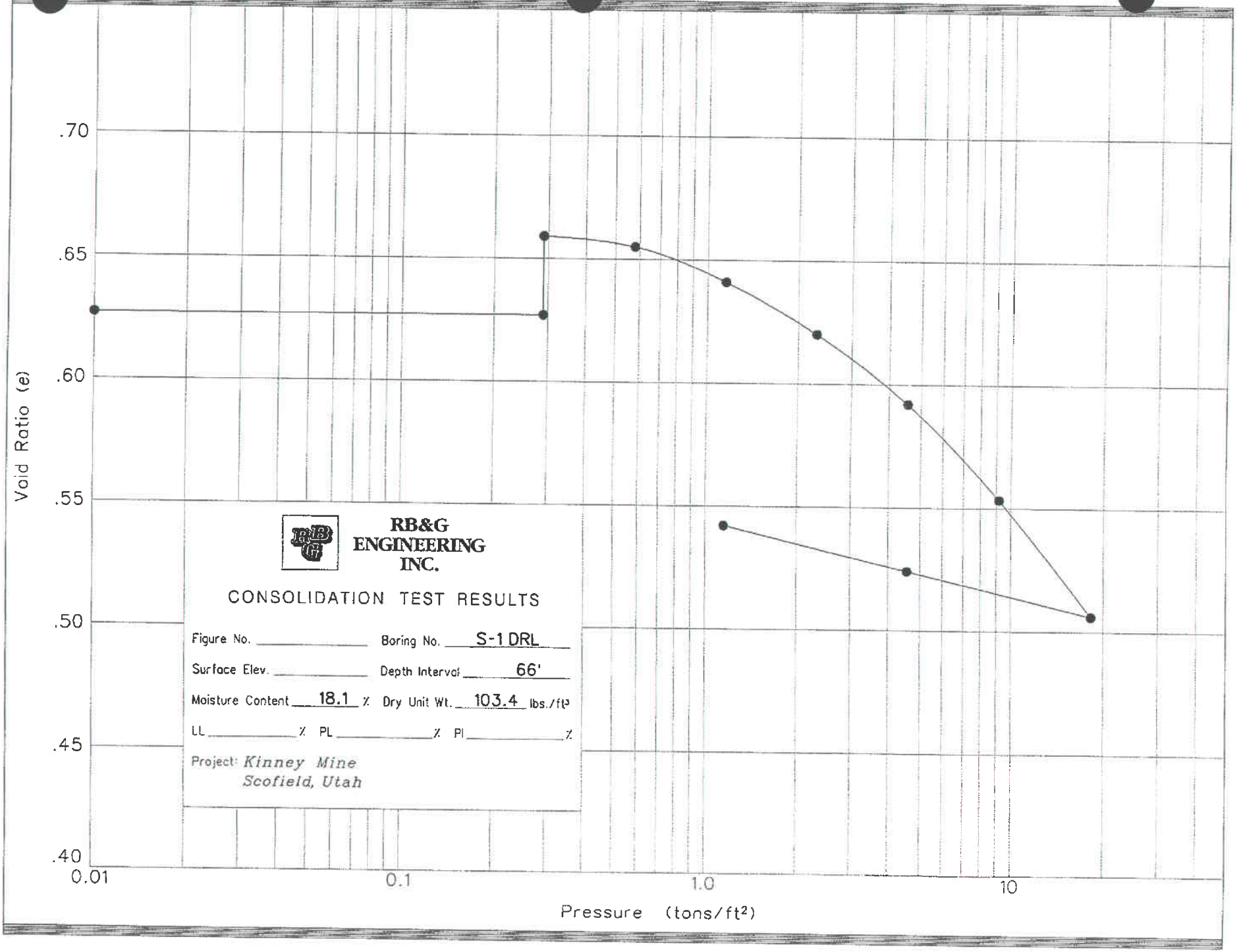
Figure No. _____ Boring No. S-1 DRL

Surface Elev. _____ Depth Interval 57'

Moisture Content 16.3 % Dry Unit Wt. 113.9 lbs./ft³

LL _____ % PL _____ % PI _____ %

Project: *Kinney Mine*
Scofield, Utah


.70
.65
.60
.55
.50
.45
.40
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G
ENGINEERING
INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. S-1 DRL
Surface Elev.
Depth Interval 66'
Moisture Content 18.1 %
Dry Unit Wt. 103.4 lbs./ft³
LL % PL % PI %
Project: Kinney Mine
Scofield, Utah

CONVEYOR SECTION-4

BORINGS CV-4-1 & SC-2

DRILL HOLE LOG

BORING NO. CV-4-1 DRL

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: CONVEYOR BENT / N:75,077 E:38,786
DRILLING METHOD: LONGYEAR 44 / H.Q. CORE W/SPLIT SPOON
DRILLER: S. KISSNER
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/13/07
DATE COMPLETED: 9/14/07
GROUND ELEVATION: 7776.3'
LOGGED BY: M. HANSEN

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
7775				11	Core 18,0	CL	brown, dry, very stiff								
7770	5			18	9,9,12	CL-1	brown, slightly moist, very stiff		10	25	7				
				35	Core 83,0	CL	very dk. brown to black, slightly moist, very stiff								
7765	10			6	55/6"	CL	dk. gray, slightly moist, hard								
				42	Core 0.99+ 78,44	CL-1	brown & yellow-brown, slightly moist, very stiff		9.2	20	7	24	24	52	
7760	15			18	18,25,30	CL-1	brown, slightly moist, hard		10.2	21	10				
				42	Core 100,57	CL	brown, slightly moist, hard								
7755	20			18	17,27,41 0.90+	CL	brown, slightly moist, hard, weathered coal in sample	SANDY LEAN CLAY W/GRAVEL sandstone cobbles & boulders							TS
				38	Core 91,69	CL-1	brown & dk. gray, moist, hard		11.9	22	10				
7750	25			14	7,11,11 0.56	CL-2	brown, moist, stiff to very stiff		13.8	26	16				
				38	Core 0.79 91,0	CL	brown, moist, stiff to very stiff								
7745	30			18	5,5,8 0.55 0.58	CL	brown, moist, stiff								
				22	Core 0.69 51,0	CL-1	brown, moist, stiff		10.5	21	11				
7740	35			18	3,4,5 0.80	CL-1	brown, moist, stiff		17.1	21	10				
				19	Core 0.42 0.77 46,0	CL	brown & yellow-brown, moist, stiff								
7735	40			10	9,12,15	CL	brown, moist, stiff								
				42	Core 0.90+ 100,0	CL-2	green-gray, yellow-brown & gray to black, moist, very stiff		17.1	29	16				
7730	45			13	20,18,56 0.83	CL-2	lt. gray to brown, moist, stiff to very stiff	GRAVELLY LEAN CLAY W/SAND sandstone cobbles & boulders	14.6	30	16				
				42	Core 0.90+ 100,29	CL	dk. gray & brown, moist, very stiff								

DH_LOGV3 KINNEYMINE_DH.GPJ US_EVAL.GDT 10/30/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE: 2,3,2 ← Blow Count per 6"; 0.45 ← Torvane (tsf)

CORE: CORE 95,60 ← Rock Quality Designation (% RQD); ← Percent Sample Recovery

UNDISTURBED SAMPLE: PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

DRILL HOLE LOG

BORING NO. CV-4-1 DRL

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: CONVEYOR BENT / N:75,077 E:38,786
DRILLING METHOD: LONGYEAR 44 / H.Q. CORE W/SPLIT SPOON
DRILLER: S. KISSNER
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/13/07
DATE COMPLETED: 9/14/07
GROUND ELEVATION: 7776.3'
LOGGED BY: M. HANSEN

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
7725				4	50/4"	CL	brown, very moist, hard								
				37	Core 0.99+ 67,18	CL	brown & yellow-brown, moist to very moist, very stiff								
	55			0	30/0"	-	GRAVELLY LEAN CLAY W/SAND sandstone cobbles & boulders								
7720				60	Core 0.99+ 100,0	CL-1	brown & yellow-brown, very moist, hard		12.6	21	7				
	60			18	8,20,41 0.90+	CL	brown, moist, very stiff								
7715				42	Core 100,0	CL	brown to dk. gray-brown, moist, very stiff								
	65			9	13,40,54 0.90+	CL	brown to rusty-brown, moist, hard								
7710				42	Core 0.99+ 100,0	CL-2	GRAVELLY LEAN CLAY W/SAND TO SANDY LEAN CLAY W/GRAVEL sandstone cobbles & boulders; brown, moist, hard		12.6	29	18				
	70			16	12,33,52 0.90+	CL	brown, moist, hard								
7705															
	75														
7700															
	80														
7695															
	85														
7690															
	90														
7685															
	95														
7680															

DH_LOGV3 KINNEYMINE DH.GPJ US EVAL.GDT 10/30/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE — 2,3,2 ← Blow Count per 6"; 0.45 ← Torvane (tsf)
CORE — CORE 95,60 ← Rock Quality Designation (% RQD); ← Percent Sample Recovery
UNDISTURBED SAMPLE — PUSHED 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

DRILL HOLE LOG

BORING NO. SC-2 DRL

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: SCREENING & CRUSHING / N:75,227 E:38,820
DRILLING METHOD: LONGYEAR 44 & CME-2800 / C.F. AUGER & H.Q. CORE
DRILLER: S. MCCRAKEN
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/14/07
DATE COMPLETED: 9/14/07
GROUND ELEVATION: 7741.2'
LOGGED BY: M.N.H., G.L.H.

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
7740							NOT SAMPLED									
	5															
7735																
	10															
7730																
	15															
7725																
	20			16	11,12,13 *0.66*	CL	brown, slightly moist, stiff									
7720				14	Core *34,0*	CL-1	brown, slightly moist, stiff	SANDY LEAN CLAY W/GRAVEL sandstone cobbles	115.6	15.3	24	12				TS
	25			18	5,6,10 *0.52*	CL	brown, slightly moist, stiff									
7715				19	Core *46,0*	CL-ML	brown, slightly moist, stiff	SANDY SILTY CLAY W/GRAVEL sandstone cobbles	123.8	11.3	18	5				CT
	30			18	9,9,15 *0.25* *0.57*	CL	brown, slightly moist, firm to stiff	SANDY LEAN CLAY W/GRAVEL sandstone cobbles								
7710																

DH_LOGV3 KINNEYMINE_DH.GPJ US EVAL.GDT 11/16/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE — 2,3,2 ← Blow Count per 6"; 0.45 ← Torvane (tsf)

CORE — CORE 95.60 ← Rock Quality Designation (% RQD); ← Percent Sample Recovery

UNDISTURBED SAMPLE — PUSHED 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

1F
5
5-CV-4
6

2F
3F
5-CV-4
8

3F
4F
8
5-CV-4
9

4F
5F
9
10

10
5-CV-4
10.5

2F
10.5
11
5-CV-4
12

2F
3F
12
13

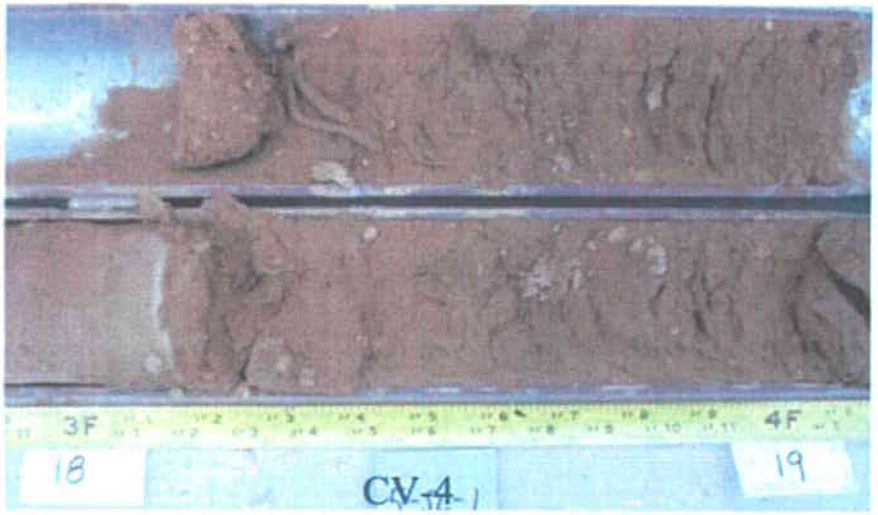
3F
4F
13
14

4F
14
15

3F
4F
15
5-CV-4
16
16.5

2F
16.5
CV-4
17

2F
3F
17
CV-4
18


3F
4F
18
CV-4
19

4F
5F
19
20

1F
20
CV-4
21
21.5

2F
22

CV-4 Page 3

2F
3F
22
23

3F
4F
23
24

4F
5F
24
25

1F
25
5-CV4
26
26.5

2F
5-CV4
27

2F
3F
27
5-CV4
28

3F
4F
28
29

4F
5F
29
5-CV4
30

1F
30
31.5'

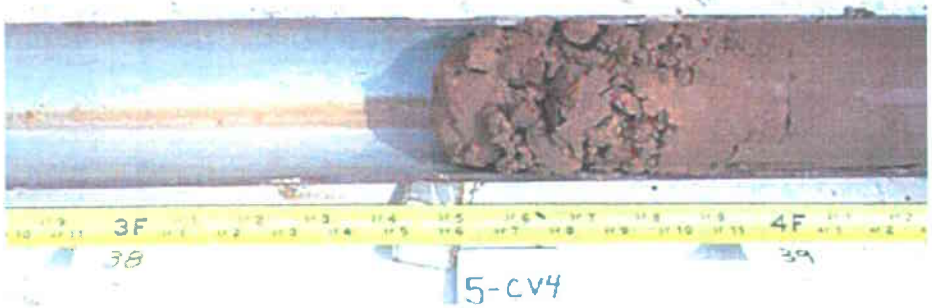
2F
31.5'
32
5-CV4
33

4F
34
5-CV4

4F
5F
34
35'

1F
5-CV4
36.5

2F
36.5'
37
5-CV4


3F
4F
38
39
5-CV4

4F
5F
39
5-CV4
40

1F
5-CV4
41.5

2F
41.5
5-CV4
42

2F
3F
42
5-CV4
43

3F
4F
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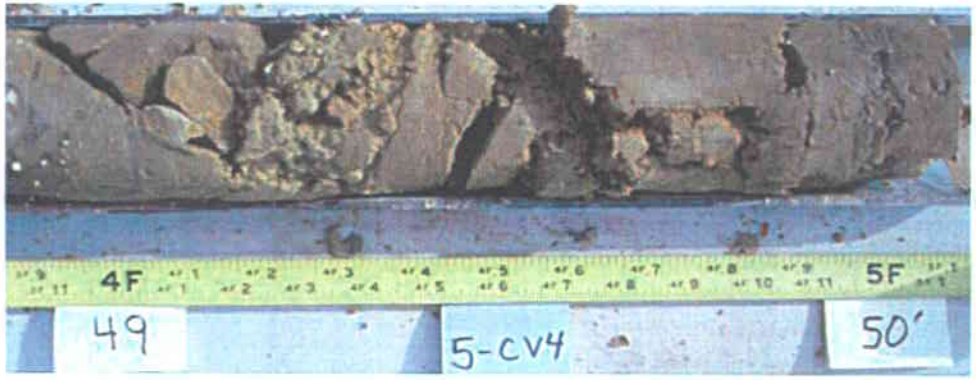
44

4F
5F
44
5-CV4
45

1F
5-CV4
46
46.5



TD

SCF-1

Table 1

SUMMARY OF TEST DATA

PROJECT Kinney Mine
LOCATION Scofield, Utah

PROJECT NO. 200701-045
FEATURE Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE		UNCONFINED COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM (modified)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
Portal 1-DRL	10-11.5	17		5.0				NP	55	23	22	GM
	19-20.5	16		72.0		78	74	4	0	41	59	OH
CV-2-2 DRL	3-4.5	52		3.6				NP	15	59	26	SM
	9-10.5	11		4.9				NP	17	61	22	SM
	15-16.5	19		4.4				NP	42	49	9	SP-SM
	25-26.5	19		10.7		31	15	16				CL-2
NS-1 DRL	6-7.5	28		5.3		22	13	9				CL-1
	9-10.5	52		6.1		26	13	13				CL-1
	15-16.5	46		5.3				NP	6	25	69	ML
	22.5-24	23		11.8		26	13	13				CL-1
	31.5-31.9		109.6	18.8								CL
S-1 DRL	10-11.5	23		7.8		28	14	14				CL-1
	20-21.5	19		12.9		24	14	10				CL-1
	30-31.5	27		12.8		26	14	12				CL-1
	40-41.5	25		17.5	6280*	28	15	13				CL-1
	50-51.5	29		16.2	5840*	34	15	19				CL-2
	57		113.9	16.3								
	66		103.4	18.1								CL
	70-71.5	35		17.2	8280*	35	14	21				CL-2
CV-4-1 DRL	5-6.5	21		10.0		25	18	7				CL-1
	10.5-15	Core		9.2		20	13	7	24	24	52	CL-1
	15-16.5	55		10.2		21	11	10				CL-1
	21.5-25	Core		11.9	3600*	22	12	10				CL-1
	25-26.5	22		13.8	2240*	26	10	16				CL-2
	31.5-35	Core		10.5	2220*	21	10	11				CL-1
	35-36.5	9		17.1	3200*	21	11	10				CL-1
	41.5-45	Core		17.1		29	13	16				CL-2
	45-46.5	74		14.6	3320*	30	14	16				CL-2
	55-60	Core		12.6	4000*	21	14	7				CL-1
	66.5-70	Core		12.6	4000*	29	11	18	15	19	66	CL-2
SC-2 DRL	23-24					24	12	12				CL-1

NP=Nonplastic
*Torvane value used to estimate unconfined compressive strength

OTHER LABORATORY TESTING

PROJECT Kinney Mine
LOCATION Scofield, Utah

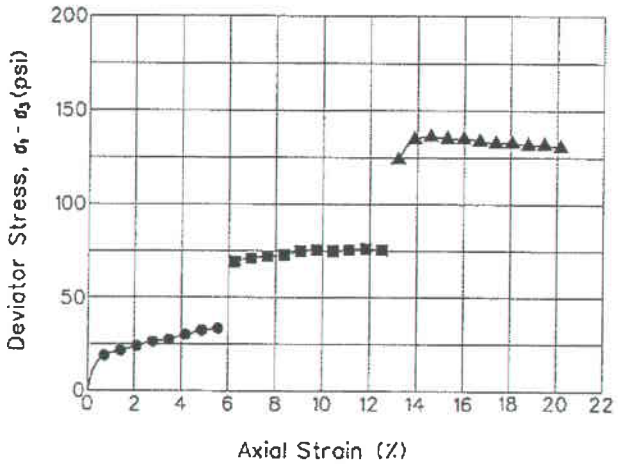
PROJECT NO. 200701-045
FEATURE

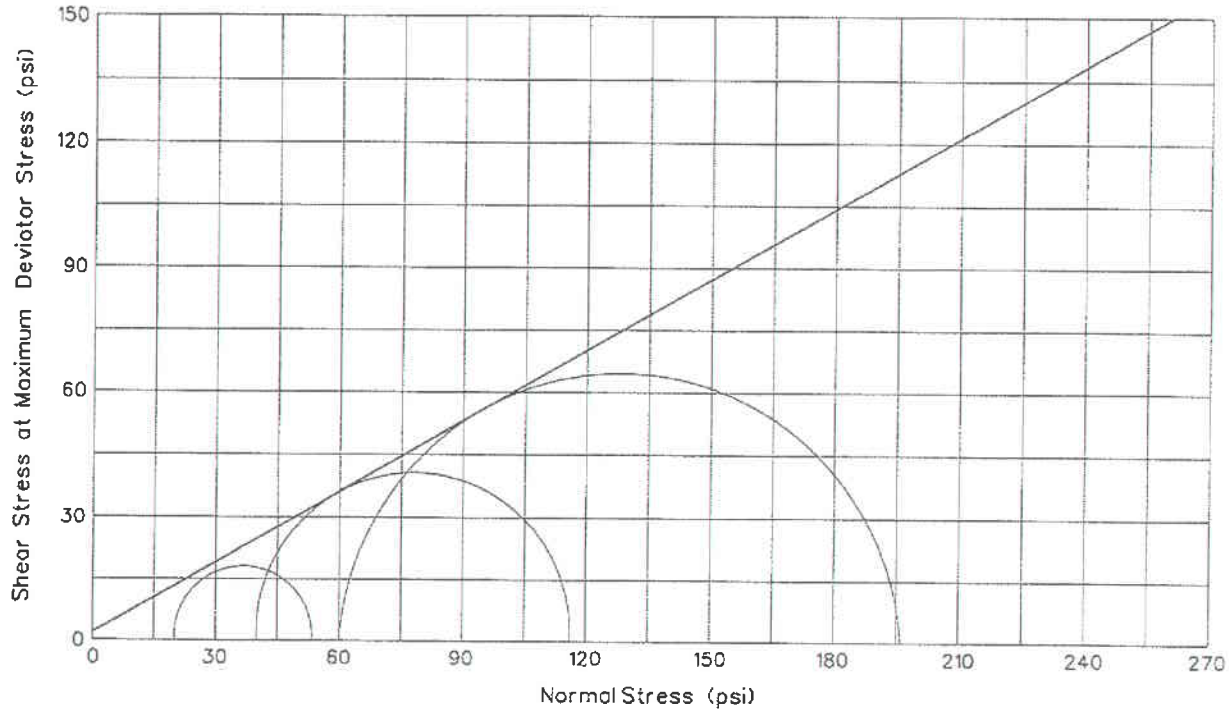
CHEMICAL TESTS					
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	pH	RESISTIVITY (ohm-cm)	SULFATE (%)	USCS (MODIFIED) / AASHTO CLASSIFICATION
3-NS-1	6-7.5	8.0	6761	0.0031	CL-1
11-MDF-2	3	8.2	7202	0.0064	SC-SM
9-WSF-1	6	7.3	3322	0.0195	CL-ML
13-WSF-2	3	7.8	6502	0.0315	SM

DIRECT SHEAR TESTS CONSOLIDATED DRAINED					
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	DRY DENSITY (pcf)	FRICTION ANGLE Φ (degrees)	COHESION c (psi)	USCS (MODIFIED) / AASHTO CLASSIFICATION
07-CV-5-1 TH	12	95.8	20	15	CL-1

TRIAXIAL SHEAR TESTS MULTI-STAGE CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENTS						
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	TOTAL STRESS		EFFECTIVE STRESS		USCS (MODIFIED) / AASHTO CLASSIFICATION
		FRICTION ANGLE $\Phi_{(cu)}$ (degrees)	COHESION $c_{(cu)}$ (psi)	FRICTION ANGLE Φ (degrees)	COHESION c (psi)	
CV-4-1 DRL	20-21.5	29.6	2	36.0	2	CL
SC-2 DRL	23-24	32.5	2	36.7	2	CL-1

* Visual Classification
**Bulk Sample





MULTI-STAGE CONSOLIDATED UNDRAINED W/PORE PRESSURE MEASUREMENTS:

TOTAL STRESS FAILURE ENVELOPE

Test No. or Symbol	Sample Data		Degree of Saturation (%)	Confining Pressure (psi)	Maximum Deviator Stress (psi)	Strength Values at Failure		Sample Size, L/D (inches)	Strain Rate (inches/minute)
	Dry Density (pcf)	Moisture Content (%)				Friction Angle ϕ (degrees)	Cohesion (c/psi)		
●	115.0	7.8	~100	20	53.4	29.6	2	2.88/1.38	0.001
■	115.0	7.8	~100	40	116.1				
▲	115.0	7.8	~100	60	196.1				

MATERIAL: SANDY LEAN CLAY (CL)

RB&G ENGINEERING INC.
Provo, Utah

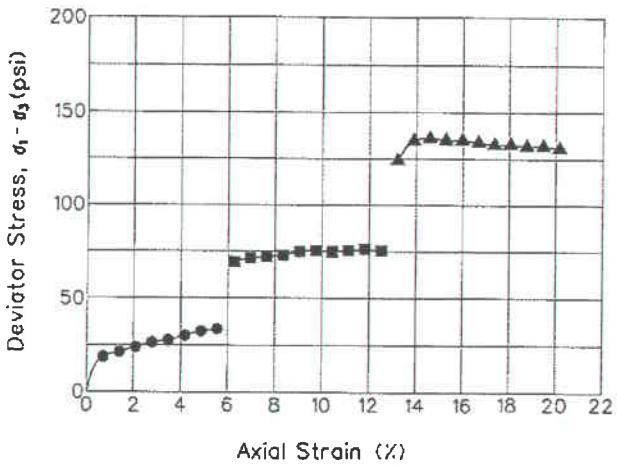
TRIAXIAL SHEAR TEST

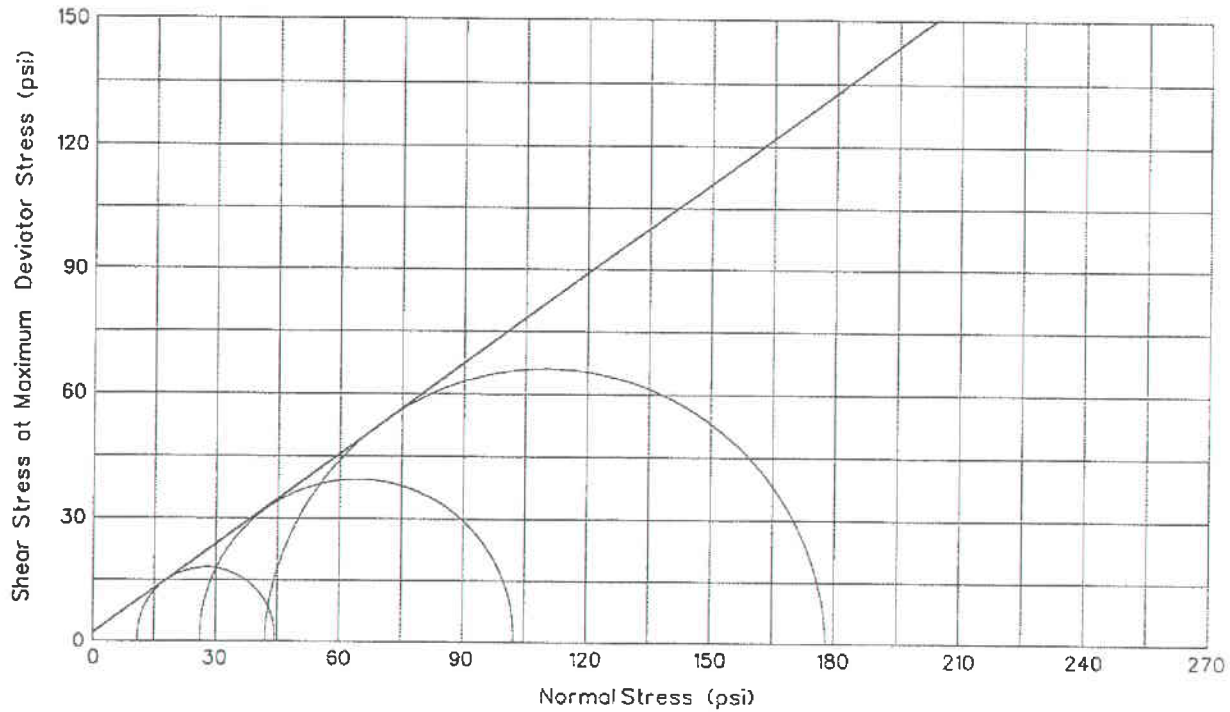
Project: *Kinney Mine*
Scofield, Utah

HOLE NO.: CV-4-1 DRL

DEPTH: 20'-21.5'

Figure





MULTI-STAGE CONSOLIDATED UNDRAINED W/PORE PRESSURE MEASUREMENTS:
EFFECTIVE STRESS FAILURE ENVELOPE

Test No. or Symbol	Sample Data		Degree of Saturation (%)	Confining Pressure (psi)	Maximum Deviator Stress (psi)	Strength Values at Failure		Sample Size, L/D (inches)	Strain Rate (inches/minute)
	Dry Density (pcf)	Moisture Content (%)				Friction Angle ϕ (degrees)	Cohesion (c/psi)		
●	115.0	7.8	~100	11.0	44.4	36.0	2	2.88/1.38	0.001
■	115.0	7.8	~100	26.3	102.4				
▲	115.0	7.8	~100	42.0	178.1				

MATERIAL: SANDY LEAN CLAY (CL)

RB&G ENGINEERING INC.
Provo, Utah

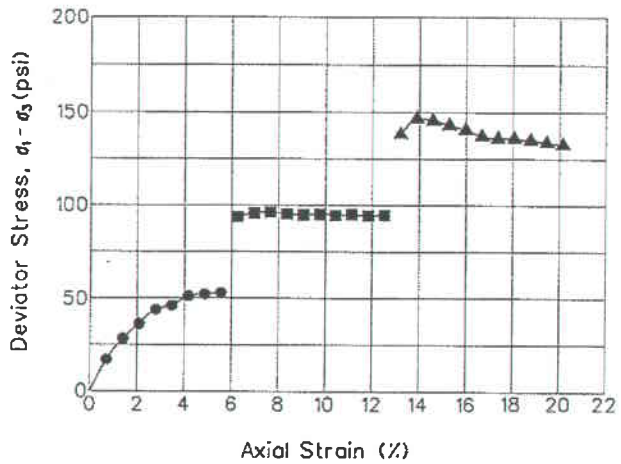
TRIAXIAL SHEAR TEST

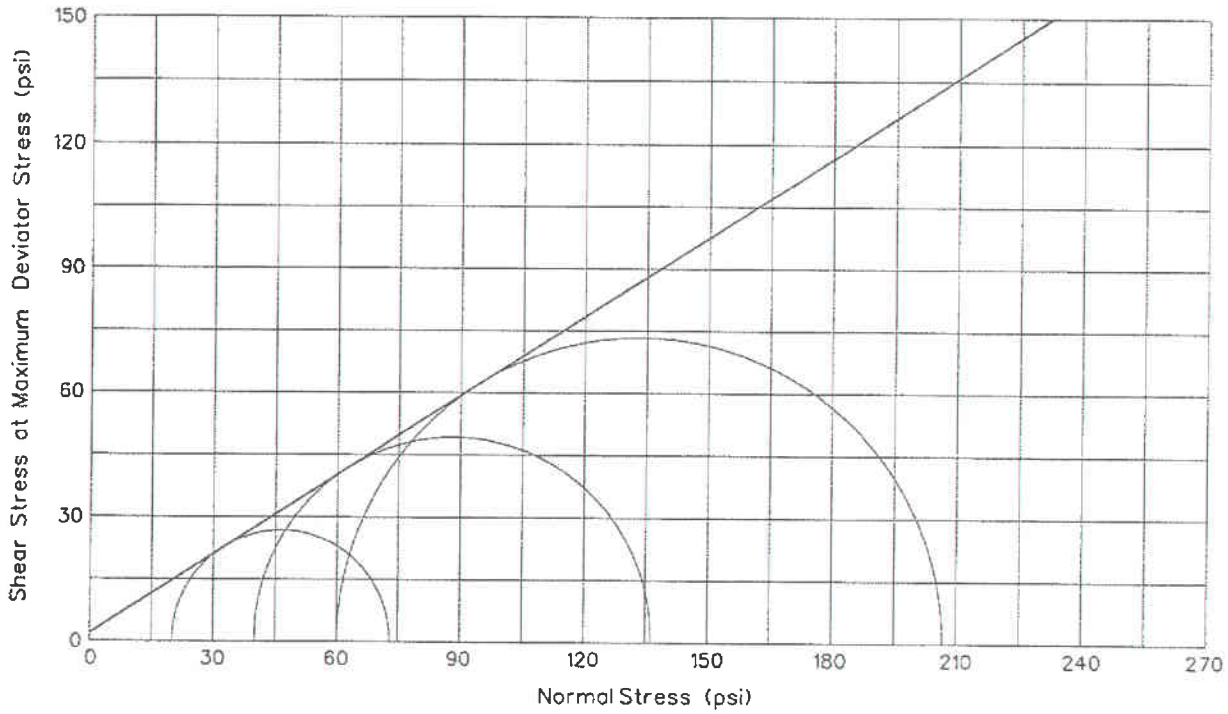
Project: *Kinney Mine*
Scofield, Utah

HOLE NO.: CV-4-1 DRL

DEPTH: 20'-21.5'

Figure





MULTI-STAGE CONSOLIDATED UNDRAINED W/PORE PRESSURE MEASUREMENTS:

TOTAL STRESS FAILURE ENVELOPE

Test No. or Symbol	Sample Data		Degree of Saturation (%)	Confining Pressure (psi)	Maximum Deviator Stress (psi)	Strength Values at Failure		Sample Size, L/D (inches)	Strain Rate (inches/minute)
	Dry Density (pcf)	Moisture Content (%)				Friction Angle ϕ (degrees)	Cohesion (c/psi)		
●	115.6	15.3	~100	20	72.9	32.5	2	2.88/1.38	0.001
■	115.6	15.3	~100	40	136.3				
▲	115.6	15.3	~100	60	206.7				

MATERIAL: SANDY LEAN CLAY (CL)

RB&G ENGINEERING INC.
Provo, Utah

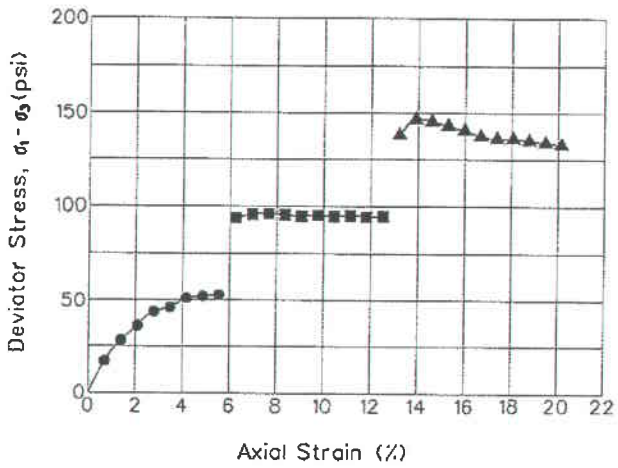
TRIAXIAL SHEAR TEST

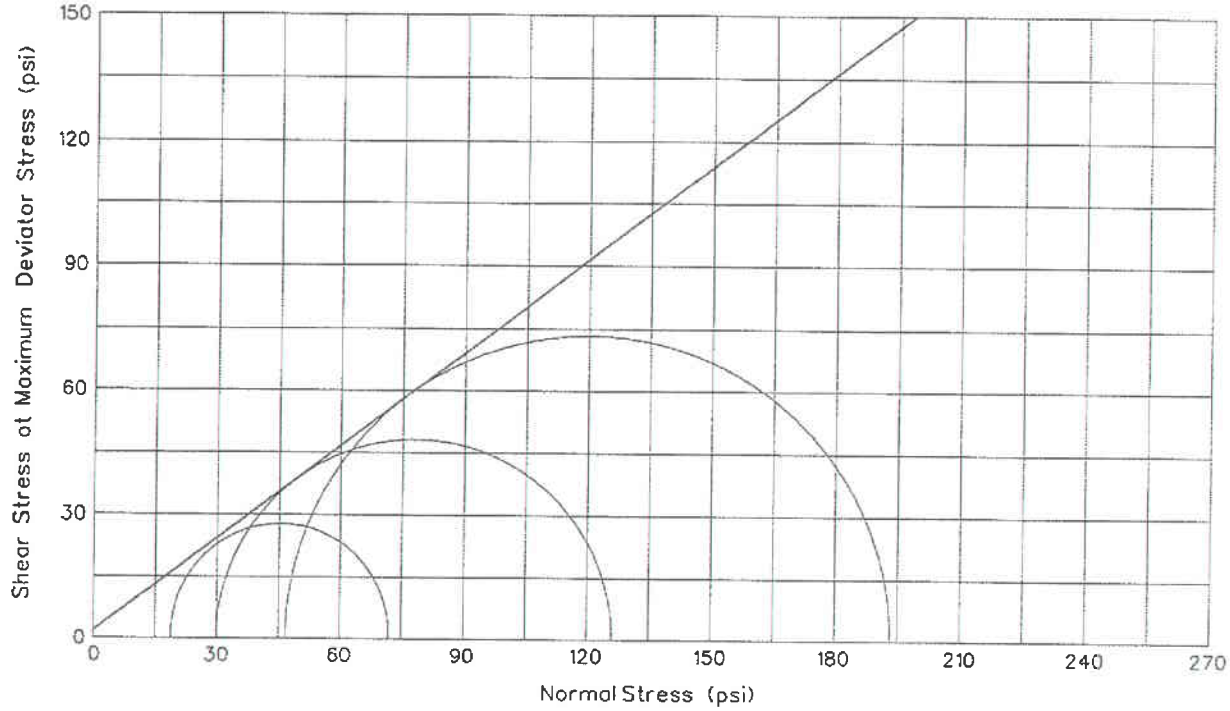
Project: *Kinney Mine*
Scofield, Utah

HOLE NO.: SC-2 DRL

DEPTH: 23'-24'

Figure





MULTI-STAGE CONSOLIDATED UNDRAINED W/PORE PRESSURE MEASUREMENTS:
EFFECTIVE STRESS FAILURE ENVELOPE

Test No. or Symbol	Sample Data		Degree of Saturation (%)	Confining Pressure (psi)	Maximum Deviator Stress (psi)	Strength Values at Failure		Sample Size, L/D (inches)	Strain Rate (inches/minute)
	Dry Density (pcf)	Moisture Content (%)				Friction Angle ϕ (degrees)	Cohesion (c/psi)		
●	115.6	15.3	~100	18.9	71.8	36.7	2	2.88/1.38	0.001
■	115.6	15.3	~100	29.8	126.1				
▲	115.6	15.3	~100	46.6	193.3				

MATERIAL: SANDY LEAN CLAY (CL)

RB&G ENGINEERING INC.
Provo, Utah

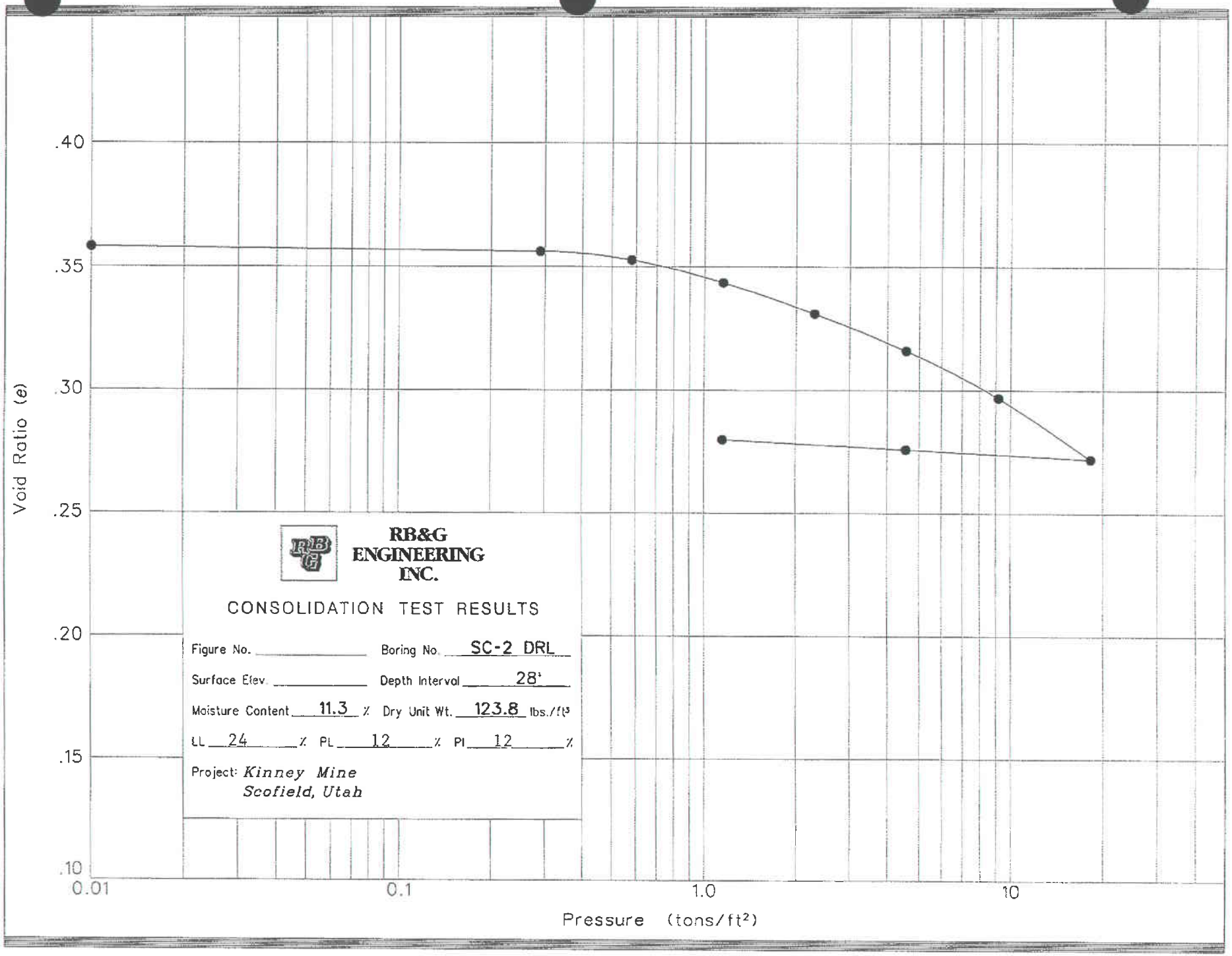
TRIAXIAL SHEAR TEST

Project: *Kinney Mine*
Scofield, Utah

HOLE NO.: SC-2 DRL

DEPTH: 23'-24'

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

Figure No. _____ Boring No. SC-2 DRL

Surface Elev. _____ Depth Interval 28'

Moisture Content 11.3 % Dry Unit Wt. 123.8 lbs./ft³

LL 24 % PL 12 % PI 12 %

Project: *Kinney Mine*
Scofield, Utah

CONVEYOR SECTION-5

TEST PITS CV-5-1 & CV-5-2

TEST PIT LOG

TEST PIT NO. CV-5-1 TH

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: CONVEYOR BENT / N:75,340 E:38,792
DIGGING METHOD: JOHN DEERE 160 TRACKHOE
OPERATOR:
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/5/07
DATE COMPLETED: 9/5/07
GROUND ELEVATION: 7737.7'
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
7735						CL-1	SANDY LEAN CLAY sandy silt layers & pockets (fill) brown, dry, stiff	89.8	5.8	22	7				
	5				+1.00	CL-ML	lt. brown, dry, very stiff	95.6	4.9						
7730					+1.00	CL-ML	SANDY SILTY CLAY pinhole structure, occasional cobble and/or boulder lt. brown, dry to slightly moist, very stiff	90.7	7.1	21	4				CT
	10				+1.00	CL-1	lt. brown, dry, very stiff		9.7	22	10				DS
7725					+1.00	CL	lt. brown, slightly moist, hard SANDY LEAN CLAY pinhole structure, occasional cobble and/or boulder								
	15				+1.00	CL-1	lt. brown, slightly moist, hard		9.6	23	10				
7720															

TP_LOGV1 KINNEYMINE_TP.GPJ US EVAL.GDT 10/29/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:
DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)
UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

TEST PIT LOG

TEST PIT NO. CV-5-2 TH

SHEET 1 OF 1

PROJECT: KINNEY MINE
CLIENT: GEO-HUNT CONSULTING, LLC
LOCATION: CONVEYOR BENT / N:75,688 E:38,928
DIGGING METHOD: JOHN DEERE 160 TRACKHOE
OPERATOR:
DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 200701.045
DATE STARTED: 9/5/07
DATE COMPLETED: 9/5/07
GROUND ELEVATION: 7749.8'
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
						COAL, CL,GM	brown, slightly moist, very stiff		101.8	7.9						
7745	5					COAL, CL,GM	brown, dry, very stiff	INTERBEDDED LAYERS OF COAL, SANDY LEAN CLAY & SILTY GRAVEL W/SAND (fill)	107.3	4.2						
7740	10					COAL, CL,GM	brown, dry, very stiff		100.4	6.9						
					+1.00	CL-2	brown, slightly moist, very stiff		112.7	13.8	42	26				CT
7735	15				+1.00	CL-2	brown, slightly moist, hard	SANDY LEAN CLAY slight pinhole structure		14.1	33	18				
7730					+1.00	CL	brown, slightly moist, hard									

TP_LOGV1 KINNEYMINE_TP.GPJ US EVAL.GDT 10/29/07

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio

Table 1

SUMMARY OF TEST DATA

PROJECT Kinney Mine
LOCATION Scofield, Utah

PROJECT NO. 200701-045
FEATURE Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE		UNCONFINED COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM (modified)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
CV-2-1 TH	3	Grab	95.0	9.0		32	15	17				CL-2
	6	Grab		3.1				NP	64	23	13	GM
CV-2-3 TH	3	Grab	106.1	7.6	4000+*	25	13	12				CL-1
	6	Grab	88.6	6.5	4000+*	23	17	6				CL-ML
	9	Grab	97.1	4.8	4000+*	19	15	4				CL-ML / SC-SM
CV-5-1 TH	3	Grab	89.8	5.8	4000+*	22	15	7				CL-1
	9	Grab	90.7	7.1	4000+*	21	17	4				CL-ML
	12	Grab	95.8	9.7	4000+*	22	12	10				CL-1
	19	Grab		9.6	4000+*	23	13	10				CL-1
CL-5-2 TH	12	Grab	112.7	13.8	4000+*	42	16	26				CL-2
	15	Grab		14.1	4000+*	33	15	18				CL-2
WSF-1 TH	6	Grab	97.9	4.5	2827	21	16	5				CL-ML
WSF-2 TH	3	Grab	91.0	4.6				NP	29	45	26	SM
	9	Grab		4.7		19	15	4				CL-ML / SC-SM
WSF-3 TH	6	Grab	89.6	4.6				NP	34	38	28	SM
	9	Grab	96.3	10.1	3000*	22	14	8				CL-1
	12	Grab		6.1	3320*			NP	34	38	28	SM
MDF-1 TH	3	Grab	102.7	4.9		20	16	4				CL-ML / SC-SM
	9	Grab	86.6	8.4	3240*	25	14	11				CL-1
	18.5	Grab	108.7	10.8	2760*	23	13	10				CL-1
MDF-2 TH	3	Grab	108.6	4.6		20	15	5	34	38	28	SC-SM
	6	Grab	118.5	3.8				NP	38	47	15	SM
	15	Grab	94.8	9.3	3520*	23	14	9				CL-1
MDF-3 TH	6	Grab	102.9	5.8				NP	34	39	27	SM
	15	Grab		7.5	4000+*	22	12	10				CL-1
	18	Grab		5.3	4000+*	21	13	8				CL-1
CS-1 TH	6	Grab										Coal
	9	Grab		8.8	2080*	23	14	9				CL-1
	12	Grab		15.5	2240*	24	16	8				CL-1
F-1 TH	6	Grab	91.3	5.6		22	18	4	18	42	40	SC-SM
	9	Grab		6.1		21	16	5				CL-ML / SC-SM

NP=Nonplastic
*Toravne value used to estimate unconfined compressive Strength.

OTHER LABORATORY TESTING

PROJECT Kinney Mine
LOCATION Scofield, Utah

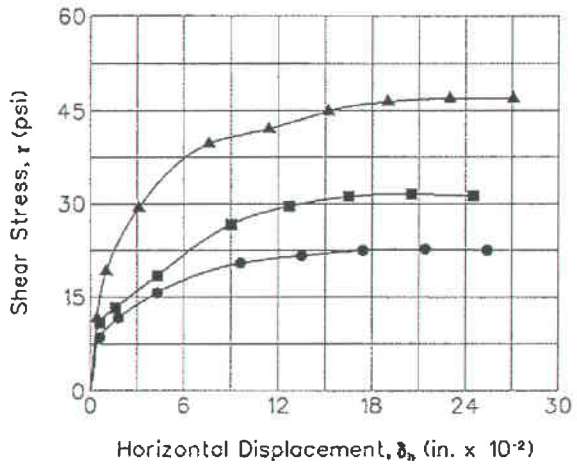
PROJECT NO. 200701-045
FEATURE

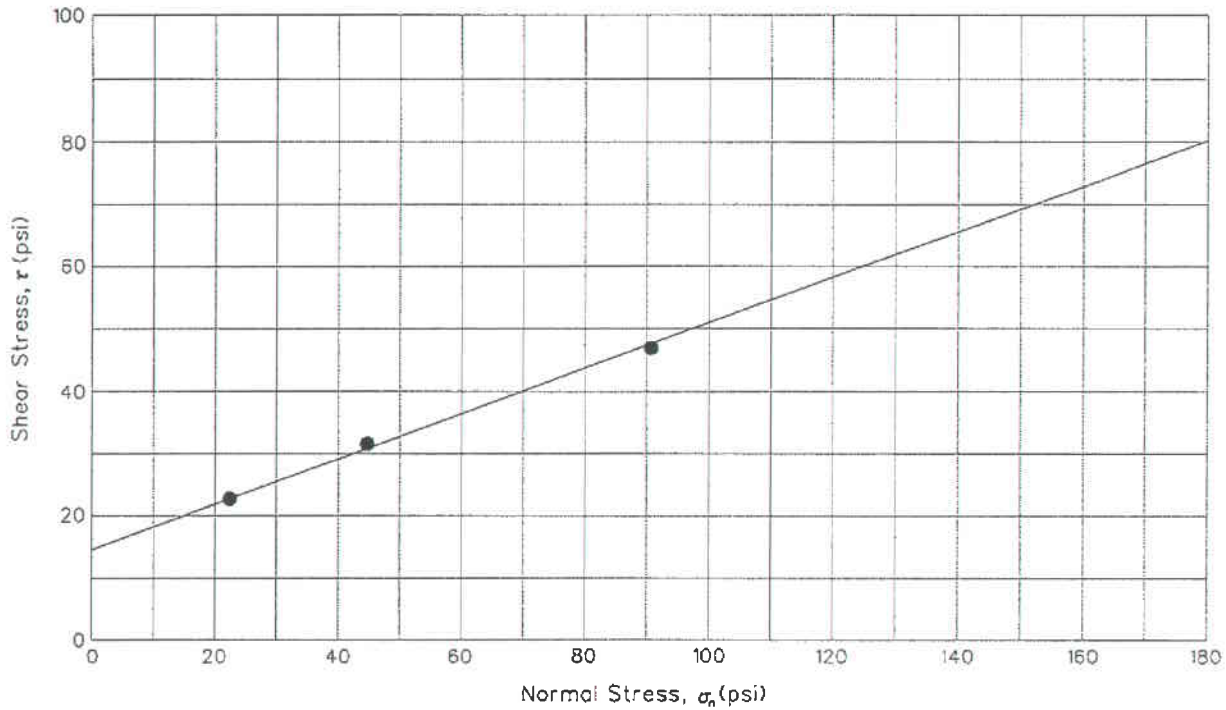
CHEMICAL TESTS					
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	pH	RESISTIVITY (ohm-cm)	SULFATE (%)	USCS (MODIFIED) / AASHTO CLASSIFICATION
3-NS-1	6-7.5	8.0	6761	0.0031	CL-1
11-MDF-2	3	8.2	7202	0.0064	SC-SM
9-WSF-1	6	7.3	3322	0.0195	CL-ML
13-WSF-2	3	7.8	6502	0.0315	SM

DIRECT SHEAR TESTS CONSOLIDATED DRAINED					
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	DRY DENSITY (pcf)	FRICTION ANGLE Φ (degrees)	COHESION c (psi)	USCS (MODIFIED) / AASHTO CLASSIFICATION
07-CV-5-1 TH	12	95.8	20	15	CL-1

TRIAXIAL SHEAR TESTS MULTI-STAGE CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENTS						
SAMPLE LOCATION	DEPTH BELOW GROUND SURFACE (ft)	TOTAL STRESS		EFFECTIVE STRESS		USCS (MODIFIED) / AASHTO CLASSIFICATION
		FRICTION ANGLE $\Phi_{(cu)}$ (degrees)	COHESION $c_{(cu)}$ (psi)	FRICTION ANGLE Φ (degrees)	COHESION c (psi)	
CV-4-1 DRL	20-21.5	29.6	2	36.0	2	CL
SC-2 DRL	23-24	32.5	2	36.7	2	CL-1

* Visual Classification
**Bulk Sample





Test No. or Symbol	Sample Size (inches)	Sample Data		Degree of Saturation (%)	Normal Stress δ_n (psi)	Maximum Shear Stress τ (psi)	Strain Rate (inches/minute)	Shear Strength Parameters	
		Dry Density (pcf)	Moisture Content (%)					Friction Angle φ (degrees)	Cohesion (c/psi)
●	2.375	95.7	9.8	~100	22.4	22.7	0.0005	20.0	15
■	2.375	95.9	9.7	~100	44.7	31.6	0.0005		
▲	2.375	95.8	9.8	~100	90.7	46.9	0.0005		

MATERIAL: SANDY LEAN CLAY (CL-1)

RB&G ENGINEERING INC.
Provo, Utah

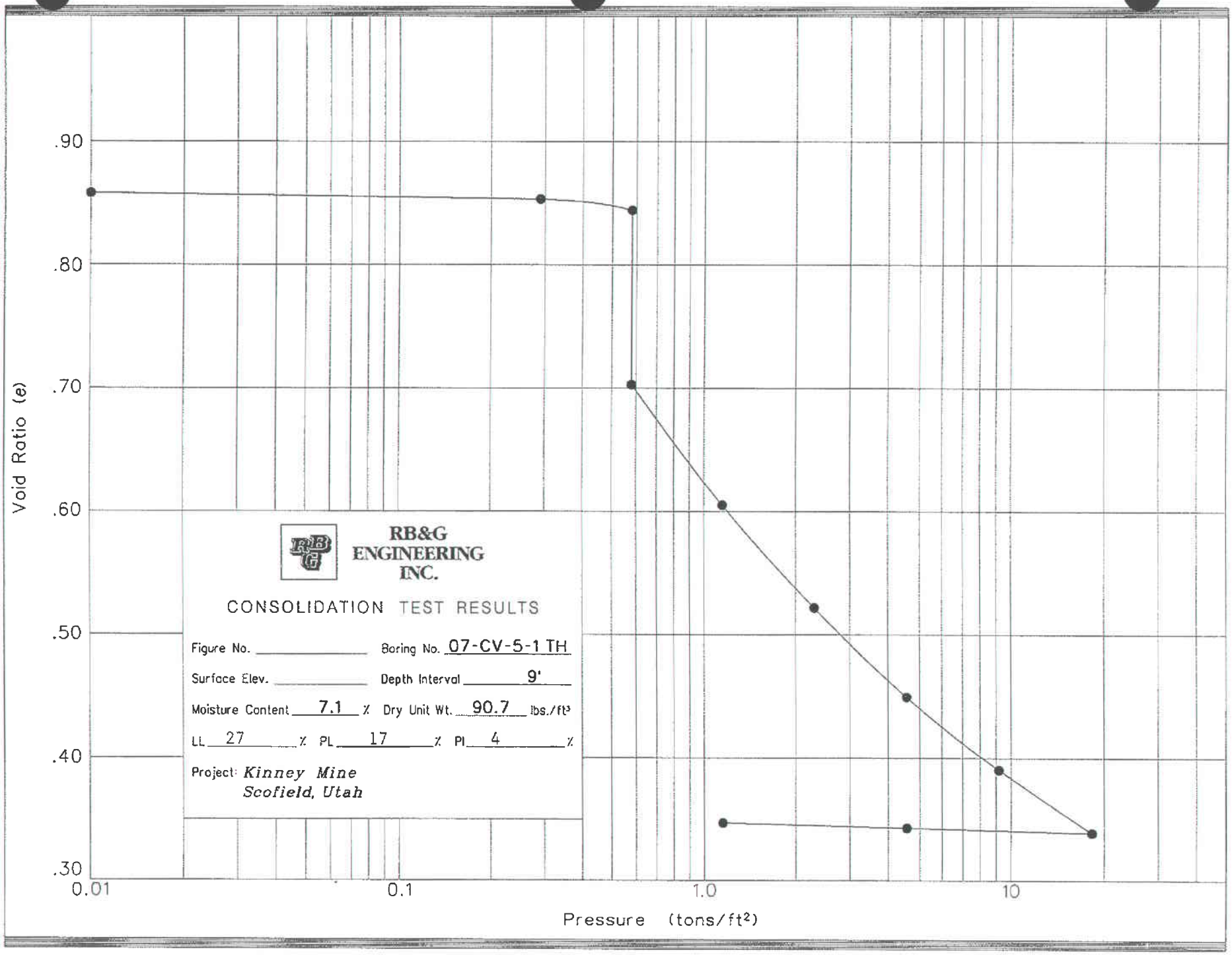
DIRECT SHEAR TEST

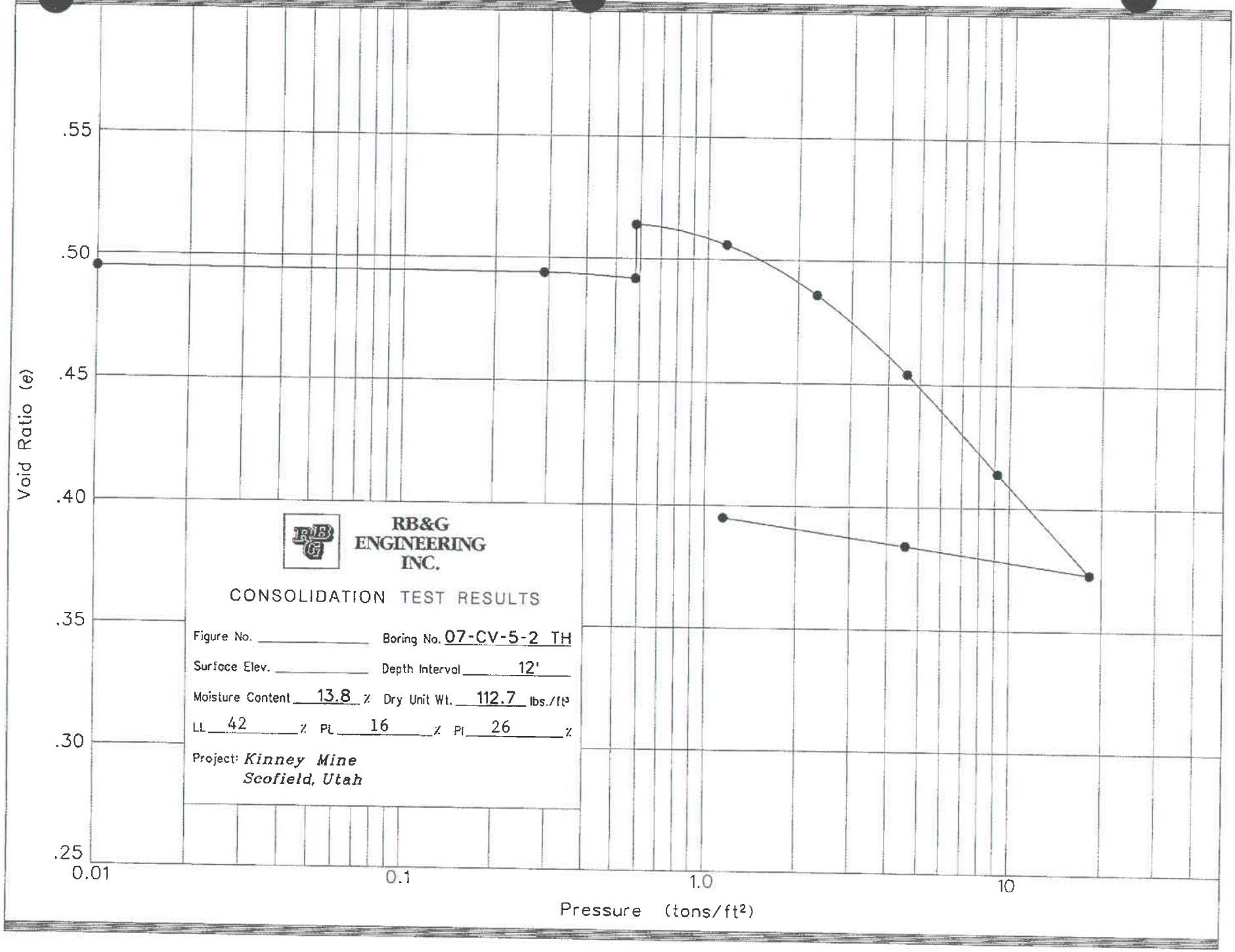
Project: *Kinney Mine*
Scofield, Utah

HOLE NO.: 07-CV-5-1 TH

DEPTH: 12'

Figure


.90
.80
.70
.60
.50
.40
.30
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G
ENGINEERING
INC.
CONSOLIDATION TEST RESULTS
Figure No.
Boring No. 07-CV-5-1 TH
Surface Elev.
Depth Interval 9'
Moisture Content 7.1 %
Dry Unit Wt. 90.7 lbs./ft³
LL 27 %
PL 17 %
PI 4 %
Project: Kinney Mine
Scofield, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

Figure No. _____ Boring No. 07-CV-5-2 TH

Surface Elev. _____ Depth Interval 12'

Moisture Content 13.8 % Dry Unit Wt. 112.7 lbs./ft³

LL 42 % PL 16 % PI 26 %

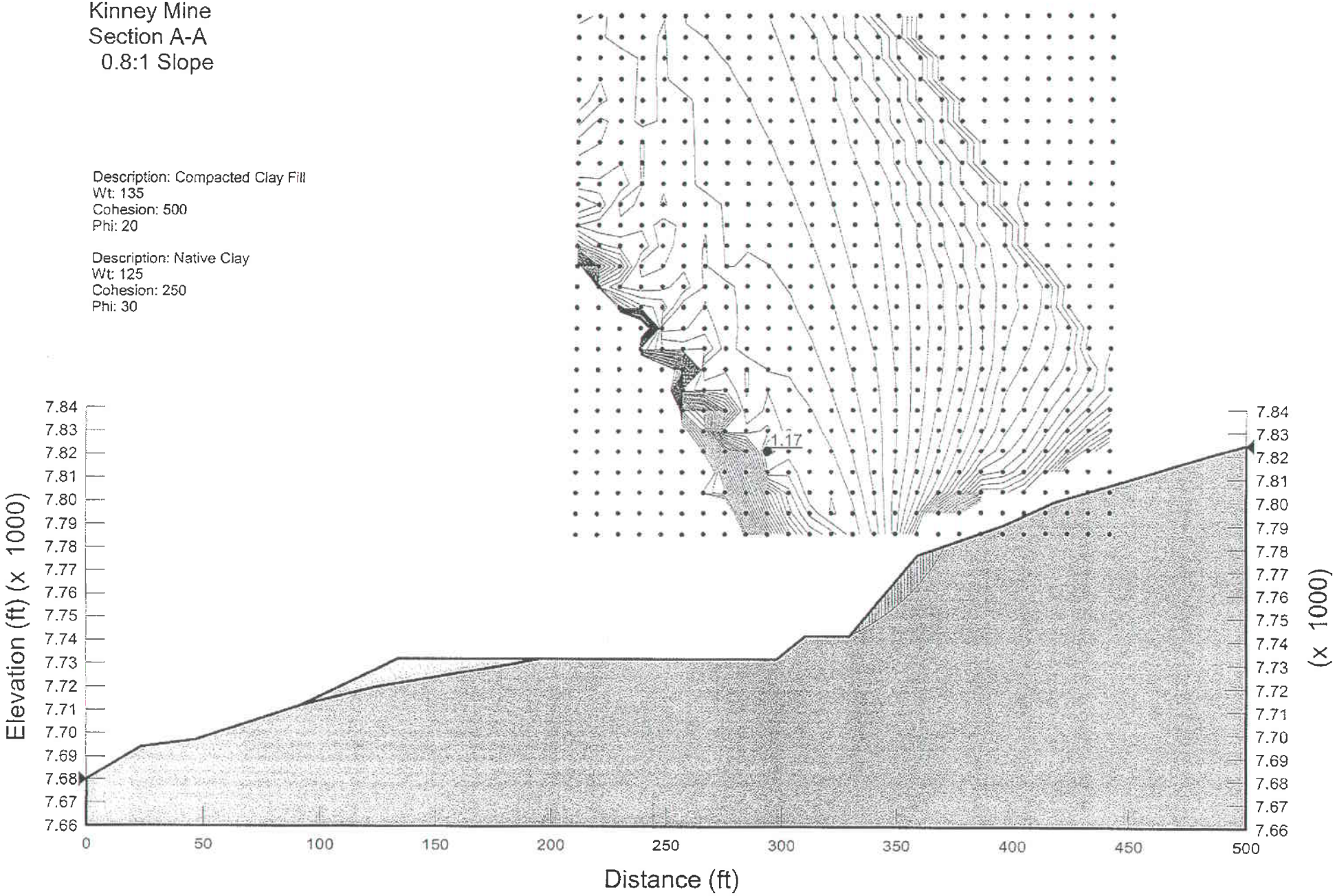
Project: *Kinney Mine*
Scofield, Utah

SLOPE STABILITY ANALYSES

Kinney Mine
Section A-A
0.8:1 Slope

Description: Compacted Clay Fill
Wt: 135
Cohesion: 500
Phi: 20

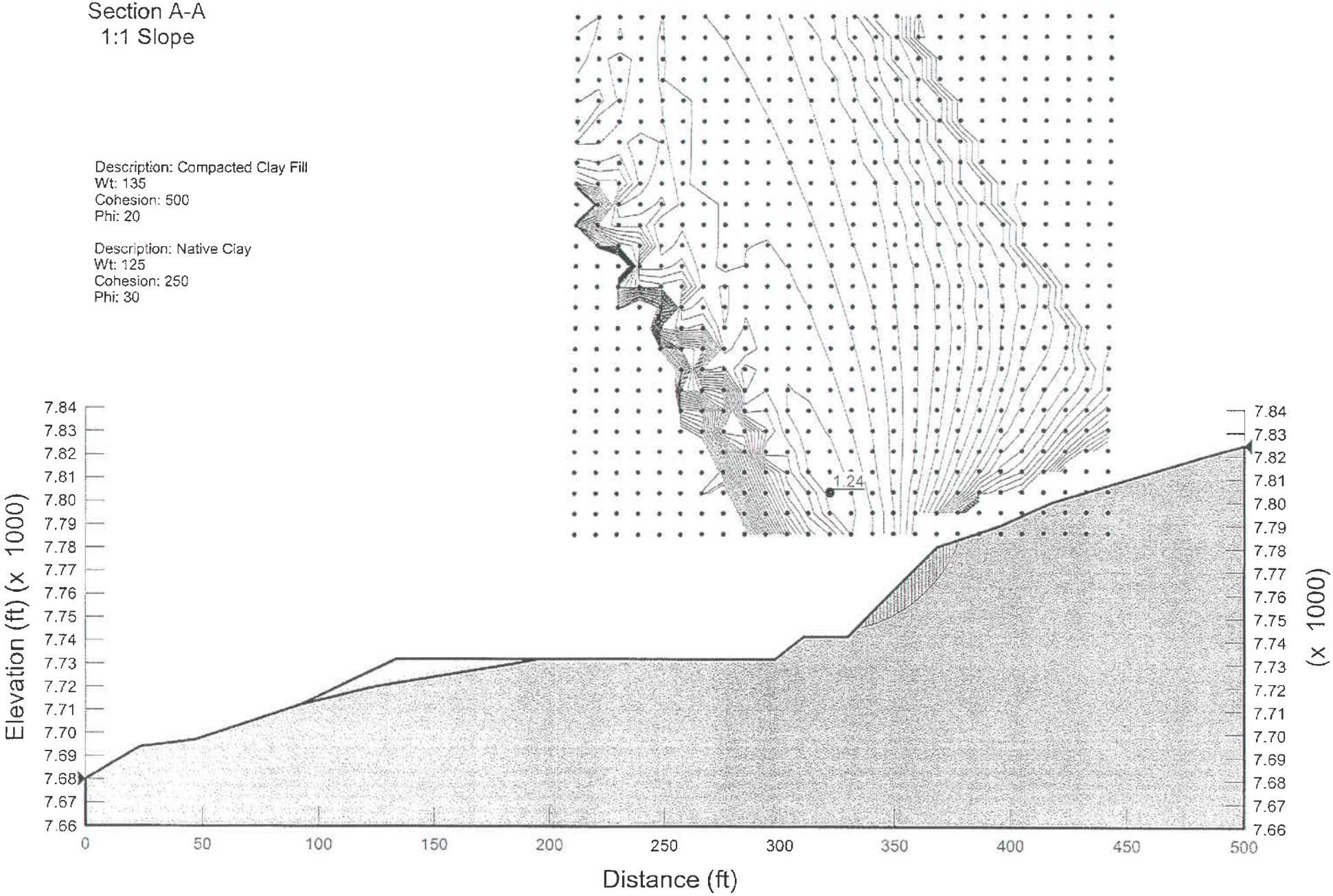
Description: Native Clay
Wt: 125
Cohesion: 250
Phi: 30



