GENWAL RESOURCES, INC
CRANDALL CANYON MINES
C/015/032

CHANGE TO THE
MINING AND RECLAMATION PLAN
TO INCLUDE

MINE DISCHARGE WATER
IRON TREATMENT FACILITY

AND ABATEMENT ACTION FOR
CITATION 10043

SUBMITTAL OF CLEAN COPIES
OF
AMENDMENT, APPROVED JANUARY 11, 2010

TASK #3461

SUBMITTED: JANUARY 13, 2010

0003

COPY

GENWAL™
RESOURCES, INC.

P.O. Box 910, East Carbon, Utah 84520 794 North "C" Canyon Rd, East Carbon, Utah 84520
Telephone (435) 888-4000 Fax (435) 888-4002

January 13, 2010

Daron Haddock
Permit Supervisor
Utah Division of Oil, Gas and Mining
P.O. Box 145801
1594 West North Temple, Suite 1210
Salt Lake City, Utah 84114-5801

Re: Crandall Canyon Mines, C/015/032
Mine Water Iron Treatment Facility
Clean Copies, Task #3461

Dear Mr. Haddock:

Enclosed are eight (8 ea.) clean copies (Task 3461) of the approved change to the Mining and Reclamation Plan to include the mine discharge water iron treatment facility.

If you have any questions or comments regarding this submittal please contact me at 435 888-4017.

Sincerely,

David Shaver
Resident Agent

File in:
☐ Confidential
☒ Shelf
☐ Expandable
Refer to Record No 0003 Date 01132010
In C/0150032 2010, Incoming
For additional information

RECEIVED
JAN 25 2010
DIV. OF OIL, GAS & MINING

Form DOGM - C1 (Last Revised January 12, 2010)

COPY

File Folder # 3

APPLICATION FOR PERMIT PROCESSING

Permit Change ☐	New Permit ☐	Renewal ☐	Transfer ☐	Exploration ☐	Bond Release ☐	Permit Number: 015/032

Title of Proposal Change to MRP to include discharge water iron treatment facility, submittal of clean copies (Task 3461)

Mine: Crandall Canyon Mines

Permittee: GENWAL Resources, Inc.

Description, include reason for application and timing required to implement:.

Instructions: *If you answer yes to any of the first 8 questions (gray), submit the application to the Salt Lake Office. Otherwise, you may submit it to your reclamation specialist.*

☐ Yes	☒ No	1. Change in the size of the Permit Area? ________ acres Disturbed Area? _____ acres ☐ increase ☐ decrease.
☐ Yes	☒ No	2. Is the application submitted as a result of a Division Order?
☐ Yes	☒ No	3. Does application include operations outside a previously identified Cumulative Hydrologic Impact Area?
☐ Yes	☒ No	4. Does application include operations in hydrologic basins other than as currently approved?
☐ Yes	☒ No	5. Does 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?
☐ 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?
☐ 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 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 calculations?
☐ Yes	☒ No	20. Does the application require or include subsidence control or monitoring?
☒ Yes	☐ No	21. Have reclamation costs for bonding been provided for?
☒ Yes	☐ No	22. Does 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?

☐ **Attach _3_ complete copies of the application.**

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. (R645-301-123)

[signature] agent 1/12/10

Signed - Name - Position - Date

Subscribed and sworn to before me this 12th day of January, 2010

[signature: Linda Kerns]
Notary Public

My Commission Expires: 3.27.13
Attest: STATE OF Utah
COUNTY OF Carbon

Notary Public
LINDA KERNS
Commission #578211
My Commission Expires
March 27, 2013
State of Utah

Received by Oil, Gas & Mining

RECEIVED
JAN 25 2010
DIV. OF OIL, GAS & MINING

ASSIGNED TRACKING NUMBER

COPY

Application for Permit Processing
Detailed Schedule of Changes to the MRP

Title of Application: Change to MRP to include discharge water iron treatment Submittal of clean copies (Task 3461)	Permit Number: 015/032
	Mine: CRANDALL CANYON MINES
	Permittee: GENWAL RESOURCES

Provide a detailed listing of all changes to the mining and reclamation plan which will be required as a result of this proposed permit application. Individually list all maps and drawings which are to be added, replaced, or removed from the plan. Include changes of the table of contents, section of the plan, pages, or other information as needed to specifically locate, identify and revise the existing mining and reclamation plan. Include page, section and drawing numbers as part of the description.

			DESCRIPTION OF MAP, TEXT, OR MATERIALS TO BE CHANGED
☐ ADD	☐ REPLACE	☐ REMOVE	
☐ ADD	☐ REPLACE	☐ REMOVE	As per C2 submitted
☐ ADD	☐ REPLACE	☐ REMOVE	Jan 6, 2010
☐ ADD	☐ REPLACE	☐ REMOVE	
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☐ ADD	☐ REPLACE	☐ REMOVE	
☐ ADD	☐ REPLACE	☐ REMOVE	

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

RECEIVED
JAN 25 2010
DIV. OF OIL, GAS & MINING

APPENDIX 1-9

OWNERSHIP AND CONTROL

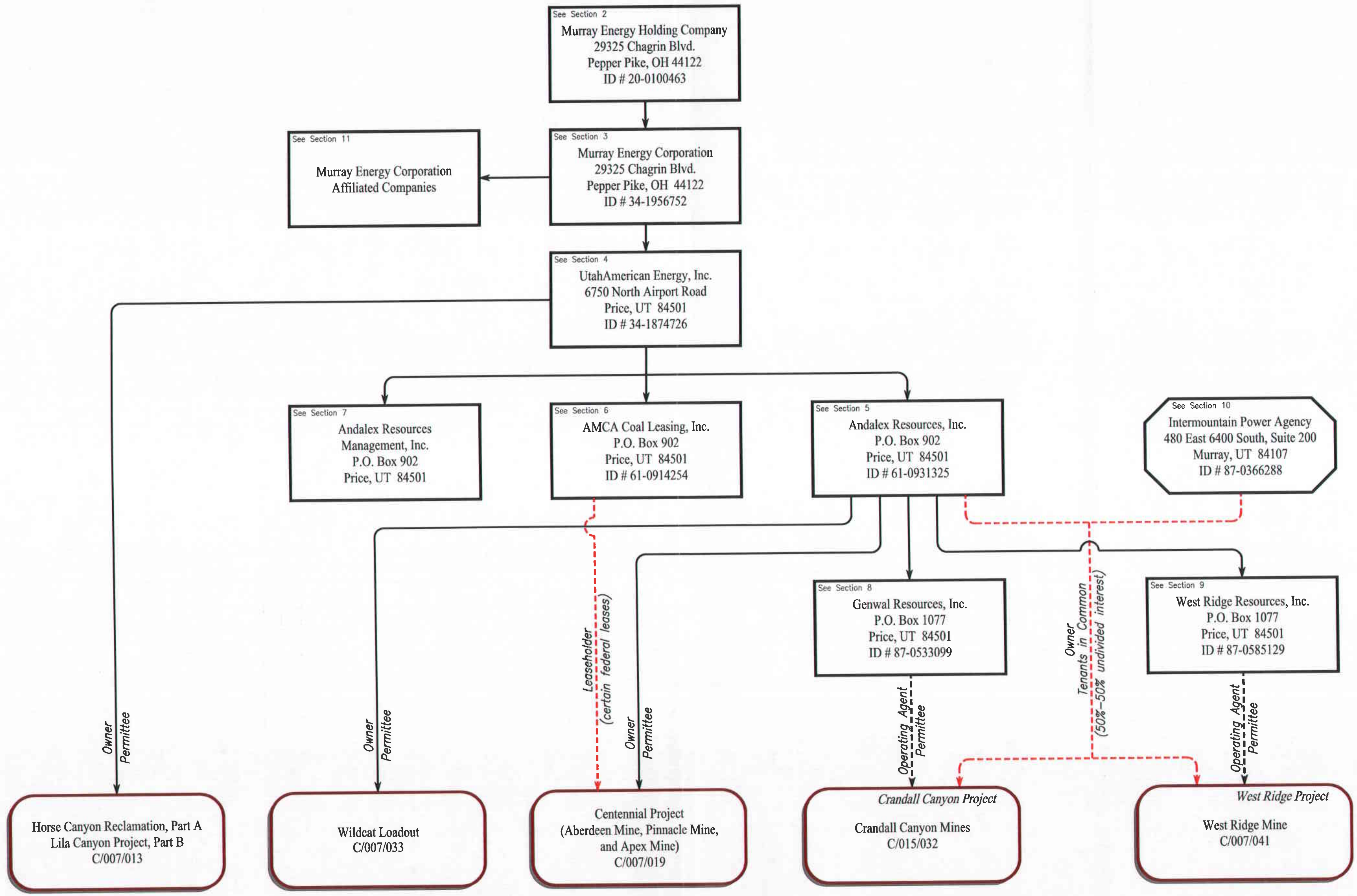
OWNERSHIP AND CONTROL

REVISED 1/12/2010

Section 1

Insert
Family Tree

OWNERSHIP AND CONTROL



Section 2

MURRAY ENERGY HOLDINGS CO.
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

Robert E. Murray	President & CEO	6/30/03	11/29/05
Scott Boyle	President & CEO	11/29/05	12/20/05
Michael D. Loiacono	President & CEO	1/10/05	4/23/07
Robert D. Moore	President & CEO	4/23/07	
Michael D. Loiacono	Treasurer	1/10/05	
		6/30/03	
Michael O. McKown	Secretary	6/30/03	

Incorporation Information:

State of Incorporation	Delaware; Charter No. 3676958
Date of Incorporation	June 27, 2003
ID #	20-0100463

Shareholders:

Robert Eugene Murray
Robert Edward Murray
Jonathan Robert Murray
Ryan Michael Murray
Fifth Third Bank of
Northeast Ohio, Trustee

Directors:

Robert E. Murray	6/30/03	
Michael D. Loiacono	6/30/03	4/23/07
Michael O. McKown	6/30/03	
Robert D. Moore	4/23/07	

Section 3

MURRAY ENERGY CORPORATION
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Appointment of Officers

		Begin	End
Robert E. Murray	Chairman, President &	02/23/01	
	Chief Executive Officer	02/23/01	
John R. Forrelli	Vice President	12/18/03	12/17/04
Robert D. Moore	Vice President &	12/17/04	
	Chief Financial Officer	04/23/07	
P. Bruce Hill	Vice President - Human Resources	12/18/03	11/05/09
Michael D. Loiacono	Treasurer	02/23/01	
Michael D. Loiacono	Chief Financial Officer	12/20/05	04/23/07
Michael O. McKown	Secretary	02/23/01	

Incorporation Information:

State of Incorporation	Ohio; Charter No. 1211519
Date of Incorporation	February 23, 2001
ID#	34-1956752

Shareholder:

	Begin	End
Murray Energy Holdings Co. (100%)	10/21/03	
Robert E. Murray	2/23/01	10/21/03

Directors:

Robert E. Murray	02/23/01	
Michael D. Loiacono	12/20/05	04/23/07
Henry W. Fayne	01/28/05	
Richard L. Lawson	01/28/05	
Andrew D. Weissman	10/23/03	
Robert D. Moore	04/23/07	

Section 4

UTAHAMERICAN ENERGY, INC.
P.O. Box 910
East Carbon, Utah 84520

Officers:

		Begin	End
David W. Hibbs	President	12/11/09	
Peter J. Vuljanic	Interim President	11/06/09	12/11/09
P. Bruce Hill	Chief Executive Officer	08/18/06	11/05/09
P. Bruce Hill	President	12/16/06	11/05/09
Douglas H. Smith	President	08/18/06	12/16/06
Clyde I. Borrell	President	07/31/98	05/19/06
Robert D. Moore	Treasurer	08/18/06	
Michael O. McKown	Secretary	08/18/06	
Marsha Baker Kocinski	Secretary	07/31/98	06/25/02
Barbara Boyce	Secretary	07/31/98	11/01/99
Jay Marshall	Manager	07/31/98	8/18/06

Directors:

		Begin	End
Robert E. Murray		07/31/98	
P. Bruce Hill		08/18/06	11/05/09

Owner:[1]

Murray Energy Corp.

[1] Coal Resources, Inc. is incorrectly listed as a shareholder the AVS OFT. Coal Resources, Inc has never been a shareholder of UEI.

Section 5

ANDALEX RESOURCES, INC.
P.O. Box 910
East Carbon, Utah 84520

Officers:

		Begin	End
David W. Hibbs	President	12/11/09	
Peter J. Vuljanic	Interim President	11/06/09	12/11/09
P. Bruce Hill	President and Chief Executive Officer	12/16/06	11/05/09
Douglas H. Smith	President	03/07/94	12/16/06
Robert D. Moore	Treasurer	08/18/06	
Michael O. McKown	Secretary	08/18/06	

Former Officers/Directors:

Peter B. Green	Director	01/05/98	08/18/06
Peter B. Green	CB	05/11/90	08/18/06
Peter B. Green	CEO	05/11/90	08/18/06
Ronald C. Beedie	Director	01/05/88	08/18/06
John Bradshaw	Secretary	02/05/90	08/18/06
John Bradshaw	Vice-President	02/05/90	08/18/06
Douglas H. Smith	Director	03/07/94	08/18/06
Samuel C. Quigley	Vice-President	02/24/95	08/18/06
Andalex Hungary Ltd.	Shareholder	12/28/20	08/18/06
Alexander Harold Samuel Green	Director	01/11/02	08/18/06

Directors:

Robert E. Murray	08/18/06	
P. Bruce Hill	08/18/06	11/05/09

Owner:

UtahAmerican Energy, Inc.	100%	08/18/06

MSHA Numbers

Apex Mine	42-01750
Pinnacle Mine	42-01474
Aberdeen Mine	42-02028
Wildcat Loadout	42-01864

Section 6

AMCA COAL LEASING, INC.
P.O. Box 910
East Carbon, Utah 84520

Appointment of Officers:

		Begin	End
David W. Hibbs	President	12/11/09	
Peter J. Vuljanic	Interim President	11/06/09	12/11/09
P. Bruce Hill	President and Chief Executive Officer	12/16/06	11/05/09
Douglas H. Smith	President	08/18/06	12/16/06
Robert D. Moore	Treasurer	12/16/06	
Michael O. McKown	Secretary	12/16/06	

Directors:

Robert E. Murray	08/18/06	
P. Bruce Hill	08/18/06	11/05/09

Owner:

UtahAmerican Energy, Inc., 100% ownership	08/18/06

Section 7

ANDALEX RESOURCES MANAGEMENT, INC.
P.O. Box 910
East Carbon, Utah 84520

Appointment of Officers:

		Begin	End
Davis W. Hibbs	President	12/11/09	
Peter J. Vuljanic	Interim President	11/06/09	12/11/09
Douglas H. Smith	President	08/18/06	12/16/06
P. Bruce Hill	President and Chief Executive Officer	12/16/06	11/05/09
Robert D. Moore	Treasurer	12/16/06	
Michael O. McKown	Secretary	12/16/06	

Directors:

Robert E. Murray		08/18/06	
P. Bruce Hill		08/18/06	11/05/09

Shareholders:

UtahAmerican Energy, Inc.	100%	08/18/06	

Section 8

GENWAL RESOURCES, INC.
P.O. Box 910
East Carbon, Utah 84520

Officers:

		Begin	End
David W. Hibbs	President	12/11/09	
Peter J. Vuljanic	Interim President	11/06/09	12/11/09
Douglas H. Smith	President	08/18/06	12/16/06
P. Bruce Hill	President and Chief Executive Officer	12/16/06	11/05/09
Robert D. Moore	Treasurer	12/16/06	
Michael O. McKown	Secretary	12/16/06	

Directors:

	Begin	End
Robert E. Murray	08/18/06	
P. Bruce Hill	08/18/06	11/05/09

Former Directors:

	End
Peter B. Green	8/9/06
Ronald C. Beedie	8/9/06
Douglas H. Smith	8/18/06
Gordon Ulrich	10/30/96

Former Officers:

		End
Peter B. Green	Chairman & CEO	8/9/06
Samuel C. Quigley	Vice President	8/18/06
John Bradshaw	Vice President	5/17/05
John Bradshaw	Secretary & Treasurer	8/18/06
Douglas H. Smith	President	12/16/06

Owner:

ANDALEX Resources, Inc. is and remains the sole shareholder of Genwal Resources, Inc.[I]

MSHA Numbers

Crandall Canyon Mine 42-01715

[I] Intermountain Power Agency holds, as a tenant in common, an undivided 50% interest in certain real property interests regarding the Crandall Canyon Mine.

Section 9

WEST RIDGE RESOURCES, INC.[I]
P.O. Box 910
East Carbon, Utah 84520

Officers:		Begin	End
David W. Hibbs	President	12/11/09	
Peter J. Vuljanic	Interim President	11/06/09	12/11/09
Douglas H. Smith	President	08/18/06	12/16/06
P. Bruce Hill	President and CEO	12/16/06	11/05/09
Robert D. Moore	Treasurer	12/16/06	
Michael O. McKown	Secretary	12/16/06	

Directors:		Begin	End
Robert E. Murray		08/18/06	
P. Bruce Hill		08/18/06	11/05/09

Owner:

Andalex Resources, Inc.[II] 100%

Former Directors[III]	Begin Date	End Date
Peter B. Green	4/1/98	8/9/06
Ronald C. Beedie	4/1/98	8/9/06
Douglas H. Smith	4/1/98	9/18/06

Former Officers[IV]	Position	Begin Date	End Date
Peter B. Green	Chairman & CEO	4/15/98	8/9/06
Samuel C. Quigley	Vice President	4/15/98	8/18/06
John Bradshaw	Secretary	4/15/98	8/18/06
Douglas H. Smith	President	4/15/98	12/168/06

MSHA Number West Ridge Mine 42-022444

[I] WEST RIDGE Resources, Inc. ("WRRI") was formed on March 10, 1998. No actions of WRRI occurred before that date.

[II] ANDALEX Resources is (and remains) the sole shareholder of WRRI. WRRI and the Intermountain Power Agency hold certain real property interests as tenants in common, each owning a 50% interest therein.

[III] The initial directors of WRRI (as shown above) were appointed on April 1, 1998; the "Begin Date[s]" for each such director shown on the OFT form are incorrect.

[IV] The initial officers of WRRI (as shown above) were appointed on April 15, 1998; the "Begin Date[s]" for each such officer shown on the OFT form are incorrect. Also, Christopher G. Van Bever never served as an officer of WRRI; the information shown on the OFT form to the contrary is incorrect.

Section 10

INTERMOUNTAIN POWER AGENCY
(Tenant in Common, 50% undivided interest; West Ridge Mine Permit C/007/041; Crandall Canyon Mine Permit C/015/032)[I]
10653 South River Front Parkway, Suite 120
South Jordan, Utah 84095
(801) 938-1333

Appointment of Officers:

Ray Farrell	Chairman	12/1998
R. Leon Bowler	Vice-Chairman	12/1984
Ted L. Olson	Secretary	01/2002
Russell F. Fjeldsted	Treasurer	03/2007

Directors:	Begin Date	End Date
R. Leon Bowler	06/1977	
Ray Farrell	11/1978	
Clifford C. Michaelis[II]	01/1988	6/2007
Ted L. Olson	01/1990	
Russell F. Fjeldsted	01/1992	
Walter Meacham	01/1999	
Gary O. Merrill	01/2002	6/2007
Robert O. Christiansen	06/2007	
Ed Collins	06/2007	

[I] Intermountain Power Agency holds, as a tenant in common, an undivided 50% interest in certain real property interests regarding the West Ridge Mine and the Crandall Canyon Mine.
[II] Replacing controller Dan R. Eldredge, serving from April 11, 1988 to January 1990.

Name and address of IPA's general manager:

Jim Hewlett
Intermountain Power Agency
10653 South River Front Parkway, Suite 120
South Jordan, Utah 84095
Telephone (801) 938-1333
Assumed position December 1, 2007

Resident Agent for IPA:

Mark Buchi
Holme, Roberts, and Owen
299 South Main, Suite 1800
Salt Lake City, Utah 84111
Assumed position January, 1988

IPA Designated representative to the Crandall Canyon Project and West Ridge Project Management Boards:

Nick Kezman
Operating Agent
Los Angeles Department of Water & Power
111 North Hope Street, Room 1263
Los Angeles, California 90012-2694
Telephone (213) 367-0286

Principle Shareholders of IPA:

IPA has no shareholders. IPA is a political subdivision of the State of Utah created under the Interlocal Cooperation Act, Title II, Chapter 13, Utah Code Ann. 1953, as amended, and as such, has not issued stock.

Section 11

MURRAY ENERGY AFFILIATE COMPANIES

A. **AMCOAL HOLDINGS, INC.**
101 Prosperous Place, Suite 125
Lexington, Kentucky 40509

B. **THE AMERICAN COAL COMPANY**
P. O. Box 727
Harrisburg, Illinois 62946

C. **THE AMERICAN COAL SALES COMPANY**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

D. **AMERICAN COMPLIANCE COAL, INC.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

E. **AMERICAN ENERGY CORPORATION**
43521 Mayhugh Hill Road
Township Highway 88
Beallsville, Ohio 43716

F. **ANCHOR LONGWALL AND REBUILD, INC.**
One Industrial Park Drive
Wheeling, West Virginia 26003

G. **AVONMORE RAIL LOADING, INC.**
125 Old Farm Drive,
Pittsburgh, PA 15239

H. **BELMONT COAL, INC.**
P. O. Box 146
Powhatan, Ohio 43942

I. **CANTERBURY COAL COMPANY**
125 Old Farm Drive
Pittsburgh, PA 15239

J. **COAL RESOURCES HOLDINGS CO.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

K. **COAL RESOURCES, INC.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

L. **CONSOLIDATED LAND COMPANY**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

M. **ENERGY RESOURCES, INC.**
P. O. Box 259
R. D.#2, Fermantown Road
Brockway, PA 15824

N. **KENAMERICAN RESOURCES, INC.**
101 Prosperous Place, Suite 125
Lexington, Kentucky 40509

O. **MAPLE CREEK MINING, INC.**
981 Route 917
Bentleyville, Pennsylvania 15314

P. **MILL CREEK MINING COMPANY**
P. O. Box 259
R. D. #2, Fermantown Road
Brockway, PA 15824

Q. **MONVALLEY TRANSPORTATION CENTER, INC.**
P. O. Box 135
1060 Ohio Avenue
Glassport, Pennsylvania 15045

R. **OHIOAMERICAN ENERGY INCORPORATED**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

S. **THE OHIO VALLEY COAL COMPANY**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

T. **OHIO VALLEY RESOURCES, INC.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

U. **THE OHIO VALLEY TRANSLOADING COMPANY**
56854 Pleasant Ridge Road
Alledonia, Ohio 43902

V. **THE OKLAHOMA COAL COMPANY**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

W. **ONEIDA COAL COMPANY, INC.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

X. **PENNAMERICAN COAL, INC.**
125 Old Farm Drive
Pittsburgh, PA 15239

Y. **PENNAMERICAN COAL LP**
125 Old Farm Drive
Pittsburgh, PA 15239

Z. **PENNSYLVANIA TRANSLOADING, INC.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio

AA. **PINSKI CORP.**
125 Old Farm Drive
Pittsburgh, PA 15239

BB. **SPRING CHURCH COAL COMPANY**
125 Old Farm Drive
Pittsburgh, PA 15239

CC. **SUNBURST RESOURCES, INC.**
586 National Road
Wheeling, West Virginia 26003

DD. **TDK COAL SALES, INCORPORATED**
P. O. Box 259
R. D. #2, Fermantown Road
Brockway, PA 15824

EE. **UMCO ENERGY, INC.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

FF. **WEST VIRGINIA RESOURCES, INC.**
953 National Road, Suite 207
Wheeling, West Virginia 26003

GG. **WYAMERICAN ENERGY, INC.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

A. **AMCOAL HOLDINGS, INC.**
101 Prosperous Place, Suite 125
Lexington, Kentucky 40509

Officers:

Robert E. Murray	President	5/23/03
P. Bruce Hill	Vice President – Human Resources	10/01/98
Robert D. Moore	Treasurer	10/01/98
Michael O. McKown	Secretary	3/1/05
Jeffrey L. Cash	Assistant Treasurer	11/01/99

Incorporation Information:

State of Incorporation: Ohio;
Charter No. 1007981

Date of Incorporation: June 12, 1998

ID #34-1867389

Shareholders: Murray Energy Corporation

Directors: Robert E. Murray

Revised 2/14/05

B. THE AMERICAN COAL COMPANY
P. O. Box 727
Harrisburg, Illinois 62946

Officers:

Robert E. Murray	Acting President	11/02/02
John R. Forrelli	Vice President	9/07/04
Michael O. McKown	Vice President, General Counsel and Secretary	3/15/99 3/1/05
Robert D. Moore	Treasurer	10/01/98
Jeffrey L. Cash	Assistant Treasurer and Assistant Secretary	11/01/99 6/01/01

Incorporation Information:

State of Incorporation	Delaware; Charter No. 2881631
Date of Incorporation	June 2, 1998
ID #73-1543124	

Shareholders:	AmCoal Holdings, Inc.
Directors:	Robert E. Murray

Revised: 2/14/05

C. THE AMERICAN COAL SALES COMPANY

29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

		Begin	End
Robert E. Murray	Chief Executive Officer	11/11/88	
B. J. Cornelius	President	9/08/95	
Edwin D. Lane	Vice President	11/01/99	3/1/05
William E. Hollars	Vice President	3/1/05	
Richard Rice	Vice President	11/11/88	11/01/99
Michael O. McKown	Secretary	3/1/05	
Steven C. Ellis	Secretary	11/10/88	3/1/05
James R. Turner, Jr.	Treasurer and Assistant Secretary	3/1/05	
Duane A. Smith	Assistant Treasurer and Assistant Secretary	6/25/01 6/25/01	
Brenda L. Murray	Assistant Secretary	9/8/95	6/25/01

Incorporation Information:

State of Incorporation	Ohio; Charter No. 727836
Date of Incorporation	June 29, 1988

ID #34-1603699

Shareholder:	Coal Resources, Inc.	
Directors:	Robert E. Murray	9/08/95

Revised
5/2/07

D. AMERICAN COMPLIANCE COAL, INC.
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

		Begin	End
Stanley T. Piasecki	President	3/1/05	
Charles E. Shestak	Vice President	03/10/03	
Michael O. McKown	Secretary	3/1/05	
Robert D. Moore	Treasurer and	6/25/01	
	Assistant Secretary	6/25/01	
Elmer A. Mottillo	Assistant Treasurer	8/22/03	

Former Officers:

Clyde I. Borrell	President	6/02/97	3/1/05
William W. Taft	Secretary	5/24/94	3/1/05

Incorporation Information:

State of Incorporation	Colorado; Charter No. 19941059260
Date of Incorporation	May 24, 1994

ID #34-1797161

Shareholder:	Murray Energy Corporation (100%)	6/1/01	
	Robert E. Murray	5/24/94	2/23/01
Director:	Robert E. Murray	5/24/94	

Revised
5/2/07

E. AMERICAN ENERGY CORPORATION
43521 Mayhugh Hill Road
Township Highway 88
Beallsville, Ohio 43716

Officers:

		Begin	End
Robert E. Murray	President	12/15/04	
Robert D. Moore	President	6/25/01	12/15/04
Michael O. McKown	Secretary	11/01/99	
James R. Turner, Jr.	Treasurer	3/1/05	
Robert D. Moore	Treasurer	6/25/01	12/15/04
Robert L. Putsock	Assistant Treasurer	1/27/04	

Incorporation Information:

State of Incorporation	Ohio; Charter No. 00842695
Date of Incorporation ID #31-1550443	April 12, 1993

Shareholder: Murray Energy Corporation (100%)

Director:

Robert E. Murray	12/15/04	
P. Bruce Hill	7/02/01	12/15/04

Revised
3/16/07

F. ANCHOR LONGWALL AND REBUILD, INC.

One Industrial Park Drive
Wheeling, West Virginia 26003

Officers:

		Begin	End
P. Bruce Hill	President and	2/16/99	11/10/06
	Assistant Secretary	2/16/99	
Chad Underkoffler	President	11/10/06	
Michael O. McKown	Secretary	11/01/99	
James R. Turner, Jr.	Treasurer	9/16/05	
Duane A. Smith	Assistant Secretary	11/01/99	

Incorporation Information:

State of Incorporation	West Virginia; Charter No. 00961100093212818
Date of Incorporation	April 18, 1996

ID #55-0749933

Shareholder: Coal Resources, Inc.
I.D. # 34-1586390
Address: 29325 Chagrin Boulevard
Suite 300
Pepper Pike, OH 44122

Director:	Charles E. Shestak	11/01/99
	P. Keith McGilton	11/01/99

Revised
3/6/07

G. AVONMORE RAIL LOADING, INC.

125 Old Farm Drive,
Pittsburgh, PA 15239

Officers:

VACANT	President	
Robert D. Moore	Treasurer	6/25/01
Michael O. McKown	Secretary	3/1/05
Robert L. Putsock	Assistant Treasurer	1/02/03
Elmer A. Mottillo	Assistant Secretary	1/02/03

Incorporation Information:

State of Incorporation	Delaware; Charter No. 0798860
Date of Incorporation Qualified	February 19, 1974 May 6, 1974 Pennsylvania; PA Entity #000302999

ID #25-1253970

Shareholder:	Mill Creek Mining Company
Director:	Charles E. Shestak

Revised: 2/14/05

H. BELMONT COAL, INC.
P. O. Box 146
Powhatan, Ohio 43942

Officers:

		Begin	End
Robert D. Moore	President	6/25/01	
Maynard St. John	Vice-President	1/02/02	6/26/02
James R. Turner, Jr.	Secretary/Treasurer	9/16/05	
Kristi D. Brown	Secretary/Treasurer	11/08/01	9/16/05

Incorporation Information:

State of Incorporation	Ohio; Charter No. 00842697
Date of Incorporation	April 12, 1993

ID #31-1536602

Shareholder:	Murray Energy Corporation (100%)	6/1/01	
	Robert E. Murray	4/19/93	6/1/01
Director:	Duane A. Smith	4/12/93	12/15/06
	Robert D. Moore	12/15/06	

Revised
3/6/07

I. CANTERBURY COAL COMPANY

125 Old Farm Drive
Pittsburgh, PA 15239

Officers:

Robert D. Moore	President & Treasurer	05/26/07
Michael O. McKown	Secretary	05/26/07
Robert L. Putsock	Asst Treasurer	01/2/03
James R. Turner, Jr.	Asst Secretary	06/1/08

Incorporation Information:

State of Incorporation	Pennsylvania; PA Entity #000055242
Date of Incorporation	July 26, 1963
ID #25-1127473	

Shareholder:	Mill Creek Mining Company (100%)
Director:	Charles E. Shestak

Revised
3/6/07

J. COAL RESOURCES HOLDINGS CO.

29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

		Begin	End
Robert E. Murray	President and CEO	6/27/03	
Michael D. Loiacono	Treasurer	6/27/03	
	CFO	12/20/05	04/23/07
Robert D. Moore	CFO	04/23/07	
Scott A. Boyle	Chief Financial Officer	10/29/05	12/20/05
P. Bruce Hill	Secretary	3/1/05	11/01/05
Michael O. McKown	Secretary	11/01/05	
Robert L. Putsock	Assistant Secretary and Assistant	6/25/01	
	Treasurer	6/25/01	

Incorporation Information:

State of Incorporation	Delaware; Charter No. 3676954
Date of Incorporation	June 27, 2003
ID #20-0100479	

Shareholder:	Robert E. Murray (Class A Shares 100%) Robert Eugene Murray (Class B Shares 20%) Robert Edward Murray (Class B Shares 20%) Ryan Michael Murray (Class B Shares 20%) Jonathan Robert Murray (Class B Shares 20%) Fifth Third Bank of Northeast Ohio, Trustee (Class B Shares 20%)	
Director:	Robert E. Murray	6/27/03

Revised
5/10/07

K. COAL RESOURCES, INC.
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

		Begin	End
Robert E. Murray	Chairman, President and Chief Executive Officer	3/1/05	
Michael D. Loiacono	Treasurer	1/28/05	
	CFO	12/20/05	04/23/07
Robert D. Moore	CFO	04/23/07	
Scott A. Boyle	Chief Financial Officer	10/17/05	12/20/05
P. Bruce Hill	Secretary	3/1/05	11/01/05
Michael O. McKown	Secretary	11/01/05	
Robert L. Putsock	Assistant Secretary and Assistant	6/25/01	
	Treasurer	6/25/01	

Incorporation Information:

State of Incorporation:	Ohio; Charter No. 717546
Date of Incorporation:	January 29, 1988

ID #34-1586390

Shareholder:	Coal Resources Holdings Co.	10/21/03	
	Robert E. Murray	1/29/88	10/21/03
Directors:	Robert E. Murray		
	Henry W. Fayne		
	Andrew Weissman		
	Richard L. Lawson		
	Michael D. Loiacono	12/20/05	04/23/07
	Robert D. Moore	04/23/07	

Revised
5/10/07

L. CONSOLIDATED LAND COMPANY

29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

Robert D. Moore	President	8/11/04
Robert D. Moore	Treasurer and Assistant Secretary	6/25/01 6/25/01
Michael O. McKown	Secretary	3/1/05
Elmer A. Mottillo	Assistant Secretary	8/22/03

Incorporation Information:

State of Incorporation	Ohio; Charter No. 00842696
Date of Incorporation	April 12, 1993

ID #34-1769562

Shareholder:	Murray Energy Corporation (100%)	6/1/01
Director:	Robert D. Moore	8/11/04

Revised
3/6/07

M. ENERGY RESOURCES, INC.

P. O. Box 259
R. D.#2, Fermantown Road
Brockway, PA 15824

Officers:

Stanley T. Piasecki	President and Chief Executive Officer	8/11/04
Elmer A. Mottillo	Treasurer	8/22/03
Michael O. McKown	Secretary	3/1/05
Charles E. Shestak	Assistant Secretary	4/30/93

Incorporation Information:

State of Incorporation	Pennsylvania; PA Entity #762734
Date of Incorporation	September 14, 1982

ID #31-1044044

Shareholder:	Mill Creek Mining Company	
Director:	Stanley T. Piasecki	8/11/04

Revised 2/14/05

N. KENAMERICAN RESOURCES, INC.

101 Prosperous Place, Suite 125
Lexington, Kentucky 40509

Officers:

		Begin	End
Robert N. Sandidge	President	12/16/06	
Dennis W. Bryant	President/Manager	10/1/05	12/16/06
B. J. Cornellius	Senior Vice-President--Sales	11/1/05	
James R. Turner, Jr.	Treasurer	3/1/05	
Robert D. Moore	Assistant Treasurer	3/1/05	
Michael O. McKown	Secretary	2/13/06	

Incorporation Information:

State of Incorporation	Kentucky; Charter No. 0331655
Date of Incorporation	June 9, 1994
ID #61-1264385	

Shareholder:	Mill Creek Mining Company	
Director:	Robert E. Murray	6/1/05

Revised
3/6/07

O. MAPLE CREEK MINING, INC.
981 Route 917
Bentleyville, Pennsylvania 15314

Officers:

		Begin	End
Paul B. Piccolini	President	4/28/06	
Ronnie D. Dietz	Vice President and Treasurer	3/1/05	
Michael B. Gardner	Secretary	3/1/05	5/01/07
VACANT			
Roberta K. Heil	Assistant Secretary	11/01/99	

Incorporation Information:

State of Incorporation	Pennsylvania; PA Entity #2607113
Date of Incorporation	November 9, 1994
ID #25-1755305	

Shareholder:	Sunburst Resources, Inc.	1/11/95
Director:	Robert E. Murray	

P. **MILL CREEK MINING COMPANY**

P. O. Box 259
R. D. #2, Fermantown Road
Brockway, PA 15824

Officers:

		Begin	End
Charles E. Shestak	President	8/18/98	
James R. Turner, Jr.	Treasurer	3/1/05	
Robert D. Moore	Treasurer	6/25/01	3/1/05
Robert D. Moore	Assistant Treasurer	3/1/05	
Michael O. McKown	Secretary	3/1/05	
Michael E. Elliott	Secretary	8-18-98	3/1/05
Robert L. Putsock	Assistant Secretary and	6/25/01	
	Assistant Treasurer	6/25/01	

Incorporation Information:

State of Incorporation	Pennsylvania; PA Entity #0007447787
Date of Incorporation	December 1, 1981
Certificate of Amendment	July 7, 1988; #8854525

ID #31-1040986

Shareholder: Coal Resources, Inc.

Director: Robert E. Murray 5/14/04

Revised
3/6/07

Q. MONVALLEY TRANSPORTATION CENTER, INC.
P. O. Box 135
1060 Ohio Avenue
Glassport, Pennsylvania 15045

Officers:

Paul B. Piccolini	President	4/28/06
James R. Turner, Jr.	Secretary and Treasurer	3/1/05

Incorporation Information:

State of Incorporation	Pennsylvania; PA Entity #856918
Date of Incorporation	February 15, 1985

ID #25-1490495

Shareholders: Pennsylvania Transloading, Inc.

Directors: Robert E. Murray and
Michael D. Loiacono 11/01/99

R. OHIOAMERICAN ENERGY INCORPORATED
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

D. Michael Jamison	President	5/1/05
Michael O. McKown	Secretary	5/1/05
Robert D. Moore	Treasurer	5/1/05
Elmer A. Mottillo	Assistant Treasurer	6/30/06

Incorporation Information:

State of Incorporation	Ohio	
Date of Incorporation	February 1, 2005	
ID # 20-3044610	Ohio Charter No. 1518533	
Director:	Robert E. Murray	5/1/05
Shareholder:	Murray Energy Corporation	5/1/05

Revised
3/6/07

S. THE OHIO VALLEY COAL COMPANY
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

		Begin	End
Vacant	President	11/4/05	
Paul B. Piccolini	Vice President	1/1/07	
Ronnie D. Dietz	Treasurer, Assistant Secretary and Corporate Comptroller	3/1/05	
Michael B. Gardner	Secretary	3/1/05	5/01/07
Roberta K. Heil	Assistant Secretary	11/01/99	
Bonnie M. Froehlich	Assistant Secretary and	6/25/01	
	Assistant Treasurer	6/25/01	

Incorporation Information:

State of Incorporation — Ohio; Charter No. 384971

Date of Incorporation — June 6, 1969

Certificate of Amendment — October 4, 1988; #201274

ID #34-1041310

Shareholder: Ohio Valley Resources, Inc.

Director: Robert E. Murray

Revised
5/2/07

T. OHIO VALLEY RESOURCES, INC.

29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

		Begin	End
Paul B. Piccolini	President	4/28/06	
John Forrelli	President	11/1/99	4/28/06
Ronnie D. Dietz	Treasurer, Assistant Secretary and Corporate Comptroller	3/1/05	
Michael D. Loiacono	Treasurer, Assistant Secretary and Corporate Comptroller	3/10/95	4/28/06
VACANT	Secretary	3/1/05	05/01/07
Stephen Ellis	Secretary	3/10/95	3/1/05

Incorporation Information:

State of Incorporation	Ohio; Charter No. 721514
Date of Incorporation	March 29, 1988

ID #34-1586391

Shareholders:	Murray Energy Corporation (100%)	6/1/01	
	Robert E. Murray	3/10/95	6/1/01

Director: Robert E. Murray

Revised
3/6/07

U. THE OHIO VALLEY TRANSLOADING COMPANY

56854 Pleasant Ridge Road
Alledonia, Ohio 43902

Officers:

		Begin	End
Vacant	President	11/4/05	
Paul B. Piccolini	Vice-President	1/1/07	
Ronnie D. Dietz	Treasurer, Assistant Secretary and Corporate Comptroller	3/1/05	
Michael B. Gardner	Secretary	3/1/05	05/01/07
Roberta K. Heil	Assistant Secretary	9/01/00	

Incorporation Information:

State of Incorporation	Ohio; Charter No. 727835
Date of Incorporation	June 29, 1988

ID #34-1611209

Shareholder:	Ohio Valley Resources, Inc.	
Director:	Robert E. Murray	4/06/93

Revised
3/6/07

V. THE OKLAHOMA COAL COMPANY

29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

		Begin	End
Paul B. Piccolini	President	4/28/06	
Gregory C. Smith	President	11/1/99	4/28/06
Michael O. McKown	Secretary	3/1/05	
Gregory A. Gorospe	Secretary	9/15/94	11/1/99
James R. Turner, Jr.	Treasurer and Assistant Secretary	3/1/05	
Kathleen Bednarek	Treasurer	6/20/00	6/26/00
Robert L. Putsock	Assistant Secretary	1/10/03	
Kathleen Bednarek	Assistant Secretary	9/3/96	6/26/00

Incorporation Information:

State of Incorporation: Oklahoma; Charter No. DB00477836

Date of Incorporation: April 17, 1989

Licensed in Ohio: February 27, 1991; FL 790739

ID #34-1673480

Shareholder: The American Coal Sales Company

Director: Robert E. Murray

Revised
3/6/07

W. ONEIDA COAL COMPANY, INC.

29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

		Begin	End
Robert D. Moore	President and	06/25/01	
	Treasurer	11/01/99	
Robert L. Putsock	Assistant Secretary	06/25/01	
Michael O. McKown	Secretary	03/1/05	

Former Officers:

John Blaine Earles	Vice-President	2/28/92	7/2/93
Tivis Arnold Graybeal	Secretary	2/28/92	4/28/94
Anthony Carl Laplaca	Secretary	4/28/94	11/1/99
Joseph R. Bourgo	Vice-President	9/1/92	10/20/00
Joseph R. Bourgo	Treasurer	4/28/94	10/20/00
Norma Jean Mccourt	Assistant Secretary	4/28/94	11/1/99

Incorporation Information:

State of Incorporation	West Virginia; Charter No. 00000020004097TAX		
Date of Incorporation	August 29, 1983		
ID #62-1011712			
Shareholder:	West Virginia Resources, Inc. (100%)	2/28/92	
Daryl Napier			02/28/92
Director:	Robert E. Murray		

Revised 5/2/07

X. PENNAMERICAN COAL, INC.

125 Old Farm Drive
Pittsburgh, PA 15239

Officers:

Robert D. Moore	President, Treasurer and Secretary	6/25/01 6/25/01
Robert L. Putsock	Assistant Secretary	6/25/01

Incorporation Information:

State of Incorporation	Pennsylvania; PA Entity #2545905
Date of Incorporation	September 13, 1993

ID #25-1722115

Shareholder:	Mill Creek Mining Co.	11/08/93
Director:	Robert E. Murray	

Revised 2/14/05

Y. PENNAMERICAN COAL LP
125 Old Farm Drive
Pittsburgh, PA 15239

Partners:

Pinski Corp.	Managing Partner	8/19/96
PennAmerican Coal, Inc.	Limited Partner	7/8/98

EIN# 25-1800809
Partnership Effective 7/8/98

Revised
3/6/07

Z. PENNSYLVANIA TRANSLOADING, INC.

29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

Paul B. Piccolini	President	4/28/06
James R. Turner, Jr.	Treasurer	3/1/05
Michael O. McKown	Secretary	3/1/05

Incorporation Information:

State of Incorporation	Ohio; Charter No. 736747
Date of Incorporation	November 18, 1988
Qualified:	Pennsylvania; December 28, 1988
Certificate of Authority	No. 8898868

ID #34-1603748

Shareholder:	Sunburst Resources, Inc. (100%)	04/01/96
Director:	Robert E. Murray	

[1]

Revised
5/10/07

[1] Sunburst Resources, Inc. has always been a shareholder and has no relation to Consolidated Land Company.

