Department of Energy
Albuquerque Operations Office
P.O. Box 5400
Albuquerque, New Mexico 87115

NOV 17 1989

Mr. Paul H. Lohaus
Branch Chief, Operations Branch
Division of Low-Level Waste
Management & Decommissioning
Office of Nuclear Materials Safety
and Safeguards
Mail Stop 5-E-4
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Lohaus:

In response to your letter of September 5, 1989 addressing issues on the preliminary final Remedial Action Plan for the Rifle, Colorado UMTRA site, the following comments should be helpful in resolving your concerns.

It is agreed that several inconsistencies have been identified as a result of NRC's review of the preliminary final RAP. These discrepancies were confined to the geotechnical section of this document and should not constitute submission of an incomplete document, especially considering the nature of the comments. For the most part, the comments by the NRC focus on the fact that the final design contains additional information beyond the RAP. It is not a case of omitted data or conflicting data, but simply additional data to support the final design. We have revised the identified pages in the RAP and are planning to resubmit the geotechnical section of the RAP by November 30, 1989.

Concerning the NRC's comments on the draft RAP, all NRC comments have been answered. The geotechnical comments (identified as GT-1 through GT-7) were transmitted by DOE to the NRC on September 25, 1989.

As to comments numbered GW-22 through GW-27, we have never received any comments with such a numbering system. NRC indicates these numbers referred to a NRC internal numbering system and are incorrect insofar as comments received by DOE. The corrected numbers should be: SW-8, GW-14, GW-16, and GW-17. All of these comments were on the Environmental Impact Statement (EIS) and not the RAP. Since these were not RAP comments, they have not been provided to the NRC.

The normal DOE procedure on EIS comments is to include the comment and response as part of Section 6 of the final EIS. Your comments on the EIS are included in this section. A publication date for the EIS is still pending as the document is waiting approval by Secretary Watkins of the DOE. A copy of the EIS comments and responses are enclosed here, as they appear in the final EIS.

On October 4, 1989, supplemental data was sent to NRC as outlined in the enclosed letter. The series borehole (MEB) and test pit logs (MET) requested by NRC are provided as an enclosure to this package.

We hope this information will help with the continuation of the Rifle RAP review. Should you have any questions, please contact Frank Bosiljevac of my staff at 844-3941.

Sincerely,

Frank D. Bosiljevac

for

Mark L. Matthews
Acting Project Manager
Uranium Mill Tailings Project Office

Enclosure

cc w/o enclosure:
B. Taber, JEG

RESPONSE TO NRC

COMMENTS SW-8,

EW-14 THROUGH EW-17

drainage region to the north. These design features all serve to divert surface water runoff away from the pile and prevent the headward advancement of drainages into the pile.

6.3.15 Comment (SN-8)

We found significant inconsistencies and voids in the technical data supporting the remedial action, but, more importantly, we have serious reservations about the ability of the proposed design to meet the long-term stability requirements of the EPA standards. We are concerned about both the characteristics of the proposed Estes Gulch disposal site and the resultant, extensive and elaborate design measures necessary to provide stability for the tailings. Erosion protection for the stabilized tailings may be difficult because of the steep slopes adjacent to and upgradient of the disposal site and the need to divert upstream surface water flows around the site. The design also incorporates steep, heavily armored diversion ditches whose satisfactory performance may not be demonstrated without relying on periodic maintenance. We also note that the design for the disposal site does not seem to be consistent with the site's geologic setting. Based on the items mentioned above and the more detailed comments enclosed, we conclude that the proposed remedial action for the Rifle sites has not been shown to provide control of the stabilized tailings for the specified period (200 to 1,000 years). Although you may choose to modify the design for the Estes Gulch site in accordance with our comments to provide reasonable assurance of long-term stability, it may be more prudent to re-examine the site selection process to determine if less costly and more viable disposal alternatives exist. Our review of the DEIS suggests that better sites than Estes Gulch may indeed be reasonably available near Rifle (4).

Response

In response to public concerns, additional design changes have been implemented to specifically control potential erosion problems at the Estes Gulch disposal site. These design modifications are detailed in Section 3.2.4, Disposal at the Estes Gulch site (the preferred alternative) and in A.3, Disposal at the Estes Gulch site. The DOE believes that the conceptual design for the Estes Gulch site complies with the EPA standards (40 CFR 192), and feels the final engineering design assures that the design life specified in the EPA standards would be met. The alternate site selection process used to select the Estes Gulch site is described in detail in Appendix B, Alternatives Analyses. Numerous factors such as geotechnical (e.g., erosional stability) and hydrological (e.g., depth to groundwater) criteria were considered in this process, and the Estes Gulch site had the highest score of the two sites selected for field evaluation. The DOE therefore believes that the Estes Gulch site will provide a tailings disposal site that will meet the requirements of PL 95-604 and the proposed EPA groundwater protection standards.

Response

The inconsistencies and deficiencies in the DEIS have been corrected in the FEIS. Analysis of new and existing data has indicated that the highest average uranium concentration occurs in New Rifle monitor well 593, as shown in Table E.2.15 of the FEIS. The discrepancy concerning the extent of contamination at the Old Rifle site has been corrected, as shown in Section E.2.3.4 under Extent of Contamination.