Kinney Mine
Section A-A
1:1 Slope

Description: Compacted Clay Fill
Wt: 135
Cohesion: 500
Phi: 20

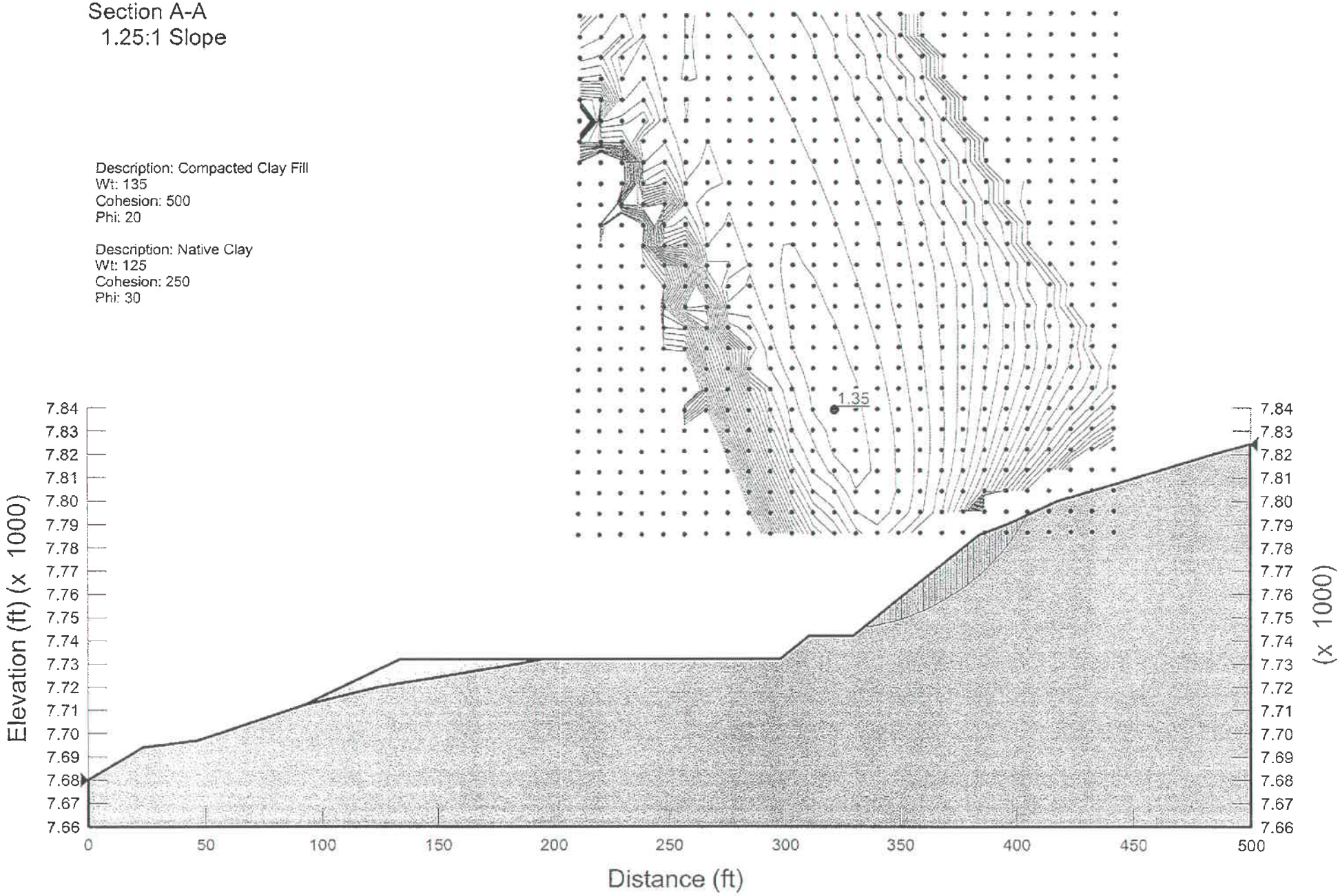
Description: Native Clay
Wt: 125
Cohesion: 250
Phi: 30



Kinney Mine
Section A-A
1.25:1 Slope

Description: Compacted Clay Fill
Wt: 135
Cohesion: 500
Phi: 20

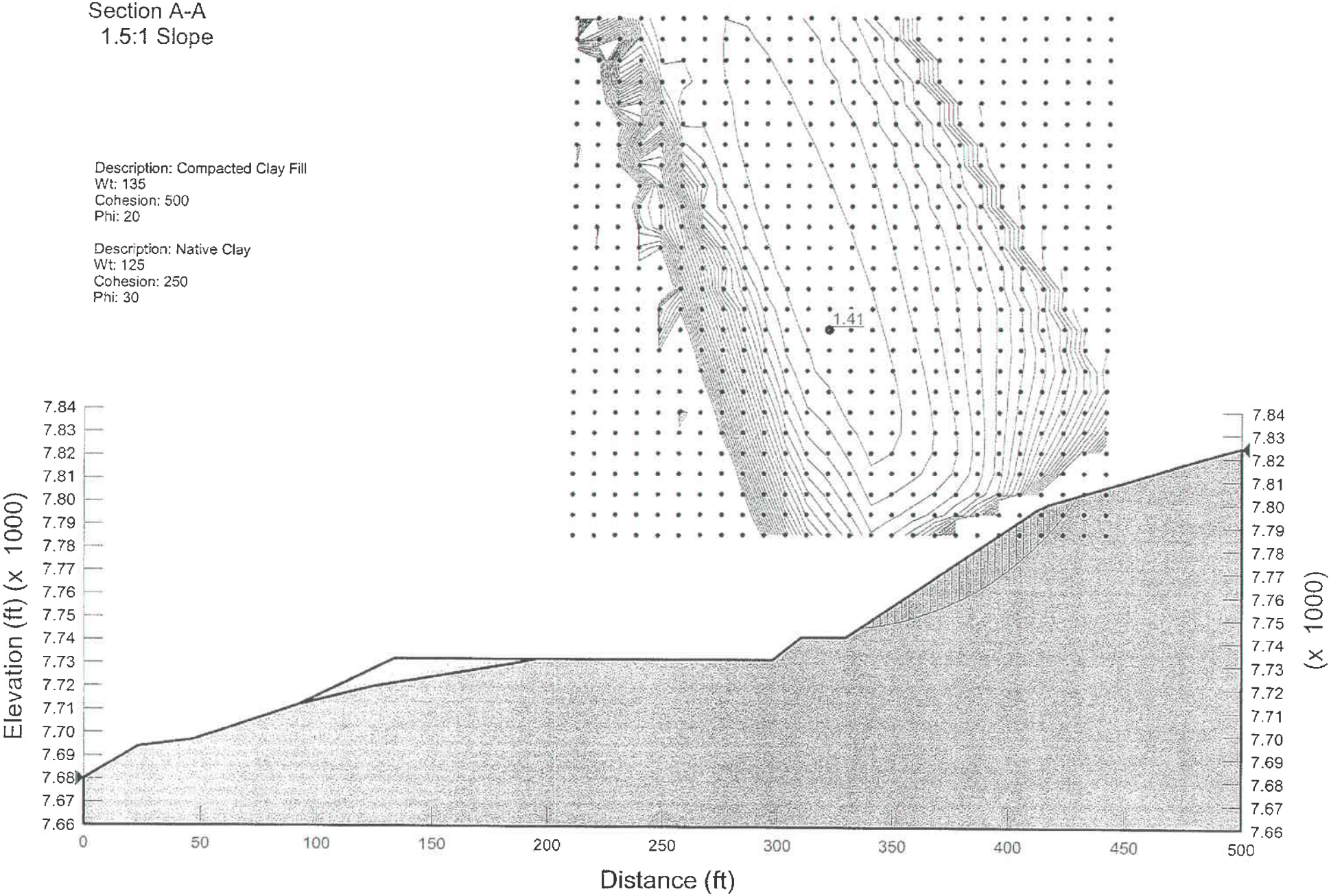
Description: Native Clay
Wt: 125
Cohesion: 250
Phi: 30



Kinney Mine
Section A-A
1.5:1 Slope

Description: Compacted Clay Fill
Wt: 135
Cohesion: 500
Phi: 20

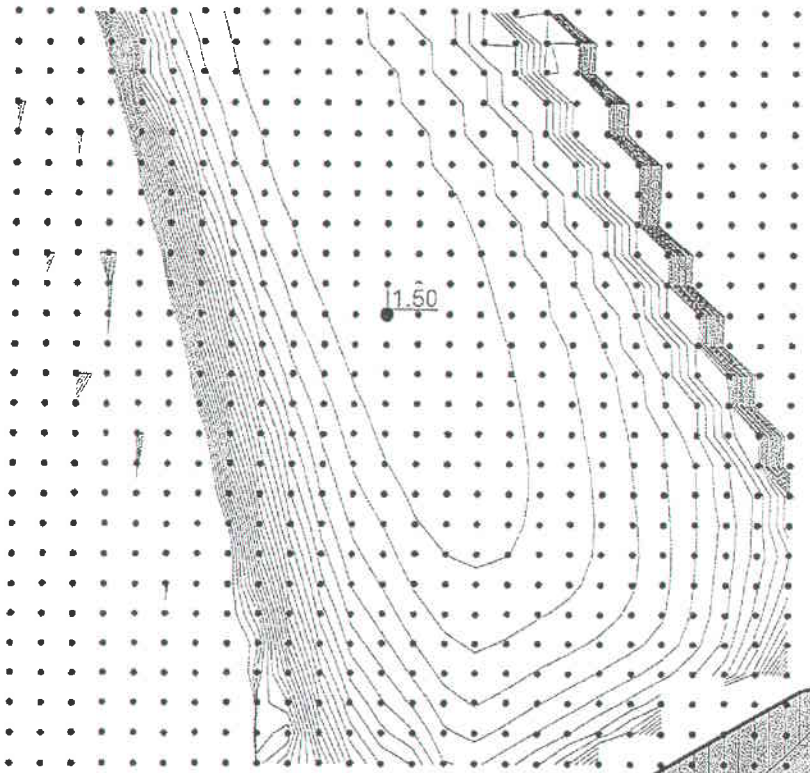
Description: Native Clay
Wt: 125
Cohesion: 250
Phi: 30

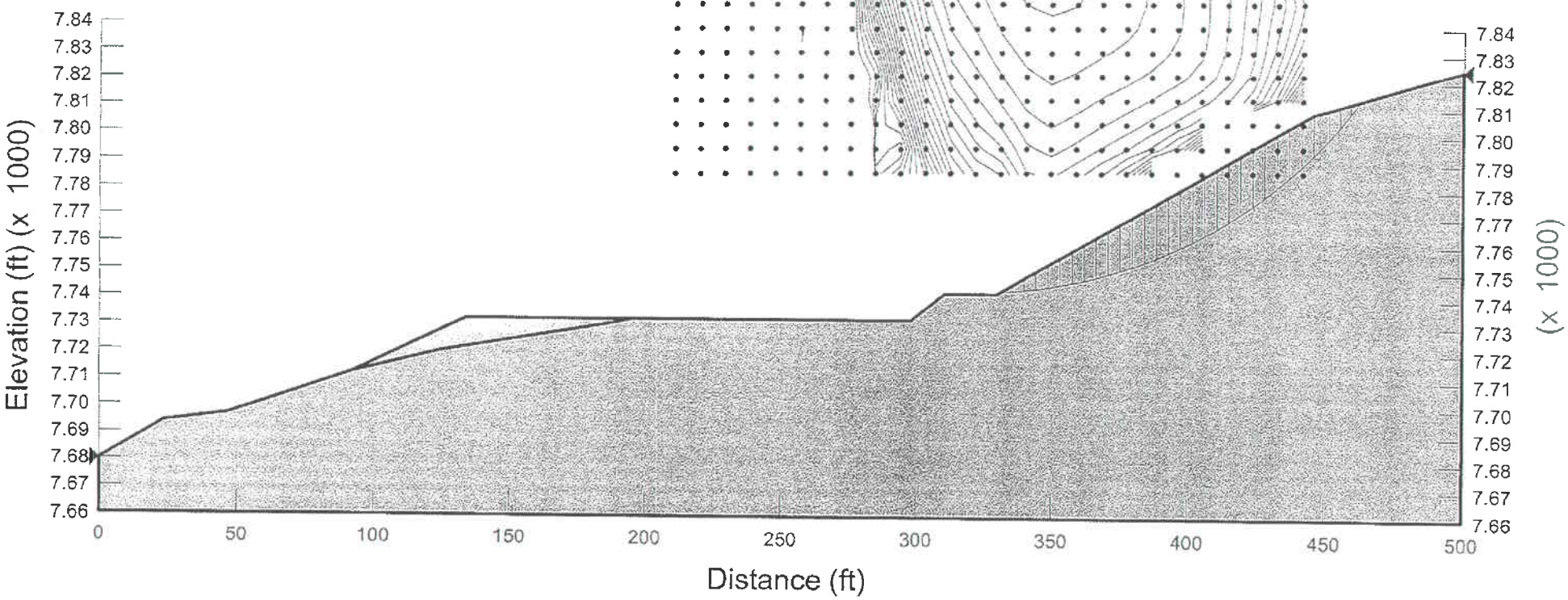


Kinney Mine
Section A-A
1.75:1 Slope

Description: Compacted Clay Fill
Wt: 135
Cohesion: 500
Phi: 20

Description: Native Clay
Wt: 125
Cohesion: 250
Phi: 30

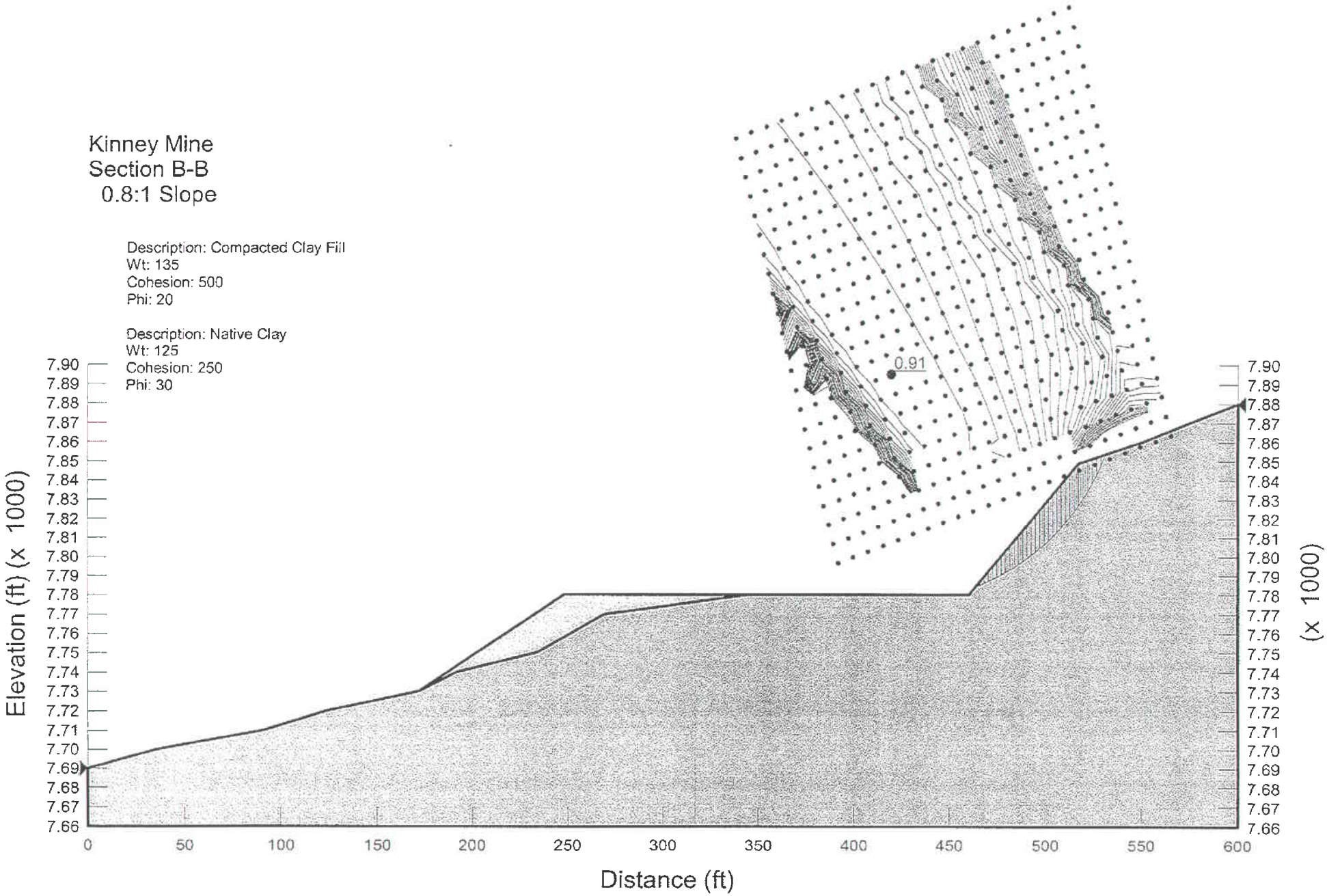




Kinney Mine
Section B-B
0.8:1 Slope

Description: Compacted Clay Fill
Wt: 135
Cohesion: 500
Phi: 20

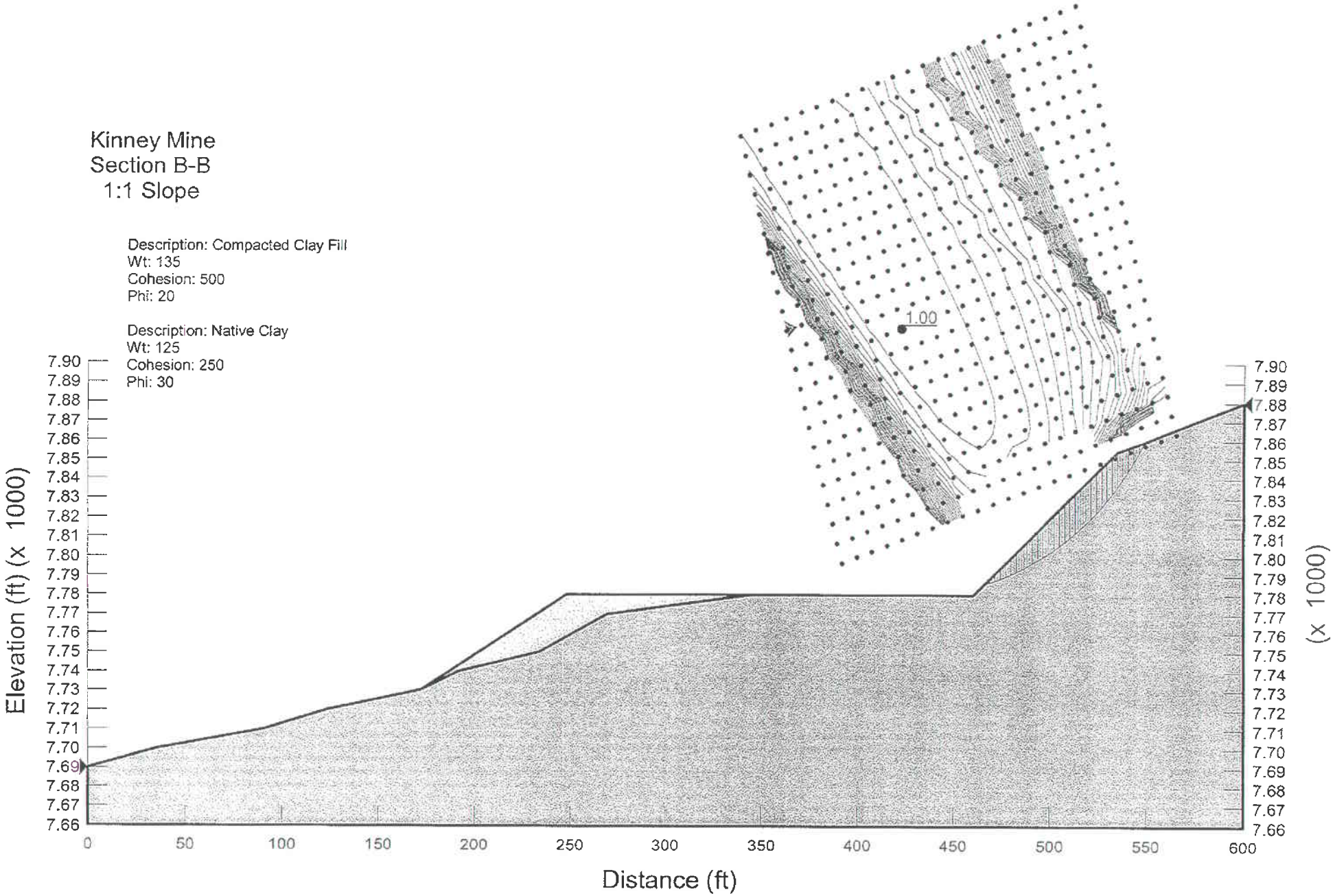
Description: Native Clay
Wt: 125
Cohesion: 250
Phi: 30



Kinney Mine
Section B-B
1:1 Slope

Description: Compacted Clay Fill
Wt: 135
Cohesion: 500
Phi: 20

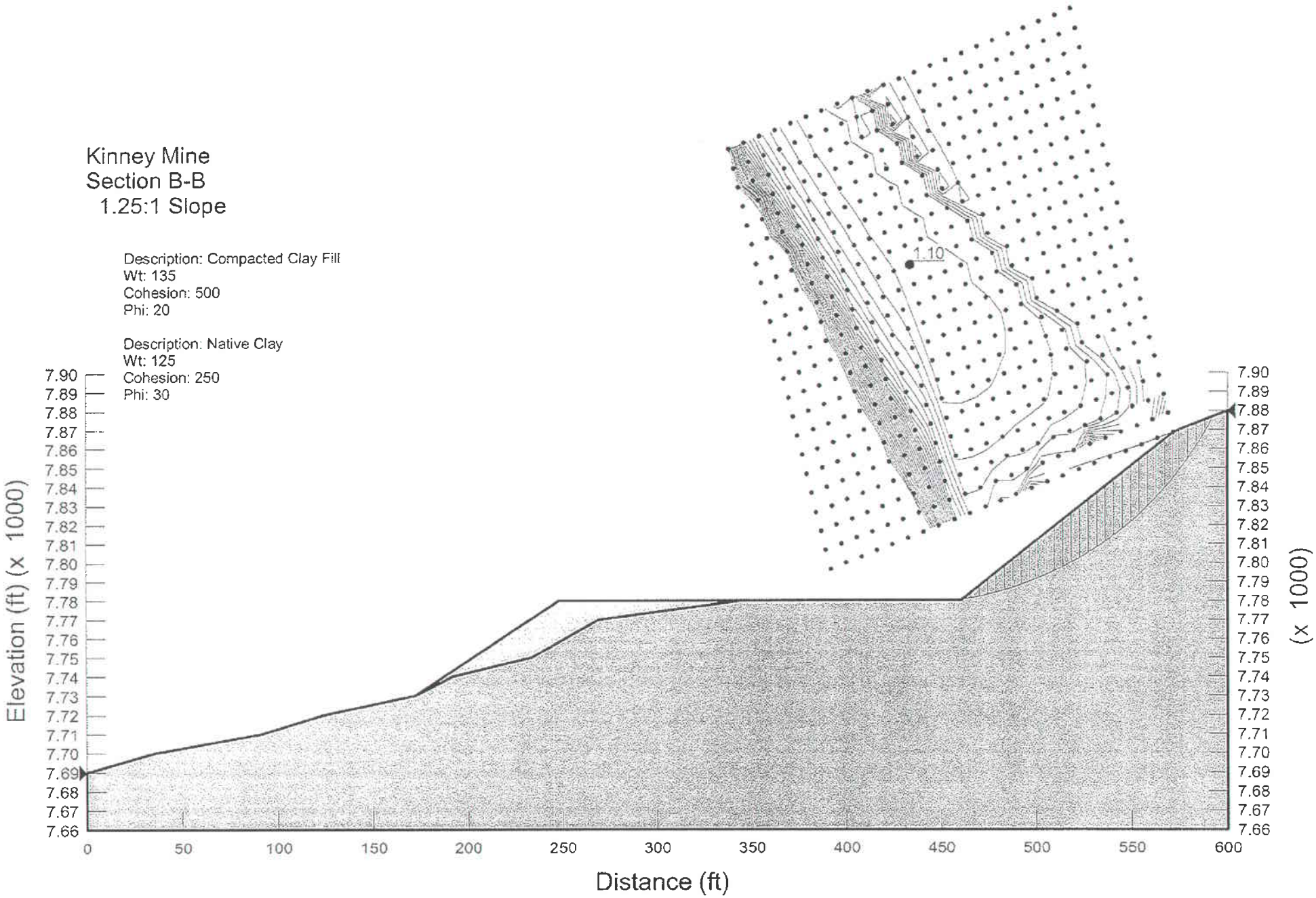
Description: Native Clay
Wt: 125
Cohesion: 250
Phi: 30



Kinney Mine
Section B-B
1.25:1 Slope

Description: Compacted Clay Fill
Wt: 135
Cohesion: 500
Phi: 20

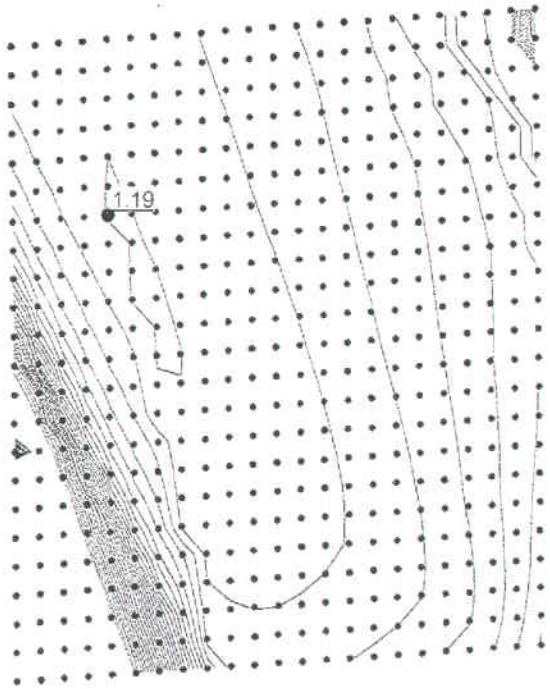
Description: Native Clay
Wt: 125
Cohesion: 250
Phi: 30

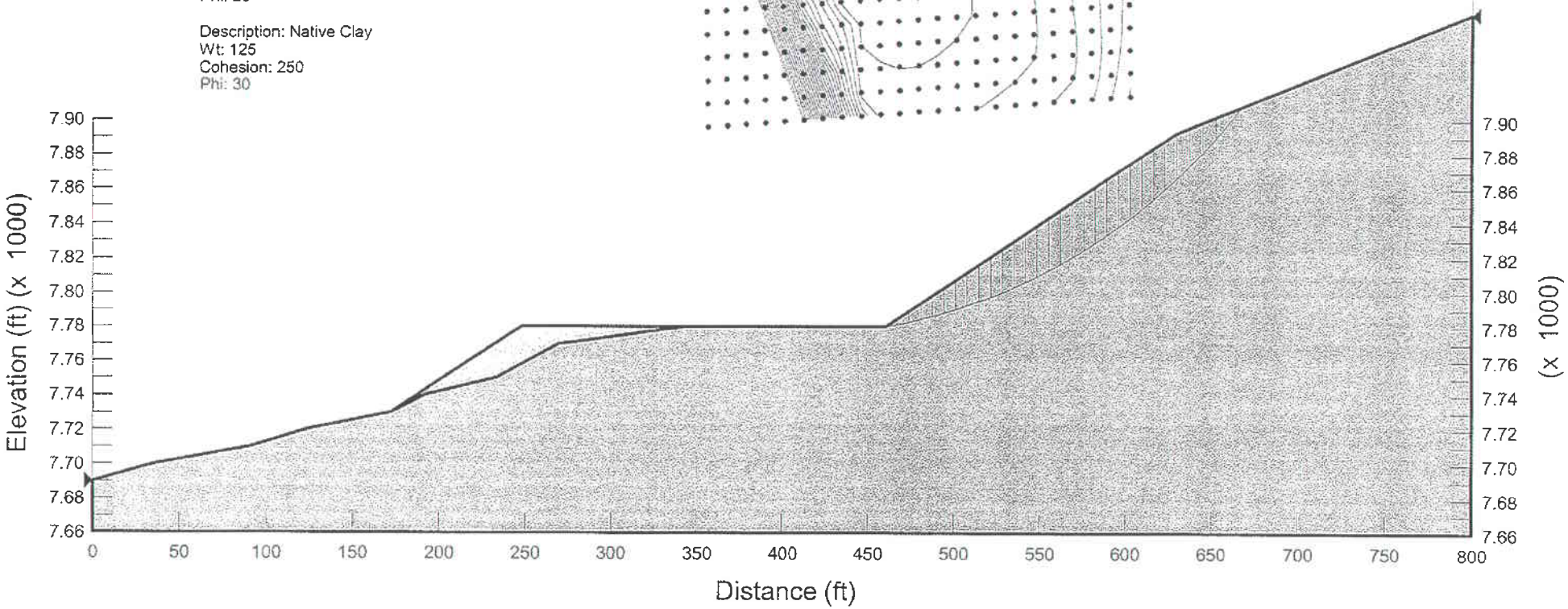


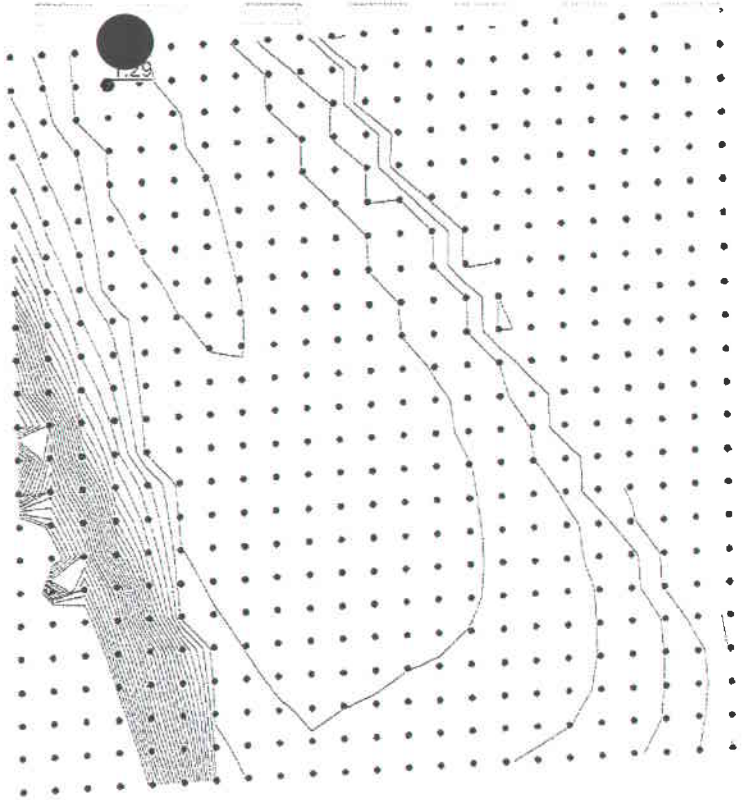
Kinney Mine
Section B-B
1.5:1 Slope

Description: Compacted Clay Fill
Wt: 135
Cohesion: 500
Phi: 20

Description: Native Clay
Wt: 125
Cohesion: 250
Phi: 30



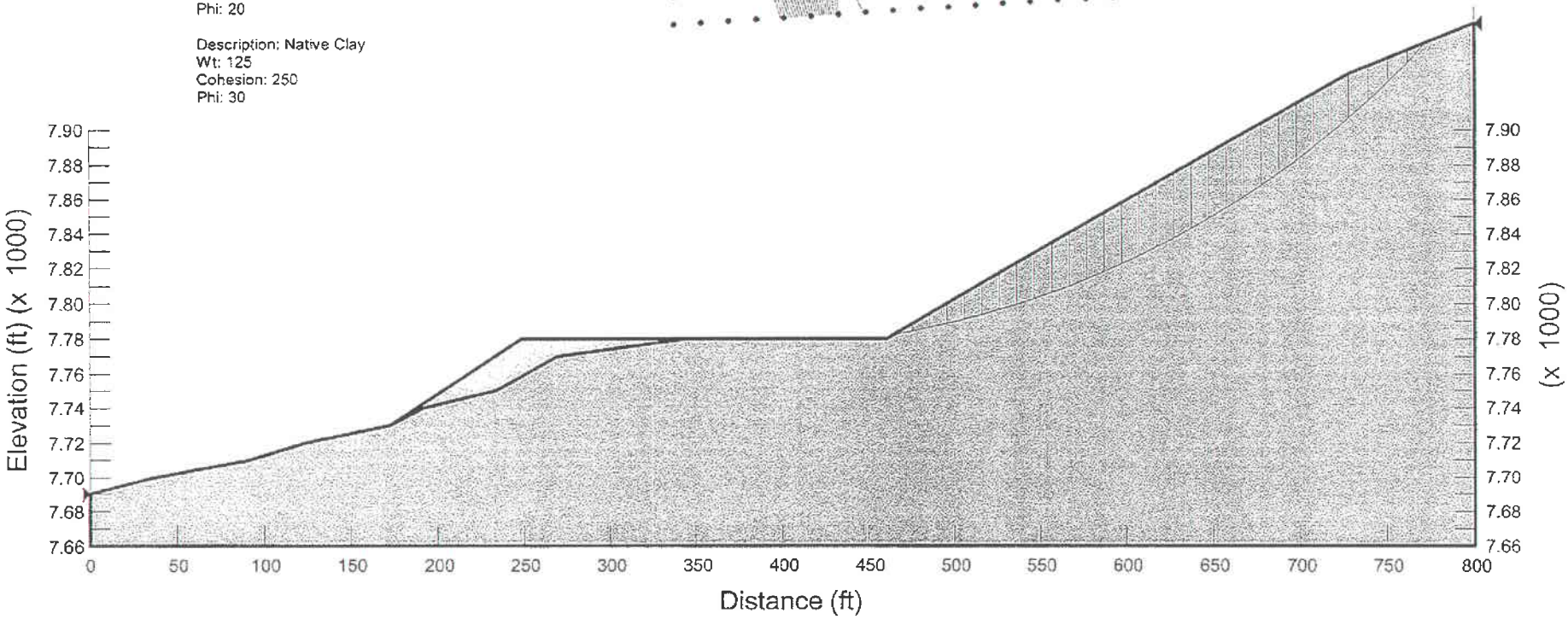




Kinney Mine
Section B-B
1.75:1 Slope

Description: Compacted Clay Fill
Wt: 135
Cohesion: 500
Phi: 20

Description: Native Clay
Wt: 125
Cohesion: 250
Phi: 30



Kinney Mine
Section F-F
0.8:1 Slope

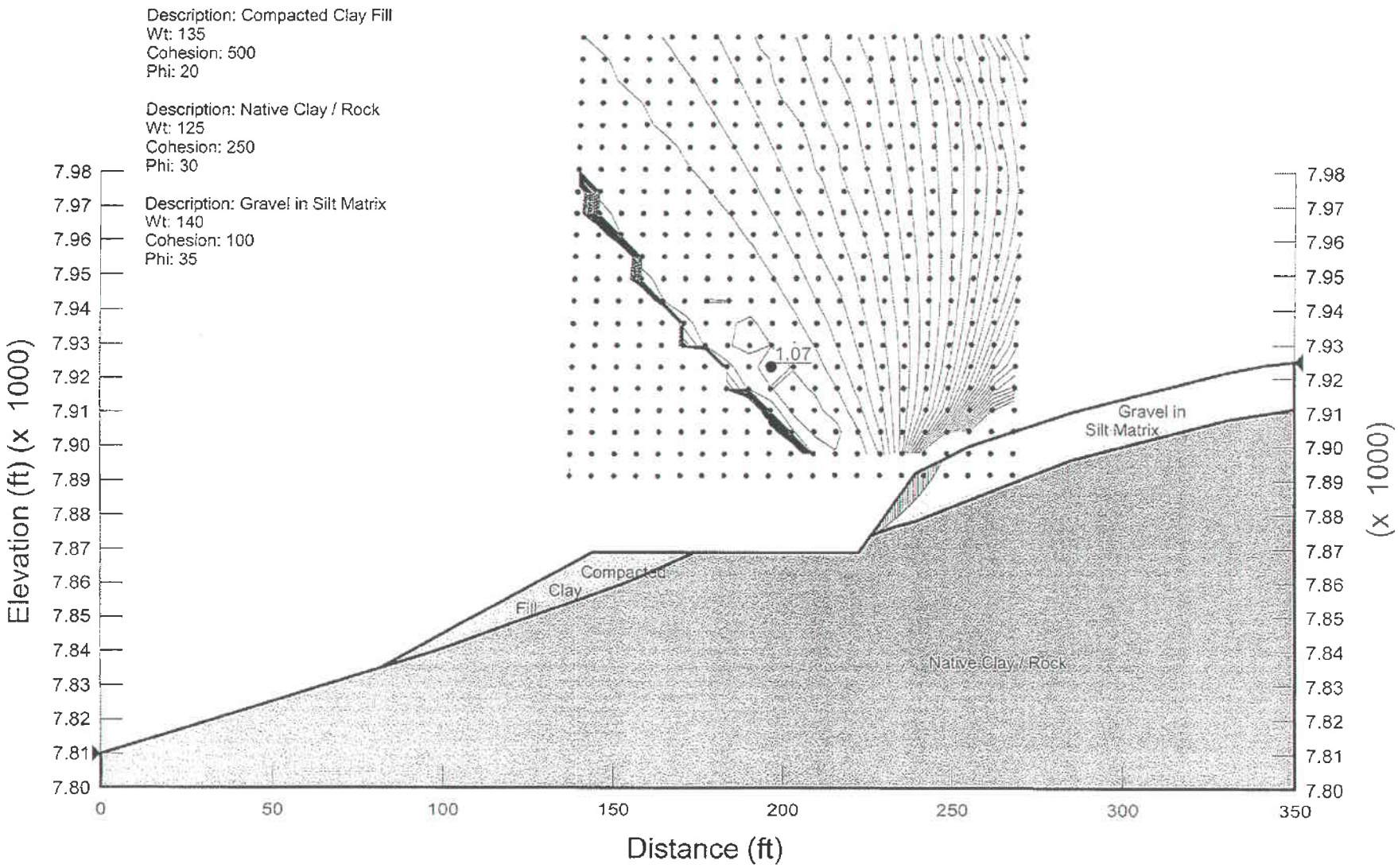


Exhibit 15

Kinney No. 2 Mine Blasting Plan

EXHIBIT 15
KINNEY NO. 2 MINE BLASTING PLAN

This blasting plan conforms to the Utah Coal Mining Rules R645-301-524 et. seq. The plan generally follows the format of the regulations, each regulation will be addressed as follows:

524.100 & 524.110

All surface blasting will be conducted under the direction of a certified blaster. Blasters will be qualified through the Division's blaster certification program.

524.120

Certificates of blaster certification will be carried by blasters or will be on file at a location within the permit area during blasting operations.

524.130

A blaster and at least one other person will be present for blasts.

524-140

The certified blaster responsible for blasting operations at the site will be familiar with the blasting plan and site-specific performance standards and give on-the-job training to persons who are not certified and who are assigned to the blasting crew or assist in the use of explosives.

524.210 – 524.240

Blasting may be required at the surface facilities of the Kinney No. 2 Mine located in the east half of the southeast quarter of Section 32, the west half of the west half of Section 33, Township 12 South, Range 7 East, Salt Lake Base & Meridian. Said areas can be seen on Map 3.4.1.4-1, Regional Land Use Map. A portion of this area is within 1,000 feet of occupied buildings, and within 500 feet of abandoned coal mines in the area. In addition, portions of the area are adjacent to Highway 96.

Blast Design

The blast design, as illustrated by Table 15-1, is intended to show the general layout and present general blasting information. Any significant deviation from this plan will be presented to the Division prior to the blast.

Structures To Be Protected

Structures to be protected will include all structures within 1,000 feet of the area described above, including the convenience store on the corner of Highway 96 south of the permit area, and all dwellings and public building located within 1,000 feet of the blasting area described above. The locations of buildings and structures within a 1,000 foot zone of the potential blasting area can be seen on Map 4.5.1.2-1 , Regional Surface Ownership Map.

Blaster Signature

This plan has been signed by a certified blaster on the last page of the plan. In the event the blaster that signed the plan no longer works for Carbon Resources (CR), or is no longer certified, a new certified blaster will be secured to execute the plan, his signature will be placed in the space below the original blaster, and a copy of the signed plan will be filed in the blasting records file.

524.300

A preblasting survey will be performed when 5 or more pounds of explosive are used as follows:

524.310 – At least 30 days before initiation of blasting, CR or its agent will notify, in writing, all residents or owners of dwellings, utilities or other structures located within on-half mile of the permit area, how to request a preblasting survey. Attachment A to this plan is a copy of a notification to be sent to the residents or owners of dwellings, utilities or other structures located within on-half mile of the permit area regarding their rights under the R645 rules to request a preblasting survey per R645-301-524.320.

524.320 – A resident or owner of a dwelling, structure, or utility within one-half mile of any part of the permit area may request a preblasting survey. The request will be made in writing directly to CR or UDOGM, who will promptly notify CR. CR will promptly conduct a preblasting survey of the dwelling, structure or utility and promptly prepare a report of the survey. An updated survey of any additions, modifications, or renovatins ill be performed by CR if requested by a resident or owner.

524.330 – CR will determine the condition of the dwelling, structure, or utility and will document any preblasting damage and other physical factors that could reasonably be affected by the blasting. Structures such as pipelines, cables, powerlines, and water systems will receive special attention, however, the assessment of these structures may be limited to surface conditions and other readily available data.

524.340 – The written report of the survey will be signed by the person that conducted the survey. Copies of the report will be promptly provided to UDOGM and to the person requesting the survey. If the person requesting the survey disagrees with the contents and/or recommendations contained therein, he or she may submit to both CR and UDOGM a detailed description of the specific areas of disagreement.

524.350 – Any surveys requested more than ten days before the planned initiation of blasting will be completed by CR before the initiation of blasting.

524.400

Blasting schedule: Blasting during construction of the Kinney No. 2 Mine surface facilities will begin any time after start of construction, which is scheduled to begin as soon after all appropriate permit approvals as possible. After construction is completed, blasting will be conducted as needed.

Blasting during initial site construction and during full mine operation will be done during daylight hours.

524.410 – Unscheduled blasts may occur for the following reasons:

- Where public safety requires

- Emergency blasting, such as boulders falling onto roadways, and etc.
- Destruction of damaged or deteriorated explosives or detonators in a safe manner
- Disposal of misfires and undetonated explosives
- Firing of charged holes as soon as practical after cessation of static electricity or stray current conditions when electrical detonators are used
- Firing of charged holes when weather conditions indicate the existence of a safety hazard is imminent

Residents of buildings or structures within one-half mile will be notified of unscheduled blasts using audible signals. CR will document the reason for the unscheduled blasts on the blasting records in accordance with R645-301-524.760.

524.430 – Written notice of blasting that is conducted within one-half mile of residents, structures, local governments, or utilities including Scofield Town, PacificCorp Power, and the Utah Department of Transportation will be given. A notice for blasting conducted during construction will be sent to the above entities weekly but in no case less than 24 hours before blasting will occur. The notices will contain the following:

- General location of the blasting
- Genera schedule
- General times of blasts
- Warning signals to be used before and after blasting

Notification to UDOT will be given that Highway 96 may be closed temporarily during blasting if a public safety hazard exists. A general notice of blasting will be placed in the Sun Advocate Newspaper before construction begins. Daily notices will be given each morning to the town of Scofield, and weekly notices will be given to UDOT if blasting during the following week has the potential to interfere with traffic on Highway 96.

524.500 & 524.510 – Blasting signs will be posted at the entrances to the Kinney No. 2 Mine site warning all who enter thereon of blasting. There are three possible entrances to the site, at the main entrance from Highway 96, at the private property road east of the site and the private property road at the north end of the permit area. The signs will be in accordance with R645-301-521.200 as follows:

- Signs will be posted, maintained, and removed by CR or its agent
- Signs will be of uniform design that can be easily seen and read
- Signs will be of durable materials and conform to local laws and regulations
- Signs will be maintained during all activities which they pertain

524.511 - Signs reading "BLASTING AREA" will be placed at conspicuous places along the edge of Highway 96 adjacent to the permit boundary where blasting may occur.

524.512 – Signs reading "WARNING! EXPLOSIVES IN USE" will be placed in conspicuous locations at all entrances to the permit area. The signs will also clearly list and describe the meaning of the audible blast warning and all-clear signals, and explain the marking of blasting areas and charged holes awaiting firing within the permit area.

524.520 – CR or its agent will give warning and all-clear signals of different character that are audible within a range of one-half mile from the point of the blast. A single long tone will be sounded approximately three (3) minutes before all blasts as the warning signal and two (2) short tones from the siren will signal all clear after each blast. Persons within the permit area and

Exhibit 16

Runoff Control Design Details

Hydrology and Hydraulics

Ditches and Culverts

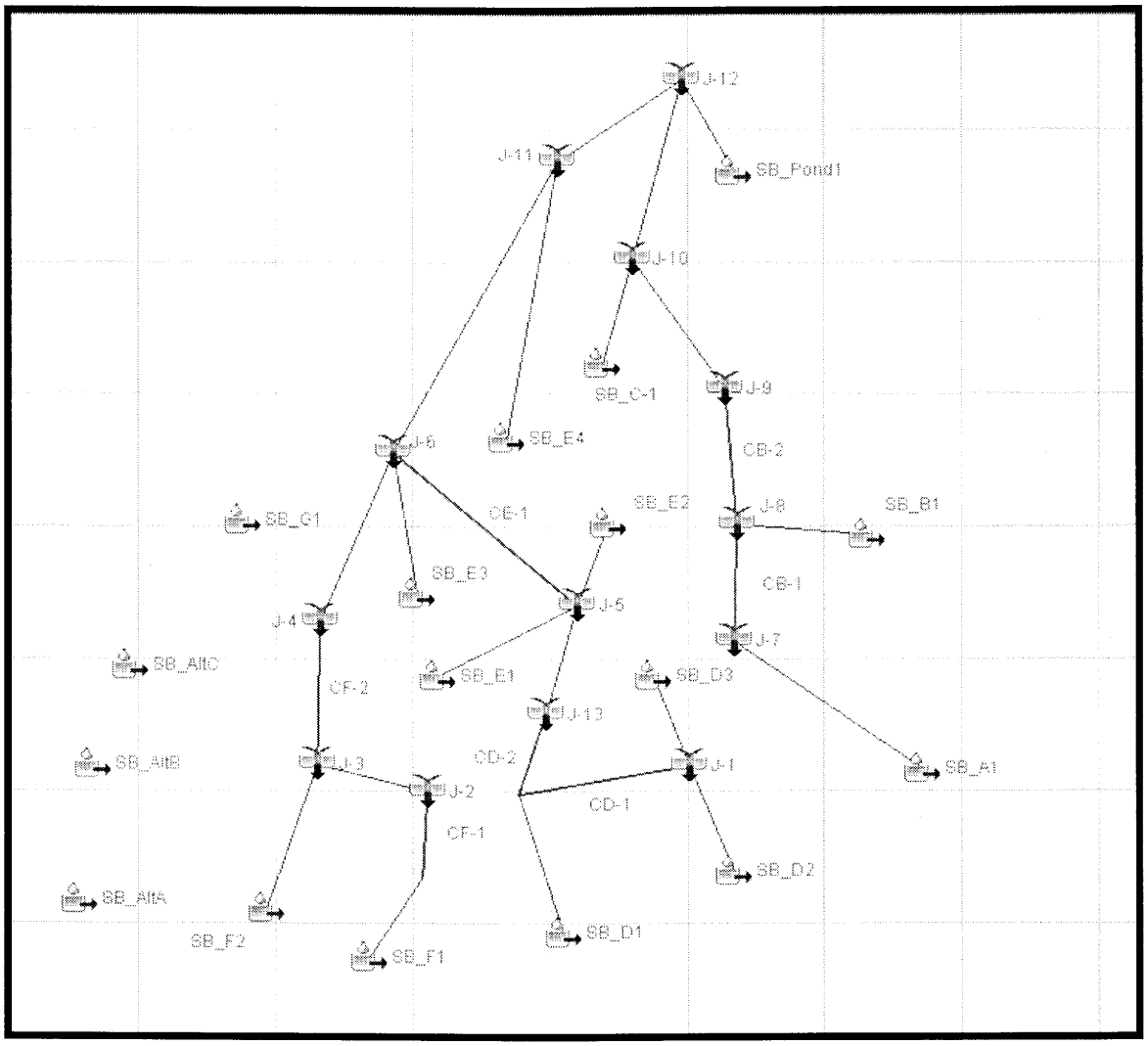
Sedimentation Pond 1

Energy Dissipation Structures

Hydrology and Hydraulics

Hydrology and Hydraulics

KINNEY MINE HYDROLOGY
HEC-HMS MODEL LAYOUT



Hydrologic Element	Drainage Area (mi2)	10yr 6hr Peak Discharge (cfs)	Time of Peak	Volume (in)
CB-1	0.0064	0.9	01Jul2007, 03:32	0.26
CB-2	0.01188	2	01Jul2007, 03:32	0.3
CD-1	0.00517	0.3	01Jul2007, 03:33	0.17
CD-2	0.00952	0.6	01Jul2007, 03:36	0.19
CE-1	0.0190796	2.4	01Jul2007, 03:33	0.28
CF-1	0.00581	1.3	01Jul2007, 03:31	0.39
CF-2	0.00779	1.7	01Jul2007, 03:31	0.37
J-1	0.00517	0.3	01Jul2007, 03:33	0.17
J-10	0.0184117	2.9	01Jul2007, 03:32	0.3
J-11	0.0300896	4.2	01Jul2007, 03:32	0.29
J-12	0.0518713	7.6	01Jul2007, 03:32	0.29
J-13	0.00952	0.6	01Jul2007, 03:36	0.19
J-2	0.00581	1.3	01Jul2007, 03:31	0.39
J-3	0.00779	1.7	01Jul2007, 03:31	0.37
J-4	0.00779	1.7	01Jul2007, 03:31	0.37
J-5	0.0190796	2.4	01Jul2007, 03:33	0.28
J-6	0.0276996	4.1	01Jul2007, 03:32	0.3
J-7	0.0064	0.9	01Jul2007, 03:31	0.26
J-8	0.01188	2	01Jul2007, 03:32	0.3
J-9	0.01188	2	01Jul2007, 03:32	0.3
SB_A1	0.0064	0.9	01Jul2007, 03:31	0.26
SB_AltA	0.00401	0.4	01Jul2007, 03:34	0.23
SB_AltB	0.00092	0.2	01Jul2007, 03:30	0.32
SB_AltC	0.0007	0.1	01Jul2007, 03:30	0.32
SB_B1	0.00548	1.1	01Jul2007, 03:32	0.35
SB_C-1	0.0065317	1	01Jul2007, 03:33	0.29
SB_D1	0.00435	0.3	01Jul2007, 03:37	0.21
SB_D2	0.00308	0.2	01Jul2007, 03:34	0.16
SB_D3	0.00209	0.2	01Jul2007, 03:33	0.18
SB_E1	0.00693	1.6	01Jul2007, 03:32	0.43
SB_E2	0.0026296	0.2	01Jul2007, 03:36	0.23
SB_E3	0.00083	0.1	01Jul2007, 03:31	0.23
SB_E4	0.00239	0.1	01Jul2007, 03:35	0.13
SB_F1	0.00581	1.3	01Jul2007, 03:31	0.39
SB_F2	0.00198	0.4	01Jul2007, 03:31	0.32
SB_G1	0.00712	0.3	01Jul2007, 03:35	0.14
SB_Pond1	0.00337	0.6	01Jul2007, 03:30	0.29
UDC-1	0.15526	2.7	01Jul2007, 05:45	0.09
UDD-1	0.101508	1.8	01Jul2007, 05:45	0.09

Hydrologic Element	Drainage Area (mi2)	100yr 6hr Peak Discharge (cfs)	Time of Peak	Volume (in)
CB-1	0.0064	2.9	01Jul2007, 03:31	0.75
CB-2	0.01188	5.8	01Jul2007, 03:31	0.82
CD-1	0.00517	1.6	01Jul2007, 03:32	0.59
CD-2	0.00952	2.9	01Jul2007, 03:34	0.62
CE-1	0.0190796	7.8	01Jul2007, 03:32	0.78
CF-1	0.00581	3.3	01Jul2007, 03:31	0.97
CF-2	0.00779	4.4	01Jul2007, 03:31	0.94
J-1	0.00517	1.6	01Jul2007, 03:32	0.59
J-10	0.0184117	8.7	01Jul2007, 03:31	0.81
J-11	0.0300896	12.9	01Jul2007, 03:31	0.79
J-12	0.0518713	23.2	01Jul2007, 03:31	0.8
J-13	0.00952	2.9	01Jul2007, 03:34	0.62
J-2	0.00581	3.3	01Jul2007, 03:31	0.97
J-3	0.00779	4.4	01Jul2007, 03:30	0.94
J-4	0.00779	4.4	01Jul2007, 03:31	0.94
J-5	0.0190796	7.8	01Jul2007, 03:32	0.78
J-6	0.0276996	12.4	01Jul2007, 03:31	0.82
J-7	0.0064	2.9	01Jul2007, 03:30	0.75
J-8	0.01188	5.8	01Jul2007, 03:31	0.82
J-9	0.01188	5.8	01Jul2007, 03:31	0.82
SB_A1	0.0064	2.9	01Jul2007, 03:30	0.75
SB_AltA	0.00401	1.5	01Jul2007, 03:33	0.7
SB_AltB	0.00092	0.5	01Jul2007, 03:30	0.85
SB_AltC	0.0007	0.4	01Jul2007, 03:30	0.85
SB_B1	0.00548	2.9	01Jul2007, 03:31	0.91
SB_C-1	0.0065317	2.9	01Jul2007, 03:32	0.8
SB_D1	0.00435	1.4	01Jul2007, 03:35	0.65
SB_D2	0.00308	0.9	01Jul2007, 03:33	0.57
SB_D3	0.00209	0.7	01Jul2007, 03:32	0.61
SB_E1	0.00693	4.1	01Jul2007, 03:31	1.03
SB_E2	0.0026296	0.9	01Jul2007, 03:35	0.7
SB_E3	0.00083	0.3	01Jul2007, 03:31	0.7
SB_E4	0.00239	0.6	01Jul2007, 03:33	0.49
SB_F1	0.00581	3.3	01Jul2007, 03:31	0.97
SB_F2	0.00198	1	01Jul2007, 03:30	0.85
SB_G1	0.00712	1.9	01Jul2007, 03:33	0.53
SB_Pond1	0.00337	1.6	01Jul2007, 03:30	0.8
UDC-1	0.15526	14.3	01Jul2007, 04:16	0.42
UDD-1	0.101508	9.4	01Jul2007, 04:14	0.42

Hydrologic Element	Drainage Area (mi2)	100yr 6hr Peak Discharge (cfs)	Time of Peak	Volume (in)
Reclaimed Watershed	0.112	11.5	01Jul2007, 04:14	0.45

Hydrologic Element	Drainage Area (mi2)	100yr 24hr Peak Discharge (cfs)	Time of Peak	Volume (in)
UDC-1	0.15526	38.5	01Jul2007, 13:34	0.79
UDD-1	0.101508	25.7	01Jul2007, 13:33	0.79

Hydrologic Element	Drainage Area (mi2)	100yr 6hr Peak Discharge (cfs)	Time of Peak	Volume (in)
Combined	0.05887	18.7	01Jul2007, 03:43	0.8

Kinney Mine Hydrology
Time of Concentration/Lag Time Esitimates

Method: SCS TR 55

Tc = Sheet flow time + shallow concentrated flow time + channel flow time

Tt = 0.007*(n*L) ^ 0.8/((P2) ^ .5*S ^ .4)
P2 = 2-yr 24-hr precip = 1.39 inches
S = Slope (ft/ft)

SUBBASIN	SHEET FLOW TIME				SHALLOW CONCENTRATED TIME				Channel Time				TOTAL Tc	LAG TIME	LAG TIME
	L (ft)	S	n	Tt (hrs)	L	S	v (fps)	T (hrs)	L	S	v (fps)	T (hrs)	(hrs)	(hrs)	(mins)
SB_A1	24	0.583	0.13	0.02	0	0.000	0	0.00	1515	0.064	6.5	0.07	0.08	0.05	3.0
SB_B1	157	0.682	0.13	0.08	0	0.000	0	0.00	644	0.010	2.6	0.07	0.15	0.09	5.3
SB_C1	224	0.393	0.13	0.13	0	0.000	0	0.00	599	0.023	3.9	0.04	0.17	0.10	6.1
SB_D1	300	0.313	0.13	0.18	1303	0.058	3.8	0.10	240	0.021	3.7	0.02	0.29	0.17	10.5
SB_D2	300	0.333	0.13	0.17	176	0.244	8	0.01	350	0.082	7.3	0.01	0.19	0.12	6.9
SB_D3	47	0.021	0.13	0.12	0	0.000	0	0.00	467	0.029	4.4	0.03	0.15	0.09	5.3
SB_E1	300	0.008	0.011	0.10	51	0.011	1.6	0.01	490	0.010	2.6	0.05	0.17	0.10	6.0
SB_E2	413	0.240	0.13	0.25	0	0.000	0	0.00	424	0.021	3.7	0.03	0.29	0.17	10.3
SB_E3	63	0.333	0.13	0.05	0	0.000	0	0.00	525	0.010	2.6	0.06	0.11	0.06	3.8
SB_E4	73	0.260	0.13	0.06	0	0.000	0	0.00	1238	0.010	2.6	0.13	0.20	0.12	7.1
SB_F1	240	0.013	0.011	0.07	154	0.013	1.8	0.02	244	0.033	4.6	0.01	0.11	0.07	4.0
SB_F2	56	0.125	0.13	0.07	0	0.000	0	0.00	503	0.090	7.7	0.02	0.08	0.05	3.1
SB_G1	30	0.020	0.013	0.01	0	0.000	0	0.00	1809	0.010	2.6	0.20	0.21	0.13	7.6
SB_Pond1	64	0.313	0.13	0.05	0	0.000	0	0.00	544	0.065	6.5	0.02	0.07	0.04	2.7
SB_AltA	300	0.200	0.13	0.21	0	0.000	0	0.00	133	0.010	2.6	0.01	0.23	0.14	8.1
SB_AltB	63	0.270	0.13	0.05	0	0.000	0	0.00	145	0.083	7.4	0.01	0.06	0.04	2.1
SB_AltC	29	0.720	0.13	0.02	0	0.000	0	0.00	227	0.044	5.4	0.01	0.03	0.02	1.1
Combined	190	0.005	0.03	0.20	500	0.005	1.2	0.12	2080	0.01	2.6	0.23	0.54	0.32	19.5

Chapter 3 Time of Concentration and Travel Time

Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of time of concentration (T_c), which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system.

T_c influences the shape and peak of the runoff hydrograph. Urbanization usually decreases T_c, thereby increasing the peak discharge. But T_c can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

Factors affecting time of concentration and travel time

Surface roughness

One of the most significant effects of urban development on flow velocity is less retardance to flow. That is, undeveloped areas with very slow and shallow overland flow through vegetation become modified by urban development: the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

Channel shape and flow patterns

In small non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

Slope

Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water management system. Slope will tend to increase when channels are straightened and decrease when overland flow is directed through storm sewers, street gutters, and diversions.

Computation of travel time and time of concentration

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600V} \qquad \text{[eq. 3-1]}$$

where:

T_t = travel time (hr)
L = flow length (ft)
V = average velocity (ft/s)
3600 = conversion factor from seconds to hours.

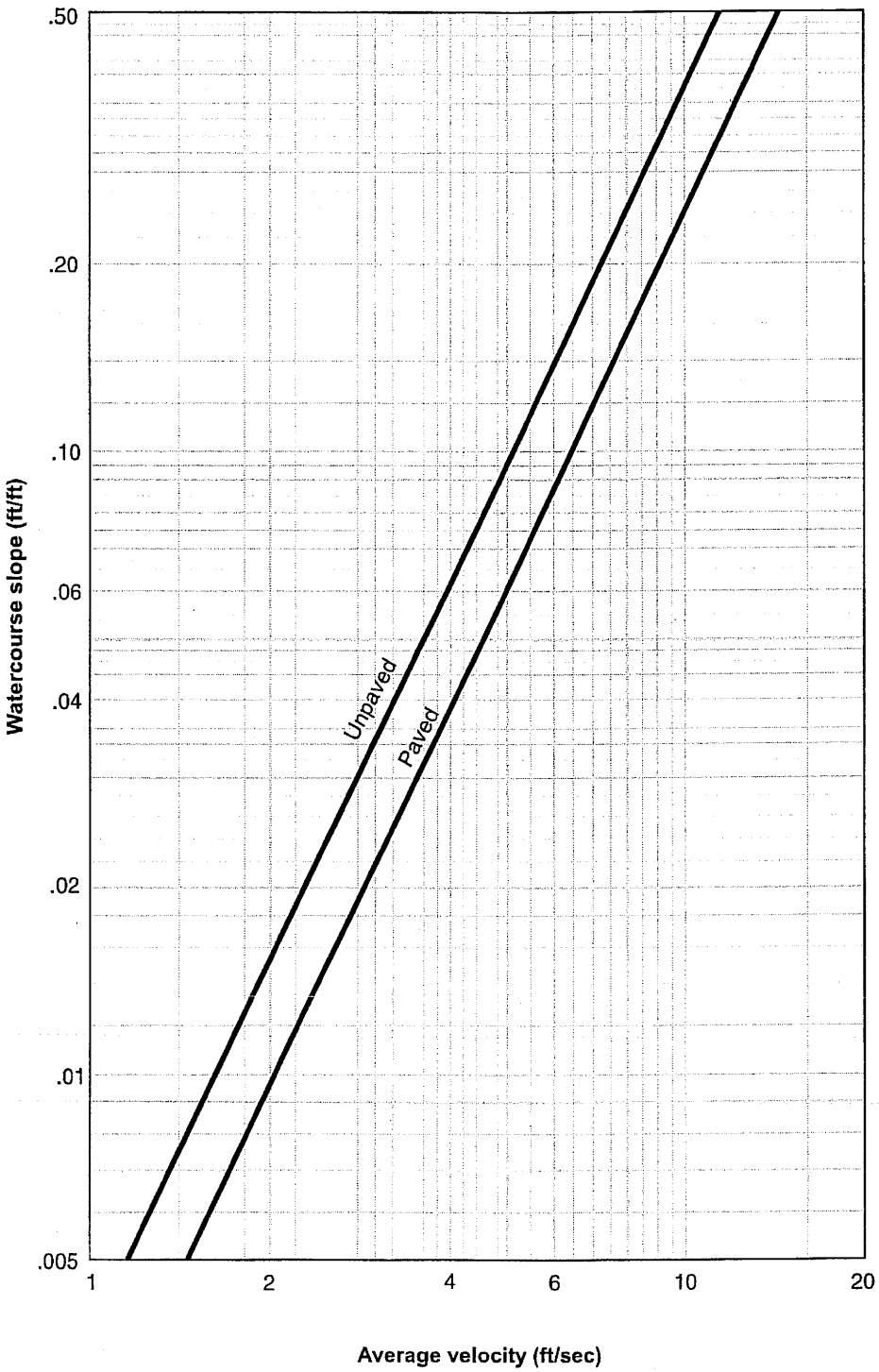
Time of concentration (T_c) is the sum of T_t values for the various consecutive flow segments:

$$T_c = T_{t_1} + T_{t_2} + \ldots T_{t_m} \qquad \text{[eq. 3-2]}$$

where:

T_c = time of concentration (hr)
m = number of flow segments

Figure 3-1 Average velocities for estimating travel time for shallow concentrated flow



Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1] The n values are a composite of information compiled by Engman (1986).
[2] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3] When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \qquad \text{[eq. 3-3]}$$

where:

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bankfull elevation.

Manning's equation is:

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \qquad \text{[eq. 3-4]}$$

where:

V = average velocity (ft/s)
r = hydraulic radius (ft) and is equal to a/p_w
a = cross sectional flow area (ft^2)
p_w = wetted perimeter (ft)
s = slope of the hydraulic grade line (channel slope, ft/ft)
n = Manning's roughness coefficient for open channel flow.

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (1959) or Linsley et al. (1982). After average velocity is computed using equation 3-4, T_t for the channel segment can be estimated using equation 3-1.

Reservoirs or lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.

Limitations

- Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation 3-3 was developed for use with the four standard rainfall intensity-duration relationships.

- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate T_c. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or nonpressure flow.

- The minimum T_c used in TR-55 is 0.1 hour.

- A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. The procedures in TR-55 can be used to determine the peak flow upstream of the culvert. Detailed storage routing procedures should be used to determine the outflow through the culvert.

Example 3-1

The sketch below shows a watershed in Dyer County, northwestern Tennessee. The problem is to compute T_c at the outlet of the watershed (point D). The 2-year 24-hour rainfall depth is 3.6 inches. All three types of flow occur from the hydraulically most distant point (A) to the point of interest (D). To compute T_c, first determine T_t for each segment from the following information:

Segment AB: Sheet flow; dense grass; slope (s) = 0.01 ft/ft; and length (L) = 100 ft. Segment BC: Shallow concentrated flow; unpaved; s = 0.01 ft/ft; and L = 1,400 ft. Segment CD: Channel flow; Manning's n = .05; flow area (a) = 27 ft^2; wetted perimeter (p_w) = 28.2 ft; s = 0.005 ft/ft; and L = 7,300 ft.

