0063

Canyon Fuel Company, LLC
Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542

Incoming
C/007/0039

September 20, 2007

Ms. Pamela Grubaugh-Littig
Utah Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
Salt Lake City, UT 84114-5801

RE: Clean Copies of Degas Wells Amendment to Add Wells G-18, G-31 and AMV Road, Task ID# 2846 - Dugout Canyon Mine, Canyon Fuel Company, LLC, C/007/039, Carbon County, Utah

Dear Ms. Grubaugh-Littig:

Attached please find four copies of the information to be incorporated both into the M&RP binders and the Degas Methane binders for Dugout Canyon Mine. The changes to the permit have been coordinated with Division staff. In addition two copies of archeological report have been provided for incorporation into the Divisions confidential folders. Please stamp for incorporation and return one of the two copies to the Dugout Canyon Mine for inclusion into our set of confidential binders.

A copy of this information will be delivered to the Price Field Office.

We appreciate the timely review of this information. Please call with questions (435) 636-2869.

Sincerely yours,

Vicky S Miller

Vicky S. Miller

cc: Dave Spillman

File in:
C/0070039, 2007, Incoming
Refer to:
☐ Confidential
☐ Shelf
☐ Expandable
Date 9/20/07 For additional information

RECEIVED
SEP 2 0 2007
DIV. OF OIL, GAS & MINING

APPLICATION FOR COAL PERMIT PROCESSING

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

Permittee: Canyon Fuel Company, LLC
Mine: Dugout Canyon Mine **Permit Number:** C/007/039
Title: Clean Copies of Degas Wells Amendment to Add Wells G-18, G-31 and the AMV Road, Task ID # 2846
Description, Include reason for application and timing required to implement:

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

☒ Yes ☐ No 1. Change in the size of the Permit Area? Acres: _____ Disturbed Area: 20.63 ☒ increase ☐ decrease.
☐ Yes ☒ No 2. Is the application submitted as a result of a Division Order? DO# _____
☐ Yes ☒ No 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?
☐ Yes ☒ No 4. Does the application include operations in hydrologic basins other than as currently approved?
☐ Yes ☒ No 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?
☐ Yes ☒ No 6. Does the application require or include public notice publication?
☐ Yes ☒ No 7. Does the application require or include ownership, control, right-of-entry, or compliance information?
☐ Yes ☒ No 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
☐ Yes ☒ No 9. Is the application submitted as a result of a Violation? NOV # _____
☐ Yes ☒ No 10. Is the application submitted as a result of other laws or regulations or policies?
Explain: ______
☐ Yes ☒ No 11. Does the application affect the surface landowner or change the post mining land use?
☐ Yes ☒ No 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
☒ Yes ☐ No 13. Does the application require or include collection and reporting of any baseline information?
☒ Yes ☐ No 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
☒ Yes ☐ No 15. Does the application require or include soil removal, storage or placement?
☒ Yes ☐ No 16. Does the application require or include vegetation monitoring, removal or revegetation activities?
☐ Yes ☒ No 17. Does the application require or include construction, modification, or removal of surface facilities?
☒ Yes ☐ No 18. Does the application require or include water monitoring, sediment or drainage control measures?
☒ Yes ☐ No 19. Does the application require or include certified designs, maps or calculation?
☐ Yes ☒ No 20. Does the application require or include subsidence control or monitoring?
☒ Yes ☐ No 21. Have reclamation costs for bonding been provided?
☒ Yes ☐ No 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?
☐ Yes ☒ No 23. Does the application affect permits issued by other agencies or permits issued to other entities?

Please attach four (4) review copies of the application. If the mine is on or adjacent to Forest Service land please submit five (5) copies, thank you. (These numbers include a copy for the Price Field Office)

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

David Spillman
Print Name

David Spillman Engineering Manager 9/19/07
Sign Name, Position, Date

Subscribed and sworn to before me this 19 day of September, 2007

Vicky Sue Miller
Notary Public

My commission Expires: 1-5, 2008 }
Attest: State of UTAH } ss:
County of CARBON

VICKY SUE MILLER
NOTARY PUBLIC • STATE of UTAH
1776 KENILWORTH RD.
HELPER, UTAH 84526
COMM. EXPIRES 1-5-2008

For Office Use Only:	Assigned Tracking Number:	Received by Oil, Gas & Mining
		RECEIVED SEP 20 2007 DIV. OF OIL, GAS & MINING

Form DOGM- C1 (Revised March 12, 2002)

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

Permittee: Canyon Fuel Company, LLC
Mine: Dugout Canyon Mine **Permit Number:** C/007/039
Title: Clean Copies of Degas Wells Amendment to Add Wells G-18, G-31 and AMV Road, Task ID#2846

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

Add	Replace	Remove	DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐ Add	☒ Replace	☐ Remove	Degas Wells - Chapter 1 and Figure 1-1
☐ Add	☒ Replace	☐ Remove	Degas Wells - Chapter 2
☒ Add	☐ Replace	☐ Remove	Attachment 2-1 - Soil Inventory and Assessment - add to back of existing information
☒ Add	☐ Replace	☐ Remove	Attachment 2-2 - Topsoil Calcualtions - add to back of existing information
☒ Add	☐ Replace	☐ Remove	Attachment 2-4 - Reclamation Information
☐ Add	☒ Replace	☐ Remove	Degas Wells - Chapter 3 and Figures 3-1 and 3-2
☒ Add	☐ Replace	☐ Remove	Attachment 3-1 - NRCS Letter, Vegetation Report - Add to back of existing information
☒ Add	☐ Replace	☐ Remove	Attachment 3-2 - Bat Survey, T&E Lists
☐ Add	☒ Replace	☐ Remove	Degas Wells - Chapter 4
☐ Add	☒ Replace	☐ Remove	Degas Wells - Chapter 5 and Figure 5-26
☒ Add	☐ Replace	☐ Remove	Attachment 5-1, Figures 1, 2 & 3 for Degas Wells G-18 and G-31
☒ Add	☐ Replace	☐ Remove	Attachment 5-2, Well Plugging and Reclamation Chart and Drawing showing Locations of Methane Drainage Wells and Well Construction and Reclamation Schedule
☒ Add	☐ Replace	☐ Remove	Attachment 5-4 - Degas Wells Access Road
☐ Add	☒ Replace	☐ Remove	Degas Wells - Chapter 7
☒ Add	☐ Replace	☐ Remove	Attachment 7-1 - Containment and Hydrologic Calculations Degas Well G-18, G-31 & Road
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	
☐ Add	☒ Replace	☐ Remove	M&RP - Chapter 1, Page 1-9
☐ Add	☒ Replace	☐ Remove	M&RP - Appendix 1-4
☐ Add	☒ Replace	☐ Remove	M&RP - Plates 1-4
☒ Add	☐ Replace	☐ Remove	M&RP - Appendix 5-6, Degas Well G-18, G-31 and AMV Road Bond Calculations
☐ Add	☒ Replace	☐ Remove	M&RP - Appendix 5-6, Page 1, Bond Totals
☐ Add	☒ Replace	☐ Remove	M&RP - Plates7-1
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	Confidential Folder - Archeological Reports SPUT-553 and 387
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	

Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.	Received by Oil, Gas & Mining
9/20/07 The Degassification Amendment is a stand alone document, pages in this submittal will be incorporated into the existing binder. M&RP A page from Chapter 1, Plates 1-4, 7-1, Appendix 1-4 and 5-6 have been included in this submittal they go into the M&RP binder.	RECEIVED SEP 2 0 2007 DIV. OF OIL, GAS & MINING

CHAPTER 1

LEGAL, FINANCIAL, COMPLIANCE AND RELATED INFORMATION

M&RP

T13 S., R13 E., SLBM, Utah (Added to Permit Area in 2005, approximately 2,360 acres)

Section 17: E1/2SW1/4, SW1/4SE1/4, E1/2E1/2W1/2SW1/4

Section 20: E1/2W1/2, E1/2, E1/2E1/2W1/2W1/2

Section 21: SW1/4NW1/4, SW1/4

Section 28: NW1/4, N1/2SW1/4, SW1/4SW1/4

Section 29: All

Section 30: E1/2, E1/2W1/2

Waste Rock Storage Facility

T. 14 S., R. 12 E., SLBM, Utah (Approximately 26.8 acres)

Section 18: Portions of NE1/4, SW1/4 and SE1/4 of the NE1/4

All of Lease ML-42648, except the E1/2 of Section 8 and the NE1/4 of Section 17, is included within the Dugout Canyon Mine permit boundary. However, only the S1/2 SE1/4 of Section 9 from Lease ML-42649 is within the permit boundary. The ten acres described in UTU-76601 are also described in UTU-77985. The U.S. Department of Interior, Bureau of Land Management (BLM) right-of-way application UTU-76601 is included in Appendix 1-3.

The disturbed area encompasses 20.80 acres (Mine Facility area, including Gilson well pad and small substation), 30.4 acres (G-2, G-3, G-4, G-5, G-6, G-7, G-9, G-10, G-11, G-12, G-13, G-14, G-15, G-16, G-17, G-18, G-19 and G-31 Degas Well), 14.25 acres (AMV Road) 0.85 (Topsoil Stockpile), 1.8 acres (Leach field/pipeline area), 2.7 acres (Pace Canyon Fan Facility) and 26.8 acres (Refuse Pile area) totaling approximately 97.6 acres. That acreage includes a pre- and post mining road with an area of 1.6 acres and 2.03 acres of undisturbed land within the mine facilities disturbed area and 11.2 acres within the refuse pile disturbed area.

The permit boundary encompasses approximately 9,511 acres which includes the following surface ownership and acreage: 10 acres in the BLM right-of-way, approximately 567 acres of other federal lands, 920 acres of state lands, and fee acreage of approximately 8,014 acres (Plate 1-1 and RA Plate 1-1).

Coal ownership acreage within the permit area includes approximately 2,844 acres of federal coal, approximately 5840 acres of state coal, and 827 acres of fee coal (Plate 1-2 and RA1-1B). Approximately 745 acres which include the surface subsidence area, refuse pile and leach field

APPENDIX 1-4

Disturbed Area Legal Description

LEGAL DESCRIPTION OF BONDED AREA:

Waste Rock Storage Facility
T. 14 S., R. 12 E., SLBM, Utah (Approximately 26.8 acres)
Section 18: Portions of NW1/4NE1/4NE1/4
Portions of NE1/4NE1/4NE1/4
Portions of SW1/4NE1/4NE1/4
Portions of SE1/4NE1/4NE1/4
Portions of NW1/4SE1/4NE1/4

Leachfield and Pipeline
T. 13 S., R. 12 E., SLBM, Utah (Approximately 1.8 acres)
Section 22: Portion of SE1/4SE1/4NE1/4SE1/4
Portion of NE1/4SE1/4NE1/4SE1/4
Portion of N1/2NE1/4SE1/4SE1/4;
Portion of SW1/4NE1/4SE1/4SE1/4;
Portion of S1/2NW1/4SE1/4SE1/4;
Portion of SE1/4NE1/4SW1/4SE1/4;
Portion of N1/2SE1/4SW1/4SE1/4;
Portion of NE1/4SW1/4SW1/4SE1/4;
Portion of S1/2SW1/4SW1/4SE1/4
Section 23: Portion of SW 1/4NW1/4NW1/4SW1/4;
Portion of SE1/4NW1/4NW1/4SW1/4;
Portion of NW1/4SW1/4NW1/4SW1/4;
Section 27: Portion of W1/2NW1/4NW1/4NE1/4
Portion of SE1/4NE1/4NE1/4NW1/4
Portion of E1/2SE1/4NE1/4NW1/4
Portion of SW1/4SE1/4NE1/4NW1/4

Main Facilities Area T. 13 S., R. 12 E., SLBM, Utah (Approximately 20.80 acres)

Section 23: A Portion of the following:
NE1/4NE1/4NW1/4SW1/4; NE1/4NW1/4NW1/4SW1/4;
NW1/4NE1/4NW1/4SW1/4;SW1/4SE1/4SW1/4NW1/4;
SE1/4SE1/4SW1/4NW1/4;NW1/4SE1/4SW1/4NW1/4;
NE1/4SE1/4SW1/4NW1/4;SW1/4SW1/4SE1/4NW1/4;
SE1/4SW1/4SE1/4NW1/4;NW1/4SW1/4SE1/4NW1/4;
NE1/4SW1/4SE1/4NW1/4;SW1/4NW1/4SE1/4NW1/4;
SE1/4NW1/4SE1/4NW1/4;NE1/4NW1/4SE1/4NW1/4;
SW1/4NE1/4SE1/4NW1/4;NW1/4NE1/4SE1/4NW1/4;
NE1/4NE1/4SE1/4NW1/4;W1/2SE1/4NE1/4NW1/4;
SW1/4NE1/4NE1/4NW1/4;NW1/4NE1/4NE1/4NW1/4;
NE1/4NE1/4NE1/4NW1/4

Section 14: A Portion of the following:
SE1/4SE1/4SE1/4SW1/4;
NE1/4SE1/4SE1/4SW1/4;
NW1/4SW1/4SW1/4SE1/4

G-2 Thru G-17 Degas Well, (Approximately 24.85 acres)

G-2	Portion of N1/2SW1/4NE1/4 Section 24	Township 13 South, Range 12 East, SLBM
G-3	Portion of N1/2SW1/4NW1/4 Section 19	Township 13 South, Range 13 East, SLBM
G-4	Portion of N1/2NE1/4NW1/4 Section 24	Township 13 South, Range 12 East, SLBM
G-5	Portion of N1/2NW1/4NE1/4 Section 24	Township 13 South, Range 12 East, SLBM
G-6	Portion of S1/2SW1/4NW1/4 Section 18	Township 13 South, Range 13 East, SLBM
G-7	Portion of SW1/4NE1/4SE14 Section 24	Township 13 South, Range 12 East, SLBM
G-9	Portion of NW1/4NW1/4SW1/4 Section 21	Township 13 South, Range 13 East, SLBM
G-10	Portion of NE1/4NE1/4SE1/4 Section 20	Township 13 South, Range 13 East, SLBM
G-11	Portion of NE1/4SE1/4SW1/4 Section 20	Township 13 South, Range 13 East, SLBM
G-12	Portion of SE1/4NW1/4SW1/4 Section 20	Township 13 South, Range 13 East, SLBM
G-13	Portion of NW1/4NE1/4SE1/4 Section 19	Township 13 South, Range 13 East, SLBM
G-14A	Portion of SW1/4SW1/4SE1/4 Section 17	Township 13 South, Range 13 East, SLBM
G-15	Portion of NW1/4SE1/4NE1/4 Section 19	Township 13 South, Range 13 East, SLBM
G-16	Portion of SW1/4SE1/4SE1/4 Section 18	Township 13 South, Range 13 East, SLBM
G-17	Portion of SE1/4NW1/4SE1/4 Section 18	Township 13 South, Range 13 East, SLBM
G-18	Portion of NE1/4SE1/4NW1/4 Section 20	Township 13 South, Range 13 East, SLBM
G-19	Portion of SW1/4NW1/4SE1/4 Section 20	Township 13 South, Range 13 East, SLBM
G-31	Portion of NW1/4SW1/4NW1/4 Section 20	Township 13 South, Range 13 East, SLBM
AMV	Portion of S1/2NW1/4 Section 20	Township 13 South, Range 13 East, SLBM
Road	Portion of SW1/4SW1/4NE1/4 Section 20	Township 13 South, Range 13 East, SLBM

Pace Canyon Fan Facility Township 13 South, Range 13 East, SLBM (Approximately 2.7 acres)
Section 30: Portion of E1/2NW1/4NW1/4

Total Approximately 97.6 Acres

APPENDIX 5-6

Reclamation Bond Estimate

Bonding Calculations

Direct Costs		
Subtotal Demolition and Removal	$1,104,109.00	
Subtotal Backfilling and Grading	$827,141.00	
Subtotal Revegetation	$466,399.00	
Direct Costs	$2,397,649.00	
Indirect Costs		
Mob/Demob	$239,765.00	10.0%
Contingency	$119,882.00	5.0%
Engineering Redesign	$59,941.00	2.5%
Main Office Expense	$163,040.00	6.8%
Project Mainagement Fee	$59,941.00	2.5%
Subtotal Indirect Costs	$642,569.00	26.8%
Total Cost	$3,040,218.00	
Escalation factor		0.016
Number of years		4
Escalation	$199,294.00	
Reclamation Cost Escalated	$3,239,512.00	
Reclamation Cost (rounded to nearest $1,000) 2010 Dollars	$3,240,000.00	
Bond in 2010 dollars	$3,300,000.00	
Difference Between Cost Estimate and Bond	$60,000.00	
Percent Difference	1.85%	

BOND CALCULATIONS FOR DEGAS WELLS G-18 AND G-31

Ref.	Description	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
	Mine Belt BC-1 No 1																		19359
	Transfer Building No 2																		34970
	Feed Belt BC 2 No3																		13812
	Stack Tubes 2 No4																		3673
	Head House 1 No 5																		6687
	Transfer Belt BC 2 No 6																		8800
	Head House 2 No 7																		1632
	Reclaim Tunnel No 8																		33969
	Reclaim Belt BC 4 No 9																		12015
	Escape Tunnel 60 inch No 10																		953
	Crusher Building No 11																		31287
	Truck Loadout Belt BC 5 No 12																		9946
	Truck Loudout and Scale No 13																		25633
	Bathhouse No 14																		138047
	Substation No 15																		1803
	Power Lines and Poles No 16																		1958
	Retaining Wall No 17																		698
	Gabion Wall No 18																		59675
	Pump House No 19																		2708
	Paved Road No 20																		141491
	Stream Culvert 72 inch No 21																		46216
	Water Tanks No 22																		3097
	Rock Dust Bin No 23																		1092
	Fuel Tank and Fuel Station No 24																		1615
	Holding Tank No 25																		331
	Ventilation Fan No 26																		2260
	Magnet 27																		491
	Water System 28																		73801
	Sewage System 29																		24734
	Item 30 removed																		
	Storage Containers 31																		9800
	Gilson Well No 32																		1517
	Shop Building No 33																		5053
	Switch House No 34																		1035
	Portals No 35																		26000
	Storage Building No 36																		1795
	Sampling System No 37																		1335
	Stoker Storage Bin No 41																		822
	Substation No 2 No 42																		2654
	Gabion Baskets No 43																		982
	Pace Fan Culvert																		2031
	Pace Fan Generator																		52771
	Pace Fan Portal																		5200
	Refuse Site No 44																		9913
	Degas Well G2																		12297
	Degas Well G3																		7990
	Degas Well G4																		7670
	Degas Well G5																		11058
	Degas Well G6																		8324
	Degas Well G7																		12314
	Degas Well G9																		11054
	Degas Well G10																		2301
	Degas Well G11																		9287
	Degas Well G12																		9081
	Degas Well G13																		13065
	Degas Well G14																		12924
	Degas Well G15																		11354
	Degas Well G16																		10369
	Degas Well G17																		10043
	Degas Well G18																		21636
	Degas Well G19																		13857
	Degas Well G31																		27825
	Total																		1036110

Ref.	Descriptior	Materials	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
	Degas Well G18																			
	Grade and	Front end	02315 424	1.43	/CY						6962					CY		6962	CY	9956
	Fill in Mud	Backfill Tre	02315 610	1.58	/CY						430					CY		430	CY	679
	Subtotal																			10635
	Plug Well	Concrete F	03310 220	196	/CY						21					CY		21	CY	4116
	Subtotal																			4116
	Spread To	Front end	02315 424	1.43	/CY						2195					CY		2195	CY	3139
	Subtotal																			3139
	Fence																			
	Remove B	Fencing B	02220 220	1.59	/LF	1300										FT		1300	FT	2067
	Subtotal																			2067
	Support																			
	Pickup Tru	Pickup Re	01 54 33 4	80.42	/day									24		hr		3	day	241
	Foreman	Foreman A	Foreman	$59.90	HR									24		hr		24	hr	1438
	Subtotal																			1679
	Total																			21636

Ref.	Description	Materials	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
	Degas Well G31																			
	Grade and	Front end	02315 424	1.43	/CY						8470					CY		8470	CY	12112
	Fill in Mud	Backfill Tre	02315 610	1.58	/CY						430					CY		430	CY	679
	Subtotal																			12791
	Plug Well	Concrete F	03310 220	196	/CY						21					CY		21	CY	4116
	Subtotal																			4116
	Spread To	Front end	02315 424	1.43	/CY						4624					CY		4624	CY	6612
	Subtotal																			6612
	Fence																			
	Remove B	Fencing B	02220 220	1.59	/LF	1300										FT		1300	FT	2067
	Subtotal																			2067
	Support																			
	Pickup Tru	Pickup Re	01 54 33 4	80.42	/day									32		hr		4	day	322
	Foreman	Foreman A	Foreman	$59.90	HR									32		hr		32	hr	1917
	Subtotal																			2239
	Total																			27825

Ref.	Description	Materials	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
	Dugout Mine Vegetation																			151810
	Dugout Mine Refuse Pile																			104889
	Pace Canyon Fan Portal																			7231
	Degas Well G2																			6260
	Degas Well G3																			5179
	Degas Well G4																			4143
	Degas Well G5																			4143
	Degas Well G6																			4143
	Degas Well G7																			5159
	Degas Well G9																			10350
	Degas Well G10																			8260
	Degas Well G11																			8482
	Degas Well G12																			6245
	Degas Well G13																			12574
	Degas Well G14																			9520
	Degas Well G15																			11536
	Degas Well G16																			9520
	Degas Well G17																			6394
	Degas Well G18																			6870
	Degas Well G19																			12574
	Degas Well G31																			13116
	Total																			408418

Ref.	Description	Materials	Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
	Degas Well G18																			
	Soil Preparation																			
	Pocking	Excavation Bulk Bank 2 CY (322BL)	M023154240260	1.74	/CY					1.36						AC		2194	CY	3818
	Subtotal																			3818
	Seed Mix No 1																			
	Hydroseed Equipment and Labor	Hydro Spreader (equip. & labor) B-81 80MS	Reveg002	19.8	/MSF					1.36						AC		59	MSF	1168
	Hydroseed Material	Dugout Seed Mix No 1	Dugout 07391S	394.75	/AC					1.36						AC		1.36	AC	537
	Hay Mulch	Hay 1" material only 029105000250	Reveg001	69.85	/MSF					1.36						AC		1.36	ton/AC	95
	Subtotal																			1800
	Direct Vegetation																			5618
	Reseeding																			
	Assume 25% reveg rate																			1252
	Total																			6870

Ref.	Description	Materials	Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
	Degas Well G31																			
	Soil Preparation																			
	Pocking	Excavation Bulk Bank 2 CY (322BL)	M023154240260	1.74	/CY					2.87						AC		4630	CY	8056
	Subtotal																			8056
	Seed Mix No 1																			
	Hydroseed Equipment and Labor	Hydro Spreader (equip. & labor) B-81 80MS	Reveg002	19.8	/MSF					2.87						AC		125	MSF	2475
	Hydroseed Material	Dugout Seed Mix No 1	Dugout 07391S	394.75	/AC					2.87						AC		2.87	AC	1133
	Hay Mulch	Hay 1" material only 029105000250	Reveg001	69.85	/MSF					2.87						AC		2.87	ton/AC	200
	Subtotal																			3808
	Direct Vegetation																			11864
	Reseeding																			
	Assume 25% reveg rate																			1252
	Total																			13116

BOND CALCULATIONS FOR
AMV ROAD

Ref.	Description	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
	Mine Belt BC-1 No 1																		
	Transfer Building No 2																		19359
	Feed Belt BC 2 No3																		34970
	Stack Tubes 2 No4																		13812
	Head House 1 No 5																		3673
	Transfer Belt BC 2 No 6																		6687
	Head House 2 No 7																		8800
	Reclaim Tunnel No 8																		1632
	Reclaim Belt BC 4 No 9																		33969
	Escape Tunnel 60 inch No 10																		12015
	Crusher Building No 11																		953
	Truck Loadout Belt BC 5 No 12																		31287
	Truck Loudout and Scale No 13																		9946
	Bathhouse No 14																		25633
	Substation No 15																		138047
	Power Lines and Poles No 16																		1803
	Retaining Wall No 17																		1958
	Gabion Wall No 18																		698
	Pump House No 19																		59675
	Paved Road No 20																		2708
	Stream Culvert 72 inch No 21																		141491
	Water Tanks No 22																		46216
	Rock Dust Bin No 23																		3097
	Fuel Tank and Fuel Station No 24																		1092
	Holding Tank No 25																		1615
	Ventilation Fan No 26																		331
	Magnet 27																		2260
	Water System 28																		491
	Sewage System 29																		73801
	Item 30 removed																		24734
	Storage Containers 31																		
	Gilson Well No 32																		9800
	Shop Building No 33																		1517
	Switch House No 34																		5053
	Portals No 35																		1035
	Storage Building No 36																		26000
	Sampling System No 37																		1795
	Stoker Storage Bin No 41																		1335
	Substation No 2 No 42																		822
	Gabion Baskets No 43																		2654
	Pace Fan Culvert																		982
	Pace Fan Generator																		2031
	Pace Fan Portal																		52771
	Refuse Site No 44																		5200
	Degas Well G2																		9913
	Degas Well G3																		12297
	Degas Well G4																		7990
	Degas Well G5																		7670
	Degas Well G6																		11058
	Degas Well G7																		8324
	Degas Well G9																		12314
	Degas Well G10																		11054
	Degas Well G11																		2301
	Degas Well G12																		9287
	Degas Well G13																		9081
	Degas Well G14																		13065
	Degas Well G15																		12924
	Degas Well G16																		11354
	Degas Well G17																		10369
	Degas Well G18																		10043
	Degas Well G19																		21636
	Degas Well G31																		13857
	AMV Road																		27825
	Total																		67999
																			1104109

Ref.	Description	Materials	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
	AMV ROAD																			
	Grade and	Front end	02315 424	1.43	/CY						15207					CY		15207	CY	21746
	Subtotal																			21746
	Subtotal																			0
	Spread To	Front end	02315 424	1.43	/CY						24374					CY		24374	CY	34855
	Subtotal																			34855
	Subtotal																			0
	Support																			
	Pickup Tru	Pickup Re	01 54 33 4	80.42	/day									240		hr		30	day	2413
	Foreman	Foreman A	Foreman	$59.90	HR									150		hr		150	hr	8985
	Subtotal																			11398
	Total																			67999

Ref.	Description	Materials	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
	Dugout Mine Vegetation																			151810
	Dugout Mine Refuse Pile																			104889
	Pace Canyon Fan Portal																			7231
	Degas Well G2																			6280
	Degas Well G3																			5179
	Degas Well G4																			4143
	Degas Well G5																			4143
	Degas Well G6																			4143
	Degas Well G7																			5159
	Degas Well G9																			10350
	Degas Well G10																			8280
	Degas Well G11																			8482
	Degas Well G12																			6245
	Degas Well G13																			12574
	Degas Well G14																			9520
	Degas Well G15																			11536
	Degas Well G16																			9520
	Degas Well G17																			6394
	Degas Well G18																			6870
	Degas Well G19																			12574
	Degas Well G31																			13116
	AMV Road																			57981
	Total																			406399

Ref.	Description	Materials	Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
	AMV Road																			
	Soil Preparation																			
	Pocking	Excavation Bulk Bank 2 CY (322BL)	M023154240260	1.74	/CY					13.72						AC		22135	CY	38515
	Subtotal																			38515
	Seed Mix No 1																			
	Hydroseed Equipment and Labor	Hydro Spreader (equip. & labor) B-81 80MS	Reveg002	19.8	/MSF					13.72						AC		598	MSF	11840
	Hydroseed Material	Dugout Seed Mix No 1	Dugout 07391S	394.75	/AC					13.72						AC		13.72	AC	5416
	Hay Mulch	Hay 1" material only 029105000250	Reveg001	69.85	/MSF					13.72						AC		13.72	ton/AC	958
	Subtotal																			18214
	Direct Vegetation																			56729
	Reseeding																			
	[illegible]																			[illegible]
	Total																			57981

CHAPTER 1

LEGAL, FINANCIAL, COMPLIANCE AND RELATED INFORMATION

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110 MINIMUM REQUIREMENTS FOR LEGAL, FINANCIAL, COMPLIANCE AND RELATED INFORMATION

111 Introduction

The degassification wells will be located on property owned by the Milton and Ardith Thayn Trust. The well locations are found in Table 1-1 and are shown in Figure 1-1.

112 Identification of Interests

Refer to the same section of the General Chapter 1 for Canyon Fuel Company, LLC prepared for the Dugout Canyon Mine, Soldier Canyon Mine and Banning Loadout operations.

112.100 Business Entity

Refer to the same section of the General Chapter 1 for Canyon Fuel Company, LLC prepared for the Dugout Canyon Mine, Soldier Canyon Mine and Banning Loadout operations.

112.200 Applicant and Operator

Refer to the same section of the General Chapter 1 for Canyon Fuel Company, LLC prepared for the Dugout Canyon Mine, Soldier Canyon Mine and Banning Loadout operations.

112.300 Officers of the Applicant

Refer to the same section of the General Chapter 1 for Canyon Fuel Company, LLC prepared for the Dugout Canyon Mine, Soldier Canyon Mine and Banning Loadout operations.

TABLE 1-1

Degas Well Locations

Pine Canyon, Utah Quadrangle, Salt Lake Meridian

Hole Number	Section	Township and Range
G-1	Portion of N1/2SE1/4NW1/4 Section 24	Township 13 South, Range 12 East
G-2	Portion of N1/2SW1/4NE1/4 Section 24	Township 13 South, Range 12 East
G-3	Portion of N1/2SW1/4NW1/4 Section 19	Township 13 South, Range 13 East
G-4	Portion of N1/2NE1/4NW1/4 Section 24	Township 13 South, Range 12 East
G-5	Portion of N1/2NW1/4NE1/4 Section 24	Township 13 South, Range 12 East
G-6	Portion of S1/2SW1/4NW1/4 Section 18	Township 13 South, Range 13 East
G-7	Portion of SW1/4NE1/4SE14 Section 24	Township 13 South, Range 12 East
G-8	Portion of NE1/4NE1/4NE14 Section 26	Township 13 South, Range 12 East
G-9	Portion of NW1/4NW1/4SW1/4 Section 21	Township 13 South, Range 13 East
G-10	Portion of NE1/4NE1/4SE1/4 Section 20	Township 13 South, Range 13 East
G-11	Portion of NE1/4SE1/4SW1/4 Section 20	Township 13 South, Range 13 East
G-12	Portion of SE1/4NW1/4SW1/4 Section 20	Township 13 South, Range 13 East
G-13	Portion of NW1/4NE1/4SE1/4 Section 19	Township 13 South, Range 13 East
G-14	Portion of SW1/4SW1/4SE1/4 Section 17	Township 13 South, Range 13 East
G-15	Portion of NW1/4SE1/4NE1/4 Section 19	Township 13 South, Range 13 East
G-16	Portion of SW1/4SE1/4SE1/4 Section 18	Township 13 South, Range 13 East
G-17	Portion of SE1/4NW1/4SE1/4 Section 18	Township 13 South, Range 13 East
G-18	Portion of NE1/4SE1/4NW1/4 Section 20	Township 13 South, Range 13 East
G-19	Portion of SW1/4NW1/4SE1/4 Section 20	Township 13 South, Range 13 East
G-31	Portion of NW1/4SW1/4NW1/4 Section 20	Township 13 South, Range 13 East
AMV Road	Portion of S1/2NW1/4 Section 20 Portion of SW1/4SW1/4NE1/4 Section 20	Township 13 South, Range 13 East

112.400 Coal Mining and Reclamation Operation Owned or Controlled

Refer to the same section of the General Chapter 1 for Canyon Fuel Company, LLC prepared for the Dugout Canyon Mine, Soldier Canyon Mine and Banning Loadout operations.

112.500 Legal or Equitable Owner of the Surface and Mineral Properties

The legal and equitable owner of the surface and mineral properties to be affected by this operation during the duration of the permit period are list below.

Milton & Ardith Thayn Trust
7730 East US Highway 6
Sunnyside Star Route
Price, Utah 84501

United States of America
State of Utah, Department of Interior
Bureau of Land Management
Price Field Office
125 South 600 West
Price, Utah 84501

State of Utah
School and Institutional
Trust Lands Administration
675 East 500 South
Salt Lake City, Utah 84102-2818

Gil L. Conover
450 So. State
Ferron, Utah 84523

112.600 Owners of Record of Property Contiguous to Proposed Permit Area

Owners of record for surface and mineral properties contiguous to the proposed permit area are list below.

United States of America
Department of Interior
Bureau of Land Management
Price Field Office
125 South 600 West
Price, Utah 84501

State of Utah
School and Industrial
Trust Lands Administration
675 East 500 South
Salt Lake City, Utah 84102-2818

George and Alice Conover, Et Al
2701 Georgia Way
Sandy, Utah 84092

KFJ Ranch Partnership
C/O Kerwin Jensen
Cleveland, Utah 84518

J. George Conover
275 West Main
Ferron, Utah 84523

Gil L. Conover
450 So. State
Ferron, Utah 84523

112.700 MSHA Numbers

Refer to the same section of the approved M&RP.

112.800 Interest In Contiguous Lands

Canyon Fuel Company, LLC has no interest in contiguous lands other than those currently owned as shown on Plate 1-1 of the approved M&RP.

112.900 Certification of Submittal Information

No information has changed in the approved M&RP because of this submittal. Refer to the same section of the approved M&RP.

113 Violation Information

Refer to the same section of the General Chapter 1 for Canyon Fuel Company, LLC prepared for the Dugout Canyon Mine, Soldier Canyon Mine and Banning Loadout operations.

114 Right-of-Entry Information

Refer to the same section of the approved M&RP.

See Table 1-2 for disturbed acreage for each well site. The disturbed acres will be added to the total disturbed acreage for the Dugout Mine as each site is constructed.

Additional correspondence pertaining to right-of-entry is located in Attachments 2-3, 4-2, 5-3, and 5-4. Although notification of mining activities is required under R645.301.525.700, response when requested from landowner or others concerning right-of-entry is entirely at their discretion. The landowner agreement between the permittee and the Thayn Trust can be reviewed in Appendix 4-2 of the Methane Degassification Amendment.

115 Status of Unsuitability Claims

Refer to the same section of the approved M&RP.

116 Permit Term

Refer to the same section of the approved M&RP.

TABLE 1-2

Disturbed Acres by Well Site

Well Site	Disturbed Acres
G-1	0.6
G-2	1.21
G-3	0.97
G-4	0.85
G-5	0.75
G-6	0.32
G-7	1.25
G-8	0.9
G-9	2.2
G-10	1.7
G-11	1.6
G-12	2
G-13	2.75
G-14	2
G-15	2.5
G-16	2
G-17	1.25
G-18	1.4
G-19	2.3
G-31	1.75

The disturbed acreage for the AMV access road is approximately 14.25 acres including areas for topsoil storage and turnouts. STP-7 will add approximately 0.85 acres to the disturbed area.

117 Insurance, Proof of Publication, and Facilities and Structures Used in Common

The certificate of insurance(s) for each well will be obtained if required when the well is drilled. The certificate of insurance(s) will be included in Appendix 1-2 of the approved M&RP and General Chapter 1.

118 Filling Fees

Refer to the same section of the approved M&RP.

120 PERMIT APPLICATION FORMAT AND CONTENTS

This amendment submittal will comply with R645-301-120.

130 REPORTING OF TECHNICAL DATA

All technical data submitted in the amendment will be accompanied by the name or organization responsible for the collection and analysis of data, dates of collection and descriptions of methodology used. Technical analyses will be planned by or under the direction of a qualified professional in the subject to be analyzed.

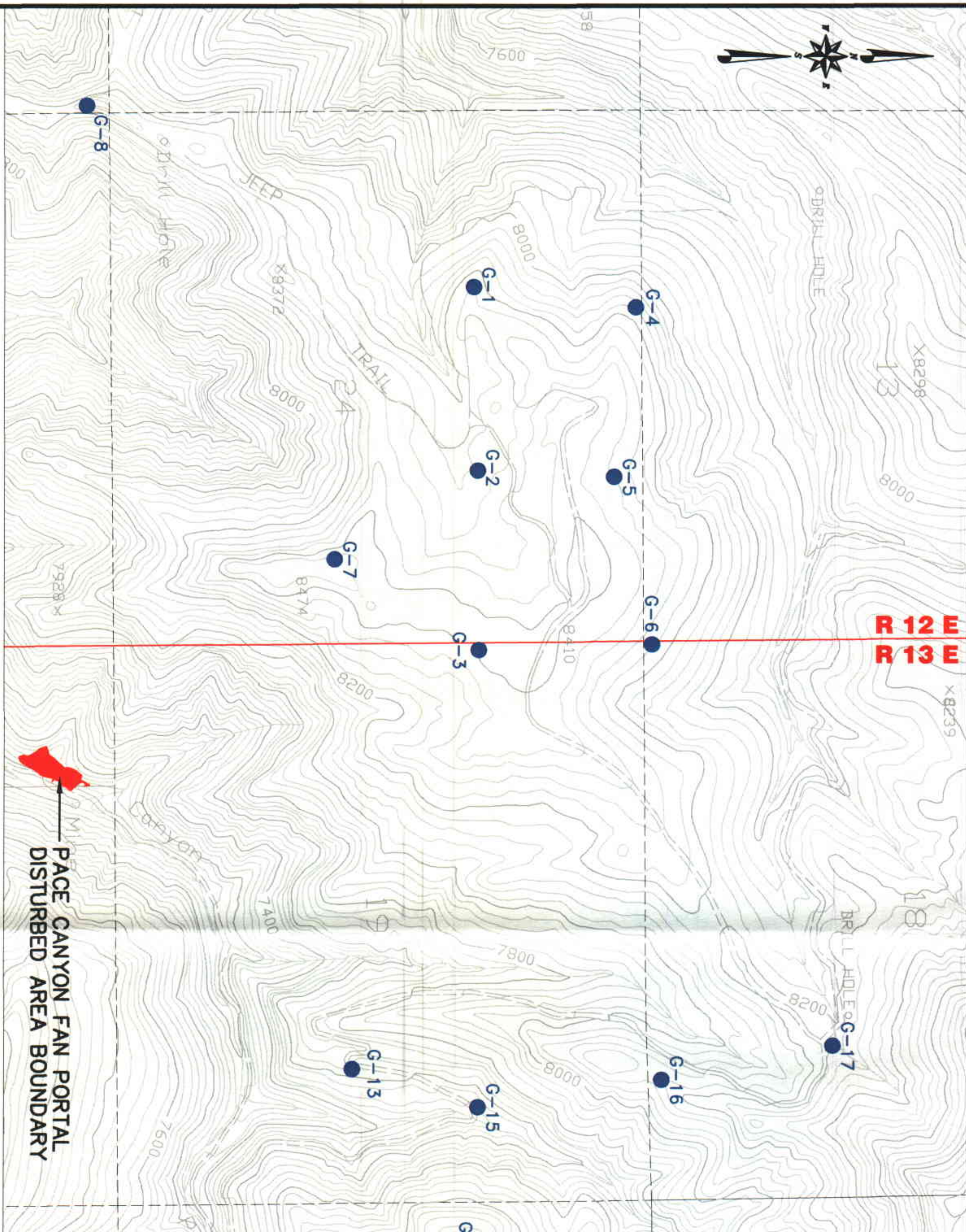
140 MAPS AND PLANS

The maps and plans in the Mining and Reclamation Plan will correspond with the requirements in R645-301-140.

150 COMPLETENESS

CFC believes the information in this permit application to be complete and correct.

Access Road\FIG1-1-BHL.dwg, 9/20/2007 9:00:43 AM



CHAPTER 2

SOILS

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210 INTRODUCTION

This chapter and associated attachments address the pertinent data required for the addition of the degassification well sites for the Dugout Canyon Mine. Only those sections of the Division regulations that apply to the well sites have been addressed. The remainder of the regulations have already been addressed in the existing M&RP. The M&RP and this document contain pertinent information relating to the identification, management, and reclamation activities associated with the soil resources.

220 ENVIRONMENTAL DESCRIPTION

The well sites range in elevation from approximately 7400 to 9000 feet. The well sites are located in the Pace Canyon area of the Book Cliffs. General vegetation includes sagebrush, serviceberry, aspen, Douglas-fir, and snowberry.

221 Prime Farmland Investigation

Due to limiting terrain, lack of water for irrigation and no evidence of past cultivation of the sites, it is concluded that no prime farmland exists within the area of the well site disturbance.

222 Soil Survey

222.100 Soils Map

The soils have been mapped as part of the Soil Survey of the Carbon Area, Utah by the Soil Conservation Service (1988), at an Order III intensity level.

A description of the soils is included in Appendix 2-2 of the approved M&RP and in Attachment 2-1, which includes a report by Dan Larsen, Soil Scientist, entitled “Soil Inventory and Assessment Six

Methane Degassification Borehole Sites". An additional report for well site G-6 was prepared in 2004 and is incorporated into Attachment 2-1. Soil information for Well G-7 is incorporated into Attachment 2-1. A photograph of the G-7 site is included in Attachment 3-1. Well site G-3 and the access road can be seen on the photograph.

The soils report prepared by Dan Larsen, Soil Scientist for wells G-8 thru G-13 is provided in Attachment 2-1. Wells are being permitted in groups: G-8 thru G-10, G-11 thru G-12 and G-13 thru G-17.

222.200 Soil Identification

Well No.	Soil Map Unit	Soil Components
G-1	62/88	Midfork-Comodore complex, Rabbitex-Datino Varient
G-2	7	Brycan, Beje-Trag complex, 3-30% slopes
G-3	7	Beje-Trag complex, 3-30% slopes
G-4	62/103	Midfork-Comodore complex, Senchert-Toze complex
G-5	103	Senchert-Croydon
G-6	62	Midfork-Comodore complex
G-7	7	Beje-Trag complex, 3-30% slopes
G-8	21	Croydon Loam, 8 to 30% slopes
G-9	97/62	Midfork-Comodore complex, Rottulee family-Trag complex
G-10	97	Rottulee family-Trag complex
G-11	11, 26	Cabba- family, 40 to 70 percent slopes, Doney family, 50 to 70 percent slopes
G-12	47, 88	Guben-Rock outcrop complex, Rabbitex family-Datino Variant complex

G-13	23	Curecanti family
G-14A	62	Midfork family - Comodore complex
G-15	115, 62	Trag stony loam, 30 to 60 percent slopes,
		Midfork family - Comodore complex
G-16	26	Doney family
G-17	103	Senchert-Toze family Complex
G-18	97	Rottulee family-Trag complex
G-19	62	Midfork family - Comodore complex
G-31	97	Rottulee family-Trag complex
Access Road	97	Rottulee family-Trag complex
	62	Midfork family - Comodore complex

222.300 Soil Description

Refer to Attachment 2-1 of the submittal for soil descriptions.

222.400 Soil Productivity

The depth of topsoil at each site was measured to determine the amount of growth medium available for reclamation. The following table lists each well site and the approximate amount of growth medium available.

TABLE 2-1

Topsoil Volumes*

Well No.	Cubic Yards of Material
G-1	415
G-2	3,104
G-3	1,182
G-4	1,100
G-5	1,909
G-6	792
G-7	1251
G-8	543
G-9	1,574
G-10	2,344
G-11	254
G-12	563
G-13	2,162
G-14	1,544
G-15	1,475
G-16	1,092
G-17	797
G-18	2,195
G-19	2,037
G-31	4,624
Access Road	9,167

* These total do not include soil salvaged from short roads accessing well sites which is bladed to the side of the road.

Figure 5-1 through Figure 5-25 show the layout and approximate size of well pads for G-1 thru G-6. Figures 5-27 thru 5-29 show the layout and size for well G-7. The figures for wells G-8 thru G-19 are located in Attachment 5-1. Topsoil volume calculations can be found in Attachment 2-2.

Estimated topsoil salvage from the G-1 well site will average about 7". This site on a ridge top has previously been disturbed for exploration drilling. The site has pockets of fractured sandstone bedrock at the surface and stony subsoils, which are the limiting factors in the quantity of salvageable topsoil. The average topsoil depth at well site G-2 is 30". The average topsoil thickness for well site G-3 is 10". However, enough soil will be stripped to allow 12" of soil to be placed during reclamation. Thus some subsoils will be stripped with the topsoil to generate the required volume. The estimated topsoil salvage from well site G-4 area will be 28" except on the area of the exiting road(s). The average salvageable topsoil at well site G-5 is 22". Well site G-6 will be established on a pre-existing drill pad, with a portion of the new pad extending onto undisturbed area. Topsoil on the pre-existing drill pad ranges from 0 to 30 inches, on the north edge in from 20 to 28 inches and on the cut slope on the south edge from 6 to 30 inches. The slope will be restored to original contour with the application of topsoil, the entire site will receive at least 12 inches of topsoil. Twelve inches was used to calculate the volume of topsoil to be salvaged and to determine the size of the topsoil pile for drill site G-6. Degas well G-7 will be developed on a site with soils consistent with G-3. There is a pre-existing road to well G-3 that continues on to the G-7 proposed site. There are signs of previous vehicle disturbance at the site, however the majority of the site is undisturbed. Topsoil available for salvage has been estimated to be 10 to 12 inches. Available topsoil will be salvaged and if necessary some subsoils will be stripped with the topsoil to generate the required volume to place a minimum of 12 inches during site reclamation. Available topsoil at each site will be salvaged, stockpiled and redistributed.

Twelve inches of soil will be salvaged at well site s G-9. Well site G-9 has no topsoil over approximately half of the site, thus requiring the salvage of subsoil to generate the foot of soil proposed for reclamation. Suitable soil for salvage at site G-10 is approximately 15 inches with some areas having 24 inches of soil. Where available soil will be salvaged to a minimum of 15 inches and approximately 18 inches will be available to cover the G-10 disturbed area at the time of reclamation. G-8 was not constructed, however the available topsoil at site was estimated at about six inches.

The majority of the area at well site G-11 has been disturbed by road construction and the major part of the undisturbed portion has shallow eroded soils, except for a small area on the west side of the site. The shallow eroded soils are approximately 5 inches deep and the soils in the small area are between 10 and 16 inches deep. Approximately fifty percent of the G-12 well site is a road with no topsoil or vegetation. Between 12 and 30 inches of soil is suitable for salvage from the other fifty percent of the pad area for site G-12.Twelve inches will be returned to the reclamation slope at G-11 and between 12 and 15 inches at G-12. Large boulders are suspected to be present at the G-12 site.

At well site G-13, parent materials for soil formation are primarily colluvial deposits derived from sandstone and shale. The surface ranges from relatively smooth and non-stoney to very stoney. Suitable soil for salvage ranges from about 8 to 28 inches, limitation are due to high rock fragment content and low organic matter. Portions along the southeast edge are too stony for soil salvage. Well site G-14 (DUG205), is relatively uniform with soils of and similar to the Midfork family. Topsoil thickness range from 12 to 24 inches, with the typical depth being 15 to18 inches. The G-14 well site has been disturbed by logging. Between 14 and 16 inches of topsoil will be placed at well sites G-13 and G-14 during reclamation.

The road to G-13 and G-14 are existing roads, however, the soil will be bladed to the side of the road at site G-14 and replaced during reclamation.

Well site G-15 is about 50 percent disturbed by a road, slope cut and fill. The undisturbed portion of the site is a slope with a southeast aspect (35 to 45 percent gradient). The topsoil on this slope is typically 13 to 20 inches thick, with a loam texture. Approximately 14 inches of topsoil will be replaced during reclamation.

Well site G-16 was previously the site of an exploration hole, having been disturbed and reclaimed. Approximately, 14 inches of soil will be salvaged as topsoil and replaced during reclamation. The topsoil on the access road will be bladed to one side of the road and replaced during reclamation.

At well site G-17 approximately one-third of the site is an existing road. Sufficient topsoil will be salvaged to replace 12 inches over the area of disturbance during reclamation.

The entire area of well site G-19 was previously disturbed by logging activities with two roads crossing through the area. During the soil survey it was determined that the topsoil was 8 inches in depth. Approximately 12 inches of topsoil and subsoil will be salvaged for replacement during reclamation. Although, two soil pits were samples only SP-2 is representative of the site. SP-1 is not within the G-19 site's disturbed area.

The report for sampling completed May 1 and 5, 2007 summarizes the methodology and results of the soil survey conducted by Clement Drilling & Geophysical, Inc. for the proposed access road and G-18 and G-31 wells (Attachment 2-1, May 22, 2007).

The proposed road (AMV) and drill pads for wells G-31 and G-18 were evaluated using the United States Department of Agriculture (USDA), Natural Resources Conservation Services (NRCS) WEB Soil Survey (WSS) utility. NRCS Order III descriptions for the soil series that occur in the study area are presented in Appendix A of the May 22, 2007 report located in Attachment 2-1.

Soil test pits were excavated at the two proposed well locations. The soil test pit at well G-31 was excavated by hand on May 1, 2007. The soil test pit for well G-18 was excavated by hand on May 5, 2007. Soil test pits were also excavated in areas representative of each of the three soil map units that occur in the vicinity of the proposed road and vent wells. The three test pits were excavated by hand on May 5, 2007. The coordinates of each test pit collected using a GPS receiver are presented in the test pit logs. The test pit logs are presented in Appendix B and photographs of the excavations in Appendix C. The soils observed in the test pits appear to generally correlate to the NRCS Order III Map Units. Soil samples were collected from each test pit from each horizon, where possible, for laboratory analysis. The analyses will be incorporated into Attachment 2-1. Two additional soils samples were taken along the road corridor, these samples were labeled AMV SP-1 and AMV SP-2. These samples were dug by hand with a shovel and pick. The lab analysis of these samples is included in Attachment 2-1.

Per the review of aerial photography taken of the area in November 2006, there does not appear to be rock outcrops along the path of the AMV access road. When Mr. Clements walked the road area in conjunction with the soil survey, he identified no concerns with the soil map units designated on Plate 1 included in Attachment 2-1.

223 Soil Characterization

The topsoil evaluation described in this chapter was performed by Daniel M. Larsen, Professional Soil Scientist and Dean Stacy, NRCS Range Management Specialist in accordance with the standards of the National Cooperative Soil Survey. The topsoil evaluation for Wells G-18, G-19, G-31 and the Access Road were performed by Craig Clement, P.G. and Dean Stacy, NRCS Management Specialist in accordance with the standards of the National Cooperative Soil Survey and using the USDA/NRCS WEB Soil Survey utility.

224 Substitute Topsoil

Dugout Canyon does not plan to use substitute topsoil as growth media except as described in Section 222.400.

230 OPERATION PLAN

231 General Requirements

231.100 Removing and Storing Topsoil Methods

The topsoil will be removed, stockpiled and protected with a berm and/or silt fence. A qualified person will be on site during soil salvage to monitor and supervise the operation for the purpose of maximizing salvage volumes. Prior to topsoil salvage shrubs/vegetation will be removed and placed/wind rowed along the inside perimeter of the disturbed area.

After the topsoil is removed, the mud pit will be excavated and the soils from the mud pit excavation will be stored immediately adjacent to the mud pit. Mud pit excavation of subsoil will be approximately 110 CY at each well site (G-2 thru G-6).

The subsoil excavation for the mud pits at G-7 thru G-19 and G-31 was approximately 430 CY. A portable container for drilling fluids will be used if necessary, should there not be sufficient subsoil depth to excavate a mud pit.

Topsoil beneath the topsoil stockpiles will not be removed. Ribbon or a marking fabric will be placed on top of the topsoil prior to placement of the topsoil from the well pad area.

The approximate volume of subsoil to be salvaged and used to create berms around the perimeter of the well site including the topsoil stockpile perimeter is: G-1 - 161 CY; G-2 - 254 CY, G-3 - 208 CY, G-4-165 CY, G-5 - 191 CY, G-6 - 156 CY, G-7 - 107 CY, G-8 - 143 CY, G-9 - 182 CY, G-10 - 137 CY, G-11 - 185 CY, G-12 - 260 CY, G-13 - 142 CY, G-14A - 123 CY, G-15 - 101 CY, G-16 - 98 CY, G-18 - 39 CY excludes topsoil pile, G-19 - 48 CY, G-31 - 62 CY excludes topsoil pile, Topsoil Stockpiles STP-1 thru STP 7 - 309 CY and Access Road - 265 CY.

At the G-19 drill pad there is a variance between the disturbed area acreage and the acreage where topsoil will be salvaged. Portions of the site have no topsoil, due to previous disturbance by logging, these areas include roads, a gully and skid trails. In addition there is a perimeter buffer area that will not be disturbed and thus will not have topsoil removed from the area unless it becomes necessary due to unforseen issues during construction, such as buried outcrops, large boulders, tree root systems, etc. An area within the northeastern portion of the disturbed area has two road forks extending from the end of the existing road, these two forks have no topsoil on them and the area between them will not be disturbed and therefore will not have topsoil salvaged. A sketch of these areas is located in Attachment 2-1.

There is a difference between the topsoil volumes totals and the estimated inches to be salvaged on pads G-18, G-31 and the AMV road. The topsoil volume totals assume that the entire disturbed area will be stripped of 12 inches of topsoil/growth medium. Any areas within the disturbed area boundary which can remain undisturbed will remain undisturbed. In addition, the soils to be salvaged are assumed to be the same depth as the test pit or 12 inches. The available soil for salvage is likely to vary throughout the areas to be salvaged. A commitment is made to salvage available topsoil or 12 inches of growth medium. Sketches of the well pads are included in Attachment 2-1.

231.200 Suitability of Topsoil Substitutes/Supplements

See Section 224.

231.300 Testing of Topsoil Handling and Reclamation Procedures Regarding Revegetation

Dugout will exercise care to guard against erosion during and after application of topsoil and will employ the necessary measures to ensure the stability on graded slopes. Erosion control measures will include silt fences, berms, seeding, straw bales, soil roughening, and mulching of the soils.

Topsoil will be redistributed and the original soil surface beneath the topsoil stockpile will be roughened as presented in Section 242.100 and seeded with the seed mix described in Chapter 3, Section 352.

Methods used to evaluate success of revegetation and stabilization are discussed in Chapter 3, Section 356.

231.400 Construction, Modification, Use, and Maintenance of Topsoil Storage Pile

Topsoil removed from the drill pad sites will be stockpiled on the site, except at well site G-14 where it will be stockpiled approximately 1/10 mile away. The estimated volumes of topsoil stockpile for each site are shown in Table 2-1. The stockpiles will be sized as shown in Table 2-2.

The slopes of the stockpile will be 1H:1V or approximately 45^0 during the construction phase. Soils in these areas generally have an angle of repose greater than 50 degrees, making a stockpile with 1:1 slopes feasible. The steeper slope also help minimize the area to be disturbed. When space is available topsoil will be stockpiled with slopes of 2H:1V.

232 Topsoil and Subsoil Removal

232.100 Topsoil Removal and Segregation

All topsoil will be removed as a single layer with no segregation. Topsoil will be removed using a dozer and/or loader. Refer to Section 231.100 for additional details.

232.200 Poor Topsoil

No poor soils exist at the well sites see Attachment 2-1.

TABLE 2-2

Topsoil Stockpile Dimensions*

Well No.	Length (ft)	Width (ft)	Height (ft)
G-1	55	35	16
G-2	156	50	20
G-3	70	60	17
G-4	110	35	17
G-5	90	65	21
G-6	105	30	13
G-7	80	70	6 to12
G-8	168	60	6
G-9	160	90	30
G-10	170	80	65
G-11	40	50	12
G-12	60	80	18
G-13	120	100	17
G-14A	120	60	11
G-15	90	90	19
G-16	100	80	12
G-17	85	55	10

TABLE 2-2 (Continued)

Topsoil Stockpile Dimensions*

Well No.	Description	Length (ft)	Width (ft)	Height (ft)
G-18	STP-6	200	50	22
G-19	Lower Road	235	8	5
	Pad	140	52	35
G-31	STP-4	150	110	25
	STP-5	150	70	25
Access Road	STP-1	85	50	20
	STP-2	90	40	22
	STP-3	205	120	25
	STP-7	125	62	15

* These are approximate dimensions of the topsoil stockpile and construction dimensions may vary. The height represents the elevation difference between the lowest point and highest point of the topsoil stockpile. The topsoil thickness will vary with the slope of the native ground surface. When stored on steep slopes the topsoil thickness will be much less than the estimated height of the stockpile.

See Section 234.200 for detailed information on the topsoil stockpile(s).

232.300 Thin Topsoil

Not applicable see Attachment 2-1.

232.400 Minor Disturbances Not Requiring Topsoil Removal

Topsoil will not be removed along the fence line at the wells sites.

232.500 Subsoil Segregation

The B and C soil horizons will not be removed. Any small quantity of subsoil removed with the topsoil will not be segregated.

232.600 Timing

Topsoil removal will take place after all vegetation that could interfere with salvaging the topsoil has been grubbed.

232.700 Topsoil and Subsoil Removal Under Adverse Conditions

The topsoil will be removed first and stockpiled and the remaining soil horizons will be left in place, except where natural conditions render removal operations hazardous or detrimental to soils outside the disturbed area then topsoil will not be removed.

Conventional Machines - In locations where steep grades, adverse terrains, severe rockiness, limited depth of soils, or other adverse conditions exist that render soil removal activities using conventional machines hazardous, soils will not be salvaged and stockpiled. Such conditions are not likely to occur in these areas.

Substitute Topsoil - Importing of substitute topsoil is not anticipated (Section 224).

233 Topsoil Substitutes and Supplements

233.100 Overburden Materials Supplementing and/or Replacing Topsoil

No overburden material will be used.

233.200 Suitability of Topsoil Substitutes and Supplements

No substitute topsoil is planned.

233.300 Physical and Chemical Analysis

See Section 243.

233.400 Testing of Substitute Topsoil

No substitute topsoil is planned.

234 Topsoil Storage

234.100 Topsoil Stockpiling

Topsoil will be stockpiled for later use in reclamation operations. The topsoil will be stored and treated as outlined in Section 234 of this amendment. Refer to Sections 231 through 234 of the M&RP for additional information pertaining to the topsoil at the Pace Canyon Fan site.

234.200 Topsoil Stockpile

Stable Stockpile Site - Stockpiled material will be placed on a stable site.

Protection from Contaminants and Compaction - To protect the topsoil from contaminants and unnecessary compaction that could interfere with vegetation, the stockpile will be isolated from the main surface area by a berm and/or silt fence. A sign designating "topsoil" will be installed on the stockpile.

The topsoil stockpile will be constructed in such a manner as to allow access for repair of the pile surfaces and diversion structures.

Wind and Water Erosion Protection - The topsoil stockpile will be protected from water erosion by berms, which trap sediment runoff from the stockpile. The berms have been designed to completely contain the 10-year 24-hour storm event (see Attachment 7-1). The stockpile will be surface pitted, gouged and/or roughened and revegetated using the grass seeds listed in Table 3-2 to prevent wind erosion.

Topsoil Redistribution - Stockpile soil will not be moved until redistribution during contemporaneous or final reclamation operations unless approved by the Division.

At well pad G-19 a portion of the salvaged topsoil will be stored on a fork of the existing road. There is no topsoil remaining on the road and the road will remain following reclamation of the G-19 pad site. Wide flagging will be used as a marker to identify the separate between the road surface and the stored topsoil. Landowner correspondence pertaining to topsoil storage on the existing road is contained in Attachment 2-3.

Cross-sections of topsoil piles STP-1 thru STP-7 are shown on Plates 2 and 3, in Attachment 5-4. As-built cross sections with horizontal and vertical scales equal with two perpendicular cross sections provided for each of the topsoil stockpiles will be submitted within 30 days following the completion of the construction of topsoil stockpiles STP-1 thru STP-7. The perpendicular cross sections will extend through the area where the stockpiles join the road.

234.300 Topsoil Stockpile Relocation

Stockpiled soil in jeopardy of being detrimentally affected in terms of its quantity and quality by drilling operations may be temporarily redistributed or relocated on approval by the Division and modification of this M&RP.

240 RECLAMATION PLAN

As-built cross section where both horizontal and vertical scales are equal will be provided within 30 days of completion of the AMV road construction. The as-built road cross sections provided would be drawn at stations 0+00, 15+00, 30+00, 45+00 and 53+00 on the section of the road leading to G-31. On the section of the road leading to G-18 the proposed cross sections will be at station 5+00, 12+00 and 18+00. In addition, an as-built road profile will be provided within 30 days of completion of the AMV road construction

241 General Information

Reclamation of the degassification sites (topsoil redistribution, amendments, and stabilization) is discussed in Sections 242, 243, and 244 respectively.

242 Soil Redistribution

242.100 Soil Redistribution Practices

The topsoil will be placed after recontouring of the site has occurred. Topsoil will be handled when they are loose or in a friable condition. The moisture content will be visually monitored and water will be added as needed to enhance the soil's condition for handling. The approximate amount of topsoil available for each site is shown in Table 2-1. The reclamation time line can be found on Figure 5-15 for sites G-2 and G-3 and on Figure 5-26 for sites G-4 thru G-19 and G-31. Figure 5-26 has been revised to include the access road (AMV).

The topsoil will be distributed in two phases at well site G-2, the first phase will be the contemporaneous reclamation of a portion of the pad area used during well construction (see Figures 5-4, 5-8 and 5-12). During contemporaneous reclamation topsoil from the stockpile will be distributed in the depths shown in Table 2-3.

Final reclamation will occur at all well sites after venting of the methane gas is complete, venting equipment has been removed and the well has been plugged. Well plugging will be delayed at well sites G-2, G-5 and G-7, to allow additional time for venting of the gob behind the sealed panels and to provide surface access to the mine. The surface at well sites G-2 and G-5 will be reclaimed in 2007/2008, however the wells will not be plugged. The surface at well site G-7 will be reclaimed in 2008, but the wells will not be plugged. The topsoil stockpile storage area and access road (G-2 and G-5) will be reclaimed during this final phase. The access roads to G-3, G-4, G-6, G-7, G-8, G-9, G-10, G-11 and G-12 are pre-existing and will not be reclaimed.

The topsoil stockpile storage area and access road (G-2 and G-5) will be reclaimed following the plugging of the wells. The access roads to G-3, G-4, G-6, G-7, G-8, G-9, G-10, G-11, G-12, G-13, G-15, G-17 and G-19 are pre-existing and will not be reclaimed. The access road joining the pre-existing road to G-16 and the portion of the access road between the topsoil stockpile and the well site at G-14 will be pocked/gouged and seeded during final reclamation of the site.

The AMV access road will be reclaimed using the technology discussed in Section 240 of this amendment following the sealing and reclamation of well pads G-18 and G-31.

Refer to Section 341 for additional information.

Soil Thickness - The topsoil will be distributed during contemporaneous and final reclamation in the thickness shown in Table 2-3.

Compaction - Prior to the application of topsoil, compacted subsoils will be roughened or loosened for a depth of 18 to 24 inches. To prevent compaction of topsoil, soil moving equipment will refrain from unnecessary operation over spread topsoil. The topsoil will be in a loosened condition prior to seeding.

Following the drying of the mud pit materials, the dirt excavated to create the mud pit will be mixed with the drill cutting and returned to the pit to prevent a boundary of hard material from forming in the mud pit area that would hamper root penetration and then compacted to minimize settling.

Erosion - Care will be exercised to ensure the stability of topsoil on graded slopes to guard against erosion during and after topsoil application. Post reclamation (contemporaneous and final) erosion control measures will be surface roughing, mulching and seeding.

242.200 Regrading

The areas will be graded to their approximate original topographic configuration, except as approved by the Division.

242.300 Topsoil Redistribution on Impoundments and Roads

The mud pits will be dismantled and filled following completion of drilling. See Section 242.100, Compaction for additional information. Mud pits will be covered with the same amount of topsoil as the rest of the site. The roads existing prior to starting the drilling program will not be reclaimed. Access roads built to allow entrance to the drilling pads will be reclaimed and will receive topsoil in the same depth as their corresponding pad areas, unless specified otherwise .

243 Soil Nutrients and Amendments

The soils will be analyzed directly following salvage to determine if amendments are needed. Testing of the topsoil will be done according to Table 6 of the Division's Topsoil and Overburden Guidelines. The topsoil will be tested at a minimum for the following parameters: pH, electrical conductivity, total carbon, SAR, water holding capacity, plant available nitrogen, and phosphorus. Results of these analyses will be incorporated into Attachment 2-1 and 2-2.

244 Soil Stabilization

244.100 Protection and Stabilization of Surface Area

All reclaimed areas will be stabilized to control erosion by application of mulch, tackifier, and roughening of the surface. The areas will be graded to the approximately original topographic configuration. Seeding will be accomplished with the application of seeds and mulch with a long fiber tackifier or broadcast. Methods of protection and stabilization are further discussed in Chapter 3, Section 341.

244.200 Mulch Application

Mulch/tackifier will be applied to stabilize the soil on all areas that have been regraded and covered with growth media. For further discussion of revegetation practices to be utilized, see Chapter 3, Section 341.

244.300 Rills and Gullies

Postmining Land Use and Revegetation - Rills and gullies that are approximately nine (9) inches in depth and disrupt the postmining land use or reestablishment of vegetative cover will be regraded and seeded. In addition, the repair of rills and gullies will assist in the maintenance of water quality standards.

TABLE 2-3

Approximate Topsoil Distribution Thickness

Well Site No.	Topsoil Thickness (Inches)
G-1*	7
G-2	30
G-3	12
G-4	28
G-5	22
G-6	12
G-7	12
G-8*	12
G-9	12
G-10	18
G-11	12
G-12	15
G-13	14 - 16
G-14A	14 - 16
G-15	14
G-16	14
G-17	12
G-18	12
G-19	12
G-31	15
AMV Access Road	12

* Wells G-1 and G-8 were never constructed.

250 PERFORMANCE STANDARDS

251 Topsoil, Subsoil, and Topsoil Supplements Management

All topsoil, subsoil, and topsoil supplements will be managed as outlined in Sections 230 and 240.

252 Stockpiled Topsoil and Subsoil

All stockpiled topsoil and subsoil will be managed according to plans outlined in Sections 230 and 240.

ATTACHMENT 2-1

SOIL INVENTORY AND ASSESSMENT

add to the back of existing information

CRAIG M. CLEMENT, P.G.

GEOLOGIST

Education

BS, Geology, Brigham Young University, 1994

Professional Registrations

Professional Geologist: Wyoming #PG-3460, 2002; Utah #5263617-2250, 2003

Continuing Education

40-hr OSHA HAZWOPER: 1997

8-hr OSHA HAZWOPER Refresher: 2002

MS Degree Coursework in Hydrogeology/ Geophysics

Mine Safety Training Administration Part 48 (24-hr) New Miner Training: August 2005

I have over thirteen years of experience as a geologist/ environmental scientist and have worked on projects in fifteen states. Responsibilities have included utilizing various geophysical methods to provide information regarding subsurface conditions and properties. I have experience with geophysical methods including well logs, seismic SASW and refraction, ground penetrating radar and electrical resistivity. Projects I have worked on also include Environmental Impact Statements, risk assessments (used to evaluate threats to human health and the environment); preparation of air, surface water and groundwater discharge permit applications; and compliance monitoring associated with the resultant permits. I have assisted with mining related permitting including evaluating impacts to soil, groundwater and surface waste resources. I am proficient with Trimble GPS equipment, including data loggers and software for differential correction, and am familiar with Geographic Information System (GIS) database management and ESRI ArcGIS software.

GEOLOGIC / GEOPHYSICAL RECONNAISSANCE AND MAPPING

- ***Wind Turbine Geotechnical Investigations: Abilene, Texas, Idaho Falls, Idaho and Judith Gap, Montana.*** *Project Geologist.* Conducted down-hole seismic shear wave surveys and spectral analysis of surface waves (SASW) surveys to determine shear and compression wave velocities for wind turbine foundation design using a Geometrics SmartSeis S12 seismograph. Projects included investigating more than 175 turbine locations. Collected and interpreted seismic data and calculated the bulk modulus, shear modulus, Poisson's ratio and Young's modulus of the subsurface materials.

- ***Proposed Housing Development Fault Mapping: Jackson Hole, Wyoming.*** *Project Geologist.* Conducted bedrock mapping to establish fault locations at the proposed Elk Dance Estates using Geometrics SmartSeis S12 seismograph and seismic refraction modeling software. Collected and interpreted seismic data and developed cross-sections for determining fault locations.

- ***Jim Bridger Power Plant Ash Pond Expansion Bedrock Mapping: Sweetwater County, Wyoming.*** *Project Geologist.* Conducted bedrock mapping to establish depth to bedrock and bedrock velocities using Geometrics SmartSeis S12 seismograph and seismic refraction modeling software. Collected and interpreted seismic data and developed cross-sections for determining bedrock characteristics.

- ***Montana and Wyoming Departments of Transportation Projects Bedrock Mapping: Montana and Wyoming.*** *Project Geologist.* Projects included Bigfork North and South, U.S. Highway 93 North, Clearwater Junction, Carbon County Line and I-90 slope failures near Sheridan, WY. Conducted bedrock mapping using Geometrics SmartSeis S12 seismograph and seismic refraction modeling software. Collected and interpreted seismic data and developed cross-sections for determining depth to bedrock and bedrock rippability.

- ***CENEX and ConocoPhillips Refinery Cross-Hole Hear Wave Seismic Surveys: Laurel and Billings, Montana.*** *Project Geologist.* Conducted cross-hole seismic surveys to determine shear and compression wave velocities for process equipment foundation design using a Geometrics SmartSeis S12 seismograph, a triaxial borehole geophone and a Ballard Borehole Seismic Source. Collected and interpreted seismic data and calculated the bulk modulus, shear modulus, Poisson's ratio and Young's modulus of the subsurface materials.

NATURAL RESOURCE DEVELOPMENT

- ***Garfield Wetlands Monitoring, Kennecott Utah Copper: Magna, Utah.*** *Project Geologist.* Assisted Kennecott in developing monitoring protocols for sampling water, soil and macroinvertabrates in the North End Wetland Mitigation Area. Monitoring was performed under an agreement with the U.S. Environmental Protection Agency (EPA) in order to evaluate potential impacts of metals in the wetlands to avian species. Conducted monitoring and assisted Kennecott with report presentation and representation to meetings with the Technical Resource Committee and representatives from EPA, U.S. Fish and Wildlife Service, Utah Department of Environmental Quality, Friends of the Great Salt Lake and the local community.