6.7.38 Comment (GW-14)

The DOE determined that contaminated groundwater at the Old Rifle site would be restored naturally in 1.9 years. Based on our review of the DEIS, this restoration period is highly non-conservative. Specifically, we question the assumption that additional contaminants would not be released to the groundwater by dissolution and disorption of contaminants. If dissolution and desorption occur, the amount of water flux required to restore the contaminated aquifer would be expected to exceed the one pore volume assumed in the DEIS. Numerous research programs have shown that several pore volumes of groundwater are needed to clean up contaminated aquifers because of dissolution and mobilization of constituents sorbed onto the porous media. In addition, we question the assumption that contaminants would migrate at one-half the groundwater flow rate. Some of the contaminants would be expected to be mobile and thus would migrate at the same velocity as groundwater. Migration of other contaminants, however, may by considerably retarded as a result of sorption and precipitation-dissolution reactions which would result in a wide variability of contaminant migration rates relative to groundwater flow rates. The DEIS should be revised to assess natural restoration using conservative assumptions and calculations to present a reasonable range of restoration rates (4).

Response

See Response 6.7.2.

6.7.39 Comment (GW-15)

The DOE used the concentrations of constituents in neutralized groundwater in subsoils beneath the tailings as the source term for contamination. This method underestimates the potential source term because contaminant concentrations in neutralized solutions are generally much lower than in solutions that are in contact with the tailings. In addition, the source term at the Rifle sites may be considerably higher than at other UMTRA Project sites because of the recent operation of raffinate ponds and other onsite activities creating a range of potential

6.7.2 Comment

The conclusion that the minimum amount of time required to flush all contaminants from the alluvial aquifer would be approximately two years is lacking in substantive documentation. Geochemical processes such as absorption, precipitation, etc. do not appear to have been considered in this estimate. Based on similar situations at other UMTRA Project sites, there is evidence that the minimum amount of time for natural flushing at this site would be in the range of many decades and perhaps several centuries. It is misleading for the DEIS to represent a two-year natural cleanup scenario as indicative of what may optimistically occur in the future at the Old Rifle site. This section should be amended to reflect an estimate based on the best available data for this situation (2).

Response

Additional analysis has determined that the flushing times for groundwater contaminants included in the DEIS were preliminary, and they have since been removed from presentation by the DOE. Additional modeling indicates that, at the Old and New Rifle sites, natural flushing would reduce concentrations of conservative contaminant species to background levels in the alluvium within 10 years after the tailings have been removed at the Old Rifle site. and within 50 years at the New Rifle site. However, natural flushing of non-conservative (geochemically reactive) species could require considerably more time and require active aquifer restoration. Natural flushing in the underlying Wasatch Formation within 100 years would be negligible because of the formation's low hydraulic conductivity.

For all of the action alternatives, natural flushing with proper institutional controls would eventually bring contaminant concentrations at the Old and New Rifle sites into compliance with MCLs However, for stabilization at the New Rifle site, periods of flooding of the Colorado River could cause periodic exceedance of the proposed standards. If natural flushing is not sufficient to reduce all concentrations to MCLs or background within 100 years, or if period flooding causes periodic exceedance of the proposed groundwater protection standards, then design modifications, active aquifer restoration, active restoration in combination with natural flushing, or ACLs would be required to ensure compliance. The need for and extent of aquifer restoration will be evaluated under a separate NEPA decision-making process when the final groundwater protection standards are promulgated. Sections 5.5.2 and E.2.4 have been revised to reflect this new information.

6.7.3 Comment

There is no existing law in Colorado that gives the state authority to regulate or prevent access to a private well in an

contaminants. The DOE should collect representative samples of tailings material and/or tailings pore water. The DEIS should be revised to characterize the contaminant source term (4).

Response

Samples of groundwater commingled with tailings fluids collected from wells screened below the tailings piles were used to characterize the source, as they are the best available indicators of the chemistry of the source. As part of the geochemical characterization of the Rifle sites, lysimeter samples of tailings fluids will be collected and analyzed to better evaluate the source.

6.7.40 Comment (GW-16)

The DOE claims that irrigation water is no longer percolating through the tailings, thereby inferring that irrigation of the tailings piles has ceased. However, during a site visit on June 11, 1987, we observed the New Rifle tailings pile being irrigated at a rate of 700 gallons per minute for about 8 hours per day. Therefore, additional leachate may be percolating downward into the alluvial groundwater system at the New Rifle site. The DEIS should be revised to indicate that irrigation is ongoing and that additional leachate is being produced (4).

Response

The DOE concurs with this comment. The tailings pile at the New Rifle site is currently being irrigated as a dust control measure, as stated in Section 4.2.1. The additional leachate produced is contributing to the groundwater contamination problem at the New Rifle site.

6.7.41 Comment (GW-17)

The DOE claims that sufficient data are not available for calculating natural restoration rates for the aquifers at the New Rifle site. Natural restoration represents, in part, the no action alternative for assessing environmental impacts associated with remedial actions at Rifle. If impacts associated with natural restoration cannot be assessed, then the DOE cannot compare these impacts to water quality impacts for tailings stabilization at the New Rife site. The DEIS should be revised to sufficiently characterize the groundwater systems at the New Rifle site to assess natural restoration and to evaluate the environmental impacts (4).

Response

See Response 6.7.18.

6.7.42 Comment

Accepting the estimated flushing time of 45 years to lower pollutant concentrations in the alluvial aquifer at the Old and New Rifle sites to background levels, the proposed program of long-term institutional controls to prohibit the use of groundwater from the affected zones does seem to be a reasonable and acceptable approach. However, for the contaminated zone in the Wasatch Formation at the New Rifle site, this approach does not seem to be a viable control mechanism in view of the projected flushing time of 3,840 years. It may well be that future utilization of this aquifer at this location is not a critical concern; however, an approach other than institutional controls would be needed if there is a definite need to protect public health in the event of use (5).