See figure 3-2 for the computations made on worksheet 3.

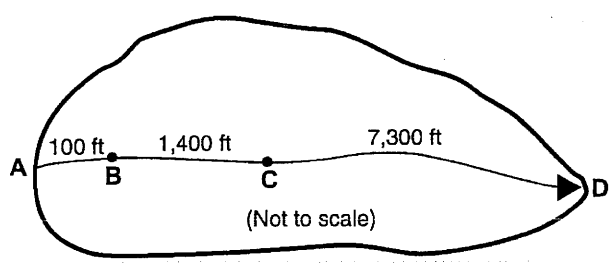


Figure 3-2 Worksheet 3 for example 3-1

Worksheet 3: Time of Concentration (T_c) or travel time (T_t)

Project	Heavenly Acres	By DW	Date 10/6/85
Location	Dyer County, Tennessee	Checked NM	Date 10/8/85

Check one: ☐ Present ☒ Developed

Check one: ☒ T_c ☐ T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

	Segment ID	AB		
1. Surface description (table 3-1)		Dense Grass		
2. Manning's roughness coefficient, n (table 3-1)		0.24		
3. Flow length, L (total L ≤ 300 ft) ft		100		
4. Two-year 24-hour rainfall, P_2 in		3.6		
5. Land slope, s ft/ft		0.01		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t hr		0.30	+	= 0.30

Shallow concentrated flow

	Segment ID	BC		
7. Surface description (paved or unpaved)		Unpaved		
8. Flow length, L ft		1400		
9. Watercourse slope, s ft/ft		0.01		
10. Average velocity, V (figure 3-1) ft/s		1.6		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t hr		0.24	+	= 0.24

Channel flow

	Segement ID	CD		
12. Cross sectional flow area, a ft^2		27		
13. Wetted perimeter, p_w ft		28.2		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft		0.957		
15 Channel slope, s ft/ft		0.005		
16. Manning's roughness coefficient, n		0.05		
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ft/s		2.05		
18. Flow length, L ft		7300		
19. $T_t = \frac{L}{3600\ V}$ Compute T_t hr		0.99	+	= 0.99
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) Hr				1.53

HANSEN ALLEN & LUCE inc
ENGINEERS

CLIENT Carbon Resources
PROJECT Kinney Mine Hydrology
FEATURE Mountain Watershed Lag Time
PROJECT NO 308.01.400

SHEET ____ OF ____
COMPUTED TDS
CHECKED ____
DATE 6-4-07

Lag Time for Mountain Watersheds

Watershed Calcs

$$t_{lag} = 0.0051 \times width^{0.594} \times slope^{-0.150} \times S_{nat}^{0.313}$$

$$width = \frac{\text{watershed area}}{\text{watershed length}}$$

$$slope = \frac{\text{max elevation difference}}{\text{longest flow path}}$$

$$S_{nat} = \frac{1000}{CN} - 10$$

(1) UDC-1

$$width = \frac{3{,}936{,}738\ ft^2}{3{,}030\ ft} = 1299\ ft$$

$$slope = \frac{8810 - 7850}{3{,}080\ ft} = 0.314$$

$$S_{nat} = \frac{1000}{CN} - 10 = \frac{1000}{75} - 10 = 3.33$$

$$t_{lag} = 0.0051 \times (1299)^{0.594} \times (0.314)^{-0.15} \times (3.33)^{0.313}$$

$$= 0.63\ hrs = \underline{\underline{37.8\ min}}$$

HANSEN ALLEN & LUCE inc
ENGINEERS

CLIENT Carbon Resources
PROJECT Kinney Mine Hydrology
FEATURE Mountain Watershed Lag Time
PROJECT NO 308.01.400

SHEET ____ OF ____
COMPUTED TDS
CHECKED ____
DATE 8-3-07

(2) UDD-1

$$\text{width} = \frac{2{,}829{,}870\ ft^2}{2{,}320\ ft} = 1{,}220\ ft$$

$$\text{slope} = \frac{8{,}610\ ft - 7{,}840\ ft}{2{,}670\ ft} = 0.288$$

$$S_{nat} = \frac{1000}{CN} - 10 = \frac{1000}{75} - 10 = 3.33$$

$$t_{lag} = 0.0051 \times (1{,}220\ ft)^{0.594} \times (0.288)^{-0.15} \times (3.33)^{0.313}$$

$$= 0.61\ hrs = \underline{\underline{36.6\ min}}$$

Lag time characteristics for small watersheds in the U.S.

M.J. Simas[1], R.H. Hawkins[2]

Abstract

Lag time, defined as the time from the centroid of rainfall excess to the centroid of direct runoff, was evaluated for over 50,000 rainfall-runoff events in 168 small watersheds in the United States ranging from 0.243 to 3490 acres. In most watersheds a stable value of lag time was observed for the larger storms, with peak flow the variable that best showed this tendency. The watersheds were divided into groups to explain the variation of lag time between watersheds. The groups that had a significant effect in the regression equation were geographical regions, watershed management practices, and the stability of the lag time value for the bigger storms. Separation of watersheds by land use and hydrologic behavior did not significantly improve the regression analyses. When only watersheds with stable behavior were used (N=78), no group significantly improved the regression equation, $t_{lag} = 0.0051 \times width^{0.594} \times slope^{-0.150} \times S_{nat}^{0.313}$, which exhibited R^2=58%.

Introduction

Public investment in surface drainage improvements in developing urban areas involves an annual capital investment on the order of a few billion of dollars (Pilgrim and Cordery, 1993). The average annual expenditure for works in small rural drainage basins amounts to 46 percent of the total expenditure on structures and works, making

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flood estimation for these small drainage basins of great importance in terms of national expenditure.

In design flood estimation, characteristic response times are required for the determination of hydrograph parameters and critical duration of flood producing rainfall (Ward et al., 1980). A given volume of water may or may not represent a flood hazard, as the hazard will depend on the time distribution of the flood runoff. Almost all hydrologic analysis of rainfall and runoff usually require the value of at least one time parameter as input (McCuen, 1989).

Most hydrologic models require a watershed characteristic that reflects the timing of runoff. One of the most widely used methods for estimating floods on small drainage basins is the U.S. Soil Conservation Service (SCS) method. The SCS method uses lag time, defined as the time difference between the centroid of the effective rainfall and the peak of direct runoff.

There is some inconsistency in the definition of lag time, and this leads to difficulty in analyzing the results from the different models that use it. Singh (1988) gathered nine different definitions for lag time. Still another constraint in the applicability of the time parameters is the lack of diversity of data (McCuen et al., 1984), since most empirical equations were developed for urbanized areas, rather than for rural areas (Miller et al., 1995).

The accuracy of the design flood estimate is directly related to the accuracy with which an estimate of the watershed response time is made (Singh, 1988). Errors on the order of 75% in the estimation of the peak discharge can be attributed to errors in the estimated value of the time parameter (McCuen, 1989; Singh, 1988). Little is known about the accuracy of estimates of response times on ungaged watersheds. For a specified recurrence interval, a first approximation of the design flood estimate is inversely proportional to the response time (Singh, 1988). In performing hydrologic computations of runoff, a particular synthetic unit hydrograph is often selected, and as such, a particular time parameter consistent with the unit hydrograph theory adopted. However, if a unit hydrograph method is chosen and the selected time parameter is inconsistent with it, unknowingly significant errors may be introduced in runoff computations (Miller et al., 1995).

Lag time is affected by watershed and rainstorm parameters. The physiographic parameters that affect lag time are areal extent, form, slope, surface topographic characteristics, vegetation, and land use. The rainfall characteristics are intensity in time and space, rainfall duration, and direction of runoff. There are still other factors that affect lag time, like the antecedent moisture conditions, infiltration characteristics, wind velocity, and weather condition (Singh, 1988).

Lag time used in this study was defined as the time from the centroid of rainfall excess to the centroid of direct runoff. This definition has been accepted as being the most stable measure of lag time (Schultz and Lopez, 1974).

Methodology

Lag time values were evaluated from rainfall-runoff data in over 50,000 events from 168 small watersheds in the United States. The watersheds ranged from 0.243 to 3490 acres, with periods of rainfall-runoff records from 3 to 58 years.

The data used in this study was obtained entirely from the Water Data Center maintained by the US Department of Agriculture, the Agricultural Research Service (ARS) in Beltsville, Maryland. This national archive of variable time-series readings for precipitation and runoff contains sufficient detail to reconstruct storm hydrographs and hyetographs. Textual files containing watershed descriptive information, land use and soils are published in the Hydrologic Data for Experimental Agricultural Watersheds in the United States book series.

Rainfall and runoff events were separated using GETPQ, a software developed at the University of Arizona which uses breakpoint rainfall-runoff data, and separates hydrographs using a constant baseflow separation slope. It then matches the rainfall to this hydrograph by comparing the times of occurrence of both the hydrograph and the hyetograph.

The lag time definition used in this study is the difference from the centroid of effective rainfall and the centroid of direct runoff.

Effective rainfall was defined and computed by an initial loss followed by a continuing loss rate (phi index). The phi was determined iteratively by adjusting its value until the effective rainfall hyetograph matched observed direct runoff depth. This done, the centroid of effective rainfall is computed.

Direct runoff was defined and computed as the runoff that has occurred once the baseflow has been deducted. The baseflow separation was done by using a constant baseflow separation slope (0.0002 in/hr^2).

The rainfall-runoff events were selected based on some pre-defined criteria. This filtering followed the approaches of Gray (1961) and Eagleson (1962) to select only those hydrographs with a single peak followed by an uninterrupted recession. All rainfall-runoff events were visually inspected. The rainfall-runoff events were discarded if the hydrographs were multi-peaked; if the hydrographs started before the hyetographs, suggesting inconsistency in the timing of rainfall and runoff data; if the hydrographs started after the hyetograph ended, because effective rainfall contributing to that runoff event cannot be computed; or if the events presented a negative lag time (the centroid of effective rainfall occurring after the centroid of runoff) suggesting that there is some inconsistency in the timing of rainfall and runoff data.

A total of 31,030 events were selected (out of 55,645) for further analysis of the 168 watersheds under study. Most of the factors described above that affect lag time were evaluated in this study. The study was separated in two parts. The first one evaluated the rainfall characteristics and how they affect lag time, and the second part evaluated how the watershed characteristics affected it.

Lag time should be a constant for all storms of a given watershed if the excess rainfall-direct runoff process was truly linear. However, some differences were observed when computing lag time from observed data (Barnes, 1959; Minshall, 1960; Gray, 1961; Eagleson, 1962; Diskin, 1964; Rastogi and Jones, 1969; Laureson, 1964; Askew, 1970).

In the present study, four rainfall-runoff characteristics were used to evaluate the variation of lag time within a watershed. These factors were degree of saturation of a watershed (Ramser, 1927) - represented by the previous 48 hour rainfall; effective

rainfall intensity (Ramser, 1927; Ragan and Duru, 1972; Singh and Agiralioglu, 1982) - defined as the average effective rainfall intensity, effective rainfall being defined as the rainfall that occurred after the hydrograph started; mean total discharge (Ramser, 1927; Barnes, 1959; Laureson, 1964; Askew, 1970) - ratio between total runoff depth and its duration; peak flow - introduced in this study as another hydrologic variable to explain the variation of lag time values within a watershed. Peak flow is represented by the maximum flow rate in a hydrograph.

Several watershed parameters were thought to be related to lag time, like for example length and slope of the catchment (Bell and Karr, 1969; Ragan and Duru, 1972). Vegetation cover seemed to be the most influential factor in the computation of lag time (Ragan and Duru; 1972). Imperviousness of a watershed was another factor that seemed to be important on lag time computation (Rao and Delleur, 1974).

The watershed variables observed in this study were watershed area (ac); watershed length (ft) - longest flow-path from the highest elevation to the watershed outlet; watershed slope - ratio between the maximum difference in elevation and the longest flow-path length; S_{nat} - storage coefficient (in) used in the Curve Number (CN) method. Width (ft) is the watershed area divided by the watershed length. CN was computed using the asymptotic determination of runoff Curve Numbers from rainfall and runoff data technique (Hawkins, 1992).

Multiple linear regression analysis was performed on the data. The desired form of the fitted equation was $Lag = a_0 * width^{a_1} * slope^{a_2} * S_{nat}^{a_3}$.

The watersheds were separated into four diverse groups to clarify possible grouping relationships and give more reliable fittings. The groups represented qualitative characteristics of a watershed and were: regions (East, Midwest, Central, Southwest); land use (pasture, mixed, agriculture, forest); management (high, medium and low disturbance); behavior (Complacent, Standard, Violent) (Hawkins, 1992).

Results and Discussion

Variations of lag time within a watershed

Lag time was not a constant for a watershed but varied considerably. Some watersheds showed a tendency towards a constant value of lag time for the bigger storms. Unlike what is described in the literature, the degree of saturation of a watershed, represented by the prior 48-hour rainfall, showed no significant or consistent relationship to lag time. As for the effective rainfall intensity, previous studies had found that time of concentration (directly related to lag time) should decrease for the higher rainfall intensity storms (Ramser, 1927; Ragan and Duru, 1972; Agiraloglu and Singh, 1981; Singh, 1982). Such relationship was not observed in this study. A non-linear relation between lag time and mean total discharge was suggested by Askew (1970). In this study, only 5 of the 168 watersheds had a coefficient of determination (r^2) above 0.50 upon for such relationships.

However, some watersheds showed a tendency to a constant value of lag time at the higher values of previous 48-hour rainfall, suggesting that the scatter observed under 'drier' conditions is perhaps because of partial area contribution to runoff. The same is true for the higher intensity storms, suggesting that the watershed might not be

at equilibrium for the small storms, when the hydrology of the watershed is still not well developed. The same tendency towards a constant value of lag time at the high mean runoff rate values was found, suggesting that the hydrology of the watershed is better defined for bigger storms. Also, for bigger storms the watershed may reach steady-state conditions. The variable introduced in this study was peak flow, and similarly to the previous evaluations, lag time showed a stable value for larger peak flow values. The higher peak flow suggests bigger storms, that might be better distributed both in time and space. This might represent steady-state conditions, and the value of lag time should not be affected by the size of the storm, once these conditions are met. The best estimate of lag time was computed for each watershed.

Variations of lag time between watersheds

All variables (width, slope, S_{nat}) were significant in explaining the variation of lag time in regression analysis. Two sets of watersheds were evaluated, the first being all watersheds, and the second being composed of the watersheds that showed a stable value for the larger storms. For the first set, the groups that had a significant effect were geographical regions, watershed management practices, and the tendency towards a constant value of lag time for the bigger storms. Separation of watersheds by land use and hydrologic behavior did not significantly improve the regression analyses. When the second set of watersheds was used, no group significantly improved the regression equation. The final regression equation (second set) was

$$t_{lag} = 0.0051 \times width^{0.594} \times slope^{-0.150} \times S_{nat}^{0.313} \ .$$

This equation had R^2= 58, and N= 78. It bears repeating that t_{lag} is in hours, *width* is in feet, *slope* is a decimal fraction, and S_{nat} is in inches.

Conclusions

There was a tendency towards a stable value of lag time for the larger storms. Peak flow was the hydrologic variable that best showed this tendency. Hydrologic relationships previously described in the literature were not verified in this study.

In order to compute lag time rainfall-runoff data should be used, especially for the larger storms. If there is not enough data available, grouping the watersheds into regions and management practices will improve the regression equation. Width, slope and S_{nat} are good variables for prediction of lag time. The model developed in this study had a higher coefficient of determination compared to other models presented in the literature.

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Table 9.1.--Runoff curve numbers for hydrologic soil-cover complexes

(Antecedent moisture condition II, and $I_a = 0.2\ S$)

Land use	Cover: Treatment or practice	Cover: Hydrologic condition	Hydrologic soil group A	B	C	D
Fallow	Straight row	----	77	86	91	94
Row crops	"	Poor	72	81	88	91
	"	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	"	Good	65	75	82	86
	"and terraced	Poor	66	74	80	82
	" " "	Good	62	71	78	81
Small grain	Straight row	Poor	65	76	84	88
		Good	63	75	83	87
	Contoured	Poor	63	74	82	85
		Good	61	73	81	84
	"and terraced	Poor	61	72	79	82
		Good	59	70	78	81
Close-seeded legumes 1/ or rotation meadow	Straight row	Poor	66	77	85	89
	" "	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	"	Good	55	69	78	83
	"and terraced	Poor	63	73	80	83
	"and terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	"	Fair	25	59	75	83
	"	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads (dirt) 2/		----	72	82	87	89
(hard surface) 2/		---	74	84	90	92

1/ Close-drilled or broadcast.
2/ Including right-of-way.

Pad

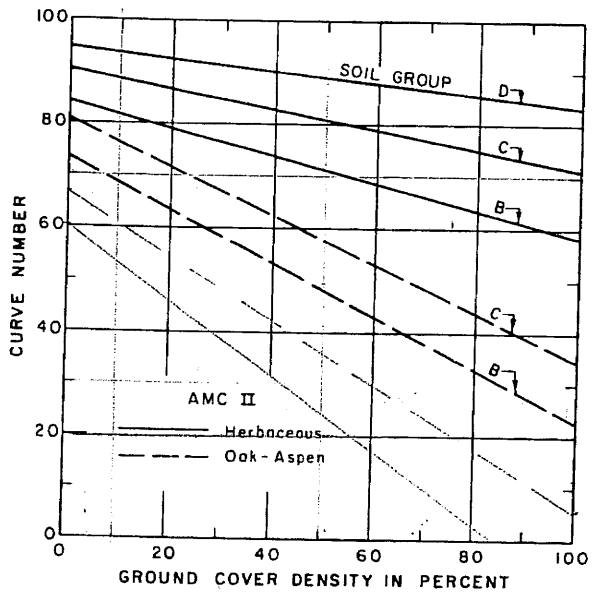


Figure 9.5.--Graph for estimating runoff curve numbers of forest-range complexes in western United States: herbaceous and oak-aspen complexes.

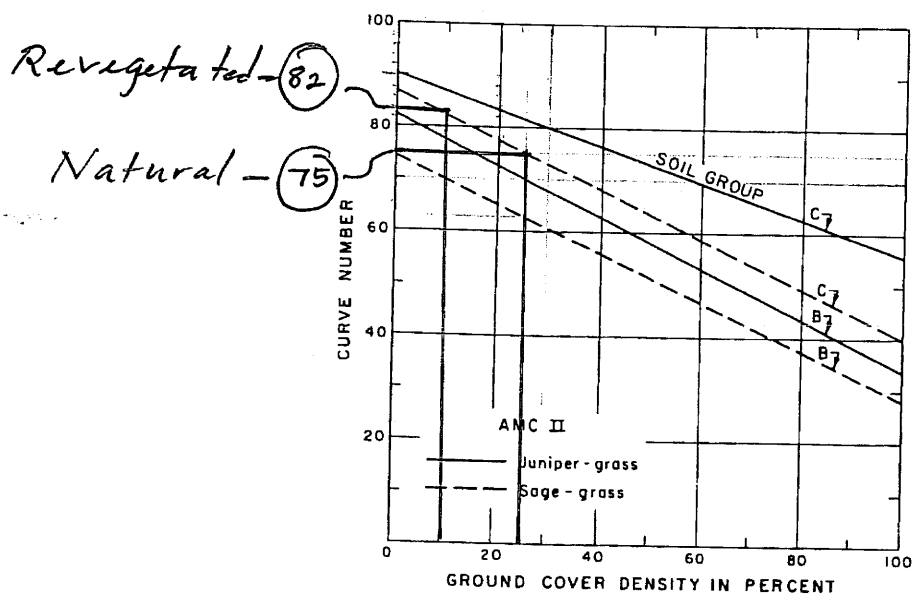
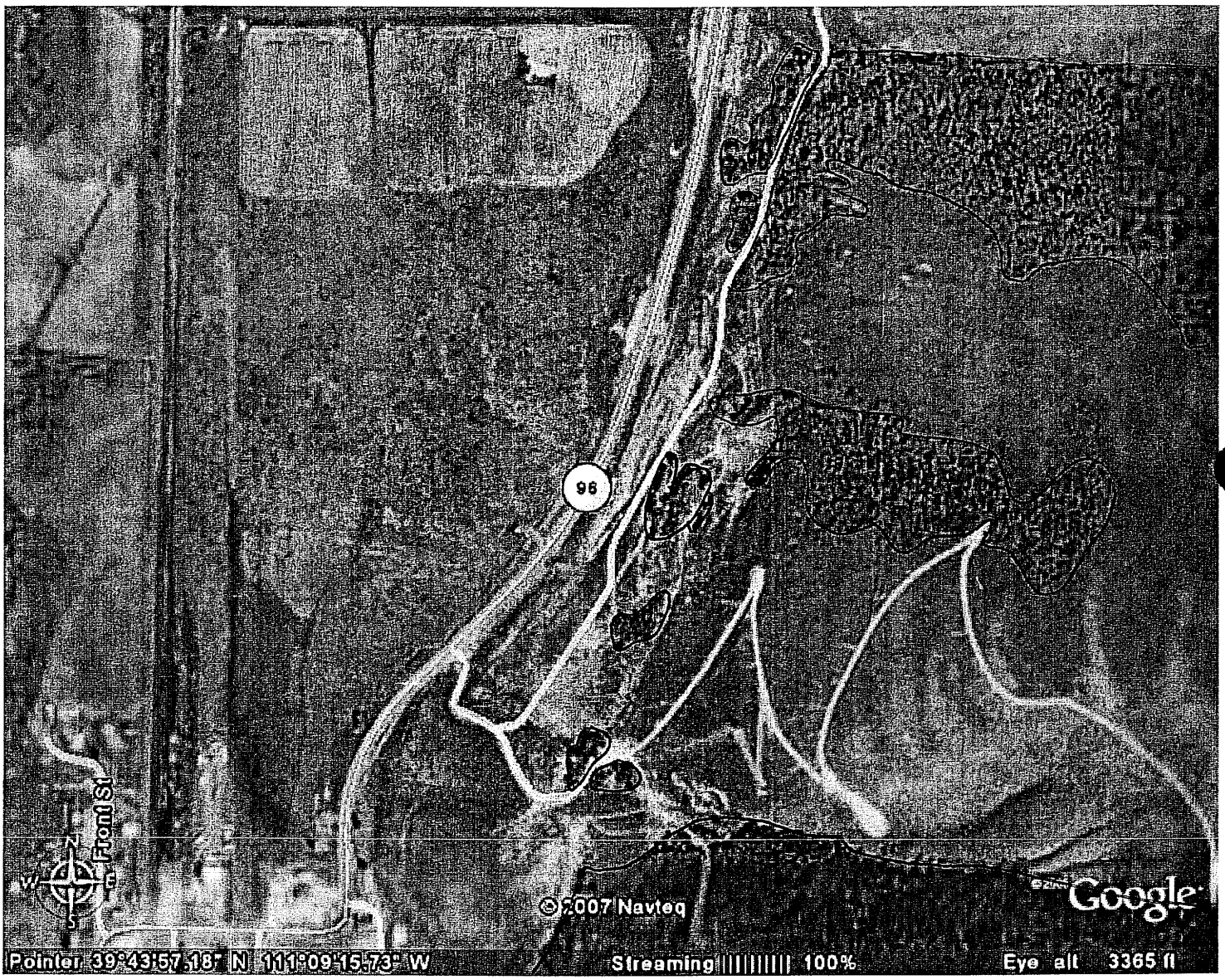


Figure 9.6.--Graph for estimating runoff curve numbers of forest-range complexes in western United States: juniper-grass and sage-grass complexes.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POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

Utah 39.730247 N 111.1550194 W 7998 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Wed May 30 2007

Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Help | Docs | U.S. Map

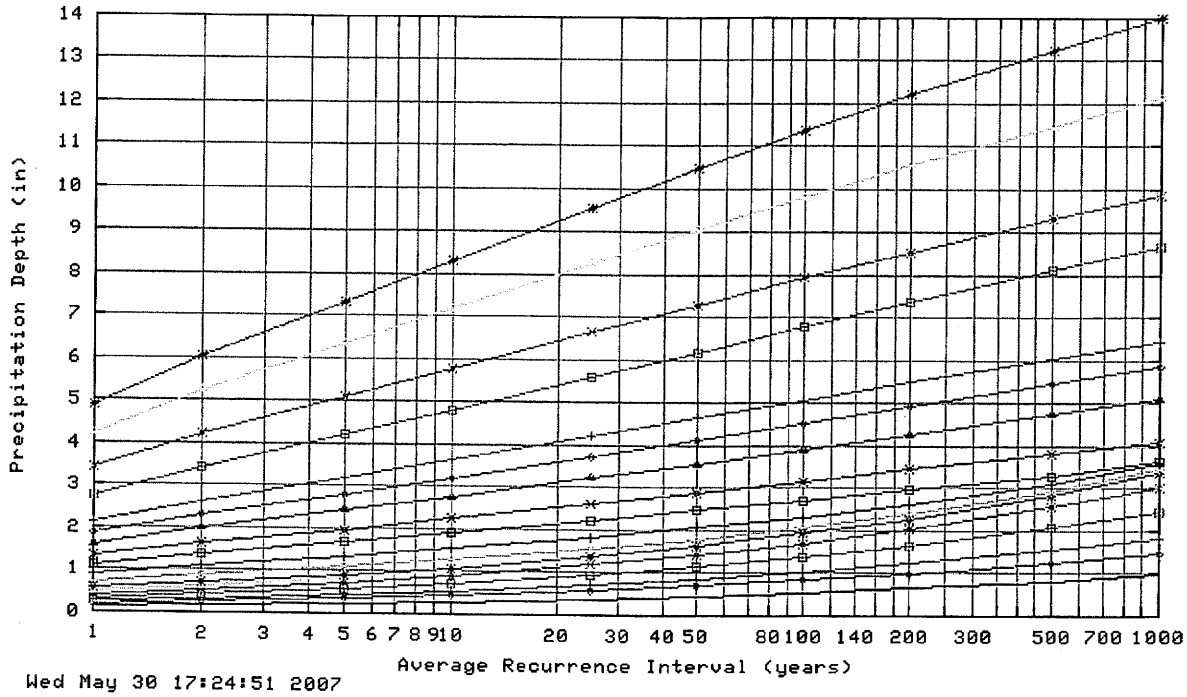
Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.13	0.20	0.24	0.33	0.41	0.50	0.56	0.71	0.90	1.12	1.31	1.62	1.88	2.13	2.77	3.40	4.22	4.89
2	0.17	0.25	0.32	0.42	0.53	0.63	0.70	0.89	1.11	1.39	1.62	2.00	2.32	2.64	3.44	4.21	5.23	6.06
5	0.23	0.35	0.44	0.59	0.73	0.84	0.90	1.10	1.35	1.69	1.97	2.42	2.82	3.20	4.21	5.10	6.34	7.35
10	0.29	0.44	0.54	0.73	0.90	1.03	1.08	1.28	1.56	1.92	2.25	2.77	3.21	3.64	4.81	5.78	7.18	8.32
25	0.38	0.57	0.71	0.95	1.18	1.33	1.38	1.54	1.84	2.24	2.61	3.22	3.74	4.22	5.60	6.66	8.27	9.57
50	0.45	0.69	0.86	1.15	1.43	1.59	1.63	1.78	2.07	2.48	2.89	3.58	4.14	4.65	6.19	7.30	9.05	10.48
100	0.54	0.83	1.03	1.38	1.71	1.90	1.94	2.08	2.31	2.73	3.17	3.93	4.55	5.08	6.78	7.94	9.82	11.36
200	0.65	0.99	1.22	1.65	2.04	2.26	2.29	2.40	2.61	2.97	3.45	4.28	4.95	5.51	7.36	8.55	10.56	12.20
500	0.81	1.24	1.53	2.07	2.56	2.82	2.85	2.95	3.13	3.29	3.81	4.75	5.47	6.05	8.12	9.32	11.47	13.25
1000	0.96	1.46	1.81	2.44	3.02	3.34	3.37	3.46	3.62	3.65	4.09	5.11	5.87	6.46	8.68	9.88	12.13	13.99

Text version of table

* These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval. Please refer to the documentation for more information. NOTE: Formatting forces estimates near zero to appear as zero.

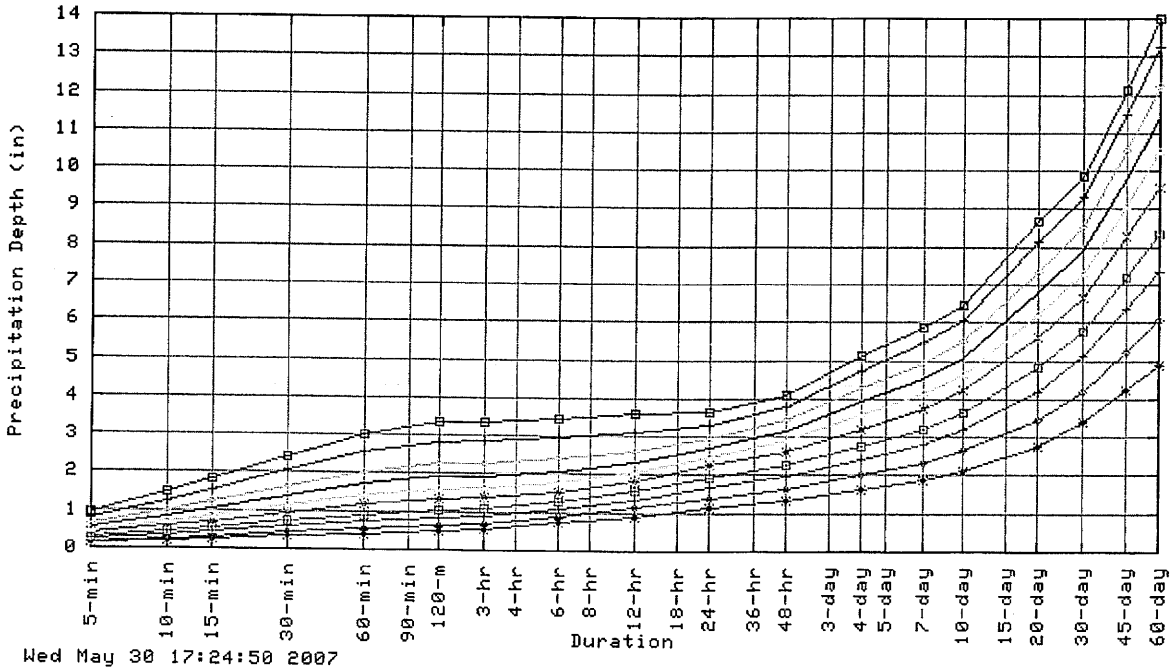
Partial duration based Point Precipitation Frequency Estimates Version: 4
39.730247 N 111.1550194 W 7998 ft



Wed May 30 17:24:51 2007

Duration			
5-min	120-m	48-hr	30-day
10-min	3-hr	4-day	45-day
15-min	6-hr	7-day	60-day
30-min	12-hr	10-day	
60-min	24-hr	20-day	

Partial duration based Point Precipitation Frequency Estimates Version: 4
39.730247 N 111.1550194 W 7998 ft



Wed May 30 17:24:50 2007

Average Recurrence Interval (years)	
1	50
2	100
5	200
10	500
25	1000

Confidence Limits -

*** Upper bound of the 90% confidence interval**
Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.16	0.24	0.29	0.40	0.49	0.60	0.66	0.82	1.01	1.27	1.48	1.86	2.18	2.46	3.31	4.02	5.03	5.74
2	0.20	0.31	0.38	0.51	0.63	0.75	0.82	1.01	1.24	1.57	1.83	2.30	2.69	3.05	4.11	4.99	6.25	7.13
5	0.28	0.42	0.52	0.71	0.87	1.00	1.07	1.26	1.51	1.91	2.22	2.79	3.26	3.71	5.05	6.07	7.60	8.65
10	0.35	0.53	0.65	0.88	1.09	1.23	1.28	1.47	1.74	2.18	2.53	3.18	3.72	4.22	5.79	6.88	8.61	9.79
25	0.45	0.69	0.86	1.15	1.43	1.59	1.63	1.78	2.07	2.54	2.95	3.70	4.34	4.90	6.76	7.94	9.92	11.29
50	0.55	0.84	1.04	1.40	1.73	1.92	1.94	2.07	2.34	2.82	3.26	4.12	4.82	5.41	7.50	8.71	10.89	12.41
100	0.66	1.01	1.25	1.68	2.08	2.31	2.32	2.43	2.62	3.10	3.59	4.53	5.30	5.93	8.23	9.48	11.84	13.48
200	0.79	1.21	1.50	2.02	2.50	2.76	2.77	2.83	3.00	3.38	3.92	4.94	5.79	6.45	8.97	10.26	12.78	14.52
500	1.01	1.54	1.91	2.57	3.18	3.50	3.52	3.54	3.65	3.77	4.37	5.52	6.46	7.13	9.97	11.24	13.96	15.87
1000	1.21	1.85	2.29	3.08	3.81	4.22	4.27	4.31	4.35	4.40	4.70	5.97	6.97	7.65	10.72	11.98	14.86	16.86

* The **upper** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **greater** than.
** These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

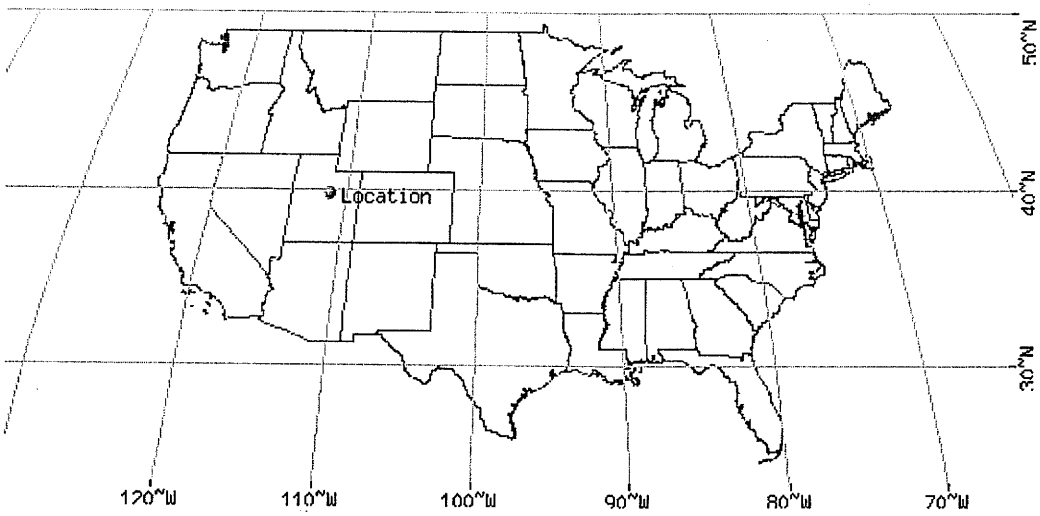
*** Lower bound of the 90% confidence interval**
Precipitation Frequency Estimates (inches)

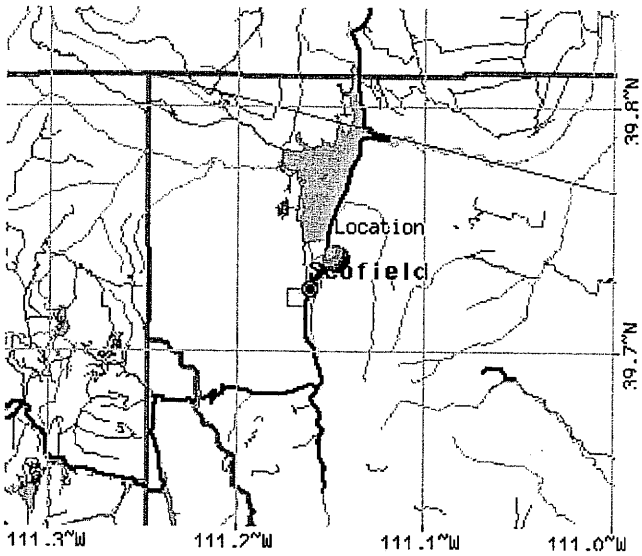
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.11	0.17	0.21	0.28	0.35	0.43	0.49	0.64	0.81	1.00	1.17	1.42	1.66	1.86	2.39	2.92	3.63	4.22
2	0.14	0.22	0.27	0.36	0.45	0.54	0.61	0.79	1.00	1.24	1.44	1.75	2.04	2.30	2.97	3.62	4.50	5.24
5	0.20	0.30	0.37	0.50	0.61	0.72	0.78	0.97	1.22	1.50	1.74	2.12	2.48	2.78	3.61	4.37	5.42	6.34
10	0.24	0.37	0.45	0.61	0.76	0.87	0.94	1.13	1.39	1.71	1.98	2.41	2.82	3.15	4.11	4.93	6.13	7.17
25	0.31	0.47	0.58	0.78	0.96	1.10	1.17	1.34	1.63	1.98	2.29	2.79	3.26	3.63	4.75	5.64	7.01	8.19
50	0.36	0.55	0.69	0.92	1.14	1.29	1.35	1.53	1.81	2.18	2.52	3.07	3.58	3.98	5.21	6.15	7.64	8.91
100	0.43	0.65	0.80	1.08	1.34	1.50	1.57	1.75	2.00	2.38	2.74	3.35	3.90	4.32	5.67	6.63	8.27	9.60
200	0.49	0.75	0.93	1.25	1.55	1.73	1.82	1.99	2.23	2.57	2.97	3.61	4.22	4.65	6.11	7.09	8.82	10.23
500	0.59	0.90	1.12	1.50	1.86	2.07	2.18	2.38	2.62	2.81	3.25	3.96	4.62	5.05	6.63	7.63	9.49	10.99
1000	0.67	1.02	1.27	1.71	2.12	2.36	2.49	2.72	2.97	2.99	3.45	4.20	4.90	5.34	7.02	8.03	9.97	11.53

* The **lower** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **less** than.

** These precipitation frequency estimates are based on a partial duration maxima series. **ARI** is the Average Recurrence Interval.
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

Maps -





These maps were produced using a direct map request from the U.S. Census Bureau Mapping and Cartographic Resources Tiger Map Server.

Please read disclaimer for more information.

LEGEND

State
County
Indian Resv
Lake/Pond/Ocean
Street
Expressway
Highway
Connector
Stream
Military Area
National Park
Other Park
City
County

Scale 1:228583
*average--true scale depends on monitor resolution

0 2 4 6 8 mi
0 2 4 6 8 10 km

Other Maps/Photographs -

View USGS digital orthophoto quadrangle (DOQ) covering this location from TerraServer; **USGS Aerial Photograph** may also be available
from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the USGS for more information.

Watershed/Stream Flow Information -

Find the Watershed for this location using the U.S. Environmental Protection Agency's site.

Climate Data Sources -

Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information
about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study,
please refer to our documentation.

Using the **National Climatic Data Center's (NCDC)** station search engine, locate other climate stations within:

+/-30 minutes ...OR... +/-1 degree of this location (39.730247/-111.1550194). Digital ASCII data can be obtained directly from **NCDC**.

Find Natural Resources Conservation Service (NRCS) SNOTEL (SNOwpack TELemetry) stations by visiting the **Western Regional Climate Center's state-specific SNOTEL station maps**.

Hydrometeorological Design Studies Center
DOC/NOAA/National Weather Service
1325 East-West Highway
Silver Spring, MD 20910
(301) 713-1669
Questions?: HDSC.Questions@noaa.gov

Disclaimer

SCS CURVE NUMBER
Kinney Mine Hydrology

SB_F1

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Roads	2288.29	0.05	0.00008	1.4	98	0.20	1.1	202.9	1.7	323.2	1.9	353.5
Pad	122526.6	2.81	0.00440	75.7	90	1.11	0.5	5267.5	1.0	10478.0	1.2	11869.8
Natural	21443.42	0.49	0.00077	13.2	75	3.33	0.1	170.3	0.3	612.0	0.4	752.0
Revegetated	15641.47	0.36	0.00056	9.7	82	2.20	0.2	303.6	0.6	777.7	0.7	915.0
TOTALS	161899.8	3.72	0.00581	100	87			5944.3		12190.9		13890.2
										0.28 ac-ft		0.32 ac-ft

SB_D1

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Roads	2165.29	0.05	0.00008	2.5	98	0.20	1.1	192.0	1.7	305.9	1.9	334.5
Pad	40914.9	0.94	0.00147	33.7	90	1.11	0.5	1758.9	1.0	3498.9	1.2	3963.6
Natural	67374.28	1.55	0.00242	55.5	75	3.33	0.1	535.2	0.3	1922.9	0.4	2362.7
Revegetated	10895.72	0.25	0.00039	9.0	82	2.20	0.2	211.5	0.6	541.7	0.7	637.4
TOTALS	121350.2	2.79	0.00435	101	81			2697.6		6269.3		7298.2
										0.14 ac-ft		0.17 ac-ft

SB_D2

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Roads	2442.07	0.06	0.00009	2.8	98	0.20	1.1	216.5	1.7	345.0	1.9	377.2
Pad	12679.13	0.29	0.00045	14.8	90	1.11	0.5	545.1	1.0	1084.3	1.2	1228.3
Natural	59411.24	1.36	0.00213	69.1	75	3.33	0.1	471.9	0.3	1695.6	0.4	2083.5
Revegetated	11426.79	0.26	0.00041	13.3	82	2.20	0.2	221.8	0.6	568.1	0.7	668.4
TOTALS	85959.23	1.97	0.00308	100	79			1455.3		3693.0		4357.4
										0.08 ac-ft		0.10 ac-ft

SB_F2

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Roads	10732.04	0.25	0.00038	19.4	98	0.20	1.1	951.5	1.7	1516.0	1.9	1657.8
Natural	0	0.00	0.00000	0.0	75	3.33	0.1	0.0	0.3	0.0	0.4	0.0
Revegetated	44561.29	1.02	0.00160	80.6	82	2.20	0.2	865.0	0.6	2215.6	0.7	2606.7
TOTALS	55293.33	1.27	0.00198	100	85			1816.6		3731.6		4264.5
										0.09 ac-ft		0.10 ac-ft

SB_E1

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Pad	143106.9	3.29	0.00513	74.1	90	1.11	0.5	6152.2	1.0	12237.9	1.2	13863.5
Natural	9446.91	0.22	0.00034	4.9	75	3.33	0.1	75.0	0.3	269.6	0.4	331.3
Revegetated	40693.85	0.93	0.00146	21.1	82	2.20	0.2	789.9	0.6	2023.3	0.7	2380.5
TOTALS	193247.7	4.44	0.00693	100	88			7017.2		14530.8		16575.3
										0.33 ac-ft		0.38 ac-ft

SB_D3

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Roads	11513.94	0.26	0.00041	19.7	98	0.20	1.1	1020.9	1.7	1626.4	1.9	1778.6
Natural	39630.22	0.91	0.00142	20.5	75	3.33	0.1	314.8	0.3	1131.0	0.4	1389.8
Revegetated	7211.62	0.17	0.00026	12.4	82	2.20	0.2	140.0	0.6	358.6	0.7	421.9
TOTALS	58355.78	1.34	0.00209	53	80			1475.6		3116.0		3590.2
										0.07 ac-ft		0.08 ac-ft

SB_A1

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Roads	19147.5	0.44	0.00069	32.8	98	0.20	1.1	1697.7	1.7	2704.7	1.9	2957.8
Natural	63174.77	1.45	0.00227	32.7	75	3.33	0.1	501.8	0.3	1803.0	0.4	2215.5
Pad	42016.47	0.96	0.00151	21.7	90	1.11	0.5	1806.3	1.0	3593.1	1.2	4070.4
Revegetated	54006.16	1.24	0.00194	30.3	82	2.20	0.2	1048.4	0.6	2685.2	0.7	3159.2
TOTALS	178344.9	4.09	0.00640	118	83			5054.1		10786.0		12402.8
										0.25 ac-ft		0.28 ac-ft

SB_B1

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Pad	91371.01	2.10	0.00328	47.3	90	1.11	0.5	3928.1	1.0	7813.7	1.2	8851.6
Natural	26384.94	0.61	0.00095	13.7	75	3.33	0.1	209.6	0.3	753.0	0.4	925.3
Revegetated	34907.15	0.80	0.00125	22.9	82	2.20	0.2	677.6	0.6	1735.6	0.7	2042.0
TOTALS	152663.1	3.50	0.00548	84	86			677.6		1735.6		2042.0
										0.04 ac-ft		0.05 ac-ft

SB_C1

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Roads	0	0.00	0.00000	0.0	98	0.20	1.1	0.0	1.7	0.0	1.9	0.0
Pad	91265.3	2.10	0.00327	136.8	90	1.11	0.5	3923.5	1.0	7804.6	1.2	8841.3
Natural	52325.33	1.20	0.00188	27.1	75	3.33	0.1	415.6	0.3	1493.4	0.4	1835.0
Revegetated	38502.3	0.88	0.00138	21.1	82	2.20	0.2	747.4	0.6	1914.3	0.7	2252.3
TOTALS	182092.9	4.18	0.00653	185	84			5086.5		11212.3		12928.6
										0.26 ac-ft		0.30 ac-ft

SB_E2

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Roads	13703.95	0.31	0.00049	7.5	98	0.20	1.1	1215.0	1.7	1935.8	1.9	2116.9
Pad	0	0.00	0.00000	0.0	90	1.11	0.5	0.0	1.0	0.0	1.2	0.0
Natural	26904.93	0.62	0.00097	13.9	75	3.33	0.1	213.7	0.3	767.9	0.4	943.5
Revegetated	32464.12	0.75	0.00116	17.8	82	2.20	0.2	630.2	0.6	1614.1	0.7	1899.1
TOTALS	73073	1.68	0.00262	39	82			2058.9		4317.8		4959.5
										0.10 ac-ft		0.11 ac-ft

SB_E4

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Natural	50993.98	1.17	0.00183	76.5	75	3.33	0.1	405.0	0.3	1455.4	0.4	1788.3
Revegetated	15708.03	0.36	0.00056	23.5	82	2.20	0.2	304.9	0.6	781.0	0.7	918.9
TOTALS	66702.01	1.53	0.00239	100	77			710.0		2236.4		2707.2
										0.05 ac-ft		0.06 ac-ft

SB_E3

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Revegetated	23139.08	0.53	0.00083	34.7	82	2.20	0.2	449.2	0.6	1150.5	0.7	1353.6
TOTALS	23139.08	0.53	0.00083	35	82			449.2		1150.5		1353.6
										0.03 ac-ft		0.03 ac-ft

SB_Pond1

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Detention Pond	19356.6	0.44	0.00069	20.6	100	0.00	1.3	2064.7	1.9	3097.1	2.1	3355.1
Revegetated	46571.36	1.07	0.00167	69.8	82	2.20	0.2	904.0	0.6	2315.5	0.7	2724.3
Natural	28145.53	0.65	0.00101	29.9	75	3.33	0.1	223.6	0.3	803.3	0.4	987.0
TOTALS	94073.49	2.16	0.00337	120	84			3192.3		6215.8		7066.5
										0.14 ac-ft		0.16 ac-ft

SB_AltA

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	10-YR 6-HR Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	10-yr 24-HR Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	100-YR 6-HR Vol (cf)
Revegetated	111806.6	2.57	0.00401	167.6	82	2.20	0.2	2170.4	0.6	5559.0	0.7	6540.3
TOTALS	111806.6	2.57	0.00401	168	82			2170.4		5559.0		6540.3
										0.13 ac-ft		0.15 ac-ft

SB_AltB

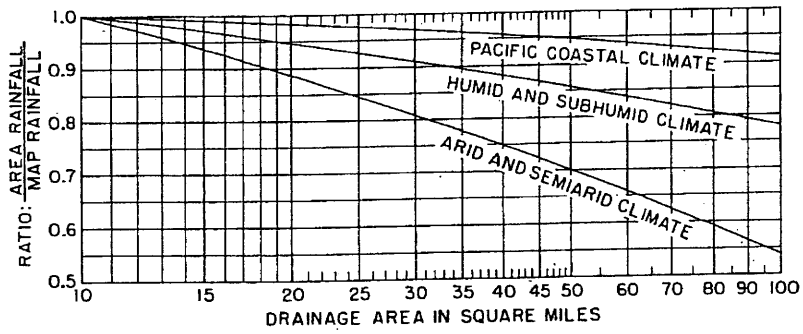
Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	10-YR 6-HR Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	10-yr 24-HR Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	100-YR 6-HR Vol (cf)
Roads	4030.63	0.09	0.00014	2.2	98	0.20	1.1	357.4	1.7	569.4	1.9	622.6
Revegetated	21513.94	0.49	0.00077	32.3	82	2.20	0.2	417.6	0.6	1069.7	0.7	1258.5
TOTALS	25544.57	0.59	0.00092	34	85			775.0		1639.0		1881.1
										0.04 ac-ft		0.04 ac-ft

SB_AltC

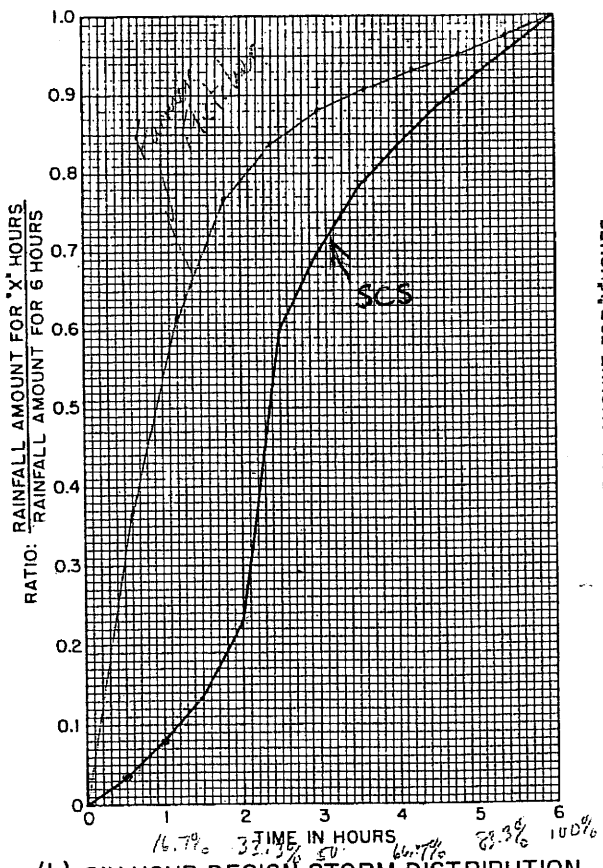
Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	10-YR 6-HR Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	10-yr 24-HR Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	100-YR 6-HR Vol (cf)
Roads	3773.2	0.09	0.00014	2.1	98	0.20	1.1	334.5	1.7	533.0	1.9	582.9
Revegetated	15615.05	0.36	0.00056	23.4	82	2.20	0.2	303.1	0.6	776.4	0.7	913.4
TOTALS	19388.25	0.45	0.00070	25	85			637.7		1309.4		1496.3
										0.03 ac-ft		0.03 ac-ft
Overall Totals	1602934	36.80	0.0575		84							

Total Approximate Storage Volumes = 2.06 ac-ft 2.37 ac-ft

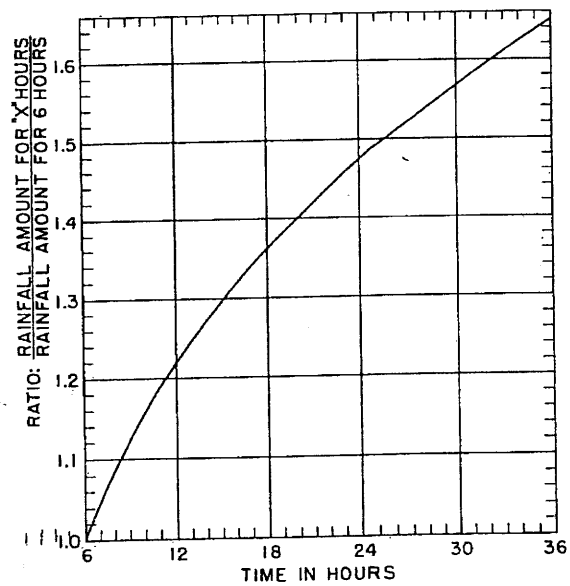
HYDROLOGY: CRITERIA FOR DESIGN STORMS USED IN DEVELOPING EMERGENCY SPILLWAY DESIGN AND FREEBOARD HYDROGRAPHS



(a) RAINFALL RATIOS FOR DRAINAGE AREAS OF 10 TO 100 SQUARE MILES



(b) SIX HOUR DESIGN STORM DISTRIBUTION



(c) RELATIVE INCREASE IN RAINFALL AMOUNT FOR STORM DURATIONS OVER SIX HOURS

FIGURE 21.2

REFERENCE	U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE ENGINEERING DIVISION - CENTRAL TECHNICAL UNIT	STANDARD DWG. NO. ES- 1003 SHEET 1 OF 1 DATE 7-2-56 REVISED 9-10-63

Ref: NEH-4

```
      PROGRAM HYDRO
C.    This is the new version of hydro. Updated Nov 17, 1987.
C..   This version allows time and flow to be saved on disk.
C...  It also has been modified for output page formating.
C....  This version has been modified to ease input for subsequent
C.....  runs by screen editing of input data.
$DEBUG
$LARGE
      DIMENSION GAMMA(2),DRAN(100),RANFF(11),RANSCS(13),RNSC24(49)
     1,DIMRAN(50),SDIMRN(1701),STMACC(1701),RAINEX(1701),Q(1701)
     1,QT(1701),DIMO(1701),QH(1701),GS(1701),UPL1(21),UPL2(21),UPL3(21)
     1,XX(220),YY(220),RANF2(21)
      CHARACTER ASED*1,ADIST*1,ATITLE*62,ADISTR*20,AGR*1,AFILE*3,AF*12,
     1AGAIN*3,ANEW*1,IOUT*1
      DATA RANFF/0.0,.365,.615,.769,.839,.88,.908,.932,.952,.977,1./
      DATA RANF2/0.0,.002,.009,.015,.026,.05,.10,.19,.30,.44,.586
     1,.73,.82,.87,.91,.935,.96,.97,.98,.99,1.00/
      DATA RANSCS/0.,.035,.08,.135,.23,.6,.7,.78,.835,.885,.925,.965
     1,1./
      DATA RNSC24/0.,.008,.011,.017,.022,.029,.034,.042,.048,.057
     1,.062,.072,.08,.09,.1,.111,.12,.132,.147,.163,.181,.204,.236
     1,.283,.663,.735,.772,.799,.82,.84,.854,.868,.88,.891,.901,.912
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     1530.,540.,550.,560.,570.,580.,590.,600.,610.,620.,630.,640.,650.,
     1660./
      DATA YY/0.,.06,.12,.18,.24,.3,.37,.47,.58,.72,.9,1.09,1.31,1.58,
     11.91,2.3,2.54,2.81,3.11,3.44,3.8,4.09,4.41,4.74,5.11,5.5,5.74,5.99
```

SCS 6 hr distributi
(30 min intervals)

72 min interval

HANSEN ALLEN & LUCE inc
ENGINEERS

CLIENT Carbon Resources
PROJECT Kinney Mine Hydrology
FEATURE Reclaimed Channel J (UDC-1)
PROJECT NO 308.01.400

SHEET 1 OF 7
COMPUTED TDS
CHECKED
DATE 7-6-07

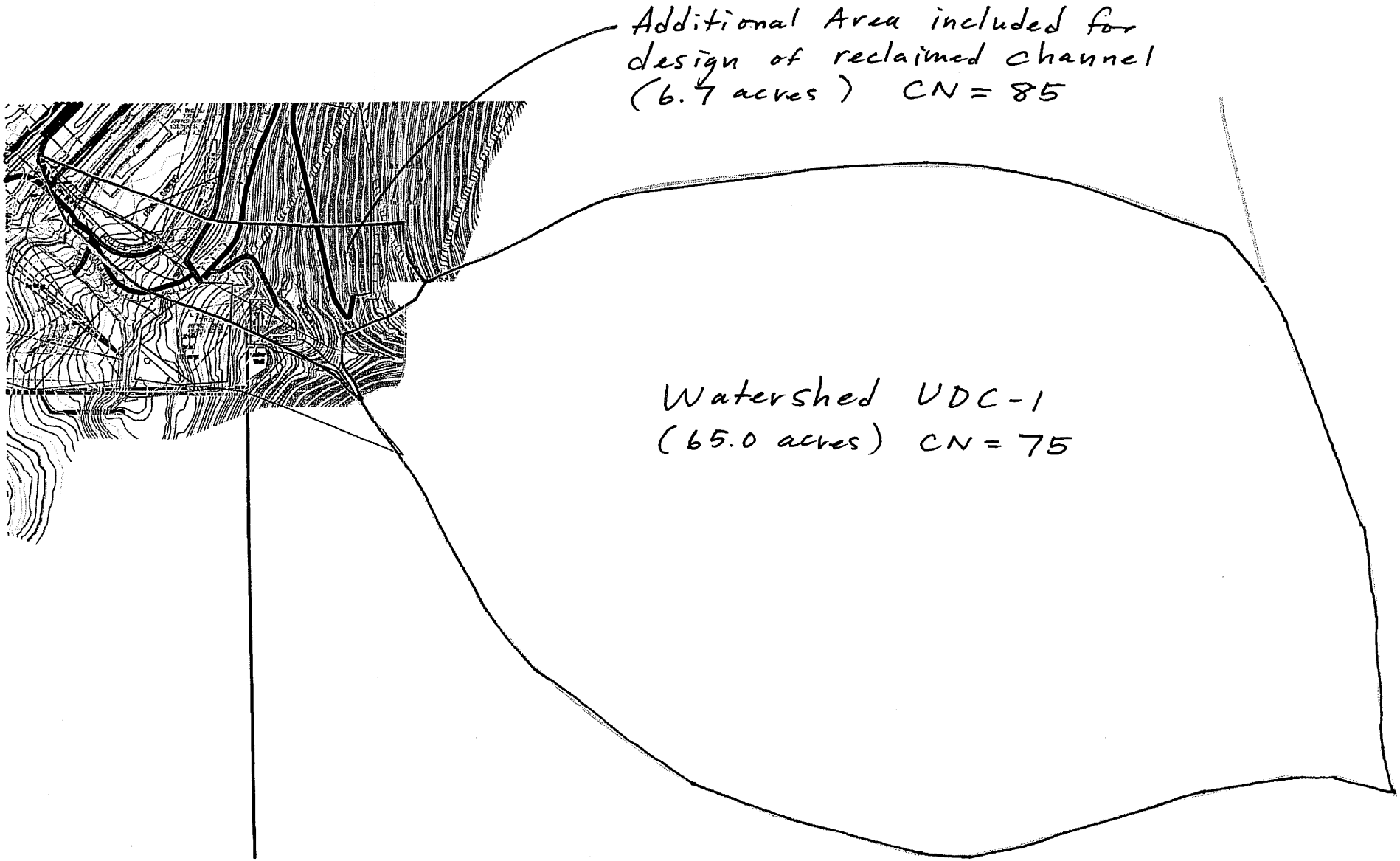
Reclaimed Channel designed for the 100yr 6hr event.

HEC-HMS analysis was performed to determine 100 yr 6hr discharge for design of the reclaimed channel.

Area weighted CN for area =

$$CN_{weighted} = \frac{(6.7\text{ acres})(85) + (65.0\text{ acres})(75)}{(6.7\text{ acres} + 65.0\text{ acres})}$$

$$= \underline{\underline{76}}$$


Additional Area included for design of reclaimed channel (6.7 acres) CN = 85
Watershed UDC-1 (65.0 acres) CN = 75

N

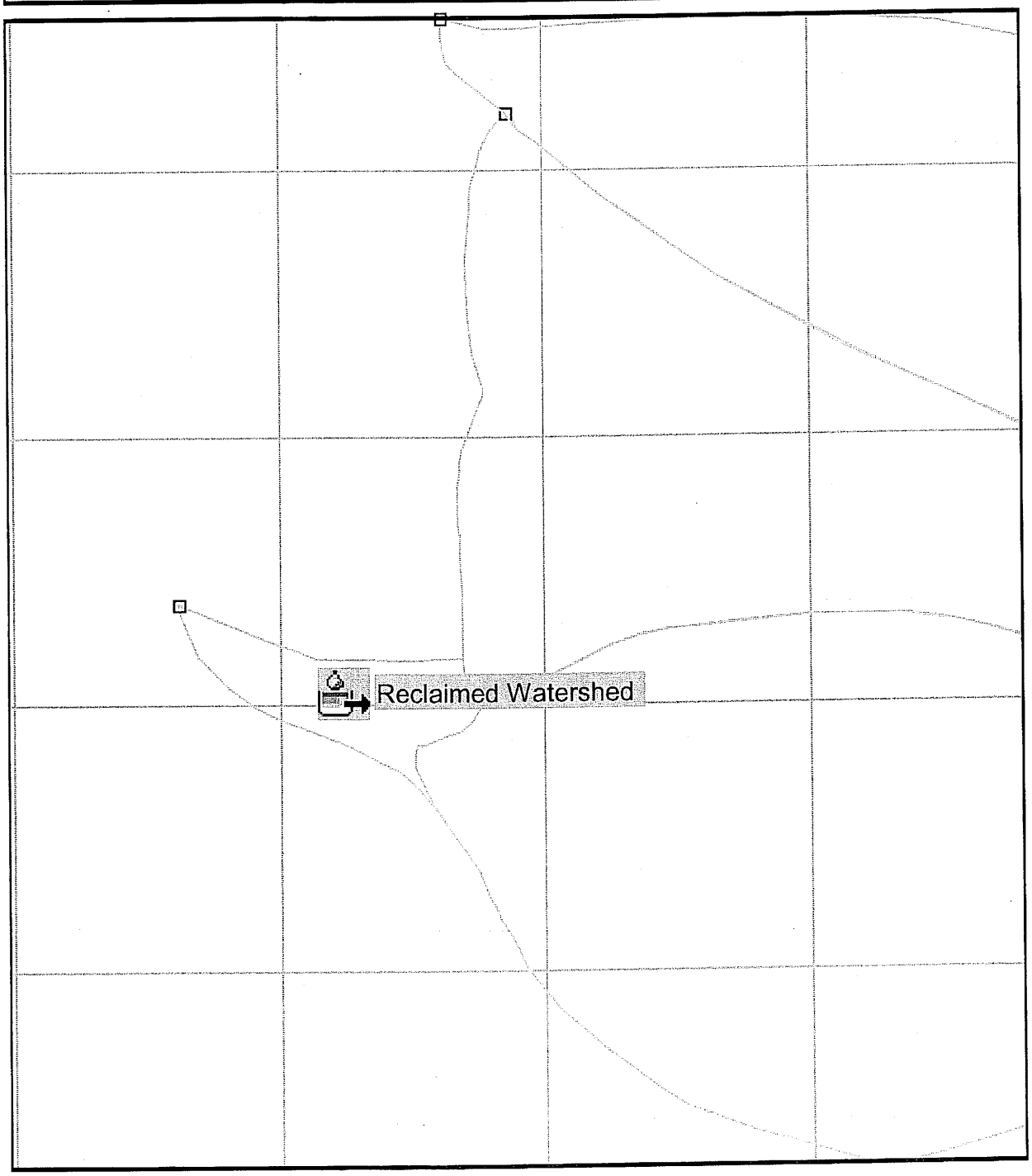
Scale: 1" = 500'

HEC-HMS

Project : Reclaimed Watershed-A

Basin Model : Kinney Mine

Aug 03 16:52:28 MDT 2007



Hydrologic Element	Drainage Area (mi2)	100yr 6hr Peak Discharge (cfs)	Time of Peak	Volume (in)
Reclaimed Watershed	0.112	11.5	01Jul2007, 04:14	0.45

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (UDC-1)	Chck'd	
Project #	308.01.400	Date	06-Jul-07

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	11.50	cfs
Bottom Width:	3.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	1.0	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.040	
Min. Bottom Slope:	0.13	ft/ft
Max. Bottom Slope:	0.13	ft/ft
Freeboard:	0.5	feet

Depth Check

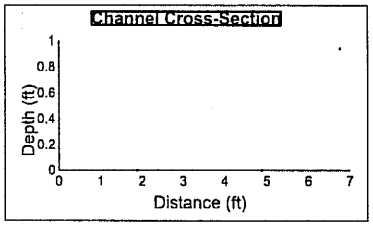
Depth (Min. Slope):	0.44	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.94	feet
Area:	1.72	ft2
Perimeter:	4.98	feet
Hydraulic Radius:	0.35	feet
Velocity:	6.69	ft/sec
Froude Number:	1.96	

Velocity Check

Depth (Max. Slope):	0.44	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.94	feet
Area:	1.72	ft2
Perimeter:	4.98	feet
Hydraulic Radius:	0.35	feet
Velocity:	6.69	ft/sec
Froude Number:	1.96	

Channel Design Summary:

Bottom Width:	3.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.13	ft/ft
Max. Bottom Slope:	0.13	ft/ft
Min. Channel Depth:	0.94	feet
Channel Top Width:	6.77	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (UDC-1)	Chck'd	
Project #	308.01.400	Date	06-Aug-07

DESIGN CRITERIA:

Design Flow:	11.50	cfs
Bottom Width:	3.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Friction Factor:	0.04	
Min. Bottom Slope:	13.0	%
Max. Bottom Slope:	13.0	%
Flow Depth (Min. S):	0.44	feet
Flow Depth (Max. S):	0.44	feet
Angle Repose (Ar):	42.0	degrees
Specific Gravity	2.65	

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	1.20
Reynolds # for Smin	85,860
U=(gRS)^0.5 for Smax	1.20
Reynolds # for Smax	85,860

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0,25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.064
K for S max (See K vs. R Chart)	0.064
F for S min	14.9
F for S max	14.9

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

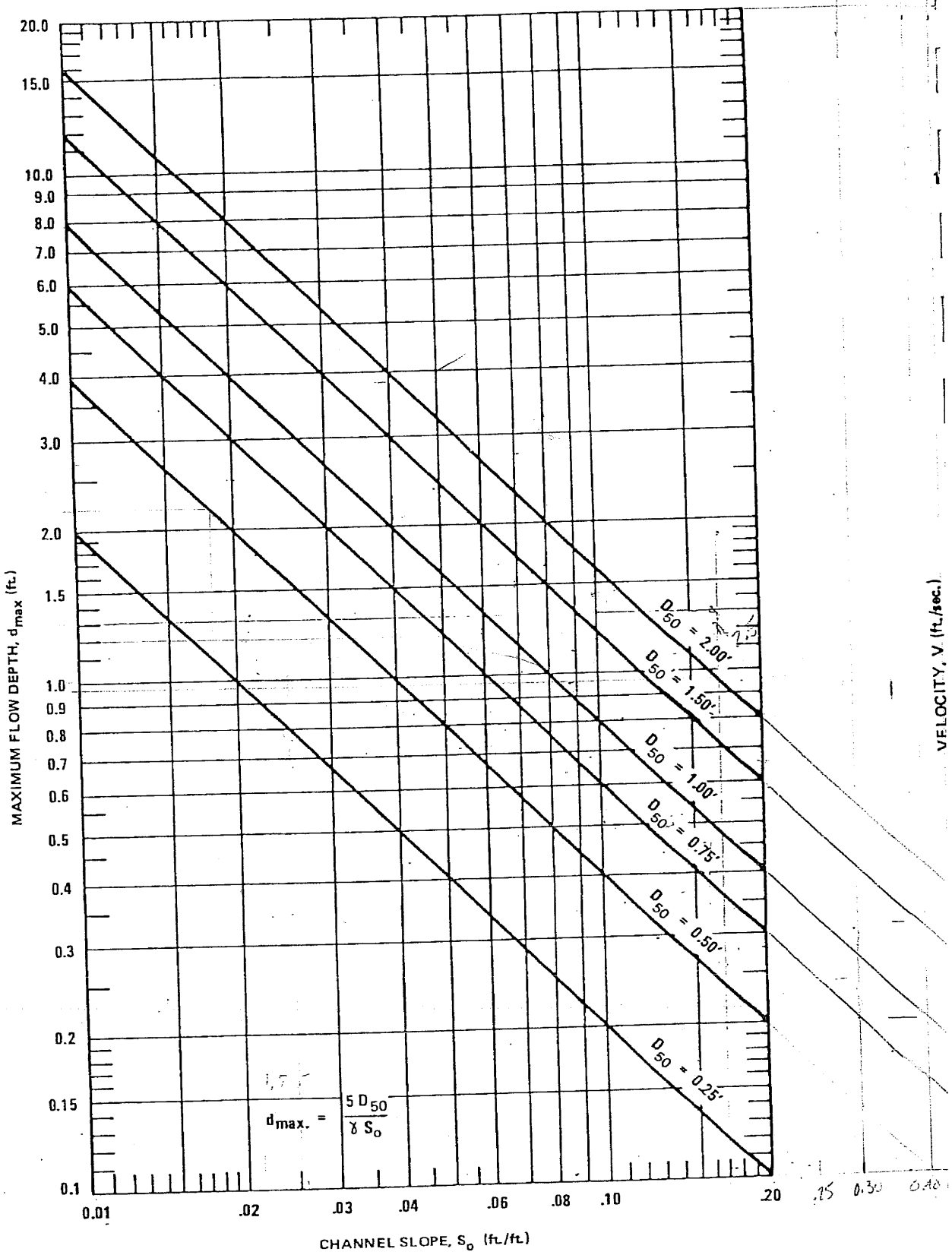
SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	1.00	1.00	feet
T	3.59	3.59	lb/ft2
Nb	0.52	0.52	
Tmax	2.73	2.73	lb/ft2
Ns	0.39	0.39	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	20.53	20.53	degrees
Nsp	0.29	0.29	
SFb	1.50	1.50	
SFs	1.18	1.18	

7/7

Chart 27



MAXIMUM PERMISSIBLE DEPTH OF FLOW (d_{max})
FOR CHANNELS LINED WITH ROCK RIPRAP

$n = .0395 D_{50}^{1/6}$

Ref: "Design of Stable Channels with Flexible Linings"

Ditches and Culverts

Ditches and Culverts

CULVERT/DITCH DESIGN FLOWS

	System Element	10yr 6hr Peak Discharge (cfs)	100yr 6hr Peak Discharge (cfs)	Model Element
Culverts	CB-1	0.9	2.9	CB-1
	CB-2	2.0	5.8	CB-2
	CC-1	2.9	8.7	J-10
	CD-1	0.3	1.6	CD-1
	CD-2	0.6	2.9	CD-2
	CE-1	2.4	7.8	CE-1
	CF-1	1.7	4.4	J-3
Ditches	DA-1	0.6	1.6	SB-A1
	DC-1	1.1	2.9	SB_C1
	DC-2	2.9	8.7	J-10
	DC-3	2.9	8.7	J-10
	DC-4	1.1	2.9	SB_C1
	DC-5	2.9	8.7	J-10
	DC-6	3.5	10.3	J-10 + SB_Pond1
	DD-1	0.2	0.7	SB_D3
	DD-2	0.2	0.9	SB_D2
	DD-3	0.3	1.6	CD-1
	DE-1	0.6	2.9	J-13
	DE-2	0.2	0.9	SB_E2
	DE-3	4.1	12.4	J-6
	DE-4	4.2	12.9	J-11
	DF-1	0.4	1.0	SB_F2
	DF-2	0.4	1.0	SB_F2
	DF-3	1.3	3.3	SB_F1
	DF-4	1.7	4.4	J-4
	DF-5	1.7	4.4	CF-2
	ALT C-1	0.2	0.5	SB_AltB
	ALT B-1	0.2	0.5	SB_AltB
	ALT A-1	0.4	1.5	SB_AltA
	ALT A-2	0.4	1.5	SB_AltA

HANSEN ALLEN & LUCE inc
ENGINEERS

CLIENT Carbon Resources
PROJECT Kinney Mine Hydrology
FEATURE Culvert Sizing
PROJECT NO 308.01.400

SHEET ____ OF ____
COMPUTED TDS
CHECKED ____
DATE 6-7-07

Determined the size of culverts based of Chart 5 in the "Hydraulic Charts for the Selection of Highway Culverts" assuming HW/D = 1.0 with a projecting entrance type. Design discharge for culverts were estimated from HEC-HMS results. A minimum size culvert was assumed to be 18 in.

