Supplier Document Status Stamp

BSC

A. Records Designator: ☐ QA: QA ☒ QA: NA
B. LSN Relevancy: ☐ LSN Relevant ☒ Not LSN Relevant
C. Privileged or Copyright Protected: ☐ Yes _____ ☒ No
D. Procurement Document No. NN-HC4-00197
E. BSC Standard Document No. V0-CY05-NHC4-00197-00009-001-004

F. SUPPLIER DOCUMENT STATUS

1. ☒ WORK MAY PROCEED.
2. ☐ REVISE AND RESUBMIT. WORK MAY PROCEED SUBJECT TO RESOLUTION OF INDICATED COMMENTS.
3. ☐ REVISE AND RESUBMIT. WORK MAY NOT PROCEED.
4. ☐ REVIEW NOT REQUIRED. WORK MAY PROCEED.
5. ☐ FOR INFORMATION ONLY.

PERMISSION TO PROCEED DOES NOT CONSTITUTE ACCEPTANCE OR APPROVAL OF DESIGN DETAILS, CALCULATIONS, ANALYSES, TEST METHODS, OR MATERIALS DEVELOPED OR SELECTED BY THE SUPPLIER AND DOES NOT RELIEVE SUPPLIER FROM FULL COMPLIANCE WITH CONTRACTUAL OBLIGATIONS.

G. REVIEW COPY													
	NVM	NE											
	bg	KAM											

H. Area Code NA System Code NA Baseline Level NA

I. DOCUMENT CATEGORY NA
(Attach 3, Attach 4, or SSRS Form as applicable)

J. William Garfield Wm. I. Garfield 9/5/07
RESPONSIBLE ENGINEER/ANALYST (Printed Name and Signature) DATE

Title: Geotechnical Report Volume 1 Caliente Rail Corridor

Supplier Document #: 21-1-20102-112

Supplier Rev.: 2

Supplier Date: 07/16/07

Reference #: NVT-DV-00007

NVM Nevada Transportation Manager Bill Garfield
NE Nevada Engineering Kathy Mrotek

BSC

Supplier Document Distribution

Complete only applicable items.

QA: N/A

1. Supplier/Subcontractor Name:	Purchase Order/Subcontract No. and Title:	
Shannon & Wilson	NN-HC4-00197 / Task 4.12 Preliminary Geotechnical Analysis Report (Submittal No. 8.8) / Ehibit I submitttal no. 7.20 Final Revised Preliminary Geotechnical Report	
2. BSC Submittal No.:	Revision:	Title:
V0-CY05-NHC4-00197-00009-001	004	Geotechnical Report Volume 1 Caliente Rail Corridor

Responsible Individual:	Kathy Mrotek	KAM	423	09/04/07	09/11/07
	Name (Print)	Initials	Mailstop	Date	Due Date

DISTRIBUTION

Discipline/Organizations	Abbrev.*	3. Name	Mailstop	4. For Review	5. After Acceptance
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H
				☐	☐ E ☐ H

6. Document transmitted contains OUO information? ☐ **Yes** ☐ **No**

*** Use these abbreviations on the Supplier Document Status stamp to indicate reviewers.**

Transportation Data Pedigree Form

Complete only applicable items.

Subcontractor:	Item Number/Title/Revision:	Submittal Date:	SRCT No.:
Shannon & Wilson, Inc.	Geotechnical Report, Volume 1 of 2 – Caliente, Rev. 2 (Submittal No. 8.8)	16 Jul 2007	06-00101

Section I. Submittal Information (includes above information)

Submittal Description and Revision Summary for Entire Submittal:

This report documents information collected from a literature review and field reconnaissance performed for the purpose of describing geologic conditions and presenting preliminary geotechnical recommendations for the proposed Caliente alignment of the Nevada Rail Line for the Yucca Mountain Project.

Revision Summary:
Rev 0, 21 Jun 05: Original submittal
Rev 1, 14 Mar 06: Added alignments from the Supplemental Report (GF3 and BBE), and the Rev 11 alignments
Rev 2, 16 Jul 07: Revised Appendix I and Plate 3 (Sheet 2 of 2) to address copyrighted material, and edited typographical errors

Special Instructions:

Section II. Data File Information (Add lines below if needed for additional files. Indicate "Last item" or "End of list" after last line used.)

Filename	Rev.	File Size	Description (File description and revision summary for file)	Application and Version/ Add-in or Extension and Version
_Cover Geo 16 July 07.ppt	2	698 KB	Geotechnical Report Cover, Vol. 1 of 2	MS Power Point 2003 SP2
SW-ColourMidWidth 100.ctb	2	5 KB	Geotechnical Report Cover, Vol. 1 of 2	AutoCAD 2007
Spine 1.5.jpg	2	417 KB	Geotechnical Report Cover Spine, Vol. 1 of 2	Corel PHOTO-PAINT 8.0 Image
_Spines 2007.dwg	2	300 KB	Geotechnical Report Cover Spine, Vol. 1 of 2	AutoCAD 2007
BSC Logo.jpg	2	22 KB	Geotechnical Report Cover and CD Label Image, Vol. 1 of 2	Corel PHOTO-PAINT 8.0 Image
Jacobs LOGO.jpg	2	29 KB	Geotechnical Report Cover Spine Image, Vol. 1 of 2	Corel PHOTO-PAINT 8.0 Image
_CD Labels 2007.dwg	2	621 KB	Geotechnical Report CD Label	AutoCAD 2007
CD Background 2007.jpg	2	1,280 KB	Geotechnical Report CD Label	Corel PHOTO-PAINT 8.0 Image
21-1-20102-112-Rev2-X.doc	2	285 KB	Geotechnical Report Cover Sheet	MS Word 2003 SP2
21-1-20102-112-Change-History-C-Geo.doc	2	35 KB	Geotechnical Report Change History Sheet	MS Word 2003 SP2
21-1-20102-112-Rev2.doc	2	348 KB	Geotechnical Report Text	MS Word 2003 SP2
21-1-20102-112-AX-Rev2.doc	2	32 KB	Geotechnical Report Appendix Flysheets	MS Word 2003 SP2
SOIL FIELD REFERENCE, rev-jul07.pdf	2	1,485 KB	Geotechnical Report Soil Field Reference	Adobe Acrobat 7.0
ROCK FIELD REFERENCE, rev-jul07.pdf	2	624 KB	Geotechnical Report Rock Field Reference	Adobe Acrobat 7.0

BSC

Transportation Data Pedigree Form

Complete only applicable items.

Subcontractor:	Item Number/Title/Revision:	Submittal Date:	SRCT No.:
Shannon & Wilson, Inc.	Geotechnical Report, Volume 1 of 2 – Caliente, Rev. 2 (Submittal No. 8.8)	16 Jul 2007	06-00101

Caliente_S&W_Geotech.mdb	2	13,368 KB	ESRI 9.2 Personal Geodatabase containing the following Shannon & Wilson, Inc. native files pertaining to studies related to the Geotechnical Report dated 16-Jul-07.	ESRI Geodatabase
Photos.*	2	1,216,348 KB	Geotechnical Report Appendix H photos folder	Corel PHOTO-PAINT 8.0 Image
CalienteGeotechRpt-V1,R2,16jul07	2	214,837 KB	Adobe Acrobat Report, Volume 1	Adobe Acrobat 7.0
			----------Last Item----------	

Section III. Metadata

☒ **GIS Metadata** All GIS data is preferred in ArcGIS9.1 UTM, NAD1983, Zone11, Feet.	Projection: UTM
	Datum: NAD 83
	Zone: 11 N
	Units: Feet
☐ **CAD Metadata** CAD drawings are preferred in **Bentley MicroStation V8 and/or InRoads** and should adhere to established **CAD standards**.	Level descriptions:
	Scale:
	Units of Measurement:
	Horizontal and Vertical Datum:

Section IV. Data Screening (Completed by BSC personnel)

Acceptable for Review?	Screener Name:	Signature:	Date:
☒ Yes* ☐ No	Cathy Stettler	Cathy Stettler	8/23/07

*If "Yes", Data Storage Location: nvtdata\SW\Phase1\06-00101_GeotechRpt\Geotech Report CRC Rev 02 07-16-07

Comments: *(Justification for returning submittal is **required**; other comments are optional.)*

Section V. STR/STR Support Disposition of Submittal

Process for Review?	** If "No", date returned:	Comments:
☐ Yes ☐ No**		

STR/STR Support Name:	Signature:	Date:
Wm. Garfield	Wm. Garfield	8/23/07

KAH 8/24/07

QA: N/A

Data Definitions for Preliminary Caliente Geotechnical Report GIS Features

Feature Class: geo_comp_map_ref_boundary

Description: Designation of limits to cited geologic maps. Maps appear as images on Plate 2.

Revision History: No changes.

Number of records: 5

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polygon.
SHAPE_Length	Double	Length of feature in feet generated by software.
SHAPE_Area	Double	Area of feature in feet generated by software.

Feature Class: geologic_units_rev11

Description: Geologic mapping in relation to BSC alignment, rev 11, by S&W at 1:24k scale.

Purpose: Geologic mapping in relation to BSC alignment, rev 11, by S&W at 1:24k scale.

Revision History: No changes.

Number of records: 914

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.

Field Name	Data Type	Description of field
Shape	Geometry	Polygon
geounit	Text	Geologic Units
SHAPE_Length	Double	Length of feature in feet generated by software.
SHAPE_Area	Double	Area of feature in feet generated by software.

Feature Class: GPS_waypoints_geotech

Description: This point feature class represents areas of interest collected by Shannon & Wilson, Inc. in the field while individual teams investigated the Caliente Corridor.

Purpose: To identify areas visited in various team field reconnaissance trips

Revision History: No changes.

Number of records: 525

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Point
NAME	Text	Waypoint ID
Trip	Text	Trip ID

Feature Class: NTS_building_rev8

Description: Nevada Test Site building mock-up

Purpose: To show an approximate schematic of the Nevada Test Site buildings

Revision History: No changes.

Number of records: 14

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polygon.
SHAPE_Length	Double	Length of feature in feet generated by software.
SHAPE_Area	Double	Area of feature in feet generated by software.

Feature Class: NTS_rail_rev8

Description: Nevada Test Site rail mock-up

Purpose: To show an approximate schematic of the Nevada Test Site rail

Revision History: No changes

Number of records: 28

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polyline
Type	Text	Type
SHAPE_Length	Double	Length of feature in feet generated by software.

Feature Class: project_outline_250000

Description: Polygon area of project extent at 250K

Purpose: Show the extent of the Caliente project

Revision History: No Changes

Number of records: 1

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polygon
SHAPE_Length	Double	Length of feature in feet generated by software.
SHAPE_Area	Double	Area of feature in feet generated by software.

Feature Class: pub_geologic_features_corridor_anno

Description: Geologic features annotation (related to "geolgic_uints_rev11").

Revision History: No Changes

Number of records: 259

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Point
Layer	Text	Feature type for annotation
Text_	Text	Text string

Feature Class: pub_geologic_features_corridor_line

Description: Geologic feature lines (related to "geolgic_uints_rev11").

Revision History: No Changes

Number of records: 1279

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polygon
Feature	Text	Feature Type
SHAPE_Length	Double	Length of feature in feet generated by software.

Feature Class: pub_geologic_features_corridor_poly

Description: Geologic feature polygons (related to "geolgic_uints_rev11").

Revision History: No Changes

Number of records: 280

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polygon
Feature	Text	Feature Type
SHAPE_Length	Double	Length of feature in feet generated by software.
SHAPE_Area	Double	Area of feature in feet generated by software.

Feature Class: sheet_index_24000

Description: Sheet index for 24K scale maps

Purpose: To produce mapsheets at 24K scale

Revision History: No Changes

Number of records: 71

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polygon
Sheet_No	Text	Sheet Number
SHAPE_Length	Double	Length of feature in feet generated by software.
SHAPE_Area	Double	Area of feature in feet generated by software.

Feature Class: stationing_rev11_24000_anno

Description: Alignment stationing annotation at 24K scale for BSC alignment, rev 11.

Revision History: No Changes

Number of records: 249

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Annotation
TextString	Text	Annotation Text

Feature Class: stationing_rev11_24000_line

Description: Alignment stationing leader lines at 24K scale for BSC alignment, rev 11.

Revision History: No Changes

Number of records: 2509

Field Name	Data Type	Description of field

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polyline
SHAPE_Length	Double	Length of feature in feet generated by software.

Feature Class: stationing_rev11_250000_anno

Description: Alignment stationing annotation at 250K scale for BSC alignment, rev 11.

Revision History: No Changes

Number of records: 55

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Annotation
TextString	Text	Annotation Text

Feature Class: stationing_rev11_250000_line

Description: Alignment stationing leader lines at 250K scale for BSC alignment, rev 11.

Revision History: No Changes

Number of records: 282

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polyline
SHAPE_Length	Double	Length of feature in feet generated by software.

Feature Class: sw_seg_start_points_rev11

Description: This point feature class represents S&W interpretation of segments based on BSC alignment, rev 11.

Revision History: No changes.

Number of records: 65

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Point
Segment	Text	Segment Name

Feature Class: title_block_250000

Description: Polygon area for title block of 250K scale maps

Purpose: To create white space for text to be inserted in the page layout on the map documents

Revision History: No Changes

Number of records: 2

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polygon
SHAPE_Length	Double	Length of feature in feet generated by software.
SHAPE_Area	Double	Area of feature in feet generated by software.

Feature Class: title_block_fig

Description: Polygon area for title block for figure sheets

Purpose: To create white space for text to be inserted in the page layout on the map documents

Revision History: No Changes

Number of records: 1

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polygon
SHAPE_Length	Double	Length of feature in feet generated by software.
SHAPE_Area	Double	Area of feature in feet generated by software.

Feature Class: xs_loc_anno_plate2

Description: Cross section annotation for Plate 2.

Revision History: No changes.

Number of records: 18

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Point
label	Text	Label

Feature Class: xs_loc_line_plate2

Description: Cross section lines for Plate 2.

Revision History: No Changes

Number of records: 9

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polygon
ID	Integer	Cross Section ID
SHAPE_Length	Double	Length of feature in feet generated by software.

Geotechnical Report
Caliente Rail Corridor
Volume 1 of 2

SRCT:
06-00101

Task 4.12: Preliminary Geotechnical Analysis Report (Submittal No. 8.8)

Rev. 2

Prepared by:

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

In Association With:

JACOBS

Ninyo & Moore

Prepared for:

BECHTEL SAIC COMPANY LLC

Nevada Rail Corridor
Yucca Mountain Project
Geotechnical Analysis
NN-HC4-00197

July 16, 2007

Preliminary Geotechnical Report
Rev. 2
Caliente Rail Corridor
Yucca Mountain Project, Nevada

Subcontract No. NN-HC4-00197

16 July 2007

SHANNON & WILSON, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

At Shannon & Wilson, our mission is to be a progressive, well-managed professional consulting firm in the fields of engineering and applied earth sciences. Our goal is to perform our services with the highest degree of professionalism with due consideration to the best interests of the public, our clients, and our employees.

Submitted To:
Bechtel SAIC Company
1180 Town Center Drive
Las Vegas, Nevada 89144

By:
Shannon & Wilson, Inc.
400 N 34th Street, Suite 100
Seattle, Washington 98103

In Association With:
Jacobs Civil, Inc.
2500 N. Buffalo Drive, Suite 110
Las Vegas, Nevada 89128

And:

Ninyo & Moore, Inc.
6700 Paradise Road, Suite E
Las Vegas, Nevada 89119

21-1-20102-112

Prepared using MS-WORD 2003

CHANGE HISTORY

Revision Number	Date	Description of Change
00	21 June 2005	Initial Issue
01	14 March 2006	Added Alignments From Supplemental Report (GF3 and BBE), and the Rev 11 Alignments
02	16 July 2007	Revised Appendix I and Plate 3 (Sheet 2 of 2), and edited typographical errors

TABLE OF CONTENTS

Page

VOLUME 1

ACRONYMS AND ABBREVIATIONS v

1.0 INTRODUCTION 1
- 1.1 Project Description 1
- 1.2 Purpose and Scope 2
- 1.3 Acknowledgements 2
- 1.4 Authorization 3

2.0 LITERATURE AND DATA REVIEW 3
- 2.1 Review of Existing Project Data 3
- 2.2 Literature Search and Review 4

3.0 GEOTECHNICAL RECONNAISSANCE 5

4.0 REGIONAL GEOLOGY AND TECTONIC SETTING 7
- 4.1 Geographical Description of the Caliente Rail Corridor 7
- 4.2 Geologic Setting 8
- 4.3 Tectonics and Regional Seismicity 12
- 4.4 Hydrogeology 15

5.0 STRATIGRAPHIC NOMENCLATURE AND DESCRIPTION OF GEOLOGIC UNITS 19
- 5.1 Quaternary Eolian Dune, Sheet, and Ramp Deposits (Qe) 20
- 5.2 Playa and Lake Sediments (Qp) 20
- 5.3 Quaternary Stream Channel and Floodplain Alluvium (Qc) 21
- 5.4 Young Quaternary Fine-grained Alluvium (Qayf) 22
- 5.5 Young Quaternary Fan, Valley Floor, and Tributary Alluvium (Qay) 22
- 5.6 Intermediate-age Quaternary Fan Alluvium (Qam) 23
- 5.7 Old Quaternary Fan, Valley Floor, and Tributary Alluvium (Qao) 23
- 5.8 Quaternary-Tertiary Alluvium (QTa) 24
- 5.9 Quaternary-Tertiary Alluvium, Undivided (QTau) 24
- 5.10 Quaternary-Tertiary Landslide Deposits (QTls) 24
- 5.11 Quaternary-Tertiary Colluvium (QTc) 24
- 5.12 Quaternary-Tertiary Basalt (QTb) 25
- 5.13 Tertiary Fan Alluvium (Tf) 26
- 5.14 Tertiary Lake Beds (Tl) 26
- 5.15 Younger Tertiary Sedimentary Rocks (Tsy) 26
- 5.16 Older Tertiary Sedimentary Rocks (Tso) 27
- 5.17 Volcanics of Stonewall Mountain (Tsv) 28

Page

5.18 Late to Middle Miocene Lava Flows and Intrusives of Intermediate Composition (Ta4) 28
5.19 Tertiary Rhyolite Lava Flows and Related Intrusives (Tvr) 28
5.20 Tuff of Gold Flat (Tg) 29
5.21 Thirsty Canyon Group (Tt) 29
5.22 Volcanics of Fortymile Canyon (Tfv) 29
5.23 Timber Mountain Group (Tm) 29
5.24 Steamboat Mountain Formation (Tsb) 30
5.25 Ox Valley Tuff (Tox) 30
5.26 Paintbrush Group (Tp) 30
5.27 Calico Hills Formation (Tac) 31
5.28 Wahmonie Formation (Twa) 31
5.29 Crater Flat Group (Tc) 31
5.30 Belted Range Group (Tb) 31
5.31 Tuff of Etna (Te) 32
5.32 Tram Ridge Group (Tr) 32
5.33 Volcanics of Quartz Mountain (Tqv) 32
5.34 Tuff of Yucca Flat (Toy) 32
5.35 Redrock Valley Tuff (Tor) 33
5.36 Miocene-Oligocene Mostly Silicic Ash-flow Tuff with Interbedded Ash-fall Tuff (Tt_3) 33
5.37 Miocene-Oligocene Lava Flows and Intrusives of Intermediate Composition (Ta_3) 33
5.38 Shingle Pass Tuff, Monotony Tuff, and Related Tuffs (Tsm) 34
5.39 Shingle Pass Tuff, Needles Range Group, and Related Tuffs (Tsn) 34
5.40 Oligocene Silicic to Intermediate Tuff and Volcaniclastic Rocks (Tt_2) 35
5.41 Oligocene Lava Flows and Intrusives of Intermediate Composition (Ta_2) 35
5.42 Sheep Pass Formation (Tsp) 36
5.43 Tertiary to Jurassic Granitic Rocks (TJg) 36
5.44 Permian and Pennsylvanian Carbonate Rocks (PPl) 36
5.45 Upper Mississippian Clastic Rocks (Muc) 37
5.46 Joana Limestone (Mj) 37
5.47 Mississippian and Devonian Shale and Limestone (MDs) 37
5.48 Guilmette Formation (Dg) 38
5.49 Devonian and Silurian Carbonate Rocks (DSl) 38
5.50 Ordovician Sedimentary Rocks (Os) 38
5.51 Upper Cambrian Sedimentary Rocks (Cus) 39
5.52 Lower Cambrian and Late Proterozoic Sedimentary Rocks (CZs) 39

6.0 CHARACTERIZATION OF SOILS WITHIN THE CORRIDOR 40

Page

7.0 GEOLOGIC HAZARDS 41
7.1 Rock Slope Hazards 41
7.2 Earthquake Hazards 42
7.3 Surface Fissures 43
7.4 Surface Erosion 43
7.5 Mined Land Subsidence 44
7.6 Debris Flows 45
7.7 Soil Collapse 46
7.8 Soft Soil (Low Bearing Capacity) 46

8.0 PRELIMINARY ENGINEERING AND CONSTRUCTION CONSIDERATIONS 46
8.1 Ballast and Subballast 47
8.2 Excavations 47
8.3 Cut Slopes 47
8.4 Embankments 48
8.4.1 Subgrade Preparation 49
8.4.2 Subgrade Stabilization 49
8.4.3 Sources of Fill Material 49
8.5 Drainage and Erosion Protection 50
8.5.1 Surface Drainage 50
8.5.2 Subsurface Drainage 51
8.5.3 River and Streambank Erosion 51
8.5.4 Erosion at Culverts 51
8.5.5 Erosion of Cut–and-Fill Slopes 52
8.5.6 Erosion by Wind 52
8.6 Structures 52
8.6.1 Bridges 52
8.6.2 Buildings 53
8.6.3 Retaining Walls 53
8.6.3.1 Rigid Gravity and Semi-gravity Walls 54
8.6.3.2 Prefabricated Modular Gravity Walls 54
8.6.3.3 Mechanically Stabilized Earth Walls (MSEW) 55
8.6.3.4 Reinforced Soil Slopes (RSS) 56
8.6.3.5 Non-gravity Cantilevered and Anchored Walls 56
8.6.3.6 In Situ Reinforced Walls 58

9.0 CONCLUSIONS 58

LIST OF PLATES

Plate No.

1	Shaded Relief Map
2	Regional Geology Compilation Map (2 sheets)
3	Geologic Cross-Sections (2 sheets)
4	Faults and Seismic Activity Map

LIST OF APPENDICES

Appendix

A	Preliminary Geotechnical Design Criteria Manual (under separate cover)
B	Ballast Sourcing Cost Analysis (under separate cover)
C	Preliminary Construction Aggregate Report (under separate cover)
D	Preliminary Mineral and Energy Resource Occurrence Report (under separate cover)
E	In Reserve
F	In Reserve
G	In Reserve
H	Photographs from Field Reconnaissance (DVD)
I	Shannon & Wilson, Inc. Field References – Soil and Rock Classification

VOLUME 2

LIST OF TABLES

Table No.

1	Project Bibliography (9 pages)
2	Generalized Stratigraphic Columns (2 pages)
3	Description of Geologic Units (8 pages)
4	Soil Survey Data by Station Interval (48 pages)
5	Summary of Geologic Conditions Along Alignments (48 pages)
6	Summary of Preliminary Engineering Recommendations Along Alignments (17 pages)
7	Preliminary Recommendations for Cut and Fill Slopes and Excavation Methods by Station Interval (6 pages)

LIST OF FIGURES

Figure No.

1	Corridor Location Map
2	Index and Legend to Detail Maps (2 sheets)
3	Detail Maps (71 sheets)

ACRONYMS AND ABBREVIATIONS

A	insufficient evidence for certainty rating (as relates to mineral potential)
AASHTO	American Association of State Highway and Transportation Officials
Ag	silver
ANSI	American National Standards Institute
AREMA	American Railway Engineering and Maintenance-of-Way Association
As	arsenic
ASTM	American Society for Testing and Materials
Au	gold
AWWA	American Water Works Association
B	low certainty rating (as relates to mineral potential)
Ba	barium
BBE	Busted Butte East
BCFG	billion cubic feet of gas
Be	beryllium
BGRR	Beatty Goldfield Railroad
Bi	bismuth
BLM	U.S. Bureau of Land Management
BMPs	Best Management Practices
BNSF	Burlington Northern Santa Fe Railway Company
BSC	Bechtel SAIC Company, LLC
C	moderate certainty rating (as relates to mineral potential)
CAPP	Chemical Accident Prevention Program
Cd	cadmium
cm	centimeter
Co	cobalt
CPT	cone penetrometer test
Cr	chromium
CRC	Caliente Rail Corridor
CS	common segment
Cu	copper
D	high certainty rating (as relates to mineral potential)
DCM	Design Criteria Manual
DEIS	Draft Environmental Impact Statement
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
EIS	Environmental Impact Statement
EOL	end-of-line
EOR	engineer of record
EPA	U.S. Environmental Protection Agency
EWDP	Early Warning Drilling Program

LIST OF ACRONYMS AND ABBREVIATIONS (cont.).

F	fluorine
FEIS	Final Environmental Impact Statement
FHWA	Federal Highway Administration
FOB	free on board
FRA	Federal Railroad Administration
FY	fiscal year
GCMC	Goldfield Consolidated Mines Company
G-DCM	Geotechnical Design Criteria Manual
GF3	Goldfield 3 Route
GIS	Geographic Information System
gpm	gallons per minute
GPS	global positioning system
g/t	grams per ton
H	high mineral potential
HASP	Health and Safety Plan
Hg	mercury
HSA	hollow-stem auger
H:V	horizontal to vertical
HSU	hydrostratigraphic units
IDW	investigation-derived waste
in/sec	inches per second
ISRM	International Society of Rock Mechanics
Jacobs	Jacobs Engineering, Inc.
K	potassium
KGRA	known geothermal resource area
km	kilometer
L	low mineral potential
LV&TRR	Las Vegas and Tonopah Railroad
M	moderate mineral potential
Ma	million years old or million years ago or million years before present
MGR	Managed Geologic Repository
MILS	mineral property location database compiled by the U.S. Bureau of Mines
mm	millimeter
mm/sec	millimeters per second
mm/yr	millimeters per year
MMBO	million barrels of oil
Mn	manganese
MnO	manganese oxide
Mo	molybdenum
M&O	Maintenance and Operation
mph	miles per hour

LIST OF ACRONYMS AND ABBREVIATIONS (cont.).

MPR	Mineral Potential Report
MRDI	Mineral Resource Development, Inc.
MRDS	mineral resource dataset compiled by U.S. Geological Survey
MS	mineral survey
MSE	mechanically stabilized earth
MSEW	mechanically stabilized earth wall
MVGI	Metallic Ventures Gold, Inc.
N&M	Ninyo & Moore, Inc.
Na	sodium
NAC	Nevada Administrative Code
NBMG	Nevada Bureau of Mines and Geology
NDEP	Nevada Division of Environmental Protection
NDOT	Nevada Department of Transportation
NEPA	National Environmental Policy Act
Ni	nickel
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRL	Nevada Rail Line
NRP	Nevada Rail Partners
NTS	Nevada Test Site
NTTR	Nevada Test and Training Range (formerly Nellis Air Force Base and Testing Range)
NVT	Nevada Transportation
NWRPO	Nuclear Waste Repository Project Office
O	no mineral potential
OCRWM	Office of Civilian Radioactive Waste Management
O.D.	outside diameter
opt	ounces per ton
oz	ounce, specifically troy ounce in this report
oz/t	ounces per ton
P	phosphorous
Pb	lead
PGA	peak ground acceleration
PGR	Preliminary Geotechnical Report
PM	particulate matter
ppb	parts per billion
ppm	parts per million
PSHA	probabilistic seismic hazard analysis
psi	pounds per square inch
PV	prefabricated vertical
PVC	polyvinyl chloride

LIST OF ACRONYMS AND ABBREVIATIONS (cont.).

QA	quality assurance
QC	quality control
RFI	Request for Information
RFP	Request for Proposal
ROD	Record of Decision
ROE	right-of-entry
ROW	right-of-way
RQD	Rock Quality Designation
RSS	reinforced soil slopes
S&W	Shannon & Wilson, Inc.
Sb	antimony
Sc	scandium
SCS	Soil Conservation Service
Se	selenium
SFRS	steel fiber-reinforced shotcrete
SI	International System of Units
Sm	samarium
Sn	tin
SPT	Standard Penetration Test
Sr	strontium
SR	State Route
SSURGO	Soil Survey Geographic Database
T&TRR	Tolicha and Tonopah Railroad
TBM	Tunnel Boring Machine
T N	Township North
T S	Township South
Tl	thallium
tpd	tons per day
tpy	tons per year
tsf	tons per square foot
U	uranium
UPRR	Union Pacific Railroad Company
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USBM	U.S. Bureau of Mines
USBR	U.S. Bureau of Reclamation
USCS	Unified Soil Classification System
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
V	vanadium

LIST OF ACRONYMS AND ABBREVIATIONS (cont.).