Response

See Responses 6.7.2 and 6.7.4.

6.7.43 Comment

The statement "Groundwater was not encountered in the three monitor wells drilled (maximum depth of 203 feet) at the Lucas Mesa site; . . ." is made in the DEIS. This finding raises doubt about the need for the inclusion of the bentonite in the radon barrier at the Lucas Mesa site and the prediction that the migration of pollutants could reach groundwater in approximately 500 years (as opposed to 800 years at the Estes Gulch site). Moreover, it undermines the credibility of the conclusion presented on the second page of the cover sheet (i.e., "Also, groundwater contamination could occur at the Lucas Mesa site in a short period of time"). There is no justification for the implication of a greater groundwater pollution potential at the Lucas Mesa site in comparison to the Estes Gulch site (5).

Response

In response to public concern, the Lucas Mesa groundwater characterization (Sections 4.6.2 and E.2.3.7) has been revised in the FEIS. However, additional analysis has determined that the travel time estimates to contaminate groundwater beneath the proposed disposal sites included in the DEIS were preliminary, and they have since been removed from presentation by the DOE. See Responses 6.7.2 and 6.7.22 for additional information on

estimated value of contaminated groundwater presented is based on the current known extent of contamination and the volume of groundwater likely to become contaminated during the period when contaminants are being flushed from the aquifer. The DOE has estimated that conservative (geochemically nonreactive) species will be flushed to background concentrations within fifty years in the alluvium beneath the New Rifle site and within ten years in the alluvium beneath the Old Rifle site. However, the total number of pore volumes required to flush the geochemically reactive species from the alluvium is presently unknown, and hence the value of contaminated groundwater cannot be accurately assessed. The value of groundwater will be addressed with considerably more detail during the aquifer restoration phase.

6.7.18 Comment

The cost estimates for aquifer restoration exclude a plume management scenario, which could be the most cost-effective approach of cleaning up the tailings sites. Plume management and capture options should be further addressed in the FEIS. It is not necessarily true that plume management or capture is complicated and made more costly by the presence of the Colorado River adjacent to the contaminant plumes (2).

Response

Cost estimates for aquifer restoration are not addressed in detail in the final EIS. A detailed review of the various possibilities for aquifer restoration at the Old and New Rifle sites will be evaluated in a separate NEPA decision-making process.

6.7.19 Comment

No data are given on the soluble chemical content of the tailings. Heavy metals are stated to be present, but no data on concentrations are given. A thorough chemical analysis to determine soluble and insoluble constituents is necessary before developing a disposal plan. Both concentrations and ranges are necessary (3).

Response

The only existing data on soluble chemical content of the tailings was unacceptable according to UMTRA quality assurance/quality control (QA/QC) standards. The contaminant source was characterized using analytical results from monitor wells screened beneath the tailings piles at both sites (Sections E.2.3.4 and E.2.3.5). This provides a good indication of the geochemical mobility of heavy metals and other chemical constituents within the contaminant source.

MET AND MEB

BOREHOLE AND TEST

PIT LOGS

ESTES GULCH DISPOSAL SITE

5025-RFL-R-01-00750-02
4256U/0125U

LOG OF TEST BORING

Date Drilled 9/27/8[illegible] **Field Engineer** Baker **Boring Number** MEB-2

Location N56915.00 [illegible]2155.00 **Elevation** 6020.70

Diameter 6 inches **Total Depth** 25 Feet **Water Table** None Encountered 9/27/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		St	18/6 30/6 22/6	Clay, silty, very stiff to hard, dry, light brown, (CL) with chemical deposits	
	5	St	5/6 5/6 5/6		
		St	7/6 12/6 16/6		
	10	St	15/6 17/6 27/6		
		St	20/6 32/6 36/6	Clay, silty, sandy, hard, dry, light brown, (CL), heavy chemical deposits, some scattered gravels, maximum size 1 inch, subangular	2- 50 pound samples
BULK	15	St	20/6 42/6 60/5		
		St	26/6 36/6 58/6		
CORE	20			Formational material, sandstone, clayey, soft to medium hard, intensely weathered, lightly fractured, gray No laminations or bedding planes apparent	Core from 20 feet to 25 feet Recovery = $\frac{57''}{60''}$ RQD = 0 rock was not hard and sound
	25			Bottom of Test Boring at 25 Feet	

Project Name RFL-87-01, Rifle, Colorado **Project Number** 4870540E **Figure** _____

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING

Date Drilled 11/87 **Field Engineer** Baker **Boring Number** MEB-3

Location N56850.00 E53555.00 **Elevation** 6032.40

Diameter 6" hollow stem **Total Depth** 11 1/2 Feet **Water Table** None Encountered 9/10/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		ST	4/6 6/6	Clay,sandy,silty,medium stiff,dry, light brown (CL) low plasticity approximately 40% sand	
	5	ST	18/6 24/6 29/4	Formational material,sandstone,clayey weathered, gray harder with depth Gravels & shale chips encountered	Core from 7 feet to 11 1/2 feet No Recovery
	10	Core		Harder at 11 Feet	
				Bottom of Test Boring at 11 1/2 Feet	
	15				
	20				
	25				

Project Name RFL-87-01, Rifle, Colorado **Project Number** M870540E **Figure** _____