AA. PINSKI CORP.
125 Old Farm Drive
Pittsburgh, PA 15239

Officers:

VACANT	President and General Manager	
Robert D. Moore	Treasurer and Secretary	6/25/01 6/25/01
Robert L. Putsock	Assistant Treasurer and Assistant Secretary	6/25/01 6/25/01

Incorporation Information:

State of Incorporation	Pennsylvania; PA Entity #002710766
Date of Incorporation	August 19, 1996
ID #25-1800870	

Shareholder:	PennAmerican Coal, Inc.
Director:	Charles E. Shestak

Revised 2/14/05

BB. SPRING CHURCH COAL COMPANY
125 Old Farm Drive
Pittsburgh, PA 15239

Officers:

Robert D. Moore	President	05/26/07
Robert S. Moore	Treasurer	06/25/01
Michael O. McKown	Secretary	05/26/07
Robert L. Putsock	Asst Treasurer	01/02/03
James R. Turner, Jr.	Asst Secretary	06/01/08

Incorporation Information:

State of Incorporation	Pennsylvania; PA Entity #000696663
Date of Incorporation	November 2, 1979

ID #25-1372128

Shareholder: Mill Creek Mining Company

Director: Charles E. Shestak

Revised: 2/14/05

CC. **SUNBURST RESOURCES, INC.**
586 National Road
Wheeling, West Virginia 26003

Officers:

		Begin	End
Paul B. Piccolini	President	4/28/06	
Ronnie D. Dietz	Treasurer	3/1/05	
Michael B. Gardner	Secretary	3/1/05	05/01/07

Incorporation Information:

State of Incorporation	Pennsylvania; PA Entity #2616384
Date of Incorporation	January 10, 1995

ID #25-1766427

Shareholder:	Ohio Valley Resources, Inc.	4/01/97
Director:	Robert E. Murray	

Revised
3/7/07

DD. TDK COAL SALES, INCORPORATED
P. O. Box 259
R. D. #2, Fermantown Road
Brockway, PA 15824

Officers:

Stanley T. Piasecki	President and Chief Executive Officer	8/11/04
Elmer A. Mottillo	Treasurer	8/22/03
Michael O. McKown	Secretary	3/1/05
Charles E. Shestak	Assistant Secretary	2/01/99

Incorporation Information:

State of Incorporation	Pennsylvania; PA Entity #00758582
Date of Incorporation	June 28, 1982

ID #25-1422374

Shareholder:	Energy Resources, Inc.	
Director:	Stanley T. Piasecki	8/11/04

Revised: 02/14/05

EE. **UMCO ENERGY, INC.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

		Begin	End
Paul B. Piccolini	President	4/28/06	
Ronnie D. Dietz	Treasurer and Assistant Secretary	3/1/05	
Michael B. Gardner	Secretary	3/1/05	05/01/07
	Vice-President	5/3/06	

Incorporation Information:

State of Incorporation — Pennsylvania; PA Entity #1072295

Date of Incorporation — December 29, 1988

ID #52-1615668

Shareholder: — Maple Creek Mining, Inc. and Toni J. Southern

Director: — Robert E. Murray

Revised
3/6/07

FF. WEST VIRGINIA RESOURCES, INC.
953 National Road, Suite 207
Wheeling, West Virginia 26003

Officers:

		Begin	End
Neil Kok	President	10/2/06	
Robert D. Moore	President	10/20/00	10/20/00
Robert E. Murray	President, CEO	12/27/91	10/20/00
Anne Besece	Treasurer and Secretary	10/2/06	
Robert L. Putsock	Treasurer and	6/25/01	10/2/06
	Assistant Secretary	6/25/01	
Robert E. Murray	Treasurer	12/27/91	6/25/01
Michael O. McKown	Secretary	3/1/05	10/2/06
Anthony Carl Laplaca	Secretary	12/27/91	3/1/05

Incorporation Information:

State of Incorporation: West Virginia; Charter No. 00913610154813604

Date of Incorporation: December 27, 1991

ID #55-0713676

Shareholder: Mill Creek Mining Company (100%) 12/27/91

Director: Robert E. Murray

Revised
3/6/07

GG. WYAMERICAN ENERGY, INC.
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

Robert D. Moore	President, Treasurer and Secretary	5/3/06

Incorporation Information:

State of Incorporation	Wyoming; Charter No. 1998003378171
Date of Incorporation	September 22, 1998

ID #34-1875051

Shareholder:	Murray Energy Corporation
Director:	Robert E. Murray

Revised
3/7/07

APPENDIX 1-11

VIOLATION INFORMATION

VIOLATION INFORMATION

Information updated to November 25 , 2009

Name of Operation	Identifying number for operation	Federal or State Permit Number	MSHA ID Number
Centennial		007/019	42-01750 42-01474 42-02028 42-01864

Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
9/27/2006	10000	DOGM			Failure to renew	9/29/2006	terminated	N
10/6/2006	10002	DOGM			Failure to submit fan plan	12/4/2006	terminated	N
2/7/2007	10003	DOGM			Non coal Waste	2/12/2007	terminted	N
7/6/2007	10007	DOGM			Vehicle in ditch	7/06/07	terminated	N
8/27/2007	10008	DOGM			vehicle in ditch	8/28/2007	terminated	N
8/27/2007	10009	DOGM			no sed pond inspection	8/27/07	terminated	N
6/18/2007	10024	DOGM			non coal waste	6/18.08	terminated	N
10/28/2008	10030	DOGM			guard shack		terminated	N
1/21/09	10032	DOGM			Rocks in ditch		Term	N
7/2/09	10040	DOGM			Failure to maintain sediment control, GVH			N

Name of Operation	Identifying number for operation	Federal or State Permit Number	MSHA ID Number
Crandall		015/032	42-01715

Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
8/19/2004	Nov4-49-4-1	DOGM			Parking in Forest	Term	moved vehicle	N
9/13/2004	Nov4-49-5-1	DOGM			non-coal waste	Term	moved waste	N
9/8/2005	Nov5-49-2-1	DOGM			Failure annual subsidene	Term		N
10/4/2006	#10001	DOGM			Culvet Plugged	TErm	Unplugged	N
9/6/2007	10014	DOGM			no sed pond inspection	TERM	Inspected	N
9/10/2007	10015	DOGM			plugged culvert	term	unplugged	N
1/14/2008	10016	DOGM			mine water stored in pond	Term	rerouted water	N
1/14/2008	10017	DOGM			grvity flow fro m portals	Term	stopped flow	N
2/06/2008	10019	DOGM			failure to request permit renewal	Term	submitted renewal	N
5/28/2008	10021	DOGM			Plugged culverts	Term	Unplugged	N
5/28/2008	10022	DOGM			Failure to maintain silt fence	Term	Cleaned fence	N
8/10/2009	10043	DOGM			High iron discharge in Crandall Creek			N
8/10/2009	10044	DOGM			No macroinvertebrate studies			N
10/29/2009	10046	DOGM			Failure to clean out sediment pond			N

Name of Operation	Identifying number for operation	Federal or State Permit Number	MSHA ID Number
West Ridge		007/041	42-02233

Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
1/22/2004	Nov4-49-1-1	DOGM			Failure to request renewal	Term		N
4/6/2005	Nov5-39-1-1	DOGM			Failure to submit 4qtr water	Term		N
7/31/2008	10025	DOGM			coal pushed on topsoil	Term		N
1/29/2009	10033	DOGM			sediment in stream	Pending		N

Name of Operation	Identifying number for operation	Federal or State Permit Number	MSHA ID Number
Horse Cyn.		007/013	42-00100

Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
3/17/2009	10035	DOGM		007/013	failure to change bond	term		N
3/19/2009	10036	DOGM			working in closure period	pending		Y

Name of Operation			Identifying number for operation			Federal or State Permit Number	MSHA ID Number
Canterbury Coal Inc.			644			D-024-1/S-1020	3600813/3605708
Date Issued	**Violation Number**	**Name of Issuing Agency**	**Person Issued To**	**Permit Number**	**Brief Description of Violation**	**Abatement Action**	**Appeal Y or N**
5/13/2004	143419	PADEP		3743701	90.124		N
7/29/2004	165278	PADEP		3743701	90.106		N
7/29/2004	165278	PADEP		3743701	90.152		N
7/29/2004	169136	PADEP		3743701	90.152		N
7/29/2004	165279	PADEP		3743701	89.68		N
7/29/2004	165279	PADEP		3743701	89.83		N
8/13/2004	169138	PADEP		3743701	90.124		N
9/7/2004	169139	PADEP		3743701	89.81		N
5/13/2004	143416	PADEP		3743701	86.13 CO		N
6/15/2004	145872	PADEP		3743701	89.52 CO		N
2/8/2005	182734	PADEP		3743701	90.124		N
8/5/2005	199322	PADEP		3743701	90.159		N

Name of Operation			Identifying number for operation				Federal or State Permit Number	MSHA ID Number
UMCO			74645				PA 63921301	3608375
Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
9/1/2004	426787	DMRM		63921301	86.13	No resolution		N
9/3/2004	426786	DMRM		63921301	89.142a(b)	No resolution		N
9/20/2004	427936	DMRM		63921301	89.142a(b)	No resolution		N
1/4/2005	445603	Air Quality		63921301	25.127.25	ADM. Close Out		N
1/13/2005	445603	Air Quality		63921301	25.127.25	ADM Close Out		N
3/18/2005	445603	Air Quality		63921301	25.127.25	ADM Close Out		N
6/10/2005	466153	DEP		63921301	25.89.21	No resolution		N
7/15/2005	448412	DEP		63921301	25.89.68	Abated		N
7/15/2005	448413	DEP		63921301	25.89.83(a)	Abated		N
10/10/2006	499479	PADEP		63921301	89.142a(f)	No resolution		Y

Name of Operation			Identifying number for operation				Federal or State Permit Number	MSHA ID Number
Maple Creek			4244				63723707	36-00970
Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
5/7/2004	394440	MCM		63841302	89.142A.F.1	Abated		N
5/12/2004	394880	MCM		63841302	89.142A.F.1	No resolution		N
5/13/2004	395344	MCM		63841302	89.142A.F.1	No resolution		N
5/13/2004	395345	MCM		63841302	89.142A.F.1V	No resolution		N
5/13/2004	395346	MCM		63841302	89.142A.E	Abated		N
5/7/2004	394440	MCM		63841302	89.142A.F.1	Abated		N
7/7/2004	401714	MCM		63841302	89.142A.F.1	No resolution		N
7/30/2004	421806	MCM		63841302	SMCRA.18.6	Abated		N
8/26/2004	425804	MCM		63841302	89.142A.F.1	No resolution		N
8/13/2004	426148	MCM		63723707	86.13	Abated		N
9/8/2004	427302	MCM		63723707	90.102	Abated		N
9/10/2004	427564	MCM		63723707	90.102	Abated		N
9/13/2004	427565	MCM		63723707	90.102	Abated		N
9/14/2004	427566	MCM		63723707	90.102	Abated		N
9/14/2004	427567	MCM		63723707	90.112	Abated		N
10/19/2004	432068	MCM		63723707	90.102	Abated		N
7/29/2005	469866	DEP		63723707	89.142a(b)(1)(iii)	No Resolution		N
12/1/2005	478486	PADEP		63841302	89.145a(b)	No Resolution		N
12/1/2005	478487	PADEP		63841302	89.145a(f)(1)(v)	No Resolution		N
12/1/2005	478488	PADEP		63841302	89.145a(b)	No Resolution		N
1/9/2006	480660	PADEP		63841302	1396.18(f)	Abated		N
6/12/2006	491619	PADEP		6381302	89.142a(e)	No Resolution		Y

Name of Operation	Identifying number for operation	Federal or State Permit Number	MSHA ID Number
PENNAMERICAN COAL LP	93081	32951301	36-00970

Kim Betcher

Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N

Name of Operation	Identifying number for operation	Federal or State Permit Number	MSHA ID Number
Ohio American Coal, Inc.	N/A	N/A	3304550/3304569

Kim Betcher

Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
8/9/2006	21861	ODNR	OAEI	D-2180	outside of perrmit bndry	Abadted	IBR	N
3/1/2007	13101	ODNR	OAEI	D-2291	mining without a permit	Abadted	Permit issued	N

Name of Operation	Identifying number for operation	Federal or State Permit Number	MSHA ID Number
Energy Resources, Inc.	470	License # 1465	360 269 5

Charlie Shestak

Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
5/11/2004	143258	PaDEP	ERI	24010101	87.147	Abated	Corrected	N
8/26/2004	167665	PaDEP	ERI	24010101	87.140	Abated	Corrected	N
8/30/2004	168590	PaDEP	ERI	24970102	87.147	Abated	Corrected	N
7/6/2004	147120	PaDEP	ERI	33901602	89.52	Abated	Corrected	N
7/31/2006	211989	PaDEP	ERI	17841607	86.152	Abated	Corrected	N
4/11/2006	486936	PaDEP	ERI	17930120	87.157	Abated	Corrected	N

Name of Operation	Identifying number for operation	Federal or State Permit Number	MSHA ID Number
TDK Coal Sales, Inc.	27182	17910124	3608867

Charlie Shestak

Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
5/13/2004	143257	PaDEP	TDK	24970104	87.147	Abated	Waved	N
6/1/2004	144659	PaDEP	TDK	03940101	87.148	Abated	Corrected	N
9/15/2004	169382	PaDEP	TDK	03940102	87.106	Abated	Corrected	N
9/20/2004	169388	PaDEP	TDK	24970104	87.14	Abated	Corrected	N
10/7/2004	170575	PaDEP	TDK	24970104	87.106	Abated	Corrected	N
4/11/2006	486945	PaDEP	TDK	17900143	87.157	Abated	Corrected	N

Name of Operation	Identifying number for operation	Federal or State Permit Number	MSHA ID Number
Belmont Coal Company		D-0241/D-1020	33-04397/33-03048

David Bartsch

Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
2/24/2004	24541	DMR	Mine	D-0241	Gullies exis in regraded	Terminated	regraded	N

David Bartsch

Name of Operation	Identifying number for operation	Federal or State Permit Number	MSHA ID Number
The Ohio Valley Coal Co.	Powhatan No. 6 Mine	State – D-0360	33-01159

Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
8/2/2004	19662	DMRM	Mine	D-0360	Failure to maintain sediment control	Terminated	Cleaned Ditch	N
5/23/2006	19656	DMRM	Mine	D-0360	Failure to maintain the perimeter of diversion ditch	Terminated	Cleaned Ditch	N
11/30/2006	28473	DMRM	Mine	D-0360	Undirected Drainage	Terminated	Cleaned Ditch	N
11/30/2006	28484	DMRM	Mine	D-0360	Coal Blocking Diversion Ditch	Terminated	Cleaned Ditch	N

Name of Operation		Identifying number for operation					Federal or State Permit Number	MSHA ID Number
American Energy Corp							D-0425	33-01070
Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
1/25/2005	21807	ODNR		D-0425	subsided residnet ran out of water	Terminated	filled tank with water	N
4/27/2005	19696	ODNR		D-0425	Coal located outside stockpile area	Terminated	cleaned coal	N
4/29/2005	19695	ODNR		D-0425	Maintenance on pond 018	Terminated	cleaned out pond	N
4/27/2005	19697	ODNR		D-0425	drainage from property not entering sumps	Terminated	construct sumps	N
10/3/2005	21871	ODNR		D-0425	Failure to sub specific repairs (landowner)	Active		N
6/15/2006	21860	ODNR		D-1159	Segregate Prim Farmland soils	Active	Waiting on ODNR, All information submitted	N
Aug-05	CO-1726	ODNR		D-0425	Uncontroled discharge (Slurry)	Avtive	Will submit revised Plan Mid Month	N

Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
Name of Operation			Identifying number for operation				Federal or State Permit Number	MSHA ID Number
The American Coal Co.			Galatia Mine & Millennium Portal				IDNR Mining Pemrit #2 and #352	11-02752
9/27/2004	37-1-04	IDNR	DeNeal	Permit #2	Failure to submit groundwater report on schedule	Terminited		N
4/13/2005	37-01-05	IDNR	DeNeal	Permit #2	Failure to submit u/g mining maps	Terminited		N
5/12/2005	37-02-05	IDNR	DeNeal	Shadow Area 9	failure to complete subsidence mitigation in	Modified		N
					contemporaneous manner.			
6/1/2005	37-03-05	IDNR	DeNeal	352	broken waterline-fialure to prevent minepumpage from passing through sediment pond before going offsite	Terminated		N

The following companies either did not have any violations in the last three years or do not have permits.

Oklahoma Coal Company

KenAmerican Resources, Inc.

Onieda Coal, Inc.

MonValley Transportation Center, Inc.

Mill Creek Mining Co.

Pinski Corp

American Compliance Coal Inc.

Coal Resources Inc.

PA Transloading, Inc.

West Virginia Resources Inc.

WildCat Loadout

American Coal Sales Co.

Hocking Valley Resources Co..

In the fall of 2009 the company constructed a facility on the surface to treat the excessive iron content in the mine discharge water. Details of this facility can be found in Appendix 7-65.

5.26.21 Utility Installation and Protection

All coal mining and reclamation operations will be conducted in a manner which minimizes damage, destruction, or disruption of services provided by oil, gas, and water wells; oil, gas, and coal slurry pipelines, railroads; public utilities; etc. which pass over, under, or through the permit area, unless otherwise approved by the owner of those facilities and the Division.

5.26.22 Operation of Support Facilities

Support facilities will be operated in accordance with a permit issued for the mine to which it is incident or from which its operation results.

5.26.3 Water Pollution Control

See "Waste Disposal Plans" under the Mining Operation section of this chapter.

In the fall of 2009 the company constructed a facility on the surface to treat the excessive iron content in the mine discharge water. Details of this facility can be found in Appendix 7-65

5.26.4 Air Pollution Control

Coal mining and reclamation activities will be conducted in accordance with R645-301-420 and the Air Quality Approval Order issued by the Utah Division of Air Quality (Appendix 4-7).

5.27 Transportation Facilities

The coal from the mine will be transported to the rail loadout or final destination by truck. The trucks are typical 45 ton tandem trailer coal haulers used in the Utah coal fields. GENWAL uses a loading site on the Utah Railway located at Mohrland, Utah, a loading facility on the Southern Pacific Railway in Wellington, Utah, and other independently owned loadouts within the Carbon/Emery county area.

The Forest Development Road from Huntington Creek to the truck turn around area was constructed under the definition of a class one road and will be maintained as a primary road, in compliance with the road use permit issued by the U. S. Forest Service, Manti-La Sal National Forest. The forest access road will remain as part of the post mining land use in accordance with the Forest Service Permit (Appendix 1-2). The Forest Service Access Road, upgraded under the definition of a class two road, is maintained as a primary road. The road connects the main pad area, the truck turn around area, and the Forest Service Parking/Turnaround to the Huntington Canyon

Road (State Route 31). The road is designed, maintained and will be restored in accordance with the Forest Service road use permit.

The road from the lower pad area to the upper pad area was built under the definition of a class two road and is maintained as a primary road. It is designed (as shown on Plate 5-10), maintained and restored in accordance with R645-301-527.120. The Ancillary road to the portal area was built under the definition of a class three road and was designed (as Shown on Plate 5-10), is maintained and restored in accordance with R645-527.130.

The Forest Service Development road has been designed and was approved by the USFS prior to construction. The design drawings are on file with the Manti-La Sal National Forest in Price, Utah. During the 1991 construction season GENWAL Resources Inc. improved and asphalted the Forest Service Development road and surface facilities area of the Crandall Canyon Mine (as shown on Plate 5-3). The improvement information covering the haul road and facilities area is addressed in Appendices 5-15, 5-16, and 5-17.

The Forest Service road (primary road) is utilized by coal haul trucks, mining equipment (on a limited basis), support vehicles, employees, and recreational users (public). The two roads located on the permit area, the portal pad road and the access road to the main pad, are utilized by both surface and underground mining equipment, support vehicles, and employee vehicles. The ancillary road to the portal area is utilized by service vehicles on a very limited basis. The ancillary road to the upper unused area has been reseeded.

The forest parking area past the mine site was preserved for recreational/forest service parking and with verbal approval for the short term storage or mine equipment being onloaded/offloaded or moved as a part of upgrading or retrofitting.

Because of the limited space available at the existing site, snow removal and storage is now a problem. Currently, under agreement with the Forest Service, limited snow storage is allowed in the Forest Service trailhead parking area. This practice is less than ideal however. Snow storage in this area limits the amount of available public parking. Snow melt and runoff from the snowpiles often makes the parking area muddy in the springtime and makes sediment control into nearby Crandall Creek more challenging. The expanded operations area should relieve congestion at the site and free up both the parking area and the Forest Service road and make snow storage in the parking area unnecessary. Snow storage will become available in the area of the existing loadout facilities once these facilities have been removed and the area cleaned up properly as part of the overall site expansion project. Snowmelt from this new storage area will be able to report directly to the sediment pond located nearby. There will be absolutely no snow storage in the sediment pond itself.

After construction of the surface expansion is completed, the Forest Development Road 50248 will be returned to double lane width through the permit area to the Forest Service trailhead parking area. This will be accomplished by the following:

a) The existing loadout facilities will be removed and cleaned up and the road will be widened, realigned, and repaved through this area.

7-56	Investigation of Potential for Little Bear Spring Recharge
7-57	Determination of Recharge Location of Little Bear Spring (Dye Tracing)
7-58	Summary of Hydro logic Baseline Information, South Crandall Lease
7-59	Little Bear Spring Study (Initial study, 1998) AquaTrack
7-60	Little Bear Spring Study (Expanded Study, 1999) AquaTrack
7-61	Mill Fork Resistivity Study, 2001 AquaTrack
7-62	Little Bear Spring (2nd Expanded Study, 2001) AquaTrack
7-63	Hydrology/Geology Map of Little Bear Watershed
7-64	Baseline Information for the U-68082 Lease Mod Area
7-65	Mine Discharge Water Iron Treatment Facility

Note: Bold number plates and appendices are included with this submittal.

3. Diverting runoff using protected channels or pipes through disturbed areas so as not to cause additional erosion;

4. Using straw dikes, riprap, check dams, mulches, vegetative sediment filters, dugout ponds and other measures that reduce overland flow velocities, reduce runoff volumes or trap sediment;

5. Treating with chemicals/paving;

6. For the purposes of UNDERGROUND COAL MINING AND RECLAMATION ACTIVITIES, treating mine drainage in underground sumps.

7.42.20 Siltation Structures

7.42.21 General Requirements

Additional contributions of suspended solids and sediment to stream flow or runoff outside the permit area will be prevented to the extent possible using the best technology currently available.

Alternate Sediment Control Areas and Small Area Exemptions

There are seven ASCA sites associated with this property. All ASCA's are maintained to minimize additional contributions of suspended solids and sediment to stream flow or runoff outside the permit area. Details on the ASCA's are included in Appendix 7-4.

As a result of the Crandall Canyon Mine disaster of August 6, 2007, the mine has been de-activated and the portals have been sealed. Mine water inflow has built up to the extent that water is now discharging from the portals and is discharged through a 12" pipe into Crandall Creek under UPDES permit UT0024368. The mine is presently discharging approximately 400-500 gallons per minute, with the flow fluctuating with barametric pressure and seasons. In early 2009 the iron concentrations in the water began to exceed UPDES limits. Because there is no way to treat the water underground the company constructed an aeration treatment system located on the surface in the "old loadout" area, immediately below the portal bench. Complete details of the treatment facility can be found in Appendix 7-65. While the facility is neither an ASCA nor a small area exemption, it represents a small area within the disturbed area wherein runoff is treated along with the mine discharge water and discharges through an approved UPDES outfall point, and therefore does not drain to the sediment pond.

A suitably constructed barricade has been constructed between the treatment facility and the road which prevents any disturbed area drainage from entering the treatment facility area, and similarly prevents any of the mine discharge water from running over the adjacent disturbed area and reporting to the sediment pond. See Plate 5-3 for the location of the facility

At the lower end of the treatment facility, the treated minewater water is collected into a buried pipeline which crosses underneath the road and connects to the existing discharge line. In this manner the treated water ends up reporting to the Crandall Canyon drainage (by way of the main bypass culvert) at the existing approved UPDES outfall point.

There is every reason to believe that water will permanently discharge from the Crandall Mine portals. The iron level of the mine water historically was very low, and began rising only after the water began to build up and impound within the mine workings following the mine collapse of 2007. It is now the consensus that the elevated iron concentration will be a permanent situation, and that the reclamation plan must provide for a permanent means of treating the discharge water so as to meet UPDES requirements, even subsequent to final reclamation. To address this situation, the company commits to revising the reclamation plan in the near future. Additional baseline data will be incorporated into this revised reclamation plan. This data will include: 1) flow quantities from the seep in the sandstone ledge above the treatment facility, 2) historical data concerning the iron concentration levels in the mine discharge water, and 3) performance data demonstrating the effectiveness of the existing treatment system methodology, i.e., oxidation/settling, as opposed to other treatment methods such as reverse-osmosis, fine-element filtration, chemical coagulants/flocculants, etc. Based on recent input from various state and federal agencies (Div. Oil, Gas and Mining, Forest Service, BLM, Div Water Resources, Div. Wildlife Resources) a conceptual treatment plan was agreed upon. This plan would utilize a passive aeration system (modifying the existing portal access road into a long, cascading, open-air aeration waterway), emptying out into a set of large settling basins to be constructed in the area presently occupied by the shop/warehouse building, in accordance with the agreed-upon passive concept, so that the revised reclamation plan can be approved by August 1, 2010. This plan will include not only the facility design but also projected operating and maintenance costs for long-term (perpetual) bonding considerations. In light of the long-term treatment requirements for final reclamation, the existing treatment facility is considered temporary (i.e., operational) and will be removed at the time of final reclamation after the permanent (post-reclamation) facility is constructed.

7.42.22 Sedimentation Pond

<u>Design</u>

The sedimentation pond located in Crandall Canyon has been redesigned to control the additional storm runoff from the pad extension and from the designated undisturbed drainage areas above the pad extension associated with the proposed culvert expansion. The topography and watershed boundaries are shown on Plate 7-5 and 7-5C. Cross sections of the pond design are shown on Plate 7-3.

Runoff- and Sediment-Control Facilities

Results of analyses to determine the required size and hydraulics of the sedimentation pond are included in Appendix 7-4. Details of the sedimentation pond required for compliance with 30 CFR 77.216-1 and 30 CFR 77.216-2 are contained in Appendix 7-8. Permanent disposal of the sediment removed during cleanout will be in accordance with Section 535.

Prior to any discharges through the decant system on the sedimentation pond, a sample will be collected to determine total suspended solids, settleable solids, total dissolved solids, oil and grease, total iron, total manganese concentrations, and pH. The sample will be collected by opening the gate valve on the dewatering device, allowing water to flow from the pond through the primary spillway for a sufficient time to collect a sample of the water, and then immediately shutting the gate valve to prevent further dewatering. This sample will then be submitted to a laboratory for analyses of the indicated parameters.

After receipt of analytical results from the laboratory, if the pH and concentrations of total suspended solids, settleable solids, total dissolved solids, oil and grease, total iron, and total manganese are within the acceptable limits, water will be discharged from the pond through the dewatering device. If the parameters of concern are not within the acceptable limits, no water will be discharged through the device.

During discharge of water to Crandall Creek from the sedimentation pond, samples of the water will be collected at the discharge point at the beginning and end of the discharge time. These samples will be sent to a laboratory following the discharge period for analyses of total suspended solids, settleable solids, total dissolved solids, total iron, total manganese, oil and grease, and pH. Analytical results will be submitted to the Division with the subsequent quarterly report.

The emergency spillway discharges onto the boulder-covered slope adjacent to the sedimentation pond. Boulders that cover this slope were blasted from the cut above the pond during construction of the mine-access road. Due to the large size of the boulders, laboratory size-fraction analyses could not be conducted. However, the boulders are visually estimated to range in size up to at least 10 feet in diameter. It is further estimated that approximately 80 percent of the coarse rock on the slope is finer than 8 feet in diameter, 30 percent is finer than 5 feet in diameter, and 10 percent is finer than 3 feet in diameter.

The blasted rock has an approximate thickness of 15 to 20 feet at the top of the slope and 5 to 6 feet at the bottom of the slope. The soil that underlies the rock is a silty sand. Size-fraction analyses presented by Delta Geotechnical Consultants (1982) indicate that this soil is 70 percent sand and 30 percent silt and clay (the latter being minus 200 mesh).

The emergency spillway is lined with riprap and a filter blanket to reduce erosion potential. A concrete cutoff has also been installed immediately downstream of the inlet. The concrete cutoff ensures that the emergency spillway will not erode during a discharge event. Grading of the riprap, filter blanket, and embankment materials are shown in Figure 7-10. The spillway will discharge directly onto the boulder-covered slope. Due to the extreme thickness of the boulders and cobbles on the slope, additional erosion protection below the emergency-spillway outflow will not be required.

All new fill required to modify the embankment will be placed in 6-inch lifts. This new fill will be compacted in place by repeated passes of a front-end loader or equivalent prior to placing the next lift. Compaction will continue until the density of the material is at least 90 percent of Proctor density (as determined by sandcone density tests in the field).

As included in the original design, the interior of the pond will be lined with a 12-inch thick local, compacted clay to reduce seepage from the pond and, thereby, increase the stability of The embankment. The clay liner will be placed in 6-inch lifts and compacted during placement by at least four passes of a front end loader or equivalent. The initial layer will be disk-harrowed into the bottom of the pond prior to completion.

After pond cleanout, the thickness of the clay liner will be sampled by means of a bucket auger at 8 locations. Three holes will be placed along the ingress/egress route and five additional holes will be randomly selected from the remaining pond area. If any of the holes penetrate less than 10 inches of clay, additional clay will be compacted into the deficient areas of the pond.

Flow conditions in Crandall Creek adjacent to the sedimentation pond were examined to determine if flood flows may erode the downstream toe (see Appendix 7-5). As noted, the peak flow from the 100-year, 24-hour precipitation event will encroach 0.6 foot above the toe of the embankment. Thus, a riprap protective layer (with a median rock diameter of 12.5 inches) was placed along the lower 2.0 feet of the embankment as shown in Plate 7-4. Placement of this riprap will serve an incidental purpose of increasing the stability of the dam by placing additional weight on the downstream toe (Figure 7-10).

Following construction of the sedimentation pond as designed herein, all disturbed areas associated with pond construction (with the exception of the interior of the pond) will be revegetated with the temporary seed mixture. This mixture was developed in consultation with Lynn Kunzler of the Division and Walt Nowak of the U.S. Forest Service. This mixture provides rapid growth species, sod-forming species, and species that are compatible with other plants.

Seeding will be done in the late fall, just prior to the first heavy snowfall of the year (Plummer et al., 1968). Seeding will be accomplished by hydroseeder. Mulch will be placed after seeding. The mulch, which consists of two tons of straw or grass hay per acre of disturbed area, will be spread over the area to be planted by hydromulcher.

Following seeding, the revegetated outslopes of the pond will be inspected during normal pond inspections to determine the effectiveness of the seeding. Straw-bale dikes will be added as necessary to control excessive gullying on the dam face. These dikes will be installed as noted by Figure 7-11.

7.42.30 Diversions

Diversion UD-1 is a 42" culvert placed along the western edge of the site at the location shown on Plate 7-5 to divert water from a 95-acre undisturbed watershed around the yard area. Analyses and design information associated with this and other diversions associated with the site are contained in Appendix 7-4. (Table 10)

Two additional diversions were designed to convey water from undisturbed areas away from the disturbed site. One (UD-2) was constructed in the northwest portion of the site along the proposed substation pad. UD-2 is an open ditch diversion. UD-3 is a 24" culvert diversion located in the northeastern portion of the site to convey water away from the portal area. Design details are presented in Tables 8 and 10 respectively in Appendix 7-4.

As a result of the Crandall Canyon Mine disaster of August 6, 2007, the mine has been de-activated and the portals have been sealed. During the process of constructing the seals much of the UD-3 culvert diversion structure was damaged beyond repair. Upon further evaluation it was determined that the undisturbed drainage from WSUD-3 above the portals could be diverted into the existing surface drainage ditches rather than try to re-establish it back across the portals as it had been previously. The drainage from WSUD-3 is now proposed to report to disturbed drainage ditch DD-8, then to culvert C-1, then to ditch DD-5, then culvert C-12, and ultimately into the sediment pond. As shown in Tables 3, 5, 6 and 7 of Appendix 7-4, all ditches and culverts are presently sized to adequately handle the additional runoff from the undisturbed area. Also, as shown in Table 11 of Appendix 7-4, the sediment pond is also adequately sized to handle this additional contribution. The existing inlet structure to culvert UD-3 is a substantially constructed concrete box located about 20' above the intake portal. This structure will remain in place. The existing culvert is an 18" PVC pipe, which is undamaged in the area immediately above the portal. This pipe will be cut off about 10' below the inlet structure and fitted with a PVC 90 degree elbow. From this elbow a new segment of 12" HDPE pipe will be routed over and around the intake portal and allowed to discharge into the existing disturbed drainage ditch DD-8 which runs along the portal access road. Due to the short length and steepness of this new segment, calculations show that use of a 12" pipe will easily handle the anticipated flow. This HDPE pipe will be supported by cables anchored into the concrete inlet box, and by an existing steel lamp-post located above the portal. The semi-flexible nature of the replacement pipe will allow it to be directed around the portal to ditch DD-8. Details of the pipe sizing and schematic drawings of the installation plans for this re-routed culvert can be found in Figures 13A and 13B of Appendix 7-4.

The existing culverts in the mine yard were examined to determine their adequacy with respect to passing the peak flow. Details of these designs are provided in Appendix 7-4.

Similarly, ditches within the disturbed area are designed to pass the peak flow from the 10-year, 6-hour storm. Typical cross sections and design calculations are contained in Appendix 7-4 for these ditches. Ditches have been evaluated for adequacy in passing the 10 year-24 hour storm and found to be of adequate size (see Appendix 7-4).

A berm was placed around the (un-used) power substation area to prevent runoff water that accumulates thereon from flowing across the remainder of the site. A small channel on the

APPENDIX 7-4

SEDIMENTATION AND DRAINAGE CONTROL PLAN

APPENDIX 7-4

CRANDALL CANYON MINE
SEDIMENTATION AND DRAINAGE CONTROL PLAN

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CRANDALL CANYON MINE
SEDIMENTATION AND DRAINAGE CONTROL PLAN

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1. Introduction

The Sedimentation and Drainage Control Plan for the Crandall Canyon Mine has been designed according to the State of Utah R645- Coal Mining Rules, November 1, 1996. All design criteria and construction will be certified by a Utah Registered Professional Engineer.

This plan has been divided into the following three sections:

1) *Design of Drainage Control Structures for the Proposed Construction*
2) *Design of Sediment Control Structures*
3) *Design of Drainage Control Structures for Reclamation*

The general surface water control plan for this project will consist of the following:

(a) *The proposed pad expansion will necessitate modifications of a number of existing hydrologic structures on the site. In an effort to clarify the new plan, the entire sedimentation and drainage control plan has been re-evaluated for the site and presented in this Appendix.*

(b) *The general plan for the pad expansion is to divert undisturbed drainage from Crandall Canyon above the minesite through a 6' diameter CMP culvert beneath the expansion area and discharge below the disturbed area. As a result of the expansion, existing culverts C-2, C-8, C-10 and Ditch DD-9 will be removed. 2 new ditches (DD-12 & DD-13) and 3 new culverts (Main Canyon, C-11 and C-11A) will be added to provide for drainage control for the expanded facility. The existing sediment pond will also be expanded to contain additional runoff from the expansion area. All other existing drainage controls will remain unchanged. All minesite drainage controls are shown on Plate 7-5 "Drainage Map".*

(c) *The main canyon culvert is sized to safely pass the runoff from a 100 year - 6* *hour precipitation event. All other undisturbed diversions, disturbed ditches and culverts are sized to safely convey runoff from a 10 year - 24 hour precipitation event. The sediment pond is sized to contain runoff from a 10 year - 24 hour precipitation event, as required.*

(d) *The cresent-shaped area below the portals will be utilized as a water treatment facility for the mine water discharging from the mine and seeping from the slope below the portals. The plan is to divert all mine water into this area, where it will be treated with an aeration system and settling pond to reduce the iron content. Once treated, the mine water will flow into the main canyon culvert at the UPDES #002 discharge location. Calculations show a minimum 12" pipeline at a minimum grade of 3 % is more than adequate to carry the expected maximum discharge of 800 gpm or 1.78 cfs. A larger pipeline may be used. This system will be isolated from the rest of the minesite drainage by topography and jersey-barriers, and will no longer flow to the sediment pond. The location and drainage plans are shown on Plate 7-5. As a result of constructing this facility, the volume of runoff reporting to the sediment pond actually decreases by a small amount, estimated at about 0.05 ac/ft. However, since the facility may not be permanent and could be removed in the future, the runoff calculations for the affected ditches, culverts and sediment pond have not been changed to reflect any resulting decrease.*

(e) *When the Crandall Canyon Mine Portals were sealed as a result of the 2007 disaster, culvert system UD-3 which diverts undisturbed drainage area WSUD-3, was damaged beyond repair. Therefore it was decided to re-route UD-3 as shown on Figures 13A and 13B. Culvert UD-3 now reports to Disturbed Ditch DD-8, Culvert C-1, Disturbed Ditch DD-5, Culvert C-12 and ultimately into the Sediment Pond. Calculations show that all affected ditches, culverts and the Sediment Pond are adequately sized to handle the increased flow from WSUD-3 (See Tables 3, 5, 6, 7 and 11).*

DESIGN OF DRAINAGE CONTROL STRUCTURES

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Table 8	*Undisturbed Ditch Design Summary*
Table 9	*Disturbed Culvert Design Summary*
Table 10	*Undisturbed Culvert Design Summary*

Design Parameters:

2.1 Precipitation

The precipitation-frequency values for the area were taken from the existing plan which lists Miller, et.al. (1973) as the sources.

Frequency - Duration	*Precipitation*
10 year-6 hour	*1.55"*
10 year-24 hour	*2.50"*
25 year-6 hour	*1.90"*
100 year-6 hour	*2.40"*
100 year-24 hour	*3.70"*

2.2 Flow

Peak flows, flow depths, areas and velocities were calculated using the computer program "Office of Surface Mining Watershed Model", Storm Version 6.21 by Gary E. McIntosh. All flow is based on the SCS - TR55 Method for Type II storms.

Time of concentration of storm events was calculated for each drainage area using the following formula:

$$t_L = \frac{L^{0.8}\,(S+1)^{0.7}}{1900\,Y^{0.5}}$$

where:

	t_C	=	Time of Concentration (hrs.)
	t_L	=	Lag Time (hrs.) = $0.6\,t_C$
	L	=	Hydraulic Length of Watershed (ft.)
	Y	=	Average Land Slope (%)
	S	=	$\frac{1000}{CN} - 10$

2.3 Velocity

Flow velocities for each ditch structure were calculated using the Storm computer program with Manning's Formula:

$$V = \frac{1.49}{n} R^{2/3} S^{1/3}$$

where:			
	V	=	*Velocity (fps)*
	R	=	*Hydraulic Radius (ft.)*
	S	=	*Slope (ft. per ft.)*
	n	=	*Manning's n; Table 3.1, p. 159,*

"Applied Hydrology and Sedimentology for Disturbed Areas", Barfield, Warner & Haan, 1983.

Note: The following Manning's n were used in the calculations:

Structure	Manning's n
Culverts (cmp)	0.020
Unlined Disturbed Area Ditches	0.035

2.4 Drainage Areas

All drainage areas were planimetered directly from Plate 7-5, Drainage Map, and Plate 7-5C, Watershed Boundaries.

2.5 Slopes, Lengths

All slopes and lengths were measured directly from the topography on Plate 7-5, Drainage Map, and Plate 7-5C, Watershed Boundaries.

2.6 *Runoff*

Runoff was calculated using the SCS Formula for Type II Storms; using the Storm Version 6.21 computer program:

$$Q = \frac{(P - 0.2\,S)^2}{P + 0.8\,S}$$

where:	CN	=	*Runoff Curve Number*
	Q	=	*Runoff in inches*
	P	=	*Precipitation in inches*
	S	=	$\frac{1000}{CN} - 10$

2.7 *Runoff Curve Numbers*

Two curve numbers were utilized for the undisturbed areas. Average curve numbers for the north facing and south facing slopes were determined from curves presented in Figure 7-3 (Chapter 7), using measured cover densities as reported in Chapter 3 and the northern half of lease area SL 062648, assuming a hydrologic soil group of C. Curve numbers of 60 and 69 were obtained for the north facing and south facing undisturbed areas, respectively, using Chart A for Oak-Aspen and ground cover densities of 45 and 26 for north facing and south facing areas, respectively. The above referenced Figure 7-3 (Chapter 7) is included in this Appendix as Figure 9.

Runoff curve numbers for reclaimed, disturbed and paved areas were selected based on comparison with Table 2.20 (p. 82, Barfield, et al, 1983) and numbers previously approved in the M.R.P. A conservative number of 75 was used for reclaimed areas within the disturbed boundary. Curve numbers of 90 and 95 were used for all disturbed areas and paved areas, respectively. See Plates 7-5 and 7-5C for referenced areas.

The following is a summary of runoff curve numbers used in these calculations:

Watershed	*Runoff CN*
Undisturbed (North Facing):	*60*
Undisturbed (South Facing):	*69*
Reclaimed:	*75*
Disturbed:	*90*
Paved:	*95*

2.8 Culvert Sizing

Minimum culvert sizing is based on the following Manning's Equation; using the Haestad Methods, Flowmaster I, Version 3.42 computer program:

$$D = \left(\frac{2.16\ Q\ n}{\sqrt{s}}\right)^{0.35}$$

where: D	=	*Required Diameter (feet)*
Q	=	*QP = Peak Discharge (cfs)*
n	=	*Roughness Factor (0.020 for cmp)*
S	=	*Slope (ft. Per ft.)*

Using the above formula, minimum required culvert sizes were calculated for each applicable area. Culverts were then selected above the required minimum, and these sizes were checked for adequacy against the Culvert Nomograph included as Figure 1 of this report.

2.9 Culverts

As indicated in Section 1, the proposed pad expansion will necessitate modifications of a number of existing hydrologic structures on the site, including culverts. As a result of the expansion, existing culverts C-2, C-8 and C-10 will be removed. Two new culverts (Main Canyon, C-11) were added to provide drainage control for the expanded facility during phase I of the surface expansion. One more (C-11A) will be added during the phase II south portal construction. All other existing culverts on the site will remain unchanged.

Culverts have been sized according to the calculations previously described, and are summarized on the following tables. The culverts are shown on Plate 7-5, Drainage Map.