Culvert	10 yr 24 hr Q (cfs)	Required Diameter Based on Chart 5 (in)	Actual Diameter (in)
CF-1	1.7	12	18
CE-1	2.4	15	18
CB-1	2.0	15	18
CB-2	2.0	15	18
CD-2	0.6	10	18
CD-1	0.4	10	18
CF-2	1.7	12	18
CC-1	2.9	15	18

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CLIENT Carbon Resources
PROJECT Kinney Mine Hydrology
FEATURE UDC-1 Culvert
PROJECT NO 308.01.400

SHEET ____ OF ____
COMPUTED GLO
CHECKED ____
DATE 12/20/07

UDC-1

Design Flow = 14.3 cfs

(Based on the 100 yr - 6 hr event)

Based on Chart 5 in the "Hydraulic Charts for the selection of Highway Culverts," assuming $H_w/D = 1.0$ with a projecting entrance type, D = 27.5 in, so use

D = 30 in

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PROJECT Kinney Mine Hydrology
FEATURE Culvert Design
PROJECT NO

SHEET ___ OF ___
COMPUTED GWJ
CHECKED
DATE 12/21/07

Culvert #1 (UDC-2)

Design Flow (Q_1) = 9.4 cfs
(Comes from UDD1 for 100yr 6hr event)

Based on Chart 5 in the "Hydraulic Charts for the Selection of Highway Culverts" assuming $H_w/D = 1.0$ with a projecting entrance type, $D_1 = 23$ in

So use $D_1 = 24$ in

Culvert #2 (CP-1)

$D_2 = 24$ in (Design based on overflow discharge from detention basin - see detention basin calculations)

Culvert #3 (CP-2)

Design Flow (Q_3) = 33.8 cfs

(Combination of flows from culvert #1 & #2, a subbasin 6-1 of 22.5 cfs, 9.4 cfs and 1.9 cfs respectively)

Based on Chart 5 in the "Hydraulic Charts for the Selection of Highway Culverts," assuming $H_w/D = 1.0$ with a projecting entrance type, $D_3 = 42''$

There is an existing 36" diameter pipe at this location

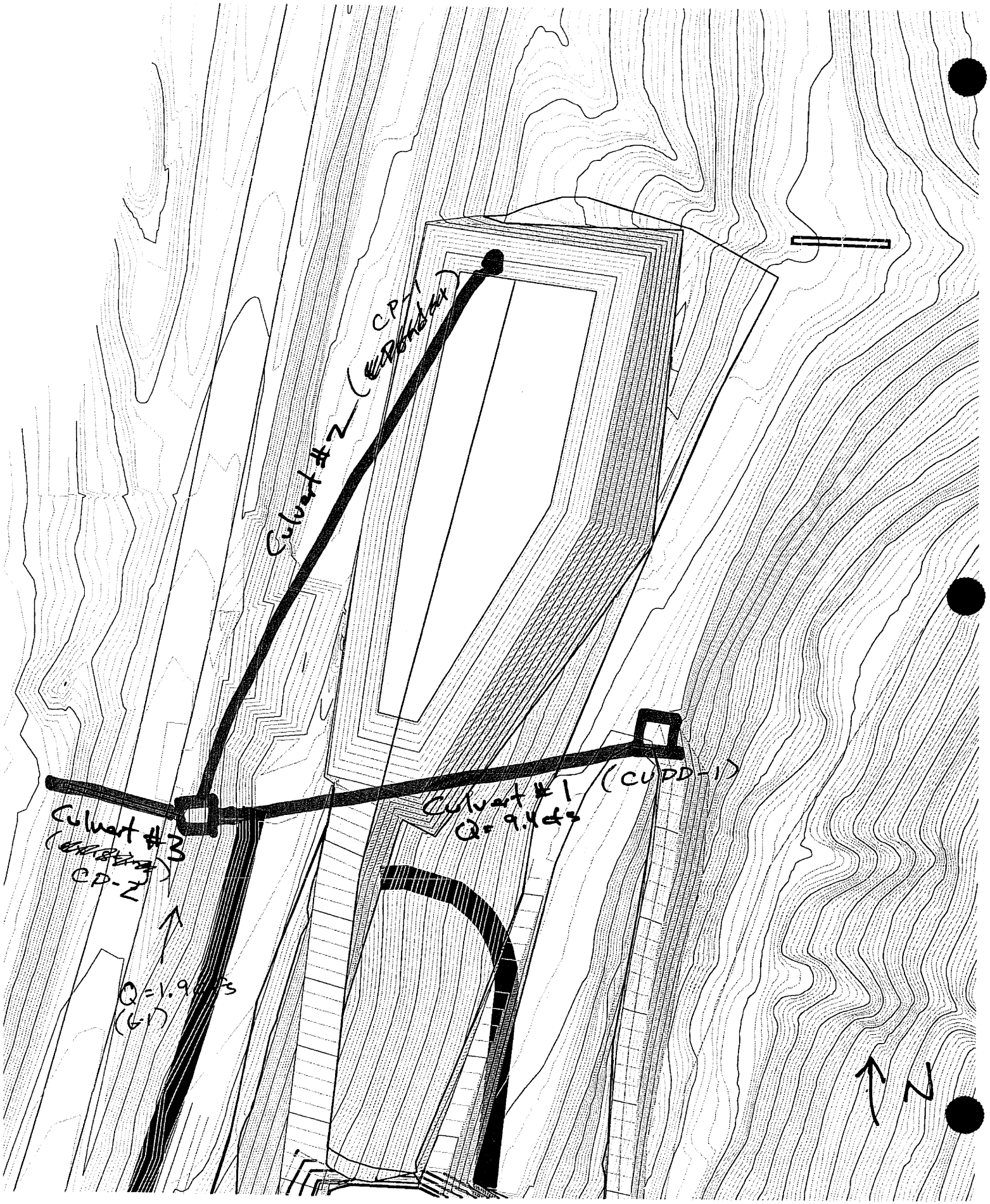
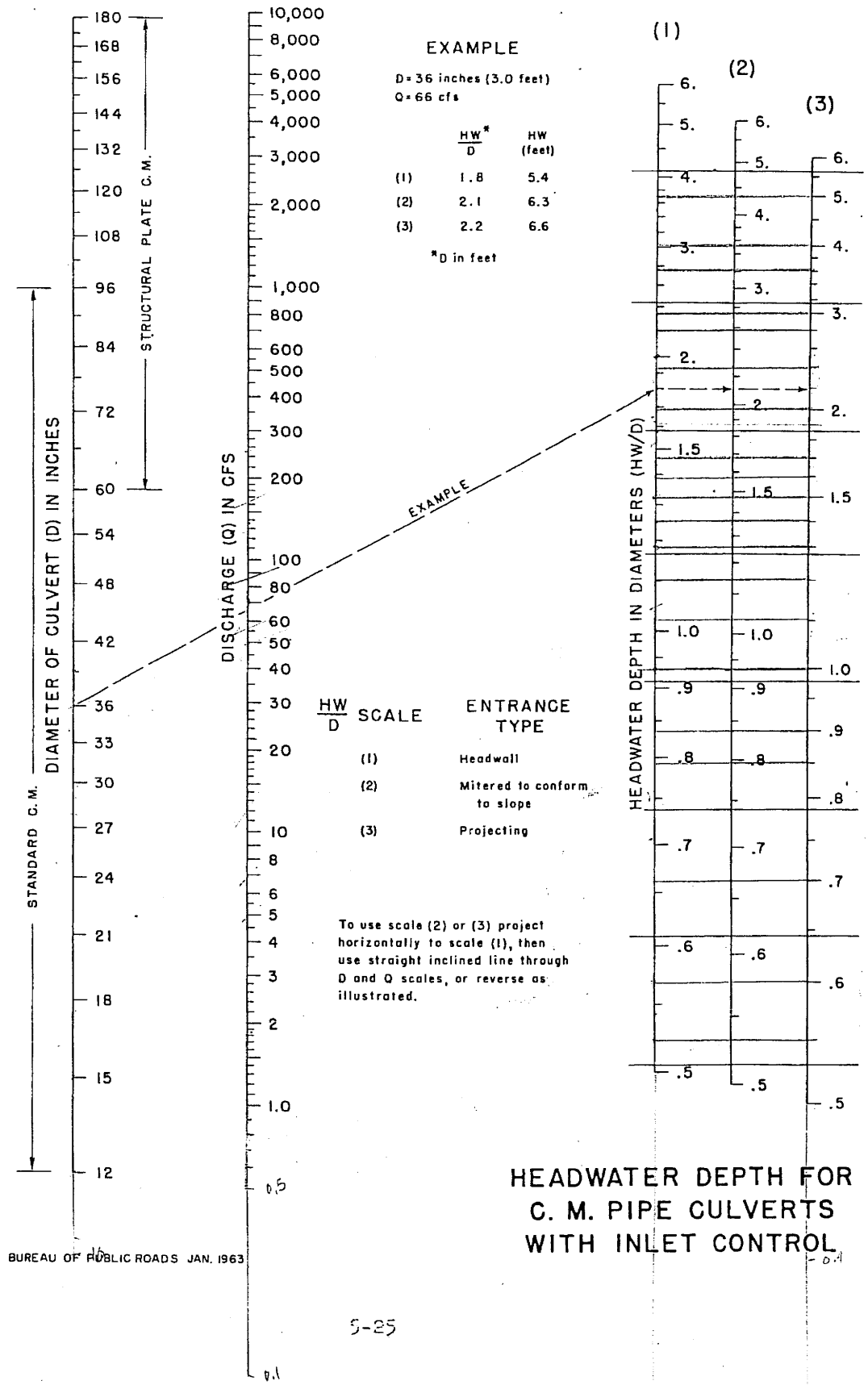

Culvert #2 (CP-1)
Culvert #1 (CUDD-1)
Q= 9.4 cfs
Culvert #3
CP-2
Q=1.9 cfs
(G-1)
N

CHART 5



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

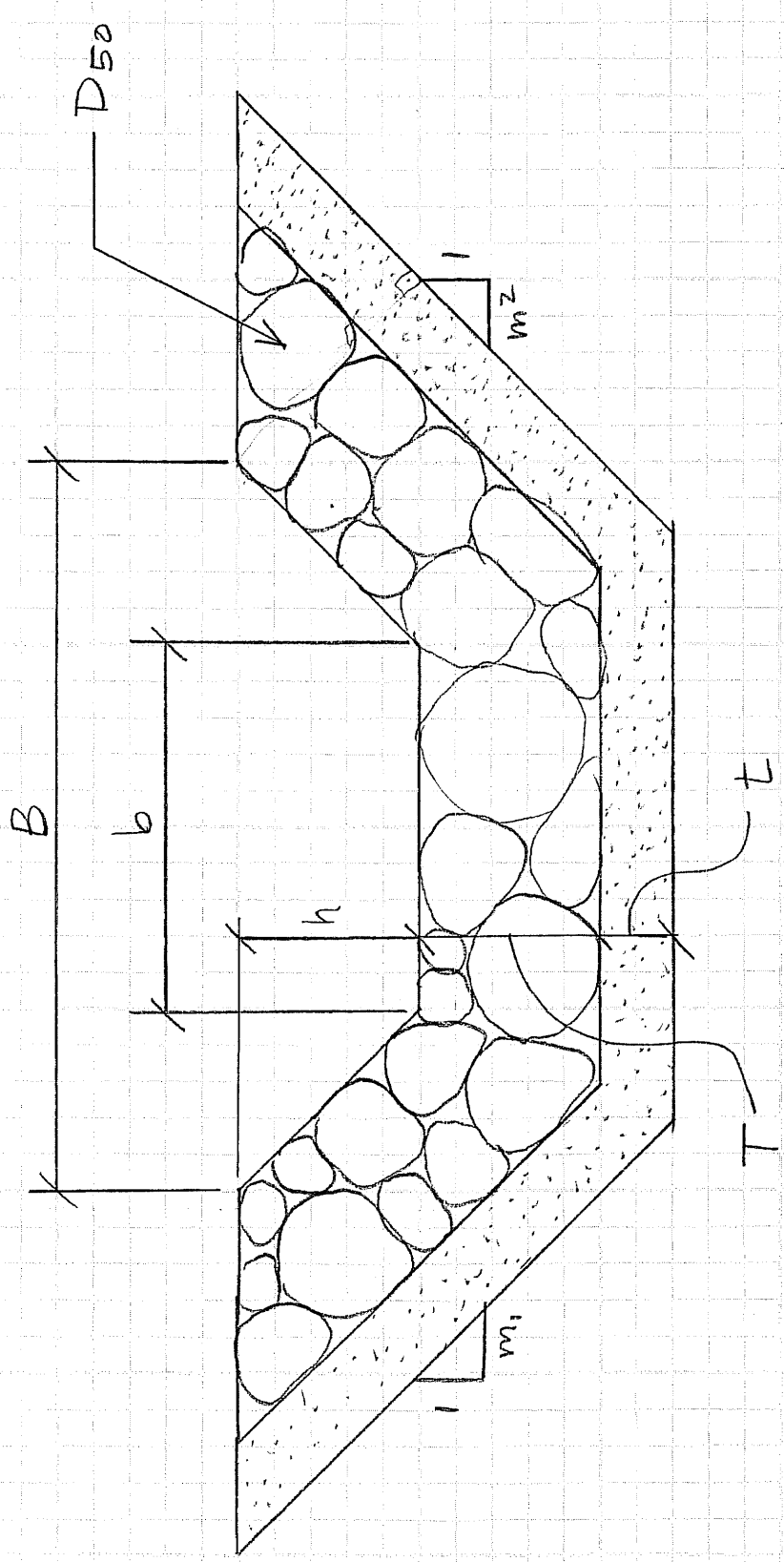
BUREAU OF PUBLIC ROADS JAN. 1963

Ref: Hydraulic Charts for the Selection of Highway Culverts

HANSEN ALLEN & LUCE inc
ENGINEERS

CLIENT Carbon Resources
PROJECT Kinney Mine Hydrology
FEATURE Typical Ditch Cross Section
PROJECT NO 308.01.403

SHEET ____ OF ____
COMPUTED TDS
CHECKED ____
DATE 7-3-07



HANSEN ALLEN & LUCE inc
ENGINEERS

CLIENT Carbon Resources
PROJECT Kinney Mine Hydrology
FEATURE Ditch Design
PROJECT NO 308.01.400

SHEET ____ OF ____
COMPUTED TDS
CHECKED ____
DATE 1-2-07

Ditch Design Procedure:

1. Determined velocities in ditch based on minimum and maximum slopes.

2. Ditches with velocities less than 4 ft/s will not require any rip-rap.

3. Ditches with velocities greater than or equal to 4 ft/s will require rip-rap.

   a. Estimated D50 size in order to achieve a minimum safety factor of 1.5.

   b. If D50 size was an unreasonable size for the associated ditch, the D50 size was determined to be 0.25 ft (diameter) and the ditch will need to be grouted. (This was the case for all ditches with velocities greater than 4 ft/s)

* Sizing details for each ditch are shown in "Ditch Design Details" spreadsheet.

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DA-1))	Chck'd	
Project #	308.01.400	Date	26-Dec-07

Trapezoidal Channel Flow Calculations

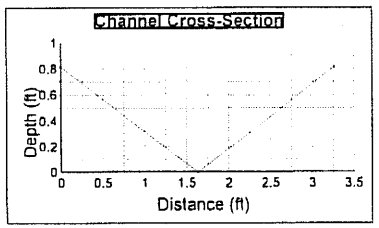
GENERAL CRITERIA:

	Design Flow:	0.90	cfs
	Bottom Width:	0.0	feet
	Side Slope1:	2.0	m1
	Side Slope2:	2.0	m2
	Friction Factor:		
	Assumed D50:	1.50	
Anderson et al. (1970)	If X=1, n=0.0395(D50)^1/6		
Abt, et al. (1987, 1988)	If X=2, n=0.0456(D50*S)^0.0159		
	If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}		
	Generally Applicable for R/D50 > 0.5		
Jarrett (1984)	If X=4, n=0.39*(S^0.38)*(R^0.16)		
	If X=5, n=input n value		
	X:	1	
	Input n Value when X=5:		
	Calc (used) n Value:	0.020	
	Min. Bottom Slope:	0.05	ft/ft
	Max. Bottom Slope:	0.14	ft/ft
	Freeboard:	0.5	feet

Depth Check	Depth (Min. Slope):	0.32	feet
	Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
	Required Depth:	0.82	feet
	Area:	0.20	ft2
	Perimeter:	1.41	feet
	Hydraulic Radius:	0.14	feet
	Velocity:	4.52	ft/sec
	Froude Number:	2.00	
Velocity Check	Depth (Max. Slope):	0.26	feet
	Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
	Required Depth:	0.76	feet
	Area:	0.14	ft2
	Perimeter:	1.16	feet
	Hydraulic Radius:	0.12	feet
	Velocity:	6.64	ft/sec
	Froude Number:	3.25	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.05	ft/ft
Max. Bottom Slope:	0.14	ft/ft
Min. Channel Depth:	0.82	feet
Channel Top Width:	3.26	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DA-1))	Chck'd	
Project #	308.01.400	Date	03-Jan-08

DESIGN CRITERIA:

Design Flow:	0.90		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	5.0	%	
Max. Bottom Slope:	14.0	%	
Flow Depth (Min. S):	0.32		feet
Flow Depth (Max. S):	0.26		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.48
Reynolds # for Smin	51,075
U=(gRS)^0.5 for Smax	0.72
Reynolds # for Smax	77,606

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0,25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.065
K for S max (See K vs. R Chart)	0.068
F for S min	15.8
F for S max	15.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax = Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	1.50	1.50	feet
T	0.98	2.27	lb/ft2
Nb	0.10	0.22	
Tmax	0.75	1.73	lb/ft2
Ns	0.08	0.17	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	4.39	9.35	degrees
Nsp	0.04	0.11	
SFb	6.39	2.62	
SFs	1.66	1.49	

HANSEN ALLEN & LUCE inc
ENGINEERS

Client: Carbon Resources
Project: Kinney Mine Hydrology
Feature: Ditch Design (DC-1)
Project #: 308.01.400

Sheet:
Comp.: TDS
Chck'd:
Date: 02-Jan-08

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	1.00	cfs
Bottom Width:	1.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	0.20	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt, et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.005	ft/ft
Max. Bottom Slope:	0.005	ft/ft
Freeboard:	0.5	feet

Depth Check

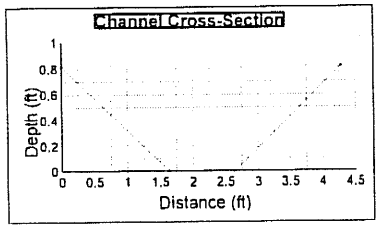
Depth (Min. Slope):	0.32	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.82	feet
Area:	0.53	ft2
Perimeter:	2.43	feet
Hydraulic Radius:	0.22	feet
Velocity:	1.90	ft/sec
Froude Number:	0.70	

Velocity Check

Depth (Max. Slope):	0.32	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.82	feet
Area:	0.53	ft2
Perimeter:	2.43	feet
Hydraulic Radius:	0.22	feet
Velocity:	1.90	ft/sec
Froude Number:	0.70	

Channel Design Summary:

Bottom Width:	1.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.005	ft/ft
Max. Bottom Slope:	0.005	ft/ft
Min. Channel Depth:	0.82	feet
Channel Top Width:	4.28	feet



HANSEN ALLEN & LUCE inc
ENGINEERS

Client: Carbon Resources
Project: Kinney Mine Hydrology
Feature: Ditch Design (DC-1)
Project #: 308.01.400

Sheet: of
Comp.: TDS
Chck'd:
Date: 03-Jan-08

DESIGN CRITERIA:

Design Flow:	1.00		cfs
Bottom Width:	1.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	0.5	%	
Max. Bottom Slope:	0.5	%	
Flow Depth (Min. S):	0.32		feet
Flow Depth (Max. S):	0.32		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.19
Reynolds # for Smin	2.666
U=(gRS)^0.5 for Smax	0.19
Reynolds # for Smax	2.666

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0.25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	0.20	0.20	feet
T	0.10	0.10	lb/ft2
Nb	0.08	0.08	
Tmax	0.08	0.08	lb/ft2
Ns	0.06	0.06	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	3.43	3.43	degrees
Nsp	0.03	0.03	
SFb	11.91	11.91	
SFs	1.70	1.70	

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DC-2)	Chck'd	
Project #	308.01.400	Date	02-Jan-08

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

	Design Flow:	2.90	cfs
	Bottom Width:	1.0	feet
	Side Slope1:	2.0	m1
	Side Slope2:	2.0	m2
	Friction Factor:		
	Assumed D50:	1.50	
Anderson et al. (1970)	If X=1, n=0.0395(D50)^1/6		
Abt. et al. (1987, 1988)	If X=2, n=0.0456(D50*S)^0.0159		
	If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}		
	Generally Applicable for R/D50 > 0.5		
Jarrett (1984)	If X=4, n=0.39*(S^0.38)*(R^0.16)		
	If X=5, n=input n value		
	X:	1	
	Input n Value when X=5:		
	Calc (used) n Value:	0.020	
	Min. Bottom Slope:	0.006	ft/ft
	Max. Bottom Slope:	0.150	ft/ft
	Freeboard:	0.5	feet

Depth Check

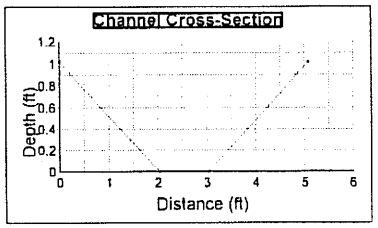
Depth (Min. Slope):	0.52	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	1.02	feet
Area:	1.06	ft2
Perimeter:	3.32	feet
Hydraulic Radius:	0.32	feet
Velocity:	2.75	ft/sec
Froude Number:	0.83	

Velocity Check

Depth (Max. Slope):	0.23	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.73	feet
Area:	0.33	ft2
Perimeter:	2.02	feet
Hydraulic Radius:	0.17	feet
Velocity:	8.68	ft/sec
Froude Number:	3.66	

Channel Design Summary:

Bottom Width:	1.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.00625	ft/ft
Max. Bottom Slope:	0.15	ft/ft
Min. Channel Depth:	1.02	feet
Channel Top Width:	5.07	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DC-2)	Chck'd	
Project #	308.01.400	Date	03-Jan-08

DESIGN CRITERIA:

Design Flow:	2.90		cfs
Bottom Width:	1.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	0.6	%	
Max. Bottom Slope:	15.0	%	
Flow Depth (Min. S):	0.52		feet
Flow Depth (Max. S):	0.23		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.25
Reynolds # for Smin	27,116
U=(gRS)^0.5 for Smax	0.89
Reynolds # for Smax	95,652

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0.25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.070
F for S min	16.1
F for S max	14.6

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax = Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan(Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	1.50	1.50	feet
T	0.20	2.14	lb/ft2
Nb	0.02	0.20	
Tmax	0.15	1.63	lb/ft2
Ns	0.02	0.15	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	0.93	8.55	degrees
Nsp	0.01	0.10	
SFb	35.63	2.68	
SFs	1.77	1.51	

HANSEN ALLEN & LUCE inc ENGINEERS

Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DC-3)	Chck'd	
Project #	308.01.400	Date	02-Jan-08

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	2.90	cfs
Bottom Width:	1.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	0.20	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.008	ft/ft
Max. Bottom Slope:	0.008	ft/ft
Freeboard:	0.5	feet

Depth Check

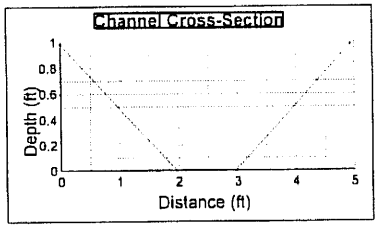
Depth (Min. Slope):	0.48	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.98	feet
Area:	0.95	ft2
Perimeter:	3.16	feet
Hydraulic Radius:	0.30	feet
Velocity:	3.05	ft/sec
Froude Number:	0.94	

Velocity Check

Depth (Max. Slope):	0.48	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.98	feet
Area:	0.95	ft2
Perimeter:	3.16	feet
Hydraulic Radius:	0.30	feet
Velocity:	3.05	ft/sec
Froude Number:	0.94	

Channel Design Summary:

Bottom Width:	1.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.0083	ft/ft
Max. Bottom Slope:	0.0083	ft/ft
Min. Channel Depth:	0.98	feet
Channel Top Width:	4.93	feet



HANSEN ALLEN & LUCE inc ENGINEERS

Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DC-3)	Chck'd	
Project #	308.01.400	Date	03-Jan-08

DESIGN CRITERIA:

Design Flow:	2.90		cfs
Bottom Width:	1.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	0.8	%	
Max. Bottom Slope:	0.8	%	
Flow Depth (Min. S):	0.48		feet
Flow Depth (Max. S):	0.48		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.28
Reynolds # for Smin	4,051
U=(gRS)^0.5 for Smax	0.28
Reynolds # for Smax	4,051

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0.25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax = Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	0.20	0.20	feet
T	0.25	0.25	lb/ft2
Nb	0.20	0.20	
Tmax	0.19	0.19	lb/ft2
Ns	0.15	0.15	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	8.53	8.53	degrees
Nsp	0.09	0.09	
SFb	4.87	4.87	
SFs	1.55	1.55	

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DC-4)	Chck'd	
Project #	308.01.400	Date	02-Jan-08

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	1.00	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	1.25	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.093	ft/ft
Max. Bottom Slope:	0.093	ft/ft
Freeboard:	0.5	feet

Depth Check

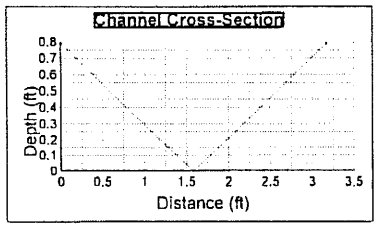
Depth (Min. Slope):	0.29	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.79	feet
Area:	0.17	ft2
Perimeter:	1.31	feet
Hydraulic Radius:	0.13	feet
Velocity:	5.86	ft/sec
Froude Number:	2.70	

Velocity Check

Depth (Max. Slope):	0.29	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.79	feet
Area:	0.17	ft2
Perimeter:	1.31	feet
Hydraulic Radius:	0.13	feet
Velocity:	5.86	ft/sec
Froude Number:	2.70	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.0932	ft/ft
Max. Bottom Slope:	0.0932	ft/ft
Min. Channel Depth:	0.79	feet
Channel Top Width:	3.17	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DC-4)	Chck'd	
Project #	308.01.400	Date	03-Jan-08

DESIGN CRITERIA:

Design Flow:	1.00		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	9.3	%	
Max. Bottom Slope:	9.3	%	
Flow Depth (Min. S):	0.29		feet
Flow Depth (Max. S):	0.29		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.63
Reynolds # for Smin	55,912
U=(gRS)^0.5 for Smax	0.63
Reynolds # for Smax	55,912

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0.25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	15.7
F for S max	15.7

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks:	0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	1.25	1.25	feet
T	1.70	1.70	lb/ft2
Nb	0.21	0.21	
Tmax	1.29	1.29	lb/ft2
Ns	0.16	0.16	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	8.83	8.83	degrees
Nsp	0.10	0.10	
SFb	3.21	3.21	
SFs	1.52	1.52	

HANSEN ALLEN & LUCE inc ENGINEERS

Client: Carbon Resources
Project: Kinney Mine Hydrology
Feature: Ditch Design (DC-5)
Project #: 308.01.400

Sheet:
Comp.: TDS
Chck'd:
Date: 02-Jan-08

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	2.90	cfs
Bottom Width:	1.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	0.20	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.008	ft/ft
Max. Bottom Slope:	0.008	ft/ft
Freeboard:	0.5	feet

Depth Check

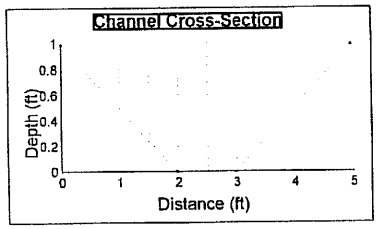
Depth (Min. Slope):	0.49	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.99	feet
Area:	0.96	ft2
Perimeter:	3.18	feet
Hydraulic Radius:	0.30	feet
Velocity:	3.01	ft/sec
Froude Number:	0.93	

Velocity Check

Depth (Max. Slope):	0.49	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.99	feet
Area:	0.96	ft2
Perimeter:	3.18	feet
Hydraulic Radius:	0.30	feet
Velocity:	3.01	ft/sec
Froude Number:	0.93	

Channel Design Summary:

Bottom Width:	1.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.008	ft/ft
Max. Bottom Slope:	0.008	ft/ft
Min. Channel Depth:	0.99	feet
Channel Top Width:	4.95	feet



HANSEN ALLEN & LUCE inc ENGINEERS

Client: Carbon Resources
Project: Kinney Mine Hydrology
Feature: Ditch Design (DC-5)
Project #: 308.01.400

Sheet: of
Comp.: TDS
Chck'd:
Date: 08-Jan-08

DESIGN CRITERIA:

Design Flow:	2.90		cfs
Bottom Width:	1.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	0.8	%	
Max. Bottom Slope:	0.8	%	
Flow Depth (Min. S):	0.49		feet
Flow Depth (Max. S):	0.49		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.28
Reynolds # for Smin	3,992
U=(gRS)^0.5 for Smax	0.28
Reynolds # for Smax	3,992

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0,25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	0.20	0.20	feet
T	0.24	0.24	lb/ft2
Nb	0.19	0.19	
Tmax	0.19	0.19	lb/ft2
Ns	0.15	0.15	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	8.30	8.30	degrees
Nsp	0.08	0.08	
SFb	5.01	5.01	
SFs	1.56	1.56	

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DC-6)	Chck'd	
Project #	308.01.400	Date	02-Jan-08

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	3.50	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	2.25	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.123	ft/ft
Max. Bottom Slope:	0.123	ft/ft
Freeboard:	0.5	feet

Depth Check

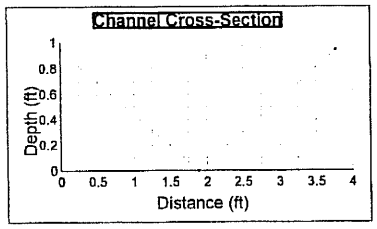
Depth (Min. Slope):	0.44	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.94	feet
Area:	0.39	ft2
Perimeter:	1.99	feet
Hydraulic Radius:	0.20	feet
Velocity:	8.88	ft/sec
Froude Number:	3.32	

Velocity Check

Depth (Max. Slope):	0.44	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.94	feet
Area:	0.39	ft2
Perimeter:	1.99	feet
Hydraulic Radius:	0.20	feet
Velocity:	8.88	ft/sec
Froude Number:	3.32	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.1225	ft/ft
Max. Bottom Slope:	0.1225	ft/ft
Min. Channel Depth:	0.94	feet
Channel Top Width:	3.78	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DC-6)	Chck'd	
Project #	308.01.400	Date	08-Jan-08

DESIGN CRITERIA:

Design Flow:	3.50		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	12.3	%	
Max. Bottom Slope:	12.3	%	
Flow Depth (Min. S):	0.44		feet
Flow Depth (Max. S):	0.44		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.89
Reynolds # for Smin	142,240
U=(gRS)^0.5 for Smax	0.89
Reynolds # for Smax	142,240

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0,25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	13.4
F for S max	13.4

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	2.25	2.25	feet
T	3.39	3.39	lb/ft2
Nb	0.20	0.20	
Tmax	2.58	2.58	lb/ft2
Ns	0.15	0.15	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	8.34	8.34	degrees
Nsp	0.09	0.09	
SFb	2.99	2.99	
SFs	1.53	1.53	

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DD-1)	Chck'd	
Project #	308.01.400	Date	26-Dec-07

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	0.20	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	0.50	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.038	ft/ft
Max. Bottom Slope:	0.038	ft/ft
Freeboard:	0.5	feet

Depth Check

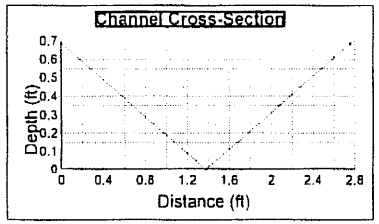
Depth (Min. Slope):	0.19	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.69	feet
Area:	0.07	ft2
Perimeter:	0.85	feet
Hydraulic Radius:	0.08	feet
Velocity:	2.80	ft/sec
Froude Number:	1.60	

Velocity Check

Depth (Max. Slope):	0.19	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.69	feet
Area:	0.07	ft2
Perimeter:	0.85	feet
Hydraulic Radius:	0.08	feet
Velocity:	2.80	ft/sec
Froude Number:	1.60	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.038	ft/ft
Max. Bottom Slope:	0.038	ft/ft
Min. Channel Depth:	0.69	feet
Channel Top Width:	2.76	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DD-1)	Chck'd	
Project #	308.01.400	Date	03-Jan-08

DESIGN CRITERIA:

Design Flow:	0.20		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	3.8	%	
Max. Bottom Slope:	3.8	%	
Flow Depth (Min. S):	0.19		feet
Flow Depth (Max. S):	0.19		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.32
Reynolds # for Smin	11,487
U=(gRS)^0.5 for Smax	0.32
Reynolds # for Smax	11,487

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0.25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	0.50	0.50	feet
T	0.45	0.45	lb/ft2
Nb	0.14	0.14	
Tmax	0.34	0.34	lb/ft2
Ns	0.11	0.11	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	6.10	6.10	degrees
Nsp	0.06	0.06	
SFb	5.47	5.47	
SFs	1.61	1.61	

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DD-2)	Chck'd	
Project #	308.01.400	Date	26-Dec-07

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	0.20	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	1.00	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.130	ft/ft
Max. Bottom Slope:	0.130	ft/ft
Freeboard:	0.5	feet

Depth Check

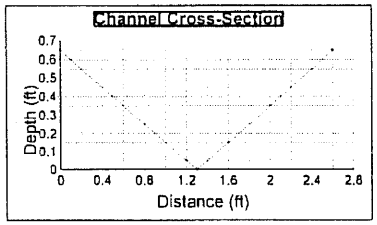
Depth (Min. Slope):	0.15	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.65	feet
Area:	0.05	ft2
Perimeter:	0.67	feet
Hydraulic Radius:	0.07	feet
Velocity:	4.44	ft/sec
Froude Number:	2.85	

Velocity Check

Depth (Max. Slope):	0.15	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.65	feet
Area:	0.05	ft2
Perimeter:	0.67	feet
Hydraulic Radius:	0.07	feet
Velocity:	4.44	ft/sec
Froude Number:	2.85	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.13	ft/ft
Max. Bottom Slope:	0.13	ft/ft
Min. Channel Depth:	0.65	feet
Channel Top Width:	2.60	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DD-2)	Chck'd	
Project #	308.01.400	Date	03-Jan-08

DESIGN CRITERIA:

Design Flow:	0.20		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	13.0	%	
Max. Bottom Slope:	13.0	%	
Flow Depth (Min. S):	0.15		feet
Flow Depth (Max. S):	0.15		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.53
Reynolds # for Smin	37,866
U=(gRS)^0.5 for Smax	0.53
Reynolds # for Smax	37,866

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0,25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.063	
K for S max (See K vs. R Chart)	0.063	
F for S min	16.1	
F for S max	16.1	

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax = Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	1.00	1.00	feet
T	1.22	1.22	lb/ft2
Nb	0.19	0.19	
Tmax	0.93	0.93	lb/ft2
Ns	0.14	0.14	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	8.08	8.08	degrees
Nsp	0.09	0.09	
SFb	2.96	2.96	
SFs	1.53	1.53	

HANSEN ALLEN & LUCE inc ENGINEERS	Client *Carbon Resources*	Sheet	
	Project *Kinney Mine Hydrology*	Comp.	*TDS*
	Feature *Ditch Design (DD-3)*	Chck'd	
	Project # *308.01.400*	Date	*26-Dec-07*

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

	Design Flow:	0.30	cfs
	Bottom Width:	0.0	feet
	Side Slope1:	2.0	m1
	Side Slope2:	2.0	m2
	Friction Factor:		
	Assumed D50:	0.50	
Anderson et al. (1970)	If X=1, n=0.0395(D50)^1/6		
Abt. et al. (1987, 1988)	If X=2, n=0.0456(D50*S)^0.0159		
	If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}		
	Generally Applicable for R/D50 > 0.5		
Jarrett (1984)	If X=4, n=0.39*(S^0.38)*(R^0.16)		
	If X=5, n=input n value		
	X:	1	
	Input n Value when X=5:		
	Calc (used) n Value:	0.020	
	Min. Bottom Slope:	0.038	ft/ft
	Max. Bottom Slope:	0.038	ft/ft
	Freeboard:	0.5	feet

Depth Check

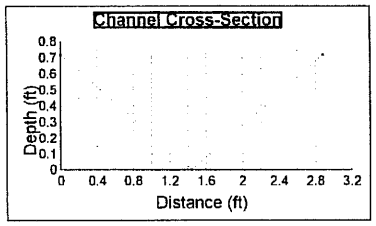
Depth (Min. Slope):	0.22	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.72	feet
Area:	0.10	ft2
Perimeter:	0.98	feet
Hydraulic Radius:	0.10	feet
Velocity:	3.10	ft/sec
Froude Number:	1.64	

Velocity Check

Depth (Max. Slope):	0.22	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.72	feet
Area:	0.10	ft2
Perimeter:	0.98	feet
Hydraulic Radius:	0.10	feet
Velocity:	3.10	ft/sec
Froude Number:	1.64	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.038	ft/ft
Max. Bottom Slope:	0.038	ft/ft
Min. Channel Depth:	0.72	feet
Channel Top Width:	2.88	feet



HANSEN ALLEN & LUCE inc ENGINEERS	Client *Carbon Resources*	Sheet	*of*
	Project *Kinney Mine Hydrology*	Comp.	*TDS*
	Feature *Ditch Design (DD-3)*	Chck'd	
	Project # *308.01.400*	Date	*08-Jan-08*

DESIGN CRITERIA:

Design Flow:	0.30		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	3.8	%	
Max. Bottom Slope:	3.8	%	
Flow Depth (Min. S):	0.22		feet
Flow Depth (Max. S):	0.22		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.35
Reynolds # for Smin	12,395
U=(gRS)^0.5 for Smax	0.35
Reynolds # for Smax	12,395

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0,25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	0.50	0.50	feet
T	0.52	0.52	lb/ft2
Nb	0.16	0.16	
Tmax	0.40	0.40	lb/ft2
Ns	0.12	0.12	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	7.09	7.09	degrees
Nsp	0.07	0.07	
SFb	4.86	4.86	
SFs	1.58	1.58	

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DE-1)	Chck'd	
Project #	308.01.400	Date	26-Dec-07

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	0.60	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	0.20	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.009	ft/ft
Max. Bottom Slope:	0.009	ft/ft
Freeboard:	0.5	feet

Depth Check

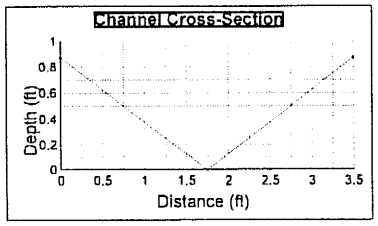
Depth (Min. Slope):	0.37	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.87	feet
Area:	0.28	ft2
Perimeter:	1.67	feet
Hydraulic Radius:	0.17	feet
Velocity:	2.15	ft/sec
Froude Number:	0.87	

Velocity Check

Depth (Max. Slope):	0.37	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.87	feet
Area:	0.28	ft2
Perimeter:	1.67	feet
Hydraulic Radius:	0.17	feet
Velocity:	2.15	ft/sec
Froude Number:	0.87	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.009	ft/ft
Max. Bottom Slope:	0.009	ft/ft
Min. Channel Depth:	0.87	feet
Channel Top Width:	3.50	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DE-1)	Chck'd	
Project #	308.01.400	Date	03-Jan-08

DESIGN CRITERIA:

Design Flow:	0.60		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	0.9	%	
Max. Bottom Slope:	0.9	%	
Flow Depth (Min. S):	0.37		feet
Flow Depth (Max. S):	0.37		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.22
Reynolds # for Smin	3.145
U=(gRS)^0.5 for Smax	0.22
Reynolds # for Smax	3.145

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0.25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan(Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	0.20	0.20	feet
T	0.21	0.21	lb/ft2
Nb	0.16	0.16	
Tmax	0.16	0.16	lb/ft2
Ns	0.13	0.13	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	7.16	7.16	degrees
Nsp	0.07	0.07	
SFb	5.73	5.73	
SFs	1.59	1.59	

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DE-2)	Chck'd	
Project #	308.01.400	Date	02-Jan-08

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

	Design Flow:	0.20	cfs
	Bottom Width:	0.0	feet
	Side Slope1:	2.0	m1
	Side Slope2:	2.0	m2
	Friction Factor:		
	Assumed D50:	0.25	
Anderson et al. (1970)	If X=1, n=0.0395(D50)^1/6		
Abt. et al. (1987, 1988)	If X=2, n=0.0456(D50*S)^0.0159		
	If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}		
	Generally Applicable for R/D50 > 0.5		
Jarrett (1984)	If X=4, n=0.39*(S^0.38)*(R^0.16)		
	If X=5, n=input n value		
	X:	1	
	Input n Value when X=5:		
	Calc (used) n Value:	0.020	
	Min. Bottom Slope:	0.020	ft/ft
	Max. Bottom Slope:	0.020	ft/ft
	Freeboard:	0.5	feet

Depth Check

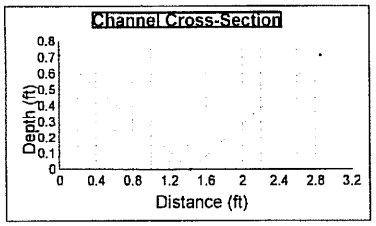
Depth (Min. Slope):	0.21	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.71	feet
Area:	0.09	ft2
Perimeter:	0.96	feet
Hydraulic Radius:	0.10	feet
Velocity:	2.18	ft/sec
Froude Number:	1.18	

Velocity Check

Depth (Max. Slope):	0.21	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.71	feet
Area:	0.09	ft2
Perimeter:	0.96	feet
Hydraulic Radius:	0.10	feet
Velocity:	2.18	ft/sec
Froude Number:	1.18	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.01961	ft/ft
Max. Bottom Slope:	0.01961	ft/ft
Min. Channel Depth:	0.71	feet
Channel Top Width:	2.86	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DE-2)	Chck'd	
Project #	308.01.400	Date	08-Jan-08

DESIGN CRITERIA:

Design Flow:	0.20		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	2.0	%	
Max. Bottom Slope:	2.0	%	
Flow Depth (Min. S):	0.21		feet
Flow Depth (Max. S):	0.21		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.25
Reynolds # for Smin	4,390
U=(gRS)^0.5 for Smax	0.25
Reynolds # for Smax	4,390

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0,25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	0.25	0.25	feet
T	0.26	0.26	lb/ft2
Nb	0.16	0.16	
Tmax	0.20	0.20	lb/ft2
Ns	0.12	0.12	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	7.14	7.14	degrees
Nsp	0.07	0.07	
SFb	5.38	5.38	
SFs	1.59	1.59	

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	West Side Ditch Design (DE-3)	Chck'd	
Project #	308.01.400	Date	20-Dec-07

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	4.10	cfs
Bottom Width:	2.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	0.25	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	5	
Input n Value when X=5:		
Calc (used) n Value:	0.030	
Min. Bottom Slope:	0.01	ft/ft
Max. Bottom Slope:	0.01	ft/ft
Freeboard:	0.5	feet

Depth Check

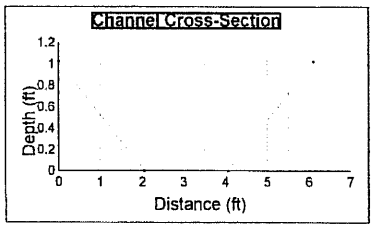
Depth (Min. Slope):	0.53	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	1.03	feet
Area:	1.61	ft2
Perimeter:	4.35	feet
Hydraulic Radius:	0.37	feet
Velocity:	2.55	ft/sec
Froude Number:	0.72	

Velocity Check

Depth (Max. Slope):	0.53	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	1.03	feet
Area:	1.61	ft2
Perimeter:	4.35	feet
Hydraulic Radius:	0.37	feet
Velocity:	2.55	ft/sec
Froude Number:	0.72	

Channel Design Summary:

Bottom Width:	2.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.01	ft/ft
Max. Bottom Slope:	0.01	ft/ft
Min. Channel Depth:	1.03	feet
Channel Top Width:	6.10	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	West Side Ditch Design (DE-3)	Chck'd	
Project #	308.01.400	Date	08-Jan-08

DESIGN CRITERIA:

Design Flow:	4.10		cfs
Bottom Width:	2.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.03		
Min. Bottom Slope:	1.0	%	
Max. Bottom Slope:	1.0	%	
Flow Depth (Min. S):	0.53		feet
Flow Depth (Max. S):	0.53		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.34
Reynolds # for Smin	6,154
U=(gRS)^0.5 for Smax	0.34
Reynolds # for Smax	6,154

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0,25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	0.2	Smax	
D50	0.25	0.25	feet
T	0.33	0.33	lb/ft2
Nb	0.21	0.21	
Tmax	0.25	0.25	lb/ft2
Ns	0.16	0.16	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	8.93	8.93	degrees
Nsp	0.09	0.09	
SFb	4.61	4.61	
SFs	1.54	1.54	

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	West Side Ditch Design (DE-4)	Chck'd	
Project #	308.01.400	Date	20-Dec-07

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	4.20	cfs
Bottom Width:	2.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	0.25	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	5	
Input n Value when X=5:		
Calc (used) n Value:	0.030	
Min. Bottom Slope:	0.01	ft/ft
Max. Bottom Slope:	0.01	ft/ft
Freeboard:	0.5	feet

Depth Check

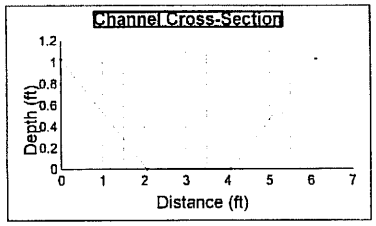
Depth (Min. Slope):	0.53	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	1.03	feet
Area:	1.63	ft2
Perimeter:	4.38	feet
Hydraulic Radius:	0.37	feet
Velocity:	2.57	ft/sec
Froude Number:	0.72	

Velocity Check

Depth (Max. Slope):	0.53	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	1.03	feet
Area:	1.63	ft2
Perimeter:	4.38	feet
Hydraulic Radius:	0.37	feet
Velocity:	2.57	ft/sec
Froude Number:	0.72	

Channel Design Summary:

Bottom Width:	2.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.01	ft/ft
Max. Bottom Slope:	0.01	ft/ft
Min. Channel Depth:	1.03	feet
Channel Top Width:	6.13	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	West Side Ditch Design (DE-4)	Chck'd	
Project #	308.01.400	Date	08-Jan-08

DESIGN CRITERIA:

Design Flow:	4.20		cfs
Bottom Width:	2.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.03		
Min. Bottom Slope:	1.0	%	
Max. Bottom Slope:	1.0	%	
Flow Depth (Min. S):	0.53		feet
Flow Depth (Max. S):	0.53		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.35
Reynolds # for Smin	6,186
U=(gRS)^0.5 for Smax	0.35
Reynolds # for Smax	6,186

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0,25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	0.2	Smax	
D50	0.25	0.25	feet
T	0.33	0.33	lb/ft2
Nb	0.21	0.21	
Tmax	0.25	0.25	lb/ft2
Ns	0.16	0.16	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	9.04	9.04	degrees
Nsp	0.09	0.09	
SFb	4.56	4.56	
SFs	1.53	1.53	

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DF-1))	Chck'd	
Project #	308.01.400	Date	26-Dec-07

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	0.40	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	1.25	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.033	ft/ft
Max. Bottom Slope:	0.143	ft/ft
Freeboard:	0.5	feet

Depth Check

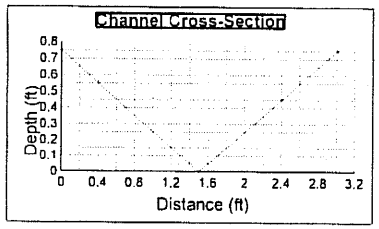
Depth (Min. Slope):	0.25	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.75	feet
Area:	0.13	ft2
Perimeter:	1.13	feet
Hydraulic Radius:	0.11	feet
Velocity:	3.16	ft/sec
Froude Number:	1.57	

Velocity Check

Depth (Max. Slope):	0.19	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.69	feet
Area:	0.07	ft2
Perimeter:	0.86	feet
Hydraulic Radius:	0.09	feet
Velocity:	5.47	ft/sec
Froude Number:	3.12	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.033	ft/ft
Max. Bottom Slope:	0.143	ft/ft
Min. Channel Depth:	0.75	feet
Channel Top Width:	3.01	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DF-1))	Chck'd	
Project #	308.01.400	Date	03-Jan-08

DESIGN CRITERIA:

Design Flow:	0.40		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	3.3	%	
Max. Bottom Slope:	14.3	%	
Flow Depth (Min. S):	0.25		feet
Flow Depth (Max. S):	0.19		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.35
Reynolds # for Smin	30,883
U=(gRS)^0.5 for Smax	0.63
Reynolds # for Smax	56,029

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0.25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.063
K for S max (See K vs. R Chart)	0.063
F for S min	16.1
F for S max	15.7

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax = Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	1.25	1.25	feet
T	0.52	1.71	lb/ft2
Nb	0.06	0.21	
Tmax	0.30	1.30	lb/ft2
Ns	0.05	0.16	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	2.84	8.75	degrees
Nsp	0.03	0.10	
SFb	9.83	2.70	
SFs	1.71	1.51	

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DF-2)	Chck'd	
Project #	308.01.400	Date	26-Dec-07

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	0.40	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	0.75	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.061	ft/ft
Max. Bottom Slope:	0.061	ft/ft
Freeboard:	0.5	feet

Depth Check

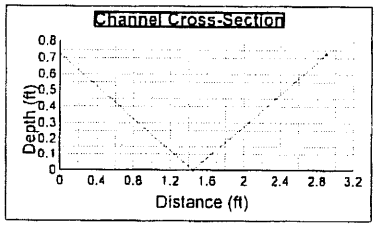
Depth (Min. Slope):	0.22	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.72	feet
Area:	0.10	ft2
Perimeter:	1.00	feet
Hydraulic Radius:	0.10	feet
Velocity:	3.97	ft/sec
Froude Number:	2.09	

Velocity Check

Depth (Max. Slope):	0.22	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.72	feet
Area:	0.10	ft2
Perimeter:	1.00	feet
Hydraulic Radius:	0.10	feet
Velocity:	3.97	ft/sec
Froude Number:	2.09	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.061	ft/ft
Max. Bottom Slope:	0.061	ft/ft
Min. Channel Depth:	0.72	feet
Channel Top Width:	2.90	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DF-2)	Chck'd	
Project #	308.01.400	Date	03-Jan-08

DESIGN CRITERIA:

Design Flow:	0.40	cfs
Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Friction Factor:	0.02	
Min. Bottom Slope:	6.1	%
Max. Bottom Slope:	6.1	%
Flow Depth (Min. S):	0.22	feet
Flow Depth (Max. S):	0.22	feet
Angle Repose (Ar):	42.0	degrees
Specific Gravity	2.65	

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.44
Reynolds # for Smin	23,786
U=(gRS)^0.5 for Smax	0.44
Reynolds # for Smax	23,786

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0,25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax = Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	0.75	0.75	feet
T	0.85	0.85	lb/ft2
Nb	0.18	0.18	
Tmax	0.65	0.65	lb/ft2
Ns	0.14	0.14	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	7.69	7.69	degrees
Nsp	0.08	0.08	
SFb	4.05	4.05	
SFs	1.56	1.56	

HANSEN ALLEN & LUCE inc ENGINEERS		
Client *Carbon Resources*	Sheet	
Project *Kinney Mine Hydrology*	Comp.	*TDS*
Feature *Ditch Design (DF-3)*	Chck'd	
Project # *308.01.400*	Date	*26-Dec-07*

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	1.30	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	1.50	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.100	ft/ft
Max. Bottom Slope:	0.100	ft/ft
Freeboard:	0.5	feet

Depth Check

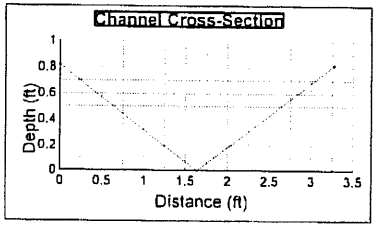
Depth (Min. Slope):	0.32	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.82	feet
Area:	0.20	ft2
Perimeter:	1.42	feet
Hydraulic Radius:	0.14	feet
Velocity:	6.42	ft/sec
Froude Number:	2.84	

Velocity Check

Depth (Max. Slope):	0.32	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.82	feet
Area:	0.20	ft2
Perimeter:	1.42	feet
Hydraulic Radius:	0.14	feet
Velocity:	6.42	ft/sec
Froude Number:	2.84	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.1	ft/ft
Max. Bottom Slope:	0.1	ft/ft
Min. Channel Depth:	0.82	feet
Channel Top Width:	3.27	feet



HANSEN ALLEN & LUCE inc ENGINEERS		
Client *Carbon Resources*	Sheet	*of*
Project *Kinney Mine Hydrology*	Comp.	*TDS*
Feature *Ditch Design (DF-3)*	Chck'd	
Project # *308.01.400*	Date	*03-Jan-08*

DESIGN CRITERIA:

Design Flow:	1.30	cfs
Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Friction Factor:	0.02	
Min. Bottom Slope:	10.0 %	
Max. Bottom Slope:	10.0 %	
Flow Depth (Min. S):	0.32	feet
Flow Depth (Max. S):	0.32	feet
Angle Repose (Ar):	42.0	degrees
Specific Gravity	2.65	

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.68
Reynolds # for Smin	72,524
U=(gRS)^0.5 for Smax	0.68
Reynolds # for Smax	72,524

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0.25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.063
K for S max (See K vs. R Chart)	0.063
F for S min	15.2
F for S max	15.2

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan(Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	1.50	1.50	feet
T	1.99	1.99	lb/ft2
Nb	0.20	0.20	
Tmax	1.51	1.51	lb/ft2
Ns	0.15	0.15	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	8.36	8.36	degrees
Nsp	0.09	0.09	
SFb	3.24	3.24	
SFs	1.53	1.53	

HANSEN ALLEN & LUCE inc ENGINEERS		
Client *Carbon Resources*	Sheet	
Project *Kinney Mine Hydrology*	Comp.	*TDS*
Feature *Ditch Design (DF-4)*	Chck'd	
Project # *308.01.400*	Date	*26-Dec-07*

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	1.70	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	1.00	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.057	ft/ft
Max. Bottom Slope:	0.057	ft/ft
Freeboard:	0.5	feet

Depth Check

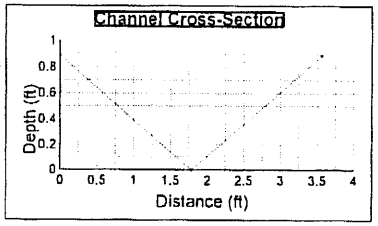
Depth (Min. Slope):	0.39	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.89	feet
Area:	0.31	ft2
Perimeter:	1.75	feet
Hydraulic Radius:	0.17	feet
Velocity:	5.56	ft/sec
Froude Number:	2.22	

Velocity Check

Depth (Max. Slope):	0.39	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.89	feet
Area:	0.31	ft2
Perimeter:	1.75	feet
Hydraulic Radius:	0.17	feet
Velocity:	5.56	ft/sec
Froude Number:	2.22	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.057	ft/ft
Max. Bottom Slope:	0.057	ft/ft
Min. Channel Depth:	0.89	feet
Channel Top Width:	3.56	feet



HANSEN ALLEN & LUCE inc ENGINEERS		
Client *Carbon Resources*	Sheet	*of*
Project *Kinney Mine Hydrology*	Comp.	*TDS*
Feature *Ditch Design (DF-4)*	Chck'd	
Project # *308.01.400*	Date	*03-Jan-08*

DESIGN CRITERIA:

Design Flow:	1.70		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	5.7	%	
Max. Bottom Slope:	5.7	%	
Flow Depth (Min. S):	0.39		feet
Flow Depth (Max. S):	0.39		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.57
Reynolds # for Smin	40,463
U=(gRS)^0.5 for Smax	0.57
Reynolds # for Smax	40,463

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0,25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.063
K for S max (See K vs. R Chart)	0.063
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	1.00	1.00	feet
T	1.39	1.39	lb/ft2
Nb	0.22	0.22	
Tmax	1.06	1.06	lb/ft2
Ns	0.17	0.17	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	9.33	9.33	degrees
Nsp	0.10	0.10	
SFb	3.56	3.56	
SFs	1.51	1.51	

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DF-5)	Chck'd	
Project #	308.01.400	Date	26-Dec-07

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	1.70	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	1.00	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.057	ft/ft
Max. Bottom Slope:	0.057	ft/ft
Freeboard:	0.5	feet

Depth Check

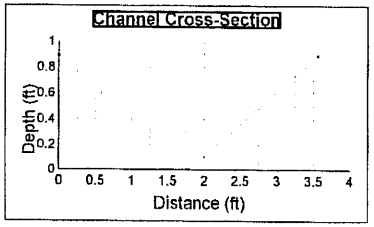
Depth (Min. Slope):	0.39	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.89	feet
Area:	0.31	ft2
Perimeter:	1.75	feet
Hydraulic Radius:	0.17	feet
Velocity:	5.56	ft/sec
Froude Number:	2.22	

Velocity Check

Depth (Max. Slope):	0.39	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.89	feet
Area:	0.31	ft2
Perimeter:	1.75	feet
Hydraulic Radius:	0.17	feet
Velocity:	5.56	ft/sec
Froude Number:	2.22	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.057	ft/ft
Max. Bottom Slope:	0.057	ft/ft
Min. Channel Depth:	0.89	feet
Channel Top Width:	3.56	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DF-5)	Chck'd	
Project #	308.01.400	Date	08-Jan-08

DESIGN CRITERIA:

Design Flow:	1.70		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	5.7	%	
Max. Bottom Slope:	5.7	%	
Flow Depth (Min. S):	0.39		feet
Flow Depth (Max. S):	0.39		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.57
Reynolds # for Smin	40,463
U=(gRS)^0.5 for Smax	0.57
Reynolds # for Smax	40,463

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0,25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.063
K for S max (See K vs. R Chart)	0.063
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	1.00	1.00	feet
T	1.39	1.39	lb/ft2
Nb	0.22	0.22	
Tmax	1.06	1.06	lb/ft2
Ns	0.17	0.17	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	9.33	9.33	degrees
Nsp	0.10	0.10	
SFb	3.56	3.56	
SFs	1.51	1.51	

d	=	Depth of flow;
S	=	Channel slope in feet per feet;
SG	=	Specific gravity of rock, and
D_{50}	=	Mean riprap size, in feet.

An analysis of side slope stability was completed by applying equations 784.14-12 through 784.14-14.

$$SF = \frac{\cos \alpha \tan \phi}{\eta' \tan \phi + \sin \alpha \cos \beta} \qquad (742.312\text{-}12)$$

$$\beta = \arctan \left(\frac{\cos \theta}{\frac{2 \sin \alpha}{\eta \tan \phi} + \sin \theta} \right) \qquad (742.312\text{-}13)$$

$$\eta' = C \eta \left(\frac{1 + \sin (\theta + \beta)}{2} \right) \qquad (742.312\text{-}14)$$

where

α	=	Tan^{-1} (1/sideslope); and
C	=	0.76 for 2H:1V sideslopes
	=	0.86 for 3H:1V sideslopes.

Sideslope is defined as the number of feet horizontal per foot vertical of the channel embankments. All other variables are as previously defined.

Once mean riprap size is determined, a riprap gradation and thickness must be determined. Table 742.312a, Recommended Riprap Gradation Limits, shows the recommended gradation for both mild and steep channel conditions. In some cases, grout was used in riprapped sections to increase channel stability and/or reduce riprap size.

Conveyor Lining. A second type of channel lining utilized consists of overlapped conveyor belt material. This lining was installed in excavated channels in short pieces so that the upstream belt material overlapped the downstream piece thereby preventing water from washing beneath the downstream liner. Each section of channel lining was secured with wire and rebar anchors. The locations of lined channel sections are shown on Maps 731.720a through 731.720c.

TABLE 742.312a
Recommended Riprap Gradation Limits

DESIGN RATIO	STEEP SLOPE	MILD SLOPE
$\frac{D_{max}}{D_{50}}$	1.25	2
$\frac{D_{50}}{D_{10-20}}$	2-3	2-3

From "Surface Mining Water Diversion Design Manual", 1982

Half Round CMP Pipe. In other locations such as around Ponds 4 and 6, half round CMP pipe has been placed to provide the required erosion protection. CMP pipe has also been used in steep areas where channel flow is infeasible but yet the water must be conveyed down a hillside. Examples of such areas are noted near the upper mine portals and along the roadway leading to the upper mine offices located on the Lion Deck.

Ditch sections requiring erosion protection are shown on Maps 731.720a through 731.720c. Areas downstream from culvert installations requiring similar protection are shown on Maps 731.720d through 731.720f. Specific mention should be made with regard to the design of erosion protection at some of the locations shown on the maps. Current riprap design methodologies do not allow for the design of erosion protection on extremely steep slopes using such materials as rock riprap. In some locations, however, such as at Culverts 57A through 60A (as well as at other locations within the mine permit area), consideration must be given to the fact that local drainage must be transferred down a steep hillside or stream channel. At such locations, procedures are not available for designing riprap erosion protection and, therefore, calculations under such conditions have not been, nor can they be made.