W	tungsten
WPCP	Water Pollution Control Permit
wt%	weight percent
YMP	Yucca Mountain Project
Zn	zinc

PRELIMINARY GEOTECHNICAL REPORT

CALIENTE RAIL CORRIDOR
YUCCA MOUNTAIN PROJECT, NEVADA

1.0 INTRODUCTION

This report summarizes the results of preliminary geotechnical engineering evaluations to support route optimization and conceptual design of a proposed rail line for the Yucca Mountain Project (YMP). This report is a revision of the Preliminary Geotechnical Report (Shannon & Wilson, Inc., 2005), and it includes the Revision 11 alignments, as shown in the map provided by Bechtel SAIC Company, LLC (BSC), dated 18 August 2005.

1.1 Project Description

The U.S. Department of Energy (DOE) has selected the Caliente Rail Corridor within which to determine an alignment for the construction and operation of a railroad to transport spent nuclear fuel and high-level waste to a repository planned near Yucca Mountain, Nevada.

The proposed 319-mile corridor originates at the Union Pacific Railroad (UPRR) mainline track near Caliente, Nevada. It then extends northwest toward Tonopah. It wraps around the north and west sides of the Nevada Test and Training Range (NTTR) before entering the Nevada Test Site (NTS) near its southwest corner. It terminates at the southern entrance to the repository (Figure 1). The exact location of the connection between the proposed rail line and UPRR has not been identified and two alternatives are currently being evaluated. The rail line would consist of a single track, with passing sidings at appropriate intervals.

It is estimated that approximately 3.1 million tons of crushed rock ballast would be required for new track construction (Nevada Rail Partners, 2005a). In addition, approximately 2.5 million tons of subballast would be required for roadbed construction. Other construction materials that would be required for the Nevada Rail Line (NRL) include embankment fill, erosion control stone (riprap), and aggregate for concrete.

1.2 Purpose and Scope

The geotechnical engineering scope of work for the project is phased to correspond with evolving levels of project development as follows:

- Preliminary geotechnical engineering to support initial route selection and alignment optimization, the conceptual design of the railroad, and the EIS.
- Geotechnical engineering to support final route selection and alignment optimization, preliminary engineering, and final design.
- Geotechnical engineering analysis and testing support during construction.

This report includes descriptions of the data review and initial field reconnaissance. It provides a description of the regional geologic conditions and geologic hazards that occur within the corridor. Information is provided on the route alignment within the corridor with respect to the geologic hazards and difficult soil conditions based on the data review and field reconnaissance. Local geologic conditions are summarized for discrete segments of the corridor, and preliminary geotechnical engineering and construction considerations are provided for each segment.

In addition to presenting preliminary, yet detailed, geologic data and geotechnical considerations for the NRL, this report summarizes all of the preliminary geotechnical engineering activities by including deliverables prepared for other subcontract tasks. These deliverables include:

- Preliminary Geotechnical Design Criteria Manual (G-DCM)
- Ballast Sourcing Cost Analysis
- Preliminary Construction Aggregate Report
- Preliminary Mineral and Energy Resources Assessment Report

These documents are included in the appendices, under separate covers, and should be referenced for specific subject information. The remainder of this report specifically addresses geologic data and geotechnical considerations.

1.3 Acknowledgements

This report was prepared by Shannon & Wilson, Inc. (S&W). Paul Godlewski (Project Manager) provided oversight for the work. Will Hultman and Steve McMullen managed the field reconnaissance and report preparation. Art Geldon and Steve McMullen comprised the primary field reconnaissance team and participated in data review and report preparation. Neal McCulloch and Bruce Stover performed reconnaissance over a portion of the corridor. William

Perkins provided faulting and seismic information. Andy Caneday, William Lewis, and Leslie Regier prepared the maps presented in the figures and plates. Dex McCulloch, Principal-in-Charge, and many other S&W personnel provided valuable assistance in the execution of the work and development of this report.

1.4 Authorization

This work was performed by S&W for Bechtel SAIC Company, LLC (BSC) in general accordance with YMP Technical Services Subcontract No. NN-HC4-00197, Caliente Rail Corridor Geotechnical Analysis. Revision of this report for the Revision 11 alignments was authorized by Subcontract Change Notice 6, effective October 31, 2005. This document is Submittal No. 8.8 of this subcontract.

2.0 LITERATURE AND DATA REVIEW

2.1 Review of Existing Project Data

BSC provided maps and reports previously developed for portions of the NRL. Review of these materials provided an understanding of the rail corridor selection process and the current level of development of the NRL as the baseline route. The principal project documents reviewed included a conceptual design report for the Caliente route (DeLeuw-Cather & Co., 1992), and an engineered plan and profile drawing set (Nevada Rail Partners, 2005b). The DeLeuw-Cather report included regional geology, soils data, and conceptual-level geotechnical recommendations. The Nevada Rail Partners (NRP) study included rail alignment plan and profile sheets for the NRL, current as of July 22, 2005.

BSC also provided various maps and geographical information systems (GIS) files that included data on the alignment, geology, soils, environmental studies, land use, hydrology, transportation routes, and other data related to the project. Topographic surveying done by other subcontractors to BSC was unavailable during the time of our fieldwork and engineering analysis. Thus, U.S. Geological Survey (USGS) 7.5-minute (1:24,000 scale) and 30 x 60-minute (1:100,000 scale) topographic maps were used during our work.

2.2 Literature Search and Review

We performed an extensive literature search to identify published references that contain information relevant to the corridor. S&W technical library staff conducted the literature search using keywords determined by project technical staff. Searches were conducted on publication databases from the USGS, Nevada Bureau of Mines and Geology (NBMG), Nevada Department of Transportation (NDOT), the DOE, the USGS Mercury Core Library, the State of Nevada Agency for Nuclear Projects, the Center for Nuclear Waste Regulatory Analyses, the Office of Civilian Radioactive Waste Management (OCRWM), the Desert Research Institute, and others.

S&W engineers and geologists reviewed the publication lists generated from the searches. References believed to contain relevant information were identified and obtained if available. The collected references are catalogued in the Project Bibliography, Table 1, and most are kept in our project library. Additional references are identified in the other reports referenced in the appendices.

Many references were collected that were too specific in topic for this study, but could be relevant for subsequent work. Some references were superseded by more recent publications, and some references describe conditions outside the corridor, but provide information that can be correlated to conditions within the corridor. As references were reviewed, they were rated A, B, or C in Table 1 to indicate their relevance to this current stage of the project as follows:

A Highly relevant to the NRL.
B Some relevance to the NRL.
C Little relevance to the NRL, but could be relevant for final design or construction.

The purpose of the literature review was to develop an understanding of the geologic conditions in the vicinity of the NRL. The intent was to begin building a project reference library that would be useful not only for current tasks, but for subsequent phases as well. We expect that additional references would be identified and obtained as the project develops. Therefore, it is desirable that the project bibliography be maintained and updated through all phases of the project.

Another purpose of the data review was to plan the geotechnical reconnaissance. Using the maps and profiles developed during the NRP study (Nevada Rail Partners, 2005b), and GIS overlays of soil and geologic data, we identified areas of differing geology and locations of features such as

deep cuts and bridge locations. Based on this information, we developed reconnaissance trip itineraries. The itineraries were refined as we obtained more recent or more detailed information.

3.0 GEOTECHNICAL RECONNAISSANCE

To facilitate planning of our field reconnaissance program, the corridor was divided into geomorphic segments. Segment boundaries were selected based on proposed start and end points for common and alternative alignments, and major changes in topography and geology observed on the USGS topographic and county geology maps. Geologic features that could require special engineering consideration (e.g., faults, playa deposits or mining districts), and locations of bridges, deep cuts, and high fills, were identified on the maps and designated for further investigation during the field reconnaissance.

During the reconnaissance, sites were accessed via established roads and existing two-wheel tracks, or by hiking short distances. Only four-wheel-drive pickup trucks and sport utility vehicles were used and no off-road driving was performed. Each geotechnical reconnaissance team consisted of a S&W engineer and a S&W geologist. The teams carried camping equipment but it was not used, since the teams were able to return to a town and stay in motels during the entire reconnaissance effort.

While in the field, the teams determined their positions relative to the alignment using mapping software and global positioning system (GPS) receivers. Using the computer program Terrain Navigator Pro by Maptech, USGS topographic maps at scales of 1:24,000 and 1:100,000 were displayed on a laptop computer inside the vehicle. Using a Garmin GPS receiver connected to the computer, a symbol was displayed on the map representing the current position of the vehicle. Real-time tracking was enabled so that the symbol on the map would move as the vehicle moved. For most of the reconnaissance, the tracks were recorded by plotting a colored line segment every 30 seconds showing the traveled route. The NRL alignment was also displayed on the computer screen. Latitude and longitude coordinates, or waypoints, for the alignment were downloaded into the GPS receiver before starting the reconnaissance. The waypoints were designated to define a route that plotted as a series of line segments connecting closely spaced points. When the GPS receiver was connected to the computer, the NRL

alignment appeared on the topographic maps. This system enabled the field personnel to know their location relative to the NRL at all times.

Geologic conditions observed during the field reconnaissance are presented in the Detail Maps, Figure 3. An Index and Legend to the Detail Maps are presented in Figure 2. Geomorphic segment start points are identified in Figure 3 using an alphanumeric designation beginning with letter "S" followed by a one- or two-digit number with the segment numbering beginning at Caliente, Nevada, and increasing toward the NTS.

Typical data collection procedures at each stop during the reconnaissance included taking digital photographs, recording a GPS waypoint, classifying the soil and rock materials, and recording information on data forms regarding geologic hazards, design and construction considerations, and future explorations. Select photographs that illustrate features observed during the reconnaissance are listed in Table 5. Reconnaissance photographs are presented in Appendix H.

The geotechnical reconnaissance was performed in eight trips as follows:

- Trip 1 – From June 18 to June 25, 2004, two teams performed reconnaissance on the western segment of the NRL between the NTS boundary and Mud Lake near Tonopah. All subsequent Task 1 geotechnical reconnaissance trips were performed by a single two-person team.
- Trip 2 - We performed the second reconnaissance trip between August 23 and August 31, 2004. The area covered during this trip extended from Mud Lake eastward to the Nye County-Lincoln County line in the White River Valley.
- Trip 3 – The third trip was performed between September 29 and October 7, 2004. On this trip, we covered the corridor from the White River Valley eastward to the UPRR interface at the end of the Caliente, Eccles, and Crestline options.
- Trip 4 – Access to the NTS had not been granted within the timeframe of the first three trips. Therefore, geotechnical reconnaissance for the portion of the NRL on the NTS was not performed until March 3 and 4, 2005.
- Trip 5 – Between April 8 and 12, our two-person team performed reconnaissance along new alternatives in northern Garden Valley, near Goldfield, in Oasis Valley, and from Tram Ridge (part of Yucca Mountain) to Beatty Wash.
- Trip 6 – Between May 2 and 10, 2005, we completed reconnaissance for new alternatives near Goldfield, from southern Garden Valley to southern Coal Valley, from Reveille Valley to Railroad Valley, and from Sarcobatus Flat to Lida Valley.

- Trip 7 – Between August 1 and 6, 2005, we completed reconnaissance along the GF3 alternative alignment.
- Trip 8 – In some areas, sections of the Revision 11 baseline and alternative alignments plotted outside of the areas covered by previous reconnaissance trips. Between December 3 and 5, 2005, we performed reconnaissance mostly in Garden Valley and the Goldfield Hills to collect geologic and geotechnical data along these sections of the Revision 11 alignments.

4.0 REGIONAL GEOLOGY AND TECTONIC SETTING

4.1 Geographical Description of the Caliente Rail Corridor

The eastern portion of the NRL crosses parts of the Colorado River Basin, while the majority of the NRL traverses the southern Great Basin section of the Basin and Range physiographic province. As shown in the Shaded Relief Map, Plate 1, the terrain consists of relatively narrow northern and northwestern trending mountain ranges surrounded by broad sediment-filled basins, each about 10 to 15 miles wide. Elevations along the corridor range from 6,291 feet at Warm Springs Summit in the Kawich Range to 3,215 feet at the base of Busted Butte, east of Yucca Mountain.

Beginning at Yucca Mountain, located within the NTS, the corridor generally trends north-northwesterly to Mud Lake through southern Nye County and the eastern portion of Esmeralda County. As shown in Plate 1, this segment generally parallels U.S. Highway 95 and is situated between the highway and the NTTR boundary. This western portion of the NRL traverses several basins, including Crater Flat, Oasis Valley, Sarcobatus Flat, Lida Valley, Montezuma Valley, and Mud Lake. The closest upland areas to the NRL in this western portion are Yucca Mountain (including Tram Ridge), Bare Mountain, the Bullfrog Hills (including Oasis Mountain), Pahute Mesa, Stonewall Mountain, the Goldfield Hills, Malpais Mesa, and the San Antonio Mountains. Drainage from upland areas in this portion of the NRL generally flows through ephemeral streams, such as Beatty Wash, Tolicha Wash, and numerous unnamed washes into playas, including Alkali Flat, Stonewall Flat, and Mud Lake. The only through-flowing streams in this part of the corridor are Fortymile Wash and the Amargosa River, which drain to Death Valley.

Beyond Mud Lake, the NRL continues generally eastward through southern Nye County to the western Lincoln County line, traversing land between the NTTR, U.S. Highway 6, and Nevada

State Route 375. The NRL crosses several basins, including Ralston Valley, Cactus Flat, Stone Cabin Valley, Reveille Valley, and Railroad Valley. Upland areas in this portion of the corridor include the Monitor Range (which terminates in the Monitor Hills), the Kawich Range, and the Reveille Range. All drainage runs off into playas.

From the Lincoln County line, the NRL continues along an eastern trend through Sand Spring Valley crossing lobes of the Quinn Canyon Range, as shown in Plate 1. It curves around the north end of the Worthington Mountains into Garden Valley, then crosses the Golden Gate Range, Coal Valley, and the Seaman Range before descending into the White River Valley. The NRL then crosses the North Pahroc Range and Dry Lake Valley before it ascends to Bennett Pass between the Chief and Highland Ranges. It descends from Bennett Pass to a point along U.S. Highway 93 in Meadow Valley, south of Panaca, where two alternative routes proposed as potential connections to the UPRR diverge. The Caliente Option follows U.S. Highway 93 and Meadow Valley Wash along an old railroad grade south to the town of Caliente. The Eccles Option trends southeast over Miller Bench to Dutch Flat along Clover Creek, where it meets the UPRR tracks at Eccles siding. Drainage from the mountains in this portion of the NRL generally flows to playas, but the White River, Meadow Valley Wash, and its tributary, Clover Creek, flow to the Colorado River.

4.2 Geologic Setting

Mountain ranges and valleys in the NRL area reflect the underlying structure of the southern Great Basin, which mostly has resulted from large-scale crustal extension since the Oligocene epoch along north- to northeast-striking normal faults (see Section 4.3 for a discussion of regional tectonics). The NRL area is underlain by a wide variety of geologic units ranging in age from Precambrian to Quaternary. In general, this area can be divided into a western region where mostly Tertiary volcanic rocks crop out in upland areas and an eastern region where Paleozoic sedimentary rocks and Tertiary volcanic rocks form the upland terrain (Plate 2, Sheet 1). About 60 percent of the geology shown in the Regional Geology Compilation Map, Plate 2, Sheet 1, was compiled from a geologic map of the Death Valley groundwater model area by Workman et al. (2002a). In our opinion, the map by Workman et al. represents the most comprehensive, up-to-date, geologic map of the region in which the NRL is located. Geology for parts of the NRL area not covered by the Workman et al. map was compiled from geologic maps of Esmeralda County (Albers and Stewart, 1972), northern Nye County (Kleinhampl and Ziony, 1985), southern Nye County (Cornwall, 1972), and Lincoln County (Tschanz and

Pampeyan, 1970). Geologic units shown in the Regional Geology Compilation Map are described in legends reprinted from the above-referenced maps in Plate 2, Sheet 2.

Geologic cross-sections at various locations in the NRL area are presented in Plate 3, and the locations of these cross-sections are indicated on Plate 2. The purpose of these cross-sections is to show in a general way how the regional structure affects spatial relationships between stratigraphic units. These cross-sections were compiled from several references. Consequently, stratigraphic nomenclature among the cross-sections is not consistent. Table 2 compares some of the geologic names used in different parts of the NRL area, but it was beyond the scope of this report to correlate all stratigraphic names used in the various cross-sections and on the Regional Geology Compilation Map. To describe local geologic conditions within the NRL area, a consistent stratigraphic nomenclature was developed, as described in Section 5.0.

The oldest rocks in the NRL area consist of early Proterozoic metamorphic rocks that crop out in the Funeral Mountains northeast of Death Valley, in the Bullfrog Hills west of Beatty, and in the Trappman Hills northwest of Pahute Mesa (Workman et al., 2002a). These 1.7 to 1.4 billion-year-old rocks consist largely of biotite, hornblende, and muscovite schist, quartzofeldspathic gneiss, migmatized, sillimanite-grade metasedimentary rocks, granitic to monzonitic plutons, and pegmatite and aplite dikes (Slate et al., 1999).

The Pahrump Group was deposited on the eroded surface of the Early Proterozoic rocks within and adjacent to Death Valley during the Middle and Late Proterozoic periods. The Pahrump Group consists of conglomerate, quartzite, sandstone, shale, dolomite, limestone, chert, and diabase. Although the upper surface has been eroded, the Pahrump Group is more than 11,000 feet thick in places (Hunt and Mabey, 1966).

Deposition of the Noonday Dolomite during the Late Proterozoic period marked the beginning of alternately marine and terrestrial sedimentation that continued without lengthy interruption into the Permian period (Workman et al., 2002a). Late Proterozoic to early Middle Cambrian rock consists of quartzite, sandstone, siltstone, and shale with subordinate limestone and dolomite that represent brief transgressive sequences. Late Middle Cambrian to Middle Devonian rocks are mostly limestone and dolomite, but regressive clastic sequences, such as the Dunderberg Shale and the Eureka Quartzite, intertongue with the carbonate rocks. The Antler Orogeny at the end of the Devonian period uplifted parts of the area and caused a major change in sedimentation patterns (Cole and Cashman, 1999). During the Mississippian period, deposition of carbonate

rocks, as typified by the Joana Limestone, continued in stable shelf areas, whereas argillite, quartzite, sandstone, and conglomerate, as typified by the Eleana Formation and Chainman Shale, accumulated in foreland basins. During the Late Pennsylvanian and Early Permian periods, seas returned to most of the area, which resulted in deposition of the Ely Limestone, Bird Spring Formation, and equivalent stratigraphic units. Following terrestrial deposition in the Early Permian, Late Permian seas deposited the Toroweap and Kaibab Formations. From the Late Proterozoic period to the Late Permian period, more than 35,000 feet of sedimentary rocks accumulated in the NRL area (Laczniak et al., 1996).

Late Permian to Jurassic sedimentary rocks are present as erosional remnants in the Spring Mountains southeast of the NTS and in southeastern Lincoln County (Tschanz and Pampeyan, 1970; Grose and Smith, 1989). In these areas, alternately terrestrial sandstone, shale, and siltstone and marine limestone, dolomite, and gypsum of Permian and Early Triassic age grade upward into coastal plain and eolian sequences of Late Triassic and Jurassic age. In Esmeralda and northern Nye Counties, conglomerate, pebbly sandstone, sandstone, siltstone, argillite, limestone, chert, and greenstone of Permian to Jurassic age have scattered exposure (Albers and Stewart, 1972; Kleinhampl and Ziony, 1985).

During the Middle Jurassic to Late Cretaceous Sevier Orogeny, major thrust faults, such as the Keystone and Pahranagat Faults, wrench faults, and folds developed (Laczniak et al., 1996; Faunt, 1997). Intrusion of granitic magmas as scattered small stocks and, locally as larger plutons, accompanied this tectonic activity and continued into the Tertiary period (Grose and Smith, 1989).

Following erosion throughout most of the early Tertiary period (65 to about 38 million years ago [Ma]), the Death Valley region began to be pulled apart along low-angle normal faults, such as the Bare Mountain Fault, and strike-slip faults, such as the Furnace Creek Fault. The strike-slip faults are associated with the Walker Lane Belt (Laczniak et al., 1996; Faunt, 1997), a region of complex stratigraphic and structural elements that extends in the NRL area from Yucca Mountain to the vicinity of Goldfield. Regional extension was also accommodated in the NRL area by listric-normal faults stair-stepping down into calderas and topographic basins (Scott, 1990; Minor et al., 1993), by intra-block grabens (Fridrich et al, 1999a), and by wrench faulting between strike-slip faults (Blakely et al., 1999). The regional structural fabric is north-northwestern to north-northeastern, but major strike-slip faults strike northwesterly (Workman et al., 2002a).

Episodic eruptions of tuffaceous rocks and rhyolitic to basaltic lava flows began after deposition of the lacustrine Sheep Pass Formation of Paleocene and Eocene age (Kleinhampl and Ziony, 1985). In Oligocene and early Miocene time, several major ash-flow tuff sheets, such as the Needles Group, the Monotony and Shingle Pass Tuffs, and the Pahranagat Formation, were emplaced from northern and eastern source areas (Best et al., 1989 and 1993; Scott et al., 1995a; Rowley et al., 1995).

Volcanism in middle to late Miocene time (about 16 to 7 Ma) formed the southwestern Nevada volcanic field, which is more than 13,700 feet thick beneath eastern Pahute Mesa (Laczniak et al., 1996; Warren et al., 1998). Eruption of 17 extensive ash-flow tuff sheets and associated lava flows occurred from at least 7 large, overlapping caldera complexes. The greatest volcanic activity occurred between 14 and 11 Ma, during which time the Belted Range, Crater Flat, Paintbrush, and Timber Mountain Groups erupted from the Claim Canyon, Silent Canyon, Timber Mountain, and other caldera complexes. The youngest caldera-forming events associated with the southwestern Nevada volcanic field occurred between 9.4 and 7.4 Ma, during which time the Thirsty Canyon Group erupted from the Black Mountain Caldera, and the Volcanics of Stonewall Mountain erupted from the Stonewall Mountain Caldera (Minor et al., 1993).

Substantially reduced and much less frequent eruptive events and tectonic activity continued into Pliocene and Pleistocene time. The youngest dated volcanic rocks, basalt flows and cinder cones in the Oasis Valley, Crater Flat, and Amargosa Valley areas are 1.1 to 0.077 Ma (Warren et al., 1998; Slate et al., 1999).

From Oligocene to Quaternary time, coarse-grained detritus shed from uplifted areas, and fine-grained and calcareous lacustrine sediments alternately filled syntectonic basins, together with lesser amounts of eolian sand and silt, evaporite deposits, marsh and playa sediments, and spring-carbonate deposits (Rowley and Shroba, 1991; Swadley and Simonds, 1994a; Scott et al., 1995a; Fridrich et al., 1999a; Snow and Lux, 1999; Slate et al., 1999). The older, deeper basin-fill sediments typically are lithified, whereas the younger basin-fill sediments become progressively less indurated with decreasing depth and age. Quaternary sediments typically are unconsolidated. Relatively thin basalt flows and tuff layers commonly are intercalated with basin-fill sediments. The basin-fill sediments can be more than 4,000 feet thick (Laczniak et al., 1996). In areas, such as Crater Flat, Yucca Mountain, Oasis Valley, and Dry Lake Valley, faults

have remained active and have offset basin-fill sediments during Holocene time (Minor et al., 1993; Swadley and Simonds, 1994a; Simonds et al., 1995; Fridrich et al., 1999a).

4.3 Tectonics and Regional Seismicity

The NRL area is located in the southern part of the Great Basin section of the Basin and Range physiographic province. The Basin and Range is a region of Cenozoic extensional deformation that extends nearly 1,600 miles from Idaho and Montana on the north to central Mexico on the south (Dickinson, 2003). The Great Basin extends westerly about 500 miles from the Wasatch Range and Colorado Plateau, in Utah and Arizona, to the Sierra Nevada and Great Valley, in California, and southerly about the same distance from southern Oregon and Idaho to the vicinity of Death Valley and Lake Mead, in California and Nevada (Plume, 1996).

Tectonic evolution of the Great Basin has resulted from two distinctly different styles of deformation - thrust faulting and folding, which occurred during the Paleozoic and Mesozoic eras, and extensional normal and strike-slip faulting, which began early in the Cenozoic era and has continued into the present (TRW Environmental Safety Systems, Inc., 2000). Ongoing extension in the southern great Basin has doubled its width in the last 20 million years (Thatcher et al., 1999).

Major recognizable, post Proterozoic, compressional deformation began in the NRL area with episodic uplift and thrust faulting during the late Devonian to Mississippian Antler orogeny (Kleinhampl and Ziony, 1985). This folding and faulting created a mountainous region and a foreland marine basin to the east, into which detritus shed from the rising mountains was deposited (Stewart, 1980; Trexler et al., 1996).

Emplacement of north-northwest- to north-northeast-trending overthrust belts from Permian to Cretaceous time terminated marine deposition in the NRL area (TRW Environmental Safety Systems, Inc., 2000). From west to east, these deformational features include the Death Valley thrust belt (Snow, 1992), the Sevier orogenic belt (Snow, 1992; Taylor et al., 1993; Trexler et al., 1996), and the Central Nevada thrust belt (Taylor et al., 1993). In most of these belts, thrust faults were accompanied by overturned or dismembered folds, and most thrusts displaced rocks eastward (TRW Environmental Safety Systems, Inc., 2000). Cenozoic crustal extension and strike-slip movement laterally offset and rotated segments, but most major thrust faults can be traced along strike for more than 60 miles (Workman et al., 2002b). Prominent faults in and near

the NRL area that resulted from this tectonic episode include the Meikeljohn, Panama, Belted Range, CP, Specter Range, Spotted Range, Wheeler Pass, Keystone, Gass Peak, Lincoln, Mount Irish, and Golden Gate Thrusts (Workman et al., 2002b).

Starting in the Oligocene epoch, before development of Basin and Range topography, magmatism characterized by shallow intrusion and development of calderas and stratavolcanos occurred in belts that paralleled subduction along the western edge of the North America plate (Burchfiel et al., 1992; Christiansen and Yeats, 1992; Lipman, 1992). Faulting accompanied, but was secondary to magmatism during this period of extension (Rowley, 1998). Most of the faults that developed during this period either strike northeast with a left-lateral strike-slip component or strike northwest with a right-lateral strike-slip component (Ekren et al., 1968). The Mount Helen, Cactus Range, and Cathedral Ridge Calderas (Ekren et al., 1971), the Quinn Canyon Range Caldera (Sargent and Houser, 1970; Best et al, 1989), the Kawich Range Caldera (Stewart and Carlson, 1976; Best et al, 1989 and 1995), the Goldfield Caldera (Albers and Stewart, 1972; Cornwall, 1972), the Timpahute transverse zone (Ekren et al., 1976 and 1977; Rowley, 1998), and the Bellehellen lineament (Ekren et al., 1976; Gardner et al., 1980) formed during this period.

In the early Miocene epoch, prior to about 20 million years ago, movement on the San Andreas Fault system resulted in oblique extension over much of the Basin and Range province (Hamilton and Myers, 1966). Some of the motion between the North American and Pacific Plates transferred across the Sierra Nevada-Great Valley block into the Great Basin, resulting in a pattern of right-lateral and normal faulting in the western part of the Great Basin and predominantly normal faulting in the eastern part of this area (Bennett et al., 1999, and 2003; Thatcher et al., 1999; Oldow et al., 2001). Right-lateral shear generated the Walker-Lane belt.

The Walker-Lane belt is a 60-mile-wide structural domain that extends northwesterly subparallel to the Nevada-California state line from the vicinity of Las Vegas, Nevada to northern California (Stewart, 1988). The Walker-Lane belt separates the Basin and Range domain, on the north, from the Inyo-Mono domain and Sierra Nevada block, on the south, although structural elements of the Walker-Lane belt overlap adjacent domains. The Walker-Lane belt is characterized by an assemblage of crustal blocks separated by discontinuous, northwest-striking, right-lateral faults and northeast-striking, left-lateral faults (Stewart, 1988; Carr, 1990).

The Inyo-Mono domain includes all of the extended terrain west of the Furnace Creek-Death Valley fault zone, east of the Sierra Nevada front, and north of the Garlock Fault (Carr, 1984; Stewart, 1988). This domain is characterized by concentrated right-lateral shear and oblique extension, resulting in a series of rhombohedral pull-apart basins, including sub-basins within Death Valley (Blakely et al., 1999). Structural relief is very high, in part because detachment faulting has unroofed some mountain ranges, such as the Funeral Range and Black Mountains. Faults in this region are more continuous, better defined, and more active than those in the Walker-Lane belt (Workman et al., 2002b). As distinctive as the Inyo-Mono domain is, it could be partly represented within the Walker-Lane belt by less developed features, including the Pahrump-Stewart Valley-Amargosa Fault system (Blakely et al., 1999) and the Sarcobatus Flat-Goldfield Hills fault zone (Blakely and Ponce, 2001; Workman et al., 2002b).