All undisturbed diversions are labeled with a UD number (i.e. UD-1). One of these diversions is a culvert (UD-1), and is clearly marked on Plate 7-5. Contributing watersheds for undisturbed diversions are labeled with a WSUD number, (i.e. WSUD-1) as shown on Plates 7-5 and 7-5C. All undisturbed diversion culverts will be fitted with trash racks to minimize plugging by rocks or other debris.

The proposed Main Canyon culvert is sized to carry runoff from a 100 year - 6 hour precipitation event for the Crandall Canyon area above the minesite. A 6' diameter C.M.P. culvert is proposed to carry the Crandall Canyon runoff beneath the expanded pad area and discharge below the minesite. Calculations in Table 10 show the proposed 6' diameter culvert to be more than adequate to carry the expected peak flow. The culvert will be equipped with an inlet headwall and trash rack and a properly sized outlet apron and energy dissipator for erosion protection. Runoff characteristics, flow and culvert design are presented in this Appendix.

The remaining undisturbed culverts on the site (UD-1 and UD-3) are existing. These culverts are adequate for the required 10 year - 6 hour precipitation event, as shown on Table 10 of this Appendix.

Culverts carrying disturbed drainage are designed with a C number (i.e. C-1). Contributing watersheds for disturbed area culverts (and ditches) are designated with a WSDD number (i.e. WSDD-1) shown on Plate 7-5. All disturbed area drainage culverts have been designed to carry the runoff from a 10 year - 24 hour precipitation event. All calculations and design criteria are included in this Appendix.

Existing culverts C-2, C-8 and C-10 will be removed during the pad extension, and therefore are not included in this Appendix. These culverts are shown on Plate 7-5C, dated 03/21/91.

All culverts will be inspected regularly, and cleaned as necessary to provide for passage of design flows. Inlets and outlets shall also be maintained to prevent plugging, undue restriction of water flow and erosion. Culvert outlets will be rip-rapped where necessary to protect from erosion.

One culvert, UD-1, is considered a permanent diversion, and will remain in place after reclamation. This culvert is sized to carry runoff in-excess of a 100 year - 6 hour storm. Justification for leaving it in place is provided in the Reclamation Hydrology Section 4.1, of this Appendix.

All other culverts are considered temporary, and will be removed upon final reclamation, with the exception of the lower 300' of the Main Canyon Culvert. This portion of the culvert will be left in place until the sediment pond is removed during Phase II Reclamation. The remaining portion of the culvert will be removed at that time.

2.10 Ditches

The proposed pad expansion will necessitate modifications to hydrologic structures, including ditches. As a result of the expansion, existing ditch DD-9 will be eliminated. Two new ditches (DD-12 and DD-13) will be added to provide drainage control for the expanded facility. All other existing ditches on the site will remain unchanged.

Undisturbed diversions are designated with a UD number (i.e. UD-2). There is only one undisturbed diversion ditch - (UD-2). This ditch is existing. Contributing watersheds for the undisturbed diversion are labelled with a WSUD number (i.e. WSUD-2), and are shown on Plate 7-5C.

Disturbed diversions (ditches) are designated with a DD number (i.e. DD-1). Contributing watersheds for disturbed diversions are labelled with a WSDD number (i.e. WSDD-1) as shown on Plates 7-5 and 7-5C. All disturbed diversions carry runoff which ultimately goes to the sediment pond.

All ditches are designed to carry the expected runoff from respective watersheds from a 10 year - 6 hour precipitation event, with a minimum freeboard of 0.3'. Ditches were assumed to be unlined with a Manning's No. of 0.035. All ditches have been conservatively evaluated for size using the computer program "Office of Surface Mining Watershed Model," Storm, Version 6.21, by Gary E. McIntosh, to calculate peak flows, which were then routed into triangular shaped channels with 1:1 side slopes. This evaluation shows conditions which are not uncommon at minesites and which tend to maximize required flow depths. All ditches are designed with the steeper (1:1) side slopes to allow for maintenance by road grading or other equipment. Actual side slopes may vary in the field; however, as long as the ditch has the required depth and cross-sectional area to carry the flow with required *freeboard, the ditch is adequate.*

Ditches with flow velocities of 5 fps or greater will be lined with properly sized rip-rap or other controls to protect from erosion.

All ditch slopes and lengths were taken from Plate 7-5, "Drainage Map".

A typical ditch section, as well as a summary of flow depths and sizes is provided in Figure 3 of this Appendix.

All ditches will be inspected regularly, constructed and maintained to the minimum dimensions to provide adequate capacity for the design flow. All ditches are temporary and will be removed during final reclamation.
Note: Ditches were also evaluated for adequacy to carry runoff from the 10 year - 24 hour precipitation event.

2.11 Main Canyon Culvert

The proposed main canyon culvert will be placed to closely approximate the existing stream alignment. In an effort to protect the natural channel, the area will be covered with a filter fabric (geotextile material). An underdrain will then be installed on the fabric, consisting of an 18" perforated drain pipe surrounded by a bed of clean 2" drain drainrock. The underdrain will be covered by a second layer of fabric which in turn will be covered with a layer of marker material used to facilitate visibility during final reclamation. A layer of bedding material will then be placed over the marker material. The proposed 72" cmp culvert will then be installed on the bedding material and backfilled and compacted throughout the length of the mine site - approximately 1500'.

The culvert has been sized to safely carry the runoff from a 100 year - 6 hour precipitation event for all of Crandall Canyon above the minesite. The 100 year - 6 hour flow has been calculated at 222.79 cfs, as shown on Table 3. This flow can be carried by a 3.75' minimum diameter culvert, as calculated by the Manning's Equation and shown in Table 10; therefore, the proposed 6' diameter culvert is more than adequate.

There have been some questions raised as to previous main canyon flow calculations which showed the expected runoff from the 100 year - 6 hour storm to be as high as 431 cfs. It appears this number was generated by using a computer program called "Peak", using slightly different parameters than those used in this report.

The runoff numbers in this Appendix were calculated using the "Office of Surface Mining Watershed Model", Storm Version 6.21, by Gary E. McIntosh. All flows were based on the SCS-TR55 Method for Type II storms. This program has been supplied to the operators by the Division, and results have been consistently accepted *by the agencies.*

In an effort to make the runoff values more conservative, yet realistic, for design purposes, some parameters, such as concentration time and SCS Upland Curve numbers were placed on the conservative side in the program. Based on these numbers, a very conservative flow of 222.79 cfs was obtained. It should be noted that this flow agrees closely with a previous calculation using the equation of Thomas and Lindskov (1983), *which estimates the 100 year - 6 hour flow for the main canyon at 272 cfs.*

Summary: *It is obvious that the final number on the main channel flow is entirely dependent upon which computer program or method is used. Since the OSM Storm program has been used throughout calculations for this plan, and since it is a widely accepted method, the more conservative figure of 222.79 cfs has been used in design calculations for this plan.*

2.12 Main Canyon Culvert Inlet Structure

The culvert inlet will be protected by an inlet section and trash rack, along with a rip-rapped headwall. An additional trash rack will be installed upstream of the inlet at a location convenient for maintenance and cleanout, as shown on Figure 10. Based on the Culvert Nomograph, Figure 1, the expected flow will enter the culvert at slightly over 1 diameter of head; therefore, additional headwall protection will be provided for a minimum of 5' above and around the inlet structure. Headwall protection will be of 18" D_{50} rip-rap, as shown on Figure 10.

A small side drainage enters Crandall Creek just west of the bypass culvert inlet. As the drainage calculations took into consideration the runoff from this side canyon, the bypass culvert and inlet riprap are adequately sized to handle drainage from this side canyon. The riprap has been extended up this drainage for a short distance (see Map 5-3) in order to protect the culvert inlet.

2.13 Main Canyon Culvert - Outlet Structure

The outlet of the 6' diameter main canyon culvert has been designed to flow into a rip-rap apron to protect against scouring and for energy dissipation. The rip-rap apron is designed to fit the natural channel configuration as closely as possible, and will allow runoff to re-enter the natural channel at a reduced velocity which is no greater than natural flow conditions. Runoff from the 100 year - 6 hour precipitation event in the canyon above the minesite has been calculated at 222.79 cfs.

The rip-rap apron design is based on Figure 7-26, Design of Outlet Protection - Maximum Tailwater Condition, "Applied Hydrology and Sedimentology for Disturbed Areas", Barfield, Warner and Haan, 1983. Based on the figure, the apron should be a minimum of 22' in length, widening from 6' to 15', with a 0% slope. The proposed length has been increased to 30', with an 18' width, to ensure adequate time for velocity reduction. The slope is kept at 0%. Rip-rap size is conservatively placed at 30" D_{50}. Rip-rap will be placed to a depth of 1.5 D_{50} and will be embedded in a 12" layer of 2" drain rock filter. Rip-rap will also be placed on 1:1 side slopes to the height of the culvert (6') at the culvert outlet tapering to 3' at the outlet of the apron. This rip rap apron has been sized and designed to adequately dissipate energy from flow velocities of a 100 year, 24 hour precipitation event and resist dislodgement. The drain rock filter bed will also serve to secure the rip rap boulders firmly in place, to add an additional element of stability, and prevent scouring underneath the boulder bed.

The natural channel below the proposed outlet has been measured from field surveys to have a bottom width of approximately 17' at the proposed apron outlet, with side slopes approximately 1:1. When the flow is routed from the culvert across the apron to the natural channel, the velocity is reduced from 21.70 fps at the culvert outlet to 10.83 fps at the outlet of the apron. Refer to 72" Culvert Outlet Rip-Rap Apron Flow Velocity Calculations in Section 4.6. Based on actual field measurements, the natural channel flow velocity would be approximately 11.02 fps at this location with the same flow of 222.79 cfs. Therefore, the velocity of the stream flow exiting the rip rap apron will be less than the velocity in the naturally existing stream bed, at that location, under similar conditions.

TABLE 1
WATERSHED SUMMARY

Watershed	Type	CN	Acres	Drains To		Final
Crandall	Undisturbed	69	3480.00	Main Culvert	-	Crandall Creek
WSUD-1	Undisturbed	69	84.88	Culvert UD-1	-	Crandall Creek
WSUD-2	Undisturbed	69	1.39	Ditch UD-2	-	Culvert UD-1
WSUD-3	Undisturbed	69	8.66	Culvert UD-3	-	Sediment Pond
WSDD-1	Undisturbed	69	0.14	Ditch DD-1	-	Sediment Pond
WSDD-1	Reclaimed	75	0.08	Ditch DD-1	-	Sediment Pond
WSDD-2	Reclaimed	75	0.15	Ditch DD-1	-	Sediment Pond
WSDD-3	Undisturbed	69	0.13	Ditch DD-3	-	Sediment Pond
WSDD-3	Reclaimed	75	0.15	Ditch DD-3	-	Sediment Pond
WSDD-3	Disturbed	90	0.26	Ditch DD-3	-	Sediment Pond
WSDD-3	Paved	95	0.33	Ditch DD-3	-	Sediment Pond
WSDD-4	Paved Road	95	0.11	Ditch DD-4	-	Sediment Pond
WSDD-4	Disturbed	90	0.08	Ditch DD-4	-	Sediment Pond
WSDD-5	Undisturbed	69	0.12	Ditch DD-5	-	Sediment Pond
WSDD-5	Reclaimed	75	0.33	Ditch DD-5	-	Sediment Pond
WSDD-5	Paved Road	95	0.33	Ditch DD-5	-	Sediment Pond
WSDD-7	Undisturbed	69	0.18	Ditch DD-7	-	Sediment Pond
WSDD-7	Disturbed	90	0.17	Ditch DD-7	-	Sediment Pond
WSDD-7	Paved Road	95	0.09	Ditch DD-7	-	Sediment Pond
WSDD-8	Undisturbed	69	3.59	Ditch DD-8	-	Sediment Pond
WSDD-8	Reclaimed	75	0.15	Ditch DD-8	-	Sediment Pond
WSDD-8	Disturbed	90	0.37	Ditch DD-8	-	Sediment Pond
WSDD-8	Paved Road	95	0.25	Ditch DD-8	-	Sediment Pond
WSDD-10	Undisturbed	69	0.07	Ditch DD-10	-	Sediment Pond
WSDD-10	Reclaimed	75	0.12	Ditch DD-10	-	Sediment Pond
WSDD-10	Disturbed	90	0.61	Ditch DD-10	-	Sediment Pond
WSDD-10	Paved Road	95	0.27	Ditch DD-10	-	Sediment Pond
WSDD-11	Undisturbed	69	2.09	Ditch DD-11	-	Sediment Pond
WSDD-11	Reclaimed	75	0.15	Ditch DD-11	-	Sediment Pond
WSDD-11	Disturbed	90	0.04	Ditch DD-11	-	Sediment Pond
WSDD-12	Undisturbed	60	8.82	Ditch DD-12	-	Sediment Pond
WSDD-12	Disturbed	90	2.29	Ditch DD-12	-	Sediment Pond
WSDD-13	Undisturbed	60	17.72	Ditch DD-13	-	Sediment Pond
WSDD-13	Disturbed	90	3.70	Ditch DD-13	-	Sediment Pond
WSDD-13	Paved	95	0.27	Ditch DD-13	-	Sediment Pond
WSDD-14	Disturbed	90	0.89	Sediment Pond	-	Sediment Pond
WSDD-14	Undisturbed	60	0.78	Sediment Pond	-	Sediment Pond
WSDD-14	Paved	95	0.02	Sediment Pond	-	Sediment Pond
WSDD-15	Paved	95	0.09	Ditch DD-7	-	Sediment Pond

TABLE 2
WATERSHED PARAMETERS

Watershed	Type	CN	Acres	Hyd. Length(ft.)	Land Slope(%)	Elev.Change(ft.)
Crandall	Und.	69	3480.00	16,500	17.58	2900
WSUD-1	Und.	69	84.88	3,100	53.55	1660
WSUD-2	Und.	69	1.39	320	78.13	250
WSUD-3	Und.	69	8.66	1300	70.77	920
WSDD-1	Und.	69	0.14	100	40.00	40
WSDD-1	Recl.	75	0.08	120	25.00	30
WSDD-2	Recl.	75	0.15	200	25.00	50
WSDD-3	Und.	69	0.13	80	50.00	40
WSDD-3	Recl.	75	0.15	100	48.00	48
WSDD-3	Dist.	90	0.26	125	56.00	70
WSDD-3	Paved	95	0.33	100	3.00	3
WSDD-4	Paved	95	0.11	250	8.33	20
WSDD-4	Dist.	90	0.08	100	10.00	10
WSDD-5	Und.	69	0.12	60	50.00	30
WSDD-5	Recl.	75	0.33	80	50.00	40
WSDD-5	Paved	95	0.33	300	8.33	25
WSDD-7	Und.	69	0.18	100	78.00	78
WSDD-7	Dist.	90	0.17	120	66.67	80
WSDD-8	Und.	69	3.59	700	65.71	460
WSDD-8	Recl.	75	0.15	80	62.50	50
WSDD-8	Dist.	90	0.37	60	65.71	39
WSDD-8	Paved	95	0.25	560	5.36	30
WSDD-10	Und.	69	0.07	45	62.22	28
WSDD-10	Recl.	75	0.12	50	72.00	36
WSDD-10	Dist.	90	0.61	120	62.50	75
WSDD-10	Paved	95	0.27	335	5.37	18
WSDD-11	Und.	69	2.09	570	64.91	370
WSDD-11	Recl.	75	0.15	30	66.67	20
WSDD-11	Dist.	90	0.04	35	66.67	23
WSDD-12	Und.	60	8.82	1600	42.50	680
WSDD-12	Dist.	90	2.29	80	72.73	58
WSDD-13	Und.	60	17.72	2100	53.81	1130
WSDD-13	Dist.	90	3.70	650	9.09	59
WSDD-13	Paved	95	0.27	40	4.00	2
WSDD-14	Dist.	90	0.89	140	16.11	23
WSDD-14	Und.	60	0.78	380	64.41	245
WSDD-14	Paved	95	0.02	30	3.00	1
WSDD-15	Paved	95	0.09	150	3.33	5

TABLE 3
RUNOFF SUMMARY
UNDISTURBED DIVERSIONS

Diversion	Main Culvert	UD-1	UD-2	UD-3
Watershed	Crandall Canyon	WSUD-1	WSUD-2	WSUD-3
Area (Acres)	3480.0	84.88	1.39	8.66
Runoff CN	69	69	69	69
10 year/6 hour Rainfall (in.)	1.55	1.55	1.55	1.55
Peak Flow 10/6 (cfs)	N/A	1.91	0.04	0.23
25 year/6 hour Rainfall (in.)	1.90	1.90	1.90	1.90
Peak Flow 25/6 (cfs)	N/A	3.68	0.08	0.43
100 year/6 hour Rainfall (in.)	2.40	2.40	2.40	2.40
Peak Flow 100/6 (cfs)	222.79	6.81	0.21	0.89
10 year/24 hour Rainfall (in.)	N/A	2.50	2.50	2.50
Runoff Volume 10/24 (ac.ft.)	N/A	2.98	0.05	0.30

TABLE 4
RUNOFF SUMMARY
DRAINAGE TO SEDIMENT POND

Watershed	Type	10 year/24 hour Volume-ac.ft.	10 year/24 hour Peak Flow-cfs	10 year/6 hour Peak Flow-cfs	25 year/6 hour Peak Flow-cfs
WSDD-1	Undisturbed	0.02	0.10	0.04	0.06
WSDD-1	Reclaimed	0.01	0.04	0.01	0.01
WSDD-2	Reclaimed	0.01	0.06	0.01	0.03
WSDD-3	Undisturbed	0.00	0.03	0.00	0.01
WSDD-3	Reclaimed	0.01	0.05	0.01	0.02
WSDD-3	Disturbed	0.03	0.18	0.08	0.12
WSDD-3	Paved	0.05	0.32	0.17	0.22
WSDD-4	Paved	0.02	0.12	0.07	0.09
WSDD-4	Disturbed	0.01	0.08	0.04	0.05
WSDD-5	Undisturbed	0.00	0.03	0.00	0.01
WSDD-5	Reclaimed	0.02	0.10	0.02	0.04
WSDD-5	Paved	0.05	0.39	0.21	0.27
WSDD-7	Undisturbed	0.01	0.05	0.00	0.01
WSDD-7	Disturbed	0.02	0.12	0.05	0.07
WSUD-3	Undisturbed	0.30	1.40	0.23	0.43
WSDD-8	Undisturbed	0.13	0.75	0.10	0.20
WSDD-8	Reclaimed	0.01	0.05	0.01	0.02
WSDD-8	Disturbed	0.05	0.23	0.10	0.14
WSDD-8	Paved	0.04	0.37	0.20	0.26
WSDD-10	Undisturbed	0.00	0.03	0.00	0.01
WSDD-10	Reclaimed	0.01	0.03	0.01	0.01
WSDD-10	Disturbed	0.08	0.42	0.19	0.27
WSDD-10	Paved	0.04	0.35	0.19	0.24
WSDD-11	Undisturbed	0.07	0.47	0.06	0.12
WSDD-11	Reclaimed	0.01	0.04	0.01	0.02
WSDD-11	Disturbed	0.01	0.06	0.03	0.04
WSDD-12	Undisturbed	0.13	0.25	0.04	0.16
WSDD-12	Disturbed	0.29	3.33	1.51	2.10
WSDD-13	Undisturbed	0.26	0.49	0.07	0.30
WSDD-13	Disturbed	0.47	5.39	2.44	3.39
WSDD-13	Paved	0.04	0.20	0.11	0.14
WSDD-14	Disturbed	0.11	0.78	0.35	0.49
WSDD-14	Undisturbed	0.01	0.03	0.00	0.02
WSDD-14	Paved	0.02	0.07	0.04	0.05
WSDD-15	Paved	0.02	0.11	0.06	0.08
Totals		2.36	16.53	6.46	9.50

TABLE 5
RUNOFF CONTROL STRUCTURE
WATERSHED SUMMARY

Structure	*Type*	*Contributing Watersheds*
Main Culvert	Culvert	Crandall Canyon Above Mine
UD-1	Culvert	WSUD-1
UD-2	Culvert	WSUD-2
UD-3	Culvert	WSUD-3
DD-1	Ditch	WSDD-1, WSDD-2
DD-3	Ditch	WSDD-1, WSDD-2, WSDD-3
DD-4	Ditch	WSDD-1, WSDD-2, WSDD-3, WSDD-4, WSDD-8, WSDD-12
DD-5	Ditch	WSDD-1, WSDD-2, WSDD-3, WSDD-4, WSDD-5, WSDD-8, WSDD-12
DD-7	Ditch	WSDD-7, WSDD-11
DD-8	Ditch	WSDD-8, WSUD-3
DD-10	Ditch	WSDD-10 + Mine Water
DD-11	Ditch	WSDD-11
DD-12	Ditch	WSDD-12
DD-13	Ditch	WSDD-13
DD-14	Sheet Flow	WSDD-14
C-1	Culvert	WSDD-1, WSDD-2, WSDD-3, WSDD-8
C-3	Culvert	WSDD-7, WSDD-11, WSDD-15
C-4	Culvert	WSDD-10 + Mine Water
C-5	Culvert	WSDD-11
C-6	Culvert	WSUD-2
C-7	Culvert	WSDD-1, WSDD-2, WSDD-3
C-9	Culvert	WSDD-4, WSDD-12
C-11	Culvert	WSDD-12
C-11A	Culvert	WSDD-12
C-12	Culvert	WSDD-1, 2, 3, 4, 5, 8, 12
C-13	Culvert	WSDD-13
C-14	Slot Culvert	WSDD-4
C-15	Slot Culvert	WSDD-15
C-16	Culvert	WSDD-13
C-17	Culvert	WSDD-13
Sediment Pond	Pond	WSDD-1, 2, 3, 4, 5, 7, 8, 10, 11, 12, 13, 14, WSUD-3

TABLE 6
RUNOFF CONTROL STRUCTURE
FLOW SUMMARY

Structure	Type	10 year/6 hour Peak Flow-cfs	10 year/24 hour Peak Flow-cfs	25 year/6 hour Peak Flow-cfs	100 year/6 hour Peak Flow-cfs
Main Culvert	Culvert	-	-	-	222.79
UD-1	Culvert	1.91	-	3.68	6.81
UD-2	Ditch	0.04	-	0.08	0.21
UD-3	Culvert	0.23	-	0.43	0.89
DD-1	Ditch	0.06	0.20	0.10	-
DD-3	Ditch	0.32	0.78	0.47	-
DD-4	Ditch	2.39	5.96	3.49	-
DD-5	Ditch	2.85	7.88	4.24	-
DD-7	Ditch	0.21	0.85	0.34	-
DD-8	Ditch	0.64	2.80	1.05	-
DD-10	Ditch	2.62	3.06	2.76	-
DD-11	Ditch	0.10	0.57	0.18	-
DD-12	Ditch	1.55	3.58	2.26	-
DD-13	Ditch	2.62	6.08	3.83	-
DD-14	Sht Flw	0.39	0.88	0.56	-
C-1	Culvert	0.96	3.58	1.52	-
C-3	Culvert	0.21	0.85	0.34	-
C-4	Culvert	2.62	3.06	2.76	-
C-5	Culvert	0.10	0.57	0.18	-
C-6	Culvert	0.04	-	0.08	-
C-7	Culvert	0.32	0.78	0.47	-
C-9	Culvert	0.11	0.20	0.14	-
C-11	Culvert	1.55	3.58	2.26	-
C-11A	Culvert	1.55	3.58	2.26	-
C-12	Culvert	2.85	7.36	3.92	-
C-13	Culvert	2.62	6.08	3.83	-
C-14	Slot Cul.	0.11	0.20	0.14	-
C-15	Slot Cul.	0.06	0.11	0.08	-
C-16	Culvert	2.62	6.08	3.83	-
C-17	Culvert	2.62	6.08	3.83	-
Sediment Pond	Pond	6.46	16.53	9.50	-

TABLE 7
DISTURBED DITCH DESIGN SUMMARY

Ditch	DD-1	DD-3	DD-4	DD-5	DD-7	DD-8	DD-10
Slope (%)	30.77	3.00	11.91	4.50	3.33	3.59	3.33
Length (ft.)	130	75	168	628	142	557	70
Manning's No.	0.035	0.035	0.035	0.035	0.035	0.035	0.035
Side Slope (H:V)	1:1	1:1	1:1	1:1	1:1	1:1	1:1
*Bottom Width (ft.)	0	0	0	0	0	0	0
Peak Flow 10/6 (cfs)	0.06	0.32	2.39	2.85	0.21	0.64	2.62**
Peak Flow 10/24 (cfs)	0.20	0.78	5.96	7.88	0.85	2.80	3.06**
Flow Depth (ft.) 10/6	0.14	0.40	0.66	0.84	0.33	0.50	0.86
Flow Depth (ft.) 10/24	0.22	0.56	0.92	1.23	0.57	0.87	0.92
Flow Area (ft^2)10/6	0.02	0.16	0.43	0.71	0.11	0.25	0.75
Flow Area (ft^2)10/24	0.05	0.31	0.85	1.52	0.32	0.76	0.84
Velocity (fps)10/6	3.15	2.00	5.55	4.02	1.87	2.55	3.51
Velocity (fps) 10/24	4.26	2.50	6.97	5.19	2.66	3.68	3.65
Rip-Rap Req'd (Y/N)	N	N	Y	N	N	N	N
Rip-Rap D_{50}	-	-	6"	-	-	-	-

* All ditches are triangular.
** Flows include 1000 gpm (2.23 cfs) Mine Water Flow.
Note: Slope/Lengths from Plate 7-5.

TABLE 7 (Continued)
DISTURBED DITCH DESIGN SUMMARY

Ditch	DD-11	DD-12	DD-13 (MIN.)	DD-13 (MAX.)
Slope (%)	3.00	3.29	1.79	50.00
Length (ft.)	173	50	280	80
Manning's No.	0.035	0.035	0.035	0.035
Side Slope (H:V)	1:1	1:1	1:1	2:1
Bottom Width (ft.)	0	0	0	2
Peak Flow 10/6 (cfs)	0.10	1.55	2.62	2.62
Peak Flow 10/24 (cfs)	0.57	3.58	6.08	6.08
Flow Depth (ft.) 10/6	0.26	0.71	0.97	0.15
Flow Depth (ft.) 10/24	0.50	0.97	1.33	0.24
Flow Area (ft^2) 10/6	0.07	0.50	0.94	0.34
Flow Area (ft^2) 10/24	0.25	0.94	1.77	0.60
Velocity (fps) 10/6	1.50	3.07	2.79	7.66
Velocity (fps) 10/24	2.31	3.79	3.44	10.12
Rip-Rap Req'd (Y/N)	N	N	N	Y
Rip-Rap D_{50}	-	-	-	9"

**All ditches are triangular.*
Note: Slope/Lengths from Plate 7-5.
Note: DD-12 is shortened due to construction of the south portal access ramp/fan pad.

TABLE 8
UNDISTURBED DITCH DESIGN SUMMARY

Ditch	UD-2
Slope (%)	12.5
Length (ft.)	400
Manning's No.	0.035
Side Slope (H:V)	1:1
Bottom Width (ft.)	0
Peak Flow-10/6 (cfs)	0.04
Flow Depth (ft.)	0.14
Flow Area (ft^2)	0.02
Velocity (fps)	2.03
Lined (Y/N)	N
Rip-Rap Req'd (Y/N)	N

Note: Slope/Lengths from Plate 7-5.

TABLE 9
DISTURBED CULVERT DESIGN SUMMARY

Culvert	C-1	C-3	C-4	C-5	C-6	C-7	C-9	C-11	C-11A	C-12	C-13	C-14	C-15	C-16	C-17
Slope (%)	16.67	8.00	25.07	57.14	17.20	3.00	3.50	3.50	1.50	4.50	3.00	1.00	1.00	25.00	20.0 0
Length (ft.)	60	360	69	120	12	80	18	30	60	330	100	40	30	40	60
Manning's No.	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Peak Flow 10/6 (cfs)	0.96	0.21	2.62*	0.10	0.04	0.32	0.11	1.55	1.55	2.85	2.62	0.11	0.06	2.62	2.62
Peak Flow 10/24 (cfs)	3.58	0.85	3.06*	0.57	N/A	0.78	0.20	3.58	3.58	7.36	6.08	0.20	0.11	6.08	6.08
Min. Diam. Req'd (ft.) 10/6	0.42	0.28	0.57	0.14	0.13	0.39	0.25	0.68	0.80	0.82	0.85	0.32	0.25	0.57	0.60
Min. Diam. Req'd (ft.) 10/24	0.69	0.46	0.61	0.28	N/A	0.54	0.32	0.93	1.09	1.16	1.17	0.40	0.32	0.79	0.82
Diam. Installed (ft.)	1.50	2.00	2.00	1.00	1.00	1.00	1.00	1.50	1.50	2.00	2.00	1.00	1.00	1.67	1.50
Velocity (fps) 10/6	6.80	3.53	10.18	6.13	3.11	2.71	2.20	4.27	3.10	5.46	4.59	1.38	1.18	10.17	9.35
Velocity (fps) 10/24	9.44	5.01	10.58	9.47	N/A	3.39	2.56	5.26	3.83	6.92	5.67	1.60	1.38	12.55	11.5 4
Rip-Rap D_{50}	12"	-	12"	6"	-	-	-	-	-	6"	-	-	-	12"	12"

* Includes 1000 gpm (2.23 cfs) Mine Water Flow.
Note: Slope/Lengths from Plate 7-5.
Source: (Haestad Methods, Flowmaster I, Version 3.42)

TABLE 10
UNDISTURBED CULVERT DESIGN SUMMARY

Culvert	**Main Canyon*	*UD-1*	*UD-3*
Slope (%)	*8.00*	*23.33*	*30.00*
Length (ft.)	*1500*	*270*	*50'*
Manning's No.	*0.02*	*0.02*	*0.02*
Peak Flow 100/6 (cfs)	*222.79*	-	-
Peak Flow 10/6 (cfs)	-	*1.91*	*0.23*
Min. Diam. Req'd (ft.)	*3.75*	*0.52*	*0.22*
Diam. Installed (ft.)	*6.00*	*3.50*	*1.00*
Velocity (fps)	*20.14*	*9.16*	*5.93*

** Culvert to be installed under expansion plan.*
All other undisturbed culverts are existing.

Note: Slope/Lengths from Plate 7-5.
Source: (Haestad Methods, Flowmaster I, Version 3.43)

DESIGN OF SEDIMENT CONTROL STRUCTURES

Design Specifications:

Tables:

Figures:

3.1 Design Specification for Expanded Sediment Pond

The sedimentation pond located in Crandall Canyon has been redesigned and reconstructed to control the additional storm runoff from the pad extension and from the undisturbed drainage areas above the pad extension. The "As-Constructed" topography and cross sections of the pond design are shown on Plate 7-3.

The pond has been sized to meet the requirements of R645-301-742.221.33 (DOGM), which stipulates that sedimentation ponds be capable of containing or treating the 10-year 24-hour precipitation event. According to Miller, et al (1973), the 10-year, 24-hour design storm for Crandall Canyon is 2.5 inches. The design storm calculations for the sedimentation pond are presented in Table 4 of this Appendix. These calculations include the proposed pad extension, the additional watersheds above the pad extension, the existing pad and reclaimed areas, and the undisturbed watersheds above the existing pad.

As required by R645-301-742.223, the 25 year-6 hour precipitation event was routed through the sedimentation pond to determine the adequacy of the spillway. Overflow from the pond is discharged to Crandall Creek. Total precipitation from the 25 year-6 hour storm is 1.9 inches (Miller, et al, 1973). The 25 year-6 hour flow is calculated at 9.07 cfs. Based on the calculations, the primary spillway is more than adequate to carry the expected runoff from a 25 year-6 hour event.

3.2 Sediment Yield

The Universal Soil Equation (USLE) was used to estimate sediment yield from all drainage areas contributing to the pond. All soil loss from this area was assumed to be delivered to, and deposited in the sedimentation pond.

Erosion rate (A) in tons-per-acre-per-year is determined using the USLE as follows:

$$A = (R)\ (K)\ (LS)\ (CP)$$

Where the variables R, K, LS, and CP are defined as follows:

Variable "R" is the rainfall factor which can be estimated from $R = 27P^{2.2}$*; where P is the 2-year, 6-hour precipitation value. P for the Crandall Canyon area is estimated at 1.00" based on Figure 5.4, page 315, Barfield, et.al. 1983. Therefore, the estimated value of "R" for this area is* *<u>27.00</u>.*

Variable "K" is the soil erodibility factor. For disturbed areas, the "K" value is taken as 0.06 as determined from soils samples and shown on the soil erodibility chart, Figure 4. K is estimated to be <u>0.15</u> for undisturbed and reclaimed areas, based on soils data and the soil erodibility chart, Figure 5.

Variable "LS" is the length-slope factor. This figure was determined by calculating a weighted average slope length and percentage for the undisturbed, reclaimed and disturbed areas, respectively. The slope length and percentage were then substituted into the following equation to determine the LS Factor:

$$\left(\frac{\pi}{72.6}\right)^m \left(\frac{430\ x^2 + 30\ x + 0.}{6.613}\right)$$

where:			
	π	=	*Field slope length in feet;*
	m	=	*0.5 if S is 5% or greater;*
	x	=	*sin θ;*
	θ	=	*Angle of slope in degrees.*

Variable "CP" is the control practice factor, which can be divided into a cover and practice factor. Values were determined from Appendix 5A, Barfield, et.al., 1983.

Site	*CP Factor*
Disturbed Areas	*1.20*
Reclaimed Areas	*0.100*
Undisturbed Areas	*0.003*

The sediment volume is based on a density of 100 pounds per cubic foot of sediment.

SEDIMENT YIELD CALCULATIONS - USLE

Drainage	*R*	*K*	*Acres*	*Slope Length Feet*	*%*	*LS*	*CP*	*A**	*Yield***
Undisturbed	*27.00*	*0.15*	*42.25*	*1700*	*53*	*79.60*	*0.003*	*00.967*	*0.019*
Reclaimed	*27.00*	*0.15*	*1.22*	*90*	*52*	*17.81*	*0.10*	*07.213*	*0.004*
Disturbed	*27.00*	*0.06*	*8.92*	*350*	*26*	*11.69*	*1.200*	*22.725*	*0.093*

Total Sediment 1 year (ac.ft.) *0.116*

Total Sediment 3 years (ac. ft.). *0.348*

* *A = tons/acre-year*
** *Yield = acre-ft/year*

3.3 Sediment Pond Volume

The volumes shown in Table 11 are from the volumes calculated from the precipitation, runoff and sediment yield for a 10 year-24 hour precipitation event. The volumes were calculated based on the disturbed areas (and contributing undisturbed areas) runoff values, developed using the design parameters described in this section.

The sediment pond has been reconstructed, and the sediment pond volumes on Table 11, Table 12 and Figure 6 all represent the "As-Constructed" pond.

Mine Water

There may be times that the mine water oxidizer must be shut down for repair or cleaning, at which time the mine discharge water will need to bypass the treatment system. In such a case, the water will be directed to temporarily run down the road around the outside of the basin, and into the sediment pond through ditch DD-10 and existing culvert C-4 located below the treatment facility. Assuming the sediment level in the pond is below the approved clean-out level (7769'), and assuming the pond has been previously decanted under approved UPDES discharge criteria, the remaining capacity in the sediment pond is 3.22 ac. ft., as described in Table 12. The required freeboard for a 10 year -24 hour event is 2.452 ac. ft. (2.36 ac. ft. runoff + 0.092 ac. ft. direct precipitation) leaving a usable volume of 0.771 ac. ft. for the purpose of the above bypass. This equates to approximately 251,000 gallons. At an average flow rate of 500 gpm from the mine, the sediment pond could theoretically contain 8.37 hours worth of by-passed mine water in addition to the required 10 year - 24 hour storm event. The maximum amount of by-passed mine water storage would occur at a volume of 1.061 ac. ft. (0.290 acre-feet sediment level plus 0.771 acre-feet of mine water). As shown on Table 12, this volume would occur at elevation of 7773.2.

Expanded Area Pond Requirement
3 Year Sediment Storage

TABLE 11
SEDIMENT POND DESIGN

1. *Use 2.50" for 10 year-24 hour event.*

2. *Runoff Volume (from Table 4, 10 yr/24 hr) =* <u>*2.360 ac. ft.*</u>

3. *Sediment Storage Volume*

   USLE 0.116 ac.ft./yr. x 3 yrs. = <u>*0.348 ac. ft.*</u>

4. *Direct Precipitation into Pond*

   0.441 acres x 2.50" / 12 in./ft. = <u>*0.092 ac. ft.*</u>

5. *Total Required Pond Volume*

   2.360 + 0.348 + 0.092 = <u>*2.800 ac. ft.*</u>

6.* *Peak Flow (25 yr. - 6 hr. event) =* <u>*9.500 cfs*</u>

7. *Pond Design Volume @ Principle Spillway =*
   (See Table 12) <u>*3.513 ac. ft.*</u>

* *Peak Flow values from Table 4.*

TABLE 12
SEDIMENT POND
STAGE / VOLUME DATA

Elev.	Area	Volume	Acc. Volume (ac.ft.)	Remarks
7766	1756.67	.0000	.0000	Bottom of Pond
7767	3706.92	2731.80	0.063	
7768	5119.14	4413.03	0.164	
7769	5857.00	5488.07	0.290	Sediment Cleanout Level
7770	6949.54	6403.32	0.437	Maximum Sediment Level
7771	7806.54	7378.14	0.606	
7772	8894.51	8350.53	0.798	
7773	9905.02	9399.77	1.014	
7773.2	-	-	1.061	Max. Elev. of Mine Water
7774	11055.91	10480.47	1.254	
7775	12153.06	11604.49	1.520	
7776	13120.22	12636.64	1.810	
7777	14084.05	13602.14	2.123	
7778	15043.33	14563.69	2.457	
7779	15984.66	15514.00	2.813	
7780	16934.94	16459.15	3.191	
7780.81	17669.26	14014.70	3.513	Principal Spillway
7781	17868.13	3376.05	3.591	
7781.81	18661.53	15028.20	3.936	Emergency Spillway
7782	18848.42	3430.08	4.012	
7783	19886.14	19367.28	4.457	
7784	21113.55	20499.85	4.927	
7785	22110.39	21611.97	5.423	Top of Embankment

TABLE 13
SEDIMENT POND
STAGE / DISCHARGE DATA

Head (ft.)	Q (cfs) Weir Controlled	Q (cfs) Orfice Controlled	Q (cfs) Pipe Flow Controlled
0.0	-	-	-
0.2	1.69	6.77	17.14
0.4	4.77	9.57	17.32
0.6	8.76	11.72	17.50
0.8	13.49	13.53	17.68
1.0	18.85	15.13	17.86

Note: 1- 25 year-6 hour flow = 9.500 cfs.

2- Flow will be weir controlled at a head of 0.64' over riser inlet.

Weir Controlled

$Q = CLH^{1.5}$; where : $C = 3.0$, L = Circumference of Riser = 6.2832'

Orifice Controlled

$Q = C'a\ (2gH)^{0.5}$; where : $C = 0.6$, a =Area of Riser = 3.1416 ft^2, $g = 32.2\ ft/sec^2$

Pipe Flow Controlled

$$Q = \frac{a\ (2gH')0.5}{(1+Ke+Kb+KcL)^{0.5}}$$; where

a = Area of Pipe = 1.77 ft^2

H' = Head = $H + 9.1$ (At outlet of Riser)

$Ke = 1.0$

$Kb = 0.5$

$Kc = 0.043$

$L = 90'$

3.4 Sediment Pond Summary

a) *The sedimentation pond has been designed to contain the disturbed area (and contributing undisturbed area) runoff from a 10 year-24 hour precipitation event, along with 3 years of sediment storage capacity. Runoff to the pond will be directed by various ditches and culverts as described in the plan.*

b) *The required volume for the sediment pond is calculated at 2.800 acre feet, including 3 years of sediment storage. The existing sediment pond size is 3.513 acre feet (at the principle spillway), which is more than adequate.*

c) *The pond will meet a theoretical detention time of 24 hours. It is equipped with a decant, a culvert principle spillway and an open-channel emergency spillway. Any discharge from the pond will be in accordance with the approved UPDES Permit.*

d) *The pond inlets will be protected from erosion, and the spillway will discharge into the main Crandall Canyon drainage.*

e) *The pond is temporary, and will be removed upon final reclamation of the property.*

f) *The pond expansion will be constructed according to the regulations and under supervision of a Registered, Professional Engineer.*

g) The pond volume has been increased at the request of the Forest Service to provide a greater level of protection for forest resources located down stream from the minesite. The enlarged pond capacity (3.513 acre ft.) is over-designed by nearly 25% to contain the 10 year-24 hour design evert.

Storm Event	*Pond Volume Required*	*Pond Capacity Provided*
10 yr./24 hr.	*2.800 acre ft.*	*125%*

3.5 <u>Alternate Sediment Control Areas (ASCA's)</u>

ASCA-2 (consisting of 0.34 acre) exists at the northwest corner of the site. This area was initially constructed as a substation pad but was never utilized as such. A 12-inch CMP culvert was installed to act as a discharge into UD-1. A silt fence and strawbale dike have been placed to trap the sediment and prevent erosion. (Refer to Plates 7-5)

ASCA-5, ASCA-6, ASCA-7 and ASCA-11 consist of the topsoil stockpiles #1, #2, #3, and #4 respectfully. These stockpiles are located on the north and south side of the access road as shown on Plate 2-3. Disturbed areas associated with the topsoil stockpiles are 0.20 acres, 0.22 acres, 0.62 acres and 0.65 acres for ASCA-5, ASCA-6, ASCA-7, and ASCA-11, respectively. All topsoil stockpiles have been protected from erosion by a combination of dikes, silt-fencing, berms, and a vegetative cover. (Refer to Plate 2-3)

ASCA-9 (0.15 acres) is the outslope of the sediment pond; ASCA-10 (0.02 acres) is the headwall of the inlet of the main by-pass culvert. The drainage from these areas can not be directed to the sediment pond and are too close to the creek to construct separate sediment ponds. Therefore GENWAL has used alternate sediment control methods such as silt fences, straw bale dikes and vegetation. (Refer to Plate 7-5)

Note: ASCA's 1, 3, 4 and 8 have been eliminated through previous permitting actions.

A 0.30 acre water treatment facility is located within WSDD-10. This facility contains a settling basin for treating mine discharge water. The treated water is then piped directly to a UPDES outfall into Crandall Creek. Therefore, surface runoff from this facility does not report to the sediment pond.

DESIGN OF DRAINAGE CONTROL STRUCTURES FOR RECLAMATION

Reclamation Hydrology

4.1 *General (Phase I)*

During Phase I of reclamation, all disturbed area culverts and ditches will be removed except as shown on Plate 5-16. Undisturbed diversion UD-2 will also be removed, and the drainage from that area will be directed to the sediment pond. Undisturbed diversion UD-1 will remain in place as a permanent structure for the following reasons:

(1) The diversion is necessary to continue to divert runoff from the reclaimed site, the U.S. Forest Service turnaround area and beneath the U.S. Forest Service Road;

(2) The 10 year-24 hour storm runoff from WSUD-1 is approximately 2.98 acre feet, which combined with runoff from the reclaimed site, exceeds the holding capacity of the sediment pond;

(3) The existing diversion is a 42" full-round C.M.P. pipe, which is well in excess of the size required to carry runoff from a 100 year-6 hour storm event for the area (See Table 10).