- ***BLM Black Butte Pit 14 Coal Lease-by-Application Environmental Impact Statement (EIS): Paonia, Colorado.*** *Project Scientist.* Responsible for preparing the Soil, Surface Water and Groundwater Resources sections of the EIS and assessing impacts of mining-related impacts on soil and water resources.

- ***USDA-Forest Service Dry Fork Coal Lease-by-Application Environmental Impact Statement (EIS): Paonia, Colorado.*** *Project Scientist.* Responsible for preparing the Water Resources sections of the EIS and assessing impacts of mining-related subsidence on water resources.

- ***Bureau of Land Management (BLM) Pocatello Resource Management Plan (RMP): Southeastern Idaho.*** *Project Scientist.* Prepared sections of the RMP related to soils and geology. Evaluated soil types in the Pocatello District and potential impacts to soil quality through activities conducted on BLM-administered lands.

- ***BLM Utah Fire Management Plan Environmental Assessments (EAs) and Land Use Plan Amendments EA: Utah.*** *Project Scientist.* Prepared sections of the RMP related to soils and geology. Coordinated with BLM resource specialists across the state of Utah to obtain information necessary for the Affected Environment and Environmental Consequence sections of the documents.

- ***Dubois Fish Rearing Station Groundwater Supply Evaluation: Dubois, Wyoming.*** *Project Geologist.* Evaluated potential groundwater sources not influenced by surface water, recommended drilling locations and designed test and production wells. Conducted on-site oversight of drilling and well completion. Conducted well performance testing. Project resulted in two flowing artesian wells to supply fish hatchery needs.

- ***Underground Mining Impacts on Surface Water Sources: Sevier County, Utah.*** *Project Geologist.* Conducted gain/loss studies to characterize effects on perennial streams of proposed long-wall mining activity at the Box Canyon Tract of SUFCO Mine. The project involved stream gauging and water quality monitoring to evaluate potential impacts of underground mining on the west and east forks of Box Canyon Creek.

WATER RESOURCE INVESTIGATION

- ***Bear Claw Ranch Groundwater Study Evaluation: Sheridan County, Wyoming.*** *Staff Geologist.* Conducted an evaluation of a regional geologic and hydrogeologic setting. Developed alternatives for supplying groundwater to meet ranch water supply requirements.

- ***Coal Lease Area Seep and Spring Survey: Scofield, Utah.*** *Project Geologist.* Conducted a seep and spring survey as part of baseline data collection for a proposed coal lease area. Located all seeps and springs in the 12-square mile lease area, and collected water quality data at each site. Mapped the sites using GPS coordinates. Baseline data was incorporated into an environmental impact study.

GEOGRAPHIC INFORMATION SYSTEMS SERVICES

- ***Seminoe and Pioneer Pipe Lines Geotechnical Survey: Utah and Wyoming.*** *Project Geologist.* Conducted a geotechnical survey of over 600 miles of pipeline to identify areas of potential instability, pipeline exposures due to erosion and other threats to pipeline integrity. Compiled data in a GIS database with geologic and topographic information to identify areas requiring field inspections. Results of the field inspections were recorded and located using GPS equipment and added to the GIS database. Areas of concern were ranked based on potential threat to the pipeline.

- ***Boy Scouts of America Camp GPS Mapping: Summit County, Utah.*** *Project Geologist.* Mapped new and existing camp facilities (using GPS equipment) at Bear West Company Boy Scouts of America Camp Steiner. Compiled existing base map information mapped features, aerial photography and U.S. Geological Survey (USGS) topographic maps into GIS database. Produced maps for environmental assessment scoping document and public meeting presentation.

- ***Pioneer Pipe Line GPS Mapping: Utah and Wyoming.*** *Project Geologist.* Conducted helicopter-borne GPS mapping of potential routes for the Pioneer Pipe Line, and evaluated potential slope instabilities along the proposed route.

ABANDONED MINE RECLAMATION

- ***Abandoned Uranium Mines Location and Evaluation: Utah.*** *Field Technician.* Work performed for Bureau of Land Management. Mines were prioritized for reclamation based on health and safety criteria, including measured radiation levels. Collected data using Trimble GPS systems and compiled it into a GIS database after differential correction.

PROFESSIONAL INSTRUCTION

- ***Geology, Physical Science and Astronomy Courses: Utah Valley State College.*** *Adjunct Faculty.* Responsible for conducting oral, visual and written presentations of technical material to a wide variety of audiences.

- ***Geology Courses: Brigham Young University, Provo, Utah.*** *Teaching and Research Assistant.* Taught geology courses and assisted with summer field camp for seniors in geology, which included geologic and structural mapping, measuring geologic sections and environmental field methods. Led a field trip to Hidalgo, Mexico, to assess groundwater problems associated with wastewater from Mexico City and set up exchange of graduate students between La Universidad Autonoma De Hidalgo and Brigham Young University.

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PROFESSIONAL EMPLOYMENT HISTORY

2006 – Present	President and Operator of Clement Drilling & Geophysical, Inc.
1997 – 2006	Project Manager and Geophysical Department Manager, Maxim Technologies (now Tetra Tech)
1996 – 1997	Adjunct Faculty, Utah Valley State College
1993 – 1997	Geologist, Mayo and Associates

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CLEMENT DRILLING
& GEOPHYSICAL, INC.

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Cedar Hills, Utah 84062
Phone 801-372-3685
Fax 801-785-5748

July 29, 2007

Ms. Vicky Miller,
Dugout Canyon Mine
PO Box 1029
Wellington, Utah 84542

Dear Ms. Miller,

This letter report summarizes the methodology and results of the soil survey conducted by Clement Drilling & Geophysical, Inc. for the proposed AMV Road and vent well locations in Pace Canyon, Carbon County, Utah.

NRCS Soil Data

The proposed AMV Road and drill pads for vent well G31 and G18 were evaluated using the United States Department of Agriculture (USDA), Natural Resources Conservation Services' (NRCS) WEB Soil Survey (WSS) utility. Figure 1 presents the map generated by the utility with annotation added showing the approximate location of the soil test pits. In addition, modifications to the soil map units are shown on Figure 1 based on field observations. Detailed soil series descriptions for the soil series that occur in the study area are presented in Appendix A.

Soil Test Pits

Soil test pits were excavated at the two proposed vent well locations. The soil test pit at vent well G31 was excavated by hand on May 1, 2007. The soil test pit for vent well G19 was excavated by hand on May 5, 2007. Soil test pits were also on excavated July 29, 2007 in areas representative of each of the two soil map units that occur in the vicinity of the proposed road and vent wells. The locations of the test pits are approximately located on Figure 1 and coordinates of each test pit collected using a GPS receiver are presented in the test pit logs. The test pit logs are presented in Appendix B and photographs of the excavations in Appendix C. The soils observed in the test pits appear to generally correlate to the NRCS soil series map.

Soil samples were collected from each test pit from each horizon, where possible, for laboratory analysis.

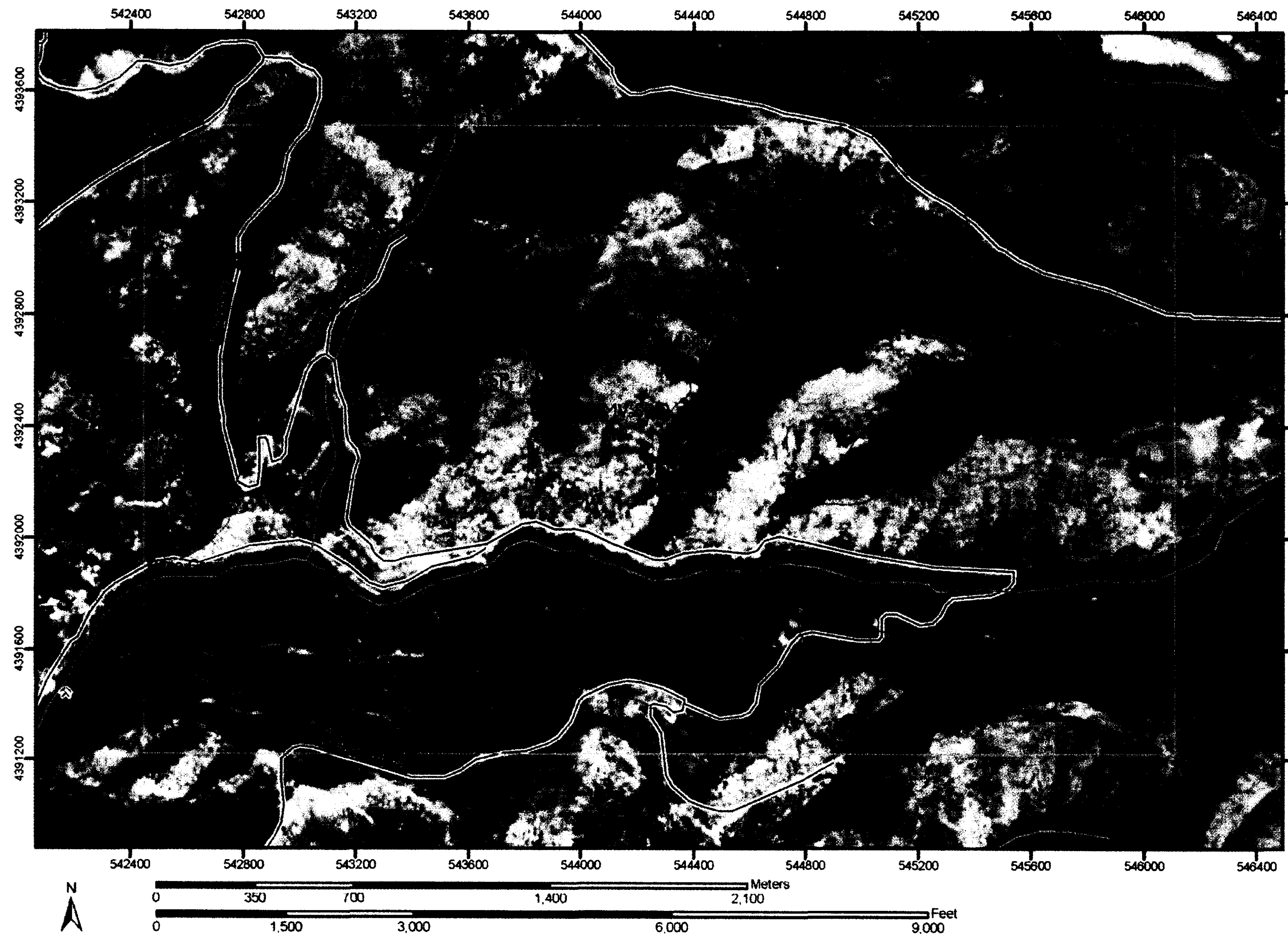
Please feel free to contact me if you have any questions regarding the results of the soil survey. I appreciate the opportunity to work with you on this project.

Sincerely,
Clement Drilling & Geophysical, Inc.

Craig M. Clement

Craig M. Clement, P.G.

Figures



USDA Natural Resources Conservation Service

Web Soil Survey 2.0
National Cooperative Soil Survey

Figure 1
Soil Map and Location of Test Pits

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features

Municipalities
- Cities
- Urban Areas

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails

Roads
- Interstate Highways
- US Routes
- State Highways
- Local Roads
- Other Roads

■ G31-SP-1 Soil Test Pit Location

——— Soil Map Unit modification based on field obsevations

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 12N

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Carbon Area, Utah, Parts of Carbon and Emery Counties
Survey Area Data: Version 3, Dec 14, 2006

Date(s) aerial images were photographed: 10/8/1998; 11/2/1998

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Figure 2
Soil Map Legend

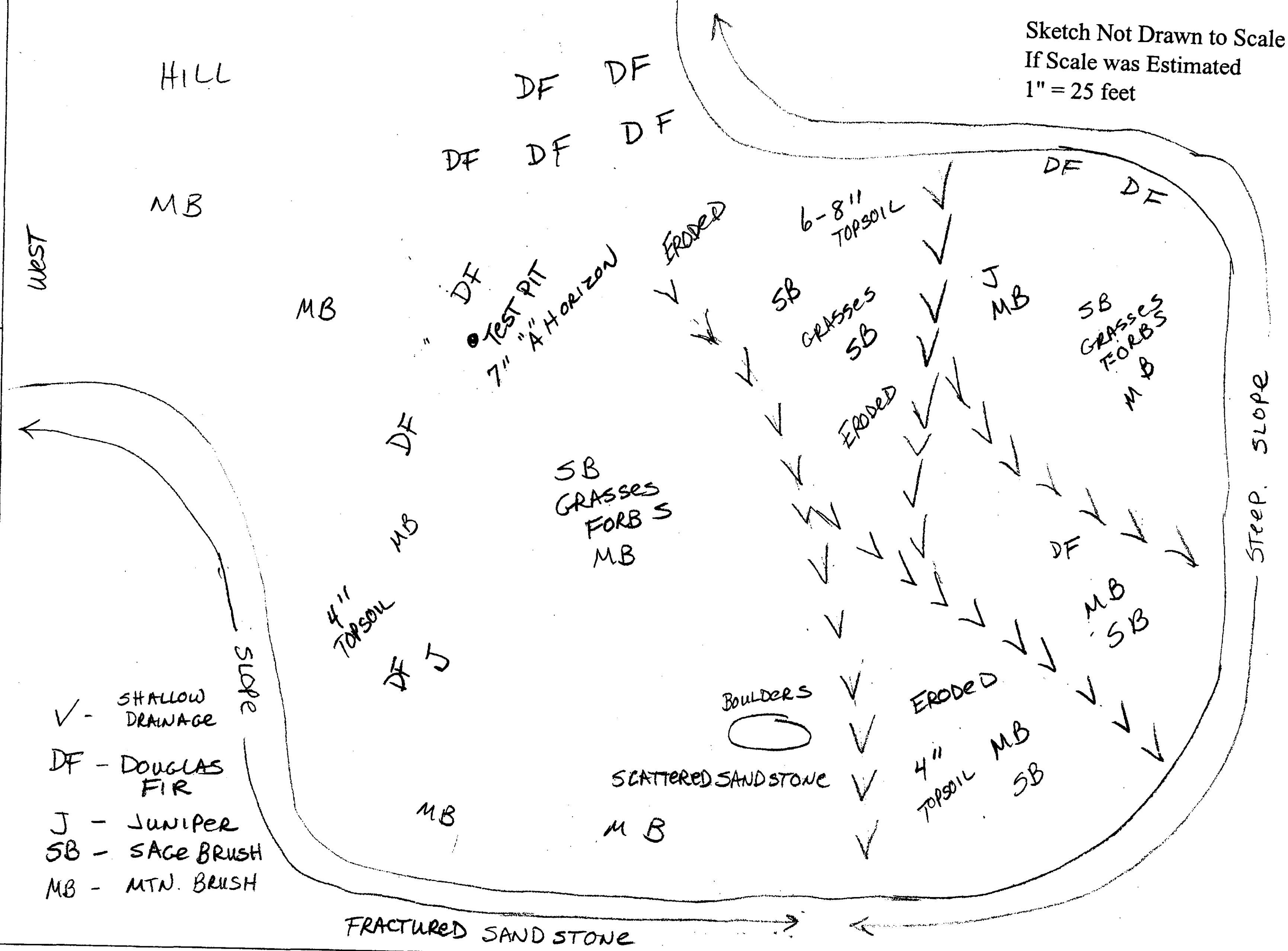
Map Unit Legend

Carbon Area, Utah, Parts of Carbon and Emery Counties (UT616)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
7	Beje-Trag complex	131.7	6.4%
13	Cabba family-Guben-Rock outcrop complex	85.5	4.2%
21	Croydon loam, 8 to 30 percent slopes	140.0	6.9%
62	Midfork family-Comodore complex	525.6	25.7%
84	Podo-Rock outcrop complex	14.5	0.7%
96	Rock outcrop-Rubbleland-Travessilla complex	77.9	3.8%
97	Rottulee family-Trag complex	873.3	42.8%
100	Senchert loam, 3 to 15 percent slopes	155.3	7.6%
101	Senchert loam, 30 to 50 percent slopes	35.3	1.7%
103	Senchert-Toze family complex	3.0	0.1%
Totals for Area of Interest (AOI)		2,042.1	100.0%

Figure 3
Soil Map Map Unit Legend

G-18

Sketch Not Drawn to Scale
If Scale was Estimated
1" = 25 feet



G-31

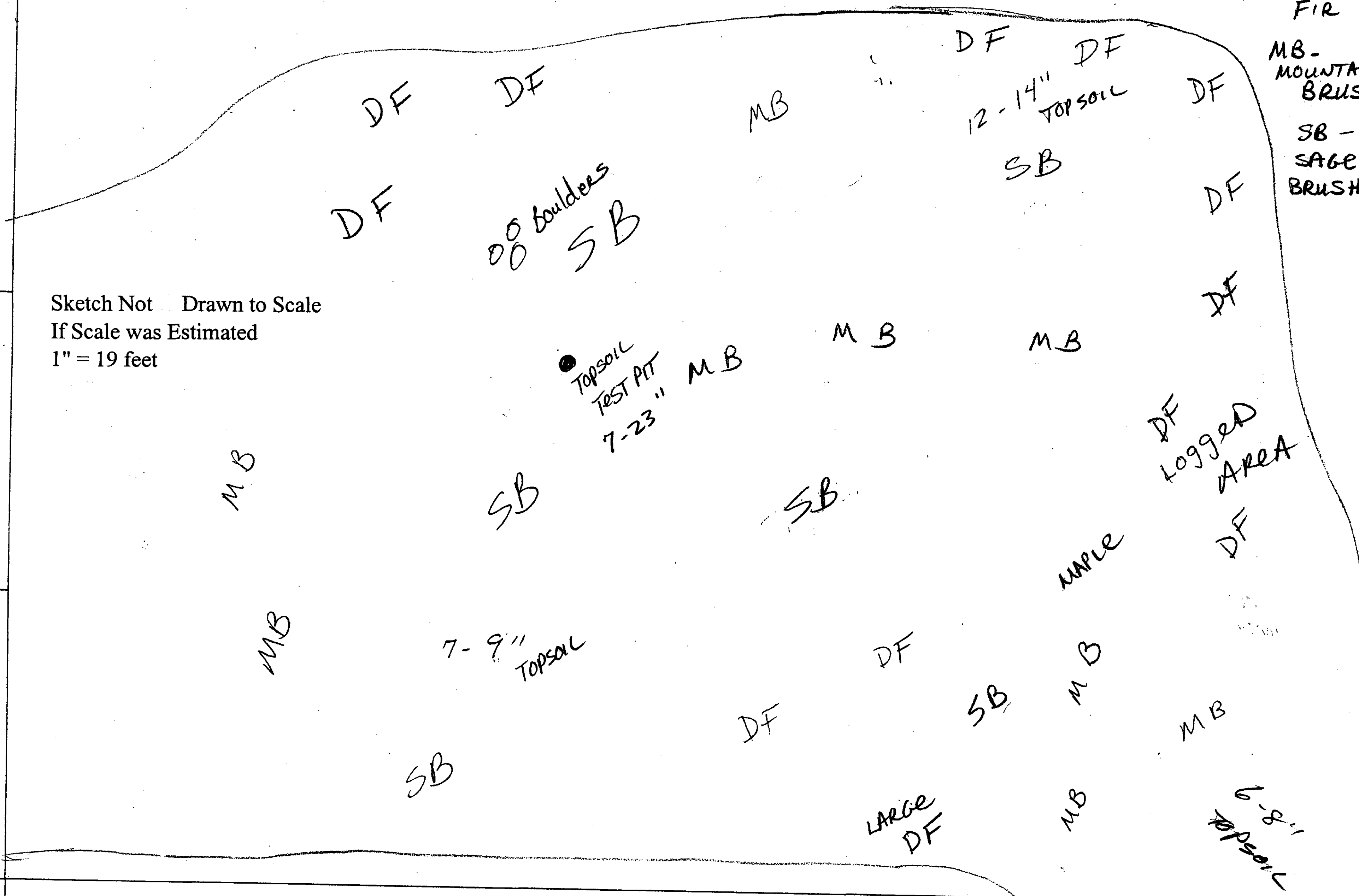
WEST

BRUSH IS VERY TALL OBSTRUCTING VISION

DF - DOUGLAS FIR

MB - MOUNTAIN BRUSH

SB - SAGE BRUSH



Sketch Not Drawn to Scale
If Scale was Estimated
1" = 19 feet

Appendix A
Map Unit Descriptions

Map Unit Description

Carbon Area, Utah, Parts of Carbon and Emery Counties

7 Beje-Trag complex

Setting

Elevation: 6980 to 9670 feet
Mean annual precipitation: 16 to 20 inches
Mean annual air temperature: 38 to 45 degrees F
Frost-free period: 60 to 100 days

Composition

Beje and similar soils: 55 percent
Trag and similar soils: 20 percent

Description of Beje

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Slope alluvium and/or colluvium over residuum weathered from sandstone and shale

Properties and Qualities

Slope: 3 to 15 percent
Depth to restrictive feature: 10 to 20 inches to Lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low or moderately high (0.06 to 0.20 in/hr)
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate maximum: 5 percent
Gypsum maximum: 0 percent
Available water capacity: Very low (about 2.4 inches)

Interpretive Groups

Land capability (non irrigated): 6s
Ecological site: Mountain Shallow Loam (Mountai (R047XA446UT)

Typical Profile

0 to 6 inches: loam
6 to 14 inches: clay loam
14 to 18 inches: unweathered bedrock

Description of Trag

Setting

Landform: Draws
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium and/or colluvium derived from sandstone and shale

Properties and Qualities

Slope: 3 to 30 percent
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate maximum: 10 percent
Gypsum maximum: 0 percent
Available water capacity: High (about 10.8 inches)

Interpretive Groups

Land capability (non irrigated): 6e
Ecological site: MOUNTAIN LOAM (SALINA WILDRYE) (R048AY409UT)

Typical Profile

0 to 5 inches: clay loam
5 to 39 inches: clay loam
39 to 60 inches: clay loam

Map Unit Description

Carbon Area, Utah, Parts of Carbon and Emery Counties

Map Unit Description

Carbon Area, Utah, Parts of Carbon and Emery Counties

13 Cabba family-Guben-Rock outcrop complex

Setting

Elevation: 5980 to 8180 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 42 to 45 degrees F
Frost-free period: 60 to 120 days

Composition

Cabba and similar soils: 50 percent
Guben and similar soils: 20 percent
Rock outcrop: 15 percent

Description of Cabba

Setting
Landform: Canyons
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium and/or slope alluvium over residuum weathered from shale and siltstone

Properties and Qualities
Slope: 40 to 70 percent
Surface area covered with stones and boulders: 13.0 percent
Depth to restrictive feature: 8 to 20 inches to Paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low or moderately high (0.06 to 0.20 in/hr)
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate maximum: 10 percent
Gypsum maximum: 0 percent
Available water capacity: Very low (about 2.3 inches)

Interpretive Groups
Land capability (non irrigated): 7e
Ecological site: Upland Very Steep Shallow Loam (R034XY342UT)

Typical Profile
0 to 3 inches: bouldery loam
3 to 15 inches: loam
15 to 19 inches: weathered bedrock

Description of Guben

Setting
Landform: Hillslopes
Landform position (two-dimensional): Toeslope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium derived from sandstone and shale

Properties and Qualities
Slope: 40 to 75 percent
Surface area covered with stones and boulders: 33.0 percent
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high or high (0.60 to 6.00 in/hr)
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate maximum: 40 percent
Gypsum maximum: 0 percent
Sodium adsorption ratio maximum: 5.0
Available water capacity: Low (about 4.6 inches)

Interpretive Groups
Land capability (non irrigated): 7e
Ecological site: Upland Very Steep Shallow Loam (R034XY342UT)

Map Unit Description

Carbon Area, Utah, Parts of Carbon and Emery Counties

Typical Profile

0 to 7 inches: extremely bouldery loam
7 to 15 inches: very stony loam
15 to 30 inches: very stony loam
30 to 60 inches: very stony loam

Description of Rock outcrop

Setting

Landform: Canyons
Down-slope shape: Linear
Across-slope shape: Linear

Properties and Qualities

Slope: 40 to 75 percent
Depth to restrictive feature: 0 to 0 inches to Lithic bedrock
Capacity of the most limiting layer to transmit water (Ksat): Very low or moderately low (0.00 to 0.06 in/hr)
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 0.0 inches)

Interpretive Groups

Land capability (non irrigated): 8s

Typical Profile

0 to 60 inches: unweathered bedrock

Map Unit Description

Carbon Area, Utah, Parts of Carbon and Emery Counties

62 Midfork family-Comodore complex

Setting

Elevation: 7880 to 9470 feet
Mean annual precipitation: 16 to 25 inches
Mean annual air temperature: 34 to 45 degrees F
Frost-free period: 40 to 80 days

Composition

Midfork and similar soils: 50 percent
Comodore and similar soils: 20 percent

Description of Midfork

Setting

Landform: Mountain slopes
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium derived from sedimentary rock

Properties and Qualities

Slope: 50 to 70 percent
Surface area covered with stones and boulders: 13.0 percent
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high or high (0.60 to 2.00 in/hr)
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate maximum: 5 percent
Gypsum maximum: 0 percent
Available water capacity: Low (about 5.1 inches)

Interpretive Groups

Land capability (non irrigated): 7e
Ecological site: High Mountain Very Steep Loam (R048AY530UT)

Typical Profile

0 to 4 inches: bouldery loam
4 to 7 inches: bouldery loam
7 to 17 inches: very channery loam
17 to 60 inches: very gravelly loam

Description of Comodore

Setting

Landform: Mountain slopes
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium derived from sandstone

Properties and Qualities

Slope: 50 to 70 percent
Surface area covered with stones and boulders: 13.0 percent
Depth to restrictive feature: 10 to 20 inches to Lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low or moderately high (0.06 to 0.20 in/hr)
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate maximum: 0 percent
Gypsum maximum: 0 percent
Available water capacity: Very low (about 1.7 inches)

Interpretive Groups

Land capability (non irrigated): 7e
Ecological site: High Mountain Very Steep Loam (R048AY530UT)

Typical Profile

0 to 6 inches: bouldery loam

6 to 19 inches: very stony loam
19 to 23 inches: unweathered bedrock

Map Unit Description

Carbon Area, Utah, Parts of Carbon and Emery Counties

97 Rottulee family-Trag complex

Setting

Elevation: 7080 to 8670 feet
Mean annual precipitation: 16 to 20 inches
Mean annual air temperature: 38 to 45 degrees F
Frost-free period: 60 to 100 days

Composition

Rottulee and similar soils: 60 percent
Trag and similar soils: 20 percent

Description of Rottulee

Setting

Landform: Mountain slopes, canyons
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Colluvium over residuum weathered from sandstone and shale

Properties and Qualities

Slope: 30 to 60 percent
Depth to restrictive feature: 20 to 40 inches to Lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low or moderately high (0.06 to 0.20 in/hr)
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate maximum: 15 percent
Gypsum maximum: 0 percent
Available water capacity: Low (about 5.2 inches)

Interpretive Groups

Land capability (non irrigated): 7e
Ecological site: MOUNTAIN VERY STEEP STONY LOAM (R047XA473UT)

Typical Profile

0 to 8 inches: loam
8 to 15 inches: clay loam
15 to 23 inches: gravelly silty clay loam
23 to 34 inches: gravelly silt loam
34 to 38 inches: unweathered bedrock

Description of Trag

Setting

Landform: Canyons, mountain slopes
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Alluvium and/or colluvium derived from sandstone and shale

Properties and Qualities

Slope: 30 to 60 percent
Surface area covered with stones and boulders: 13.0 percent
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate maximum: 10 percent
Gypsum maximum: 0 percent
Available water capacity: High (about 10.2 inches)

Interpretive Groups

Land capability (non irrigated): 7e
Ecological site: MOUNTAIN LOAM (SALINA WILDRYE) (R048AY409UT)

Typical Profile

0 to 10 inches: stony loam

10 to 36 inches: clay loam
36 to 60 inches: clay loam

100 Senchert loam, 3 to 15 percent slopes

Setting

Elevation: 8670 to 9470 feet
Mean annual precipitation: 20 to 30 inches
Mean annual air temperature: 36 to 38 degrees F
Frost-free period: 40 to 60 days

Composition

Senchert and similar soils: 80 percent

Description of Senchert

Setting
Landform: Ridges, plateaus
Landform position (two-dimensional): Summit
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Colluvium and/or slope alluvium over residuum weathered from sandstone and shale

Properties and Qualities
Slope: 3 to 15 percent
Depth to restrictive feature: 20 to 40 inches to Lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low or moderately high (0.06 to 0.20 in/hr)
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate maximum: 0 percent
Gypsum maximum: 0 percent
Sodium adsorption ratio maximum: 5.0
Available water capacity: Moderate (about 6.2 inches)

Interpretive Groups
Land capability (non irrigated): 6e
Ecological site: High Mountain Loam (Aspen) (R047XA508UT)

Typical Profile
0 to 4 inches: loam
4 to 16 inches: loam
16 to 35 inches: clay loam
35 to 39 inches: unweathered bedrock

Map Unit Description

Carbon Area, Utah, Parts of Carbon and Emery Counties

101 Senchert loam, 30 to 50 percent slopes

Setting

Elevation: 8580 to 9370 feet
Mean annual precipitation: 20 to 30 inches
Mean annual air temperature: 36 to 38 degrees F
Frost-free period: 40 to 60 days

Composition

Senchert and similar soils: 80 percent

Description of Senchert

Setting
Landform: Mountain slopes
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium and/or slope alluvium over residuum weathered from sandstone and shale

Properties and Qualities
Slope: 30 to 50 percent
Depth to restrictive feature: 20 to 40 inches to Lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low or moderately high (0.06 to 0.20 in/hr)
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate maximum: 0 percent
Gypsum maximum: 0 percent
Sodium adsorption ratio maximum: 5.0
Available water capacity: Moderate (about 6.2 inches)

Interpretive Groups
Land capability (non irrigated): 7e
Ecological site: High Mountain Loam (Aspen) (R047XA508UT)

Typical Profile
0 to 4 inches: loam
4 to 16 inches: loam
16 to 35 inches: clay loam
35 to 39 inches: unweathered bedrock

Map Unit Description

Carbon Area, Utah, Parts of Carbon and Emery Counties

103 Senchert-Toze family complex

Setting

Elevation: 7480 to 9470 feet
Mean annual precipitation: 20 to 25 inches
Mean annual air temperature: 36 to 38 degrees F
Frost-free period: 40 to 60 days

Composition

Senchert and similar soils: 50 percent
Toze and similar soils: 30 percent

Description of Senchert

Setting
Landform: Mountain slopes
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium and/or slope alluvium over residuum weathered from sandstone and shale

Properties and Qualities
Slope: 15 to 30 percent
Depth to restrictive feature: 20 to 40 inches to Lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low or moderately high (0.06 to 0.20 in/hr)
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate maximum: 0 percent
Gypsum maximum: 0 percent
Available water capacity: Low (about 4.5 inches)

Interpretive Groups
Land capability (non irrigated): 7e
Ecological site: High Mountain Loam (Douglas Fi (R047XA512UT)

Typical Profile
0 to 4 inches: loam
4 to 18 inches: clay loam
18 to 25 inches: silty clay
25 to 29 inches: unweathered bedrock

Description of Toze

Setting
Landform: Mountain slopes
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium derived from sandstone, shale and siltstone

Properties and Qualities
Slope: 15 to 35 percent
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high or high (0.60 to 2.00 in/hr)
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate maximum: 30 percent
Gypsum maximum: 0 percent
Available water capacity: Moderate (about 6.5 inches)

Interpretive Groups
Land capability (non irrigated): 6e
Ecological site: High Mountain Loam (Douglas Fi (R047XA512UT)

Typical Profile
0 to 3 inches: loam
3 to 33 inches: gravelly silt loam
33 to 60 inches: very gravelly fine sandy loam

Map Unit Description

Detailed Soil Map Units

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. The contrasting components are mentioned in the map unit descriptions. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description indicates the composition of the map unit and selected properties of the components of the unit.

Soils that have profiles that are almost alike make up a "soil series." Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into "soil phases." Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A "complex" consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An "association" is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An "undifferentiated group" is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include "miscellaneous areas." Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Additional information about the map units described in this report is available in other Soil Data Mart reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the Soil Data Mart reports define some of the properties included in the map unit descriptions.

Appendix B
Soil Test Pit Logs

Site **G31-SP-1** AMV Road

Name	Craig Clement	**Drainage**	WD	Well Drained
Date	5/1/2007	**Flooding**	none	
Weather	Clear, 70°F	**Ponding**	none	
Location	N 39.68164°, W 110.49317°	**Depth to Water Table**	Unknown	
Datum	NAD 83	**Earth Cover**	SOS	sagebrush, serviceberry w/ some Douglas fir & juniper
Topographic Map	Mount Bartles, UT; 1:24,000; 1972	**Parent Material**	COL	colluvium
Slope Aspect	SW	**Bedrock, Kind**	SST, SIS, SHA	Interbedded sandstone, siltstone and shale
Slope Gradient	45%	**Bedrock, Fracture**	-	
Slope Complexity	Complex	**Bedrock, Hardness**	MO	Moderate
Slope Shape	VV Convex, Convex	**Bedrock, Depth**	100 cm	estimated
Hillslope Profile Postion	SH shoulder	**Erosion, Kind**	R	rill
Geomorphic Component	TR tread	**Erosion, Degree**	1	>0 up to 25%
Microrelief	MH microhigh	**Runoff**	VH	Very High
Drainage Pattern	dendritic	**Surface Fragments**	Stony	

Diagnostic Horizons	**Observation Method**	**Depth (cm)**		**Boundary**		**Color (moist)**		**Texture**	**Structure**	**Reaction (HCl)**	**% Rock Fragments & Size**	**% Roots, Size & Location**
		From	To	Distinctness	Topography							
AO	SP	0	15	Gradual	Wavy	Moderate yellowish brown	10YR 5/4	SIL, CB	1,VF,GR	VE	15%,GR to CB	5%, VF to M, T
A	SP	15	61	Gradual	Wavy	Moderate yellowish brown	10YR 5/4	SI, trace FS	1,VF,GR	VE	10%,GR to CB	10%,VF to M, T
B	SP	61	84	Gradual	Wavy	Yellowish gray	5Y 7/2	SI, trace FS	1,VF,GR	VE	15%,GR to CB	5%,VF to M, T

Penetration with pick became very difficult.

Depth (cm)		**Description**
From	To	
0	15	Loamy silt, slightly moist abundant sandstone clasts
15	61	Silt with trace fine sand, abundant sandstone clasts , slightly moist, moderate amount of roots
61	84	Silt with trace fine sand, abundant sandstone clasts , slightly moist, minor amount of root material

Site	G18-SP-1	AMV Road							
Name	Craig Clement		**Drainage**	WD	Well Drained				
Date	5/5/2007		**Flooding**	none					
Weather	Clear, 75°F		**Ponding**	none					
Location	N 39.68265°, W 110.48699°		**Depth to Water Table**	Unknown					
Datum	NAD 83		**Earth Cover**	SOS	primarily sagebrush & serviceberry				
Topographic Map	Mount Bartles, UT; 1:24,000; 1972		**Parent Material**	COL	colluvium				
Slope Aspect	SSW		**Bedrock, Kind**	SST, SIS, SHA	Interbedded sandstone, siltstone and shale				
Slope Gradient	45%		**Bedrock, Fracture**	-					
Slope Complexity	Complex		**Bedrock, Hardness**	MO	Moderate				
Slope Shape	LV	Linear, Convex	**Bedrock, Depth**	66 cm					
Hillslope Profile Postion	SH	shoulder	**Erosion, Kind**	R	rill				
Geomorphic Component	CT	crest	**Erosion, Degree**	1	>0 up to 25%				
Microrelief	MH	microhigh	**Runoff**	VH	Very High				
Drainage Pattern	dendritic		**Surface Fragments**	Stony					

Diagnostic Horizons	**Observation Method**	**Depth (cm)**		**Boundary**		**Color (moist)**		**Texture**	**Structure**	**Reaction (HCl)**	**% Rock Fragments & Size**	**% Roots, Size & Location**
		From	To	Distinctness	Topography							
A	SP	0	18	Gradual	Wavy	Moderate yellowish brown	10YR 5/4	Sl w/ FS	1,VF,GR	VE	5%, GR to CB	5% VF to F, T
B	SP	18	53	Gradual	Wavy	Moderate olive brown	5Y 4/4	Sl w/ FS	1,VF,GR	VE	5%,GR to CB	2% VF to F, T
BC	SP	53	66	Gradual	Wavy	Light olive gray	5Y 5/2	FS w/ trace Sl	1,F,GR	VE	5%, GR to CB	>2% VF to F, T
Weathered bedrock at 66 cm												

Depth (cm)		**Description**
From	To	
0	18	Silt with fine sand, moderate amount of root material, sandstone clasts, slightly moist
18	53	Silt with trace fine sand, moderate root material decreasing with depth, slightly moist,sandstone clasts
53	66	Fine sand with trace silt, minor root material, hard @ 66cm, may be weathered bedrock

Site **AMV-SP-1** AMV Road

Name	Craig Clement	**Drainage**	WD	Well Drained
Date	7/23/2007	**Flooding**	none	
Weather	Clear, 85°F	**Ponding**	none	
Location	N 39.68271°, W 110.48338°	**Depth to Water Table**	Unknown	
Datum	NAD 83	**Earth Cover**	SOS	Douglas fir, Mtn maple, sagebrush, Gambel oak
Topographic Map	Mount Bartles, UT; 1:24,000; 1972	**Parent Material**	COL	colluvium
Slope Aspect	N	**Bedrock, Kind**	SST, SIS, SHA	Interbedded sandstone, siltstone and shale
Slope Gradient	75%	**Bedrock, Fracture**	-	
Slope Complexity	Complex	**Bedrock, Hardness**	MO	Moderate
Slope Shape	LV Linear, Convex	**Bedrock, Depth**	120 cm	estimated
Hillslope Profile Postion	BS back slope	**Erosion, Kind**	G	gully
Geomorphic Component	NS nose slope	**Erosion, Degree**	1	>0 up to 25%
Microrelief	MH microhigh	**Runoff**	VH	Very High
Drainage Pattern	dendritic	**Surface Fragments**	Stony	

Diagnostic Horizons	**Observation Method**	**Depth (cm)**		**Boundary**		**Color (dry)**		**Texture**	**Structure**	**Reaction (HCl)**	**% Rock Fragments & Size**	**% Roots, Size & Location**
		From	To	Distinctness	Topography							
AO	SP	0	76	Gradual	Wavy	Grayish brown	5YR 3/2	SICL	1,VF,GR	VE	<2%, GR to CB, T	5% VF to C, T
BC	SP	76	120	Gradual	Wavy	Moderate brown	5YR 3/4	SIC	1,VF,GR	VE	5%, GR to CB, T	>2% VF to M, T

Penetration with pick became very difficult at 120 cm.

Depth (cm)		**Description**
From	To	
0	76	clayey loamy silt, sandstone gravel to boulders on surface, dry
76	120	clayey silt, sanstone & siltstone clasts, dry

AMV-SP-2 AMV Road

Craig Clement		**Drainage**	WD	Well Drained
7/23/2007		**Flooding**	none	
Clear, 90°F		**Ponding**	none	
N 39.67975°, W 110.48692°		**Depth to Water Table**	Unknown	
NAD 83		**Earth Cover**	SOS	Other shrub cover, sagebrush, serviceberry, bunch grasses
Mount Bartles, UT; 1:24,000; 1972		**Parent Material**	COL	colluvium
SW		**Bedrock, Kind**	SST, SIS, SHA	Interbedded sandstone, siltstone and shale
60%		**Bedrock, Fracture**	-	
Complex		**Bedrock, Hardness**	MO	Moderate
LL	Linear, Linear	**Bedrock, Depth**	200 cm	estimated
BS	basckslope	**Erosion, Kind**	G	Gully
SS	side slope	**Erosion, Degree**	1	>0 up to 25%
MH	microhigh	**Runoff**	VH	Very High
dendritic		**Surface Fragments**	Stony	

Observation Method	**Depth (cm)**		**Boundary**		**Color (dry)**		**Texture**	**Structure**	**Reaction (HCl)**	**% Rock Fragments & Size**	**% Roots, Size & Location**
	From	To	Distinctness	Topography							
SP	0	15	Gradual	Wavy	Moderate yellowish brown	10YR 5/4	SI	1,VF,GR	VE	5%, GR to CB	5% VF to F, T
SP	15	91	Gradual	Wavy	Pale yellowish brown	10YR 6/2	SI	1,VF,GR	VE	<2%,GR to CB	2% VF to M, T
SP	91	+	Gradual	Wavy	Pale yellowish brown	10YR 6/2	weathered siltstone bedrock				

Depth (cm)		**Description**
From	To	
0	15	Silt, gravelly on surface (~20%) less below surface (5%), dry, moderate amount of roots
15	91	Silt with sandstone clasts (5%), minor amount of roots, dry
91	+	Siltstone bedrock, weathered, dry

BRUSH IS VERY TALL OBSTRUCTING VISION

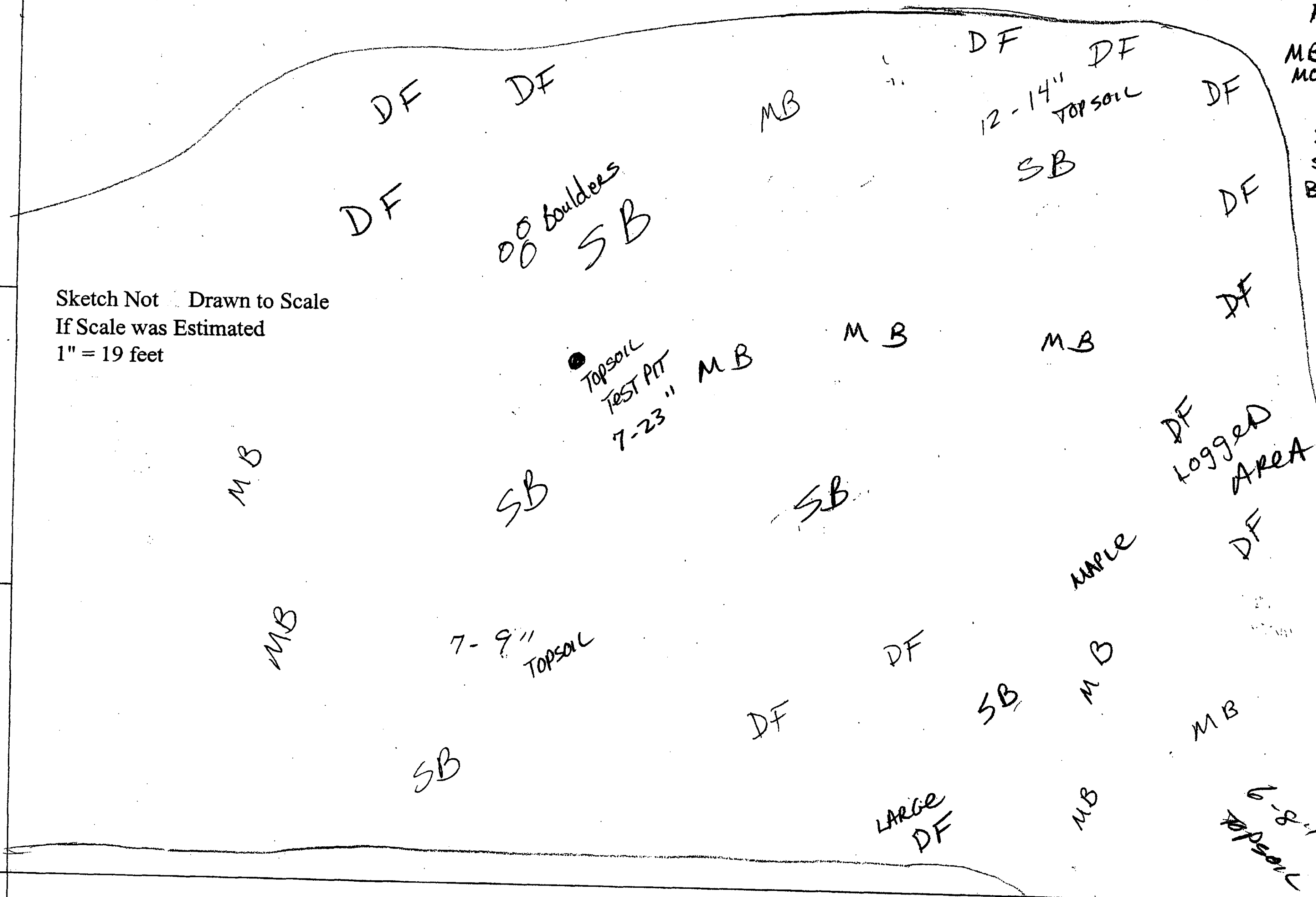
WEST

G-31

DF - DOUGLAS FIR

MB - MOUNTAIN BRUSH

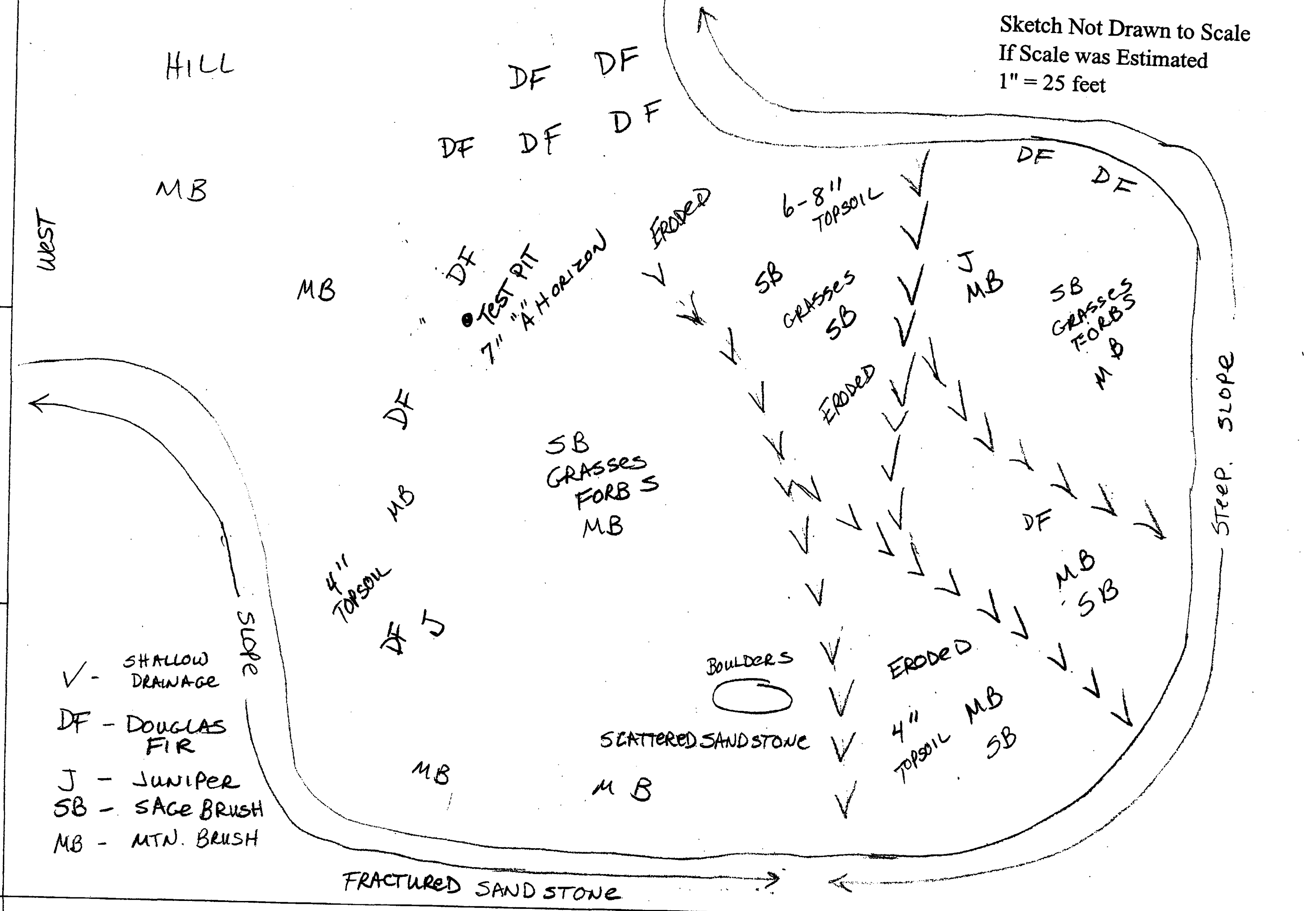
SB - SAGE BRUSH



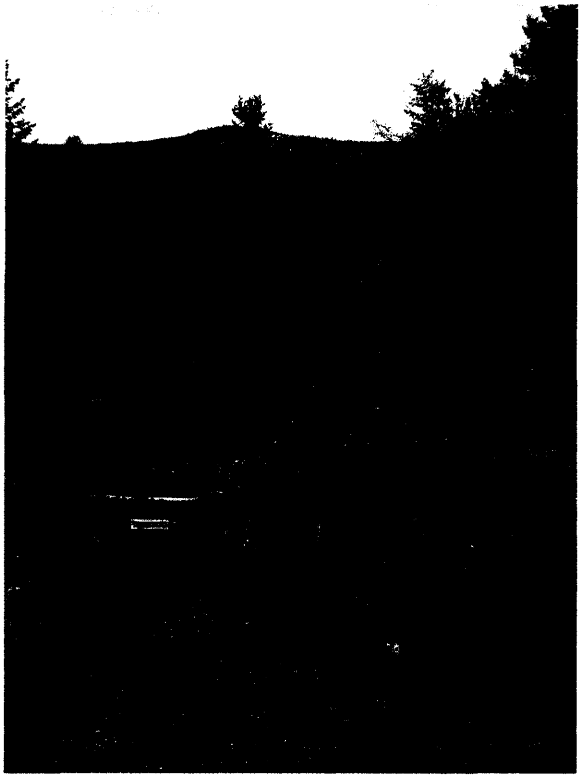
Sketch Not Drawn to Scale
If Scale was Estimated
1" = 19 feet

G-18

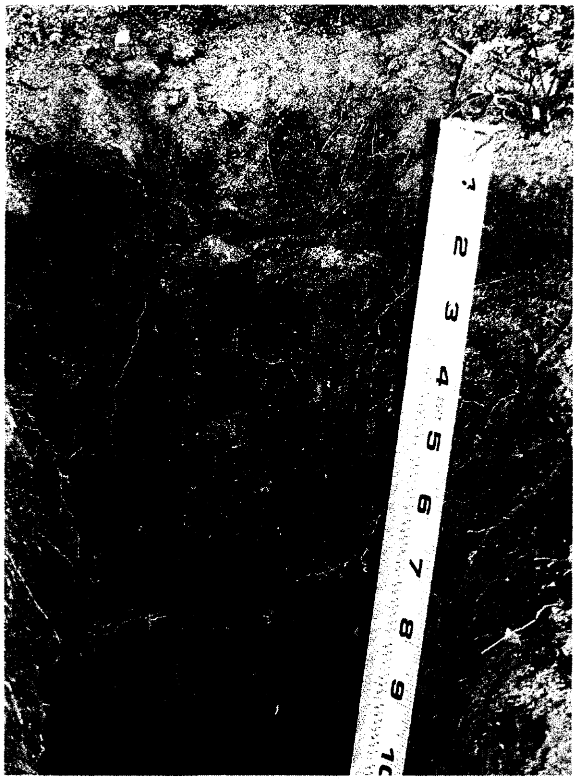
Sketch Not Drawn to Scale
If Scale was Estimated
1" = 25 feet



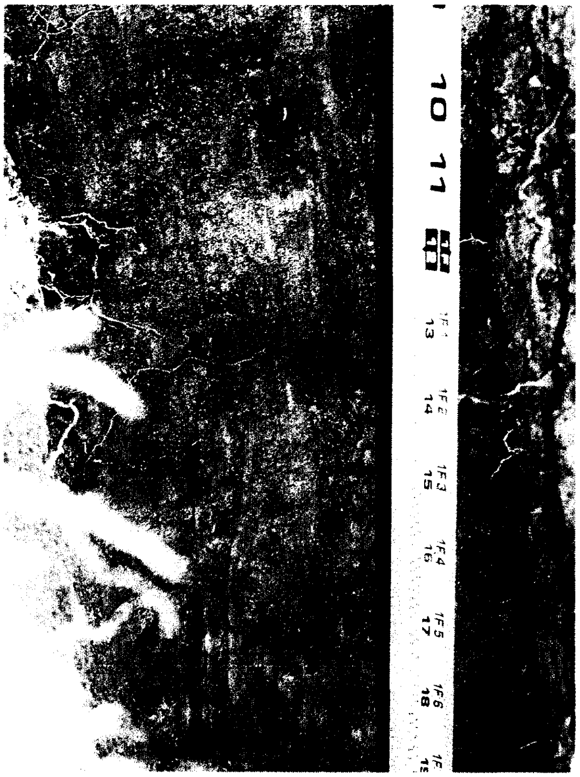
Appendix C
Photographs



G31-SP-1 - Photograph 1
Looking NW at SP-1



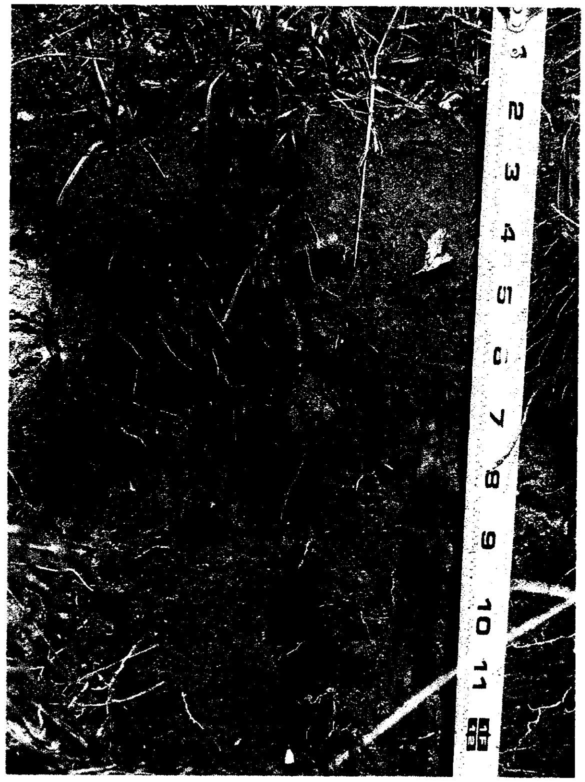
G31-SP-1 - Photograph 2
0 to 25 cm



G31-SP-1 - Photograph 3
25 to 48 cm

G31-SP-1 - Photograph 4
48 to 76 cm

G18-SP-1 - Photograph 1
Looking north at SP-1

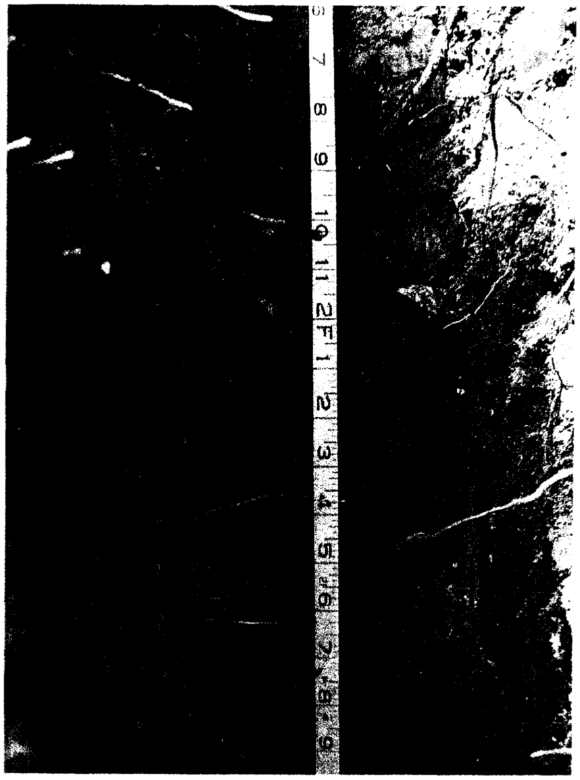


G18-SP-1 - Photograph 2
0 to 30 cm

G18-SP-1 - Photograph 3
30 to 66 cm

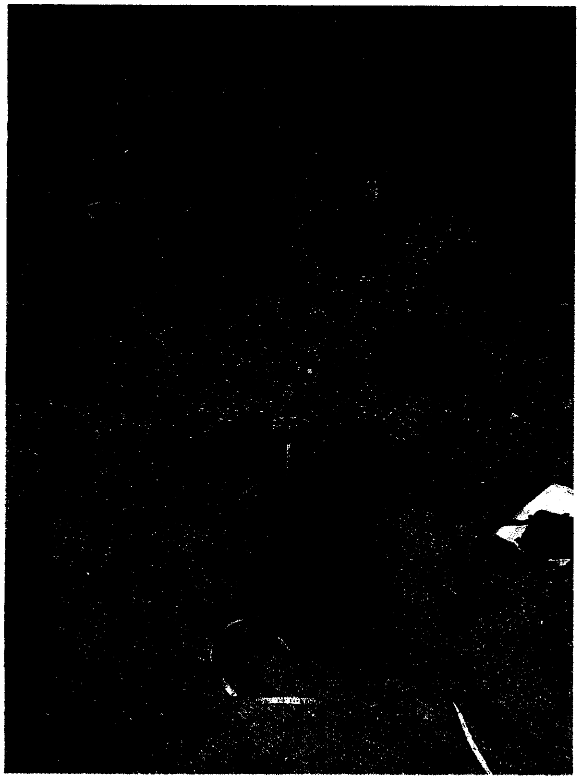
AMV-SP-1 – Photograph 1
Looking south at SP-1

AMV-SP-1 – Photograph 2
0 to 53 cm



AMV-SP-1 – Photograph 3
53 to 83 cm

AMV-SP-1 – Photograph 4
83 to 120 cm



AMV-SP-2 – Photograph 1
Looking northeast at SP-1

AMV-SP-2 – Photograph 2
0 to 55 cm

AMV-SP-2 – Photograph 3
40 to 90 cm

CRAIG M. CLEMENT, P.G.

GEOLOGIST

Education

BS, Geology, Brigham Young University, 1994

Professional Registrations

Professional Geologist: Wyoming #PG-3460, 2002; Utah #5263617-2250, 2003

Continuing Education

40-hr OSHA HAZWOPER: 1997

8-hr OSHA HAZWOPER Refresher: 2002

MS Degree Coursework in Hydrogeology/ Geophysics

Mine Safety Training Administration Part 48 (24-hr) New Miner Training: August 2005

I have over thirteen years of experience as a geologist/ environmental scientist and have worked on projects in fifteen states. Responsibilities have included utilizing various geophysical methods to provide information regarding subsurface conditions and properties. I have experience with geophysical methods including well logs, seismic SASW and refraction, ground penetrating radar and electrical resistivity. Projects I have worked on also include Environmental Impact Statements, risk assessments (used to evaluate threats to human health and the environment); preparation of air, surface water and groundwater discharge permit applications; and compliance monitoring associated with the resultant permits. I have assisted with mining related permitting including evaluating impacts to soil, groundwater and surface waste resources. I am proficient with Trimble GPS equipment, including data loggers and software for differential correction, and am familiar with Geographic Information System (GIS) database management and ESRI ArcGIS software.

GEOLOGIC / GEOPHYSICAL RECONNAISSANCE AND MAPPING

- ***Wind Turbine Geotechnical Investigations: Abilene, Texas, Idaho Falls, Idaho and Judith Gap, Montana.*** *Project Geologist.* Conducted down-hole seismic shear wave surveys and spectral analysis of surface waves (SASW) surveys to determine shear and compression wave velocities for wind turbine foundation design using a Geometrics SmartSeis S12 seismograph. Projects included investigating more than 175 turbine locations. Collected and interpreted seismic data and calculated the bulk modulus, shear modulus, Poisson's ratio and Young's modulus of the subsurface materials.

- ***Proposed Housing Development Fault Mapping: Jackson Hole, Wyoming.*** *Project Geologist.* Conducted bedrock mapping to establish fault locations at the proposed Elk Dance Estates using Geometrics SmartSeis S12 seismograph and seismic refraction modeling software. Collected and interpreted seismic data and developed cross-sections for determining fault locations.

- ***Jim Bridger Power Plant Ash Pond Expansion Bedrock Mapping: Sweetwater County, Wyoming.*** *Project Geologist.* Conducted bedrock mapping to establish depth to bedrock and bedrock velocities using Geometrics SmartSeis S12 seismograph and seismic refraction modeling software. Collected and interpreted seismic data and developed cross-sections for determining bedrock characteristics.

- ***Montana and Wyoming Departments of Transportation Projects Bedrock Mapping: Montana and Wyoming.*** *Project Geologist.* Projects included Bigfork North and South, U.S. Highway 93 North, Clearwater Junction, Carbon County Line and I-90 slope failures near Sheridan, WY. Conducted bedrock mapping using Geometrics SmartSeis S12 seismograph and seismic refraction modeling software. Collected and interpreted seismic data and developed cross-sections for determining depth to bedrock and bedrock rippability.

- ***CENEX and ConocoPhillips Refinery Cross-Hole Hear Wave Seismic Surveys: Laurel and Billings, Montana.*** *Project Geologist.* Conducted cross-hole seismic surveys to determine shear and compression wave velocities for process equipment foundation design using a Geometrics SmartSeis S12 seismograph, a triaxial borehole geophone and a Ballard Borehole Seismic Source. Collected and interpreted seismic data and calculated the bulk modulus, shear modulus, Poisson's ratio and Young's modulus of the subsurface materials.

NATURAL RESOURCE DEVELOPMENT

- ***Garfield Wetlands Monitoring, Kennecott Utah Copper: Magna, Utah.*** *Project Geologist.* Assisted Kennecott in developing monitoring protocols for sampling water, soil and macroinvertabrates in the North End Wetland Mitigation Area. Monitoring was performed under an agreement with the U.S. Environmental Protection Agency (EPA) in order to evaluate potential impacts of metals in the wetlands to avian species. Conducted monitoring and assisted Kennecott with report presentation and representation to meetings with the Technical Resource Committee and representatives from EPA, U.S. Fish and Wildlife Service, Utah Department of Environmental Quality, Friends of the Great Salt Lake and the local community.

- ***BLM Black Butte Pit 14 Coal Lease-by-Application Environmental Impact Statement (EIS): Paonia, Colorado.*** *Project Scientist.* Responsible for preparing the Soil, Surface Water and Groundwater Resources sections of the EIS and assessing impacts of mining-related impacts on soil and water resources.

- ***USDA-Forest Service Dry Fork Coal Lease-by-Application Environmental Impact Statement (EIS): Paonia, Colorado.*** *Project Scientist.* Responsible for preparing the Water Resources sections of the EIS and assessing impacts of mining-related subsidence on water resources.

- ***Bureau of Land Management (BLM) Pocatello Resource Management Plan (RMP): Southeastern Idaho.*** *Project Scientist.* Prepared sections of the RMP related to soils and geology. Evaluated soil types in the Pocatello District and potential impacts to soil quality through activities conducted on BLM-administered lands.

- ***BLM Utah Fire Management Plan Environmental Assessments (EAs) and Land Use Plan Amendments EA: Utah.*** *Project Scientist.* Prepared sections of the RMP related to soils and geology. Coordinated with BLM resource specialists across the state of Utah to obtain information necessary for the Affected Environment and Environmental Consequence sections of the documents.

- ***Dubois Fish Rearing Station Groundwater Supply Evaluation: Dubois, Wyoming.*** *Project Geologist.* Evaluated potential groundwater sources not influenced by surface water, recommended drilling locations and designed test and production wells. Conducted on-site oversight of drilling and well completion. Conducted well performance testing. Project resulted in two flowing artesian wells to supply fish hatchery needs.

- ***Underground Mining Impacts on Surface Water Sources: Sevier County, Utah.*** *Project Geologist.* Conducted gain/loss studies to characterize effects on perennial streams of proposed long-wall mining activity at the Box Canyon Tract of SUFCO Mine. The project involved stream gauging and water quality monitoring to evaluate potential impacts of underground mining on the west and east forks of Box Canyon Creek.

WATER RESOURCE INVESTIGATION

- ***Bear Claw Ranch Groundwater Study Evaluation: Sheridan County, Wyoming.*** *Staff Geologist.* Conducted an evaluation of a regional geologic and hydrogeologic setting. Developed alternatives for supplying groundwater to meet ranch water supply requirements.

- ***Coal Lease Area Seep and Spring Survey: Scofield, Utah.*** *Project Geologist.* Conducted a seep and spring survey as part of baseline data collection for a proposed coal lease area. Located all seeps and springs in the 12-square mile lease area, and collected water quality data at each site. Mapped the sites using GPS coordinates. Baseline data was incorporated into an environmental impact study.

GEOGRAPHIC INFORMATION SYSTEMS SERVICES

- ***Seminoe and Pioneer Pipe Lines Geotechnical Survey: Utah and Wyoming.*** *Project Geologist.* Conducted a geotechnical survey of over 600 miles of pipeline to identify areas of potential instability, pipeline exposures due to erosion and other threats to pipeline integrity. Compiled data in a GIS database with geologic and topographic information to identify areas requiring field inspections. Results of the field inspections were recorded and located using GPS equipment and added to the GIS database. Areas of concern were ranked based on potential threat to the pipeline.

- ***Boy Scouts of America Camp GPS Mapping: Summit County, Utah.*** *Project Geologist.* Mapped new and existing camp facilities (using GPS equipment) at Bear West Company Boy Scouts of America Camp Steiner. Compiled existing base map information mapped features, aerial photography and U.S. Geological Survey (USGS) topographic maps into GIS database. Produced maps for environmental assessment scoping document and public meeting presentation.

- ***Pioneer Pipe Line GPS Mapping: Utah and Wyoming.*** *Project Geologist.* Conducted helicopter-borne GPS mapping of potential routes for the Pioneer Pipe Line, and evaluated potential slope instabilities along the proposed route.

ABANDONED MINE RECLAMATION

- ***Abandoned Uranium Mines Location and Evaluation: Utah.*** *Field Technician.* Work performed for Bureau of Land Management. Mines were prioritized for reclamation based on health and safety criteria, including measured radiation levels. Collected data using Trimble GPS systems and compiled it into a GIS database after differential correction.

PROFESSIONAL INSTRUCTION

- ***Geology, Physical Science and Astronomy Courses: Utah Valley State College.*** *Adjunct Faculty.* Responsible for conducting oral, visual and written presentations of technical material to a wide variety of audiences.

- ***Geology Courses: Brigham Young University, Provo, Utah.*** *Teaching and Research Assistant.* Taught geology courses and assisted with summer field camp for seniors in geology, which included geologic and structural mapping, measuring geologic sections and environmental field methods. Led a field trip to Hidalgo, Mexico, to assess groundwater problems associated with wastewater from Mexico City and set up exchange of graduate students between La Universidad Autonoma De Hidalgo and Brigham Young University.

PROFESSIONAL EMPLOYMENT HISTORY

2006 – Present	President and Operator of Clement Drilling & Geophysical, Inc.
1997 – 2006	Project Manager and Geophysical Department Manager, Maxim Technologies (now Tetra Tech)
1996 – 1997	Adjunct Faculty, Utah Valley State College
1993 – 1997	Geologist, Mayo and Associates

Inter-Mountain Laboratories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
(307) 672-8945

Soil Analysis Report

Canyon Fuel Company
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0707453001

Project: Dugout Canyon Mine
Date Received: 7/26/2007

Date: 8/6/2007
Work Order: S0707453

Lab ID	Sample ID	Depths cm	pH s.u.	Saturation %	Electrical Conductivity dS/m	Field Capacity %	Wilt Point %
S0707453-001	G-20 SP1	0-30	7.4	34.3	0.42	14	10
S0707453-002	G-20 SP1	30-	7.5	39.7	0.42	17	12
S0707453-003	AMV Road SP1	0-30	7.3	48.6	0.40	20	17
S0707453-004	AMV Road SP1	30-48	7.6	45.9	0.31	20	16
S0707453-005	AMV Road SP2	0-6	7.6	41.3	0.31	17	14
S0707453-006	AMV Road SP2	6-36	7.7	43.4	0.23	19	15

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Secor, Soil Lab Supervisor

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Work Order: S0707453

Lab ID	Sample ID	Depths cm	Calcium meq/L	Magnesium meq/L	Sodium meq/L	Potassium meq/L	SAR
S0707453-001	G-20 SP1	0-30	3.20	0.97	0.28	0.36	0.20
S0707453-002	G-20 SP1	30-	3.87	1.00	0.19	0.30	0.12
S0707453-003	AMV Road SP1	0-30	3.28	0.99	0.11	0.18	0.08
S0707453-004	AMV Road SP1	30-48	2.43	0.78	0.11	0.16	0.09
S0707453-005	AMV Road SP2	0-6	2.97	0.50	0.21	0.16	0.16
S0707453-006	AMV Road SP2	6-36	2.52	0.51	0.11	0.09	0.09

These results apply only to the samples tested.

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INTER-MOUNTAIN LABS

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Project: Dugout Canyon Mine

Date Received: 7/26/2007

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Work Order: S0707453

Lab ID	Sample ID	Depths cm	Total Sulfur %	T.S. AB t/1000t	Neut. Pot. t/1000t	T.S. ABP t/1000t	Total Carbon %	TOC %	Available Sodium meq/100g	Exchangeable Sodium meq/100g
S0707453-001	G-20 SP1	0-30	0.04	1.23	11.0	9.73	1.8	1.6	0.03	0.02
S0707453-002	G-20 SP1	30-	0.01	0.40	107	107	2.8	1.5	0.03	0.03
S0707453-003	AMV Road SP1	0-30	0.04	1.09	146	145	4.2	2.5	0.02	0.01
S0707453-004	AMV Road SP1	30-48	<0.01	<0.01	189	189	3.9	1.6	0.02	0.02
S0707453-005	AMV Road SP2	0-6	<0.01	<0.01	207	207	3.8	1.3	0.02	<0.01
S0707453-006	AMV Road SP2	6-36	<0.01	<0.01	286	286	4.2	0.8	0.02	0.01

These results apply only to the samples tested.