The Basin and Range domain is characterized by generally northerly trending relatively narrow mountain ranges separated by broad structural and topographic basins filled with alluvium derived from erosion of the mountains. This topography resulted mostly from differential movement along north- to northeast-trending normal faults. Mountain ranges generally are composed of tilted fault blocks, with range-bounding faults defining one or both sides of mountain ranges and adjacent basins, such that these basins are either grabens or half-grabens (Stewart, 1980). Many of these faults have been inactive since at least middle to late Quaternary time and are buried beneath basin-fill sediments (Workman et al., 2002b), but some normal faults displace upper Pliocene to Quaternary surficial deposits (Simonds et al., 1995). Major faults in this structural domain include the Paintbrush Canyon and Solitario Canyon Faults at Yucca Mountain, the Bare Mountain Fault, the Hogback Fault in Oasis Valley, the Kawich Range and Hot Creek-Reveille Faults bordering the Kawich Range, the East Reveille Range and West Railroad Faults bordering the Reveille Range, the Quinn Canyon Fault on the west side of the Quinn Canyon Range, the Penoyer Fault on the west side of the Worthington Mountains, the Pahroc Fault on the east side of the Seaman Range, the White River Fault on the west side of the North Pahroc Range, and the Antelope Canyon and Chief Canyon Fault zones bordering the Chief Range (Taylor, 1990; Rowley et al, 1994; Workman et al., 2002b).

During Basin-and-Range extension, magmatism was secondary to faulting (Workman et al., 2002b). Nevertheless, prominent calderas developed in the Southwest Nevada Volcanic Field from 13.7 to 7.5 million years ago. These calderas included the Silent Canyon Caldera complex,

the Claim Canyon Caldera, the Timber Mountain Caldera complex, the Black Mountain Caldera, and the Stonewall Mountain Caldera (Workman et al., 2002b).

Consistent with east-west extension across the Great Basin and northwesterly right-lateral shear in its western part, Quaternary surface faults tend to strike north-northwesterly toward the western part of the region and northerly elsewhere, as shown in the Faults and Seismic Activity Map, Plate 4. Geodetic measurements indicate about 0.35 to 0.51 inches per year (9-13 mm/year) of deformation in the western fourth of the Great Basin (Bennett et al., 1999 and 2003; Thatcher et al., 1999). As shown on Plate 4, faults in the NRL area typically have relatively low slip rates of less than 0.008 inches per year (<0.2 mm/yr). Few of the numerous Quaternary faults in the NRL area have been shown to have Holocene surface rupture.

Historically, numerous small- to moderate- and occasionally large-magnitude earthquakes have occurred within the Great Basin as a result of ongoing extensional deformation across the region. Epicenter distribution patterns (shown on Plate 4) and geodetic strain data indicate that strain presently is concentrated primarily north of Yucca Mountain in a zone along latitude 37^0 N (the intermountain seismic belt), in the eastern California shear zone, and in the central Nevada seismic zone (Bennett et al., 1999). As indicated on Plate 4, a few magnitude 6 or larger earthquakes have occurred within the NRL area, but the largest recorded earthquakes in this area consistently have been in the magnitude 5.0 to 5.9 range.

4.4 Hydrogeology

The NRL region is located near the terminus of a large series of interconnected hydrographic basins that comprise the Great Basin regional aquifer system (Prudic et al., 1993; Plume, 1996). All basins have interior drainage, except those of Meadow Valley Wash and the White River, which are tributaries of the Colorado River. East of the Quinn Canyon Range, regional groundwater flow is toward Muddy River Springs (southeast of the Pahranagat Valley) and the Colorado River; to the west, regional groundwater flow is toward Oasis Valley, Ash Meadows (in the Amargosa Desert), and Death Valley.

In the vicinity of the NRL region, groundwater moves at local, intermediate, and regional scales through multiple aquifers. Hydraulic connection between basins most commonly is maintained through unconsolidated sediments that were deposited across low topographic divides. In many structural basins, such as the Amargosa Desert, Oasis Valley, Sarcobatus Flat, Lida Valley,

Stonewall Flat, Ralston Valley, Stone Cabin Valley, Dry Lake Valley, and Meadow Valley, groundwater occurs abundantly at shallow (≤100 feet) depths in basin-fill sediments (Dudley and Larson, 1976; Bunch and Harrill, 1984; Claasen, 1985; and Robledo et al., 1998). Tertiary lava flows, ash-flow tuff sheets, and bedded tuff deposits can be very transmissive (Laczniak et al., 1996; Luckey et al., 1996). However, transmissive intervals in the volcanic rocks are laterally discontinuous, and water moving vertically through fractures across stratigraphic and lithologic contacts maintains regional flow through these rocks (Geldon et al., 1998, and 2002; Geldon, 2004). Deep interbasin flow occurs primarily through Paleozoic carbonate rocks (Dettinger et al., 1995).

Faults and related fractures are the largest influence on groundwater flow through bedrock aquifers within the NRL region (Faunt, 1997). Faults disrupt stratigraphic continuity, which can divert water in regional circulation to local and subregional outlets. For example, juxtaposition of Paleozoic carbonate rocks against Quaternary and Tertiary lacustrine and playa sediments by the Ash Meadows Fault has created an oasis at Ash Meadows in the Amargosa Desert, where water originating in the Paleozoic rocks issues profusely as springs from Quaternary-Tertiary sediments (Winograd and Thordarson, 1975). At Yucca Mountain, faults enhance the permeability of adjacent Miocene tuffaceous rocks. The faults act as either barriers or conduits to groundwater flow and delimit hydrologic domains (Geldon, 1996, and 2004). In the Kawich, Quinn Canyon, North Pahroc, and Cedar Ranges, and in the Goldfield Hills, faults appear to control the location of springs issuing from Tertiary volcanic rocks.

Less important than structure, but also an influence on groundwater flow, is the lithology of rocks along flow paths. In basin-fill sediments, shifting depositional environments over short distances resulted in substantial facies changes that affect transmissivity and hydraulic conductivity, particularly where silt and clay became intermixed or interbedded with sand and gravel (Bunch and Harrill, 1984; Plume, 1996). In volcanic rocks, a characteristic change from lava flows to welded tuffs and, ultimately, nonwelded and bedded tuffs with increasing distance from eruptive centers can cause the same stratigraphic units to have substantially different hydraulic properties in different areas (Laczniak et al., 1996; Geldon, 2004). Depositional pinchouts of Miocene tuffs in Jackass Flats, east and south of Yucca Mountain, force water into alluvium that is unsaturated where it overlies these same tuffs about 7 miles to the north (Claasen, 1973; Thordarson, 1983; and Nye County Nuclear Waste Repository Project Office, 2005). Lateral facies changes within Paleozoic rocks (e.g., from cherty limestone to shaly

limestone or from limestone to dolomite) might affect permeability, but a westward facies change in Mississippian rocks from predominantly limestone and dolomite to predominantly argillite and quartzite produced a sinuous barrier to regional groundwater flow extending northerly from Ash Meadows (in the Amargosa Desert) to Elko, Nevada. (Mifflin and Hess, 1979). Outcrops of Cambrian and Proterozoic quartzite, gneiss, schist, marble, metadiorite, and granitic rocks force water into overlying aquifers and create flow-system boundaries throughout the region (Winograd and Thordarson, 1975).

Factors other than lithology and structure in the NRL region that have been discussed as possible influences on permeability and groundwater flow include increasing induration in basin-fill sediments and decreasing fracture openness in bedrock aquifers with depth (Winograd and Thordarson, 1975), alteration and welding in tuffs (Laczniak et al., 1996), and the coupled effects of hydrochemical changes in response to thermal gradients (Moore et al., 1984).

Geldon (2004) recognized 11 hydrostratigraphic units (HSUs) in the region traversed by the NRL. HSUs are composed of related geologic units that have similar lithologic and hydraulic properties over laterally extensive areas.

Most basin-fill sediments are included in the Quaternary-Tertiary fan, floodplain, and stream alluvium HSU. Component geologic units are Holocene to Pliocene in age. Included sediments consist of sand, gravelly sand, sandy gravel, and gravel, with cobbles, boulders, silty to clayey intervals, and thin interbeds of clay and silt, that were deposited mostly in alluvial fans, floodplains, and stream channels. Subordinate eolian silt and sand, landslide deposits, debris flows, talus, colluvium, basalt flows, and tuff layers are present locally. Generally unconsolidated at and near the water table, sediments become more indurated with increasing depth. This HSU tends to be an aquifer regionally, but finer-grained sediments, calcrete layers, and intercalated volcanics impede groundwater movement.

The Quaternary-Tertiary playa and spring deposits HSU consists of playa, lake, marsh, and spring-deposited clay, marl, limestone, silt, sand, gravel, evaporite deposits, and thin tuff layers. Component geologic units are Holocene to Pliocene in age. Regionally, this HSU tends to be a confining unit, but limestone and sand layers can be very productive aquifers.

The Quaternary-Tertiary basalt lava flows HSU consists of mafic lava flows intercalated with, and underlying basin-fill sediments and, also, cinder cones that are present locally in topographic

basins. Component geologic units, which are Holocene to Miocene in age, are not laterally extensive. Hydraulic properties of individual lava flows are extremely variable, and cinder cones typically are above the water table.

The Younger Tertiary tuff and lava flows HSU consists of nonwelded to densely welded ash-flow tuff, depositional and fault-related tuff breccia, ash-fall tuff, reworked tuff, volcaniclastic rocks, and rhyolite, comendite, and trachyte lava flows. Component geologic units are Pliocene to Miocene in age. The volcanic rocks that comprise this HSU tend to have both fracture and matrix permeability. Fracturing, which is most intense near faults, is believed to enhance permeability. Alteration of rock-forming minerals to zeolite, clay, carbonate, silica, and other minerals, which is most intense toward eruptive centers, is believed to reduce permeability. Hydraulic properties within this HSU are extremely variable laterally and vertically. Fortuitous combinations of lithology and structure can result in very transmissive intervals or major impediments to groundwater flow over large areas.

The Older Tertiary tuff and lava flows HSU consists mostly of ash-flow tuff, ash-fall tuff, reworked tuff, tuff breccia, volcaniclastic rocks, and rhyolite, comendite, rhyodacite, and dacite lava flows; however, shale, sandstone, and conglomerate are intercalated. Component geologic units are older Miocene to Oligocene in age. The volcanic rocks that comprise this HSU tend to have both fracture and matrix permeability. Ash-flow tuffs tend to be nonwelded, but they can be partly to densely welded. Alteration of ash-flow, ash-fall, and reworked tuffs to zeolite, clay, carbonate, silica, and other minerals is common. Regionally, this HSU tends to be a confining unit.

The Tertiary and Mesozoic granitic rocks HSU consists of granodiorite, quartz monzonite, granite, and tonalite stocks and larger plutons. Component geologic units are Oligocene to Jurassic in age. Although these intrusive rocks can produce small quantities of water from fractures and weathered zones, they impede groundwater flow wherever they are present.

The Mesozoic and Permian sedimentary rocks HSU consists of interbedded conglomerate, gravelly sandstone, sandstone, siltstone, shale, calcareous shale, limestone, and gypsum. Component geologic units are Jurassic to Permian in age. Hydraulic properties are extremely variable. The Shinarump Conglomerate Member of the Chinle Formation and the Kaibab Limestone are regional aquifers, and other sandstone and limestone intervals transmit water

locally. Conversely, intervals predominantly composed of shale, such as upper members of the Chinle Formation, are regional confining units.

The Paleozoic carbonate rocks HSU interfingers with the Paleozoic and Proterozoic clastic rocks HSU. The Paleozoic carbonate rocks HSU consists of cherty, siliceous, silty, shaly, and fine-grained limestone and cherty, silty, sandy, and fine-grained dolomite with subordinate chert, shale, siltstone, sandstone, and quartzite. Component geologic units are Permian to Cambrian in age. Although clastic intervals confine flow, Mississippian, Devonian, Silurian, Ordovician, and Cambrian limestone and dolomite are aquifers throughout the Great Basin and adjacent physiographic provinces.

The Paleozoic and Proterozoic clastic rocks HSU consists of argillite, shale, siltstone, quartzite, sandstone, and conglomerate with subordinate chert, limestone, dolomite, and diabase. Component geologic units are Permian to Middle Proterozoic in age. Although limestone, dolomite, and clastic rocks locally transmit water, this HSU regionally is considered a confining unit.

The Early Proterozoic igneous and metamorphic rocks HSU consists of schist, metaconglomerate, gneiss, marble, and metadiorite, which are intruded by monzonitic to granitic dikes. Although these rocks can produce small quantities of water from fractures and weathered zones, they constitute a confining unit that is the base of the groundwater flow system in the region.

5.0 STRATIGRAPHIC NOMENCLATURE AND DESCRIPTION OF GEOLOGIC UNITS

Geologic units present along and adjacent to the NRL range in age from Holocene to Late Proterozoic. Table 2 presents generalized stratigraphic columns for four principal areas along the corridor. Table 3 lists most major stratigraphic units included in the combined regional geologic units. Properties of the geologic units shown on the Detail Maps in Figure 3 that were mapped during the field reconnaissance are presented in Table 5. A field reference sheet for rock classification is included in Appendix I. It defines the terminology used in our rock descriptions.

Geologic unit designations in Tables 3 and 5 differ slightly because the stratigraphic nomenclature used for the Detail Maps was compiled from local, subregional, and regional-scale geologic maps as the reconnaissance mapping progressed, and it was beyond the scope of this report to resolve differences in stratigraphic nomenclature used from area to area and in different references for the same area..

Stratigraphic nomenclature used on the Detail Maps in Figure 3, in Tables 2, 3, and 5, and in the body of the report (with the exception of geologic cross-sections shown on Plate 3) was chosen in accordance with two main objectives:

- An abundance of stratigraphic names in use in the NRL area needed to be condensed on the basis of lithologic and engineering properties into a much smaller number of regionally significant names. The geologic map by Workman et al. (2002a) and the county geologic maps guided this initial step in the selection of stratigraphic names.
- Stratigraphic nomenclature used in this report needed to incorporate the most current and widely accepted geologic names assigned in the study area. Numerous geologic reports and maps (referenced in Table 1), which were prepared at local, subregional, and regional scales over the last 40 years, were studied to sort through stratigraphic nomenclature that has evolved repeatedly in response to ever-increasing levels of knowledge and changes in conceptual geologic models.

Observations made during the field reconnaissance and the literature review led to some revisions in nomenclature. It is expected that additional literature searches and field work during subsequent phases of the project might result in additional revisions in nomenclature.

5.1 Quaternary Eolian Dune, Sheet, and Ramp Deposits (Qe)

Holocene to early Pleistocene eolian deposits cover large areas, but they generally were too thin to show on field reconnaissance maps. They consist mostly of loose, light brown, brown, pale yellowish-brown, and light gray, fine- to medium-grained sand, silty sand, and sandy silt. Locally, gravel and cobbles are intermixed with the sand and silt or occur as lag deposits. The eolian deposits form low mounds with gravel pavement, sand sheets, dune fields, and ramp deposits.

5.2 Playa and Lake Sediments (Qp)

All valleys along the Caliente rail corridor, except Oasis Valley, White River Valley, and Meadow Valley Wash, lack external drainage. Holocene and latest Pleistocene playas exist at

the lowest points of Sarcobatus Flat, Lida Valley, Stonewall Flat, Ralston Valley, Cactus Flat, Railroad Valley, Sand Spring Valley, Coal Valley, and Dry Lake Valley. Sediments that fill these playas and surrounding areas that were lakes when the climate was wetter consist of tan, light brown, brown, and light-gray to white mixtures of stiff to hard silt, clay, and dense, fine-grained sand. The playa sediments are desiccated at land surface and covered with patches of loose, fine gravel or wind-blown, medium to coarse-grained sand.

5.3 Quaternary Stream Channel and Floodplain Alluvium (Qc)

Holocene and latest Pleistocene (?) alluvium occurs in channels and on adjacent floodplains of the Amargosa River, White River, Cottonwood Creek, Cherry Creek, Clover Creek, Beatty Wash, Tolicha Wash, Big Wash, Meadow Valley Wash, Cow Canyon, and numerous other drainages. No systematic attempt was made on the Detail Maps to distinguish these deposits from young Quaternary (Holocene and late Pleistocene) alluvium in tributary washes (discussed below).

Stream channels typically contain loose to medium-dense, unconsolidated, variably silty, sandy gravel, and variably silty, gravelly sand. Cobbles and boulders commonly are intermixed with the sand and gravel. Boulders as much as 4 to 7 feet in diameter were observed in washes on the west sides of the Quinn Canyon, North Pahroc, and Highland-Chief Ranges. High-energy runoff events of unknown frequency are indicated by the presence of boulders exceeding 3 feet in diameter. Deposits of desiccated silt and sandy silt, and silty sand, commonly present between channels, indicate that overbank flow occurs during large runoff events.

Floodplain deposits vary in character according to geologic and geomorphic settings. Floodplains in mountainous terrain (e.g., those of the Amargosa River, Clover, Cherry, and Cottonwood Creeks, Big Wash, and Cow Canyon) contain interbedded, loose to dense, reddish-brown, brown, and light brown, variably gravelly, variably silty, fine- to coarse-grained sand, and variably silty, sandy, fine to coarse gravel. Floodplains in basins containing lakebeds (e.g., those of White River and Meadow Valley Wash) contain reddish-brown, brown, light brown, tan, and light-gray, stiff to hard clay and clayey silt, and loose to dense, clayey sand, silty sand, and fine-grained sand.

5.4 Young Quaternary Fine-grained Alluvium (Qayf)

Holocene and latest Pleistocene (?) fine-grained sediments, some of which were deposited in Quaternary lakes, form aprons around several playas, including Mud Lake at the southern end of Ralston Valley. This apron extends east to surround a playa in Stone Cabin Valley. Aprons of fine-grained sediments also surround playas in Sarcobatus Flat, Lida Valley, Stonewall Flat, Cactus Flat, Railroad Valley, Sand Spring Valley, Coal Valley, and Dry Lake Valley. The fine-grained sediments consist of tan, beige, light brown, yellowish-brown, reddish-brown, and grayish-white, stiff to hard silt, clayey silt, sandy silt, and silty clay and dense, silty sand. The fine-grained sediments locally are cemented with calcium carbonate. At the ground surface, these sediments are typically tan and desiccated. They become very soft to soft during periods of seasonally high precipitation and runoff. These deposits occur in small to large unvegetated areas sparsely covered with patches of loose, fine gravel or beneath small mounds of eolian, fine to medium-grained sand stabilized by shrubs or grass.

5.5 Young Quaternary Fan, Valley Floor, and Tributary Alluvium (Qay)

Quaternary geologists working in the Death Valley region distinguish young, intermediate, and old Quaternary alluvium on the basis of many criteria that, for the most part, were not readily discernible during field reconnaissance. The presence or absence of calcrete layers within the alluvium seemed to be the only consistent basis for distinguishing young Quaternary (Holocene and late Pleistocene) from middle Quaternary (late and middle Pleistocene) and old Quaternary (early and middle Pleistocene) alluvium in the absence of published maps addressing this distinction. Consequently, identifications of young, middle, and old Quaternary alluvium east of Garden Valley are considered tentative.

The young Quaternary alluvium becomes finer grained from the upper parts of alluvial fans to the lower parts of these fans and to the adjacent valley floors. The loose to very dense upper and middle fan alluvium consists mostly of well-bedded, gently sloping, reddish-brown, brown, and light brown, sandy gravel and silty, sandy gravel, with cobbles and boulders up to 3 feet in diameter. Subordinate gravelly sand; gravelly, silty sand; and fine-grained sand layers are present. Scour and fill and cross-bedding were observed locally.

Lower and distal young Quaternary fan alluvium consists of medium dense to very dense, light brown, brown, and reddish-brown, sandy, silty gravel and gravelly, silty, fine-grained sand, with scattered cobbles and rare boulders.

Young Quaternary valley floor alluvium consists of locally damp to wet, medium dense to very dense, reddish-brown, slightly gravelly, silty to slightly silty, fine- to medium-grained sand with minor very stiff, red-brown to tan, sandy silt.

Young Quaternary tributary alluvium consists of loose to medium dense, brown, sandy gravel, gravelly sand, gravelly, silty sand, and silty, fine-grained sand.

5.6 Intermediate-age Quaternary Fan Alluvium (Qam)

The intermediate-age (Middle) Quaternary fan alluvium consists mostly of medium dense, light grayish-brown, reddish-brown, brown, and light brown, slightly silty, sandy gravel with cobbles and boulders and gravelly, silty sand with scattered cobbles. Thin horizons of very dense, white calcrete occur within the alluvium. These calcrete layers consist of cobble- to boulder-sized clasts up to 2 feet in diameter in gravelly, calcium carbonate-cemented, silty sand.

5.7 Old Quaternary Fan, Valley Floor, and Tributary Alluvium (Qao)

The old Quaternary alluvium becomes finer grained from the upper parts of alluvial fans to the lower parts of these fans and to the adjacent valley floors. The typically medium dense to very dense upper and middle fan alluvium predominantly consists of unconsolidated to well-cemented, reddish-brown, brown, and light brown, sandy gravel, and slightly silty to silty, locally clayey, sandy gravel. The gravel layers contain abundant carbonate-coated cobbles and scattered boulders of sedimentary and volcanic rocks, which are up to 4 feet in diameter. Interbedded subordinately with the gravel layers are gravelly, fine- to coarse-grained sand, gravelly, silty to clayey sand, and silty sand. Thin layers of low to moderate-strength (or very dense), white calcrete (carbonate-cemented gravel, cobbles, and some boulders) pervade the alluvium.

Lower and distal old Quaternary fan alluvium consists mostly of dense to very dense, reddish-brown, brown, light brown, light grayish-brown, gray, and tan, slightly silty to silty, sandy gravel with carbonate-coated cobbles and scattered small boulders, and loose to dense, slightly gravelly to gravelly, silty sand with scattered cobbles. Locally, stiff, sandy silt, stiff, gravelly, sandy clay layers, or moderate-strength (very dense) calcrete layers could be present.

Old Quaternary valley floor alluvium consists of dense to very dense, reddish-brown and light brown, silty, fine-grained sand, and slightly gravelly to gravelly, silty sand.

Old Quaternary tributary alluvium consists of dense to very dense, reddish-brown, clayey, sandy, fine to coarse gravel, slightly silty, gravelly, fine- to coarse-grained sand, and slightly gravelly, silty sand.

5.8 Quaternary-Tertiary Alluvium (QTa)

Pediment gravel, remnants of alluvial fans on basin margins, and paleocolluvium, i.e., basin-fill deposits with strongly developed or eroded relict soils are mapped as middle Pleistocene to Pliocene. Pediment gravel in Montezuma Valley consists of medium-dense to dense, brown to brownish-yellow, slightly gravelly, medium- to coarse-grained sand, gravelly sand, and sandy gravel, unconsolidated to poorly cemented with limonite. Remnant alluvial fans at the southern end of Reveille Valley and in an intermontane basin between the Timpahute and Golden Gate Ranges consist of very dense, reddish- to yellowish-brown, non- to well-indurated, slightly gravelly to gravelly, silty sand and sandy gravel. Exposures of paleocolluvium present in Sheep Spring Draw, in the Cedar Range, consist of very stiff to hard, brick-red and reddish-brown clay with seams of slightly gravelly to gravelly clay, very dense coarse-grained sand and fine gravel, and very dense, slightly gravelly, silty sand.

5.9 Quaternary-Tertiary Alluvium, Undivided (QTau)

Where several units of Quaternary and Tertiary alluvium interfinger and the geology could not be mapped in detail, the alluvium was not differentiated on the Detail Maps. Undivided Quaternary-Tertiary alluvium was mapped in areas from Yucca Mountain northwest to Sarcobatus Flat. The undivided Quaternary-Tertiary alluvium variably combines properties of component geologic units that are described previously.

5.10 Quaternary-Tertiary Landslide Deposits (QTls)

Landslide deposits consist of angular, gravel to boulder-sized fragments and blocks of bedrock in a poorly sorted matrix of unconsolidated to well-indurated clay, silt, and sand. The lithology of these deposits reflects the underlying bedrock. Landslides generally form on rock with low bearing strength, such as hydrothermally altered volcanic rocks and shale.

5.11 Quaternary-Tertiary Colluvium (QTc)

Colluvium consists of gravel to boulder-sized clasts of underlying bedrock in a matrix containing variable amounts of clay, silt, and sand, some of which might be cemented partly by calcite

seeping down through the erosional debris. Colluvium includes talus deposits. Although colluvium accumulates at the base of most outcrops, deposits generally are thin and limited in area. Consequently, few areas of colluvium were distinguished on field reconnaissance maps.

5.12 Quaternary-Tertiary Basalt (QTb)

Holocene to Pleistocene (approximately 0.07 to 1.1 Ma) cinder cones and related lava flows and feeder dikes occur in three volcanic centers: near Amargosa Valley (formerly Lathrop Wells), in central and western Crater Flat, and in northern Oasis Valley. Cinder cones include the Lathrop Wells Cone near Amargosa Valley; Little, Black, Red, and Makani Cones in Crater Flat; and Little Black Peak and Hidden Cones in Oasis Valley. The black and reddish-brown scoria cinder cones and basalt lava flows generally are resistant.

Basaltic trachyandesite, of Pliocene age (2.9 to 4.6 Ma), forms Buckboard Mesa, the Thirsty Mountain shield volcano, and a fissure-vent complex of moderately dissected scoria mounds, lava flows, and feeder dikes in southeastern Crater Flat. The rock forming these features is dark gray to dark reddish-brown and resistant.

Miocene and locally Oligocene basalt and basaltic andesite lava flows have widespread distribution in and adjacent to the rail corridor. Most of these lava flows erupted between 6 and 11.5 Ma. They include lava flows in southwestern Crater Flat, lava flows and cinder cones centered on the Black Mountain caldera, lava flows covering Blackcap Mountain and other high areas in the Goldfield Hills, and lava flows extending west from the Reveille Range into Reveille Valley (see Table 3 for a more complete list of component geologic units). These lava flows generally are dark gray to black, finely crystalline to porphyritic, locally auto-brecciated, and variably vesicular. Many vesicular basalt flows contain secondary minerals (amygdules) partially or nearly completely filling voids. Basalt megabreccia, consisting of rounded to sub-rounded, small to very large boulders of basalt in a matrix of welded, lithic-rich, basaltic andesite? tuff, forms most of the cliffs flanking the southwest side of Echo Canyon in the Reveille Range. Basalt breccia cemented with calcium carbonate was observed beneath a lava flow in Sarcobatus Flat. This geologic unit generally has very high strength and has closely to widely spaced fractures. Basalt flows, in general, are resistant and form or cap many upland areas, including Skull Mountain, Coba Mountain, Blackcap Mountain, the northern Goldfield Hills, and Malpais Mesa.

5.13 Tertiary Fan Alluvium (Tf)

This Pliocene unit includes the Fan Alluvium of Antelope Canyon. The unit consists of light gray and locally light pink, gravelly sandstone and conglomerate, with layers of silt, ash-flow tuff, and possible mudflow breccias. Bedding ranges from indistinct (massive) to slabby. Typically, moderately to well-cemented by microcrystalline calcium carbonate. Clasts are chiefly comprised of subangular quartzite and subordinate subrounded granodiorite from rock units exposed in the Chief Range. The unit locally contains boulders up to 5 feet in diameter. Where observed in Cobalt Canyon north of Indian Cove, the unit exhibited moderate to high strength. This unit is present generally on the east side of the Chief Mountains and in small, isolated outcrops on the floor of Meadow Valley. The Caliente alternative crosses a small outcrop of this unit just south of Indian Cove.

5.14 Tertiary Lake Beds (Tl)

Included in this Pliocene and Miocene geologic unit are the informally named White River Narrows unit in the White River Valley, the Panaca Formation in Meadow Valley, and lakebeds cropping out in and adjacent to Sheep Spring Draw, in the Cedar Range. The lacustrine sediments are tan, beige, brown, reddish-brown, salmon-pink, light gray, and white, and poorly to moderately consolidated. In Meadow Valley, the lakebeds thicken and become finer grained toward the center of the basin. In most places, the lakebeds consist of stiff to hard clay and silt, with subordinate, loose to medium dense, locally cross-bedded, fine- to medium-grained sand, and minor thin beds of medium dense, fine gravel, limestone, and diatomite. In and near Sheep Spring Draw, fine- to coarse-grained sand, gravelly sand, and gravelly, clayey sand, with thin beds of gravelly sandstone and conglomerate, predominate over sandy clay and silt. Where the sediments are moderately to strongly indurated, they have moderate to medium to high strength. In outcrops of the Panaca Formation, fractures in sandstone and claystone are closely to medium-spaced. The lakebeds, which are thin- to thick-bedded, locally erode into spires and columns and generally form hills and swales (badlands).

5.15 Younger Tertiary Sedimentary Rocks (Tsy)

This Pliocene and middle Miocene geologic unit is composed of predominantly clastic sedimentary rocks that accumulated in topographic basins between 2.9 and 16 Ma. Component geologic units include the rocks of Pavits Spring, conglomerate and sandstone in the Goldfield

Hills, Oasis and Meadow Valleys, and valleys of the White River and Clover Creek, caldera-moat filling sediments in the Pahute Mesa area, and other geologic units listed in Table 3.

These sedimentary rocks consist of tan, light-gray, light-orange, green, brownish- to greenish-yellow, yellowish- to reddish-brown, red, and pink, poorly to moderately consolidated, thinly to very thickly bedded, fluvial conglomerate, gravelly sandstone, sandstone, siltstone, and shale; locally intercalated with bedded tuff, playa sediments, and lakebeds. Typically, sandstone, gravelly sandstone, and conglomerate grade into each other and erode easily into gravelly sand and sandy gravel colluvium. Sedimentary rocks comprise most of the misnamed Siebert Tuff, but in the Goldfield Hills, sandstone and conglomerate in the Siebert are intercalated with a prominent light-gray to white, nonwelded, biotite-rich, lithic-rich ash-fall tuff. In the White River Valley, mostly unconsolidated cobble-gravel intervals interfinger with, and grade into lacustrine silt, clay, and fine-grained sand.