The main canyon 72" culvert will also be removed during Phase I reclamation, except for the lower approximately 300', which will be left in place to divert undisturbed and treated runoff beneath the sediment pond. Once the main canyon culvert is removed, Crandall Creek will be directed back to the original drainage channel through the area. Silt fences will be installed on both sides of the restored channel to treat runoff from the reclaimed pad areas, as shown on Plate 5-16.

The U.S. Forest Service Road will be left as a permanent feature. A berm and ditch (RD-1) will be established along the road. This ditch will direct all runoff from areas above the road to the sediment pond. The sediment pond will remain in place until Phase II of reclamation.

Watersheds are shown on Plates 7-5 and 7-5C. Reclamation drainage details are shown on Plates 5-16 and 5-17.

4.2 General (Phase II)

Once the criteria for Phase II Bond Release are met, the sediment pond will be removed and, the area recontoured and reseeded according to the plan. The remaining 300' of the main canyon 72" culvert will also be removed at this time. At the discretion of the U.S. Forest Service, the berm along the road can also be removed at this time, or left in place. If the berm if left in place, reclaimed ditch RD-1 will be extended through the reclaimed pond area to the main channel.

4.3 Reclamation - Disturbed Drainage Control

Drainage from all contributing watersheds above the U.S. Forest Service Road, except WSUD-1, will be collected in a reclamation ditch (RD-1) and diverted into the sediment pond during Phase I reclamation. Drainage from the reclaimed areas and contributing watersheds below the road, will be treated through silt fences along the restored natural main channel, during Phase I reclamation.

Approximately 300' of the main canyon culvert will remain in place beneath the sediment pond area during Phase I.

Upon Phase II reclamation, the sediment pond will be removed and the area restored. The remaining portion of the main canyon culvert will also be removed at this time. Silt fences along the previously reclaimed channel section may also be removed during Phase II; however, additional silt fences will be installed along the 300' section of culvert removal channel restoration.

4.4 Restored Channels

Upon final reclamation, the main canyon drainage will be returned to the natural channel. During construction, this channel is to be covered by filter fabric and an underdrain system. The culvert will then be placed over the protected channel. Upon removal of the culvert, filter fabric will also be removed, exposing the natural channel. Construction in this manner will have a temporary effect on the riparian vegetation; however, this can readily be restored upon reclamation. Flow characteristics, bedding and other natural features of the natural channel will not be changed appreciably; therefore, no actual channel reconstruction or reclamation (beyond revegetation) is proposed.

No other channels are proposed to be restored within the reclaimed minesite.

4.5 Sediment Pond

The sediment pond will remain in place during Phase I reclamation. The pond will be removed during Phase II and all drainage will be returned to the Main Crandall Canyon channel at that time.

Calculations show the sediment pond to be adequately sized to contain the runoff from contributing watersheds from a 10 year-24 hour precipitation event, along with a minimum of 3 years of sediment storage. The principle and emergency spillways are each capable of passing the runoff from a 25 year-6 hour event, as required.

4.6 Calculations

For ease of calculation and to ensure a conservative runoff requirement for sediment pond adequacy, no curve numbers for contributing watersheds were changed for reclamation purposes. Contributing watershed characteristics and flows were taken from Tables 1 through 4 of this report. Watersheds and pre-reclamation drainage control are shown on Plates 7-5 and 7-5C. Phase I and Phase II drainage control are shown on Plates 5-16 and 5-17, respectively.

TABLE 14

RECLAMATION - PHASE I
RUNOFF SUMMARY
DRAINAGE TO SEDIMENT POND

Watershed	10 year/24 hour Volume-ac.ft.	10 year/ 6 hour Peak Flow-cfs	25 year/6 hour Peak Flow-cfs
WSUD-2	0.05	0.04	0.08
WSUD-3	0.30	0.23	0.43
WSDD-1	0.03	0.05	0.07
WSDD-2	0.01	0.01	0.03
WSDD-3	0.09	0.26	0.37
WSDD-4	0.03	0.11	0.14
WSDD-5	0.07	0.23	0.32
WSDD-7	0.05	0.11	0.16
WSDD-8	0.23	0.41	0.62
WSDD-10	0.13	0.39	0.53
WSDD-11	0.09	0.10	0.18
WSDD-14	0.13	0.39	0.56
Totals	1.21	2.33	3.49

Note: *Volumes and flows are totals from respective watersheds on Tables 3 and 4 of this report.*

TABLE 15

RECLAMATION - PHASE I
RUNOFF CONTROL STRUCTURE
WATERSHED SUMMARY

Structure	*Type*	*Contributing Watersheds*
Main Channel	*Silt Fence*	*WSDD-12, WSDD-13*
UD-1	*Culvert*	*WSUD-1*
RD-1	*Ditch*	*WSUD-2, WSUD-3, WSDD-1 thru WSDD-11*
Sediment Pond	*Pond*	*WSUD-2, WSUD-3, WSDD-1 thru WSDD-11 and WSDD-14*

TABLE 16

RECLAMATION - PHASE I
RUNOFF CONTROL STRUCTURE
FLOW SUMMARY

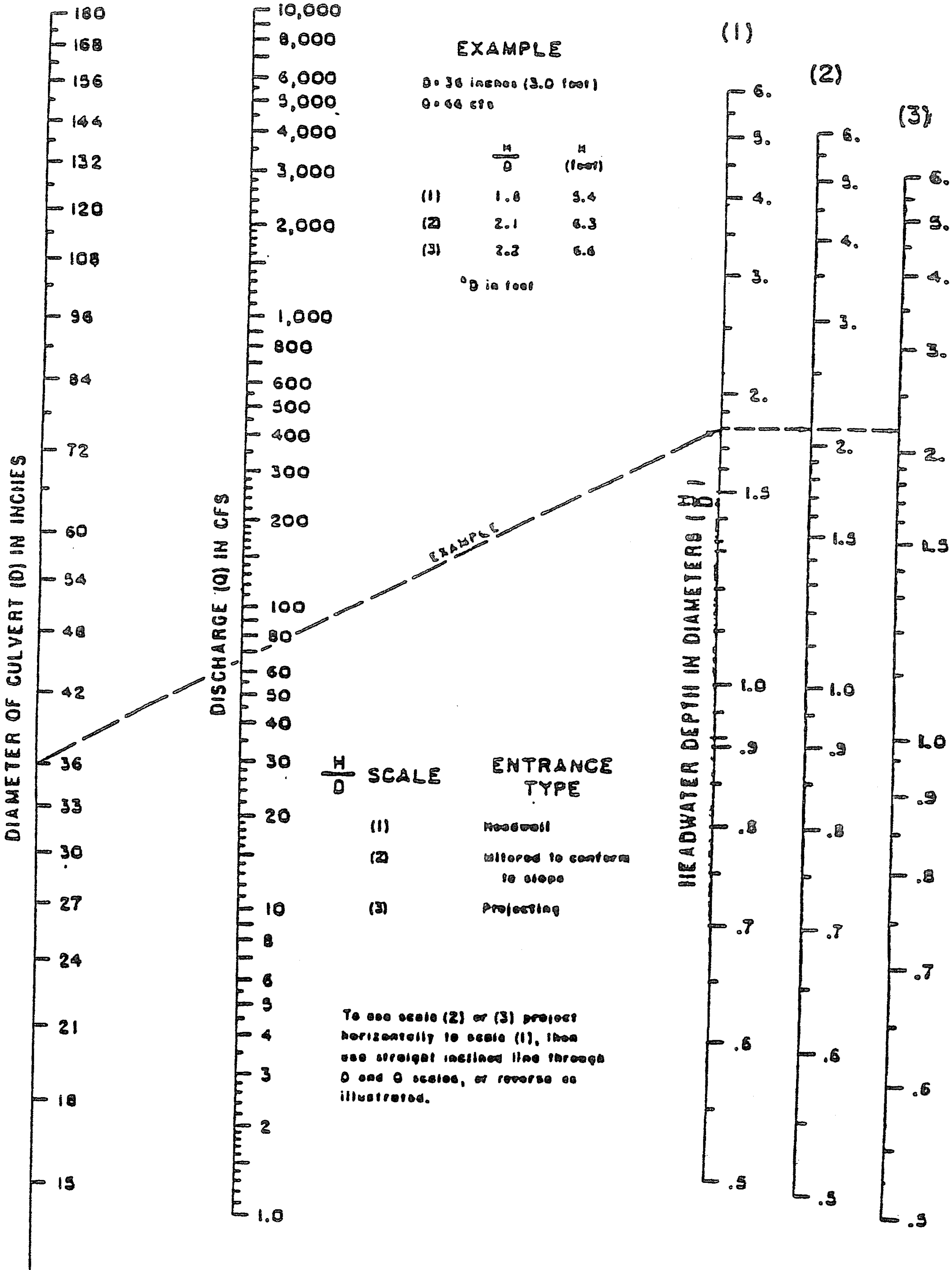
Structure	*Type*	*10 year/6 hour Peak Flow (cfs)*	*25 year/6 hour Peak Flow (cfs)*	*100 year/6 hour Peak Flow (cfs)*
Main Channel	*Silt Fence*	*3.73*	*5.44*	-
UD-1	*Culvert*	*1.91*	*3.68*	*6.81*
RD-1	*Ditch*	*1.94*	*2.93*	-
Sediment Pond	*Pond*	*2.33*	*3.49*	-

TABLE 17

RECLAMATION - PHASE 1
RECLAIMED DITCH/CULVERT DESIGN SUMMARY

Ditch	*RD-1*
Slope (%)	*10.10*
Length (ft.)	*990*
Manning's No.	*0.035*
Side Slope (H:V)	*1.5:1*
Bottom Width (ft.)	*0*
Peak Flow 10/6 (cfs)	*1.94*
Flow Depth (ft.)	*0.52*
Flow Area (ft^2)	*0.40*
Velocity (fps)	*4.85*
Lined (Y/N)	*N*
Rip Rap Req'd (Y/N)	*N*

Note: Slope / Length from Plate 5-16

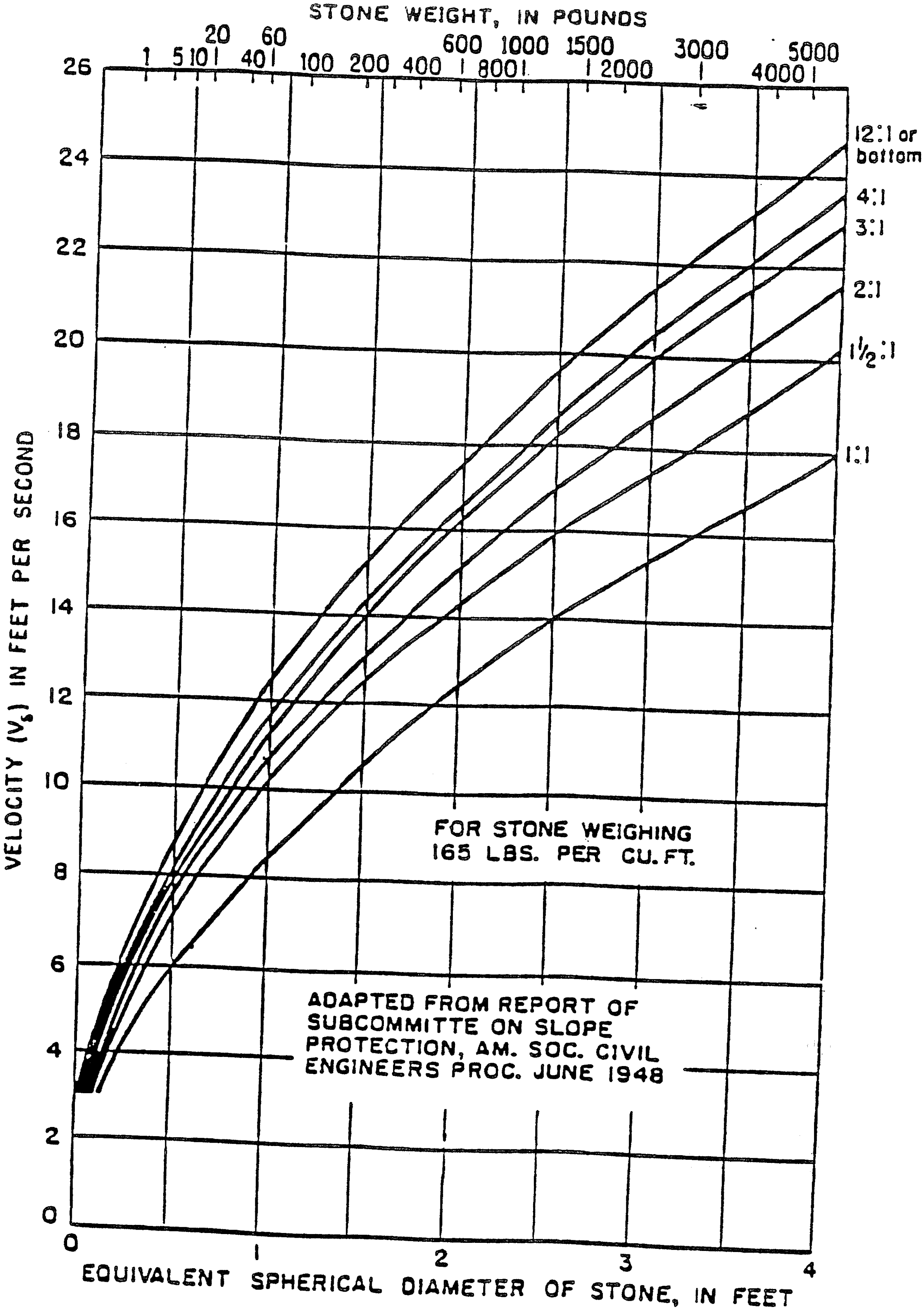


Culvert Nomograph

Headwater depth for corrugated-metal pipe culverts with entrance control. (U.S. Bureau of Public Roads) 288-D-2909.

FIGURE 1

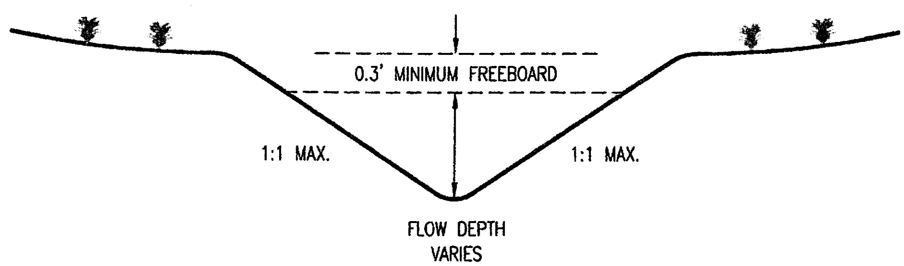
RIP-RAP CHART



SIZE OF STONE THAT WILL RESIST DISPLACEMENT FOR VARIOUS VELOCITIES AND SIDE SLOPES

FIGURE 2

UNDISTURBED AND DISTURBED DITCH TYPICAL SECTION



DITCH SIZING					
10 YEAR 6 HOUR STORM			* 10 YEAR 24 HOUR STORM		
DITCH	FLOW DEPTH	FLOW AREA	DITCH	FLOW DEPTH	FLOW AREA
UD–2	0.14	0.02	UD–2	–	–
DD–1	0.14	0.02	DD–1	0.22	0.05
DD–3	0.40	0.16	DD–3	0.56	0.31
DD–4	0.66	0.43	DD–4	0.92	0.85
DD–5	0.84	0.71	DD–5	1.23	1.52
DD–7	0.33	0.11	DD–7	0.57	0.32
DD–8	0.50	0.25	DD–8	0.87	0.76
DD–10	0.86	0.75	DD–10	0.92	0.84
DD–11	0.26	0.07	DD–11	0.50	0.25
DD–12	0.71	0.50	DD–12	0.97	0.94
DD–13	0.56	0.32	DD–13	0.77	0.59

NOTE:

DITCH CONFIGURATIONS MAY VARY IN FIELD; HOWEVER, MINIMUM FLOW DEPTHS AND AREAS WILL BE MAINTAINED.

* FOR REFERENCE ONLY.

FIGURE 3

FIGURE 4

SOIL ERODIBILITY CHART

(DISTURBED AREAS)

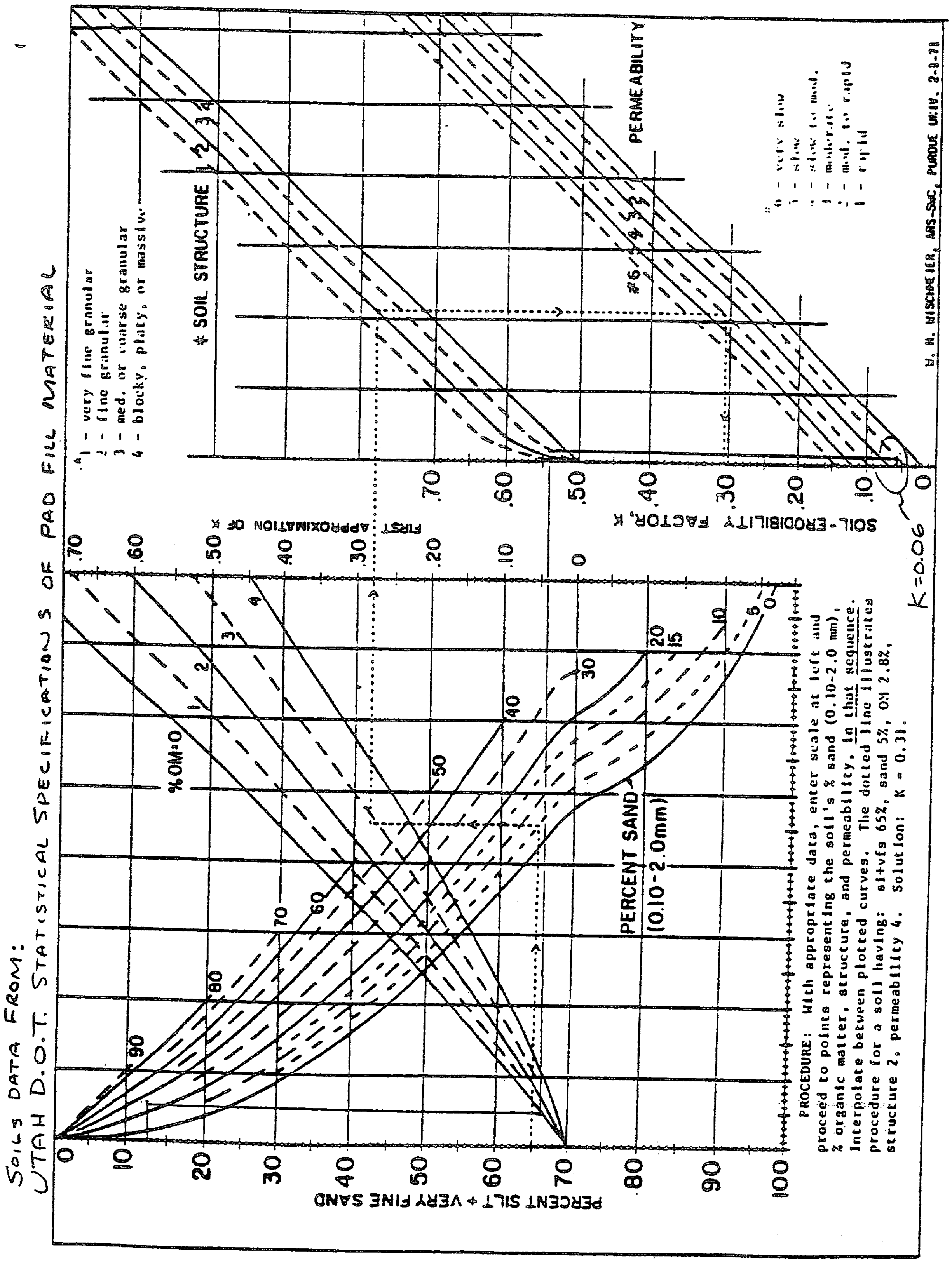
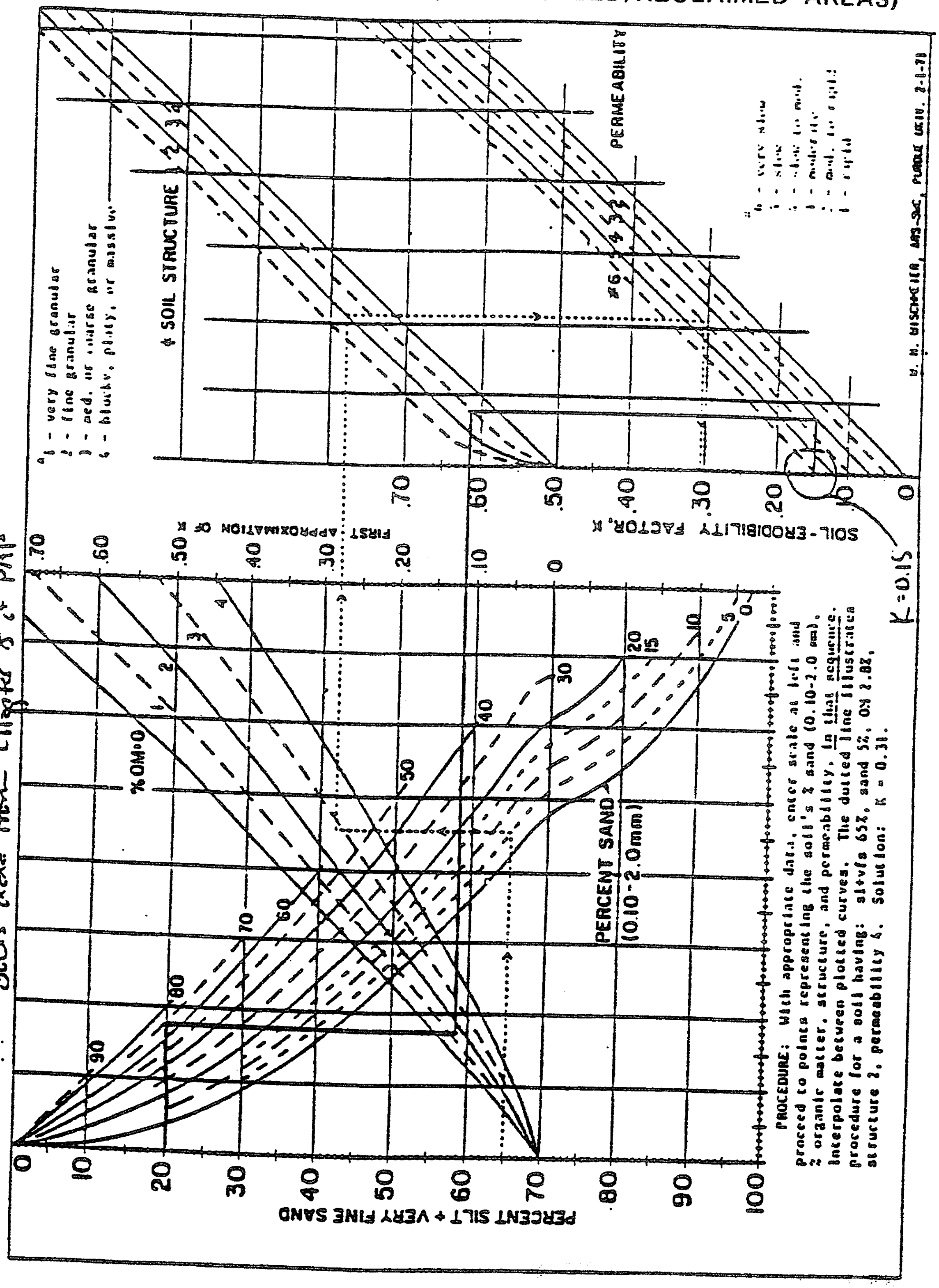


FIGURE 5

SOIL ERODIBILITY CHART (UNDISTURBED/RECLAIMED AREAS)



STAGE-VOLUME

GENWAL SEDIMENT POND (As-Constructed)

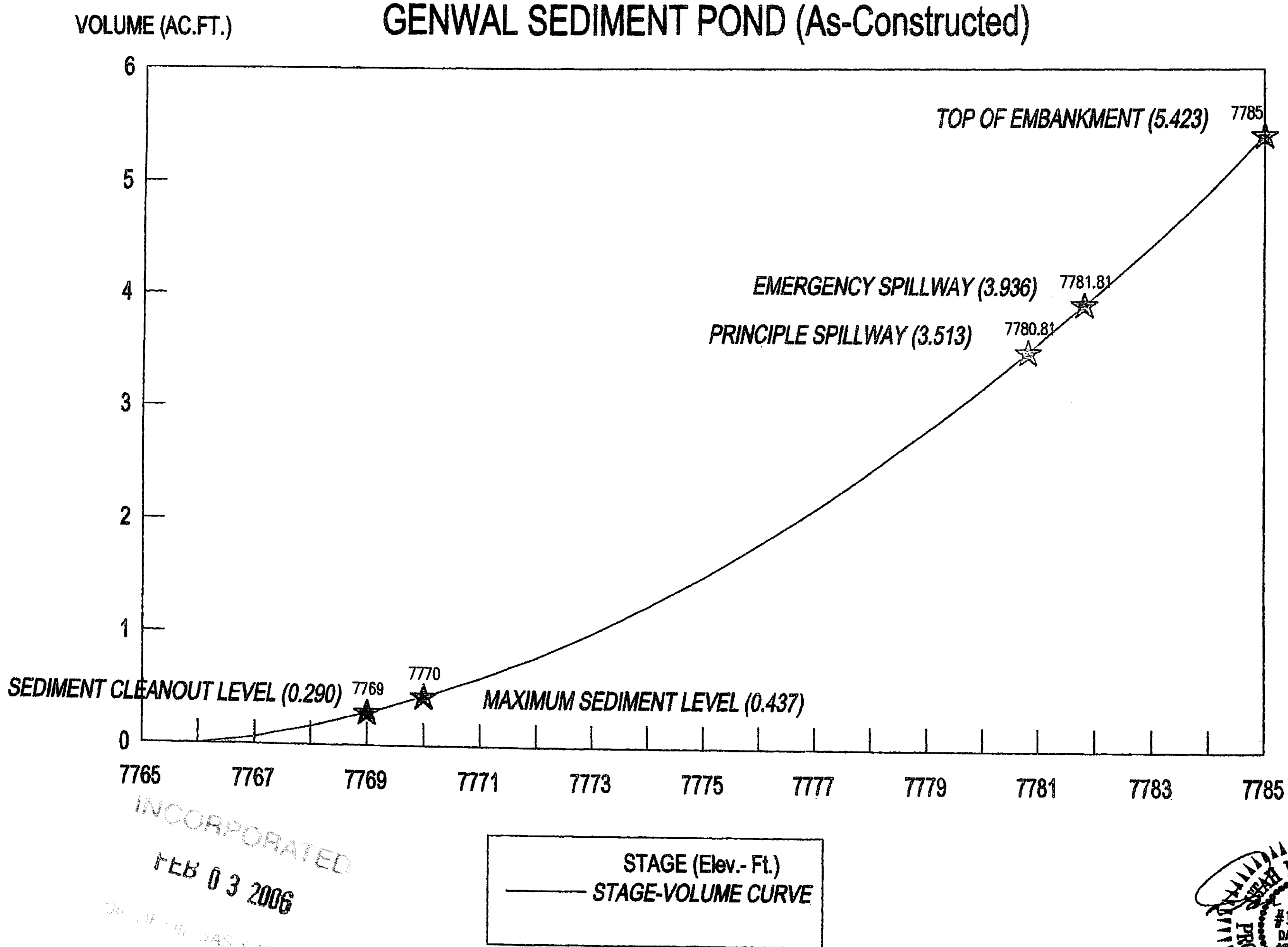


FIGURE 6

UTAH REGISTERED PROFESSIONAL ENGINEER #154168 DAN W. GUY 12/12/05

SEDIMENT POND
STAGE-DISCHARGE CURVE

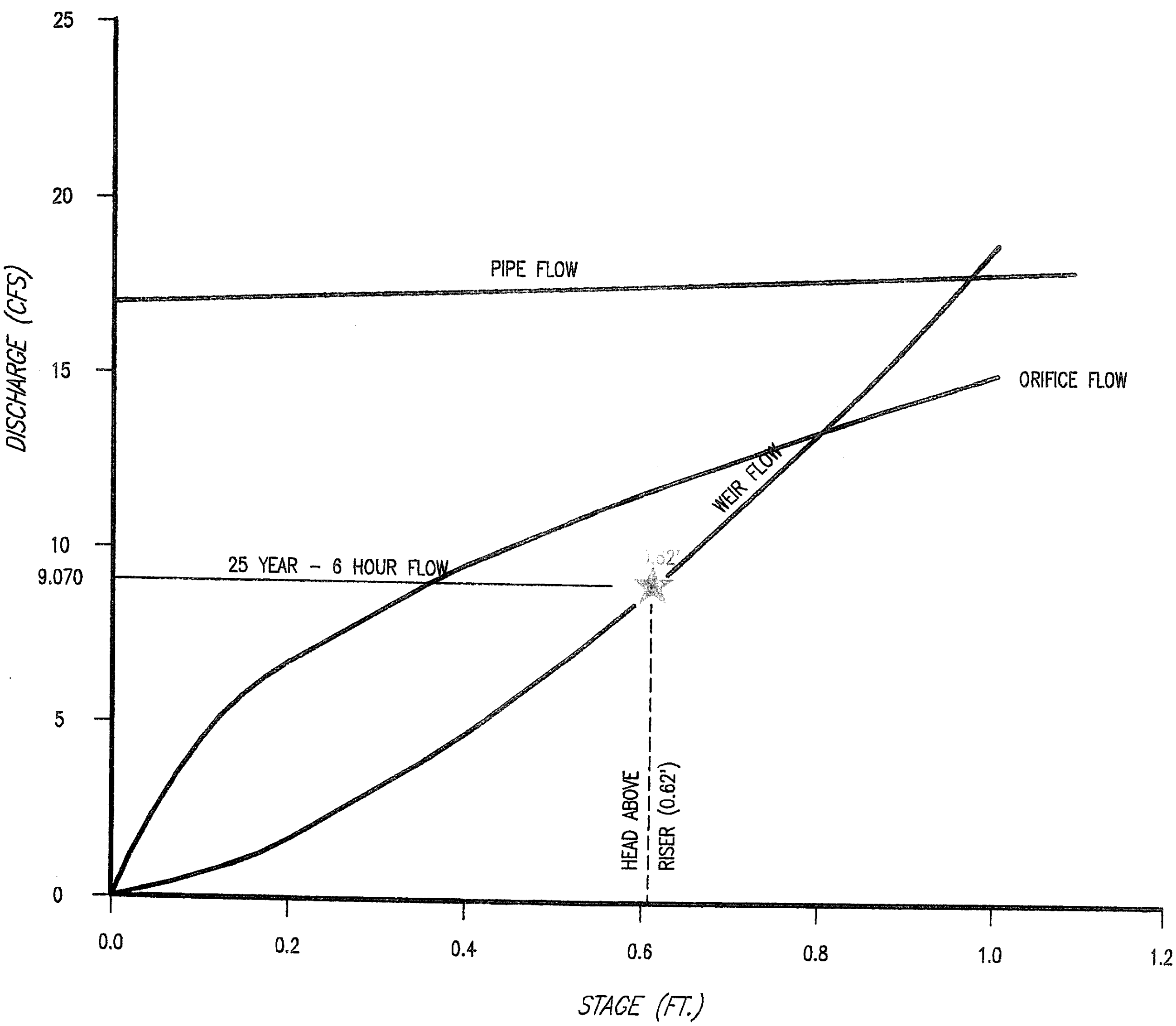
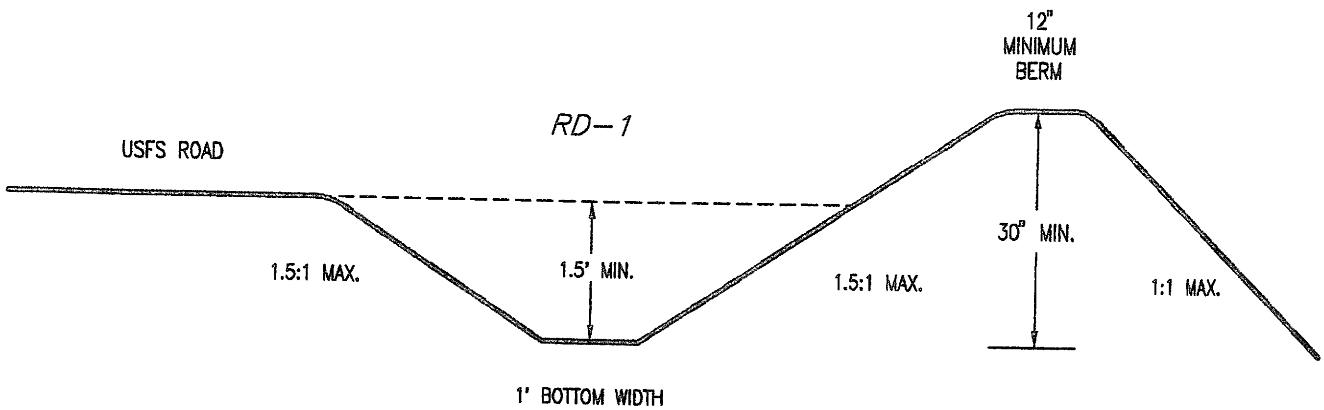


FIGURE 7

RECLAMATION DITCH RD-1
TYPICAL SECTION



DITCH SIZING		
DITCH	FLOW DEPTH	FLOW AREA
RD-1	0.52	0.40

NOTE:

DITCH CONFIGURATIONS MAY VARY IN FIELD; HOWEVER, MINIMUM FLOW DEPTHS AND AREAS WILL BE MAINTAINED.

FIGURE 8

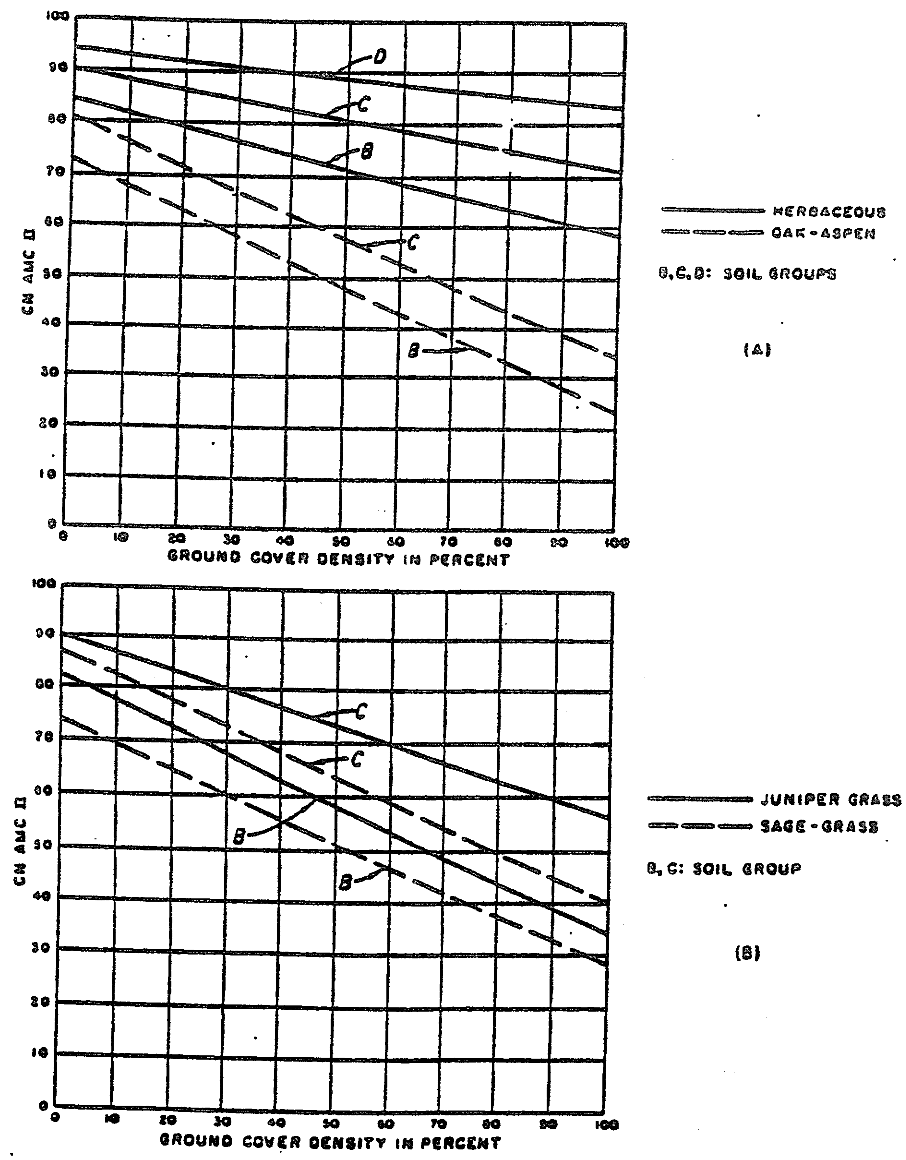


Figure 7-3. Runoff curve numbers for forest-range in the western U.S. (from U.S. Bureau of Reclamation, 1977).

FIGURE 9

MAIN CULVERT INLET AND TRASH BARRIERS

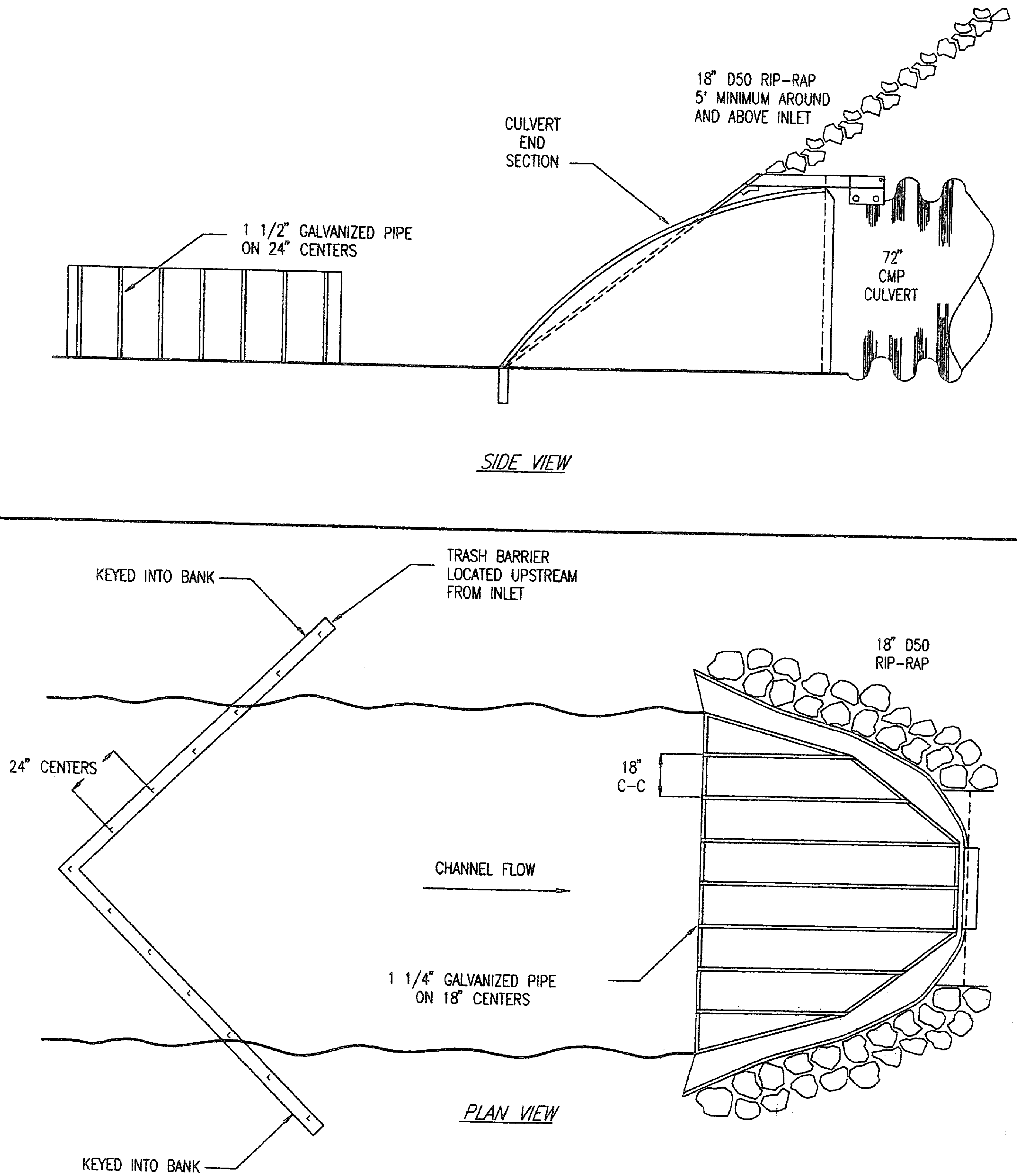
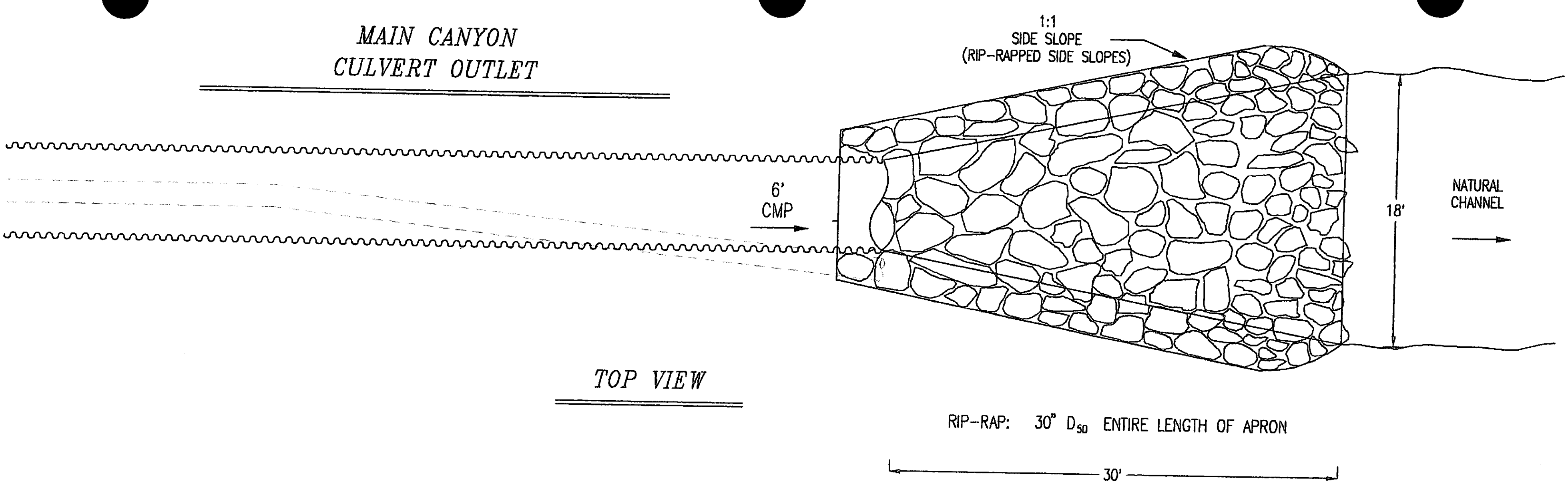
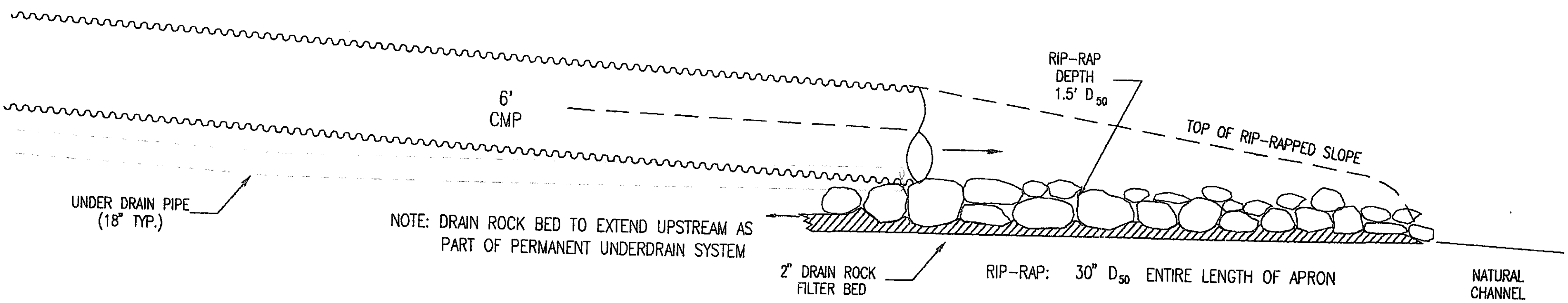


FIGURE 10

MAIN CANYON CULVERT OUTLET



TOP VIEW



SECTION VIEW

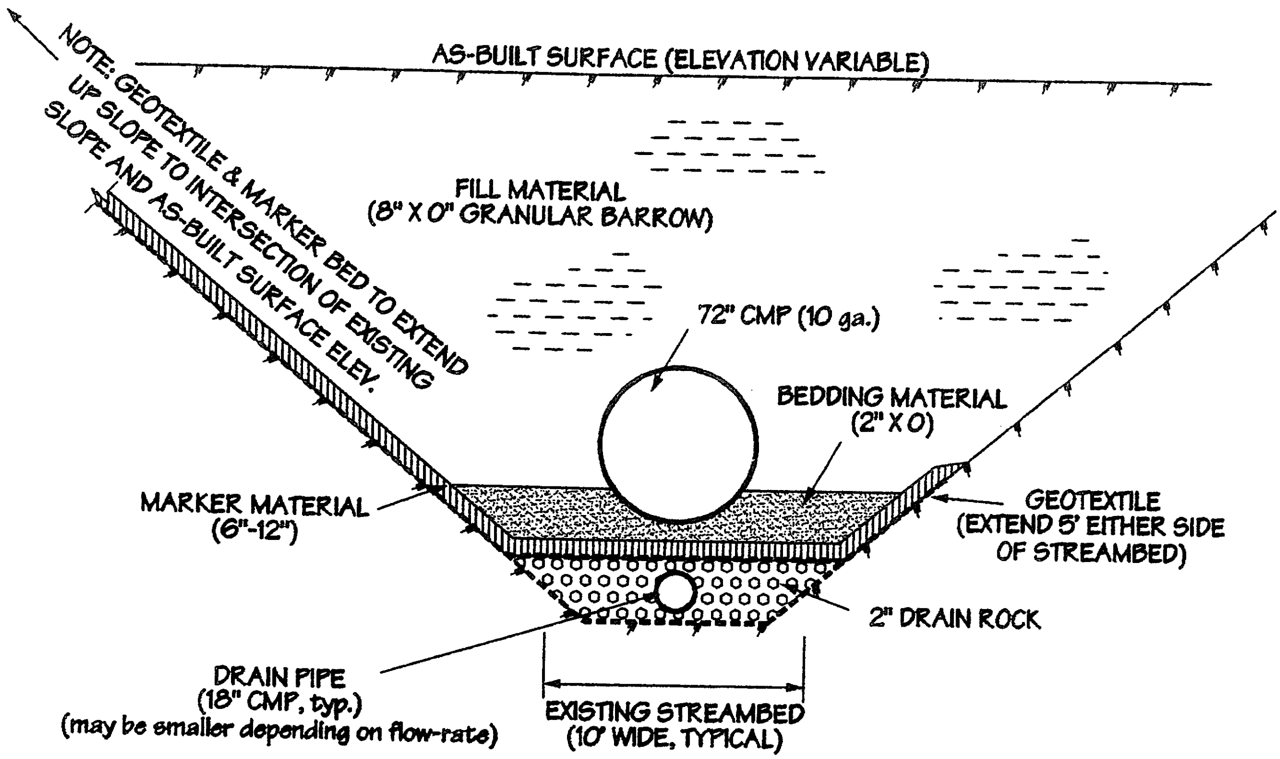
* DESIGN BASED ON FIGURE 7–26, DESIGN OF OUTLET PROTECTION – MAXIMUM TAILWATER CONDITION, "APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS", BARFIELD, WARNER & HAAN, 1983.