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Reviewed by: Karen A Secor

Secor, Soil Lab Supervisor

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Lab ID	Sample ID	Depths cm	Sand %	Silt %	Clay %	Texture	Coarse Fragment %
S0707453-001	G-20 SP1	0-30	49.0	28.0	23.0	Loam	0.03
S0707453-002	G-20 SP1	30-	35.0	41.0	24.0	Loam	0.02
S0707453-003	AMV Road SP1	0-30	20.0	46.0	34.0	Clay Loam	0.06
S0707453-004	AMV Road SP1	30-48	17.0	48.0	35.0	Silty Clay Loam	0.24
S0707453-005	AMV Road SP2	0-6	15.0	53.0	32.0	Silty Clay Loam	5.71
S0707453-006	AMV Road SP2	6-36	6.0	66.0	28.0	Silty Clay Loam	3.41

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Lab ID	Sample ID	Depths cm	Boron ppm	TKN %	Nitrogen Nitrate ppm	Phosphorus ppm	Selenium ppm
S0707453-001	G-20 SP1	0-30	0.40	0.10	1.88	8.45	<0.02
S0707453-002	G-20 SP1	30-	0.52	0.19	5.10	20.0	<0.02
S0707453-003	AMV Road SP1	0-30	0.40	0.21	0.66	2.41	<0.02
S0707453-004	AMV Road SP1	30-48	0.33	0.14	0.50	1.29	<0.02
S0707453-005	AMV Road SP2	0-6	0.32	0.13	0.21	1.14	<0.02
S0707453-006	AMV Road SP2	6-36	0.21	0.08	0.29	<0.01	<0.02

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Report ID: S0707379001

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Date: 8/7/2007

Work Order: S0707379

Lab ID	Sample ID	Depths cm	pH s.u.	Saturation %	Electrical Conductivity dS/m	Field Capacity %	Wilt Point %
S0707379-001	G-19 SP1	0-90	7.5	33.8	0.46	15	10
S0707379-002	G-19 SP1	90-150	8.0	37.6	0.20	15	11
S0707379-003	G-19 SP2	0-20	7.6	57.3	0.44	24	18
S0707379-004	G-19 SP2	20-80	7.8	37.7	0.31	16	11

These results apply only to the samples tested.

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S0707379-001	G-19 SP1	0-90	4.31	1.46	0.34	0.20	0.20
S0707379-002	G-19 SP1	90-150	2.05	1.08	0.16	0.12	0.13
S0707379-003	G-19 SP2	0-20	3.87	0.74	0.25	0.23	0.16
S0707379-004	G-19 SP2	20-80	2.74	0.61	0.23	0.28	0.18

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S0707379-001	G-19 SP1	0-90	0.02	0.68	442	441	6.6	1.3	0.03	0.02
S0707379-002	G-19 SP1	90-150	<0.01	<0.01	463	463	5.9	0.4	0.03	0.02
S0707379-003	G-19 SP2	0-20	0.01	0.43	162	162	5.8	3.9	0.03	0.01
S0707379-004	G-19 SP2	20-80	<0.01	<0.01	185	185	3.4	1.2	0.03	0.02

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Soil Analysis Report

Canyon Fuel Company

Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Report ID: S0707379001

Date: 8/7/2007

Work Order: S0707379

Project: Dugout Canyon Mine

Date Received: 7/23/2007

Lab ID	Sample ID	Depths cm	Sand %	Silt %	Clay %	Texture	Coarse Fragment %
S0707379-001	G-19 SP1	0-90	36.0	44.0	20.0	Loam	19.8
S0707379-002	G-19 SP1	90-150	8.0	56.0	36.0	Silty Clay Loam	22.1
S0707379-003	G-19 SP2	0-20	36.0	39.0	25.0	Loam	11.2
S0707379-004	G-19 SP2	20-80	37.0	38.0	25.0	Loam	12.8

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor

Secor, Soil Lab Supervisor

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Lab ID	Sample ID	Depths cm	Boron ppm	TKN %	Nitrogen Nitrate ppm	Phosphorus ppm	Selenium ppm
S0707379-001	G-19 SP1	0-90	0.40	0.13	1.72	3.88	<0.02
S0707379-002	G-19 SP1	90-150	0.18	0.07	0.35	<0.01	<0.02
S0707379-003	G-19 SP2	0-20	0.70	0.20	1.71	26.3	<0.02
S0707379-004	G-19 SP2	20-80	0.42	0.11	1.46	6.80	<0.02

These results apply only to the samples tested.

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Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
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Reviewed by: Karen A Secor
Secor, Soil Lab Supervisor

ATTACHMENT 2-2

TOPSOIL CALCULATIONS

add to the back of existing information

ATTACHMENT 2-2
TOPSOIL CALCULATIONS

REGISTERED PROFESSIONAL ENGINEER
No. 168246
RICHARD B. WHITE
24 Aug 2007
STATE OF UTAH

Stockpile Dimensions and Volumes

Stockpile	Length (ft)	Width (ft)	Height (ft)	Volume (yd^3)
STP-1	85	50	20	765
STP-2	90	40	22	625
STP-3	205	120	25	5,120
STP-4	150	110	25	6,000
STP-5	150	70	25	1,820
STP-6	200	50	22	1,085
STP-7	125	62	15	4,305
				19,720

Notes

Stockpile locations are shown on the map.

Stockpile dimensions are approximate, and site conditions may affect their sizes and locations.

Stockpile volumes were calculated using AutoCAD Land Desktop Design 2008 software.

ATTACHMENT 2-4

RECLAMATION INFORMATION

Well No.	**Year Constructed**		**Year Plugged**		**Contemporaneous Reclamation**		**Final Reclamation**	
	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual
G-2		2004			2007			
G-3		2004		2005		2005		2006
G-4		2004		2005				2005
G-5		2004			2007			
G-6		2004		2005				2007
G-7		2005			2007			
G-9		2005			2008			
G-10	2006				2007			
G-11	2006				2008			
G-12	2006				2007			
G-13	2006				2008			
G-14	2006				2008			
G-15	2007				2008			
G-16	2008							
G-17	2008							
G-18	2007				2009			
G-19	2007				2008			
G-31	2007				2009			

Dates are approximate, all events are subject to availability of contractors, weather, mining needs, etc.

Although permitted, wells G-1 and G-8 were never drilled/constructed.

Attachment 5-2 and

Attachment 2-4

ATTACHMENTS 2-4 AND 5-4

The grade of the AMV Road is defined below:

<u>Segment from bottom to well pad G-31</u>
Station 0+00 to 15+00 is 12%
Station 15+00 to 30+00 is 10%
Station 30+00 to 45+00 is 8%
Station 45+00 to 53.25+00 is 6%

<u>Segment from well pad G-31 to well pad G-8</u>
Station 0+00 to 10+00 is 9%
Station 10+00 to 19+00 is 11%

CHAPTER 3

BIOLOGY

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310 INTRODUCTION

This chapter presents a description of the biological resources found on the Dugout Canyon degas well site areas and the AMV road.

311 Vegetative, Fish and Wildlife Resources

Vegetative, fish, and wildlife resource conditions in and adjacent to the proposed degassification wells are discussed in Section 320 of this submittal and the approved M&RP.

312 Potential Impacts to Vegetative, Fish, and Wildlife Resources

Potential impacts to vegetative, fish, and wildlife resources and the associated mitigation plan is presented in Sections 330 and 340 of this chapter.

313 Description of Reclamation Plan

The reclamation plan used to restore the vegetative, fish, and wildlife resources to a condition suitable for the post mining land use is presented in Section 340.

320 ENVIRONMENTAL DESCRIPTION

321 Vegetation Information

This section and the approved M&RP contain the environmental descriptions of the vegetation for the permit and adjacent areas.

321.100 Plant Communities Within the Proposed Permit Area

During June 2003, the degassification well sites were surveyed by Patrick Collins, Mt. Nebo Scientific. The report and survey for the areas are included in Attachment 3-1. The site for G-6 was moved to a pre-disturbed exploration well pad, the plant communities described in Mr. Collins report reflect the undisturbed portions on the north and south edges of the well pad. Vegetation information for G-7 was obtained from a report prepared by the NRCS Range Management Specialist, Dean Stacy (refer to Attachment 2-1 and 3-1) and the Patrick Collins survey prepared for well site G-3. A photograph of the G-7 site is included in Attachment 3-1. Well site G-3 and the access road can be seen on the photograph.

A vegetation survey of well sites G-8 thru G-12 was completed in July 2005 by Patrick Collins, Mt. Nebo Scientific. These sites have all been pre-disturbed, with a road running through the center of G-8 and remnants of logging activity at both G-9 and G-10. Approximately fifty percent of the well pads at sites G-11 and G-12 are existing roads which have no topsoil or vegetation. The remaining area at site G-11 has been disturbed, except for a small portion on the west side of the site. Well site G-12 has evidence of disturbance above the road cut however both soil and vegetation are intact. The reports and surveys for the areas will be included in Attachment 3-1.

The vegetation survey of well sites G-13 thru G-17 were completed between July and September 2005. The reports and surveys for the areas are included in Attachment 3-1. At well site G-13, the surface ranges from relatively smooth and non-stoney to very stoney. Portions along the southeast edge are too stony for soil salvage. The G-14 well site has been disturbed by logging. The road to G-13 and G-14 are existing roads, however, the soil will be bladed to the side of the road at site G-14 and replaced during reclamation.

Well site G-15 is about 50 percent disturbed by a road, slope cut and fill. The undisturbed portion of the site is a slope with a southeast aspect (35 to 45 percent gradient). Well site G-16 was previously the site of an exploration hole, having been disturbed and reclaimed. The topsoil on the access road to G-16 will be bladed to one side of the road and replaced during reclamation. At well site G-17 approximately one-third of the site is an existing road.

The entire area of well site G-19 was previously disturbed by logging activities with two roads crossing through the area. Well site G-18 appears to be undisturbed, while G-31 has evidence of disturbance by logging and evidence of use by cattle. The AMV access road to pad G-31 has been used by cattle and hunters to access the top of the ridge. The portion of the AMV road which accesses well site G-18 appears to be undisturbed.

Per an exception granted by the Division during a meeting on April 16, 2007, vegetation on the AMV is being compared to quantitative vegetative analysis information surveyed for degassification well pads. Qualitative data recorded on the access road is discussed in "Vegetation of the De-Gas Sites G-18, G-31 & Reference Area", located in Attachment 3-1. The reference area for the AMV road is the same area as G-16, G-17, G-18 and G-31. The path of the AMV road is a trail used by livestock, hunters, wildlife and a length was disturbed by logging activities, as well as the other activities.

The vegetation on the AMV is similar if not identical to the vegetation analysis presented for degas wells pads G-18, G-19 and G-31. Segment A (approximately 1100 feet) of the road parallels a drainage, the road is on the west side of the drainage and drill pad G-19 is on the east side of the same drainage. The vegetation on Segment A is similar to the vegetation surveyed on Degas pads G-18 and G-31. Segment B approximately 700 feet mimics the soil type and vegetation on the G-19 pad site. A second similarity to the G-19 pad is that Segment B of the road has also been disturbed by logging, containing slash piles and skid trails, this area has experienced natural recovery, except for the width of the trail. Segment C, includes the remainder of the road. Segment C mimics the vegetation on drill pads G-18 and G-31. Segments A and C have a trail running through them, the trail is approximately six feet wide and runs the entire length of the road, including running through Segment B. A drawing of the road, being included to show the segments described above, is provided in Attachment 3-1.

An area approximately 100 x 100 feet on drill pad G-18 was disturbed by logging activity and has experienced natural recovery.

TABLE 3-1

Land Productivity

Well No.	Productivity (lbs.) Per Acre
G-1 (Previously Disturbed)	100
G-2	1,500*
G-3	1,500*
G-4 (Previously Disturbed)	150
G-5	1500*
G-6 (Majority Previously Disturbed)	300*
G-7	1200*
G-8 (Previously Disturbed)	1200
G-9 (Previously Disturbed)	1000*
G-10 (Previously Disturbed)	1000*
G-11 (Previously Disturbed)	1000*
G-12 (Previously Disturbed)	1000*
G-13	1000*
G-14 (Previously Disturbed)	1000*
G-15 (Previously Disturbed)	1000*
G-16 (Previously Disturbed)	1000*
G-17 (Previously Disturbed)	1000*
G-18	900 - 1200*
G-19 (Previously Disturbed)	500 - 800*

G-31 (Previously Disturbed)	900 - 1200*
Access Road - AMV (Previously Disturbed)	900 - 1200*
Reference Areas	
Sagebrush/Snowberry/Grass (G-2, G-3, G-4, G-5, and G-7)	1,500*
Aspen/Maple/Douglas Fir (G-1, G-6, and G-8)	300*
Mountain Brush/Conifer (G-9 thru G-11)	1200
Conifer/Mountain Brush/Pinyon Juniper (G-12, G-13 and G-15)	1100
Aspen/Conifer (G-14 and G-19)	300
Mountain Brush/Snowberry (G-16, G-17, G-18 and G-31, AMV Access Road)	1400

* Community composition is experiencing a declining trend, with decrease in herbaceous production, increase in shrub/tree production.

321.200 Land Productivity Prior to Mining

Productivity of the well site lands and the AMV road prior to mining are shown in Table 3-1. Refer to Appendix 3-1 for a copy of the NRCS letter pertaining to productivity.

322 Fish and Wildlife Information

Fish and wildlife information associated with the degas wells is provided in this chapter. A summary of the fish and wildlife resource information for the permit and adjacent areas is contained in Sections 322.100 through 322.200 of the approved M&RP.

322.100 Level of Detail

The scope and level of detail within the "Methane Degassification Amendment" are sufficient to design the protection and enhancement plan for wildlife and fish associated with the degas wells. Additional information pertaining to fish and wildlife in the permit area is located in the M&RP.

322.200 Site-Specific Resource Information

Raptors - An aerial raptor nest survey was done of the area by the Utah Division of Wildlife Resource (DWR, Chris Colt, Leroy Mead) and CFC personnel in May of 2003, refer to the Confidential Folder. Surveys were completed in May of 2004 and 2005, the information has been incorporated into the Confidential Folder.

No raptor nests were recorded during the survey (2003) in the area (portions of N1/2SE1/4NW1/4 and N1/2SW1/4NE1/4 of Section 24; a portions of N1/2SW1/4NW1/4 Section 19, Township 13 South, Range 13 East) of the degas wells. Refer to Figure 1-1 for mapped well locations.

During the 2004 raptor survey, there were no active or tended nests identified in the vicinity of the degas wells. During the 2005 raptor survey (May 12 & 20), there were no active or tended nests identified in the vicinity of degas wells G-9 and G-10. Two golden eagles nests were observed in the cliffs adjacent to degas well G-8 (Nest 9, DWR 2005 Raptor Survey). A single young eagle was observed, but habitually vacates the nest within 45 days of birth. A raptor survey will be conducted of the well site areas, each year that the wells are in operation.

A raptor survey was performed by Division of Wildlife Resources personnel in May 2006, a copy of the written log is included with deficiencies for Task ID #2456 (located in the confidential folder). Nest 424 when inventoried during the 1998 annual raptor survey was determined to be an inactive raven nest and was not found or inventoried again until 2004 when it was listed as inactive. Nest 424 was not inventoried or found during the annual raptor surveys in 2005 and 2006 by the Division of Wildlife Resources.

During a ground-truthing by Leroy Mead of the Division of Wildlife Resources on July 11, 2006, the two well sites with potential habitat for NSO and northern goshawks were G-14 and G-17. A calling survey will be performed if drilling at either of these sites will begin prior to the end of the exclusionary period, described as July 15.

Well G-14 will be drilled in 2006 after July 15. Well G-17 is to be drilled in 2009, the date for drilling will be scheduled according to the availability of drilling companies and a calling survey if needed will be performed at that time. If a calling survey is performed, the results will be incorporated into the confidential folder.

A Northern Goshawk calling survey was performed in July of 2003 for four weeks in the area of well site G-17. According to the survey there was no response from a northern goshawk. A copy of this survey is located in the confidential binder.

On July 12, 2006, Nest 9 a golden eagle nest was inventoried on the ground by Leroy Mead, although there is evidence of disturbance associated with subsidence in the area, the nest was not disturbed. The 2006 raptor survey lists Nest 9 as being tended.

The G-19 well site was inventoried by Leroy Mead in November 2006 and on June 11, 2007, no wildlife concerns were noted. The area was part of the annual raptor survey, no nest are located in the area.

Well sites G-18, G-31 and the AMV access road were inventoried by Leroy Mead on June 11, 2007, no wildlife concerns were noted. Cattle were observed along the road and on the G-31 well pad site. The area was part of the annual raptor survey, no nests are located in the area.

Bats - No known open mine shafts, caves, adits or other man made structures that might provide habitats for bats are known to exist in the degas project area.

During June of 2005 a bat survey was performed by JBR Environmental Consultants, Inc, on Pace Creek. Site/stop #6 was in the W1/2SE1/4 of Section 20, Appendix 3-3 of M&RP, Confidential Folder, Figure 1, this stop was the closest to the proposed AMV road and drill pads G-18 and G-19. In the summary of the report it states "the nearly constant bat activity at the Stop #7 pond suggests that this water feature is an important resource for bats in terms of both water and feeding." The Stop #7 pond is approximately one mile east of Site/stop #6, drill sites G-18, G-19 and the AMV road and will not be disturbed in association with these mining activities. The same pond is approximately 1.5 miles from drill pad G-31 and the portion of the AMV road which connects the G-31 and G-18 pads. According to the JBR consultants the pond surveyed at Site/stop #7 which is at a minimum one mile east of the road and drill sites is likely one of the water source used by the bats in the area.

According to the 2005 survey only the Fringed Myotis is listed as a bat species of concern when compared with the Utah Sensitive Species list dated October 17, 2006. "Concerning the fringed syotis, of the 3,246 recordings, 10 were identified as showing nearly conclusive patterns to that known for the species. The 10 good recordings occurred over 3 consecutive nights at Station 7, located at the east edge of the Inventory Area. It is unknown if the species actually utilizes the Inventory Area for roosting or if it just visits the pond for foraging (JBR, 2005)."

On the nights of May 21 and 22, 2007 JBR Environmental Consultants, Inc conducted bat surveys along the northern cliffs of Pace Creek Canyon. The inventory area of the survey included portions of Sections 16, 17, 18, 19, 20 and 21 T13SR13E. Pad G-19 was within the area inventoried. During the two night of recording bat calls, no bat call files were produced (Attachment 3-2).

Mexican Spotted Owl - In the Summer of 2003, a calling point survey was conducted in the degas well area by EIS Environmental and Engineering Consulting. The survey report concluded that " within the project area, a thorough search did not reveal the presence of any Mexican spotted owls". The report is included in Attachment 3-2. A second survey was completed in May of 2004, the information is incorporated into Appendix 3-3 of the M&RP .

Threatened and Endangered Plant and Wildlife Species - There are no known federally or state listed threatened and endangered plant and wildlife species within the sites planned for degassification wells or for the AMV road.

Bureau of Land Management Environmental Assessment No. UT-070-2001-83 and UT-070-2004-49 contain determination in accordance with the United States Fish and Wildlife Service's protocols, for sites G-11, G-15, G-16 and G-17. The sites were inventoried for the presence of threatened, endangered, and sensitive faunal, and floral species in June of 2001, April, May and June of 2004, no species were found. In the assessment the sites were being used for exploration holes and were referenced by a different number which is in parenthesis following the degas well number G-11 (DT-2), G-15(DUG0204), G-16 (E) and G-17 (DUG0304).

Mt. Nebo Scientific, Inc. conducted a survey of Pad G-18, G-19, G-31 and the AMV access road no rare, endemic, threatened or endangered or otherwise sensitive species were found in the study area (Attachment 3-1).

There are no known groundwater or surface water flows to the Colorado or Green Rivers with

There are no known groundwater or surface water flows to the Colorado or Green Rivers with potential for impact by the drilling of the degas wells. Potential adverse affects to the four Colorado River endangered fish species (refer to table below) would not be likely since there is no direct route to the Colorado River or Green River from the proposed well locations. Per the Windy Gap Process (referenced by personal communication Jerriann Ernstsen, 8/19/03) consumption estimates for the degas wells: evaporation from ventilation - zero, drill holes will not intersect the coal seam being mined, therefore no access to mine ventilation until after area is sealed; coal preparation - zero, no coal preparation at degas sites (see Sections 522 and 523) ; sediment pond evaporation - zero, no sediment pond at degas sites (see Section 732.200); subsidence effects on springs - zero, no anticipated subsidence at degas sites (see Section525); alluvial aquifer abstractions into mines - zero, no alluvial aquifer abstractions associated with degas drill holes (see Sections 513.500 and 600); postmining inflow to workings - zero, no workings for postmining inflow associated with degas wells (see Sections 513.500 and 600); coal moisture loss - zero, no coal therefore no moisture loss (see Sections 522 and 523); direct diversion - zero, no direct diversions associated with degas wells (see Sections 522 and 523). Water **purchased** for drilling is estimated at 420,000 gallons per hole. Mitigation will not be required since the estimated loss for the construction and reclamation of the degas holes is zero acre feet per year.

Windy Gap Process as it Applies to Existing Coal Mines in the Upper Colorado River Basin
Per meetings with Division of Water Quality personnel during application for a UPDES permit in 2004, "there is no data supporting the premise that surface waters associated with the area of the mine operations reached the Price River or Colorado River prior to or since mining disturbance".

Mining Consumption:
Culinary Water is purchased from PRWID and hauled by D & D Trucking to the Mine.
Estimated **Purchased** Gallons/yr: 2,522,160
Ventilation Consumption/Evaporation:
87,108 gallons/day
87,108 X 0.5 = 43,554 gallons/day (average)
43,554 x 365 = 15,897,210 gallons/yr
Coal Producing Consumption/Coal Moisture Loss:

Water added to coal produced -	3.97% inherent moisture - source Dugout Geologist
	6.38% run-of-mine moisture - year to date average
	2.41% moisture added to coal by cutting operation
Projected Tonnage 2005	4,525,093 tons
Projected Tonnage 6 year average	4,894,100 tons
Tons water/yr 117,977	

Pounds water/yr	235,954,986
Gallons water/yr	28,258,082

Sediment Pond Evaporation:

Mine Site Pond	0.107 acres (surface area)
	18.1 in/yr (high estimate based on HCI Technical Memo, August 22, 2002)
	0.16 ac/ft
	7030 gallons/yr
Refuse Pile Pond	0.41 acres (surface area)
	9 in/yr
	0.31 ac/ft
	5612 gallons/yr (high estimate)

Spring and Seeps Effects From Subsidence - Not Applicable
Alluvial Aquifer Abstractions into Mines - Not Applicable
Alluvial Well Pumpage - Not Applicable
Deep Aquifer Pumpage - Not Applicable
Postmining Inflow to Workings - Not Applicable
Direct Diversions: - Not Applicable
Dust Suppression - 1,000 gallons per truck load, 3 load per day, for 335 days = 1,005,000 gallons plus 1,000 per truck load, 1 load per day, for 193 days = 193,000. Total: 1,198,000 gallons per year.
Mine Discharge: 6 Month Average 420,537gpd = 155,260,050 gal/yr

Calculation estimates for water use in 2005 were necessary since we are using 2005 purchases and usage and the year is 2 months short.

Utah's Federally (US F&WS) Listed
Carbon County, Utah - County of Occurrence
08/27/07

Common Name	Scientific Name	Status	Habitat Present*
Plants Species			
Uinta Basin Hookless Cactus	Sclerocactus glaucus	T	No habitat available
Fish Species			
Humpback Chub	Gila cypha	E	No habitat available
Bonytail	Gila elegans	E	No habitat available
Colorado Pikeminnow	Ptychocheilus lucius	E	No habitat available
Razorback Sucker	Xyrauchen texanus	E	No habitat available

Birds			
Yellow-billed Cuckoo	Coccyzus americanus	C	No habitat available
Mexican Spotted Owl	Strix occidentalis lucida	T	Habitat possible in general area
Mammals			
Black-footed Ferret	Mustela nigripes	E/EXP	No habitat available

* Habitat availability in Carbon County/Dugout Mine/Degas Well Sites and AMV road.

E = A taxon that is listed by the U.S. Fish and Wildlife Service as "endangered" with the possibility of worldwide extinction.
E/EXP = E Experimental - An endangered taxon that is considered by the U.S. Fish and Wildlife Service to be experimental and non-essential in its designated use areas in Utah.
T = A taxon that is listed by the U.S. Fish and Wildlife Service as "threatened" with becoming endangered.
C = A taxon for which the U.S. Fish and Wildlife Service has on file sufficient information on biological vulnerability and threats to justify it being a "candidate" for listing as and endangered or threatened.

Source: Utah Division of Wildlife Resources - created 8/27/2007(Attachment 3-2)

Refer to Attachment 3-2 for a listing of Federal and State Listed, Threatened, Endangered and Candidate Species and Sensitive Species.

322.300 Fish and Wildlife Service Review

If requested, Dugout Canyon authorizes the release of information pertaining to Section 322 and 333 to the U. S. Fish and Wildlife Service Regional and Field Office for their review. On the 25th of May

2005, Leroy Mead of the DWR toured degas well sites G-8, G-9, G-10, G-11 thru G-14. During the tour no wildlife concerns were noted.

The G-18, G-19 and G-31 well sites, as well as, the AMV access road was inventoried by Leroy Mead on June 11, 2007 and no concerns were noted.

323 Maps and Aerial Photographs

Location of the well sites can be seen in Figure 1-1 of this submittal. The AMV road is shown on Plate 1 , in Attachment 5-4.

323.100 Location and Boundary of Proposed Reference Area

Reference areas for the degassification wells were established during the vegetative study conducted in the Summer of 2003. Well sites G-2, G-3, G-4, G-5, and G-7 will be compared to the Sagebrush/Snowberry/Grass reference area and G-1, G-6, and G-8 to the Aspen/Maple/Douglas Fir reference area. Mountain Brush and Conifer is the reference area for well sites G-9 thru G-11. The reference area for Degas Well G-12 , G-13 and G-15 is Conifer, Mountain Brush and Pinyon Juniper. The reference area for Degas Well G-14 and G-19 is Aspen/Conifer, the reference area for G-16 thru G-18, G-31 and the AMV access road is Mountain Brush/Snowberry. Refer to Attachment 3-1 and Figure 3-1 for the location of the reference areas associated specifically with the degas wells. Reference areas are also shown on Plate 3-1 and 3-1E in the M&RP.

323.200 Elevation and Locations of Monitoring Stations

Refer to Section 323.200 of the approved M&RP.

323.300 Facilities for Protection and Enhancement

Section 333.300 and 358.500 of the approved M&RP contain additional discussion pertaining to protective measures to be taken by Dugout Canyon on behalf of wildlife.

323.400 Vegetation Type and Plant Communities

Vegetative types and plant communities are outlined in the vegetative report in Attachment 3-1. Figure 3-2 and the vegetation drawing in Attachment 3-1 (Vegetation, Sections 19 and 20, Township 13 S R13 E)give details of the vegetation types located adjacent to the well sites and the AMV road.

330 OPERATION PLAN

331 Measures Taken to Disturb the Smallest Particle Area

The well sites will be sized to disturb the smallest acreage possible and still meet the requirements for the drilling equipment. The AMV road will be constructed disturbing the small area possible. The drainage control required will be built to satisfy the environmental requirements.

332 Description of Anticipated Impacts of Subsidence

Refer to Section 525.

333 Plan to Minimize Disturbances and Adverse Impacts

General control and mitigation measures addressing potential related biological impacts will include the following:

- Minimizing the total area of disturbance,

- Design, construction, and operation of the well sites and AMV road to minimize impacts
- Establishment of stream buffer zones
- Control of surface discharges
- Exclusion of wildlife from potentially hazardous areas, and
- Reclamation of disturbed areas when they are no longer needed.

All water associated with the drilling of these wells will be appropriated and hauled and/or pumped to the sites by a licensed contractor. Since the drilling of degas wells does not involve the mining of coal, the USWFS consumption requirements for underground operations do not apply (i.e., evaporation form ventilation, coal preparation, sediment pond evaporation, subsidence of springs, alluvial aquifer abstractions into the mine, postmining inflow to workings, coal moisture loss, direct diversions).

As inventoried by the Division of Wildlife Resources in 2003, 2004, 2005 and 2006, Nest 424 was determined to be a raven's nest , which was either inactive, not inventoried or found. Wells G-13, G-14 were drilled post July 15^{th}. Wells G-18, G-19 and G-31 will be drilled post September 1^{st}.

333.100 Minimize Disturbance to Endangered or Threatened Species

Dugout Canyon will apply all methods necessary to minimize disturbances or any adverse effects to threatened or endangered species. See Section 322.200.

333.200 Species and Habitats

All species and habitats within the permit area will be protected to the best of Dugout Canyon's ability.

333.300 Protective Measures

Refer to Section 333.300 of the approved M&RP.

AMV Road - Protection of Upper Channel

Probable Hydrologic Consequences within the area associated with the road is discussed in Section 728.300 and Attachment 7-1, buffer zone designation is discussed in Section 731.600, road drainage is further discussed in Sections 732.400 and 742.400.

Silt fencing will be used at the down hill toe of the slope of the road fill during road construction and reclamation to capture loose soils and rocks. A diagram of the AMV road is provided in Attachment 7-1, during the operation phase the road will have a ditch, berm and culverts with rip rapped outlets to collect and treat road runoff. Outslopes and ditches associated with the road will be seeded during operations to encourage the establishment of vegetation and for erosion control.

A spring designated at SC-96 on Plate 7-1 (M&RP) was not flowing during the months of permitting preparations for the AMV road. Employees of Dugout Canyon Mine were traversing the area in May thru August, during that time no flow from the spring was observed.

340 RECLAMATION PLAN

341 Revegetation

Revegetation of the sites will occur in two phases at drill site G-2. The first phase is to redistribute topsoil and seed the well area not needed for access and operation of the gas exhaust blower. The second phase will consist of plugging the well and distributing the remaining topsoil and seeding on the remaining pad area. Complete final reclamation at well sites G-2, G-5 and G-7 will be delayed, refer to Section 242.100 for additional detail and Attachment 5-2. Sites G-3, G-4, G-6, G-8 (never constructed), G-9, G-10, G-11thru G-19 and G-31 will be reclaimed in one phase. A separate reclamation schedule has been proposed for the AMV road, it will be needed to access the degas wells during and following reclamation (Figure 5-26).

The short-term goal of this revegetation plan is the immediate stabilization of the disturbed sites through erosion control. This objective will be achieved through controlled grading practices, proper seedbed preparation to encourage rapid plant establishment, inclusion of rapidly establishing species in the seed mixture to be planted, and mulch application.

The long-term goals are to establish useful, and productive range. These goals will be attained through the selection and placement of desirable and productive plant species and a commitment to monitor and maintain revegetated areas throughout the bond liability period.

The well sites will be fenced to discourage wildlife and livestock from grazing the reclaimed areas until bond release.

341.100 Schedule and Timetable

The reclamation timetable is shown in Figures 5-15 (G-2)and 5-26 (G-3 thru G-19, G-31 and AMV access road) of this submittal and the reclamation monitoring schedule is found in Chapter 3, Table 3-3 of the approved M&RP.

341.200 Descriptions

Species and Amounts of Seed - The well sites and AMV road will be planted with the seed mix listed on Table 3-2. The seed mix will be used in both contemporaneous and final reclamation phases. The seed will be incorporated with a small amount of wood fiber mulch and applied by hydroseeding equipment or broadcast. Refer to Section 234.200 for topsoil stockpile seeding description.

Methods Used for Planting and Seeding - The degassification sites will be graded to final contour, then ripped to relieve compaction. The depth of ripping will be from 18 to 24 inches. Following ripping, topsoil will be applied to the ripped surface and left in a gouged and roughened state.

Mulching Techniques - Wood fiber mulch will be applied on top of the seed with hydroseeding equipment at the rate of 2,000 pounds per acre and anchored with a tackifier in amounts specified by the manufacturer.

Irrigation, Pest, and Disease Control - No irrigation is planned and pesticides will not be used unless previously approved by the Division.

Measures Proposed for Revegetation Success - Refer to Section 356.

341.300 Greenhouse Studies, Field Trials or Other Equivalent Studies

Refer to the Section 341.300 of the approved M&RP.

342 Fish and Wildlife

342.100 Enhancement Measures

Post bond release enhancement measure will include the establishment of vegetation for wildlife food, cover, and the break up of large blocks of monoculture to diversify habitat. The current blocks of monoculture include large area of sagebrush and mixed brush. According to Dean Stacy, Range Management Specialist, USDA-NRCS "past management practices have allowed the shrub (mainly mountain sage brush) to surpass the 25-35%, while the herbaceous production has declined". By planting reclamation seed mixes with grasses and forbs the planted areas will breakup the monocultures and provide a future seed source.

In consultation with UDWR (Tony Wright, July 6, 2004) and UDOGM (Jerriann Ernstsen, July 6, 2004) a mitigation project was designated for the Northern Saw Whet Owl to compensate for drilling . The project will be completed prior to October 1, 2004. The project will include the construction and installation of 6 to 10 nest boxes on property owned by Canyon Fuel Company, LLC. Because of the UDWR knowledge and experience their personnel will choose the location and install the boxes. Information (goals, procedures, agencies, dates, box locations - township, range, section) concerning the owl mitigation project will be included in the annual report for 2004.

342.200 Plants Used for Wildlife Habitat

Nutritional Value - The nutritional value will be consistent with that of vegetation in the surrounding areas.

Cover - Cover will be comparable to the cover on the associated reference area.

342.300 Cropland

Cropland is not a postming land use.

342.400 Residential, Public Service, and Industrial Land Use

No residential, industrial or public service use is planned.

350 PERFORMANCE STANDARDS

351 General Requirements

Dugout Canyon commits to conduct all operations in accordance with the plans submitted in Sections R645-301-330 through R645-301-340 of the permit application.

352 Contemporaneous Reclamation

Reclamation activities prior to final reclamation will to the extent feasible, be preformed contemporaneously. Contemporaneous reclamation will be performed at the well sites following construction of the wells. Refer to Section 341 for additional details.

353 Revegetation: General Requirements

A vegetative cover will be established on all reclaimed areas to allow for the designated postmining land use of grazing. Refer to Section 411 for additional information.

353.100 Vegetative Cover

The seed mix proposed for revegetation is intended to provide vegetative cover that will be diverse, effective, and permanent. The seed mixture was selected with respect to the climate, potential seedbed quality, erosion control, drought tolerance, and the mixture's ability for quick establishment and spreading.

Native Species - The reclamation vegetation mixture will be comprised of species indigenous to the area and capable of achieving the postmining land use. Diversity of species should allow utilization of plants by wildlife and domestic livestock. The recommended seed mix is comprised of native species.

Extent of Cover - The vegetative cover will be at least equal in extent to the cover at the designated reference areas.

Stabilizing - The vegetative cover mixture is capable of stabilizing the soil surfaces from erosion.

353.200 Reestablished Plant Species

Compatible - The reestablished plant species have been selected to insure their compatibility with the approved postmining use.

Seasonal Characteristics - The revegetation plant species will have the same growing season as the adjacent areas.

Self-Generation - The reestablished plants are species capable of self-generation and plant succession.

Compatibility - The seed mix suggested for revegetation contains plants native to the area and compatible with the plant and animal species of the permit area.

Federal and Utah Laws or Regulations - The seed mix purchased to revegetate the degassification well sites and AMV road will contain no poisonous or noxious plant (see Section 234.200). No species will be introduced in the area without being approved by the Division.

353.300 Vegetative Exception

Dugout Canyon does not require vegetative exception at this time.

353.400 Cropland

The permit area contains no land designated as cropland.

354 Revegetative: Timing

Dugout Canyon will follow the recommended guidelines for revegetation and planting during the first normal period for favorable planting conditions after replacement of the topsoil. In Utah the planting period is usually Fall due to the precipitation events.

355 Revegetation: Mulching and Other Soil Stabilizing Practices

Mulch and/or other soil stabilizing practices (roughing, etc.) will be used on all areas that have been regraded and covered by topsoil (Section 341.200). Dugout Canyon Mine will exercise care to guard against erosion during and after application of topsoil.

Table 3-2

Reclamation Seed Mix

SPECIES	# pls/acre	# pls/sq. ft.**
Grasses, Forbs, and Shrubs		
Kentucky Bluegrass (1,390,000 seeds/lb)*	0.5	16
Mountain Brome (64,000 seeds/lb)*	2.0	3
Sandberg Bluegrass (1,100,000 seeds/lb)*	1.0	25
Bluebunch Wheatgrass (126,000 seeds/lb)*	4.0	12
Bottlebrush Squirreltail (192,000 seeds/lb)*	1.0	4
Rocky Mountain Penstemon (478,000 seeds/lb)*	1.0	11
Mountain Lupine (12,000 seeds/lb)*	3.0	1
Mtn. Snowberry (54,000 seeds/lb)*	4.0	5
Wyoming Big Sage (2,500,000 seeds/lb)*	0.5	29
TOTAL	17	106

* Native Plants

** Rounded nearest whole seed

Grass seed quantities will be doubled if the area is broadcast seeded.

356 Revegetation: Standards for Success

356.100 Success of Revegetation

The success of revegetation will be judged on the effectiveness of the vegetation for postmining land use, the extent of cover on each degassification well site and the AMV road compared to their respective reference areas.

Sampling Techniques - Dugout Canyon will comply with the standards for success, statistically valid sampling techniques for measuring success, and the approved methods outline in the Division's "Vegetation Information Guidelines, Appendix A" for sampling.

The sampling methods to be used during reclamation will be specific to the requirements at the time of reclamation. Nonetheless, according to the currently approved UDOGM guidelines, these sampling methods would be used: sample adequacy, cover (line interception), density (belt transects or plots) and productivity (clipping). The Jaccard's Community Coefficient will be used to calculate acceptable plant similarity and diversity.

Standards for Success - The standards for success will include criteria representative of undisturbed lands in the area of the degas wells as means to evaluate ground cover, production and stocking of the reclaimed site.

356.200 Standards for Success

Standards of success will be applied in accordance with the approved postmining land use as described in this section.

Grazing Land and Pasture Land - The ground cover and production of living plants on the revegetated area will be at least equal to the reference area.

Cropland - There is no area designated as cropland within the degassification well sites or the area of the AMV road.

Fish and Wildlife Habitat - The postmining land use for the degas well sites and AMV road will be grazing, except on pre-existing roads or trails. Pre-existing roads will be returned to their approximate original contour and compacted.

Industrial, Commercial or Residential - The postmining land use for the permit area is not designated for industrial, commercial, or residential use.

Previously Disturbed Areas - Site G-1 (never constructed), G-4, G-6, G-7, G-8 (never constructed), G-9, G-10, G-11, G-12, G-14, G-15, G-16, G-17, G-19, G-31 and AMV access road have been previously disturbed. The AMV access road was previously used for logging, as a trail for hunting and for cattle to access the site of degas well G-31, the road from G-31 to G-18 has not been disturbed. Sites G-2, G-3, G-5, G-13 and G-18 have not been previously disturbed. Standards of success for all sites will be applied in accordance with the postmining land use of grazing as described in this section.

356.300 Siltation Structures

Siltation structures will be maintained until the disturbed areas have been stabilized and revegetated. For additional details on siltation structures, see Sections 542 and 763 of this amendment.

356.400 Removal of Siltation Structures

The land on which siltation structures are located will be revegetated in accordance with the reclamation plan discussed in Section 353 and 357. Refer to Section 763 for addition information pertaining to the removal of siltation structures.

357 Revegetation: Extended Responsibility Period

Dugout Canyon will be responsible for the success of revegetation for a period of 10 years following seeding of the reclaimed area or upon Division bond release.

357.100 Extended Period Begins

The period of extended responsibility will begin after disturbed areas have been reseeded.

357.200 Vegetation Parameters

Vegetation parameters will equal or exceed the approved success standard during the last 2 years of the responsibility period. The success standards are outline in Section 356 of this application.

357.300 Husbandry Practices

The use of husbandry practices are not being requested by Dugout Canyon for the degas well sites and the AMV road.

358 Protection of Fish, Wildlife, and Related Environmental Values

Dugout Canyon will minimize disturbances and adverse impacts on wildlife and their related environments as outline in Section 333 of the approved M&RP and Sections 333 and 342 of this submittal. See Chapter 7, Section 731.100 of the approved M&RP for methods to protect water sources in the area.

358.100 Existence of Endangered or Threatened Species

The well sites and the AMV road will not be constructed or operated where they might jeopardize the existence of any endangered or threatened species. Refer to Section 322.200 and Attachments

3-1, 3-2 and 3-3 for additional information pertaining to threatened, endangered, and sensitive species.

State or federally listed endangered or threatened species will be reported to the Division upon its discovery.

358.200 Bald and Golden Eagles

Dugout Canyon understands that there is no permission implied by these regulations for taking of bald or golden eagles, their nests, or eggs. If found, nests will be reported to the Division.

358.300 Taking of Endangered or Threatened Species

Dugout Canyon understands that there is no permission implied by these regulations for taking of endangered or threatened species, their nests, or eggs.

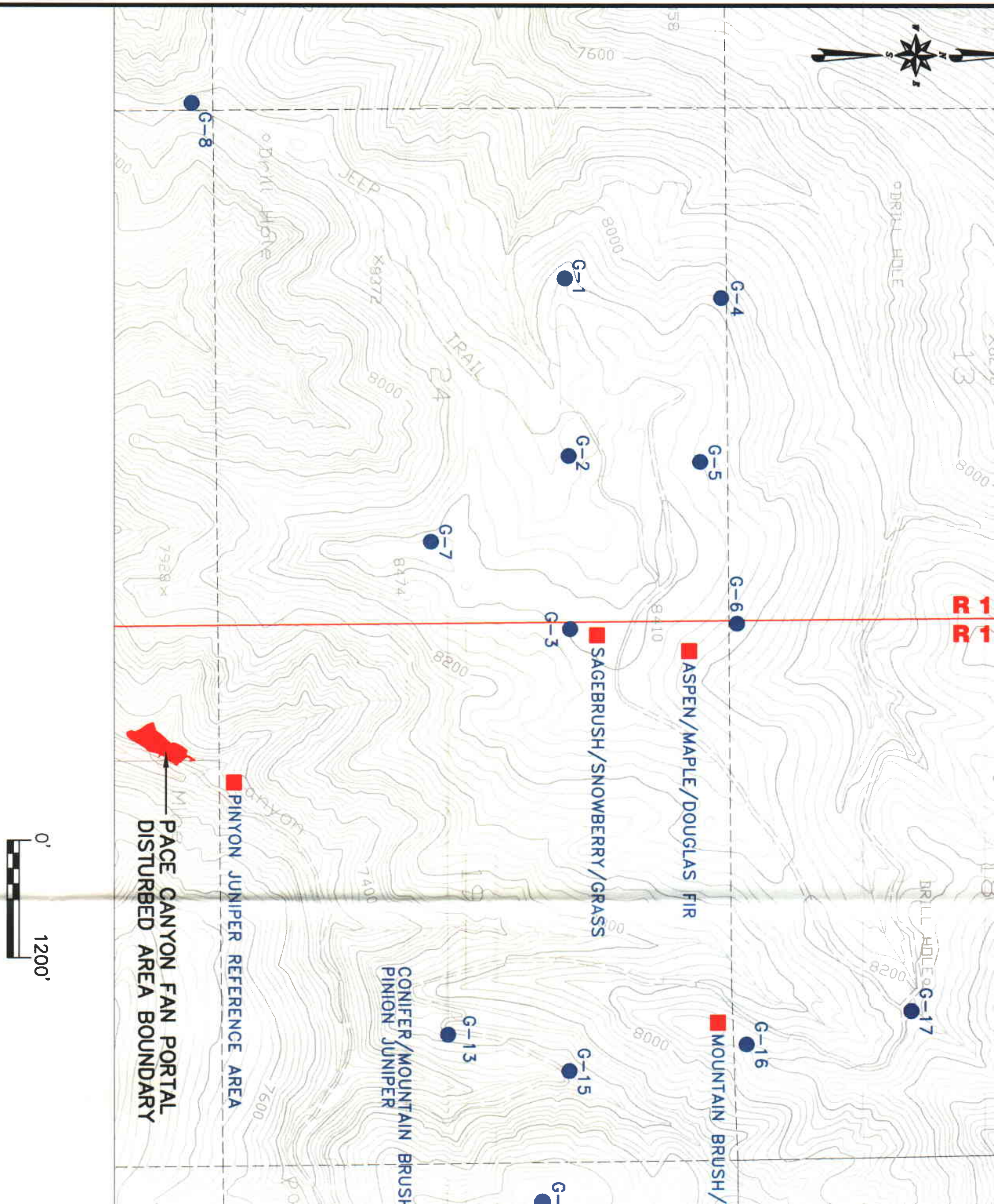
358.400 Replacement of Wetland or Riparian Vegetation

The sites contain no wetland or riparian vegetation, unless specifically noted in the vegetation survey. The disturbed area of the AMV road, outlined on Plate 1 (Attachment 5-4) contains no wetland or riparian vegetation.

358.500 Manmade Wildlife Protection Measure

Electric Power Lines - No utilities will exist at the well sites or on the AMV road.

Potential Barriers - No potential barriers will exist at any of the well sites or on the AMV road, except for the perimeter fence at the well sites. No ponds exist at the well sites or on the AMV road. Refer to Sections 231.100 and 242 for information pertaining to the mud pit.



G-1
G-2
G-3
G-4
G-5
G-6
G-7
G-8
G-13
G-15
G-16
G-17
SAGEBRUSH/SNOWBERRY/GRASS
ASPEN/MAPLE/DOUGLAS FIR
PINYON JUNIPER REFERENCE AREA
CONIFER/MOUNTAIN BRUSH PINION JUNIPER
MOUNTAIN BRUSH/
PACE CANYON FAN PORTAL DISTURBED AREA BOUNDARY
JEEP TRAIL
DRILL HOLE
7600
8000
8200
8372
8474
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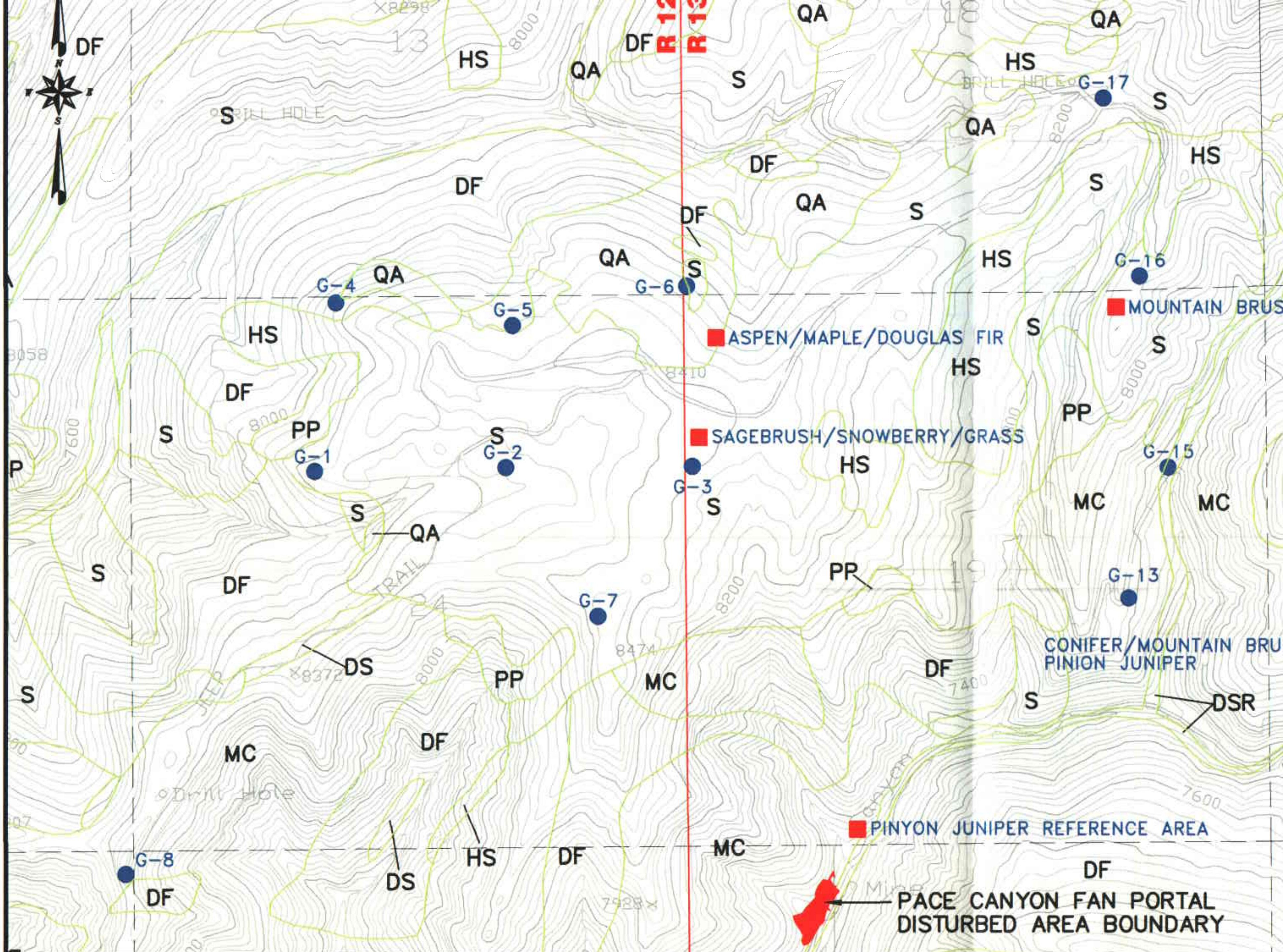
1200'



NOTE: SEE PLATE 3-1 FOR VEGETATION TYPE DESCRIPTION.

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ATTACHMENT 3-1

VEGETATION INVENTORY

NRCS LETTER

add to the back of existing information

VEGETATION OF THE DE-GAS SITES G-18, G-31 & REFERENCE AREA

FOR THE DUGOUT CANYON MINE

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for

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June 2007

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INTRODUCTION

History of Studies

For the past few years Canyon Fuel Company has been constructing borehole drill sites as part of a de-gasification process for safety and to facilitate coal mining operations at the Dugout Canyon Mine. The Dugout Mine is located on the Book Cliffs Plateau in eastern Utah. Permitting of the "de-gas" drill sites has been done in consecutive order on a site-by-site basis and has been driven by their location and role in the mine plan. Earlier reports have been submitted to address the plant communities to be impacted by other drill sites. The first of those reports was called *Vegetation of the Dugout Canyon Mine De-gas Borehole Sites* (July 2003). This report quantitatively described the vegetation proposed for disturbance and reference areas chosen for future revegetation success standards on sites G-1, G-2, G-3, G-4, G-5 and G-6. A report was later written for the next drill sites to be constructed called *Vegetation of the De-gas Borehole Sites: G-8, G-9, G-10 & Reference Areas* (August 2005). The next report in the sequence provided vegetation data for G-11, G-12 and the reference areas associated with them. Accordingly, this report was titled *Vegetation of the De-gas Borehole Sites: G-11, G-12 & Reference Areas* (November 2005). The next document quantified and described boreholes sites and was called *Vegetation of the De-Gas Borehole Sites: G-13, G-14, G-15, G-16, G-17 & Reference Areas* (March 2006). The last document contained quantitative information for De-Gas drill site G-19; it was called *Vegetation of the De-Gas Borehole Site G-19 & Reference Area*

(March 2007).

This information herein contains a study of the vegetation of De-Gas Borehole Sites G-18, G-31 and the associated reference area. It also has information about the access roads to them.

Proposed Disturbed & Reference Areas

For all sites, in order to develop the drill pads, a small amount of land has been proposed to be disturbed at each location. Each proposed borehole drill pad is approximately 200 ft. x 300 ft in size. The plant communities proposed for disturbance at each of these sites have been described and sampled with the results provided in this report. A sensitive plant species survey was also conducted at the sites.

As mentioned, reference areas were chosen to represent future standards for final revegetation success. The reference areas were chosen with respect to their similarities in geology, soils, slope, aspect, and plant community composition to the areas that are proposed for disturbance.

METHODS

Methodologies used for this study were performed in accordance with the guidelines supplied by the State of Utah, Division of Oil, Gas and Mining (DOGM). Quantitative data were recorded on the vegetation of the areas proposed for disturbance at G-18 and G-31 were recorded June 25,

2007. Qualitative data were also recorded on the access roads to these sites the same day. The reference area for this site was sampled September 14, 2005.

Proposed drill sites and access roads to them were surveyed, mapped and staked in the field by Canyon Fuel prior to the vegetation field work. The reference area chosen was approximately one acre in size and was marked in the field using a GPS instrument. The coordinates for the proposed de-gas drill pads and reference areas are given below.

**GPS COORDINATES FOR
DUGOUT CANYON MINE
DE-GAS BOREHOLE SITES:
G-18 & G-31 REFERENCE AREA**

Waypoint Name	Zone	Easting	Northing	Datum	Notes
DUGG18	12S	0544107	4392469	NAD 27	Proposed Disturbed Borehole Site G-18.
DUGG31	12S	0543527	4392360	NAD 27	Proposed Disturbed Borehole Site G-31.
DUG16R	12S	0542993	4392921	NAD27	Reference Area for Borehole Sites: G-18 and G-31 (also G-16, G-17).

Sampling Design and Transect/Quadrat Placement

Transect lines for vegetation sampling were placed randomly within the boundaries of the proposed disturbed and reference area. The sample boundaries included 100 ft outside the proposed drill site. The transect placement technique was employed with the goal to adequately sample a representative subset of the entire site as a whole. Once the transects were established, quadrat locations for sampling were chosen using random numbers from the transect lines with the objective to record data without preconceived bias.

Cover and Composition

Cover estimates were made using ocular methods with meter square quadrats. Species composition, cover by species, and relative frequencies were also assessed from the quadrats. Additional information recorded on the raw data sheets were: estimated precipitation, slope, exposure, grazing use, animal disturbance and other appropriate notes. Plant nomenclature follows "A Utah Flora" (Welsh et al., 2003).

Woody Species Density

Density of woody plant species for the proposed disturbed and reference areas were estimated using the point-quarter method. In this method, random points were placed on the sample sites and measured into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was equal to the square root of the mean area per individual. The number of individuals per acre was the end results of the calculations.

Sample Size & Adequacy

Sampling adequacy for cover and density was attempted by using the formula given below.

$$nMIN = \frac{t^2 s^2}{(dx)^2}$$

where,

nMIN	= minimum adequate sample
t	= appropriate confidence t-value
s	= standard deviation
x	= sample mean
d	= desired change from mean

Statistical Analyses

Student's t-tests were employed to compare the total living cover and total woody species density of each proposed disturbed borehole site with its reference area.

Photographs

Color photographs of the sample areas were taken at the time of sampling and have been submitted with this report.

Threatened & Endangered Plant Species

Prior to recording quantitative data on the plant communities, a sensitive plant species survey was conducted. To initiate the study, appropriate agencies were consulted (e.g. *Utah Natural Heritage Program*) and other sources were reviewed (sensitive species files at *Mt. Nebo Scientific, Inc.*) for potential plant species that are known to be rare, endemic, threatened, endangered or otherwise sensitive in the study area.

Raw Data

The raw data for cover have been summarized on a spreadsheet and were included in the Appendix of this report.

RESULTS

De-Gas Borehole Site G-18

The site proposed for drilling activities at De-Gas Borehole Site G-18 was located on a knoll or a point on the plateau. This area is more flat than its surrounding areas, which was probably a consideration when it was chosen as a drill site. Because of its relatively unique (but not uncommon) location on the mountain, it supports transitional zones between three plant communities including; sagebrush/grass, mountain brush and pinyon-juniper (see Photographs of the Study Areas).

The dominant plant species present in the sample quadrats by cover and frequency (Table 1) were: Vasey sagebrush (*Artemisia tridentata* var *vaseyana*), Salina wildrye *(Elymus salinus*) and Utah serviceberry (*Amelanchier utahensis*). The total living cover, that includes overstory and understory combined, was estimated at 62.75% (Table 2-A). The composition of the understory cover by lifeform was made up of 53.72% shrubs, 26.79% grasses and 19.49% forbs (Table 2-B). Finally, the woody species density of De-Gas Site G-18 was 5,758 individuals per acre (Table 3).

Access Road to De-Gas Borehole Site G-18

The access road to G-18, or the proposed road from G-31 to G-18 was located on a hillside with a predominantly southern exposure. Although the road will be constructed along the contours, the slope angle of the hillside approached 30 degrees. The plant communities that dominate the access road were primarily mountain brush and sagebrush/grass (see Photographs of the Study Areas). Consequently, the most common plant species along the proposed road were noted as Utah Serviceberry, Vasey sagebrush, alder-leaf mountain-mahogany (*Cercocarpus montanus*) and Salina wildrye.

<u>De-Gas Borehole Site G-31</u>

The proposed drill site for De-Gas Bolehole Site G-31 was situated similarly on the plateau as the above-described borehole site. Consequently, similar but slightly different transitional plant communities dominated the area including sagebrush/grass and mountain brush, but conifer trees were also commonly interspersed throughout the site (see Photographs of the Study Areas).

The most common plant species in the understory by cover and frequency in this study area were Vasey sagebrush, snowberry (*Symphoricarpos oreophilus)*, Utah serviceberry and Salina wildrye (Table 4). The overstory was comprised of Utah serviceberry and Douglas fir (*Pseudotsuga menziesii*).

The total living cover of G-31 was estimated at 68.25%, of which 18.50% was overstory and 49.75% was overstory (Table 5). The understory composition consisted of 56.76% trees and shrubs, 25.50% forbs and 17.74% grasses (Table 5-B). The total woody species density of the site was estimated as 4,319 individuals per acre (Table 6).

Access Road to De-Gas Borehole Site G-31

The proposed access road to Borehole Site G-31 begins in a drainage near previous Borehole Site G-19. Because it begins lower in the drainage, a conifer plant community was common at the beginning of the road. As the proposed road corridor gains elevation and changes exposures it dissects mountain brush, sagebrush/grass, pinyon-juniper communities, along with transitional zones between these communities (see Photographs of the Study Areas).

Common plant species along the proposed corridor of the access road to G-31 included Douglas fir, Utah serviceberry, alder-leaf mountain-mahogany, snowberry, pinyon pine (*Pinus edulis*), Utah juniper (*Juniperus osteosperma*) and Salina wildrye.

Mountain Brush/Snowberry/Sagebrush Reference Area

The reference area chosen for future revegetation success standards for De-Gas Borehole Sites G-18 and G-31 was a previously established reference area for Borehole Sites G-16 and G-17 (see Photographs of the Study Areas). It is located in close proximity to G-16. In this mountain brush/snowberry community, the most common species were big sagebrush, Watson's penstemon (*Penstemon watsonii*), snowberry and serviceberry (Table 7).

The total living combined cover was 64.50%, 57.00% was understory and 7.50% overstory (Table 8-A). Woody species dominated the composition at 54.44%, followed by forbs at 28.08%

and grasses at 17.49% (Table 8-B). The woody species density was estimated at 5,137 plants per acres and was dominated by big sagebrush and snowberry (Table 9).

Threatened & Endangered Plant Species Survey

State databases revealed only one potential sensitive species to be located in the vicinity of the proposed disturbed Borehole Sites. This plant was canyon vetch (*Hedysarum occidentale* var. *canone*). Each proposed disturbed area was surveyed in the field for canyon vetch (or any other unusual or sensitive plants). This survey was done prior to recording the quantitative data used to describe the major plant community of the study area. In addition, more searching for sensitive species was done during quantitative sampling of the areas. No rare, endemic, threatened or endangered or otherwise sensitive species were found in the study areas.

Table 1: Cover, standard deviation and frequency by species for the De-Gas Site G-18 (2007).

Proposed Disturbed Community: Sagebrush/Mountain Brush	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
Amelanchier utahensis	11.00	21.13	25.00
UNDERSTORY			
TREES & SHRUBS			
Amelanchier utahensis	5.00	16.28	10.00
Artemisia tridentata	15.50	12.64	85.00
Cercocarpus montanus	2.75	6.02	25.00
Chrysothamnus viscidiflorus	0.95	2.48	15.00
Symphoricarpos oreophilus	4.25	6.57	35.00
FORBS			
Calochortus nuttallii	0.30	1.10	10.00
Castilleia rhexifolia	0.25	1.09	5.00
Eriogonum umbellatum	2.75	5.36	25.00
Gayophytum ramosissimum	0.25	1.09	5.00
Hedysarum boreale	0.50	2.18	5.00
Ipomopsis aggregata	0.50	1.50	10.00
Penstemon watsonii	1.50	4.77	10.00
Petradoria pumila	3.00	5.10	35.00
Senecio sp.	0.75	1.79	15.00
GRASSES			
Elymus salinus	12.00	10.77	70.00
Elymus trachycaulus	0.50	2.18	5.00
Poa secunda	1.00	4.36	5.00

Table 2: Mean total cover, composition, standard deviation and sample size for the De-Gas Site G-18 (2007).

Proposed Disturbed Community: Sagebrush/Mountain Brush	Mean	Standard Deviation	Sample Size
A. TOTAL COVER			
Overstory (O)	11.00	21.13	20
Understory (U)	51.75	8.98	20
Litter	12.45	11.52	20
Bareground	31.40	14.15	20
Rock	4.40	3.95	20
O + U	62.75	26.24	20
B. % COMPOSITION			
Shrubs	53.72	27.15	20
Forbs	19.49	18.50	20
Grasses	26.79	19.71	20

Table 3: Woody Species Density for the De-Gas Site G-18 (2007).

Proposed Disturbed Community: Sagebrush/Mountain Brush	
Species	**Individuals Per Acre**
Amelanchier utahensis	143.95
Artemisia tridentata	3598.72
Cercocarpus montanus	791.72
Chrysothamnus viscidiflorus	215.92
Opuntia sp.	71.97
Pseudotsuga menziesii	215.92
Symphoricarpos oreophilus	719.74
TOTAL	5757.95

Table 4: Cover, standard deviation and frequency by species for the De-Gas Site G-31 (2007).

Proposed Disturbed Community: Sagebrush/Mountain Brush/Conifer	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
Amelanchier utahensis	17.25	25.27	35.00
Pseudotsuga menziesii	1.25	3.83	10.00
UNDERSTORY			
TREES & SHRUBS			
Amelanchier utahensis	4.50	8.50	25.00
Artemisia tridentata	18.50	15.34	75.00
Pseudotsuga menziesii	0.25	1.09	5.00
Symphoricarpos oreophilus	4.75	5.36	50.00
FORBS			
Antennaria microphylla	1.75	5.76	10.00
Astragalus sp.	0.25	1.09	5.00
Hedysarum boreale	0.25	1.09	5.00
Lupinus argenteus	5.75	7.95	40.00
Penstemon watsonii	5.00	4.47	60.00
Petradoria pumila	0.25	1.09	5.00
GRASSES			
Elymus salinus	6.25	5.67	65.00
Elymus spicatus	0.25	1.09	5.00
Elymus trachycaulus	0.25	1.09	5.00
Poa secunda	1.75	7.63	5.00

Table 5: Mean total cover, composition, standard deviation and sample size for the De-Gas Site G-31 (2007).

Proposed Disturbed Community: Sagebrush/Mountain Brush/Conifer	Mean	Standard Deviation	Sample Size
A. TOTAL COVER			
Overstory (O)	18.50	24.70	20
Understory (U)	49.75	15.61	20
Litter	27.55	20.15	20
Bareground	19.20	16.00	20
Rock	3.50	4.47	20
O + U	68.25	17.56	20
B. % COMPOSITION			
Trees & Shrubs	56.76	24.12	20
Forbs	25.50	17.17	20
Grasses	17.74	16.43	20

Table 6: Woody Species Density for the De-Gas Site G-31 (2007).

Proposed Disturbed Community: Sagebrush/Mountain Brush/Conifer	
Species	**Individuals Per Acre**
Amelanchier utahensis	215.96
Artemisia tridentata	2699.51
Pseudotsuga menziesii	215.96
Symphoricarpos oreophilus	1187.79
TOTAL	4319.22

Table 7: Dugout Mine De-Gas Reference Area for G-18 and G-31 (also G-16 & G-17).
Total cover, standard deviation and sample size (2005).

Reference Area: Mountain Brush/Snowberry/Sagebrush	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
Amelanchier utahensis	6.75	12.58	25.00
Juniperus scopulorum	0.75	3.27	5.00
UNDERSTORY			
TREES & SHRUBS			
Amelanchier utahensis	7.00	16.16	35.00
Artemisia tridentata	15.25	14.79	75.00
Juniperus scopulorum	0.25	1.09	5.00
Symphoricarpos oreophilus	10.50	15.96	50.00
FORBS			
Astragalus sp.	0.25	1.09	5.00
Lupinus argenteus	4.05	4.60	55.00
Penstemon watsonii	10.70	7.89	80.00
GRASSES			
Elymus salinus	0.25	1.09	5.00
Elymus spicatus	2.00	3.67	25.00
Elymus trachycaulus	2.00	3.67	25.00
Poa pratensis	2.25	5.36	20.00
Poa secunda	2.50	6.22	20.00

Table 8: Dugout Mine Degas Reference Area for G-18 and G-31 (also G-16 & G-17).
Total cover, standard deviation and sample size (2005).

Reference Area: Mountain Brush/Snowberry/Sagebrush	Mean Percent	Standard Deviation	Sample Size
A. TOTAL COVER			
Overstory	7.50	12.60	20
Understory	57.00	12.08	20
Litter	18.60	7.52	20
Bareground	15.65	13.13	20
Rock	8.75	9.59	20
Overstory + Understory	64.50	19.49	20
B. % COMPOSITION			
Trees & Shrubs	54.44	26.60	20
Forbs	28.08	17.03	20
Grasses	17.49	14.43	20

Table 9: Dugout Mine Degas Reference Area for G-18 and G-31 (also G-16 & G-17).
Woody species densities (2005).

Reference Area: Mountain Brush/Snowberry/Sagebrush	
Species	**Individuals Per Acre**
Amelanchier utahensis	834.68
Artemisia tridentata	2375.64
Juniperus scopulorum	64.21
Symphoricarpos oreophilus	1861.99
TOTAL	5136.52

SUMMARY & CONCLUSIONS

The plant communities currently supported on the proposed new De-Gas Borehole Sites have been quantitatively sampled and compared statistically with a reference area chosen for future revegetation standards for success. Figure 1 shows the results of Student's t-test analyses of total living covers. When the **total living covers** of the proposed disturbed communities of Borehole Site G-18 and G-31 were compared to the reference area, the differences were non-significant statistically (Figure 1).

Woody species densities of those communities proposed for disturbance were also compared with the respective reference area (Figure 2). Results of statistical comparisons suggest that there were no significant differences between the proposed disturbed communities of G-18 and G-31 their reference area.

In conclusion, results from quantitatively sampling those plant communities proposed for disturbance and their reference area have been submitted in this report. Specific parameters of these communities have been compared statistically with results suggesting that the reference area chosen for revegetation success standards at the time of final reclamation may be appropriate.

FIGURE 1. A statistical comparison (Student's t-tests) of the **total living cover** between the proposed disturbed de-gas sites and their reference areas.

	$\bar{x}$	s	n	t	df	SL
De-Gas Site G-18						
Proposed Disturbed:	62.75	26.24	20			
Reference Area:	64.50	19.49	20			
t-test				-0.239	38	N.S.
De-Gas Site G-31						
Proposed Disturbed:	68.25	17.56	20			
Reference Area:	64.50	19.49	20			
t-test				0.369	38	N.S.

$\bar{x}$ = mean
s = standard deviation
n = sample size
t = Student's t-value
df = degrees of freedom
SL= Significance Level
N.S.=Non-Significant

FIGURE 2. A statistical comparison (Student's t-tests) of the **woody species density** between the proposed disturbed de-gas sites and their reference areas.

	$\bar{x}$	s	n	t	df	SL
De-Gas Site G-18						
Proposed Disturbed:	5757.95	2087.41	20			
Reference Area:	5136.52	2140.91	20			
t-test				0.929	38	N.S.
De-Gas Site G-31						
Proposed Disturbed:	4319.22	2632.26	20			
Reference Area:	5136.52	2140.91	20			
t-test				-1.077	38	N.S.