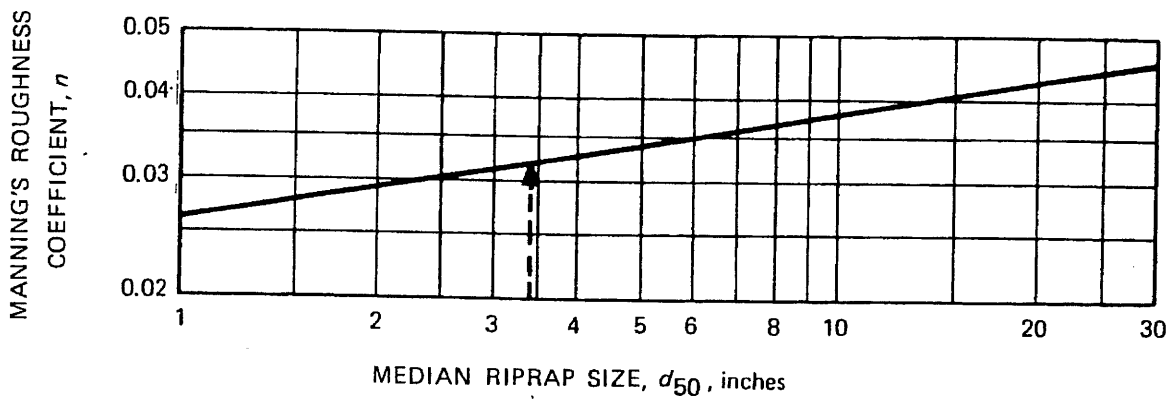
An effort has been made by CPMC to reduce or eliminate the potential for serious erosion at these locations by placing culvert exits onto existing or man-made rock rubble piles, or onto rock ledges which act as energy dissipation devices and effectively reduce downstream erosion. CPMC will continue to monitor culvert outfalls at these locations and thereby determine the efficiency of the rock rubble piles and what additional action, if any, should or can be taken.

Conditions related to lining of individual ditches are shown on Maps 731.720a through 731.720c. Conditions related to culvert outfall linings are shown on Maps 731.720d through 731.720f. Channel and Culvert riprap calculations are presented in Exhibit 742.312a, Riprap Calculations.

Culvert Design.

Following the determination of a given peak watershed discharge, design sizes for culverts were calculated as part of the runoff diversion and conveyance facilities. Flow capacity calculations were made

In the design of riprap-lined channels, National Cooperative Highway Research Program Report No. 108, "Tentative Design Procedure for Riprap-Lined Channels"[10] details the procedure for determining a design stone size such that the stone is stable under the design flow conditions with a reasonable factor of safety. The design stone size used is the d_{50}, or median stone diameter, defined as that stone size which is exceeded in weight by 50 percent of the mixture.



$n = 0.0395\,(d_{50})^{1/6}$

Figure I-17. Manning's n for riprap-lined channels.[1]

Erosive forces of flowing water are greater in bends than in straight channels. Therefore, riprap size for bends and straights in the channel must be computed. If the riprap size (d_{50}) computed for bends is less than 10 percent greater than the riprap size for straight channels, then the riprap size for straight channels shall be considered to be of adequate size; otherwise, the larger riprap size shall be used in the bend. This is done in order to minimize the number of riprap sizes required. No more than two riprap sizes should be used on any single contract, in order to minimize construction problems caused by too many sizes. The riprap size to be used in a bend shall extend upstream from the point of curvature, and downstream from the point of tangency a distance equal to five times the channel bottom width (length = 5 b). This riprap size shall extend across the bottom and up both sides of the channel.

Riprap

The riprap shall be composed of a well-graded mixture down to the 1-inch size particle, such that 50 percent of the mixture by weight shall be larger than the d_{50} size. A well-graded mixture is defined as a mixture composed primarily of the larger stone sizes but with a sufficient mixture of other sizes to fill the progressively-smaller voids between the stones. The diameter of the largest stone size in such a mixture shall be considered to be 1.5 times the d_{50} size. The riprap size as shown on the plans and specifications or for other construction purposes shall be the size of the largest stone in the mixture, i.e., 1.5 x d_{50}. The minimum thickness of the riprap layer shall be 1.5 times the maximum stone diameter but not less than 6 inches. The riprap shall extend up the banks to a height equal to maximum depth of flow or to a point where vegetation can be established to adequately protect the channel.

Ref: "Erosion and Sediment Control
Surface Mining in the Eastern U.S"
EPA Technology Transfer Seminar Publication
October 1976

In channels where there is no riprap or paving in the bottom, the toe of the bank riprap shall extend below the channel bottom a distance at least 1.5 times the maximum stone size, but in no case less than 1 foot. The only exception to this would be in the event that there is a non-erodible hard rock bottom. The channel bank shall not be steeper than 2.0 horizontal to 1.0 vertical.

After determining the riprap size that will be stable under the flow conditions, the designer shall consider that size to be a minimum size and then, based on riprap graduations actually available in the area, shall select the size or sizes that equal or exceed the minimum size. The possibility of damage by children shall be considered in selecting a riprap size, especially if there is nearby water to to toss the stones into.

Filter

A filter is a layer of material placed between the riprap and the underlying soil surface to prevent soil movement into and through the riprap.

Riprap shall have a filter placed under it when either of the following conditions exist:

1. The riprap is not well graded down to the 1-inch size particle.

2. Riprap is placed on the side slopes of a channel and the soil is sand-size or finer with a plasticity index, *PI*, less than 10. This requirement applies to slopes having this soil in lenses or layers greater than 3 inches in thickness.

A filter can be of two general forms. One is a single layer of plastic filter cloth manufactured for that express purpose. The plastic filter cloth shall be woven of polypropylene monofilament yarns and shall be equivalent to "Poly-Filter X" as manufactured by Carthage Mills, Inc., Cincinnati, Ohio. Another is a properly graded layer of sand, gravel, or stone.

The criteria for the design of an aggregate filter are as follows:

$$\frac{d_{15}\ \text{Riprap}}{d_{85}\ \text{Filter}} \leqslant 5 \qquad \frac{d_{15}\ \text{Filter}}{d_{85}\ \text{Base}} \leqslant 5$$

in which d_{15} or d_{85} is the size of base, filter or riprap material. In these equations, 15 and 85 percent, respectively, are finer. The base is the soil layer underneath the filter. The filter shall be graded down to sand-size particles. Riprap 12 inches and larger shall not be dumped directly onto the plastic filter cloth, since it may tear or displace the filter cloth. Instead, a 4-inch-minimum thickness blanket of gravel shall be placed over the filter cloth or the riprap shall be placed directly on the filter cloth by hand or by the bucket of the equipment. Side slopes shall be 2:1 or flatter to prevent the gravel from sliding down the filter cloth before placing the riprap.

Soil Size Classification

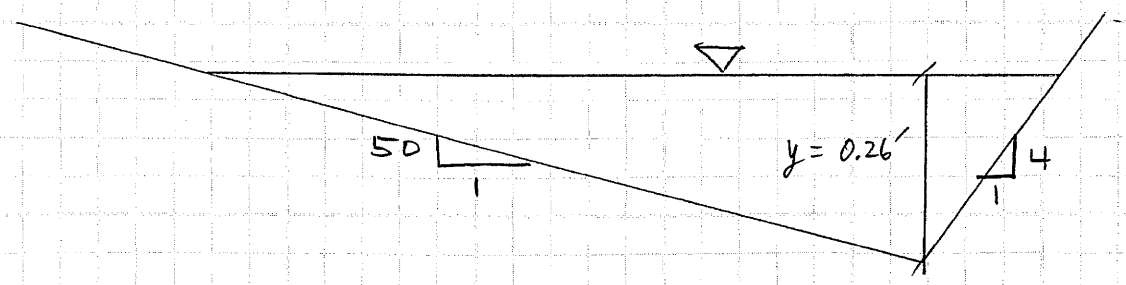
Soil sizes given herein are according to the Unified Soil Classification System as shown on the following page.

HANSEN ALLEN & LUCE inc
ENGINEERS

CLIENT Carbon Resources
PROJECT Kinney Mine Hydrology
FEATURE Road/Ditch Design (VDD-1)
PROJECT NO 308.01.400

SHEET 1 OF 3
COMPUTED TDS
CHECKED
DATE 8-6-07

Road / Ditch design to contain 100 yr 6hr discharge of 9.4 cfs.



Road w/ these minimum dimensions will pass the 100yr 6hr event of 9.4 cfs.

Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (UDD-1)	Chck'd	
Project #	308.01.400	Date	06-Jul-07

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	9.40	cfs
Bottom Width:	0.0	feet
Side Slope1:	50.0	m1
Side Slope2:	4.0	m2
Friction Factor:		
Assumed D50:	0.1	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	5	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.07	ft/ft
Max. Bottom Slope:	0.07	ft/ft
Freeboard:	0.0	feet

Depth Check

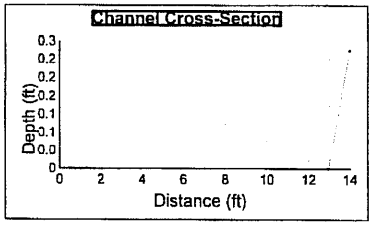
Depth (Min. Slope):	0.26	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.26	feet
Area:	1.81	ft2
Perimeter:	14.03	feet
Hydraulic Radius:	0.13	feet
Velocity:	5.18	ft/sec
Froude Number:	2.54	

Velocity Check

Depth (Max. Slope):	0.26	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.26	feet
Area:	1.81	ft2
Perimeter:	14.03	feet
Hydraulic Radius:	0.13	feet
Velocity:	5.18	ft/sec
Froude Number:	2.54	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	50.00	1/m1
Side Slope2:	4.00	1/m2
Min. Bottom Slope:	0.074	ft/ft
Max. Bottom Slope:	0.074	ft/ft
Min. Channel Depth:	0.26	feet
Channel Top Width:	14.00	feet



Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (UDD-1)	Chck'd	
Project #	308.01.400	Date	06-Aug-07

DESIGN CRITERIA:

Design Flow:	9.40		cfs
Bottom Width:	0.00		feet
Side Slope1:	50.00		1/m1
Side Slope2:	4.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	7.4	%	
Max. Bottom Slope:	7.4	%	
Flow Depth (Min. S):	0.26		feet
Flow Depth (Max. S):	0.26		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.56
Reynolds # for Smin	3,964
U=(gRS)^0.5 for Smax	0.56
Reynolds # for Smax	3,964

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0,25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	0.10	0.10	feet
T	1.20	1.20	lb/ft2
Nb	1.87	1.87	
Tmax	0.91	0.91	lb/ft2
Ns	1.42	1.42	
m Critical	4.00	4.00	
A (m crit)	14.04	14.04	degrees
B	65.63	65.63	degrees
Nsp	1.38	1.38	
SFb	0.51	0.51	
SFs	0.65	0.65	

1/3

Area tributary
to UDD-1
(65.0 acres)
CN = 75

Q (100 yr 6 hr) = 9.4 cfs

↑ N

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Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DF-5)	Chck'd	
Project #	308.01.400	Date	03-Aug-10

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	1.70	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	1.00	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*{2.25+5.23*LOG(R/D50)}}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.057	ft/ft
Max. Bottom Slope:	0.057	ft/ft
Freeboard:	0.5	feet

Depth Check

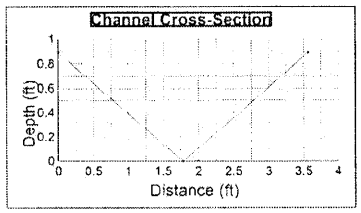
Depth (Min. Slope):	0.39	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.89	feet
Area:	0.31	ft2
Perimeter:	1.75	feet
Hydraulic Radius:	0.17	feet
Velocity:	5.56	ft/sec
Froude Number:	2.22	

Velocity Check

Depth (Max. Slope):	0.39	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.89	feet
Area:	0.31	ft2
Perimeter:	1.75	feet
Hydraulic Radius:	0.17	feet
Velocity:	5.56	ft/sec
Froude Number:	2.22	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.057	ft/ft
Max. Bottom Slope:	0.057	ft/ft
Min. Channel Depth:	0.89	feet
Channel Top Width:	3.56	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (DF-5)	Chck'd	
Project #	308.01.400	Date	04-Aug-10

DESIGN CRITERIA:

Design Flow:	1.70		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	5.7	%	
Max. Bottom Slope:	5.7	%	
Flow Depth (Min. S):	0.39		feet
Flow Depth (Max. S):	0.39		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.57
Reynolds # for Smin	40,463
U=(gRS)^0.5 for Smax	0.57
Reynolds # for Smax	40,463

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0.25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.063
K for S max (See K vs. R Chart)	0.063
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax = Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar)) +Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar) +Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	1.00	1.00	feet
T	1.39	1.39	lb/ft2
Nb	0.22	0.22	
Tmax	1.06	1.06	lb/ft2
Ns	0.17	0.17	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	9.33	9.33	degrees
Nsp	0.10	0.10	
SFb	3.56	3.56	
SFs	1.51	1.51	

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Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (ALT C-1)	Chck'd	
Project #	308.01.400	Date	03-Aug-10

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	0.20	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	1.00	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.053	ft/ft
Max. Bottom Slope:	0.143	ft/ft
Freeboard:	0.5	feet

Depth Check

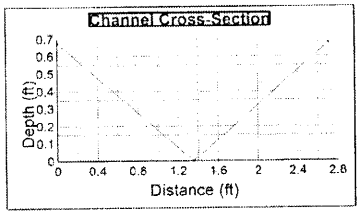
Depth (Min. Slope):	0.18	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.68	feet
Area:	0.06	ft2
Perimeter:	0.79	feet
Hydraulic Radius:	0.08	feet
Velocity:	3.17	ft/sec
Froude Number:	1.88	

Velocity Check

Depth (Max. Slope):	0.15	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.65	feet
Area:	0.04	ft2
Perimeter:	0.66	feet
Hydraulic Radius:	0.07	feet
Velocity:	4.60	ft/sec
Froude Number:	2.98	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.053	ft/ft
Max. Bottom Slope:	0.143	ft/ft
Min. Channel Depth:	0.68	feet
Channel Top Width:	2.71	feet



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Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (ALT C-1)	Chck'd	
Project #	308.01.400	Date	04-Aug-10

DESIGN CRITERIA:

Design Flow:	0.20		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	5.3	%	
Max. Bottom Slope:	14.3	%	
Flow Depth (Min. S):	0.18		feet
Flow Depth (Max. S):	0.15		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.37
Reynolds # for Smin	26,297
U=(gRS)^0.5 for Smax	0.55
Reynolds # for Smax	39,362

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0.25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax = Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan(Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	1.00	1.00	feet
T	0.59	1.32	lb/ft2
Nb	0.09	0.21	
Tmax	0.45	1.00	lb/ft2
Ns	0.07	0.16	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	4.91	8.68	degrees
Nsp	0.04	0.10	
SFb	6.62	2.72	
SFs	1.67	1.51	

HANSEN ALLEN & LUCE inc ENGINEERS	Client *Carbon Resources*	Sheet	
	Project *Kinney Mine Hydrology*	Comp.	*TDS*
	Feature *Ditch Design (ALT B-1)*	Chck'd	
	Project # *308.01.400*	Date	*03-Aug-10*

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	0.20	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	1.00	

Anderson et al. (1970) If X = 1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X = 2, n=0.0456(D50*S)^0.0159

If X = 3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X = 4, n=0.39*(S^0.38)*(R^0.16)

If X = 5, n=input n value

X:	1	
Input n Value when X = 5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.053	ft/ft
Max. Bottom Slope:	0.143	ft/ft
Freeboard:	0.5	feet

Depth Check

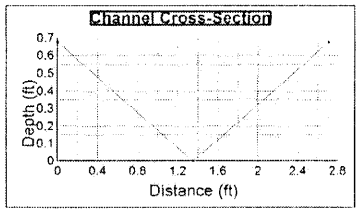
Depth (Min. Slope):	0.18	feet
Q-1.49AR(2/3)S(1/2)/n=	0.000	Accuracy
Required Depth:	0.68	feet
Area:	0.06	ft2
Perimeter:	0.79	feet
Hydraulic Radius:	0.08	feet
Velocity:	3.17	ft/sec
Froude Number:	1.88	

Velocity Check

Depth (Max. Slope):	0.15	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.65	feet
Area:	0.04	ft2
Perimeter:	0.66	feet
Hydraulic Radius:	0.07	feet
Velocity:	4.60	ft/sec
Froude Number:	2.98	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.053	ft/ft
Max. Bottom Slope:	0.143	ft/ft
Min. Channel Depth:	0.68	feet
Channel Top Width:	2.71	feet



HANSEN ALLEN & LUCE inc ENGINEERS	Client *Carbon Resources*	Sheet	*of*
	Project *Kinney Mine Hydrology*	Comp.	*TDS*
	Feature *Ditch Design (ALT B-1)*	Chck'd	
	Project # *308.01.400*	Date	*04-Aug-10*

DESIGN CRITERIA:

Design Flow:	0.20		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	5.3	%	
Max. Bottom Slope:	14.3	%	
Flow Depth (Min. S):	0.18		feet
Flow Depth (Max. S):	0.15		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.37
Reynolds # for Smin	26,297
U=(gRS)^0.5 for Smax	0.55
Reynolds # for Smax	39,362

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0.25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	16.1
F for S max	16.1

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax = Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan(Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	1.00	1.00	feet
T	0.59	1.32	lb/ft2
Nb	0.09	0.21	
Tmax	0.45	1.00	lb/ft2
Ns	0.07	0.16	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	4.01	8.68	degrees
Nsp	0.04	0.10	
SFb	6.62	2.72	
SFs	1.67	1.51	

HANSEN ALLEN & LUCE inc ENGINEERS		
Client *Carbon Resources*	Sheet	
Project *Kinney Mine Hydrology*	Comp.	*TDS*
Feature *Ditch Design (ALT A-1)*	Chck'd	
Project # *308.01.400*	Date	*03-Aug-10*

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	0.40	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	0.50	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.047	ft/ft
Max. Bottom Slope:	0.047	ft/ft
Freeboard:	0.5	feet

Depth Check

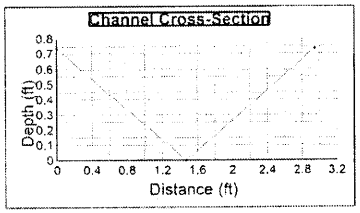
Depth (Min. Slope):	0.24	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.74	feet
Area:	0.11	ft2
Perimeter:	1.05	feet
Hydraulic Radius:	0.11	feet
Velocity:	3.60	ft/sec
Froude Number:	1.85	

Velocity Check

Depth (Max. Slope):	0.24	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.74	feet
Area:	0.11	ft2
Perimeter:	1.05	feet
Hydraulic Radius:	0.11	feet
Velocity:	3.60	ft/sec
Froude Number:	1.85	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.047	ft/ft
Max. Bottom Slope:	0.047	ft/ft
Min. Channel Depth:	0.74	feet
Channel Top Width:	2.94	feet



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Client *Carbon Resources*	Sheet	*of*
Project *Kinney Mine Hydrology*	Comp.	*TDS*
Feature *Ditch Design (ALT A-1)*	Chck'd	
Project # *308.01.400*	Date	*04-Aug-10*

DESIGN CRITERIA:

Design Flow:	0.40		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	4.7	%	
Max. Bottom Slope:	4.7	%	
Flow Depth (Min. S):	0.24		feet
Flow Depth (Max. S):	0.24		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

U=(gRS)^0.5 for Smin	0.40
Reynolds # for Smin	14,262
U=(gRS)^0.5 for Smax	0.40
Reynolds # for Smax	14,262

T = G*d*S where G=Unit weight of Water

Nb = F*T/(G(SD-1)D50)

F=(1/0.047)=21.3 for flat slopes with Reynolds No. < 500

F=(1/0.062)=16.1 for 500 < Reynolds No. < 40,000

F=varies from (1/0.062)=16.1 for Reynolds No. = 40,000 to (1/0.25)=4 for Reynolds No. = 500,000 or larger

K for S min (See K vs. R Chart)	0.062	
K for S max (See K vs. R Chart)	0.062	
F for S min	16.1	
F for S max	16.1	

SFb = (Cos a tan b)/(sin a + Nb tan b)

Tmax = Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks:	0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan(Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	0.50	0.50	feet
T	0.69	0.69	lb/ft2
Nb	0.22	0.22	
Tmax	0.53	0.53	lb/ft2
Ns	0.16	0.16	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	9.32	9.32	degrees
Nsp	0.10	0.10	
SFb	3.72	3.72	
SFs	1.52	1.52	

HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (ALT A-2)	Chck'd	
Project #	308.01.400	Date	03-Aug-10

Trapezoidal Channel Flow Calculations

GENERAL CRITERIA:

Design Flow:	0.40	cfs
Bottom Width:	0.0	feet
Side Slope1:	2.0	m1
Side Slope2:	2.0	m2
Friction Factor:		
Assumed D50:	0.50	

Anderson et al. (1970) If X=1, n=0.0395(D50)^1/6

Abt. et al. (1987, 1988) If X=2, n=0.0456(D50*S)^0.0159

If X=3, n={D50^1/6*(R/D50)^1/6}/{3.82*[2.25+5.23*LOG(R/D50)]}

Generally Applicable for R/D50 > 0.5

Jarrett (1984) If X=4, n=0.39*(S^0.38)*(R^0.16)

If X=5, n=input n value

X:	1	
Input n Value when X=5:		
Calc (used) n Value:	0.020	
Min. Bottom Slope:	0.047	ft/ft
Max. Bottom Slope:	0.047	ft/ft
Freeboard:	0.5	feet

Depth Check

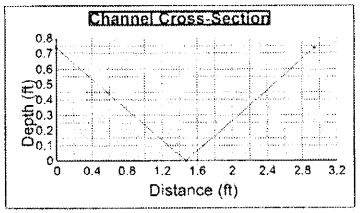
Depth (Min. Slope):	0.24	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.74	feet
Area:	0.11	ft2
Perimeter:	1.05	feet
Hydraulic Radius:	0.11	feet
Velocity:	3.60	ft/sec
Froude Number:	1.85	

Velocity Check

Depth (Max. Slope):	0.24	feet
Q-1.49AR(2/3)S(1/2)/n=	-0.000	Accuracy
Required Depth:	0.74	feet
Area:	0.11	ft2
Perimeter:	1.05	feet
Hydraulic Radius:	0.11	feet
Velocity:	3.60	ft/sec
Froude Number:	1.85	

Channel Design Summary:

Bottom Width:	0.00	feet
Side Slope1:	2.00	1/m1
Side Slope2:	2.00	1/m2
Min. Bottom Slope:	0.047	ft/ft
Max. Bottom Slope:	0.047	ft/ft
Min. Channel Depth:	0.74	feet
Channel Top Width:	2.94	feet



HANSEN ALLEN & LUCE inc ENGINEERS			
Client	Carbon Resources	Sheet	of
Project	Kinney Mine Hydrology	Comp.	TDS
Feature	Ditch Design (ALT A-2)	Chck'd	
Project #	308.01.400	Date	04-Aug-10

DESIGN CRITERIA:

Design Flow:	0.40		cfs
Bottom Width:	0.00		feet
Side Slope1:	2.00		1/m1
Side Slope2:	2.00		1/m2
Friction Factor:	0.02		
Min. Bottom Slope:	4.7	%	
Max. Bottom Slope:	4.7	%	
Flow Depth (Min. S):	0.24		feet
Flow Depth (Max. S):	0.24		feet
Angle Repose (Ar):	42.0		degrees
Specific Gravity	2.65		

Reynolds No. = U*D50/v, where U=Shear Velocity, v=viscosity

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K for S min (See K vs. R Chart)	0.062
K for S max (See K vs. R Chart)	0.062
F for S min	16.1
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Tmax= Ks*G*d*S

Set Ks=0.75 for 1.5:1 slope, 0.76 for 2:1 slope, and 0.85 for 3:1 slope

Ks: 0.76

Ns = F*Tmax/(G(SG-1)D)

A = Atan(1/m)

B = Atan(Cos(Ar)/(2Sin(A)/NsTan)Ar))+Sin(Ar))

Nsp = Ns(1+Sin(Ar+B)/2)

SFs = Cos(A)Tan(Ar)/(nTan(Ar)+Sin(A)Cos(B))

RIPRAP DESIGN:

	Smin	Smax	
D50	0.50	0.50	feet
T	0.69	0.69	lb/ft2
Nb	0.22	0.22	
Tmax	0.53	0.53	lb/ft2
Ns	0.16	0.16	
m Critical	2.00	2.00	
A (m crit)	26.57	26.57	degrees
B	9.32	9.32	degrees
Nsp	0.10	0.10	
SFb	3.72	3.72	
SFs	1.52	1.52	

Sedimentation Pond 1

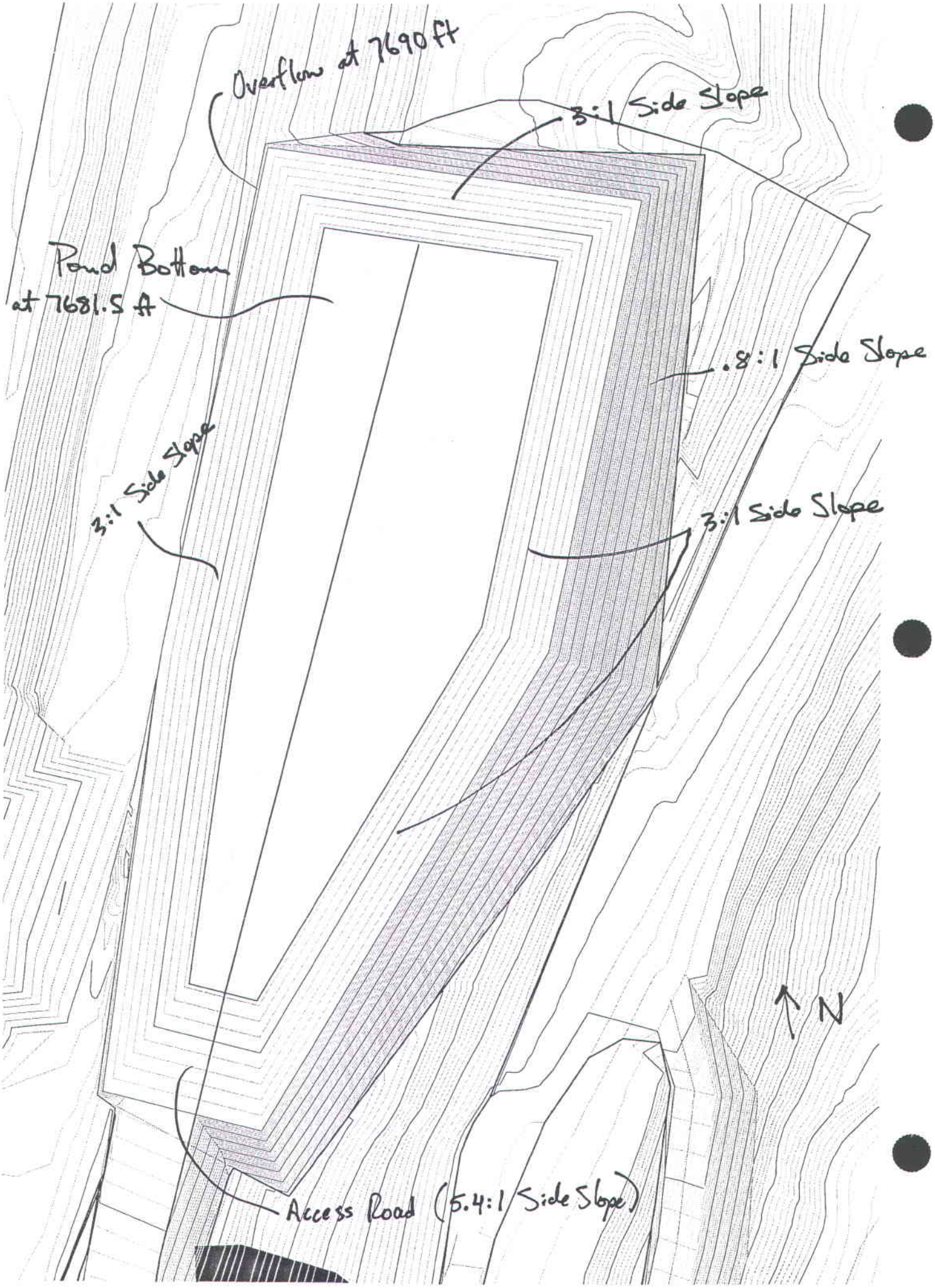
Sedimentation Pond 1

Storage Element	Volume (ac-ft)	Cumulative Volume (ac-ft)	Depth (ft)	Elevation (ft)
1. Pond Bottom	0.00	0.00	0.0	7681.5
2. 5.3yr Sediment	1.12	1.12	2.3	7683.8
(calculated a required 0.64 ac-ft but increased to 1.12 ac-ft)				
3. 10yr 24hr	2.06	3.18	5.4	7686.9
4. 100yr 6hr	1.67	4.85	7.5	7689.0
(A depth of 2.1 ft was calculated to pass the 100yr 6hr flow of 22.5 ft³/s through a 24-in diameter overflow pipe. Cumulative volume was taken from stage-volume spreadsheet)				
5. Freeboard	0.89	5.74	8.5	7690.0

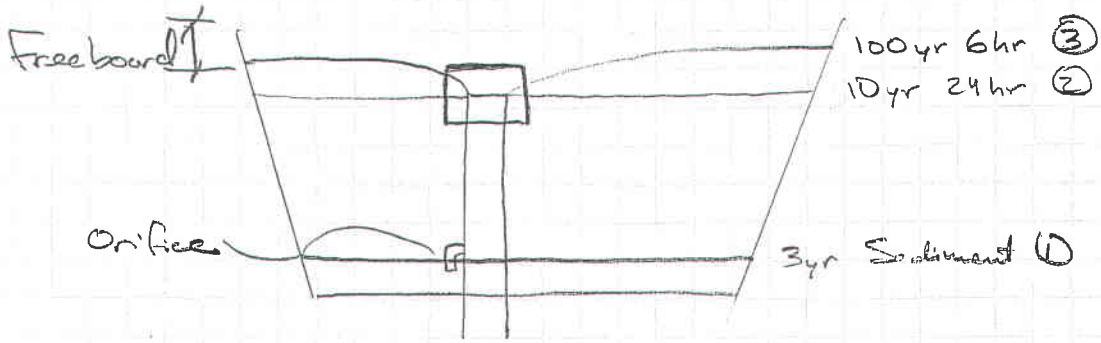
HANSEN ALLEN & LUCE INC ENGINEERS

CLIENT Carbon Resources
PROJECT Kinney Mine Hydrology
FEATURE Detent Volume
PROJECT NO 308.01.400

SHEET ___ OF 7DS
COMPUTED ___
CHECKED ___
DATE 12/26/07


Overflow at 7690 ft
3:1 Side Slope
Pond Bottom
at 7681.5 ft
.8:1 Side Slope
3:1 Side Slope
3:1 Side Slope
N
Access Road (5.4:1 Side Slope)

Sediment / Detention Volumes



① 3yr Sediment Volume

$A = (R)(K)(LS)(C)(P)$ → Universal Soil Loss Equation (USLE)

where:

A = Soil loss (tons/acre/yr)
R = Rainfall factor (ft-tons/acre/hr)
K = Soil Erodibility Factor
LS = Topographic factor
C = Cover or cropping management factor
P = Erosion Control Practice factor

Values of R and K were determined from Clyde et al. (1978)

R = 22.0 tons/acre/yr

K = 0.28 tons/acre/yr/Unit of R

$$LS = \frac{(650 + 450S + 65S^2)(L/72.6)^m}{10{,}000 + S^2}$$

where:

L = average overland flow length (ft)
S = Slope (%)
m = exponent dependent upon steepness of slope

$m = 0.3$ for $S < .5\%$, $m = 0.5$ for $0.51\% < S < 10\%$

$m = 0.6$ for $S > 10\%$

HANSEN ALLEN & LUCE inc
ENGINEERS

CLIENT Carbon Resources
PROJECT Kinney Mine Hydrology
FEATURE Detention Volume
PROJECT NO 305.01.400

SHEET ____ OF ____
COMPUTED GLT
CHECKED ____
DATE 12/21/07

L & S Calculations

Subbasin	L (ft)	S (%)
SB L 1.5	640	2.0
SB L 2	1840	9.5
SB L 3	830	20.7
SB Access A	560	9.3
SB L 1	840	0.9
SB Access B	520	2.8
SB L 5	1540	7.2
SB L 2.5	800	14.2
SB L .75	1250	4.2
SB Ditch B	1310	2.4
SB Ditch A	590	4.4
SB Pond	610	9.1
Average	944	7.2

$$LS = \frac{(650 + 450(7.2) + 65(7.2)^2)\left(944\text{ ft}/72.6\right)^{0.5}}{10{,}000 + (7.2)^2}$$

$$= 2.6$$

Values of C and P were determined from the U.S. Soil Conservation Service (1977)

C = 1.0 (for disturbed)

P = 1.0

$$A = (R)(K)(LS)(C)(P)$$

$$= (22.0 \text{ tons/acre/yr})(0.28 \text{ tons/acre/yr/Unit of R})(2.6)(1.0)(1.0)$$

$$= 16.0 \text{ tons/acre/yr}$$

HANSEN ALLEN & LUCE inc
ENGINEERS

CLIENT Carbon Resources
PROJECT Kinney Mine Hydrology
FEATURE Detention Volume
PROJECT NO 303.01.400

SHEET ____ OF ____
COMPUTED GWJ
CHECKED ____
DATE 12/21/07

Sediment density of 75 lb/ft³ was used in conjunction with the USLE to determine volume of reservoir sediment storage required.

Pond is designed so that sediment will be removed when the sediment volume reaches 60% of accumulated sediment storage volume.

$$A(0.6) = 16.0 \text{ tons/acre/yr } (0.6)$$

$$= 9.6 \text{ tons/acre/yr}$$

$$\forall \text{ (ac-ft/ac/yr)} = \frac{A}{\gamma_{sediment}}$$

$$= \frac{(9.6 \text{ tons/acre/yr})\left(\frac{2000 \text{ lb}}{1 \text{ ton}}\right)}{75 \text{ lb/ft}^3 \left(\frac{43{,}560 \text{ ft}^3}{1 \text{ acre-ft}}\right)}$$

$$= 0.00588 \text{ acre-ft/acre/yr}$$

$$\forall (3 \text{ yrs}) = (0.00588 \text{ acre-ft/acre/yr})(3 \text{ yr})(36.3 \text{ ac})$$

$$= \underline{\underline{0.64 \text{ acre-ft}}}$$

(2) 10 yr 24 hr Volume was determined from spreadsheet calculations.

$$V_{10yr\text{-}24hr} = \underline{2.06 \text{ ac-ft}}$$

- The orifice was sized to drain the 10yr 24hr runoff volume over a 24 hr period. See spreadsheet

$$D_{orifice} = \underline{6.2 \text{ in}}$$

(3) Volume in the detent basin required to pass the 100 yr 6hr flow is based on the heigth required to pass the flow (22.5 ft^3/s). Volume of 1.67 ac-ft is required above 10yr 24hr volume. (Cumulative volume selected from stage-volume spreadsheet)

- h required above 10yr 24hr depth to pass the 100yr 6hr flow

$$Q_{100yr6hr} = 22.5 \text{ ft}^3/\text{s} \quad \text{(from HMS model)}$$

$$Q = C_d A \sqrt{2gh}$$

$$= C_d \left(\frac{\pi d^2}{4}\right) \sqrt{2gh}$$

$d = 24$ in
$C_d = 0.62$
$g = 32.2$ ft/s^2
$h = ?$

$$h = \frac{\left[\dfrac{Q}{C_d\left(\frac{\pi d^2}{4}\right)}\right]^2}{2g}$$

$$= \frac{\left[\dfrac{22.5 \text{ ft}^3/\text{s}}{0.62\left(\frac{\pi(2\text{ ft})^2}{4}\right)}\right]^2}{2(32.2 \text{ ft/s}^2)} = 2.1 \text{ ft}$$

Orifice Sizing to Drain 10-yr 24-hr Volume Over a 24 hour Period

V initial = 2.67 ac-ft (10-yr 24-hr + 3yr sediment volume)
116305 ft3

Orifice Design Parameters
D = 6.2 in
Cd = 0.62
Heigth to center of orifice above pond bottom = 1.60 ft (top of 3yr sediment volume + orifice diameter/2)

Time (min)	Time (hr)	Volume (ft3)	Depth (ft)	Q (ft3/s)	ΔVolume (ft3)
0	0.00	116305	4.7	1.84	1653
15	0.25	114652	4.6	1.81	1627
30	0.50	113025	4.6	1.81	1627
45	0.75	111399	4.5	1.78	1599
60	1.00	109799	4.5	1.78	1599
75	1.25	108200	4.4	1.75	1571
90	1.50	106629	4.4	1.75	1571
105	1.75	105057	4.3	1.71	1543
120	2.00	103514	4.2	1.68	1514
135	2.25	102000	4.2	1.68	1514
150	2.50	100486	4.1	1.65	1485
165	2.75	99001	4.1	1.65	1485
180	3.00	97516	4.0	1.62	1455
195	3.25	96061	4.0	1.62	1455
210	3.50	94606	3.9	1.58	1424
225	3.75	93182	3.9	1.58	1424
240	4.00	91757	3.8	1.55	1393
255	4.25	90364	3.8	1.55	1393
270	4.50	88971	3.7	1.51	1361
285	4.75	87610	3.7	1.51	1361
300	5.00	86249	3.6	1.48	1328
315	5.25	84921	3.6	1.48	1328
330	5.50	83593	3.5	1.44	1295
345	5.75	82298	3.5	1.44	1295
360	6.00	81003	3.4	1.40	1260
375	6.25	79743	3.4	1.40	1260
390	6.50	78483	3.4	1.40	1260
405	6.75	77223	3.3	1.36	1225
420	7.00	75998	3.3	1.36	1225
435	7.25	74773	3.2	1.32	1188
450	7.50	73585	3.2	1.32	1188
465	7.75	72397	3.1	1.28	1150
480	8.00	71247	3.1	1.28	1150
495	8.25	70096	3.0	1.24	1112
510	8.50	68985	3.0	1.24	1112
525	8.75	67873	3.0	1.24	1112
540	9.00	66762	2.9	1.19	1071
555	9.25	65690	2.9	1.19	1071
570	9.50	64619	2.8	1.14	1029
585	9.75	63590	2.8	1.14	1029
600	10.00	62561	2.7	1.09	985
615	10.25	61576	2.7	1.09	985
630	10.50	60590	2.7	1.09	985
645	10.75	59605	2.6	1.04	940
660	11.00	58665	2.6	1.04	940

Time (min)	Time (hr)	Volume (ft3)	Depth (ft)	Q (ft3/s)	ΔVolume (ft3)
675	11.25	57726	2.6	1.04	940
690	11.50	56786	2.5	0.99	891
705	11.75	55895	2.5	0.99	891
720	12.00	55003	2.4	0.93	841
735	12.25	54162	2.4	0.93	841
750	12.50	53322	2.4	0.93	841
765	12.75	52481	2.3	0.87	786
780	13.00	51695	2.3	0.87	786
795	13.25	50908	2.3	0.87	786
810	13.50	50122	2.2	0.81	728
825	13.75	49394	2.2	0.81	728
840	14.00	48666	2.2	0.81	728
855	14.25	47937	2.2	0.81	728
870	14.50	47209	2.1	0.74	665
885	14.75	46544	2.1	0.74	665
900	15.00	45879	2.1	0.74	665
915	15.25	45214	2.0	0.66	595
930	15.50	44619	2.0	0.66	595
945	15.75	44024	2.0	0.66	595
960	16.00	43429	2.0	0.66	595
975	16.25	42834	1.9	0.57	516
990	16.50	42319	1.9	0.57	516
1005	16.75	41803	1.9	0.57	516
1020	17.00	41287	1.9	0.57	516
1035	17.25	40772	1.9	0.57	516
1050	17.50	40256	1.8	0.47	422
1065	17.75	39834	1.8	0.47	422
1080	18.00	39413	1.8	0.47	422
1095	18.25	38991	1.8	0.47	422
1110	18.50	38570	1.8	0.47	422
1125	18.75	38148	1.7	0.33	299
1140	19.00	37849	1.7	0.33	299
1155	19.25	37549	1.7	0.33	299
1170	19.50	37250	1.7	0.33	299
1185	19.75	36951	1.7	0.33	299
1200	20.00	36651	1.7	0.33	299
1215	20.25	36352	1.7	0.33	299
1230	20.50	36053	1.7	0.33	299
1245	20.75	35753	1.6	0.04	38
1260	21.00	35715	1.6	0.04	38
1275	21.25	35677	1.6	0.04	38
1290	21.50	35638	1.6	0.04	38
1305	21.75	35600	1.6	0.04	38
1320	22.00	35562	1.6	0.04	38
1335	22.25	35523	1.6	0.04	38
1350	22.50	35485	1.6	0.04	38
1365	22.75	35447	1.6	0.04	38
1380	23.00	35408	1.6	0.04	38
1395	23.25	35370	1.6	0.04	38
1410	23.50	35332	1.6	0.04	38
1425	23.75	35293	1.6	0.04	38
1440	24.00	35255	1.6	0.04	38

Detention Basin Stage-Volume

Elevation (ft)	Area (ft2)	Volume (ft3)	Cum Volume (ft3)	Cum Volume (ac-ft)
7681.5	19356.6	0	0	0.00
7681.6	19561	1946	1946	0.04
7681.7	19765	1966	3912	0.09
7681.8	19970	1987	5899	0.14
7681.9	20174	2007	7906	0.18
7682.0	20379	2028	9934	0.23
7682.1	20596	2049	11982	0.28
7682.2	20813	2070	14053	0.32
7682.3	21030	2092	16145	0.37
7682.4	21248	2114	18259	0.42
7682.5	21465	2136	20395	0.47
7682.6	21682	2157	22552	0.52
7682.7	21900	2179	24731	0.57
7682.8	22117	2201	26932	0.62
7682.9	22334	2223	29154	0.67
7683.0	22551	2244	31399	0.72
7683.1	22778	2266	33665	0.77
7683.2	23004	2289	35954	0.83
7683.3	23230	2312	38266	0.88
7683.4	23457	2334	40600	0.93
7683.5	23683	2357	42957	0.99
7683.6	23909	2380	45337	1.04
7683.7	24135	2402	47739	1.10
7683.8	24362	2425	50164	1.15
7683.9	24588	2447	52612	1.21
7684.0	24814	2470	55082	1.26
7684.1	25050	2493	57575	1.32
7684.2	25285	2517	60092	1.38
7684.3	25520	2540	62632	1.44
7684.4	25756	2564	65196	1.50
7684.5	25991	2587	67783	1.56
7684.6	26227	2611	70394	1.62
7684.7	26462	2634	73028	1.68
7684.8	26697	2658	75686	1.74
7684.9	26933	2682	78368	1.80
7685.0	27168	2705	81073	1.86
7685.1	27412	2729	83802	1.92
7685.2	27657	2753	86555	1.99
7685.3	27901	2778	89333	2.05
7685.4	28146	2802	92136	2.12
7685.5	28390	2827	94962	2.18
7685.6	28634	2851	97814	2.25
7685.7	28879	2876	100689	2.31

Elevation (ft)	Area (ft2)	Volume (ft3)	Cum Volume (ft3)	Cum Volume (ac-ft)
7685.8	29123	2900	103589	2.38
7685.9	29367	2925	106514	2.45
7686.0	29612	2949	109463	2.51
7686.1	29865	2974	112437	2.58
7686.2	30119	2999	115436	2.65
7686.3	30372	3025	118460	2.72
7686.4	30626	3050	121510	2.79
7686.5	30879	3075	124586	2.86
7686.6	31133	3101	127686	2.93
7686.7	31386	3126	130812	3.00
7686.8	31639	3151	133963	3.08
7686.9	31893	3177	137140	3.15
7687.0	32146	3202	140342	3.22
7687.1	32409	3228	143570	3.30
7687.2	32671	3254	146824	3.37
7687.3	32934	3280	150104	3.45
7687.4	33196	3306	153410	3.52
7687.5	33459	3333	156743	3.60
7687.6	33721	3359	160102	3.68
7687.7	33983	3385	163487	3.75
7687.8	34246	3411	166899	3.83
7687.9	34508	3438	170337	3.91
7688.0	34771	3464	173800	3.99
7688.1	35042	3491	177291	4.07
7688.2	35314	3518	180809	4.15
7688.3	35585	3545	184354	4.23
7688.4	35857	3572	187926	4.31
7688.5	36129	3599	191525	4.40
7688.6	36400	3626	195152	4.48
7688.7	36672	3654	198805	4.56
7688.8	36943	3681	202486	4.65
7688.9	37215	3708	206194	4.73
7689.0	37486	3735	209929	4.82
7689.1	37767	3763	213692	4.91
7689.2	38047	3791	217482	4.99
7689.3	38328	3819	221301	5.08
7689.4	38609	3847	225148	5.17
7689.5	38889	3875	229023	5.26
7689.6	39170	3903	232926	5.35
7689.7	39450	3931	236857	5.44
7689.8	39731	3959	240816	5.53
7689.9	40011	3987	244803	5.62
7690.0	40292	4015	248818	5.71

SCS CURVE NUMBER
Kinney Mine Hydrology

SB_F1

							10-YR 6-HR		10-yr 24-HR		100-YR 6-HR	
							Rainfall (in)	1.28	Rainfall (in)	1.92	Rainfall (in)	2.08
Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	Runoff (cfs)	Vol (cf)	Runoff (cfs)	Vol (cf)	Runoff (cfs)	Vol (cf)
Roads	2288.29	0.05	0.00008	1.4	98	0.20	1.1	202.9	1.7	323.2	1.9	353.5
Pad	122526.6	2.81	0.00440	75.7	90	1.11	0.5	5267.5	1.0	10478.0	1.2	11869.8
Natural	21443.42	0.49	0.00077	13.2	75	3.33	0.1	170.3	0.3	612.0	0.4	752.0
Revegetated	15641.47	0.36	0.00056	9.7	82	2.20	0.2	303.6	0.6	777.7	0.7	915.0
TOTALS	161899.8	3.72	0.00581	100	87			5944.3		12190.9		13890.2
										0.28 ac-ft		0.32 ac-ft

SB_D1

							10-YR 6-HR		10-yr 24-HR		100-YR 6-HR	
							Rainfall (in)	1.28	Rainfall (in)	1.92	Rainfall (in)	2.08
Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	Runoff (cfs)	Vol (cf)	Runoff (cfs)	Vol (cf)	Runoff (cfs)	Vol (cf)
Roads	2165.29	0.05	0.00008	2.5	98	0.20	1.1	192.0	1.7	305.9	1.9	334.5
Pad	40914.9	0.94	0.00147	33.7	90	1.11	0.5	1758.9	1.0	3498.9	1.2	3963.6
Natural	67374.28	1.55	0.00242	55.5	75	3.33	0.1	535.2	0.3	1922.9	0.4	2362.7
Revegetated	10895.72	0.25	0.00039	9.0	82	2.20	0.2	211.5	0.6	541.7	0.7	637.4
TOTALS	121350.2	2.79	0.00435	101	81			2697.6		6269.3		7298.2
										0.14 ac-ft		0.17 ac-ft

SB_D2

							10-YR 6-HR		10-yr 24-HR		100-YR 6-HR	
							Rainfall (in)	1.28	Rainfall (in)	1.92	Rainfall (in)	2.08
Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	Runoff (cfs)	Vol (cf)	Runoff (cfs)	Vol (cf)	Runoff (cfs)	Vol (cf)
Roads	2442.07	0.06	0.00009	2.8	98	0.20	1.1	216.5	1.7	345.0	1.9	377.2
Pad	12679.13	0.29	0.00045	14.8	90	1.11	0.5	545.1	1.0	1084.3	1.2	1228.3
Natural	59411.24	1.36	0.00213	69.1	75	3.33	0.1	471.9	0.3	1695.6	0.4	2083.5
Revegetated	11426.79	0.26	0.00041	13.3	82	2.20	0.2	221.8	0.6	568.1	0.7	668.4
TOTALS	85959.23	1.97	0.00308	100	79			1455.3		3693.0		4357.4
										0.08 ac-ft		0.10 ac-ft

SB_F2

							10-YR 6-HR		10-yr 24-HR		100-YR 6-HR	
							Rainfall (in)	1.28	Rainfall (in)	1.92	Rainfall (in)	2.08
Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	Runoff (cfs)	Vol (cf)	Runoff (cfs)	Vol (cf)	Runoff (cfs)	Vol (cf)
Roads	10732.04	0.25	0.00038	19.4	98	0.20	1.1	951.5	1.7	1516.0	1.9	1657.8
Natural	0	0.00	0.00000	0.0	75	3.33	0.1	0.0	0.3	0.0	0.4	0.0
Revegetated	44561.29	1.02	0.00160	80.6	82	2.20	0.2	865.0	0.6	2215.6	0.7	2606.7
TOTALS	55293.33	1.27	0.00198	100	85			1816.6		3731.6		4264.5
										0.09 ac-ft		0.10 ac-ft

SB_E1

							10-YR 6-HR		10-yr 24-HR		100-YR 6-HR	
							Rainfall (in)	1.28	Rainfall (in)	1.92	Rainfall (in)	2.08
Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	Runoff (cfs)	Vol (cf)	Runoff (cfs)	Vol (cf)	Runoff (cfs)	Vol (cf)
Pad	143106.9	3.29	0.00513	74.1	90	1.11	0.5	6152.2	1.0	12237.9	1.2	13863.5
Natural	9446.91	0.22	0.00034	4.9	75	3.33	0.1	75.0	0.3	269.6	0.4	331.3
Revegetated	40693.85	0.93	0.00146	21.1	82	2.20	0.2	789.9	0.6	2023.3	0.7	2380.5
TOTALS	193247.7	4.44	0.00693	100	88			7017.2		14530.8		16575.3
										0.33 ac-ft		0.38 ac-ft

SB_D3

							10-YR 6-HR		10-yr 24-HR		100-YR 6-HR	
							Rainfall (in)	1.28	Rainfall (in)	1.92	Rainfall (in)	2.08
Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	Runoff (cfs)	Vol (cf)	Runoff (cfs)	Vol (cf)	Runoff (cfs)	Vol (cf)
Roads	11513.94	0.26	0.00041	19.7	98	0.20	1.1	1020.9	1.7	1626.4	1.9	1778.6
Natural	39630.22	0.91	0.00142	20.5	75	3.33	0.1	314.8	0.3	1131.0	0.4	1389.8
Revegetated	7211.62	0.17	0.00026	12.4	82	2.20	0.2	140.0	0.6	358.6	0.7	421.9
TOTALS	58355.78	1.34	0.00209	53	80			1475.6		3116.0		3590.2
										0.07 ac-ft		0.08 ac-ft

SB_A1

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Roads	19147.5	0.44	0.00069	32.8	98	0.20	1.1	1697.7	1.7	2704.7	1.9	2957.8
Natural	63174.77	1.45	0.00227	32.7	75	3.33	0.1	501.8	0.3	1803.0	0.4	2215.5
Pad	42016.47	0.96	0.00151	21.7	90	1.11	0.5	1806.3	1.0	3593.1	1.2	4070.4
Revegetated	54006.16	1.24	0.00194	30.3	82	2.20	0.2	1048.4	0.6	2685.2	0.7	3159.2
TOTALS	178344.9	4.09	0.00640	118	83			5054.1		10786.0		12402.8
										0.25 ac-ft		0.28 ac-ft

SB_B1

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Pad	91371.01	2.10	0.00328	47.3	90	1.11	0.5	3928.1	1.0	7813.7	1.2	8851.6
Natural	26384.94	0.61	0.00095	13.7	75	3.33	0.1	209.6	0.3	753.0	0.4	925.3
Revegetated	34907.15	0.80	0.00125	22.9	82	2.20	0.2	677.6	0.6	1735.6	0.7	2042.0
TOTALS	152663.1	3.50	0.00548	84	86			677.6		1735.6		2042.0
										0.04 ac-ft		0.05 ac-ft

SB_C1

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Roads	0	0.00	0.00000	0.0	98	0.20	1.1	0.0	1.7	0.0	1.9	0.0
Pad	91265.3	2.10	0.00327	136.8	90	1.11	0.5	3923.5	1.0	7804.6	1.2	8841.3
Natural	52325.33	1.20	0.00188	27.1	75	3.33	0.1	415.6	0.3	1493.4	0.4	1835.0
Revegetated	38502.3	0.88	0.00138	21.1	82	2.20	0.2	747.4	0.6	1914.3	0.7	2252.3
TOTALS	182092.9	4.18	0.00653	185	84			5086.5		11212.3		12928.6
										0.26 ac-ft		0.30 ac-ft

SB_E2

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Roads	13703.95	0.31	0.00049	7.5	98	0.20	1.1	1215.0	1.7	1935.8	1.9	2116.9
Pad	0	0.00	0.00000	0.0	90	1.11	0.5	0.0	1.0	0.0	1.2	0.0
Natural	26904.93	0.62	0.00097	13.9	75	3.33	0.1	213.7	0.3	767.9	0.4	943.5
Revegetated	32464.12	0.75	0.00116	17.8	82	2.20	0.2	630.2	0.6	1614.1	0.7	1899.1
TOTALS	73073	1.68	0.00262	39	82			2058.9		4317.8		4959.5
										0.10 ac-ft		0.11 ac-ft

SB_E4

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Natural	50993.98	1.17	0.00183	76.5	75	3.33	0.1	405.0	0.3	1455.4	0.4	1788.3
Revegetated	15708.03	0.36	0.00056	23.5	82	2.20	0.2	304.9	0.6	781.0	0.7	918.9
TOTALS	66702.01	1.53	0.00239	100	77			710.0		2236.4		2707.2
										0.05 ac-ft		0.06 ac-ft

SB_E3

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Revegetated	23139.08	0.53	0.00083	34.7	82	2.20	0.2	449.2	0.6	1150.5	0.7	1353.6
TOTALS	23139.08	0.53	0.00083	35	82			449.2		1150.5		1353.6
										0.03 ac-ft		0.03 ac-ft

SB_Pond1

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	Vol (cf)
Detention Pond	19356.6	0.44	0.00069	20.6	100	0.00	1.3	2064.7	1.9	3097.1	2.1	3355.1
Revegetated	46571.36	1.07	0.00167	69.8	82	2.20	0.2	904.0	0.6	2315.5	0.7	2724.3
Natural	28145.53	0.65	0.00101	29.9	75	3.33	0.1	223.6	0.3	803.3	0.4	987.0
TOTALS	94073.49	2.16	0.00337	120	84			3192.3		6215.8		7066.5
										0.14 ac-ft		0.16 ac-ft

SB_AltA

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	10-YR 6-HR Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	10-yr 24-HR Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	100-YR 6-HR Vol (cf)
Revegetated	111806.6	2.57	0.00401	167.6	82	2.20	0.2	2170.4	0.6	5559.0	0.7	6540.3
TOTALS	111806.6	2.57	0.00401	168	82			2170.4		5559.0		6540.3
										0.13 ac-ft		0.15 ac-ft

SB_AltB

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	10-YR 6-HR Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	10-yr 24-HR Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	100-YR 6-HR Vol (cf)
Roads	4030.63	0.09	0.00014	2.2	98	0.20	1.1	357.4	1.7	569.4	1.9	622.6
Revegetated	21513.94	0.49	0.00077	32.3	82	2.20	0.2	417.6	0.6	1069.7	0.7	1258.5
TOTALS	25544.57	0.59	0.00092	34	85			775.0		1639.0		1881.1
										0.04 ac-ft		0.04 ac-ft

SB_AltC

Subbasin Area	AREA (ft2)	AREA (acres)	AREA (mi2)	% AREA (%)	CN	S	10-YR 6-HR Rainfall (in) 1.28 Runoff (cfs)	10-YR 6-HR Vol (cf)	10-yr 24-HR Rainfall (in) 1.92 Runoff (cfs)	10-yr 24-HR Vol (cf)	100-YR 6-HR Rainfall (in) 2.08 Runoff (cfs)	100-YR 6-HR Vol (cf)
Roads	3773.2	0.09	0.00014	2.1	98	0.20	1.1	334.5	1.7	533.0	1.9	582.9
Revegetated	15615.05	0.36	0.00056	23.4	82	2.20	0.2	303.1	0.6	776.4	0.7	913.4
TOTALS	19388.25	0.45	0.00070	25	85			637.7		1309.4		1496.3
										0.03 ac-ft		0.03 ac-ft

Overall Totals	1602934	36.80	0.0575		84

Total Approximate Storage Volumes = 2.06 ac-ft 2.37 ac-ft

Pond No.	Available Sediment Storage Volume (acre-feet)	Required 3-year Accumulated Sediment Storage Volume (acre-feet)	Available Runoff Storage Volume (acre-feet)	Required 10-yr, 24-hr Runoff Storage Volume (acre-feet)	Comments and Recommendations
7	0.04	0.04	0.63	0.58	Pond Adequate
8	1.1	1.1	2.77	2.20	Pond Adequate
9	2.02	1.98	4.50	4.45	Pond Adequate

Note: Pond No. 1 is classified as a treatment facility and not a sedimentation pond.

The sediment ponds and treatment facility were designed (where possible) to contain the accumulated sediment volume from a three-year period and to prevent short circuiting. The amount of sediment to be yielded to the sedimentation ponds was determined from the Universal Soil Loss Equation (USLE) (Clyde et al., 1978, and U. S. Soil Conservation Service, 1977). In accordance with this equation, soil erosion caused by water is determined from

$$A = R*K*LS*C*P \tag{742-2}$$

where:

A = computed amount of soil loss, in tons/acre/year;
R = rainfall factor, in foot-tons/acre/hour;
K = soil erodibility factor, in tons/acre/year/unit of R;
LS = topographic factor (length and steepness of slope), dimensionless;
C = cover or cropping management factor, dimensionless; and
P = erosion control practice factor, dimensionless.

Values for R and K were determined from Clyde et al. (1978). The topographic factor (LS) was determined from

$$LS = \frac{(650 + 450\,S + 65\,S^2)\ (L/72.6)^m}{10,000 + S^2} \tag{742-3}$$

where:

L = average overland flow length, in feet;
S = average steepness of slope, in percent; and
m = an exponent dependent upon the steepness of slope (0.3 for slopes less than 0.5%, 0.5 for slopes 0.51% to 10%, and 0.6 for slopes greater than 10%).

The average overland flow length (L) was determined from Williams and Berndt (1972) as defined by the equation

$$L = \frac{0.5\ DA}{LCH} \qquad (742\text{-}4)$$

where:

DA = drainage area, in square feet; and
LCH = total length of channels in the watershed, in feet.

Values for C and P were determined from the U. S. Soil Conservation Service (1977).

A sediment density of 75 lb/ft^3 was used in conjunction with the USLE to determine the volume of reservoir sediment storage required. This value was obtained based upon on-site soil surveys (see Section 200 for more soils related information) which show that local soils consist mostly of a mixture of silty clayey sands. Sands commonly have unit weights in the order of 85-100 pcf based upon ASCE findings (see Sedimentation Engineering - ASCE M & R No. 54) with values more commonly used in the order of 95 pcf. Other references confirm this and indicate that silts and clays usually have lower unit weights, but at times do range from 27 to 100 pcf. Because local soil complexes do contain substantial quantities of silts and clays, a more conservative sediment density of 75 pcf was chosen as the appropriate value to use for calculation of sediment volume.

The ponds have been designed so that sediment will be removed when the sediment volume reaches 60 percent of the accumulated sediment storage volume. All sediments will be disposed of in the washed coal refuse pile. Sediment yield parameters and the accumulated sediment volume for each pond (including Treatment Facility No. 1) are contained in Table 742.221b, Sediment Design Parameters for Sediment Ponds 1 through 9.

TABLE 742.221b
Sediment Design Parameters for Sediment Ponds 1 through 9.

Sedimentation Pond No.	Contributing Area D-Disturbed U-Undisturbed	Rainfall Factor (R) ft-tons/ac/hr	Soil Erodibility Factor (K) tons/ac/yr per unit of R	Slope Length Factor L ft	Slope Gradient Factor S percent	LS	Cover Factor	Erosion Control Practice Factor (P)	Estimated Soil Loss (A) ton/ac/yr	Sediment Delivery Ratio	Estimated Sediment Contribution in Sedimentation Ponds: ac-ft/ac/yr	ac-ft/yr	Accumulated Sediment Volume ac-ft: 3-year	2-year
1	D-5.1 U-9.5	22.0 22.0	0.28 0.28	82 105	3.0 70.0	0.28 29.4	1.0 0.2	1.0 1.0	1.7 36.2	0.65 0.60	0.0007 0.0133	0.004 0.126	0.39	0.26
2	D-9.1 U-6.0	22.0 22.0	0.28 0.28	200 220	34.0 39.0	11.9 19.8	1.0 0.2	1.0 1.0	73.3 24.4	0.60 0.56	0.0269 0.0084	0.245 0.050	0.89	0.59
3	D-5.0 U-52.1	22.0 22.0	0.28 0.28	63 140	2.0 65.0	0.17 31.7	1.0 0.2	1.0 1.0	1.0 39.0	0.60 0.45	0.0004 0.0107	0.002 0.557	1.68	1.11
4	D-23.0 U-17.6	22.0 22.0	0.28 0.28	160 84	12.8 45.0	2.7 13.8	1.0 0.2	1.0 1.0	16.6 17.0	0.52 0.60	0.0053 0.0062	0.122 0.109	0.69	0.46
5	D-65.6 U-29.4	22.0 22.0	0.28 0.28	205 118	16.0 54.0	4.5 22.2	1.0 0.2	1.0 1.0	27.7 27.4	0.45 0.50	0.0076 0.0084	0.499 0.247	2.24	1.49
6	D-27.5 U-6.5	22.0 22.0	0.28 0.28	99 99	10.0 43.5	1.4 14.5	1.0 0.2	1.0 1.0	8.6 17.9	0.50 0.65	0.0026 0.0071	0.072 0.046	0.35	0.24

Energy Dissipation Structures

Energy Dissipation Structures

Design of rip-rap apron for outlets of ICP-2 and UDC-1 using Drainage Criteria Manual (V.2)

	Pipe Size (in)	Design Flow (cfs)	
CP-2	42	33.8	
UDC-1	30	14.3 + 1 cfs = 15.3 cfs	(Assumed minimal irrigation pipe)

Design of rip-rap apron completed for both throughout.

$$Q_{full} = \frac{1.49}{n} A_{full} (R_{full})^{2/3} (S_o)^{1/2}$$

$n = 0.024$ (Ref: Civil Engineering Reference Manual, 2006)

$$A_{full} = \frac{\pi D^2}{4}$$

$$= \frac{\pi \left(\frac{42\,in}{12\,in}\right)^2}{4} = 9.6211\ ft^2 \quad (4.9087\ ft^2)$$

$$R_{full} = \frac{D}{4} = \frac{\left(\frac{42\,in}{12\,in}\right)}{4} = 0.875\ ft \quad (0.625\ ft)$$

$$S_o = \frac{(7667.61\ ft - 7655.45\ ft)}{74.1\ ft} = 0.1641\ ft/ft$$

$$(0.0761\ ft/ft)$$

$$Q_{full} = \frac{1.49}{0.024} (9.6211\ ft^2)(0.875\ ft)^{2/3} (0.1641\ ft/ft)^{1/2}$$

$$= 221.357\ ft^3/s$$

$$(61.455\ ft^3/s)$$

$$V_{full} = \frac{Q_{full}}{A_{full}} = \frac{221.357\ ft^3/s}{9.6211\ ft^2} = 23.01\ ft/s$$

$$(12.52\ ft/s)$$

Q_{design} (see culvert design calcs) = 33.8 ft^3/s

(15.3 ft^3/s)

$$\frac{Q_{design}}{Q_{full}} = \frac{33.8\ ft^3/s}{221.357\ ft^3/s} = 0.153$$

(0.249)

Using Figure HS-18b $\frac{d}{D} = 0.30$

(0.38)

Using Figure HS-19 $\frac{d}{D} = 0.42$

(0.435)

$$\frac{Q_{design}}{D^{2.5}} = \frac{33.8\ ft^3/s}{(3.5\ ft)^{2.5}} = 1.47\ (1.55)$$

Using Figure HS-18b: $\frac{A}{A_{full}} = 0.25\ (0.35)$

$$A = \left(\frac{A}{A_{full}}\right) A_{full}$$

$$= (0.25)(9.6211\ ft^2) = 2.4053\ ft^2$$

(1.7180 ft^2)

$$V_{design} = \frac{Q_{design}}{A}$$

$$= \frac{33.8\ ft^3/s}{2.4053\ ft^2} = 14.05\ ft/s$$

(8.91 ft/s)

$$P_d = (V^2 + gd)^{1/2} \quad (HS-16)$$

$V = 14.05\ ft/s$ (8.91 ft/s)
$g = 32.2\ ft/s^2$
$d = 1.05\ ft$ (0.95)

$$\frac{d}{D} = 0.3 \quad (0.38)$$

$$d = 0.3\ (3.5\ ft) = 1.05\ ft\ (0.95)$$

$$P_d = \left[(14.05\ ft/s)^2 + (32.2\ ft/s^2)(1.05\ ft) \right]^{1/2}$$

$$= 15.21\ ft/s$$

$$(10.49\ ft/s)$$

* Based on the 42-inch pipe and a P_d of 15.21 ft/s, rip-rap type L should be used.

$\rightarrow D_{50} =$ 9 inches (0.75 ft)

* Based on the 30-inch pipe and a P_d of 10.49 ft/s, rip-rap type L should be used.