FIGURE 11

SCALE: 1" = 10'

ACAD REF: FIGURE11A

TYPICAL UNDERDRAIN CONSTRUCTION



SCALE: 1" = 15'

Note: Culvert installation will generally follow the existing stream alignment, but may vary slightly to accommodate accepted engineering and installation standards.

FIGURE 12

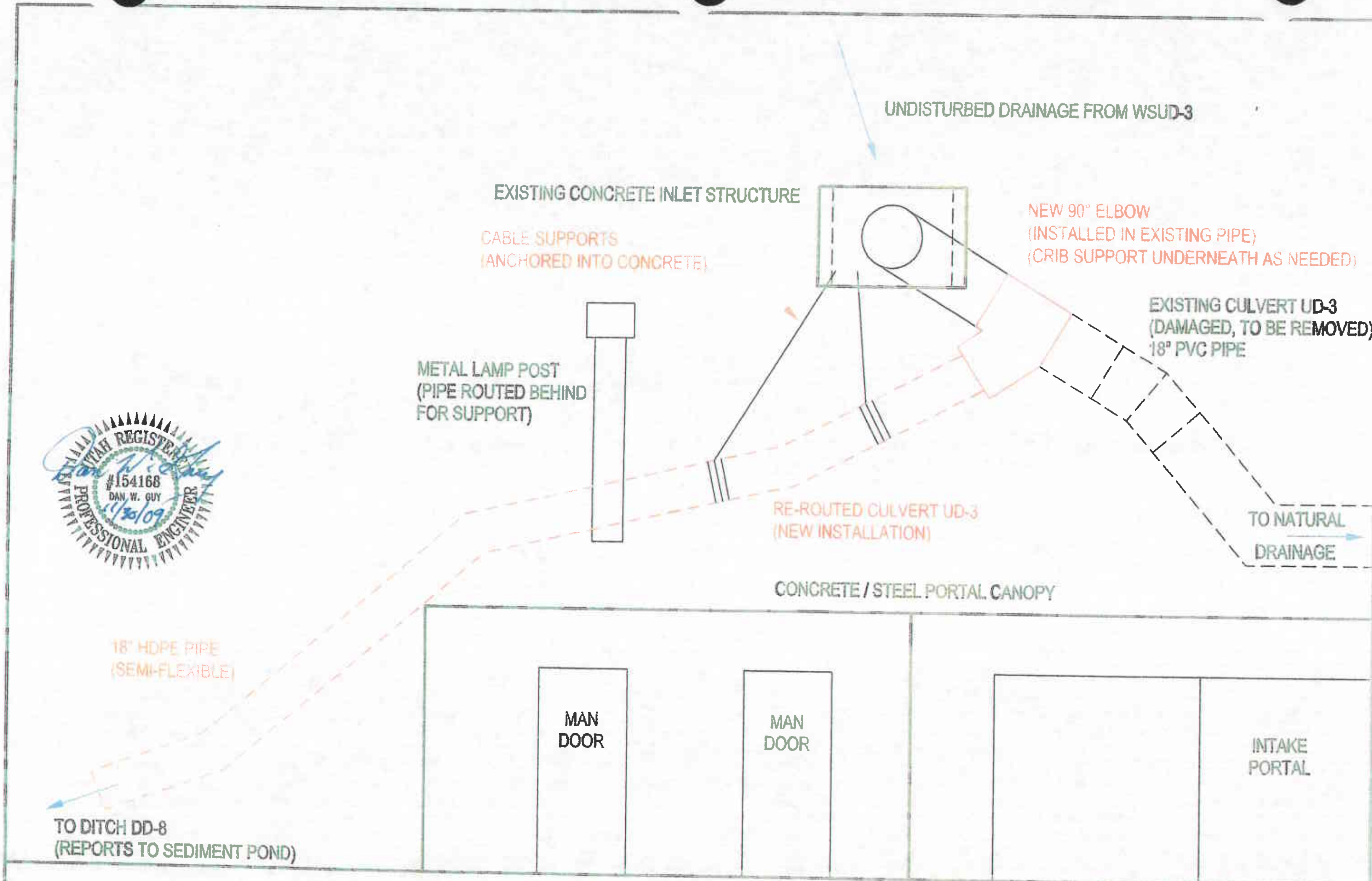


FIGURE 13A
INSTALLATION OF RE-ROUTED CULVERT UD-3
FRONT VIEW

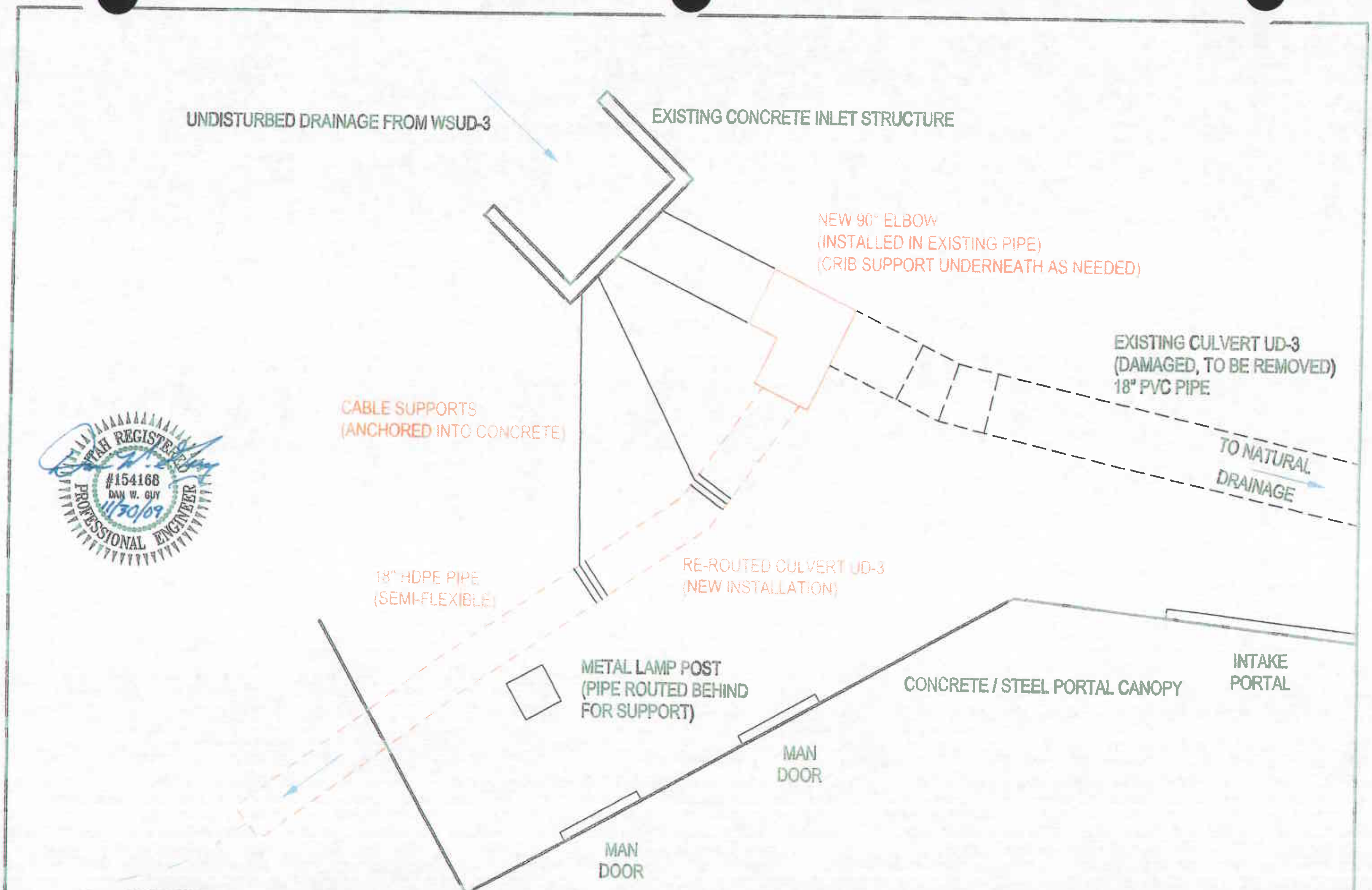


FIGURE 13B
INSTALLATION OF RE-ROUTED CULVERT UD-3
SIDE VIEW

DITCH FLOW CALCULATIONS

```
Title of run: DITCH DD-5 (10/6)
   Solving for...............= Depth Normal
Triangle
   Flow depth (ft)............=     0.84
   First Side slope...........=      1.0
   Second Side slope..........=      1.0
   Slope of diversion.........=   0.0450
   Manning"s n................=    0.035
   CFS........................=     2.85
   Cross section area (sqft)..=     0.71
   Hydrualic radius...........=     0.30
   fps........................=     4.02
   Froude number..............=     1.30
```

```
Title of run: DITCH DD-5 (10/24)
  Solving for..................= Depth Normal
Triangle
  Flow depth (ft)..............=    1.23
  First Side slope.............=    1.0
  Second Side slope............=    1.0
  Slope of diversion...........=  0.0450
  Manning"s n..................=   0.035
  CFS..........................=    7.88
  Cross section area (sqft)..=      1.52
  Hydrualic radius.............=    0.44
  fps..........................=    5.19
  Froude number................=    1.39
```

Title of run: DD-8 (10/6)

Solving for................= Depth Normal

Triangle

Flow depth (ft)	.............=	0.50
First Side slope	...........=	1.0
Second Side slope	..........=	1.0
Slope of diversion	.........=	0.0359
Manning"s n	...............=	0.035
CFS	.......................=	0.64
Cross section area (sqft)	..=	0.25
Hydrualic radius	...........=	0.18
fps	.......................=	2.55
Froude number	..............=	1.07

```
Title of run: DD-8 (10/24)
   Solving for.................= Depth Normal
Triangle
   Flow depth (ft).............=    0.87
   First Side slope............=     1.0
   Second Side slope...........=     1.0
   Slope of diversion..........=  0.0359
   Manning"s n.................=   0.035
   CFS.........................=    2.80
   Cross section area (sqft)...=    0.76
   Hydrualic radius............=    0.31
   fps.........................=    3.68
   Froude number...............=    1.17
```

CULVERT FLOW CALCULATIONS

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: UNDISTURBED CULVERT UD-3 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.............	0.3000 ft/ft
Manning's n.......	0.020
Discharge.........	0.23 cfs

Computed Results:

Full Flow Diameter.....	0.22 ft
Full Flow Depth........	0.22 ft
Velocity..........	5.93 fps
Flow Area.........	0.04 sf
Critical Depth....	0.22 ft
Critical Slope....	0.2806 ft/ft
Percent Full......	100.00 %
Full Capacity.....	0.23 cfs
QMAX @.94D........	0.25 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: CULVERT C-1 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.............	0.1667 ft/ft
Manning's n.......	0.020
Discharge.........	0.96 cfs

Computed Results:

Full Flow Diameter.....	0.42 ft
Full Flow Depth........	0.42 ft
Velocity..........	6.80 fps
Flow Area.........	0.14 sf
Critical Depth....	0.42 ft
Critical Slope....	0.1518 ft/ft
Percent Full......	100.00 %
Full Capacity.....	0.96 cfs
QMAX @.94D........	1.03 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: CULVERT C-1 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.............	0.1667 ft/ft
Manning's n.......	0.020
Discharge.........	3.58 cfs

Computed Results:

Full Flow Diameter.....	0.69 ft
Full Flow Depth........	0.69 ft
Velocity..........	9.44 fps
Flow Area.........	0.38 sf
Critical Depth....	0.69 ft
Critical Slope....	0.1537 ft/ft
Percent Full......	100.00 %
Full Capacity.....	3.58 cfs
QMAX @.94D........	3.85 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: CULVERT C-12 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.............	0.0450 ft/ft
Manning's n.......	0.020
Discharge.........	2.85 cfs

Computed Results:

Full Flow Diameter.....	0.82 ft
Full Flow Depth........	0.82 ft
Velocity..........	5.46 fps
Flow Area.........	0.52 sf
Critical Depth....	0.74 ft
Critical Slope....	0.0395 ft/ft
Percent Full......	100.00 %
Full Capacity.....	2.85 cfs
QMAX @.94D........	3.07 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: CULVERT C-12 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.............	0.0450 ft/ft
Manning's n.......	0.020
Discharge.........	7.36 cfs

Computed Results:

Full Flow Diameter.....	1.16 ft
Full Flow Depth........	1.16 ft
Velocity..........	6.92 fps
Flow Area.........	1.06 sf
Critical Depth....	1.07 ft
Critical Slope....	0.0391 ft/ft
Percent Full......	100.00 %
Full Capacity.....	7.36 cfs
QMAX @.94D........	7.92 cfs
Froude Number.....	FULL

APPENDIX 7-65

MINE DISCHARGE WATER
IRON TREATMENT FACILITY

APPENDIX 7-65

CRANDALL CANYON MINE

MINE DISCHARGE WATER IRON TREATMENT FACILITY

Discussion	
Attachment 1	Maelstrom Oxidizer Unit
Attachment 2	Iron Treatment Bench Test Results, and Settling Basin Volume Determination
Attachment 3	Pit Liner Information
Attachment 4	Wildcat Sediment Pond C Volume Determination
Attachment 5	Settling Basin Clean-up Volume Estimatation
Attachment 6	Drainage Information
Attachment 7	Safety Factor Determination
Attachment 8	Construction Specifications and Drawings

DISCUSSION

BACKGROUND

As a result of the Crandall Canyon Mine disaster of August 6, 2007, the mine has been de-activated and the portals have been sealed. Mine water inflow has built up to the extent that water is now discharging from the portals and is discharged through a 12" pipe into Crandall Creek under UPDES permit UT0024368. The mine is presently discharging approximately 500 gallons per minute, with the flow fluctuating with barometric pressure and seasons. In early 2009 the iron concentrations in the water began to exceed UPDES limits. By the summer of 2009, Crandall Creek below the mine began to display an orange discoloration from the iron staining, resulting in violations from both DOGM and Division of Water Quality. Because there is no way to treat the water underground the company has constructed an aeration treatment system located on the surface in the "old loadout" area, immediately below the portal bench. In concept, the facility consists of two basic components; 1) an aeration devise which allows atmospheric oxygen to chemically react with the dissolved iron in the water, thereby creating iron particulates, and 2) a settling basin which allows the iron particulates to settle out of the water. (See Attachment 8 for the construction specifications and engineering drawings for the facility.)

CONSTRUCTION

A new 12" HDPE pipeline has been tapped into the existing discharge line from the mine near the upper portals and extends to the new facility. It is equipped with shutoff valves, which allows the flow of mine water to be routed down to the treatment facility, or bypassed directly to the existing UPDES outfall. This line is supported by cables attached to bolts drilled into the ledgerock and epoxied in place.

The settling basin is contained on three sides by an earthen berm constructed from a structural granular borrow material. The berm was constructed in 8" lifts and compacted to 90% density using vibratory sheeps-foot mechanical compacting equipment, and the embankments do not exceed 2.5H/1V sideslopes. As shown in Attachment 7, the berm has been designed and constructed to achieve a 1.3 safety factor. Attachment 7 also includes geotechnical information about the granular borrow material used for construction of the berm. The settling basin and berm are constructed in the area previously referred to as the "Old Loadout Area". To make room for this old loadout, a large enclave was blasted out of the solid ledgerock in the past. This blasted rock was then used as fill material to extend the loadout area, and to construct the adjacent Forest Service road. This area was originally compacted for construction purposes, but was also compacted even more through many years of loading operations involving loaded trucks and front-end loaders operating on the site. Prior to constructing the settling basin berm all loose material was removed from the site, revealing the underlying compacted rock subsurface. Therefore, the foundational material for the berm and basin is either the solid sandstone bedrock from the original ledge, or else the highly compacted rock material located next to it. Refer to

Figure 1 of Attachment 8, which shows the extent of the solid bedrock underlying the basin and berm. It should also be noted that the inner portion of the basin containment is constructed from a pre-existing concrete wall. This wall is a massive 12" thick, reinforced concrete structure which was part of the original "old loadout" system.

The berm is ringed on top with a double row of concrete Jersey barriers placed side-by-side with the intervening space filled with earthen material for added stability. The remaining side of the basin is constructed from the 12" thick pre-existing concrete wall mentioned above. The Jersey barriers on the earth berm, along with the existing concrete wall left over from the old loadout, define the limits of the settling basin. The barriers also provide public safety by keeping vehicular traffic, foot traffic and animals from entering the basin area.

The interior of the basin is lined with a pit liner similar to that used for containing drilling fluids in drilling operations. (See Attachment 3 for additional information on the liner material.) The pit liner is secured around the perimeter by tucking it into the space between the barrier walls and backfilling with earth material. A felt underlining was also placed down before (below) the pit liner to provide protection against damage. A chain link fence is installed around the basin atop the barriers to provide additional public security.

The outslopes of the berm have been covered with a layer of gravel to help prevent erosion and maintain stability. Also, the outer toe of the berm located adjacent to the Forest Service road has been armored with concrete jersey barriers sufficient to prevent potential erosion from surface runoff along the road.

Prior to constructing the berm and placing the pit-liner, an underdrain system was installed in the area of the basin. This underdrain system consists of cleaned drain rock and perforated drainpipe placed in a trench running along the upper toe of the berm at the lower (down-dip) end of the basin. The drain is then routed in a buried 4" pipe to the main discharge line. This underdrain system is designed to carry any water, possibly coming from pin-hole leaks in the pit liner, directly out from the basin so that it cannot saturate any portion of the berm. The pit liner is fabricated and fused as a single piece and is not expected to leak, but the underdrain system was installed as a measure of added insurance. As mentioned previously, the berm has been constructed on the site of the old loadout which was constructed on both solid rock blasted out of the ledge, and on previously compacted structural fill material.

OPERATION

The treatment facility consists of a manufactured mechanical aeration device known as the "Maelstrom Oxidizer Unit". (See Attachment 1 for additional information regarding this unit.) This oxidizer unit consists of a pre-fabricated high-density plastic structure equipped with a series of baffles and a 20 hp blower. The mine water is fed into one end of the unit where it then travels a serpentine route over and under the baffles, and at the same time, a large volume of air is forced through the water by way of a number of nozzles located in the bottom of the unit. The unit has been sized according to the anticipated flow rate, such that the dissolved oxygen in the water as it exits from the unit is nearly 100%. The high oxygen content then reacts chemically to change the dissolved iron from the ferrous state to the ferric state, which forms iron precipitates which can then be settled out. Samples of the Crandall mine water were sent to the factory for bench testing and the results were very encouraging, showing treated water well within UPDES compliance levels. (Results of the bench test are included in Attachment 2.)

While the bench testing indicates that the iron should settle in 5.5 hours sufficient to meet UPDES compliance levels, the option remains open to treat the water with chemical flocculants as well if needed to enhance the settling rate. Previous bench tests conducted by Nalco Chemical showed that particle settling rates can be greatly accelerated through the application of a small amount of chemical additives. Electric power has been installed to the unit which could be utilized in the future for a chemical pumping/injection system. However, a simpler and perhaps more dependable system would involve the use of chemical gel-logs. These logs are designed to be immersed in to stream flow after aeration and dissolve at a predetermined rate in order to add the proper amount of chemical flocculant to the discharge water ahead of the settling basin. Typically, such gel-log applications can operate for several weeks without requiring attendance. The oxidizer unit has been constructed such that if, in the future, iron levels in the mine-water increase sufficiently to the extent that chemical treatment is required in addition to the oxidization, either a chemical injection system or gel-log chamber can easily be fitted to the unit.

The treated water from the oxidizer unit is then sent to a settling basin. This basin is constructed within a compacted earthen berm. Iron precipitates generated in the oxidizer unit will drop out of suspension and accumulate in the settling basin. The basin has been designed with nearly twice the volume (i.e., retention time) recommended from the bench testing in order to maximize the potential for meeting UPDES compliance level (see Attachment 2 for details). The treated water exits the basin through a spillway, dropping into an inlet structure to a discharge pipe which is buried under the road and connects to the existing discharge line leading to the designated UPDES outfall point. A flow meter has also been installed in the line. The UPDES water samples are taken at the outlet of the basin prior to entering the pipe leading to the outfall. This is similar to the manner and location in which the UPDES monitoring was previously conducted, and is agreeable to Division of Water Quality.

CLEAN-OUT

Precipitated iron will be allowed to settle and accumulate in the settling basin. Because of the newness of this type of facility it is not known at this time the exact nature of the iron precipitate material that is expected to accumulate in the settling basin as a result of the oxidizer treatment. It is assumed that the accumulations will be visible as they begin to settle out in the bottom of the basin, because the water is generally clear and inherently devoid of suspended solids. Also regular sampling of the water at the approved UPDES outfall will provide a good indication that the settling mechanism is functioning properly. By utilizing both visual observations and sampling results it should become apparent when the basin is ready to be cleaned. Since the rate of accumulations is expected to be consistent (unlike a sediment pond that fills up in response to often violent precipitation events), the cleaning process can be anticipated well in advance. Also, due to the slow rate of accumulation, the accumulation level should be easy to monitor. A series of floating booms will be strung across the basin to slow down and spread out the flow of water through the basin, in order to maximize retention time and to help direct the pattern of material accumulation within the bottom of the basin.

As indicated by the calculations appearing in Attachment 5, the basin should be capable of holding several years of accumulation before cleaning is required. However, in order to be safe, the company commits to cleaning the basin when accumulations have reached the 7812' level, which would be about 3' deep at the deepest part of the basin. As explained in Attachment 5, this still leaves ample pond volume above the accumulation level to achieve the 5.5 hour settling time recommended by the bench testing. Several staff gauges (sediment markers) will be installed in the deepest areas of the basin to serve as a visual aid in determining when the basin should be cleaned. Because the iron staining may render the tick marks of the staff gauges illegible, additional markers will be also be installed beside the gauges whose top is cut off at the 7812' elevation in order to make visual observations of the accumulation level easier. The company proposes to use the accumulation level of 7812' for the initial cleaning. However, based on operational experience, this level may be changed to reflect actual (versus hypothetical) accumulation rates, refinements in clean-out techniques, topographic and spatial patterns of accumulations within the basin, and other operational dynamics.

After the accumulated material has reached the 7812' level (which is 4' below the surface level), the clean-out will begin. Without prior operational experience it is difficult at this time to predict the exact nature of the precipitated iron accumulation material that will have to be cleaned out of the bottom of the basin. However, based on input from Division staff, literature on treatment systems for mining sites suggest that solids content in the accumulation material is about 5%. This consistency of material would allow removal by vacuum methods. Vacuum tanker trucks will be positioned along the road next to the basin in preparation for clean-up. The semi-flexible 4" suction inlet line will be lowered into the deepest part of the basin, which is located at the lower (outlet) end of the facility, where iron accumulations are expected to be deepest, and the material will be sucked up into the waiting trucks. Care will be taken during the clean-out process to minimize stirring up the accumulations so that suspended iron particles do not begin to flow out of the pond. During the clean-out process, excelsior logs or other suitable sediment control (filtration) devises will be installed at the basin outlet spillway to help trap any iron material stirred up. Visual observations and sampling of the water will be made at the spillway (i.e., UPDES monitoring point) to make certain that stirred up iron material is not exiting the basin. If needed, cleaning operations will be delayed until sufficient time is allowed to re-settle any stirred up material. Experience will help refine the cleaning technique. For example, it may be determined that using a perforated suction line that allows multiple access points for material entry along the length of the pipe is more effective than a single entry point. It may also be determined that several cleanup suction lines can be left permanently in place at designated locations within the basin to make future clean-out efforts quicker and easier. Experience will tell.

Prior to cleaning operation a sample of the iron material will be taken an analyzed for RCRA hazardous constituents. If the RCRA analysis shows the material to be hazardous, it will be disposed of at an approved, licensed hazardous waste diposal facility. However, if the results of this RCRA analysis showsthe material to be non-hazardous, the iron precipitate material from the basin clean-out will be hauled to the company-owned Wildcat Loadout where it will be disposed of in Sediment Pond C. There it can dry out and remain in-place until buried at final reclamation, or if the volume is excessive, it can be scooped out and moved to the approved refuse disposal pile located at the loadout. Under the currently approved Mining and Reclamation Plan for the Wildcat Loadout (C/007/033), this refuse pile will be buried under at least 4' of earthen material upon final reclamation. (As shown in Attachment 4, Sediment Pond C is a very large pond with ample capacity to contain more than 2.5 acre-ft (108,900 cu. ft.) of material and still have sufficient volume to contain a 10-year/24-hour precipitation event. This is far more volume than is expected to be needed to accommodate the iron clean-out material, as explained in Attachment 5. However, under no circumstance will the pond level be allowed to exceed the 10-year/24-hour design capacity level. Additional information about Wildcat Sediment Pond C and the refuse disposal pile can be found in Mining & Reclamation Plan C/007/033 on file with the Division.

Prior to initiating any cleaning of the basin, the company will provide a minimum of 24-hour notice to the Division.

MAINTENANCE

There may be times during required maintenance that the oxidizer must be shut down for repair or cleaning, at which time the mine discharge water will need to bypass the treatment system. By opening the by-pass valve located ahead of the oxidizer unit, the water will be directed into a flexible 8" discharge hose which will route the water around the settling basin and into the main sediment pond through the existing disturbed ditch DD-10 and culvert C-4 located immediately below the treatment facility. Information included in the back of Attachment 6 shows that an 8" hose can carry nearly 1300 gpm, which is adequate for bypassing the normal flow from the mine discharge. Disturbed ditch DD-10 and culvert C-4 are both sized to adequately handle the maximum anticipated bypass flow of about 1000 gpm in addition to the potential flow from a 10-year, 24-hour precipitation event, as shown in Appendix 7-4.

Prior to bypassing any mine water into the sediment pond for maintenance or cleaning of the settling basin the static water level in the sediment pond will be decanted to as low as possible below the elevation level of 7773.2'. This will ensure that there is still sufficient capacity left in the pond to accommodate a 10-year/24-hour precipitation event. At no time during the flow bypass will the water level in the sediment pond be allowed to exceed the 7773.2' level, unless specifically authorized by the Division. A clearly visible reference marker will be installed within the sediment pond to clearly delineate the 7773.2' elevation level so that persons in charge of the maintenance operations can observe the water level at all times during any bypass situation. Any decanting of the sediment pond will be done according to the requirements of the approved UPDES permit for this outfall point. Also, prior to bypassing any water into the sediment pond, the sediment level in the pond will be verified to be below the approved clean-out level of 7769'. *(Note: The sediment pond was completely cleaned in December of 2009, immediately prior to putting the iron treatment facility into operation, and certification reports were supplied to the Division).* Since the required capacity volume for a 10yr-24hr event is 2.45 acre-ft, this leaves a usable volume of 0.77 acre-ft for the purpose of maintenance bypass, assuming the water level has been previously decanted down to the sediment cleanout level of 7769' This equates to 251,000 gallons At an average flow rate of 500 gpm from the mine, the sediment pond could theoretically contain over 8 hours worth of by-passed discharge flow. In other words, this could allow more than 8 hours of time to perform maintenance work on the treatment facility before the sediment pond was filled to within the 10/24 capacity volume level at the maximum level of 7773.2'. This should provide sufficient time for most routine or emergency maintenance procedures, especially in light of the mechanical simplicity of the system. Details of the sediment pond capacity for this scenario can be found in Appendix 7-4.

Prior to initiating any routine or scheduled maintenance on the oxidizer unit or the settling basin, the company will provide a minimum 24-hour notice to the Division. Emergency maintenance occasions will be reported to the Division immediately.

DRAINAGE

The "old loadout area" is depicted on Plate 7-5 and in Appendix 7-4 (Sedimentation and Drainage Control Plan) as disturbed drainage area WSDD-10. Much of this area is now dedicated to the installation of the iron treatment facility. The treated minewater, along with any direct precipitation falling into the settling basin, is discharged into Crandall Creek via the original approved UPDES outfall point. Therefore, part of this treatment area is now excluded from draining into the sediment pond as disturbed area drainage. The basin berm, which supports the concrete barrier wall, serves to effectively separate the settling basin from the disturbed area drainage around it. Effectively, all surface drainage now bypasses the treatment facility area, and there is no co-mingling of storm surface runoff with the mine discharge water undergoing treatment. Relevant drainage information from Appendix 7-4 is included in Attachment 6 for ease of reference. This attachment also contains information that shows the adequacy of the basin spillway and the discharge pipe to handle the combined flow of the mine water and a 10 year/24 hour precipitation event on the surface.

While the facility is neither an ASCA nor a small area exemption, it represents a small area within the disturbed area wherein runoff is treated along with the mine discharge water and discharges through an approved UPDES outfall point, and therefore does not drain to the sediment pond. Also, the outer toe of the berm located adjacent to the Forest Service road has been armored with concrete jersey barriers sufficient to prevent potential erosion from surface runoff along the road, and to route surface drainage around the basin into drainage ditch DD-10, thence into culvert C-4, and thence into the sediment pond. Calculations in Appendix 7-4 show that these drainage structures are adequately sized to handle the bypass flow (at a peak of about 1200 gpm) in addition to the 10 yr-24 hr precipitation event design flow.

FINAL RECLAMATION

There is every reason to believe that water will permanently discharge from the Crandall Mine portals. The iron level of the mine water historically was very low, and began rising only after the water began to build up and impound within the mine workings following the mine collapse of 2007. It is now the consensus that the elevated iron concentration will be a permanent situation, and that the reclamation plan must provide for a permanent means of treating the discharge water so as to meet UPDES requirements, even subsequent to final reclamation. To address this situation, the company commits to revising the reclamation plan in the near future.

Based on recent input from various state and federal agencies (Div. Oil, Gas and Mining, Forest Service, BLM, Div Water Resources, Div. Wildlife Resources) a conceptual treatment plan for final reclamation was agreed upon. This plan would utilize a passive aeration system (modifying the existing portal access road into a long, cascading, open-air aeration waterway), emptying out into a set of large settling basins to be constructed in the area presently occupied by the shop/warehouse building. The company commits to collecting the necessary baseline data, consulting with the appropriate agencies, and revising the reclamation plan in accordance with the agreed-upon passive concept, so that the revised reclamation plan can be approved by August 1, 2010. This plan will include not only the facility design but also projected operating and maintenance costs for long-term (perpetual) bonding considerations. In light of the long-term treatment requirements for final reclamation, the existing treatment facility is now considered temporary (i.e., short-term, operational) and will be removed at the time of final reclamation after the permanent (post-reclamation) passive facility is constructed.

BASELINE MONITORING

Additional baseline data will be incorporated into the revised reclamation plan referenced above. This data will include: 1) flow quantities from the seep in the sandstone ledge above the treatment facility, 2) historical data concerning the iron concentration levels in the mine discharge water, and 3) performance data demonstrating the effectiveness of the existing treatment system methodology of oxidation/settling. as opposed to other treatment methods such as reverse-osmosis, fine-element filtration, chemical coagulants/flocculants, etc.

1) Ledge seep water flow: The treatment area is separated from the portal bench above by a massive sandstone ledge of bare sandstone rock. There are several seeps emanating from this ledge and this seep water drains down the ledge toward the area of the settling basin. Based on previous measurements, the flow is minimal (approximately 1-2 gpm), but constant. A concrete trough has been poured behind the existing retaining wall (between the ledge rock and the back of the wall) to collect this seepage water and route it through a 4" PVC pipe to the settling basin overflow culvert inlet. In this manner the seepage water is contained, can be monitored, and is also subject to treatment thru dilution. The flow data collected from monitoring this seep will be provided to the Division and will assist in determining the most appropriate geotechnical method for future reclamation of this area, i.e., final reclamation. Monitoring will be conducted monthly, although freeze/thaw conditions in winter months will have to be factored into interpreting the data. The monitoring information will be provided to the Division (via email) prior to the end of each month and will continue until the Division determines that it is no longer necessary, and at a minimum, until such time the revised final reclamation plan (see discussion below) has been approved, since this information will be needed in order to properly design the approximate-original-contour requirements for the "old loadout area".

The location of the seep water discharge pipe into the basin overflow culvert inlet provides safe and convenient access for collection of this data. It should also be noted that much of the seep water seems to be coming from underneath the concrete pad of the old crusher building sitting on top of the ledge. Since this building, and its concrete floor, will be removed during final reclamation, there is a high probability that muc of the seep water can be isolated and contained at time of final reclamation. This issue will be addressed in greater detail in the preparation of the revised final reclamation plan. Details of this seep collection system can be found in the engineering drawings in Attachment 8.

2) Mine discharge water quality: This data is essentially the monthly UPDES sampling and monitoring that is presently on-going.

3) Operational performance data: In addition to the normal UPDES data (item 2), the company commits to gathering data to reflect on the effectiveness of the oxidation/settling methodology employed in the existing system. This data will facilitate the design of a final reclamation treatment system that will include perpetual treatment of the mine-water discharge. This data will be collected monthly and will be provided to the Division via email. Samples will be collected from the 12" HDPE pipeline prior to the oxidizer unit, and at the UPDES sampling point at the outlet of the settling basin. The analytical parameters will include the following:

Iron (total, dissolved, and ferrous)
Manganese (total and dissolved)
Aluminum (total and dissolved)
Alkalinity
Sulfate
pH
Dissolved Oxygen

BONDING

As described above (under FINAL RECLAMATION) this facility is to be considered as a short-term, operational facility, designed to treat to the discharge water up until the time of final reclamation, but not thereafter. Because the facility has been constructed using non-permanent structures it will be easy to reclaim. For example, the earthen berm has been constructed out of less than 700 cubic yards of granular borrow which can easily be hauled off or used as backfill material during final reclamation. The oxidizer unit is a pre-fabricated unit that can be removed with a fork-lift. The Jersey barriers can be removed with a backhoe and hauled off to be re-used elsewhere. There is no concrete to be removed and disposed of. The only concrete associated with the facility is a small amount which was poured behind the existing retaining wall which will remain in place during final reclamation. Because all components can easily be dismantled and removed (i.e., are not permanent), any increased costs for reclamation should be negligible. Indeed, if the iron concentrations of the mine water come back into compliance naturally, as they have always been in the past, the treatment facility might no longer be needed and could be disassembled prior to final reclamation of the minesite. Based on discussions with Division, in light of the short-term, non-permanent nature of construction of the facility, the cost of reclamation would be less than $3000, which include demolition and disposal costs.

It should also be noted that at the present time (November, 2009), the Crandall Canyon Mines reclamation bond contains positive coverage for the following reasons:

1) The East Mountain Drillpads have been reclaimed and the ivision has determined that the site now qualifies for Phase 1 bond release. This bond is presently posted at $286,196. Phase 1 release would free up 60% of this amount, or $171,717 which could be transferred to apply to any increase resulting from the treatment facility.

2) Due to the construction of the Crandall Canyon Memorial, the upper end of the mineyard has been deeded over to Emery County, and will not be reclaimed as reflected in the current mine reclamation bond. Based on estimates previously submitted to the Division (Task #3092, April 6, 2009, reprint available on request), this should result in a reduction of the reclamation costs of the minesite by about estimated amount of $77,798. This positive bonding re-adjustment could also be utilized to cover any increase resulting from the installation of the treatment facility.

As stated previously, the company is committed, under Division Order DO09A, to revising the final reclamation plan to include a permanent, passive treatment facility which will replace the existing one. This revised reclamation plan will include a major re-evaluation of the overall reclamation costs of the Crandall Canyon minesite, and subsequent bond re-adjustments. In light of this pending revision, and the relatively minor reclamation and operating costs associated with the existing facility, and the existing bonding excess presently in place, the company requests that bonding considerations for this existing facility be delayed temporarily and worked into the up-coming "permanent facility" revised reclamation plan and bond.

OFF-SITE IMPACTS

In early 2009 the iron concentrations in the water began to exceed UPDES limits. By the summer of 2009, Crandall Creek below the mine began to display an orange discoloration from the iron staining, resulting in violations from both DOGM and Division of Water Quality. Therefore, the company commits to perform an on-site inspection of the Crandall Creek drainage with the appropriate regulatory agencies once access is possible (late spring/early summer 2010). The purpose of the inspection will be to assess the extent of the total iron accumulations within Crandall Creek. Following the site-visit, the Division (with concurrence with the Forest Service, and consultation from other agencies) will make a determination as to what clean-up measures, <u>if any</u>, should be taken to remove the iron accumulations from the stream channel.

BACK UP/CONTINGENCY PLAN

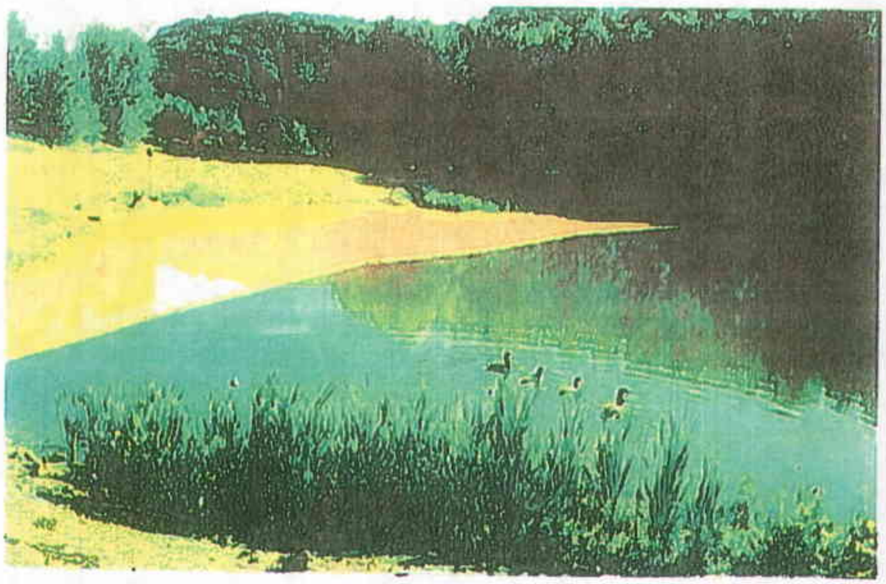
The company commits to establishing a back-up/contingency plan for the oxidizer unit once it has been demonstrated that the mine-water discharge levels of total iron are within UPDES limits for three consecutive months.