$\bar{x}$ = mean
s = standard deviation
n = sample size
t = Student's t-value
df = degrees of freedom
SL= Significance Level
N.S.=Non-Significant

COLOR PHOTOGRAPHS
OF THE
SAMPLE AREAS

De-Gas Site: G-18

De-Gas Site: G-31

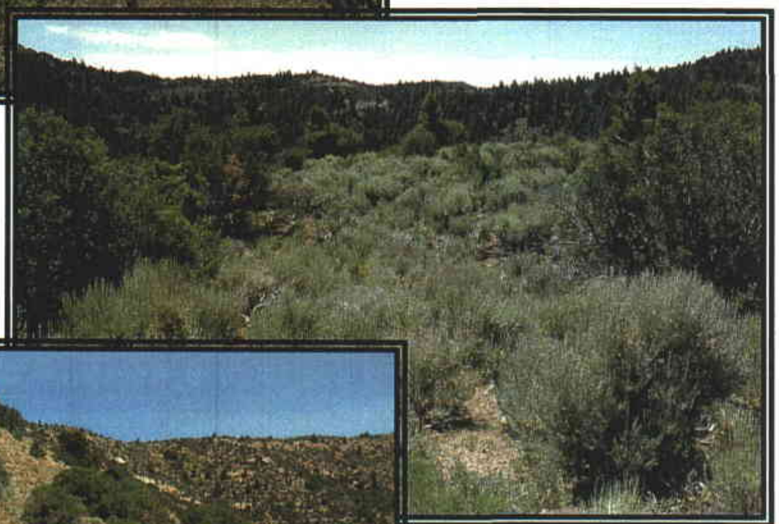
Mtn.Brush/Snowberry/Sagebrush Reference Area

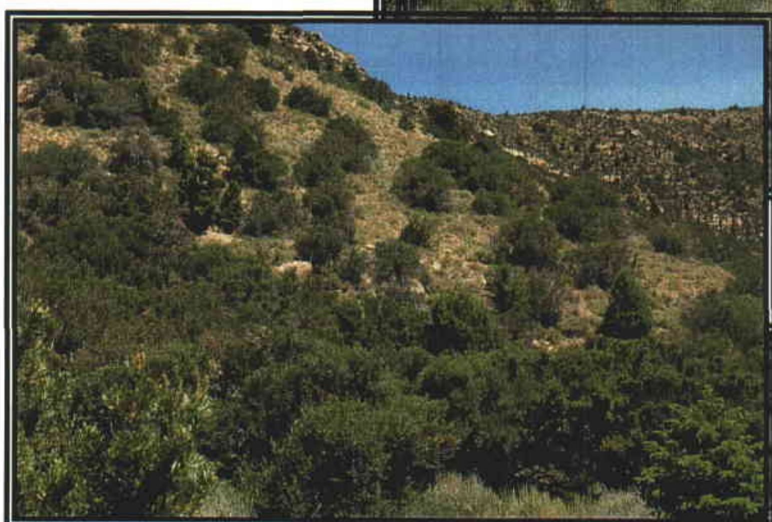
Mtn.Brush/Snowberry/Sagebrush Reference Area

Access to De-Gas G18

Access to De-Gas G-18

Access to De-Gas G-31





Access to De-Gas G-31

Access to De-Gas G-31

APPENDIX
(Raw Data)

CANYON FUEL
Dugout Mine
DE-GAS SITE: G-18
Exposure: E
Slope: 6 deg.

Sample Date: June 25 2007	1.00	2.00	3.00	4.00	5.00	6.00	7.00
OVERSTORY							
Amelanchier utahensis	0.00	0.00	0.00	0.00	0.00	25.00	70.00
UNDERSTORY							
TREES & SHRUBS							
Amelanchier utahensis	0.00	0.00	0.00	0.00	0.00	0.00	70.00
Artemisia tridentata	25.00	20.00	20.00	25.00	55.00	5.00	0.00
Cercocarpus montanus	0.00	0.00	0.00	0.00	5.00	0.00	0.00
Chrysothamnus viscidiflorus	0.00	0.00	4.00	0.00	0.00	0.00	0.00
Symphoricarpos oreophilus	0.00	0.00	10.00	0.00	0.00	10.00	0.00
FORBS							
Calochortus nuttallii	0.00	0.00	1.00	0.00	0.00	0.00	0.00
Castilleia rhexifolia	0.00	5.00	0.00	0.00	0.00	0.00	0.00
Eriogonum umbellatum	0.00	20.00	0.00	0.00	0.00	0.00	0.00
Gayophytum ramosissimum	0.00	0.00	0.00	5.00	0.00	0.00	0.00
Hedysarum boreale	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ipomopsis aggregata	0.00	0.00	5.00	0.00	0.00	0.00	0.00
Penstemon watsonii	0.00	0.00	0.00	0.00	0.00	20.00	0.00
Petradoria pumila	0.00	5.00	0.00	5.00	0.00	0.00	0.00
Senecio sp.	0.00	0.00	5.00	0.00	0.00	5.00	0.00
GRASSES							
Elymus salinus	0.00	10.00	0.00	10.00	10.00	10.00	0.00
Elymus trachycaulus	0.00	0.00	10.00	0.00	0.00	0.00	0.00
Poa secunda	20.00	0.00	0.00	0.00	0.00	0.00	0.00
COVER							
Overstory	0.00	0.00	0.00	0.00	0.00	25.00	70.00
Understory	45.00	60.00	55.00	45.00	70.00	50.00	70.00
Litter	9.00	9.00	9.00	14.00	10.00	40.00	1.00
Bareground	45.00	30.00	35.00	40.00	15.00	9.00	25.00
Rock	1.00	1.00	1.00	1.00	5.00	1.00	4.00
% COMPOSITION							
Shrubs	55.56	33.33	61.82	55.56	85.71	30.00	100.00
Forbs	0.00	50.00	20.00	22.22	0.00	50.00	0.00
Grasses	44.44	16.67	18.18	22.22	14.29	20.00	0.00
Overstory + Understory	45.00	60.00	55.00	45.00	70.00	75.00	140.00

8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
0.00	40.00	60.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	0.00	30.00	20.00	5.00	15.00	10.00	15.00	20.00	20.00
10.00	25.00	0.00	0.00	0.00	0.00	10.00	5.00	0.00	0.00
0.00	0.00	0.00	0.00	10.00	5.00	0.00	0.00	0.00	0.00
10.00	25.00	0.00	10.00	0.00	0.00	0.00	10.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	5.00	10.00	0.00	0.00	10.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	10.00	5.00	5.00	0.00
0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	20.00	25.00	20.00	5.00	15.00	20.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	40.00	60.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00
40.00	50.00	60.00	50.00	50.00	50.00	40.00	50.00	60.00	40.00
10.00	45.00	30.00	5.00	10.00	5.00	5.00	10.00	10.00	9.00
45.00	4.00	5.00	40.00	35.00	40.00	40.00	30.00	20.00	50.00
5.00	1.00	5.00	5.00	5.00	5.00	15.00	10.00	10.00	1.00
75.00	100.00	100.00	60.00	30.00	40.00	50.00	60.00	33.33	50.00
25.00	0.00	0.00	0.00	20.00	20.00	37.50	10.00	33.33	25.00
0.00	0.00	0.00	40.00	50.00	40.00	12.50	30.00	33.33	25.00
40.00	90.00	120.00	75.00	50.00	50.00	40.00	50.00	60.00	40.00

CANYON FUEL
Dugout Mine
DE-GAS SITE: G-18
Exposure: E
Slope: 6 deg.

18.00	19.00	20.00	Mean	SDev	Freq Cnts	Freq	Sample Date: 18 May 07
							OVERSTORY
0.00	0.00	0.00	11.00	21.13	5.00	25.00	*Amelanchier utahensis*
							UNDERSTORY
							TREES & SHRUBS
0.00	0.00	0.00	5.00	16.28	2.00	10.00	*Amelanchier utahensis*
5.00	10.00	0.00	15.50	12.64	17.00	85.00	*Artemisia tridentata*
0.00	0.00	0.00	2.75	6.02	5.00	25.00	*Cercocarpus montanus*
0.00	0.00	0.00	0.95	2.48	3.00	15.00	*Chrysothamnus viscidiflorus*
10.00	0.00	0.00	4.25	6.57	7.00	35.00	*Symphoricarpos oreophilus*
							FORBS
0.00	0.00	0.00	0.30	1.10	2.00	10.00	*Calochortus nuttallii*
0.00	0.00	0.00	0.25	1.09	1.00	5.00	*Castilleia rhexifolia*
0.00	0.00	0.00	2.75	5.36	5.00	25.00	*Eriogonum umbellatum*
0.00	0.00	0.00	0.25	1.09	1.00	5.00	*Gayophytum ramosissimum*
0.00	0.00	10.00	0.50	2.18	1.00	5.00	*Hedysarum boreale*
0.00	0.00	0.00	0.50	1.50	2.00	10.00	*Ipomopsis aggregata*
0.00	0.00	0.00	1.50	4.77	2.00	10.00	*Penstemon watsonii*
0.00	10.00	20.00	3.00	5.10	7.00	35.00	*Petradoria pumila*
0.00	0.00	0.00	0.75	1.79	3.00	15.00	*Senecio sp.*
							GRASSES
25.00	40.00	20.00	12.00	10.77	14.00	70.00	*Elymus salinus*
0.00	0.00	0.00	0.50	2.18	1.00	5.00	*Elymus trachycaulus*
0.00	0.00	0.00	1.00	4.36	1.00	5.00	*Poa secunda*
							COVER G-18
0.00	0.00	0.00	11.00	21.13			Overstory
40.00	60.00	50.00	51.75	8.98			Understory
4.00	4.00	10.00	12.45	11.52			Litter
55.00	35.00	30.00	31.40	14.15			Bareground
1.00	1.00	10.00	4.40	3.95			Rock
							% COMPOSITION
37.50	16.67	0.00	53.72	27.15			Shrubs
0.00	16.67	60.00	19.49	18.50			Forbs
62.50	66.67	40.00	26.79	19.71			Grasses
40.00	60.00	50.00	62.75	26.24			Overstory + Understory

CANYON FUEL
Dugout Mine
DE-GAS SITE: G-31
Exposure: SW
Slope: 3-5 deg.

Sample Date: June 25 2007	1.00	2.00	3.00	4.00	5.00	6.00	7.00
OVERSTORY							
Amelanchier utahensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pseudotsuga menziesii	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UNDERSTORY							
TREES & SHRUBS							
Amelanchier utahensis	0.00	0.00	0.00	0.00	20.00	0.00	0.00
Artemisia tridentata	25.00	45.00	30.00	25.00	0.00	30.00	0.00
Pseudotsuga menziesii	0.00	0.00	5.00	0.00	0.00	0.00	0.00
Symphoricarpos oreophilus	5.00	0.00	10.00	0.00	0.00	10.00	10.00
FORBS							
Antennaria microphylla	0.00	25.00	0.00	0.00	0.00	0.00	0.00
Astragalus sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hedysarum boreale	0.00	0.00	0.00	0.00	0.00	0.00	5.00
Lupinus argenteus	10.00	0.00	5.00	15.00	20.00	15.00	0.00
Penstemon watsonii	5.00	0.00	0.00	10.00	10.00	0.00	10.00
Petradoria pumila	5.00	0.00	0.00	0.00	0.00	0.00	0.00
GRASSES							
Elymus salinus	0.00	0.00	0.00	10.00	0.00	10.00	0.00
Elymus spicatus	5.00	0.00	0.00	0.00	0.00	0.00	0.00
Elymus trachycaulus	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Poa secunda	0.00	0.00	0.00	0.00	0.00	0.00	35.00
COVER							
Overstory	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Understory	55.00	70.00	50.00	60.00	50.00	65.00	60.00
Litter	10.00	25.00	30.00	25.00	30.00	9.00	10.00
Bareground	15.00	4.00	10.00	10.00	18.00	25.00	25.00
Rock	20.00	1.00	10.00	5.00	2.00	1.00	5.00
% COMPOSITION							
Shrubs	54.55	64.29	90.00	41.67	40.00	61.54	16.67
Forbs	36.36	35.71	10.00	41.67	60.00	23.08	25.00
Grasses	9.09	0.00	0.00	16.67	0.00	15.38	58.33
Overstory + Understory	55.00	70.00	50.00	60.00	50.00	65.00	60.00

8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
50.00	0.00	50.00	70.00	15.00	0.00	60.00	0.00	0.00	50.00
0.00	10.00	0.00	0.00	0.00	15.00	0.00	0.00	0.00	0.00
0.00	0.00	10.00	0.00	25.00	25.00	0.00	0.00	0.00	0.00
35.00	15.00	0.00	0.00	5.00	25.00	0.00	45.00	35.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	10.00	10.00	15.00	0.00	0.00	0.00	0.00	15.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	25.00	0.00	0.00	0.00	15.00	10.00	0.00	0.00
10.00	5.00	0.00	0.00	10.00	5.00	0.00	5.00	10.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	15.00	10.00	0.00	10.00	5.00	10.00	10.00	5.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50.00	10.00	50.00	70.00	15.00	15.00	60.00	0.00	0.00	50.00
50.00	45.00	60.00	15.00	50.00	60.00	30.00	70.00	65.00	15.00
10.00	9.00	35.00	75.00	30.00	30.00	9.00	25.00	10.00	75.00
35.00	45.00	4.00	5.00	19.00	9.00	60.00	4.00	20.00	9.00
5.00	1.00	1.00	5.00	1.00	1.00	1.00	1.00	5.00	1.00
70.00	55.56	33.33	100.00	60.00	83.33	0.00	64.29	76.92	66.67
20.00	11.11	41.67	0.00	20.00	8.33	66.67	21.43	15.38	0.00
10.00	33.33	25.00	0.00	20.00	8.33	33.33	14.29	7.69	33.33
100.00	55.00	110.00	85.00	65.00	75.00	90.00	70.00	65.00	65.00

CANYON FUEL
Dugout Mine
DE-GAS SITE: G-31
Exposure: SW
Slope: 3-5 deg.

18.00	19.00	20.00	Mean	SDev	Freq Cnts	Freq	Sample Date: June 25 2007
							OVERSTORY
0.00	0.00	50.00	17.25	25.27	7.00	35.00	*Amelanchier utahensis*
0.00	0.00	0.00	1.25	3.83	2.00	10.00	*Pseudotsuga menziesii*
							UNDERSTORY
							TREES & SHRUBS
0.00	0.00	10.00	4.50	8.50	5.00	25.00	*Amelanchier utahensis*
30.00	10.00	10.00	18.50	15.34	15.00	75.00	*Artemisia tridentata*
0.00	0.00	0.00	0.25	1.09	1.00	5.00	Pseudotsuga menziesii
0.00	0.00	5.00	4.75	5.36	10.00	50.00	*Symphoricarpos oreophilus*
							FORBS
0.00	10.00	0.00	1.75	5.76	2.00	10.00	*Antennaria microphylla*
0.00	0.00	0.00	0.25	1.09	1.00	5.00	*Astragalus sp.*
0.00	0.00	0.00	0.25	1.09	1.00	5.00	*Hedysarum boreale*
0.00	0.00	0.00	5.75	7.95	8.00	40.00	*Lupinus argenteus*
10.00	0.00	10.00	5.00	4.47	12.00	60.00	*Penstemon watsonii*
0.00	0.00	0.00	0.25	1.09	1.00	5.00	*Petradoria pumila*
							GRASSES
10.00	20.00	0.00	6.25	5.67	13.00	65.00	*Elymus salinus*
0.00	0.00	0.00	0.25	1.09	1.00	5.00	*Elymus spicatus*
0.00	0.00	0.00	0.25	1.09	1.00	5.00	*Elymus trachycaulus*
0.00	0.00	0.00	1.75	7.63	1.00	5.00	*Poa secunda*
							COVER G-31
0.00	0.00	50.00	18.50	24.70			Overstory
50.00	40.00	35.00	49.75	15.61			Understory
40.00	9.00	55.00	27.55	20.15			Litter
9.00	50.00	8.00	19.20	16.00			Bareground
1.00	1.00	2.00	3.50	4.47			Rock
							% COMPOSITION
60.00	25.00	71.43	56.76	24.12			Shrubs
20.00	25.00	28.57	25.50	17.17			Forbs
20.00	50.00	0.00	17.74	16.43			Grasses
50.00	40.00	85.00	68.25	17.56			Overstory + Understory

CANYON FUEL

Dugout Mine

AMUT/SYOR/ARTR

Reference Area G-16, G-17, G-18, G-13

Slope: W

Exposure: 10 deg

Sample Date: 13-14 Sept 2005	1.00	2.00	3.00	4.00
OVERSTORY				
Amelanchier utahensis	0.00	0.00	0.00	0.00
Juniperus scopulorum	0.00	0.00	0.00	15.00
UNDERSTORY				
SHRUBS				
Amelanchier utahensis	0.00	0.00	0.00	0.00
Artemisia tridentata	10.00	10.00	20.00	0.00
Juniperus scopulorum	0.00	0.00	0.00	5.00
Symphoricarpos oreophilus	0.00	15.00	5.00	5.00
FORBS				
Astragalus sp.	0.00	0.00	0.00	0.00
Lupinus argenteus	10.00	10.00	0.00	10.00
Penstemon watsonii	25.00	0.00	20.00	0.00
GRASSES				
Elymus salinus	0.00	0.00	0.00	0.00
Elymus spicatus	10.00	5.00	10.00	0.00
Elymus trachycaulus	0.00	0.00	0.00	0.00
Poa pratensis	0.00	0.00	0.00	20.00
Poa secunda	0.00	0.00	0.00	0.00
COVER				
Overstory	0.00	0.00	0.00	15.00
Understory	55.00	40.00	55.00	40.00
Litter	25.00	8.00	15.00	40.00
Bareground	10.00	45.00	25.00	5.00
Rock	10.00	7.00	5.00	15.00
% COMPOSITION				
Shrubs	18.18	62.50	45.45	25.00
Forbs	63.64	25.00	36.36	25.00
Grasses	18.18	12.50	18.18	50.00
Overstory + Understory	55.00	40.00	55.00	55.00

5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00
0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	15.00	0.00	0.00	0.00	0.00	70.00	5.00
15.00	5.00	20.00	50.00	35.00	45.00	0.00	35.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	20.00	0.00	0.00	0.00	0.00	0.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	1.00	15.00	0.00	5.00	0.00	0.00	5.00
10.00	19.00	5.00	15.00	15.00	15.00	5.00	15.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	10.00	0.00	10.00	10.00	0.00	5.00
15.00	5.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00
45.00	65.00	50.00	70.00	70.00	70.00	75.00	70.00
10.00	15.00	20.00	15.00	15.00	25.00	20.00	25.00
30.00	15.00	15.00	10.00	10.00	4.00	4.00	4.00
15.00	5.00	15.00	5.00	5.00	1.00	1.00	1.00
33.33	61.54	40.00	71.43	50.00	64.29	93.33	64.29
33.33	30.77	40.00	21.43	28.57	21.43	6.67	28.57
33.33	7.69	20.00	7.14	21.43	14.29	0.00	7.14
45.00	65.00	50.00	70.00	70.00	70.00	100.00	70.00

13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00
35.00	0.00	40.00	0.00	20.00	15.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30.00	5.00	10.00	0.00	0.00	0.00	0.00	5.00
0.00	10.00	10.00	20.00	0.00	0.00	10.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35.00	15.00	45.00	0.00	0.00	55.00	0.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00
0.00	5.00	0.00	0.00	10.00	0.00	5.00	0.00
0.00	5.00	0.00	25.00	10.00	5.00	15.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	5.00	0.00	0.00	0.00	10.00	0.00	0.00
0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	15.00	25.00	0.00	5.00	5.00
35.00	0.00	40.00	0.00	20.00	15.00	0.00	0.00
65.00	50.00	65.00	60.00	45.00	70.00	40.00	40.00
19.00	20.00	30.00	20.00	15.00	15.00	10.00	10.00
15.00	15.00	1.00	15.00	35.00	5.00	45.00	5.00
1.00	15.00	4.00	5.00	5.00	10.00	5.00	45.00
100.00	60.00	100.00	33.33	0.00	78.57	25.00	62.50
0.00	20.00	0.00	41.67	44.44	7.14	62.50	25.00
0.00	20.00	0.00	25.00	55.56	14.29	12.50	12.50
100.00	50.00	105.00	60.00	65.00	85.00	40.00	40.00

CANYON FUELS
Dugout Mine
AMUT/SYOR/ARTR
G-16, G-17, G-18, G-13 Reference Area
Slope: W
Exposure: 10 deg

Mean	SDev	Freq	Sample Date: 13-14 Sept 2005
			OVERSTORY
6.75	12.58	25.00	*Amelanchier utahensis*
0.75	3.27	5.00	*Juniperus scopulorum*
			UNDERSTORY
			SHRUBS
7.00	16.16	35.00	*Amelanchier utahensis*
15.25	14.79	75.00	*Artemisia tridentata*
0.25	1.09	5.00	*Juniperus scopulorum*
10.50	15.96	50.00	*Symphoricarpos oreophilus*
			FORBS
0.25	1.09	5.00	*Astragalus sp.*
4.05	4.60	55.00	*Lupinus argenteus*
10.70	7.89	80.00	*Penstemon watsonii*
			GRASSES
0.25	1.09	5.00	*Elymus salinus*
2.00	3.67	25.00	*Elymus spicatus*
2.00	3.67	25.00	*Elymus trachycaulus*
2.25	5.36	20.00	*Poa pratensis*
2.50	6.22	20.00	*Poa secunda*
			COVER
7.50	12.60		Overstory
57.00	12.08		Understory
18.60	7.52		Litter
15.65	13.13		Bareground
8.75	9.59		Rock
			% COMPOSITION
54.44	26.60		Shrubs
28.08	17.03		Forbs
17.49	14.43		Grasses
64.50	19.49		Overstory + Understory

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
540 West Price River Drive
Field Office
Price, UT 84501
(435) 637-0041
FAX (435) 637-3146

July 3, 2007

Ms Vicky Miller
Canyon Fuel Company, LLC
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Re: Vegetation Production of Proposed Degas Wells G-18, 19, 20, 31 and AMV Road.

Dear Ms Miller,

Following the review of the photos you provided, as well as experience with recent climatic conditions, I have made the following determinations for vegetative production and overall, health and trend of the sites. The three ecotypes that will be described in relation to these proposed well sites are, *browse/sagebrush, Douglas-fir and aspen*. It is noted that most of the sites have previously been disturbed with differing levels of success in the reestablishment of the Potential Natural Community (PNC). Not having a chance to visit the sites personally, I will use my best judgment based on the photos provided and my knowledge of past and present climatic conditions and anthropogenic disturbances.

Well location G-19 lies within a complex landscape with three primary Ecological Site Descriptions (ESDs). The first two, *Mountain very steep stony loam (browse) and Mountain loam (Mountain big sagebrush)* experience less effective moisture during the growing season due to their aspect (mostly southern/eastern). The third, *High mountain very steep loam (Douglas-fir)* has more effective moisture associated with a north aspect. It is difficult to distinguish from the photos exactly which ESD the proposed well location lies, I will therefore give productivity estimates for all of them until a site visit can help make this designation.

Based on the PNC for the first ESD (*browse)* percent air-dry weight for the primary functional groups should be as such; 20% grasses, 10% forbs and 70% shrubs. It appears that there has been some disturbance in the past (timber harvest) which would set back the Community from PNC within the State to one going through secondary succession. Based on this factor and the past and present precipitation experienced at these elevations, I would estimate that the production for the site would be 700 lbs Ac^{-1}.

The second ESD (*Mountain big sagebrush)* would have a PNC with 60% grasses, 10% forbs and 30% shrubs. Like the previous ESD and associated disturbances and climatic conditions, I would estimate that the production for this site would be 1000 lbs Ac^{-1}.

The final ESD (*Douglas-fir*) has production broken out into different classes based on the percent canopy cover. From the pictures provided, and the evidence of past timber harvesting, the canopy cover appears to be sparse (11-20%). The PNC for this site would have an overstory tree canopy of 30-40% with 25% grasses, 10% forbs and 65% shrubs. Knowing that the timber has been harvested and canopy cover is only 11-20% now, I would estimate that the current understory composition is 35% grasses, 15% forbs and 50% shrubs. Based on the previous disturbances and climatic conditions, I would estimate that the production for the site to be 500 lbs. Ac^{-1}.

Well locations G-18, G-31 and the AMV road are within the same complexes (*browse and Mountain big sagebrush)* as listed above and would follow under the same description. Portions of well location G-31 have been previously disturbed by logging activities, however well location G-18 does not appear to have been previously disturbed. The AMV road follows a trail used to drive cows and for logging. Based on the recent climatic conditions and photos provided, I would estimate production to be 900 lbs. Ac^{-1} for the *browse* site and 1200 lbs. Ac^{-1} for the *Mountain big sagebrush* site.

Well location G-20 is located within ESD *High mountain loam (Aspen)* which is also previously disturbed. The PNC for this ESD would typically have an overstory tree canopy of 40-60%. Based on the photos provided, this site is nowhere near the PNC as it is going through secondary succession and has an understory dominated by perennial grasses and shrubs. Based on the overstory canopy cover being open (0-10%), I would estimated that the production for the site would be 900 lbs. Ac^{-1}.

I look forward to our rescheduled site visit on July 13, 2007.

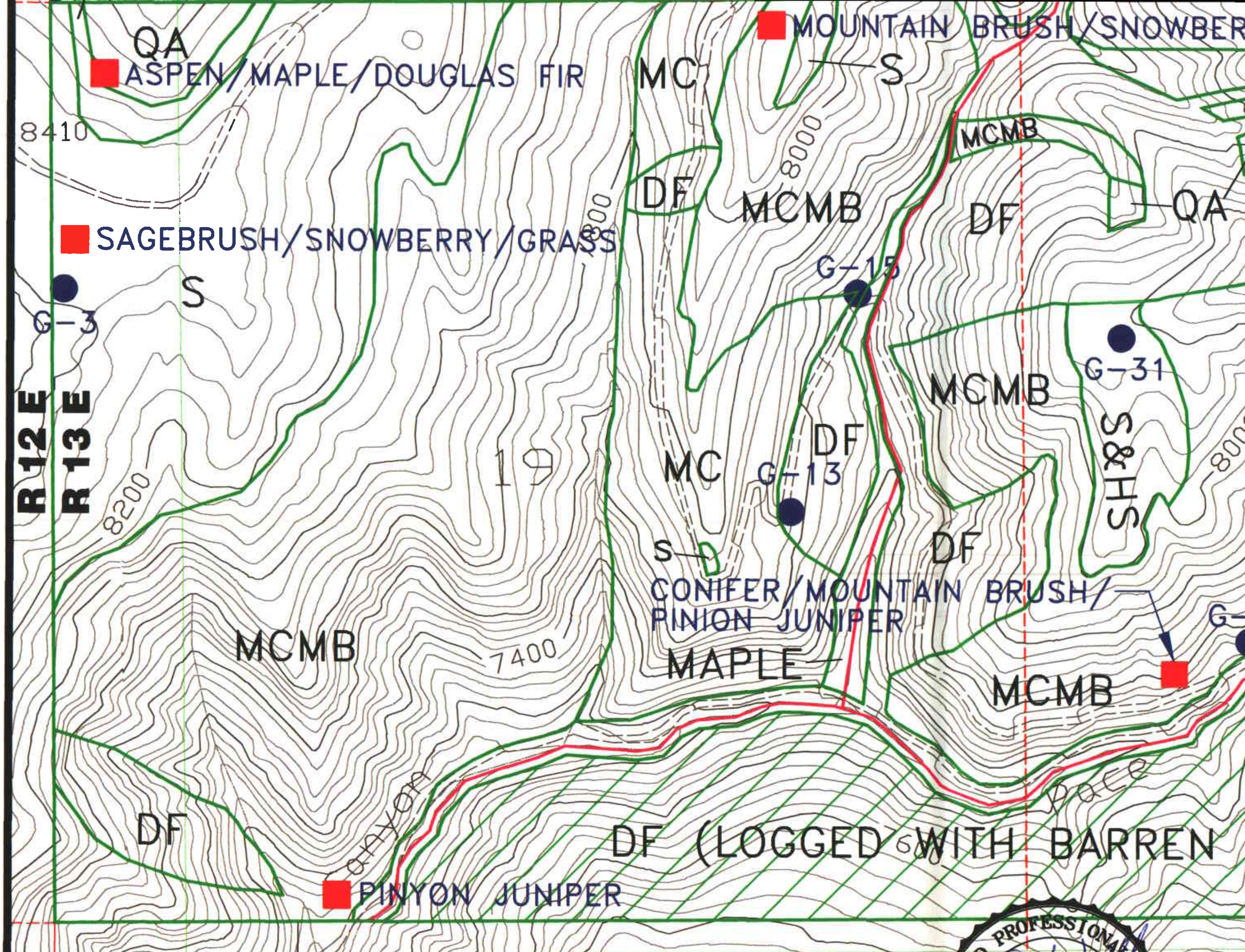
Please feel free to contact me if you have any further questions or concerns.

Sincerely,

M. Dean Stacy

M. DEAN STACY
Range Management Specialist
USDA-NRCS, Price FO

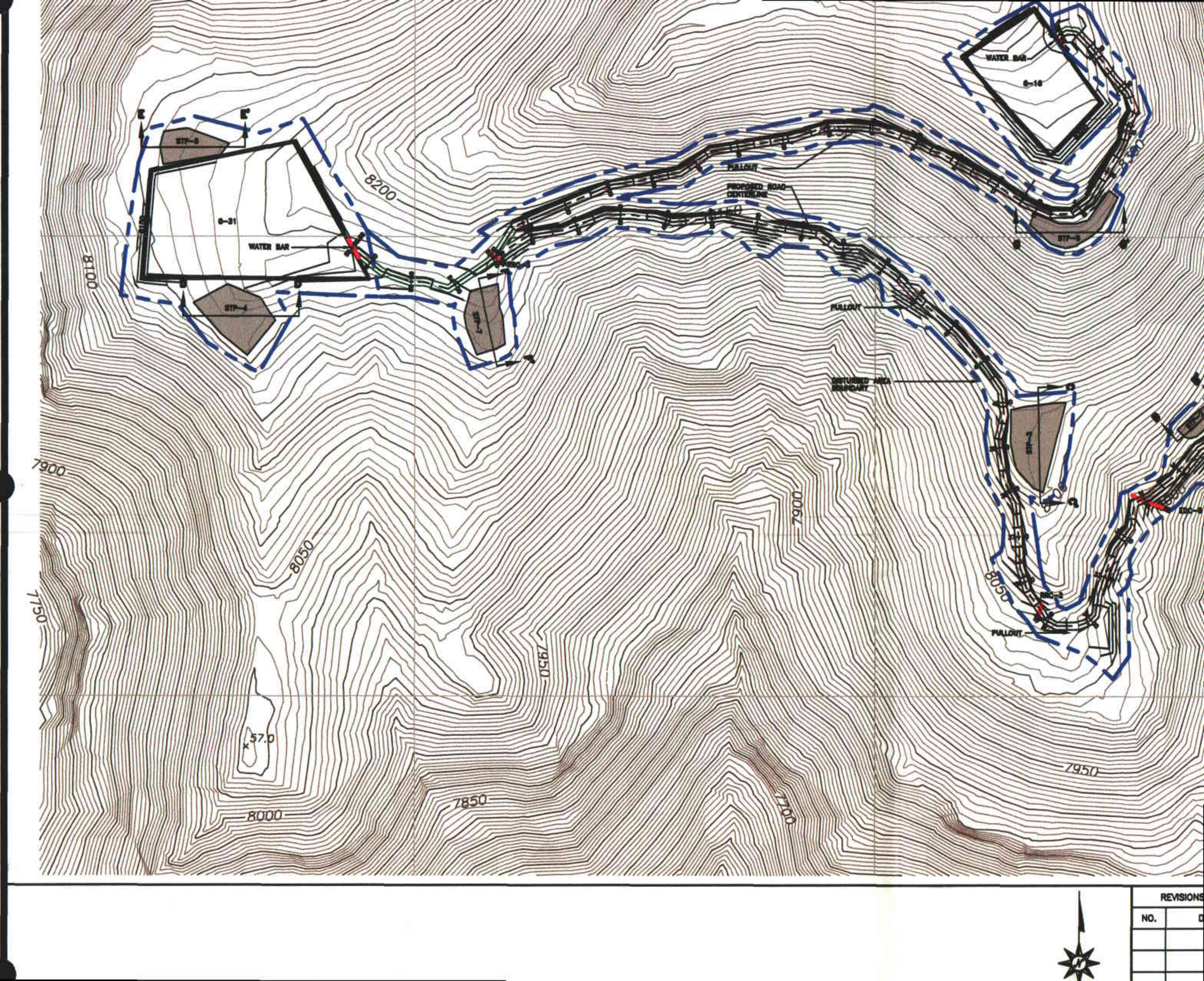
cc: Barry Hamilton, ASTC-FO, Price AO
Wayne Greenhalgh, District Conservationist, Price FO
File



REFERENCE AREA LOCATION
DECIDUOUS STREAM BANK
DF DOUGLAS FIR

MC MIXED CONIFER
MCMB MIXED CONIFER – MOUNTAIN BRUSH
QA QUAKING ASPEN

REGISTERED PROFESSIONAL ENGINEER
No. 151610
DAVID G.
SPILLMAN


WATER BAR
PULLOUT
PROPOSED ROAD CENTERLINE
DISTURBED AREA BOUNDARY
8200
8100
7900
8050
7750
7900
7950
57.0
8000
7850
7700
7950
REVISIONS
NO.

ATTACHMENT 3-2

THREATENED, ENDANGERED, AND SENSITIVE SPECIES INFORMATION

Add to the back of existing information

Utah's Federally (US F&WS) Listed
Threatened (T), Endangered (E), and Candidate (C) Plant Species

Common Name	Scientific Name	Status	County of Occurrence
Monocot Plants:			
	Family Cyperaceae		
Navajo Sedge	*Carex specuicola*	T	San Juan & Kane.
	Family Orchidaceae		
Ute Ladies'-tresses	*Spiranthes diluvialis*	T	Daggett, Duchesne, Garfield, Tooele, Uintah, Utah, Wasatch, & Wayne. Possibly Juab. Formerly Salt Lake & Weber.
Dicot Plants:			
	Family Apocynaceae		
Jones Cycladenia	*Cycladenia humilis var jonesii*	T	Emery, Garfield, Grand, & Kane.
	Family Asclepiadaceae		
Welsh's Milkweed	*Asclepias welshii*	T	Kane.
	Family Asteraceae		
Maguire Daisy	*Erigeron maguirei*	T	Emery, Garfield, & Wayne.
Last Chance Townsendia	*Townsendia aprica*	T	Emery, Sevier, & Wayne.
	Family Brassicaceae		
Barneby Ridge-cress	*Lepidium barnebyanum*	E	Duchesne.
Kodachrome Bladderpod	*Lesquerella tumulosa*	E	Kane.
Clay Reed-mustard	*Schoenocrambe argillacea*	T	Uintah.
Barneby Reed-mustard	*Schoenocrambe barnebyi*	E	Emery & Wayne.
Shrubby Reed-mustard	*Glaucocarpum suffrutescens*	E	Duchesne & Uintah.
	Family Cactaceae		
San Rafael Cactus	*Pediocactus despainii*	E	Emery & Wayne.
Siler Pincushion Cactus	*Pediocactus sileri*	T	Kane & Washington.
Winkler Pincushion Cactus	*Pediocactus winkleri*	T	Emery & Wayne.
Uinta Basin Hookless Cactus	*Sclerocactus glaucus*	T	Carbon, Duchesne, & Uintah.
Wright Fishhook Cactus	*Sclerocactus wrightiae*	E	Emery, Sevier, & Wayne.
	Family Fabaceae		
Deseret Milkvetch	*Astragalus desereticus*	T	Utah.
Shivwits or Shem Milkvetch	*Astragalus ampullarioides*	E	Washington.
Holmgren Milkvetch	*Astragalus holmgreniorum*	E	Washington.
Heliotrope Milkvetch	*Astragalus montii*	T	Sanpete & Sevier.
	Family Hydrophyllaceae		
Clay Phacelia	*Phacelia argillacea*	E	Utah.
	Family Ophioglossaceae		
Slender Moonwort	*Botrychium lineare*	C	Salt Lake.
	Family Papaveraceae		
Dwarf Bearclaw-poppy	*Arctomecon humilis*	E	Washington.
	Family Primulaceae		
Maguire Primrose	*Primula maguirei*	T	Cache.
	Family Ranunculaceae		
Autumn Buttercup	*Ranunculus aestivalis*	E	Garfield.
	Family Scrophulariaceae		
White River Beardtongue	*Penstemon scariosus var albifluvis*	C	Uintah.

Utah's Federally Listed
Threatened (T), Endangered (E), and Candidate (C) Invertebrate Species

Common Name	Scientific Name	Status	County of Occurrence
Mollusks:			
Ogden Rocky Mountainsnail	*Oreohelix peripherica wasatchensis*	C	Weber.
Kanab Ambersnail	*Oxyloma kanabense*	E	Kane.
Utah Valvata Snail	*Valvata utahensis*	E Extirpated	Formerly found in Utah.
Fat-whorled Pondsnail	*Stagnicola bonnevillensis*	C	Box Elder.
Insects:			
Coral Pink Sand Dunes Tiger Beetle	*Cicindela limbata albissima*	C	Kane.

Utah's Federally Listed
Threatened (T), Endangered (E), and Candidate (C) Vertebrate Species

Common Name	Scientific Name	Status	County of Occurrence
Amphibians:			
Relict Leopard Frog	*Rana onca*	C Extirpated	Formerly Washington.
Fishes:			
Lahontan Cutthroat Trout	*Oncorhynchus clarkii henshawi*	T	Introduced in Box Elder.
Humpback Chub	*Gila cypha*	E	Carbon, Emery, Garfield, Grand, San Juan, Uintah, & Wayne. Possibly Duchesne. Formerly Daggett & Kane.
Bonytail	*Gila elegans*	E	Carbon, Emery, Garfield, Grand, San Juan, Uintah, & Wayne. Possibly Duchesne. Formerly Daggett & Kane.
Virgin Chub	*Gila seminuda*	E	Washington.
Colorado Pikeminnow	*Ptychocheilus lucius*E		Carbon, Daggett, Emery, Garfield, Grand, San Juan, Uintah, & Wayne. Possibly Duchesne. Formerly Kane.
Woundfin	*Plagopterus argentissimus*	E	Washington.
June Sucker	*Chasmistes liorus*	E	Utah. Introduced in Box Elder, Salt Lake, & Weber.
Razorback Sucker	*Xyrauchen texanus*	E	Carbon, Emery, Garfield, Grand, San Juan, Uintah, & Wayne. Possibly Duchesne. Formerly Daggett & Kane.
Reptiles:			
Desert Tortoise	*Gopherus agassizii*	T	Washington.
Birds:			
California Condor	*Gymnogyps californianus*	E Experimental	Visits Southern Utah from Northern Arizona. Formerly Beaver & Iron.
Whooping Crane	*Grus americana*	E Extirpated	Formerly passed through E Utah.
Yellow-billed Cuckoo	*Coccyzus americanus*	C	Occurs or possible in all counties except Rich.
Mexican Spotted Owl	*Strix occidentalis lucida*	T	Emery, Garfield, Iron, Kane, San Juan, Uintah, Washington, & Wayne. Possibly Carbon & Grand.
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	E	Emery, Garfield, Grand, Iron, Kane, San Juan, Washington, & Wayne.

Created by the Utah Division of Wildlife Resources - 08/27/2007

Mammals:			
Utah Prairie-dog	*Cynomys parvidens*	T	Beaver, Garfield, Iron, Kane, Millard, Piute, Sanpete, Sevier, & Wayne.
Gray Wolf	*Canis lupus*	E Extirpated	Formerly found throughout Utah.
Brown (Grizzly) Bear	*Ursus arctos*	T Extirpated	Formerly found throughout Utah.
Black-footed Ferret	*Mustela nigripes*	E Experimental	Unconfirmed sightings persist from Carbon, Daggett, Duchesne, Emery, Grand, Rich, San Juan, & Summit. Introduced as experimental non-essential in Uintah.
Canada Lynx	*Lynx canadensis*	T	Daggett, Duchesne, Summit, Uintah, & Wasatch. Formerly Sanpete. Possibly Cache, Morgan, Rich, Salt Lake, Utah, & Weber.

DEFINITIONS

E	A taxon that is listed by the U.S. Fish and Wildlife Service as "endangered" with the possibility of worldwide extinction.
E Experimental	An "endangered" taxon that is considered by the U.S. Fish and Wildlife Service to be "experimental and non-essential" in its designated use areas in Utah.
E, T, or C Extirpated	An "endangered," "threatened," or "candidate" taxon that is "extirpated" and considered by the U.S. Fish and Wildlife Service to no longer occur in Utah.
E or T Proposed	A taxon "proposed" to be listed as "endangered" or "threatened" by the U.S. Fish and Wildlife Service.
T	A taxon that is listed by the U.S. Fish and Wildlife Service as "threatened" with becoming endangered.
C	A taxon for which the U.S. Fish and Wildlife Service has on file sufficient information on biological vulnerability and threats to justify it being a "candidate" for listing as endangered or threatened.

Note: Please contact the U.S. Fish and Wildlife Service (801-975-3330) for the purpose of consultation under the Endangered Species Act.

State of Utah
Department of Natural Resources
Division of Wildlife Resources

Utah Sensitive Species List

October 17, 2006

This list has been prepared pursuant to Utah Division of Wildlife Resources Administrative Rule R657-48. By rule, wildlife species that are federally listed, candidates for federal listing, or for which a conservation agreement is in place automatically qualify for the *Utah Sensitive Species List*. The additional species on the *Utah Sensitive Species List*, "wildlife species of concern," are those species for which there is credible scientific evidence to substantiate a threat to continued population viability. It is anticipated that wildlife species of concern designations will identify species for which conservation actions are needed, and that timely and appropriate conservation actions implemented on their behalf will preclude the need to list these species under the provisions of the federal Endangered Species Act. Please see Appendix A for the rationale behind each wildlife species of concern designation.

Utah Sensitive Species List

Fishes

Federal Candidate Species
(None)

Federally Threatened Species

Lahontan cutthroat trout (introduced)	*Oncorhynchus clarkii henshawi*

Federally Endangered Species

humpback chub	*Gila cypha*
bonytail	*Gila elegans*
Virgin chub	*Gila seminuda*
Colorado pikeminnow	*Ptychocheilus lucius*
woundfin	*Plagopterus argentissimus*
June sucker	*Chasmistes liorus*
razorback sucker	*Xyrauchen texanus*

Conservation Agreement Species

Bonneville cutthroat trout	*Oncorhynchus clarkii utah*
Colorado River cutthroat trout	*Oncorhynchus clarkii pleuriticus*
Virgin spinedace	*Lepidomeda mollispinis mollispinis*
least chub	*Iotichthys phlegethontis*
roundtail chub	*Gila robusta*
bluehead sucker	*Catostomus discobolus*
flannelmouth sucker	*Catostomus latipinnis*

Wildlife Species of Concern

leatherside chub	*Gila copei*
desert sucker	*Catostomus clarkii*
Yellowstone cutthroat trout	*Oncorhynchus clarkii bouvieri*
Bear Lake whitefish	*Prosopium abyssicola*
Bonneville cisco	*Prosopium gemmifer*
Bonneville whitefish	*Prosopium spilonotus*
Bear Lake sculpin	*Cottus extensus*

See Appendix A for the rationale behind each wildlife species of concern designation.

Utah Sensitive Species List

Amphibians

Federal Candidate Species
relict leopard frog (extirpated) — *Rana onca*

Federally Threatened Species
(None)

Federally Endangered Species
(None)

Conservation Agreement Species
Columbia spotted frog — *Rana luteiventris*

Wildlife Species of Concern
western toad — *Bufo boreas*
Arizona toad — *Bufo microscaphus*

See Appendix A for the rationale behind each wildlife species of concern designation.

Utah Sensitive Species List

Reptiles

Federal Candidate Species
(None)

Federally Threatened Species

desert tortoise	*Gopherus agassizii*

Federally Endangered Species
(None)

Conservation Agreement Species
(None)

Wildlife Species of Concern

zebra-tailed lizard	*Callisaurus draconoides*
western banded gecko	*Coleonyx variegatus*
desert iguana	*Dipsosaurus dorsalis*
Gila monster	*Heloderma suspectum*
common chuckwalla	*Sauromalus ater*
desert night lizard	*Xantusia vigilis*
sidewinder	*Crotalus cerastes*
speckled rattlesnake	*Crotalus mitchellii*
Mojave rattlesnake	*Crotalus scutulatus*
cornsnake	*Elaphe guttata*
smooth greensnake	*Opheodrys vernalis*
western threadsnake	*Leptotyphlops humilis*

See Appendix A for the rationale behind each wildlife species of concern designation.

Utah Sensitive Species List

Birds

Federal Candidate Species	
Yellow-billed Cuckoo	*Coccyzus americanus*
Federally Threatened Species	
Bald Eagle	*Haliaeetus leucocephalus*
Mexican Spotted Owl	*Strix occidentalis lucida*
Federally Endangered Species	
California Condor (experimental)	*Gymnogyps californianus*
Whooping Crane (extirpated)	*Grus americana*
Southwestern Willow Flycatcher	*Empidonax traillii extimus*
Conservation Agreement Species	
Northern Goshawk	*Accipiter gentilis*
Wildlife Species of Concern	
Grasshopper Sparrow	*Ammodramus savannarum*
Short-eared Owl	*Asio flammeus*
Burrowing Owl	*Athene cunicularia*
Ferruginous Hawk	*Buteo regalis*
Greater Sage-grouse	*Centrocercus urophasianus*
Black Swift	*Cypseloides niger*
Bobolink	*Dolichonyx oryzivorus*
Lewis's Woodpecker	*Melanerpes lewis*
Long-billed Curlew	*Numenius americanus*
American White Pelican	*Pelecanus erythrorhynchos*
Three-toed Woodpecker	*Picoides tridactylus*
Sharp-tailed Grouse	*Tympanuchus phasianellus*

See Appendix A for the rationale behind each wildlife species of concern designation.

Utah Sensitive Species List

Mammals

Federal Candidate Species
(None)

Federally Threatened Species

Utah prairie-dog	*Cynomys parvidens*
brown/grizzly bear (extirpated)	*Ursus arctos*
Canada lynx	*Lynx canadensis*

Federally Endangered Species

black-footed ferret (experimental, non-essential in Duchesne and Uintah counties)	*Mustela nigripes*
gray wolf (extirpated)	*Canis lupus*

Conservation Agreement Species
(None)

Wildlife Species of Concern

Preble's shrew	*Sorex preblei*
Townsend's big-eared bat	*Corynorhinus townsendii*
spotted bat	*Euderma maculatum*
Allen's big-eared bat	*Idionycteris phyllotis*
western red bat	*Lasiurus blossevillii*
fringed myotis	*Myotis thysanodes*
big free-tailed bat	*Nyctinomops macrotis*
pygmy rabbit	*Brachylagus idahoensis*
Gunnison's prairie-dog	*Cynomys gunnisoni*
white-tailed prairie-dog	*Cynomys leucurus*
silky pocket mouse	*Perognathus flavus*
dark kangaroo mouse	*Microdipodops megacephalus*
Mexican vole	*Microtus mexicanus*
kit fox	*Vulpes macrotis*

See Appendix A for the rationale behind each wildlife species of concern designation.

Utah Sensitive Species List

Mollusks

Federal Candidate Species	
Ogden rocky mountainsnail	*Oreohelix peripherica wasatchensis*
fat-whorled pondsnail	*Stagnicola bonnevillensis*
Federally Threatened Species	
(None)	
Federally Endangered Species	
Kanab ambersnail	*Oxyloma kanabense*
desert valvata (extirpated)	*Valvata utahensis*
Conservation Agreement Species	
(None)	
Wildlife Species of Concern	
southern tightcoil	*Ogaridiscus subrupicola*
Eureka mountainsnail	*Oreohelix eurekensis*
lyrate mountainsnail	*Oreohelix haydeni*
Brian Head mountainsnail	*Oreohelix parawanensis*
Deseret mountainsnail	*Oreohelix peripherica*
Yavapai mountainsnail	*Oreohelix yavapai*
cloaked physa	*Physa megalochlamys*
Utah physa	*Physella utahensis*
wet-rock physa	*Physella zionis*
longitudinal gland pyrg	*Pyrgulopsis anguina*
smooth Glenwood pyrg	*Pyrgulopsis chamberlini*
desert springsnail	*Pyrgulopsis deserta*
Otter Creek pyrg	*Pyrgulopsis fusca*
Hamlin Valley pyrg	*Pyrgulopsis hamlinensis*
carinate Glenwood pyrg	*Pyrgulopsis inopinata*
Ninemile pyrg	*Pyrgulopsis nonaria*
bifid duct pyrg	*Pyrgulopsis peculiaris*
Bear Lake springsnail	*Pyrgulopsis pilsbryana*
Black Canyon pyrg	*Pyrgulopsis plicata*
sub-globose Snake pyrg	*Pyrgulopsis saxatilis*
southern Bonneville pyrg	*Pyrgulopsis transversa*
northwest Bonneville pyrg	*Pyrgulopsis variegata*
California floater	*Anodonta californiensis*
western pearlshell	*Margaritifera falcata*

See Appendix A for the rationale behind each wildlife species of concern designation.

Bat Survey Report
Canyon Fuel Company
Dugout Mine
Pace Creek Canyon, Northern Cliffs

Prepared by:
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321 N Mall Drive #I-202
St. George, Utah 84790
435.652.8301

12 June 2007

Introduction

On the nights of 21 and 22 May 2007, JBR Environmental Consultants Inc. (JBR) conducted bat surveys along the northern cliffs of Pace Creek Canyon, Carbon County, Utah (**Figures 1 and 2**). These surveys were conducted as required under an existing Utah Division of Oil, Gas, and Mining permit, due to the potential for subsidence in the area as a result of activities at Canyon Fuel Company's Dugout Mine operation.

Inventory Area

The Inventory Area lies between 7,800 – 9,000 feet elevation and is characterized by steep sided canyon walls consisting of exposed rock outcrops (see cover photo). The vegetative community is dominated by mixed-age stands of pinyon, juniper, Douglas-fir, and aspen. Shrub species include mountain mahogany, maple, serviceberry, and sagebrush.

As a function of the vast expanses of rock outcrops and associated fissures and cracks, the Inventory Area appears to contain a virtually unlimited potential for day and night bat roosting sites. Snag habitat is also available. No known caves, open mine shafts, adits, or other man made structures that might provide additional habitats are known to exist in the Inventory Area. Perhaps the only habitat feature limiting bat presence within the Inventory Area is the availability of water for drinking and foraging.

Results

During the 2 nights of recording bat calls, no bat call files were produced. The lack of detecting bat calls does not infer that bats are not present in the Inventory Area; it simply means that no bats were active near the locations in which the ANABAT was used. It is unknown why bats were not active at the ANABAT stops, but it was likely a function of both the lack of good foraging habitat (water) and that a cold front had pushed through the area during the nights of the survey. In 2005, JBR conducted bat surveys along Pace Creek and left the ANABAT unattended for 4 nights at a relatively large pond located within 0.25 miles of the southeast corner of the 2007 Inventory Area (JBR 2005). During the 2005 survey, over 3,000 bat calls were recorded from at least 7 different species of bats. It is likely that many of the individual bats that forage over and/or drink from the pond, also utilize at least portions of the 2007 Inventory Area.

Methodology

To record bat activity, JBR used an ANABAT II Bat Detector and an ANABAT CF Storage Zero Crossing Analysis Interface Module (ZCAIM) manufactured by Titley Electronics, Ltd., Ballina, NSW, Australia. Between the hours of approximately 20:30 – 22:30 on the nights of 21 and 22 May, JBR biologists ran the ANABAT at each of the 5 stops (**Figure 1**) for approximately 20 minutes.

In addition to the above surveys, the ANABAT was left unattended at stop #4, which contained a small cattle trough (see photo), on 21 and 22 May (2 nights). When left unattended, the bat detector and ZCAIM were enclosed in a weatherproof container. The bat detector's ultrasound transducer was positioned at a 45-degree angle to an acrylic reflector plate. This arrangement allowed the transducer to remain dry while recording bat calls unattended. Bat calls were recorded automatically; the equipment was programmed to turn on at 20:30 and to turn off at 06:00.

The ANABAT system records bat echolocation calls and stores them as digital format computer files. The file names specify the date and time the files were recorded. The recorded files were analyzed on a desktop computer using Analook software. The call identification process consists of visually comparing time-frequency displays of recorded call sequences against reference files (provided with the ANABAT system), which were recorded from known species that were hand released under controlled conditions. The analysis is somewhat subjective because it depends on making a visual comparison. The training and experience of the biologist doing the analysis is also important. At present, there is no objective, standardized procedure that can be used to analyze and identify the recorded calls.

Figure 1. Inventory Area and Stops - Topo

: Mount Bartles, Utah - 1:24,000 (USGS)

R13E Sections 16, 17, 18, 19, 20, and 21

ANABAT Stop

Inventory Area

Canyon Fuel Company

Pace Creek Canyon, Northern Cliffs

0 0.5 1 Miles

1:14,782

N

Created: 05 June 2007
Edited: Version 1

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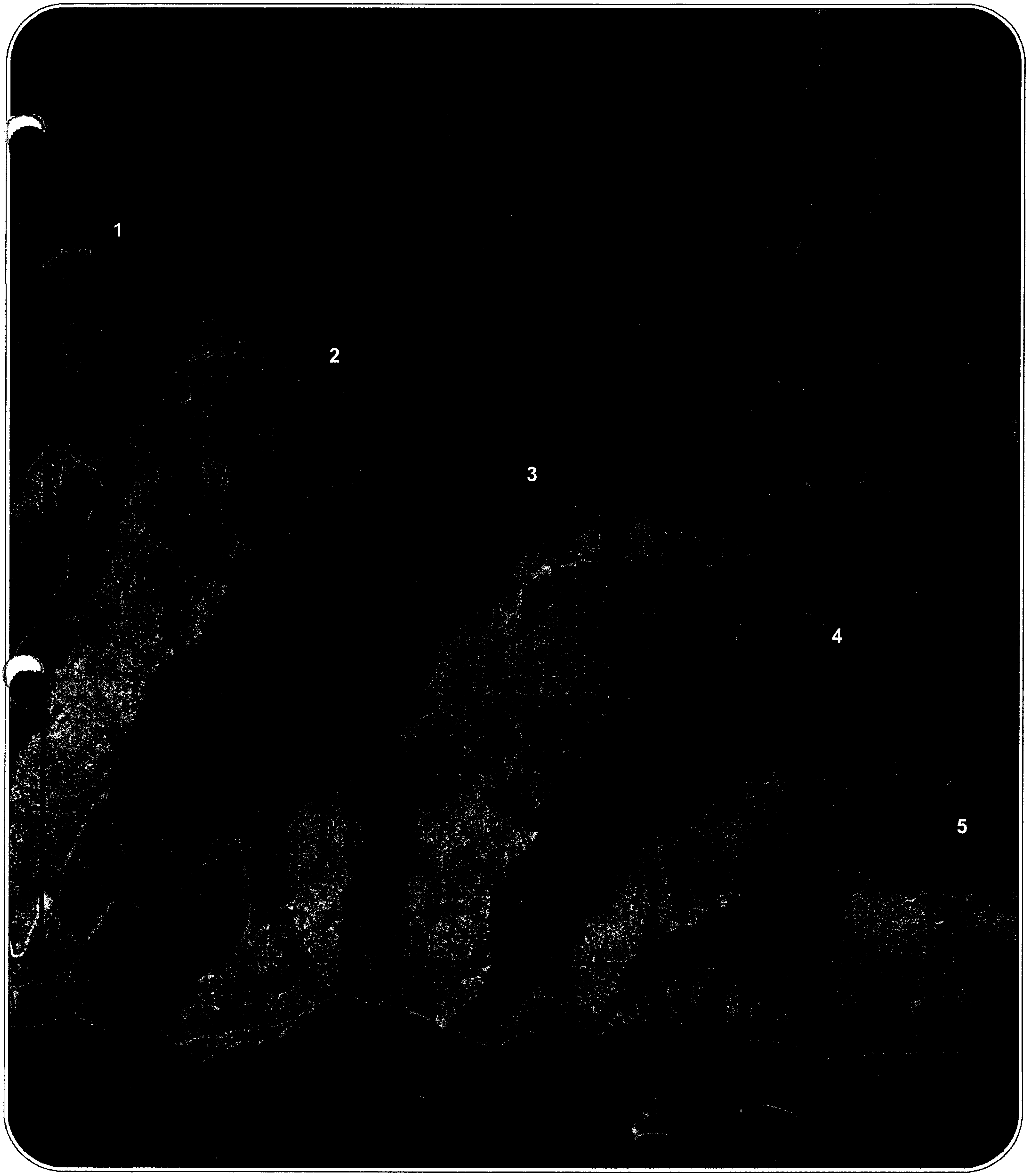

Figure 2. Inventory Area and Stops - Airial

: 2006 NAIP (USDA)

R13E Sections 16, 17, 18, 19, 20, and 21

ANABAT Stop

Inventory Area

Canyon Fuel Company

Pace Creek Canyon, Northern Cliffs

0 0.5 1 Miles

1:14,782

N

JBR\eah c:\\my documents\CFC\Dugout2007\Figure2.mxd

Created: 05 June 2007
Edited: Version 1

The ability of the ANABAT system to detect bat calls depends on factors such as the bat species, the call frequency, air temperature, relative humidity, distance from the bat, and orientation of the detector's transducer. Bat activity at a given location is known to be highly variable, both from one night to the next and at different times during the night.

The purpose of the bat investigation was to identify which species of bats utilize the Inventory Area, especially those considered a Species of Concern by the State of Utah: fringed myotis (*Myotis thysanodes*), western red bat (*Lasiurus blossevillii*), Townsend's big-eared bat (*Corynorhinus townsendii*), and spotted bat (*Euderma maculatum*), and to estimate relative abundance of bats in the area. Spotted bat calls are easily recognized because they are generally between 7 and 12 kHz, which is relatively low compared to other bats and still within the range of human hearing. Townsend's bat calls are not as distinctive but have one character that allows them to be identified with some confidence. Although bat calls normally consist of a fundamental frequency and one or more harmonics, the ANABAT system records only the most dominant frequency component. In Townsend's bat calls, the dominant frequency often switches between the fundamental and second harmonic, a character not usually observed in other species' calls.

Unfortunately, the calls of both spotted bats and Townsend's bats are more difficult to detect with the ANABAT system than most other species. Townsend's bats have relatively low intensity calls, which means that the bat must be closer to the equipment to be detected. Spotted bats are reported to forage at higher elevations than most species, and the ANABAT ultrasound transducer is not as sensitive to their low-frequency calls. Placing the ANABAT system near a cattle trough where bat activity may be concentrated maximized the likelihood of detecting these two species.

References

JBR Environmental Consultants, Inc. (JBR). 2005. Bat survey report, Canyon Fuel Company, Dugout Mine, Pace Creek Canyon. Sandy, Utah.

CHAPTER 4

LAND USE AND AIR QUALITY

TABLE OF CONTENTS

LIST OF ATTACHMENTS

410 LAND USE

411 Environmental Description

A statement of the conditions and capabilities of the land to be affected by mining and reclamation operations follows in this section.

411.100 Preming Land Use

The area is utilized for the landowners private use, including hunting and as open range for livestock and wildlife.

411.110 Land Use Map and Narrative

Refer to the same section of the approved M&RP.

411.120 Land Capability

The major plant communities at the well sites are identified in Section 321. No cultivated lands lie within the well boundaries, due to the limiting terrain and lack of water for irrigation. Refer to Section 321.200, Table 3-1 of this submittal for forage production per acre for each well site.

The well site areas are located on the flatter mesa tops and rolling terrain. This type of terrain receives heavier pressure because of more available forage and easier movement by livestock.

411.130 Land Use Description

The wells are located on land administered by Milton & Ardith Thayn Trust and zoned by Carbon County for mining and grazing (MG-1).

No industrial or municipal facilities are located on or immediately adjacent to the well sites.

411.140 Cultural and Historic Resources Information

Cultural and Historic Resource Maps - Archaeological surveys were conducted in 2003 of the well sites G-1 through G-6. Nothing was found that required future investigation. There are no cemeteries, public parks, or units of the National System of Trails or the Wild and Scenic Rivers System located within the well site boundaries. The reports can be found in Attachment 4-1 of this submittal, Appendix 4-1 and 4-3 of the M&RP and in the Confidential Folder. Well site G-7 and G-8 were inventoried by AERC in 1980 (see below), a letter from John Senulis of Senco-Phenix to SHPO has been written requesting proof of clearance for the G-7 and G-8 sites. A copy of the Senco-Phenix letter is included in the confidential folder.

Previous research in 1980 by "AERC surveyed several sample blocks in Sections 13 and 24, T13S, R12E and Sections 18, 19 and 30 T13S, R13E. They also surveyed the access road into the Snow Mine site. One archeological site (42CB292) was located. The site was described as "Coal mine located in Pace Canyon consists of one known mine portal which has been closed. Site of historic Snow Mine in Pace Canyon which was active in 1906 but had its primary production period from 1932-1940." The site was relatively pristine at the time and still contained a standing coal loadout and foundation with depth potential. Avoidance was recommended pending further historic research. <u>As noted the site has since been extensively modified</u>" (Attachment 4-1, Senco-Phenix, June 24, 2003, SPUT-455, page 2).

Access to the degas holes will not impact or disturb what remains of the archeological site (42CB292). The road in the bottom of Pace Canyon passes the archeological site, but the closed portal is not visible from the road, therefore there is nothing to draw attention to the site. The loadout referenced in the survey no longer exist at the site.

During June 2005 a Class III intensive walkover survey was performed of the access roads and degas well sites G-9 thru G-13 and site DUG0105/DUG0205 (G-14) by Senco-Phenix. The well sites are being permitted in groups. Wells G-8 thru G-10 are the group currently being presented for consideration for approval. In the canyon where degas well sites G-9 and G-10 are located near site 42CB2435. The major portion of the site has been removed and there is little potential for further information. The site is not considered eligible for the NRHP. Reference the Confidential Binder for further information pertaining to the aforementioned survey. Per the survey "No other cultural resources were located and the potential for undetected remains is remote. A finding of no effect is appropriate and archeological clearance without stipulations is recommended" by Senco-Phenix to SHPO for the G-8 thru G-14 degas well sites. Site 42CB1595 was recommended for archeological clearance without stipulations by Senco-Phenix to SHPO and was not recommended as eligible for the NRHP.

The sites of G-11 and G-16 were previously used for coal exploration holes. No "areas of critical environmental concern" or "native american religious concerns" were identified for either site in the archeological inventory of the area conducted by Senco-Phenix Archeological Consulting Services in June 20, 2001(SPUT-387, Confidential Binder) and no cultural or historical properties were listed by NRHP. Site G-11 was labeled as "DT-2" and site G-16 was labeled as "E" in SPUT-387.

Sites G-15(DUG0204), G-17 (DUG0304) were previously used for coal exploration holes. An archeological inventory of the area was conducted by Senco-Phenix Archeological Consulting Services in 2001 (SPUT-387, Confidential Binder) and no historical or cultural resources were identified for listing by NRHP/SHPO per the BLM EA UT-070-2004-49, provided for incorporation into Attachment 3-3. Site G-15 was labeled as "DUG0204" and site G-17 was labeled as "DUG0304" in the Environmental Assessment prepared by the BLM for the drilling of these exploration holes.

The areas for the exploration holes were presumably cleared by the BLM prior to the drilling of the exploration holes.

In SPUT-387 the drill pad areas are not labeled with a number but are designated as being inventoried by a blue outline on the drawing provided in the sput. A IMACS site form was prepared and submitted to SHPO for a site at well pad G-17 (42CB1596), this site was "Determined NR ineligible and non-significant for National Register Status.

A drawing has been prepared by archeological consultants "Senco-Phenix" designating areas including roads surveyed for archeological and cultural resources. The drawing entitled"Previous Archeological Surveys, July 2006" is included in the confidential binder. The road used for access to all degas drill sites have been surveyed.

SPUT-553 prepared by Senco-Phenix contains an intensive survey on 14 acres. Part of this survey was an access road connect the existing road to well pad G-19 and a trail to G-31 and on to well pad G-18. " A finding of no effect is appropriate and archeological clearance without stipulations is recommended" for the area associated with the sites listed above.

The G-31 well pad was surveyed in 2001 by Senco-Phenix (SPUT-387). In the report, the site is referenced as DT-3 and was inventoried as a location for a potential exploration well. A copy of SPUT-387 is on file at the Division and was submitted to SHPO in association with the Pace Canyon Fan Portal amendment. In the report it states that, "a finding of no effect is appropriate and archeological clearance without stipulations is recommended" for this site.

SPUT-553 also includes a survey of a proposed well site G-22 and the existing road from G-14 to G-22. Cultural resources (42CB2621) were located during this survey, but are not related to the AMV access road, well site G-31 or G-18. The information for this site was provided to the Division on June 14, 2007 under separate cover for submittal to SHPO.

SPUT-542 is an intensive cultural resource survey covering three drill holes and a staging area. The site for Degas well G-19 (G-190) is part of this survey. The refer to the drawing within the survey and Figure 1-1 of this amendment for verification of the surveyed location. "No cultural resources were located and the potential for undetected remains is remote. A finding of no effect is appropriate and archeological clearance without stipulations is recommended."

Dugout Canyon agrees to notify the Division and State Historical Preservation Office (SHPO) of previously unidentified cultural resources discovered in the course of operations. Dugout Canyon also agrees to have any such cultural resources evaluated in terms of NRHP eligibility criteria. Protection of eligible cultural resources will be in accordance with Division and SHPO requirements. Dugout Canyon will also instruct its employees that it is a violation of federal and state law to collect individual artifacts or to otherwise disturb cultural resources.

411.200 Previous Mining Activity

Dugout Canyon has no knowledge of previous removal of coal or other minerals in the well site areas.

412 Reclamation Plan

412.100 Postming Land-Use Plan

All uses of the land prior to the wells construction/operation and the capacity of the land to support prior alternate uses will remain available throughout the life of the sites.

Dugout Canyon intends the postmining land use to be livestock and wildlife grazing and other uses as dictated by the land owner (hunting, roads, corrals, stock ponds, etc.). Final reclamation activities will be completed in a manner to provide the lands able to parallel the premining land use.

412.200 Land Owner or Surface Manager Comments

Milton & Ardith Thayn Trust is the landowner. Canyon Fuel Company, LLC has a surface land owner agreement with the Thayne Trust for the drilling of degassification holes (Attachment 4-2). Prior to drilling the landowner will be contacted and the requirements related to drilling as outlined in the surface land owner agreement will be met. A copy of the letter will be included in Attachment 4-2.

413 Performance Standards

413.100 Postmining Land Use

Postmining land uses are discussed in Section 412.100. The postmining lands will be reclaimed in a timely manner and capable of supporting such uses (see Chapters 2, 3, 5, and 7).

413.200 Determining Premining Uses of Land

Refer to Section 411.100.

413.300 Criteria for Alternative Postming Land Uses

No alternative postmining land uses have been planned.

414 Alternative Land Use

No alternative postmining land uses have been planned.

420 AIR QUALITY

421 Air Quality Standards

Dugout Canyon activities will be conducted in compliance with the requirements of the Federal Clean Air Act and the Utah Air Conservation Rules.

422 Compliance Efforts

See Fugitive Dust Control Plan, Section 424.

423 Monitoring Program

Refer to the same section in the approved M&RP.

424 Fugitive Dust Control Plan

Operational areas that are used by mobile equipment will be water sprayed to control fugitive dust. The application of water will be of sufficient frequency and quantity to maintain the surface material in a damp/moist condition unless it is below freezing.

425 Additional Division Requirements

Refer to the same section of the approved M&RP.

CHAPTER 5

ENGINEERING

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LIST OF ATTACHMENTS

LIST OF FIGURES

Figures follow the text, unless noted otherwise

510 INTRODUCTION

This chapter provides a discussion of general engineering aspects, an operation plan, a reclamation plan, design criteria, and performance standards related to the degassification well sites. The activities associated with the construction and reclamation of the well sites have been or will be designed, located, constructed, maintained, and reclaimed in accordance with the operation and reclamation plans.

511 General Requirements

The permit application includes descriptions of construction, maintenance, and reclamation operations of the proposed well sites with maps and plans. Potential environmental impact as well as methods and calculations utilized to achieve compliance with the design criteria are also presented.

512 Certification

Where required by the regulations, cross sections and maps in this permit application have been prepared by or under the direction of, and certified by, qualified registered professional engineers or land surveyors. As appropriate, these persons were assisted by experts in the fields of hydrology, geology, biology, etc.

512.100 Cross Sections and Maps

Cross sections for the degassification well pads are shown on Figures 5-2, 5-6, 5-10, 5-18, 5-21, 5-24 and typical road cross sections are shown on Figures 5-13 and 5-14. Cross sections for the degassification well pads G-8, G-9, G-10, G-11 thru G-19 and G-31 are shown on figures located in Attachment 5-1.

512.200 Plans and Engineering Designs

Excess Spoil - No excess spoil will be generated from the well sites.

Durable Rock Fills - No durable rock fills will exist at the well sites.

Coal Mine Waste - No coal mine waste will exist at the well sites.

Impoundments - Refer to Section 733.200 of this submittal.

Primary Roads - Short sections of road are required to access well sites G-2, G-5, and G-16. These access roads are classified as primary roads. Well sites G-1 and G-8 (not drilled), G-3 thru G-15 and G-19, are on existing roads, no primary access roads will be constructed. Refer to Section 527.200 for additional information.

Variance from Approximate Original Contour - No variance from approximate original contour is required for the well sites.

513 Compliance with MSHA Regulations and MSHA Approval

513.100 Coal Processing Waste Dams and Embankments

No coal processing waste dams and embankments will exist at the well sites.

513.200 Impoundments and Sedimentation Ponds

Refer to Section 733.200 of this submittal.

513.300 Underground Development Waste, Coal Processing Waste, and Excess Spoil

No underground waste, coal processing waste, and excess spoil will exist at the well sites.

513.400 Refuse Piles

No refuse piles will exist at the well sites.

513.500 Underground Openings to the Surface

The well will be equipped with a valve that will be closed and locked when not in use. A typical well head is shown in Figure 5-16.

513.600 Discharge to Underground Mine

No discharge to the underground mine will occur at the well sites.

513.700 Surface Coal Mining and Reclamation Activities

No surface coal mining, or reclamation activities associated with surface coal mining will occur at the well sites.

513.800 Coal Mine Waste Fire

No coal waste will be developed, therefore, no coal waste fires will occur at the well sites.

514 Inspection

514.100 Excess Spoil

No excess spoil will be stored at the well sites.

514.200 Refuse Piles

No refuse piles will exist at the well sites.

514.300 Impoundments

Refer to Section 733.200 of this submittal.

515 Reporting and Emergency Procedures

515.100 Slides

Refer to Section 515.100 in the approved M&RP.

515.200 Impoundments Hazards

No impoundments will exist at the well sites.

515.300 Temporary Cessation of Operations

If temporary cessation of the mining operations does occur, the wells will remain open. Once liberation of the methane gas is completed, the wells will be sealed as discussed in Section 542.700 of this submittal.