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING

Date Drilled 9/26/87 **Field Engineer** Baker **Boring Number** MEB-4

Location N57060.00 E52950.00 **Elevation** 6024.20

Diameter 6 Inches **Total Depth** 30 Feet **Water Table** None Encountered 9/26/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		St	10/6 16/6 15/6	Clay, silty, very stiff to hard, dry to slightly moist, light brown, (CL) with chemical deposits	
	5	St	3/6 5/6 4/6		
		St	6/6 7/6 15/6		
	10	St	10/6 20/6 25/6		
		St	17/6 25/6 32/6		
	15	St	10/6 11/6 12/6		
		BULK St	16/6 32/6 34/6		2- 50 pound samples
	20	SHELBY			
				Clay, silty, sandy, very stiff, slightly moist, light brown, (CL)	
	25				

Project Name RFL-87-01, Rifle, Colorado **Project Number** MB7054GE **Figure** _____

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LOG OF TEST BORING
(continued)

Date Drilled 9/26/87 Field Engineer Baker Boring Number MEB-4 continued

Location N57060.00 E52950.00 Elevation 6024.20

Diameter 6 Inches Total Depth 30 Feet Water Table None Encountered 9/26/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		St	12/6 13/6 20/6	Clay,silty,sandy,very stiff,slightly moist,light brown,(CL)-	
		CORE		Formational material,claystone,soft, intensely weathered,intensely fractured,gray	Core from 26 1/2 feet to 30 feet Recovery = $\frac{36''}{42''}$ RQD = 0
	30			Bottom of Test Boring at 30 Feet	
	35				
	40				
	45				
	50				

Project Name RFL-87-01,Rifle,Colorado Project Number M87054GE Figure ____

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LOG OF TEST BORING

Date Drilled 9/28/87 **Field Engineer** Baker **Boring Number** MEB-5

Location N57055.00 E51860.00 **Elevation** 6031.30

Diameter 6 Inches **Total Depth** 30 Feet **Water Table** None Encountered 9/28/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		St	7/6 6/6 6/6	Clay, silty, sandy, stiff to very stiff, dry, light brown, (CL) Some chemical denosits	
	5	St	4/6 4/6 7/6		
		St	14/6 19/6 24/6		
	10	St	28/6 30/6 31/6	Sand lenses and gravels encountered at 10 Feet	
		BULK St	20/6 29/6 47/6	Approximateiy 10% subangular gravels approximateiy 1 inch maximum size	2- 50 pound samples
	15	SHELBY		Formational material, sandstone, medium hard, weakly cemented, light brown	
		St	20/6 42/6 50/3	Formational material, claystone, medium hard, gray	
	20	CORE		Formational material, sandstone, clayey, soft, intensely weathered, intensely fractured, gray contained fragments	Core from 20 feet to 25 feet Recovery = $\frac{34''}{60''}$ RQD = 0
	25				

Project Name RFL-87-01, Rifle, Colorado **Project Number** M87054GE **Figure** _____

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING
(continued)

Date Drilled 9/28/87 Field Engineer Baker Boring Number MEB-5 continued

Location N57055.00 E51860.00 Elevation 6031.30

Diameter 6 Inches Total Depth 30 Feet Water Table None Encountered 9/28/37

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		CORE		Formational material, sandstone, medium hard, moderately weathered, moderately fractured, closely to moderately spaced fractures, fractures spaced 8 to 23 inches, some discoloration noted at fractures, gray	Core from 25 feet to 30 feet Recovery = $\frac{54''}{60''}$ RQD = $\frac{51''}{60''}$
	30			Bottom of Test Boring at 30 Feet	
	35				
	40				
	45				
	50				

Project Name RFL-87-01, Rifle, Colorado Project Number M87054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

MKE DOCUMENT NO. 5025-RFL-C-09-00906-00

LOG OF TEST BORING

Date Drilled 9 27 87 Field Engineer Baker Boring Number MEB-6

Location N57360.00 E52310.00 Elevation 6052.90

Diameter 6 Inches Total Depth 7½ Feet Water Table None Encountered 9/27/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
				Clay, silty, sandy, scattered gravel, stiff, dry, brown, (CL)	MKE comment bedrock was encountered at 3'
	5	St / CORE	20/6 52/6	Formational material, sandstone, clayey, soft, intensely weathered, intensely fractured, grav	Core from 2 1/2 feet to 7 1/2 feet Recovery = 29" / 48" ROD = 0
	10			Bottom of Test Boring at 7 1/2 Feet	
	15				
	20				
	25				

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Project Name RFL-87-01, Rifle, Colorado Project Number M87054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING

Date Drilled 9/11/87 **Field Engineer** Baker **Boring Number** MEB-8

Location N57530.00 E53405.00 **Elevation** 6110.40

Diameter 6 Inches **Total Depth** 31 Feet **Water Table** None Encountered 9/11/87

Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
			Clay, sandy, medium stiff, dry, light brown (CL), low plasticity some gravels, chemical deposits, sandstone	
	ST	21/6 50/3	Sandstone boulder encountered at 1/2 foot to 3 feet	
5	SH			
	BULK			2- 50 pound samples
10	ST	20/6 52/6 22/6	Gravels encountered in drive	
			Increasing sand & sandstone gravels, maximum size 1 inch gravels are subrounded	
15	ST	27/6 20/6 13/6	Sand, gravelly, clayey, dense, dry, light brown (SC) fine grained sand predominate, gravels up to 1 inch, gravels are subrounded	
20	BULK		Clay, sandy, gravelly, very stiff, dry, light brown (CL), medium plasticity gravels are subrounded, about 20% gravels, maximum size 2 inches with chemical deposits	1- 50 pound sample
	CORE		Gravel and cobbles encountered at 22 1/2 feet, sandstone cobbles up to 8 inches in size	Core 23'6" to 27'7" Recovery = 34"/49"
25				