Basin-fill sediments in Oasis Valley, the Bullfrog Hills, and Clover Creek Valley generally have moderate to medium-high strength and have very closely to medium-spaced fractures. Colluvium, which is dense to very dense sand and gravel, generally covers most of the surface area where these basin-fill sediments are present. Sedimentary rocks in the Siebert Tuff have moderate to high strength, have closely to widely spaced fractures, and are prone to slumping; the ash-fall tuff in this geologic unit has low to moderate strength and has closely to very widely spaced fractures. Basin-fill sediments in the White River Valley typically consist of loose to very dense gravel interbedded in variable proportions with stiff to very stiff silt and clay. The younger Tertiary sedimentary rocks, in general, are moderately resistant and characteristically form benches.

5.16 Older Tertiary Sedimentary Rocks (Tso)

This middle Miocene and Oligocene geologic unit is composed of predominantly clastic sedimentary rocks that accumulated in topographic basins between 16 and 36 Ma. Component geologic units include the Titus Canyon Formation; the Panuga Formation; sedimentary and volcaniclastic rocks in the Seaman, North Pahroc, and Chief Ranges; and other geologic units listed in Table 3. These sedimentary rocks consist of brown, red, gray, green, and orange boulder to pebble conglomerate, sandstone, siltstone, mudstone, marl, and limestone, with landslide-deposited megabreccia, mudflow breccia, reworked and ash-fall tuff, and locally

intercalated lava flows. Although present near the rail corridor, this geologic unit does not crop out within it and was not visited during field reconnaissance.

5.17 Volcanics of Stonewall Mountain (Tsv)

The Miocene (7.5 to 7.8 Ma) Volcanics of Stonewall Mountain include the Spearhead and Civet Cat Canyon Members of the Tuff of Stonewall Flat and the central dome-forming Rhyolite of Stonewall Mountain. The latter unit was included in Table 3 with other rhyolite lava flows and related intrusives and is not discussed here.

The Tuff of Stonewall Flat consists of light gray, gray, pink, purple, light-orange-brown, and brick-red, nonwelded to moderately welded, crystal-poor, lithic-rich, trachyte to comendite ash-flow tuff. Most outcrops observed on the south flank of the Goldfield Hills and at Malpais Mesa had high to very high strength, but weathering was found to decrease rock strength significantly. At a site in the Goldfield Hills where the rock was weathered cavernously, relative strength was low. In general, this geologic unit has closely to widely spaced fractures. Bedding ranges from slabby to indistinct (massive). The geologic unit tends to form caprock on mesas underlain by less resistant formations.

5.18 Late to Middle Miocene Lava Flows and Intrusives of Intermediate Composition (Ta4)

This 7.5 to 16 Ma geologic unit includes the Andesite of Sarcobatus Flat, andesite south of Black Spring, andesite in the Clifford Mine area, and volcanic rocks of Klondike Spring. The geologic unit consists of black, gray, purple, and reddish-brown, commonly glassy, commonly foliated, locally hydrothermally altered, dacite, andesite, and basaltic andesite lava flows and flow breccia, with mudflow breccia and subordinate tuffaceous and sedimentary rocks. On the west side of the Kawich Range, a moderately to highly weathered, porphyritic dacite lava flow has medium-high to high strength and has very closely to closely spaced fractures with oxidized surfaces.

5.19 Tertiary Rhyolite Lava Flows and Related Intrusives (Tvr)

Small to moderate exposures of Miocene (7.5 to 23 Ma) rhyolite lava flows and related intrusives are common in the northwest part of the study area. They include the Rhyolite of Colson Pond (Oasis Valley), Rhyolite of Sarcobatus Flat, Rhyolite of Wildhorse Spring (Goldfield Hills), Rhyolite of O'Brien's Knob (Kawich Range) and other geologic units listed in Table 3. They

consist of red, purple, gray, black, white, and yellowish-brown, porphyritic to crystal-poor, commonly foliated, rhyolite to rhyodacite lava flows and domes with subordinate perlite, dikes and pyroclastic rocks. On the west side of the Kawich Range and in Oasis Valley, outcrops of rhyolite lava flows and perlite were found to have high to very high strength and very closely to widely spaced fractures. In both places, they formed small hills.

5.20 Tuff of Gold Flat (Tg)

The Miocene (9.15 Ma) Tuff of Gold Flat consists of bluish-green, yellow, and reddish-brown, partially to densely welded, crystal-poor, lithic-poor to lithic-rich, pantellerite ash-flow tuff. Although present near the rail corridor, this geologic unit does not crop out within it and was not visited.

5.21 Thirsty Canyon Group (Tt)

Composed of the Miocene (9.3 to 9.45 Ma) Trail Ridge, Pahute Mesa, and Rocket Wash Tuffs, this geologic unit consists of tan, pink, rusty-red, gray, and greenish-brown, nonwelded to densely welded, crystal-poor, comendite ash-flow tuff. Although present near the rail corridor, this geologic unit does not crop out within it and was not visited.

5.22 Volcanics of Fortymile Canyon (Tfv)

The Miocene (10.3 to 11.45 Ma) Volcanics of Fortymile Canyon includes the Beatty Wash Formation, Rhyolite of Fortymile Canyon, Rhyodacite of Fleur-de-lis Ranch, and several other formations listed in Table 3. This geologic unit consists of black, gray, brown, orange, red, purple, and white, crystal-rich to crystal-poor, rhyolite, rhyodacite, trachyte, andesite, basaltic andesite, and basalt lava flows, flow breccia, mudflow breccia, nonwelded to densely welded ash-flow tuff, and bedded ash-fall, ash-flow, and reworked tuff. Although crossed by the rail corridor in Oasis Valley, this geologic unit was not visited because of restricted access.

5.23 Timber Mountain Group (Tm)

The Miocene Timber Mountain Group is divisible into upper and lower parts on the basis of variations in the degree of welding. The upper (11.45 to 11.6 Ma) Timber Mountain Group (Tmar) includes the Ammonia Tanks and Rainier Mesa Tuffs. It consists of purple, purplish-gray, gray, pink, light-brownish-red, and reddish- to light-brown, nonwelded to densely welded, crystal-rich, variably lithic, variably lithophysal, locally flow-banded, trachyte to rhyolite ash-

flow tuff with minor bedded tuff. Outcrops of the Ammonia Tanks and Rainier Mesa Tuffs have moderate to very high strength and very closely to widely spaced fractures. Because of variable lithology, the Ammonia Tanks and Rainier Mesa Tuffs crop out as cliffs, ledges, and slopes.

The lower (11.6 to 11.7 Ma) Timber Mountain Group (Tmrf) includes the Rhyolite of Fluorspar Canyon and the Tuff of Holmes Road. It consists of white, grayish-white, salmon-pink, pink, and beige, slightly to highly weathered, thickly bedded, rhyolitic, nonwelded ash-flow tuff, ash-fall tuff, and reworked ash-fall tuff with subordinate lava flows. Outcrops of the Rhyolite of Fluorspar Canyon have low to medium-high strength and closely to widely spaced fractures. The Rhyolite of Fluorspar Canyon erodes easily and typically forms slopes below the Rainier Mesa Tuff from Crater Flat northwest to Sarcobatus Flat.

5.24 Steamboat Mountain Formation (Tsb)

The Miocene (approximately 11.7 Ma) Steamboat Mountain Formation consists of pinkish-, lavender-, greenish-, and yellowish-gray, tan, and white rhyolite lava flows, domes, and lithic-rich ash-flow tuff with subordinate sandstone beds. Although present near the rail corridor, this geologic unit does not crop out within it and was not visited.

5.25 Ox Valley Tuff (Tox)

The Miocene (12.3 to 12.6 Ma) Ox Valley Tuff consists of light-gray, partially to densely welded, crystal-rich, rhyolite ash-flow tuff. Although present near the rail corridor, this geologic unit does not crop out within it and was not visited.

5.26 Paintbrush Group (Tp)

The Miocene (12.5 to 12.8 Ma) Paintbrush Group, which includes the Tiva Canyon Tuff, Topopah Spring Tuff, and other formations listed in Table 3, forms most of the outcrop at Yucca Mountain. The Paintbrush Group consists of light-tan, brown, purplish-brown, purple, purplish-gray, gray, grayish-white, red, pink, and light orange, moderately to densely welded, crystal-poor, variably lithophysal, rhyolite to trachyte ash-flow tuff with subordinate nonwelded to partially welded ash-flow tuff, vitrophyre, tuff breccia, bedded tuff, and lava flows. Red to reddish-orange, variably indurated, variably altered breccia is common in fault zones. Moderately to densely welded tuff, vitrophyre, tuff breccia, and lava flows generally have high to very high strength, but nonwelded to partially welded ash-flow tuff and bedded tuff can have low to moderate strength. Typically shattered, weathered, and oxidized fault breccia has low to

high strength. Fractures generally are closely to widely spaced, but spacing can be wide to very wide in bedded tuff intervals and extremely close to very close adjacent to faults. Because of variable lithology, this geologic unit crops out as cliffs, ledges, and slopes.

5.27 Calico Hills Formation (Tac)

The Miocene (12.9 Ma) Calico Hills Formation consists of salmon-pink, light purple, light yellow, brown, gray, and grayish-green, rhyolite lava flows and bedded, commonly zeolitized, lithic-rich, ash-flow tuff, ash-fall tuff, tuff breccia, and tuffaceous sandstone. Although present near the rail corridor, this geologic unit does not crop out within it and was not visited.

5.28 Wahmonie Formation (Twa)

The Miocene (13.0 Ma) Wahmonie Formation consists of purple, red, brown, olive-gray, gray, and black, porphyritic andesite, dacite, and rhyodacite lava flows, flow breccia, and mudflow breccia, and white, gray, pink, green, and brown, bedded tuff, tuff breccia, sandstone, and conglomerate. Although present near the rail corridor, this geologic unit does not crop out within it and was not visited.

5.29 Crater Flat Group (Tc)

The Miocene (13.1 to 13.5 Ma) Crater Flat Group, which includes the Prow Pass, Bullfrog, and Tram Tuffs and the Rhyolite of Prospector Pass, has good exposure in fault blocks making up a western extension of Yucca Mountain known as Tram Ridge. The Crater Flat Group consists of olive, gray, lavender, red, brown, and orange, nonwelded to densely welded, crystal-poor, rhyolite ash-flow tuff with subordinate lava flows and bedded tuff. An outcrop of brecciated, silicified, densely welded ash-flow tuff near a fault cutting Tram Ridge exhibited very high strength, even though it was very closely fractured. In three boreholes drilled at the north end of Bow Ridge, fractures pervade tuff of the Crater Flat Group, but they are distributed unevenly, and intervals range from unfractured to very fractured. On the average, moderately to densely welded ash-flow tuff and fault-brecciated tuff intervals are the most fractured. Because of variable lithology, this geologic unit forms cliffs, ledges, and slopes.

5.30 Belted Range Group (Tb)

The Miocene (13.5 to 13.85 Ma) Belted Range Group, which includes the Dead Horse Flat Formation and the Grouse Canyon Tuff, consists of gray, greenish-gray, bluish-gray, and red,

comendite to trachyte lava flows, flow breccia, ash-flow tuff, vitrophyre, and bedded tuff. Although present near the rail corridor, this geologic unit does not crop out within it and was not visited.

5.31 Tuff of Etna (Te)

The Miocene (~13.8 to 14.1 Ma) Tuff of Etna consists of gray, partially to densely welded, crystal-poor to crystal-rich, rhyolite ash-flow tuff. Although present near the rail corridor, this geologic unit does not crop out within it and was not visited.

5.32 Tram Ridge Group (Tr)

The Miocene (14.0 to 14.1 Ma) Tram Ridge Group, which includes the Lithic Ridge Tuff and the Rhyolite of Picture Rock, has good exposure in fault blocks making up Tram Ridge. It consists of light to grayish-green, light olive-gray, ochre, brown, and maroon, partially welded, crystal-poor, lithic-rich, rhyodacite ash-flow tuff, bedded ash-fall tuff, and porphyritic dacite to rhyolite lava flows. Although present near the rail corridor, this geologic unit does not crop out within it and was not visited.

5.33 Volcanics of Quartz Mountain (Tqv)

The Miocene (14.3 to 14.8 Ma) Volcanics of Quartz Mountain include the Rhyolite of Quartz Mountain, the Tuff of Tolicha Peak, the Dacite of Mount Helen, and other formations listed in Table 3. The geologic unit consists of gray, grayish-brown, pinkish-brown, orange, and white, rhyolite to dacite lava flows, flow breccia, domes, partially to densely welded ash-flow tuff, tuff breccia, ash-fall tuff, reworked tuff, and sedimentary rocks. Although present near the rail corridor, this geologic unit does not crop out within it and was not visited.

5.34 Tuff of Yucca Flat (Toy)

The Miocene (15.1 Ma) Tuff of Yucca Flat consists of white, light-red, and light olive-gray, nonwelded to partially welded, crystal-poor, rhyolite ash-flow tuff. Although present near the rail corridor, this geologic unit does not crop out within it and was not visited.

5.35 Redrock Valley Tuff (Tor)

The Miocene (15.4 Ma) Redrock Valley Tuff consists of orange to reddish-brown, densely welded, crystal-poor, rhyolite ash-flow tuff. Although present near the rail corridor, this geologic unit does not crop out within it and was not visited.

5.36 Miocene-Oligocene Mostly Silicic Ash-flow Tuff with Interbedded Ash-fall Tuff (Tt_3)

Early Miocene to late Oligocene (approximately 16 to 27 Ma), mostly silicic ash-flow tuff and subordinate ash-fall tuff, have widespread exposure from the Goldfield Hills east to the Chief Range and Clover Mountains. Included within this geologic unit are the Fraction, Hiko, Harmony Hills, and Shingle Pass Tuffs, the Pahranagat, Condor Canyon, Leach Canyon, and Isom Formations, and many other formations listed in Table 3. This geologic unit consists of black, light- to dark-gray, greenish-gray, lavender-to reddish-gray, purple, red, brownish-red, pink, orange, purplish-brown, brown, tan, pinkish-beige, and white, nonwelded to densely welded, locally vitrophyric, variable porphyritic, variably lithic, locally foliated, variable lithophysal, rhyolite to rhyodacite ash-flow tuff with subordinate dacite, andesite, and trachyte ash-flow tuff, vitrophyre, and intercalated andesite to basalt laval flows. Tuff intervals locally are hydrothermally altered.

Most outcrops have high to very high strength, but nonwelded to partially welded tuff and hydrothermally altered rock can have moderate to medium-high strength. At a site in the northern Goldfield Hills, moderately welded tuff breaks readily perpendicular to foliation planes. Conversely, nonwelded to partially welded tuff in the Cedar Range tends to form massively rounded cliffs. Fractures typically are very closely to widely-spaced, but they can be widely to very widely spaced where the rock is especially resistant. In the Golden Gate and Chief Ranges, some tuffs tend to weather along rectangular fractures into rounded, bouldery looking columns. Because of variable lithology, this geologic unit forms cliffs, ledges, and slopes.

5.37 Miocene-Oligocene Lava Flows and Intrusives of Intermediate Composition (Ta_3)

Early Miocene to late Oligocene (approximately 16 to 27 Ma) lava flows and intrusives of intermediate composition with subordinate pyroclastic rocks have good exposure from the Goldfield Hills east to the Cedar Range and Clover Mountains. Included within this geologic unit are the Dacite at Goldfield, Milltown Andesite, lava flows of Indian Cove and other

formations listed in Table 3. Unit Ta3 consists mostly of black, gray, olive, greenish-gray, purplish-gray, pale grayish-purple, red, pink, reddish-brown, brown, tan, orange, and white, porphyritic, andesite to rhyodacite lava flows, flow breccia, mudflow breccia, domes, plugs, and dikes. The lava flows of intermediate composition locally are intercalated with tuff, clastic rocks, or basalt lava flows or underlain by grayish-green to black perlite layers. Lava flows and intercalated tuff in the Goldfield Hills have been altered extensively to clay and clayey megabreccia by hydrothermal solutions. Lava flows, perlite, intrusive bodies, and volcanic mudflow breccia typically have high to very high strength, but strength decreases to very low to low where the rocks have been hydrothermally altered to clay or clayey megabreccia. Very closely to widely spaced fractures were observed in outcrops of unaltered andesite and dacite lava flows, perlite, and moderately weathered diorite. Unaltered rocks are resistant and tend to form hills and cliffs.

5.38 Shingle Pass Tuff, Monotony Tuff, and Related Tuffs (Tsm)

This Oligocene (approximately 24 to 27 Ma) geologic unit, which consists of the Pahroc sequence, Shingle Pass Tuff, Monotony Tuff, and other formations listed in Table 3, was mapped for expediency only in the North Pahroc Range. Elsewhere, component geologic units were assigned to either unit Tt_3 or unit Tt_2. Unit Tsm consists of pale red, gray, brownish- to yellowish-gray, grayish-orange-pink, and reddish-brown, nonwelded to densely welded, partly vitrophyric, generally crystal-poor, rhyolite, trachyte, and dacite ash-flow tuff. Where observed, densely welded tuff and lava flows exhibited high to very high strength and had closely to medium-spaced fractures. Because of variable lithology, unit Tsm forms cliffs, ledges, and slopes.

5.39 Shingle Pass Tuff, Needles Range Group, and Related Tuffs (Tsn)

This Oligocene (approximately 24 to 27.9 Ma) geologic unit, which consists of the Isom Formation, Shingle Pass Tuff, Lund Formation, and other formations listed in Table 3, was mapped for expediency only in the Golden Gate and Seaman Ranges. Elsewhere, component geologic units were assigned to either unit Tt_3 or unit Tt_2. Unit Tsn consists of light to dark gray, pinkish-gray, orange-pink, pink, and lavender, moderately to densely welded, partly vitrophyric, generally crystal-poor, mostly rhyolite to trachyte ash-flow tuff. Where observed, moderately to densely welded tuff exhibited high to very high strength and had very closely to widely spaced fractures. Because of variable lithology, unit Tsn forms cliffs, ledges, and slopes.

5.40 Oligocene Silicic to Intermediate Tuff and Volcaniclastic Rocks (Tt_2)

Oligocene (approximately 27 to 33 Ma), silicic to intermediate ash-flow tuff, ash-fall tuff, and volcaniclastic rocks have good exposure in the Goldfield Hills, Kawich Range, and Quinn Canyon Range. Included within this geologic unit are the Monotony, Petroglyph Cliff, and Cottonwood Wash Tuffs, the Lund, Wah Wah Springs, and Windous Butte Formations, and other formations listed in Table 3. This geologic unit consists of gray, light-gray, greenish-gray, green, brown, grayish-brown, yellow, buff, pale-purple, red, brownish-red, pink, pinkish-tan, orange, and white, nonwelded to densely welded, variably porphyritic, variably lithic, variably lithophysal, dacite, trachyte, and rhyolite ash-flow tuff, with bedded lithic-rich tuff and volcaniclastic rocks, tuff breccia, mudflow breccia, andesite lava flows, and diorite plugs. Locally, as in the Goldfield Hills and at Warm Springs Summit, unit Tt_2 is altered hydrothermally to predominantly clay minerals or mixtures of chlorite, sericite, amorphous silica, and carbonate minerals.

Unaltered ash-flow tuff has very high strength where densely welded and medium to high strength where partially welded. Where chloritized or argillized, the strength of ash-flow tuff can be expected to decrease to moderate to low. Observed fracture spacing was very close to wide in unaltered and altered ash-flow tuff.

Bedded, reworked tuff and volcaniclastic rocks are friable in outcrop and exhibit moderate to medium-high strength. Outcrops of reworked tuff and volcaniclastic rocks have thickly to very thickly spaced bedding, as do outcrops of volcanic mudflow breccia. Observed fracture spacing was very close to wide in reworked tuff and volcaniclastic rocks.

Because of variable lithology, unit Tt_2 tends to form cliffs, ledges and slopes. Locally, as on the west side of the Quinn Canyon Range, bedded tuff weathers to knobs and buttes.

5.41 Oligocene Lava Flows and Intrusives of Intermediate Composition (Ta_2)

Oligocene (approximately 27 to 33 Ma) lava flows and intrusives of intermediate composition with subordinate pyroclastic rocks have limited exposure from Reveille Valley east to the North Pahroc Range. Included within this geologic unit are dacite at the southern end of Reveille Valley, andesite lava flows at the southern end of Reveille Valley, and andesite lava flows in the North Pahroc Range (Table 3). Unit Ta_2 consists mostly of black, dark gray, greenish-gray, brownish-gray, light brown, purple, and red, porphyritic, flow-banded, partly vesicular, andesite

to dacite lava flows and domes. Dacite lava flows in Reveille Valley exhibit very high strength, have very closely to widely spaced fractures, and form steep cliffs where a slot canyon is incised into a plateau underlain by the lava flows.

5.42 Sheep Pass Formation (Tsp)

The Eocene and Paleocene Sheep Pass Formation accumulated in lakes and streams before emplacement of the tuff sheets and lava flows that dominated Tertiary history in the study area. The formation has limited exposure in the White River Valley, at the northern end of the Seaman Range, and in the Quinn Canyon-Grant Ranges. The formation consists of calcite-cemented conglomerate and breccia overlain by limestone and thin-bedded shale, marl, and fine-grained sandstone. Strength is estimated to range from moderate in thin shale layers to very high in thick-bedded limestone and conglomerate intervals. The formation is thin- to thick-bedded and forms ledgy slopes.

5.43 Tertiary to Jurassic Granitic Rocks (TJg)

Tertiary to Jurassic granitic rocks, which include granite in Fluorspar Canyon, quartz monzonite in the Goldfield Hills, and the Porphyry of Meadow Valley Wash (Table 3), have limited exposure in the NRL area. The geologic unit consists of gray, pink, and orange quartz monzonite, granodiorite, and granite (dacite to rhyolite where fine-grained) stocks, plugs, and dikes. Strength is estimated to be high to very high. Fractures are estimated to be very closely to widely spaced. The rocks are mostly resistant, but they crop out locally as crumbly grus.

5.44 Permian and Pennsylvanian Carbonate Rocks (PPl)

Permian and Pennsylvanian carbonate rocks include the Ely Limestone (PPe) and Bird Spring Formation in the Golden Gate, Seaman, and North Pahroc Ranges and the Tippipah Limestone at Syncline Ridge northeast of the rail corridor. These formations consist of light gray, dark gray, and olive-gray, fine-grained to coarsely crystalline, fossiliferous, cherty, siliceous, and silty limestone and dolomite with subordinate sandy limestone and dolomite, algal limestone, and grayish-orange-pink to pale yellowish-brown, cross-bedded, fine- to coarse-grained sandstone. Strength is generally very high, but more thinly bedded intervals tend to have moderate to high strength. Bedding ranges from laminated to thickly spaced, with thinner bedding in silty intervals and thicker bedding in siliceous and cherty intervals. Fractures are very closely to widely spaced, with more fracturing in cherty intervals. The rock locally is brecciated, but

fractures in the breccia are healed with calcite. Variations in texture and lithology give the geologic unit a characteristic slope and ledge appearance.

5.45 Upper Mississippian Clastic Rocks (Muc)

Upper Mississippian clastic rocks, which include the Scotty Wash Quartzite and Diamond Peak Formation, are exposed in the Golden Gate, Seaman, and North Pahroc Ranges, on the northeast side of the study area and in the Calico Hills on the southeast side of the study area. This geologic unit consists of dark gray, grayish-orange, yellowish-brown, and brown, cross-bedded, fine- to medium-grained, calcite- and silica-cemented, quartz sandstone and quartzite with interbedded siltstone, mudstone, and pebble conglomerate, which are overlain in northwestern Lincoln County by olive, gray, and red, bioclastic limestone and subordinate shale. Estimated strength ranges from moderate to very high, with lowest strength in shale intervals and highest strength in quartzite intervals. Bedding ranges from laminated to very thickly spaced. Depending on the type and degree of cement, sandstone ranges from slightly friable to resistant. Variations in texture and lithology give the geologic unit a characteristic slope, ledge, and cliff appearance.

5.46 Joana Limestone (Mj)

The Mississippian Joana Limestone, which crops out in the Golden Gate, Seaman, and North Pahroc Ranges, consists mostly of medium gray, dark gray, and bluish-gray, commonly fossiliferous, partly cherty, fine-grained and finely to coarsely crystalline limestone. Locally, shale laminae are present. Strength is estimated to be generally high to very high. Bedding ranges from laminated to very thickly spaced. Because of variations in texture and lithology, this geologic unit forms ledgy slopes and cliffs.

5.47 Mississippian and Devonian Shale and Limestone (MDs)

This geologic unit consists of the Chainman Shale, Pilot Shale, and West Range Limestone in the Golden Gate, Seaman, and North Pahroc Ranges, the Chainman Shale and Eleana Formation in the Calico Hills, and the Eleana Formation at Bare Mountain. The geologic unit consists of black, dark to medium gray, greenish- to olive-gray, brown, reddish-brown, yellowish-brown, and yellowish-orange, siltstone, mudstone, calcareous shale, argillite, and commonly cherty, commonly bioclastic to fossiliferous, generally fine-grained to finely crystalline limestone and silty limestone, with subordinate to minor, fine- to coarse-grained sandstone, chert-lithic

sandstone, quartzite, conglomerate, and bedded chert. Observed strength of interbedded shale and limestone in the Golden Gate Range was moderate to high, but the strength of conglomerate, sandstone, quartzite and thickly bedded limestone intervals generally should be high to very high. Bedding generally is laminated to thin and commonly fissile, but it can be thick to very thick in more resistant intervals. The geologic unit characteristically crops out as ledgy slopes or as low, rounded hills and swales.

5.48 Guilmette Formation (Dg)

The Devonian Guilmette Formation crops out at Shoshone Mountain and Bare Mountain on the southwest side of the NRL area and from Garden Valley to Dry Lake Valley on the northeast side. The formation consists of light to dark gray, olive- to brownish-gray, and yellowish-brown, fossiliferous, finely to coarsely crystalline dolomite, limestone, and silty limestone interbedded in the upper part of the formation with gray, tan, and white, fine- to coarse-grained quartzite and sandstone. The formation generally has medium-high to very high strength, although platy splitting limestone and dolomite have moderate strength. Bedding is thinly to thickly spaced in the upper part of the formation and mostly thinly spaced in the lower part of the formation. Fractures generally are closely to widely spaced, but they can be very closely spaced in thinly bedded carbonate intervals. The formation weathers to cliffs and ledgy slopes.

5.49 Devonian and Silurian Carbonate Rocks (DSl)

This geologic unit includes the Simonson, Sevy, and Laketown Dolomites in the Spotted Range, southeast of Yucca Mountain, and from the Reveille Range east to Dry Lake Valley. Equivalent rocks at Bare Mountain are called the Lone Mountain Dolomite and Roberts Mountain Formation. The geologic unit consists of light to dark gray, light olive-gray, tan, and dark brown, commonly fossiliferous, partly cherty, commonly brecciated, locally silty to sandy, fine-grained and finely to coarsely crystalline dolomite, with minor interbedded, fine-grained sandstone. Estimated strength is high to very high. Bedding typically is thinly to thickly spaced, but it can be indistinct where the rock has been brecciated or recrystallized. The geologic unit forms ledgy cliffs and slopes.

5.50 Ordovician Sedimentary Rocks (Os)

The Ely Springs Dolomite, Eureka Quartzite, and Pogonip Group crop out in the Spotted Range and Bare Mountain areas, and from the Kawich Range east to the Black Canyon and Burnt

Springs Ranges. Equivalent rocks in the vicinity of the Goldfield Hills are assigned to the Palmetto Formation. The geologic unit consists of light to dark gray, bluish-gray, olive-gray, black, and brown, fossiliferous, partly cherty, partly nodular, commonly silty, locally shaly to sandy, fine-grained and finely to coarsely crystalline dolomite and limestone; white, light brown, and varicolored, commonly cross-bedded, fine to medium-grained quartzite and quartz sandstone; and generally subordinate, varicolored, fissile siltstone, calcareous siltstone, claystone, and chert. Strength is estimated to be moderate to very high, decreasing in shaly intervals and increasing in quartzite and cherty carbonate intervals. Bedding is laminated to very thickly spaced. Laminated to very thinly bedded rocks tend to split into flaggy pieces. The Ely Springs Dolomite and Eureka Quartzite mostly form cliffs and ledges, whereas the Pogonip Group forms cliffs, ledges, slopes, and swales. The Palmetto Formation is estimated to weather mostly to ledgy slopes and swales.