$\rightarrow D_{50} =$ 9 inches (0.75 ft)

$$T = 1.75\,(D_{50})$$

$$= 1.75\,(0.75\ ft) = 1.31\ ft\ (1.31\ ft)$$

$$L = 4\,D$$

$$= 4\,(3.5\ ft) = 14\ ft\ (10\ ft)$$

$$L = (D)^{1/2}\left(\frac{V}{2}\right)$$

$$= (3.5\ ft)^{1/2}\left(\frac{14.05\ ft/s}{2}\right) = 8.90\ ft\ (7.04\ ft)$$

$$L = 14\ ft\ (10\ ft)$$

$$W = 4\,D$$

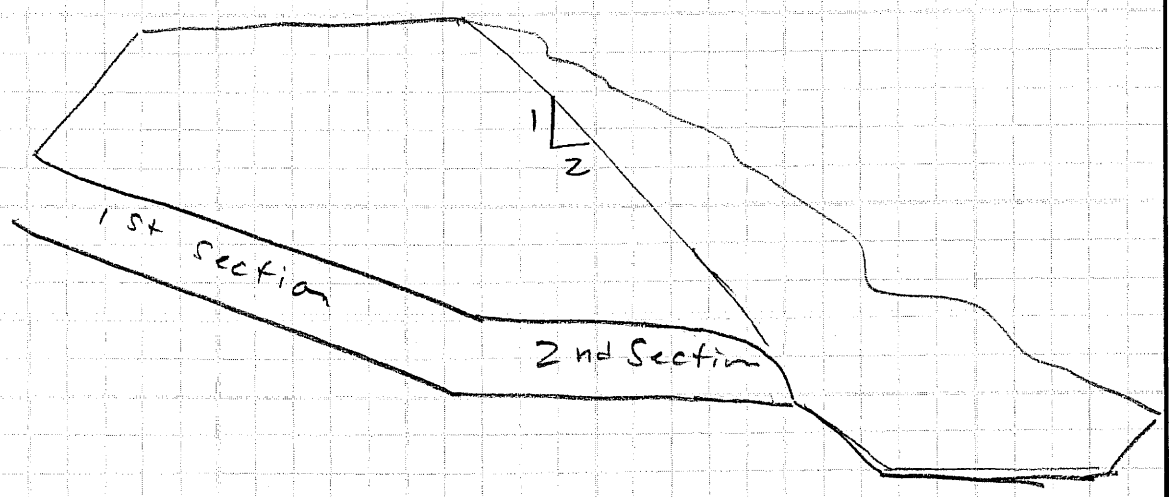
$$= 4\,(3.5\ ft) = 14\ ft\ (10\ ft)$$

HANSEN ALLEN & LUCE inc
ENGINEERS

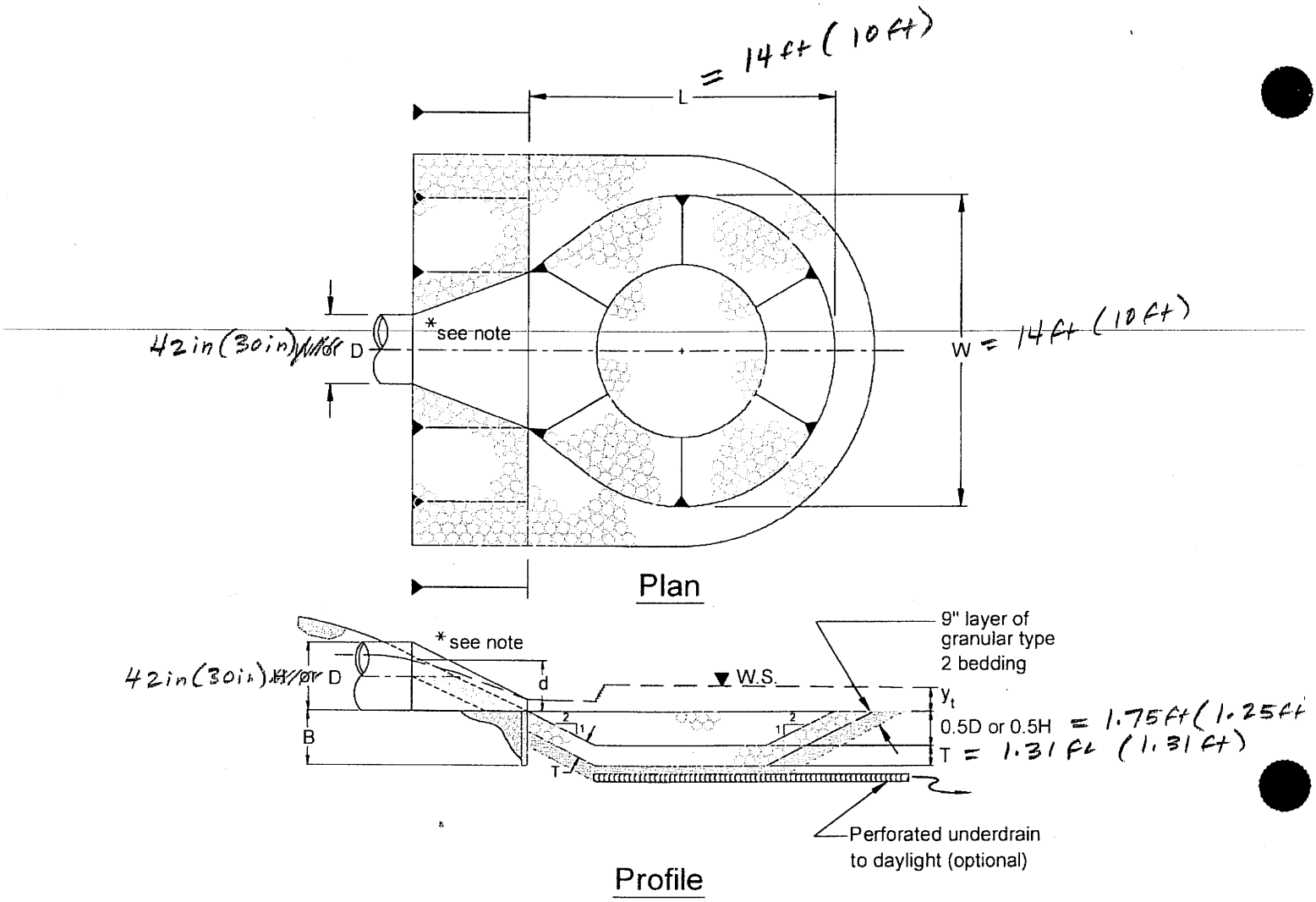
CLIENT Carbon Resources
PROJECT Kinney Mine
FEATURE Rip-rap apron design
PROJECT NO 368.01.400

SHEET 4 OF 1
COMPUTED TDS
CHECKED
DATE 1-23-08

- Refer to page HS-76 for typical rip-rap apron outlet.
- In order to maintain the flat bottom for the rip-rap apron, a change in grade of the outlet pipes may require a deflection when going under the highway (see drawing). The second section of pipe should be installed with a slope of 0.16 ft/ft (CP-2) and 0.08 ft/ft (UDC-1) or less.



SPECIAL NOTE:
ENERGY DISSIPATION POOL WILL BE COORDINATED WITH UDOT. IF INSUFFICIENT ROW CAN BE UTILIZED FOR CONSTRUCTION, AN ALTERNATIVE WILL BE WORKED OUT WHEREIN A CONCRETE ENERGY DISSIPATION DEVICE CAN BE USED TO MINIMIZE REQUIRED AREA.

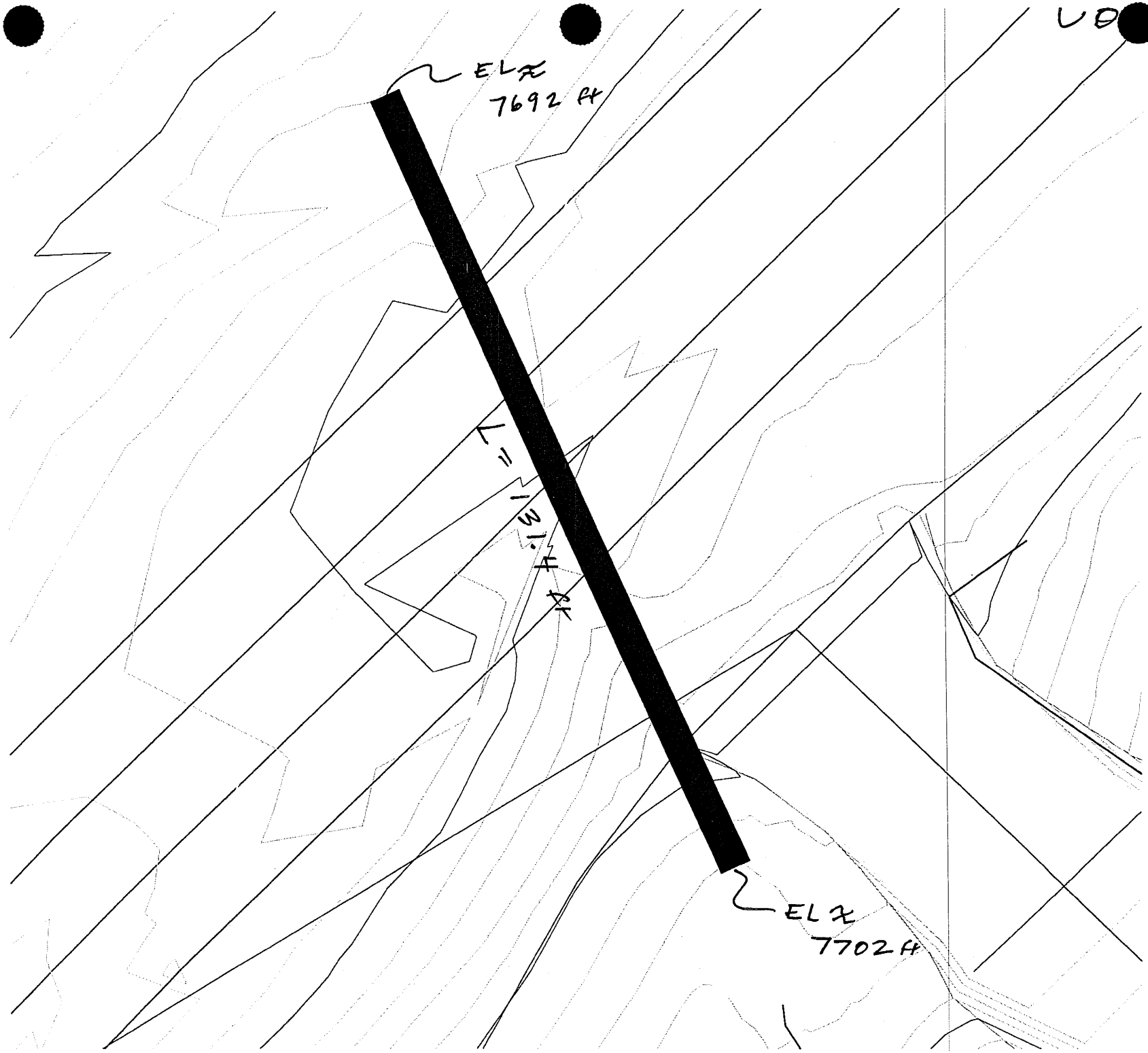


*Note: For rectangular conduits use a standard design for a headwall with wingwalls, paved bottom between the wingwalls, with an end cutoff wall extending to a minimum depth equal to B

Figure HS-18A—Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets—

Low Tailwater Basin at Pipe Outlets

(Stevens and Urbonas 1996)


EL ≈
7692 ft
L = 1.14 mi
EL ≈
7702 ft
N

CP-2

386
7658.38
TOP 36IN CMP
FL ≈ 7655.45 ft
L = 74.1 ft
390
7667.61
FL
389
7670.54
TOP 36IN CMP

↑ N

L1.

APPENDIX 17.F
Corrugated Metal Pipe

Corrugated metal pipe (CMP, also known as *corrugated steel pipe*) is frequently used for culverts. Pipe is made from corrugated sheets of galvanized steel that are rolled and riveted together along a longitudinal seam. Aluminized steel may also be used in certain ranges of soil pH. Standard round pipe diameters range from 8 to 96 in (200 to 2450 mm). Metric dimensions of standard diameters are usually rounded to the nearest 25 or 50 mm (e.g., a 42 in culvert would be specified as a 1050 mm culvert, not 1067 mm).

Larger and noncircular culverts can be created out of curved steel plate. Standard section lengths are 10 to 20 ft (3 to 6 m). Though most corrugations are transverse (i.e., annular), helical corrugations are also used. Metal gages of 8, 10, 12, 14, and 16 are commonly used, depending on the depth of burial.

The most common corrugated steel pipe has transverse corrugations that are ½ in (13 mm) deep and 2⅔ in (68 mm) from crest to crest. These are referred to as "2½ inch" or "68 × 13" corrugations. For larger culverts, corrugations with a 2 in (25 mm) depth and 3, 5, and 6 in (76, 125, or 152 mm) pitches are used. Plate-based products using 6 in by 2 in (152 mm by 51 mm) corrugations are known as *structural plate corrugated steel pipe* (SPCSP) and *multiplate* after the trade-named product "Multi-Plate™."

The flow area for circular culverts is based on the nominal culvert diameter, regardless of the gage of the plate metal used to construct the pipe. Flow area is calculated to (at most) three significant digits.

A Hazen-Williams coefficient, C, of 60 is typically used with all sizes of corrugated pipe. Values of C and Manning's constant, n, for corrugated pipe are generally not affected by age. *Design Charts for Open Channel Flow* (U.S. Department of Transportation, 1979) recommends a Manning constant of $n = 0.024$ for all cases. The U.S. Department of the Interior recommends the following values. For standard (2⅔ in by ½ in or 68 mm by 13 mm) corrugated pipe with the diameters given: 12 in (457 mm), 0.027; 24 in (610 mm), 0.025; 36 to 48 in (914 to 1219 mm), 0.024; 60 to 84 in (1524 to 2134 mm), 0.023; 96 in (2438 mm), 0.022. For (6 in by 2 in or 152 mm by 51 mm) multiplate construction with the diameters given: 5 to 6 ft (1.5 to 1.8 m), 0.034; 7 to 8 ft (2.1 to 2.4 m), 0.33; 9 to 11 ft (2.7 to 3.3 m), 0.32; 12 to 13 ft (3.6 to 3.9 m), 0.31; 14 to 15 (4.2 to 4.5 m), 0.030; 16 to 18 ft (4.8 to 5.4 m), 0.029; 19 to 20 ft (5.8 to 6.0 m), 0.028; 21 to 22 ft (6.3 to 6.6 m), 0.027.

If the inside of the corrugated pipe has been asphalted completely smooth 360° circumferentially, Manning's n ranges from 0.009 to 0.011. For culverts with 40% asphalted inverts, $n = 0.019$. For other percentages of paved invert, the resulting value is proportional to the percentage and the values normally corresponding to that diameter pipe. For field-bolted corrugated metal pipe arches, $n = 0.025$.

It is also possible to calculate the Darcy friction loss if the corrugation depth, 0.5 in (13 mm) for standard corrugations and 2.0 in (51 mm) for multiplate, is taken as the specific roughness.

Ref: Civil Engineering Reference Manual, 2006

Support Material

accumulation at the upstream row of baffles.

Flow entering the chute should be well distributed laterally across the width of the chute. The velocity should be below critical velocity at the crest of the chute. To insure low velocities at the upstream end of the chute, it may be necessary to provide a short energy dissipating pool. The sequent or conjugate depth in the approach basin should be maintained to prevent jump sweep-out, but the basin length may be considerably less than a conventional hydraulic jump basin since the primary purpose of this pool is only to reduce the average entrance velocity. A basin length of twice the sequent depth will usually provide ample basin length. The end check of the pool may be used as the crest of the chute as shown in Figure HS-17.

3.4 Low Tailwater Basins

3.4.1 General

The design of low tailwater riprap basins for storm sewer pipe outlets and some culverts is necessary when the receiving channel may have little or no flow and uncontrolled pipe velocities would create erosional problems in the channel. Design criteria are provided in Figures HS-18a through HS-20.

3.4.2 Objective

By providing a low tailwater basin at the end of a storm sewer conduit or culvert, the kinetic energy of the discharge is dissipated under controlled conditions without causing scour at the channel bottom. Photograph HS-12 shows a representative low tailwater basin.

3.4.3 Low Tailwater Basin Design

For storm sewers, low tailwater is defined as being equal to or less than ⅓ of the storm sewer height, that is:

$$y_t \leq \frac{D}{3} \quad \text{or} \quad y_t \leq \frac{H}{3}$$

in which:

y_t = tailwater depth at design

D = diameter of circular pipe (ft)

H = height of rectangular pipe (ft)

3.4.3.1 Finding Flow Depth and Velocity of Storm Sewer Pipe Outlets

The first step in the design of a scour protection basin at the outlet of a storm sewer is to find the depth and velocity of flow at the outlet. Pipe-full flow can be found using Manning's equation and the pipe-full velocity can be found using the well-known and standard continuity equation. Namely,

$$Q_{full} = \frac{1.49}{n} A_{full} \left(R_{full}\right)^{2/3} S_o^{1/2}$$

in which:

Q_{full} = pipe full discharge at its slope (cfs)

n = Manning's n for the pipe full depth

A_{full} = cross-sectional area of the pipe (ft^2)

S_o = longitudinal slope of the pipe (ft/ft)

R = hydraulic radius of the pipe flowing full, ft [$R_{full} = D/4$ for circular pipes, $R_{full} = A_{full}/(2H + 2w)$ for rectangular pipes, where D = diameter of a circular conduit, H = height of a rectangular conduit, and w = width of a rectangular conduit (ft)]

Then,

$$V_{full} = Q_{full} / A_{full}$$

In which:

V_{full} = flow velocity of the pipe flowing full (ft/sec)

The normal depth of flow, d, and the velocity at that depth in a conduit can be found with the aid of Figure HS-18b. Using the known design discharge, Q, and the calculated pipe-full discharge, Q_{full}, enter Figure HS-18b with the value of Q/Q_{full} and find d/D for a circular pipe of d/H for a rectangular pipe.

Compare the value of this d/D (or d/H) with that obtained from Figure HS-19 using the Froude parameter, namely,

$$Q/D^{2.5} \quad \text{or} \quad Q/\left(wH^{1/5}\right)$$

Choose the smaller of the two (d/D or d/H) ratios to calculate the flow depth at the end of the pipe, namely,

$$d = D(d/D) \quad \text{or} \quad d = H(d/H)$$

Again, enter Figure HS-18b using the smaller d/D (or d/H) ratio to find the A/A_{full} ratio. Use this to calculate the area of flow at the end of the pipe, namely,

$$A = \left(A/A_{full}\right)A_{full}$$

in which:

A = area of the design flow in the end of the pipe (ft^2)

Finally,

$$V = Q/A$$

in which:

V = design flow velocity at the pipe outlet (ft/sec)

3.4.3.2 Riprap Size

For the design velocity, use Figure HS-20 to find the size and type of the riprap to use in the scour protection basin downstream of the pipe outlet (i.e., B18, H, M or L). First, calculate the riprap sizing design parameter, P_d, namely,

$$P_d = \left(V^2 + gd\right)^{1/2} \qquad \text{(HS-16)}$$

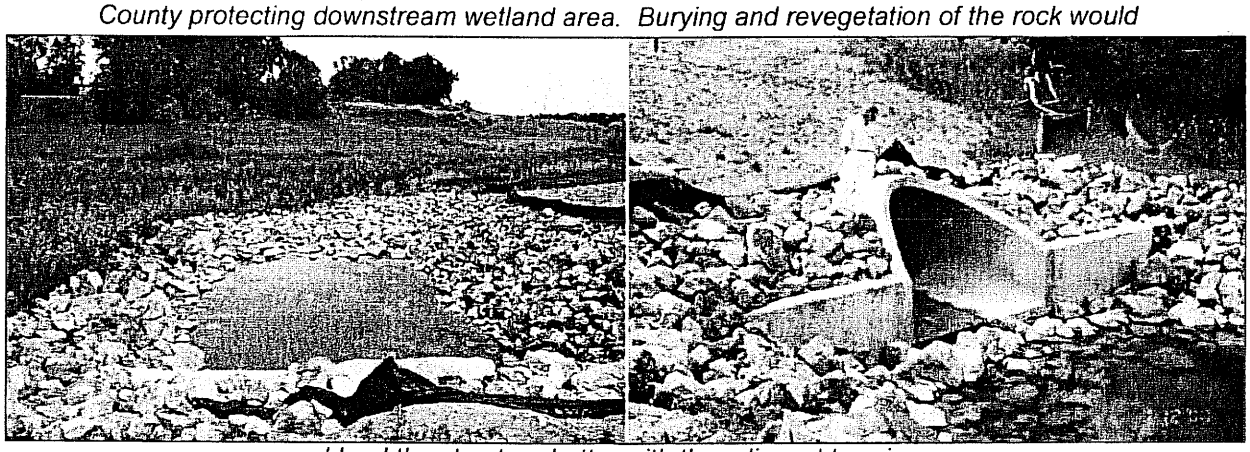
in which:

V = design flow velocity at pipe outlet (ft/sec)

g = acceleration due to gravity = 32.2 ft/sec^2

d = design depth of flow at pipe outlet (ft)

Photograph HS-12—Upstream and downstream views of a low tailwater basin in Douglas County protecting downstream wetland area. Burying and revegetation of the rock would



blend the structure better with the adjacent terrain.

When the riprap sizing design parameter indicates conditions that place the design above the Type H riprap line in Figure HS-20, use B18, or larger, grouted boulders. An alternative to a grouted boulder or loose riprap basin is to use the standard USBR Basin VI, as described in Section 3.2.

After the riprap size has been selected, the minimum thickness of the riprap layer, T, in feet, in the basin is set at:

$$T = 1.75 D_{50} \qquad \text{(HS-17)}$$

in which:

D_{50} = the median size of the riprap (see Table HS-9.)

Table HS-9—Median (i.e., D_{50}) Size of District's Riprap

Riprap Type	D_{50}—Median Rock Size (inches)
L	9
M	12
H	18
B18	18 (grouted)

3.4.3.3 Basin Length

The minimum length of the basin, L, in Figure HS-18a, is defined as being the greater of the following lengths:

for circular pipe,

$$L = 4D \quad \text{or} \quad L = (D)^{1/2}\left(\frac{V}{2}\right) \qquad \text{(HS-18)}$$

for rectangular pipe,

$$L = 4H \quad \text{or} \quad L = (H)^{1/2}\left(\frac{V}{2}\right) \qquad \text{(HS-19)}$$

in which:

L = basin length (Figure HS-18a)

H = height of rectangular conduit

V = design flow velocity at outlet

D = diameter of circular conduit

3.4.3.4 Basin Width

The minimum width, W, of the basin downstream of the pipe's flared end section is set as follows:

for circular pipes,

$$W = 4D \qquad \text{(HS-20)}$$

for rectangular pipe,

$$W = w + 4H \qquad \text{(HS-21)}$$

in which:

W = basin width (Figure HS-18a)

D = diameter of circular conduit

w = width of rectangular conduit

3.4.3.5 Other Design Requirements

All slopes in the pre-shaped riprapped basin are 2H to 1V.

Provide pipe joint fasteners and a structural concrete cutoff wall at the end of the flared end section for a circular pipe or a headwall with wingwalls and a paved bottom between the walls, both with a cutoff wall that extends down to a depth of

$$B = \frac{D}{2} + T \quad \text{or} \quad B = \frac{H}{2} + T \qquad \text{(HS-22)}$$

in which:

B = cutoff wall depth

D = diameter of circular conduit

T = Equation HS-17

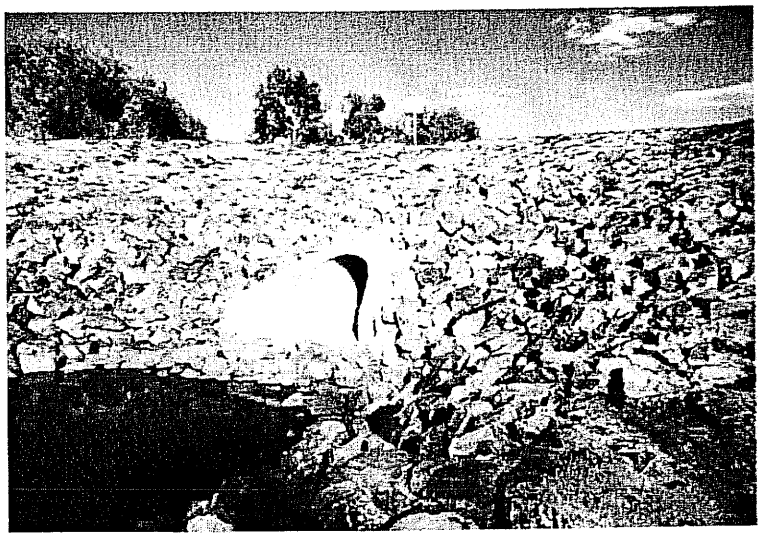
The riprap must be extended up the outlet embankment's slope to the mid-pipe level.

3.5 Culvert Outlets

Culvert outlets in the Denver area represent a persistent problem because of concentrated discharges and turbulence that are not fully controlled prior to the flow reaching the standard downstream channel configuration. Too often the designer's efforts are focused on the culvert inlet and the culvert sizing with the outlet hydraulics receiving only passing attention. A culvert design is not complete until adequate attention is paid to the outlet hydraulics and proper stilling of the design flow.

Culvert outlet energy dissipator and flow spreading may require special structures downstream of the culvert outlet to limit local scour, general stream degradation, and troublesome head cutting.

Local scour is typified by a scour hole produced at the culvert outlet. This is the result of high exit velocities, and the effects extend only a limited distance downstream. Coarse material scoured from the circular or elongated hole is deposited immediately downstream, often forming a low bar. Finer material is transported further downstream. The dimensions of the scour hole change due to sedimentation during low flows and the varying erosive effects of storm events. The scour hole is generally deepest during passage of the peak flow. Methods for predicting scour hole dimensions are found in HEC No. 14 (Corry, et al. 1975).



Photograph HS-13—Culvert outlets are often left unprotected causing downstream degradation. The designer's job is not complete until the outlet hydraulic provisions are made. Burying of riprap and revegetation of the surface would have blended this structure better into the adjacent landscape.

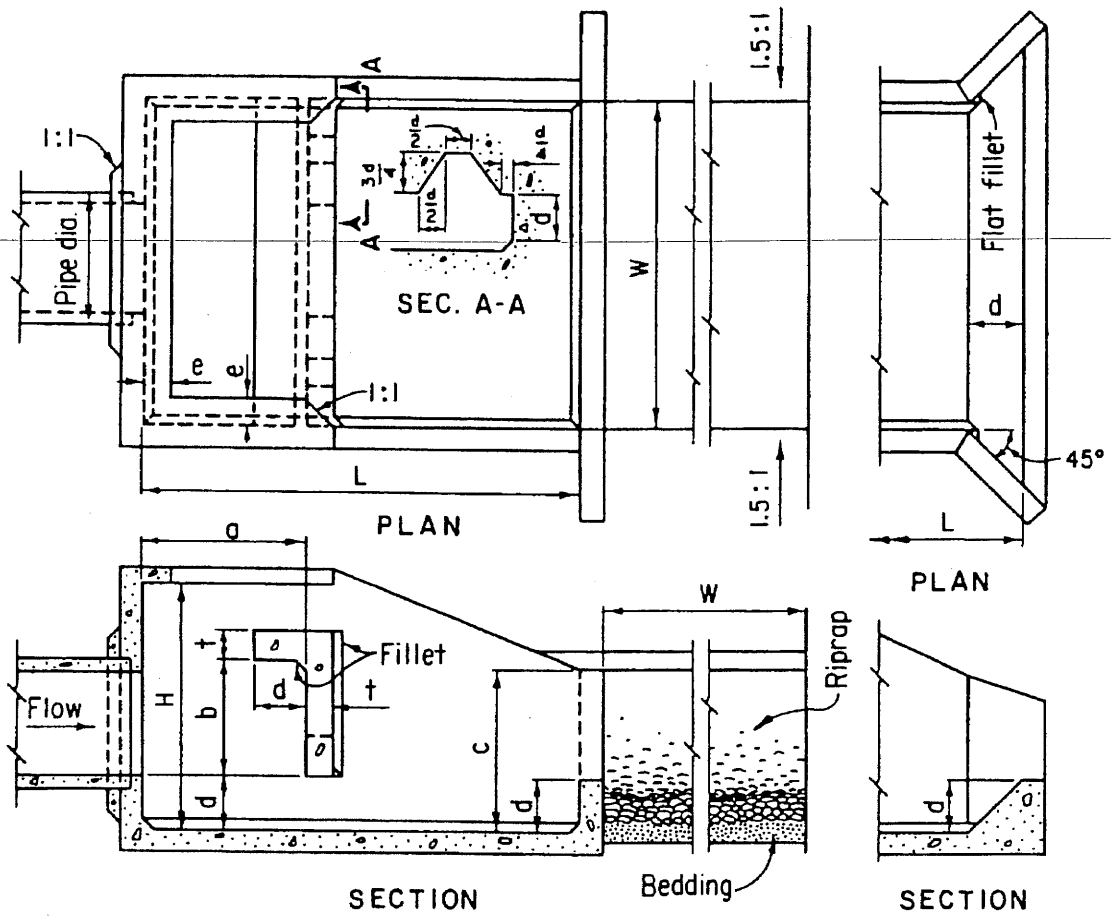
General storm degradation, or head cutting, can be a phenomenon independent of culvert performance. Natural causes produce a lowering of the streambed over time. The identification of a degrading stream is an essential part of the original site investigation. However, high-energy discharges from a culvert often cause stream degradation that is similar to the former, though limited in distance. Both types of scour can occur simultaneously at a culvert outlet.

As described in HEC No. 14, various measures exist to control culvert outlet flow, as listed below. It is beyond the scope of this *Manual* to provide information about these controls, but the District encourages their proper application and design.

1. Colorado State University rigid boundary basin

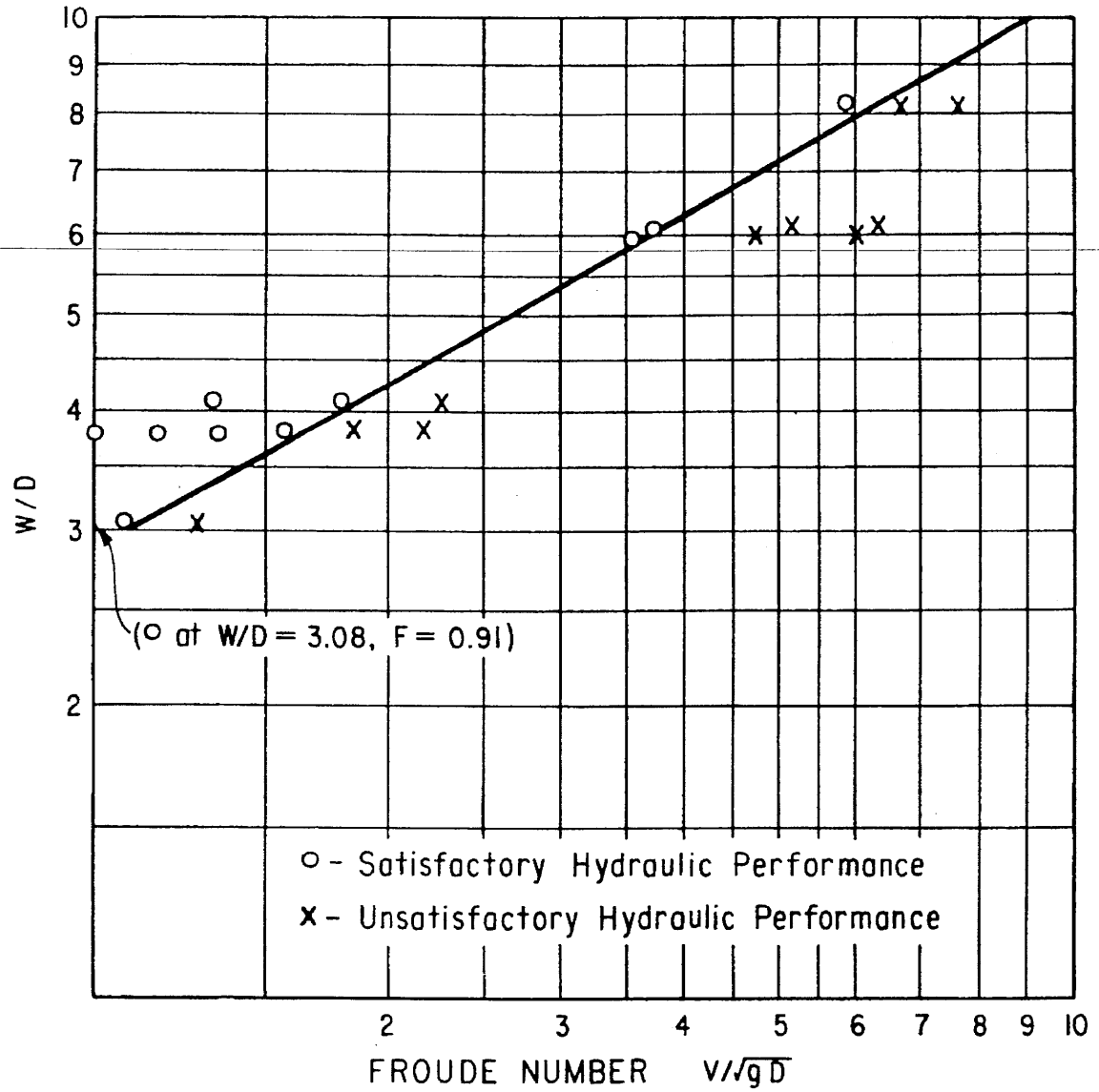
2. Tumbling flow rectangular section
3. Increased resistance—box culverts
4. Roughness elements—circular culverts
5. USBR Type II
6. USBR Type III
7. USBR Type IV
8. Contra Costa
9. Hook-type energy dissipator
10. Straight drop structure
11. Riprap basins

In addition, one might consider an extended culvert apron with one or more rows of baffles, or using large rows of offset racks set downstream of the culvert outlet on a bed of suitable riprap without a basin, but with an adequate tailwater depth, all designed in accordance with the criteria given in Section 2.0 of this chapter.



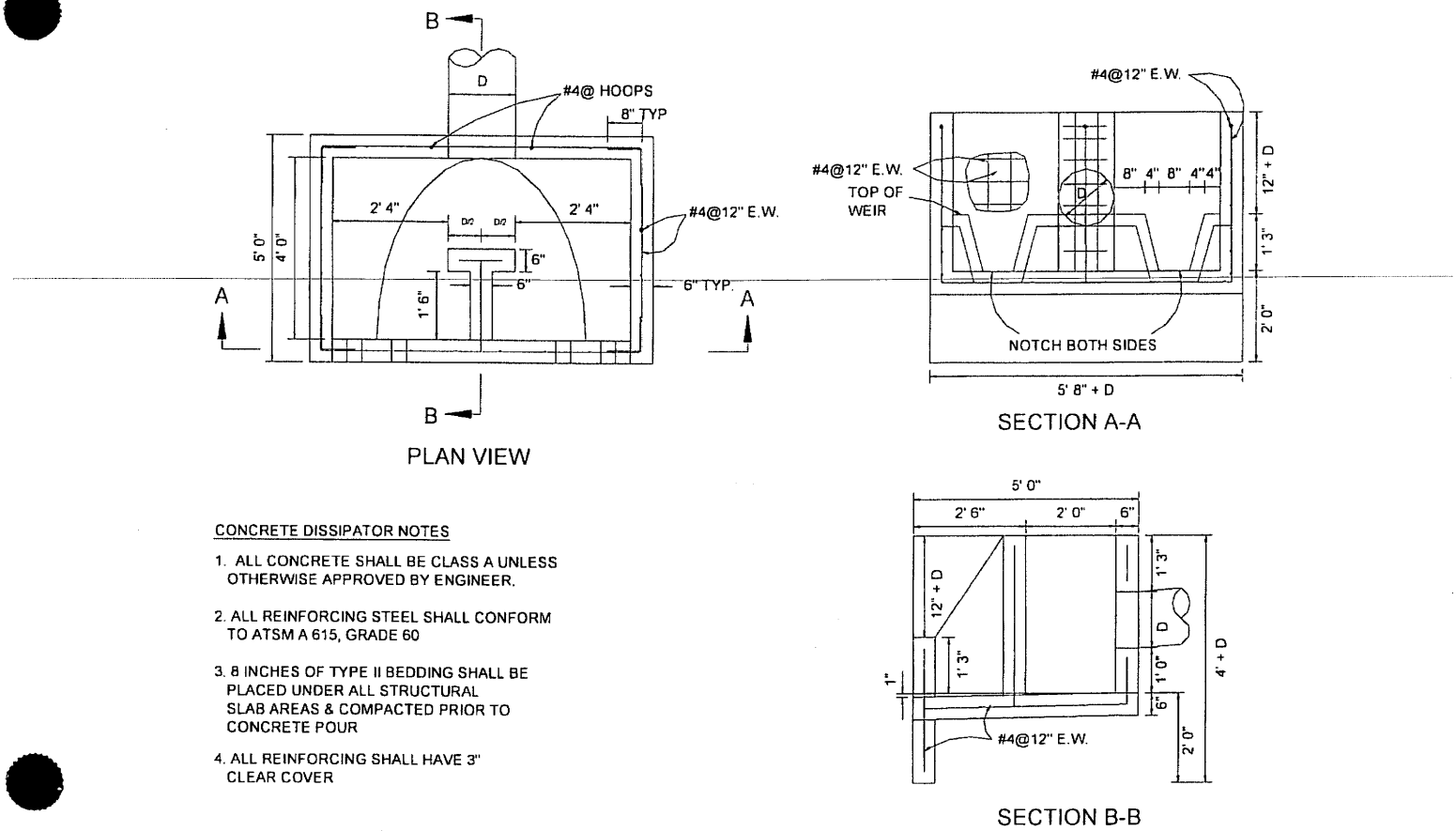
H = 3W/4 c = W/2
L = 4W/3 d = W/6
a = W/2 e = W/12
b = 3W/8 t = W/12 suggested minimum thickness

Figure HS-14—General Design Dimensions Impact Stilling Basin (USBR VI)



"W" is the inside width of the basin.
"D" represents the depth of flow entering the basin and is the square root of the flow area at the conduit outlet.
"V" is the velocity of the incoming flow.
The tailwater depth is uncontrolled.

Figure HS-15—Basin Width Diagram for an Impact Stilling Basin (USBR VI)

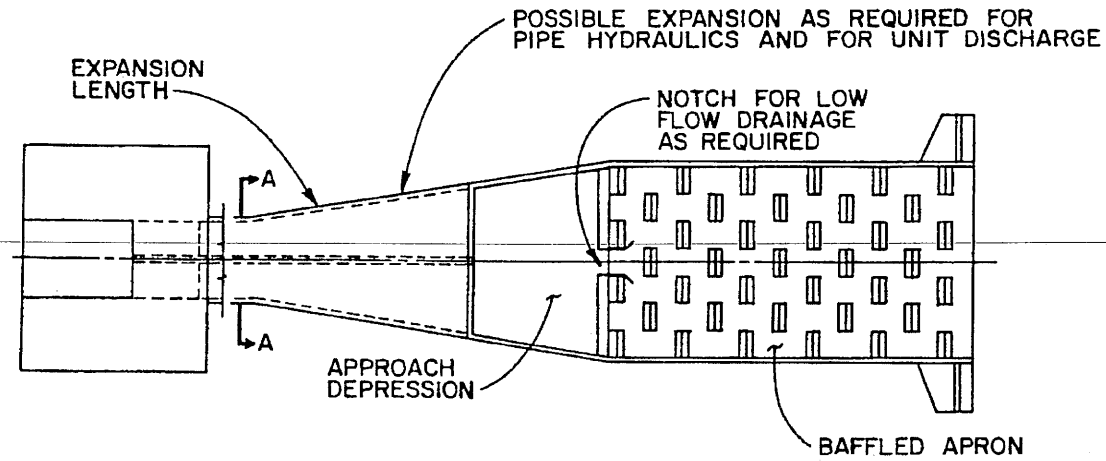


CONCRETE DISSIPATOR NOTES

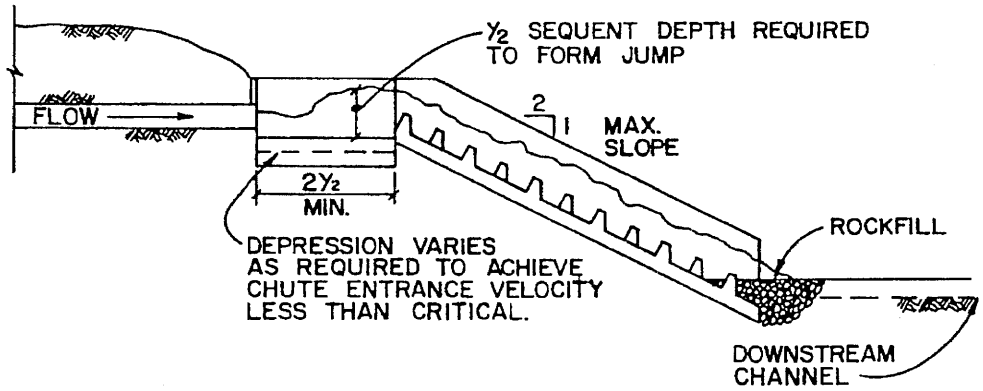
1. ALL CONCRETE SHALL BE CLASS A UNLESS OTHERWISE APPROVED BY ENGINEER.
2. ALL REINFORCING STEEL SHALL CONFORM TO ATSM A 615, GRADE 60
3. 8 INCHES OF TYPE II BEDDING SHALL BE PLACED UNDER ALL STRUCTURAL SLAB AREAS & COMPACTED PRIOR TO CONCRETE POUR
4. ALL REINFORCING SHALL HAVE 3" CLEAR COVER

ENERGY DISSIPATOR FOR PIPE OULET DIAMETERS $\leq$ 36"

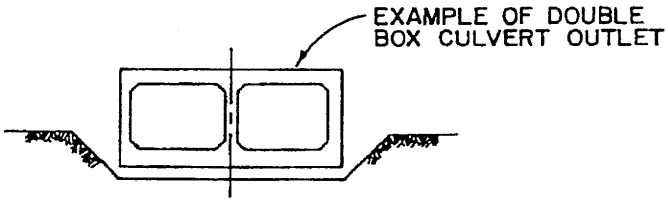
Figure HS-16—Modifications of Impact Stilling Basin to Allow Basin Drainage for Urban Applications



PLAN



PROFILE



SECTION A-A

Figure HS-17—Baffle Chute Pipe Outlet

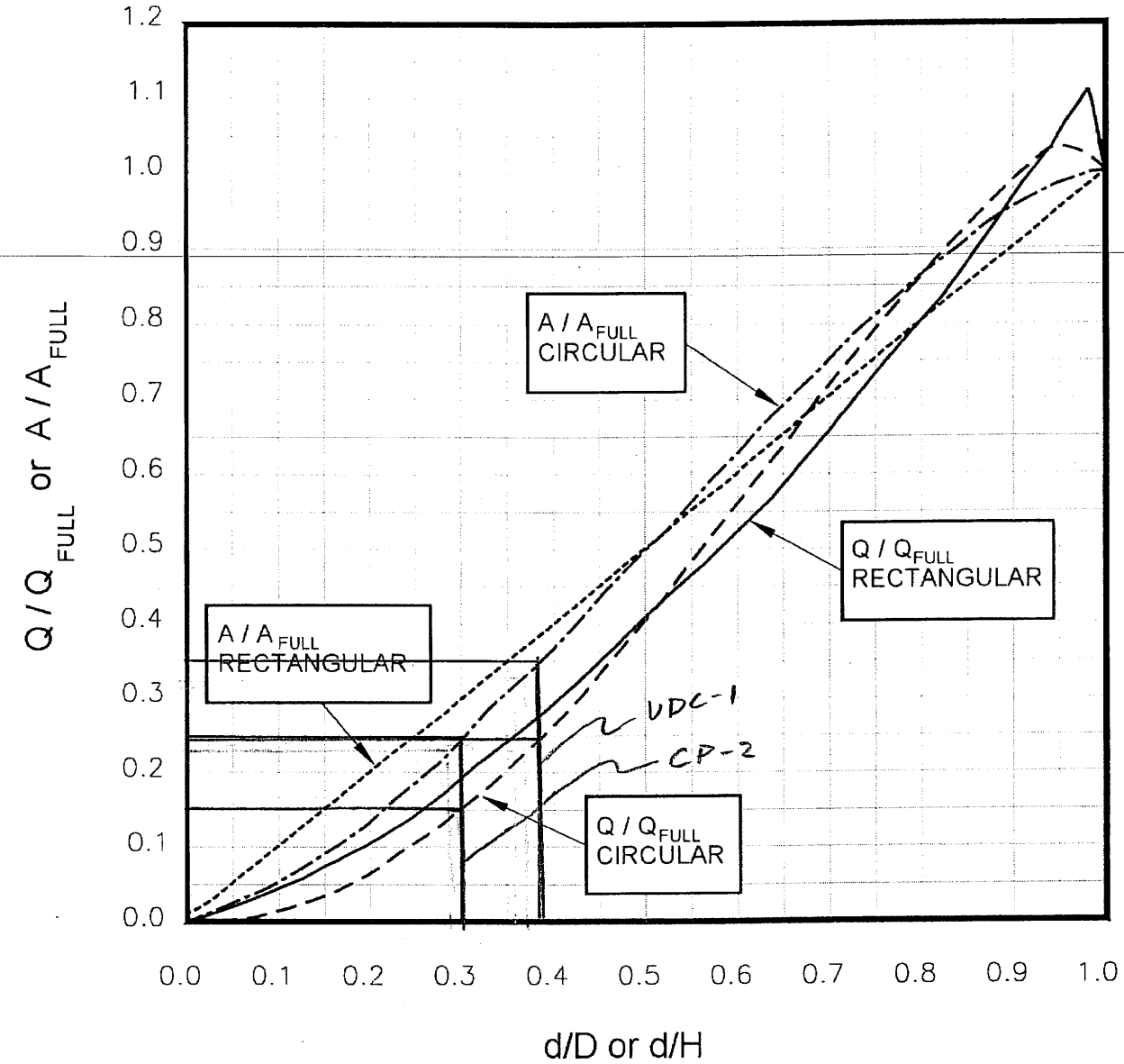


Figure HS-18b—Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets—Discharge and Flow Area Relationships for Circular and Rectangular Pipes

(Ratios for Flow Based on Manning's n Varying With Depth)
(Stevens and Urbonas 1996)

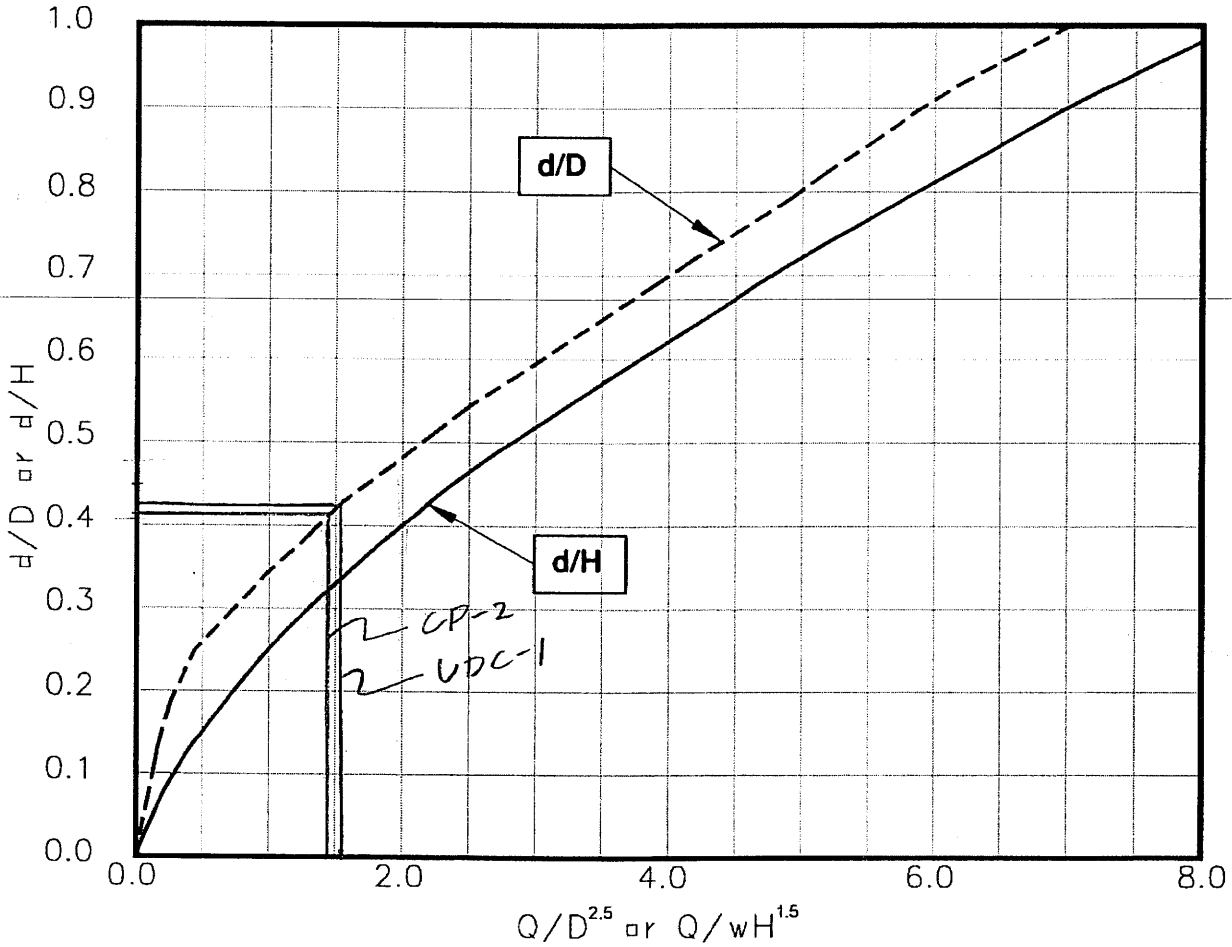


Figure HS-19—Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets—Brink Depth for Horizontal Pipe Outlets

(Stevens and Urbonas 1996)

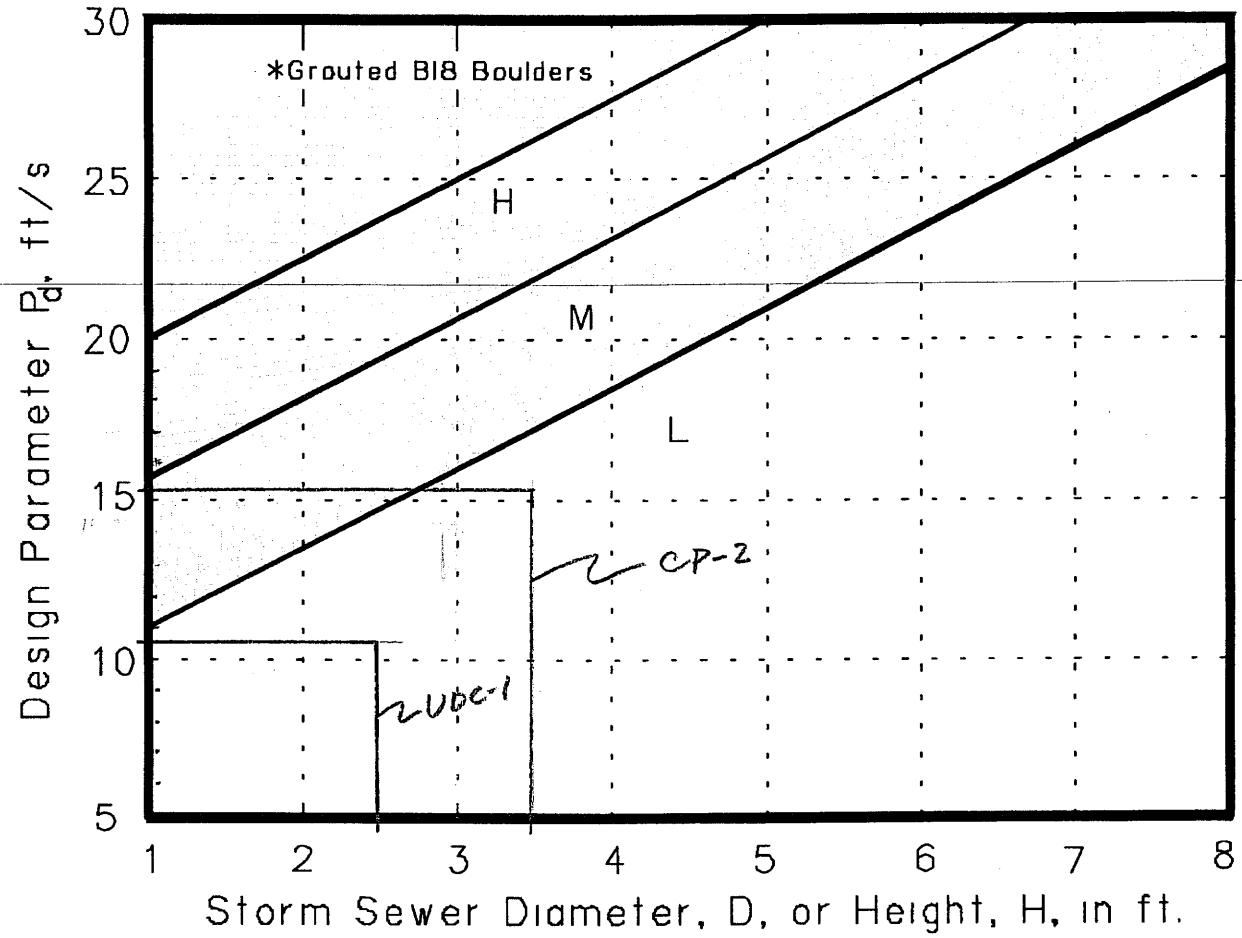
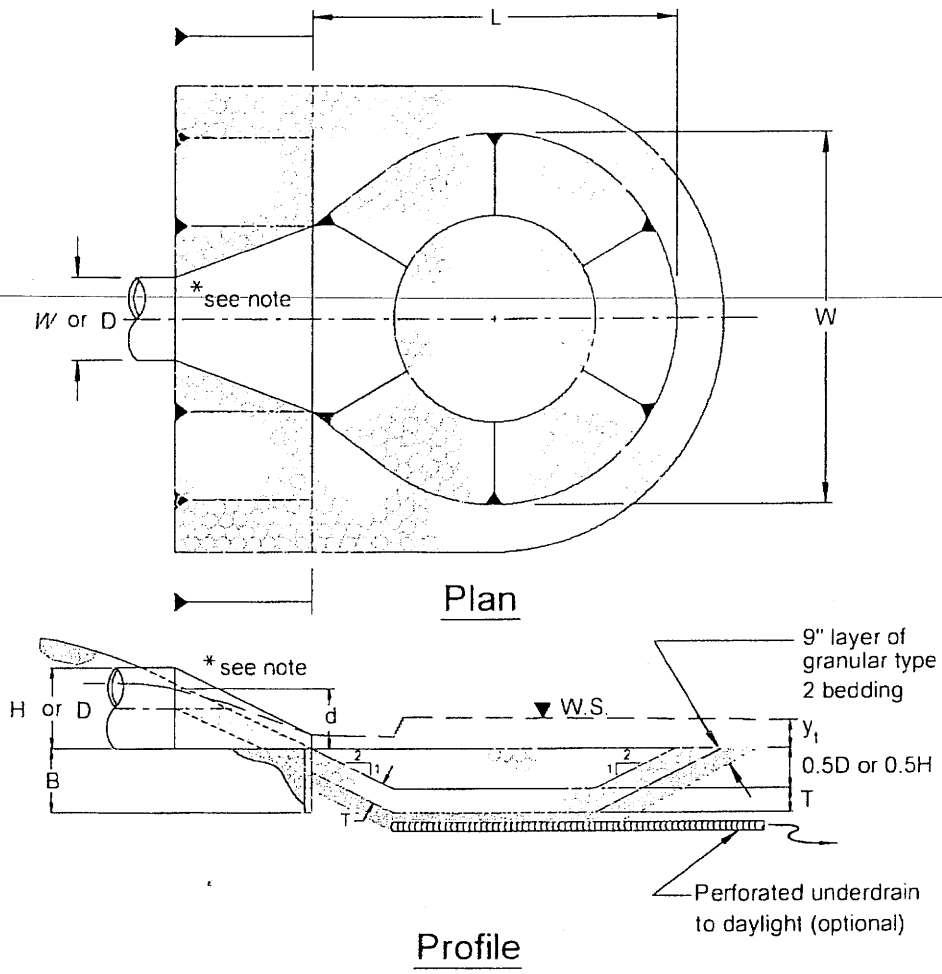


Figure HS-20—Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets—Riprap Selection Chart for Low Tailwater Basin at Pipe Outlet

(Stevens and Urbonas 1996)



* Note: For rectangular conduits use a standard design for a headwall with wingwalls, paved bottom between the wingwalls, with an end cutoff wall extending to a minimum depth equal to B

Figure HS-18A—Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets—Low Tailwater Basin at Pipe Outlets

(Stevens and Urbonas 1996)

Exhibit 17

Cumulative Hydrologic Impact Analysis From UDOGM

Exhibit 18

Bonding and Insurance Information

Exhibit 19

Geological Information
Roof & Floor Analyses, SGS Lab Sheets
Rock Strength Data, Agapito Reports

Roof & Floor Analyses, SGS Lab Sheets

Sample recd 7/28/06 Instructions 8/2/06

CORE INSTRUCTION FORM

PROJECT Carbon Resources Drilling
HOLE NUMBER **CR-06-01**
SEAM NAME Hiawatha
DATE SAMPLED 2/14/2006

COMPLETED BY Brad Lindsay
PHONE (435)851-9044
E-MAIL rocklogicconsulting@gmail.com

SHIP TO: SGS Minerals Services Division
4665 Paris Street
Suite B-200
Denver, CO 80239

SHIPPED FROM: Rock Logic Consulting LLC
PO Box 544
Cedaredge, Colorado 81413
ATTN: Brad Lindsay
INVOICE: Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
ATTN: Clay Wisdom

Samples Analysed for ACID FORMING & Toxic Metals

BOX # SAMPLE #	FROM	TO	Interval	SHORT PROXIMATE	LONG PROXIMATE	ULTIMATE	8 POINT ASH FUSION	APPARENT SPECIFIC GRAVITY	HARDGROVE GRIND	SULFUR FORMS	FREE SWELLING INDEX	MINERAL ASH	WATER SOL. ALKALIES	Na (SINGLE ELEMENT)	FLOURINE (SINGLE ELEMENT)	CHLORINE (SINGLE ELEMENT)	TRACE ELEMENTS (Coal Suite)	TRACE ELEMENTS (Rock Suite)	TOXIC METALS	ACID FORMING POTENTIAL	RESIN	SAVE SAMPLE FOR ARCHIVE	SPECIAL INSTRUCTIONS
5B/5	75.60	76.40	Hia Roof		X			X				X							X	X		X	1 foot upper roof rock
5C/5	76.40	76.90	Hia Roof		X			X				X							X	X		X	6" immediate roof rock
6/5	76.90	77.40	Hia Top		X			X				X										X	6" top coal
7/5	77.40	78.20	Hia Upper		X			X				X										X	upper section of coal seam
1/6	78.20	78.80	Hia Part		X			X				X							X	X		X	rock parting
2&3/6	78.80	81.70	Hia Middle		X			X				X										X	middle section of coal seam
4&5/6	81.70	84.00	Hia Lower		X			X				X										X	lower section of coal seam
6/6	84.00	85.00	Hia Bottom		X			X				X										X	1 foot of floor coal
7/6	85.00	85.50	Hia Floor		X			X				X										X	6" of floor rock
COMP-1	76.90	85.00	Hia Seam		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	Composite of all six coal samples (6/5, 7/5, 1/6, 2&3/6, 4&5/6, and 6/6)

1/7 Added 9-2010

NOTE: Sample 5B/5 from 75.6' to 76.4' is currently being tested for rock mechanics properties and will be forwarded to SGS at a future time

072-21001-001
5B/5
Carbon Resources LLC
Due: **08/17/2006**
085488
Rec: 07/28/2006

CHANGE IN POSSESSION

Relinquished by	Signed	Date	Time	Representing	Received By	Signed	Date	Time	Representing

SGS

August 23, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	5B/5	**Footage Begin :**	75.60
Date Received:	07/28/2006	**Footage End :**	76.40
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	2210.20		
Core Hole ID :	CR-06-01		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-21001-001

	As Received	Dry	MAF
% Moisture, Total	2.35		
% Ash	86.32	88.40	
% Volatile Matter	3.57	3.66	31.51
% Fixed Carbon	7.76	7.94	68.49
Gross Calorific Value (Btu/lb)	971	995	8574
% Sulfur	0.16	0.16	

Analyte	Result
Acid Potential	4.91 TCaCO3/1000T
Pounds of Ash/mm Btu	888.62 lb
Pounds of Sulfur/mm Btu	1.60 lb
Pounds of SO2/mm Btu	3.21 lb

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

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SGS

August 23, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	5B/5	**Footage Begin :**	75.60
Date Received:	07/28/2006	**Footage End :**	76.40
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	2210.20		
Core Hole ID :	CR-06-01		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-21001-001

Analyte	Result
Ash Analysis Basis	Ignited
Silicon Dioxide SiO2	85.48 %
Aluminum Oxide Al2O3	6.73 %
Titanium Dioxide TiO2	0.43 %
Iron Oxide Fe2O3	1.12 %
Calcium Oxide CaO	2.72 %
Magnesium Oxide MgO	0.97 %
Potassium Oxide K2O	1.88 %
Sodium Oxide Na2O	0.06 %
Sulfur Trioxide SO3	0.33 %
Phosphorus Pentoxide P2O5	0.23 %
Strontium Oxide SrO	0.01 %
Barium Oxide BaO	0.03 %
Manganese Oxide, Mn3O4	0.01 %
Undetermined	0.00 %
Sum	100.00 %
Alkalies	1.30 %
Silica Value	94.67 %
Base:Acid Ratio	0.07 %
T250 Temperature	>2900 °F
Type of Ash	Lignitic

Respectfully submitted,
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August 23, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID: 5B/5
Date Received: 07/28/2006
Matrix: ~~Coal~~ Rock
Net Sample Weight: 2210.20
Core Hole ID : CR-06-01
Project Name/# : Carbon Resources Drilling
Seam : Hiawatha ROOF

Footage Begin : 75.60
Footage End : 76.40

SGS Sample ID: 072-21001-001

Analyte	Result
Arsenic - TCLP	<0.01 mg/L
Barium - TCLP	0.12 mg/L
Cadmium - TCLP	<0.005 mg/L
Chromium - TCLP	<0.005 mg/L
Lead - TCLP	<0.05 mg/L
Selenium - TCLP	<0.01 mg/L
Silver - TCLP	<0.005 mg/L
Mercury - TCLP	<0.0002 mg/L
Specific Gravity, Apparent	2.36 g/cc

Respectfully submitted,
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May 01, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	5C/5	**Footage Begin :**	76.40
Date Received:	04/21/2006	**Footage End :**	76.90
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	1810.50		
Core Hole ID :	CR-06-01		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-19142-002

	As Received	Dry	MAF
% Moisture, Total	3.60		
% Ash	90.26	93.63	
% Volatile Matter	5.12	5.31	83.49
% Fixed Carbon	1.02	1.06	16.51
Gross Calorific Value (Btu/lb)	348	361	5670
% Sulfur	0.23	0.24	

Analyte	Result
Acid Potential	7.50 TCaCO3/1000T
Pounds of Ash/mm Btu	2594.42 lb
Pounds of Sulfur/mm Btu	6.64 lb
Pounds of SO2/mm Btu	13.26 lb

Respectfully submitted,
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May 01, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	5C/5	**Footage Begin :**	76.40
Date Received:	04/21/2006	**Footage End :**	76.90
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	1810.50		
Core Hole ID :	CR-06-01		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-19142-002

Analyte	Result	
Ash Analysis Basis	Ignited	
Silicon Dioxide SiO2	83.48	%
Aluminum Oxide Al2O3	8.48	%
Titanium Dioxide TiO2	0.51	%
Iron Oxide Fe2O3	1.29	%
Calcium Oxide CaO	1.86	%
Magnesium Oxide MgO	1.41	%
Potassium Oxide K2O	2.19	%
Sodium Oxide Na2O	0.07	%
Sulfur Trioxide SO3	0.42	%
Phosphorus Pentoxide P2O5	0.25	%
Strontium Oxide SrO	0.00	%
Barium Oxide BaO	0.03	%
Manganese Oxide, Mn3O4	0.01	%
Undetermined	0.00	%
Sum	100.00	%
Alkalies	1.51	%
Silica Value	94.82	%
Base:Acid Ratio	0.07	%
T250 Temperature	>2900	°F
Type of Ash	Lignitic	
Specific Gravity, Apparent	2.46	g/cc
Arsenic - TCLP	<0.01	mg/L
Mercury - TCLP	<0.0002	mg/L
Barium - TCLP	<0.01	mg/L
Cadmium - TCLP	<0.005	mg/L
Chromium - TCLP	<0.005	mg/L
Lead - TCLP	<0.05	mg/L
Selenium - TCLP	<0.01	mg/L
Silver - TCLP	<0.005	mg/L

Respectfully submitted,
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May 01, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	1/6	**Footage Begin :**	78.20
Date Received:	04/21/2006	**Footage End :**	78.80
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	943.30		
Core Hole ID :	CR-06-01		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-19142-005

	As Received	Dry	MAF
% Moisture, Total	7.58		
% Ash	56.80	61.45	
% Volatile Matter	17.99	19.47	50.51
% Fixed Carbon	17.63	19.08	49.49
Gross Calorific Value (Btu/lb)	4577	4952	12847
% Sulfur	0.28	0.30	

Analyte	Result
Acid Potential	9.38 TCaCO3/1000T
Pounds of Ash/mm Btu	124.10 lb
Pounds of Sulfur/mm Btu	0.62 lb
Pounds of SO2/mm Btu	1.23 lb

Respectfully submitted,
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May 01, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	1/6	**Footage Begin :**	78.20
Date Received:	04/21/2006	**Footage End :**	78.80
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	943.30		
Core Hole ID :	CR-06-01		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-19142-005

Analyte	Result	
Ash Analysis Basis	Ignited	
Silicon Dioxide SiO2	72.21	%
Aluminum Oxide Al2O3	19.85	%
Titanium Dioxide TiO2	0.93	%
Iron Oxide Fe2O3	1.97	%
Calcium Oxide CaO	0.51	%
Magnesium Oxide MgO	1.38	%
Potassium Oxide K2O	2.92	%
Sodium Oxide Na2O	0.10	%
Sulfur Trioxide SO3	0.04	%
Phosphorus Pentoxide P2O5	0.05	%
Strontium Oxide SrO	0.01	%
Barium Oxide BaO	0.03	%
Manganese Oxide, Mn3O4	<0.01	%
Undetermined	0.00	%
Sum	100.00	%
Alkalies	2.02	%
Silica Value	94.93	%
Base:Acid Ratio	0.07	%
T250 Temperature	>2900	°F
Type of Ash	Bituminous	
Specific Gravity, Apparent	1.80	g/cc
Arsenic - TCLP	<0.01	mg/L
Mercury - TCLP	<0.0002	mg/L
Barium - TCLP	<0.01	mg/L
Cadmium - TCLP	<0.005	mg/L
Chromium - TCLP	<0.005	mg/L
Lead - TCLP	<0.05	mg/L
Selenium - TCLP	0.01	mg/L
Silver - TCLP	<0.005	mg/L

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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Analysis Report

August 20, 2010

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID: CR-06-01 1/7 Floor
Date Received: 08/06/2010
Matrix: Unknown Rock

Kind of Sample : Overburden

SGS Minerals Sample ID: 072-47377-001

Tests	Result	Unit
Specific Gravity	2.67	
pH	6.10	s.u.
pH Temperature	19.20	°C
Acid Potential	19.1	
Neutralization Potential	4.0	
Conductivity	2500	umhos/cm
Carbon, Total Organic	0.54	%
Calcium Carbonate	<0.10	%
Selenium, Hot Water	0.07	ppm
Calcium, Soluble	490	ppm
Magnesium, Soluble	100	ppm
Potassium, Soluble	130	ppm
Sodium, Soluble	59	ppm
Sodium Absorption Ratio	3.4	
Boron Available	1	ppm

Sample Notes:
Neutralization Potential and Acid Potential reported as tons $CaCO_3$ / 1000 tons material.