520 OPERATION PLAN

521 General

See Figures 5-1, 5-5, 5-9, 5-17, 5-20, 5-23, 5-27 and Attachment 5-1 (G-8 thru G-19 and G-31) for the contour map showing pre-disturbance and drilling phase contours. These figures also show the disturbed area boundary and the new access road contours. Figures 5-3, 5-7, 5-11, 5-19, 5-22, 5-25, 5-29 and Attachment 5-1 (G-8 thru G-19 and G-31) show the layout of the well sites during the drilling phase. Figures 5-4, 5-8, 5-12 show the layout of the well sites during the operational phase and the area to be reclaimed at the completion of drilling. Cross sections for each site can be found on Figures 5-2, 5-6, 5-10, 5-18, 5-21, 5-24, 5-28 and Attachment 5-1 (G-8 thru G-19 and G-31).

521.100 Cross Sections and Maps

Existing Surface and Subsurface Facilities Features - No buildings are located on or within 1,000 feet of any of the well sites.

Landowner, Right-of-Entry, and Public Interest - The land which the wells will be drilled on is owned by the Milton and Ardith Thayn Trust. Canyon Fuels, LLC has reached an agreement with the Thayn trustees to allow access for the construction and drilling of the wells (see Attachment 4-2).

Mining Sequence and Planned Subsidence - Refer to Section 525. Mining sequence maps showing the location of drilled degas wells are submitted to the BLM and UDOGM as part of their annual reports. A drawing representing the drill holes previously permitted for drilling and those currently proposed for drilling in 2007 are shown on a drawing included in Attachment 5-4. The drawing shows the pad locations not the location where the drill hole will be completed. Drill holes from the G-9 pad were or are being drilled to release gas from the Gil-5 and Gil-6 panels. Drill holes from the G-10, G-11, G-12, and G-13 pads were drilled to release gas from the Gil-5 panel. Drill holes from the G-15, G-18, G-19, and G-31 pads will be drilled to release gas from the Gil-6 panel.

Land Surface Configuration - Surface contours of undisturbed well sites are included in Figures 5-1, 5-5, 5-9, 5-17, 5-20, 5-23, 5-27 and Attachment 5-1 (G-8 thru G-19 and G-31).

Surface Facilities - No permanent surface facilities will exist at the well sites.

521.200 Signs and Markers

Mine and Permit Identification Signs - A mine and permit identification sign will be displayed at each well site. This sign will be a design that can be easily seen and read, will be made of durable material, will conform to local regulations, and will be maintained until after the release of all bonds for the well site areas. The sign will contain the following information:

- Mine name,
- Company name,
- Company address and telephone number
- MSHA identification number, and
- Permanent program permit identification number

Perimeter Markers - The perimeter of all areas affected will be clearly marked before beginning mining activities. The markers will be a design that can be easily seen and read, will be made of durable material, will conform to local regulations, and will be maintained until after the release of all bonds for the permit area.

Buffer Zone Markers - Stream buffer zone markers will not be required at the G-2 thru G-10, G-13, G-14, G-16 and G-17 well sites. Stream buffer zone markers will be placed at G-11, G-12 , G-15, G-19 and on the AMV road where required by regulation.

Topsoil Markers - Markers will be placed on all topsoil stockpiles. These markers will be a design that can be easily seen and read, will be made of durable material, will conform to local regulations, and will be maintained until topsoil is redistributed on the well sites.

Construction Markers - Not applicable.

Hazard Signs - Signs will be place at the degas wells with open degas holes, declaring danger, no smoking, etc.

522 Coal Recovery

No coal recovery will be performed at the well sites. The operator has been contact by the BLM, in reference to changes in Operator's R2P2 associated with Federal Regulation 43 CFR Chapter 11, Subpart 3484. Degas wells G-11, G-12, G-18, G-19 and G-31 are on the SITLA lease and not on a federal lease, therefore changes in the R2P2 are not required.

523 Mining Methods

No mining will be performed at the well sites.

524 Blasting and Explosives

No explosives are to be used at the well sites.

525 Subsidence

No subsidence will occur at the well sites, as a result of drilling and development of the degassification well sites. Subsidence could occur at the well site because of underground mining see Section 525 of the approved M&RP.

526 Mine Facilities

526.100 Mine Structures and Facilities

No buildings exist or are proposed at the well sites; therefore, no existing building will be used in connection with or to facilitate this proposed coal mining and reclamation plan.

526.200 Utility Installation and Support Facilities

No utilities are to be installed at the well sites. A portable methane exhaust unit will be temporarily installed to draw methane to the surface from the mined panel. The exhaust blower will be started by using propane from portable tanks. Once started and running, the unit will be powered by burning the extracted methane gas. The level of extracted methane required to operate the exhaust blower is greater than 30%. Excess methane will be vented to the atmosphere. The blower is approximately 12-feet long by 6-feet wide and about 10-feet tall. It is not known how long the degassification of the longwall panel will take.

527 Transportation Facilities

527.100 Road Classification

Well sites will be developed near existing private roads as shown on Figures 1-1, 5-1, 5-5, 5-9, 5-17, 5-20, 5-23, 5-27 and Attachment 5-1 (G-8 thru G-17 and G-19). The new short segments of access roads will be classified as primary roads and will be maintained by the permittee (see Figure 5-14). The AMV access road will be classified as an ancillary road per a discussion with Wayne Western during a meeting at the UDOGM offices on April 16, 2007. The road is improving a trail used for hunting, cattle and for logging. There are small slash piles along segments of the trail.

527.200 Description of Transportation Facilities

The well sites were chosen close to existing roads in the area to limit surface disturbance. The existing roads were constructed and are maintained by the land owner. The existing roads are approximately 20 feet wide and are shown on Figures 5-1, 5-5, 5-9, 5-17, 5-20, 5-23, 5-27 and Attachment 5-1 (G-8 thru G-17 and G-19). See Figure 5-13 for a typical cross section of the existing roads.

The access road to the G-16 well site follows an existing road which has been reclaimed. The incised road is approximately 500 feet long, 15 to 20 feet wide and will be constructed on compacted subsoil. Topsoil will be stripped from the road alignment and either wind rowed adjacent to the road or stored with the topsoil stripped from the pad area. The access road will have a maximum grade of 10% and an average grade of 5%. The road will be constructed as shown on Figure 5-14 in the approved methane degassification amendment. As needed, water bars will be used to direct flow off the road and either silt fences or strawbales will be used to treat runoff . Refer to Chapter 5, Attachment 5-1 for drawings of well site. The access road to G-16 is also discussed in Chapter 7, Section 732.400.

The AMV access road will be classified as an ancillary road per a discussion with Wayne Western during a meeting at the UDOGM offices on April 16, 2007. The road is improving a trail used for hunting, cattle and for logging. A drawing showing the alignment of the road can be found in Attachment 5-4, as Plate 1. The drawing outlines the disturbed area and shows the road center line, culvert locations, turnouts and topsoil stockpile locations. Topsoil will be removed from the road and stockpiled along the road as shown on Plate 1. The cut and fill volumes for the road have been determined to be close, making it unlikely that subsoil will need to be stored. However, should it be necessary to store subsoil a pile will be created on one of the proposed turnouts. The subsoil pile will be bermed, pocked, gouged and seeded. The topsoil piles will be treated as described in Chapters 2 and 3 of the Methane Degassification Amendment.

A typical road cross section is found in Attachment 5-4 as Figure 1. The road will be at a minimum 12 feet wide, with two addition feet of the road width being added as a berm and two feet being used as a ditch, making the road approximately 16 feet wide. Additional descriptive information for the road is located in Attachment 5-4, including cross-sections of the road on Plates 2 and 3 within the attachment.

The steepness of access road cut slopes will depend on the stability of the exposed subsurface material. Cuts into competent material such as bedrock will be sloped at angles of approximately 0.5H:1V (63.4 degrees). Cut into unconsolidated material such as soils will be sloped at angles of approximately 1H:1V (45 degrees). The steepness of these slopes is justified by the presence of several near-vertical bedrock outcrops and naturally steep (approximately 1H:1V) colluvial slopes along road cuts in the vicinity of the proposed access road. Furthermore, the nearby cut slopes along access roads have maintained such slopes for several years. Cut slopes will be maintained along the length of the proposed access road. Area determined to be unstable will be regraded to a stable configuration.

When necessary during the normal use of the AMV road, it will be graded, berms will be repaired, culverts inlets/outlets and ditches will be cleaned. The materials excavated during road maintenance will be stockpiled to be used for either repair or during reclamation. The AMV road is not likely to be used during winter due to the access from below the road being impassable, therefore snow removal and storage has not been discussed. Damage to the AMV access road will be repaired as soon as practical following a catastrophic event. The Division will be notified of a catastrophic event involving the failure of the AMV road and/or drill pads.

On the AMV road silt fences will be placed in the ditch upstream of the approach to the culverts to treat road runoff during construction. Silt fences will be placed at the toe of fill slopes during construction to reduce the amount of loose soil material and sediment laden runoff from entering the drainage. Outslopes and ditches associated with the road will be seeded during operations to encourage the establishment of vegetation and erosion control.

528 Handling and Disposal of Coal, Excess Spoil, and Coal Mine Waste

No disposal of coal, excess spoil, and coal mine waste will occur at the well sites.

529 Management of Mine Openings

The perimeter of the sites, including the topsoil stockpiles will be fenced with gates on the access roads. The well casing will have a valve that is closed and locked. The valve will also prevent access by animals or other material. Mine openings will be monitored in accordance with Federal and State Regulations.

During the life of the methane wells, the sites will be inspected as needed by mine personnel to verify the continued operation of the pumping equipment and general site conditions. Motorized vehicles to access the methane wells may include trucks, four-wheelers, a snow cat, snowmobiles and etc.

530 OPERATIONAL DESIGN CRITERIA AND PLANS

531 General

This section contains the general plans for the construction of sediment controls and general construction and maintenance of the well sites.

The decision to construct each well will be based on the amount of methane encountered during mining. If small amounts of methane are encountered and the mine's ventilation system can dilute the methane, no well will be drilled. The proposed well site locations are shown on Figure 1-1.

The topography above the Dugout Canyon Mine severely limits the selection of methane drainage drill sites (degas wells). Various other factors also affect the drill site locations. These include proximity to the mining area, existing access verses new access, site slope, meeting reclamation success standards, etc. Sites with exiting access are given preference over sites without, where possible sites are located along existing roads and at other pre-disturbed areas. In addition, drill methods are often modified (using directional drilling methods vs. conventional vertical drilling methods) to allow drilling along existing access and to reduce environmental impacts. Directional drilling methods allow the surface site to be located as described yet allow the bottom of the hole to be completed in the required mining area.

532 Sediment Control

Sediment control measures for the well sites are described in Sections 732 and 742 of this submittal. Runoff control structures at the well sites have been designed to convey runoff in a non-erosive manner. Sediment yields in the well permit area are minimized by:

- Disturbing the smallest practicable area during the construction of the well site and
- Contemporaneously reclaiming areas suitable for such reclamation.

The runoff control measures for the AMV access road are discussed in Attachment 5-4 , Attachment 7-1, Sections 732.400 and 742.

533 Impoundments

No impoundments will exist at the well sites or on the AMV road.

534 Roads

Refer to Section 527 and 532 of this submittal.

535 Spoil

No spoil will be generated at the well sites.

536 Coal Mine Waste

No coal mine waste will be stored at the well sites.

537 Regraded Slopes

537.100 Division Approval

No mining or reclamation activities will be conducted in the permit area that requires approval of the Division for alternative specifications or for steep cut slopes.

537.200 Regrading of Settled and Revegetated Fills

Upon completion of the well site, the areas not required for the exhaust blower will be regraded to approximate original contour. Because of the nature of the well site, settling is not anticipated. However, if settlement does occur, these areas will be regraded.

540 RECLAMATION PLAN

541 General

541.100 Commitment

Upon the permanent cessation of methane venting, Dugout Canyon Mine will seal the wells and permanently reclaim all affected areas in accordance with the R645 regulations and this reclamation plan.

541.200 Surface Coal Mining and Reclamation Activities

Not applicable.

541.300 Underground Coal Mining and Reclamation Activities

Upon completion of the methane venting activities the wells will be reclaimed.

541.400 Environmental Protection Performance Standards

The plan presented is designed to meet the requirements of R645-301 and the environmental protection performance standards of the State Program.

542 Narratives, Maps, and Plans

542.100 Reclamation Timetable

A timetable for the completion of each major step in the reclamation plan is presented in Figure 5-15 (G-2 and G-5) and 5-26 (G-3, G-4, G-6 thru G-19, G-31 and the AMV access road). Per Task ID #2408, "the Division requires notification and a reasonably specific time to initiate the reclamation activities associated with degassification well sites." In addition to the two figures referenced above, information pertaining to reclamation timing for methane degas wells is provided in Attachment 5-2 of this amendment.

542.200 Plan for Backfilling, Soil Stabilization, Compacting, and Grading

Following completion of the venting activities, the well site will be prepared for contouring and soil distribution. Details regarding topsoil placement and revegetation are provided in Section 242 and Section 353, respectively.

Sedimentation Pond Removal and Interim Sediment Control - See Section 542.500 of this submittal.

542.300 Final Surface Configuration Maps and Cross Sections

The sites will be regraded to the approximate original contour, the contours representing the pre-disturbance topography also represent the reclamation topography. Refer to Figures 5-2, 5-6, 5-10, 5-18, 5-21, 5-24, 5-28 and Attachment 5-1 (G-8 thru G-19 and G-31) to see cross sections representing the final surface configuration. Refer to Attachment 5-4, Plates 1 thru 3 for the surface configuration of the road and cross sections showing pre-mining, operational and post-mining contours.

542.400 Removal of Temporary Structures

The well sites will not have surface structures.

542.500 Removal of Sedimentation Pond

No sediment pond will be constructed at the well sites.

542.600 Roads

The roads which existed prior to the drilling program will be retained after reclamation. The access roads established during the drilling program will be reclaimed after methane extraction has been completed. See Section 242 for additional detail concerning the reclamation plan.

The road to well site G-16 is pre-existing however it has been reclaimed, the road to access well sites G-13, G-14, G-15, G-17 and G-19 are existing roads. Subsoil being cut in order to construction the pad for well G-15 will be placed on the existing road, causing it to be elevated. Refer to Section 527.200 and Attachment 5-4 for a description of the AMV access road.

Once the degassification is completed at wells G-18 and G-31 the AMV road will be reclaimed. To begin, the segment of the road will be reclaimed which joins pad G-18 to G-31, then reclamation of the road will continue on downhill until the road rejoins the existing road connecting the Pace Canyon road and degas pad G-19. The area of the road will be returned to approximate original contour, pocked and gouged and seeded (Section 350).

542.700 Final Abandonment of Mine Openings and Disposal Areas

Degas drill holes G-9 thru G-19 and G-31 will be sealed in accordance with Federal Regulations 43 CFR Ch. 11, Subpart 3484, (3) per a decision by the BLM and UDOGM.

The casings on degas well sites G-2 thru G-7 will be plugged at the bottom to hold concrete. A lean concrete mixture will be poured into the casing until the concrete is within five (5) feet of the surface. At that time the casing will be cut off at ground level and the rest of the casing will be filled with lean concrete. The concrete will be allowed to harden before final reclamation is completed.

A copy of 43 CFR Ch. 11, Subpart 3484, (3) and a discussion of how methane is removed from mines is contained in Attachment 5-2.

542.800 Estimated Cost of Reclamation

Refer to the Appendix 5-6 of the existing M&RP. It is anticipated that the cost of reclamation of the well sites and AMV road are adequately covered by the Dugout Canyon Reclamation Bond, refer to Chapter 8 for additional detail.

550 RECLAMATION DESIGN CRITERIA AND PLANS

551 Casing and Sealing of Underground Openings

Permanent sealing is described in Section 542.700.

552 Permanent Features

552.100 Small Depressions

No permanent small depressions will be created as part of the well site or AMV road construction and reclamation.

552.200 Permanent Impoundments

See Section 515.200 of this submittal.

553 Backfilling and Grading

553.100 Disturbed Area Backfilling and Grading

Approximate Original Contour - The well sites and AMV road will be returned to their approximate original contour after reclamation is completed.

Erosion and Water Pollution - Sediment controls will consist of gouging the surface to create depressions and mounds which store and impede the movement of water. As vegetation becomes established on the reclaimed surface, erosion potential will be further minimized.

Post-Mining Land Use - The disturbed area will be reclaimed in a manner that supports the approved post-mining land use. Refer to Sections 411 and 412 for additional detail.

553.200 Spoil and Waste

Spoil - No spoil will be generated within the well sites.

Coal Processing Waste - No coal processing waste will be generated within the well sites.

553.250 Refuse Piles

No refuse piles will exist at the well sites.

553.300 Exposed Coal Seams, Acid and Toxic Forming Materials and Combustible Materials

No coal seams will be left exposed at the well sites. All wells will be sealed according to Federal and State regulations.

553.400 Cut and Fill Terraces

No cut and fill terraces will be constructed at the well sites or on AMV road.

553.500 Highwall From Previously Mined Areas

No highwalls exist or will be built at the well sites or on AMV road.

553.600 Previously Mined Area

No previously mined areas exist at the well sites or on AMV road.

553.700 Backfilling and Grading - Thin Overburden

No surface mining and reclamation activities involving thin overburden will occur at the well sites or on AMV road.

553.800 Backfilling and Grading - Thick Overburden

No surface mining and reclamation activities involving thick overburden will occur at the well sites or on AMV road.

553.900 Regrading of Settled and Revegetated Rills

If settlement or rills occur at the well sites or on AMV road, they will be regraded and revegetatived. Refer to Section 244.300.

560 PERFORMANCE STANDARDS

Dugout Canyon Mine well sites will be conducted in accordance with the approved permit and the requirements of R645-301-510 through R645-301-553.

FIGURE 5-26

Reclamation Schedule - Wells G-3, G-4, G-6 thru G-19 and G-31

Task	Weeks to Complete from Start of Reclamation Activities		
	1	2	3
Plug Well			
Regrade Site to Original Contour			
Rip Subsoil			
Place Topsoil and Roughen			
Seed and Mulch			
The schedule assumes that weather conditions are conducive. Schedule is for each individual well not wells collectively. If necessary the timing may be extended.			

Reclamation Schedule - AMV Access Road

Task	Weeks to Complete from Start of Reclamation Activities		
	1	2	3
Regrade Road to Original Contour			
Rip Subsoil			
Place Topsoil and Roughen			
Seed and Mulch			
Move to Next Road Segment, Repeat First Four Tasks.			
The schedule assumes that weather conditions are conducive. Schedule is for individual segments of the road not the entire road. The road will be broken up into 3 to 4 segments, thus the reclamation will take from six to eight weeks. If necessary the timing may be extended.			

ATTACHMENT 5-1

Degas Wells G-8 thru G-19 and G-31

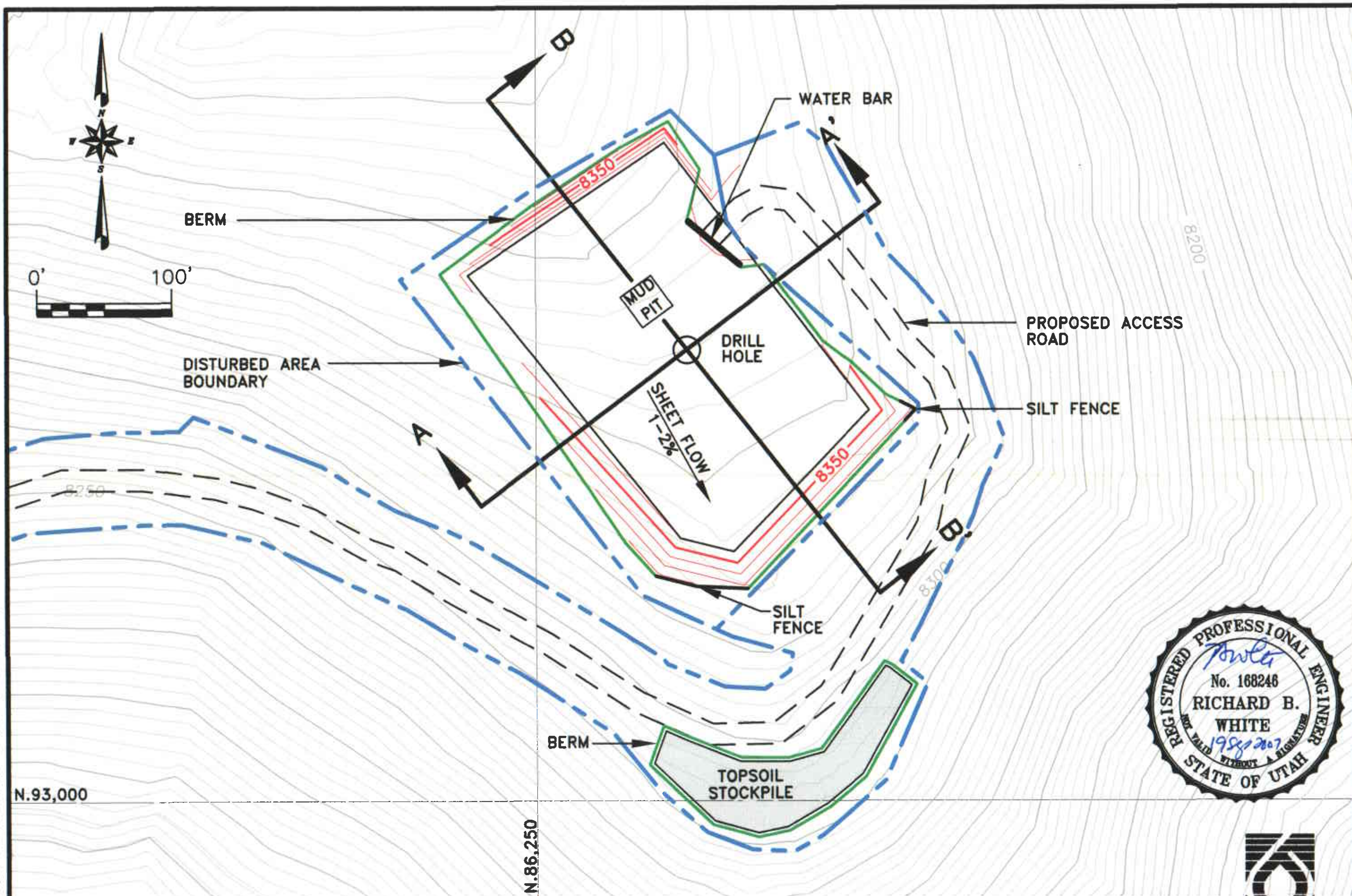

FIGURE 1. CONTOUR MAP FOR G-18

G:\UC1098\03\ ACCESS ROAD\G-18\FIG1-G31.DWG

G:\UC1098\03 Access Road\G-18\FIG1-G18.DWG, 9/19/2007 7:33:10 AM

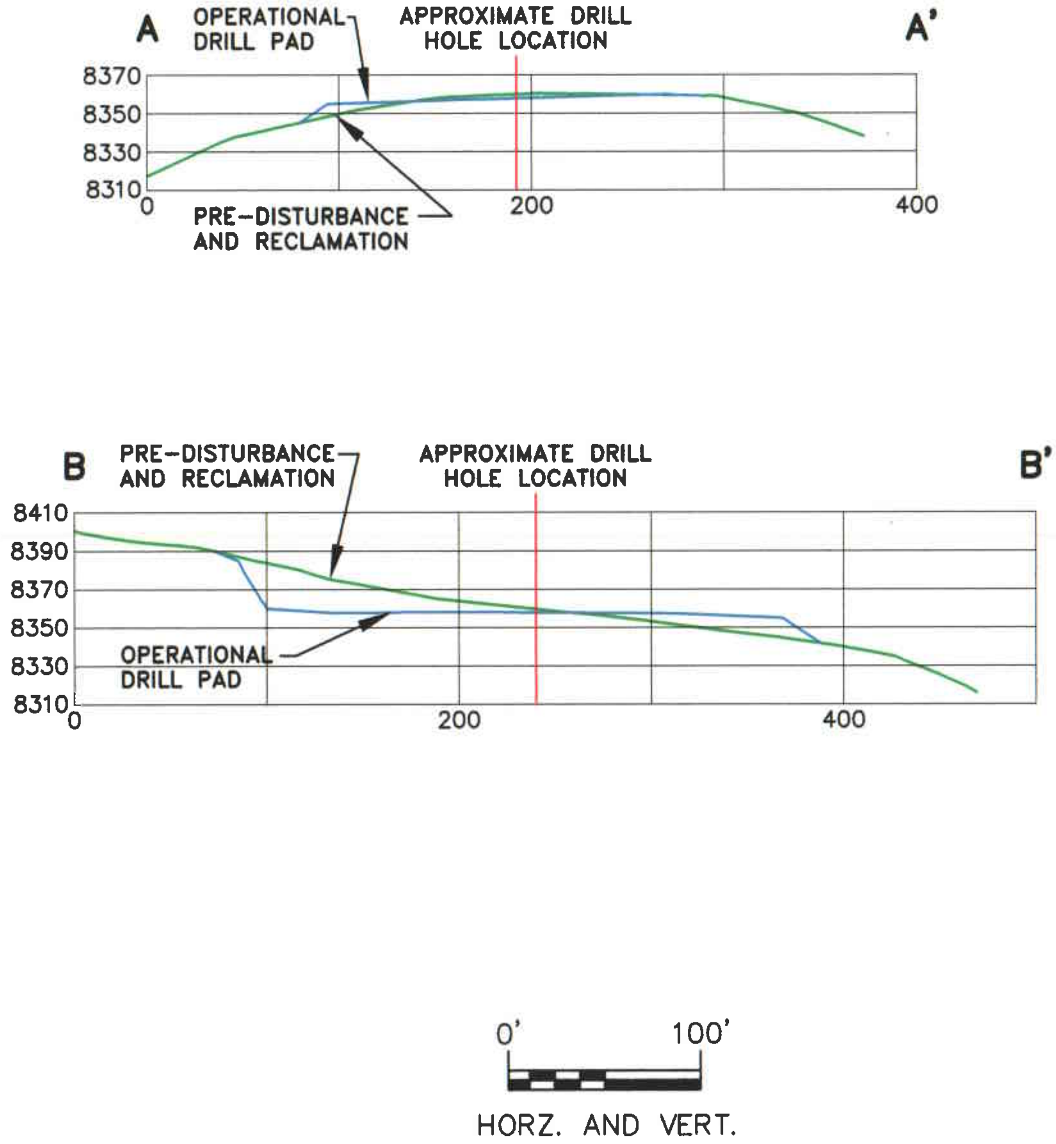

FIGURE 2. TYPICAL CROSS-SECTIONS FOR G-18

REGISTERED PROFESSIONAL ENGINEER
No. 168246
RICHARD B. WHITE
19 Sep 2007
NOT VALID WITHOUT A SIGNATURE
STATE OF UTAH

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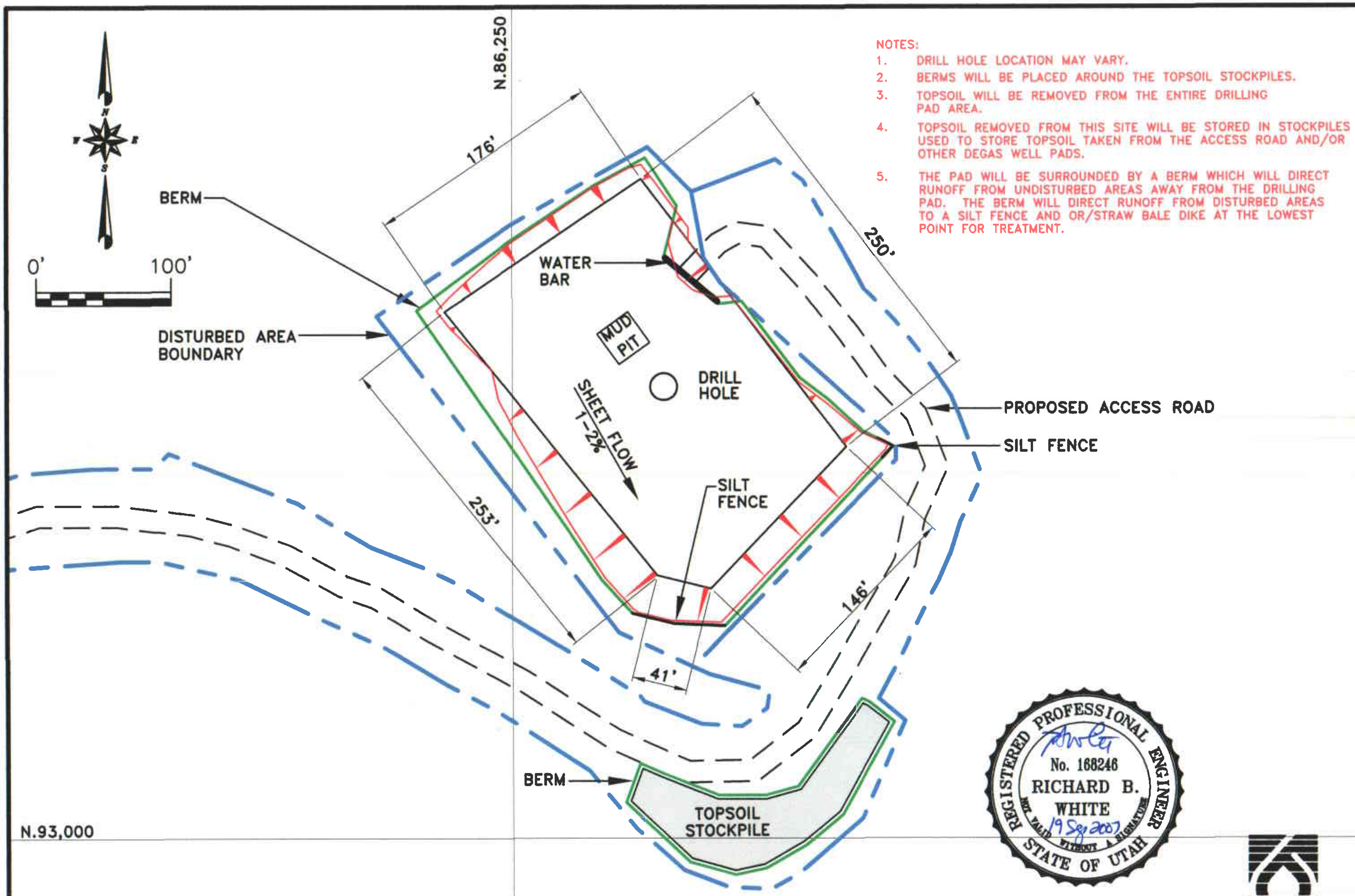
G:\UC1098\03\ ACCESS ROAD\G-18\FIG2-G18-XSEC.DWG

G:\UC1098\03 Access Road\G-18\FIG2-G18-XSEC.DWG, 9/19/2007 7:34:07 AM



NOTES:

1. DRILL HOLE LOCATION MAY VARY.
2. BERMS WILL BE PLACED AROUND THE TOPSOIL STOCKPILES.
3. TOPSOIL WILL BE REMOVED FROM THE ENTIRE DRILLING PAD AREA.
4. TOPSOIL REMOVED FROM THIS SITE WILL BE STORED IN STOCKPILES USED TO STORE TOPSOIL TAKEN FROM THE ACCESS ROAD AND/OR OTHER DEGAS WELL PADS.
5. THE PAD WILL BE SURROUNDED BY A BERM WHICH WILL DIRECT RUNOFF FROM UNDISTURBED AREAS AWAY FROM THE DRILLING PAD. THE BERM WILL DIRECT RUNOFF FROM DISTURBED AREAS TO A SILT FENCE AND OR/STRAW BALE DIKE AT THE LOWEST POINT FOR TREATMENT.

FIGURE 3. APPROXIMATE DRILLING LOCATION FOR G-18

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G:\UC1098\03\ ACCESS ROAD\FIG3-G18-LAYOUT.DWG

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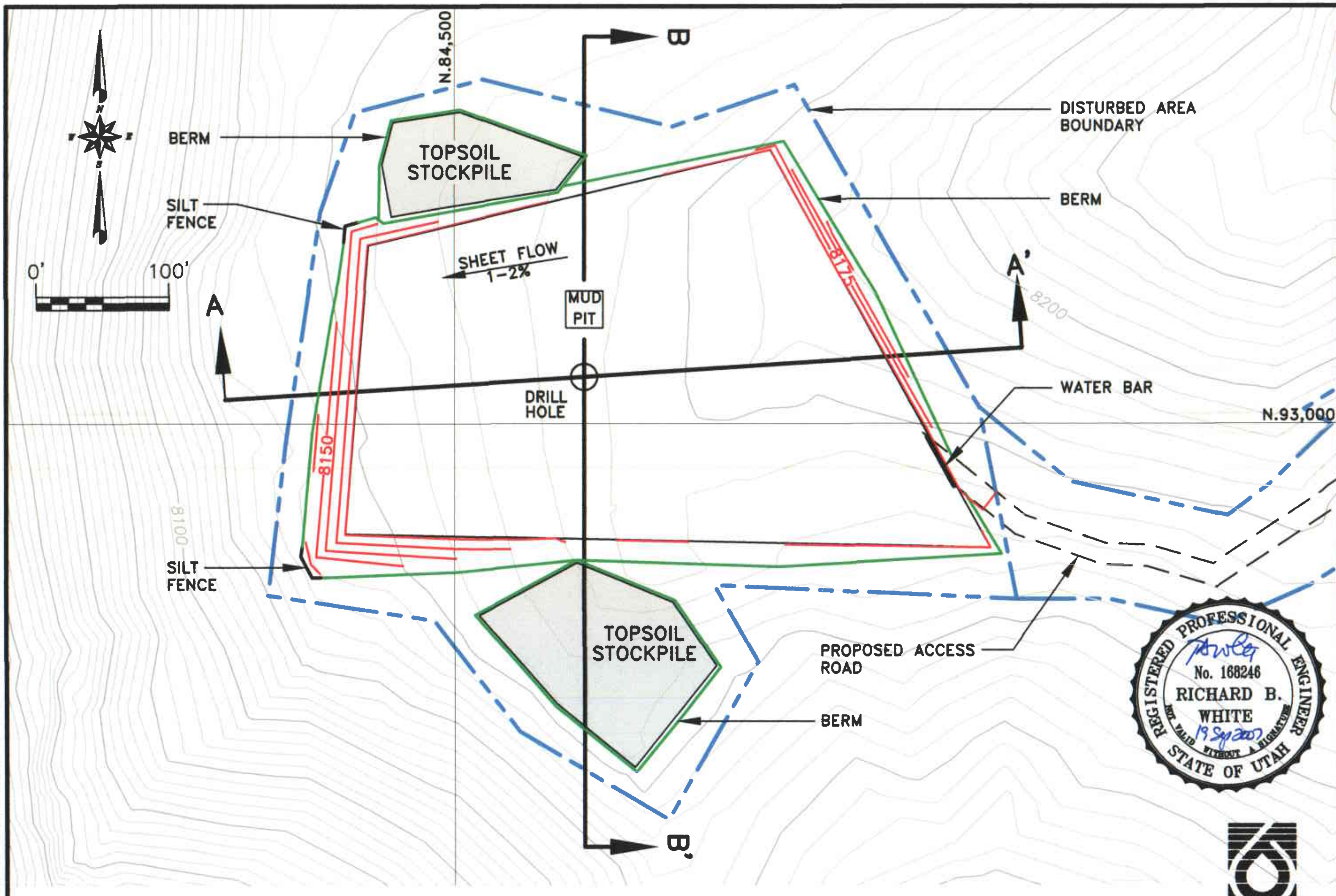
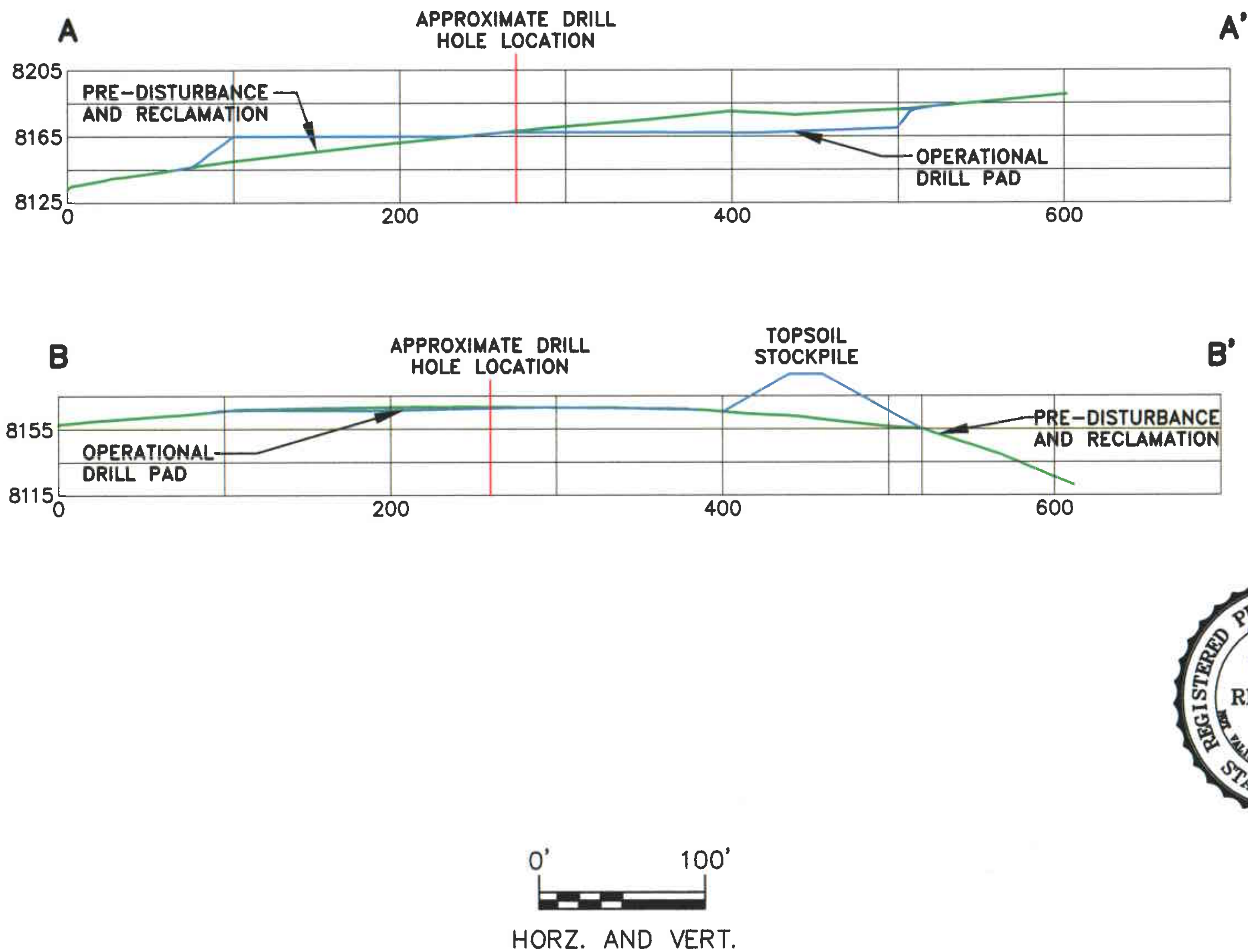


FIGURE 1. CONTOUR MAP FOR G-31

G:\UC1098\03 Access Road\G-31\FIG1-G31.DWG, 9/19/2007 7:36:25 AM

G:\UC1098\03\ ACCESS ROAD\G-31\FIG1-G31.DWG



REGISTERED PROFESSIONAL ENGINEER No. 168246 RICHARD B. WHITE 19 Sep 2007 NOT VALID WITHOUT A SIGNATURE STATE OF UTAH

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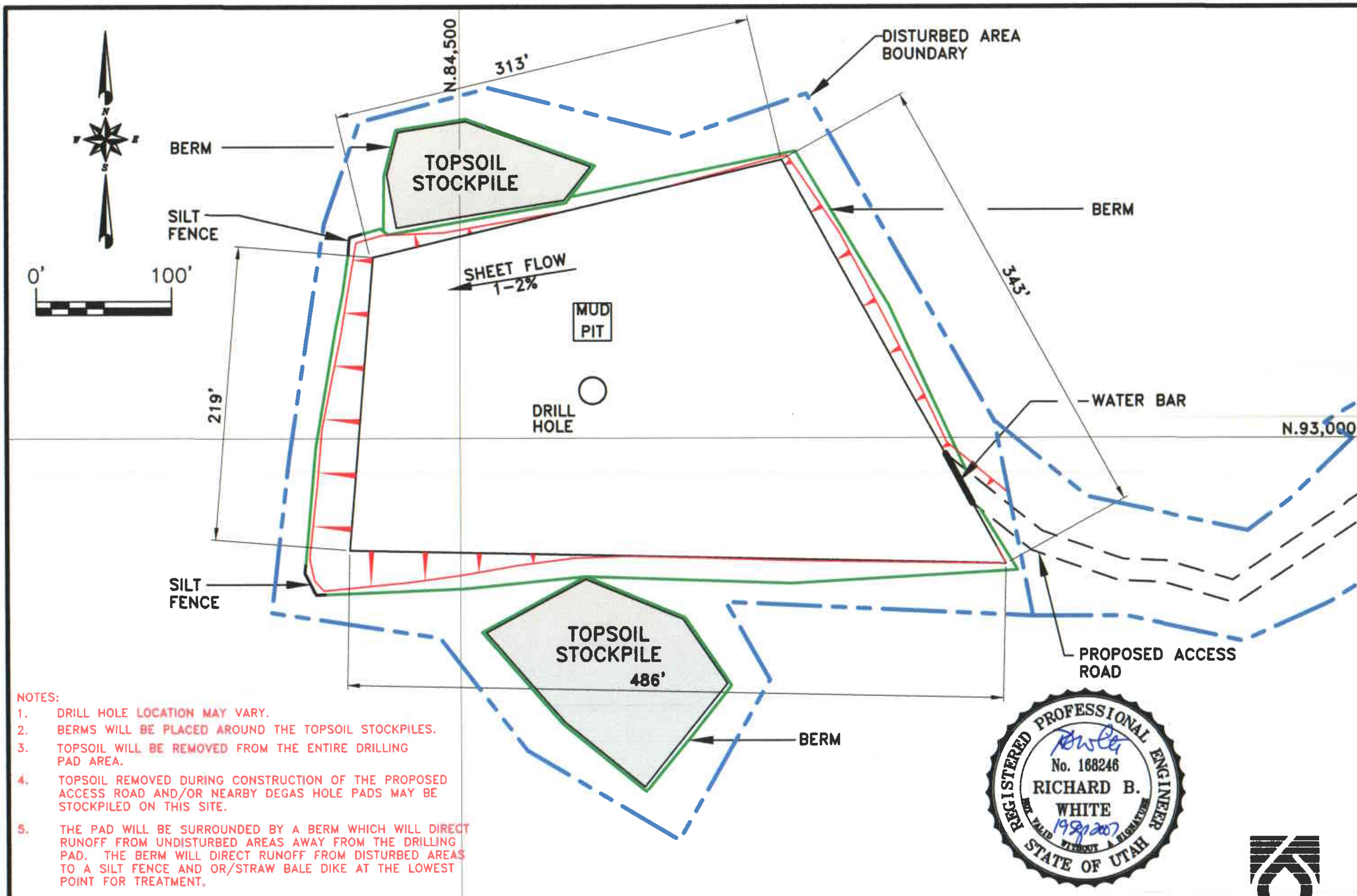
FIGURE 2. TYPICAL CROSS-SECTIONS FOR G-31



NOTES:

1. DRILL HOLE LOCATION MAY VARY.
2. BERMS WILL BE PLACED AROUND THE TOPSOIL STOCKPILES.
3. TOPSOIL WILL BE REMOVED FROM THE ENTIRE DRILLING PAD AREA.
4. TOPSOIL REMOVED DURING CONSTRUCTION OF THE PROPOSED ACCESS ROAD AND/OR NEARBY DEGAS HOLE PADS MAY BE STOCKPILED ON THIS SITE.
5. THE PAD WILL BE SURROUNDED BY A BERM WHICH WILL DIRECT RUNOFF FROM UNDISTURBED AREAS AWAY FROM THE DRILLING PAD. THE BERM WILL DIRECT RUNOFF FROM DISTURBED AREAS TO A SILT FENCE AND OR/STRAW BALE DIKE AT THE LOWEST POINT FOR TREATMENT.

FIGURE 3. APPROXIMATE DRILLING LOCATION FOR G-31

G:\UC1098\03 Access Road\G-31\FIG3-G31-LAYOUT.DWG, 9/19/2007 7:38:03 AM

G:\UC1098\03\ ACCESS ROAD\FIG3-G19-LAYOUT.DWG

ATTACHMENT 5-2

Methane Degassification

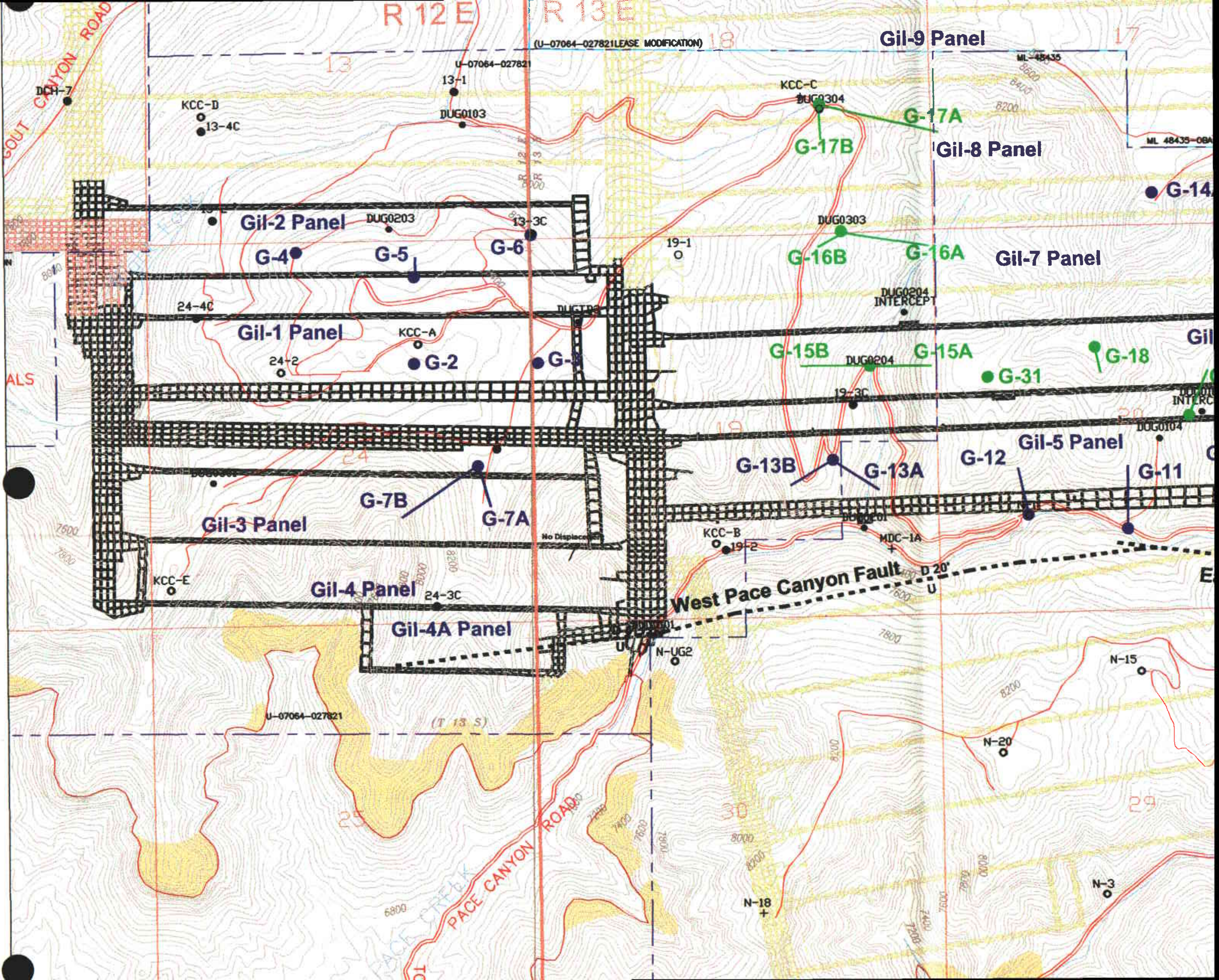
Well No.	**Year Constructed**		**Year Plugged**		**Contemporaneous Reclamation**		**Final Reclamation**	
	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual
G-2		2004			2007			
G-3		2004		2005		2005		2006
G-4		2004		2005				2005
G-5		2004			2007			
G-6		2004		2005				2007
G-7		2005			2007			
G-9		2005			2008			
G-10	2006				2007			
G-11	2006				2008			
G-12	2006				2007			
G-13	2006				2008			
G-14	2006				2008			
G-15	2007				2008			
G-16	2008							
G-17	2008							
G-18	2007				2009			
G-19	2007				2008			
G-31	2007				2009			

Dates are approximate, all events are subject to availability of contractors, weather, mining needs, etc.

Although permitted, wells G-1 and G-8 were never drilled/constructed.

Attachment 5-2 and

Attachment 2-4


R 12 E
R 13 E
(U-07064-027821LEASE MODIFICATION)
Gil-9 Panel
Gil-8 Panel
Gil-7 Panel
Gil-5 Panel
Gil-2 Panel
Gil-1 Panel
Gil-3 Panel
Gil-4 Panel
Gil-4A Panel
West Pace Canyon Fault
PACE CANYON ROAD
U-07064-027821
(T 13 S)
ML-48435
ML 48435-OBA
DCH-7
KCC-D
13-4C
13-1
DUG0103
DUG0203
13-3C
24-4C
KCC-A
24-2
KCC-C
DUG0304
DUG0303
19-1
DUG0204 INTERCEPT
DUG0204
19-3C
DUG0104
KCC-B
19-2
MDC-1A
KCC-E
24-3C
N-UG2
N-15
N-20
N-18
N-3
G-2
G-4
G-5
G-6
G-7A
G-7B
G-11
G-12
G-13A
G-13B
G-15A
G-15B
G-16A
G-16B
G-17A
G-17B
G-18
G-31
No Displacement
D 20'
U

ATTACHMENT 5-4

Degas Wells Access Road

ATTACHMENT 5-4
G31/G18 ACCESS ROAD HYDROLOGY CALCULATIONS
AND CUT/FILL VOLUMETRICS CALCULATIONS

ATTACHMENT 5-4
DEGAS WELLS ACCESS ROAD

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No. 168246
RICHARD B.
WHITE
24 Aug 2007
STATE OF UTAH

Cut/Fill Volumetrics

Area	Road	Pad 31	Pad 18	TOTAL
Disturbed Acreage	5.68	2.87	1.36	9.91
Disturbed Area Acreage within Boundary	14.23	4.66	1.74	20.63
Topsoil Volume (cyd)	9,167	4,624	2,195	15,986
Subsoil Cut Volume (cyd)	15,207	8,470	6,962	30,639
Cut Volume Total (cyd)	24,374	13,094	9,157	46,625
Fill Volume Required (cyd)	11,954	11,781	5,938	29,673
Net Cut(+)/Fill(-) Subsoil Only (cyd)	3,253	-3,311	1,024	966

<u>Notes</u>

Proposed road is 7,155 feet long.

Topsoil Volume assumes that the Disturbed Area will have 1 foot (avg) thickness topsoil to be stockpiled.

The Subsoil Cut Volume is the Cut Volume Total minus the Topsoil Volume.

The Net Cut Volume (966 cyd) does not include the volume of subsoil required to construct berms along the proposed road (265 cyd), around the proposed topsoil stockpiles (309 cyd), or around the proposed degas well pads G-31 (62 cyd) and G-18 (39 cyd). The net cut is thus 966-309-265-62-39= 291 cyd. The road and pad berm volumes were calculated assuming that they will be 1 ft tall with 1H:1V side slopes. The lengths of the berms for the road, G-31, and G-18 were taken as 7155, 1670, and 1023 feet long, respectively. Stockpile berm volumes are calculated on the Stockpile Runoff Containment Volume Calculations table.

All acreages and cut/fill volumes were calculated with AutoCAD software.

Stockpile Runoff Volume Calculations

Stockpile	Watershed Area (sq. ft.)	Watershed Area (acres)	Precip. - *P* (in)	Curve Number (*CN*)	Potential Max. Retention - *S* (in.)	Runoff - *Q* (in)	Runoff Volume - *V* (ft^3)
STP-1	3,282	0.08	2.05	87	1.49	0.94	258
STP-2	3,312	0.08	2.05	87	1.49	0.94	261
STP-3	15,690	0.36	2.05	87	1.49	0.94	1,235
STP-4	14,734	0.34	2.05	87	1.49	0.94	1,160
STP-5	7,895	0.18	2.05	87	1.49	0.94	622
STP-6	8,417	0.19	2.05	87	1.49	0.94	663

Notes

Calculations have been performed for the 10-year, 24-hour design storm event.

Topsoil is derived from the Midfork Family - Comodore Complex, as described in the NRCS Soil Survey for Carbon Area, Parts of Carbon and Emery Counties.

Calculations based on Soil Conservation Service (SCS) Method, National Engineering Handbook Section 4, Chapters 9 & 10 by Victor Mockus, 1972

Precipitation for 10-year, 24-hour event taken from National Weather Service web site (http://hdsc.nws.noaa.gov/hdsc/pfds/sa/ut_pfds.html)

CN = 87, based on Table 9.1, NEH s4 ch9. Assume Hyd. Soil Gp. C (as given for Rottulee family - Trag complex in NRCS survey). Assume road, dirt surface (non-vegetated, conservative case).

$S = (1000/CN) - 10$

$L = [(l^{0.8}(S+1)^{0.7}]/(1900Y^{0.5})$

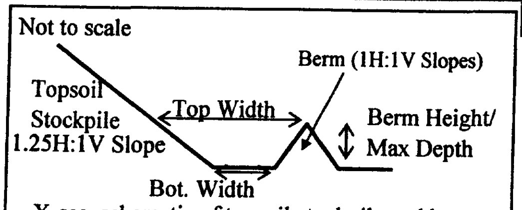
$T_c = 1.67L$

$Q = (P - 0.2*S)^2 / (P + 0.8*S)$

$V = Area * Q$

Stockpile Runoff Containment Volume Calculations

Stockpile	Bottom Width (ft)	Top Width (ft)	Max Depth (ft)	Impounding Length of Berm (ft)	Total Length of Berm (ft)	Fill Req'd for Berm (yd^3)	Cntnmt Vol. (ft^3)	Contain Vol > Runoff Vol ?
STP-1	2	4.25	1	78	268	10	244	Yes
STP-2	2	4.25	1	89	257	10	278	Yes
STP-3	2	6.5	2	250	510	76	2,125	Yes
STP-4	2	6.5	2	227	509	75	1,930	Yes
STP-5	2	6.5	2	76	402	60	646	Yes
STP-6	2	4.25	1	262	513	19	819	Yes
						249	Total fill for berms (yd^3)	



X-sec. schematic of topsoil stockpile and berm

Notes

The bottom width is the distance between the toe of the topsoil stockpile and the base of the berm. (see schematic)

The top width is the horizontal distance between the crest of the berm and the topsoil stockpile. (see schematic)

The max depth is the height of the berm.

The Impounding Length of the berm accounts for the slope of the ground, and is the portion of the berm that will impound runoff.

The Total Length of Berm is its entire length around the topsoil stockpile.

The Fill Required for Berm is the volume of subsoil required to construct each berm, and is based on the length, height, and width of each berm. Berms shall be constructed with 1H:1V slopes.

The Containment Volume = Length * Cross sectional area of the space between the topsoil stockpile and the inby side of the berm.

Watershed Hydrology - Culvert Design

Watershed	Watershed Area (sq. ft.)	Watershed Area (acres)	Precip. *P* (in)	Hydraulic Length - *I* (ft)	Avg Watershed Slope - *Y* (%)	Duration of Storm (hr)	Curve Number (*CN*)	Potential Max. Retention *S* (in.)	Lag - *L* (hr)	Time of Concentration - *Tc* (hr)	Runoff - *Q* (in)	Runoff Volume - *V* (ft3)	Peak Discharge (cfs)
WS1	1,532,383	35.2	2.05	2,262	60.5	24	77	2.99	0.09	0.14	0.48	60,692	24.68
WS2	276,566	6.3	2.05	1,502	60.1	24	77	2.99	0.06	0.10	0.48	10,954	4.94
WS3	205,995	4.7	2.05	1,151	57.7	24	77	2.99	0.05	0.09	0.48	8,159	3.79
WS4	395,010	9.1	2.05	1,100	49.8	24	77	2.99	0.05	0.09	0.48	15,645	7.25
WS5	74,016	1.7	2.05	589	45.7	24	82	2.20	0.03	0.05	0.68	4,206	2.25

Notes

Calculations have been performed for the 10-year, 24-hour design storm event.

Refer to attached figures for locations of watersheds and NRCS soils units

Calculations based on Soil Conservation Service (SCS) Method, National Engineering Handbook Section 4, Chapters 9 & 10 by Victor Mockus, 1972

CN determined based on NRCS soils map, which shows that each watershed (except WS5) contains soils of which half are in Hydrologic Soils Group B and half are in Group C. According to the UDOT Manual of Instruction, Table 7-14, woods-grass combination, poor condition has a CN of 73 for Group B and 82 for Group C. The weighted average CN is thus approximately 77. WS5 is comprised entirely of soils in Group C.

$S = (1000/CN) - 10$

$L = [(I^{0.8}(S+1)^{0.7}]/(1900Y^{0.5})$

$T_c = 1.67L$

$Q = (P - 0.2*S)^2 / (P + 0.8*S)$

$V = Area * Q$

Peak discharge calculated using HydroCad 2005 software (see attached sheets for output).

Average Watershed Slope Calculation (Sum of lengths of contour lines X contour interval / Area)

WS1

Contour (ft)	Length (ft)
7,900	825
8,000	1,021
8,100	1,353
8,200	1,483
8,300	1,481
8,400	1,327
8,500	843
8,600	546
8,700	256
8,800	131
TOTAL	**9,266**
AvgSlope	**60.5%**

WS2

Contour (ft)	Length (ft)
7,800	142
7,900	298
8,000	251
8,100	328
8,200	245
8,300	398
TOTAL	**1,662**
AvgSlope	**60.1%**

WS3

Contour (ft)	Length (ft)
7,800	246
7,900	231
8,000	294
8,100	202
8,200	156
8,300	60
TOTAL	**1,189**
AvgSlope	**57.7%**

WS4

Contour (ft)	Length (ft)
7,800	284
7,900	380
8,000	624
8,100	451
8,200	170
8,300	60
TOTAL	**1,969**
AvgSlope	**49.8%**

WS5

Contour (ft)	Length (ft)
8,100	282
8,200	56
TOTAL	**338**
AvgSlope	**45.7%**

Culvert Sizing Summary

Culvert No.	Diameter (in)	Length (ft)	Inlet Elevation (ft)	Outlet Elevation (ft)	Average Slope (ft/ft)	Peak Flow (cfs)	Peak Inlet Depth (ft)	Peak Inside Depth (ft)
1	36	203	7,890	7,845	0.22	24.68	2.52	0.79
2	24	117	7,735	7,730	0.04	4.94	1.14	0.34
3	18	89	7,735	7,700	0.39	3.79	1.02	0.34
4	24	64	7,712	7,690	0.34	7.25	1.5	0.44
5	18	80	8,020	7,997	0.29	2.25	0.6	0.28

Notes

Culvert No. corresponds to Watershed No. on Watershed Hydrology - Culvert Design Table. i.e. Culvert No. 1 will be located where WS-1 crosses the road.

Culverts were conservatively assumed to be corrugated metal pipe. Polyethylene pipe may also be used.

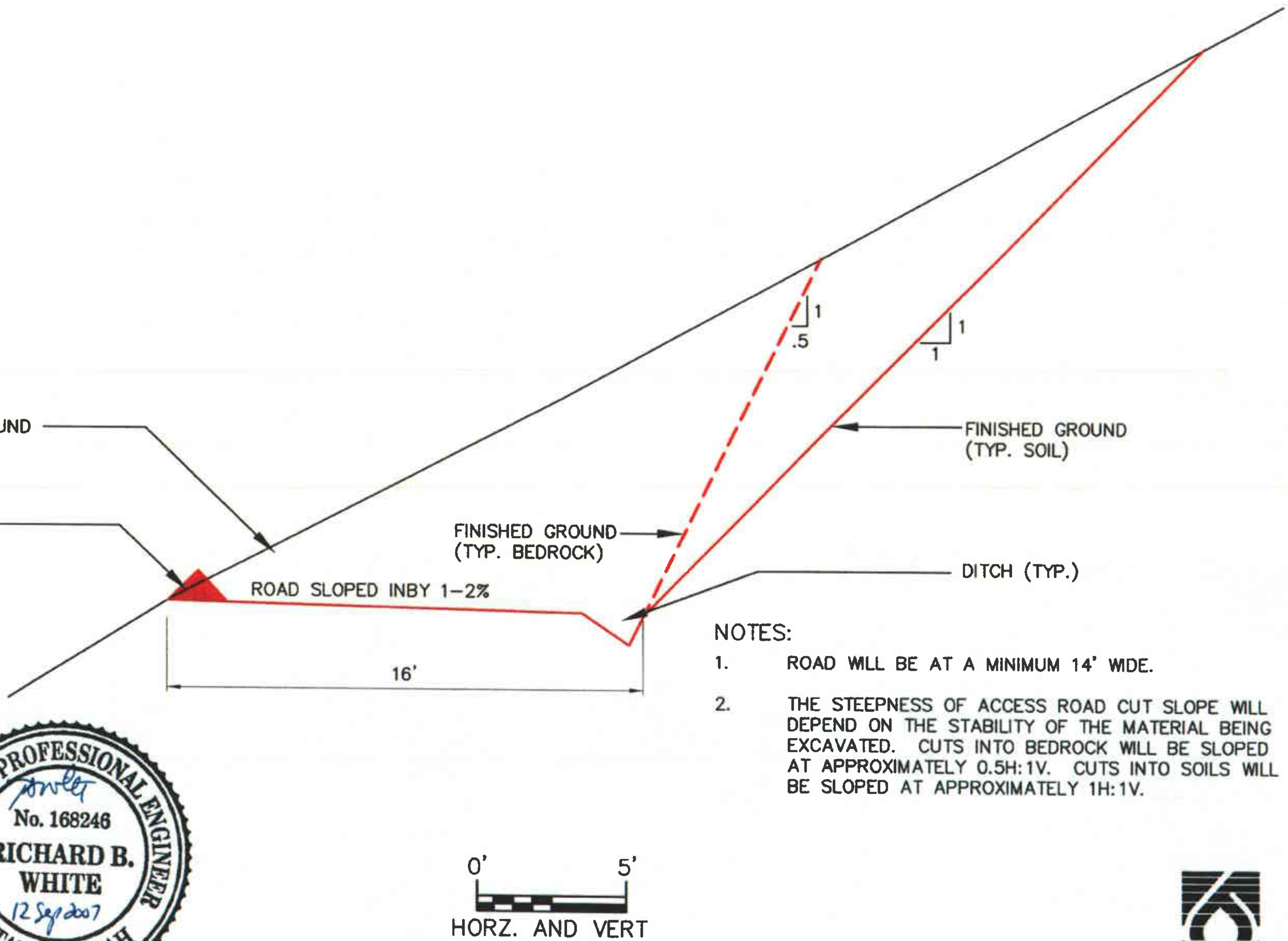
The peak flow in each culvert was calculated using HydroCad 2005 software using the Soil Conservation Service (SCS) method, as shown in the Watershed Hydrology - Culvert Design Table. The design storm was the 10-year, 24-hour precipitation event.

The peak inlet depth was determined using Hydraulic Engineering Circular No. 5 Chart 5 (U.S. Department of Transportation, 1977). As a conservative measure, the projecting condition was assumed. See the attached nomograph for additional information.

The peak inside depth was calculated using HydroCad 2005 software. See attached output sheets for additional information.

WATERSHEDS FOR CULVERT SIZING CALCULATIONS
ATTACHMENT 5-4 FIGURE

ATTACHMENT 5–4



NOTES:

1. ROAD WILL BE AT A MINIMUM 14' WIDE.

2. THE STEEPNESS OF ACCESS ROAD CUT SLOPE WILL DEPEND ON THE STABILITY OF THE MATERIAL BEING EXCAVATED. CUTS INTO BEDROCK WILL BE SLOPED AT APPROXIMATELY 0.5H:1V. CUTS INTO SOILS WILL BE SLOPED AT APPROXIMATELY 1H:1V.

REGISTERED PROFESSIONAL ENGINEER No. 168246 RICHARD B. WHITE STATE OF UTAH 12 Sep 2007

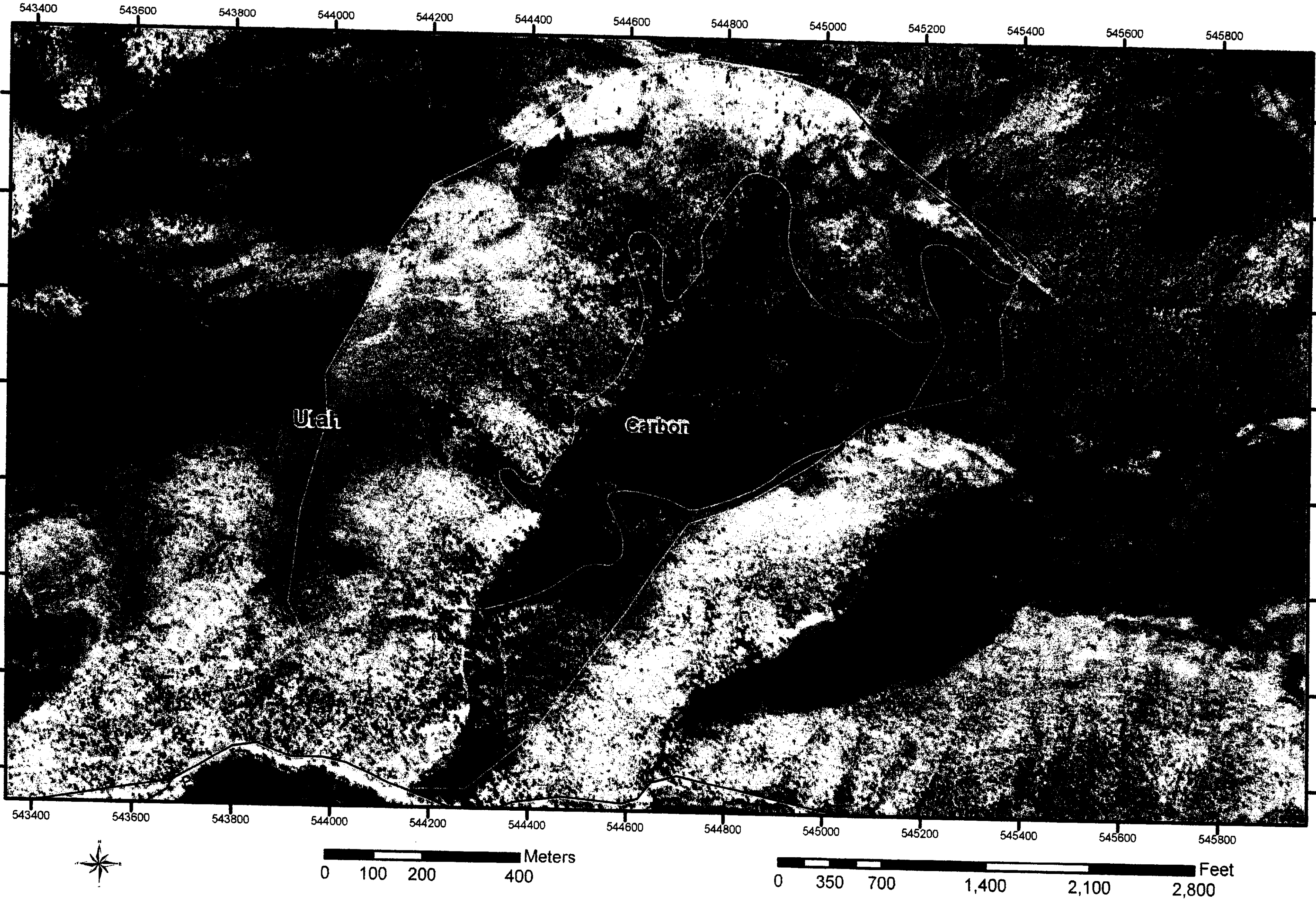
FIGURE 1. TYPICAL ROAD CROSS SECTION

EarthFax

G:UC1098\03 ACCESS ROAD\FIG-1.DWG

BACKUP INFORMATION

SOIL SURVEY OF CARBON AREA, UTAH, PARTS OF CARBON AND EMERY COUNTIES



Tables - Hydrologic Soil Group

Summary by Map Unit - Carbon Area, Utah, Parts of Carbon and Emery Counties

Soil Survey Area Map Unit Symbol	Map Unit Name	Rating	Total Acres in AOI	Percent of AOI
62	Midfork family-Comodore complex	B	81.7	25.3
97	Rottulee family-Trag complex	C	230.8	71.3
100	Senchert loam, 3 to 15 percent slopes	C	11.0	3.4

Description - Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Parameter Summary - Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff:

Tie-break Rule: Lower

TABLE 7-14 — Other Agricultural Lands[1]

Cover Description — Cover Type	Hydrologic Condition	Curve Numbers for Hydrologic Soil Group A	B	C	D
Pasture, grassland, or range — continuous forage for graving [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow — continuous grass — protected from grazing and generally mowed for hay		30	58	71	78
Brush — brush-weed-grass mixture with brush the major element [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30[4]	48	65	73
Woods — grass combination (orchard or tree farm) [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30[4]	55	70	77
Farmsteads — buildings, land, driveways and surrounding lots	—	59	74	82	86

1 Average runoff condition and $I_a = 0.2S$.

2 Poor: < 50% ground cover or heavily grazed with no mulch
Fair: 50% to 75% ground cover and not heavily grazed
Good: > 75% ground cover and lightly or only occasionally grazed

3 Poor: < 50% ground cover
Fair: 50% to 75% ground cover
Good: > 75% ground cover

4 Actual Curve Number is less than 30; use CN = 30 for runoff computations.

5 CNs shown were computed for areas with 50% grass (pasture) cover. Other combinations of conditions may be computed from CNs for woods and pasture.