5.51 Upper Cambrian Sedimentary Rocks (Cus)

This geologic unit, which includes the Bonanza King, Nopah, and Highland Peak Formations; the Lyndon Limestone, the Dunderberg and Pioche Shales; and several other formations listed in Table 3, has widespread exposure throughout the NRL area. The geologic unit consists of light to dark gray, orange, and tan, partly cherty, oolitic, or silty, locally stromatolitic or sandy, fine-grained and finely to coarsely crystalline dolomite and limestone, and green, gray, pale red, pale purple, brown, and light yellow-brown, locally micaceous, siltstone, shale, and argillite, with scattered thin beds of sandstone and quartzite. Strength is estimated to be moderate to very high, with lowest strength in shale and siltstone intervals and highest strength in thickly bedded carbonate rocks and quartzite. Shale and siltstone typically are laminated to thinly bedded and fissile. Carbonate rocks are laminated to very thickly or indistinctly bedded. Laminated to very thinly spaced carbonate rocks tend to split into flaggy pieces. Although massive appearing, thickly bedded carbonate rocks can have closely to medium spaced fractures and be locally brecciated. Shale and siltstone form slopes and valleys, whereas carbonate rocks form cliffs, ledges, and ledgy slopes.

5.52 Lower Cambrian and Late Proterozoic Sedimentary Rocks (CZs)

This geologic unit has good exposure from the Spotted Range and Bare Mountain to the Goldfield Hills, on the west side of the NRL area, and in the Black Canyon and Chief Ranges in the northeast part. Included within the geologic unit are the Prospect Mountain, Zabriskie, and

Stirling Quartzites; the Wood Canyon and Johnnie Formations; and other formations listed in Table 3. The geologic unit consists of white, pink, red, purple, green, gray, yellowish-gray, brown, light yellowish-brown, and orange, commonly cross-bedded, arkosic to quartzose, partly micaceous, silty, or gravelly, locally calcareous, fine- to coarse-grained quartzite and sandstone, with minor conglomerate; partly micaceous, locally sandy or calcareous siltstone and shale; and subordinate, locally sandy, oolitic, or algal, fine-grained to coarsely crystalline dolomite and limestone. Toward Death Valley and in contact with intrusive rocks, the rocks could be metamorphosed to phyllite, schist, hornfels, and marble. Estimated strength is moderate to very high, with lowest strength in siltstone and shale intervals and highest strength in quartzite, marble, and thicker-bedded limestone and dolomite intervals. Bedding is laminated to thickly (or indistinctly) spaced. Quartzite and sandstone tend to form cliffs, ridges, and ledges; carbonate rocks are moderately resistant; and siltstone and shale tend to be fissile and form slopes and valleys.

6.0 CHARACTERIZATION OF SOILS WITHIN THE CORRIDOR

Soil comprises the surficial material over approximately two-thirds to three-quarters of the NRL. Soils consist of unconsolidated alluvium, colluvium, and highly weathered bedrock. Some poorly indurated bedrock units such as the Tertiary Lake bed deposits (Tl) exhibit characteristics more like soil than rock in some locales.

Descriptions and area limits of soil deposits were initially determined based on the locations of unconsolidated Quaternary and Tertiary sediments shown on geologic maps obtained during the literature search. During the field reconnaissance, soils within each geologic unit were visually classified in accordance with the Unified Soil Classification System (USCS), as described in American Society for Testing and Materials (ASTM) D 2487, Standard Procedure for Classification of Soils for Engineering Purposes (USCS). A field reference sheet for soil classification is included in Appendix I. Soil classifications are shown in Table 3 for the geologic units consisting primarily of soil deposits.

Soil properties within the same geologic unit would vary depending on the location within the geologic unit and other factors. Therefore, classifications at a few easily accessible locations would not necessarily be representative of soil conditions throughout the corridor as it traverses the unit. To map soil deposits in greater detail, GIS soil survey map units were overlain onto the

NRL alignment maps. The alignment stations at contacts between different soil map units were determined and listed in a table. After tabulating station intervals and the corresponding soil map units, soil properties associated with each unit were downloaded from the Natural Resource Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) and added to the table. The resulting summary of soil survey data along the NRL is presented in Table 4.

7.0 GEOLOGIC HAZARDS

Several types of geologic hazards occur throughout the corridor that could impact route selection, design, construction, and operation. These hazards are discussed in general terms in the following sections. Typical mitigation methods are also discussed. Specific hazards that were identified within each geomorphic segment during the geologic reconnaissance effort are listed in Table 6.

7.1 Rock Slope Hazards

Rock slope hazards could occur throughout the NRL depending on the geologic conditions within each segment, orientation of the rail alignment and cut slopes relative to geologic structure, and the distance from the alignment to existing rock or constructed slopes. Because of the steep and rugged terrain through which the corridor extends, rock slope hazards would likely be a significant geologic hazard affecting the alignment through the corridor. Like landslides, rock slope failures occur when the driving forces (gravity) exceed the resisting forces (friction and cohesion).

Rock slope failures can result from a wide range of mechanisms, such as circular failures, structurally controlled failures (i.e., plane shear, wedge, and toppling), buckling, key block, and differential erosion, among others. Rock slope failures typically occur where rock discontinuities, including joints, bedding and foliation, are adversely oriented with respect to the natural or constructed slope face. Slope stability could be further reduced by natural processes of weathering (freezing and thawing, precipitation, vegetation, and erosion by humans and animals), which contributes to the mechanical breakdown of the rock mass within the rock matrix and along the discontinuities. Groundwater seepage, earthquake-induced ground shaking, and construction vibrations further reduce rock slope stability.

Mitigation of rock fall hazards could be accomplished using one or, more likely, a combination of mitigation measures, loosely defined as stabilization, protection, and instrumentation. Generally, stabilization measures reduce the driving forces or increase the resisting forces. Typically this includes either removing the potential rockfall hazard by hand, mechanical or blast scaling, or controlled blasting, or by providing external support to the rock slope using rock bolts/dowels, shotcrete, retaining walls and buttresses, cable lashing, or other methods.

In some situations, implementation of stabilization methods is not appropriate because of cost, accessibility, environmental constraints, or other factors. Consequently, protection measures can be considered that do not improve the stability of the rock slope, but provide measures that reduce the hazard to railroads. Protection measures include relocation of the railroad away from the hazard (increased ditch widths/depths), draped mesh barriers, diversion berms, mid-slope benches, catchment fences, rock sheds, and tunnels.

Railroads have for a number of years employed instrumentation to alert approaching trains to rockfall events. Typically, the instrumentation system consists of a multi-wire slide fence of varying heights and configurations. When a falling rock breaks a wire in the slide fence, it results in a signal indication that alerts approaching trains. Often slide fences are used where neither stabilization nor protection methods are provided. However, there are numerous situations where slide fences augment the stabilization and protection measures described above.

7.2 Earthquake Hazards

Earthquake hazards in the project area include ground shaking, fault rupture and displacement, and liquefaction and lateral spreading. Seismic activity could also initiate rockfalls and landslides as described above. Ground shaking of sufficient intensity could conceivably cause a train derailment. Ground fault rupture could have a significant impact to the railway alignment, and displacement of tens of feet is possible along numerous faults. Seismic activity could also induce liquefaction and lateral spreading of the subsurface soils, which could potentially impact the alignment.

Mitigation of earthquake-related hazards would likely consist of avoidance, warning, and adequate infrastructure design and construction. Avoidance of active faults would reduce the hazard of fault rupture impacts to the tracks; however, because of the potential number of faults and their uncertain return periods, complete avoidance is probably not feasible. Earthquake

warning could include the installation of seismometers to supplement seismographs already installed in the vicinity of the NRL. The operating plan for the railroad should include procedures to inspect the railroad prior to continuing train operation following significant earthquakes to locate and correct any problems with the track structure. Structures (such as bridges and retaining walls) should be designed to American Railway Engineering and Maintenance-of-Way Association (AREMA) seismic standards, as discussed in the G-DCM.

7.3 Surface Fissures

Surface fissures are naturally occurring cracks in the ground that range in size from about 90 feet to several miles long and up to 15 feet wide (Swadley, 1995). Fissures are widest near the ground surface and narrow quickly at a depth of 9 to 15 feet, making measurement of total depth difficult. The large amount of sediment that is accommodated in the subsurface part of the fracture suggests that the total depth could be considerable (Swadley, 1995). Fissures develop from erosion of material by water into existing cracks in the ground. Subsurface piping of material into a crack eventually leads to collapse of the roof. The fissures enlarge as water runoff erodes material into the crack from the edges of the fissure. Fissures eventually become inactive when the cracks fill up with material. Surface fissures have been observed in the Quaternary deposits in Dry Lake Valley.

Mitigation of surface fissures would consist of avoidance or design of remedial measures to repair existing fissures that would impact the alignment. Fissures that are identified prior to construction could be filled with appropriate backfill material. Existing fissures could be instrumented to provide warning if they become active in such a way that might impact the tracks. Subsurface explorations in areas that have a history of surface fissures could help identify fissures that have not opened to the ground surface or that could become active in the future.

7.4 Surface Erosion

Surface erosion hazards along the alignment are primarily those associated with water flowing overland and within existing channels. Flash floods can cause substantial erosion and scour of the loose sediments commonly found in the stream and river channels and in their banks within the project area. Deep channel scour can expose bridge piers and reduce their resistance to loads. Floods across alluvial fans can cause channel avulsions, resulting in floodwaters and debris diverted away from bridges or culverts, and instead, passing over and depositing debris on the

railway. Floods, as well as lesser channel flow events, can also cause bank erosion that allows the channel to migrate toward the railway over a period of time such that eventually, the railway can be undermined.

Avoidance again would be the primary method to reduce risk associated with this hazard; however, this would not always be feasible. Bridges and culverts should be designed and constructed for specific design events, including potential scour. River banks could be armored with rock to resist erosion. Structures, such as barbs or groins, could also be built to redirect river or stream flow away from the track structure. Channels on alluvial fans could be monitored to assess their trends and potential future behavior so that preventive measures could be planned and implemented. Dikes could be constructed and/or new channels excavated in an attempt to channelize and contain streamflow on these fans. Detection systems for high water, track displacement, movement of the embankment, or loss of embankment materials could be used in conjunction with or in place of these mitigation methods. Erosion control measures are discussed further in Section 8.5.

7.5 Mined Land Subsidence

Collapse of ground overlying mine works is a potential hazard at localized areas along the NRL. Depending on the size and depth of the mine and the engineering geology of the overlying rock, ground collapse could be significant. With time, support structures in abandoned mines deteriorate, and rock masses weather and continue to open along discontinuities so that eventually, mine roofs and walls collapse. If the mines are relatively deep, the overlying rock could bridge the collapse. However, if the mine is relatively shallow or the overlying rock is weak, the collapse could progress to the ground surface. Ground collapse beneath the track structure could cause significant damage to track infrastructure and adversely impact train operations.

Avoidance of active and abandoned mining areas is the primary measure to mitigate the risk of mine collapse. The alignment should be assessed for known underground mine sites. Where these sites cannot be avoided, the mined ground should be evaluated for evidence of past instability and potential for future collapse. This would include an evaluation of the geology and topography. Geophysical methods could be used to evaluate the size and depth of the mine features and, in conjunction with borings, the condition of the overlying rock. Measures to reduce the potential for mine collapse could include stabilization of the mine with additional

support or backfilling all or portions of the mine with an appropriate backfill material. Generally, mine subsidence below railroad embankments and fills could be accommodated by placement of additional fill, allowing restoration of track geometry with relatively low impacts to train operations. However, mine subsidence that could impact structures should be carefully assessed and structures should be appropriately designed and positioned to reduce the associated risks. In some cases, this might require that the railroad alignment be relocated to an alternative alignment.

7.6 Debris Flows

Debris flows, which for the purposes of this report include debris torrents, mud flows, and debris avalanches, are rapidly moving mixtures of water, soil, rock, and sometimes organic material. A debris flow is typically initiated during an intense precipitation event and develops when a shallow landslide deposits into and temporarily dams a stream channel. After the dam fails, the saturated debris can travel downslope for several miles within a steep, confined channel. Debris flows lose energy and begin to deposit material when the stream gradient flattens or when the channel widens.

Many areas of debris flow and alluvial fan deposition were observed within the NRL, and debris flows could be a significant hazard during operation of the railroad. Avoidance of debris flow hazards is not feasible; therefore, measures to reduce the impacts from debris flows should be developed. Channels in which debris flows could occur and impact the railway should be identified. Approximate sizes of debris flows could be estimated given the size of the drainage basin, channel characteristics, types of material involved, and evidence of past debris flow events. Structural measures, such as appropriately sized bridges, culverts, and overgrade debris flow chutes, could be constructed so that a given design debris flow could pass the tracks with no significant impacts. Alternatively, measures could be constructed to trap and retain the debris prior to its reaching the tracks. These measures could include debris dams, debris basins, debris racks, and flexible barriers. Measures to both trap debris and to allow debris to pass the railway could be constructed where the estimated debris flow volumes are too large for a single type of measure. Instrumentation and warning systems could be installed to alert approaching trains of debris flows that have impacted the railway.

7.7 Soil Collapse

Soil collapse, also known as hydrocollapse or hydroconsolidation, can occur in certain arid soils upon wetting. The phenomenon is discussed in more detail in the G-DCM. Soils in arid regions are often rapidly deposited during debris flows on alluvial fans. These soils have a weakly cemented soil structure that breaks down upon an increase in moisture content. The effects of soil collapse are a decrease in volume and loss of shear strength. Soils deposited by wind also tend to have a high potential for collapse. Some engineered fills can also collapse if compacted to a low density and dry of optimum moisture content. Increasing moisture content can occur as a result of rising groundwater table or cut–and-fill construction.

The data in Table 4 provides an indication of soils that can exhibit volume changes upon fluctuations in moisture content. Correlation to index properties would need to be conducted to determine the potential for a soil unit to collapse, to exhibit high swell pressures due to an increase in volume upon wetting, and other moisture sensitivities.

Potential methods of soil improvement to mitigate soil collapse are presented in the G-DCM.

7.8 Soft Soil (Low Bearing Capacity)

In some areas, new embankment construction could cross soft, wet, or otherwise unsuitable soils. Poor subgrade conditions would most likely be encountered in Quaternary and Tertiary lakebed deposits (Tl), localized channel alluvium (Qc), young alluvium (Qay and Qayf), and Playa Deposits (Qp).

Where fill is to be placed in these areas for embankment construction, subgrade treatment or stabilization could be required. The appropriate method could include over-excavation of the soft soils and replacement with compacted fill, treatment with a chemical additive, or bridging with a rock fill and/or geosynthetic, such as geogrid or geocell. Preloading of the subgrade can also be used to increase soil strength and decrease settlement of soft soils.

8.0 PRELIMINARY ENGINEERING AND CONSTRUCTION CONSIDERATIONS

The following text presents preliminary engineering and construction considerations for earthwork, drainage, erosion protection, and geotechnical design for structures. This discussion is intended to supplement the information provided in the G-DCM. Preliminary

recommendations specific to each alignment segment are presented in Table 6. In addition, general recommendations for preliminary cut slopes and embankment fill slopes introduced in Table 6 were used to develop the preliminary slope recommendations and excavation methods by station interval presented in Table 7.

At this time, the locations and characteristics of cuts, fills, and structures are not known with certainty. General references to cut-and-fill heights, bridge lengths, and other engineering features are based on plan and profile drawings prepared by NRP. Differences between engineering features shown on these drawings (Nevada Rail Partners, 2005b) and actual conditions could exist. The engineering considerations presented in Tables 6 and 7 are based on generalized or average conditions within a geomorphic segment. Therefore, recommended cut–and-fill slope angles presented in Tables 6 and 7 are preliminary; cut and fill slopes could be steeper or flatter than indicated as design of the NRL progresses.

8.1 Ballast and Subballast

Preliminary recommendations for ballast and subballast are discussed in detail in the Preliminary Construction Aggregate Report included in Appendix C.

8.2 Excavations

Excavations would be required to construct drainage ditches, to remove unsuitable soils in fill placement areas, and to construct cuts. Most soils encountered along the alignment could likely be excavated using conventional earthmoving equipment such as dozers, scrapers, graders, rubber-tired backhoes, and track-mounted excavators. Excavation of caliche, older cemented alluvium, and highly weathered rock could require the use of rippers attached to conventional equipment. Unweathered rock encountered along much of the alignment would likely require drilling and blasting. Excavation methods required for the geologic units encountered along the NRL are identified in Tables 6 and 7.

8.3 Cut Slopes

Preliminary cut-slope recommendations are presented in Tables 6 and 7. The recommendations were developed from a combination of field observations of the stability of existing cut slopes and our experience with similar materials. Actual cut-slope angles excavated during construction could vary significantly depending on the engineering properties of the soil and rock contained within the cut. Appropriate cut-slope angles in rock would depend on the

orientation of the discontinuities with respect to the track alignment, and the engineering characteristics of the discontinuities such as length, spacing, roughness, infilling/coating, and groundwater conditions. In general, the use of mid-slope benches is not recommended. They tend to accumulate water and are a common cause of shallow slope failure in soil slopes. They can sometimes serve as launching features, adding to the run-out of falling rocks in rock slopes. However, mid-slope benches, slope flattening, or stabilization/protection methods discussed in Section 7.0 could be necessary to improve the stability and reduce the rockfall hazard of cut slopes in some areas.

8.4 Embankments

Embankment fills along the corridor would be constructed of both soil and rock, depending on the proximity of suitable material source. Embankment slope angles and fill base widths would depend on the material used to construct the fills and the properties of the subgrade materials. Foundation preparation and compaction of the fill material would be critical to control the internal settlement of the embankment. In soft subgrade areas, ground improvement, geotextiles, prefabricated vertical (PV) drains, preloading, staged construction, or other mitigation methods could be required depending on height of fill, anticipated settlement, and other factors to obtain the desired factor of safety or to limit post-construction settlement.

Three embankment slope inclinations are proposed in this level of design. For embankments constructed on coarse-grained alluvial deposits or fresh to moderately altered/weathered rock, 2H:1V cut slopes are proposed. Flatter embankment slopes (3H:1V and 4H:1V) are proposed for fine-grained soil deposits and highly to completely altered volcanic rocks composed of silt and clay material. Within the NRL, thick sequences of silt and clay deposits are found in Playa deposits (Qp), younger fine-grained alluvium (Qayf), Tertiary Lake Bed (Tl) deposits, and Miocene lava flows (Ta_3). Generally, 2H:1V embankment slopes are recommended for Quaternary Channel (Qc) deposits; however, flatter 3H:1V slopes are recommended in areas where this deposit is finer grained. Although nearly any of the soil deposits could be a suitable sources of material for embankment fill, the fine-grained deposits (Qayf, Qc, Qp, and Tl) could require moisture conditioning prior to placement in the fills. Highly to completely altered Ta_3 deposits in the Goldfield area are likely not suitable as embankment fill. Embankment fills constructed of shot rock over coarse-grained soil or rock subgrade could likely be constructed at 1.5H:1V. However, there is insufficient information to precisely locate possible shot-rock embankments, so embankment slopes steeper than 2H:1V are not shown in Tables 6 or 7.

8.4.1 Subgrade Preparation

We recommend the following procedure for subgrade preparation in fill areas:

- Establish erosion-control barriers as necessary.
- Strip vegetation, organics, and topsoil to expose the subsoil.
- Stockpile topsoil for later placement over areas to be seeded.
- A geotechnical professional should evaluate the subsoil to determine suitability, need for stabilization, and/or over-excavation depth and limits.
- Construct site drainage-control features such as ditches or drains in wet areas.
- Slope or crown the subgrade surface to shed water.
- Proof-compact the subgrade surface to at least 95 percent of the maximum dry density.

8.4.2 Subgrade Stabilization

Soft, weak, and moisture-sensitive soils are present along portions of the alignment and most likely would be encountered in Qayf, Qp, Qc, and Tl deposits. Where fill is to be placed in these areas for embankment construction, subgrade treatment or stabilization could be required. The appropriate method could include over-excavation of the soft soils and replacement with appropriate compacted fill, treatment with a chemical additive, or bridging with a rock fill and/or geosynthetic, such as a geogrid or geocell.

Fills constructed on soft subgrade or where soft soils are present at a depth less than or equivalent to the height of the proposed fill would likely require slopes of 3H:1V or flatter. Flatter slopes would distribute the stresses in the underlying soft soils, reducing settlement and providing an improved factor of safety for global stability compared with embankments with steeper slopes. The minimum factor of safety for global stability of fills on soft subgrades should be 1.5.

8.4.3 Sources of Fill Material

Much of the soil along the alignment could be used as fill for embankment construction. Fine-grained soil, typically associated with Qayf, Qc, Qp, and Tl deposits, might be suitable as fill with appropriate handling and moisture conditioning. Topsoil and organic soils and highly to completely altered bedrock (Ta_3 near Goldfield) should not be used as fill. These materials should be stockpiled and then spread over finish-grade areas. No snow or ice should be

incorporated into fill soils. Field test sections should be constructed using various fill materials to determine appropriate lift thickness and compactive effort to obtain the required compaction. Upon completion of subgrade preparation, fill should be placed and compacted up to the appropriate track roadbed elevation. All fill should be placed in layers and compacted to a dense and unyielding condition. In general, the thickness of fill layers before compaction should not exceed 12 inches for heavy compaction equipment. Where hand-operated compaction equipment would be used, such as backfill adjacent to culverts, the layer thickness should not exceed 6 inches. We recommend that each layer of fill be compacted to a dry density that is at least 95 percent of the maximum dry density, as determined by ASTM D 1557. All fill placement and compaction should be monitored and tested by an experienced geotechnical professional.

Fill soils encountered along the alignment could require wetting or aerating to adjust moisture contents to levels suitable for compaction.

8.5 Drainage and Erosion Protection

The alignment crosses numerous alluvial fans with complex drainage patterns. Careful design of site drainage and erosion protection would help prevent washouts and damage to the track structure during rainfall events. Groundwater could impact design and construction of cuts, fills, and other structures. Subsurface drainage improvements and dewatering could be required. In addition to erosion caused by water, the loose, fine-grained soils present across most of the alignment are subject to erosion by wind. Measures would be necessary to maintain drainage and protect the soils from water and wind erosion both during and after construction.

Typically, sandy soils on steep slopes subject to high-velocity water flow or non-vegetated areas are susceptible to erosion. The arid climate of the NRL area does not normally experience prolonged rainfall events. When rainfall does occur, it is typically brief, but can be very intense. During periods of heavy rainfall, the erodible soils are deposited into the normally dry washes. Water could also carry a significant amount of sediment and debris in the wash channels, resulting in scour along the banks and at bridge crossings.

8.5.1 Surface Drainage

Surface ditches, berms, culverts, and grading in conjunction with preparing the base of cuts and the final layer of fill should have a minimum 2 percent slope to promote drainage away

from the track. The maximum grade of ditches would be determined by the erosion susceptibility of the material that lines the ditch. Periodic inspection and maintenance of ditches and culverts would likely be required following significant rainfall events.

8.5.2 Subsurface Drainage

Trench drains, interceptor drains, horizontal drains, and drainage galleries could be suitable means for providing subsurface drainage depending on the depth to the water. For relatively shallow groundwater control, trench drains are commonly used to promote drainage away from the roadbed and to improve the stability of landslides driven by groundwater. Interceptor drains are used to reduce the flow of groundwater toward the roadbed below the surface, and are also best suited for shallow groundwater control. Horizontal drains can be used where relatively steep slopes are adjacent to the roadbed, the depth to groundwater is relatively deep (on the order of 25 feet deep or deeper) but still needs to be controlled, and the use of trench drains is not practical. Drainage galleries could be appropriate for providing groundwater control for long cuts. Although no areas were specifically identified during our fieldwork that would require subsurface drainage, further evaluations could be necessary during subsequent design phases.

8.5.3 River and Streambank Erosion

Riverbanks and drainages adjacent to the railroad could be armored with rock to resist erosion. Structures, such as barbs or groins, could also be built to redirect flow away from the track structure. Channels on alluvial fans could be monitored to assess their trends and potential future behavior so that preventive measures could be planned and implemented. Dikes could be constructed and/or new channels excavated in an attempt to channelize and contain streamflow on these fans. Established washes parallel the NRL in several areas. These areas are identified on Table 6. Riprap protection or similar mitigation measures would likely be required to protect the embankment toe within these areas. During final design, erosion protection of embankment slopes needs to be evaluated for specific sites.

8.5.4 Erosion at Culverts

The inlets and outlets of culverts should be armored to protect the embankment from scour. Culvert outlets should be adequately armored or tight-lined to an appropriate discharge area from the embankment toe.

8.5.5 Erosion of Cut–and-Fill Slopes

Erosion control measures such as interceptor ditches, erosion control blankets, terracing, selective plantings, or desert armor could be required for some slopes depending on slope height, material type, and other factors. Slopes in erosion-susceptible areas can be armored with angular rock fragments, such as 6- to 12-inch quarry spalls.

8.5.6 Erosion by Wind

Loose, fine-grained soils present across much of the NRL are subject to erosion by wind. Typically, a wind speed greater than 12 miles per hour is sufficient to lift and carry sand (U.S. Department of Agriculture [USDA], 1978). The impacts from blowing sand consist of sand dune migration and fugitive dust. Sand dunes are natural features and consist of migrating mounds of blowing sand. There is also the potential that dunes that are stable at present could be reactivated by natural causes or construction-induced changes. Migrating sand dunes could bury the track. Other problems associated with blowing sand and dust include rail-seat abrasion, loosening of track fasteners, excessive rail wear, and fouled ballast. Typical measures used to stabilize dunes and control fugitive dust include the following:

- Change of alignment to avoid dune areas
- Barriers (fences, concrete barriers, etc.)
- Desert pavement (gravel placed over the erodible surface soil)
- Application of adhesives and soil stabilizers
- Vegetation

In addition, water could be used to temporarily control dust during construction activities. Published U.S. Environmental Protection Agency (EPA) guidelines (EPA, 1999) provide a summary of temporary and permanent measures for controlling dust.

8.6 Structures

Preliminary recommendations pertaining to proposed structures are included in Table 6.

8.6.1 Bridges

Where competent bedrock is present at a shallow depth and when the foundations are outside the channel floodplain, bridges could be supported on shallow foundations. However, given the aggressive scour conditions of some of the washes, it is likely that most of the bridge structures would be supported on a deep foundation system, such as driven piles or drilled shafts.

However, because many of the bridges would cross existing stream channels and washes where the subsurface soil would contain cobbles and boulders, drilled shaft foundations would likely be the preferred alternative. Although sufficient axial and lateral capacities could be achieved using driven piles in some instances, the potential for encountering cobbles and boulders would significantly complicate the installation of driven foundation elements.

Although many factors influence drilled shaft foundation design that are not known at this time (i.e., height of bridge, dead and live load factors, seismic loads, scour depth, and engineering properties of the subsurface material), drilled shaft diameters would likely range from 3 to 5 feet.

8.6.2 Buildings

Building type, size, and locations are presently unknown. We assume that most of the buildings would be single or two-story structures, and that such buildings could be founded on shallow foundations or thickened (at edges) slab foundations.

Recommendations for allowable bearing pressures would be based on soil type and density. Minimum depth of footing is determined by maximum depth of frost penetration. Estimates of differential settlements would be based on footing subgrade conditions.

Floors would typically be constructed as slab-on-grade. Placement of compacted structural fill could be required to establish a prepared surface for the slab. Under-slab and perimeter drainage recommendations would be based on specific-site conditions.

8.6.3 Retaining Walls

A number of options are available for constructing retaining walls along the project alignment. Factors affecting the selection of the most appropriate wall type would include the available right-of-way, excavation slopes, performance considerations, cost, and aesthetics. An example of wall performance would be its flexibility or ability to accommodate differential settlements. In addition, selection of an appropriate wall type could be affected by the geometry of the retained slope and the underlying soil conditions.

The following section provides a brief discussion of various standard wall types, which could be considered for use along the project alignment for retaining cut–and-fill slopes. As mentioned previously, subsurface conditions, aesthetics, right-of-way (ROW) considerations and restrictions, and cost would be the primary factors dictating the wall type(s) that would

ultimately be selected. Retaining wall systems could be divided into several categories, which are listed below:

- Rigid Gravity and Semi-gravity Walls
  - Cast-in-place and Precast Concrete Gravity Wall
  - Cast-in-place Concrete Cantilevered Wall
- Prefabricated Modular Gravity Walls
  - Crib Wall
  - Bin Wall
  - Gabion Wall
  - Lock-block/Ecology Block Wall
- Mechanically Stabilized Earth Walls (MSEW)
  - Segmental Precast Facing
  - Modular Block Facing
  - Geotextile/Geogrid/Welded Wire Facing
- Reinforced Soil Slopes (RSS)
- Non-gravity Cantilevered and Anchored Walls
  - Sheetpile Wall
  - Soldier Pile and Lagging Wall
  - Slurry Wall
  - Tangent Pile and Secant Pile Wall
- In Situ Reinforced Wall
  - Soil-nailed Wall

8.6.3.1 Rigid Gravity and Semi-gravity Walls

Concrete gravity and cantilever retaining walls are commonly used for walls with heights up to 30 feet. These types of wall generally provide a high level of performance with minimal lateral wall movement. The concrete retaining walls are not very flexible and cannot tolerate significant differential settlements without damage, compared with MSEW systems. Consequently, this type of wall needs to be constructed on stable foundation soils. Concrete gravity walls are commonly used for retained fills, bridge abutments, and slope stabilization.

8.6.3.2 Prefabricated Modular Gravity Walls

Prefabricated modular gravity walls are externally stabilized fill walls that are constructed with interlocking reinforced or unreinforced concrete elements, timber, steel bins, or wire baskets that are fabricated on site and filled with select backfill material.