ATTACHMENT 1

MAELSTROM OXIDIZER UNIT

Environmental Solutions

Breathing Life into Polluted Waters



Environmental Solutions LLC has patents on an apparatus and method for transferring mass quantities of oxygen into a liquid to oxidize and precipitate metals. This apparatus, the Maelstrom Oxidizer, will precipitate all hazardous metals of concern. Iron, lead, zinc, cadmium, manganese, magnesium and copper are examples. Arsenic can also be removed. The process can be used wherever oxygen transfer into liquids is necessary for cost effective treatment. The process is also effective for removal of gasses such as carbon dioxide and Ammonia Nitrogen and for conversion of sulfite into sulfate.

Individual Maelstrom Oxidizer systems are designed specifically for volume of flow and metals content. Size and system requirements are determined by on site testing. On occasion, modifications and catalysts are required for economical treatment. This is also determined by on site testing.

There are no limitations on volume of flow or metals content

Home Page Accelerate Oxidation Manganese Penn Allegh Mine Sulfide Charts Links

Water----Land----Money

Charts Graphs and Pictures

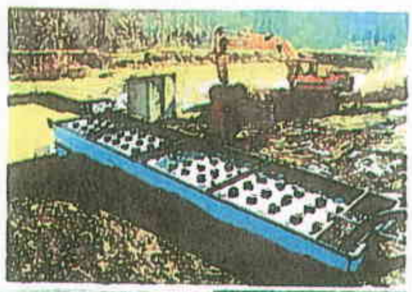
Maelstrom Oxidizer Canterbury Mine

These Valuable resources are being squandered needlessly in the treatment of Acid Mine Drainage.

Treated water can be purer; land area can be smaller; costs can be lower.

Oxidation is the means to conserve these resources. Oxidation precipitates metals from the Acid Mine Drainage at a lower pH. Ferrous iron is precipitated as ferric hydroxide rather than ferrous hydroxide. Sludge is denser; less voluminous.

The Maelstrom Oxidizer is an apparatus and method for mass transfer of oxygen into a liquid to strip carbon dioxide and to oxidize and precipitate metals.



Photos are of an installation that's treats 720,000 gallons per day of net alkaline Acid Mine Drainage that contains 105 mg/l of iron. Effluent meets NPDES and Pa. DEP discharge limitations. No chemicals are used in the treatment. Land area is twenty times smaller than recommended for passive systems.

Life Cycle Costs (25 years), calculated with the computer program AMDTreat, are 69% lower than for a passive aerobic wetland. This program was developed jointly by the US Office of Surface Mining (OSM), Pa. DEP and the W. Virginia DEP.

Acidic water can be treated by the system by combining it with an anoxic limestone drain. Chemical reagent can also be introduced and mixed within the system chambers. The Maelstrom is a gravity flow system. There are no limitations on flow volume, total acidity or metals content. The system can be designed for new systems or can be retrofitted into existing systems.

WATER-----Effluent meets federal and state regulations.

LAND-----Treatment area can be reduced by a factor of 10 or more

MONEY---Costs can be reduced 50% or more

Don Budeit, Environmental Solutions LLC

314 Polo Club Drive; Moon Township, Pa. 15108----412 262-2606

environmentalsolutions@comcast.ne

The Maelstrom Oxidizer is a proven innovative process

Penn Allegh Mine---Pennsylvania

Net alkaline pH 6.5 water containing 105 mg/l iron

Effluent is 0.6 mg/l in all seasons without chemical addition

Settling area is 13 to 26 times less than required for passive treatment

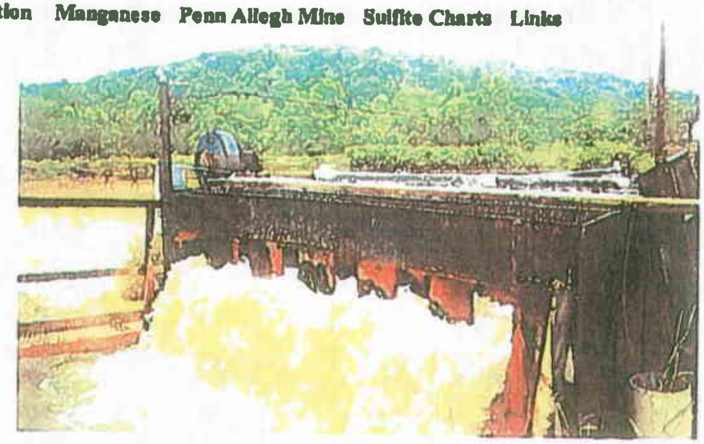
Maelstrom Oxidizer system monitored by Pa. DEP for six years

Never in violation of NPDES Permits

This installation was documented in a paper titled "Innovative Method to Reduce Land area and Cost in the Treatment of Acid Mine Drainage" presented at the National Association of Abandoned Mine Lands Conference at Ohio University 2001.

Canterbury Mine---Pennsylvania

This mine site owned by Murray Energy has near alkaline water but contains both Iron and Manganese. The Maelstrom Oxidizer replaced an existing aeration system. Chemical costs were reduced 41%. The system transferred oxygen in an initial chamber prior to chemical addition in a subsequent chamber. This degassing of carbon dioxide raised the pH and resulted in additional chemical savings.



Maple Creek Mine—Pennsylvania

This Pennsylvania Mine has acidic water with a pH of 3.1. Total iron is 1800 milligrams per liter. The treatment flow is 1850 liters per minute (500 gallons) per minute. Oxygen saturation had to be replenished 28 times every minute to oxidize all of the iron to meet discharge limitations. The 15 horse power blower supplied the oxygen demand of 64 pounds per hour. This relates to more than 4 pounds of oxygen per horse power hour. Sodium Hydroxide was used to increase pH. In Figure 1, the water is turning green in the first reaction chamber. As it leaves the second reaction chamber 15 seconds later, it is already brown from the oxidation of the iron.

Figure 1 Maple Creek Mine Maelstrom Oxidizer.

ATTACHMENT 2

1) IRON TREATMENT BENCH TEST RESULTS

2) SETTLING BASIN VOLUME DETERMINATION

Environmental Solutions LLC receive raw water from the Utah site on Saturday August 29. These are the results of our testing of that water.

Raw water

6.97 pH

Dissolved Iron 0.79 mg/l

Total Iron 2.16 mg/l

This water was processed through a Maelstrom Oxidizer test unit with results as follows:

pH 8.17

5.5 hour settle time

Dissolved Iron 0.00 mg/l

Total Iron 0.52 mg/l

The increase from 6.97 mg/l to 8.17 mg/l was due to the out gassing of carbon dioxide in the Maelstrom Oxidizer. The pH increase was within one minute of processing. It is important in the treatment of mine drainage because each .5 increase in pH increases the oxidation rate of iron 10 times. A full point increases the oxidation rate 100 times. Any dissolved iron remaining in water cannot precipitate and is discharged as total iron.

These results are without the addition of chemical reagents or polymers.

Currently the raw water contains low amounts of iron but the amount seems to be steadily increasing. The proposed Maelstrom Oxidizer is capable of treating your maximum flows with iron in the hundreds of mg/l.

Don Budeit, President

Environmental Solutions LLC

Dave Shaver:

I have previously sent you the results of our in house testing. Water from the Crandall Canyon site was processed through a M vaelstron Oxidizer test unit. You will note that the raw water pH increased from 6.97 pH to 8.17 pH without the addition of any chemical reagent. The increase was due to out gassing of carbon dioxide in the Maelstrom Oxzidizer unit. Each 0.5 increase in pH will increase the oxidation rate of iron ten times. A 1 point increase in pH increases the oxidation rate 100 times. Any dissolved iron in the raw water will be oxidized and precipitated in 36 seconds. In our in house testing, all iron was oxidized and settled out in 5.5 hours. Water leaving the oxidizer unit should settle out in the pond area as shown on your plan. You show an area of approximately 38,500 cubic feet equal to 288,000 gallons. At a treatment flow of 600 gallons per minute, retention time in your pond will be approximately 8 hours. According to in house testing, the area should be adequate for your flows.

Don Budeit, President

Environmental Solutions LLC

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412 262 2606

Cell 412 606 8283

SETTLING BASIN VOLUME DETERMINATION

1) Continuous flow readings from September 9, 2009 through October 27, 2009 have been taken on a daily basis. The cumulative flow over this 48 day time period was 33,249,830 gallons. This equates to 692,704 gal/day = 481 gal/min. The instantaneous readings ranged between a low of 314 gpm to a high of 1033 gpm. The average instantaneous reading was 491 gpm, which agrees closely with the cumulative average of 481 gpm. Therefore, the design parameter for the treatment facility was chosen at 500 gpm.

2) Based on the bench test conducted by the manufacturer of the oxidizer unit (see Attachment 2) compliance levels of iron reduction was achieved with a 5.5 hr retention (settling) time, without the use of chemical flocculants or coagulants.

3) Therefore, the manufactures recommended settling basin volume is:

   5.5 hrs x 500 gal/min x 60 min/hr = 165,000 gal

4) Based on computer generated volumetrics, the proposed settling basin has a volume of 288,000 gallons. Therefore, the settling basin is 288,000/165,000 = 1.75 time bigger than the manufacturer's recommendation. Actual usable settling volume will gradually decrease as accumulation material settles in the bottom of the basin.

5) However, if during operation of the facility, it is determined that additional settling is needed, a chemical coagulant and/or flocculant can be added. The oxidizer unit has been modified to allow easy addition of a chemical injection system in the future. These chemicals dramatically increase the settling rate of the iron particulates.

ATTACHMENT 3

PIT LINER INFORMATION

WOVEN POLYOLEFIN FABRICS

NOVA-THENE®

RB8-6

DATA SHEET

A heavy duty fabric designed for protective covers, haystack covers, pit and pond liners and pool covers.

FABRIC SPECIFICATIONS

WEAVE	Woven black HDPE scrim using 1600 denier tapes
COATING	1.75 mil average, two sides (41 g/m^2, two sides)
COLOUR	Black or coloured coatings available silver/black available from stock
WEIGHT	6.0 oz/yd^2 (203 g/m^2) +/- 10%

PERFORMANCE

GRAB TENSILE	Warp 210 lb 933 N	Weft 180 lb 801 N	ASTM D5034
TONGUE TEAR	Warp 70 lb 311 N	Weft 70 lb 311 N	ASTM D2261
MULLEN BURST	370 psi 2553 kPa		ASTM D3786
ACCELERATED UV WEATHERING[1]	> 80 % strength after 2000 hrs		ASTM G53

[1] Q.U.V. [A-340 Lamps]: 8 hrs UV @ 60° C, 4 hrs condensation @ 50° C

ROLL SPECIFICATIONS

CORES	4 inch (101.6 mm) or 5 inch (127 mm) I.D.
WIDTH	Up to 150 inches (-0 , +0.5) as ordered, 3.81 m (-0, +12 mm), 144" (3.66 m) available from stock
LENGTH	Minimum 500 yds/roll (457 m); up to 1000 yds/roll (914 m)

These values are typical data and are not intended as limiting specifications.

DM2005(RB8-6)
Rev 5 01/01/05

intertape polymer group
P.O. Box 868, 50 Abbey Avenue, Truro, Nova Scotia, Canada B2N 5G6 Tel: 800-565-2000 Fax: 902 893-0220

ATTACHMENT 4

WILDCAT SEDIMENT POND C
VOLUME DETERMINATION

TABLE 9
SEDIMENT POND "C" DESIGN

1-	Use 1.85" for 10 year - 24 hour event.		
2-	Disturbed Area Draining to Pond = 18.43 acres.		
3-	Runoff Curve Number = CN = 90 (Disturbed)		
4-	Disturbed Area Runoff = (From Table 2, 10 yr./24 hr.)	=	1.490 ac.ft.
5-	Sediment Storage Volume USLE - 0.213	=	0.213 ac.ft.
6-	Direct Precipitation into Pond 0.86 acres x 1.85" / 12 in./ft.	=	0.133 ac.ft.
7-	Total Required Pond Volume 1.490 + 0.213 + 0.133	=	1.836 ac.ft.
*8-	Pond Actual Volume at Principal Spillway	=	4.732 ac.ft.
9-	Peak Flow (25 year - 6 hour event)	=	10.99 cfs

* Existing.

From: Dan Guy

Subject: Excess Volume in Pond C at the Wildcat Loadout

Date: June 2, 2009

Per your request, I have checked the required and actual volumes for Pond C at the Wildcat Loadout. I have also evaluated the Stage-Volume information to determine the maximum level to which the pond could be filled and still retain the required volume for the 10-year, 24-hour storm event. All information is based on the attached Tables 9 and 17, which represent the latest information on this pond.

Based on Table 9, the required pond volume for Pond C is 1.836 ac. ft., and the actual pond volume is 4.732 ac. ft., leaving an excess volume of 2.896 ac. ft. at the principle spillway. On Table 17 (Stage-Volume), the principle spillway is at an elevation of 6137.0. Based on the stage-volume information, the pond could be filled to within 3' of the principle spillway, to an elevation of 6134.0, and still have 2.155 ac. ft. of capacity or 0.319 ac. ft. in excess of that required for the 10-year, 24-hour event. This would allow for placement of approximately 2.577 ac. ft. of material into the pond. This is the maximum elevation I would recommend for adding material to the pond, since it still provides a safety factor for the design storm.

UTAH REGISTERED PROFESSIONAL ENGINEER
#15[illegible]168
DAN W. GUY

TABLE 17
SEDIMENT POND "C"
STAGE VOLUME DATA (AS-CONSTRUCTED)

Elevation	Area (ft²)	Volume (ac. ft.)	Acc. Volume (ac. ft.)	Remarks
6127.7	804.3	0	0	Bottom of Pond
6130.0	18,075.7	0.498	0.498	
6131.5	-	0.700	1.198	Sediment Cleanout Level
6132.0	22,596.8	0.234	1.432	
6134.0	27,274.0	1.145	2.577	
6136.0	32,557.0	1.374	3.951	
6137.0	35,481.1	0.781	4.732	Principal Spillway
6138.0	38,405.1	0.848	5.580	Emergency Spillway
6140.0	45,286.6	1.921	7.501	Crest of Dam

ATTACHMENT 5

SETTLING BASIN CLEAN-UP VOLUME ESTIMATION

SETTLING BASIN CLEAN-UP VOLUME ESTIMATION

Based on history of non-compliance the iron level has been about 2 to 3 mg/liter (spiking on occasion to 8 mg/liter), with compliance level being 1 mg/liter. Therefore, to achieve compliance could require the removal of up to 7 mg/liter of iron

Removal of 7 mg/liter of iron from a 500 gal/min flow would result in 21 kg/day iron removal, or 33.4 k/day of iron oxide. Assuming the accumulation material which settles at the bottom of the basin is in a semi-liquid (slurry) form of 5% solids (iron oxide)-95% water, the yearly volume of accumulated sludge material would be approximately 8,200 cubic feet. The stage volumes for the settling basin are as follows:

elevation	cumulative volume(cu ft)	years of storage
7810'	1,487	0.18
7811'	4,429	0.54
7812'	9,105	1.11
7813'	15,856	1.93
7814'	23,241	2.83
7815'	31,055	3.78
7816' (water level)	39,135	4.77

Based on the manufacturer's bench testing, 5.5 hours of settling time is sufficient to bring the treated mine-water into UPDES compliance. Five and one half hours of discharge is equivalent to 165,000 gallons or 22,059 cubic feet. Since the total basin volume at the spillway level is 39,135 cubic feet, the available capacity of basin volume for iron accumulation over 17,000 cubic feet. As indicated by the figures above, this equates to an estimated two years of storage. Although these estimates are conservative and subject to speculative variables at this time, it seems safe to assume that the basin can hold sufficient iron accumulations to allow for a regular scheduled clean-out program.

Cleaning out the basin when the accumulations have reached a depth of 3' (i.e., at elevation 7812') would leave sufficient capacity for adequate settling volume above the accumulations. At this level, clean-out could be expected about once per year.

****

According to Attachment 4, "Wildcat Pond C Volume Determination" (attached hereto), Pond C has excess capacity to store 2.577 ac-ft of material while still retaining sufficient free-board capacity for a 10-year, 24-hour storm event.

$$2.577 \text{ ac-ft} \times \frac{43560 \text{ cu ft}}{\text{ac-ft}} \times \frac{\text{year}}{8200 \text{ cu ft}} = 13.7 \text{ years}$$

Since Wildcat Loadout Sediment Pond C is in a very dry environment, it is safe to assume that the iron material will dry out soon after it is put in the pond. In this case, assuming the accumulation material is 5% solids-95% water, the pond could hold more than 250 years worth of material. The purpose of this "quick-and-dirty"calculation is to demonstrate that there is ample reason to conclude that the volume of Wildcat Sediment Pond C is more than capable of containing the iron accumulation material from the Crandall Mine for a very long time.

ATTACHMENT 6

DRAINAGE INFORMATION

NOTE: The following pages are taken from:

APPENDIX 7-4

CRANDALL CANYON MINE, SEDIMENTATION AND DRAINAGE CONTROL PLAN

and relate directly to the installation of the

MINE WATER DISCHARGE
IRON TREATMENT FACILITY

References are bold and underlined

CRANDALL CANYON MINE
SEDIMENTATION AND DRAINAGE CONTROL PLAN

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hour precipitation event. All other undisturbed diversions, disturbed ditches and culverts are sized to safely convey runoff from a 10 year - 24 hour precipitation event. The sediment pond is sized to contain runoff from a 10 year - 24 hour precipitation event, as required.

(d) *The cresent-shaped area below the portals will be utilized as a water treatment facility for the mine water discharging from the mine and seeping from the slope below the portals. The plan is to divert all mine water into this area, where it will be treated with an aeration system and settling pond to reduce the iron content. Once treated, the mine water will flow into the main canyon culvert at the UPDES #002 discharge location. Calculations show a minimum 12" pipeline at a minimum grade of 3 % is more than adequate to carry the expected maximum discharge of 800 gpm or 1.78 cfs. A larger pipeline may be used. This system will be isolated from the rest of the minesite drainage by topography and jersey-barriers, and will no longer flow to the sediment pond. The location and drainage plans are shown on Plate 7-5. As a result of constructing this facility, the volume of runoff reporting to the sediment pond actually decreases by a small amount, estimated at about 0.05 ac/ft. However, since the facility may not be permanent and could be removed in the future, the runoff calculations for the affected ditches, culverts and sediment pond have not been changed to reflect any resulting decrease.*

(e) *When the Crandall Canyon Mine Portals were sealed as a result of the 2007 disaster, culvert system UD-3 which diverts undisturbed drainage area WSUD-3, was damaged beyond repair. Therefore it was decided to re-route UD-3 as shown on Figures 13A and 13B. Culvert UD-3 now reports to Disturbed Ditch DD-8, Culvert C-1, Disturbed Ditch DD-5, Culvert C-12 and ultimately into the Sediment Pond. Calculations show that all affected ditches, culverts and the Sediment Pond are adequately sized to handle the increased flow from WSUD-3 (See Tables 3, 5, 6, 7 and 11).*

TABLE 1
WATERSHED SUMMARY

Watershed	Type	CN	Acres	Drains To		Final
Crandall	Undisturbed	69	3480.00	Main Culvert	-	Crandall Creek
WSUD-1	Undisturbed	69	84.88	Culvert UD-1	-	Crandall Creek
WSUD-2	Undisturbed	69	1.39	Ditch UD-2	-	Culvert UD-1
WSUD-3	Undisturbed	69	8.66	Culvert UD-3	-	Sediment Pond
WSDD-1	Undisturbed	69	0.14	Ditch DD-1	-	Sediment Pond
WSDD-1	Reclaimed	75	0.08	Ditch DD-1	-	Sediment Pond
WSDD-2	Reclaimed	75	0.15	Ditch DD-1	-	Sediment Pond
WSDD-3	Undisturbed	69	0.13	Ditch DD-3	-	Sediment Pond
WSDD-3	Reclaimed	75	0.15	Ditch DD-3	-	Sediment Pond
WSDD-3	Disturbed	90	0.26	Ditch DD-3	-	Sediment Pond
WSDD-3	Paved	95	0.33	Ditch DD-3	-	Sediment Pond
WSDD-4	Paved Road	95	0.11	Ditch DD-4	-	Sediment Pond
WSDD-4	Disturbed	90	0.08	Ditch DD-4	-	Sediment Pond
WSDD-5	Undisturbed	69	0.12	Ditch DD-5	-	Sediment Pond
WSDD-5	Reclaimed	75	0.33	Ditch DD-5	-	Sediment Pond
WSDD-5	Paved Road	95	0.33	Ditch DD-5	-	Sediment Pond
WSDD-7	Undisturbed	69	0.18	Ditch DD-7	-	Sediment Pond
WSDD-7	Disturbed	90	0.17	Ditch DD-7	-	Sediment Pond
WSDD-7	Paved Road	95	0.09	Ditch DD-7	-	Sediment Pond
WSDD-8	Undisturbed	69	3.59	Ditch DD-8	-	Sediment Pond
WSDD-8	Reclaimed	75	0.15	Ditch DD-8	-	Sediment Pond
WSDD-8	Disturbed	90	0.37	Ditch DD-8	-	Sediment Pond
WSDD-8	Paved Road	95	0.25	Ditch DD-8	-	Sediment Pond
WSDD-10	Undisturbed	69	0.07	Ditch DD-10	-	Sediment Pond
WSDD-10	Reclaimed	75	0.12	Ditch DD-10	-	Sediment Pond
WSDD-10	Disturbed	90	0.61	Ditch DD-10	-	Sediment Pond
WSDD-10	Paved Road	95	0.27	Ditch DD-10	-	Sediment Pond
WSDD-11	Undisturbed	69	2.09	Ditch DD-11	-	Sediment Pond
WSDD-11	Reclaimed	75	0.15	Ditch DD-11	-	Sediment Pond
WSDD-11	Disturbed	90	0.04	Ditch DD-11	-	Sediment Pond
WSDD-12	Undisturbed	60	8.82	Ditch DD-12	-	Sediment Pond
WSDD-12	Disturbed	90	2.29	Ditch DD-12	-	Sediment Pond
WSDD-13	Undisturbed	60	17.72	Ditch DD-13	-	Sediment Pond
WSDD-13	Disturbed	90	3.70	Ditch DD-13	-	Sediment Pond
WSDD-13	Paved	95	0.27	Ditch DD-13	-	Sediment Pond
WSDD-14	Disturbed	90	0.89	Sediment Pond	-	Sediment Pond
WSDD-14	Undisturbed	60	0.78	Sediment Pond	-	Sediment Pond
WSDD-14	Paved	95	0.02	Sediment Pond	-	Sediment Pond
WSDD-15	Paved	95	0.09	Ditch DD-7	-	Sediment Pond

TABLE 4
RUNOFF SUMMARY
DRAINAGE TO SEDIMENT POND

Watershed	Type	10 year/24 hour Volume-ac.ft.	10 year/24 hour Peak Flow-cfs	10 year/6 hour Peak Flow-cfs	25 year/6 hour Peak Flow-cfs
WSDD-1	Undisturbed	0.02	0.10	0.04	0.06
WSDD-1	Reclaimed	0.01	0.04	0.01	0.01
WSDD-2	Reclaimed	0.01	0.06	0.01	0.03
WSDD-3	Undisturbed	0.00	0.03	0.00	0.01
WSDD-3	Reclaimed	0.01	0.05	0.01	0.02
WSDD-3	Disturbed	0.03	0.18	0.08	0.12
WSDD-3	Paved	0.05	0.32	0.17	0.22
WSDD-4	Paved	0.02	0.12	0.07	0.09
WSDD-4	Disturbed	0.01	0.08	0.04	0.05
WSDD-5	Undisturbed	0.00	0.03	0.00	0.01
WSDD-5	Reclaimed	0.02	0.10	0.02	0.04
WSDD-5	Paved	0.05	0.39	0.21	0.27
WSDD-7	Undisturbed	0.01	0.05	0.00	0.01
WSDD-7	Disturbed	0.02	0.12	0.05	0.07
WSUD-3	Undisturbed	0.30	1.40	0.23	0.43
WSDD-8	Undisturbed	0.13	0.75	0.10	0.20
WSDD-8	Reclaimed	0.01	0.05	0.01	0.02
WSDD-8	Disturbed	0.05	0.23	0.10	0.14
WSDD-8	Paved	0.04	0.37	0.20	0.26
WSDD-10	Undisturbed	0.00	0.03	0.00	0.01
WSDD-10	Reclaimed	0.01	0.03	0.01	0.01
WSDD-10	Disturbed	0.08	0.42	0.19	0.27
WSDD-10	Paved	0.04	0.35	0.19	0.24
WSDD-11	Undisturbed	0.07	0.47	0.06	0.12
WSDD-11	Reclaimed	0.01	0.04	0.01	0.02
WSDD-11	Disturbed	0.01	0.06	0.03	0.04
WSDD-12	Undisturbed	0.13	0.25	0.04	0.16
WSDD-12	Disturbed	0.29	3.33	1.51	2.10
WSDD-13	Undisturbed	0.26	0.49	0.07	0.30
WSDD-13	Disturbed	0.47	5.39	2.44	3.39
WSDD-13	Paved	0.04	0.20	0.11	0.14
WSDD-14	Disturbed	0.11	0.78	0.35	0.49
WSDD-14	Undisturbed	0.01	0.03	0.00	0.02
WSDD-14	Paved	0.02	0.07	0.04	0.05
WSDD-15	Paved	0.02	0.11	0.06	0.08
Totals		2.36	16.53	6.46	9.50

TABLE 5
RUNOFF CONTROL STRUCTURE
WATERSHED SUMMARY

Structure	Type	Contributing Watersheds
Main Culvert	Culvert	Crandall Canyon Above Mine
UD-1	Culvert	WSUD-1
UD-2	Culvert	WSUD-2
UD-3	Culvert	WSUD-3
DD-1	Ditch	WSDD-1, WSDD-2
DD-3	Ditch	WSDD-1, WSDD-2, WSDD-3
DD-4	Ditch	WSDD-1, WSDD-2, WSDD-3, WSDD-4, WSDD-8, WSDD-12
DD-5	Ditch	WSDD-1, WSDD-2, WSDD-3, WSDD-4, WSDD-5, WSDD-8, WSDD-12
DD-7	Ditch	WSDD-7, WSDD-11
DD-8	Ditch	WSDD-8, WSUD-3
DD-10	Ditch	WSDD-10 + Mine Water
DD-11	Ditch	WSDD-11
DD-12	Ditch	WSDD-12
DD-13	Ditch	WSDD-13
DD-14	Sheet Flow	WSDD-14
C-1	Culvert	WSDD-1, WSDD-2, WSDD-3, WSDD-8
C-3	Culvert	WSDD-7, WSDD-11, WSDD-15
C-4	Culvert	WSDD-10 + Mine Water
C-5	Culvert	WSDD-11
C-6	Culvert	WSUD-2
C-7	Culvert	WSDD-1, WSDD-2, WSDD-3
C-9	Culvert	WSDD-4, WSDD-12
C-11	Culvert	WSDD-12
C-11A	Culvert	WSDD-12
C-12	Culvert	WSDD-1, 2, 3, 4, 5, 8, 12
C-13	Culvert	WSDD-13
C-14	Slot Culvert	WSDD-4
C-15	Slot Culvert	WSDD-15
C-16	Culvert	WSDD-13
C-17	Culvert	WSDD-13
Sediment Pond	Pond	WSDD-1, 2, 3, 4, 5, 7, 8, 10, 11, 12, 13, 14, WSUD-3

TABLE 6
RUNOFF CONTROL STRUCTURE
FLOW SUMMARY

Structure	*Type*	*10 year/6 hour Peak Flow-cfs*	*10 year/24 hour Peak Flow-cfs*	*25 year/6 hour Peak Flow-cfs*	*100 year/6 hour Peak Flow-cfs*
Main Culvert	Culvert	-	-	-	222.79
UD-1	Culvert	1.91	-	3.68	6.81
UD-2	Ditch	0.04	-	0.08	0.21
UD-3	Culvert	0.23	-	0.43	0.89
DD-1	Ditch	0.06	0.20	0.10	-
DD-3	Ditch	0.32	0.78	0.47	-
DD-4	Ditch	2.39	5.96	3.49	-
DD-5	Ditch	2.85	7.88	4.24	-
DD-7	Ditch	0.21	0.85	0.34	-
DD-8	Ditch	0.64	2.80	1.05	-
DD-10	Ditch	2.62	3.06	2.76	-
DD-11	Ditch	0.10	0.57	0.18	-
DD-12	Ditch	1.55	3.58	2.26	-
DD-13	Ditch	2.62	6.08	3.83	-
DD-14	Sht Flw	0.39	0.88	0.56	-
C-1	Culvert	0.96	3.58	1.52	-
C-3	Culvert	0.21	0.85	0.34	-
C-4	Culvert	2.62	3.06	2.76	-
C-5	Culvert	0.10	0.57	0.18	-
C-6	Culvert	0.04	-	0.08	-
C-7	Culvert	0.32	0.78	0.47	-
C-9	Culvert	0.11	0.20	0.14	-
C-11	Culvert	1.55	3.58	2.26	-
C-11A	Culvert	1.55	3.58	2.26	-
C-12	Culvert	2.85	7.36	3.92	-
C-13	Culvert	2.62	6.08	3.83	-
C-14	Slot Cul.	0.11	0.20	0.14	-
C-15	Slot Cul.	0.06	0.11	0.08	-
C-16	Culvert	2.62	6.08	3.83	-
C-17	Culvert	2.62	6.08	3.83	-
Sediment Pond	Pond	6.46	16.53	9.50	-

TABLE 7
DISTURBED DITCH DESIGN SUMMARY

Ditch	*DD-1*	*DD-3*	*DD-4*	*DD-5*	*DD-7*	*DD-8*	*DD-10*
Slope (%)	30.77	3.00	11.91	4.50	3.33	3.59	3.33
Length (ft.)	130	75	168	628	142	557	70
Manning's No.	0.035	0.035	0.035	0.035	0.035	0.035	0.035
Side Slope (H:V)	1:1	1:1	1:1	1:1	1:1	1:1	1:1
**Bottom Width (ft.)*	0	0	0	0	0	0	0
Peak Flow 10/6 (cfs)	0.06	0.32	2.39	2.85	0.21	0.64	2.62**
Peak Flow 10/24 (cfs)	0.20	0.78	5.96	7.88	0.85	2.80	3.06**
Flow Depth (ft.) 10/6	0.14	0.40	0.66	0.84	0.33	0.50	0.86
Flow Depth (ft.) 10/24	0.22	0.56	0.92	1.23	0.57	0.87	0.92
Flow Area (ft^2)10/6	0.02	0.16	0.43	0.71	0.11	0.25	0.75
Flow Area (ft^2)10/24	0.05	0.31	0.85	1.52	0.32	0.76	0.84
Velocity (fps)10/6	3.15	2.00	5.55	4.02	1.87	2.55	3.51
Velocity (fps) 10/24	4.26	2.50	6.97	5.19	2.66	3.68	3.65
Rip-Rap Req'd (Y/N)	N	N	Y	N	N	N	N
Rip-Rap D_{50}	-	-	6"	-	-	-	-

** All ditches are triangular.*
*** Flows include 1000 gpm (2.23 cfs) Mine Water Flow.*
Note: Slope/Lengths from Plate 7-5.

TABLE 9
DISTURBED CULVERT DESIGN SUMMARY

Culvert	C-1	C-3	C-4	C-5	C-6	C-7	C-9	C-11	C-11A	C-12	C-13	C-14	C-15	C-16	C-17
Slope (%)	16.67	8.00	25.07	57.14	17.20	3.00	3.50	3.50	1.50	4.50	3.00	1.00	1.00	25.00	20.0 0
Length (ft.)	60	360	69	120	12	80	18	30	60	330	100	40	30	40	60
Manning's No.	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Peak Flow 10/6 (cfs)	0.96	0.21	2.62*	0.10	0.04	0.32	0.11	1.55	1.55	2.85	2.62	0.11	0.06	2.62	2.62
Peak Flow 10/24 (cfs)	3.58	0.85	3.06*	0.57	N/A	0.78	0.20	3.58	3.58	7.36	6.08	0.20	0.11	6.08	6.08
Min. Diam. Req'd (ft.) 10/6	0.42	0.28	0.57	0.14	0.13	0.39	0.25	0.68	0.80	0.82	0.85	0.32	0.25	0.57	0.60
Min. Diam. Req'd (ft.) 10/24	0.69	0.46	0.61	0.28	N/A	0.54	0.32	0.93	1.09	1.16	1.17	0.40	0.32	0.79	0.82
Diam. Installed (ft.)	1.50	2.00	2.00	1.00	1.00	1.00	1.00	1.50	1.50	2.00	2.00	1.00	1.00	1.67	1.50
Velocity (fps) 10/6	6.80	3.53	10.18	6.13	3.11	2.71	2.20	4.27	3.10	5.46	4.59	1.38	1.18	10.17	9.35
Velocity (fps) 10/24	9.44	5.01	10.58	9.47	N/A	3.39	2.56	5.26	3.83	6.92	5.67	1.60	1.38	12.55	11.5 4
Rip-Rap D_{50}	12"	-	12"	6"	-	-	-	-	-	6"	-	-	-	12"	12"

* Includes 1000 gpm (2.23 cfs) Mine Water Flow.

Note: Slope/Lengths from Plate 7-5.

Source: (Haestad Methods, Flowmaster I, Version 3.42)

TABLE 10
UNDISTURBED CULVERT DESIGN SUMMARY

Culvert	*Main Canyon	UD-1	UD-3
Slope (%)	8.00	23.33	30.00
Length (ft.)	1500	270	50'
Manning's No.	0.02	0.02	0.02
Peak Flow 100/6 (cfs)	222.79	-	-
Peak Flow 10/6 (cfs)	-	1.91	0.23
Min. Diam. Req'd (ft.)	3.75	0.52	0.22
Diam. Installed (ft.)	6.00	3.50	1.00
Velocity (fps)	20.14	9.16	5.93

* Culvert to be installed under expansion plan.
All other undisturbed culverts are existing.

Note: Slope/Lengths from Plate 7-5.
Source: (Haestad Methods, Flowmaster I, Version 3.43)

Variable "CP" is the control practice factor, which can be divided into a cover and practice factor. Values were determined from Appendix 5A, Barfield, et.al., 1983.

Site	*CP Factor*
Disturbed Areas	*1.20*
Reclaimed Areas	*0.100*
Undisturbed Areas	*0.003*

The sediment volume is based on a density of 100 pounds per cubic foot of sediment.

SEDIMENT YIELD CALCULATIONS - USLE

Drainage	*R*	*K*	*Acres*	*Slope Length Feet*	*%*	*LS*	*CP*	*A**	*Yield***
Undisturbed	*27.00*	*0.15*	*42.25*	*1700*	*53*	*79.60*	*0.003*	*00.967*	*0.019*
Reclaimed	*27.00*	*0.15*	*1.22*	*90*	*52*	*17.81*	*0.10*	*07.213*	*0.004*
Disturbed	*27.00*	*0.06*	*8.92*	*350*	*26*	*11.69*	*1.200*	*22.725*	*0.093*

Total Sediment 1 year (ac.ft.) *0.116*

Total Sediment 3 years (ac. ft.). *0.348*

* *A = tons/acre-year*
** *Yield = acre-ft/year*

3.3 *Sediment Pond Volume*

The volumes shown in Table 11 are from the volumes calculated from the precipitation, runoff and sediment yield for a 10 year-24 hour precipitation event. The volumes were calculated based on the disturbed areas (and contributing undisturbed areas) runoff values, developed using the design parameters described in this section.

The sediment pond has been reconstructed, and the sediment pond volumes on Table 11, Table 12 and Figure 6 all represent the "As-Constructed" pond.

Mine Water

There may be times that the mine water oxidizer must be shut down for repair or cleaning, at which time the mine discharge water will need to bypass the treatment system. In such a case, the water will be directed to temporarily run down the road around the outside of the basin, and into the sediment pond through ditch DD-10 and existing culvert C-4 located below the treatment facility. Assuming the sediment level in the pond is below the approved clean-out level (7769'), and assuming the pond has been previously decanted under approved UPDES discharge criteria, the remaining capacity in the sediment pond is 3.22 ac. ft., as described in Table 12. The required freeboard for a 10 year -24 hour event is 2.452 ac. ft. (2.36 ac. ft. runoff + 0.092 ac. ft. direct precipitation) leaving a usable volume of 0.771 ac. ft. for the purpose of the above bypass. This equates to approximately 251,000 gallons. At an average flow rate of 500 gpm from the mine, the sediment pond could theoretically contain 8.37 hours worth of by-passed mine water in addition to the required 10 year - 24 hour storm event. The maximum amount of by-passed mine water storage would occur at a volume of 1.061 ac. ft. (0.290 acre-feet sediment level plus 0.771 acre-feet of mine water). As shown on Table 12, this volume would occur at elevation of 7773.2.

Expanded Area Pond Requirement
3 Year Sediment Storage

TABLE 11
SEDIMENT POND DESIGN

1. *Use 2.50" for 10 year-24 hour event.*

2. *Runoff Volume (from Table 4, 10 yr/24 hr) =* *2.360 ac. ft.*

3. *Sediment Storage Volume*

   USLE 0.116 ac.ft./yr. x 3 yrs. = *0.348 ac. ft.*

4. *Direct Precipitation into Pond*

   0.441 acres x 2.50" / 12 in./ft. = *0.092 ac. ft.*

5. *Total Required Pond Volume*

   2.360 + 0.348 + 0.092 = *2.800 ac. ft.*

6.* *Peak Flow (25 yr. - 6 hr. event) =* *9.500 cfs*

7. *Pond Design Volume @ Principle Spillway =*
   (See Table 12) *3.513 ac. ft.*

* *Peak Flow values from Table 4.*

TABLE 12
SEDIMENT POND
STAGE / VOLUME DATA

Elev.	Area	Volume	Acc. Volume (ac.ft.)	Remarks
7766	1756.67	.0000	.0000	Bottom of Pond
7767	3706.92	2731.80	0.063	
7768	5119.14	4413.03	0.164	
7769	5857.00	5488.07	0.290	Sediment Cleanout Level
7770	6949.54	6403.32	0.437	Maximum Sediment Level
7771	7806.54	7378.14	0.606	
7772	8894.51	8350.53	0.798	
7773	9905.02	9399.77	1.014	
7773.2	-	-	1.061	Max. Elev. of Mine Water
7774	11055.91	10480.47	1.254	
7775	12153.06	11604.49	1.520	
7776	13120.22	12636.64	1.810	
7777	14084.05	13602.14	2.123	
7778	15043.33	14563.69	2.457	
7779	15984.66	15514.00	2.813	
7780	16934.94	16459.15	3.191	
7780.81	17669.26	14014.70	3.513	Principal Spillway
7781	17868.13	3376.05	3.591	
7781.81	18661.53	15028.20	3.936	Emergency Spillway
7782	18848.42	3430.08	4.012	
7783	19886.14	19367.28	4.457	
7784	21113.55	20499.85	4.927	
7785	22110.39	21611.97	5.423	Top of Embankment

TABLE 13
SEDIMENT POND
STAGE / DISCHARGE DATA

Head (ft.)	Q (cfs) Weir Controlled	Q (cfs) Orfice Controlled	Q (cfs) Pipe Flow Controlled
0.0	-	-	-
0.2	1.69	6.77	17.14
0.4	4.77	9.57	17.32
0.6	8.76	11.72	17.50
0.8	13.49	13.53	17.68
1.0	18.85	15.13	17.86

Note: 1- 25 year-6 hour flow = 9.500 cfs.

2- Flow will be weir controlled at a head of 0.64' over riser inlet.

Weir Controlled

$Q = CLH^{1.5}$; where : $C = 3.0$, L = Circumference of Riser = 6.2832'

Orifice Controlled

$Q = C'a\,(2gH)^{0.5}$; where : $C = 0.6$, a = Area of Riser = 3.1416 ft^2, $g = 32.2\ ft/sec^2$

Pipe Flow Controlled

$$Q = \frac{a\,(2gH')0.5}{(1+Ke+Kb+KcL)^{0.5}}$$; where

a = Area of Pipe = 1.77 ft^2

H' = Head = H + 9.1 (At outlet of Riser)

$Ke = 1.0$

$Kb = 0.5$

$Kc = 0.043$

$L = 90'$

3.4 Sediment Pond Summary

a) The sedimentation pond has been designed to contain the disturbed area (and contributing undisturbed area) runoff from a 10 year-24 hour precipitation event, along with 3 years of sediment storage capacity. Runoff to the pond will be directed by various ditches and culverts as described in the plan.

b) The required volume for the sediment pond is calculated at 2.800 acre feet, including 3 years of sediment storage. The existing sediment pond size is 3.513 acre feet (at the principle spillway), which is more than adequate.

c) The pond will meet a theoretical detention time of 24 hours. It is equipped with a decant, a culvert principle spillway and an open-channel emergency spillway. Any discharge from the pond will be in accordance with the approved UPDES Permit.

d) The pond inlets will be protected from erosion, and the spillway will discharge into the main Crandall Canyon drainage.

e) The pond is temporary, and will be removed upon final reclamation of the property.

f) The pond expansion will be constructed according to the regulations and under supervision of a Registered, Professional Engineer.

g) *The pond volume has been increased at the request of the Forest Service to provide a greater level of protection for forest resources located down stream from the minesite. The enlarged pond capacity (3.513 acre ft.) is over-designed by nearly 25% to contain the 10 year-24 hour design evert.*

Storm Event	Pond Volume Required	Pond Capacity Provided
10 yr./24 hr.	2.800 acre ft.	125%

3.5 *Alternate Sediment Control Areas (ASCA's)*

ASCA-2 (consisting of 0.34 acre) exists at the northwest corner of the site. This area was initially constructed as a substation pad but was never utilized as such. A 12-inch CMP culvert was installed to act as a discharge into UD-1. A silt fence and strawbale dike have been placed to trap the sediment and prevent erosion. (Refer to Plates 7-5)

ASCA-5, ASCA-6, ASCA-7 and ASCA-11 consist of the topsoil stockpiles #1, #2, #3, and #4 respectfully. These stockpiles are located on the north and south side of the access road as shown on Plate 2-3. Disturbed areas associated with the topsoil stockpiles are 0.20 acres, 0.22 acres, 0.62 acres and 0.65 acres for ASCA-5, ASCA-6, ASCA-7, and ASCA-11, respectively. All topsoil stockpiles have been protected from erosion by a combination of dikes, silt-fencing, berms, and a vegetative cover. (Refer to Plate 2-3)

ASCA-9 (0.15 acres) is the outslope of the sediment pond; ASCA-10 (0.02 acres) is the headwall of the inlet of the main by-pass culvert. The drainage from these areas can not be directed to the sediment pond and are too close to the creek to construct separate sediment ponds. Therefore GENWAL has used alternate sediment control methods such as silt fences, straw bale dikes and vegetation. (Refer to Plate 7-5)

Note: ASCA's 1, 3, 4 and 8 have been eliminated through previous permitting actions.