Project Name RFL-87-01, Rifle, Colorado **Project Number** M87054GE **Figure** _____

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORIN

(continued)

Date Drilled 2/11/87 Field Engineer [illegible] Boring Number MES-3 [illegible]

Location N57530.00 E53405.00 Elevation 6110.40

Diameter 6 Inches Total Depth 51 Feet Water Table None Encountered 2/11/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		CORE		Clay, sandy, gravelly, very stiff, dry brown (CL), medium plasticity approximately 20% subrounded gravels and cobbles up to 8" maximum size with chemical deposits	Core 27'7" to 32 feet Recovery of scattered gravels on
	30	CORE		Increasing moisture with depth Soil is slightly moist	
	35				
	40	ST	12/6 25/6 24/6		
				Formational material Sandstone, intensely weathered to decomposed, medium hard, white to gray	
	45	ST	28/6 32/6 60/6		Core 45'1" to 50'1" Recovery = 29"/60" RQD = 0
		CORE		Formational material, claystone, moderately weathered, hard, gray	
	50				

Project Name RFL-87-01, Rifle, Colorado Project Number MR7054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING
(continued)

Date Drilled 9/14/87 Field Engineer Baker Boring Number MEB-8 continued

Location N57530.00 E53405.00 Elevation 6110.40

Diameter 6 Inches Total Depth 51 Feet Water Table None Encountered 9/14/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		CORE		Formational material interbedded sandstone and claystone, sandstone decomposed to intensely weathered soft, gray, approximately 24 inches recovery,- claystone, intensely weathered to moderately weathered, medium hard, gray, approximately 5 inches recovery, some iron staining noted, fracturing and joints could not be determined	
	55				
	60				
	65				
	70				
	75			Bottom of Test Boring at 51 Feet	

Project Name RFL-87-01, Rifle, Colorado Project Number M87054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING

Date Drilled 9/26/87 Field Engineer Baker Boring Number MEB-9

Location N57905.00 E52965.00 Elevation 6069.50

Diameter 6 Inches Total Depth 41½ Feet Water Table None Encountered 9/26/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
				Clay, silty, sandy, some gravel, very stiff, dry, light brown, (CL) with chemical deposits	
		St	11/6		
			12/6		
			12/6		
	5	St	6/6		
			6/6		
			11/6	increasing gravels up to 1 inch maximum size, subangular	
		St	13/6		
			12/6		
			8/6		
	10	SHELBY			
		St	7/6		
			10/6		
			13/6		
	15	St	10/6		
			21/6		
			26/6		2- 50 , : und samples
		BULK			
		St	16/6		
			18/6		
			32/6		
	20	St	14/6		
			24/6		
			20/6		
	25				

Project Name RFL-87-01, Rifle, Colorado Project Number 4B7054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING
(continued)

Date Drilled 9/26/87 Field Engineer Baker Boring Number MEB-9 continued

Location N57905.00 E52865.00 Elevation 6069.50

Diameter 6 Inches Total Depth 41½ Feet Water Table None Encountered 9/26/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		St	18/6 38/6 30/6	Clay, sandy, gravelly, hard, moist, light brown, (CL) with chemical deposits Medium to high plasticity fines	
	30	St	10/6 26/6 36/6		
		St	19/6 45/6 60/5		
	35				
	40	St	21/6 62/6 50/3		
				Formational material, claystone, medium hard, intensely weathered, intensely fractured, gray	
				Bottom of Test Boring at 41 1/2 Feet	
	45				
	50				

Project Name RFL-87-01, Rifle, Colorado Project Number MB7054GE Figure

Lambert and Associates

CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING

Date Drilled 9/28/87 Field Engineer Baker Boring Number MEB-10

Location N37950.00 E52090.00 Elevation 6121.40

Diameter 6 Inches Total Depth 25 Feet Water Table None Encountered 9/28/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		St	18/3	Sand, gravelly, silty, medium dense, dry, light brown, (SM) Approximately 30% subangular gravels with approximately 2 inch maximum size	
				Bource	
	5	St	24/6 11/6 14/6		
				Sand, silty, slightly gravelly, medium dense, moist, light brown, (SM)	
	10	St	12/6 17/6 13/6		
	15	St	16/6 40/6 50/5		
				Formational material, sandstone, clayey, soft to medium hard, moderately weathered, lightly fractured, core recovered in 4 foot length, gray	
	20	St	77/6		Core from 20' to 25' Recovery = $\frac{51''}{52''}$ RQD = $\frac{51''}{52''}$
				Bottom of Test Boring at 25 Feet	
	25				