Concrete crib walls are manufactured by Criblock and timber crib walls by Permacrib. These crib walls are constructed using timber or concrete elements that are stacked parallel and perpendicular to the length of the wall to form an open bin. Assembly is analogous to constructing a log cabin in that the concrete and timber elements are stacked and interlocked to form rectangular or square bins. Wall construction is completed by filling the space within the crib framework with rock or compacted structural fill. Depending on the height of the wall, lateral pressure, bearing capacity, and other factors, multiple bins can be assembled in various configurations to increase the footprint of the wall.

A bin wall is similar to a crib wall except that the bins are typically fully enclosed and the backfill material is not exposed. Depending on the height of the wall, lateral pressure, bearing capacity, and other factors, multiple bins can be constructed to increase the footprint of the wall.

Gabion walls are compartmentalized rectangular containers (baskets) made of galvanized steel wire mesh, which are filled with stone. Similar to other prefabricated modular gravity wall systems, gabion baskets could be arranged and wired together to achieve a stable configuration of a desired wall height.

Lock-block and ecology block walls are stacked concrete units that create a gravity wall structure. Typically, the blocks are cast using return concrete at a ready-mix facility. Blocks are typically 2.0 to 2.5 feet high and wide and 4 to 6 feet long. Like other prefabricated modular gravity wall systems the concrete blocks can be arranged in various configurations to accommodate wall heights up to about 30 feet. However, wall heights above 12 to 15 feet are generally not practical.

8.6.3.3 Mechanically Stabilized Earth Walls (MSEW)

Mechanically Stabilized Earth Wall (MSEW) systems are typically flexible, and can tolerate reasonable settlements if properly installed. Examples of these structures are outlined in the following paragraphs.

There are a variety of segmental, precast facing, MSEW systems. Typically, these systems use metal strips, bars, geosynthetic grids, or textile reinforcement that are connected to precast concrete or prefabricated metal facing systems to form a reinforced soil mass. The reinforcement is installed in layers within the soil mass. The length of the reinforcing elements

is typically about 70 percent of the wall height. Segmental precast facing systems are offered by Reinforced Earth, VSL Retained Earth, and Georgia Stabilized Embankment, among others.

Modular block walls consist of geogrid- or geosynthetic-reinforced fill with modular-block facing units. The geosynthetics are connected to the modular blocks with structural pins, which also serve as a shear connection between the blocks. The vertical spacing of the geosynthetic reinforcing typically varies from 1.0 to 2.5 feet. The modular units typically consist of masonry blocks that are 18 inches wide and 8 inches high. The faces of these walls are usually vertical or are constructed with a 1H:8V batter. Modular-block walls could be designed and used in applications with wall heights up to about 30 feet. Proprietary modular-block systems include Genesis, Allen, and Mesa.

Construction of MSEW systems using geotextile, geogrid, or wire facing is similar to other MSEW wall systems except that the wall facing is constructed by wrapping each layer of reinforcement around the overlying layer of backfill and then re-embedding the free end into the backfill. Permanent facings could consist of shotcrete, or could simply be left as rock or gravel-filled galvanized wire baskets. Tilt-up panels, or cast-in-place concrete facings could also be used with fasteners that are incorporated into the reinforced soil mass.

8.6.3.4 Reinforced Soil Slopes (RSS)

A RSS consists of embedding geosynthetics in spaced layers at predetermined lengths as the embankment is constructed. The geosynthetics generally extend horizontally behind the face of the slope equal to 70 percent of the embankment height. When construction slopes are steeper than about 45 degrees, the geosynthetics are wrapped around the face of the slope. Erosion protection is placed over the finished slope face and anchored into place.

8.6.3.5 Non-gravity Cantilevered and Anchored Walls

Non-gravity cantilevered and anchored walls are particularly well suited for retaining cuts, supporting bridge abutments, stabilizing landslides, and providing excavation support. Certain wall types within this category (i.e., soldier pile and sheetpile walls) could also be used in retained fill applications such as sidehill railroad embankments. Common types of non-gravity cantilevered and anchored walls are discussed below.

Sheetpile walls are particularly suited for retained-cut applications and consist of interlocking steel sections that are driven, vibrated, or pushed into the soil to create the wall. Sheetpile walls can either be constructed as cantilevered walls or supported with permanent tiebacks. It is usually not practical to drive sheetpiles into soil containing cobbles, boulders, very dense to hard soils, or weathered rock.

Cantilever and tied-back soldier pile wall systems are also suited to retain cuts. However, cantilever soldier pile walls could also be used to retain fill soils where the fill heights do not exceed 10 to 15 feet. This type of system would typically consist of placing a steel, wide-flanged beam into a predrilled, 24- to 30-inch-diameter hole and then backfilling the hole with structural concrete up to the base of the wall, and then using lean concrete to backfill the remainder of the hole. Soldier pile spacing typically varies between 5 and 12 feet. Pressure-treated wood lagging is typically used to provide temporary support of the retained soil of the excavation. A permanent cast-in-place or precast concrete fascia panel could then be placed over the face of the wall to provide the required architectural finish. Walls with heights of 15 feet or greater could require permanent tiebacks for additional structural support.

A slurry wall is a continuous concrete wall consisting of either steel-reinforced, cast-in-place concrete or precast panels that are constructed within an excavated trench. The trench is constructed from the ground surface and is supported for its full depth by a mineral or polymer slurry as the excavation is advanced. For cast-in-place applications, reinforcing elements consisting of reinforcing bar cages or structural steel members are positioned in the hole. Once the reinforcement is in place, the final concrete is tremmied into the hole, which displaces the slurry. A slurry wall can be either cantilevered or tied-back, depending on the height of the wall, the soil conditions, and other loading conditions.

Tangent pile walls consist of a single row of tangentially touching, reinforced concrete piles. The reinforcement can consist of reinforcing steel cages or structural steel sections centered in the drilled holes. Depending on soil and water conditions, the drilled holes can be open, slurry supported, or cased, or a combination of methods. A secant pile wall consists of alternatively drilled and overlapping reinforced and unreinforced piles. Secant pile installation commences by installing alternating unreinforced piles. After a short period of time to allow the concrete to set, a reinforced concrete pile is installed between and overlapping the previously installed piles. Tangent and secant pile walls can be either cantilevered or tied back, depending on the height of the wall, the soil conditions, and other loading conditions.

8.6.3.6 In Situ Reinforced Walls

Unlike the previous walls discussed above, which provide external support to a slope or fill, a soil-nailed wall is an in situ reinforcement system for the soil mass. Prior to making a cut excavation, the soil mass is internally reinforced by installing closely spaced, typically cement-grouted steel dowels into the soil mass. Soil between the rock dowels (nails) is supported with an initial steel-reinforced shotcrete. Commonly, a permanent facing of precast concrete panels or cast-in-place panels, or an architecturally finished final shotcrete facing, is installed over the initial facing. Soil nail walls are used for excavation support, slope stabilization, and widening under existing bridges.

9.0 CONCLUSIONS

Conceptual geotechnical conclusions and recommendations are presented in Tables 5, 6, and 7 for the common and alternative alignments of the NRL. Information presented in these tables is based on available technical literature and reports, field reconnaissance along the corridor, conceptual engineering studies, and our experience working on similar projects. Table 5 is a compilation of geologic conditions and anticipated construction activities for each alignment and geomorphic segment along the corridor. Geomorphic segments were established by grouping lengths of the corridor having similar geologic characteristics and topographic conditions. Conceptual geotechnical recommendations (i.e., cut-and-fill slope inclinations, excavatability, anticipated geologic hazards, foundation recommendations, etc.) for each segment are presented in Tables 6 and 7.

With regards to significant observations, conclusions, and recommendations for the NRL, we believe that debris flows, ephemeral channel erosion, and soft subgrade soils would pose the most concern. However, we do not believe that these geologic hazards or soft subgrade soil conditions are so adverse or widespread that a specific segment or reach within a segment should be removed from further consideration.

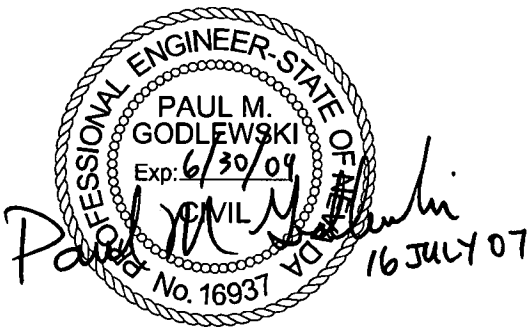
The majority of the soil and rock that would be encountered in excavations along the corridor would be suitable as embankment fill. However, fine-grained alluvium, landslide debris, and lakebed deposits would likely require moisture conditioning prior to use. We do not anticipate significant excavation volumes in soft subgrade soil because these materials typically occur in low-lying, potential embankment fill areas. Bedrock encountered in excavations would also

generally be suitable as fill and riprap, although the highly altered volcanic deposits in the vicinity of Goldfield would likely be unsuitable, due to their high clay content.

All excavations in rock would likely require drilling and blasting. The length of alignment requiring drilling and blasting covers about 15 percent of the corridor (common and alternative alignments). Older cemented alluvium and lakebed deposits that could require ripping cover approximately 40 percent of the corridor. The remaining 45 percent of the corridor consists of soil (i.e., alluvial, eolian, colluvial, and landslide deposits) that can be classified as common excavation and could be excavated using conventional excavation techniques and equipment.

Based on our engineering studies and field reconnaissance, we have identified no fatal flaws along any of the common or alternative alignments. During subsequent design studies, the actual siting of the track within a selected alignment would likely be based on operational considerations (i.e., grade and curvature), as well as geologic and drainage conditions. Slight alignment modifications are recommended in Table 6 for some segments. These observations are presented in the "Additional Recommendations" columns under both the Earthwork Recommendations and Structures sections. The suggested alignment modifications focus on moving the railroad away from rock outcrops to reduce the volume of rock excavation and rockfall hazard.

SHANNON & WILSON, INC.



Paul M. Godlewski, P.E.
Vice President
Project Manager

William A. Hultman
Senior Associate
Task 1 Team Leader

DEX:PMG:WAH/srm

APPENDIX A
PRELIMINARY GEOTECHNICAL DESIGN CRITERIA MANUAL
24 February 2005
[under separate cover]

APPENDIX B
BALLAST SOURCING COST ANALYSIS
18 February 2005
[under separate cover]

APPENDIX C
PRELIMINARY CONSTRUCTION AGGREGATE REPORT
7 March 2006
[under separate cover]

APPENDIX D
PRELIMINARY MINERAL AND ENERGY RESOURCE OCCURRENCE REPORT
23 June 2005
[under separate cover]

APPENDIX E
(In Reserve)

APPENDIX F
(In Reserve)

APPENDIX G
(In Reserve)

APPENDIX H
PHOTOGRAPHS FROM FIELD RECONNAISSANCE
(DVD)

APPENDIX I

SHANNON & WILSON, INC.
FIELD REFERENCES—SOIL AND ROCK CLASSIFICATION

FIELD REFERENCE SOIL CLASSIFICATION

ORDER OF CLASSIFICATION TERMS

Relative density or consistency,

color,

slightly (5 to 12%),

minor constituents (12 to 50%)

MAJOR constituent (>50%),

trace constituents (0 to 5%);

moisture content;

structure, plasticity, gradation, grain shape, min., cementation, organics, odor, other;

(Geologic Name: Fill, Till, Alluvium, etc.)

USCS group symbol.

EXAMPLES

Very dense, light brown, slightly silty, sandy fine GRAVEL, trace of cobbles; moist; scattered roots; (Weathered Till) GP-GM.

Medium stiff, dark gray, silty CLAY, trace of fine sand; moist; laminated (< 2mm) with light gray silt, occasional slickensides; (Glaciolacustrine) CL.

Medium dense, dark brown, sandy SILT, trace of clay; wet; numerous organics and strong organic odor; (Marsh Deposits) ML.

Loose and soft, mottled black and green, silty SAND and clayey SILT; moist; hydrocarbon sheen and faint hydrocarbon odor; (Fill) SM/ML.

STRUCTURE

TERM	THICKNESS
Parting	0 to 1/16"
Seam	1/16 to 1/2"
Layer	> 1/2"
Lamination	< 6 mm, < 1/4"
Pocket	Irregular, < 1 foot
Varved	Alternating seams or lam.
Occasional	< 1 per foot
Frequent	≥ 1 per foot

DESCRIPTION	CRITERIA, LIST THICKNESS
Stratified	Alternating layers
Interbedded	Alternating layers > 1/2"
Laminated	Alt. layers < 6 mm thick
Fractured	Breaks easily along definite fractured planes
Slickensided	Polished, glossy, striated fractured planes
Blocky, Diced	Easily breaks into small angular lumps
Lensed	Small pockets of diff. soils
Homogenous	Same color and appearance throughout
Sheared	Disturbed texture, mix of strengths

ORGANIC CONTENT

ADJECTIVE	PERCENT BY VOLUME
Occasional	0 to 1
Scattered	1 to 10
Numerous	10 to 30
Organic	30 to 50, minor constituent
PEAT	50 to 100, MAJOR const.

Describe type and size of organic debris.

TERM	GRAIN SIZE	EXAMPLES
Boulders	> 12"	> Basketball
Cobbles	3" to 12"	Fist to basketball
Gravel-coarse	3/4" to 3"	Thumb to fist
Gravel-fine	#4 to 3/4"	Pea to thumb
Sand-coarse	#10 to #4 (5 mm)	Rock salt to peat
Sand-medium	#40 to #10 (2 mm)	Sugar to rock salt
Sand-fine	#200 to #40 (0.4 mm)	Flour to sugar
Fines	< #200 (0.08 mm)	Grains not visible

MOISTURE CONTENT

Dry	Dusty, dry to the touch
Moist	Damp but no visible water near optimum
Wet	Visible free water, saturated, over optimum

RELATIVE DENSITY OF COARSE-GRAINED (COHESIONLESS) SOILS
(Cohesionless Silt, Sand, and Gravel)

N. SPT, BLOWS/FT	RELATIVE DENSITY	FIELD TEST FOR RELATIVE DENSITY OF SAND
0 to 4	Very loose	Easily penetrated with 1/2" reinforcing rod pushed by hand
4 to 10	Loose	Easily penetrated with 1/2" reinforcing rod pushed by hand
10 to 30	Medium dense	Penetrated one foot with 1/2" reinforcing rod driven with 5-lb hammer
30 to 50	Dense	Penetrated one foot with 1/2" reinforcing rod driven with 5-lb hammer
Over 50	Very dense	Penetrated only a few inches with 1/2" reinf. rod driven with 5-lb hammer

RELATIVE CONSISTENCY OF FINE-GRAINED (COHESIVE) SOILS
(Cohesive Silt, Clayey Silt, and Clay)

N. SPT, BLOWS/FT	RELATIVE CONSISTENCY	TORVANE, tsf SHEAR STR.	POC. PEN., tsf UNCONF. STR.	MANUAL PENETRATION TEST
< 2	Very soft	< 0.13	< 0.25	Easy several inches by fist
2 to 4	Soft	0.13 to 0.25	0.25 to 0.5	Easy several inches by thumb
4 to 8	Medium stiff	0.25 to 0.5	0.5 to 1	Moderate several inches by thumb
8 to15	Stiff	0.5 to 1	1 to 2	Readily indented by thumb
15 to 30	Very stiff	1 to 2	2 to 4	Readily indented by thumbnail
Over 30	Hard	> 2	> 4	Difficulty by thumbnail

UNIFIED SOIL CLASSIFICATION SYSTEM
(From USACE Tech Memo 3-357)

MAJOR DIVISIONS			GROUP SYMBOL	TYPICAL DESCRIPTION
Coarse-Grained Soils (more than 50% retained on No. 200 sieve) [Use Dual Symbols for 5 to 12% Fines (i.e. GP-GM)]	Gravels (more than 50% of coarse fraction retained on No.4 sieve)	Clean Gravels (less than 5% fines)	GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP	Poorly-Graded Gravels, Gravel-Sand Mixtures
		Gravels with Fines (more than 12% fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sands (50% or more of coarse fraction passes the No. 4 sieve)	Clean Sands (less than 5% fines)	SW	Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP	Poorly-Graded Sands, Gravelly Sands, Little or No Fines
		Sands with Fines (more than 12% fines)	SM	Silty Sands, Sand-Silt Mixtures
			SC	Clayey Sands, Sand-Clay Mixtures
Fine-Grained Soils (50% or more passes the No. 200 sieve)	Silts and Clays (liquid limit less than 50)	Inorganic	ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
		Organic	OL	Organic Silts and Organic Silty Clays of Low Plasticity
	Silts and Clays (liquid limit 50 or more)	Inorganic	CH	Inorganic Clays of Medium to High Plasticity, Sandy Fat Clay, Gravelly Fat Clay
			MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sands or Silty Soils, Elastic Silt
		Organic	OH	Organic Clays of Medium to High Plasticity, Organic Silts
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor		PT	Peat, Humus, Swamp Soils with High Organic Content (See D 4427-92)

Filename: J:\12-239\Field Guides\21-1-20102-239 SOIL FIELD REFERENCE (2 pgs).dwg Layout: Sheet1 Date: 08-01-2007 Login: BAC

Inches 1 2 3 4 5 6 cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

GRADATION	DESCRIPTION	EXAMPLES
Well-graded	Full range and even distribution of grain sizes present	Silty, sandy GRAVEL
Poorly-graded	Narrow range of grain sizes present	Fine to medium SAND, trace of silt
Uniformly -graded	Consists predominantly of one grain size	Fine SAND
Gap-graded	Within the range of grain sizes present, one or more sizes are missing	Silty, medium to coarse SAND

FIELD REFERENCE SOIL CLASSIFICATION

Dual Symbols

(symbols separated by a hyphen, i.e., SP-SM, slightly silty fine SAND) are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbols

(symbols separated by a slash, i.e., CL/ML, silty CLAY/clayey SILT; GW/SW, sandy GRAVEL/gravelly SAND) indicate that the soil may fall into one of two possible basic groups.

ASTM D 2488 Tables

"Reprinted, with permission, from D2488-06 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be purchased from ASTM (www.astm.org)."

TABLE 8 Criteria for Describing Dry Strength

DESCRIPTION	CRITERIA
None	The dry specimen crumbles into powder with mere pressure of handling.
Low	The dry specimen crumbles into powder with some finger pressure.
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and a hard surface.

TABLE 9 Criteria for Describing Dilatancy

DESCRIPTION	CRITERIA
None	No visible change in the specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

TABLE 10 Criteria for Describing Toughness

DESCRIPTION	CRITERIA
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

TABLE 11 Criteria for Describing Plasticity

DESCRIPTION	CRITERIA
Nonplastic	A 1/8-in. (3mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles

DESCRIPTION	CRITERIA
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Particles are similar to angular description but have rounded edges.
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

TABLE 2 Criteria for Describing Particle Shape

DESCRIPTION	CRITERIA
The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.	
Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and Elongated	Particles meet criteria for both flat and elongated

TABLE 4 Criteria for Describing the Reaction with HCl

DESCRIPTION	CRITERIA
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

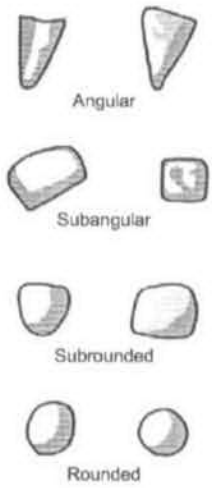
TABLE 6 Criteria for Describing Cementation

DESCRIPTION	CRITERIA
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

SOIL SYMBOL	DRY STRENGTH	DILATANCY	TOUGHNESS
ML	None to Low	Slow to Rapid	Low or Thread Cannot be Formed
CL	Medium to High	None to Slow	Medium
MH	Low to Medium	None to Slow	Low to Medium
CH	High to Very High	None	High

GRAIN SHAPE



SPT SPECS (From Dept. of Interior Earth Manual)

140-lb hammer, 30-inch freefall

Cathead: 6 to 10-inch diameter, 2-1/4 rope turns, ≥ 100 rpm, mechanical OK

Sampler: 18 to 30-inch long, shoe ID = 1.375 inches, barrel ID = 1.5 inches, OD = 2.0 inches

Count blows for each of three 6-inch increments
Refusal: 50 blows for 6 inches or less, 10 blows for 0 inches

Standard Penetration Resistance = "N-Value" = blows for last 12 inches

Filename: J:\21-2-239\Field Guides\21-1-20102-239 SOIL FIELD REFERENCE (2 pgs).dwg Layout: Sheet1 Date: 08-01-2007 Login: BAC

FIELD REFERENCE ROCK CLASSIFICATION

ORDER OF CLASSIFICATION TERMS

1. ROCK NAME: (see back of sheet)
2. strength,
3. basic rock description;
4. structure;
5. weathering;
6. other or unique features
7. (Formation or Member name)

EXAMPLE

BASALT: moderate strength, gray, fine grained; moderately vesicular, smooth, closely-spaced, high angle joints with iron-oxide staining; slightly weathered (Wanapum Basalt).

3. BASIC ROCK DESCRIPTION

COLOR

TEXTURE (see back side of sheet)

CEMENTATION: Weakly / Strongly

INDURATION: Slightly / Highly

4. STRUCTURE

a) FABRIC: Bedding, foliation, etc.; Describe type, spacing, orientation

b) VESICULARITY: Describe percent by volume and size of holes (range and typical)

c) DISCONTINUITIES: Describe type, number of sets, spacing or intercept (range and typical), roughness, healing, aperture (width), filling type and consistency (use soil terms), and orientation or dip (low / high or angle)

4a. FABRIC TERMS

Sedimentary Rocks:

MASSIVE - Rock without significant structure

BEDDED - Regular layering from sedimentation

FISSILE - Tendency to break along laminations

Metamorphic Rocks:

FOLIATED - Parallel arrangement or distribution of minerals

SCHISTOSE - Parallel arrangement of tabular minerals giving a planar fissility

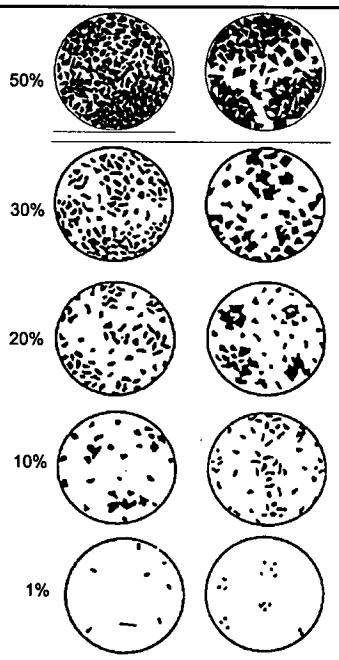
GNEISSOSE - Segregation of minerals into bands

CLEAVAGE - Tendancy to split along secondary, planar textures or structures

4b. VESICULARITY

Slightly Vesicular	1 to 10%
Moderately Vesicular	10 to 30%
Highly Vesicular	30 to 50%
Scoriaceous	>50%

COMPARISON CHART (percent by volume)



4c. DISCONTINUITY TERMS

FRACTURE - Collective term for any natural break excluding shears, shear zones, and faults

JOINT (JT) - Planar break with little or no displacement

FOLIATION JOINT (FJ) or BEDDING JOINT (BJ) - Joint along foliation or bedding

INCIPIENT JOINT (IJ) or INCIPIENT FRACTURE (IF) - Joint or fracture not evident until wetted and dried; breaks along existing surface

RANDOM FRACTURE (RF) - Natural, very irregular fracture that does not belong to a set

BEDDING PLANE SEPARATION or PARTING - A separation along bedding after extraction from stress relief or slaking

FRACTURE ZONE (FZ) - Planar zone of broken rock without gouge

MECHANICAL BREAK (MB) - Breaks due to drilling or handling; drilling break (DB), hammer break (HB).

SHEAR (SH) - Surface of differential movement evident by presence of slickensides, striations, or polishing

SHEAR ZONE (SZ) - Zone of gouge and rock fragments bounded by planar shear surfaces

FAULT (FT) - Shear zone of significant extent; differentiation from shear may be site-specific

4c. OUTCROP DATA

When collecting outcrop data, fracture orientation, aperture, roughness, and filling type / consistency, should be described in greater detail than is possible with core. Depending on the nature or investigation, additional data should also be recorded:

Fracture WALL STRENGTH

Fracture CONTINUITY OR LENGTH

Fracture ENDS OBSERVED (0, 1, 2)

Fracture MOISTURE CONDITIONS (dry, dry but stained, damp, wet, dripping, flowing)

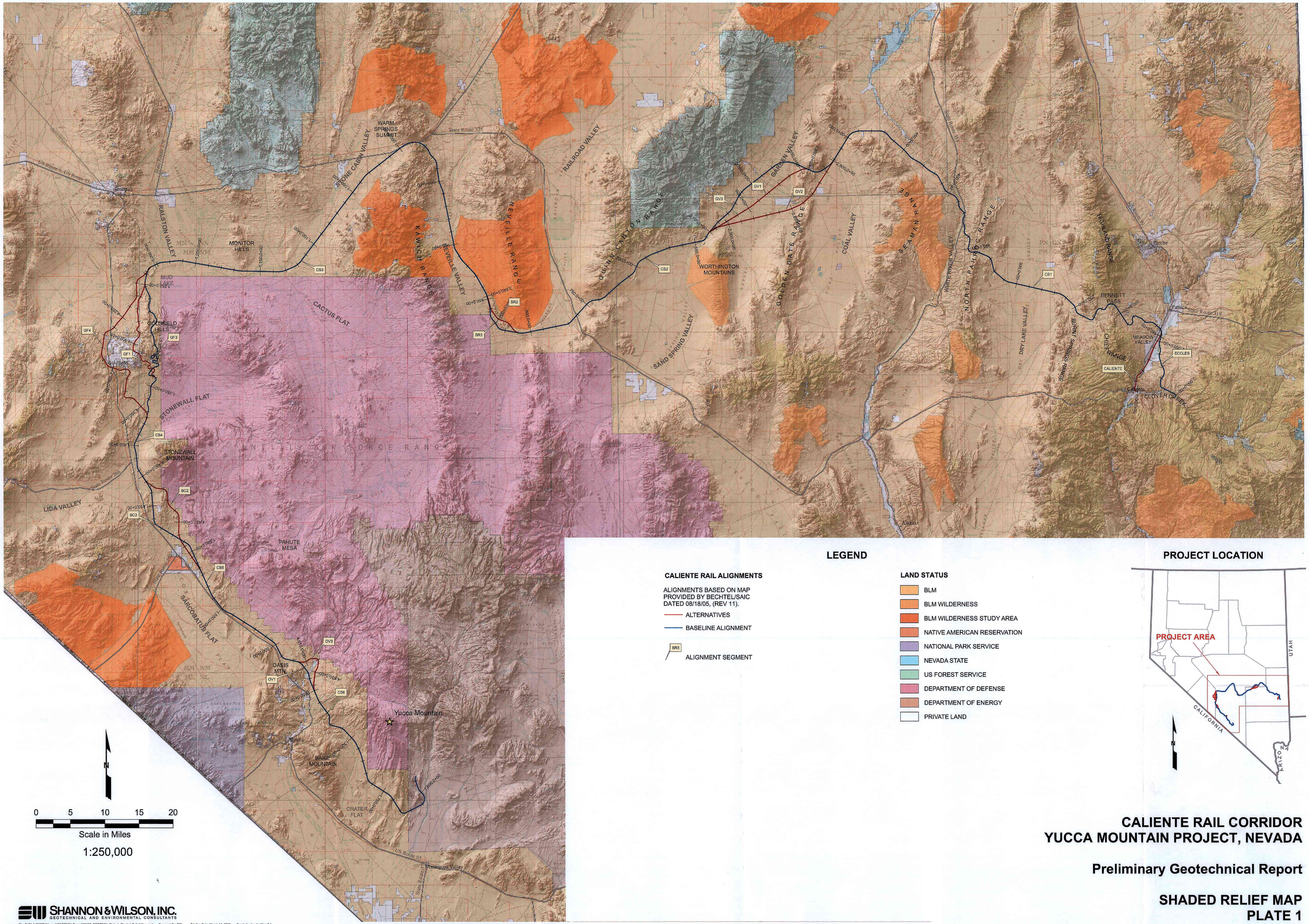
BLOCK SIZE

When this level of detail is required, a special data collection form should be used.

Filename: J:\211\20102-239\Field Guides\21-1-20102-239 FIELD ROCK CLASS 2 (3 pgs).dwg Date: 08-02-2007 Login: CNT

cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Inches 1 2 3 4 5 6



LEGEND

CALIENTE RAIL ALIGNMENTS

ALIGNMENTS BASED ON MAP PROVIDED BY BECHTEL/SAIC DATED 08/18/05, (REV 11).