6 Poor: Forest litter, small trees and brush are destroyed by heavy grazing or regular burning.
Fair: Woods grazed but not burned, and some forest litter covers the soil.
Good: Woods protected from grazing; litter and brush adequately cover soil.

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

Utah 39.68175 N 110.48129 W 7946 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Tue Jun 26 2007

Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Help | D

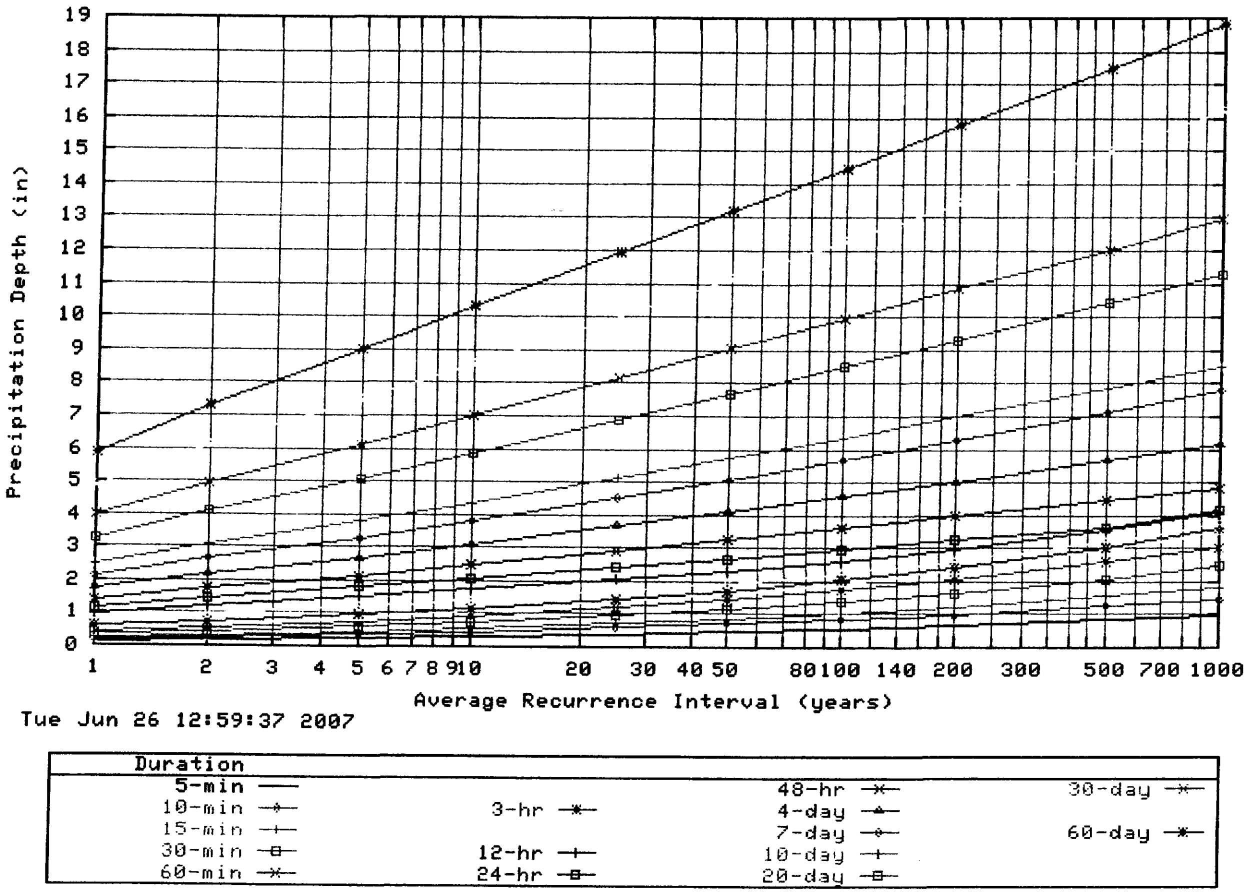
Precipitation Frequency Estimates (inches)

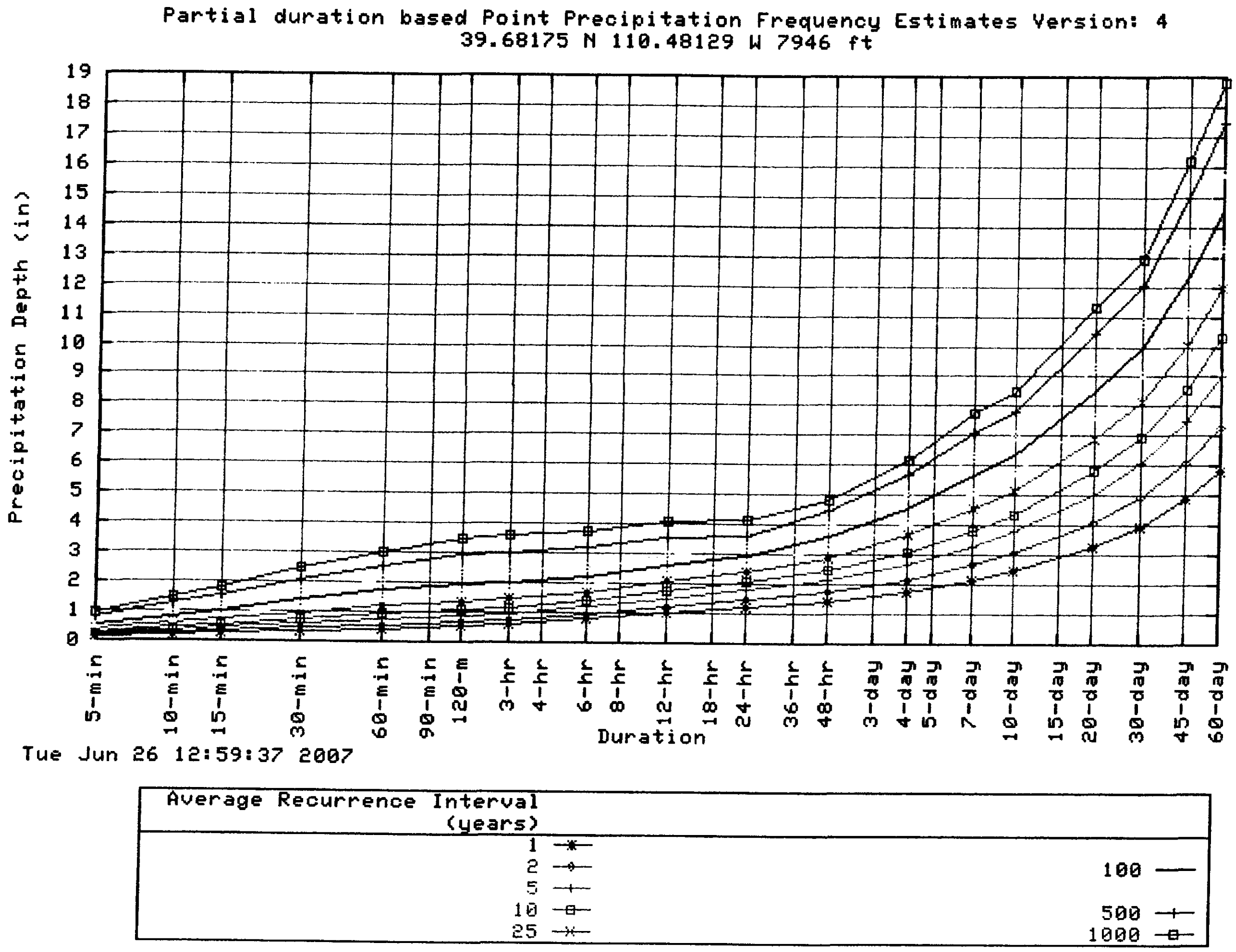
ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.14	0.20	0.25	0.34	0.42	0.52	0.59	0.77	0.99	1.18	1.40	1.74	2.12	2.44	3.26	3.97	4.88	5.83
2	0.17	0.26	0.33	0.44	0.55	0.65	0.74	0.96	1.23	1.46	1.74	2.16	2.65	3.06	4.08	4.95	6.10	7.31
5	0.24	0.36	0.45	0.60	0.74	0.86	0.95	1.19	1.50	1.78	2.13	2.67	3.29	3.78	5.05	6.09	7.50	9.00
10	0.29	0.45	0.55	0.74	0.92	1.06	1.15	1.38	1.73	2.05	2.46	3.08	3.80	4.36	5.82	6.98	8.59	10.29
25	0.38	0.58	0.72	0.97	1.20	1.36	1.45	1.67	2.05	2.40	2.89	3.65	4.52	5.14	6.86	8.15	10.04	11.96
50	0.46	0.70	0.86	1.16	1.44	1.64	1.72	1.92	2.32	2.68	3.24	4.09	5.08	5.74	7.66	9.04	11.15	13.22
100	0.55	0.83	1.03	1.39	1.72	1.96	2.04	2.22	2.60	2.96	3.60	4.55	5.67	6.36	8.48	9.94	12.29	14.50
200	0.65	0.99	1.23	1.66	2.05	2.33	2.41	2.57	2.94	3.25	3.96	5.03	6.28	7.00	9.31	10.84	13.44	15.78
500	0.82	1.24	1.54	2.08	2.57	2.93	3.03	3.18	3.53	3.64	4.45	5.67	7.11	7.86	10.44	12.03	14.99	17.48
1000	0.97	1.47	1.83	2.46	3.04	3.49	3.59	3.74	4.09	4.13	4.84	6.17	7.77	8.53	11.30	12.94	16.22	18.80

Text version of table

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval. Please refer to the documentation for more information. NOTE: Formatting forces estimates near zero to appear as zero.

Partial duration based Point Precipitation Frequency Estimates Version: 4
39.68175 N 110.48129 W 7946 ft





Confidence Limits -

* Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)																		
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.16	0.24	0.30	0.41	0.51	0.60	0.69	0.88	1.11	1.31	1.56	1.94	2.41	2.74	3.65	4.43	5.44	6.49
2	0.21	0.32	0.39	0.53	0.65	0.76	0.86	1.09	1.38	1.63	1.94	2.42	3.01	3.42	4.56	5.54	6.80	8.12
5	0.28	0.43	0.53	0.72	0.89	1.01	1.11	1.35	1.68	2.00	2.38	2.98	3.73	4.24	5.66	6.80	8.37	10.00
10	0.35	0.53	0.66	0.89	1.10	1.24	1.33	1.58	1.94	2.29	2.74	3.44	4.33	4.89	6.53	7.79	9.60	11.44
25	0.46	0.69	0.86	1.16	1.43	1.60	1.69	1.91	2.32	2.69	3.23	4.08	5.15	5.76	7.70	9.12	11.24	13.33
50	0.55	0.83	1.04	1.40	1.73	1.93	2.01	2.21	2.63	3.00	3.62	4.58	5.80	6.45	8.61	10.14	12.51	14.77
100	0.66	1.00	1.24	1.67	2.07	2.33	2.40	2.58	2.97	3.33	4.03	5.11	6.50	7.17	9.55	11.18	13.80	16.25
200	0.79	1.20	1.49	2.01	2.49	2.79	2.87	3.01	3.38	3.66	4.45	5.65	7.22	7.91	10.53	12.23	15.15	17.77
500	1.01	1.54	1.90	2.56	3.17	3.59	3.67	3.79	4.13	4.17	5.04	6.42	8.24	8.93	11.88	13.66	17.01	19.80
1000	1.22	1.85	2.30	3.09	3.83	4.35	4.43	4.52	4.85	4.90	5.51	7.04	9.06	9.75	12.94	14.77	18.49	21.43

* The **upper** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **greater** than.
** These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

*** Lower bound of the 90% confidence interval**

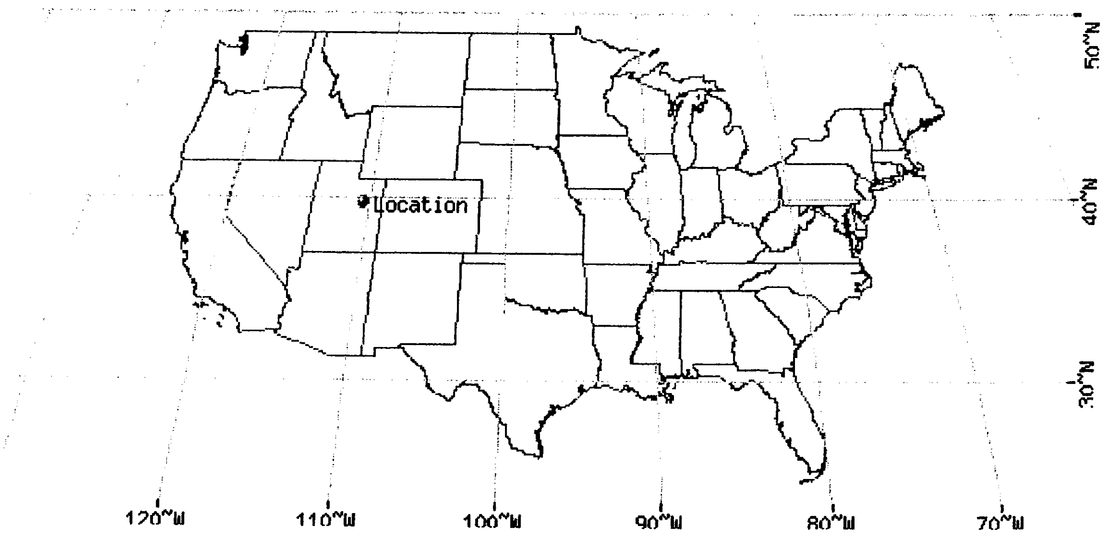
Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.12	0.18	0.22	0.29	0.36	0.45	0.52	0.69	0.90	1.07	1.26	1.56	1.89	2.19	2.94	3.59	4.41	5.28
2	0.15	0.23	0.28	0.38	0.47	0.57	0.65	0.85	1.11	1.32	1.57	1.95	2.36	2.75	3.68	4.48	5.51	6.61
5	0.20	0.31	0.38	0.52	0.64	0.75	0.84	1.05	1.34	1.61	1.92	2.39	2.92	3.38	4.53	5.49	6.75	8.10
10	0.25	0.38	0.47	0.63	0.79	0.90	1.00	1.22	1.54	1.84	2.20	2.75	3.37	3.88	5.22	6.26	7.69	9.22
25	0.32	0.48	0.59	0.80	0.99	1.14	1.24	1.45	1.81	2.15	2.58	3.23	3.97	4.55	6.10	7.27	8.94	10.66
50	0.37	0.56	0.70	0.94	1.17	1.34	1.44	1.65	2.02	2.39	2.86	3.60	4.43	5.05	6.76	8.02	9.86	11.71
100	0.43	0.66	0.82	1.10	1.36	1.56	1.67	1.88	2.23	2.62	3.15	3.97	4.90	5.55	7.41	8.75	10.78	12.73
200	0.50	0.76	0.94	1.27	1.57	1.81	1.93	2.13	2.48	2.85	3.44	4.34	5.36	6.06	8.07	9.47	11.69	13.73
500	0.60	0.91	1.13	1.52	1.88	2.17	2.32	2.56	2.93	3.15	3.81	4.82	5.99	6.71	8.90	10.36	12.86	15.01
1000	0.68	1.04	1.29	1.73	2.15	2.48	2.65	2.94	3.34	3.38	4.10	5.18	6.46	7.19	9.53	11.03	13.76	15.97

* The **lower** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **less** than.
** These precipitation frequency estimates are based on a partial duration maxima series. ARI is the Average Recurrence Interval.

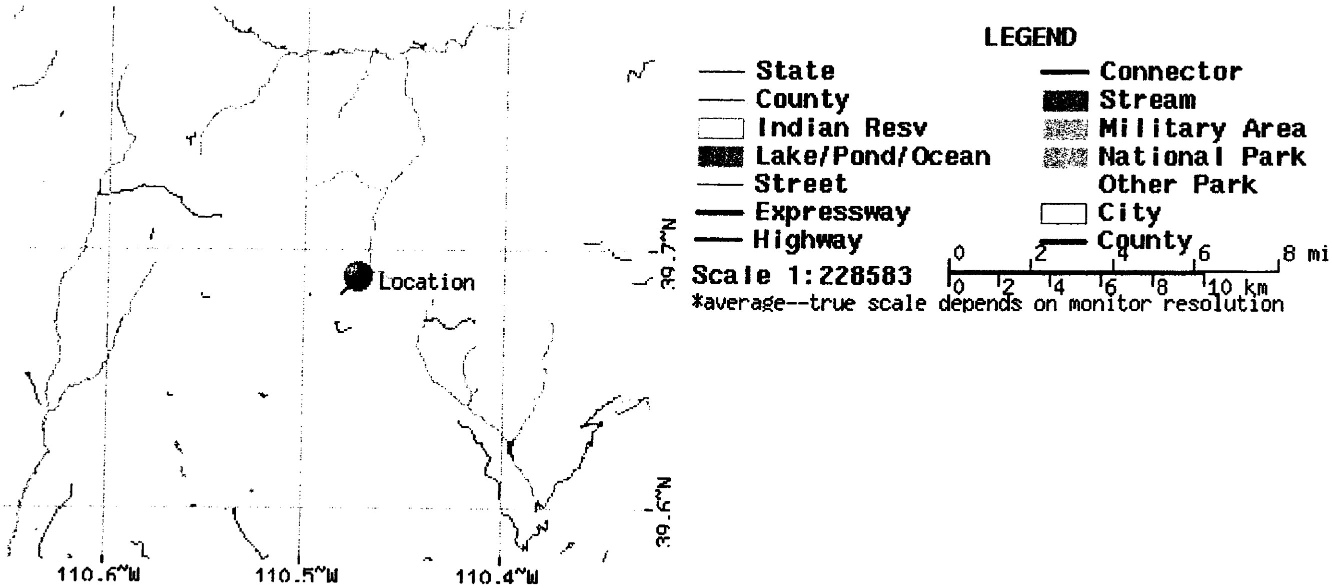
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

Maps -



These maps were produced using a direct map request from the U.S. Census Bureau Mapping and Cartographic Resources Tiger Map Server.

Please read disclaimer for more information.



Other Maps/Photographs -

View USGS digital orthophoto quadrangle (DOQ) covering this location from TerraServer; **USGS Aerial Photograph** may also be available from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the USGS for more information.

Watershed/Stream Flow Information -

Find the Watershed for this location using the U.S. Environmental Protection Agency's site.

Climate Data Sources -

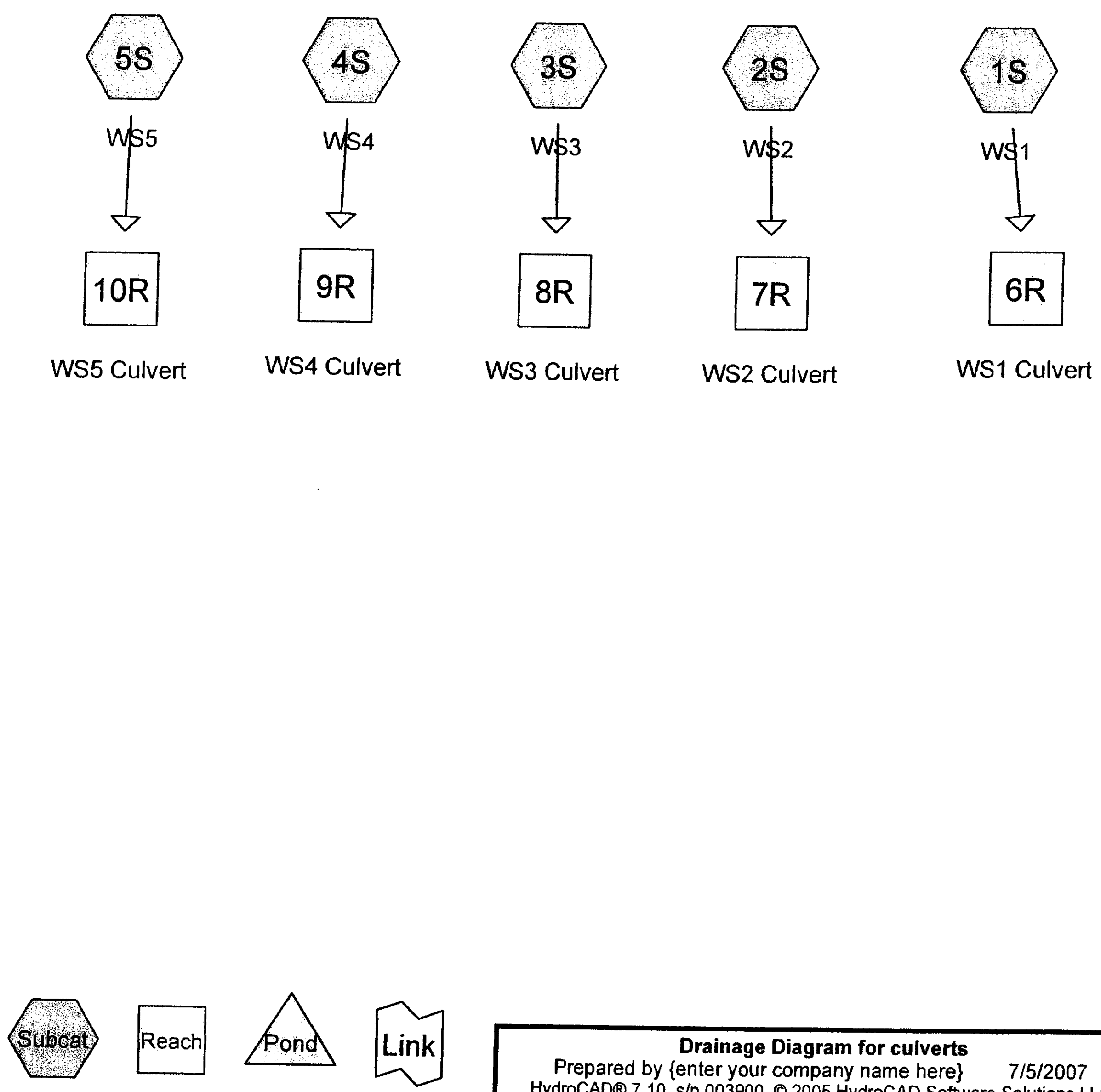
Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study, please refer to our documentation.

Using the National Climatic Data Center's (NCDC) station search engine, locate other climate stations within:

[+/-30 minutes] ...OR... [+/-1 degree] of this location (39.68175/-110.48129). Digital ASCII data can be obtained directly from NCDC.

Find Natural Resources Conservation Service (NRCS) SNOTEL (SNOwpack TELemetry) stations by visiting the Western Regional Climate Center's state-specific SNOTEL station maps.

Hydrometeorological Design Studies Center
DOC/NOAA/National Weather Service
1325 East-West Highway
Silver Spring, MD 20910
(301) 713-1669
Questions?: HDSC.Questions@noaa.gov



Drainage Diagram for culverts
Prepared by {enter your company name here} 7/5/2007

Subcatchment 1S: WS1

Runoff = 24.68 cfs @ 12.01 hrs, Volume= 60,692 cf, Depth= 0.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=2.05"

Area (sf)	CN	Description
1,532,383	77	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	2,262	0.6050	4.4		**Lag/CN Method,**

Subcatchment 2S: WS2

Runoff = 4.94 cfs @ 11.99 hrs, Volume= 10,954 cf, Depth= 0.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=2.05"

Area (sf)	CN	Description
276,566	77	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	1,502	0.6010	4.0		**Lag/CN Method,**

Subcatchment 3S: WS3

Runoff = 3.95 cfs @ 11.97 hrs, Volume= 8,159 cf, Depth= 0.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr Rainfall=2.05"

Area (sf)	CN	Description
205,995	77	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	1,151	0.5770	3.7		**Lag/CN Method,**

Subcatchment 4S: WS4

Runoff = 7.51 cfs @ 11.98 hrs, Volume= 15,645 cf, Depth= 0.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr Rainfall=2.05"

Area (sf)	CN	Description
395,010	77	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	1,100	0.4980	3.4		**Lag/CN Method,**

Subcatchment 5S: WS5

Runoff = 2.32 cfs @ 11.94 hrs, Volume= 4,206 cf, Depth= 0.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr Rainfall=2.05"

Area (sf)	CN	Description
74,016	82	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	589	0.4570	3.4		**Lag/CN Method,**

Reach 6R: WS1 Culvert

[52] Hint: Inlet conditions not evaluated

Inflow Area = 1,532,383 sf, Inflow Depth = 0.48"
Inflow = 24.68 cfs @ 12.01 hrs, Volume= 60,692 cf
Outflow = 24.32 cfs @ 12.02 hrs, Volume= 60,692 cf, Atten= 1%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 16.5 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 6.1 fps, Avg. Travel Time= 0.6 min

Peak Depth= 0.79' @ 12.02 hrs
Capacity at bank full= 163.30 cfs
Inlet Invert= 7,890.00', Outlet Invert= 7,845.00'
36.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 203.0' Slope= 0.2217 '/'

Reach 7R: WS2 Culvert

[52] Hint: Inlet conditions not evaluated

Inflow Area =	276,566 sf,	Inflow Depth = 0.48"	
Inflow =	4.94 cfs @	11.99 hrs, Volume=	10,954 cf
Outflow =	4.91 cfs @	11.99 hrs, Volume=	10,954 cf, Atten= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 13.7 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.9 fps, Avg. Travel Time= 0.4 min

Peak Depth= 0.34' @ 11.99 hrs
Capacity at bank full= 76.90 cfs
Inlet Invert= 7,780.00', Outlet Invert= 7,730.00'
24.0" Diameter Pipe, n= 0.025
Length= 117.0' Slope= 0.4274 '/'

Reach 8R: WS3 Culvert

[52] Hint: Inlet conditions not evaluated

Inflow Area =	205,995 sf,	Inflow Depth = 0.48"		
Inflow =	3.95 cfs @	11.97 hrs, Volume=	8,159 cf	
Outflow =	3.94 cfs @	11.98 hrs, Volume=	8,159 cf,	Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
Max. Velocity= 12.9 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.5 fps, Avg. Travel Time= 0.3 min

Peak Depth= 0.34' @ 11.98 hrs
Capacity at bank full= 34.25 cfs
Inlet Invert= 7,735.00', Outlet Invert= 7,700.00'
18.0" Diameter Pipe, n= 0.025
Length= 89.0' Slope= 0.3933 '/'

Reach 9R: WS4 Culvert

[52] Hint: Inlet conditions not evaluated

Inflow Area =	395,010 sf, Inflow Depth = 0.48"		
Inflow =	7.25 cfs @ 11.98 hrs, Volume=	15,645 cf	
Outflow =	7.22 cfs @ 11.98 hrs, Volume=	15,645 cf,	Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 14.1 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 5.1 fps, Avg. Travel Time= 0.2 min

Peak Depth= 0.44' @ 11.98 hrs
Capacity at bank full= 68.97 cfs
Inlet Invert= 7,712.00', Outlet Invert= 7,690.00'
24.0" Diameter Pipe, n= 0.025
Length= 64.0' Slope= 0.3438 '/'

Reach 10R: WS5 Culvert

[52] Hint: Inlet conditions not evaluated

Inflow Area =	74,016 sf,	Inflow Depth = 0.68"	
Inflow =	2.25 cfs @	11.94 hrs, Volume=	4,206 cf
Outflow =	2.22 cfs @	11.94 hrs, Volume=	4,206 cf, Atten= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 9.8 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.2 fps, Avg. Travel Time= 0.4 min

Peak Depth= 0.28' @ 11.94 hrs
Capacity at bank full= 29.29 cfs
Inlet Invert= 8,020.00', Outlet Invert= 7,997.00'
18.0" Diameter Pipe, n= 0.025
Length= 80.0' Slope= 0.2875 '/'

Hydraulic Charts for the Selection of Highway Culverts

Hydraulic Engineering Circular No. 5 December 1965*

Prepared by the Hydraulics Branch, Bridge Division, Office of Engineering, Federal Highway Administration, Washington, D.C. 20590

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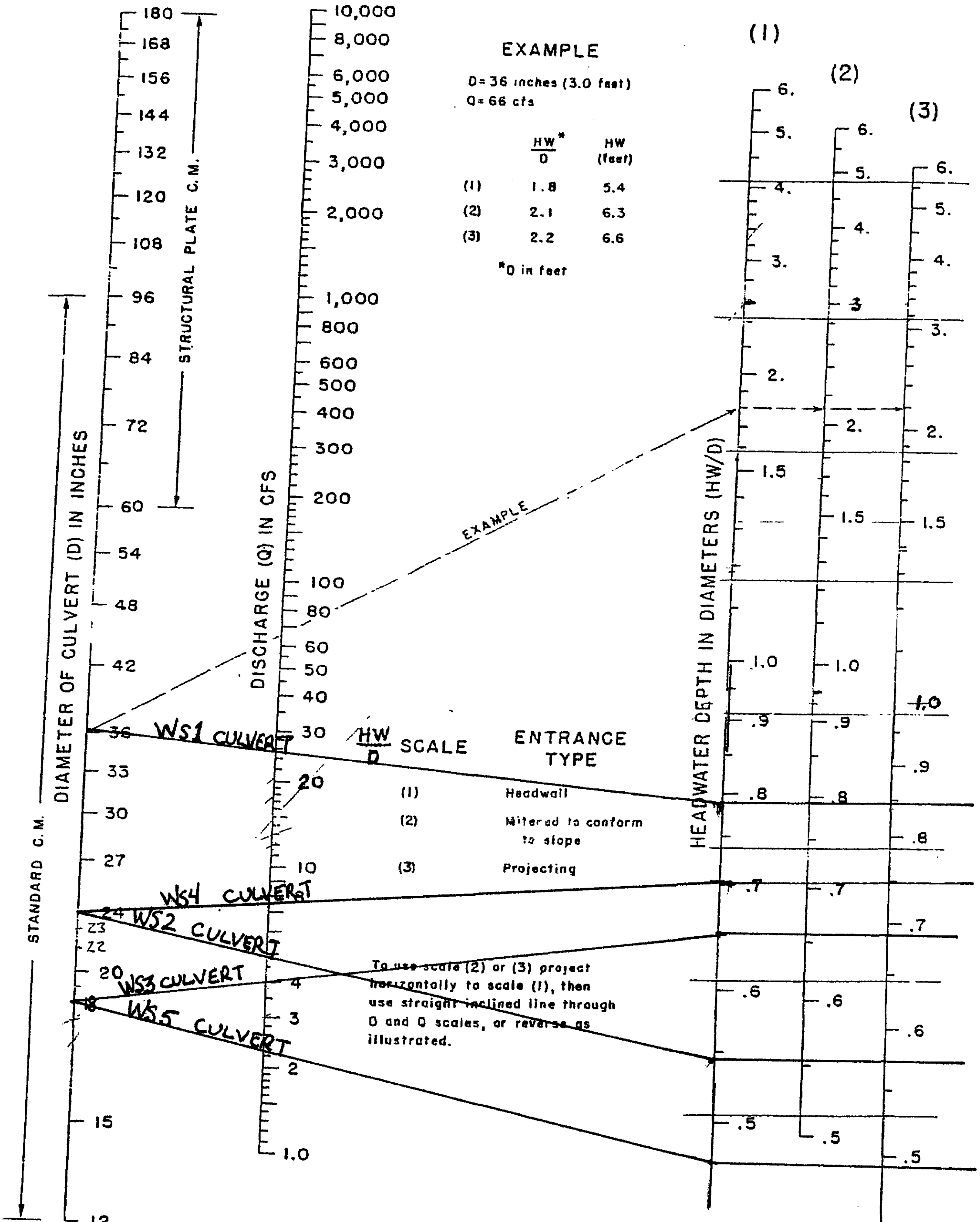
CHART 5



HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

Ref (U.S. Dept. of Transportation, 1977)

Reclamation – AMV Road

The road will be reclaimed following the reclamation of drill pads for the G-18 and G-31 degas wells. The reclamation schedule is shown on Figure 5-26 of this amendment.

The AMV road will be retuned to approximate original contour during reclamation, drainages will be restored following the removal of culverts and any associated structures. The reclaimed segments of the drainages will be tied into the existing segments of the drainage. The restored drainages will be rip raped with native rock, which has been stockpiled during the initial construction of the road, when possible. If additional rock is required it will be secured to complete the restoration of the drainages. The size of the rip rap used for the operational culvert outlets will be the size used during reclamation to restore the natural drainages. When necessary, the filter blanket material will also mimic the material used during the operational phase of the road. Refer to Attachment 7-1 for rip rap and filter blanket information. The reclaimed drainages will be seeded with the approved seed mix.

The return to approximate original contour of the road slopes may require them to be concave, the plan is that they will not need to be concave, but if required they will be concave. The restored road slopes will be seeded using the methods discussed in Section 341.200 and meeting the performance standards in Section 350.

The road surface will be ripped a minimum of 12 inches prior to the placement of subsoil and topsoil. If it becomes necessary to add gravel to the road surface during the operational phase, it will be left in place and ripped to relieve compaction. Subsoil fill material and topsoil will be placed on top of the ripped surface.

Following reclamation of the road slopes, settling/rills are not anticipated, but should they occur the small areas would be reworked with hand tools, if settling/rills occur in a large area it may become necessary to regard the area.

At the time of reclamation, a determination will be made between the permittee and the Division as to the "best current technology" for the placement or use of silt fence/strawbales for sediment control along the path of the reclaimed road.

ATTACHMENTS 2-4 AND 5-4

The grade of the AMV Road is defined below:

<u>Segment from bottom to well pad G-31</u>
Station 0+00 to 15+00 is 12%
Station 15+00 to 30+00 is 10%
Station 30+00 to 45+00 is 8%
Station 45+00 to 53.25+00 is 6%

<u>Segment from well pad G-31 to well pad G-8</u>
Station 0+00 to 10+00 is 9%
Station 10+00 to 19+00 is 11%

CHAPTER 7

HYDROLOGY

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LIST OF ATTACHMENTS

710 INTRODUCTION

711 General Requirements

This chapter presents a description of the following:

- Proposed operations and the potential impacts to the hydrologic balance;
- Methods of compliance with design criteria and the calculations utilized to show compliance; and
- Applicable hydrologic performance standards.

712 Certification

All maps, plans, and cross sections presented in this chapter have been certified by a qualified, registered professional engineer.

713 Inspection

Inspections are not required since no permanent impoundments will exist at the well sites.

720 ENVIRONMENTAL DESCRIPTION

721 General Requirements

The application will include a description of the existing premining hydrologic resources with the proposed permit and adjacent areas that may be affected or impacted by the proposed coal mining and reclamation operations.

722 Cross Sections and Maps

722.100 Location and Extent of Subsurface Water

Figure 7-1 in the approved M&RP shows a generalized hydrostratigraphic cross section of the permit and adjacent areas including the well sites. Section 724.100 of the approved M&RP provides baseline groundwater conditions.

722.200 Location of Surface Water Bodies

Plate 7-2 in the approved M&RP shows the locations of surface-water bodies and existing or pending water rights. Section 724.200 of the approved M&RP provides baseline surface water conditions.

722.300 Locations of Monitoring Stations

Plate 7-1 in the approved M&RP shows the location of surface water and groundwater monitoring stations.

722.400 Locations and Depth of Water Wells

Refer to Section 722.400 and Plate 7-1 of the approved M&RP for information pertaining to the groundwater monitoring wells. Refer to Appendix 7-9 of approved M&RP for details pertaining to the Gilson well.

722.500 Surface Topography

Surface topography features at the well sites and adjacent areas are shown on Figures 1-1, 5-1, 5-5, 5-9, 5-17, 5-20, 5-23, 5-27 and in Attachment 5-1 for Degas Wells G-8 thru G-19 and G-31. Refer to Plate1-4 in the M&RP for well locations.

The surface topography for the AMV access road is shown on Plate 1 included in Attachment 5-4.

723 Sampling and Analysis

Refer to Section 723 of the approved M&RP.

724 Baseline Information

Refer to Section 724 of the approved M&RP.

724.100 Groundwater Information

Refer to Section 724.100 of the approved M&RP.

724.200 Surface Water Information

Refer to Section 724.200 of the approved M&RP.

724.300 Geologic Information

Geologic information related to the well sites and adjacent areas in presented in Chapter 6 of this submittal and in the approved M&RP.

724.400 Climatological Information

Climatological data are summarized in Appendix 4-1 behind the Air Quality Permit of the approved M&RP and RA Attachment 7-5 of the Refuse Pile Amendment.

724.500 Supplemental Information

Refer to Section 724.500 of the approved M&RP.

724.600 Survey of Renewable Resource Lands

Refer to Section 724.600 of the approved M&RP.

724.700 Alluvial Valley Floor Requirements

Information regarding the presence or absence of alluvial valley floors in the well sites and adjacent areas is presented in Chapter 9 of this submittal and the approved M&RP.

725 Baseline Cumulative Impact Area Information

The CHIA currently in place for the Dugout Canyon Mine covers the well sites. The hydrologic and geologic information required for the Division to develop a Cumulative Hydrologic Impact Assessment (CHIA) is presented in the approved M&RP.

726 Modeling

No groundwater or surface water modeling was conducted in support of this submittal.

727 Alternative Water Source Information

Not applicable.

728 Probable Hydrologic Consequences

This section addresses the probable hydrologic consequences of construction and reclamation operations at the well sites. Mitigation measures are discussed generally in this section and in detail in Section 730 of the approved M&RP.

728.100 Potential Impacts of Surface and Groundwater

Potential impacts of the well sites in this area on the quality and quantity of surface and groundwater flow may include contamination from materials associated with the drilling of the wells. Once installed, the wells are designed as an ambient vent of methane gas, having no affect on the surface or groundwater. The potential impact is addressed in Section 728.300 of this submittal and the approved M&RP.

728.200 Baseline Hydrologic and Geologic Information

Baseline geologic information is presented in Chapter 6 of the approved M&RP. Baseline hydrologic information is presented in Section 724.100 and 724.200 of the approved M&RP.

728.300 PHC Determination

Potential Impacts to the Hydrologic Balance - Potential impacts of the Dugout Canyon Mine on the hydrologic balance of the well sites and adjacent areas are addressed in the subsections of this submittal and the approved M&RP. The PHC prepared by Mayo and Associates for the Dugout Canyon Mine is located in Appendix 7-3, Section 3 , of the approved M&RP. Refer to Chapter 3, Section 322.200 for information addressing water usage for degas well drilling, as well as mining. Little to no impacts to the Hydrologic Balance are anticipated since 1) the potential impacts are limited to the drilling and construction of the wells; 2) BTCA techniques for sediment control are implemented for the surface disturbance of the well pad; 3) hydrogeologic information from in-mine observations, Degas wells G-1 thorugh G-9, and PHC information included in the approved M&RP support that minimal groundwater is encountered in the geologic formations being drilled; and 4) any water encountered during drilling and construction of the well will need to be sealed for the well to function as an ambient vent of methane gas.

Acid and Toxic Forming Materials - No acid or toxic forming materials have been identified in the soils or strata of the Dugout Canyon Mine (Chapter 6, Section 623 of this submittal). Additional information is located in Appendix 6-2 of the approved M&RP.

Groundwater - When encountered during drilling groundwater aquifers will be sealed using drilling mud. At completion, the casing will be grouted and cement placed inside the well casing during reclamation. .

Once drilling is completed, the casing is grouted in the well hole, sealing aquifers to prevent groundwater migration, including groundwater migrating down the outside of the casing into the mine. Should water inflow greater than 15 gallon per minute be encountered during the drilling of the degas wells the depth and volume will be recorded and included in Attachment 7-1. No measurable inflows of water have been encountered during the drilling of degas wells G-1 thru G-9.

The development and construction of degas wells does not have the potential to decrease creek flow or spring discharges, the wells are not designed to capture water, dewater aquifers or cause subsidence. Methane gas, not liquid (water) is pumped from the wells following construction.

Surface Water - Degas wells are not used to access water to be discharged to the surface. As mentioned above, no measureable water has been encountered during the drilling, construction and operation of degas wells G-1 thru G-9. Also, the well cannot function as a degas well if significant water is encountered, and will need to be abandoned.

Potential Hydrocarbon Contamination - Hydrocarbon products will not be stored at the well sites, however fuels, greases, and other oils may leak from equipment during drilling operations. Absorbent materials will be used for the collection of leaked fuels, greases, and other oils. The saturated absorbent materials will be disposed of at an appropriate landfill facility.

<u>G-18, G-31 and AMV Access Road</u>

728.300 The PHC Determination:

728.310 - The construction and operation of the G-18, G-31 well pads and associated access road is not anticipated to cause adverse impacts to the hydrologic balance. Several springs are located in the drainage in which the road begins. One small seep, SC-96, has been recorded a short distance down hill of a portion of the road near the center of Section 20, T13S R13E. However, this seep has not been observed flowing the past several year, which could be due to the dry climatic conditions the area has experienced. It should be understood that SC-96 is not a seep monitored on a quarter basis. It is unlikely the construction and operation of the road will impact the aquifer that has discharged at the seep since road construction will not require significant excavation or over the aquifer outcrop. Sediment control structures will be used to reduce the amount of suspended material that will leave that portion of the disturbed area of the road during runoff events that is directed to the small drainage where the seep is located. The remaining seeps and springs are located upstream of the road and near the canyon head. These groundwater discharge locations should not be impacted by road construction and operation since the aquifers feeding these discharges will either not be encountered during construction or minimal disturbance at the outcrops of the up-dip end of the aquifer will occur.

Sediment control structures will be used to reduce the likelihood of erosion and increased sediment loads greater than background to the ephemeral and intermittent drainage areas. Sediment controls have been designed to adequately address treatment of runoff from the steep hillsides and grades associated with the access road. The locations, designs, and descriptions of the sediment control structures to be implemented during road and pad construction, operation, and reclamation are contained in Attachments 5-4 and 7-1.

Examples of construction and operational sediment and erosion control on the road include building appropriately sized water bars or the canting of the road surface toward the uphill side of the road to divert runoff into the roadside ditch. When necessary the water bar outlets will be rip rapped with native rock. Native rock will be collected during the construction of the road to be used as rip rap. Culverts will be located at appropriate sites (Attachment 5-4, Plate 1) to direct flow from the ditch to drainages that would normally contain the area runoff. Where required appropriately sized rip-rap will be placed at the outlet of the culverts used to divert water into the existing ephemeral drainages.

According to calculations, culvert inlet velocities should be less then 5 fps, therefore no inlet protection is required. Silt fences will also be placed on the upstream end of the approach to the culverts to treat road runoff during construction. Silt fences will be placed at the toe of fill slopes during construction to reduce the amount of loose soil material and sediment laden runoff from entering the drainage. Outslopes and ditches associated with the road will be seeded during operations to encourage the establishment of vegetation and erosion control.

Erosion, runoff and sediment control at pads G-18 and G-31during construction, operation, and reclamation may include, but not necessarily be limited to, construction of berms around the disturbed areas and the use of silt fence to treat runoff.

Reclamation of the road and well pads is described in Sections 340 and 760. As part of the reclamation activities the reclaimed and resoiled surfaces will be deep gouged to reduce the length of surface flow paths and trap runoff. The reclamation plan described in these sections have been designed to minimize erosion and runoff by encouraging timely revegetation of the disturbed areas. Where necessary, silt fencing will be used during reclamation activities to contain loose soils and reduce sediment laden runoff.

728.320 - Soil samples have been obtained from selected sites in the road and pad areas. Results of the soil analyses indicate the samples did not contain acid-forming or toxic-forming materials. Thus, the soils moved or exposed as a result of the construction of the road and pad will not result in the contamination of the surface or ground-water supplies. Refer to Section 231 and Attachment 2-1.

728.330 - The sediment control structures to be constructed as part of the access road and G-18 and G -31 well pads project should minimize the sediment yield from disturbed areas during runoff events. As described in Section 527 and above in Section 728.310, silt fencing will be used at the downhill toe of the slope of the road fill during road construction to capture loose soils and rock. This will prevent loose material from entering the channels.

As described in the preceding sections, acid forming materials will not be exposed or created as part of the construction, operation, or reclamation of the road and pad areas. Total suspended solids will be controlled through the use of sediment control structures. Dissolved solids within the runoff from the disturbed areas is not likely to noticeably increase above background levels since the disturbance is generally occurring within weathered soils and bedrock surfaces. Much of the soluble material will have naturally leached from the shallow soils prior to the proposed disturbance. The soil samples obtained and analyzed are located in Attachment 2-1 and referenced in Section 728.320 above do not contain significant volumes of highly soluble minerals. Therefore, it is unlikely exposing these soils to increased moisture will result in increased total dissolved solids in the surface water relative to known background levels. No significant volumes of highly soluble materials are proposed to be imported as part of the construction, operation, and reclamation of the road and pad.

No impoundments or restriction of stream flows are anticipated as part of the road and pad project, making it unlikely that unnatural flooding will occur as a result of this project. No additional or new perennial or intermittent stream channel alterations are anticipated as part of this project. Culverts are to be placed in ephemeral channels at road crossings. The culverts are adequately sized such that flooding due to the placement of the culverts should not occur. Only minimal alteration to the ephemeral channels will occur during the placement of the culverts.

No groundwater is anticipated to be encountered during construction of the road or pads, therefore no change in groundwater availability is anticipated. Minimal amounts of surface water will be used for dust suppression during construction and operation of the road and pads.

728.340 - The sediment controls installed during construction, operation, and reclamation of the road and pad will not proximately result in contamination, diminution or interruption of an underground or surface source of water within the proposed permit or adjacent areas which is used for domestic, agricultural, industrial or other legitimate purpose.

728.350 - Five ephemeral drainages will be diverted by culverts placed at various locations along the length of the AMV access road. Because of the installation of the sediment controls and since no ground water and only surface water as described previously will be diverted as a result of this project, the road and pad construction will result in imperceptible contamination, diminution or interruption of State-appropriated water in existence within the proposed permit or adjacent areas at the time the application is submitted.

729 Cumulative Hydrologic Impact Assessment (CHIA)

The Cumulative Hydrologic Impact Assessment currently in place for the Dugout Canyon Mine includes the well sites and adjacent areas.

730 OPERATION PLAN

731 General Requirements

731.100 Hydrologic - Balance Protection

Groundwater Protection - The effect on groundwater at the well sites is expected to be minimal. Groundwater encountered during drilling will be sealed off, refer to Section 728.300.

Surface Water Protection - To protect the hydrologic balance, construction, maintenance, and reclamation operations will be conducted to handle earth materials and runoff in a manner that prevents, to the extent possible, additional contributions of suspended solids to stream flow outside the permit area, and otherwise prevent water pollution.

During initial drilling, the sites will be graded to ensure that storm runoff will flow towards the berms surrounding the drilling pad area. The berms will direct the runoff to the lowest point(s) within the pad area where a silt fence and/or straw bale dike(s) will treat the runoff (see Figures 5-1, 5-5, 5-9, 5-17, 5-20, 5-23, 5-27 and Attachment 5-1). The berm placed at the top of the drilling pad cut slopes will divert runoff around the drilling pad. Thus reducing the runoff affected by the drilling pad. The pad will be re-graded to cause the storm runoff to sheet flow towards a silt fence and/or straw bale dike. A berm will be placed at the top of the fill slope to direct any runoff from the operational pad to the silt fence and/or straw bale dike(see Figures 5-4, 5-8, 5-12, 5-19, 5-22, 5-25, 5-29 and Attachment 5-1). The silt fences and/or straw bale dikes will be periodically inspected, and accumulated sediment will be removed as needed to maintain functionality. The sediment from the silt fence and/or straw bale dikes will be piled on the pad and will be used for fill during final reclamation of the well site. During the drilling phase a berm and silt fence will be installed at the toe of the fill slope as shown on Figures 5-1, 5-5, 5-9, 5-17, 5-20, 5-23, 5-27 and Attachment 5-1 to treat any runoff from the drilling pad.

731.200 Water Monitoring

No water monitoring will be conducted at the degas well sites. Refer to approved M&RP for a description of water monitoring.

731.300 Acid or Toxic Forming Materials

No acid or toxic forming materials are anticipated at the well sites (see Section 728.300).

731.400 Transfer of Wells

Refer to Section 731.400 of the approved M&RP.

731.500 Discharge

No discharges to underground workings.

731.600 Stream Buffer Zones

Stream Channel Diversions - No stream channel diversions are planned at the well sites, unless specified in the runoff controls specific to each well site. Streams in five ephemeral drainages will be diverted with the installation of culverts at various locations along the AMV road.

Buffer Zone Designation - When drilling sites are adjacent to a perennial or an intermittent stream, a stream buffer zone will be established. Well sites G-11, G-12, G-15 and G-19 require buffer zone designation. Refer to Chapter 5, Attachment 5-1 for drawings of well sites G-8 through G-17 and G-19. A buffer zone designation will be required on approximately the first 1100 feet of the AMV road, signs will be placed along the road at intervals so that the previous sign is visible at the location of the current sign.

731.700 Cross Section and Maps

Not applicable.

731.800 Water Rights and Replacement

Refer to Sections 728.300 and 731.800 of the approved M&RP.

732 Sediment Control Measures

The sediment control measures within the well sites have been designed to prevent additional contributions of sediment to stream flow or to runoff outside the well sites. In addition, the well sites have been designed to minimize erosion to the extent possible.

The structures to be used for runoff control at the well sites are berms, silt fences and/or straw bale dikes.

732.100 Siltation Structures

Berms, silt fences and straw bales dikes will be used to treat runoff.

732.200 Sedimentation Pond

The drilling sites will not have sedimentation ponds.

732.300 Diversions

Refer to Section 731.100 of this submittal.

732.400 Road Drainage

No diversion ditches will be constructed along the primary roads leading to the well sites. See Figures 5-13 and 5-14 for typical road cross sections. Where needed roads accessing the drill sites will have a water bar constructed at the base of the road to divert water off the road prior to the runoff reaching the drilling pad.

The incised road to well site G-16 will be constructed as shown on Figure 5-14 in the approved permit, water bars will be used to direct flow off the road and either silt fences or strawbales will be used to treat runoff . Refer to Chapter 5, Attachment 5-1 for drawings of well site G-16 showing the location of a single water bar, additional water bar(s) will be constructed as required to direct water from the road. Refer to Section 527.200 for road construction information.

Subsoil being cut in order to construction the pad for well G-15 will be placed on the existing road, causing it to be elevated, no new access road will be constructed to well site G-15.

The AMV access road will be classified as an ancillary road per a discussion with Wayne Western during a meeting at the UDOGM offices on April 16, 2007. The road is improving a trail used for hunting, cattle and for logging. Drawings showing the alignment and cross-sections of the road can be found in Attachment 5-4, as Plate 1 thru 3. A typical road cross section is found in Attachment 5-4 as Figure 1. The drawing outlines the disturbed area and shows the road center line, water bars, culverts, turnouts and topsoil stockpile locations.

The steepness of access road cut slopes will depend on the stability of the exposed subsurface material. Cuts into competent material such as bedrock will be sloped at angles of approximately 0.5H:1V (63.4 degrees). Cut into unconsolidated material such as soils will be sloped at angles of approximately 1H:1V (45 degrees). The steepness of these slopes is justified by the presence of several near-vertical bedrock outcrops and naturally steep (approximately 1H:1V) colluvial slopes in the vicinity of the proposed access road.

733 Impoundments

733.100 General Plans

Not applicable.

733.200 Permanent and Temporary Impoundments

No permanent impoundments will exist at the well sites.

734 Discharge Structures

A berm will surround the entire drill pad at each well site during the drilling phase (excepted as noted). The berm will divert undisturbed runoff around the drilling pad and direct runoff from the pad to a silt fence/straw bale dike at the lowest point within the well pad disturbed area. A silt fence and/or straw bale dike will be the discharge structure for each of the well sites during the operational phase.

735 Disposal of Excess Spoil

There will be no excess spoil generated at the well sites.

736 Coal Mine Waste

There will be no coal mine waste generated or stored at the well sites.

737 Non-Coal Mine Waste

There will be no non-coal mine waste disposed at the well sites.

738 Temporary Casing and Sealing of Wells

Refer to Section 542.700 of this submittal.

740 DESIGN CRITERIA AND PLANS

741 General Requirements

This submittal includes general well site plans that incorporate design criteria for the control of drainage.

742 Sediment Control Measures

742.100 General Requirements

Design - Sediment control measures have been formulated to prevent additional contributions of sediment to stream flow or to runoff outside the well site area; and minimize erosion to the extent possible.

Measures and Methods - Sediment control methods will include silt fences, berms, and straw bales to reduce runoff and trap sediment.

742.200 Siltation Structures

General Requirements - Additional contributions of suspended solids and sediment or runoff outside the well site area, including access roads will be prevented to the extent possible using silt fences, berms, and straw bale dikes. Construction activities will not occur during major precipitation events. As required, siltation structures will be installed prior to beginning site construction.

Design - All hydrology calculations were made using the 10-year, 24-hour precipitation event. Hydrology calculations are in Attachment 7-1. Locations of the berms and silt fences are shown on Figures 5-1, 5-4, 5-5, 5-8, 5-9, 5-12, 5-17, 5-20, 5-23, 5-27 and Attachment 5-1.

742.300 Diversions

No diversion ditches will be constructed as part of the drilling or operational phases, with the exception of the AMV road.

742.400 Road Drainage

Refer to Section 732.400 of this submittal. The road design for G-16 is shown on drawings located in Chapter 5, Attachment 5-1 and Figure 5-16. The road design for the AMV access raod is hsown in Attachment 5-4.

743 Impoundments

No impoundments will exist at the well sites.

744 Discharge Structures

No discharge structures have been planned or designed.

745 Disposal of Excess Spoil

There will be no excess spoil generated at the well sites.

746 Coal Mine Waste

746.100 General Requirements

There will be no coal mine waste used at the well sites.

746.200 Refuse Piles

There will be no refuse piles at the well sites.

746.300 Impounding Structures

Refer to Section 733.200 of this submittal.

746.400 Return of Coal Processing Waste to Abandoned Underground Workings

No coal processing waste will be generated at the well sites.

747 Disposal of Non-Coal Mine Waste

All non-coal mine waste will be dispose of at an approved landfill.

748 Casing and Sealing Wells

Refer to Section 542.700 of this submittal.

750 PERFORMANCE STANDARDS

751 Water Quality Standards and Effluent Limitations

Water encountered during drilling and runoff water will be treated using silt fence and/or straw bale dikes prior to leaving the site. Should it become necessary the water encountered during drilling will be pumped into a tank and hauled from the site for disposal at a licensed facility.

752 Sediment Control Measures

All sediment control measures will be located, maintained, constructed and reclaimed according to plans and designs presented in Section 732, 742, and 760 of this submittal.

752.100 Siltation Structures and Diversions

Siltation structures will be located, maintained, constructed and reclaimed according to plans and designs presented in Section 732, 742, and 763 of the submittal.

752.200 Road Drainage

Refer to Section 732.400 of this submittal.

753 Impoundments and Discharge Structures

Refer to Section 733.200 of this submittal.

754 Disposal of Excess Spoil, Coal Mine Waste and Non-Coal Mine Waste

There will be no excess spoil or coal mine waste generated at the well sites. Refer to Section 747 of this submittal regarding non-coal waste disposal.

755 Casing and Sealing

Refer to Section 542.700 of this submittal.

760 RECLAMATION

761 General Requirements

A detailed reclamation plan for the well sites is presented in Section 540. No structures will exist at the well sites.

762 Roads

Refer to Section 542.600.

762.100 Restoring the Natural Drainage Patterns

The natural drainage patterns will be restored after degassification is completed.

762.200 Reshaping Cut and Fill Slopes

Cut and fill slopes will be reshaped at the well sites.

763 Siltation Structures

763.100 Maintenance of Siltation Structures

All siltation structures will be maintained until removed in accordance with the approved reclamation plan.

763.200 Removal of Siltation Structures

When a siltation structure is removed, the land on which the siltation structure was located will be regraded and revegetated in accordance with the reclamation plan presented in Section 540.

764 Structure Removal

A timetable for the reclamation of the sites is presented in Figures 5-15 (G-2 and G-5) and 5-26 (G-3, G-4, G-6 thru G-19, G-31 and AMV access road).

765 Permanent Casing and Sealing of Wells

Refer to Section 542.700 of this submittal.

ATTACHMENT 7-1

HYDROLOGY CALCULATIONS

add to the back of existing information

The components and design considerations for controlling the drainage during construction, operational.

Construction - Refer to text in Chapter 7, Attachment 5-4, Attachment 7-1		
Component	Section(s)	Drawing
Silt Fence	728.300, 731.100, 732, 732.400, 734, 742.100, 742.200, 751	Attachment 7-1
Berms	728.300, 731, 732, 742	Attachments 5-4 & 7-1
Culverts	728, 732.400	Attachments 5-4 & 7-1
Operation - Refer to text in Chapter 7, Attachment 5-4, Attachment 5-4 (Plates 1 thru 3), Attachment 7-1		
Component	Section	Drawing
Silt Fence	731.100, 732, 732.400, 734,	Attachment 7-1
Berms	731, 732	Attachments 5-4 & 7-1
Culverts	732.400	Attachments 5-4 & 7-1

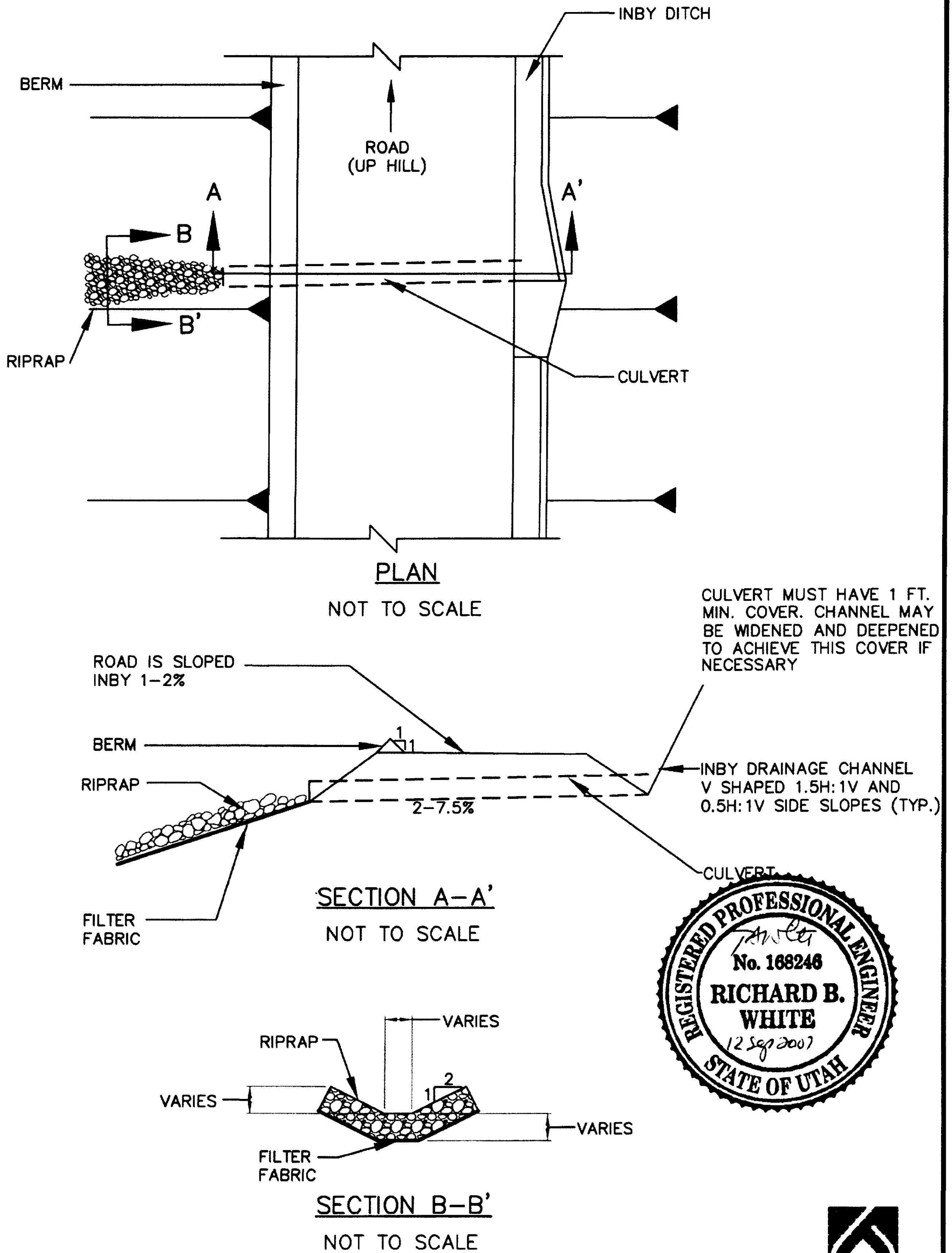
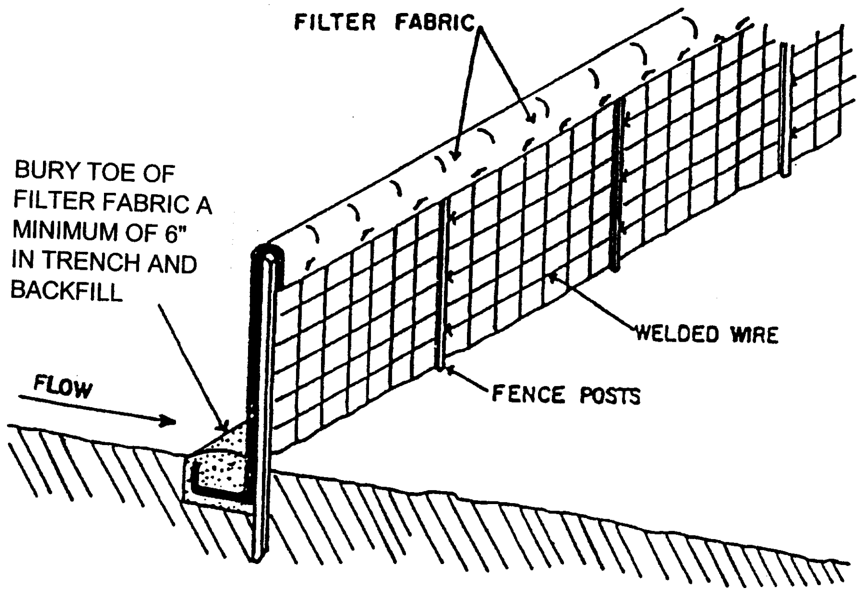


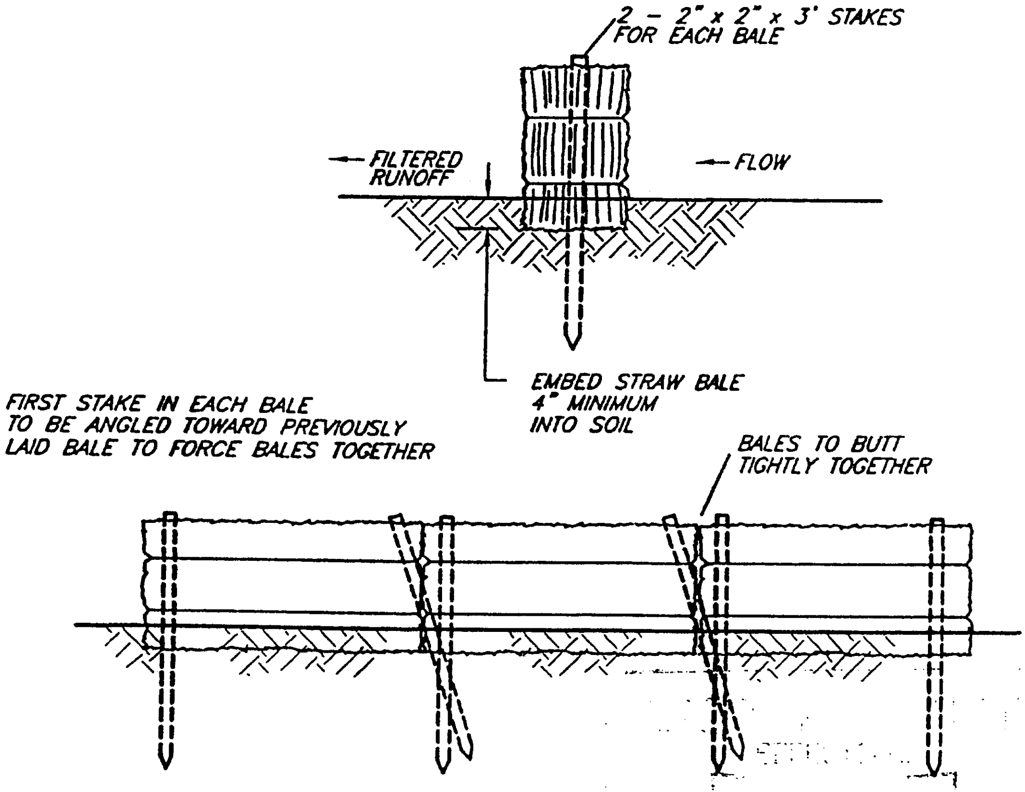
FIGURE 1. ROAD RUNOFF CULVERT PLAN

EarthFax

ATTACHMENT 7-1



SILT FENCE



STRAW-BALE DIKE

OCT 19 1998

SOURCE: Barfield, et al. (1981)
McCULLAH (1994)

SILT FENCE AND STRAW-BALE DIKE SCHEMATICS

ATTACHMENT 7-1
HYDROLOGY CALCULATIONS - AMV Road

REGISTERED PROFESSIONAL ENGINEER
No. 168246
RICHARD B.
WHITE
24 Aug 2007
STATE OF UTAH

Stockpile Runoff Volume Calculations

Stockpile	Watershed Area (sq. ft.)	Watershed Area (acres)	Precip. - ***P*** (in)	Curve Number (*CN*)	Potential Max. Retention - ***S*** (in.)	Runoff - ***Q*** (in)	Runoff Volume - ***V*** (ft^3)
STP-1	3,282	0.08	2.05	87	1.49	0.94	258
STP-2	3,312	0.08	2.05	87	1.49	0.94	261
STP-3	15,690	0.36	2.05	87	1.49	0.94	1,235
STP-4	14,734	0.34	2.05	87	1.49	0.94	1,160
STP-5	7,895	0.18	2.05	87	1.49	0.94	622
STP-6	8,417	0.19	2.05	87	1.49	0.94	663
STP-7	9,982	0.23	2.05	87	1.49	0.94	786

Notes

Calculations have been performed for the 10-year, 24-hour design storm event.

Topsoil is derived from the Midfork Family - Comodore Complex, as described in the NRCS Soil Survey for Carbon Area, Parts of Carbon and Emery Counties.

Calculations based on Soil Conservation Service (SCS) Method, National Engineering Handbook Section 4, Chapters 9 & 10 by Victor Mockus, 1972

Precipitation for 10-year, 24-hour event taken from National Weather Service web site (http://hdsc.nws.noaa.gov/hdsc/pfds/sa/ut_pfds.html)

CN = 87, based on Table 9.1, NEH s4 ch9. Assume Hyd. Soil Gp. C (as given for Rottulee family - Trag complex in NRCS survey). Assume road, dirt surface (non-vegetated, conservative case).

$S = (1000/CN) - 10$

$L = [(l^{0.8} (S+1)^{0.7}]/(1900Y^{0.5})$

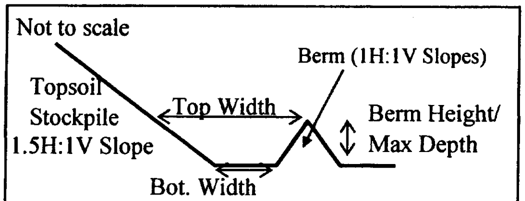
$T_c = 1.67L$

$Q = (P - 0.2*S)^2 / (P + 0.8*S)$

$V = Area * Q$

Stockpile Runoff Containment Volume Calculations

Stockpile	Bottom Width (ft)	Top Width (ft)	Max Depth (ft)	Impounding Length of Berm (ft)	Total Length of Berm (ft)	Fill Req'd for Berm (yd^3)	Cntnmt Vol. (ft^3)	Contain Vol > Runoff Vol ?
STP-1	2	4.5	1	78	268	10	254	Yes
STP-2	2	4.5	1	89	257	10	289	Yes
STP-3	2	7	2	250	510	76	2,250	Yes
STP-4	2	7	2	227	509	75	2,043	Yes
STP-5	2	7	2	76	402	60	684	Yes
STP-6	2	4.5	1	262	513	19	852	Yes
STP-7	2	7	2	183	404	60	1,647	Yes
						309	Total fill for berms (yd^3)	



X-sec. schematic of topsoil stockpile and berm

Notes

The bottom width is the distance between the toe of the topsoil stockpile and the base of the berm. (see schematic)

The top width is the horizontal distance between the crest of the berm and the topsoil stockpile. (see schematic)

The max depth is the height of the berm.

The Impounding Length of the berm accounts for the slope of the ground, and is the portion of the berm that will impound runoff.

The Total Length of Berm is its entire length around the topsoil stockpile.

The Fill Required for Berm is the volume of subsoil required to construct each berm, and is based on the length, height, and width of each berm. Berms shall be constructed with 1H:1V slopes.

The Containment Volume = Length * Cross sectional area of the space between the topsoil stockpile and the inby side of the berm.