Method Reference(s):
"Field and Laboratory Methods Applicable to Overburden and Minesoils," EPA-600 / 2-78-054, March 1978
"Agriculture Handbook No. 60," Issued February 1954
"ASTM International Standards," Vol. 05.06, Standard D 6316, Sept. 2009

Somer Rodriguez, Denver Laboratory

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CORE INSTRUCTION FORM

PROJECT Carbon Resources Drilling
HOLE NUMBER CR-06-02
SEAM NAME Hiawatha
DATE SAMPLED 2/25/2006

COMPLETED BY Brad Lindsay
PHONE (435)851-9044
E-MAIL rocklogicconsulting@gmail.com

SHIP TO: SGS Minerals Services Division
4665 Paris Street
Suite B-200
Denver, CO 80239

SHIPPED FROM: Rock Logic Consulting LLC
PO Box 544
Cedaredge, Colorado 81413
ATTN: Brad Lindsay
INVOICE: Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
ATTN: Clay Wisdom

Samples Analyzed for Acid Potential & Toxic Metals

BOX # SAMPLE #	FROM	TO	Interval	SHORT PROXIMATE	LONG PROXIMATE	UNTIMATE	8 POINT ASH FUSION	APPARENT SPECIFIC GRAVITY	HARDGROVE GRIND.	SULFUR FORMS	FREE SWELLING INDEX	MINERAL ASH	WATER SOL. ALKALIES	Na (SINGLE ELEMENT)	FLOURINE (SINGLE ELEMENT)	CHLORINE (SINGLE ELEMENT)	TRACE ELEMENTS (Coal Suite)	TRACE ELEMENTS (Rock Suite)	TOXIC METALS	ACID FORMING POTENTIAL	RESIN	SAVE SAMPLE FOR ARCHIVE	SPECIAL INSTRUCTIONS
1B/17	426.60	427.50	Hia Roof		X			X				X							X	X		X	1 foot upper roof rock
2/17	427.50	428.00	Hia Roof		X			X				X							X	X		X	6" immediate roof rock
3/17	428.00	428.50	Hia Top		X			X				X										X	6" top coal
4/17	428.50	430.00	Hia Upper		X			X				X										X	upper section of coal seam
5/17	430.00	431.20	Hia Part		X			X				X							X	X		X	rock parting
6&7/17	431.20	434.00	Hia Middle		X			X				X										X	middle section of coal seam
1/18	434.00	436.00	Hia Lower		X			X				X										X	lower section of coal seam
2/18	436.00	437.00	Hia Bottom		X			X				X										X	1 foot of floor coal
3/18	437.00	437.50	Hia Floor		X			X				X										X	6" of floor rock
COMP-2	428.00	437.00	Hia Seam		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	Composite of all six coal samples (3/17, 4/17, 5/17, 6&7/17, 1/18, and 2/18)

CHANGE IN POSSESSION

Relinquished by	Signed	Date	Time

Received By	Signed	Date	Time

Representing	Date	Time

SGS

May 01, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	1B-17	**Footage Begin :**	426.60
Date Received:	04/21/2006	**Footage End :**	427.50
Matrix:	~~Coal~~ Coal		
Net Sample Weight:	3352.40		
Core Hole ID :	CR-06-02		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-19143-001

	As Received	Dry	MAF
% Moisture, Total	2.45		
% Ash	93.23	95.57	
% Volatile Matter	4.01	4.11	92.83
% Fixed Carbon	0.31	0.32	7.17
Gross Calorific Value (Btu/lb)	230	236	5335
% Sulfur	0.07	0.07	

Analyte	Result
Acid Potential	2.19 TCaCO3/1000T
Pounds of Ash/mm Btu	4045.71 lb
Pounds of Sulfur/mm Btu	2.89 lb
Pounds of SO2/mm Btu	5.78 lb

Respectfully submitted,
SGS NORTH AMERICA INC.
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May 01, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	1B-17	**Footage Begin :**	426.60
Date Received:	04/21/2006	**Footage End :**	427.50
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	3352.40		
Core Hole ID :	CR-06-02		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-19143-001

Analyte	Result	
Ash Analysis Basis	Ignited	
Silicon Dioxide SiO2	90.11	%
Aluminum Oxide Al2O3	2.76	%
Titanium Dioxide TiO2	0.20	%
Iron Oxide Fe2O3	1.88	%
Calcium Oxide CaO	2.80	%
Magnesium Oxide MgO	0.47	%
Potassium Oxide K2O	0.98	%
Sodium Oxide Na2O	0.02	%
Sulfur Trioxide SO3	0.62	%
Phosphorus Pentoxide P2O5	0.12	%
Strontium Oxide SrO	0.00	%
Barium Oxide BaO	0.01	%
Manganese Oxide, Mn3O4	0.03	%
Undetermined	0.00	%
Sum	100.00	%
Alkalies	0.67	%
Silica Value	94.59	%
Base:Acid Ratio	0.07	%
T250 Temperature	>2900	°F
Type of Ash	Lignitic	
Specific Gravity, Apparent	2.52	g/cc
Arsenic - TCLP	<0.01	mg/L
Mercury - TCLP	<0.0002	mg/L
Barium - TCLP	<0.01	mg/L
Cadmium - TCLP	<0.005	mg/L
Chromium - TCLP	<0.005	mg/L
Lead - TCLP	<0.05	mg/L
Selenium - TCLP	<0.01	mg/L
Silver - TCLP	<0.005	mg/L

Respectfully submitted,
SGS NORTH AMERICA INC.

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May 01, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	2/17	**Footage Begin :**	427.50
Date Received:	04/21/2006	**Footage End :**	428.00
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	1891.50		
Core Hole ID :	CR-06-02		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-19143-002

	As Received	Dry	MAF
% Moisture, Total	3.97		
% Ash	91.75	95.54	
% Volatile Matter	3.63	3.78	84.77
% Fixed Carbon	0.65	0.68	15.23
Gross Calorific Value (Btu/lb)	254	265	5943
% Sulfur	0.17	0.18	

Analyte	Result
Acid Potential	5.36 TCaCO3/1000T
Pounds of Ash/mm Btu	3607.13 lb
Pounds of Sulfur/mm Btu	6.66 lb
Pounds of SO2/mm Btu	13.30 lb

Respectfully submitted,
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May 01, 2006

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USA

Client Sample ID:	2/17	**Footage Begin :**	427.50
Date Received:	04/21/2006	**Footage End :**	428.00
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	1891.50		
Core Hole ID :	CR-06-02		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-19143-002

Analyte	Result	
Ash Analysis Basis	Ignited	
Silicon Dioxide SiO2	91.01	%
Aluminum Oxide Al2O3	3.98	%
Titanium Dioxide TiO2	0.25	%
Iron Oxide Fe2O3	0.76	%
Calcium Oxide CaO	1.36	%
Magnesium Oxide MgO	0.67	%
Potassium Oxide K2O	1.34	%
Sodium Oxide Na2O	0.03	%
Sulfur Trioxide SO3	0.42	%
Phosphorus Pentoxide P2O5	0.16	%
Strontium Oxide SrO	0.00	%
Barium Oxide BaO	0.01	%
Manganese Oxide, Mn3O4	0.01	%
Undetermined	0.00	%
Sum	100.00	%
Alkalies	0.91	%
Silica Value	97.03	%
Base:Acid Ratio	0.04	%
T250 Temperature	>2900	°F
Type of Ash	Lignitic	
Specific Gravity, Apparent	2.44	g/cc
Arsenic - TCLP	<0.01	mg/L
Mercury - TCLP	<0.0002	mg/L
Barium - TCLP	<0.01	mg/L
Cadmium - TCLP	<0.005	mg/L
Chromium - TCLP	<0.005	mg/L
Lead - TCLP	<0.05	mg/L
Selenium - TCLP	<0.01	mg/L
Silver - TCLP	<0.005	mg/L

Respectfully submitted,
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May 01, 2006

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Albuquerque, NM 87192
USA

Client Sample ID:	5/17	**Footage Begin :**	430.00
Date Received:	04/21/2006	**Footage End :**	431.20
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	2125.30		
Core Hole ID :	CR-06-02		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha PARTING		

SGS Sample ID: 072-19143-005

	As Received	Dry	MAF
% Moisture, Total	5.87		
% Ash	5.92	6.29	
% Volatile Matter	40.90	43.45	46.36
% Fixed Carbon	47.31	50.26	53.64
Gross Calorific Value (Btu/lb)	12582	13367	14264
% Sulfur	0.58	0.62	

Analyte	Result
Acid Potential	19.38 TCaCO3/1000T
Pounds of Ash/mm Btu	4.70 lb
Pounds of Sulfur/mm Btu	0.46 lb
Pounds of SO2/mm Btu	0.93 lb

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

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SGS

May 01, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	5/17	**Footage Begin :**	430.00
Date Received:	04/21/2006	**Footage End :**	431.20
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	2125.30		
Core Hole ID :	CR-06-02		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha PARTING		

SGS Sample ID: 072-19143-005

Analyte	Result	
Ash Analysis Basis	Ignited	
Silicon Dioxide SiO2	56.03	%
Aluminum Oxide Al2O3	7.79	%
Titanium Dioxide TiO2	0.68	%
Iron Oxide Fe2O3	8.90	%
Calcium Oxide CaO	14.48	%
Magnesium Oxide MgO	1.43	%
Potassium Oxide K2O	0.18	%
Sodium Oxide Na2O	0.47	%
Sulfur Trioxide SO3	9.87	%
Phosphorus Pentoxide P2O5	0.01	%
Strontium Oxide SrO	0.09	%
Barium Oxide BaO	0.01	%
Manganese Oxide, Mn3O4	0.06	%
Undetermined	0.00	%
Sum	100.00	%
Alkalies	0.59	%
Silica Value	69.31	%
Base:Acid Ratio	0.39	%
T250 Temperature	2417	°F
Type of Ash	Lignitic	
Specific Gravity, Apparent	1.30	g/cc
Arsenic - TCLP	<0.01	mg/L
Mercury - TCLP	<0.0002	mg/L
Barium - TCLP	<0.01	mg/L
Cadmium - TCLP	<0.005	mg/L
Chromium - TCLP	<0.005	mg/L
Lead - TCLP	<0.05	mg/L
Selenium - TCLP	<0.01	mg/L
Silver - TCLP	<0.005	mg/L

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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RECEIVED OCT - 5 2006

CORE INSTRUCTION FORM

PROJECT: Carbon Resources Drilling
HOLE NUMBER: CR-06-05
SEAM NAME: Hiawatha
DATE SAMPLED: 9/7/2006

COMPLETED BY: Brad Lindsay
PHONE: (435)851-9044
E-MAIL: rocklogicconsulting@gmail.com

SHIP TO: SGS Minerals Services Division
4665 Paris Street
Suite B-200
Denver, CO 80239

SHIPPED FROM: Rock Logic Consulting LLC
PO Box 544
Cedaredge, Colorado 81413
ATTN: Brad Lindsay
INVOICE: Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
ATTN: Clay Wisdom

Samples Analyzed for Acid Potential & Toxic Metals

SAMPLE #	FROM	TO	Interval	SHORT PROXIMATE	LONG PROXIMATE	UNTIMATE	8 POINT ASH FUSION	APPARENT SPECIFIC GRAVITY	HARDGROVE GRIND	SULFUR FORMS	FREE SWELLING INDEX	MINERAL ASH	WATER SOL. ALKALIES	Na (SINGLE ELEMENT)	FLOURINE (SINGLE ELEMENT)	CHLORINE (SINGLE ELEMENT)	TRACE ELEMENTS (SINGLE ELEMENT)	TRACE ELEMENTS (Coal Suite)	TOXIC METALS (Rock Suite)	ACID FORMING POTENTIAL	RESIN	SAVE SAMPLE FOR ARCHIVE	SPECIAL INSTRUCTIONS
1/1	1042.00	1043.05	Hia Bottom		X			X				X										X	1 foot of floor coal
2/1	1043.05	1043.50	Hia Floor		X			X				X							X	X		X	6" of floor rock

072-22212-001
Sample # 1/1
Carbon Resources LLC
Due: **10/20/2006**
091723
Rec: 10/05/2006

072-22212-002
Sample # 2/1
Carbon Resources LLC
Due: **10/20/2006**
091724
Rec: 10/05/2006

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SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 2/1	**Footage Begin :**	1043.05
Date Received:	10/05/2006	**Footage End :**	1043.50
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	1201.70		
Core Hole ID :	CR-06-05		
Date Sampled :	9/7/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha FLOOR		

SGS Sample ID: 072-22212-002

	As Received	Dry	MAF
% Moisture, Total	5.21		
% Ash	76.12	80.30	
% Volatile Matter	5.63	5.93	30.12
% Fixed Carbon	13.04	13.77	69.88
Gross Calorific Value (Btu/lb)	2008	2118	10754
% Sulfur	0.41	0.43	

Analyte	Result
Acid Potential	13.44 TCaCO3/1000T
Pounds of Ash/mm Btu	379.07 lb
Pounds of Sulfur/mm Btu	2.02 lb
Pounds of SO2/mm Btu	4.03 lb

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 2/1	**Footage Begin :**	1043.05
Date Received:	10/05/2006	**Footage End :**	1043.50
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	1201.70		
Core Hole ID :	CR-06-05		
Date Sampled :	9/7/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha FLOOR		

SGS Sample ID: 072-22212-002

Analyte	Result	
Ash Analysis Basis	Ignited	
Silicon Dioxide SiO2	73.94	%
Aluminum Oxide Al2O3	17.57	%
Titanium Dioxide TiO2	0.87	%
Iron Oxide Fe2O3	2.10	%
Calcium Oxide CaO	0.81	%
Magnesium Oxide MgO	1.15	%
Potassium Oxide K2O	3.00	%
Sodium Oxide Na2O	0.07	%
Sulfur Trioxide SO3	0.13	%
Phosphorus Pentoxide P2O5	0.32	%
Strontium Oxide SrO	0.01	%
Barium Oxide BaO	0.03	%
Manganese Oxide, Mn3O4	<0.01	%
Undetermined	0.00	%
Sum	100.00	%
Alkalies	2.05	%
Silica Value	94.79	%
Base:Acid Ratio	0.08	%
T250 Temperature	>2900	°F
Type of Ash	Bituminous	

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 2/1	**Footage Begin :**	1043.05
Date Received:	10/05/2006	**Footage End :**	1043.50
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	1201.70		
Core Hole ID :	CR-06-05		
Date Sampled :	9/7/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha FLOOR		

SGS Sample ID: 072-22212-002

Analyte	Result
Arsenic - TCLP	<0.01 mg/L
Barium - TCLP	1.77 mg/L
Cadmium - TCLP	<0.005 mg/L
Chromium - TCLP	<0.005 mg/L
Lead - TCLP	<0.02 mg/L
Selenium - TCLP	<0.01 mg/L
Silver - TCLP	<0.005 mg/L
Mercury - TCLP	<0.0002 mg/L
Specific Gravity, Apparent	2.17 g/cc

Respectfully submitted,
SGS NORTH AMERICA INC.

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GENERAL CONDITIONS OF SERVICE ON REVERSE

072-22213-001
Sample # 8/1
Carbon Resources LLC
Due: **10/20/2006**
091733 Rec: 10/05/2006

072-22213-002
Sample # 1/2
Carbon Resources LLC
Due: **10/20/2006**
091734 Rec: 10/05/2006

072-22213-003
Sample # 2/2
Carbon Resources LLC
Due: **10/20/2006**
091735 Rec: 10/05/2006

RECEIVED OCT - 5 2006
C Montoya

072-22213-004
Sample # 4/2
Carbon Resources LLC
Due: **10/20/2006**
091736 Rec: 10/05/2006

072-22213-005
Sample # 5/2
Carbon Resources LLC
Due: **10/20/2006**
091737 Rec: 10/05/2006

CORE INSTRUCTION FORM

PROJECT Carbon Resources Drilling
HOLE NUMBER CR-06-05-A
SEAM NAME Hiawatha
DATE SAMPLED 9/19/2006

COMPLETED BY Brad Lindsay
PHONE (435)851-9044
E-MAIL rocklogicconsulting@gmail.com

SHIP TO: SGS Minerals Services Division
4665 Paris Street
Suite B-200
Denver, CO 80239

SHIPPED FROM: Rock Logic Consulting LLC
PO Box 544
Cedaredge, Colorado 81413
ATTN: Brad Lindsay
INVOICE: Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
ATTN: Clay Wisdom

Samples Analyzed for Acid Potential and Toxic Metals

091738 Rec: 10/05/2006

6/1 Added 9-2010

12/2 Added 9-2010

SAMPLE #	FROM	TO	Interval	SHORT PROXIMATE	LONG PROXIMATE	UNTIMATE	8 POINT ASH FUSION	APPARENT SPECIFIC GRAVITY	HARDGROVE GRIND.	SULFUR FORMS	FREE SWELLING INDEX	MINERAL ASH	WATER SOL. ALKALIES	Na (SINGLE ELEMENT)	FLOURINE (SINGLE ELEMENT)	CHLORINE (SINGLE ELEMENT)	TRACE ELEMENTS (Coal Suite)	TRACE ELEMENTS (Rock Suite)	TOXIC METALS	ACID FORMING POTENTIAL	RESIN	SAVE SAMPLE FOR ARCHIVE	SPECIAL INSTRUCTIONS
8/1*	1034.30	1035.30	Hia Roof		X			X				X							X	X		X	1 foot upper roof rock
1/2	1036.00	1036.30	Hia Roof		X			X				X							X	X		X	6" immediate roof rock
2/2	1036.30	1036.80	Hia Top		X			X				X										X	6" top coal
3/2	1036.80	1037.20	Hia Upper		X			X				X										X	upper section of coal seam
4/2	1037.20	1037.80	Hia Part		X			X				X							X	X		X	rock parting
5/2	1037.80	1039.50	Hia Middle		X			X				X										X	middle section of coal seam
6/2	1039.50	1041.00	Hia Middle		X			X				X										X	middle section of coal seam
7/2	1041.00	1042.00	Hia Middle		X			X				X										X	middle section of coal seam
8/2	1042.00	1043.00	Hia Lower		X			X				X										X	lower section of coal seam
9/2	1043.00	1044.25	Hia Lower		X			X				X										X	lower section of coal seam
10/2	1044.25	1045.25	Hia Bottom		X			X				X										X	1 foot of floor coal
11/2	1045.25	1045.75	Hia Floor		X			X				X							X	X		X	6" of floor rock
COMP-5	1036.30	1045.25	Hia Seam		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	Composite of all nine coal samples (2/2, 3/2, 4/2, 5/2, 6/2, 7/2, 8/2, 9/2, and 10/2)

8,2

NOTE: Samples 3/2, 8/5, [redacted] are currently being tested for rock mechanics properties and will be forwarded to SGS at a future time

CHANGE IN POSSESSION

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072-22213-007
Sample # 7/2
Carbon Resources LLC
Due: **10/20/2006**
091739 Rec: 10/05/2006

072-22213-008
Sample # 9/2
Carbon Resources LLC
Due: **10/20/2006**
091740 Rec: 10/05/2006

072-22213-009
Sample # 10/2
Carbon Resources LLC
Due: **10/20/2006**
091741 Rec: 10/05/2006

072-22213-010
Sample # 11/2
Carbon Resources LLC
Due: **10/20/2006**
091742 Rec: 10/05/2006

SGS

Analysis Report

August 20, 2010

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID: CR-06-05A 6/1 Roof
Date Received: 08/06/2010
Matrix: Unknown
Kind of Sample : Overburden

SGS Minerals Sample ID: 072-47377-003

Tests	Result	Unit
Specific Gravity	2.55	
pH	8.11	s.u.
pH Temperature	19.60	°C
→ Acid Potential	2.5	
→ Neutralization Potential	43.0	
Conductivity	1500	umhos/cm
Carbon, Total Organic	1.00	%
Calcium Carbonate	14.85	%
Selenium, Hot Water	0.04	ppm
Calcium, Soluble	200	ppm
Magnesium, Soluble	120	ppm
Potassium, Soluble	30	ppm
Sodium, Soluble	22	ppm
Sodium Absorption Ratio	1.8	
Boron Available	3	ppm

Sample Notes:
Neutralization Potential and Acid Potential reported as tons CaCO3 / 1000 tons material.

Method Reference(s):
"Field and Laboratory Methods Applicable to Overburden and Minesoils," EPA-600 / 2-78-054, March 1978
"Agriculture Handbook No. 60," Issued February 1954
"ASTM International Standards," Vol. 05.06, Standard D 6316, Sept. 2009

Somer Rodriguez, Denver Laboratory

SGS North America Inc. | Minerals Services Division
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SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 8/1	**Footage Begin :**	1034.30
Date Received:	10/05/2006	**Footage End :**	1035.30
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	3254.70		
Core Hole ID :	CR-06-05-A		
Date Sampled :	9/19/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-22213-001

	As Received	Dry	MAF
% Moisture, Total	2.59		
% Ash	88.68	91.04	
% Volatile Matter	2.18	2.23	24.93
% Fixed Carbon	6.55	6.73	75.07
Gross Calorific Value (Btu/lb)	18	18	202
% Sulfur	0.46	0.47	

Analyte	Result
Acid Potential	14.69 TCaCO3/1000T
Pounds of Ash/mm Btu	50419.62 lb
Pounds of Sulfur/mm Btu	258.72 lb
Pounds of SO2/mm Btu	516.94 lb

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 8/1	**Footage Begin :**	1034.30
Date Received:	10/05/2006	**Footage End :**	1035.30
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	3254.70		
Core Hole ID :	CR-06-05-A		
Date Sampled :	9/19/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-22213-001

Analyte	Result
Ash Analysis Basis	Ignited
Silicon Dioxide SiO2	77.15 %
Aluminum Oxide Al2O3	8.36 %
Titanium Dioxide TiO2	0.52 %
Iron Oxide Fe2O3	1.88 %
Calcium Oxide CaO	7.19 %
Magnesium Oxide MgO	1.79 %
Potassium Oxide K2O	2.15 %
Sodium Oxide Na2O	0.04 %
Sulfur Trioxide SO3	0.58 %
Phosphorus Pentoxide P2O5	0.28 %
Strontium Oxide SrO	0.01 %
Barium Oxide BaO	0.02 %
Manganese Oxide, Mn3O4	0.03 %
Undetermined	0.00 %
Sum	100.00 %
Alkalies	1.46 %
Silica Value	87.66 %
Base:Acid Ratio	0.15 %
T250 Temperature	>2900 °F
Type of Ash	Lignitic

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 8/1	**Footage Begin :**	1034.30
Date Received:	10/05/2006	**Footage End :**	1035.30
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	3254.70		
Core Hole ID :	CR-06-05-A		
Date Sampled :	9/19/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-22213-001

Analyte	Result
Arsenic - TCLP	<0.01 mg/L
Barium - TCLP	1.11 mg/L
Cadmium - TCLP	<0.005 mg/L
Chromium - TCLP	<0.005 mg/L
Lead - TCLP	<0.02 mg/L
Selenium - TCLP	<0.01 mg/L
Silver - TCLP	<0.005 mg/L
Mercury - TCLP	<0.0002 mg/L
Specific Gravity, Apparent	2.58 g/cc

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 1/2	**Footage Begin :**	1036.00
Date Received:	10/05/2006	**Footage End :**	1036.30
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	609.70		
Core Hole ID :	CR-06-05-A		
Date Sampled :	9/19/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-22213-002

	As Received	Dry	MAF
% Moisture, Total	4.69		
% Ash	56.13	58.90	
% Volatile Matter	20.88	21.91	53.30
% Fixed Carbon	18.30	19.19	46.70
Gross Calorific Value (Btu/lb)	5106	5358	13035
% Sulfur	0.65	0.68	

Analyte	Result
Acid Potential	21.25 TCaCO3/1000T
Pounds of Ash/mm Btu	109.93 lb
Pounds of Sulfur/mm Btu	1.27 lb
Pounds of SO2/mm Btu	2.53 lb

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 1/2	**Footage Begin :**	1036.00
Date Received:	10/05/2006	**Footage End :**	1036.30
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	609.70		
Core Hole ID :	CR-06-05-A		
Date Sampled :	9/19/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-22213-002

Analyte	Result	
Ash Analysis Basis	Ignited	
Silicon Dioxide SiO2	71.49	%
Aluminum Oxide Al2O3	19.39	%
Titanium Dioxide TiO2	0.84	%
Iron Oxide Fe2O3	2.72	%
Calcium Oxide CaO	0.74	%
Magnesium Oxide MgO	1.40	%
Potassium Oxide K2O	3.03	%
Sodium Oxide Na2O	0.07	%
Sulfur Trioxide SO3	0.18	%
Phosphorus Pentoxide P2O5	0.10	%
Strontium Oxide SrO	0.01	%
Barium Oxide BaO	0.03	%
Manganese Oxide, Mn3O4	<0.01	%
Undetermined	0.00	%
Sum	100.00	%
Alkalies	2.07	%
Silica Value	93.63	%
Base:Acid Ratio	0.09	%
T250 Temperature	>2900	°F
Type of Ash	Bituminous	

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 1/2	**Footage Begin :**	1036.00
Date Received:	10/05/2006	**Footage End :**	1036.30
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	609.70		
Core Hole ID :	CR-06-05-A		
Date Sampled :	9/19/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-22213-002

Analyte	Result
Arsenic - TCLP	<0.01 mg/L
Barium - TCLP	1.54 mg/L
Cadmium - TCLP	<0.005 mg/L
Chromium - TCLP	<0.005 mg/L
Lead - TCLP	<0.02 mg/L
Selenium - TCLP	<0.01 mg/L
Silver - TCLP	<0.005 mg/L
Mercury - TCLP	<0.0002 mg/L
Specific Gravity, Apparent	1.83 g/cc

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 11/2	**Footage Begin :**	1045.25
Date Received:	10/05/2006	**Footage End :**	1045.75
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	1666.40		
Core Hole ID :	CR-06-05-A		
Date Sampled :	9/19/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha FLOOR		

SGS Sample ID: 072-22213-010

	As Received	Dry	MAF
% Moisture, Total	5.46		
% Ash	87.24	92.27	
% Volatile Matter	5.72	6.05	78.33
% Fixed Carbon	1.58	1.68	21.67
Gross Calorific Value (Btu/lb)	112	118	1527
% Sulfur	0.47	0.50	

Analyte	Result
Acid Potential	15.63 TCaCO3/1000T
Pounds of Ash/mm Btu	7819.64 lb
Pounds of Sulfur/mm Btu	42.46 lb
Pounds of SO2/mm Btu	84.84 lb

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

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GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 11/2	**Footage Begin :**	1045.25
Date Received:	10/05/2006	**Footage End :**	1045.75
Matrix:	Coal		
Net Sample Weight:	1666.40		
Core Hole ID :	CR-06-05-A		
Date Sampled :	9/19/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha		

SGS Sample ID: 072-22213-010

Analyte	Result
Ash Analysis Basis	Ignited
Silicon Dioxide SiO2	73.00 %
Aluminum Oxide Al2O3	18.11 %
Titanium Dioxide TiO2	0.87 %
Iron Oxide Fe2O3	2.31 %
Calcium Oxide CaO	0.74 %
Magnesium Oxide MgO	1.22 %
Potassium Oxide K2O	3.23 %
Sodium Oxide Na2O	0.07 %
Sulfur Trioxide SO3	0.21 %
Phosphorus Pentoxide P2O5	0.22 %
Strontium Oxide SrO	0.00 %
Barium Oxide BaO	0.02 %
Manganese Oxide, Mn3O4	<0.01 %
Undetermined	0.00 %
Sum	100.00 %
Alkalies	2.20 %
Silica Value	94.47 %
Base:Acid Ratio	0.08 %
T250 Temperature	>2900 °F
Type of Ash	Bituminous

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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Analysis Report

August 20, 2010

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID: CR-06-05A 12/2 Floor
Date Received: 08/06/2010
Matrix: Unknown
Kind of Sample : Overburden

SGS Minerals Sample ID: 072-47377-002

Tests	Result	Unit
Specific Gravity	2.55	
pH	4.08	s.u.
pH Temperature	19.10	°C
→ Acid Potential	11.1	
→ Neutralization Potential	0.5	
Conductivity	4400	umhos/cm
Carbon, Total Organic	2.61	%
Calcium Carbonate	<0.10	%
Selenium, Hot Water	0.11	ppm
Calcium, Soluble	720	ppm
Magnesium, Soluble	410	ppm
Potassium, Soluble	230	ppm
Sodium, Soluble	69	ppm
Sodium Absorption Ratio	3.4	
Boron Available	3	ppm

Sample Notes:
Neutralization Potential and Acid Potential reported as tons $CaCO_3$ / 1000 tons material.

Method Reference(s):
"Field and Laboratory Methods Applicable to Overburden and Minesoils," EPA-600 / 2-78-054, March 1978
"Agriculture Handbook No. 60," Issued February 1954
"ASTM International Standards," Vol. 05.06, Standard D 6316, Sept. 2009

Somer Rodriguez, Denver Laboratory

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Carbon Resources LLC

CORE LOG

HOLE CR-06-09

PROJECT SCOFIELD SUMMER 06

Page 1 of 2

LOGGED BY BRAD LINDSAY DATE 1 SEPT 06 RUN 1 INTERVAL 988.0' – 999.5'

Length Recovered 10.6' Length Cored 10.5' % Recovery _____ Collar Elevation _____ RQD _____

Observations/comments EXTRA 0.1' IN THE SHOE

SAMPLE #/Run	Box	Thick	STRENGTH 0 1 2 3 4 5 6	DISCONTINUITIES Dip TCA	TYPE-O or C-I or S- DESCRIPTION	F	Graph	Drill Depth (ft) 988.0'	LITH. GRAPH TOP OF RUN 1	Grain Size CLAY/COAL MUD SILT VFGSS FGSS MGSS CGSS	LITHOLOGIC DESCRIPTION LITHOLOGY-COLOR-GRAIN SIZE-TEXTURE-BEDDING-STRUCTURES-FOSSILS-MISC.	Adjusted Depth (ft)
1/1	988.55			~90	PLATEY						MS: MED GRY, WEAK PLATY FRACTURES COAL LAMS	
					R-SML			989'				
				30	O-IRR, SLK							
				90	O-MEDS						... 0.7' THICK SILTY ZONE	
2/1	989.75			~90	O-W, IRR	0.89		990'				
						0.89		991'				
3/1	990.25		Roof		O-W, IRR							
4/1	990.25		Immediate Roof			1.04		992'			... GRADES BROWN	
5/1	990.75				R-SML, ANG				HIAWATHA SEAM		COAL: BLK, BRT-MED BRT, OCC RESIN, PYRITE FLAKES THROUGHOUT,	
				5-10	O-PL, CLT							
				15	O-PL, CLT			993'				
6/1						0.85						
								994'				
	994.3			15	C-PL, CLT							
				90	O-IRR, DI							
7/1				0	O-EN, PL, CLT	1.37		995'				

SGS

Analysis Report

August 20, 2010

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID: CR-06-09 3/1 ~~Floor~~ Roof
Date Received: 08/06/2010
Matrix: Unknown

Kind of Sample : Overburden

SGS Minerals Sample ID: 072-47377-004

Tests	Result	Unit
Specific Gravity	2.62	
pH	6.34	s.u.
pH Temperature	19.10	°C
→ Acid Potential	23.7	
→ Neutralization Potential	38.9	
Conductivity	3600	umhos/cm
Carbon, Total Organic	1.49	%
Calcium Carbonate	3.64	%
Selenium, Hot Water	0.22	ppm
Calcium, Soluble	630	ppm
Magnesium, Soluble	460	ppm
Potassium, Soluble	100	ppm
Sodium, Soluble	46	ppm
Sodium Absorption Ratio	2.0	
Boron Available	2	ppm

Sample Notes:
Neutralization Potential and Acid Potential reported as tons $CaCO_3$ / 1000 tons material.

Method Reference(s):
"Field and Laboratory Methods Applicable to Overburden and Minesoils," EPA-600 / 2-78-054, March 1978
"Agriculture Handbook No. 60," Issued February 1954
"ASTM International Standards," Vol. 05.06, Standard D 6316, Sept. 2009

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Analysis Report

August 20, 2010

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID: CR-06-09 4/1-~~Floor~~ Immediate Roof
Date Received: 08/06/2010
Matrix: Unknown
Kind of Sample : Overburden

SGS Minerals Sample ID: 072-47377-005

Tests	Result	Unit
Specific Gravity	2.56	
pH	4.39	s.u.
pH Temperature	19.30	°C
→ Acid Potential	40.1	
→ Neutralization Potential	21.1	
Conductivity	5400	umhos/cm
Carbon, Total Organic	8.63	%
Calcium Carbonate	0.27	%
Selenium, Hot Water	0.09	ppm
Calcium, Soluble	560	ppm
Magnesium, Soluble	1100	ppm
Potassium, Soluble	99	ppm
Sodium, Soluble	51	ppm
Sodium Absorption Ratio	1.7	
Boron Available	<1	ppm

Sample Notes:
Neutralization Potential and Acid Potential reported as tons $CaCO_3$ / 1000 tons material.

Method Reference(s):
"Field and Laboratory Methods Applicable to Overburden and Minesoils," EPA-600 / 2-78-054, March 1978
"Agriculture Handbook No. 60," Issued February 1954
"ASTM International Standards," Vol. 05.06, Standard D 6316, Sept. 2009

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072-22214-001
Sample # 8/2
Carbon Resources LLC
Due: **10/20/2006**
091743 Rec: 10/05/2006

072-22214-002
Sample # 10/2
Carbon Resources LLC
Due: **10/20/2006**
091744 Rec: 10/05/2006

072-22214-003
Sample # 11/2
Carbon Resources LLC
Due: **10/20/2006**
091745 Rec: 10/05/2006

RECEIVED OCT - 5 2006

072-22214-004
Sample # 12/2
Carbon Resources LLC
Due: **10/20/2006**
091746 Rec: 10/05/2006

CORE INSTRUCTION FORM

PROJECT: Carbon Resources Drilling
HOLE NUMBER: CR-06-09-BLW
SEAM NAME: Hiawatha
DATE SAMPLED: 8/6/2006

COMPLETED BY: Brad Lindsay
PHONE: (435)851-9044
E-MAIL: rocklogicconsulting@gmail.com

SHIP TO: SGS Minerals Services Division
4665 Paris Street
Suite B-200
Denver, CO 80239

SHIPPED FROM: Rock Logic Consulting LLC
PO Box 544
Cedaredge, Colorado 81413
ATTN: Brad Lindsay
INVOICE: Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
ATTN: Clay Wisdom

072-22214-005
Sample # 2/3
Carbon Resources LLC
Due: **10/20/2006**
091747 Rec: 10/05/2006

Samples Analyzed for Acid/Base & Toxic Metals

072-22214-006
Sample # 4/3
Carbon Resources LLC
Due: **10/20/2006**
091748 Rec: 10/05/2006

072-22214-007
Sample # 5/3
Carbon Resources LLC
Due: **10/20/2006**
091749 Rec: 10/05/2006

072-22214-008
Sample # 6/3
Carbon Resources LLC
Due: **10/20/2006**
091750 Rec: 10/05/2006

SAMPLE #	FROM	TO	Interval	SHORT PROXIMATE	LONG PROXIMATE	UNTIMATE	8 POINT ASH FUSION	APPARENT SPECIFIC GRAVITY	HARDGROVE GRIND.	SULFUR FORMS	FREE SWELLING INDEX	MINERAL ASH	WATER SOL. ALKALIES	Na (SINGLE ELEMENT)	FLOURINE (SINGLE ELEMENT)	CHLORINE (SINGLE ELEMENT)	TRACE ELEMENTS (Coal Suite)	TRACE ELEMENTS (Rock Suite)	TOXIC METALS	ACID FORMING POTENTIAL	RESIN	SAVE SAMPLE FOR ARCHIVE	SPECIAL INSTRUCTIONS
8/2	987.85	988.75	Hia Roof		X			X				X							X	X		X	1 foot upper roof rock
9/2	988.75	989.40	Hia Roof		X			X				X							X	X		X	6" immediate roof rock
10/2	989.40	989.90	Hia Top		X			X				X										X	6" top coal
11/2	989.90	990.90	Hia Upper		X			X				X										X	upper section of coal seam
12/2	990.90	992.40	Hia Upper		X			X				X										X	upper section of coal seam
1/3	996.60	997.50	Hia Middle		X			X				X										X	middle section of coal seam
2/3	997.50	998.30	Hia Middle		X			X				X										X	middle section of coal seam
3/3	998.30	999.45	Hia Middle		X			X				X										X	middle section of coal seam
4/3	999.45	1000.30	Hia Bottom		X			X				X										X	lower section of coal seam
5/3	1000.30	1001.30	Hia Bottom		X			X				X										X	1 foot of floor coal
6/3	1001.30	1001.80	Hia Floor		X			X				X							X	X		X	6" of floor rock
COMP-4	989.40	1001.30	Hia Seam		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	Composite of all eight coal samples (10/2, 11/2, 12/2, 1/3, 2/3, 3/3, 4/3, and 5/3)

NOTE: Samples 9/2, 1/3, & 3/3 are currently being tested for rock mechanics properties and will be forwarded to SGS at a future time

CHANGE IN POSSESSION

Representing

Received By

Relinquishing

Relinquished by

SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 8/2	**Footage Begin :**	987.85
Date Received:	10/05/2006	**Footage End :**	988.75
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	3012.40		
Core Hole ID :	CR-06-09-BLW		
Date Sampled :	8/6/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-22214-001

	As Received	Dry	MAF
% Moisture, Total	3.31		
% Ash	88.32	91.35	
% Volatile Matter	7.41	7.67	88.60
% Fixed Carbon	0.96	0.98	11.40
Gross Calorific Value (Btu/lb)	356	368	4253
% Sulfur	0.78	0.81	

Analyte	Result
Acid Potential	25.31 TCaCO3/1000T
Pounds of Ash/mm Btu	2481.80 lb
Pounds of Sulfur/mm Btu	21.93 lb
Pounds of SO2/mm Btu	43.83 lb

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

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GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 8/2	**Footage Begin :**	987.85
Date Received:	10/05/2006	**Footage End :**	988.75
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	3012.40		
Core Hole ID :	CR-06-09-BLW		
Date Sampled :	8/6/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-22214-001

Analyte	Result	
Ash Analysis Basis	Ignited	
Silicon Dioxide SiO2	70.81	%
Aluminum Oxide Al2O3	16.42	%
Titanium Dioxide TiO2	0.74	%
Iron Oxide Fe2O3	3.28	%
Calcium Oxide CaO	2.20	%
Magnesium Oxide MgO	2.15	%
Potassium Oxide K2O	3.18	%
Sodium Oxide Na2O	0.08	%
Sulfur Trioxide SO3	0.70	%
Phosphorus Pentoxide P2O5	0.35	%
Strontium Oxide SrO	0.01	%
Barium Oxide BaO	0.06	%
Manganese Oxide, Mn3O4	0.02	%
Undetermined	0.00	%
Sum	100.00	%
Alkalies	2.18	%
Silica Value	90.27	%
Base:Acid Ratio	0.12	%
T250 Temperature	>2900	°F
Type of Ash	Lignitic	

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 8/2	**Footage Begin :**	987.85
Date Received:	10/05/2006	**Footage End :**	988.75
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	3012.40		
Core Hole ID :	CR-06-09-BLW		
Date Sampled :	8/6/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-22214-001

Analyte	Result	
Arsenic - TCLP	<0.01	mg/L
Barium - TCLP	0.16	mg/L
Cadmium - TCLP	<0.005	mg/L
Chromium - TCLP	<0.005	mg/L
Lead - TCLP	<0.02	mg/L
Selenium - TCLP	0.01	mg/L
Silver - TCLP	<0.005	mg/L
Mercury - TCLP	<0.0002	mg/L
Specific Gravity, Apparent	2.48	g/cc

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

January 21, 2007

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	9/2	**Footage Begin :**	988.75
Date Received:	12/12/2006	**Footage End :**	989.40
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	2088.60		
Core Hole ID :	CR-06-09-BLW		
Date Sampled :	8/6/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-23528-001

	As Received	Dry	MAF
% Moisture, Total	3.83		
% Ash	83.75	87.08	
% Volatile Matter	12.40	12.89	99.82
% Fixed Carbon	0.02	0.03	0.18
Gross Calorific Value (Btu/lb)	657	683	5289
% Sulfur	0.57	0.60	

Analyte	Result
Acid Potential	16.56 TCaCO3/1000T
Pounds of Ash/mm Btu	1274.71 lb
Pounds of Sulfur/mm Btu	8.74 lb
Pounds of SO2/mm Btu	17.47 lb

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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SGS

January 21, 2007

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	9/2	**Footage Begin :**	988.75
Date Received:	12/12/2006	**Footage End :**	989.40
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	2088.66		
Core Hole ID :	CR-06-09-BLW		
Date Sampled :	8/6/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-23528-001

Analyte	Result
Ash Analysis Basis	Ignited
Silicon Dioxide SiO2	67.94 %
Aluminum Oxide Al2O3	19.54 %
Titanium Dioxide TiO2	0.82 %
Iron Oxide Fe2O3	3.36 %
Calcium Oxide CaO	1.53 %
Magnesium Oxide MgO	2.21 %
Potassium Oxide K2O	3.43 %
Sodium Oxide Na2O	0.12 %
Sulfur Trioxide SO3	0.76 %
Phosphorus Pentoxide P2O5	0.22 %
Strontium Oxide SrO	0.01 %
Barium Oxide BaO	0.05 %
Manganese Oxide, Mn3O4	0.01 %
Undetermined	0.00 %
Sum	100.00 %
Alkalies	2.38 %
Silica Value	90.54 %
Base:Acid Ratio	0.12 %
T250 Temperature	>2900 °F
Type of Ash	Lignitic

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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SGS

January 21, 2007

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	9/2	**Footage Begin :**	988.75
Date Received:	12/12/2006	**Footage End :**	989.40
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	2088.60		
Core Hole ID :	CR-06-09-BLW		
Date Sampled :	8/6/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-23528-001

Analyte	Result
Arsenic - TCLP	<0.01 mg/L
Barium - TCLP	<0.05 mg/L
Cadmium - TCLP	0.005 mg/L
Chromium - TCLP	<0.005 mg/L
Lead - TCLP	<0.02 mg/L
Selenium - TCLP	0.03 mg/L
Silver - TCLP	<0.005 mg/L
Mercury - TCLP	<0.0002 mg/L
Specific Gravity, Apparent	2.34 g/cc

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 6/3	**Footage Begin :**	1001.30
Date Received:	10/05/2006	**Footage End :**	1001.80
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	1563.70		
Core Hole ID :	CR-06-09-BLW		
Date Sampled :	8/6/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha FLOOR		

SGS Sample ID: 072-22214-008

	As Received	Dry	MAF
% Moisture, Total	3.80		
% Ash	85.57	88.94	
% Volatile Matter	7.12	7.40	66.90
% Fixed Carbon	3.51	3.66	33.10
Gross Calorific Value (Btu/lb)	281	292	2642
% Sulfur	0.92	0.96	

Analyte	Result
Acid Potential	30.00 TCaCO3/1000T
Pounds of Ash/mm Btu	3044.77 lb
Pounds of Sulfur/mm Btu	32.90 lb
Pounds of SO2/mm Btu	65.74 lb

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 6/3	**Footage Begin :**	1001.30
Date Received:	10/05/2006	**Footage End :**	1001.80
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	1563.70		
Core Hole ID :	CR-06-09-BLW		
Date Sampled :	8/6/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha FLOOR		

SGS Sample ID: 072-22214-008

Analyte	Result
Ash Analysis Basis	Ignited
Silicon Dioxide SiO2	73.18 %
Aluminum Oxide Al2O3	17.61 %
Titanium Dioxide TiO2	0.86 %
Iron Oxide Fe2O3	3.24 %
Calcium Oxide CaO	0.54 %
Magnesium Oxide MgO	1.22 %
Potassium Oxide K2O	2.95 %
Sodium Oxide Na2O	0.07 %
Sulfur Trioxide SO3	0.23 %
Phosphorus Pentoxide P2O5	0.08 %
Strontium Oxide SrO	0.00 %
Barium Oxide BaO	0.02 %
Manganese Oxide, Mn3O4	<0.01 %
Undetermined	0.00 %
Sum	100.00 %
Alkalies	2.01 %
Silica Value	93.60 %
Base:Acid Ratio	0.09 %
T250 Temperature	>2900 °F
Type of Ash	Bituminous

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 6/3	**Footage Begin :**	1001.30
Date Received:	10/05/2006	**Footage End :**	1001.80
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	1563.70		
Core Hole ID :	CR-06-09-BLW		
Date Sampled :	8/6/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha FLOOR		

SGS Sample ID: 072-22214-008

Analyte	Result
Arsenic - TCLP	<0.01 mg/L
Barium - TCLP	<0.05 mg/L
Cadmium - TCLP	0.010 mg/L
Chromium - TCLP	<0.005 mg/L
Lead - TCLP	0.04 mg/L
Selenium - TCLP	<0.01 mg/L
Silver - TCLP	<0.005 mg/L
Mercury - TCLP	<0.0002 mg/L
Specific Gravity, Apparent	2.42 g/cc

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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072-22215-001
Sample # 9A/3
Carbon Resources LLC
Due: **10/20/2006**
Rec: 10/05/2006
091753

072-22215-002
Sample # 10/3
Carbon Resources LLC
Due: **10/20/2006**
Rec: 10/05/2006
091754

072-22215-003
Sample # 11/3
Carbon Resources LLC
Due: **10/20/2006**
Rec: 10/05/2006
091755

RECEIVED OCT 5 2006

072-22215-004
Sample A# 12A/3
Carbon Resources LLC
Due: **10/20/2006**
Rec: 10/05/2006
091756

CORE INSTRUCTION FORM

PROJECT: Carbon Resources Drilling
HOLE NUMBER: CR-06-10
SEAM NAME: Hiawatha
DATE SAMPLED: 7/23/2006

COMPLETED BY: Brad Lindsay
PHONE: (435)851-9044
E-MAIL: rocklogicconsulting@gmail.com

SHIP TO: SGS Minerals Services Division
4665 Paris Street
Suite B-200
Denver, CO 80239

SHIPPED FROM: Rock Logic Consulting LLC
PO Box 544
Cedaredge, Colorado 81413
ATTN: Brad Lindsay
INVOICE: Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
ATTN: Clay Wisdom

072-22215-005
Sample # 12C/3
Carbon Resources LLC
Due: **10/20/2006**
Rec: 10/05/2006
091757

Samples Analyzed for Acid/Base & Toxic Metals

072-22215-006
Sample # 13B/3
Carbon Resources LLC
Due: **10/20/2006**
Rec: 10/05/2006
091758

SAMPLE #	FROM	TO	Interval	SHORT PROXIMATE	LONG PROXIMATE	UNTIMATE	8 POINT ASH FUSION	APPARENT SPECIFIC GRAVITY	HARDGROVE GRIND.	SULFUR FORMS	FREE SWELLING INDEX	MINERAL ASH	WATER SOL. ALKALIES	Na (SINGLE ELEMENT)	FLOURINE (SINGLE ELEMENT)	CHLORINE (SINGLE ELEMENT)	TRACE ELEMENTS (Coal Suite)	TRACE ELEMENTS (Rock Suite)	TOXIC METALS	ACID FORMING POTENTIAL	RESIN	SAVE SAMPLE FOR ARCHIVE	SPECIAL INSTRUCTIONS
9A/3	1210.25	1210.70	Hia Roof		X			X				X							X	X		X	1 foot upper roof rock
9B/3	1210.70	1211.25	Hia Roof		X			X				X							X	X		X	1 foot upper roof rock
10/3	1211.25	1211.75	Hia Roof		X			X				X							X	X		X	6" immediate roof rock
11/3	1211.75	1212.25	Hia Top		X			X				X										X	6" top coal
12A/3	1212.25	1213.55	Hia Upper		X			X				X										X	upper section of coal seam
12B/3	1213.55	1214.25	Hia Upper		X			X				X										X	upper section of coal seam
12C/3	1214.25	1216.00	Hia Upper		X			X				X										X	upper section of coal seam
13A/3	1216.00	1216.60	Hia Middle		X			X				X										X	middle section of coal seam
13B/3	1216.60	1217.65	Hia Middle		X			X				X										X	middle section of coal seam
13C/3	1217.65	1219.00	Hia Middle		X			X				X										X	middle section of coal seam
13D/3	1219.00	1220.90	Hia Middle		X			X				X										X	middle section of coal seam
1/4	1220.90	1222.00	Hia Lower		X			X				X										X	lower section of coal seam
2/4	1222.00	1222.50	Hia Bottom		X			X				X										X	1 foot of floor coal
3/4	1222.50	1223.00	Hia Floor		X			X				X							X	X		X	6" of floor rock
COMP-3			Hia Seam		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	Composite of all coal samples (11/3, 12A/3, 12B/3, 12C/3, 13A/3, 13B/3, 13C/3, 13D/3, 1/4, and 2/4)

NOTE: Samples 9B/3, 12B/3, & 13A/3 are currently being tested for rock mechanics properties and will be forwarded to SGS at a future time

072-22215-007
Sample # 13C/3
Carbon Resources LLC
Due: **10/20/2006**
Rec: 10/05/2006
091759

072-22215-008
Sample # 13D/3
Carbon Resources LLC
Due: **10/20/2006**
Rec: 10/05/2006
091760

072-22215-009
Sample # 1/4
Carbon Resources LLC
Due: **10/20/2006**
Rec: 10/05/2006
091761

072-22215-010
Sample # 2/4
Carbon Resources LLC
Due: **10/20/2006**
Rec: 10/05/2006
091762

072-22215-011
Sample # 3/4
Carbon Resources LLC
Due: **10/20/2006**
Rec: 10/05/2006
091763

CHANGE IN POSSESSION

Representing

Received By

Representing

Relinquished by

SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID: Sample # 9A/3
Date Received: 10/05/2006
Matrix: ~~Coal~~ Rock
Net Sample Weight: 1406.50
Core Hole ID : CR-06-10
Date Sampled : 7/23/2006
Project Name/# : Carbon Resources Drilling
Seam : Hiawatha ROOF

Footage Begin : 1210.25
Footage End : 1210.70

SGS Sample ID: 072-22215-001

	As Received	Dry	MAF
% Moisture, Total	3.77		
% Ash	91.47	95.06	
% Volatile Matter	4.70	4.88	98.75
% Fixed Carbon	0.06	0.06	1.25
Gross Calorific Value (Btu/lb)	58	60	1217
% Sulfur	0.35	0.37	

Analyte	Result
Acid Potential	11.56 TCaCO3/1000T
Pounds of Ash/mm Btu	15805.53 lb
Pounds of Sulfur/mm Btu	61.27 lb
Pounds of SO2/mm Btu	122.42 lb

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 9A/3	**Footage Begin :**	1210.25
Date Received:	10/05/2006	**Footage End :**	1210.70
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	1406.50		
Core Hole ID :	CR-06-10		
Date Sampled :	7/23/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-22215-001

Analyte	Result	
Ash Analysis Basis	Ignited	
Silicon Dioxide SiO2	77.01	%
Aluminum Oxide Al2O3	15.19	%
Titanium Dioxide TiO2	0.74	%
Iron Oxide Fe2O3	1.96	%
Calcium Oxide CaO	0.66	%
Magnesium Oxide MgO	1.01	%
Potassium Oxide K2O	2.91	%
Sodium Oxide Na2O	0.07	%
Sulfur Trioxide SO3	0.18	%
Phosphorus Pentoxide P2O5	0.24	%
Strontium Oxide SrO	0.01	%
Barium Oxide BaO	0.02	%
Manganese Oxide, Mn3O4	<0.01	%
Undetermined	0.00	%
Sum	100.00	%
Alkalies	1.99	%
Silica Value	95.50	%
Base:Acid Ratio	0.07	%
T250 Temperature	>2900	°F
Type of Ash	Bituminous	

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID: Sample # 9A/3
Date Received: 10/05/2006
Matrix: ~~Coal~~ ROCK
Net Sample Weight: 1406.50
Core Hole ID : CR-06-10
Date Sampled : 7/23/2006
Project Name/# : Carbon Resources Drilling
Seam : Hiawatha ROOF

Footage Begin : 1210.25
Footage End : 1210.70

SGS Sample ID: 072-22215-001

Analyte	Result
Arsenic - TCLP	<0.01 mg/L
Barium - TCLP	0.72 mg/L
Cadmium - TCLP	<0.005 mg/L
Chromium - TCLP	<0.005 mg/L
Lead - TCLP	0.04 mg/L
Selenium - TCLP	<0.01 mg/L
Silver - TCLP	<0.005 mg/L
Mercury - TCLP	<0.0002 mg/L
Specific Gravity, Apparent	2.50 g/cc

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

January 21, 2007

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	9B/3	**Footage Begin :**	1210.70
Date Received:	12/12/2006	**Footage End :**	1211.25
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	1707.20		
Core Hole ID :	CR-06-10		
Date Sampled :	7/23/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-23527-001

	As Received	Dry	MAF
% Moisture, Total	1.13		
% Ash	92.80	93.86	
% Volatile Matter	6.05	6.12	99.68
% Fixed Carbon	0.02	0.02	0.32
Gross Calorific Value (Btu/lb)	1	1	16
% Sulfur	0.04	0.04	

Analyte	Result
Acid Potential	1.25 TCaCO3/1000T
Pounds of Ash/mm Btu	936501.14 lb
Pounds of Sulfur/mm Btu	438.89 lb
Pounds of SO2/mm Btu	876.95 lb

Respectfully submitted,
SGS NORTH AMERICA INC.

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January 21, 2007

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	9B/3	**Footage Begin :**	1210.70
Date Received:	12/12/2006	**Footage End :**	1211.25
Matrix:	Coal ROCK		
Net Sample Weight:	1707.20		
Core Hole ID :	CR-06-10		
Date Sampled :	7/23/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-23527-001

Analyte	Result
Ash Analysis Basis	Ignited
Silicon Dioxide SiO2	86.49 %
Aluminum Oxide Al2O3	4.11 %
Titanium Dioxide TiO2	0.28 %
Iron Oxide Fe2O3	2.51 %
Calcium Oxide CaO	3.77 %
Magnesium Oxide MgO	1.35 %
Potassium Oxide K2O	1.10 %
Sodium Oxide Na2O	0.02 %
Sulfur Trioxide SO3	0.21 %
Phosphorus Pentoxide P2O5	0.13 %
Strontium Oxide SrO	0.00 %
Barium Oxide BaO	0.01 %
Manganese Oxide, Mn3O4	0.02 %
Undetermined	0.00 %
Sum	100.00 %
Alkalies	0.74 %
Silica Value	91.89 %
Base:Acid Ratio	0.10 %
T250 Temperature	>2900 °F
Type of Ash	Lignitic

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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SGS

January 21, 2007

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	9B/3	**Footage Begin :**	1210.70
Date Received:	12/12/2006	**Footage End :**	1211.25
Matrix:	Coal		
Net Sample Weight:	1707.20		
Core Hole ID :	CR-06-10		
Date Sampled :	7/23/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha		

SGS Sample ID: 072-23527-001

Analyte	Result
Arsenic - TCLP	<0.01 mg/L
Barium - TCLP	<0.05 mg/L
Cadmium - TCLP	<0.005 mg/L
Chromium - TCLP	<0.005 mg/L
Lead - TCLP	<0.02 mg/L
Selenium - TCLP	<0.01 mg/L
Silver - TCLP	<0.005 mg/L
Mercury - TCLP	<0.0002 mg/L
Specific Gravity, Apparent	2.59 g/cc

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 10/3	**Footage Begin :**	1211.25
Date Received:	10/05/2006	**Footage End :**	1211.75
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	1732.00		
Core Hole ID :	CR-06-10		
Date Sampled :	7/23/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-22215-002

	As Received	Dry	MAF
% Moisture, Total	4.48		
% Ash	83.23	87.14	
% Volatile Matter	0.91	0.95	7.40
% Fixed Carbon	11.38	11.91	92.60
Gross Calorific Value (Btu/lb)	1029	1077	8380
% Sulfur	0.42	0.44	

Analyte	Result
Acid Potential	13.75 TCaCO3/1000T
Pounds of Ash/mm Btu	808.76 lb
Pounds of Sulfur/mm Btu	4.07 lb
Pounds of SO2/mm Btu	8.14 lb

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 10/3	**Footage Begin :**	1211.25
Date Received:	10/05/2006	**Footage End :**	1211.75
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	1732.00		
Core Hole ID :	CR-06-10		
Date Sampled :	7/23/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-22215-002

Analyte	Result
Ash Analysis Basis	Ignited
Silicon Dioxide SiO2	73.07 %
Aluminum Oxide Al2O3	17.68 %
Titanium Dioxide TiO2	0.88 %
Iron Oxide Fe2O3	2.31 %
Calcium Oxide CaO	0.65 %
Magnesium Oxide MgO	1.27 %
Potassium Oxide K2O	3.24 %
Sodium Oxide Na2O	0.08 %
Sulfur Trioxide SO3	0.32 %
Phosphorus Pentoxide P2O5	0.21 %
Strontium Oxide SrO	0.01 %
Barium Oxide BaO	0.28 %
Manganese Oxide, Mn3O4	<0.01 %
Undetermined	0.00 %
Sum	100.00 %
Alkalies	2.21 %
Silica Value	94.53 %
Base:Acid Ratio	0.08 %
T250 Temperature	>2900 °F
Type of Ash	Bituminous

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 10/3	**Footage Begin :**	1211.25
Date Received:	10/05/2006	**Footage End :**	1211.75
Matrix:	~~Coal~~ ROCK		
Net Sample Weight:	1732.00		
Core Hole ID :	CR-06-10		
Date Sampled :	7/23/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha ROOF		

SGS Sample ID: 072-22215-002

Analyte	Result
Arsenic - TCLP	0.01 mg/L
Barium - TCLP	0.38 mg/L
Cadmium - TCLP	<0.005 mg/L
Chromium - TCLP	<0.005 mg/L
Lead - TCLP	0.03 mg/L
Selenium - TCLP	<0.01 mg/L
Silver - TCLP	<0.005 mg/L
Mercury - TCLP	<0.0002 mg/L
Specific Gravity, Apparent	2.30 g/cc

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 3/4	**Footage Begin :**	1222.50
Date Received:	10/05/2006	**Footage End :**	1223.00
Matrix:	~~Coal~~ Rock		
Net Sample Weight:	1124.10		
Core Hole ID :	CR-06-10		
Date Sampled :	7/23/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha		

SGS Sample ID: 072-22215-011

	As Received	Dry	MAF
% Moisture, Total	3.54		
% Ash	69.75	72.31	
% Volatile Matter	9.72	10.07	36.38
% Fixed Carbon	16.99	17.62	63.62
Gross Calorific Value (Btu/lb)	3332	3454	12473
% Sulfur	1.47	1.52	

Analyte	Result
Acid Potential	47.50 TCaCO3/1000T
Pounds of Ash/mm Btu	209.32 lb
Pounds of Sulfur/mm Btu	4.40 lb
Pounds of SO2/mm Btu	8.80 lb

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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GENERAL CONDITIONS OF SERVICE ON REVERSE

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October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID: Sample # 3/4
Date Received: 10/05/2006
Matrix: Coal ROCK
Net Sample Weight: 1124.10
Core Hole ID : CR-06-10
Date Sampled : 7/23/2006
Project Name/# : Carbon Resources Drilling
Seam : Hiawatha FLOOR

Footage Begin : 1222.50
Footage End : 1223.00

SGS Sample ID: 072-22215-011

Analyte	Result
Ash Analysis Basis	Ignited
Silicon Dioxide SiO2	92.55 %
Aluminum Oxide Al2O3	2.76 %
Titanium Dioxide TiO2	0.96 %
Iron Oxide Fe2O3	3.06 %
Calcium Oxide CaO	0.27 %
Magnesium Oxide MgO	0.04 %
Potassium Oxide K2O	0.12 %
Sodium Oxide Na2O	0.00 %
Sulfur Trioxide SO3	0.17 %
Phosphorus Pentoxide P2O5	0.05 %
Strontium Oxide SrO	0.01 %
Barium Oxide BaO	0.00 %
Manganese Oxide, Mn3O4	0.01 %
Undetermined	0.00 %
Sum	100.00 %
Alkalies	0.08 %
Silica Value	96.49 %
Base:Acid Ratio	0.04 %
T250 Temperature	>2900 °F
Type of Ash	Bituminous

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 30, 2006

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Sample # 3/4	**Footage Begin :**	1222.50
Date Received:	10/05/2006	**Footage End :**	1223.00
Matrix:	Coal ROCK		
Net Sample Weight:	1124.10		
Core Hole ID :	CR-06-10		
Date Sampled :	7/23/2006		
Project Name/# :	Carbon Resources Drilling		
Seam :	Hiawatha FLOOR		

SGS Sample ID: 072-22215-011

Analyte	Result	
Arsenic - TCLP	0.01	mg/L
Barium - TCLP	0.20	mg/L
Cadmium - TCLP	<0.005	mg/L
Chromium - TCLP	0.019	mg/L
Lead - TCLP	<0.02	mg/L
Selenium - TCLP	<0.01	mg/L
Silver - TCLP	<0.005	mg/L
Mercury - TCLP	<0.0002	mg/L
Specific Gravity, Apparent	2.00	g/cc

Respectfully submitted,
SGS NORTH AMERICA INC.

Denver Laboratory

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GENERAL CONDITIONS OF SERVICE ON REVERSE

Analysis Report

September 27, 2010

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	5C/5	**Core Hole ID :**	CR-06-01
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-19142-002

SGS Minerals Sample ID: 072-30789-001

Tests	Result	Unit	Method
pH	6.91	s.u.	USDA Handbook 60
Conductivity	6.62	mmhos/cm	USDA Handbook 60
Saturation %	42.3	%	USDA Handbook 60

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Analysis Report

September 27, 2010

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	6/5	**Core Hole ID :**	CR-06-01
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-19142-003

SGS Minerals Sample ID: 072-30789-002

Tests	Result	Unit	Method
pH	3.74	s.u.	USDA Handbook 60
Conductivity	9.37	mmhos/cm	USDA Handbook 60
Saturation %	56.5	%	USDA Handbook 60

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Analysis Report

September 27, 2010

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	Comp-1	**Core Hole ID :**	CR-06-01
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-19142-010

SGS Minerals Sample ID: 072-30789-004

Tests	Result	Unit	Method
pH	5.31	s.u.	USDA Handbook 60
Conductivity	3.17	mmhos/cm	USDA Handbook 60
Saturation %	76.4	%	USDA Handbook 60

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Analysis Report

September 27, 2010

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
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Client Sample ID:	2/17	**Core Hole ID :**	CR-06-02
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-19143-002

SGS Minerals Sample ID: 072-30789-005

Tests	Result	Unit	Method
pH	7.59	s.u.	USDA Handbook 60
Conductivity	7.51	mmhos/cm	USDA Handbook 60
Saturation %	35.9	%	USDA Handbook 60

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Client Sample ID:	3/17	**Core Hole ID :**	CR-06-02
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-19143-003

SGS Minerals Sample ID: 072-30789-006

Tests	Result	Unit	Method
pH	6.14	s.u.	USDA Handbook 60
Conductivity	3.47	mmhos/cm	USDA Handbook 60
Saturation %	60.8	%	USDA Handbook 60

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Client Sample ID:	4/17	**Core Hole ID :**	CR-06-02
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-19143-004

SGS Minerals Sample ID: 072-30789-007

Tests	Result	Unit	Method
pH	6.75	s.u.	USDA Handbook 60
Conductivity	6.50	mmhos/cm	USDA Handbook 60
Saturation %	67.5	%	USDA Handbook 60

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Client Sample ID:	3/18	**Core Hole ID :**	CR-06-02
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-19143-009

SGS Minerals Sample ID: 072-30789-008

Tests	Result	Unit	Method
pH	4.08	s.u.	USDA Handbook 60
Conductivity	11.6	mmhos/cm	USDA Handbook 60
Saturation %	57.7	%	USDA Handbook 60

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Client Sample ID:	Comp-2	**Core Hole ID :**	CR-06-02
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-19143-010

SGS Minerals Sample ID: 072-30789-009

Tests	Result	Unit	Method
pH	6.56	s.u.	USDA Handbook 60
Conductivity	5.39	mmhos/cm	USDA Handbook 60
Saturation %	69.4	%	USDA Handbook 60

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Client Sample ID:	1/1	**Core Hole ID :**	CR-06-05
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-22212-001

SGS Minerals Sample ID: 072-30789-010

Tests	Result	Unit	Method
pH	7.09	s.u.	USDA Handbook 60
Conductivity	0.42	mmhos/cm	USDA Handbook 60
Saturation %	78.5	%	USDA Handbook 60

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Client Sample ID:	2/1	**Core Hole ID :**	CR-06-05
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-22212-002

SGS Minerals Sample ID: 072-30789-011

Tests	Result	Unit	Method
pH	7.24	s.u.	USDA Handbook 60
Conductivity	1.00	mmhos/cm	USDA Handbook 60
Saturation %	54.1	%	USDA Handbook 60

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Client Sample ID:	7/2	**Core Hole ID :**	CR-06-05
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-22213-007

SGS Minerals Sample ID: 072-30789-012

Tests	Result	Unit	Method
pH	7.08	s.u.	USDA Handbook 60
Conductivity	0.51	mmhos/cm	USDA Handbook 60
Saturation %	80.9	%	USDA Handbook 60

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Client Sample ID:	8/1	**Core Hole ID :**	CR-06-05
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-22213-001

SGS Minerals Sample ID: 072-30789-013

Tests	Result	Unit	Method
pH	7.17	s.u.	USDA Handbook 60
Conductivity	8.23	mmhos/cm	USDA Handbook 60
Saturation %	42.4	%	USDA Handbook 60

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September 27, 2010

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Client Sample ID:	1/2	**Core Hole ID :**	CR-06-05
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-22213-002

SGS Minerals Sample ID: 072-30789-014

Tests	Result	Unit	Method
pH	7.13	s.u.	USDA Handbook 60
Conductivity	0.80	mmhos/cm	USDA Handbook 60
Saturation %	55.4	%	USDA Handbook 60

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Analysis Report

September 27, 2010

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	8/2	**Core Hole ID :**	CR-06-09-BLW
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-22214-001

SGS Minerals Sample ID: 072-30789-015

Tests	Result	Unit	Method
pH	6.67	s.u.	USDA Handbook 60
Conductivity	4.68	mmhos/cm	USDA Handbook 60
Saturation %	50.7	%	USDA Handbook 60

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Analysis Report

September 27, 2010

Carbon Resources LLC
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USA

Client Sample ID:	2/3	**Core Hole ID :**	CR-06-09-BLW
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-22214-005

SGS Minerals Sample ID: 072-30789-016

Tests	Result	Unit	Method
pH	6.77	s.u.	USDA Handbook 60
Conductivity	0.65	mmhos/cm	USDA Handbook 60
Saturation %	84.7	%	USDA Handbook 60

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Client Sample ID:	5/3	**Core Hole ID :**	CR-06-09-BLW
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-22214-007

SGS Minerals Sample ID: 072-30789-017

Tests	Result	Unit	Method
pH	6.44	s.u.	USDA Handbook 60
Conductivity	7.80	mmhos/cm	USDA Handbook 60
Saturation %	74.3	%	USDA Handbook 60

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Client Sample ID:	6/3	**Core Hole ID :**	CR-06-09-BLW
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-22214-008

SGS Minerals Sample ID: 072-30789-018

Tests	Result	Unit	Method
pH	5.03	s.u.	USDA Handbook 60
Conductivity	6.62	mmhos/cm	USDA Handbook 60
Saturation %	51.9	%	USDA Handbook 60

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Client Sample ID:	9/A3	**Core Hole ID :**	CR-06-10
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-22215-001

SGS Minerals Sample ID: 072-30789-019

Tests	Result	Unit	Method
pH	7.07	s.u.	USDA Handbook 60
Conductivity	2.60	mmhos/cm	USDA Handbook 60
Saturation %	51.8	%	USDA Handbook 60

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Client Sample ID:	10/3	**Core Hole ID :**	CR-06-10
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-22215-002

SGS Minerals Sample ID: 072-30789-020

Tests	Result	Unit	Method
pH	6.64	s.u.	USDA Handbook 60
Conductivity	2.45	mmhos/cm	USDA Handbook 60
Saturation %	53.1	%	USDA Handbook 60

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Client Sample ID:	11/3	**Core Hole ID :**	CR-06-10
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-22215-003

SGS Minerals Sample ID: 072-30789-021

Tests	Result	Unit	Method
pH	6.72	s.u.	USDA Handbook 60
Conductivity	0.60	mmhos/cm	USDA Handbook 60
Saturation %	67.0	%	USDA Handbook 60

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Client Sample ID:	12A/3	**Core Hole ID :**	CR-06-10
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-22215-004

SGS Minerals Sample ID: 072-30789-022

Tests	Result	Unit	Method
pH	6.87	s.u.	USDA Handbook 60
Conductivity	0.60	mmhos/cm	USDA Handbook 60
Saturation %	74.5	%	USDA Handbook 60

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t (303) 373-4772 f (303) 373-4791 www.sgs.com/minerals

Member of SGS Group

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Analysis Report

September 27, 2010

Carbon Resources LLC
PO Box 11789
Albuquerque, NM 87192
USA

Client Sample ID:	3/4	**Core Hole ID :**	CR-06-10
Date Received:	01/11/2008	**Project Name/# :**	Kinney #2 Mine
Matrix:	Soil	**Sample ID :**	072-22215-011

SGS Minerals Sample ID: 072-30789-023

Tests	Result	Unit	Method
pH	5.86	s.u.	USDA Handbook 60
Conductivity	5.48	mmhos/cm	USDA Handbook 60
Saturation %	42.8	%	USDA Handbook 60

Somer Rodriguez, Denver Laboratory

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Rock Strength Data, Agapito Reports

Roof & Floor Analyses, SGS Lab Sheets

Rock Strength Data, Agapito Reports

AGAPITO ASSOCIATES, INC.
CONSULTING ENGINEERS

715 HORIZON DRIVE
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630.792.1520

GOLDEN OFFICE
303.273.1511

June 19, 2006

597-01

Mr. Brad Lindsay
Rock Logic Consulting, LLC
P. O. Box 544
Cedaredge, CO 81413

RE: **Carbon Resources, LLC—Rock Mechanics Core Testing Results**

Dear Mr. Lindsay:

This letter provides a summary of the recent rock mechanics core testing performed by Agapito Associates, Inc. (AAI), on behalf of Rock Logic Consulting, LLC (Rock Logic). Rock Logic provided 3.2-inch-diameter core samples with lithologic descriptions for laboratory testing. The samples were selected by Rock Logic, and the cores were from holes numbered CR-06-01 and CR-06-02.