- ALTERNATIVES
- BASELINE ALIGNMENT
- SR3 — ALIGNMENT SEGMENT

LAND STATUS

- BLM
- BLM WILDERNESS
- BLM WILDERNESS STUDY AREA
- NATIVE AMERICAN RESERVATION
- NATIONAL PARK SERVICE
- NEVADA STATE
- US FOREST SERVICE
- DEPARTMENT OF DEFENSE
- DEPARTMENT OF ENERGY
- PRIVATE LAND

PROJECT LOCATION

CALIENTE RAIL CORRIDOR
YUCCA MOUNTAIN PROJECT, NEVADA

Preliminary Geotechnical Report

SHADED RELIEF MAP
PLATE 1

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

File: E:\21-1-201024\AV_mxd\GEOTECH Report\201002_GEOTECH_Plate-1_Shaded-Relief-Map.mxd Prepared By: BRL Printing Date: March 14, 2006 Created using ArcMap 9.1

LEGEND

CALIENTE RAIL ALIGNMENTS

ALIGNMENTS BASED ON MAP PROVIDED BY BECHTEL/SAIC DATED 08/18/05, (REV 11).

- ALTERNATIVES
- BASELINE ALIGNMENT

GEOLOGIC CROSS-SECTIONS

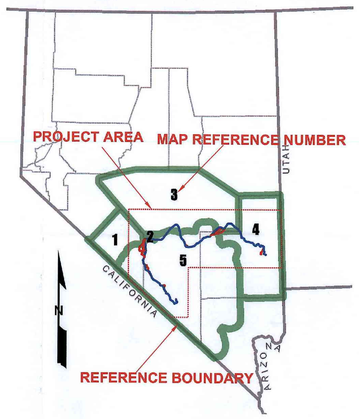
A ——— A' GEOLOGIC CROSS-SECTION DESIGNATION AND APPROXIMATE LOCATION

(1)

NOTE

Map shows approximate location of geologic cross-sections only. Geologic units shown on map do not directly correspond with those shown on the geologic cross-sections. See Plate 3 for geologic cross-sections.

PROJECT LOCATION



GEOLOGIC MAP REFERENCES

1. Albers, J.P., and Stewart, J.H., 1972, Geology and mineral deposits of Esmeralda County, Nevada: Nevada Bureau of Mines and Geology Bulletin 78, 80 p.
2. Cornwall, H.R., 1972, Geology and mineral deposits of southern Nye County, Nevada: Reno, Nev., Nevada Bureau of Mines and Geology Bulletin 77, 45 p.
3. Kleinhampl, F.J., and Ziony, J.I., 1985, Geology and mineral deposits of northern Nye County, Nevada: Nevada Bureau of Mines and Geology Bulletin 99A, 172 p.
4. Tschanz, C.M., and Pampeyan, E.H., 1970, Geology and mineral deposits of Lincoln County, Nevada: Nevada Bureau of Mines and Geology Bulletin 73, 188 p.
5. Workman, J.B., Menges, C.M., Page, W.R., Taylor, E.M., and others, 2002a, Geologic map of the Death Valley ground-water model area, Nevada and California: U.S. Geological Survey Miscellaneous Field Studies Map MF-2381-A, scale 1:250,000.

GEOLOGIC CROSS-SECTION REFERENCES

1. Day, W.C., Dickerson, R.P., Potter, C.J., Sweetkind, D.S., and others, 1998, Bedrock geologic map of the Yucca Mountain area, Nye County, Nevada: U.S. Geological Survey Geologic Investigations Series I-2627, scale 1:24,000.
2. Potter, C.J., Dickerson, R.P., Sweetkind, D.S., Drake, R.M. II, and others, 2002, Geologic map of the Yucca Mountain Region, Nye County, Nevada: U.S. Geological Survey Miscellaneous Investigations Series Map I-2755, scale 1:50,000.
3. Fridrich, C.J., Minor, S.A., Ryder, P.L., and Slate, J.L., 1999, Geologic map of the Oasis Valley Basin and vicinity, Nye County: U.S. Geological Survey Open-File Report 99-533-B, 43 p., 1 plate, scale 1:62,500.
4. Ashley, R.P., 1975, Preliminary geologic map of the Goldfield Mining District, Nevada: U.S. Geological Survey Miscellaneous Field Studies Map MF-681, scale 1:24,000.
5. duBray, E.A., and Hurtubise, D.O., 1994, Geologic map of the Seaman Range, Lincoln and Nye Counties, Nevada: U.S. Geological Survey Miscellaneous Investigation Series Map I-2282, scale 1:50,000.
6. Taylor, W.J., 1990, Spatial and temporal relations of Cenozoic volcanism and extension in the North Pahroc and Seaman Ranges, eastern Nevada, in Wernicke, B.P., ed., Basin and Range extensional tectonics near the latitude of Las Vegas Nevada: Boulder, Colo., Geological Society of America Memoir 176, chapter 8.
7. Sleeper, K.G., 1989, Structural geology of the Black Canyon Range, The Bluffs, and southwestern Highland Range, Lincoln County, Nevada: Flagstaff, Ariz., Northern Arizona University, M.S. thesis, 113 p.
8. Rowley, P.D.; Shroba, R.R.; Simonds, F.W.; Burke, K.J.; and others, 1994, Geologic map of the Chief Mountain quadrangle, Lincoln County, Nevada: U.S. Geological Survey Geologic Quadrangle Map GQ-1731, scale 1:24,000.
9. Rowley, P.D., and Shroba, R.R., 1991, Geologic map of the Indian Cove quadrangle: U.S. Geological Survey Geologic Quadrangle Map GQ-1701, scale 1:24,000.

NOTES

1. See Plate 2, Sheet 2 for description and correlation of geologic map units.
2. See associated map reference for description of map symbols.

N

0 5 10 15 20

Scale in Miles

1:250,000

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

CALIENTE RAIL CORRIDOR
YUCCA MOUNTAIN PROJECT, NEVADA

Preliminary Geotechnical Report

REGIONAL GEOLOGY COMPILATION MAP
PLATE 2 (Sheet 1 of 2)

File: E:\21-1-20102\WV_mxd\GEOTECH Report\20102_GEOTECH_Plate-2_Sht-1_Regional-Geology-Compilation-Map.mxd Prepared By: BRL Printing Date: March 14, 2006 Created using ArcMap 9.1

Southern Nye County (2)

Quaternary — Holocene, Pleistocene

Qal — Alluvium
Fan and stream gravels flanking mountains and hills and grading outward into sands and silts in valley bottoms

Qb — Basalt
Flows, plugs, and cinder cones

Tertiary — Pliocene, Miocene, Oligocene, Eocene, Paleocene

Tb — Basalt
Flows and plugs

Tw — *Welded tuff
Ash flows, mostly rhyolitic; locally includes older ash flows

Tl — *Quartz latite
Flows and intrusive masses

Tts — Tuff and tuffaceous sedimentary rocks

Tr — Rhyolite
Flows and intrusive masses

Tt — *Ash-fall tuff and nonwelded ash-flow tuff

Cretaceous, Jurassic, Triassic, Permian, Pennsylvanian, Mississippian, Devonian, Silurian, Ordovician, Cambrian, Proterozoic

Ce — Emigrant Formation
Claystone and limestone

Workman (5)

- Qc — Channel alluvium (Holocene)
- Qp — Playa and (or) salt pan deposits (Holocene)
- Qay — Young alluvium (Holocene to latest Pleistocene?)
- Qayf — Young fine-grained alluvium (Holocene to latest Pleistocene?)
- Qayo — Intermediate-age alluvium (middle Holocene to latest Pleistocene?)
- Qe — Eolian deposits (Holocene to middle Pleistocene)
- Qao — Old alluvium (late to middle Pleistocene)
- Qau — Undifferentiated alluvium (Holocene to Pleistocene)
- QTau — Undifferentiated older alluvium (Holocene to latest Tertiary)
- QTa — Oldest alluvium (middle Pleistocene to late Tertiary)
- QTd — Deposits associated with modern or past ground-water discharge (Holocene to late Tertiary)
- QTb — Basaltic lava flows, undivided (Pleistocene to Miocene)
- Tb — Old basaltic lava flows (Pliocene to Miocene)
- Ta4 — Intermediate-composition lava flows, unit 4 (Pliocene and Miocene)
- Ts4 — Sedimentary rocks, unit 4 (Pliocene and Miocene)
- Tgy — Young granitic intrusive rocks (Miocene)
- Tbt — Tuffs of the Belted Range Group
- Tst — Stonewall Flat Tuff and tuffs of the Thirsty Canyon Group, undivided
- Tpt — Tuffs of the Paintbrush Group
- Tct — Tuffs of the Crater Flat Group
- Tqv — Volcanic rocks of Quartz Mountain
- Tv — Volcanic rocks, undivided (Pliocene to Oligocene)
- Tr — Felsic-composition lava flows, undivided (Pliocene to Oligocene)
- Tls — Landslide and mega-breccia deposits (Miocene to Oligocene)
- Tai — Younger intermediate-composition intrusive rocks (Miocene to Oligocene)
- Ta3 — Intermediate-composition lava flows, unit 3 (Miocene and Oligocene)
- Tt3 — Ash-flow tuffs and interbedded air-fall tuffs, unit 3 (Miocene and Oligocene)
- Tgo — Older granitic intrusive rocks (Miocene? to Oligocene)
- Ts3 — Sedimentary rocks, unit 3 (Miocene and Oligocene)
- Tt2 — Ash-flow tuffs and interbedded air-fall tuffs, unit 2 (Oligocene)
- Tso — Sedimentary rocks older than the rocks of the Nevada Test Site and vicinity (Miocene to Eocene?)
- Tlt — Lithic Ridge Tuff, rhyolite of Picture Rock, Tunnel Formation, and comendite of Quartet Dome, undivided
- Ts1 — Sedimentary rocks, unit 1 (Eocene and Paleocene)
- TKd — Mafic intrusive rocks (Oligocene to Cretaceous)
- TKi — Older intermediate-composition intrusive rocks (Oligocene to Cretaceous)
- TRg — Oldest granitic intrusive rocks (Tertiary? to Triassic)
- Pzu — Sedimentary rocks, undivided (Paleozoic)
- PIPMb — Bird Spring (Lower Permian and Pennsylvanian) and Indian Springs Formations (Upper Mississippian)
- PIPt — Tippipah Limestone (Lower Permian and Pennsylvanian)
- Mu — Sedimentary rocks, undivided (Upper and Lower Mississippian)
- Mj — Joana Limestone (Lower Mississippian)
- Msc — Scotty Wash Quartzite (Upper Mississippian) and Chainman Shale (Upper and Lower Mississippian), undivided
- MDe — Eleana Formation (Mississippian and Upper Devonian)
- MDu — Sedimentary rocks, undivided (Lower Mississippian and Upper and Middle Devonian)
- DCd — Dolomite and limestone, undifferentiated (Devonian to Upper Cambrian)
- Ds — Simonson Dolomite (Middle Devonian)
- DSsl — Sevy (Middle and Lower Devonian) and Laketown (Upper and Middle Silurian) Dolomites, undivided
- Sr — Roberts Mountains Formation (Silurian)
- Opa — Palmetto Formation (Upper, Middle, and Lower Ordovician)
- Oes — Ely Springs Dolomite (Upper Ordovician)
- Oee — Ely Springs Dolomite (Upper Ordovician) and Eureka Quartzite (Upper and Middle Ordovician), undivided
- Oe — Eureka Quartzite (Upper and Middle Ordovician)
- OCpn — Pogonip Group (Middle and Lower Ordovician and Upper Cambrian) and Nopah Formation (Upper Cambrian), undivided
- OCp — Pogonip Group (Middle and Lower Ordovician and Upper Cambrian)
- Ce — Emigrant Formation (Upper and Middle Cambrian)
- Cn — Nopah Formation (Upper Cambrian)
- Cnbc — Nopah (Upper Cambrian), Bonanza King (Upper and Middle Cambrian), and Carrara Formations (Middle and Lower Cambrian), undivided
- Cms — Mule Spring Limestone (Lower Cambrian)
- Ch — Harkless Formation (Lower Cambrian)
- Cb — Bonanza King Formation (Upper and Middle Cambrian)
- Cpo — Poleta Formation (Lower Cambrian)
- CZw — Wood Canyon Formation (Lower Cambrian and Late Proterozoic)
- Ccam — Montenegro Member (Lower Cambrian)
- CZcaa — Andrews Mountain Member (Lower Cambrian and Late Proterozoic)
- Zd — Deep Spring Formation (Late Proterozoic)
- Zs — Stirling Quartzite and Reed Dolomite, undivided (Late Proterozoic)
- Zj — Johnnie and Wyman Formations, undivided (Late Proterozoic)
- Xmi — Metamorphic and igneous rocks, undifferentiated (Early Proterozoic)

Northern Nye County (3)

Qb, Qbc, Qba — BASALTIC ROCKS—**Qb**, basalt in flows. **Qbc**, basaltic scoria in cones and in mounds. **Qba**, basaltic ash and scoria, undifferentiated

Qa — ALLUVIUM, COLLUVIUM, TALUS—Chiefly fluviatile gravels flanking mountains and grading into fluviatile and lacustrine sand and silt in valleys. Includes eolian and playa deposits. Locally includes similar deposits of Tertiary age

Qf — FANGLOMERATE—The fanglomerate locally contains conspicuous small boulders and slabs of Mesozoic granite and Lower Cambrian schist and quartzite. Unit locally lies on Miocene and Pliocene sedimentary strata formerly assigned to the Siebert Formation. Mapped only along extreme southwest part of Toquima Range; other Quaternary fanglomerates included with Quaternary alluvium (Qa)

Qls — YOUNGER LANDSLIDE DEPOSITS

QTl — LANDSLIDE DEPOSITS—May or may not have originated like exotic slide blocks, unit Tes, below

QTb — BASALT, ANDESITE, AND LATITE—May prove to be part of much older rocks of intermediate composition, unit Td

Tb — BASALTIC ROCKS

Tes — EXOTIC SLIDE BLOCKS

Tl, Td — DACITIC AND QUARTZ LATITIC ROCKS—**Tl**, quartz latite flows, plugs, and protrusive domes; in San Antonio Mountains includes Brougher Dacite (16.2 m.y. old). **Td**, biotite-hornblende dacite porphyry in thick extensive flow, about 17 m.y. old, in San Antonio Mountains

Tay, Tad — DACITIC TO BASALTIC ROCKS—**Tay**, younger(?) mafic rocks, believed to be in the age range of about 5 or 7 to 15 m.y. **Tad**, intermediate lavas and intrusive bodies of probable widespread age span that may include Pliocene material. Some units pervasively altered (propylitized and argillized) and locally mineralized. In the Lodi Hills and vicinity, the lavas may be approximately coeval with the Mizpah Trachyte and a formation in the southern Desatoya Mountains given an unpublished name by Barrows (1971) (20.4 ± 0.6 m.y. and 21.4 ± 4.0 m.y. respectively) or as old as the 27 m.y.-old andesites mapped by Wilden and Speed (1974) nearby in southeastern Churchill County

Tdx — DEBRIS—A melange possibly formed between 18.5 and 26 m.y. ago, and containing volcanic rocks older than unit Trr. Mapped in southernmost Pancake Range and Reveille Range

Tf — FRACTION TUFF—Lithic-rich rhyolitic to quartz latitic ash-flow tuffs. At Heller Butte (Tonopah) average age is 17.0 ± 0.3 m.y., and is the oldest post-ore unit. Mineralization age at Tonopah is 19.1 ± 0.4 m.y., based on adularia in a vein. Queried where uncertain

Tr — RHYOLITE—In domes, plugs, and flows. Associated locally with pumiceous material; mostly phenocryst-poor and lithified. Mapped only near Dianas Punch Bowl Spring, Monitor Valley, and near Hunts Canyon, Monitor Range. Probably correlative with many of the nearby rhyolites in the southern Monitor Range that are mapped with the rhyolites, undifferentiated (Tru)

Tru — RHYOLITES, UNDIFFERENTIATED—Dome and plugs of rhyolite of uncertain age relations with rocks in vicinity of Ellendale and Hannapah mining districts. May be of more than one age, with possible range of about 16 to 26 m.y.

Tsw — TUFF OF SAULSBURY WASH—Rhyolitic welded ash-flow tuff. Radiometric age 21.6 ± 0.6 m.y. Lies with slight angular discordance across a surface of low to moderate relief cut into underlying volcanic rocks. May include tuff of Clipper Gap of Gromme, McKee, and Blake (1972) in northernmost exposures near Antelope Spring

Tvu, Ts, Thbx — VOLCANIC ROCKS, UNDIFFERENTIATED—**Tvu**, chiefly rhyolitic to quartz latitic(?) ash-flow tuffs, and sedimentary strata. Stratigraphic position uncertain but probably wide-ranging in age; may correlate in part with similar rocks in Toiyabe Range (unit Tvm). Mainly includes rocks previously correlated by Ferguson (1924) and Ferguson and Cathcart (1954) with the Esmeralda Formation and divided by Ferguson at Manhattan into five members: the basal Hedwig Breccia Member and successively overlying Round Rock Member (welded tuff), Diamond King Member (bedded tuffs and ash-flow tuffs), Bald Mountain Lake Beds Member, and quartz latite member (welded ash-flow tuff). Except for the Hedwig Breccia, lower units may possibly correlate with ash-flow tuffs (units Th, Tp) mapped farther north in the Wildcat Peak quadrangle. The Hedwig Breccia (Thbx), which is herein removed from the Esmeralda, is shown separately on this map. **Ts**, sedimentary strata; mapped locally. **Thbx**, Hedwig Breccia. Volcanic breccia; many clasts are composed of pre-Tertiary rocks

Twt — TOIYABE QUARTZ LATITE—**Twt**, chiefly rhyolitic to rhyodacitic welded ash-flow tuffs a few thousand feet thick and in several cooling units in Toiyabe Range and Shoshone Mountains. Typically contains abundant smoky quartz and feldspar, but some units contain conspicuous biotite and little quartz. Unit exhibits strongly inclined normal magnetic polarity. Locally in Shoshone Mountains includes at top of section intermediate lavas as much as 165 meters thick (Vitaliano and Vitaliano, 1972). Age in part is 21.5 m.y. old for welded ash-flow tuff bearing smoky quartz. Age range about 21-24 m.y. **i**, coarse-grained "dacite" of Vitaliano and Vitaliano (1972) that intrudes lower part of Toiyabe Quartz Latite

Ta, Tvm, Tis — MIDDLE VOLCANIC SEQUENCE—**Ta**, andesitic rocks; includes Gilbert Andesite as used by Ferguson and Cathcart (1954) in the southern Toiyabe Range but is probably much older than and unrelated to the type Gilbert Andesite. Occurs as dikes and flows and a possible vent complex in the southern Toiyabe Range. **Tvm**, chiefly ash-flow tuffs, breccia, lavas, and some volcanogenic sedimentary rocks of silicic composition. In southern Toiyabe Range includes conglomerate unit of possible time equivalence to sedimentary rocks in the Toquima Range. In Shoshone Mountains includes volcaniclastic rocks of Bonita Canyon Formation of Bonham (1970), rhyolitic tuff and tuff breccia of the rhyolite of Union Canyon of Vitaliano and Vitaliano (1972), and the underlying tuff of Grantsville Canyon of Vitaliano and Vitaliano (1972). In the northern Paradise Range may include two formations from the southern Desatoya Mountains given unpublished names there by Barrows (1971). Stratigraphic limits uncertain with respect to units in adjacent ranges, and absolute age generally unknown. Rocks are commonly somewhat argillized and locally mineralized. A welded tuff at the base of the unit in the Toiyabe Range from near Broad Canyon north to at least North Twin River Canyon is dated at 22.7 ± 0.8 m.y. (Speed and McKee, 1976). **Tis**, intermediate to siliceous rocks

Tb, Tan, Tii — ANDESITIC TO BASALTIC ROCKS, INCLUDING MIZPAH TRACHYTE—**Tb**, includes Red Mountain Basalt of Broderick (1949) and basaltic andesite to trachyandesite in San Antonio Mountains, and trachyandesitic to basaltic flows in the Shoshone Mountains (Bonham, 1970; Vitaliano, 1963; and Vitaliano and Vitaliano, 1972). Upper age limit of sequence unknown but possibly Pliocene. Two flows, 15.8 ± 2.0 m.y. and 17.9 ± 3.0 m.y.-old, in the San Antonio Mountains are part of a sequence possibly contemporaneous with basaltic and andesitic rocks of the Hannapah mining district, Monitor Range, where age of uppermost flow in a thick sequence at Thunder Mountains is 18.9 ± 1.5 m.y. according to Armstrong and others (1972) but which is probably not more than about 15 m.y. old according to Bonham (oral commun., May, 1974). In north end of San Antonio Mountains and in vicinity of Lodi Hills, the lavas intertongue with and cut sedimentary strata (unit Tts). **Tan**, Mizpah Trachyte, commonly altered and locally mineralized; 20.4 ± 0.6 m.y. old; mapped only in vicinity of Tonopah, where the unit is host rock for the silver deposits. **Tii**, trachyandesite dikes

The, Thm, Thv, Ta — VOLCANIC ROCKS OF HANNAPAH AND ELLENDALE MINING DISTRICTS—**The**, rhyolitic to quartz latitic welded ash-flow tuffs, vent tuffs, air-fall tuffs, pumice flows, and intercalated sedimentary rocks, undifferentiated. Some rocks shown as unit. The may be correlative with thick undifferentiated ash-flow tuffs (Twa) of the Hunts and McCann Canyons area, northern Monitor Range. **Thm**, tuffs of McKinney Tanks; air-fall tuffs and incipiently welded tuffs and sedimentary rocks; tuffaceous and lacustrine beds intercalated with fluviatile strata. Not mapped separately everywhere from unit The. Tuffaceous rocks common, but limestone not seen and may be absent. **Thv**, tuffs of Hannapah and probable vent rocks; chiefly welded, rhyolitic to quartz latitic; some agglutinates. Relatively discrete compared to the other volcanic rocks of Hannapah and Ellendale mining districts and vicinity. Not mapped separately everywhere. **Ta**, andesitic to dacitic rocks in flows, dikes, and small irregular bodies. Commonly propylitized. Age uncertain; in part may be as young as the basaltic and andesitic rocks that form the capping unit in the area (see unit QTb, above), but generally believed to be older. Includes small bodies of dacite and (or) latite near Thunder Mountain

Tw — RHYOLITIC WELDED ASH-FLOW TUFFS—Age in part 22.6 ± 0.7 m.y. Mapped in vicinity of Quinn Canyon

Tto — TONOPAH FORMATION—Silicic ash-flow tuffs and lavas; commonly altered (argillized and silicified) and locally mineralized. Includes some tuffaceous sedimentary rocks and conglomerate. Mapped only in San Antonio Mountains. Age relations uncertain with respect to Tertiary units elsewhere, but believed to be Oligocene or Oligocene(?). May be more nearly the time equivalent of the middle volcanic sequence of Shoshone Mountains and Toiyabe Range than shown

Tshu, Tj — SHINGLE PASS(?) AND SOME OTHER TUFFS—**Tshu**, Shingle Pass(?) Tuff and some other tuffs around Mount Jefferson, undifferentiated. Crystal-poor to moderately crystal-rich welded ash-flow tuffs of rhyolitic to quartz latitic(?) composition. Includes some air-fall tuff and lacustrine and fluviatile tuffaceous sedimentary rocks, and locally may include Bates Mountain Tuff and other young tuffs (Tbm). Radiometric age measured on Shingle Pass Tuff in region east of the Toquima Range is 25.1 ± 1.0 m.y. old. Queried where uncertain. **Tj**, tuffs of Mount Jefferson. Moderately crystal-rich rhyolitic to quartz latitic ash-flow tuffs; includes several thousand feet of rocks and more than one cooling unit. Radiometric age 24.7 to 26.1 m.y. for one of units; total age span unknown. Queried where identification uncertain

Tpy — YOUNG TUFFS OF THE PANCAKE CALDERA COMPLEX—Silicic to intermediate ash-flow tuffs recognized chiefly in the Hot Creek Range. Includes, from youngest to oldest, informally named granite-weathering tuff, clinkstone-weathering tuff, tuff of Black Beauty Mesa, tuff of Buckwheat Rim, tuff of Buckskin Point, and tuff of Lunar Cuesta. Last-named unit has mean age of 24.6 ± 0.75 m.y.

Trr — ROCKS OF THE REVEILLE RANGE—Silicic tuffs and intrusive bodies and sedimentary strata, all about 24 to 25 m.y. old, such as informally named rhyolite and tuff of Streuben Knob and tuff of northern Reveille Range

Tsh, Tshu, Tts — SHINGLE PASS TUFF AND STRATIGRAPHICALLY ADJACENT ROCKS—**Tsh**, Shingle Pass Tuff; crystal-poor rhyolitic ash-flow tuffs about 25.1 ± 1.0 m.y. old. **Tshu**, ash-flow tuffs, undifferentiated. Age range about 23 to 29 m.y. In Morey Peak quadrangle, Hot Creek Range, includes from top to bottom, the tuff of Lunar Cuesta, Shingle Pass Tuff, and the young tuffs of Moores Station area, Needles Range(?) Formation (of minor extent), unnamed ash-flow tuffs, and local bedded tuff and sedimentary strata. In the central part of the Monitor Range locally includes the Bates Mountain Tuff and the tuff of Clipper Gap of Gromme, McKee, and Blake (1972). **Tts**, tuffaceous sedimentary rocks; mapped only in Tybo quadrangle, Hot Creek Range

Tm, Tam — MONOTONY TUFF AND LAVA—**Tm**, Monotony Tuff; rhyolitic and quartz latitic ash-flow tuff (26.5-27.0 ± 0.8 m.y.). **Tam**, andesitic lavas and breccias underlying and locally overlying Monotony Tuff. Includes tuff and sedimentary strata

Tkc — TUFF OF KILN CANYON—Chiefly rhyolitic to quartz latitic ash-flow tuff. Age 25.1 ± 1.0 m.y. (biotite); 24.1 ± 0.9 m.y. (sanidine)

Tl, Trs — INTRUSIVE ROCKS, UNDIFFERENTIATED, AND RHYOLITE OF BIG SAND SPRINGS VALLEY—**Tl**, primarily rhyolite but also rhyodacitic and andesitic dikes and irregular small bodies. **Trs**, rhyolite of Big Sand Springs Valley, 25.8 ± 1.3 m.y. old, and other rhyolites; mapped only in southeast part of Moores Station quadrangle and in Hot Creek Range west of Tybo. Includes bodies that intrude rocks as young as tuff of Kiln Canyon, Hot Creek Range, Tybo quadrangle

Td — ROCKS OF INTERMEDIATE COMPOSITION—Chiefly latitic lavas and some welded vitric tuffs; especially extensive and thick in Pritchards Station quadrangle, Hot Creek Range, and very thin in adjacent Moores Station quadrangle. Correlative with unit Td of Pancake Range

Twa, Tnr, Twb, Tsc, Tcw, Ts, Ta — VOLCANIC ROCKS—**Twa**, chiefly crystal-rich welded ash-flow tuffs of rhyolitic to quartz latitic composition. **Tnr**, Needles Range(?) Formation. Radiometric age 27.2 to 29.7 m.y. **Twb**, Windous Butte Formation. Radiometric age 30.7 m.y. **Tsc**, Stone Cabin Formation; age 34.1 m.y. **Tcw**, Calloway Well Formation of Scott (1965a); age is 33.2 ± 0.7 m.y. **Ts**, sedimentary rocks, in part volcanogenic in origin. Includes Currant Tuff near Currant and air-fall and ash-flow tuffs older than about 22 m.y. west of Quinn Canyon. **Ta**, andesite in flows

Tgg, Tbx1 — GILMORE GULCH FORMATION AND RELATED ROCKS—**Tgg**, Gilmore Gulch Formation. Chiefly clastic sedimentary strata, with some limestone and locally underlying megabreccia and a little welded tuff. Overlies tuff of Williams Ridge and Morey Peak in the Tybo quadrangle, Hot Creek Range. **Tbx1**, megabreccia and welded tuff as much as 1000 ft thick (separated locally from unit Tgg)

Tpo — OLD TUFFS OF THE PANCAKE CALDERA COMPLEX—Silicic ash-flow tuffs; chiefly in southern Pancake Range. Includes, from youngest to oldest, informally named tuff of Palisade Mesa (29.9 m.y) and tuff of Halligan Mesa (30.3 m.y.). May locally include tuff of Black Rock Summit

Thc — TUFF OF HOT CREEK CANYON—Rhyolitic to quartz latitic welded tuff. 30.0 ± 0.9 m.y. old

IPe, IPec — ELY LIMESTONE—**IPe**, thin-bedded limestone. **IPec**, limestone with abundant chert in grit and conglomerate in Pancake Range. **IPes**, limy sandstone in Golden Gate Range

MzPzm — MAFIC ROCKS—Includes metamorphosed dacite and rhyodacite welded tuff and intrusive hornblende diorite in the San Antonio Mountains, near Thunder Mountain, where Bonham and Garside (1979) assigned the rocks to the Mesozoic. Also includes nearby porphyritic hornblende-bearing rocks in the Hannapah mining district near Thunder Mountain

Mc, Ms — CHAINMAN SHALE AND DIAMOND PEAK FORMATION—**Mc**, shale with tongues of sandstone and conglomerate in upper part. **Ms**, sandstone and conglomerate; mapped separately in some areas