Watershed Hydrology - Culvert Design

Watershed	Watershed Area (sq. ft.)	Watershed Area (acres)	Precip. ***P*** (in)	Hydraulic Length - ***I*** (ft)	Avg Watershed Slope - ***Y*** (%)	Duration of Storm (hr)	Curve Number (*CN*)	Potential Max. Retention ***S*** (in.)	Lag - ***L*** (hr)	Time of Concentration - ***Tc*** (hr)	Runoff - ***Q*** (in)	Runoff Volume - ***V*** (ft^3)	Peak Discharge (cfs)
EDWS1	1,532,383	35.2	2.05	2,262	60.5	24	77	2.99	0.09	0.14	0.48	60,692	24.68
EDWS2	276,566	6.3	2.05	1,502	60.1	24	77	2.99	0.06	0.10	0.48	10,954	4.94
EDWS3	205,995	4.7	2.05	1,151	57.7	24	77	2.99	0.05	0.09	0.48	8,159	3.79
EDWS4	395,010	9.1	2.05	1,100	49.8	24	77	2.99	0.05	0.09	0.48	15,645	7.25
EDWS5	74,016	1.7	2.05	589	45.7	24	82	2.20	0.03	0.05	0.68	4,206	2.25
RRWS-1	438,378	10.1	1.38	1,930	42.4	6	77	2.99	0.09	0.15	0.16	5,935	2.83
RRWS-2	237,126	5.4	1.38	1,695	61.7	6	77	2.99	0.07	0.11	0.16	3,211	1.84
RRWS-3	282,656	6.5	1.38	985	60.2	6	77	2.99	0.04	0.07	0.16	3,827	2.97

Notes

Calculations have been performed for the 10-year, 24-hour storm event for ephemeral drainage channel culverts and the 10-year, 6-hour design storm event road runoff culverts.

Refer to attached Figures 1 and 2 for locations of watersheds and NRCS soils units

Calculations based on Soil Conservation Service (SCS) Method, National Engineering Handbook Section 4, Chapters 9 & 10 by Victor Mockus, 1972

CN determined based on NRCS soils map, which shows that each watershed (except WS5) contains soils of which half are in Hydrologic Soils Group B and half are in Group C. According to the UDOT Manual of Instruction, Table 7-14, woods-grass combination, poor condition has a CN of 73 for Group B and 82 for Group C. The weighted average CN is thus approximately 77. EDWS5 is comprised entirely of soils in Group C.

$S = (1000/CN) - 10$

$L = [(I^{0.8} (S+1)^{0.7}]/(1900Y^{0.5})$

$T_c = 1.67L$

$Q = (P - 0.2*S)^2 / (P + 0.8*S)$

$V = Area * Q$

Peak discharge calculated using HydroCad 8.00 software (see attached sheets for output).

Average Watershed Slope Calculation (Sum of lengths of contour lines X contour interval / Area)

EDWS1

Contour (ft)	Length (ft)
7,900	825
8,000	1,021
8,100	1,353
8,200	1,483
8,300	1,481
8,400	1,327
8,500	843
8,600	546
8,700	256
8,800	131
TOTAL	**9,266**
AvgSlope	**60.5%**

EDWS2

Contour (ft)	Length (ft)
7,800	142
7,900	298
8,000	251
8,100	328
8,200	245
8,300	398
TOTAL	**1,662**
AvgSlope	**60.1%**

EDWS3

Contour (ft)	Length (ft)
7,800	246
7,900	231
8,000	294
8,100	202
8,200	156
8,300	60
TOTAL	**1,189**
AvgSlope	**57.7%**

EDWS4

Contour (ft)	Length (ft)
7,800	284
7,900	380
8,000	624
8,100	451
8,200	170
8,300	60
TOTAL	**1,969**
AvgSlope	**49.8%**

EDWS5

Contour (ft)	Length (ft)
8,100	282
8,200	56
TOTAL	**338**
AvgSlope	**45.7%**

RRWS1

Contour (ft)	Length (ft)
8,225	450
8,275	887
8,325	1,305
8,375	974
8,425	103
TOTAL	**3,719**
AvgSlope	**42.4%**

RRWS2

Contour (ft)	Length (ft)
8,075	60
8,125	485
8,175	1,242
8,225	802
8,275	337
TOTAL	**2,926**
AvgSlope	**61.7%**

RRWS3

Contour (ft)	Length (ft)
8,000	333
8,050	635
8,100	606
8,150	600
8,200	511
8,250	421
8,300	295
TOTAL	**3,401**
AvgSlope	**60.2%**

Culvert Sizing

Ephemeral Drainage Culvert No.	Minimum Diameter (in)	Length (ft)	Inlet Elevation (ft)	Outlet Elevation (ft)	Average Slope (ft/ft)	Peak Discharge (cfs)	Peak Stage in Road Ditch (ft)	Peak Velocity in Road Ditch (fps)	Culvert Peak Inlet Depth (ft)	Culvert Peak Inside Depth (ft)	Peak Flow Velocity from Culvert (fps)
EDC-1	36	203	7,890	7,845	0.22	24.3	0.54	4.72	2.46	0.78	16.60
EDC-2	24	117	7,735	7,730	0.04	6.62	0.45	4.29	1.38	0.40	14.97
EDC-3	18	89	7,735	7,700	0.39	4.30	0.41	3.98	1.23	0.36	13.25
EDC-4	18	64	7,712	7,690	0.34	3.67	0.35	3.02	1.04	0.34	12.06
EDC-5	18	80	8,020	7,997	0.29	2.27	0.32	3.41	0.86	0.29	9.90
RRC-1	18	20	NA	NA	0.02-0.075	2.26	0.68	4.95	0.86	0.39	6.10
RRC-2	18	20	NA	NA	0.02-0.075	1.00	0.53	3.51	0.45	0.26	4.80
RRC-3	18	20	NA	NA	0.02-0.075	2.31	0.63	5.84	0.86	0.40	6.14

Notes

Culvert No. corresponds to Watershed No. on Ephemeral Drainage Watershed Hydrology - Culvert Design Table. i.e. Culvert EDC-1 will be located where EDWS-1 crosses the road.

Culverts were conservatively assumed to be corrugated metal pipe. Polyethylene pipe may also be used.

Since their precise locations are subject to change, inlet and outlet elevations were not specified for the Road Runoff Culverts. It was assumed that they would slope at a grade of 7.5%.

The peak flows and stages in each culvert and ditch were calculated using HydroCad 8.00 software using the Soil Conservation Service (SCS) method, as shown in the Watershed Hydrology - Culvert Design Table. The design storm was the 10-year, 24-hour precipitation event for the ephemeral drainage culverts and the 10-year, 6-hour precipitation event for the road runoff ditches and culverts.

Since the peak design flow velocities within each ditch are less than 5 fps, they are considred non-erosive. Thus, no channel or culvert inlet protection is required.

The peak inlet depth is measured from the bottom of the culvert and was determined using Hydraulic Engineering Circular No. 5 Chart 5 (U.S. Department of Transportation, 1977). As a conservative measure, the projecting condition was assumed. See the attached nomograph for additional information.

The peak inside depth is measured from the bottom of the culvert and was calculated using HydroCad 8.00 software. See attached output sheets for additional information.

Culvert Outlet Protection

Culvert Outlet	Rip Rap Outlet Protection D_{50} (in)	Min. Length of Slope Protected Below Culvert Outlet (ft)	Min. Width of Slope Protected Below Culvert Outlet (ft)	Min. Depth of Rip Rap (ft)	Slope at Culvert Outlet (ft/ft)	Manning's Roughness (n)	Design Event Peak Culvert Flow (cfs)	Peak Design Culvert Velocity (fps)	Steady State Flow Velocity in Rip Rap Structure (fps)
EDC1	24	24	9	4	0.22	0.059	24.3	16.6	7.6
EDC2	24	16	6	4	0.30	0.062	6.6	15.0	6.3
EDC3	15	10.5	4.5	2.5	0.36	0.060	4.3	13.3	5.6
EDC4	15	12	4.5	2.5	0.27	0.057	7.8	12.1	5.9
EDC5	6	9	4.5	1.2	0.23	0.048	2.3	9.9	4.6
RRC1	15	9	4.5	4.1	0.50	0.063	2.3	6.1	5.0
RRC2	None	None	None	None	0.67	0.060	1.0	4.8	4.2
RRC3	6	9	4.5	1.7	0.29	0.050	2.3	6.1	4.8

Notes

Refer to Figure 3 for a typical drawing of road culverts and outlet protection

Sizing of rip rap intended to withstand culvert outlet flow velocities predicted in Culvert Sizing Table as per USDOT FHWA HEC 11 Fig. 2. Since the design event peak flow velocity in RRC2 < 5 fps, it is not considered erosive and thus no rip rap is specified.

Minimum lengths, widths, and depths of rip rap taken from FHWA HEC 11 (USDOT, 1989). Outlet protection structures may flare at a 3:1 angle from the culvert outlet. Filter fabric will be placed underneath the rip rap. Outlet protection will be monitored after precipitation events to ensure that the armored area is sufficient to reduce the erosive power of discharges.

Manning's Roughness calculated as $n = 0.0456(D_{50} \times S)^{0.159}$, where D_{50} is the median rip rap diameter in inches and S is the channel slope (Abt et al, 1987). Note that n for RRC2 was taken as 0.060 (overland flow through brush).

Peak culvert flows and velocities were calculated for the 10-year, 24-hour event for ephemeral drainage culverts and the 10-year, 6-hour event for road runoff culverts using HydroCAD 8.00

Steady state flow velocities calculated using Flowmaster 6.0 (Haestad Methods, Inc.) They have been calculated to show that the rip rap protection will sufficiently reduce flow velocities so that the design discharge is non-erosive when it is discharged. Velocities less than 5.0 fps are considered nonerosive. Rip rap structure discharges with velocities higher than 5.0 fps are assumed to be nonerosive because they empty into existing drainage channels which are self-armoring.

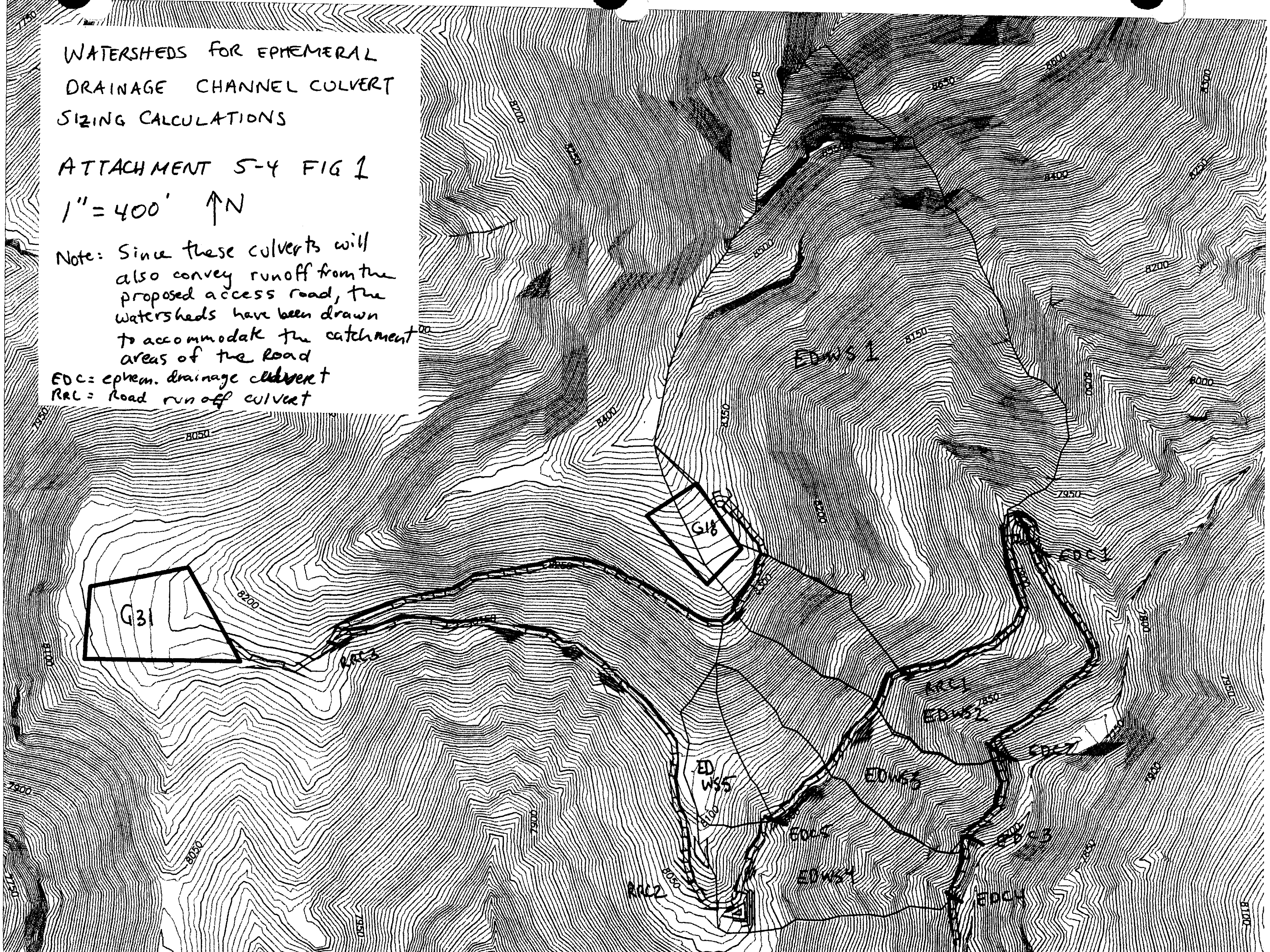
WATERSHEDS FOR EPHEMERAL DRAINAGE CHANNEL CULVERT SIZING CALCULATIONS

ATTACHMENT 5-4 FIG 1

1" = 400' ↑N

Note: Since these culverts will also convey runoff from the proposed access road, the watersheds have been drawn to accommodate the catchment areas of the Road

EDC = ephem. drainage ~~culvert~~ culvert
RRC = Road runoff culvert



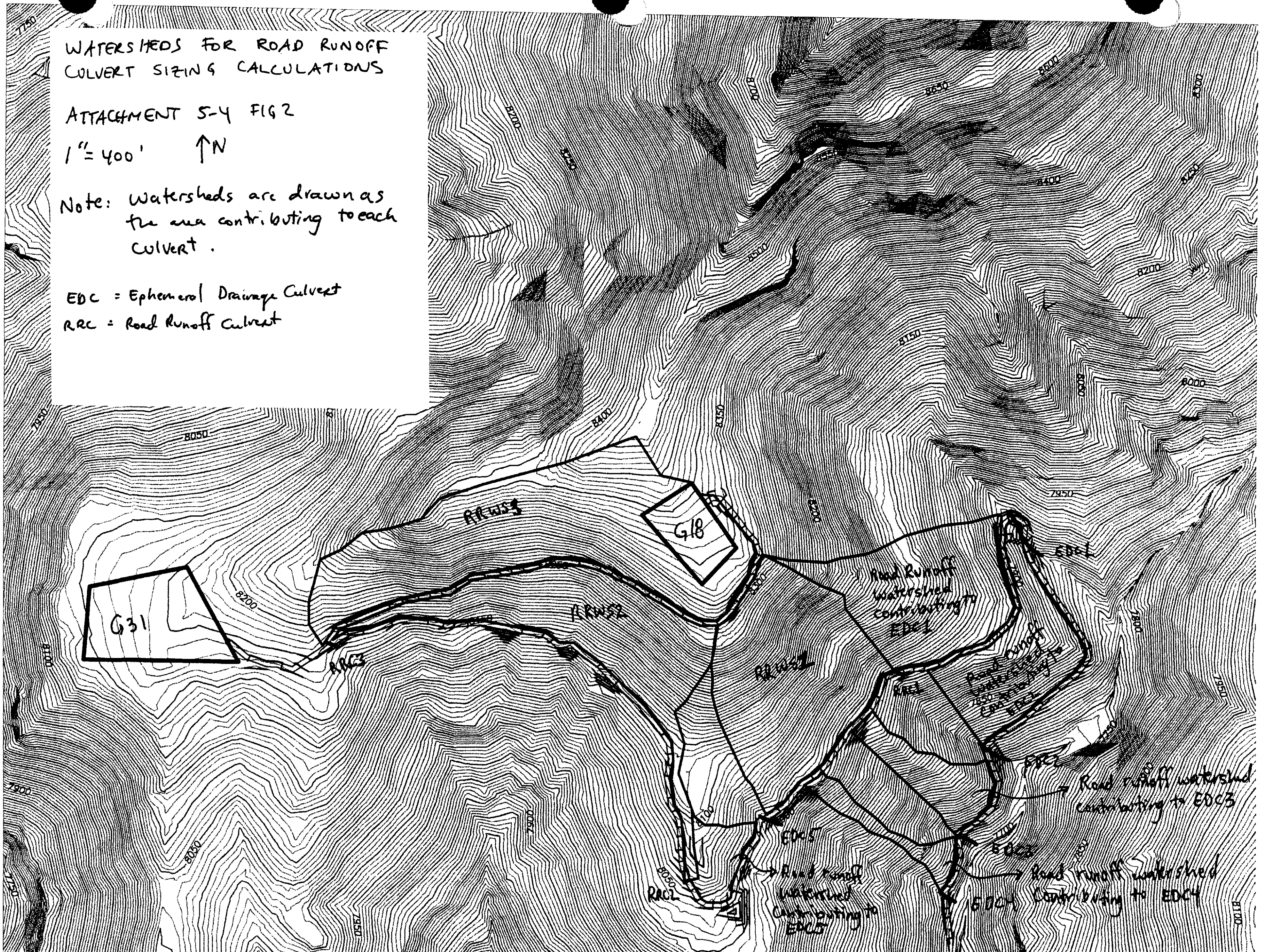
WATERSHEDS FOR ROAD RUNOFF
CULVERT SIZING CALCULATIONS

ATTACHMENT 5-4 FIG 2

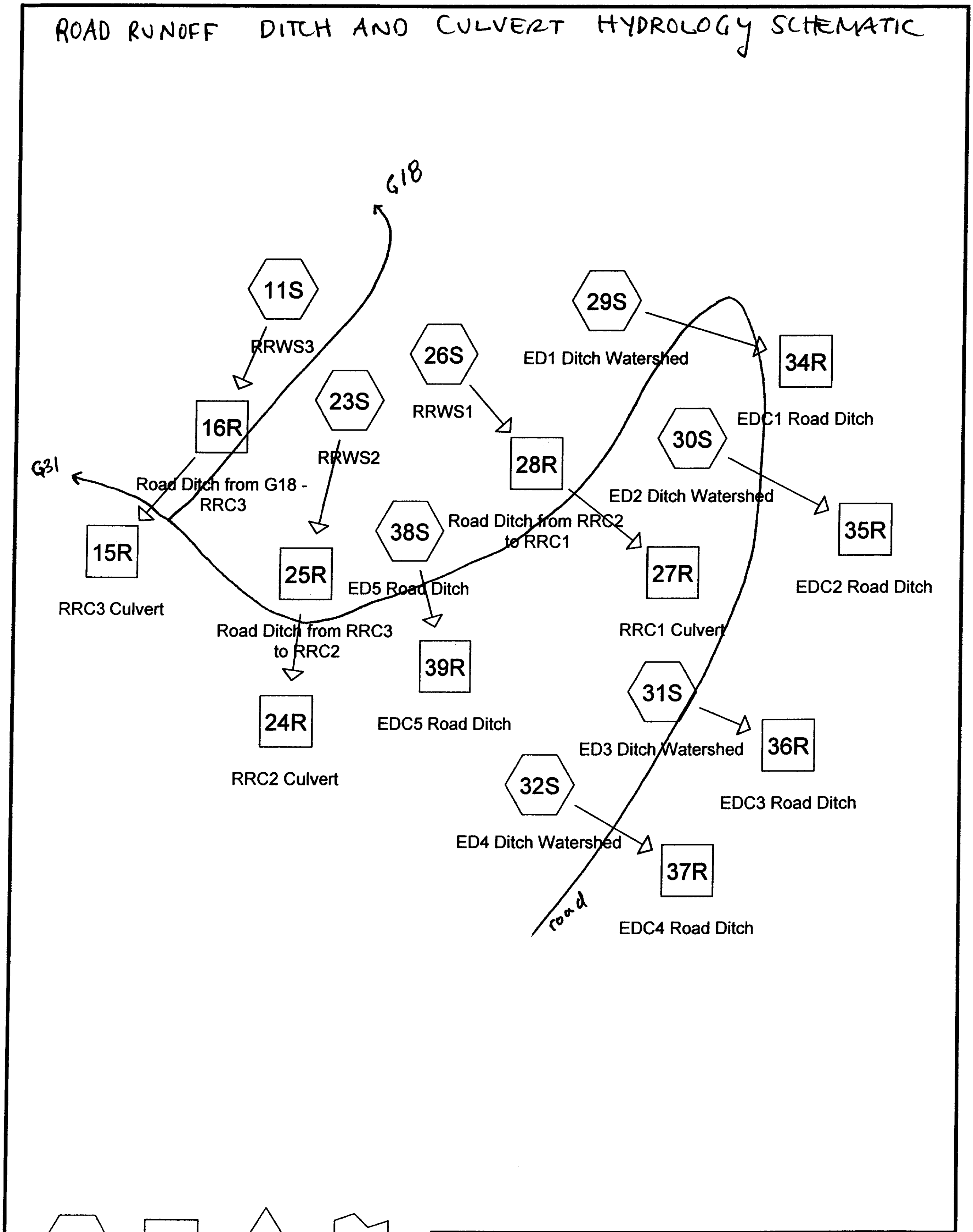
1" = 400'   ↑N

Note: Watersheds are drawn as the area contributing to each culvert.

EDC = Ephemeral Drainage Culvert
RRC = Road Runoff Culvert



BACKUP INFORMATION



Drainage Diagram for 10yr - 6hr Road Runoff Culverts
Prepared by {enter your company name here} 8/27/2007
HydroCAD® 8.00 s/n 003900 © 2006 HydroCAD Software Solutions LLC

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 11S: RRWS3 Runoff Area=438,378 sf Runoff Depth=0.16"
Flow Length=1,930' Slope=0.4240 '/' Tc=9.0 min CN=77 Runoff=2.83 cfs 5,935 cf

Subcatchment 23S: RRWS2 Runoff Area=237,126 sf Runoff Depth=0.16"
Flow Length=1,695' Slope=0.6170 '/' Tc=6.8 min CN=77 Runoff=1.84 cfs 3,211 cf

Subcatchment 26S: RRWS1 Runoff Area=282,656 sf Runoff Depth=0.16"
Flow Length=985' Slope=0.6020 '/' Tc=4.4 min CN=77 Runoff=2.97 cfs 3,827 cf

Subcatchment 29S: ED1 Ditch Watershed Runoff Area=202,641 sf Runoff Depth=0.16"
Flow Length=1,348' Slope=0.6050 '/' Tc=5.7 min CN=77 Runoff=1.78 cfs 2,744 cf

Subcatchment 30S: ED2 Ditch Watershed Runoff Area=135,524 sf Runoff Depth=0.16"
Flow Length=941' Slope=0.6010 '/' Tc=4.3 min CN=77 Runoff=1.44 cfs 1,835 cf

Subcatchment 31S: ED3 Ditch Watershed Runoff Area=65,082 sf Runoff Depth=0.16"
Flow Length=721' Slope=0.5770 '/' Tc=3.5 min CN=77 Runoff=0.79 cfs 881 cf

Subcatchment 32S: ED4 Ditch Watershed Runoff Area=33,833 sf Runoff Depth=0.16"
Flow Length=686' Slope=0.4980 '/' Tc=3.6 min CN=77 Runoff=0.41 cfs 458 cf

Subcatchment 38S: ED5 Road Ditch Runoff Area=36,179 sf Runoff Depth=0.16"
Flow Length=644' Slope=0.4570 '/' Tc=3.6 min CN=77 Runoff=0.43 cfs 490 cf

Reach 15R: RRC3 Culvert Avg. Depth=0.40' Max Vel=6.14 fps Inflow=2.31 cfs 5,935 cf
D=18.0" n=0.025 L=20.0' S=0.0750 '/' Capacity=14.96 cfs Outflow=2.31 cfs 5,935 cf

Reach 16R: Road Ditch from G18 - RRC3 Avg. Depth=0.63' Max Vel=5.84 fps Inflow=2.83 cfs 5,935 cf
n=0.035 L=1,266.0' S=0.1461 '/' Capacity=7.94 cfs Outflow=2.31 cfs 5,935 cf

Reach 24R: RRC2 Culvert Avg. Depth=0.26' Max Vel=4.80 fps Inflow=1.00 cfs 3,211 cf
D=18.0" n=0.025 L=20.0' S=0.0750 '/' Capacity=14.96 cfs Outflow=1.00 cfs 3,211 cf

Reach 25R: Road Ditch from RRC3 to RRC2 Avg. Depth=0.53' Max Vel=3.51 fps Inflow=1.84 cfs 3,211 cf
n=0.035 L=1,665.0' S=0.0661 '/' Capacity=5.34 cfs Outflow=1.00 cfs 3,211 cf

Reach 27R: RRC1 Culvert Avg. Depth=0.39' Max Vel=6.10 fps Inflow=2.27 cfs 3,827 cf
D=18.0" n=0.025 L=20.0' S=0.0750 '/' Capacity=14.96 cfs Outflow=2.26 cfs 3,827 cf

Reach 28R: Road Ditch from RRC2 to RRC1 Avg. Depth=0.68' Max Vel=4.95 fps Inflow=2.97 cfs 3,827 cf
n=0.035 L=628.0' S=0.0955 '/' Capacity=6.42 cfs Outflow=2.27 cfs 3,827 cf

Reach 34R: EDC1 Road Ditch Avg. Depth=0.54' Max Vel=4.72 fps Inflow=1.78 cfs 2,744 cf
n=0.035 L=765.0' S=0.1176 '/' Capacity=7.13 cfs Outflow=1.37 cfs 2,744 cf

Reach 35R: EDC2 Road Ditch Avg. Depth=0.45' Max Vel=4.29 fps Inflow=1.44 cfs 1,835 cf
n=0.035 L=941.0' S=0.1222 '/' Capacity=7.26 cfs Outflow=0.89 cfs 1,835 cf

Reach 36R: EDC3 Road Ditch Avg. Depth=0.41' Max Vel=3.98 fps Inflow=0.79 cfs 881 cf
n=0.035 L=292.0' S=0.1199 '/' Capacity=7.19 cfs Outflow=0.67 cfs 881 cf

Reach 37R: EDC4 Road Ditch Avg. Depth=0.35' Max Vel=3.02 fps Inflow=0.41 cfs 458 cf
n=0.035 L=173.0' S=0.0867 '/' Capacity=6.12 cfs Outflow=0.36 cfs 458 cf

Reach 39R: EDC5 Road Ditch Avg. Depth=0.32' Max Vel=3.41 fps Inflow=0.43 cfs 490 cf
n=0.035 L=323.0' S=0.1238 '/' Capacity=7.31 cfs Outflow=0.34 cfs 490 cf

Total Runoff Area = 1,431,419 sf Runoff Volume = 19,381 cf Average Runoff Depth = 0.16"
100.00% Pervious Area = 1,431,419 sf 0.00% Impervious Area = 0 sf

Subcatchment 11S: RRWS3

Runoff = 2.83 cfs @ 3.11 hrs, Volume= 5,935 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

Area (sf)	CN	Description
438,378	77	
438,378		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	1,930	0.4240	3.56		**Lag/CN Method,**

Subcatchment 23S: RRWS2

Runoff = 1.84 cfs @ 3.07 hrs, Volume= 3,211 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

Area (sf)	CN	Description
237,126	77	
237,126		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	1,695	0.6170	4.18		**Lag/CN Method,**

Subcatchment 26S: RRWS1

Runoff = 2.97 cfs @ 3.04 hrs, Volume= 3,827 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

Area (sf)	CN	Description
282,656	77	
282,656		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.4	985	0.6020	3.70		**Lag/CN Method,**

Subcatchment 29S: ED1 Ditch Watershed

Runoff = 1.78 cfs @ 3.06 hrs, Volume= 2,744 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

Area (sf)	CN	Description
202,641	77	
202,641		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	1,348	0.6050	3.95		**Lag/CN Method,**

Subcatchment 30S: ED2 Ditch Watershed

Runoff = 1.44 cfs @ 3.04 hrs, Volume= 1,835 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

Area (sf)	CN	Description
135,524	77	
135,524		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	941	0.6010	3.67		**Lag/CN Method,**

Subcatchment 31S: ED3 Ditch Watershed

Runoff = 0.79 cfs @ 3.03 hrs, Volume= 881 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

Area (sf)	CN	Description
65,082	77	
65,082		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	721	0.5770	3.41		**Lag/CN Method,**

Subcatchment 32S: ED4 Ditch Watershed

Runoff = 0.41 cfs @ 3.03 hrs, Volume= 458 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

Area (sf)	CN	Description
33,833	77	
33,833		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	686	0.4980	3.13		**Lag/CN Method,**

Subcatchment 38S: ED5 Road Ditch

Runoff = 0.43 cfs @ 3.03 hrs, Volume= 490 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

Area (sf)	CN	Description
36,179	77	
36,179		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	644	0.4570	2.96		**Lag/CN Method,**

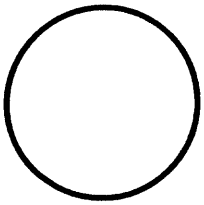
Reach 15R: RRC3 Culvert

Inflow Area = 438,378 sf, Inflow Depth = 0.16"
Inflow = 2.31 cfs @ 3.22 hrs, Volume= 5,935 cf
Outflow = 2.31 cfs @ 3.22 hrs, Volume= 5,935 cf, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.14 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.64 fps, Avg. Travel Time= 0.1 min

Peak Storage= 8 cf @ 3.22 hrs, Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 14.96 cfs

18.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 20.0' Slope= 0.0750 '/'
Inlet Invert= 8,175.00', Outlet Invert= 8,173.50'



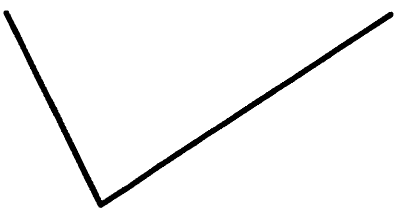
Reach 16R: Road Ditch from G18 - RRC3

Inflow Area =	438,378 sf,	Inflow Depth = 0.16"	
Inflow =	2.83 cfs @	3.11 hrs, Volume=	5,935 cf
Outflow =	2.31 cfs @	3.22 hrs, Volume=	5,935 cf, Atten= 18%, Lag= 6.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.84 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 2.55 fps, Avg. Travel Time= 8.3 min

Peak Storage= 502 cf @ 3.16 hrs, Average Depth at Peak Storage= 0.63'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.94 cfs

0.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 0.5 1.5 '/' Top Width= 2.00'
Length= 1,266.0' Slope= 0.1461 '/'
Inlet Invert= 8,360.00', Outlet Invert= 8,175.00'



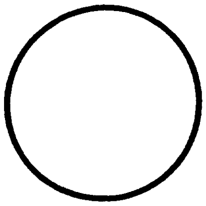
Reach 24R: RRC2 Culvert

Inflow Area =	237,126 sf,	Inflow Depth = 0.16"	
Inflow =	1.00 cfs @	3.30 hrs, Volume=	3,211 cf
Outflow =	1.00 cfs @	3.30 hrs, Volume=	3,211 cf, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.80 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.96 fps, Avg. Travel Time= 0.2 min

Peak Storage= 4 cf @ 3.30 hrs, Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 14.96 cfs

18.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 20.0' Slope= 0.0750 '/'
Inlet Invert= 8,060.00', Outlet Invert= 8,058.50'



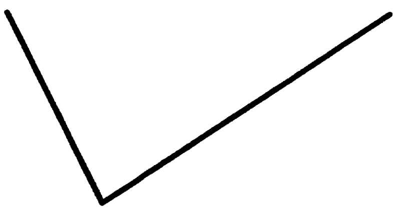
Reach 25R: Road Ditch from RRC3 to RRC2

Inflow Area = 237,126 sf, Inflow Depth = 0.16"
Inflow = 1.84 cfs @ 3.07 hrs, Volume= 3,211 cf
Outflow = 1.00 cfs @ 3.30 hrs, Volume= 3,211 cf, Atten= 46%, Lag= 13.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.51 fps, Min. Travel Time= 7.9 min
Avg. Velocity = 1.34 fps, Avg. Travel Time= 20.7 min

Peak Storage= 473 cf @ 3.17 hrs, Average Depth at Peak Storage= 0.53'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.34 cfs

0.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 0.5 1.5 '/' Top Width= 2.00'
Length= 1,665.0' Slope= 0.0661 '/'
Inlet Invert= 8,170.00', Outlet Invert= 8,060.00'



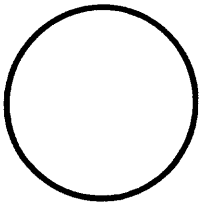
Reach 27R: RRC1 Culvert

Inflow Area = 282,656 sf, Inflow Depth = 0.16"
Inflow = 2.27 cfs @ 3.10 hrs, Volume= 3,827 cf
Outflow = 2.26 cfs @ 3.10 hrs, Volume= 3,827 cf, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.10 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.63 fps, Avg. Travel Time= 0.1 min

Peak Storage= 7 cf @ 3.10 hrs, Average Depth at Peak Storage= 0.39'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 14.96 cfs

18.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 20.0' Slope= 0.0750 '/'
Inlet Invert= 7,965.00', Outlet Invert= 7,963.50'



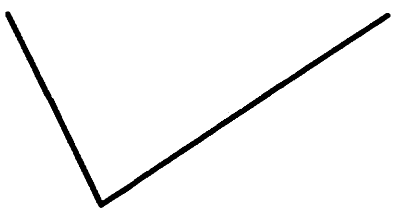
Reach 28R: Road Ditch from RRC2 to RRC1

Inflow Area = 282,656 sf, Inflow Depth = 0.16"
Inflow = 2.97 cfs @ 3.04 hrs, Volume= 3,827 cf
Outflow = 2.27 cfs @ 3.10 hrs, Volume= 3,827 cf, Atten= 24%, Lag= 3.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.95 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 2.21 fps, Avg. Travel Time= 4.7 min

Peak Storage= 288 cf @ 3.07 hrs, Average Depth at Peak Storage= 0.68'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 6.42 cfs

0.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 0.5 1.5 '/' Top Width= 2.00'
Length= 628.0' Slope= 0.0955 '/'
Inlet Invert= 8,025.00', Outlet Invert= 7,965.00'



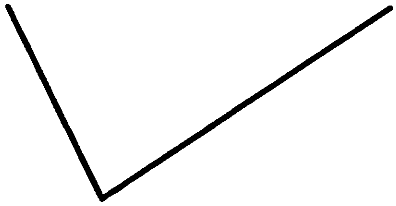
Reach 34R: EDC1 Road Ditch

Inflow Area = 202,641 sf, Inflow Depth = 0.16"
Inflow = 1.78 cfs @ 3.06 hrs, Volume= 2,744 cf
Outflow = 1.37 cfs @ 3.14 hrs, Volume= 2,744 cf, Atten= 23%, Lag= 4.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.72 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 2.18 fps, Avg. Travel Time= 5.8 min

Peak Storage= 223 cf @ 3.09 hrs, Average Depth at Peak Storage= 0.54'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.13 cfs

0.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 0.5 1.5 '/' Top Width= 2.00'
Length= 765.0' Slope= 0.1176 '/'
Inlet Invert= 7,975.00', Outlet Invert= 7,885.00'



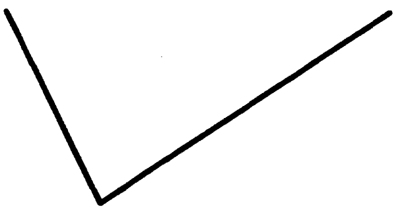
Reach 35R: EDC2 Road Ditch

Inflow Area =	135,524 sf,	Inflow Depth = 0.16"		
Inflow =	1.44 cfs @	3.04 hrs, Volume=	1,835 cf	
Outflow =	0.89 cfs @	3.14 hrs, Volume=	1,835 cf,	Atten= 39%, Lag= 6.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.29 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 1.95 fps, Avg. Travel Time= 8.1 min

Peak Storage= 194 cf @ 3.08 hrs, Average Depth at Peak Storage= 0.45'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.26 cfs

0.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 0.5 1.5 '/' Top Width= 2.00'
Length= 941.0' Slope= 0.1222 '/'
Inlet Invert= 7,885.00', Outlet Invert= 7,770.00'



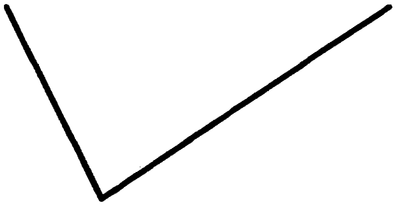
Reach 36R: EDC3 Road Ditch

Inflow Area =	65,082 sf,	Inflow Depth = 0.16"		
Inflow =	0.79 cfs @	3.03 hrs, Volume=	881 cf	
Outflow =	0.67 cfs @	3.06 hrs, Volume=	881 cf,	Atten= 15%, Lag= 2.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.98 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.96 fps, Avg. Travel Time= 2.5 min

Peak Storage= 50 cf @ 3.04 hrs, Average Depth at Peak Storage= 0.41'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.19 cfs

0.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 0.5 1.5 '/' Top Width= 2.00'
Length= 292.0' Slope= 0.1199 '/'
Inlet Invert= 7,765.00', Outlet Invert= 7,730.00'



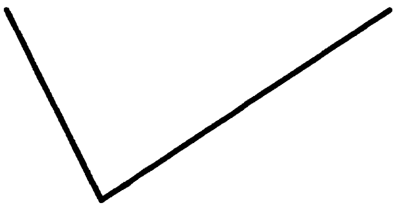
Reach 37R: EDC4 Road Ditch

Inflow Area =	33,833 sf,	Inflow Depth = 0.16"	
Inflow =	0.41 cfs @	3.03 hrs, Volume=	458 cf
Outflow =	0.36 cfs @	3.06 hrs, Volume=	458 cf, Atten= 11%, Lag= 1.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.02 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.53 fps, Avg. Travel Time= 1.9 min

Peak Storage= 21 cf @ 3.04 hrs, Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 6.12 cfs

0.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 0.5 1.5 '/' Top Width= 2.00'
Length= 173.0' Slope= 0.0867 '/'
Inlet Invert= 7,725.00', Outlet Invert= 7,710.00'



Reach 39R: EDC5 Road Ditch

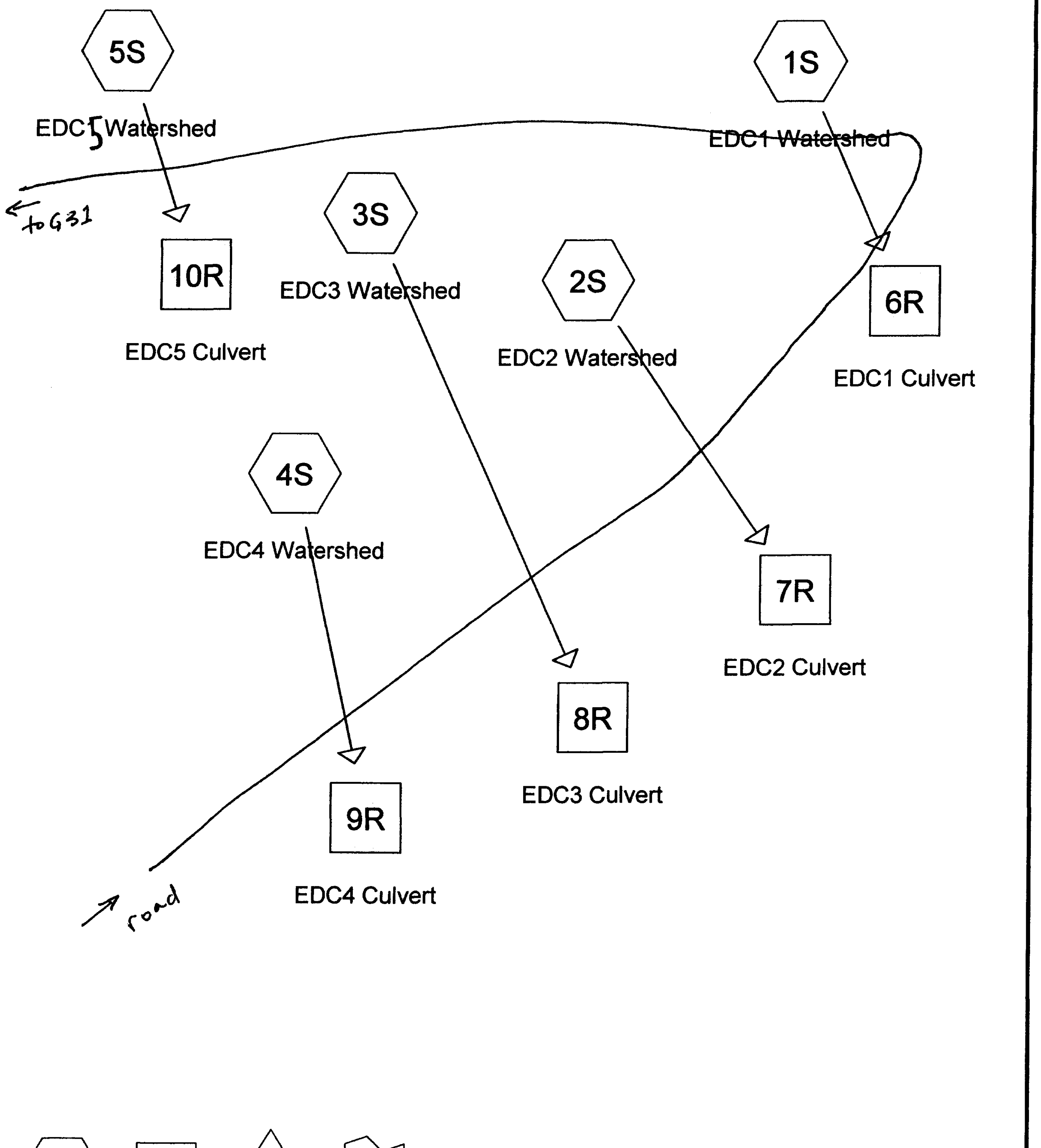
Inflow Area =	36,179 sf,	Inflow Depth = 0.16"	
Inflow =	0.43 cfs @	3.03 hrs, Volume=	490 cf
Outflow =	0.34 cfs @	3.08 hrs, Volume=	490 cf, Atten= 21%, Lag= 2.8 min

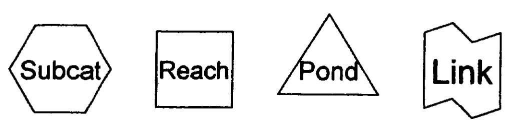
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.41 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.72 fps, Avg. Travel Time= 3.1 min

Peak Storage= 33 cf @ 3.05 hrs, Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.31 cfs

0.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 0.5 1.5 '/' Top Width= 2.00'
Length= 323.0' Slope= 0.1238 '/'
Inlet Invert= 8,065.00', Outlet Invert= 8,025.00'

EPHEMERAL DRAINAGE CULVERT HYDROLOGY SCHEMATIC





Drainage Diagram for 10-24Ephemeral Drainage Culverts
Prepared by {enter your company name here} 8/27/2007
HydroCAD® 8.00 s/n 003900 © 2006 HydroCAD Software Solutions LLC

Time span=0.00-30.00 hrs, dt=0.02 hrs, 1501 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: EDC1 Watershed Runoff Area=1,487,270 sf Runoff Depth=0.48"
Flow Length=2,262' Slope=0.6050 '/' Tc=8.6 min CN=77 Runoff=24.42 cfs 58,905 cf

Subcatchment 2S: EDC2 Watershed Runoff Area=363,860 sf Runoff Depth=0.48"
Flow Length=1,502' Slope=0.6010 '/' Tc=6.2 min CN=77 Runoff=6.65 cfs 14,411 cf

Subcatchment 3S: EDC3 Watershed Runoff Area=225,090 sf Runoff Depth=0.48"
Flow Length=1,151' Slope=0.5770 '/' Tc=5.1 min CN=77 Runoff=4.32 cfs 8,915 cf

Subcatchment 4S: EDC4 Watershed Runoff Area=407,357 sf Runoff Depth=0.48"
Flow Length=1,100' Slope=0.4980 '/' Tc=5.3 min CN=77 Runoff=7.75 cfs 16,134 cf

Subcatchment 5S: EDC1 5 Watershed Runoff Area=74,015 sf Runoff Depth=0.68"
Flow Length=589' Slope=0.4570 '/' Tc=2.9 min CN=82 Runoff=2.32 cfs 4,206 cf

Reach 6R: EDC1 Culvert Avg. Depth=0.78' Max Vel=16.60 fps Inflow=24.42 cfs 58,905 cf
D=36.0" n=0.025 L=203.0' S=0.2217 '/' Capacity=163.30 cfs Outflow=24.30 cfs 58,905 cf

Reach 7R: EDC2 Culvert Avg. Depth=0.40' Max Vel=14.97 fps Inflow=6.65 cfs 14,411 cf
D=24.0" n=0.025 L=117.0' S=0.4274 '/' Capacity=76.90 cfs Outflow=6.62 cfs 14,411 cf

Reach 8R: EDC3 Culvert Avg. Depth=0.36' Max Vel=13.25 fps Inflow=4.32 cfs 8,915 cf
D=18.0" n=0.025 L=89.0' S=0.3933 '/' Capacity=34.25 cfs Outflow=4.30 cfs 8,915 cf

Reach 9R: EDC4 Culvert Avg. Depth=0.45' Max Vel=14.52 fps Inflow=7.75 cfs 16,134 cf
D=24.0" n=0.025 L=64.0' S=0.3438 '/' Capacity=68.97 cfs Outflow=7.73 cfs 16,134 cf

Reach 10R: EDC5 Culvert Avg. Depth=0.29' Max Vel=9.89 fps Inflow=2.32 cfs 4,206 cf
D=18.0" n=0.025 L=80.0' S=0.2875 '/' Capacity=29.29 cfs Outflow=2.30 cfs 4,206 cf

Total Runoff Area = 2,557,592 sf Runoff Volume = 102,571 cf Average Runoff Depth = 0.48"
100.00% Pervious Area = 2,557,592 sf 0.00% Impervious Area = 0 sf

Subcatchment 1S: EDC1 Watershed

Runoff = 24.42 cfs @ 12.02 hrs, Volume= 58,905 cf, Depth= 0.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr Rainfall=2.05"

Area (sf)	CN	Description
1,487,270	77	
1,487,270		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	2,262	0.6050	4.38		**Lag/CN Method,**

Subcatchment 2S: EDC2 Watershed

Runoff = 6.65 cfs @ 11.99 hrs, Volume= 14,411 cf, Depth= 0.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr Rainfall=2.05"

Area (sf)	CN	Description
363,860	77	
363,860		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	1,502	0.6010	4.03		**Lag/CN Method,**

Subcatchment 3S: EDC3 Watershed

Runoff = 4.32 cfs @ 11.97 hrs, Volume= 8,915 cf, Depth= 0.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr Rainfall=2.05"

Area (sf)	CN	Description
225,090	77	
225,090		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	1,151	0.5770	3.74		**Lag/CN Method,**

Subcatchment 4S: EDC4 Watershed

Runoff = 7.75 cfs @ 11.98 hrs, Volume= 16,134 cf, Depth= 0.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr Rainfall=2.05"

Area (sf)	CN	Description
407,357	77	
407,357		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	1,100	0.4980	3.44		**Lag/CN Method,**

Subcatchment 5S: EDC~~1~~5 Watershed

Runoff = 2.32 cfs @ 11.94 hrs, Volume= 4,206 cf, Depth= 0.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr Rainfall=2.05"

Area (sf)	CN	Description
74,015	82	
74,015		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	589	0.4570	3.40		**Lag/CN Method,**

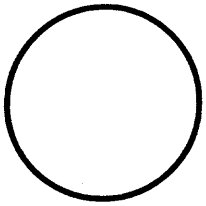
Reach 6R: EDC1 Culvert

Inflow Area = 1,487,270 sf, Inflow Depth = 0.48"
Inflow = 24.42 cfs @ 12.02 hrs, Volume= 58,905 cf
Outflow = 24.30 cfs @ 12.02 hrs, Volume= 58,905 cf, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
Max. Velocity= 16.60 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 6.06 fps, Avg. Travel Time= 0.6 min

Peak Storage= 299 cf @ 12.02 hrs, Average Depth at Peak Storage= 0.78'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 163.30 cfs

36.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 203.0' Slope= 0.2217 '/'
Inlet Invert= 7,890.00', Outlet Invert= 7,845.00'



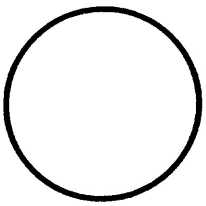
Reach 7R: EDC2 Culvert

Inflow Area =	363,860 sf,	Inflow Depth = 0.48"		
Inflow =	6.65 cfs @	11.99 hrs,	Volume=	14,411 cf
Outflow =	6.62 cfs @	11.99 hrs,	Volume=	14,411 cf, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
Max. Velocity= 14.97 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 5.32 fps, Avg. Travel Time= 0.4 min

Peak Storage= 52 cf @ 11.99 hrs, Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 76.90 cfs

24.0" Diameter Pipe, n= 0.025
Length= 117.0' Slope= 0.4274 '/'
Inlet Invert= 7,780.00', Outlet Invert= 7,730.00'



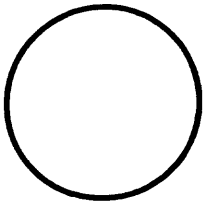
Reach 8R: EDC3 Culvert

Inflow Area =	225,090 sf,	Inflow Depth = 0.48"		
Inflow =	4.32 cfs @	11.97 hrs,	Volume=	8,915 cf
Outflow =	4.30 cfs @	11.98 hrs,	Volume=	8,915 cf, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
Max. Velocity= 13.25 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.66 fps, Avg. Travel Time= 0.3 min

Peak Storage= 29 cf @ 11.98 hrs, Average Depth at Peak Storage= 0.36'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 34.25 cfs

18.0" Diameter Pipe, n= 0.025
Length= 89.0' Slope= 0.3933 '/'
Inlet Invert= 7,735.00', Outlet Invert= 7,700.00'



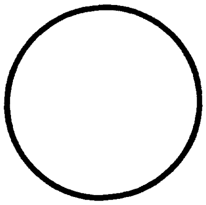
Reach 9R: EDC4 Culvert

Inflow Area = 407,357 sf, Inflow Depth = 0.48"
Inflow = 7.75 cfs @ 11.98 hrs, Volume= 16,134 cf
Outflow = 7.73 cfs @ 11.98 hrs, Volume= 16,134 cf, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
Max. Velocity= 14.52 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 5.10 fps, Avg. Travel Time= 0.2 min

Peak Storage= 34 cf @ 11.98 hrs, Average Depth at Peak Storage= 0.45'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 68.97 cfs

24.0" Diameter Pipe, n= 0.025
Length= 64.0' Slope= 0.3438 '/'
Inlet Invert= 7,712.00', Outlet Invert= 7,690.00'



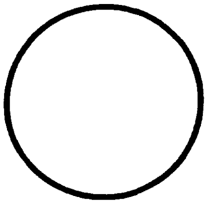
Reach 10R: EDC5 Culvert

Inflow Area = 74,015 sf, Inflow Depth = 0.68"
Inflow = 2.32 cfs @ 11.94 hrs, Volume= 4,206 cf
Outflow = 2.30 cfs @ 11.94 hrs, Volume= 4,206 cf, Atten= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
Max. Velocity= 9.89 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.20 fps, Avg. Travel Time= 0.4 min

Peak Storage= 19 cf @ 11.94 hrs, Average Depth at Peak Storage= 0.29'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 29.29 cfs

18.0" Diameter Pipe, n= 0.025
Length= 80.0' Slope= 0.2875 '/'
Inlet Invert= 8,020.00', Outlet Invert= 7,997.00'



Hydraulic Charts for the Selection of Highway Culverts

Hydraulic Engineering Circular No. 5 December 1965*

Prepared by the Hydraulics Branch, Bridge Division, Office of Engineering, Federal Highway Administration, Washington, D.C. 20590

CONTENTS

REGISTERED PROFESSIONAL ENGINEER
No. 4913
WILLIAM BAIN BIRKES
STATE OF UTAH

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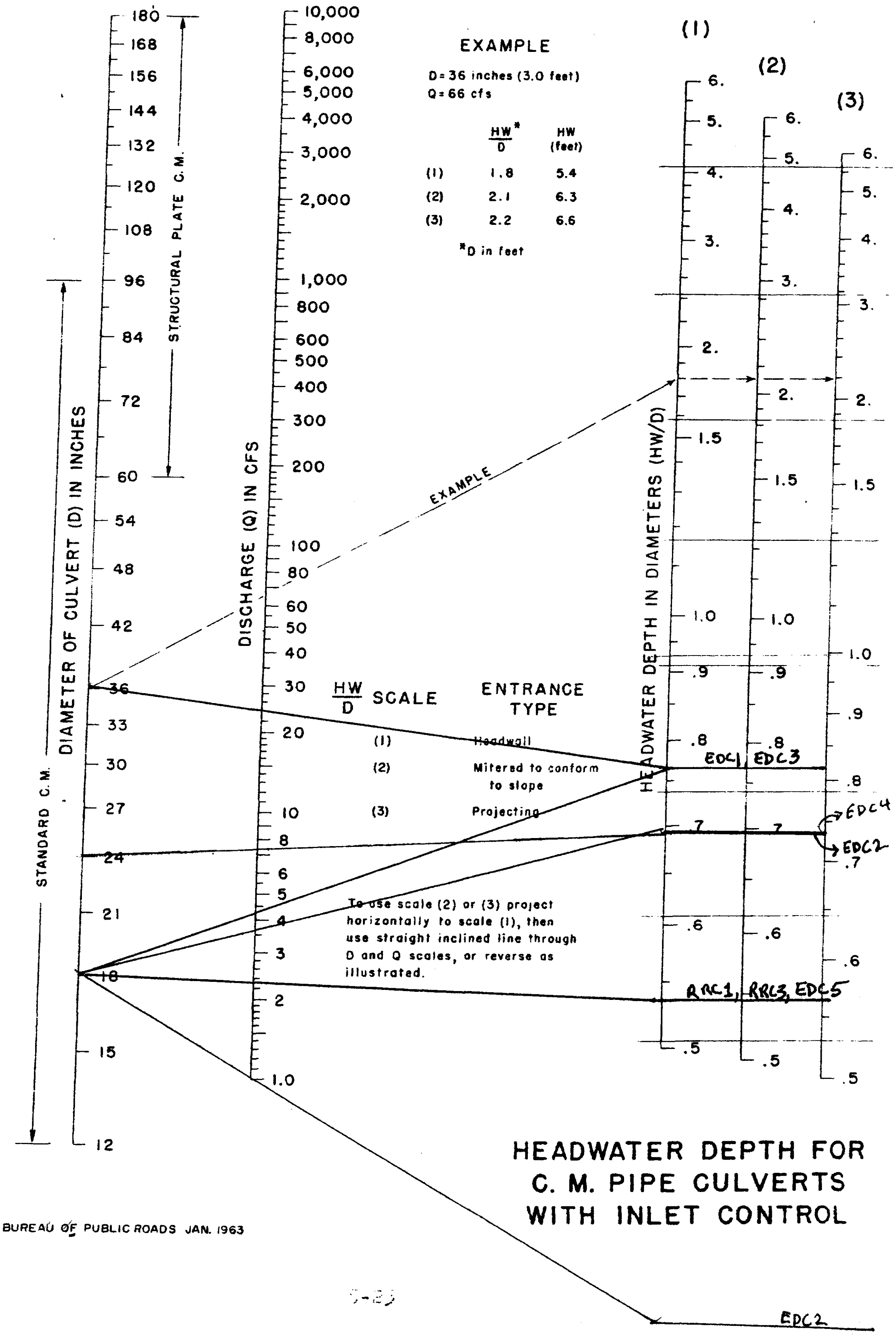
CULVERT INLET CONDITIONS

CHART 5



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

EDC1 Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Road Runoff Culvert Outlet
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.059
Slope	0.220000 ft/ft
Left Side Slope	2.00 H : V
Right Side Slope	2.00 H : V
Bottom Width	3.00 ft
Discharge	24.30 cfs

$n = 0.0456 (D_{50} \times S)^{0.159}$

where D_{50} is in inches
S is channel slope

after Abt et al, 1987

$D_{50} = 24"$
$S = 0.22$

Results	
Depth	0.72 ft
Flow Area	3.2 ft²
Wetted Perimeter	6.22 ft
Top Width	5.88 ft
Critical Depth	1.01 ft
Critical Slope	0.061793 ft/ft
Velocity	7.59 ft/s
Velocity Head	0.89 ft
Specific Energy	1.62 ft
Froude Number	1.81
Flow Type	Supercritical

OK for discharge into naturally armored channel

EDC2 Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Road Runoff Culvert Outlet
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.062	
Slope	0.300000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	2.00	ft
Discharge	6.60	cfs

→ $D_{50} = 24''$
$S = 0.30$ ft/ft

Results		
Depth	0.40	ft
Flow Area	1.1	ft²
Wetted Perimeter	3.80	ft
Top Width	3.61	ft
Critical Depth	0.57	ft
Critical Slope	0.081191	ft/ft
Velocity	5.85	ft/s
Velocity Head	0.53	ft
Specific Energy	0.93	ft
Froude Number	1.84	
Flow Type	Supercritical	

→ OK for discharge into naturally armored channel

EDC3 Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Road Runoff Culvert Outlet
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Slope	0.360000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	2.00	ft
Discharge	4.30	cfs

$D_{50} : 15''$

$S : 0.36$

Results		
Depth	0.30	ft
Flow Area	0.8	ft²
Wetted Perimeter	3.33	ft
Top Width	3.19	ft
Critical Depth	0.45	ft
Critical Slope	0.080645	ft/ft
Velocity	5.60	ft/s
Velocity Head	0.49	ft
Specific Energy	0.78	ft
Froude Number	2.01	
Flow Type	Supercritical	

OK for discharge into naturally armored channel

EDC4 Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Road Runoff Culvert Outlet
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.057	
Slope	0.270000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	2.00	ft
Discharge	7.80	cfs

$D_{50} = 15''$

Results		
Depth	0.43	ft
Flow Area	1.2	ft²
Wetted Perimeter	3.94	ft
Top Width	3.73	ft
Critical Depth	0.63	ft
Critical Slope	0.067104	ft/ft
Velocity	6.28	ft/s
Velocity Head	0.61	ft
Specific Energy	1.05	ft
Froude Number	1.92	
Flow Type	Supercritical	

OK for discharge into naturally armored channel

EDC5 Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Road Runoff Culvert Outlet
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.048	
Slope	0.230000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	2.00	ft
Discharge	2.30	cfs

$D_{50} = 6''$

Results		
Depth	0.21	ft
Flow Area	0.5	ft²
Wetted Perimeter	2.93	ft
Top Width	2.83	ft
Critical Depth	0.31	ft
Critical Slope	0.056502	ft/ft
Velocity	4.58	ft/s
Velocity Head	0.33	ft
Specific Energy	0.53	ft
Froude Number	1.92	
Flow Type	Supercritical	

OK for discharge. peak flow < 5 fps - nonerosive

RRC1 Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Road Runoff Culvert Outlet
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.063	
Slope	0.500000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	2.00	ft
Discharge	2.30	cfs

→ $D_{50} = 15"$

Results		
Depth	0.19	ft
Flow Area	0.5	ft²
Wetted Perimeter	2.87	ft
Top Width	2.78	ft
Critical Depth	0.31	ft
Critical Slope	0.097333	ft/ft
Velocity	4.95	ft/s
Velocity Head	0.38	ft
Specific Energy	0.58	ft
Froude Number	2.14	
Flow Type	Supercritical	

→ < 5 fps, nonerosive

RRC2 Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Road Runoff Culvert Outlet
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Slope	0.670000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	2.00	ft
Discharge	1.00	cfs

→ No Rip rap req'd
n for overland flow through brush

Results		
Depth	0.11	ft
Flow Area	0.2	ft²
Wetted Perimeter	2.48	ft
Top Width	2.43	ft
Critical Depth	0.19	ft
Critical Slope	0.100668	ft/ft
Velocity	4.23	ft/s
Velocity Head	0.28	ft
Specific Energy	0.39	ft
Froude Number	2.39	
Flow Type	Supercritical	

→ < 5 fps, nonerosive velocity

RRC3 Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Road Runoff Culvert Outlet
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

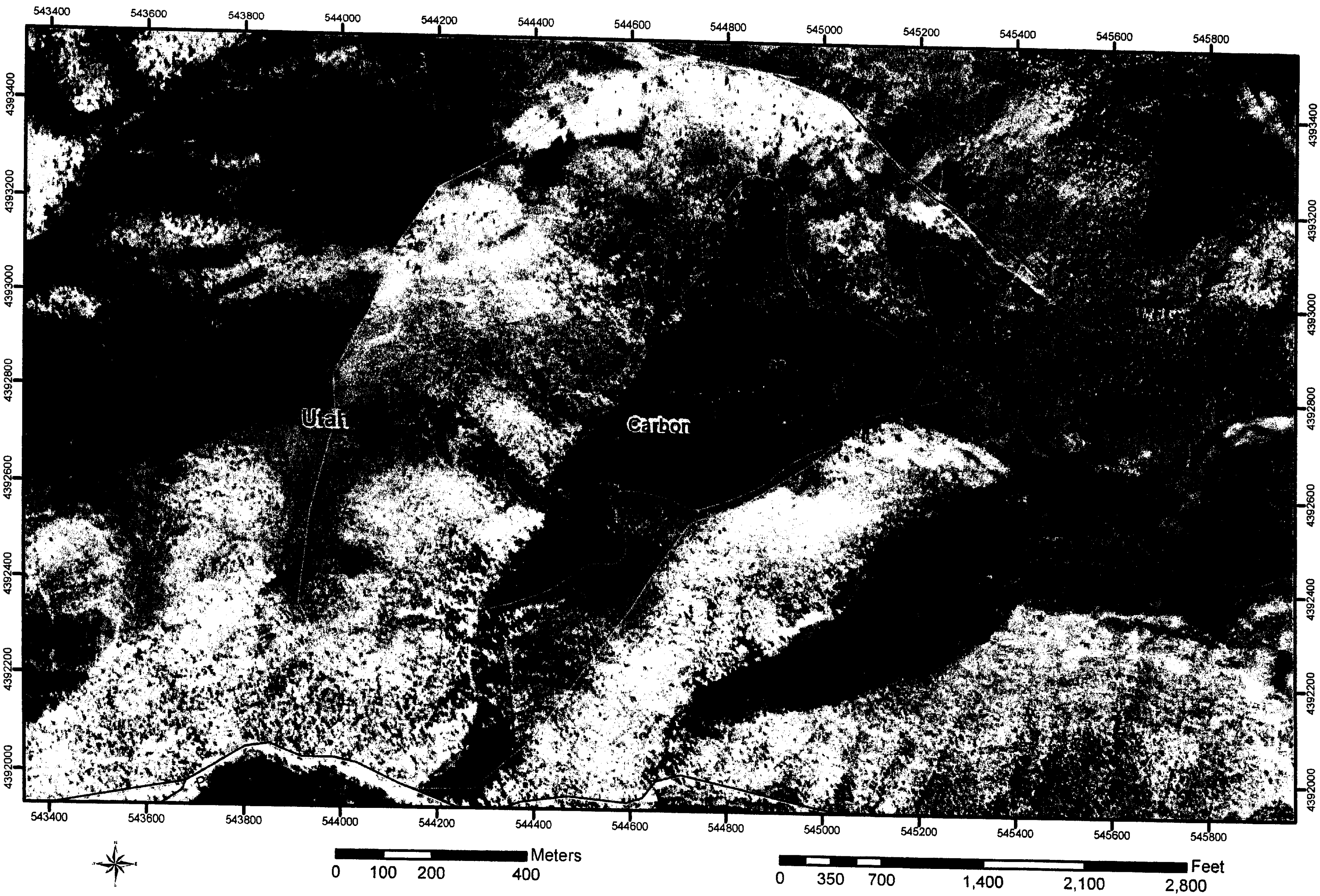
Input Data		
Mannings Coefficient	0.050	
Slope	0.290000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	2.00	ft
Discharge	2.30	cfs

→ $D_{50} = 6''$

Results		
Depth	0.20	ft
Flow Area	0.5	ft²
Wetted Perimeter	2.89	ft
Top Width	2.80	ft
Critical Depth	0.31	ft
Critical Slope	0.061308	ft/ft
Velocity	4.82	ft/s
Velocity Head	0.36	ft
Specific Energy	0.56	ft
Froude Number	2.06	
Flow Type	Supercritical	

→ < 5 fps, nonerosive velocity

SOIL SURVEY OF CARBON AREA, UTAH, PARTS OF CARBON AND EMERY COUNTIES



USDA Natural Resources Conservation Service

Tables - Hydrologic Soil Group

Summary by Map Unit - Carbon Area, Utah, Parts of Carbon and Emery Counties

Soil Survey Area Map Unit Symbol	Map Unit Name	Rating	Total Acres in AOI	Percent of AOI
62	Midfork family-Comodore complex	B	81.7	25.3
97	Rottulee family-Trag complex	C	230.8	71.3
100	Senchert loam, 3 to 15 percent slopes	C	11.0	3.4

Description - Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Parameter Summary - Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff:

Tie-break Rule: Lower

TABLE 7-14 — Other Agricultural Lands[1]

Cover Description	Hydrologic Condition	Curve Numbers for Hydrologic Soil Group			
Cover Type		A	B	C	D
Pasture, grassland, or range — continuous forage for graving [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow — continuous grass — protected from grazing and generally mowed for hay		30	58	71	78
Brush — brush-weed-grass mixture with brush the major element [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30[4]	48	65	73
Woods — grass combination (orchard or tree farm) [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30[4]	55	70	77
Farmsteads — buildings, land, driveways and surrounding lots	—	59	74	82	86

1 Average runoff condition and $I_a = 0.2S$.

2 Poor: < 50% ground cover or heavily grazed with no mulch
Fair: 50% to 75% ground cover and not heavily grazed
Good: > 75% ground cover and lightly or only occasionally grazed

3 Poor: < 50% ground cover
Fair: 50% to 75% ground cover
Good: > 75% ground cover

4 Actual Curve Number is less than 30; use CN = 30 for runoff computations.

5 CNs shown were computed for areas with 50% grass (pasture) cover. Other combinations of conditions may be computed from CNs for woods and pasture.

6 Poor: Forest litter, small trees and brush are destroyed by heavy grazing or regular burning.
Fair: Woods grazed but not burned, and some forest litter covers the soil.
Good: Woods protected from grazing; litter and brush adequately cover soil.