Uniaxial compressive strength tests were performed by AAI at ambient temperature according to the American Society for Testing and Materials (ASTM) specifications:

- Uniaxial compressive strength (UCS) test with and without elastic properties: D2938-95[1]/D3148-93[2]

Test results are summarized in Table 1.

The attached CD contains an electronic version of the Microsoft Excel test sheets, as well as UCS-with-elastic properties laboratory data sheets in Adobe Portable Document Format (PDF). Also attached is a chain of custody.

[1]American Society for Testing and Materials (ASTM), "Standard Test Method for Unconfined Compressive Strength of Intact Rock Core Specimens," Designation D2938-95 (Re-approved in 1992).

[2]American Society for Testing and Materials (ASTM), "Standard Test Method for Elastic Moduli of Intact Rock Core Specimens in Uniaxial Compression," Designation D3148-93.

Please contact me if you have any questions.

Sincerely,

Albert Adu-Acheampong
Project Engineer

AAA/smvf

Attachments (3): Table 1
Chain of Custody
CD containing complete testing data

Table 1. Summary of UCS Test Results for Holes CR-06-01 and CR-06-02

Specimen No.	Hole ID	Depth (ft)		Lithology	Weight	Average Diameter	Axial Length	Density	Failure Load	UCS	Young's Modulus	Poisson's Ratio
		From	To		(oz)	(in)	(in)	(pcf)	(lb)	(psi)	($\times 10^6$ psi)	
5B/4-U-01	CR-06-1	66.7	67.15	Sandstone	52.16	3.25	4.59	147.8	27,700	3,180		
5B/5-U-02	CR-06-1	75.60	76.40	Sandstone	83.20	3.25	7.36	147.6	49,220	5,951	0.59	0.19
2A/14-U-03	CR-06-2	415.00	415.81	Sandstone	88.80	3.25	7.47	154.8	72,900	8,785		
1A/15-U-04	CR-06-2	419.00	420.20	Silty Sandstone	80.80	3.25	6.95	151.4	41,660	5,023		
2/16-U-05	CR-06-2	425.20	426.00	Sandy Siltstone	84.00	3.24	6.87	159.9	142,800	17,299		
1A/17-U-06	CR-06-2	426.00	426.60	Sandstone	70.40	3.24	6.49	142.5	59,040	7,179	1.55	0.18
5A/18-U-07	CR-06-2	438.15	438.80	Sandstone	73.92	3.25	6.72	143.5	57,930	6,998	2.17	0.48

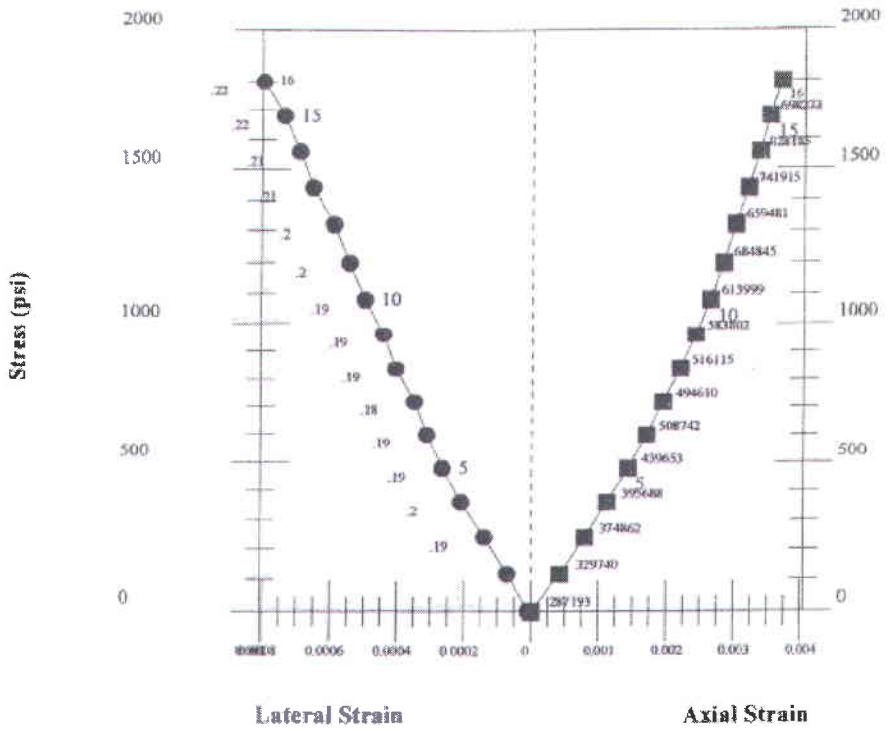
UNCONFINED COMPRESSIVE STRENGTH AND DEFORMABILITY TEST

Client: Carbon Resources

Job #:	597-01	**Sample Date:**	na
Hole #:	CR-06-01	**Testing Date:**	06/15/2006
Sample #:	06-CR0601-5B/5-U-02	**Sample Depth:**	76 ft
Length:	7.363 in	**Diameter:**	3.245 in
Area:	8.27 sq in	**Volume:**	60.894 cu in
Weight:	83.2 ounces	**Density:**	147.6 lb/cubic ft
Moisture Condition:	As Received		
Material:	Sandstone		
Failure Load:	49,220 lb		
Compressive Strength:	5,951.44 psi		

Elastic Properties:
Secant Modulus (Points 5 and 16 at 30.5% of UCS) = 5.94E+05 psi
Tangent Modulus (Mean of the slopes betweeen points 12 - 16) = 7.32E+05 psi
Poisson's Ratio (Secant between points 2 and 10) = 0.19

Sample #: 06-CR0601-5B/5-U-02 **Number of Points:** 16



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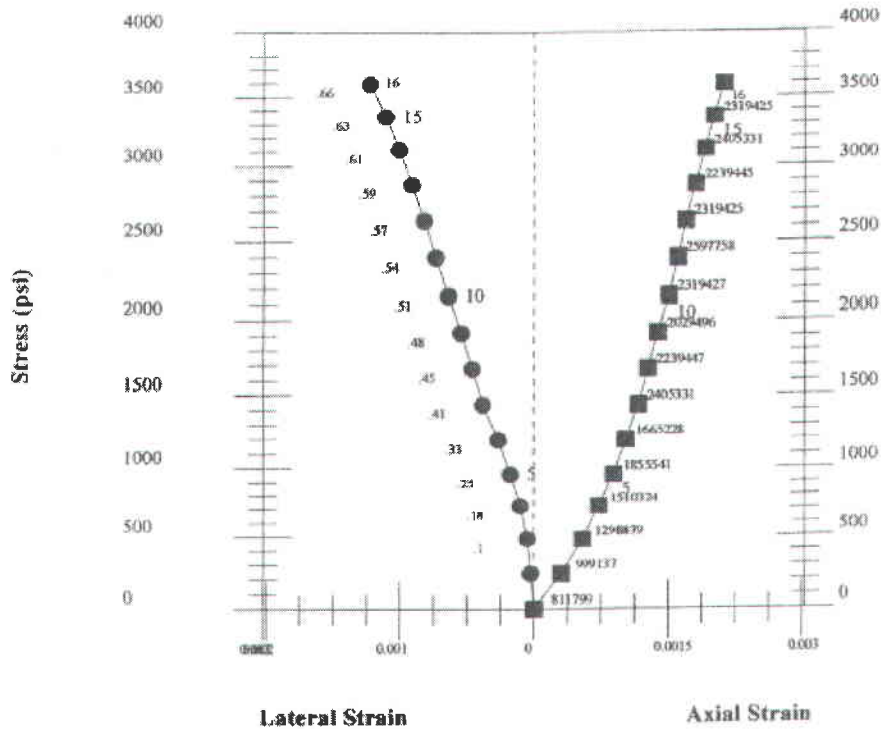
Ver. 1.0, Date: 6/19/2006

UNCONFINED COMPRESSIVE STRENGTH AND DEFORMABILITY TEST

Client:	Carbon Resources		
Job #:	555-55	**Sample Date:**	na
Hole #:	CR-06-02	**Testing Date:**	06/15/2006
Sample #:	06-CR0602-5A/18-U-07	**Sample Depth:**	438.475 ft
Length:	6.72 in	**Diameter:**	3.247 in
Area:	8.278 sq in	**Volume:**	55.628 cu in
Weight:	73.92 ounces	**Density:**	143.5 lb/cubic ft
Moisture Condition:	As Received		
Material:	Sandstone		
Failure Load:	57.930 lb		
Compressive Strength:	6,998.14 psi		

Elastic Properties:
Secant Modulus (Points 5 and 15 at 48.3% of UCS) = 2.17E+06 psi
Tangent Modulus (Mean of the slopes betweeen points 12 - 16) = 2.32E+06 psi
Poisson's Ratio (Secant between points 2 and 9) = 0.48

Sample #: 06-CR0602-5A/18-U-07 **Number of Points:** 16



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ANALYSES REQUESTED AND CHAIN OF CUSTODY-ROCK MECHANICS

Sample provided by:
Rock Logic Consulting, LLC
PO Box 544
Cedaredge, CO 81413
Attn-Brad Lindsay 435 851-9044

Sample sent to:
Agapito Associates, Inc.
715 Horizon Drive Suite 340
Grand Junction, CO 81506
Attn-Albert Adu-Acheampong 970 242-4220

Please Invoice:
Carbon Resources, LLC
PO Box 11789
Albuquerque, NM 87192
Attn-Clay Wisdom 505 286-1253

Drill Hole Number
CR-06-01

Sample ID	Sample Depth Interval From	Sample Depth Interval To	Lithology	Stratigraphic Unit	Sample Date	Length of Core (FT)	Core Diameter	Analyses Requested
5B/4	66.7'	67.15'	ss	10' abv HIA	2/14/2006	0.46	0.27	UCS
5B/5	75.6'	76.4'	ss	roof of HIA	2/14/2006	0.78	0.27	UCS + Elastic

Drill Hole Number
CR-06-02

Sample ID	Sample Depth Interval From	Sample Depth Interval To	Lithology	Stratigraphic Unit	Sample Date	Length of Core (FT)	Core Diameter	Analyses Requested
2A/14	415.0'	415.81'	ss	13' abv HIA	2/14/2006	0.83	0.27	UCS
1A/15	419.0'	420.2'	slty ss	9' abv HIA	2/14/2006	1.1	0.27	UCS
2/16	425.2'	426.0'	sndy slts	2' abv HIA	2/14/2006	0.8	0.27	UCS
1A/17	426.0'	426.6'	ss	roof of HIA	2/14/2006	0.8	0.27	UCS + Elastic
5A/18	438.15'	438.8'	ss	floor of HIA	2/14/2006	0.61	0.27	UCS + Elastic

Relinquished by BRAD LINDSAY Representing ROCK LOGIC CONSULTING
Signed [signature] Date 12 MAY 06 Time ~~10:55~~ 12:00
Recieved By [signature] Representing Agapito Assoc.
Signed Date 5/12/06 Time 5:00 pm

Relinquished by _____ Representing _____
Signed _____ Date _____ Time _____
Recieved By _____ Representing _____
Signed _____ Date _____ Time _____

Instructions

1- Do not allow the samples to dry more than needed to perform the analyses.
2- Some samples will be chemically analyzed following these tests. Thus, it is imperative that the samples are not contaminated by other samples or other materials. Please ensure that the testing apparatus and the area that will contain the debris from testing are clean.
3- It is imperative that none of the sample is lost during testing. After analysis is complete, gather the remaining sample and sample debris and place the material in a durable sealed heavy plastic bag or container for storage. Retain the sample until picked up by Rock Logic.
4- Place the drill hole number, sample ID, and sample depth interval on the analysis sheet.
5- Be sure to use the correct confining liquid for triaxial tests stated in the analyses requested.
6- Contact Brad Lindsay when the samples are ready for pick-up.

AGAPITO ASSOCIATES, INC.
CONSULTING ENGINEERS

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October 10, 2006 597-02

Mr. Brad Lindsay
Rock Logic Consulting, LLC
P. O. Box 544
Cedaredge, CO 81413

RE: **Carbon Resources, LLC—September 2006 Rock Mechanics Core Testing Results**

Dear Mr. Lindsay:

This letter provides a summary of the recent rock mechanics core testing performed by Agapito Associates, Inc. (AAI), on behalf of Rock Logic Consulting, LLC (RLC). RLC provided 3.0-inch-diameter core samples with lithologic descriptions for laboratory testing. The samples were selected by RLC, and the cores were from holes numbered CR-06-10, CR-06-09-BLW, CR-06-05, and CR-06-05-A.

Uniaxial compressive strength (UCS) tests were performed by AAI at ambient temperature according to the American Society for Testing and Materials (ASTM) specifications:

- Uniaxial compressive strength test with and without elastic properties: D2938-95[1]/ D3148-93[2]

Test results are summarized in Table 1. Per Mr. Lindsay's request, samples with length-to-diameter ratio less than 2 were tested.

The attached CD contains an electronic version of the Microsoft Excel test sheets, as well as UCS-with-elastic properties laboratory data sheets in Adobe Portable Document Format (PDF). Also attached is a chain of custody.

[1]American Society for Testing and Materials (ASTM), "Standard Test Method for Unconfined Compressive Strength of Intact Rock Core Specimens," Designation D2938-95 (Re-approved in 1992).
[2]American Society for Testing and Materials (ASTM), "Standard Test Method for Elastic Moduli of Intact Rock Core Specimens in Uniaxial Compression," Designation D3148-93.

Please contact me if you have any questions.

Sincerely,

Albert Adu-Acheampong
Project Engineer

AAA/smvf

Attachments (3): Table 1
Chain of Custody
CD containing complete testing data

Table 1. Summary of UCS Test Results

Specimen No.	Hole ID	Depth (ft) From	Depth (ft) To	Lithology	Weight (oz)	Average Diameter (in)	Axial Length (in)	Density (pcf)	Failure Load (lb)	UCS (psi)	Young's Modulus ($\times 10^6$ psi)	Poisson's Ratio
06-CR06-09-4/2-U-0	R-06-09-BL	981.7	982.25	Siltstone	31.77	3.00	6.05	80.5	90,160	12,793		
5-CR06-10-12B/3-U-(	CR-06-10	1213.65	1214.20	Coal	31.45	3.00	6.07	79.2	13,530	1,915		
6-CR06-05A-8/2-U-(	CR-06-05-A	1042.30	1042.85	Coal	29.98	3.00	6.14	74.8	8,200	1,162		
5-CR06-10-13A/3-U-(	CR-06-10	1216.00	1216.60	Coal	31.57	2.99	6.14	78.9	8,640	1,228		
6E-CR06-10-2/5-U-0	CR-06-10	1229.45	1230.00	Sandstone	56.65	2.99	6.16	141.8	28,790	4,108	0.76	0.39
6-CR06-10-3/3-U-06	CR-06-10	1204.05	1204.60	Siltstone	63.53	2.99	5.82	168.4	122,700	17,459		
06-CR06-09-3/3-U-0	R-06-09-BL	998.75	999.35	Coal	30.71	2.99	6.12	77.0	8,090	1,150		
6E-CR06-05-5/1-U-0	CR-06-05	1047.50	1048.00	Sandstone	51.36	2.98	6.03	131.5	16,530	2,363	0.39	0.41
06-CR06-09-1/3-U-0	R-06-09-BL	996.90	997.45	Coal	30.60	3.00	5.96	78.6	10,410	1,474		
6-CR06-10-9B/3-U-1	CR-06-10	1210.70	1211.25	Sandstone	61.30	2.99	5.89	160.0	95,800	13,625	2.73	0.08
06-CR06-10-7/3-U-1	CR-06-10	1207.70	1208.25	Sandstone	61.34	2.99	6.12	153.8	28,550	4,058		
6-CR06-09-10/1-U-1	R-06-09-BL	975.45	976.00	Sandstone	63.08	2.98	6.06	160.7	103,130	14,742		
5-CR06-05A-5/1-U-1	CR-06-05-A	1031.50	1031.90	Mudstone	43.28	2.98	4.21	158.6	40,850	5,561		
5-CR06-05A-6/1-U-1	CR-06-05-A	1031.90	1032.40	Sandstone	48.97	2.99	4.77	157.8	79,850	11,033		

* UCS values for samples with L/D<2.0 are corrected as per ASTM D2938-86.

ANALYSES REQUESTED AND CHAIN OF CUSTODY-ROCK MECHANICS

Sample provided by:
Rock Logic Consulting, LLC
PO Box 544
Cedaredge, CO 81413
Attn-Brad Lindsay 435 851-9044

Sample sent to:
Agapito Associates, Inc
715 Horizon Drive Suite 340
Grand Junction, CO 81506
Attn-Albert Adu-Acheampong 970 242-4220

Please Invoice:
Carbon Resources, LLC
PO Box 11789
Albuquerque, NM 87192
Attn-Clay Wisdom 505 286-1253

Drill Hole Number
CR-06-10

Sample ID	Sample Depth Interval From	Sample Depth Interval To	Lithology	Stratigraphic Unit	Sample Date	Length of Core (FT)	Diameter Core (FT)	Analyses Requested
3/3	1204.05	1204.60	slts	7' abv HIA	7/23/2006	0.55	0.25	UCS
4/3	1204.60	1205.25	ms	7' abv HIA	7/23/2006	0.65	0.25	UCS
7/3	1207.50	1208.30	ss	4' abv HIA	7/23/2006	0.80	0.25	UCS
9B/3	1210.70	1211.25	ss	roof of HIA	7/23/2006	0.55	0.25	UCS + Elastic
12B/3	1213.55	1214.25	coal	top of HIA	7/23/2006	0.70	0.25	UCS
13A/3	1216.00	1216.60	coal	middle of HIA	7/23/2006	0.60	0.25	UCS
2/5	1229.00	1230.00	ss	floor of HIA	7/23/2006	1.00	0.25	UCS + Elastic

Drill Hole Number
CR-06-09-BLW

Sample ID	Sample Depth Interval From	Sample Depth Interval To	Lithology	Stratigraphic Unit	Sample Date	Length of Core (FT)	Diameter Core (FT)	Analyses Requested
10/1	975.40	976.10	ss	13' abv HIA	8/6/2006	0.70	0.25	UCS
4/2	981.60	982.35	slts	7' abv HIA	8/6/2006	0.75	0.25	UCS
9/2	988.75	989.40	ms	roof of HIA	8/6/2006	0.65	0.25	USC +Elastic
1/3	996.60	997.50	coal	bottom of HIA	8/6/2006	0.90	0.25	UCS
3/3	998.30	999.45	coal	bottom of HIA	8/6/2006	1.15	0.25	UCS

Drill Hole Number
CR-06-05

Sample ID	Sample Depth Interval From	Sample Depth Interval To	Lithology	Stratigraphic Unit	Sample Date	Length of Core (FT)	Diameter Core (FT)	Analyses Requested
5/1	1046.5	1048.2	ss	spring canyon	9/7/2006	1.7	0.25	USC + Elastic

Drill Hole Number
CR-06-05-A

Sample ID	Sample Depth Interval From	Sample Depth Interval To	Lithology	Stratigraphic Unit	Sample Date	Length of Core (FT)	Diameter Core (FT)	Analyses Requested
5/1	1030.5	1031.9	ms	4' abv HIA	9/19/2006	1.4	0.25	UCS
6/1	1031.9	1033.7	ss	3' abv HIA	9/19/2006	1.8	0.25	UCS
3/2	1036.8	1037.2	coal	upper HIA	9/19/2006	0.4	0.25	UCS
8/2	1042	1043	coal	lower HIA	9/19/2006	1	0.25	UCS
12/2	1045.75	1046.75	ms	floor of HIA	9/19/2006	1	0.25	UCS + Elastic

Relinquished by BRAD LINDSAY Representing CARBON RESOURCES
Signed _____ Date 26 SEP 06 Time _____

Recieved By Jim Representing _____
Signed _____ Date 9/26/06 Time 1440

Instructions

1- Do not allow the samples to dry more than needed to perform the analyses.
2- Some samples will be chemically analyzed following these tests. Thus, it is imperative that the samples are not contaminated by other samples or other materials. Please ensure that the testing apparatus and the area that will contain the debris from testing are clean.
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4- Place the drill hole number, sample ID, and sample depth interval on the analysis sheet.
5- Be sure to use the correct confining liquid for triaxial tests stated in the analyses requested.
6- Contact Brad Lindsay when the samples are ready for pick-up.

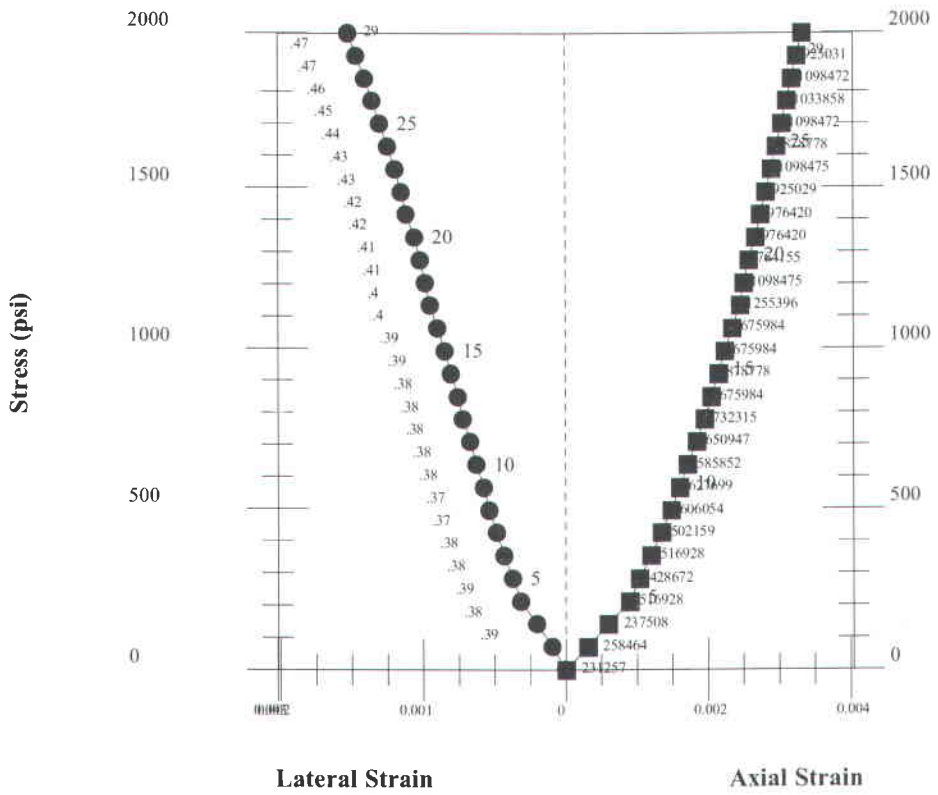
UNCONFINED COMPRESSIVE STRENGTH AND DEFORMABILITY TEST

Client: Carbon Resources

Job #:	597-01	**Sample Date:**	na
Hole #:	CR-06-10	**Testing Date:**	10/05/2006
Sample #:	06-CR0610-2/5-U-05	**Sample Depth:**	1229.725 ft
Length:	6.158 in	**Diameter:**	2.987 in
Area:	7.007 sq in	**Volume:**	43.152 cu in
Weight:	56.65 ounces	**Density:**	141.8 lb/cubic ft
Moisture Condition:	As Received		
Material:	Sandstone		
Failure Load:	28,790 lb		
Compressive Strength:	4,108.48 psi		

Elastic Properties:
Secant Modulus (Points 5 and 29 at 48.6% of UCS) = 7.56E+05 psi
Tangent Modulus (Mean of the slopes betweeen points 25 - 29) = 1.04E+06 psi
Poisson's Ratio (Secant between points 2 and 15) = 0.39

Sample #: 06-CR0610-2/5-U-05 **Number of Points:** 29



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970/242-4220 • FAX 970/245-9234 • www.agapito.com

Ver. 1.0, Date: 10/6/2006

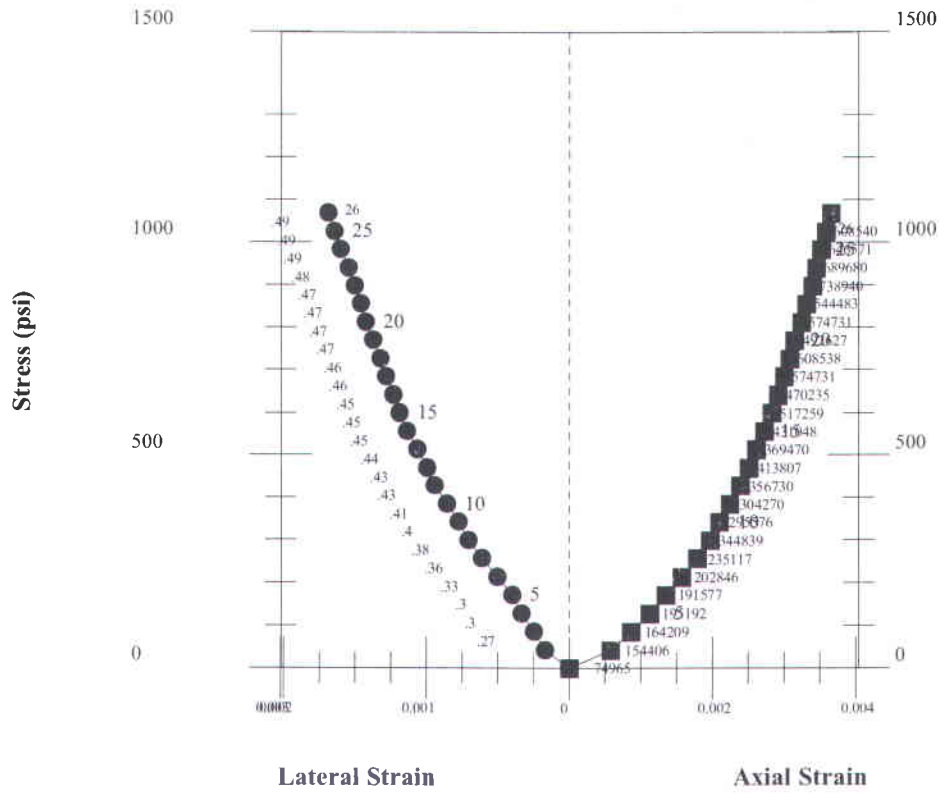
UNCONFINED COMPRESSIVE STRENGTH AND DEFORMABILITY TEST

Client: Carbon Resources

Job #:	597-01	**Sample Date:**	na
Hole #:	CR-06-05	**Testing Date:**	10/05/2006
Sample #:	06-CR0605-5/1-U-08	**Sample Depth:**	1047.75 ft
Length:	6.031 in	**Diameter:**	2.984 in
Area:	6.996 sq in	**Volume:**	42.191 cu in
Weight:	51.36 ounces	**Density:**	131.5 lb/cubic ft
Moisture Condition:	As Received		
Material:	Sandstone		
Failure Load:	16,530 lb		
Compressive Strength:	2,362.87 psi		

Elastic Properties:
Secant Modulus (Points 5 and 26 at 45.4% of UCS) = 3.94E+05 psi
Tangent Modulus (Mean of the slopes betweeen points 22 - 26) = 6.71E+05 psi
Poisson's Ratio (Secant between points 2 and 10) = 0.41

Sample #: 06-CR0605-5/1-U-08 **Number of Points:** 26



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Ver. 1.0, Date: 10/6/2006

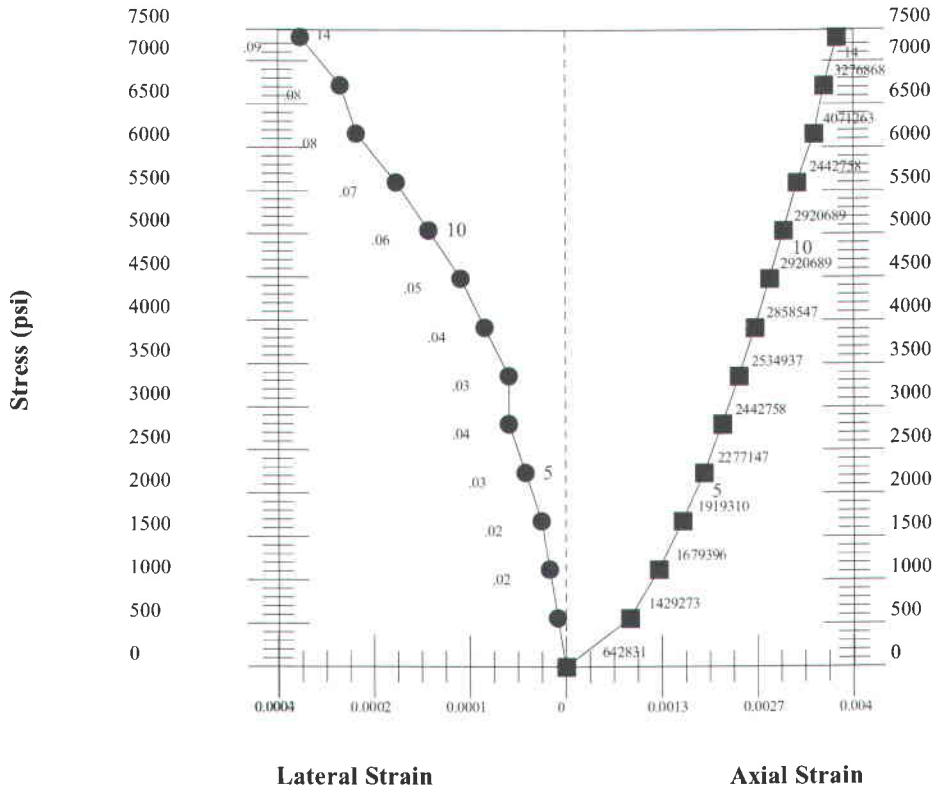
UNCONFINED COMPRESSIVE STRENGTH AND DEFORMABILITY TEST

Client: Carbon Resources

Job #:	597-01	**Sample Date:**	na
Hole #:	CR-06-10	**Testing Date:**	10/05/2006
Sample #:	06-CR0610-9B/3-U-10	**Sample Depth:**	1210.975 ft
Length:	5.894 in	**Diameter:**	2.99 in
Area:	7.019 sq in	**Volume:**	41.371 cu in
Weight:	61.29 ounces	**Density:**	160 lb/cubic ft
Moisture Condition:	As Received		
Material:	Sandstone		
Failure Load:	95,800 lb		
Compressive Strength:	13,648.30 psi		
Length/(2 X Diameter):	0.986	**Corrected UCS:**	13624.72 psi

Elastic Properties:
Secant Modulus (Points 5 and 13 at 50.1% of UCS) = 2.73E+06 psi
Tangent Modulus (Mean of the slopes betweeen points 10 - 14) = 3.18E+06 psi
Poisson's Ratio (Secant between points 2 and 13) = 0.08

Sample #: 06-CR0610-9B/3-U-10 **Number of Points:** 14



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Ver. 1.0, Date: 10/6/2006

Exhibit 20

Ephemeral Drainage Determination

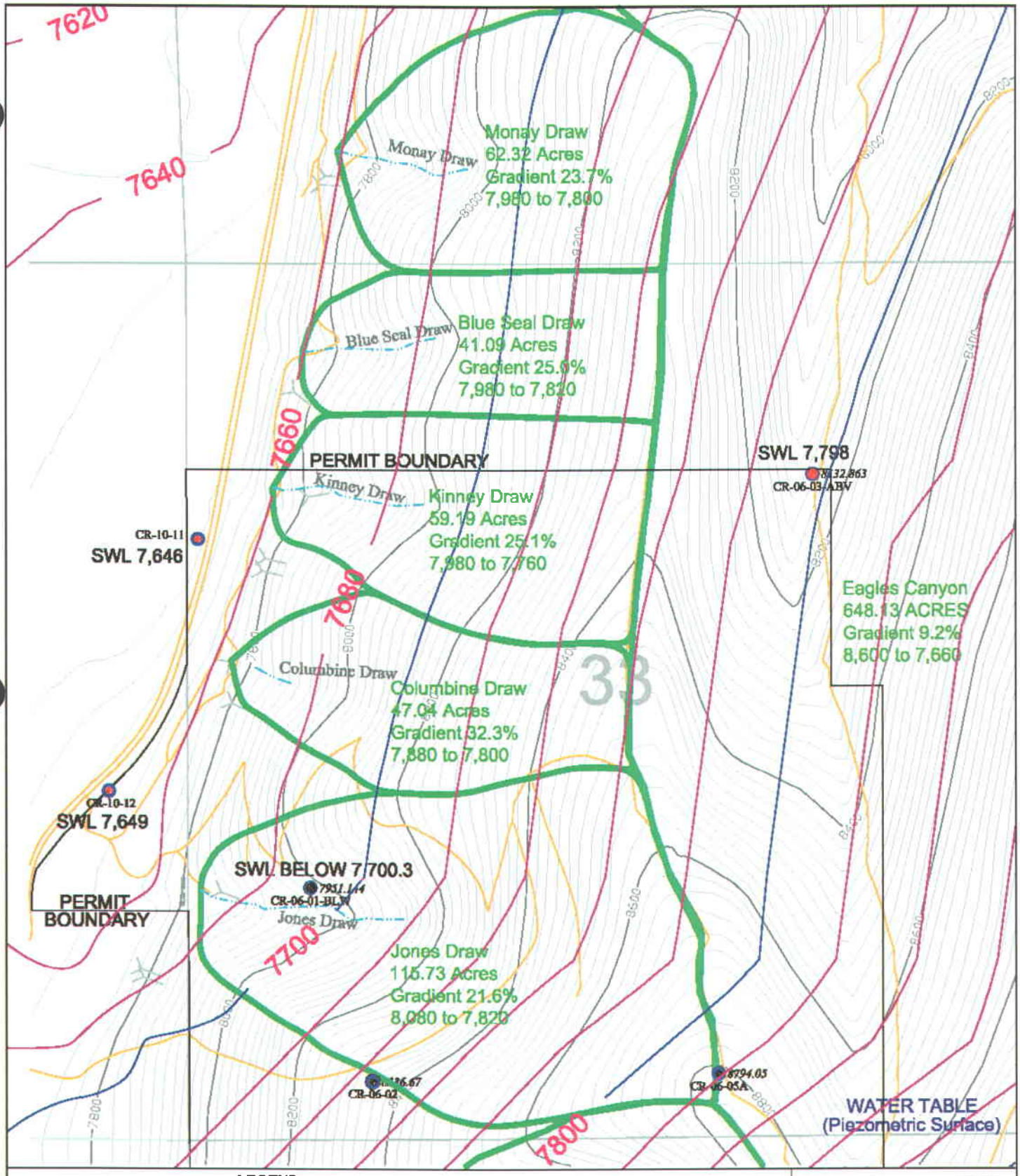
EPHEMERAL DRAINIAGE DETERMINATION

The USGS 7.5 minute Scofield Quadrangle Map depicts perennial, and intermittent, streams with a dark blue drainage line while ephemeral drainages are shown with a light blue dashed-line, or simply as a topographic v-notch without a drainage marking line altogether. There are five short, straight, E-W drainages within and or immediately north of the permit boundary shown on the Scofield USGS 7.5 Minute Quad as ephemeral drainages because they are represented by a v-notch in the topo contours only and lack any kind of drainage marking line. For purposes of this work, those five drainages have been named, from North to South, Monay Draw, Blue Seal Draw, Kinney Draw, Columbine Draw, and Jones Draw, and are marked with a dash-dot light blue line marking the likely course of each drainage, View 1, (Ephemeral Drainages, Drainage Divides, and Piezometric Surface). A light blue ephemeral drainage dashed line has been added to the map for consistency in designation. Two additional drainages, Eagles Canyon and UP Canyon, are both shown as ephemeral drainages on the USGS 7.5 minute Scofield Quadrangle with the light blue dashed line. Mud Creek and the lower reach of Miller Creek are the only Perennial Streams near the Permit Boundary and are shown with a dark blue solid line on the Scofield Quadrangle. Baseline data have been collected from these two Perennial Streams, View 2(Ephemeral Drainage Determination).

The seven ephemeral drainages described above together with the groundwater table are the subjects of this discussion due to concern that baseline data were not collected from them those seven drainages. The argument is "absent baseline water samples from the seven drainages how can we be certain they are ephemeral?"

The reason these drainages were excluded from the baseline monitoring suite is simply because flowing water was never observed in any of them during the baseline monitoring period. Photographs were taken of the four drainages that are actually located within the Permit Boundary (Eagles Canyon, Kinney Draw, Columbine Draw, and Jones Draw) during the baseline monitoring period that demonstrate the absence of water (Appendix 1, Drainage Photos). Not only do these photographs document the absence of water, when they were taken, but also document the lack of alluvium and the lack of vegetative differences across the drainage bottom.

The documented lack of running water alone, at any point in the year, disqualifies all four of these drainages from being classified as Perennial; a stream that flows year round. Therefore the only question is, are these four drainages ephemeral or intermittent? The same question is directed to the other three E-W drainages, Monay Draw and Blue Seal Draw, and Up Canyon. Photo aspects are shown on View 3, Appendix 1.



LEGEND

Ephemeral Drainage

Drainage Divide
Name, Acreage, Gradient, Elevation Range

7700 — Piezometric Surface Elevation Contour
20 Ft. Contour Interval

7,649 — SWL (Static Water Level)

CR-10-12 — Ground Water Monitor Well

Ephemeral Drainage Determination

N

TOPO Contour Interval 20 ft

Carbon Resources LLC

KINNEY NO. 2 MINE

VIEW 1

Ephemeral Drainage's, Drainage Divides & Piezometric Surface

DRAWN BY: GLH	DATE: 8/3/09
APPROVED BY: GLH	DATE: 8/12/2009

Carbon Resources
Coal for Carbon County

P.O. Box 954
Sandia Park, NM 87047

FILE: View 1 Ephemeral Drainage Determination

DEFINITIONS

A search of the literature on the internet was conducted to establish a working definition of ephemeral and intermittent streams. There appears to be a legal definition held by most government agencies, including UDOGM, and then a more robust but not settled academic definition(s). Below are a few of the many definitions of ephemeral and intermittent streams (drainages) and below them is a summary of the salient aspects of all the definitions.

Ephemeral Stream Definitions:

OXFORD UNIVERSITY PRESS Ephemeral stream

A Dictionary of Earth Sciences; AILSA ALLABY and MICHAEL ALLABY; 22 words... **ephemeral stream** A stream which flows only after rain or snow-melt and has no **baseflow component**. A desert wadi may form an **ephemeral stream**.

DETROIT DISTRICT

United States Army Corps of Engineers REGULATORY OFFICE

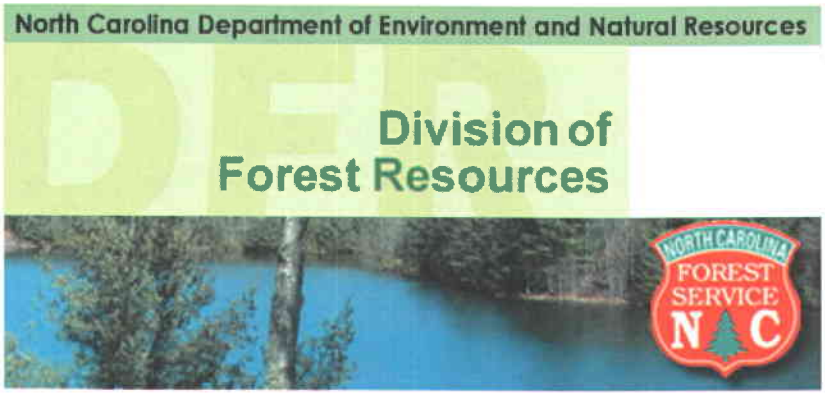
GLOSSARY OF TERMS

The following glossary of terms where taken verbatim from the *Federal Register, Vol.65, No.47,* dated March 9, 2000, pages 12897 - 12899.

EPHEMERAL STREAM: An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Run-off from rainfall is the primary source of water for stream flow.

INTERMITTENT STREAM: An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow.

The South Carolina General Assembly 116th Session, 2005-2006 officially adopted the Corps of Engineers Definition of Ephemeral Stream for use in wetlands cases. (See Reference)



Types of Water Resources Common to Forestry

It is important to understand what kind of stream or other surface water is on-site whenever forestry activities are planned or conducted. Applying the wrong stream classification may result in compliance issues related to FPGs, stream/ditch obstruction laws and/or DWQ Riparian Buffer Rules.

Protection of Streams and Waterbodies
Intermittent and perennial waterbodies, such as ponds or lakes, must be treated with the same protection as streams when complying with the FPGs and DWQ Riparian Buffer Rules. In the FPGs, a "waterbody" is a natural or man-made basin that stores water, but does not include jurisdictional wetlands or beaver ponds.

Stream Classifications for FPG Compliance
The FPGs define a stream as "a body of concentrated flowing water in a natural low area of the land surface" (15A NCAC .01I .0101-.0209). The FPGs further define three types of streams as follows.

Ephemeral Stream
An ephemeral stream is defined as "a stream that flows only during and for short periods following precipitation and flows in low areas that may or may not have a well-defined channel." Some common names for ephemeral streams include: drain, swale, gully, slough (pronounced 'slew') or hollow. Ephemeral streams do not require a SMZ. However, it is strongly encouraged that skid trails, roads, site-prep and other soil-disturbing activities be minimized in the ephemeral streams to avoid erosion and sedimentation of runoff that can flow from the ephemeral into other streams or waterbodies.

Intermittent Stream
An intermittent stream is defined as "a stream that flows only during wet periods of the year (30% - 90% of the time) and flows in a continuous well-defined channel." During dry periods, especially in spring and summer months, intermittent streams may appear as only a trickle of water or may seem to be totally dry, when in fact there is water retained within the stream bottom or "stream substrate". This water retention below the soil surface is usually caused by seasonal changes of the local water table.

American Geophysical Union, Fall Meeting 2006, abstract #H13A-1368

"In order to classify recharge potential (RCP) in ephemeral-stream channels, a method was developed that incorporates information about channel geometry, vegetation characteristics, and bed-sediment apparent electrical conductivity ('a)…."

This work includes channel geometry, vegetation and bed-sediment apparent conductivity in the definition. Some of the concepts apply to the Scofield Drainages.

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Glossary of Water Terms

EPHEMERAL STREAM

A stream or reach of a stream that flows briefly only in direct response to precipitation in the immediate locality and whose channel is at all times higher than the water table.

INTERMITTENT STREAM

A stream that ceases to flow occasionally or seasonally because evaporation and leakage to ground water exceed the available water supply.

A rather exhaustive list of ephemeral stream references can be found in Appendix( )

Intermittent Stream Definitions:

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z Home Browse Terms Help

METEOROLOGY
AMERICAN METEOROLOGICAL SOCIETY
glossary of meteorology
GLOSSARY

First Edition Preface Second Edition Preface Acknowledgments

Intermittent stream—A stream that carries water a considerable portion of the time, but that ceases to flow occasionally or seasonally because bed seepage and evapotranspiration exceed the available water supply.
Compare ephemeral stream, perennial stream.

INTERMITTENT STREAM

*R4SBF, R4SBC

In this wetland type, the channel contains flowing water for only a portion of the year. When not flowing, the water may remain in isolated pools, or surface water may be absent.

The substrate consists of organic deposits, sand, gravel, cobble, rubble, bedrock, or pioneering plants. There are generally no named soils in this community, although some areas may be listed as mixed alluvial land.

Vegetation is dependent on the length of inundation, as well as the substrate type. In many cases, streambeds are not vegetated because of the scouring effect of the moving water, but occasionally" pioneering" annuals or perennials may colonize the area during low flow. Many small drainage ditches are included with this type.

*dnr.state.il.us/Wetlands/**intermittent**.htm - 3k*

*Used throughout the community descriptions to indicate the most commonly occurring code in Illinois

Intermittent Stream Definition:

A stream that goes dry at certain times of the year. Intermittent streams flow during seasons of the year when runoff and/or ground water contributions sustain the flow of the stream. They stop flowing during dry seasons when precipitation is low and the water table drops below the bed of the stream.

UDOGM's own revised definition of Intermittent Stream.

Utah Division of Oil, Gas & Mining
Informal Rulemaking Process
UMA Topic #5: Intermittent Stream
Proposed Coal Draft Rule from UMA, DOGM Received 11/7/07
Including DOGM Nonsubstantive Edits 11/21/07

Proposed Rule Change in part of R645-100-200.:

"Intermittent Stream" means ~~(a) a stream, or reach of a stream, that drains a watershed of at least one square mile, or (b)~~ a stream, or reach of a stream, that is below the local water table for at least some part of the year and obtains its flow from both surface runoff and groundwater discharge.

Legal "consensus definitions" for stream classifications are:

Ephemeral Streams flow water only in response to precipitation and the water table is always below the stream base. Intermittent Streams flow water much of the year and the water table is above the base of the stream much of the year contributing to their flow. This definition includes the revised UDOGM definitions (above).

Characterization of Drainages

Using the criteria in the Legal Consensus definition alone it is easy to demonstrate that the seven drainages within and adjacent to the permit boundary are clearly ephemeral. First, however, a discussion of the local water table is required.

Baseline static water level data from monitor wells CR-10-11, CR-10-12, CR-06-03, and CR-06-09 were integrated with elevation intercepts from the perennial Mud Creek and the perennial lower reach of Miller Canyon/Long Canyon, and Scofield Reservoir to construct a peizometric surface model using SURV-CAD and is presented on View 1. These data provide consist support for the presence of a regional, or semi-regional, water table (piezometric surface) beneath the permit area (Maps 7A and 7B, X-Section A-A' and C-C', Chapter 7, Hydrology).

Topographic contours shown in gray with semi-regional water table (piezometric surface) contours shown in light blue, beneath the topography, clearly demonstrate that

all of the seven drainages shown as ephemeral (Eagles Canyon, Monay Draw, Blue Seal Draw, Kinney Draw, Columbine Draw, Jones Draw, UP Canyon) are above the water table throughout their entire length. Bold letters "A" through "G" on View 2 post the differences in elevation between the bottom of each drainage and the peizometric surface (depth to the water table) at the westernmost location within each respective drainage basin where the elevation difference is the smallest. That is, the difference between the bottom of each drainage and the peizometric surface is smallest down-gradient, closer to base level represented by Scofield Reservoir and increases significantly eastward or upstream on each drainage.

Constraints on the elevation and gradient of the water table also explain the observed intermittent nature of the Long Canyon portion (upper reach) of the Miller Canyon Stream.

Geometric properties (area, length, elevation and average slope) of the seven ephemeral drainages together with those of the two perennial streams are summarized below in TABLE 1.

TABLE 1

Drainages Arranged North to South

Kinney Drainage Basin Areas			Kinney Drainage Average Gradient (Slope)				
Drainage	SQ FT.	Acres	Top Elev	Base Elev	Elev Drop	Length	Avg Slope
Miller Canyon	224,900,115.77	5,163.00	9,100.0	7,660.0	1,440.0	33,275.8	4.3%
Eagles Canyon	28,232,397.56	648.13	8,600.0	7,660.0	940.0	10,182.1	9.2%
Monay Draw	2,714,510.69	62.32	7,980.0	7,800.0	180.0	760.0	23.7%
Blue Seal Draw	1,789,775.88	41.09	7,980.0	7,820.0	160.0	641.0	25.0%
Kinney Draw	2,578,528.62	59.19	7,980.0	7,760.0	220.0	875.4	25.1%
Columbine Draw	2,049,214.37	47.04	7,880.0	7,800.0	80.0	248.0	32.3%
Jones Draw	5,041,158.90	115.73	8,080.0	7,820.0	260.0	1,202.1	21.6%
UP Canyon	36,746,615.67	843.59	8,500.0	7,800.0	700.0	6,279.0	11.1%

The data presented above clearly demonstrate several things:

1. There **is** a semi-regional peizometric surface in the permit area.
    a. Evidence for this surface includes the consistency of data which is taken to be the elevation of the two perennial streams (Mud Creek, & Miller Creek/Long Canyon), along their apparent effluent reaches, and the intercepts of the four monitor wells.
    b. Even though the faults are not shown on the maps Views 1 & 2), the existing data suggest that the faults **do not significantly partition the water flow along the peizometric surface in the saturated zone**. The peizometric surface shown on the maps above is very smooth due to the paucity of data, however, it is fully expected that the surface has some ridges and valleys, very likely caused by the local down-gradient retarding or damming effect (instead of the partitioning effect) of the larger faults.

This is likely represented by the apparent anomaly of Monitor Well CR-06-05A that has never shown a static water level.

2. The local recharge area is obviously Jump Creek, Long Canyon and to a lesser extent Eagles Canyon.
3. The seven drainages (Eagles Canyon, Monay Draw, Blue Seal Draw, Kinney Draw, Columbine Draw, Jones Draw, Up Canyon) adjacent to or passing over the permit area are;
    a. a single straight reach (lacking meanders, low sinuosity) except for Eagles and UP Canyons, whose courses are controlled by faulting.
    b. steeply inclined to the west (also note elevations in Table 1)
    c. small catchment (drainage basin) areas
        i. average rainfall collected over the small catchment areas does not, on its own, support perennial flow Table 2.
    d. above the water table (peizometric surface) along their entire length (View 2).

TABLE 2

Water Calculations	**Basin**	**Annual Precipitation**		**Annual Flow**		
Drainage	Acres	Inches	Gallons	AVG gpm	Gallons	as % of Annual Precipitation
Miller Canyon	5,163.0	17.2	2,414,200,360	175.0	99,713,250	4.13028%
Eagles Canyon	648.1	17.2	303,061,935	22.0	12,535,380	4.13624%
Monay Draw	62.3	17.2	29,139,037	2.1	1,196,559	4.10638%
Blue Seal Draw	41.1	17.2	19,212,429	1.4	797,706	4.15203%
Kinney Draw	59.2	17.2	27,679,331	2.0	1,139,580	4.11708%
Columbine Draw	47.0	17.2	21,997,383	1.6	911,664	4.14442%
Jones Draw	115.7	17.2	54,114,546	3.9	2,222,181	4.10644%
UP Canyon	843.6	17.2	394,458,191	28.5	16,239,015	4.11679%
				Hypothetical Flow		

Miller Canyon is the only perennial stream on Table 2 and is used as an example of average flow as a percentage of annual precipitation. That is, Miller Canyon averages 175 gpm annually which is approximately 4.1 percent of precipitation in its catchment basin. The similarities in geology, vegetative ground cover, and elevations are expected to yield a roughly similar ratio of flow as a percentage of precipitation. Hypothetical flows that would result in the approximate same ratio were inserted into the calculations and are shown to be extremely low.

Data presented above, taken in its entirety, make it impossible to characterize the seven subject drainages as perennial or as intermittent. **The inescapable conclusion is that these seven drainages are ephemeral.**

In addition to the legal definition of ephemeral and intermittent streams cited above, the quoted definitions also include more in-depth academic definitions summarized below that provide additional parameters by which to judge the seven subject drainages.

Ephemeral Stream (Drainage):

- Flow water only after rain fall or snow melt. (In direct response to precipitation)
    - Carries water less then 30% of year
- Above water table year round
    - Ground water is not a source of water for the stream
- No base-flow component
    - No or minimal bank and bed-storage capacity
    - Minimal or no springs in drainage basin
        - Perched aquifer springs only
- May not have a well defined channel
- Very Low Sinuosity
- May or man not have water flow generated alluvium in stream bed
- A high roughness coefficient (Manning's Equation)
    - Suggests steeper vertical profiles
- Relatively low bed sediment conductivity
- Very-low to low aquatic taxa

Intermittent Stream (Drainage):

- Carries water a considerable portion of the time
    - Flows water 30 to 90% of year
    - Ceases to flow occasionally or seasonally because bed seepage and evapotranspiration exceed available water supply
- Below water table for at least some part of the year
    - Obtains flow from both surface runoff and groundwater
    - Has a base flow component
        - Typically has bank and bed-storage capacity
- May have springs in drainage basin
- Has a well defined channel
- Has flow generated alluvium in stream bed
- Low Sinuosity
- A lower roughness coefficient than ephemeral (Manning's Equation)
    - Generally less steep vertical profiles than ephemeral
- Relatively low bed sediment conductivity
- Moderate to high aquatic taxa

These "academic definitions" might not be exhaustive but are useful anyway.
Major common threads between the definitions are:

1. Use of a water table to differentiate between ephemeral and intermittent streams. As with the Legal Definition.
2. The presence of **bank and or bed storage capacity** as a part of the "base flow component" as defining intermittent streams but are lacking in ephemeral Streams.

a. Bank and bed storage requires, among other things, presence of alluvium, highly fractured bedrock, or abandoned meanders or abandoned channel segments leaving permeable stream level terraces.

The general correlation between higher sinuosity and a higher likelihood of bank and bed storage capacity forwards the idea that streams with higher sinuosity are more likely to have a component of "base flow" issuing from bank and bed storage and are therefore not likely to be ephemeral.

The discussion of bank and bed storage also has relevance to the discussion of vados zone springs addressed in Chapter 6, Geological Information.

3. **Intermittent streams always have alluvium**; ephemeral streams may or may not have alluvium.
4. **Ephemeral streams tend to have steeper gradients than do intermittent streams** as expressed as a component of the Manning Equations roughness coefficient. Ephemeral streams have a higher roughness coefficient than intermittent streams. This is also reflected in sinuosity; steeper gradient streams display less sinuosity than lower gradient streams.
5. **Intermittent streams always have a well defined channel. Ephemeral streams may or may not have a well defined channel.**

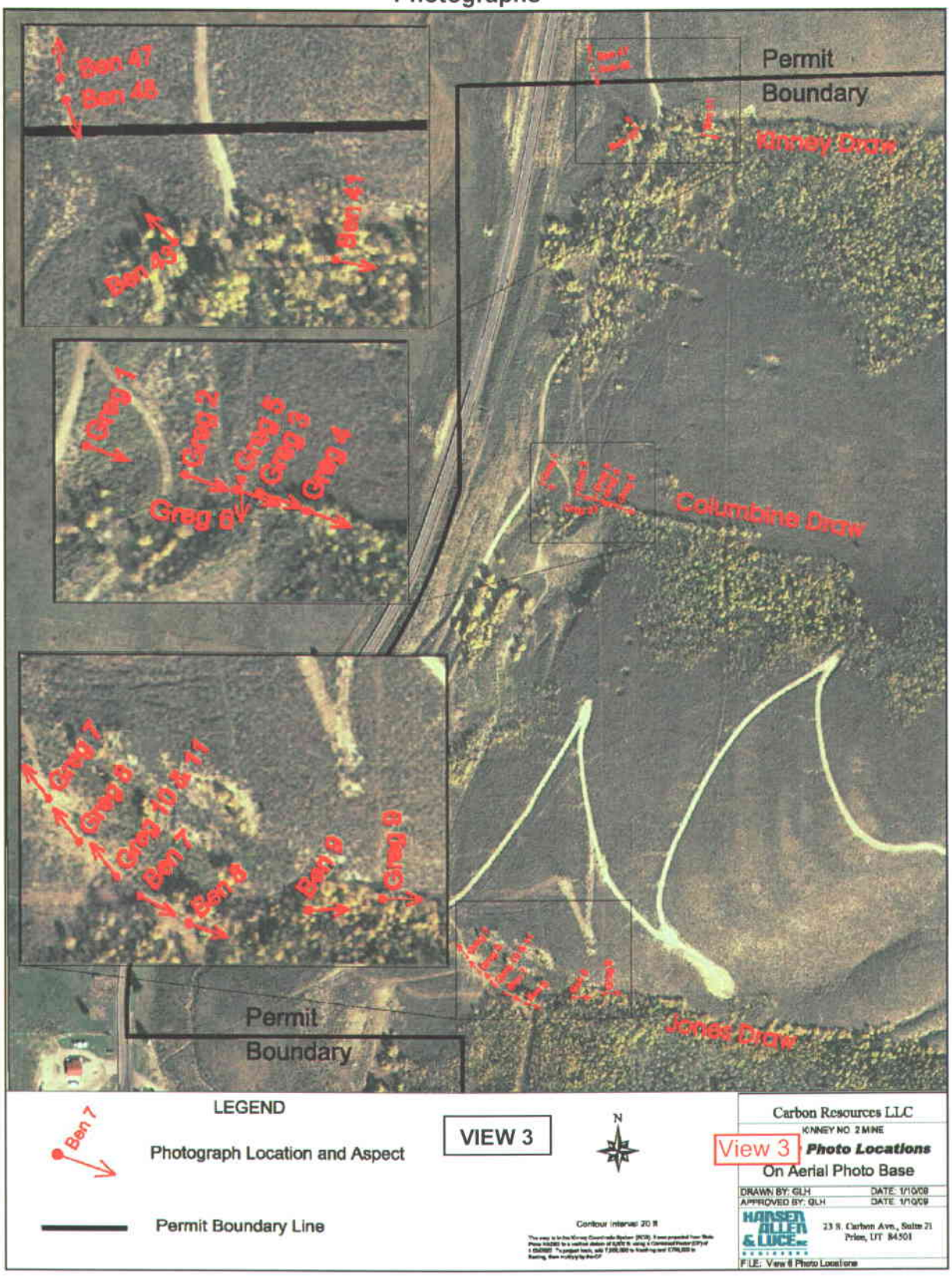
Applying the "academic definition common threads" to the four streams that pass through the permit boundary provides further weight to the argument that they are in fact ephemeral.

The commonalities of the four drainages that support an ephemeral classification are:

- Small Drainage Basin
- Elevated and steeply inclined
- Low sinuosity
- Absent or poorly defined channel
- Virtual absence of alluvium in the channel
- No noticeable difference in vegetation between channel and drainage basin
- Virtual absence of bank and bed storage material. Together these features describe drainages that are small, steeply inclined basins, high and dry above the regional water table, completely lacking the ability to catch and retain sufficient water to create sufficient bank or bed storage to support a flow that persists for more than hours following a rain storm or for days after the snow pack has melted. **This describes ephemeral streams**.

There can be little question that the seven drainages in an adjacent to the permit area (Eagles Canyon, Monay Draw, Blue Seal Draw, Kinney Draw, Columbine Draw, Jones Draw, and UP Canyon) **are in fact Ephemeral.**

APPENDIX 1: Drainage
Photographs



Ben 41: View East in Kinney Draw, Oct. 2007. Note no defined channel

Ben 43: View NW bottom of Kinney Draw, Oct. 2007. Note remnant of snow in bottom of drainage.

Ben 47: View N N-W @ old diversion North of Kinney Draw, Oct. 2007

Ben 48: View S-E @ old diversion North of Kinney Draw, Oct. 2007

Greg 1: Columbine Draw 10-29-08 View East up draw from road

Greg 2: Columbine Draw 10-29-08: @ East easement fence view E @ drainage bottom

Greg 3: Columbine Draw 10-29-08: View E @ drainage bottom from immediately E of E fence

Greg 4: Columbine Draw 10-29-08: View E @ drainage bottom from ~ 50 ft. E of E fence

Greg 5: Columbine Draw 10-29-08: Close up of drainage bottom immediately W of East fence. Note lack of rounded alluvium.

Greg 6: Columbine Draw 10-29-08: Bottom of drainage immediately W of East Fence, View E

Greg 7: Jones Draw 10-29-08: Jones Draw View NW from ~ mid drainage

Greg 8: Jones Draw 10-29-08: View W from ~ mid drainage

Greg 9: Jones Draw 10-29-08: View E from ~ E easement boundary

Greg 10: Jones Draw 10-29-08: View W N-W @ down mouth

Greg 11: Jones Draw 10-29-08: View W N-W @ drainage bottom from ~ mid drainage

Ben 7: View East in Jones Draw, Oct. 2007

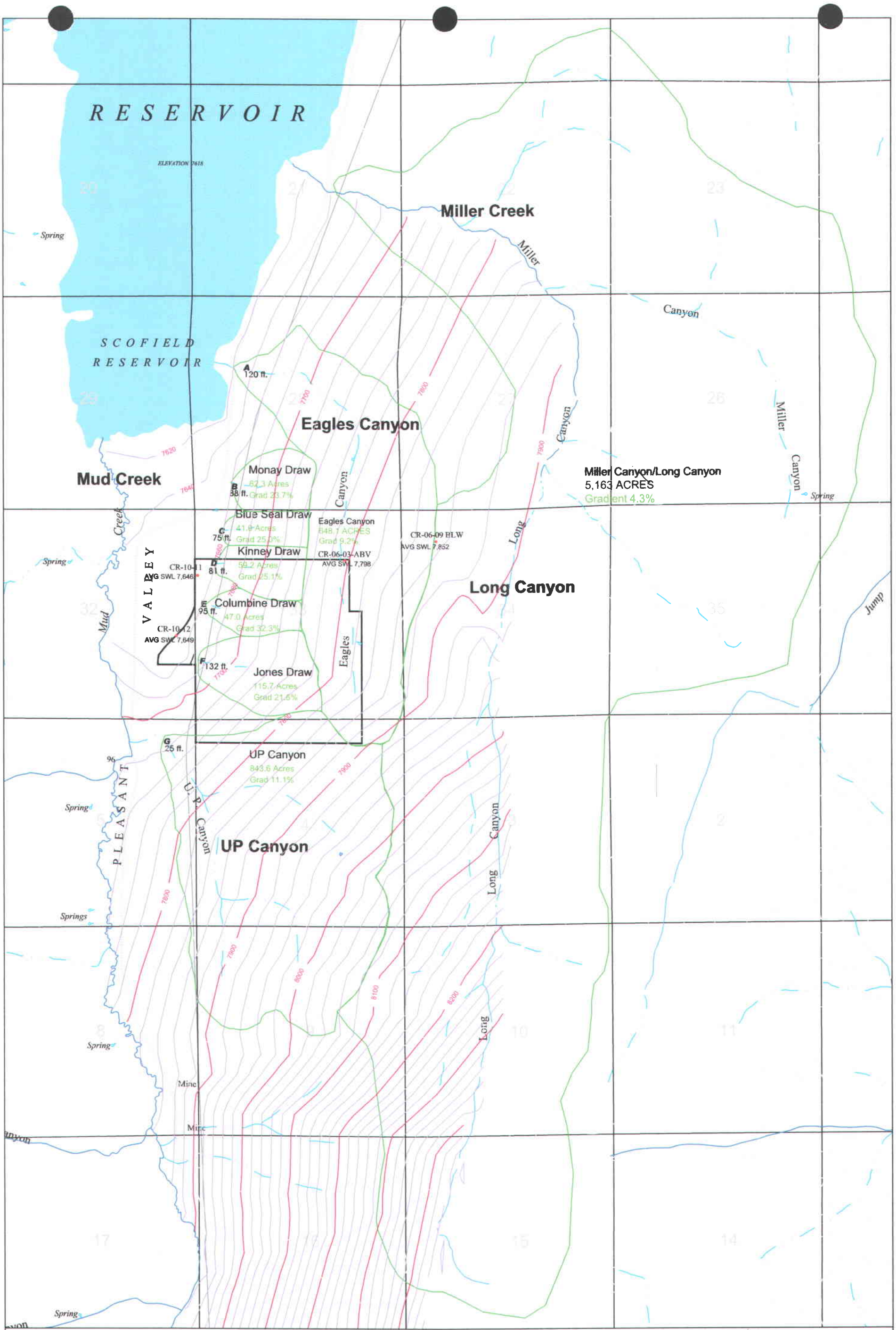
Ben 8: View East in Jones Draw, Oct. 2007

Ben 9: View East in Jones Draw, Oct. 2007

Greg 25: View West across drainage bottom of Eagles Canyon at livestock watering tank fed by Angle Spring , 4 September 2007. Note the absence of well defined drainage and absence of running water even out of the spring fed stock tank overflow.

Greg 26: Close-up, View South at the same stock tank shown in the above photo, 4 September 2007. Note the very small drizzle of water entering the trough through the white PVC pipe that brings water from Angle Spring. The flow is so small cows were barley able to get a drink. As can be seen, there was no water overflowing the tank. Rancher indicated this drizzle completely dried up on or about 20 September 2007.

NOTE: THE LOCATION OF THESE TWO PHOTOS IN EAGLES CANYON ARE IS NOT SHOWN ON VIEW 3: REFERR TO VIEW 2 AND MAP 7 FOR LOCATION OF EAGLES CANYON AND ANGLE SPRING.



LEGEND

PERENNIAL STREAM
INTERMITTENT STREAM
EPHEMERAL DRAINAGE

A 120 ft. — Difference between Topo and Piezometric Surface elevations at Point A (Depth to Regional WT)

Jones Draw
115.73 Acres
Gradient 21.6%
8,989 to 7,820

8100

CR-10-12
7,798

Drainage Divide

Name, Acerage, Gradient

Piezometric Surface Elevation Contour
20 Ft Contour Interval

Ground Water Monitor Well
SWL (Static Water Level)

Ephemeral Drainages & Piezometric Surface

N

0 2,000 ft

Scale 1:24,000 1"=2,000 ft.

Topo Contour Interval 20 ft

Kinney #2 Mine

VIEW 2

Ephemeral Drainage Determination

DRAWN BY: GLH DATE: 8/8/2010
APPROVED BY: GLH DATE: 8/8/2010

Carbon Resources

Box 954
Sandia Park, NM 87047

FILE: View 2 new_11X17 D_WT

Exhibit 21

Permit Documentation