A 0.30 acre water treatment facility is located within WSDD-10. This facility contains a settling basin for treating mine discharge water. The treated water is then piped directly to a UPDES outfall into Crandall Creek. Therefore, surface runoff from this facility does not report to the sediment pond.

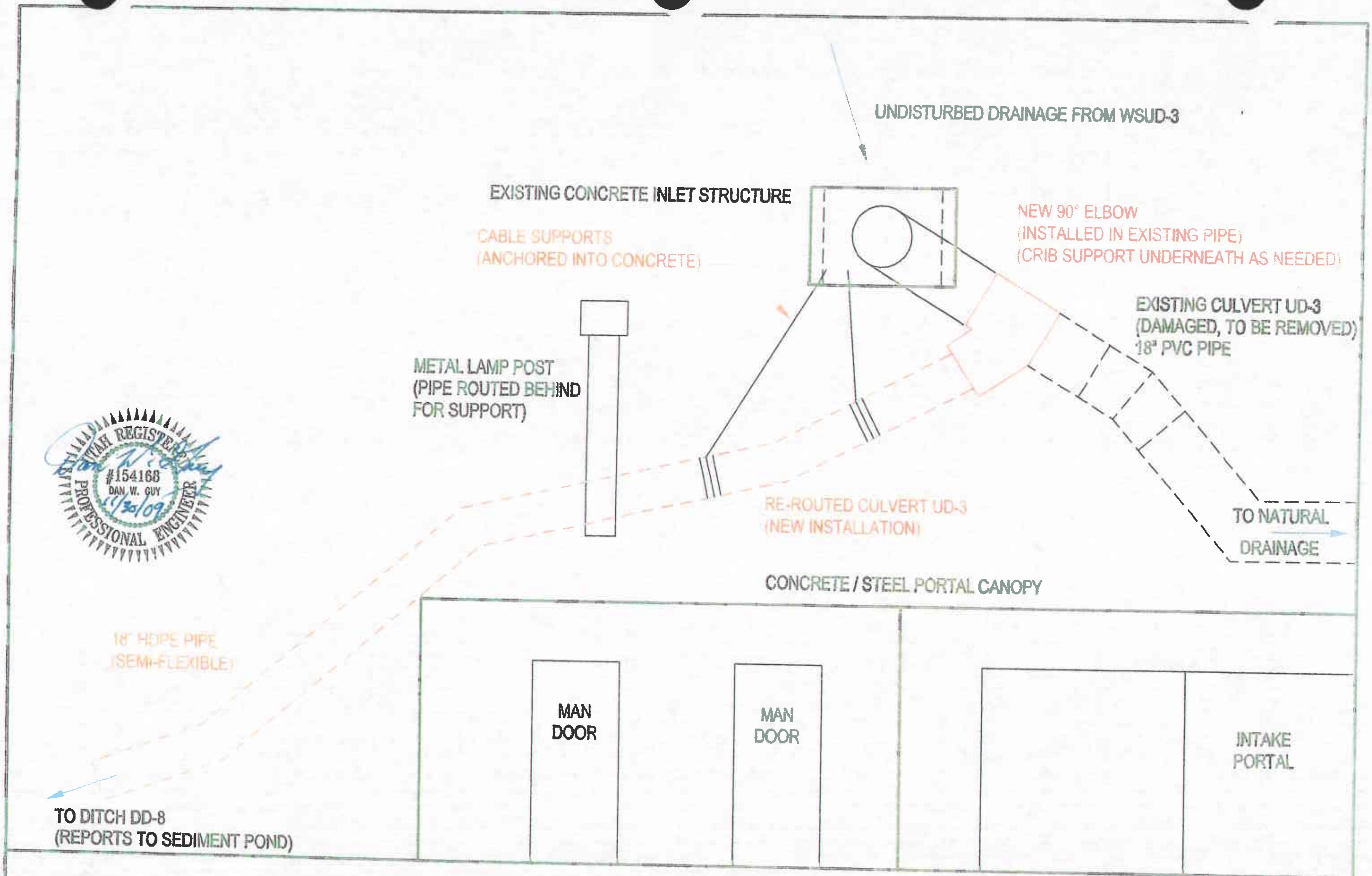


FIGURE 13A
INSTALLATION OF RE-ROUTED CULVERT UD-3
FRONT VIEW

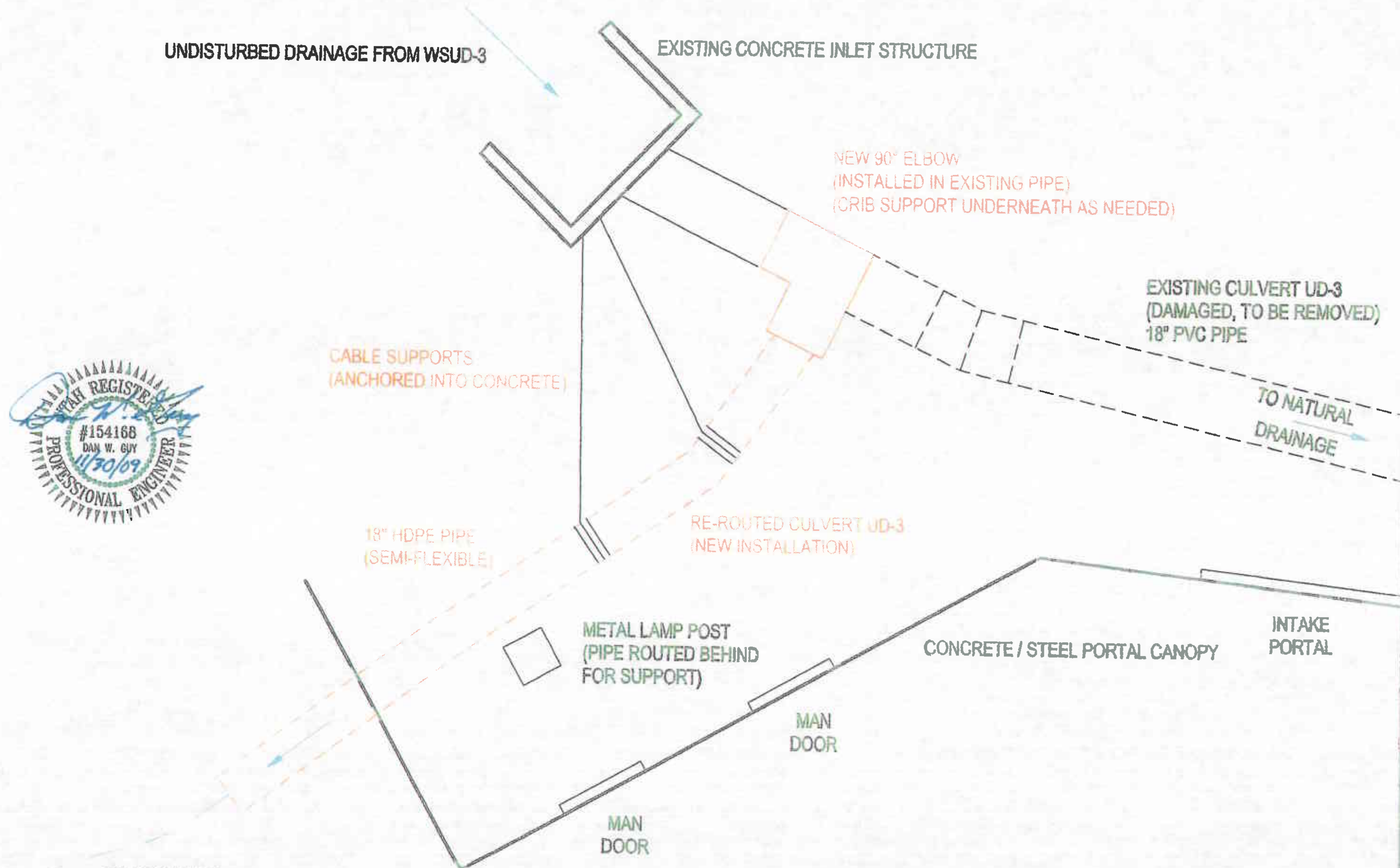


FIGURE 13B

INSTALLATION OF RE-ROUTED CULVERT UD-3

SIDE VIEW

BLACKHAWK ENGINEERING, INC.
1056 West 2060 North - Helper, Utah 84526 - Telephone (435) 637-2422 - Fax (435) 637-2431

To: Dave Shaver
From: Dan Guy
Subject: Mine Water Treatment Outlet Structures
Date: October 14, 2009

Per your request, I have evaluated the adequacy of the proposed mine water treatment area spillway and discharge pipe. The following parameters were used for the calculations:

1. Flow - 2.65 cfs or 1189 gpm;
   a. Flow is based on a maximum expected mine water discharge of 1000 gpm (2.23 cfs) plus the calculated 10 year-24 hour precipitation runoff from the disturbed area of WSDD-10 (0.42 cfs) or 189 gpm as shown on Table 4 of Appendix 7-4.

2. Spillway sizing is a concrete trapezoid with a 3'4" bottom and 1:1 side slopes with a depth of 16", at a slope of 3%;

3. The culvert is a 12" diameter poly pipe at a measured slope of 4.27%.

4. Calculations were performed with the Flowmaster I, Version 3.43 computer program.

Based on the calculations, the expected maximum flow of 2.65 cfs (1189 gpm) will pass through the spillway structure at a depth of _0.26 ft_, which is less than 20% of the 16" total depth of the spillway. The culvert will also carry the flow at a full flow diameter of _0.80 ft_, which is approximately 55% of the full flow capacity of 4.79 cfs or 2150 gpm.

The proposed outlet structures are therefore considered adequate for the maximum expected flows from this area.

UTAH REGISTERED PROFESSIONAL ENGINEER
#154168
DAN W. GUY
10/14/09

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: MINE WATER TREATMENT AREA SPILLWAY

Solve For Depth

Given Input Data:

Bottom Width.....	3.33 ft
Left Side Slope..	1.00:1 (H:V)
Right Side Slope.	1.00:1 (H:V)
Manning's n......	0.035
Channel Slope....	0.0300 ft/ft
Discharge........	2.65 cfs

Computed Results:

Depth............	0.26 ft
Velocity.........	2.79 fps
Flow Area........	0.95 sf
Flow Top Width...	3.86 ft
Wetted Perimeter.	4.08 ft
Critical Depth...	0.26 ft
Critical Slope...	0.0307 ft/ft
Froude Number....	0.99 (flow is Subcritical)

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: MINE WATER TREATMENT DISCHARGE PIPE

Solve For Full Flow Diameter

Given Input Data:

Slope..............	0.0427 ft/ft
Manning's n........	0.020
Discharge..........	2.65 cfs

Computed Results:

Full Flow Diameter.....	0.80 ft
Full Flow Depth........	0.80 ft
Velocity..........	5.26 fps
Flow Area.........	0.50 sf
Critical Depth....	0.72 ft
Critical Slope....	0.0378 ft/ft
Percent Full......	100.00 %
Full Capacity.....	2.65 cfs
QMAX @.94D........	2.85 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: MINE WATER TREATMENT DISCHARGE PIPE

Solve For Full Flow Capacity

Given Input Data:

Diameter..........	1.00 ft
Slope.............	0.0427 ft/ft
Manning's n.......	0.020
Discharge.........	4.79 cfs

Computed Results:

Full Flow Capacity.....	4.79 cfs
Full Flow Depth........	1.00 ft
Velocity..........	6.09 fps
Flow Area.........	0.79 sf
Critical Depth....	0.90 ft
Critical Slope....	0.0374 ft/ft
Percent Full......	100.00 %
Full Capacity.....	4.79 cfs
QMAX @.94D........	5.15 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: Maximum Pipe Flow for 8" Flexible Pipe

Solve For Full Flow Capacity

Given Input Data:

Diameter..........	0.67 ft
Slope.............	0.0330 ft/ft
Manning's n.......	0.010
Discharge.........	2.89 cfs

Computed Results:

Full Flow Capacity.....	2.89 cfs (1297 gpm)
Full Flow Depth........	0.67 ft
Velocity..........	8.20 fps
Flow Area.........	0.35 sf
Critical Depth....	0.66 ft
Critical Slope....	0.0299 ft/ft
Percent Full......	100.00 %
Full Capacity.....	2.89 cfs
QMAX @.94D........	3.11 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: Flexible Pipe Flow for 1000 Gpm (2.23 cfs)

Solve For Full Flow Diameter

Given Input Data:

Slope.............	0.0330 ft/ft
Manning's n.......	0.010
Discharge.........	2.23 cfs

Computed Results:

Full Flow Diameter.....	0.61 ft
Full Flow Depth........	0.61 ft
Velocity..........	7.69 fps
Flow Area.........	0.29 sf
Critical Depth....	0.60 ft
Critical Slope....	0.0298 ft/ft
Percent Full......	100.00 %
Full Capacity.....	2.23 cfs
QMAX @.94D........	2.40 cfs
Froude Number.....	FULL

ATTACHMENT 7

SAFETY FACTOR DETERMINATION

STABILITY ANALYSIS

FOR

MINE WATER TREATMENT FACILITY EMBANKMENT

GENWAL MINE

UTAH REGISTERED PROFESSIONAL ENGINEER
#154168
DAN W. GUY
11/12/09

PREPARED BY: DAN W. GUY, P.E.
BLACKHAWK ENGINEERING, INC.
NOVEMBER 2009

Introduction:

This report is an evaluation of the expected factors of safety of the proposed embankment for the Mine Water Treatment Facility.

Procedure:

Soil characteristics for the proposed embankment material have been tested by RB&G Engineering, Inc., to determine density, cohesion and internal friction angles. These parameters were then used in the safety factor calculations along with the maximum slope height and slope angles for the structure.

Calculations:

Stability calculations were performed using the Hock Method from Rock Slope Engineering. Under this method, stability projections can be made using soil characteristics such as density, cohesion, internal friction angle and proposed slope height. This information can then be plotted on the provided circular failure charts to determine factors of safety for both Dry and Saturated Conditions. The shear strength available to resist failure and the shear stress present along the possible failure surface are included in the analysis of the factor the safety. The shear strength is characterized by the cohesion and the friction angle. Failure would be assumed to occur on a circular failure slope, which is based on the angle of internal friction. These analyses have been addressed and verified using the Hoek Method (Hoek, Evert, And J.W. Bray, "Rock Slope Engineering" Spon Press, 270 Madison Ave. New York, NY, 1974)."

Slope heights and angles were estimated from the General Plan for the Iron Treatment Facility for the Crandall Canyon Mines. Since this is a proposed facility calculations were run on 2 slope height and angle scenarios:

(1) The actual proposed height of 7' with an angle of 2.5H:1V. This will allow for slight changes that may occur during construction.

(2) A maximum height of 10' with an angle of 2H:1V. This will allow for slight changes that may occur during construction.

Results:

Based on the proposed soul characteristics and slope heights and angles, a factor of safety of 10.53 for dry conditions and 7.66 for saturated conditions can be achieved for the proposed slope of 2.5h:1V (21.80°) at a height of 7'. A factor of safety of 7.66 for dry conditions and 6.02 for saturated conditions can be achieved for the steeper slope angle of 2H:1V (26.57°) and a greater height of 10'.

Summary:

Based on the parameters used in this report, expected factors of safety for the proposed embankment run from 7.66 to 10.53 for dry conditions and 6.02 to 7.66 for saturated conditions. Bother sets of parameters show the expected factor of safety to be will in excess of the required 1.30.

TABLE 1

CALCULATION SUMMARY

Maximum Slope Height (H)	7'	10'
Slope Angle	2.5H:1V (21.80°)	2H:1V (26.57°)
Safety Factor (Dry)	10.53	7.66
Safety Factor (Saturated)	7.66	6.02

*Density (γ)	=	118.1 pcf
*Cohesion (c)	=	908 psf
*Internal Friction Angle (ϕ)	=	40.1°

Note:

Based on most conservative results of laboratory tests.

FIGURES

C=Cohesion-psf

Y=Density-pcf

H=Slope Height-ft.

ϕ=Internal Friction Angle

(DRYCONDITIONS)

CIRCULAR FAILURE CHART NUMBER 1

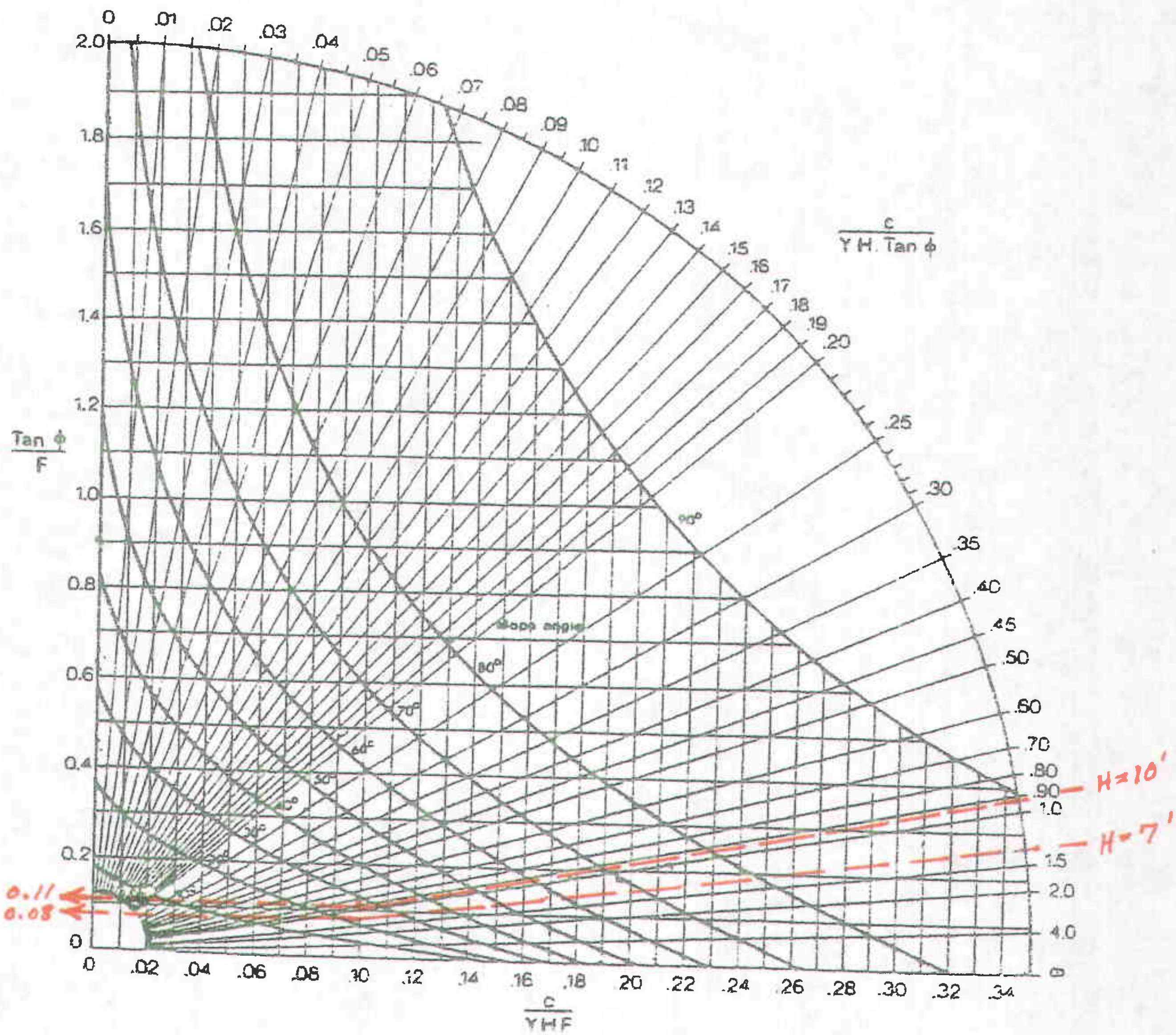


Figure 1

C=Cohesion-psf

Y=Density-pcf

H=Slope Height-ft.

Φ=Internal Friction Angle

(SATURATED CONDITIONS)

CIRCULAR FAILURE CHART NUMBER 5

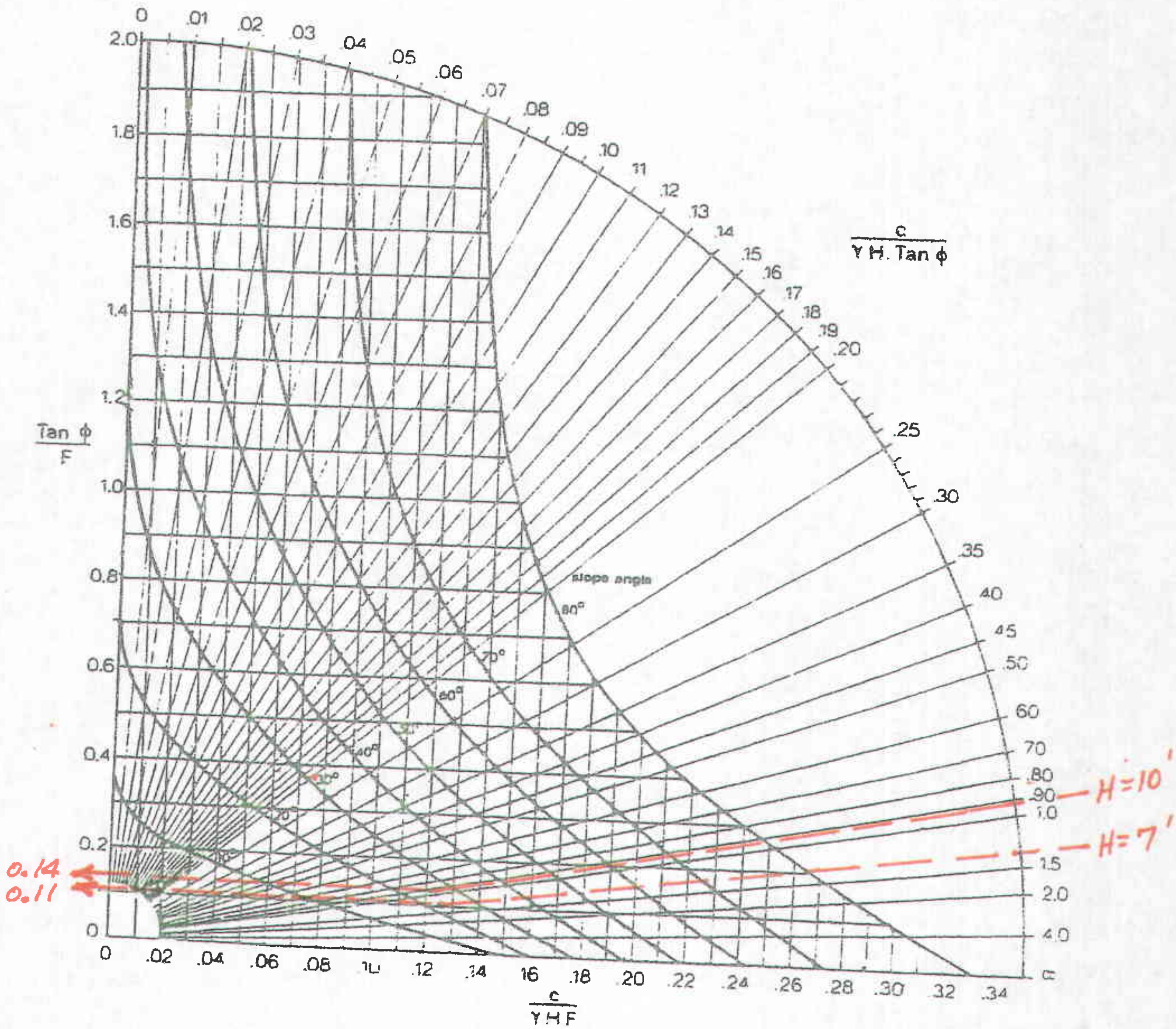


Figure 2

APPENDIX 1

SOIL ANALYSES

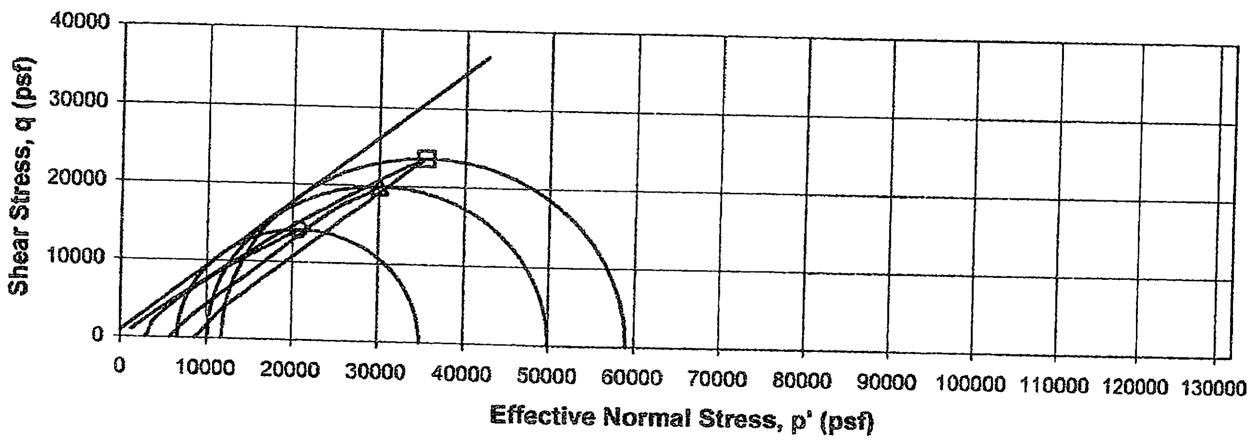
RB&G
ENGINEERING, INC.

MULTI-STAGE CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

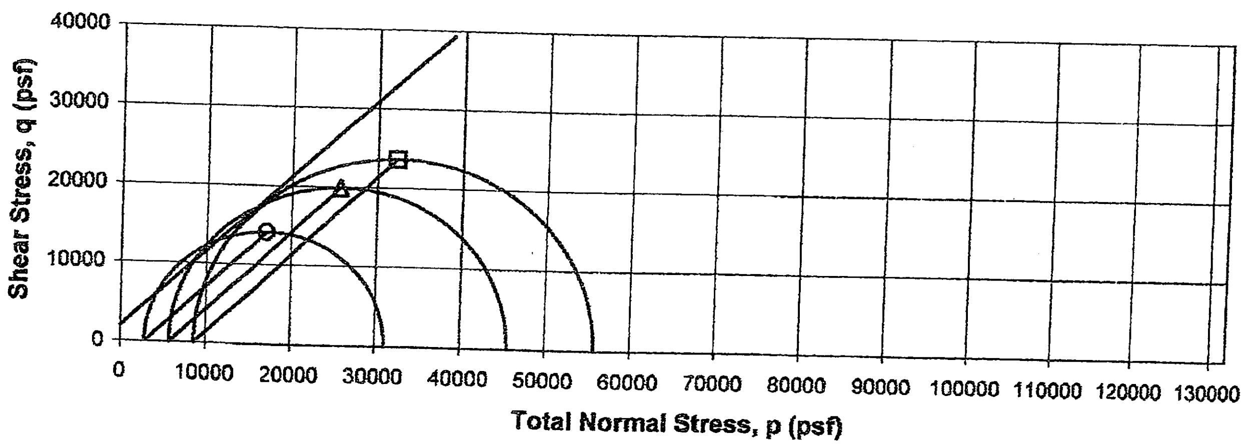
Project	~~Westridge~~ Crandall Cyn Mine		
Project No.	0	**Boring No**	0
Location	0	**Depth / Elev. (ft)**	
Date	11/5/09	**Sample Type**	Remolded
Tested By	J Boone	**Failure Criteria**	Max deviator stress
Sample Description	Lt Brown Silty Gravel w/ Sand GM: Non Plastic		

Summary of Results		σ'_{consol} psf	$\sigma_{d,f}$* psf	ε_f	$\sigma'_{1,f}$* psf	$\sigma'_{3,f}$* psf
Stage 1	○	2880	28253	6.2%	34920	6667
Stage 2	Δ	5758	39866	12.0%	49987	10121
Stage 3	□	8639	47239	12.8%	59108	11869

Effective stress failure envelope c' = 908 psf ϕ' = 40.1°



Total stress failure envelope c = 2000 psf ϕ = 44°



See page two for plots of deviator stress and pore water pressure versus strain.

*Values corrected for membrane effects
**A_c calculated according to ASTM D 4767 10.3.2.1 *Method A*
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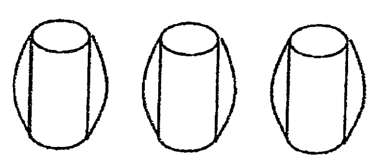
Tested in general accordance with **ASTM D 4767**

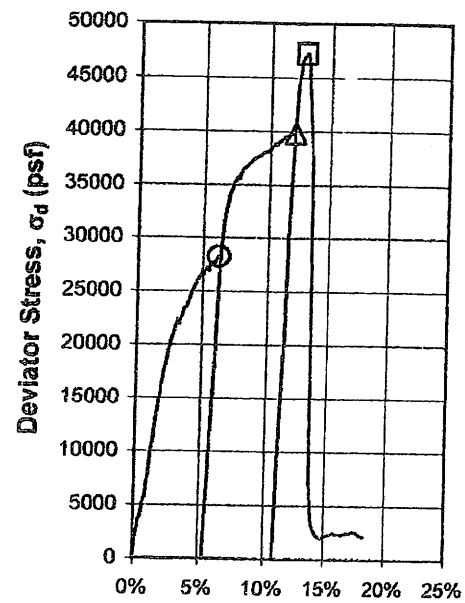
RB&G ENGINEERING, INC.

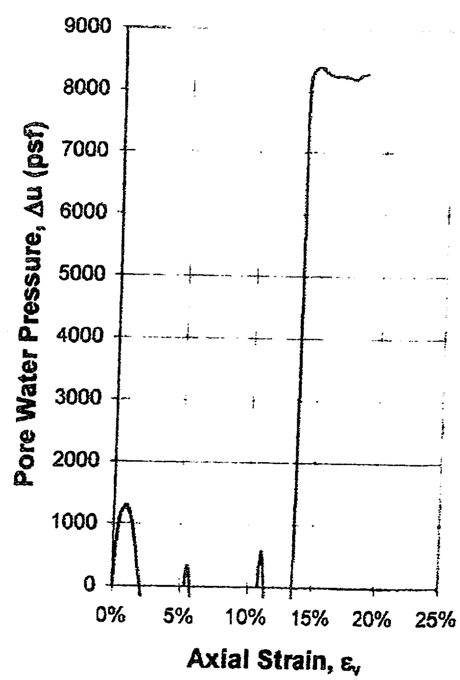
MULTI-STAGE CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Project	~~Westridge~~ Crandall Cyn Mine		
Project No.	0	Boring No	0
Location	0	Depth / Elev. (ft)	
Date	11/5/09	Sample Type	Remolded
Tested By	J Boone	Failure Criteria	Max deviator stress
Sample Description	Lt Brown Silty Gravel w/ Sand GM: Non Plastic		

Symbol			o	Δ	□	
Stage			1	2	3	
Vertical effective consolidation stress		σ'_c	2880	5758	8639	(psf)
Initial	Height	L_o	6.3	5.90	5.56	(in)
	Diameter	D_o	2.8	2.95	3.02	(in)
	Moisture	w_o	6.9%	15.5%	15.0%	
	Dry unit weight	γ_{do}	122.5	118.1	119.2	(pcf)
	Est. specific gravity	G_s	2.68	2.68	2.68	
	Void ratio	e_o	0.36	0.42	0.40	
	Saturation	S_o	51%	100%	100%	
After consolidation	Moisture	w	15.5%	15.0%	14.6%	
	Dry unit weight	γ_d	118.1	119.2	120.3	(pcf)
	Void ratio	e	0.416	0.403	0.390	
	Saturation	S	100%	100%	100%	
	Area	A_c	6.40	6.70	7.04	(in^2)
	Time to 50% consolidation	t_{50}	0.23	2.23	262.16	(min)
	B-value	B	0.95	-	-	
	Total back pressure		14400	10914	12507	(psf)
Results at Failure	Deviator stress	$\sigma_{d,f}$	28253	39866	47239	(psf)
	Major principal effective stress	σ'_1	34920	49987	59108	(psf)
	Minor principal effective stress	σ'_3	6667	10121	11869	(psf)
	Strain	ε_f	6.2%	12.0%	12.8%	
	Strain rate, /min		0.04%	0.04%	0.04%	
	Sketch at Failure					







Remarks **Draft**

*Values corrected for membrane effects

**A_c calculated according to ASTM D 4767 10.3.2.1 *Method A*

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Tested in general accordance with **ASTM D 4767**

RB&G ENGINEERING, INC.

MULTI-STAGE CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Project	~~Westridge~~ Crandall Cyn Mine		
Project No.	0	**Boring No**	0
Location	0	**Depth / Elev. (ft)**	
Date	11/5/09	**Sample Type**	Remolded
Tested By	J Boone	**Failure Criteria**	Max deviator stress
Sample Description	Lt Brown Silty Gravel w/ Sand GM: Non Plastic		

*Values corrected for membrane effects

**A_c calculated according to ASTM D 4767 10.3.2.1 *Method A*

C:\Documents and Settings\dshaver\Local Settings\Temporary Internet Files\OLK18A\Multistage CU report.xls

Tested in general accordance with
ASTM D 4767

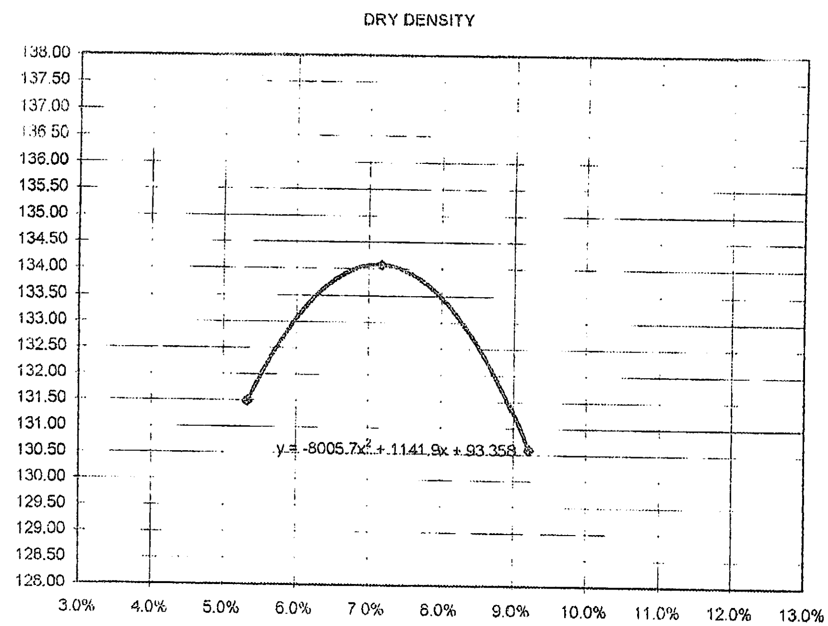
[illegible]

MOISTURE / DENSITY RELATIONSHIPS

CLIENT	SCAMP CONST.		
PROJECT	GENWALL MINE		
METHOD	AASHTO T-180		
TEST	1	2	3
WATER ADDED	2%	2%	2%
CYL. & SOIL WT	24.89	25.28	25.20
CYL. WT.	14.5	14.5	14.5
WET SOIL WT.	10.39	10.78	10.70
WET DENSITY	**138.50**	**143.70**	**142.63**
CONTAINER #	1	2	3
CONT. & WET SOIL	526.8	550.2	542.3
CONT. & DRY SOIL	502.8	516.9	501
WATER WT.	24	33.3	41.3
CONT. & DRY SOIL	502.8	516.9	501
CONT WT.	52.8	53	52.9
DRY SOIL WT.	450	463.9	448.1
MOISTURE	5.3%	7.2%	9.2%
DRY DENSITY	131.49	134.07	130.59

ROAD BASE

TEST #	1			*MAX DRY DENSITY*	134.1
DATE SAMPLE	10/15/2009	*BY*	SCAMP		
DATE TESTED	10/19/2009	*BY*	LWT	*OPTUMUM MOISTURE*	7.1%



X2= -8005.7
X= 1141.9
C= 93.356

JOHANSEN & TUTTLE ENGINEERING

NUCLEAR RELATIVE COMPACTION
TEST DATA

PROJECT: Genwall - Crandal Canyon   DATE: 10-29-00

LOCATION: Crandal Canyon Mine   TESTED BY: K.L.

DENSITY/MOISTURE STANDARDS: 2316 / 641

TEST NUMBER	1	2	3	4	5	6				
STATION										
OFFSET										
ELEVATION										
DEPTH	8"	–	–	–	–	–				
WET DENSITY	133.0	130.3	130.1	126.3	123.1	125.1				
DRY DENSITY	128.6	125.5	124.4	121.8	118.2	108.8				
MAX. DRY DENSITY	134.1	–	–	–	–	–				
OPTIMUM MOISTURE	7.1	–	–	–	–	–				
% MOISTURE	5.1	4.2	4.6	4.0	4.7	5.0				
% COMPACTION	95.9	93.6	92.8	90.8	94.4	94.2				

REMARKS: Wet & compact North corner

JOHANSEN & TUTTLE ENGINEERING

NUCLEAR RELATIVE COMPACTION
TEST DATA

PROJECT: Genwell - Crandal Canyon DATE: 11-9-04

LOCATION: Crandal Canyon Mine TESTED BY: K.E.

DENSITY/MOISTURE STANDARDS: 2316 / 641

TEST NUMBER	1	2	3	4	5					
STATION										
OFFSET										
ELEVATION										
DEPTH										
WET DENSITY	127.5	128.4	130.1	131.2	130.3					
DRY DENSITY	123.8	124.2	125.4	127.0	125.5					
MAX. DRY DENSITY	134.1	—	—	—	—					
OPTIMUM MOISTURE	7.1	—	—	—	—					
% MOISTURE	4.2	4.5	4.7	4.6	4.8					
% COMPACTION	92.3	92.6	93.8	94.7	93.6					

REMARKS: North corner Better

ATTACHMENT 8

CONSTRUCTION SPECIFICATIONS AND DRAWINGS

Crandall Canyon Mine
Mine Water Treatment Facility

Preliminary

1) Grade and pour a concrete trough behind the retaining wall (between wall and rock ledge) to catch and divert seepage water from the ledge. Concrete to be about 6" thick, and sloped to a common point where it will discharge from a pipe to the outside of the wall. Grade as necessary to get proper slope and elevation for the trough.

2) Install a French drain in the low lying area on top of the bedrock, and continue the drain in a ditch within and across the existing fill area. Underdrain will consist of a rigid perforated 4" pipe surrounded by pea gravel. From the seepage collection area the drain pipe (solid) will be laid to the existing 12" discharge line and will connect by dropping into the top. Contractor to supply drain pipe, fittings and pea gravel.

3) After the underdrain system is in place, smooth out the pond bottom area suitable for placement of the pit liner.

Construct settling basin

4) Using a structural granular borrow material, construct a berm around the perimeter of the pond area. The material must be placed in 8" lifts and compacted to 90% density using vibratory sheepsfoot compactors. The top of the berm should be a minimum of 8' wide with 2.5/1 sideslopes. Berm to be level on top, with an elevation of 7815'. Berm must be compacted as it is constructed. Water is available locally if needed.

5) Unload jersey barriers from supplier and store in convenient location upon arrival. Genwal will provide the Jersey barriers.

6) Construct a double wall of barriers atop the berm. Approximately 51 jersey barriers will be needed according to the plan. The barriers are 10' long each. Stagger the joints as much as possible. Extend the barriers beyond the end of the existing retaining wall on the east end, and abut the barriers to the wall on the west end.

7) Cut a spillway notch in the barrier wall at the lower end of the pond.

8) Install the pit liner (and felt underlayment) in the basin area. Anchor the material to the barrier wall by extending it over the inner barrier and draping it into the space between the barriers. Trim the excess material as needed. Then backfill the space between the barriers. Genwal will supply the pit liner and felt material.

9) Along the inside of the retaining wall, affix the pit liner material to a wooden board secured

securely to the concrete wall.

10) After the spillway/discharge system is completed, the area below the basin should be graded and a ditch constructed along the edge of the road to the existing culvert inlet to handle surface runoff.

Construct the spillway/discharge system

11) At the toe of the berm outslope at the discharge end of the pond, next to the ledgerock, install a 2'x2'x2' precast concrete inlet box. The box must have a grate over the inlet. Contractor to supply the inlet box.

12) Extend the 12" poly pipe from the existing pipe up to the concrete inlet box.

13) Construct a 2' high earthen berm around the inlet box and extend this berm on either side back up to the top of the spillway barriers, thereby creating a spillway channel (2' deep) leading from the barrier spillway down to the inlet box.

14) Extend a second layer of pit liner material from the barrier spillway halfway down the spillway channel.

15) Riprap the inner surface of the spillway channel from the barrier spillway to and around the inlet box (bottom and sides) with 8" minimum rock.

16) Grout the riprap with concrete

Install the oxidizer

17) Using suitable earthen material, backfill and compact the upper end of the site where the oxidizer unit goes. When finished, the area should be backfilled to near the top of the upper barrier wall. The area should be sloped slightly to drain to the east end, where a ditch constructed along the barrier wall will drain out to the road.

18) Construct and install a chain-link fence guard around the gravity take-up area between the bent columns.

19) Gravel the access area around the Oxidizer location with a 4" layer of drain-rock gravel. Contractor to supply the drain rock.

20) Disconnect the existing poly pipe manifold at the flange joint

21) Install the Oxidizer. It must be level. The unit weighs about 2000 pounds. Genwal will do the shop modifications to the unit so that it will have 12" flange connections pre-installeded at the inlet and outlet ends

22) Plumb up the 12" inlet pipe from the existing line to the oxidizer. This line must be adequately supported from underneath. It should be equipped with a Tee and a 2" drain valve extending from the end of the connection Tee. Contractor will provide all plumbing pipe, fittings and fixtures.

23) Plumb up the 12" outlet pipes (2 each) from the Oxidizer to the pond. These pipes should be sloped for positive drainage and adequately supported from underneath.

Additional construction

24) Install a 6' high chain-link fence around the outer perimeter of the basin. Affix the fence pole to the top of the inner Jersey barriers. Provide one personnel gate at the upper end of the basin, and one at the lower end near the spillway.

25) Extend additional Jersey barriers along the edge of the road from the pond barriers up to the coexisting concrete platform. Leave a gap between one set of barriers to allow personnel access to the Oxidizer.

26) Plumb up a pipe gooseneck at the existing relief port. This should be plumbed to allow relief water to spill into the pond rather than behind the retaining wall.

27) Place 8" rock (rip-rap) at toe of berm along Forest Service road suitable to prevent erosion from runoff from road.