CORE

Project Name _____ Project Number _____ Figure _____

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING

Date Drilled 3/14/87 Field Engineer Baker Boring Number MB3-11

Location N58116.90 E53504.80 Elevation 6153.10

Diameter 6 Inches Total Depth 37 1/2 Feet Water Table None Encountered 3/14/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		ST	15/6 20/6 21/6	Clay, sandy, some gravel, very stiff, dry to slightly moist, light brown (CL) Maximum size gravels approximately 1 inch, gravels are sub-angular, low plasticity	
	5	ST	7/6 17/6 15/6		
		ST	6/6 9/6 13/6	Some sand layers 1 inch to 5 inches thick	
	10	ST	6/6 11/6 3/6		
		BULK		Increasing gravels at 13 feet to 17 feet, subrounded gravels, maximum size approximately 2 inches	2- 50 pound samples
	15	ST	36/6 15/6 13/6		
	20	ST	11/6 19/6 28/6	Sand & clay layers up to 10 inches in thickness Increasing plasticity to medium plasticity clays	
	25				

Project Name RFL-87-01, Rifle, Colorado Project Number MB7054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING
(continued)

Date Drilled _____ Field Engineer Baker Boring Number [illegible]

Location N58116.90 E53504.30 Elevation 6153.10

Diameter 6 inches Total Depth 50 1/2 Feet Water Table None Encountered 8/11/87

Symbol	Length	Sample Type	Sample N	Soil Description	Laboratory Test Results
		ST	9/6 8/6 7/6	Clay, sandy, gravelly, very stiff, slightly moist, light brown (CL) approximately 20 gravels, subrounded to sub-angular, maximum size approximately 2 inches, medium plasticity	
		SH			
	30	ST	20/6 23/6 24/6		
	35	ST	7/6 13/6 22/6		
	40	ST	50/3	Auger refusal at 40 1/2 feet on cobbles	Core run from 40'6" to 44'10" Recovery consisted of a few gravels and cobbles with a maximum size of 5 inches. Core run from 44'10" to 46' 11½" recovery consisted of a few gravels & cobbles up to 4" maximum size Core run from 46'11½" to 49' 6" recovery consisted of a few gravels maximum size 2"
	45				
BAG	50				

Project Name RFL-87-01, Rifle, Colorado Project Number 87054GE Figure _____

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING
(continued)

Date Drilled 9/15/87 Field Engineer Baker Boring Number MEB-11 Continued

Location N58116.90 E53304.80 Elevation 6153.10

Diameter 6 inches Total Depth 57 1/2 Feet Water Table None Encountered 9/15/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		ST	8/6 7/6 6/6	Clay, very sandy, some gravel, very stiff, slightly moist, light brown, (CL) Maximum size gravels approximately 1 inch, low plasticity, gravels are subrounded approximately 50% fines 30% sands, 20% gravels	
	55	ST	10/6 15/6 26/6		
				Stop drilling at 57 1/2 feet due to twisting off center bit Bottom of Test Boring at 57 1/2 Feet	
	60				
	65				
	70				
	75				

Project Name RFL-87-01, Rifle, Colorado Project Number M87054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING

Date Drilled 9/24/87 **Field Engineer** Baker **Boring Number** MEB-11-B

Location 8 Feet West of MEB-11 **Elevation** 6153.00

Diameter 4 Inches **Total Depth** 61 Feet **Water Table** None Encountered 9/24/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
				Clay, sandy, gravelly, stiff, dry, light brown, (CL)	
				Scattered cobbles encountered at 4 Feet	
	5				
				Becoming very stiff at 8 Feet	
	10				
	15				
	20				
	25				

Project Name RFL-87-01, Rifle, Colorado **Project Number** M87054GE **Figure** _____

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING

(continued)

Date Drilled 9/24/87 Field Engineer Baker Boring Number MEB-11-B continued

Location 8 feet west of MEB-11 Elevation 6153.00

Diameter 4 Inches Total Depth 61 Feet Water Table None Encountered 9/24/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
				Clay, sandy, gravelly, very stiff, light brown, (CL)	
	30				
	35				
				Cobbles encountered at 37 Feet	
	40				
	45				
	50				

Project Name RFL-87-01, Rifle, Colorado Project Number MB7054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING
(continued)

Date Drilled 9/24/87 Field Engineer Baker Boring Number MEB-11-B continued

Location 8 feet west of MEB-11 Elevation 6153.00

Diameter 4 Inches Total Depth 61 Feet Water Table None Encountered 9/24/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
				Clay, sandy, gravelly, very stiff, slightly moist, light brown, (CL)	
	55				
				Cobbles encountered at 58 Feet	
	60				
		St	58/6 30/6 50/5	Bottom of Test Boring at 61 Feet	
	65				
	70				

Project Name RFL-87-01, Rifle, Colorado Project Number MB7054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING

Date Drilled 9/27/87 Field Engineer Baker Boring Number MEB-12

Location N58380.00 E52415.00 Elevation 6107.90

Diameter 6 Inches Total Depth 15 Feet Water Table None Encountered 9/27/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		St	12/6 9/6 10/6	Clay, silty, sandy, some scattered gravels, stiff to very stiff, dry, light brown, (CL), chemical deposits	
	5	St	6/6 4/6 4/6		
		St	3/6 4/6 5/6	Some sand layers encountered	
	10	St	12/6 12/6 11/6	Formational material, sandstone, medium hard to hard, light brown	
		St	30/6 58/6		
	15	St	26/6 75/6	Bottom of Test Boring at 15 Feet	
	20				
	25				

Project Name RFL-87-07, Rifle, Colorado Project Number MB7054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING

Date Drilled 9/28/87 **Field Engineer** Baker **Boring Number** MEB-13-B

Location 104 Feet South of N58825.00 E52780.00 **Elevation** 6128.10

Diameter 6 Inches **Total Depth** 20 Feet **Water Table** None Encountered 9/28/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		St	11/6 13/6 14/6	Clay, silty, sandy, some scattered gravels, very stiff, dry, light brown, (CL) Medium plasticity fines Approximately 10% subangular gravels up to 1 inch maximum size	
	5	St	10/6 12/6 17/6		
		St	13/6 18/6 22/6	Increasing sand at 7½ Feet	
	10	St	22/6 22/6 20/6		1- 50 pound sample
		BULK			
		St	24/6 63/6	Formational material, claystone, soft to medium hard, intensely weathered, intensely fractured, gray Some iron staining noted	1- 50 pound sample Core from 15' to 20' Recovery = $\frac{60''}{64''}$ ROD = 0
	15	BULK			
	20			Bottom of Test Boring at 20 Feet	
	25				

Project Name RFL-87-01, Rifle, Colorado **Project Number** M87054GE **Figure** _____

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING

Date Drilled 9/29/87 **Field Engineer** Baker **Boring Number** MEB-15

Location N59130.00 E53240.00 **Elevation** 6251.80

Diameter 6 Inches **Total Depth** 67 Feet **Water Table** None Encountered 9/29/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
				Sand,gravelly,clayey,medium dense to dense,slightly moist,light brown,(SC)	
				Approximately 30% subangular gravel with approximate 2 inch maximum size	
		St	14/6		
	5		18/6		
			13/6		
		St	15/6		
	10		5/2	Cobbles encountered at 10 Feet up	
			B	to 12 inches in size	
		St	11/6		
	15		12/6		
			14/6	Increasing moisture to moist soil	
		St	16/6		
			20/6		
	20		18/6	Less moisture at 20 Feet,soil is dry	
		St	15/6		
			27/6		
	25		33/6		

Project Name RFL-87-01,Rifle,Colorado **Project Number** M87054GE **Figure** _____

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING
(continued)

Date Drilled 9/29/87 Field Engineer Baker Boring Number MEB-15 continued

Location N59130.00 E53240.00 Elevation 6251.80

Diameter 6 Inches Total Depth 67 Feet Water Table None Encountered 9/29/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
				Sand, gravelly, clayey, medium dense, dry, light brown, (SC)	
	30	St	8/2 Bounce NR		
	35	CORE		Auger refusal at 33 feet	Core from 33' to 38' Recovery of scattered gravels up to 3" maximum size
	40				
	45				
	50				

Project Name RFL-87-01, Rifle, Colorado Project Number M87054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST BORING

(continued)

Date Drilled 9/29-9/30/87 Field Engineer Baker Boring Number MEB-15 continued

Location N59130.00 E53240.00 Elevation 6251.80

Diameter 6 Inches Total Depth 67 Feet Water Table None Encountered 9/29/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
	55			Sand, gravelly, clayey, medium dense, light brown, (SC)-CONTINUED	
	60			Formational material, claystone, soft, gray	
	65	BULK			
	70			Bottom of Test Boring at 67 Feet	
	75				

Project Name RFL-87-01, Rifle, Colorado Project Number MB7054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST HOLE

Date Excavated 9/9/97 Field Engineer Baker Test Hole Number MET-1

Location N56735.00 E5317.00 Elevation 6011.47

Size Pit Total Depth 12 Feet Water Table None Encountered 9/10/97

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		BAG		Clay, sandy, silty, very stiff, dry, light brown, (CL), organics	
	5	BAG		Increasing moisture with depth	
		BULK/BAG			
				Chemical deposits and gravel and cobbles (4 inch maximum size)	2- 50 pound samples
	10	BAG			
		BAG		Bottom of Test Hole at 12 Feet	
	15				
	20				
	25				

Project Name RFL-87-01, Rifle, Colorado Project Number M870540E Figure

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LOG OF TEST HOLE

Date Excavated 9/19/87 Field Engineer Baker Test Hole Number MET 2-B

Location N57200.00 E53151.00 Elevation 6042.9

Size Pit Total Depth 5½ Feet Water Table None Encountered 9/19/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		BAG		Clay, sandy, medium stiff, slightly moist, brown, (CL), with organics	
				Clay, silty, sandy, stiff, slightly moist buff, (CL)	
	5	BAG		Formational material, sandstone & claystone, soft to medium hard, extremely weathered, extremely fractured, buff to gray	
				Bottom of Test Hole at 5 1/2 Feet	
	10				
	15				
	20				
	25				

Project Name RFL-87-01 Project Number M87054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST HOLE

Date Excavated 9/21 87 Field Engineer Baker Test Hole Number MET-4

Location N57410.00 E51570.00 Elevation 6078.40

Size Pit Total Depth 7 Feet Water Table None Encountered 9/21/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		BAG		Sand, gravelly, clayey, medium dense, dry, light brown, (SC), approximately 40% angular gravels and cobbles up to 12 inches maximum size	
	5	BAG			
		BAG			
				Bottom of Test Hole at 7 1/2 Feet	
	10				
	15				
	20				
	25				

Project Name RFL-87-01, Rifle, Colorado Project Number M87054GE Figure

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LOG OF TEST HOLE

Date Excavated 9/21/87 Field Engineer Baker Test Hole Number MET-5

Location N57540.00 E51990.00 Elevation 6065.30

Size Pit Total Depth 11½ Feet Water Table None Encountered 9/21/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
	0	BAG		Clay, sandy, stiff, slightly moist, brown, (CL) with organics to 1 foot with chemical deposits, medium plasticity fines	
	5	BULK			2- 50 pound samples
		BAG			
	10	BAG/BULK		Some sand lenses at 10 Feet	1- 50 pound sample
		BAG/BULK		Bottom of Test Hole at 11 1/2 Feet	
	15				
	20				
	25				