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

Utah 39.68175 N 110.48129 W 7946 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G M Bonnin, D Martin, B Lin, T Parzybok, M Yekta, and D Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006
Extracted: Tue Jun 26 2007

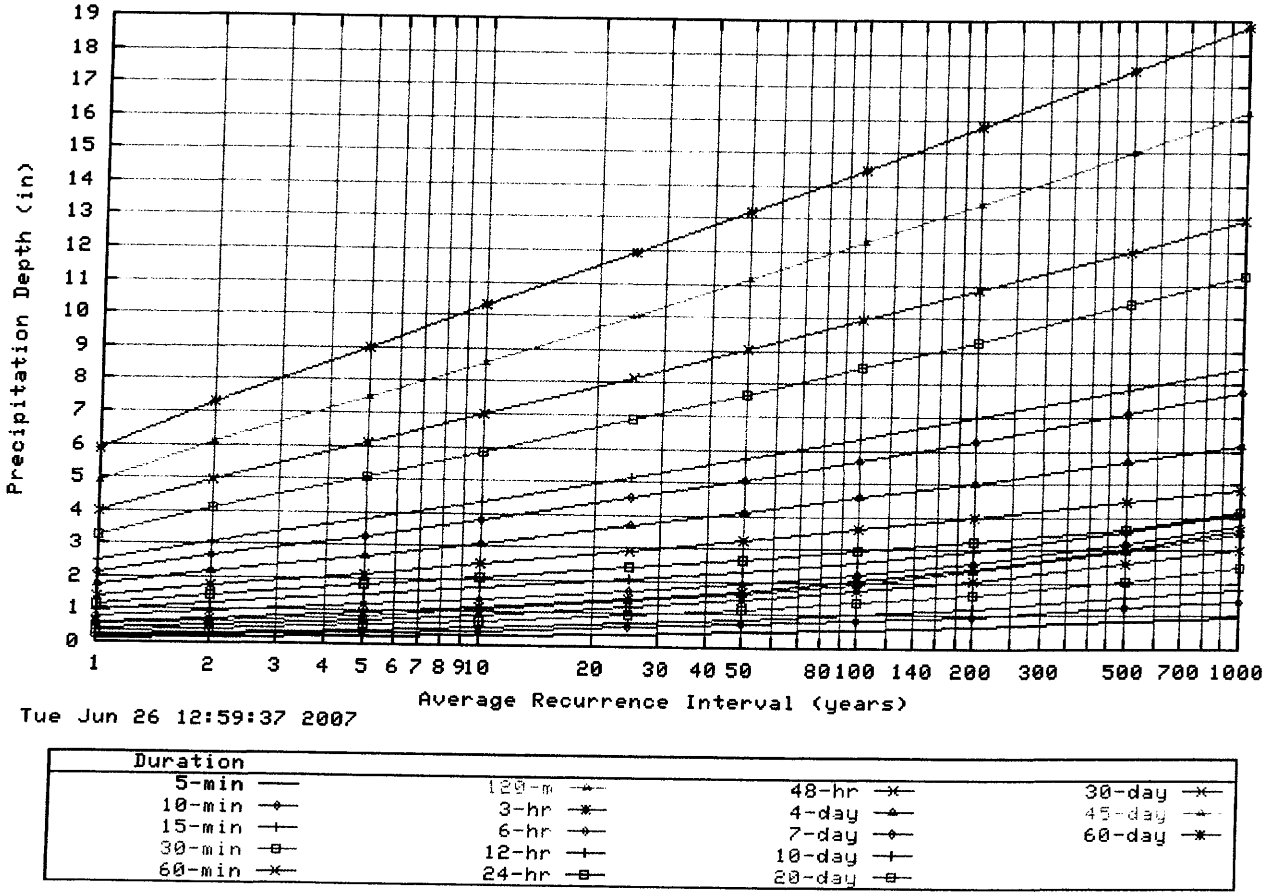
Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.14	0.20	0.25	0.34	0.42	0.52	0.59	0.77	0.99	1.18	1.40	1.74	2.12	2.44	3.26	3.97	4.88	5.83
2	0.17	0.26	0.33	0.44	0.55	0.65	0.74	0.96	1.23	1.46	1.74	2.16	2.65	3.06	4.08	4.95	6.10	7.31
5	0.24	0.36	0.45	0.60	0.74	0.86	0.95	1.19	1.50	1.78	2.13	2.67	3.29	3.78	5.05	6.09	7.50	9.00
10	0.29	0.45	0.55	0.74	0.92	1.06	1.15	1.38	1.73	2.05	2.46	3.08	3.80	4.36	5.82	6.98	8.59	10.29
25	0.38	0.58	0.72	0.97	1.20	1.36	1.45	1.67	2.05	2.40	2.89	3.65	4.52	5.14	6.86	8.15	10.04	11.96
50	0.46	0.70	0.86	1.16	1.44	1.64	1.72	1.92	2.32	2.68	3.24	4.09	5.08	5.74	7.66	9.04	11.15	13.22
100	0.55	0.83	1.03	1.39	1.72	1.96	2.04	2.22	2.60	2.96	3.60	4.55	5.67	6.36	8.48	9.94	12.29	14.50
200	0.65	0.99	1.23	1.66	2.05	2.33	2.41	2.57	2.94	3.25	3.96	5.03	6.28	7.00	9.31	10.84	13.44	15.78
500	0.82	1.24	1.54	2.08	2.57	2.93	3.03	3.18	3.53	3.64	4.45	5.67	7.11	7.86	10.44	12.03	14.99	17.48
1000	0.97	1.47	1.83	2.46	3.04	3.49	3.59	3.74	4.09	4.13	4.84	6.17	7.77	8.53	11.30	12.94	16.22	18.80

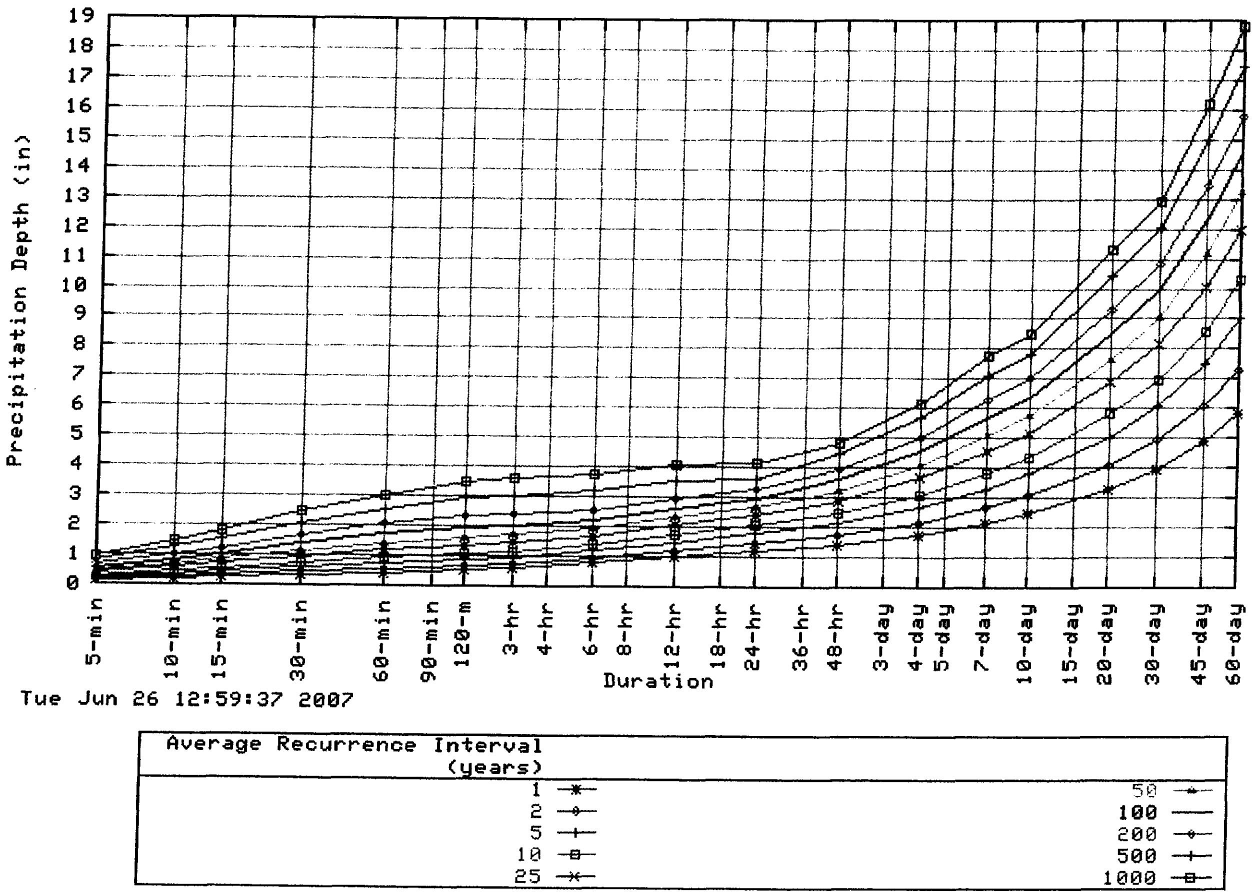
Text version of table

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval. Please refer to the documentation for more information. NOTE: Formatting forces estimates near zero to appear as zero.

Partial duration based Point Precipitation Frequency Estimates Version: 4
39.68175 N 110.48129 W 7946 ft



Partial duration based Point Precipitation Frequency Estimates Version: 4
39.68175 N 110.48129 W 7946 ft



Confidence Limits -

* Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)																		
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.16	0.24	0.30	0.41	0.51	0.60	0.69	0.88	1.11	1.31	1.56	1.94	2.41	2.74	3.65	4.43	5.44	6.49
2	0.21	0.32	0.39	0.53	0.65	0.76	0.86	1.09	1.38	1.63	1.94	2.42	3.01	3.42	4.56	5.54	6.80	8.12
5	0.28	0.43	0.53	0.72	0.89	1.01	1.11	1.35	1.68	2.00	2.38	2.98	3.73	4.24	5.66	6.80	8.37	10.00
10	0.35	0.53	0.66	0.89	1.10	1.24	1.33	1.58	1.94	2.29	2.74	3.44	4.33	4.89	6.53	7.79	9.60	11.44
25	0.46	0.69	0.86	1.16	1.43	1.60	1.69	1.91	2.32	2.69	3.23	4.08	5.15	5.76	7.70	9.12	11.24	13.33
50	0.55	0.83	1.04	1.40	1.73	1.93	2.01	2.21	2.63	3.00	3.62	4.58	5.80	6.45	8.61	10.14	12.51	14.77
100	0.66	1.00	1.24	1.67	2.07	2.33	2.40	2.58	2.97	3.33	4.03	5.11	6.50	7.17	9.55	11.18	13.80	16.25
200	0.79	1.20	1.49	2.01	2.49	2.79	2.87	3.01	3.38	3.66	4.45	5.65	7.22	7.91	10.53	12.23	15.15	17.77
500	1.01	1.54	1.90	2.56	3.17	3.59	3.67	3.79	4.13	4.17	5.04	6.42	8.24	8.93	11.88	13.66	17.01	19.80
1000	1.22	1.85	2.30	3.09	3.83	4.35	4.43	4.52	4.85	4.90	5.51	7.04	9.06	9.75	12.94	14.77	18.49	21.43

* The **upper** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **greater** than.
** These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

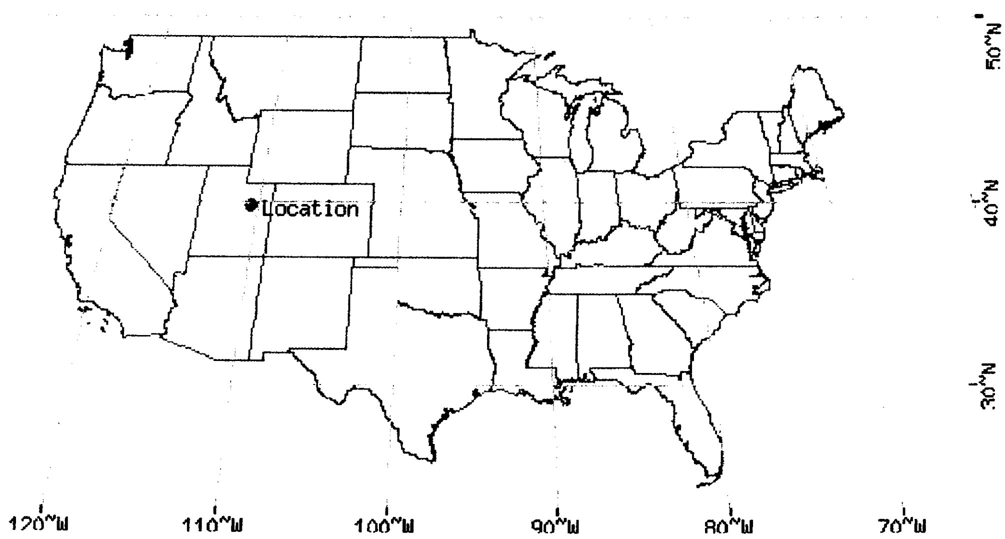
*** Lower bound of the 90% confidence interval**

Precipitation Frequency Estimates (inches)																		
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.12	0.18	0.22	0.29	0.36	0.45	0.52	0.69	0.90	1.07	1.26	1.56	1.89	2.19	2.94	3.59	4.41	5.28
2	0.15	0.23	0.28	0.38	0.47	0.57	0.65	0.85	1.11	1.32	1.57	1.95	2.36	2.75	3.68	4.48	5.51	6.61
5	0.20	0.31	0.38	0.52	0.64	0.75	0.84	1.05	1.34	1.61	1.92	2.39	2.92	3.38	4.53	5.49	6.75	8.10
10	0.25	0.38	0.47	0.63	0.79	0.90	1.00	1.22	1.54	1.84	2.20	2.75	3.37	3.88	5.22	6.26	7.69	9.22
25	0.32	0.48	0.59	0.80	0.99	1.14	1.24	1.45	1.81	2.15	2.58	3.23	3.97	4.55	6.10	7.27	8.94	10.66
50	0.37	0.56	0.70	0.94	1.17	1.34	1.44	1.65	2.02	2.39	2.86	3.60	4.43	5.05	6.76	8.02	9.86	11.71
100	0.43	0.66	0.82	1.10	1.36	1.56	1.67	1.88	2.23	2.62	3.15	3.97	4.90	5.55	7.41	8.75	10.78	12.73
200	0.50	0.76	0.94	1.27	1.57	1.81	1.93	2.13	2.48	2.85	3.44	4.34	5.36	6.06	8.07	9.47	11.69	13.73
500	0.60	0.91	1.13	1.52	1.88	2.17	2.32	2.56	2.93	3.15	3.81	4.82	5.99	6.71	8.90	10.36	12.86	15.01
1000	0.68	1.04	1.29	1.73	2.15	2.48	2.65	2.94	3.34	3.38	4.10	5.18	6.46	7.19	9.53	11.03	13.76	15.97

* The lower bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are less than.
** These precipitation frequency estimates are based on a partial duration maxima series. ARI is the Average Recurrence Interval.

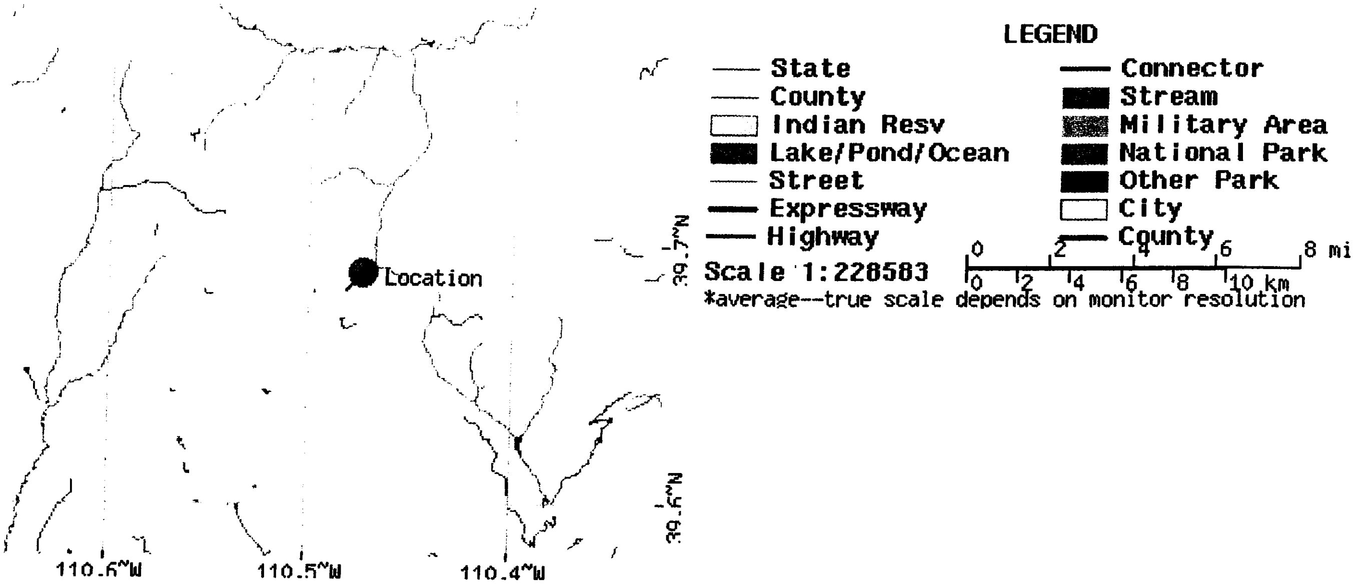
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

Maps -



These maps were produced using a direct map request from the
U.S. Census Bureau Mapping and Cartographic Resources
Tiger Map Server.

Please read disclaimer for more information.



Other Maps/Photographs -

View USGS digital orthophoto quadrangle (DOQ) covering this location from TerraServer; **USGS Aerial Photograph** may also be available
from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the USGS for more information.

Watershed/Stream Flow Information -

Find the Watershed for this location using the U.S. Environmental Protection Agency's site.

Climate Data Sources -

Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study, please refer to our documentation.

Using the National Climatic Data Center's (NCDC) station search engine, locate other climate stations within:

[+/-30 minutes] ...OR... [+/-1 degree] of this location (39.68175/-110.48129). Digital ASCII data can be obtained directly from NCDC.

Find Natural Resources Conservation Service (NRCS) SNOTEL (SNOwpack TELemetry) stations by visiting the **Western Regional Climate Center's state-specific SNOTEL station maps**.

Hydrometeorological Design Studies Center
DOC/NOAA/National Weather Service
1325 East-West Highway
Silver Spring, MD 20910

(301) 713-1669
Questions? HDSC.Questions@noaa.gov

Disclaimer

NUREG/CR-4651
ORNL/TM-10100

Development of Riprap Design Criteria by Riprap Testing in Flumes: Phase I

Prepared by S. R. Abt, M. S. Khattak, J. D. Nelson,
J. F. Ruff, A. Shaikh, R. J. Wittler/CSU
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Prepared for
U.S. Nuclear Regulatory Commission

4.3.1 Estimating Manning's n for Cascading Flow

The average Manning's roughness value, n, was computed for each failure test based on flow velocities and depths measured prior to failure, and are plotted versus the median stone size, D_{50}, in Fig. 4.7. It is observed in Fig. 4.7 that the n values for 1% and 2% slopes fall closely to the solid line representing a relationship developed by Anderson et al. (see Section 4.3.2). However, the n value for each stone size increased as the slope of the embankment increased, and the n value is over 40% higher when Depth/D_{50} < 2 (cascading flow conditions) than when Depth/D_{50} is greater than 2 (Table 4.8).

A median stone size-slope parameter (D_{50} x S) was correlated to the Manning's n value for the CSU data as presented in Fig. 4.8. Combining the median stone size and slope in one parameter appears to have reduced the data scatter. The relationship can be expressed as:

$$n = 0.0456\ (D_{50} \times S)^{0.159} \qquad (4.8)$$

where D_{50} is in inches. The correlation coefficient, r^2, is 0.90. Therefore, a Manning's n value can be estimated for a riprapped surface in cascading flow as a function of the median stone size and slope.

4.3.2 Comparison of Procedures

A commonly used expression for determining Manning's n for riprap was presented by Anderson et al. (1970) as

$$n = 0.0395\ (D_{50})^{1/6} \tag{4.9}$$

where D_{50} is the median stone size in feet. This relationship, which was developed from natural streams with slopes less than 2% for uniform flow conditions over submerged riprap is shown as the solid line in Fig. 4.7. However, the Anderson et al. (1970) relationship is commonly used and extrapolated to estimate roughness on steep slopes. Anderson et al. did not consider the resistance to be a function of slope.

The U.S. Army Corps of Engineers (COE, 1970) have also developed a procedure for estimating Manning's n value. Althrough the COE procedure was formulated for flat slopes and deep flow depths (1-60 ft), it is routinely applied to estimate flow resistance of steep slopes. The Manning's n is calculated as

$$n = \frac{R^{1/6}}{23.85 + 21.95\ \log_{10}\ (R/K)} \tag{4.10}$$

where R is the hydraulic radius and K is the equivalent roughness height in ft. The equivalent roughness for stone lined channels is the theoretical spherical diameter of the median stone size. The hydraulic radius is approximated with the depth of flow in wide channels.

The CSU and Anderson et al. (1970) equations were compared to demonstrate the effect that slope has on the Manning's n. The Manning's n values were approximated by applying Eq. 4.8 and Eq. 4.9 for median stone sizes of 2.2 inches and 5.1 inches on slopes of 1%, 2%, 5%, 10% and 20%.

The results of the analysis (Table 4.9) indicate that at slopes below 2%, the Anderson et al. equation yields slightly greater n values (approximately 10%) than does the CSU equation. The CSU and Anderson et al. relations coincide at a slope between 2% and 5%.

The CSU and Anderson et al. relations yield significantly different Manning's n values at steep slopes ($\geq$10%). The Anderson et al. n value remains constant at 0.034 for a 5.1-inch stone (D_{50}) for all slopes. However, the CSU equation yields an n value of 0.046 for a 5.1-inch stone (D_{50}) at 20% slope, a value 35% greater than predicted by Anderson et al. It is evident that the Anderson et al. formulation can lead to erroneous designs if applied to slopes greater than 2%.

An attempt was also made to compare the Manning's n value from the U.S. Army Corps of Engineers procedure (COE, 1970) with the CSU results presented in Fig. 4.8. As observed in Table 4.9, the COE n values are less than the Anderson et al. and CSU values at slopes less than 10%. However, the COE value meets or exceeds the Anderson et al. and CSU n values for slopes of 10% or greater.

It should be noted that the CSU equation was based on computed average n values and does not indicate the upper range of localized n values which extended from 0.06 to 0.08. Appendix C, Summary of Hydraulic Data, presents the localized n values resulting from each test of the testing program.

4.3.3 Bed Critical Shields' Coefficient

The bed critical Shields' coefficient, C_c, was computed for each test as presented in Table 4.6 and Table 4.7. The Shields' coefficient of each

Reference: Use of Riprap for Bank Protection
Hydraulic Engineering Circular No. 11
USDOT Federal Highway Adm 1978

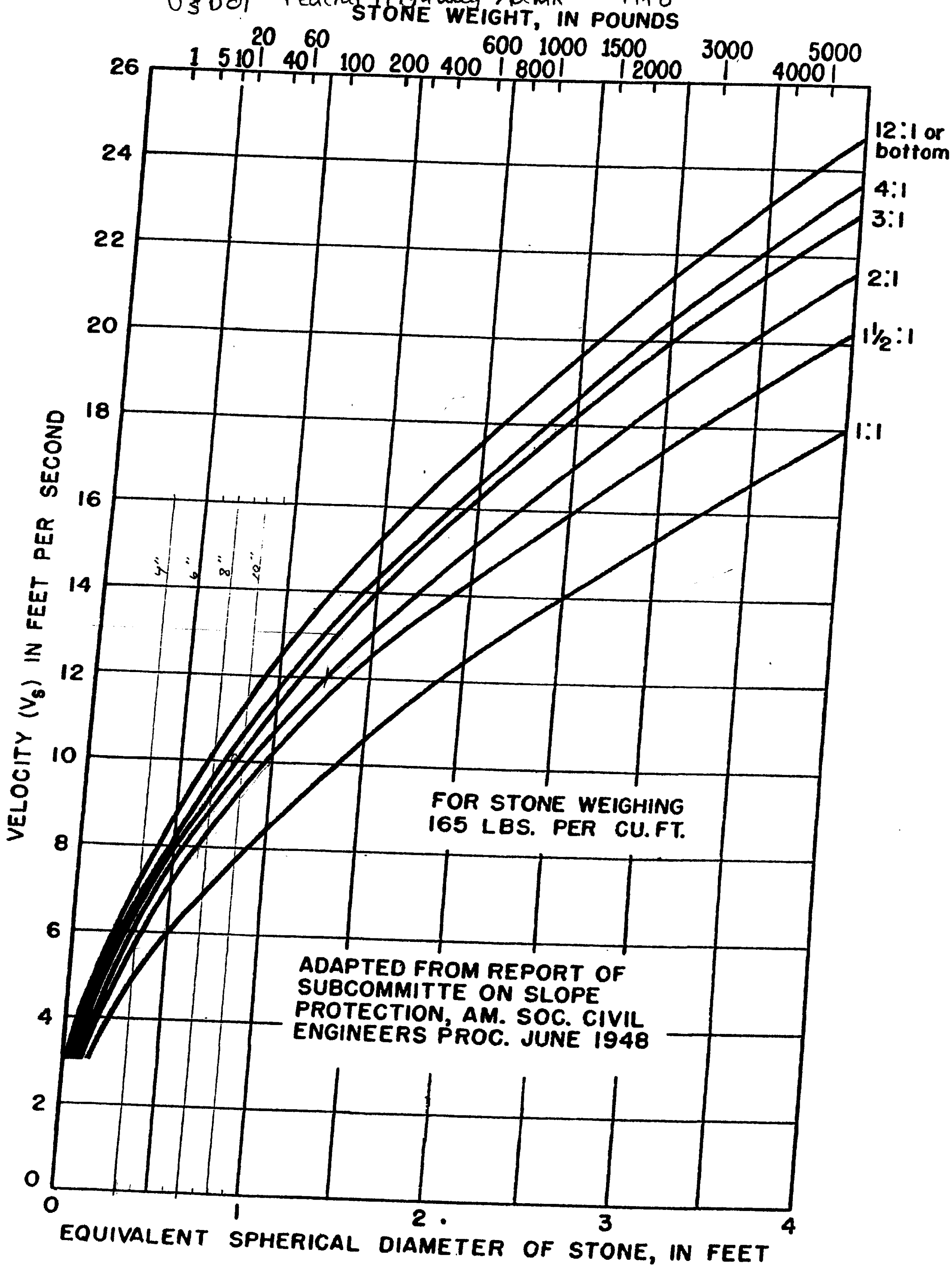


FIG. 2 - SIZE OF STONE THAT WILL RESIST DISPLACEMENT FOR VARIOUS VELOCITIES AND SIDE SLOPES

Table 4.13 Calculations for Example Problem 4.19

D_{50}[a]	Manning's n	Depth to convey flow (ft)	Maximum tractive force on channel bed (lb/ft²)	Channel bed stability factor (η_b)	Safety factor for channel bed (SF_b)	Maximum tractive force on walls (lb/ft²)	Channel wall stability factor (η')	Channel wall safety factor (SF)
1.7	0.043	0.72	4.49	0.541	1.53	3.41	0.308	1.36
2.0	0.044	0.73	4.58	0.467	1.72	3.48	0.268	1.45
2.5	0.046	0.75	4.68	0.382	2.02	3.56	0.220	1.56
2.2	0.045	0.74	4.62	0.429	1.84	3.51	0.247	1.50

[a]Use a riprap with a D_{50} of 2.2 ft for both channel sides and bottom.

From Eq. (4.46),

$$\beta = \tan^{-1}\left[\frac{\cos\lambda}{2\sin\alpha/\eta\tan\phi + \sin\lambda}\right]$$

$$= \tan^{-1}\left[\frac{\cos(5.71)}{2\sin(21.8)/(0.408\tan(42)) + \sin(5.71)}\right].$$

$$\beta = 25.1°$$

From Eq. (4.48),

$$\eta' = \eta\left[\frac{1+\sin(\lambda+\beta)}{2}\right] = 0.408\left[\frac{1+\sin(5.71+25.10)}{2}\right]$$

$$\eta' = 0.308.$$

From Eq. (4.45),

$$SF = \frac{\cos\alpha\tan\phi}{\eta'\tan\phi + \sin\alpha\cos\beta}$$

$$= \frac{\cos(21.8)\tan(42)}{0.308(\tan(42)) + \sin(21.8)\cos(25.1)}$$

$$SF = 1.36.$$

Thus the riprap is stable, but does not have the required safety factor of 1.5. The selection of an acceptable riprap for the channel side slopes will be made using trial and error. The calculations are in Table 4.13. It is assumed that the riprap on the channel bed will be the same as that used on the side slopes. It would obviously be possible to vary the side slopes and channel width to obtain a smaller D_{50}. The final selection of channel dimensions and riprap size would have to be based on economics.

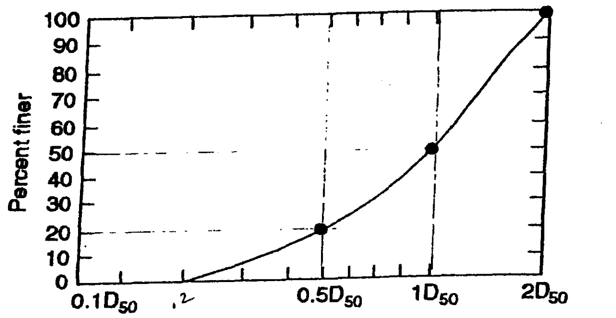


Figure 4.19 Suggested size distribution of riprap (after Simons and Senturk, 1977, 1992).

Selecting Proper Gradation

It is important for a riprap to have a gradation such that the voids between the larger particles are filled with smaller particles to reduce flow beneath the riprap and the formation of open pockets. A suggested gradation for riprap has been made by Simons and Senturk (1977, 1992) based on studies at Colorado State University. The proposed gradation is shown in Fig. 4.19.

Selecting an Underlying Filter

The placement of a properly designed filter blanket underneath the riprap is necessary when the particle size of the riprap is much larger than that of the base material. The following criteria have been established for sizing the filter, based on the size distribution of the riprap and the base material:

(1) $$\frac{D_{50}(\text{filter})}{D_{50}(\text{base})} < 40 \quad \text{also} \quad \frac{D_{50}(\text{riprap})}{D_{50}(\text{filter})} < 40$$

(2) $$5 < \frac{D_{15}(\text{filter})}{D_{15}(\text{base})} < 40 \quad \text{also} \quad 5 < \frac{D_{15}(\text{riprap})}{D_{15}(\text{filter})} < 40$$

(3) $$\frac{D_{15}(\text{filter})}{D_{85}(\text{base})} < 5 \quad \text{also} \quad \frac{D_{15}(\text{riprap})}{D_{85}(\text{filter})} < 5.$$

These criteria were developed for sizing filters around drain pipe to prevent piping of the soil into the

ATTACHMENT 7-1
Hydrology Calculations - Degas Wells G-18 and G-31

REGISTERED PROFESSIONAL ENGINEER
No. 168246
RICHARD B. WHITE
6 JUL 2007
STATE OF UTAH

HYDROLOGY CALCULATIONS
FOR
DEGAS WELL G-18

Stockpile Runoff Volume Calculations

Stockpile	Watershed Area (sq. ft.)	Watershed Area (acres)	Precip. - ***P*** (in)	Curve Number (*CN*)	Potential Max. Retention - ***S*** (in.)	Runoff - ***Q*** (in)	Runoff Volume - ***V*** (ft^3)
STP-4	14,734	0.34	2.05	87	1.49	0.94	1,160
STP-5	7,895	0.18	2.05	87	1.49	0.94	622

Notes

Calculations have been performed for the 10-year, 24-hour design storm event.

Topsoil is derived from the Midfork Family - Comodore Complex, as described in the NRCS Soil Survey for Carbon Area, Parts of Carbon and Emery Counties.

Calculations based on Soil Conservation Service (SCS) Method, National Engineering Handbook Section 4, Chapters 9 & 10 by Victor Mockus, 1972

Precipitation for 10-year, 24-hour event taken from National Weather Service web site (http://hdsc.nws.noaa.gov/hdsc/pfds/sa/ut_pfds.html)

CN = 87, based on Table 9.1, NEH s4 ch9. Assume Hyd. Soil Gp. C (as given for Rottulee family - Trag complex in NRCS survey). Assume road, dirt surface (non-vegetated, conservative case).

$S = (1000/CN) - 10$

$L = [(l^{0.8}(S+1)^{0.7}]/(1900Y^{0.5})$

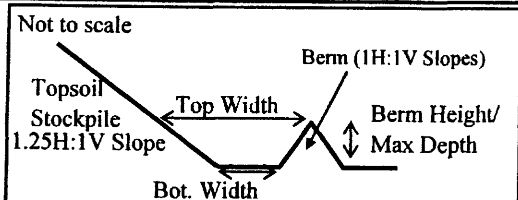
$T_c = 1.67L$

$Q = (P - 0.2*S)^2 / (P + 0.8*S)$

$V = Area * Q$

Stockpile Runoff Containment Volume Calculations

Stockpile	Bottom Width (ft)	Top Width (ft)	Max Depth (ft)	Impounding Length of Berm (ft)	Total Length of Berm (ft)	Fill Req'd for Berm (yd^3)	Cntnmt Vol. (ft^3)	Contain Vol > Runoff Vol ?
STP-4	2	6.5	2	227	509	75	1,930	Yes
STP-5	2	6.5	2	76	402	60	646	Yes
						135	Total fill for berms (yd^3)	



X-sec. schematic of topsoil stockpile and berm

Notes

The bottom width is the distance between the toe of the topsoil stockpile and the base of the berm. (see schematic)

The top width is the horizontal distance between the crest of the berm and the topsoil stockpile. (see schematic)

The max depth is the height of the berm.

The Impounding Length of the berm accounts for the slope of the ground, and is the portion of the berm that will impound runoff.

The Total Length of Berm is its entire length around the topsoil stockpile.

The Fill Required for Berm is the volume of subsoil required to construct each berm, and is based on the length, height, and width of each berm. Berms shall be constructed with 1H:1V slopes.

The Containment Vol=Length * Cross sectional area of the space between the topsoil stockpile and the inby side of the berm.

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

Utah 39.68175 N 110.48129 W 7946 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Tue Jun 26 2007

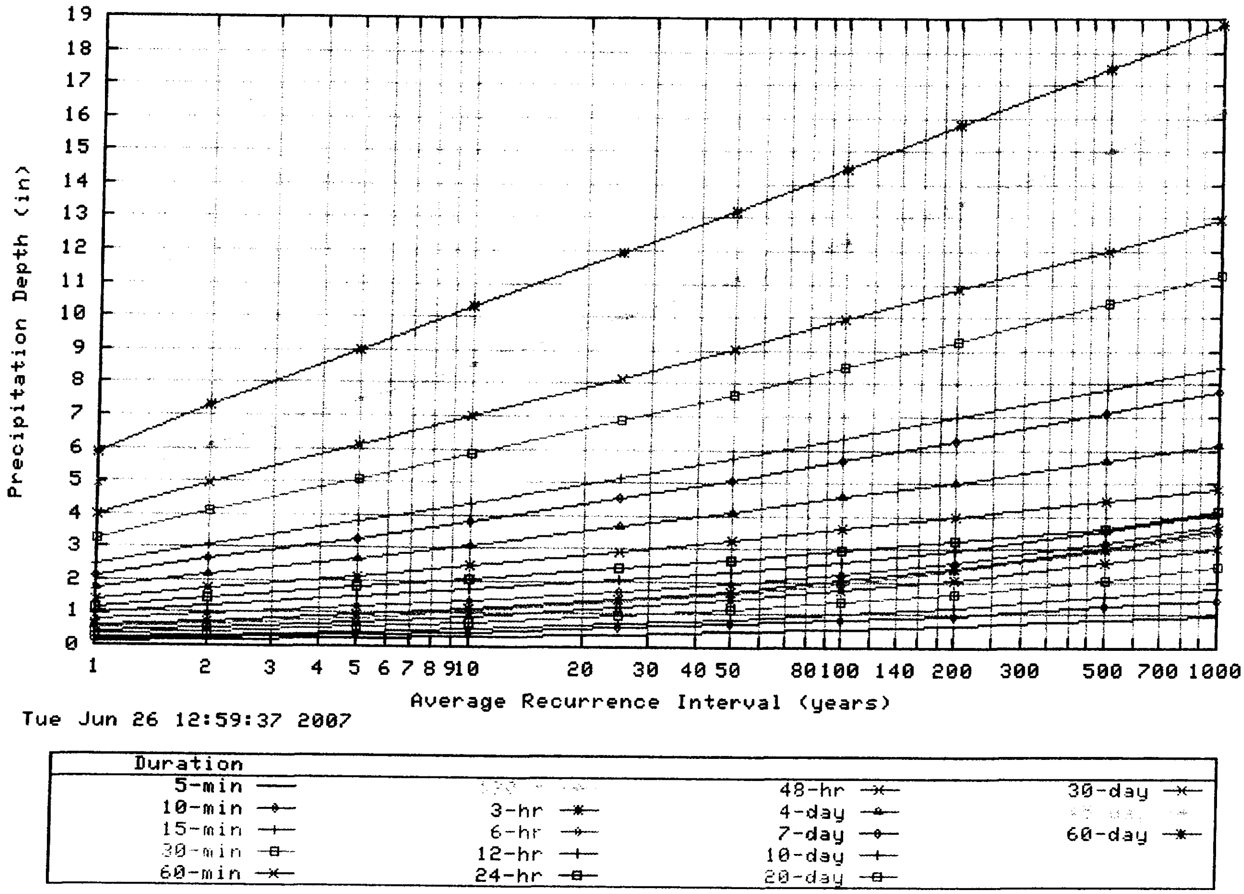
Precipitation Frequency Estimates (inches)

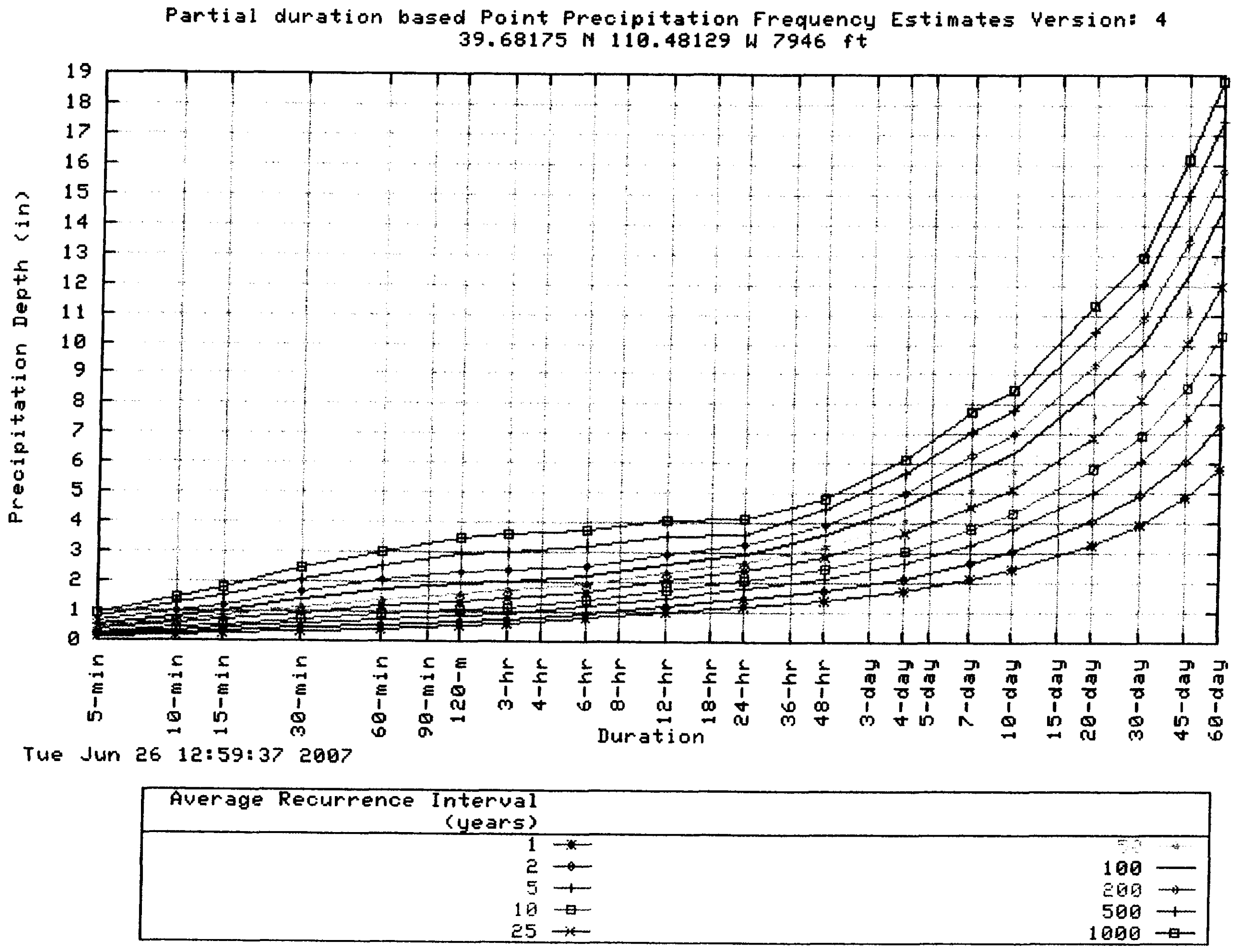
ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.14	0.20	0.25	0.34	0.42	0.52	0.59	0.77	0.99	1.18	1.40	1.74	2.12	2.44	3.26	3.97	4.88	5.83
2	0.17	0.26	0.33	0.44	0.55	0.65	0.74	0.96	1.23	1.46	1.74	2.16	2.65	3.06	4.08	4.95	6.10	7.31
5	0.24	0.36	0.45	0.60	0.74	0.86	0.95	1.19	1.50	1.78	2.13	2.67	3.29	3.78	5.05	6.09	7.50	9.00
10	0.29	0.45	0.55	0.74	0.92	1.06	1.15	1.38	1.73	2.05	2.46	3.08	3.80	4.36	5.82	6.98	8.59	10.29
25	0.38	0.58	0.72	0.97	1.20	1.36	1.45	1.67	2.05	2.40	2.89	3.65	4.52	5.14	6.86	8.15	10.04	11.96
50	0.46	0.70	0.86	1.16	1.44	1.64	1.72	1.92	2.32	2.68	3.24	4.09	5.08	5.74	7.66	9.04	11.15	13.22
100	0.55	0.83	1.03	1.39	1.72	1.96	2.04	2.22	2.60	2.96	3.60	4.55	5.67	6.36	8.48	9.94	12.29	14.50
200	0.65	0.99	1.23	1.66	2.05	2.33	2.41	2.57	2.94	3.25	3.96	5.03	6.28	7.00	9.31	10.84	13.44	15.78
500	0.82	1.24	1.54	2.08	2.57	2.93	3.03	3.18	3.53	3.64	4.45	5.67	7.11	7.86	10.44	12.03	14.99	17.48
1000	0.97	1.47	1.83	2.46	3.04	3.49	3.59	3.74	4.09	4.13	4.84	6.17	7.77	8.53	11.30	12.94	16.22	18.80

Text version of table

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval. Please refer to the documentation for more information. NOTE: Formatting forces estimates near zero to appear as zero.

Partial duration based Point Precipitation Frequency Estimates Version: 4
39.68175 N 110.48129 W 7946 ft





Confidence Limits -

* Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)																	
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.16	0.24	0.30	0.41	0.51	0.60	0.69	0.88	1.11	1.31	1.56	1.94	2.41	2.74	3.65	4.43	5.44	6.49
2	0.21	0.32	0.39	0.53	0.65	0.76	0.86	1.09	1.38	1.63	1.94	2.42	3.01	3.42	4.56	5.54	6.80	8.12
5	0.28	0.43	0.53	0.72	0.89	1.01	1.11	1.35	1.68	2.00	2.38	2.98	3.73	4.24	5.66	6.80	8.37	10.00
10	0.35	0.53	0.66	0.89	1.10	1.24	1.33	1.58	1.94	2.29	2.74	3.44	4.33	4.89	6.53	7.79	9.60	11.44
25	0.46	0.69	0.86	1.16	1.43	1.60	1.69	1.91	2.32	2.69	3.23	4.08	5.15	5.76	7.70	9.12	11.24	13.33
50	0.55	0.83	1.04	1.40	1.73	1.93	2.01	2.21	2.63	3.00	3.62	4.58	5.80	6.45	8.61	10.14	12.51	14.77
100	0.66	1.00	1.24	1.67	2.07	2.33	2.40	2.58	2.97	3.33	4.03	5.11	6.50	7.17	9.55	11.18	13.80	16.25
200	0.79	1.20	1.49	2.01	2.49	2.79	2.87	3.01	3.38	3.66	4.45	5.65	7.22	7.91	10.53	12.23	15.15	17.77
500	1.01	1.54	1.90	2.56	3.17	3.59	3.67	3.79	4.13	4.17	5.04	6.42	8.24	8.93	11.88	13.66	17.01	19.80
1000	1.22	1.85	2.30	3.09	3.83	4.35	4.43	4.52	4.85	4.90	5.51	7.04	9.06	9.75	12.94	14.77	18.49	21.43

* The **upper** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **greater** than.
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Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

* Lower bound of the 90% confidence interval

Precipitation Frequency Estimates (inches)																		
ARI (years)**	**5 min**	**10 min**	**15 min**	**30 min**	**60 min**	**120 min**	**3 hr**	**6 hr**	**12 hr**	**24 hr**	**48 hr**	**4 day**	**7 day**	**10 day**	**20 day**	**30 day**	**45 day**	**60 day**
1	0.12	0.18	0.22	0.29	0.36	0.45	0.52	0.69	0.90	1.07	1.26	1.56	1.89	2.19	2.94	3.59	4.41	5.28
2	0.15	0.23	0.28	0.38	0.47	0.57	0.65	0.85	1.11	1.32	1.57	1.95	2.36	2.75	3.68	4.48	5.51	6.61
5	0.20	0.31	0.38	0.52	0.64	0.75	0.84	1.05	1.34	1.61	1.92	2.39	2.92	3.38	4.53	5.49	6.75	8.10
10	0.25	0.38	0.47	0.63	0.79	0.90	1.00	1.22	1.54	1.84	2.20	2.75	3.37	3.88	5.22	6.26	7.69	9.22
25	0.32	0.48	0.59	0.80	0.99	1.14	1.24	1.45	1.81	2.15	2.58	3.23	3.97	4.55	6.10	7.27	8.94	10.66
50	0.37	0.56	0.70	0.94	1.17	1.34	1.44	1.65	2.02	2.39	2.86	3.60	4.43	5.05	6.76	8.02	9.86	11.71
100	0.43	0.66	0.82	1.10	1.36	1.56	1.67	1.88	2.23	2.62	3.15	3.97	4.90	5.55	7.41	8.75	10.78	12.73
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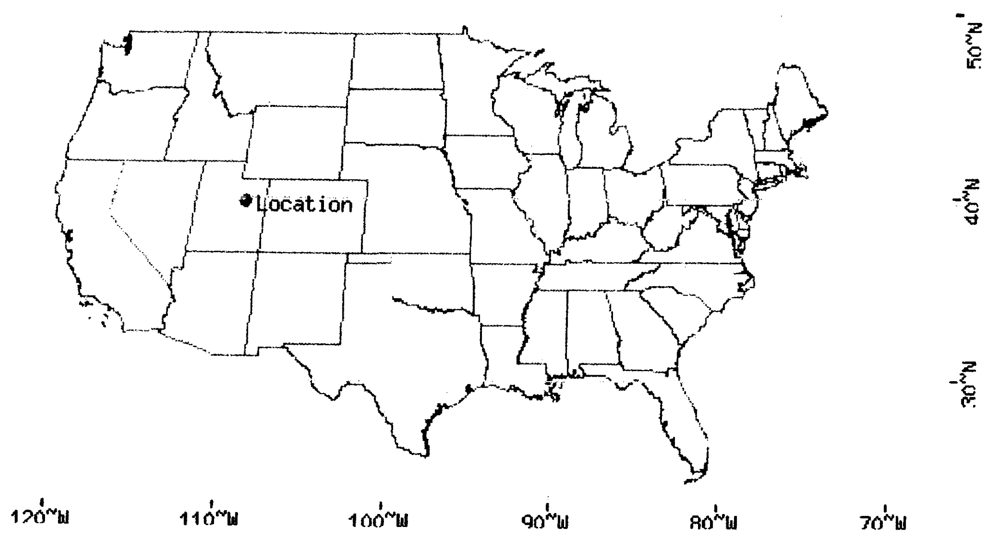
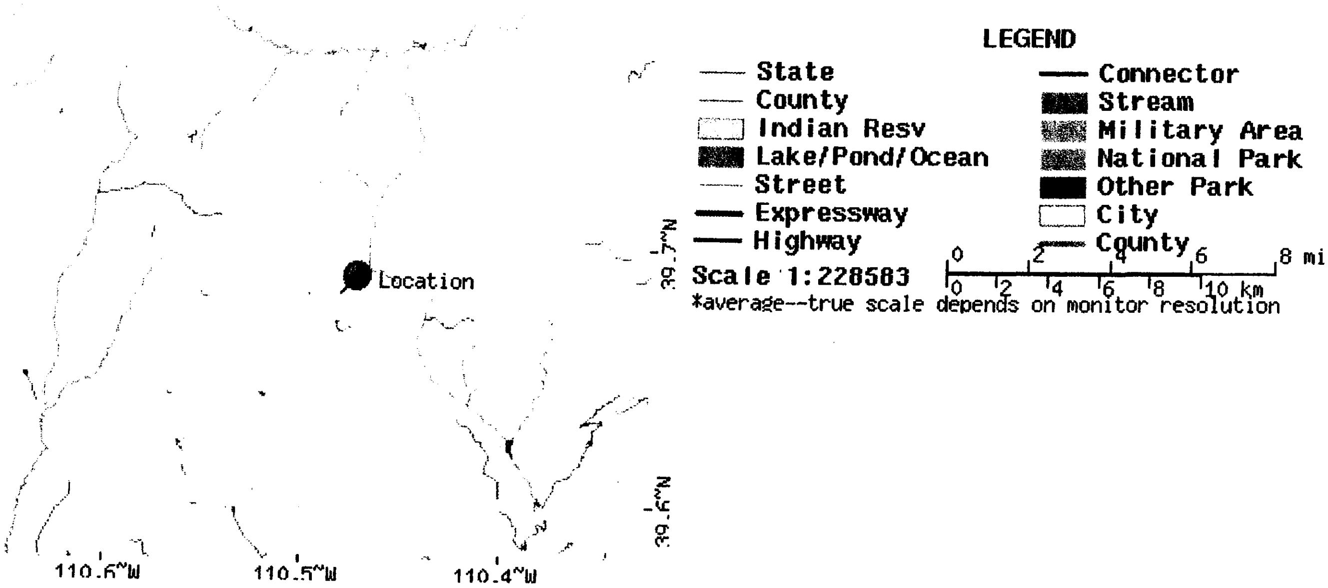
Maps -



These maps were produced using a direct map request from the
U.S. Census Bureau Mapping and Cartographic Resources
Tiger Map Server.

Please read disclaimer for more information.



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View USGS digital orthophoto quadrangle (DOQ) covering this location from TerraServer; **USGS Aerial Photograph** may also be available from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the USGS for more information.

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Using the **National Climatic Data Center's (NCDC)** station search engine, locate other climate stations within:

+/-30 minutes ...OR... +/-1 degree of this location (39.68175/-110.48129). Digital ASCII data can be obtained directly from **NCDC**.

Find Natural Resources Conservation Service (NRCS) SNOTEL (SNOwpack TELemetry) stations by visiting the **Western Regional Climate Center's state-specific SNOTEL station maps**.

Hydrometeorological Design Studies Center
DOC/NOAA/National Weather Service
1325 East-West Highway
Silver Spring, MD 20910
(301) 713-1669
Questions?: HDSC.Questions@noaa.gov

HYDROLOGY CALCULATIONS
FOR
DEGAS WELL G-31

Stockpile Runoff Volume Calculations

Stockpile	Watershed Area (sq. ft.)	Watershed Area (acres)	Precip. - *P* (in)	Curve Number (*CN*)	Potential Max. Retention - *S* (in.)	Runoff - *Q* (in)	Runoff Volume - *V* (ft^3)
STP-6	8,417	0.19	2.05	87	1.49	0.94	663

Notes

Calculations have been performed for the 10-year, 24-hour design storm event.

Topsoil is derived from the Midfork Family - Comodore Complex, as described in the NRCS Soil Survey for Carbon Area, Parts of Carbon and Emery Counties.

Calculations based on Soil Conservation Service (SCS) Method, National Engineering Handbook Section 4, Chapters 9 & 10 by Victor Mockus, 1972

Precipitation for 10-year, 24-hour event taken from National Weather Service web site (http://hdsc.nws.noaa.gov/hdsc/pfds/sa/ut_pfds.html)

CN = 87, based on Table 9.1, NEH s4 ch9. Assume Hyd. Soil Gp. C (as given for Rottulee family - Trag complex in NRCS survey). Assume road, dirt surface (non-vegetated, conservative case).

$S = (1000/CN) - 10$

$L = [(l^{0.8} (S+1)^{0.7}]/(1900Y^{0.5})$

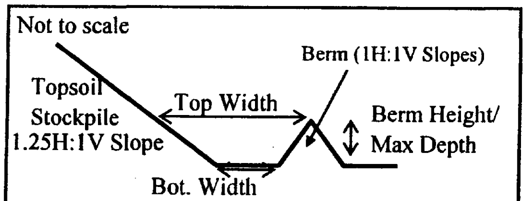
$T_c = 1.67L$

$Q = (P - 0.2*S)^2 / (P + 0.8*S)$

$V = Area * Q$

Stockpile Runoff Containment Volume Calculations

Stockpile	Bottom Width (ft)	Top Width (ft)	Max Depth (ft)	Impounding Length of Berm (ft)	Total Length of Berm (ft)	Fill Req'd for Berm (yd^3)	Cntnmt Vol. (ft^3)	Contain Vol > Runoff Vol ?
STP-6	2	4.25	1	262	513	19	819	Yes



X-sec. schematic of topsoil stockpile and berm

Notes

The bottom width is the distance between the toe of the topsoil stockpile and the base of the berm. (see schematic)

The top width is the horizontal distance between the crest of the berm and the topsoil stockpile. (see schematic)

The max depth is the height of the berm.

The Impounding Length of the berm accounts for the slope of the ground, and is the portion of the berm that will impound runoff.

The Total Length of Berm is its entire length around the topsoil stockpile.

The Fill Required for Berm is the volume of subsoil required to construct each berm, and is based on the length, height, and width of each berm. Berms shall be constructed with 1H:1V slopes.

The Containment Volume = Length * Cross sectional area of the space between the topsoil stockpile and the inby side of the berm.

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

Utah 39.68175 N 110.48129 W 7946 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G M Bonnin, D Martin, B. Lin, T Parzybok, M Yekta, and D Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Tue Jun 26 2007

Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Help | D

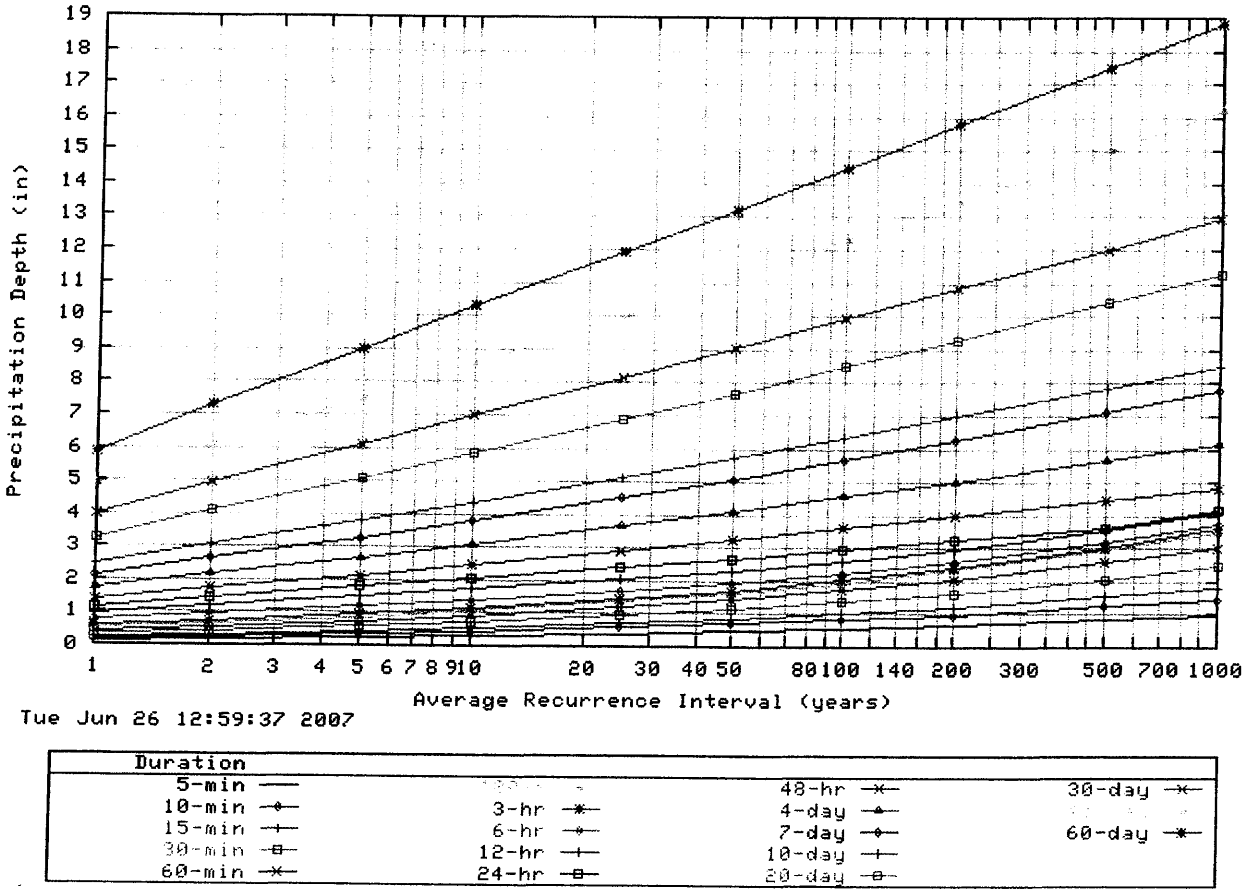
Precipitation Frequency Estimates (inches)

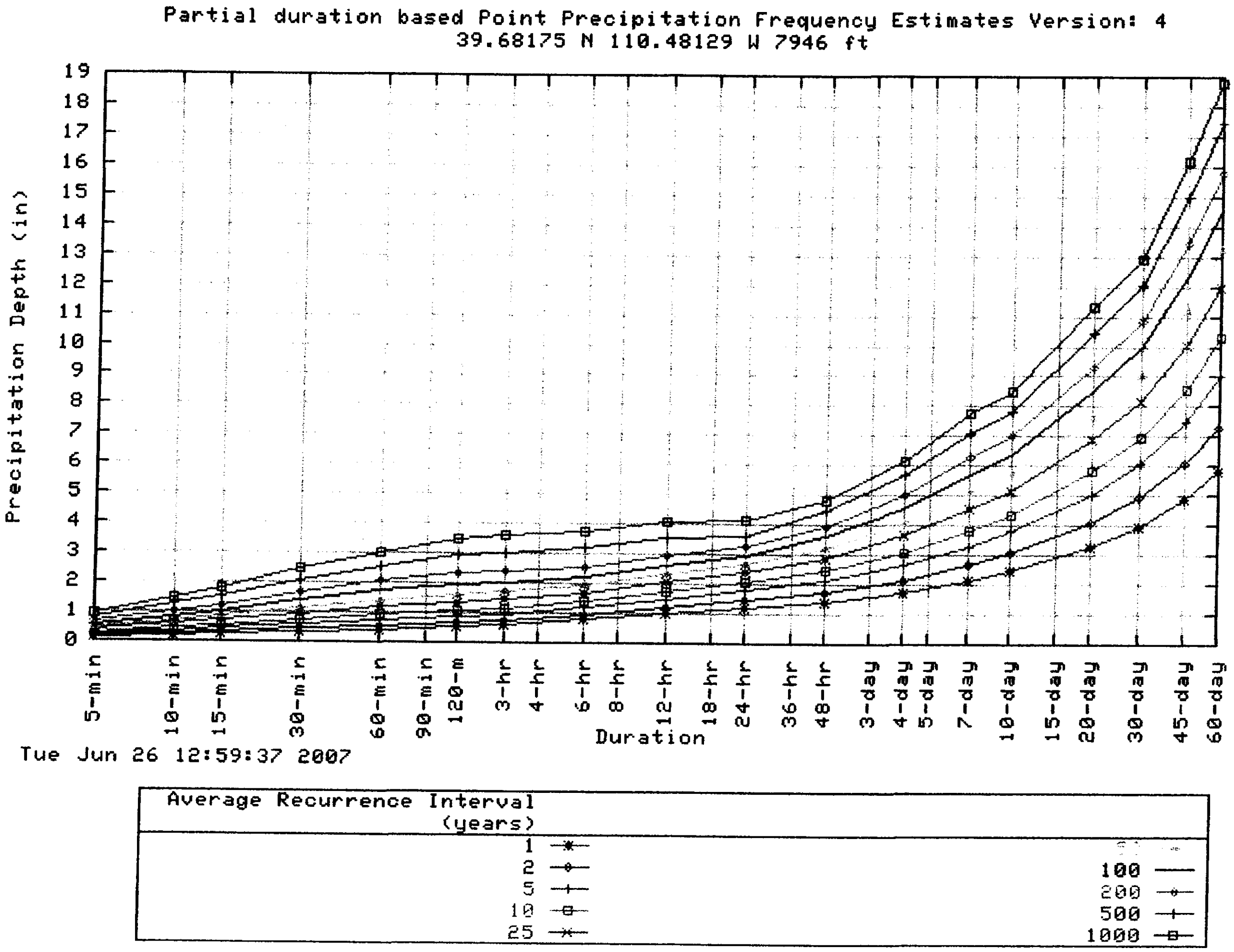
ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.14	0.20	0.25	0.34	0.42	0.52	0.59	0.77	0.99	1.18	1.40	1.74	2.12	2.44	3.26	3.97	4.88	5.83
2	0.17	0.26	0.33	0.44	0.55	0.65	0.74	0.96	1.23	1.46	1.74	2.16	2.65	3.06	4.08	4.95	6.10	7.31
5	0.24	0.36	0.45	0.60	0.74	0.86	0.95	1.19	1.50	1.78	2.13	2.67	3.29	3.78	5.05	6.09	7.50	9.00
10	0.29	0.45	0.55	0.74	0.92	1.06	1.15	1.38	1.73	2.05	2.46	3.08	3.80	4.36	5.82	6.98	8.59	10.29
25	0.38	0.58	0.72	0.97	1.20	1.36	1.45	1.67	2.05	2.40	2.89	3.65	4.52	5.14	6.86	8.15	10.04	11.96
50	0.46	0.70	0.86	1.16	1.44	1.64	1.72	1.92	2.32	2.68	3.24	4.09	5.08	5.74	7.66	9.04	11.15	13.22
100	0.55	0.83	1.03	1.39	1.72	1.96	2.04	2.22	2.60	2.96	3.60	4.55	5.67	6.36	8.48	9.94	12.29	14.50
200	0.65	0.99	1.23	1.66	2.05	2.33	2.41	2.57	2.94	3.25	3.96	5.03	6.28	7.00	9.31	10.84	13.44	15.78
500	0.82	1.24	1.54	2.08	2.57	2.93	3.03	3.18	3.53	3.64	4.45	5.67	7.11	7.86	10.44	12.03	14.99	17.48
1000	0.97	1.47	1.83	2.46	3.04	3.49	3.59	3.74	4.09	4.13	4.84	6.17	7.77	8.53	11.30	12.94	16.22	18.80

Text version of table

* These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval. Please refer to the documentation for more information. NOTE: Formatting forces estimates near zero to appear as zero.

Partial duration based Point Precipitation Frequency Estimates Version: 4
39.68175 N 110.48129 W 7946 ft





Confidence Limits -

* Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)																		
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.16	0.24	0.30	0.41	0.51	0.60	0.69	0.88	1.11	1.31	1.56	1.94	2.41	2.74	3.65	4.43	5.44	6.49
2	0.21	0.32	0.39	0.53	0.65	0.76	0.86	1.09	1.38	1.63	1.94	2.42	3.01	3.42	4.56	5.54	6.80	8.12
5	0.28	0.43	0.53	0.72	0.89	1.01	1.11	1.35	1.68	2.00	2.38	2.98	3.73	4.24	5.66	6.80	8.37	10.00
10	0.35	0.53	0.66	0.89	1.10	1.24	1.33	1.58	1.94	2.29	2.74	3.44	4.33	4.89	6.53	7.79	9.60	11.44
25	0.46	0.69	0.86	1.16	1.43	1.60	1.69	1.91	2.32	2.69	3.23	4.08	5.15	5.76	7.70	9.12	11.24	13.33
50	0.55	0.83	1.04	1.40	1.73	1.93	2.01	2.21	2.63	3.00	3.62	4.58	5.80	6.45	8.61	10.14	12.51	14.77
100	0.66	1.00	1.24	1.67	2.07	2.33	2.40	2.58	2.97	3.33	4.03	5.11	6.50	7.17	9.55	11.18	13.80	16.25
200	0.79	1.20	1.49	2.01	2.49	2.79	2.87	3.01	3.38	3.66	4.45	5.65	7.22	7.91	10.53	12.23	15.15	17.77
500	1.01	1.54	1.90	2.56	3.17	3.59	3.67	3.79	4.13	4.17	5.04	6.42	8.24	8.93	11.88	13.66	17.01	19.80
1000	1.22	1.85	2.30	3.09	3.83	4.35	4.43	4.52	4.85	4.90	5.51	7.04	9.06	9.75	12.94	14.77	18.49	21.43

* The **upper** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **greater** than.
** These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

*** Lower bound of the 90% confidence interval**

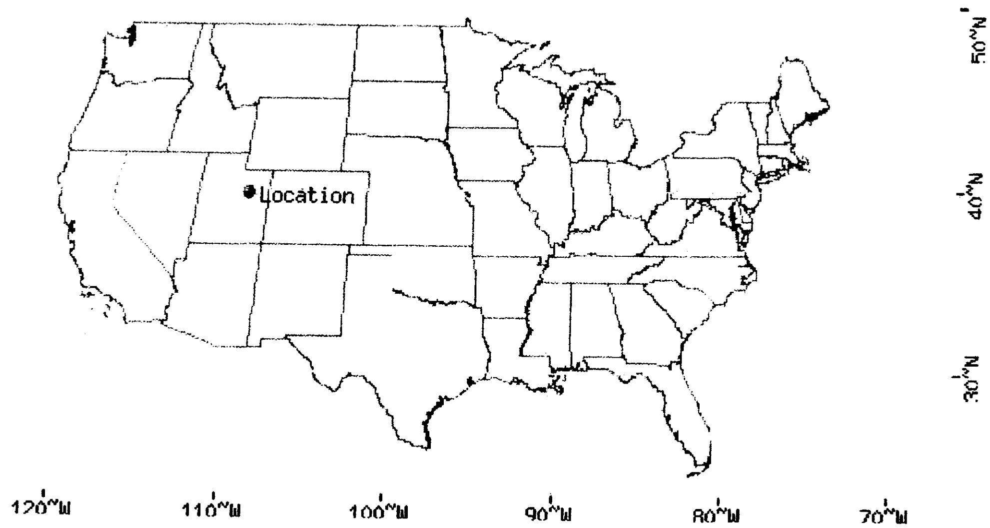
Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.12	0.18	0.22	0.29	0.36	0.45	0.52	0.69	0.90	1.07	1.26	1.56	1.89	2.19	2.94	3.59	4.41	5.28
2	0.15	0.23	0.28	0.38	0.47	0.57	0.65	0.85	1.11	1.32	1.57	1.95	2.36	2.75	3.68	4.48	5.51	6.61
5	0.20	0.31	0.38	0.52	0.64	0.75	0.84	1.05	1.34	1.61	1.92	2.39	2.92	3.38	4.53	5.49	6.75	8.10
10	0.25	0.38	0.47	0.63	0.79	0.90	1.00	1.22	1.54	1.84	2.20	2.75	3.37	3.88	5.22	6.26	7.69	9.22
25	0.32	0.48	0.59	0.80	0.99	1.14	1.24	1.45	1.81	2.15	2.58	3.23	3.97	4.55	6.10	7.27	8.94	10.66
50	0.37	0.56	0.70	0.94	1.17	1.34	1.44	1.65	2.02	2.39	2.86	3.60	4.43	5.05	6.76	8.02	9.86	11.71
100	0.43	0.66	0.82	1.10	1.36	1.56	1.67	1.88	2.23	2.62	3.15	3.97	4.90	5.55	7.41	8.75	10.78	12.73
200	0.50	0.76	0.94	1.27	1.57	1.81	1.93	2.13	2.48	2.85	3.44	4.34	5.36	6.06	8.07	9.47	11.69	13.73
500	0.60	0.91	1.13	1.52	1.88	2.17	2.32	2.56	2.93	3.15	3.81	4.82	5.99	6.71	8.90	10.36	12.86	15.01
1000	0.68	1.04	1.29	1.73	2.15	2.48	2.65	2.94	3.34	3.38	4.10	5.18	6.46	7.19	9.53	11.03	13.76	15.97

* The **lower** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **less** than.
** These precipitation frequency estimates are based on a partial duration maxima series. ARI is the Average Recurrence Interval.

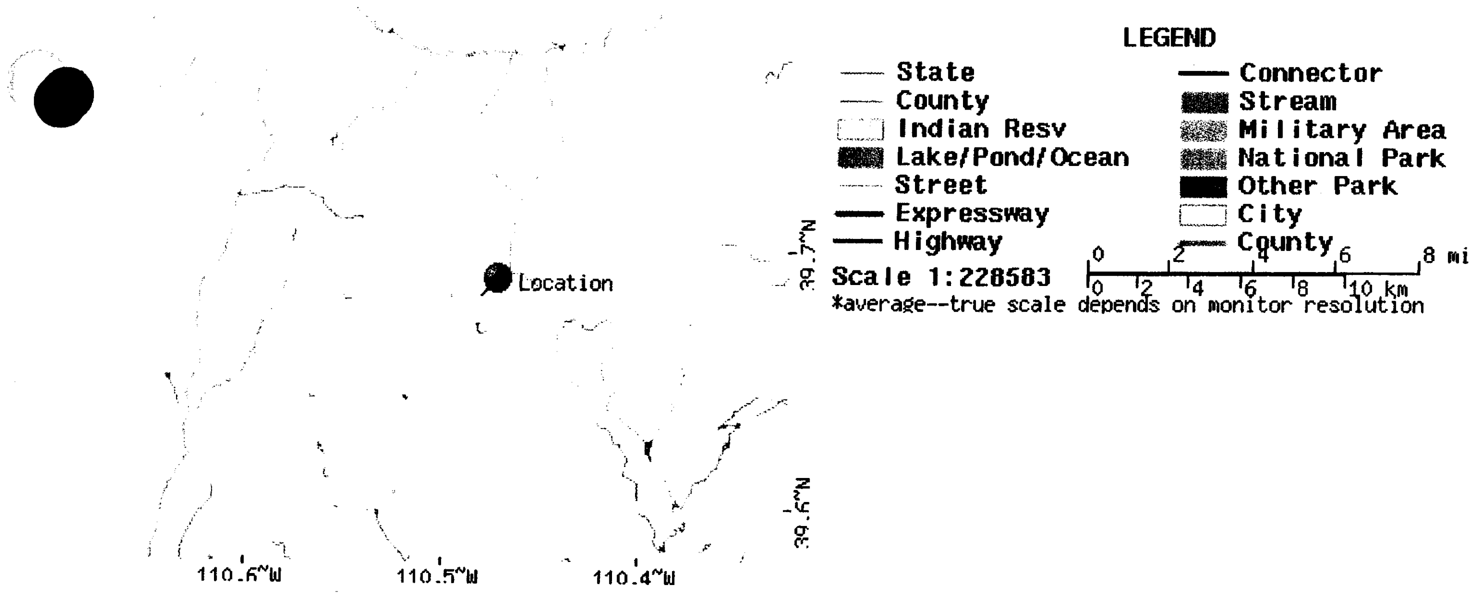
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

Maps -



These maps were produced using a direct map request from the U.S. Census Bureau Mapping and Cartographic Resources Tiger Map Server.

Please read disclaimer for more information.



Other Maps/Photographs -

View USGS digital orthophoto quadrangle (DOQ) covering this location from TerraServer; **USGS Aerial Photograph** may also be available
from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the USGS for more information.

Watershed/Stream Flow Information -

Find the Watershed for this location using the U.S. Environmental Protection Agency's site.

Climate Data Sources -

Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information
about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study,
please refer to our documentation.

Using the **National Climatic Data Center's (NCDC)** station search engine, locate other climate stations within:

[+/-30 minutes] ...OR... [+/-1 degree] of this location (39.68175/-110.48129). Digital ASCII data can be obtained directly from NCDC.

Find Natural Resources Conservation Service (NRCS) SNOTEL (SNOwpack TELemetry) stations by visiting the **Western Regional Climate Center's state-specific SNOTEL station maps**.

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