28) Roughen and re-seed the outslopes of the berm (Genwal to provide seed)

NOTES:

a) Location of barriers is approximate and can vary to accommodate final configuration of berm.

b) Berm corner can be rounded off to facilitate construction if needed.

c) Genwal will provide electrical hookup of Oxidizer and area lighting.

d) Genwal will provide datum elevation benchmark. Contractor to carry all elevations forward.

e) All work must be done in compliance with MSHA laws and regulations

g) Bids must be submitted by Wednesday, September 23. Work must commence as soon thereafter once the Purchase Order is issued, and all Genwal supplied materials ready for delivery on site.

NOTES:

MINIMUM TOP OF JERSEY BARRIERS = 7817.17'

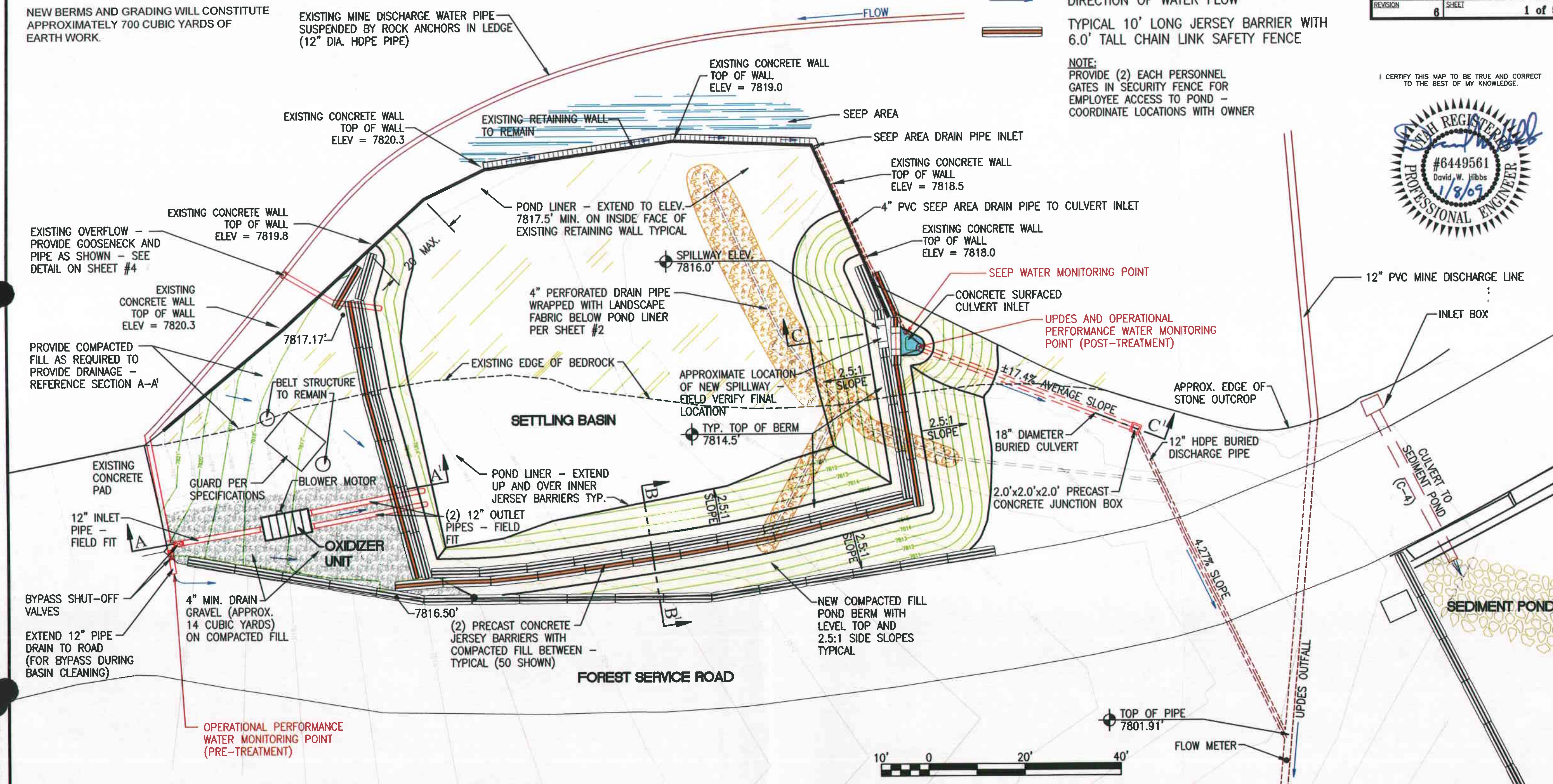
MAXIMUM TOP OF WATER ELEVATION = 7816.0'

TOP OF PAD FOR JERSEY BARRIERS - 7814.5'

SETTLING POND VOLUME = APPROX. 38,500 CUBIC FEET (APPROX. 288,000 GALLONS)

ALL NEW BERMS SHALL HAVE A MAXIMUM SLOPE OF 2.5 HORIZONTAL UNITS TO 1 VERTICAL UNIT.

NEW BERMS AND GRADING WILL CONSTITUTE APPROXIMATELY 700 CUBIC YARDS OF EARTH WORK.



LEGEND

- EXISTING 1' CONTOUR LINES
- EXISTING CONTOUR LINES COMPACTED FILL
- NEW POND BERM CONTOUR LINES
- OVERLAND DRAINAGE PATH
- TYPICAL 10' LONG JERSEY BARRIER
- DIRECTION OF WATER FLOW
- TYPICAL 10' LONG JERSEY BARRIER WITH 6.0' TALL CHAIN LINK SAFETY FENCE

NOTE:
PROVIDE (2) EACH PERSONNEL GATES IN SECURITY FENCE FOR EMPLOYEE ACCESS TO POND - COORDINATE LOCATIONS WITH OWNER

GENERAL PLAN

IRON TREATMENT FACILITY

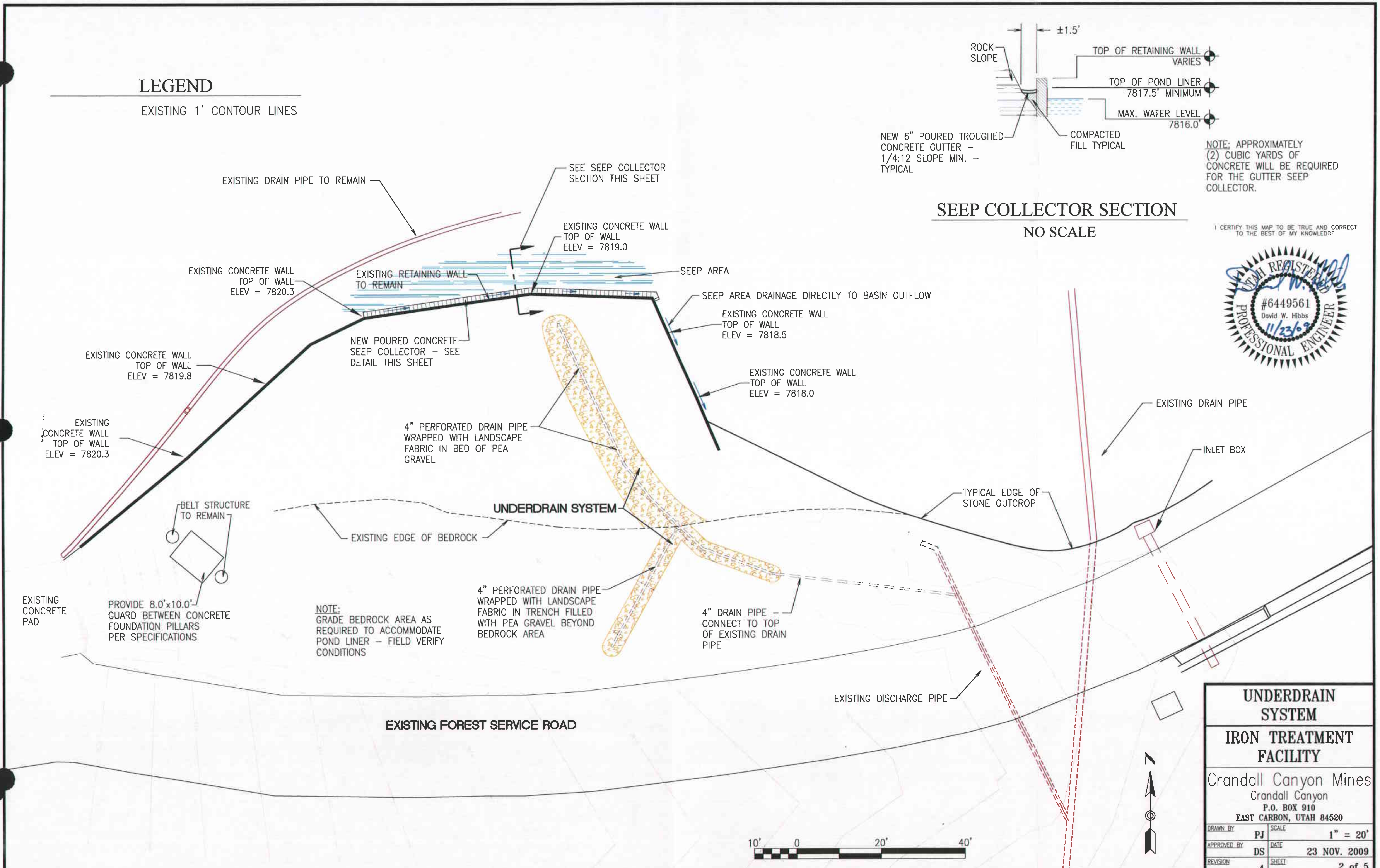
Crandall Canyon Mines
Crandall Canyon
P.O. BOX 910
EAST CARBON, UTAH 84520

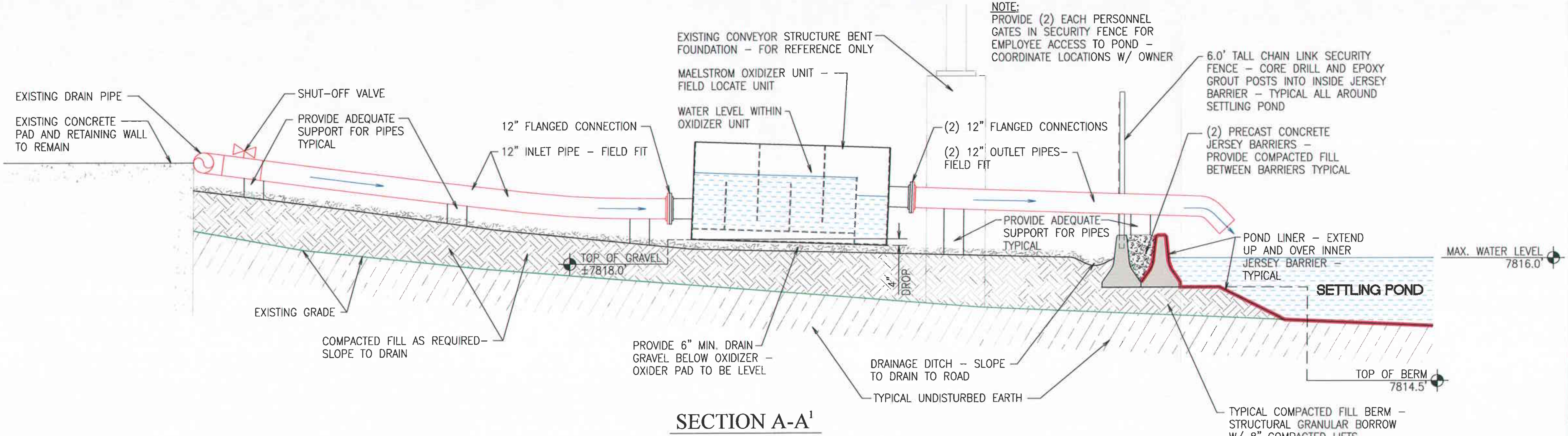
DRAWN BY	PJ	SCALE	1" = 20'
APPROVED BY	DS	DATE	8 JANUARY 2010
REVISION	6	SHEET	1 of 5

I CERTIFY THIS MAP TO BE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE.

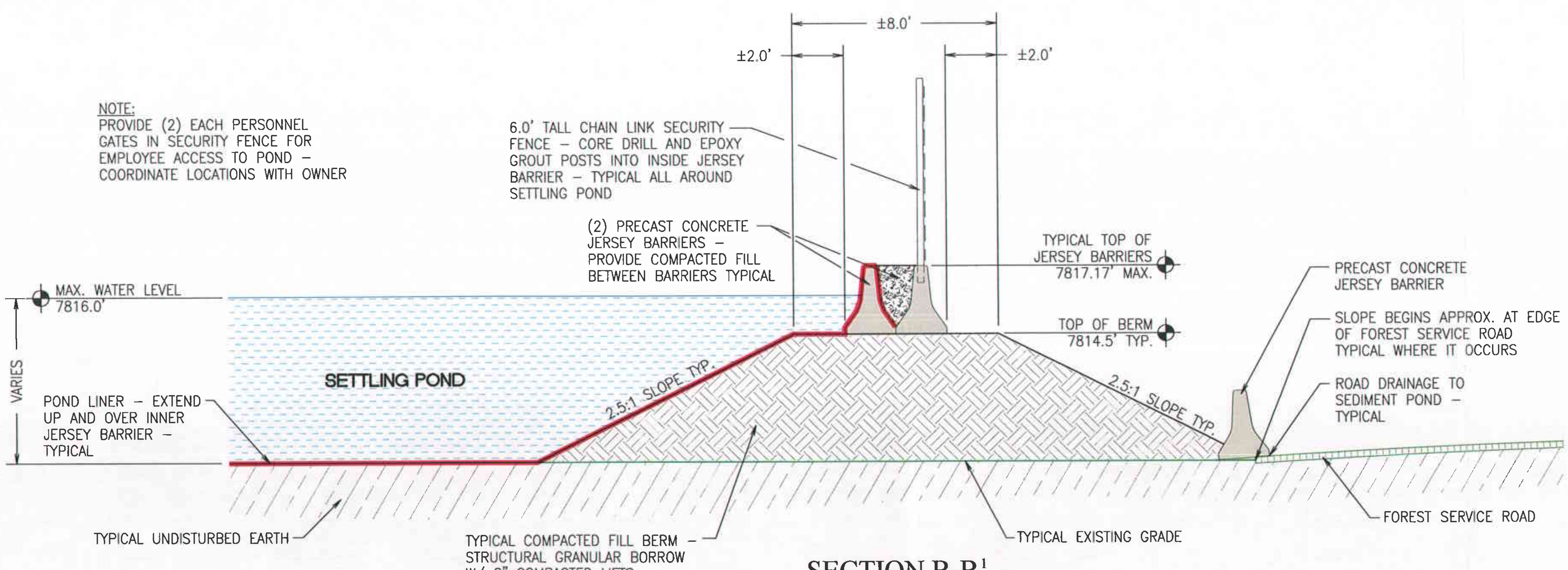
UTAH REGISTERED PROFESSIONAL ENGINEER #6449561 David W. Hibbs 1/8/09

G:\Current Drawings\MRP\...dall Canyon\Current\CranDall Portal Reclamation\Settlement Pond Design 9-10-09.dwg, Plan View, 1/8/2010 10:48:28 AM


LEGEND
EXISTING 1' CONTOUR LINES
ROCK SLOPE
±1.5'
TOP OF RETAINING WALL VARIES
TOP OF POND LINER 7817.5' MINIMUM
MAX. WATER LEVEL 7816.0'
NEW 6" POURED TROUGHED CONCRETE GUTTER – 1/4:12 SLOPE MIN. – TYPICAL
COMPACTED FILL TYPICAL
NOTE: APPROXIMATELY (2) CUBIC YARDS OF CONCRETE WILL BE REQUIRED FOR THE GUTTER SEEP COLLECTOR.
SEEP COLLECTOR SECTION
NO SCALE
I CERTIFY THIS MAP TO BE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE.
UTAH REGISTERED PROFESSIONAL ENGINEER #6449561 David W. Hibbs 11/23/09
EXISTING DRAIN PIPE TO REMAIN
SEE SEEP COLLECTOR SECTION THIS SHEET
EXISTING CONCRETE WALL TOP OF WALL ELEV = 7819.0
EXISTING CONCRETE WALL TOP OF WALL ELEV = 7820.3
EXISTING RETAINING WALL TO REMAIN
SEEP AREA
SEEP AREA DRAINAGE DIRECTLY TO BASIN OUTFLOW
EXISTING CONCRETE WALL TOP OF WALL ELEV = 7818.5
NEW POURED CONCRETE SEEP COLLECTOR – SEE DETAIL THIS SHEET
EXISTING CONCRETE WALL TOP OF WALL ELEV = 7819.8
EXISTING CONCRETE WALL TOP OF WALL ELEV = 7818.0
EXISTING DRAIN PIPE
4" PERFORATED DRAIN PIPE WRAPPED WITH LANDSCAPE FABRIC IN BED OF PEA GRAVEL
EXISTING CONCRETE WALL TOP OF WALL ELEV = 7820.3
INLET BOX
BELT STRUCTURE TO REMAIN
UNDERDRAIN SYSTEM
TYPICAL EDGE OF STONE OUTCROP
EXISTING EDGE OF BEDROCK
4" PERFORATED DRAIN PIPE WRAPPED WITH LANDSCAPE FABRIC IN TRENCH FILLED WITH PEA GRAVEL BEYOND BEDROCK AREA
EXISTING CONCRETE PAD
PROVIDE 8.0'x10.0' GUARD BETWEEN CONCRETE FOUNDATION PILLARS PER SPECIFICATIONS
NOTE: GRADE BEDROCK AREA AS REQUIRED TO ACCOMMODATE POND LINER – FIELD VERIFY CONDITIONS
4" DRAIN PIPE – CONNECT TO TOP OF EXISTING DRAIN PIPE
EXISTING DISCHARGE PIPE
EXISTING FOREST SERVICE ROAD
N
10' 0 20' 40'
UNDERDRAIN SYSTEM
IRON TREATMENT FACILITY
Crandall Canyon Mines
Crandall Canyon
P.O. BOX 910
EAST CARBON, UTAH 84520
DRAWN BY PJ
SCALE 1" = 20'
APPROVED BY DS
DATE 23 NOV. 2009
REVISION 4
SHEET 2 of 5



SECTION A-A[1]
GENERALIZED OXIDIZER UNIT PAD



SECTION B-B[1]
TYPICAL GENERALIZED BERM SECTION

I CERTIFY THIS MAP TO BE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE.

UTAH REGISTERED PROFESSIONAL ENGINEER #6449561 David W. Hibbs 11/23/09

CROSS SECTIONS
IRON TREATMENT FACILITY

Crandall Canyon Mines
Crandall Canyon
P.O. BOX 910
EAST CARBON, UTAH 84520

DRAWN BY	PJ	SCALE	1" = 20'
APPROVED BY	DS	DATE	23 NOV. 2009
REVISION	5	SHEET	3 of 5

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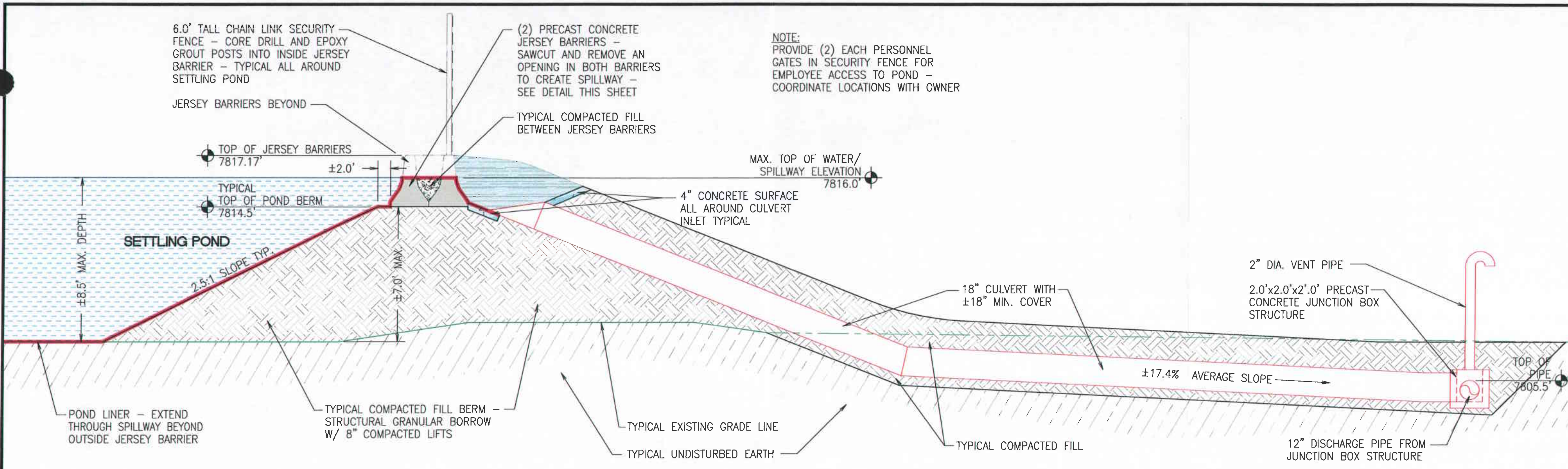
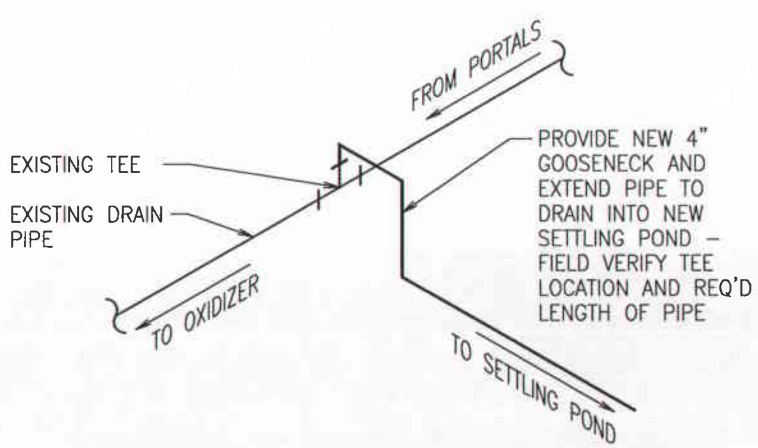


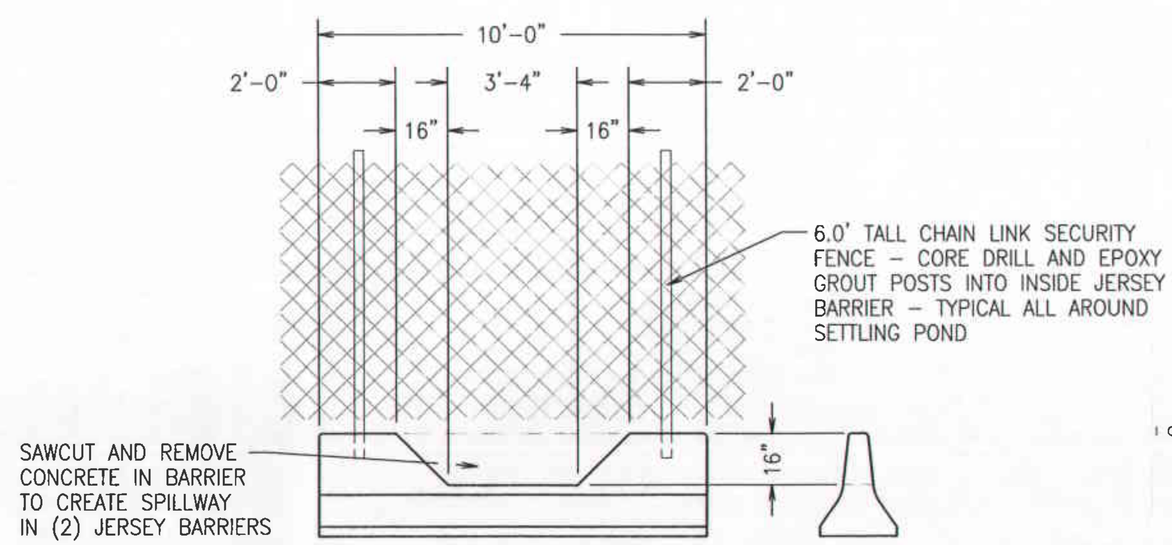
SECTION C-C[1]

SPILLWAY SECTION



OVERFLOW TEE SCHEMATIC

NO SCALE



JERSEY BARRIER DETAIL AT SPILLWAY

I CERTIFY THIS MAP TO BE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE.

UTAH REGISTERED PROFESSIONAL ENGINEER
#6449561
David W. Hibbs
11/23/09

CONSTRUCTION DETAILS	
IRON TREATMENT FACILITY	
Crandall Canyon Mines Crandall Canyon P.O. BOX 910 EAST CARBON, UTAH 84520	
DRAWN BY PJ	SCALE 1" = 20'
APPROVED BY DS	DATE 23 NOV. 2009
REVISION 4	SHEET 4 of 5

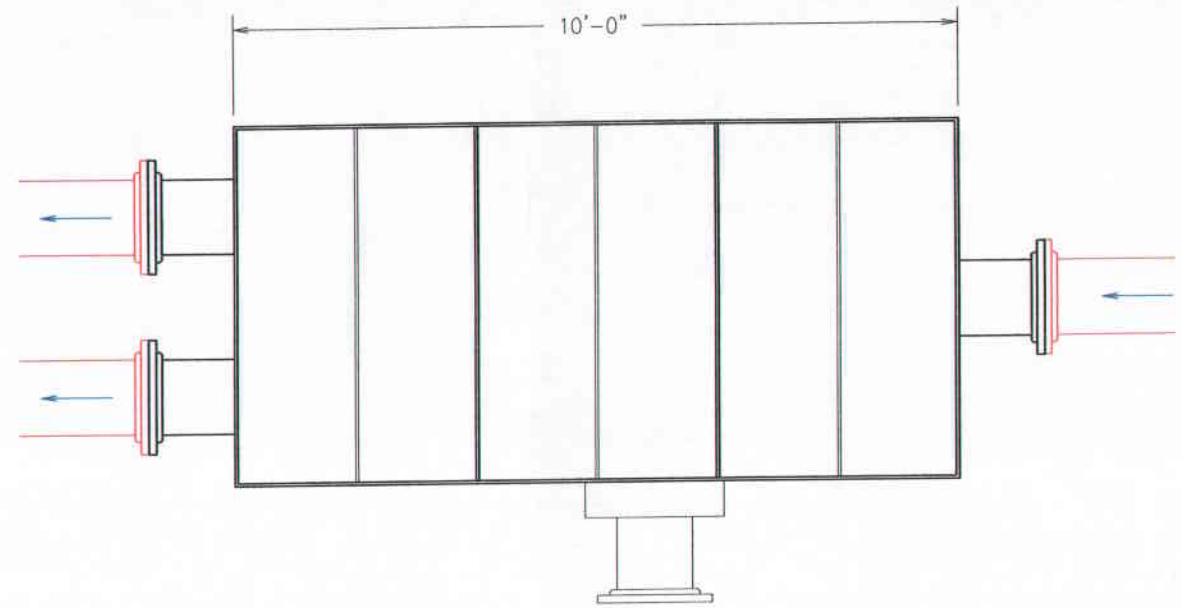
NOTES:
ITEMS DENOTED WITH BLACK LINES ARE RELATED TO THE MAELSTROM OXIDIZER UNIT.

ITEMS DENOTED WITH RED LINES ARE RELATED TO ITEMS THAT ARE TO BE FABRICATED.

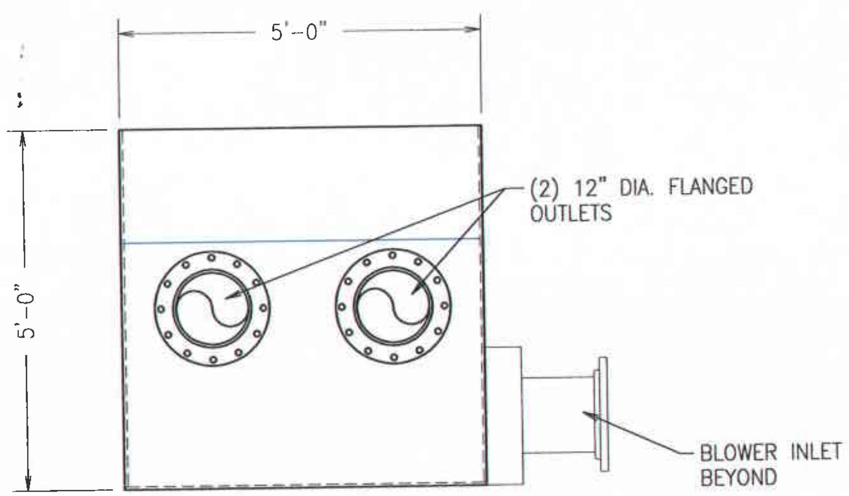
ALL JOINTS THAT CAN REASONABLY BE WELDED IN THE SHOP SHALL BE DONE SO.

ALL WELDED JOINTS SHALL BE WATER TIGHT AND GROUND SMOOTH WHENEVER POSSIBLE.

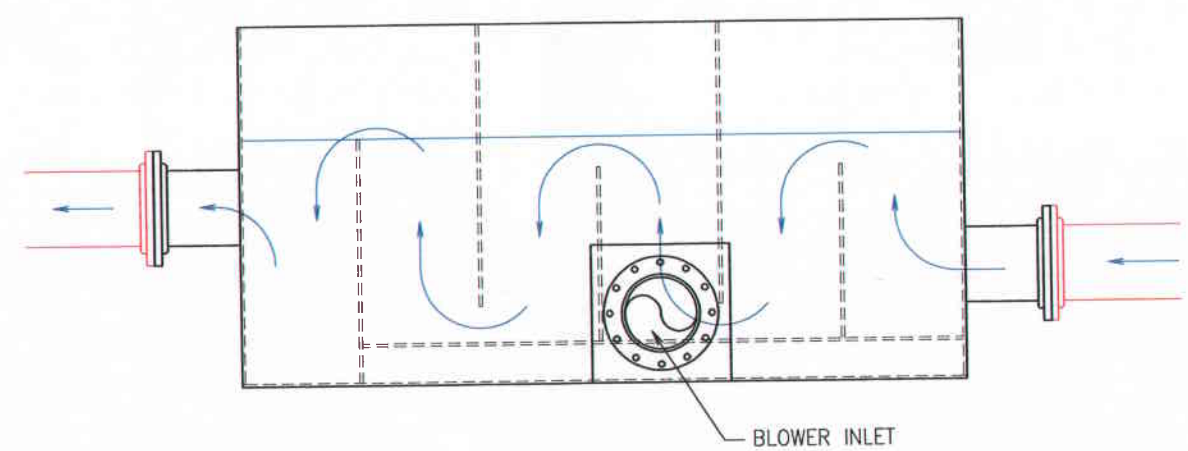
OXIDIZER UNIT MANUFACTURED BY:
ENVIRONMENTAL SOLUTIONS, LLC
314 POLO CLUB DRIVE
MOON TOWNSHIP, PENNSYLVANIA 15108
PHONE: (412) 262-2606 OR (412) 716-7600



TOP VIEW

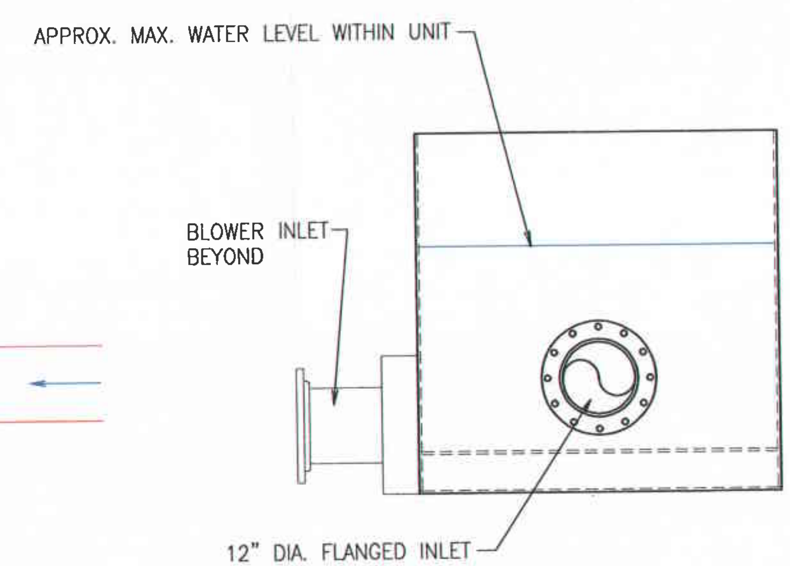


OUTLET END



NOTE:
RIGHT SIDE SIMILAR.

LEFT SIDE VIEW



INLET END

I CERTIFY THIS MAP TO BE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE.

UTAH REGISTERED PROFESSIONAL ENGINEER
#6449561
David W. Hibbs
10/12/09

OXIDIZER UNIT	
IRON TREATMENT FACILITY	
Crandall Canyon Mines Crandall Canyon P.O. BOX 910 EAST CARBON, UTAH 84520	
DRAWN BY PJ	SCALE 1" = 20'
APPROVED BY DS	DATE 12 OCT. 2009
REVISION 2	SHEET 5 of 5

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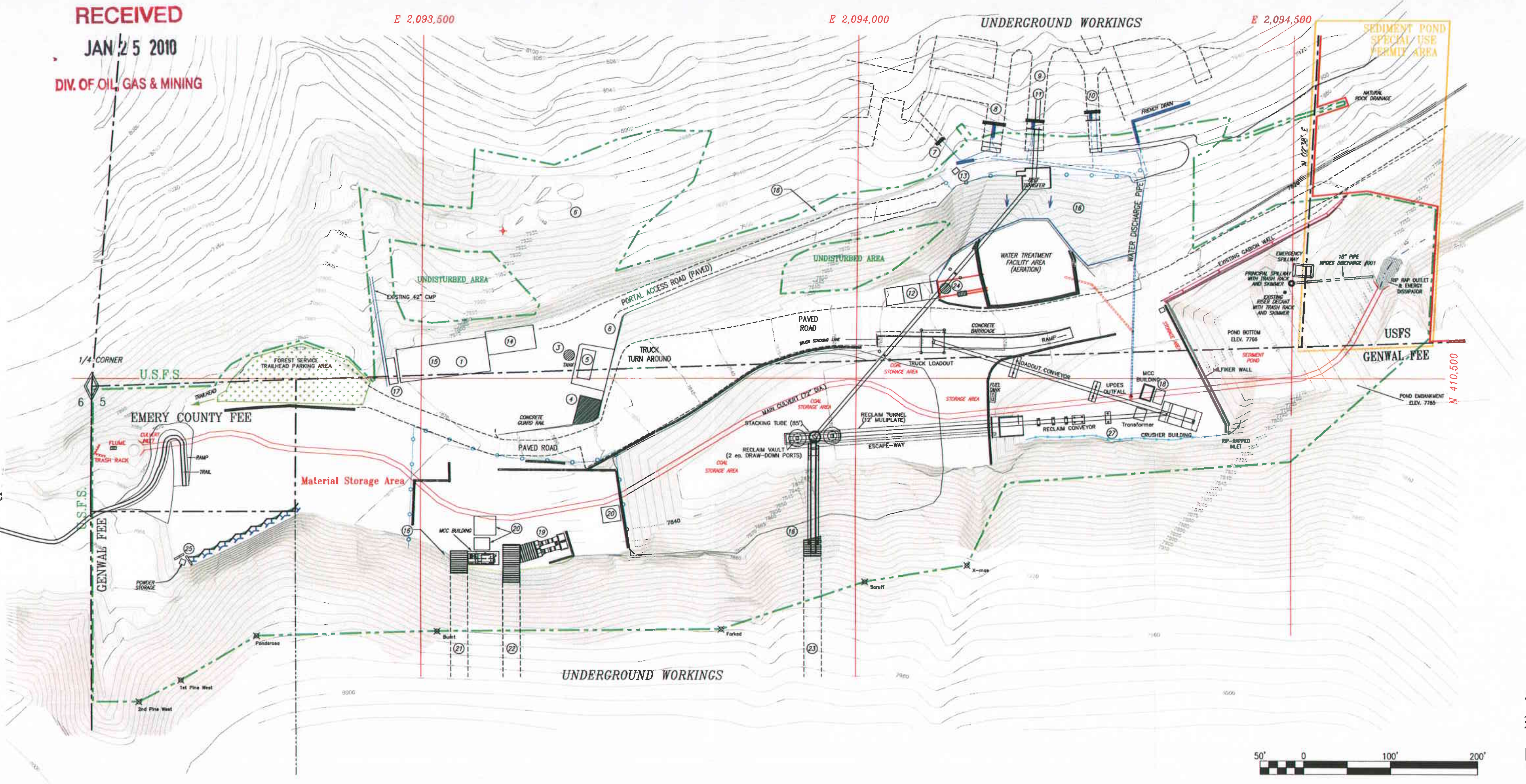
PLATE 5-3

SURFACE FACILITIES



LEGEND:

SEDIMENT POND (SPECIAL USE PERMIT AREA)	
EXTENT OF DISTURBANCE	
10' CONTOUR	
JERSEY BARRIERS	
RE-ESTABLISHED USFS ROAD (DOUBLE-LANE)	/ / / /
SAFETY BARRIERS	
FENCING	

FACILITY LEGEND:

1. Shop
2. Ventilation Fan
3. Rockdust Silo
4. Concrete Dumpster Pad
5. Power Center
6. Power Pole
7. Offices & Bathhouse (u'grd)
8. Intake Portal
9. Belt Portal
10. Fan Portal
11. Mine Belt
12. Oil Storage
13. Visual Disconnect
14. New Warehouse and Office Building
15. 4500 Gallon Culinary Water Tank
16. Shotcrete
17. Parts Shed
18. Portable Shed
19. Ventilation Fan
20. Material Storage Sheds
21. Intake Portal
22. Return Portal
23. Belt Portal
24. Mag Tank
25. Powder Storage
26. Cap Storage
27. Concrete Ditch

UTAH REGISTERED PROFESSIONAL ENGINEER #6449561 David W. Hibbs 10/12/09

GENWAL™ RESOURCES, INC.
P.O. Box 1077, 794 North "C" Canyon Rd, Price Utah
Telephone: (435) 888-4000

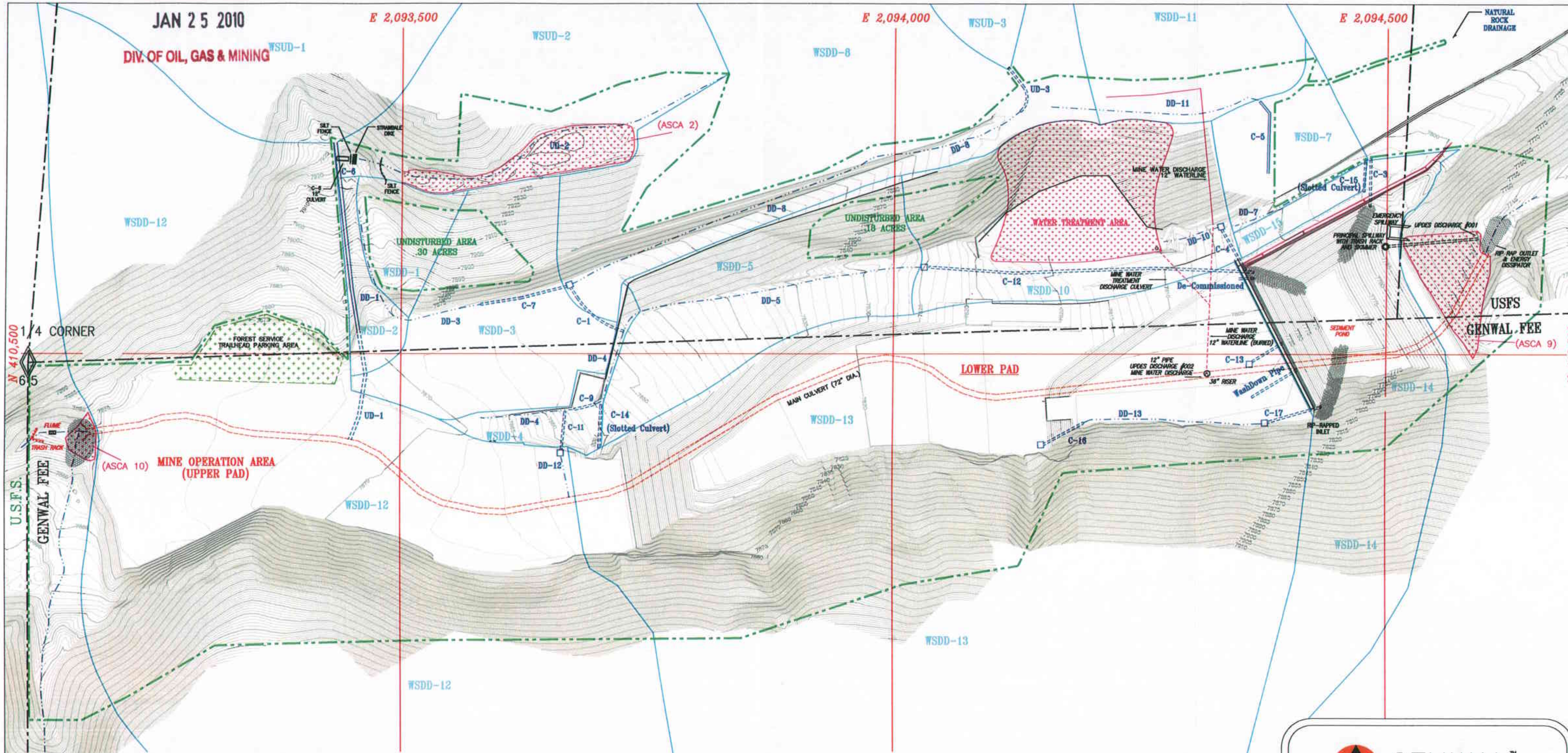
CRANDALL CANYON MINE
SURFACE FACILITIES

REV: 17	ACAD: 5-3
DATE: 10-12-09	BY: PJJ
SCALE: AS SHOWN	PLATE #: 5-3

G:\Current Drawings\MRP Maps\Crandall Canyon\INCOPORATED MAPS 03-05-08\Plate 5-3 REV 17.dwg, 11x17, 10/12/2009 9:19:15 AM

PLATE 7-5

DRAINAGE MAP



CONTOUR INTERVAL = 10'

LEGEND:

- POTENTIAL EXTENT OF DISTURBANCE
- 10' CONTOUR
- JERSEY BARRIERS
- WATERSHED BOUNDARY
- UNDISTURBED/DISTURBED WATERSHED (WSUD-1, WSDD-10)
- DIVERSION DITCH (DD-4)
- CULVERT (Solid-Above Grd/Dashed-Buried) (C-6)
- 6' DIAMETER CULVERT
- ASCA AREA:

UTAH REGISTERED PROFESSIONAL ENGINEER
#6449561
David W. Hibbs
1/12/10

GENWAL™ RESOURCES, INC.
P.O. Box 1077, 794 North "C" Canyon Rd, Price Utah
Telephone: (435) 888-4000

CRANDALL CANYON MINE DRAINAGE MAP

REV: 16	ACAD: 7-5
DATE: JAN. 2010	BY: PJJ
SCALE: 1" = 100'	PLATE #: 7-5