Project Name RFL-87-01, Rifle, Colorado Project Number M87054GE Figure

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LOG OF TEST HOLE

Date Excavated 9/21/87 Field Engineer Baker Test Hole Number MET-7

Location N58127.87 E52348.59 Elevation 6097.00

Size Pit Total Depth 9 Feet Water Table None Encountered 9/21/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		BAG		Clay, sandy, stiff, slightly moist, brown, (CL), organics to 1 foot, chemical deposits	
	5	BAG			
		BAG		Formational material, sandstone, claystone, soft, extremely weathered, buff white to gray	
		BAG			
				Bottom of Test Hole at 9 Feet	
	10				
	15				
	20				
	25				

Project Name RFL-87-01, Rifle, Colorado Project Number M87054GE Figure

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LOG OF TEST HOLE

Date Excavated 9/19/87 Field Engineer Baker Test Hole Number MET-8-B

Location N58255.00 E52995.00 Elevation 6095.1

Size Pit Total Depth 12 Feet Water Table None Encountered 9/19/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		BULK/BAG		Clay, sandy, silty, some gravels, stiff, dry, light brown (CL) organics to 1 foot	
				Chemical deposits 10 percent subangular gravels Maximum size approximately 2 inches Medium plasticity fines	2- 50 pound samples
	5	BAG			
		BAG		increasing moisture with depth	
	10	BAG			
		BAG		Bottom of Test Hole at 12 Feet	
	15				
	20				
	25				

Project Name PFL-87-01, Rifle, Colorado Project Number MB7054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST HOLE

Date Excavated 9/21/87 Field Engineer Baker Test Hole Number MET-9

Location N53495.00 E52170.00 Elevation 6160.50

Size Pit Total Depth 5½ Feet Water Table None Encountered 9/21/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		BAG		Sand, gravelly, slightly clayey, medium dense, dry, light brown, (SC), chemical deposits 40% gravels, gravels are angular	
	5	BAG/BULK		Sand, gravelly, silty, medium dense, slightly moist, light brown, (SM)	1- 50 pound sample
	10			Bottom of Test Hole at 5 1/2 Feet, Backhoe refusal on possible formational material, sandstone, hard, gray	
	15				
	20				
	25				

Project Name RFL-87-01, Rifle, Colorado Project Number M87054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST HOLE

Date Excavated 9/21/87 Field Engineer [illegible] Test Hole Number [illegible]

Location N59270.00 E53000.00 Elevation 6261.10

Size Pit Total Depth 9½ Feet Water Table None Encountered 9/21/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		BAG		Sand,gravelly,clayey,medium dense, dry,light brown,(SC),chemical denosits,30% angular gravels, cobbles and boulders up to 18 inches maximum size	
	5	BAG		Sand,clayey,gravelly,medium dense, moist,light brown,(SC)	
		BULK/BAG		20% subanguiar gravels,2 inches maximum size	1- 50 pound sample
		BAG			
	10			Bottom of Test Hole at 9 1/2 Feet, Backhoe refusal on possible formational material,sandstone,hard, gray to white	
	15				
	20				
	25				

Project Name RFL-87-01,Rifle,Colorado Project Number M87054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST HOLE

Date Excavated 9/21/87 Field Engineer Baker Test Hole Number MET-12

Location N59615.00 E53500.00 Elevation 6358.90

Size Pit Total Depth 2 Feet Water Table None Encountered 9/21/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
		BULK		Sand, clayey, gravelly, loose, slightly moist, light brown, (SC) approximately 20% angular gravels and cobbles up to 6 inches maximum size	1- 50 pound sample 2- 50 pound samples
				Bottom of Test Hole at 2 Feet	Hand Excavated
	5				
	10				
	15				
	20				
	25				

Project Name RFL-87-01, Rifle, Colorado Project Number M87054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST HOLE

Date Excavated 9/21/87 Field Engineer Baker Test Hole Number MEB-T-14

Location N58759.33 E52451.08 Elevation 6191.10

Size Pit Total Depth 7½ Feet Water Table None Encountered 9/21/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
	0	BAG		Sand, gravelly, clayey, medium dense, slightly moist, light brown, (SC) chemical deposits Approximately 30% angular gravels and cobbles with 12" maximum size	Excavated as backhoe test pit
	5	BAG			
		BAG			
	10			Bottom of Test Hole at 7 1/2 Feet, Backhoe refusal on formational material, sandstone, hard, gray to buff white	
	15				
	20				
	25				

Project Name RFL-87-01, Rifle, Colorado Project Number M87054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING

LOG OF TEST HOLE

Date Excavated 11/10/87 Field Engineer Baker Test Hole Number 1

Location Estes Gulch Entrance Elevation

Size Pit Total Depth Surface Water Table None Encountered 11/10/87

Symbol	Depth	Sample Type	Sample N	Soil Description	Laboratory Test Results
				Sand, silty, medium dense, slightly moist, light brown, (SM)	2-50 pound samples
				Taken from side of embankment in Estes Gulch near entrance	
	5				
	10				
	15				
	20				
	25				

Project Name RFL-87-01, Rifle, Colorado Project Number M87054GE Figure

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CONSULTING GEOTECHNICAL ENGINEERS AND MATERIAL TESTING