Mj — JOANA LIMESTONE

MDp — PILOT SHALE

MDe, Mld, Ml, MDu — ELEANA FORMATION AND LIMESTONE AND SHALE—**MDe**, Eleana Formation; shale, sandstone, conglomerate, limestone. A cobble conglomerate mapped with this formation crops out at Clear Creek Canyon, Monitor Range, but may be unit PIPs. **Ml**, limestone lenses of Mississippian age. **Mld**, limestone of Dobbin Summit. **MDu**, limestone and shale, undifferentiated; chiefly in central part of Hot Creek Range, but also in Monitor Range at Dobbin Summit and Clear Creek Canyon, where section may be correlative with the Chainman Shale. Includes limestone and breccia at Clear Creek and Tulle Creek Canyons, Monitor Range, where section is partly the age equivalent of the Early Mississippian Joana Limestone

Dc — COCKALORUM WASH FORMATION—Shaly siliceous siltstone and minor limestone

Dn, Dno — NEVADA FORMATION—**Dn**, chiefly dolomite. **Dno**, Oxyoke Canyon Sandstone Member

DSOd — DOLOMITE AND LIMESTONE—Locally includes quartzite, as in north end of Hot Creek Range, of uncertain stratigraphic position in the Paleozoic section

Dg — DEVILS GATE LIMESTONE IN PANCAKE RANGE; ELSEWHERE GUILMETTE FORMATION—Chiefly limestone

Dsi — SIMONSON DOLOMITE

Dse — SEVY DOLOMITE

SOd — DOLOMITE

Slm — LONE MOUNTAIN DOLOMITE—Massive dolomite; may locally include beds of Devonian age

Oes — ELY SPRINGS DOLOMITE

Op — POGONIP GROUP—The Ninemile and Antelope Valley Formations of the Pogonip are recognized in the northern mapped part of the range. Also includes the Stoneberger Shale and the Perkins Canyon Formation of Key and Crawford (1964)

Oe — EUREKA QUARTZITE—Map unit includes Ely Springs Dolomite in Reveille Range

OCsl — SHALE AND LIMESTONE—Locally metamorphosed to slate and marble. Includes some shale and siltstone in the Ellendale mining district that are probably as old as, or older than, the Zabriskie Quartzite and Wood Canyon Formation

OCpw — LOWER PART OF POGONIP GROUP AND WINDFALL FORMATION, UNDIVIDED

Cw — WINDFALL FORMATION—Cherty limestone

Csl — SHALE AND LIMESTONE, UNDIVIDED—Locally metamorphosed to slate and marble

Cpc — POLE CANYON LIMESTONE

Cp — PIOCHE SHALE

Csw — SWARBRICK FORMATION—Limestone and chert

CZgh — GOLD HILL FORMATION—Quartzite with subordinate shale and limestone

Lincoln County (4)

- Qp — Recent playa deposits
- Qal — Younger alluvium
- Ql — Younger lake beds
- QTl — Intermediate lake beds
- QTg — Older gravels
- Tl — Older lake beds
  Muddy Creek Formation, Panaca Formation, and lake beds in White River Valley
- Tb — Basalt
  Includes some older basalt flows and basalt dikes of several ages

Ts, Tvy, p, Tva, Tvb, Tvc, Tvd, Tvr, Tvt — Younger volcanic rocks
- Tvy, *younger volcanic rocks, undivided, including intravolcanic sedimentary rocks* (Ts) *and perlite* (p)
- Tva, *andesite*
- Tvb, *spheroidal-weathering ignimbrite*
- Tvc, *rhyolitic unit*
- Tvd, *biotite dacite*
- Tvr, *rhyolite complex*
- Tvt, *tuffs and tuffaceous sediments*

Tg, Tr, Tgp, Tgd, Tqm, Td, Tdi, Tvn — Intrusive rocks
- Tg, *granite stocks and dikes*
- Tr, *rhyolite and microgranite dikes*
- Tgp, *granite porphyry*
- Tgd, *granodiorite*
- Tqm, *quartz monzonite or quartz diorite*
- Td, *diorite*
- Tdi, *diabase*
- Tvn, *andesitic volcanic neck*

- Tf — Lacustrine limestone
- TKvu — Volcanic rocks, undifferentiated
- TKc — Older clastic rocks
- TKv — Older volcanic rocks

PIPl, Pl, IPs, IPl — Limestone and sandstone
- PIPl, *Permian and Pennsylvanian limestone and sandstone, undivided*
- Pl, *Permian limestone; contains some fossiliferous Pennsylvanian beds in western part of county*
- IPs, *Upper Pennsylvanian sandstone; contains some Permian beds just east of the Limestone Hills*
- IPl, *Pennsylvanian limestone; lower most beds locally contain a very Late Mississippian fauna*

- Ml — Limestone
  Includes Joana, Mercury, and Bristol Pass Limestones
- Msc, Msw, Mc — Clastic rocks
  - Msc, *Upper Mississippian clastic rocks, undivided*
  - Msw, *Scotty Wash Quartzite*
  - Mc, *Chainman Shale*
- MDp — Pilot Shale
- Dg — Guilmette Formation
- Dsi — Simonson Dolomite
- Sl — Laketown Dolomite
- Oes — Ely Springs Dolomite
- Oe — Eureka Quartzite
- Op — Pogonip Group
- Cld — Limestone and dolomite, and Dunderberg Shale, undifferentiated
- Cu — Cambrian limestone and dolomite, undifferentiated
- Chp — Highland Peak Formation
- Cc, Ccl, Cp — Chisholm Shale, Lyndon Limestone, and Pioche Shale, undivided
  Pioche Shale, where mapped separately, shown as marker bed
- Cpm — Prospect Mountain Quartzite
  Includes Wood Canyon Formation and Stirling Quartzite in the Desert Range

Esmeralda County (1)

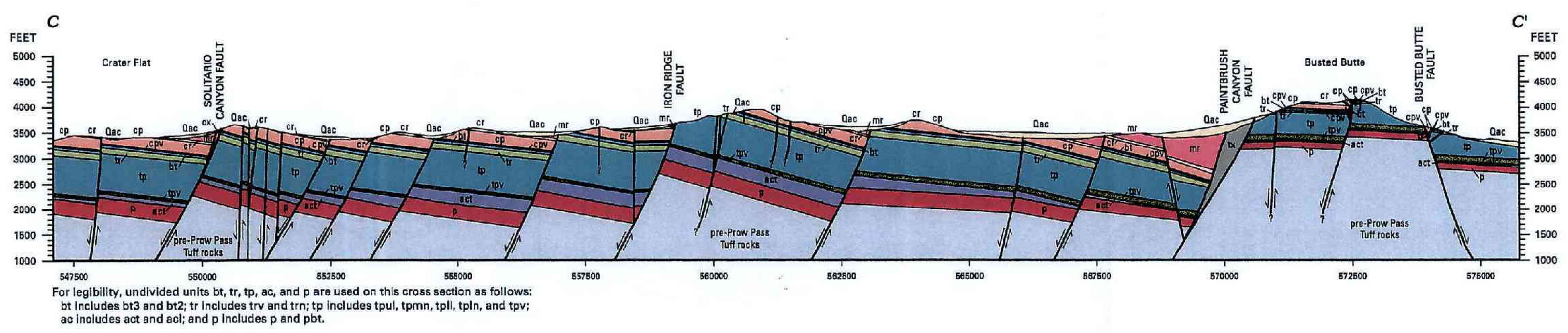
- Qal — Desert wash, colluvium, alluvium, and playa deposits
- Qoa — Older alluvium
  Chiefly gravel
- QTb — Basalt
  Age 4.8 m.y. (million years) by K-Ar methods (Robinson and others, 1968, table 1, no. 7)
- Td — Dacite
- Tql — Quartz latite and felsite
  Includes Brougher Dacite. Age 16.2 m.y. by K-Ar method (table 3, this report)
- Ta — Andesite
  Includes Divide Andesite
- Tfb — Fraction Breccia
  Ash flows of dominantly rhyolitic composition. Correlated with rocks in Nye County which are dated at 17.5 m.y. by K-Ar method
- Taw — Lower welded ash flow
  Age 21.5 m.y. by K-Ar method (Robinson and others, 1968, table 1, no. 12)
- TJd — Dark aphanitic to medium-grained rocks of dioritic to andesitic composition
- TJr — Felsic aphanitic rhyolite and quartz porphyry dike rocks

UNCONFORMITY

- Op — Palmetto Formation
  Dominantly black shale; locally contains abundant chert, limestone, and quartzite
- Ce — Emigrant Formation
  Mostly claystone in lower part, overlain by thin-bedded limestone with cherty layers
- Cms — Mule Spring Limestone
- Ch — Harkless Formation
  Dominantly green siltstone; locally includes strata lithologically similar to and correlative with Saline Valley Formation as defined by Nelson (1962)
- Cp — Poleta Formation
  Mostly thick-bedded carbonate in lower part, overlain by green siltstone with limestone and quartzite interbeds
- Ccm, Cca — Campito Formation
  - Ccm, *Montenegro Member; dominantly green siltstone*
  - Cca, *Andrews Mountain Member; dominantly dark-gray fine-grained quartzite*

REGIONAL GEOLOGY COMPILATION MAP
PLATE 2 (Sheet 2 of 2)

① SECTION C - C' FROM BEDROCK GEOLOGIC MAP OF THE YUCCA MOUNTAIN AREA, NYE COUNTY, NEVADA BY DAY, ET AL., 1998

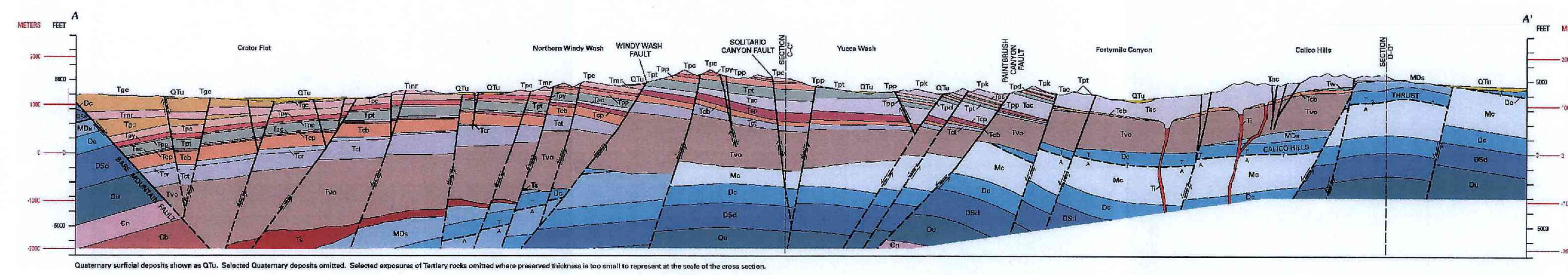


For legibility, undivided units bt, tr, tp, ac, and p are used on this cross section as follows: bt includes bt3 and bt2; tr includes trv and trn; tp includes tpul, tpmn, tpll, tpln, and tpv; ac includes act and acl; and p includes p and pbt.

List of Units

- Qac — Alluvial and colluvial deposits
- mr — Rainier Mesa Tuff, nonwelded
- cr — Crystal-rich member
- cp — Crystal-poor member
- cpv — Vitric zone of crystal-poor member
- bt — Nonwelded bedded tuffs, undivided
- tr — Crystal-rich member, undivided
- tp — Crystal-poor member, undivided
- tpv — Crystal-poor vitric zone
- tx — Undivided tectonic breccia
- act — Ash-flow tuff
- p — Prow Pass Tuff

② SECTION A - A' FROM GEOLOGIC MAP OF THE YUCCA MOUNTAIN REGION, NYE COUNTY, NEVADA BY POTTER, ET AL., 2002

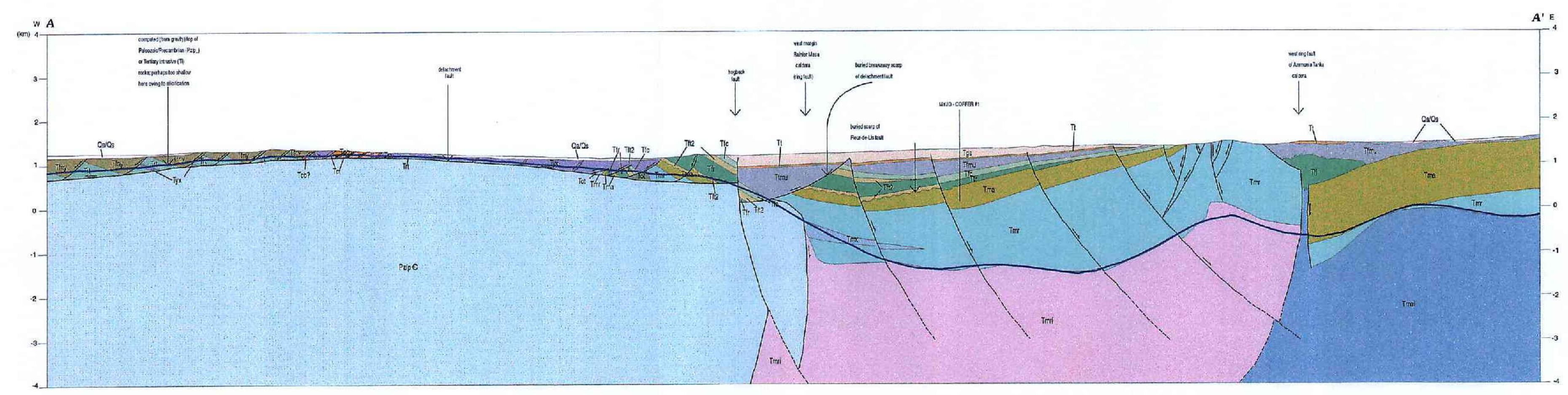


Quaternary surficial deposits shown as QTu. Selected Quaternary deposits omitted. Selected exposures of Tertiary rocks omitted where preserved thickness is too small to represent at the scale of the cross section.

LIST OF MAP UNITS

- Qa — Alluvium (Holocene)
- Qay — Younger alluvium (Holocene and late Pleistocene)
- Qam — Alluvium (late and middle Pleistocene)
- Qao — Older alluvium (middle and early Pleistocene)
- Qey — Eolian sand and fragments (Holocene and late Pleistocene)
- Qcm — Eolian-colluvial ramp deposits (Holocene to middle Pleistocene)
- Qeo — Older eolian sand (middle to early Pleistocene)
- Qe — Eolian deposits (Holocene to middle Pleistocene)
- Qsd — Spring deposits (Holocene to middle Pleistocene)
- QTu — Surficial deposits, undivided (Quaternary and Pliocene)—Shown on cross sections only
- Qby — Younger Quaternary basalt (late Pleistocene)
- Qbo — Older Quaternary basalt (early Pleistocene)
- Tby — Younger Tertiary basalt of Crater Flat (Pliocene)
- Tvy — Younger volcanic rocks (Pliocene to Miocene)
- Trx — Rock-avalanche breccia of southern Crater Flat (Miocene)
- Tgc — Conglomerates, fanglomerates, and rock-avalanche breccia (Miocene)
- Tbo — Older Tertiary basalts (Miocene) Includes older Tertiary basalts of Crater Flat, basalt of Skull Mountain, and basalt of Kiwi Mesa
- Ttr — Rocket Wash Tuff of Thirsty Canyon Group (Miocene)
- Fortymile Canyon assemblage (Miocene)
  - Tfs — Rhyolite of Shoshone Mountain
  - Tfd — Lavas of Dome Mountain
  - Tfb — Beatty Wash Formation—Includes rhyolite of Max Mountain and rhyolite of Chukar Canyon
- Timber Mountain Group (Miocene)
  - Tma — Ammonia Tanks Tuff
  - Tmr — Rainier Mesa Tuff—Includes rhyolite of Fluorspar Canyon
  - Tmp — Rhyolite of Pinnacles Ridge
  - Tmbi — Rhyolite of Waterpipe Butte
  - Tmw — Rhyolite of Windy Wash
- Paintbrush Group (Miocene)
  - Tvx — Intracaldera and caldera margin megabreccia and mesobreccia
  - Tpk — Rhyolite of Comb Peak
  - Tpv — Rhyolite of Vent Pass
  - Tpcy — Tuff of Pinyon Pass
  - Tpc — Tiva Canyon Tuff
  - Tpr — Rhyolite lavas, undivided—Includes rhyolite of Black Glass Canyon, rhyolite of Echo Peak, rhyolite of Zigzag Hill, rhyolite lava above Yucca Mountain Tuff, rhyolite lava above Pah Canyon Tuff, and rhyolite lava beneath Pah Canyon Tuff
  - Tpy — Yucca Mountain Tuff
  - Tpd — Rhyolite of Delirium Canyon
  - Tpp — Pah Canyon Tuff
  - Tpbt — Bedded tuff
  - Tpt — Topopah Spring Tuff
- Tpx — Paintbrush Group tuffs, undivided (Miocene)
- Tac — Calico Hills Formation (Miocene)
- Tw — Wahmonie Formation (Miocene)
- Crater Flat Group (Miocene)
  - Tcp — Prow Pass Tuff
  - Tcb — Bullfrog Tuff
  - Tcs — Pre-Bullfrog Tuff bedded tuff
  - Tcr — Rhyolite of Prospector Pass
  - Tct — Tram Tuff
- Tvo — Older volcanic rocks, undivided (Miocene)—Includes dacite lavas, Lithic Ridge Tuff, pre-Lithic Ridge tuffs and lavas, older tuffs of USW-G1, and tuff of Yucca Flat
- Ti — Intrusions (Miocene)
- Ts — Older sedimentary rocks, undivided (Miocene and Oligocene) Includes rocks of Pavits Spring and rocks of lower Rock Valley
- Mc — Chainman Shale (Mississippian)
- MDs — Clastic sedimentary rocks (Mississippian and Upper Devonian)
- Dc — Dolomite, limestone, and sandy dolomite (Middle and Lower Devonian)
- DSd — Dolomite (Middle and Lower Devonian and Silurian)
- Ou — Sedimentary rocks, undivided (Ordovician)—On cross sections, unit includes Upper Ordovician Ely Springs Dolomite, Upper and Middle Ordovician Eureka Quartzite, and Middle and Lower Ordovician Pogonip Group (Antelope Valley Formation, Ninemile Formation, and Goodwin Limestone). On geologic map, unit consists entirely of Pogonip Group
- Cn — Nopah Formation (Upper Cambrian)
- Cb — Bonanza King Formation (Upper and Middle Cambrian)
- Cc — Carrara Formation (Middle and Lower Cambrian)
- Cz — Zabriskie Quartzite (Lower Cambrian)
- CZw — Wood Canyon Formation (Lower Cambrian and Late Proterozoic)
- Zs — Stirling Quartzite (Late Proterozoic)
- Zj — Johnnie Formation (Late Proterozoic) Shown on cross section *B–B'* only
- ZYu — Metasedimentary rocks, undivided (Late and Middle Proterozoic) Shown on cross section *B–B'* only

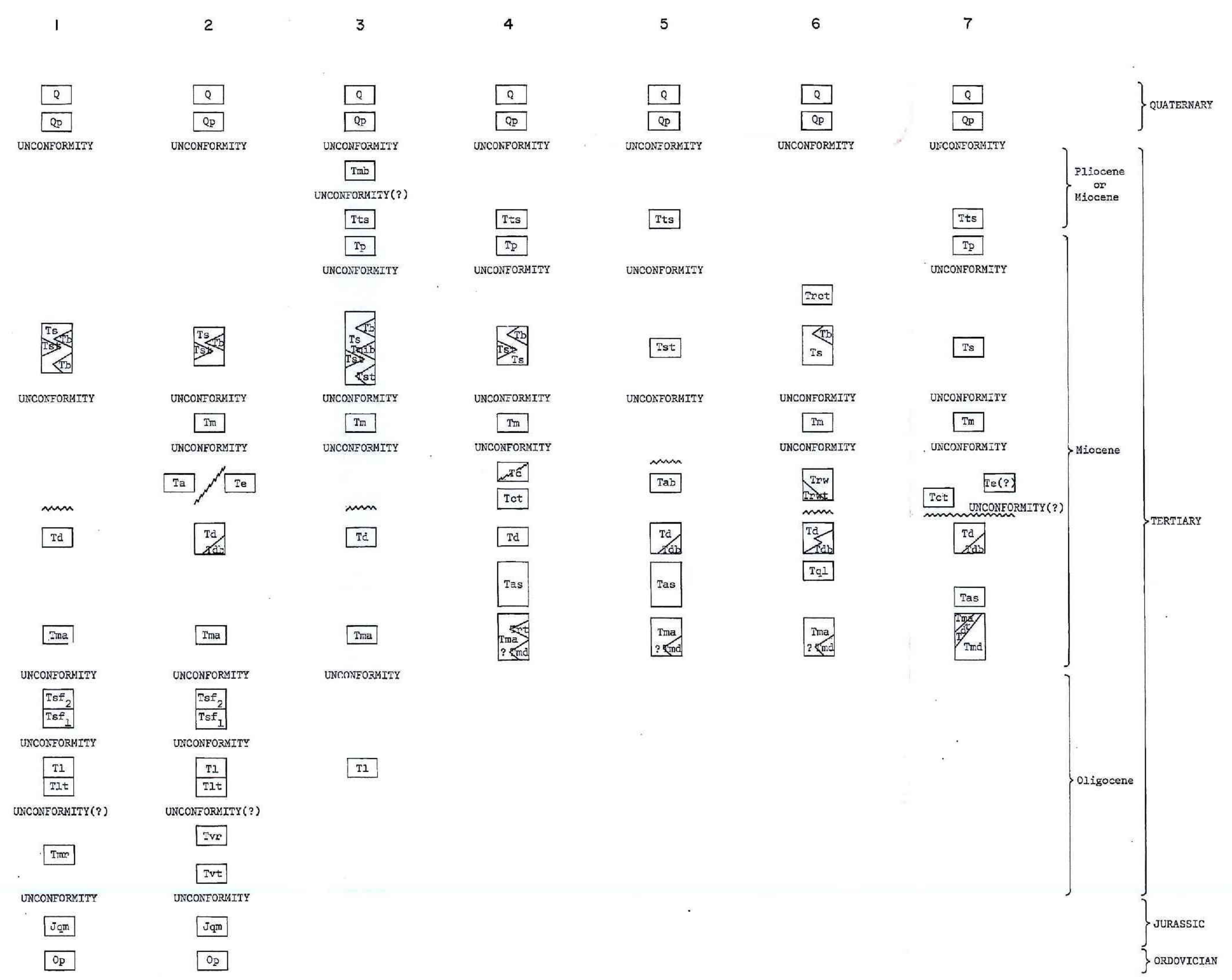
③ SECTION A - A' FROM GEOLOGIC MAP OF THE OASIS VALLEY BASIN, NYE COUNTY, NEVADA BY FRIDRICH, ET AL., 1999

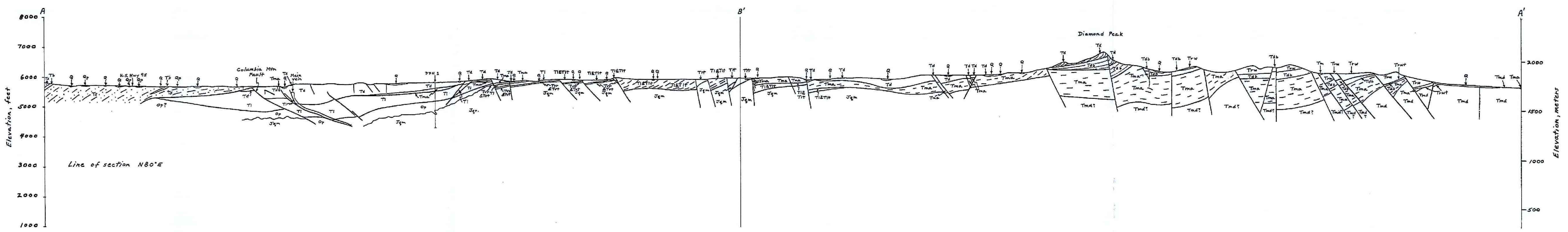


List of Map Units

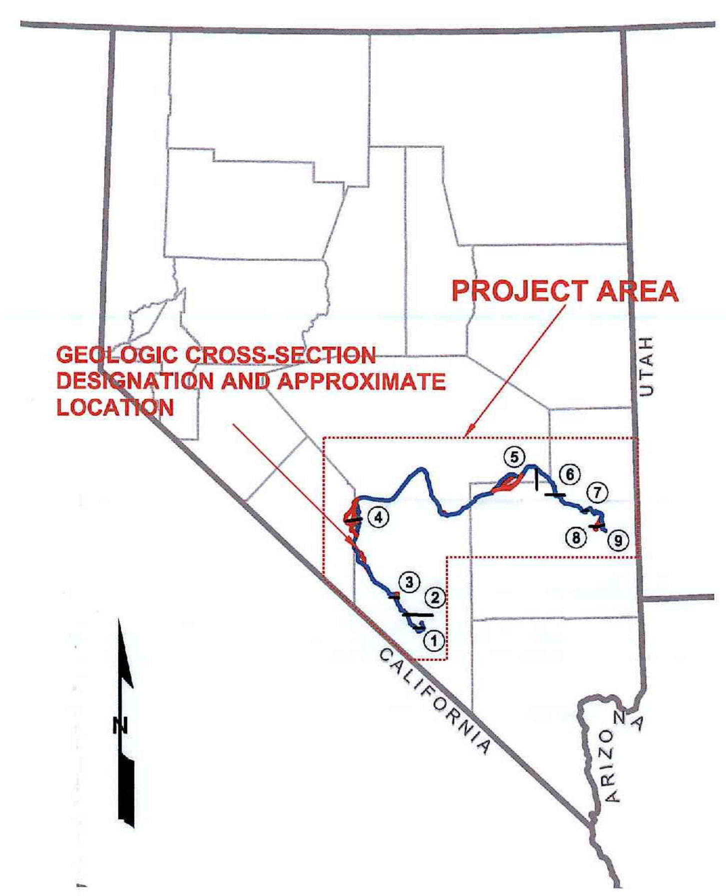
- Young alluvial deposits (Holocene)
- Eolian sand deposits (Quaternary)
- Playa deposits (Holocene)
- Colluvium (Holocene, Pleistocene, and Pliocene)
- Lacustrine beach (Holocene and late Pleistocene)
- Middle alluvial deposits (Pleistocene)
- Old alluvial deposits (early Pleistocene and Pliocene)
- Recent basalt (Quaternary)
- Older Gravels (early Pliocene and Miocene)
- Basalt of Thirsty Mountain (Pliocene)
- Spearhead Member of Stonewall Mountain Tuff (Miocene)
- Younger bedded tuffs (Miocene)
- Basalts of Thirsty Canyon (Miocene)
- Rhyolite of Obsidian Butte (Miocene)
- Thirsty Canyon (Miocene)
- Tuff of Gold Flat (Miocene)
- Andesite of Sarcobatus Flat (Miocene)
- Trachyte lavas of Pillar Spring (Miocene)
- Trail Ridge Tuff (Miocene)
- Pahute Mesa Tuff (Miocene)
- Comendite of Ribbon Cliff (Miocene)
- Rhyolite of Oasis Valley (Miocene)
- Volcanic units between Ammonia Tanks and Pahute Mesa Tuffs (Miocene)
- Upper Lava of Springdale Mtn (Miocene)
- Lower Lava of Springdale Mtn (Miocene)
- Tuffaceous sedimentary breccia (Miocene)
- Trachyte of Donovan Mountain (Miocene)
- Rhyolite of Rainbow Mountain - Lava (Miocene)
- Rhyolite of Rainbow Mountain - Tuff (Miocene)
- Intrusions of Rainbow Mountain rhyolite (Miocene)
- Younger landslide breccias (Miocene)
- Lavas of Dome Mountain (Miocene)
- Beatty Wash Formation (Miocene)
- Basalts of ~11.4 to ~10.5 Ma (Miocene)
- Tuff of Cutoff Road (Miocene)
- Upper tuff of Fleur-de-Lis Ranch (Miocene)
- Lavas of Fleur-de-Lis Ranch and of West Cat Canyon (Miocene)
- Lower tuff of Fleur-de-Lis Ranch (Miocene)
- Lake sediments of Oasis Mountain (Miocene)
- Subcaldera intrusion of Ammonia Tanks caldera (Miocene)
- Rhyolite of Beatty Wash (Miocene)
- Ammonia Tanks Tuff (Miocene)
- Basalts of Timber Mountain age (Miocene)
- Subcaldera Intrusion of Rainier Mesa Caldera (Miocene)
- Rhyolite of Tannenbaum Hill (Miocene)
- Breccias associated with Timber Mountain Tuffs (Miocene)
- Tuffs and lavas of the Twisted Canyon caldera (Miocene)
- Rainier Mesa Tuff (Miocene)
- Rhyolite of Fluorspar Canyon (Miocene)
- Older landslide breccias (Miocene)
- Sedimentary caldera fill (Miocene)
- Rhyolite of Windy Wash (Miocene)
- Intrusion of rhyolite of Windy Wash (Miocene)
- Paintbrush Group (Miocene)
- Breccias associated with Paintbrush Group Tuffs (Miocene)
- Tiva Canyon Tuff (Miocene)
- Tuff of Pinyon Pass (Miocene)
- Yucca Mountain Tuff (Miocene)
- Rhyolite of Echo Peak (Miocene)
- Pah Canyon Tuff (Miocene)
- Topopah Spring Tuff (Miocene)
- Calico Hills Formation (Miocene)
- Crater Flat Group (Miocene)
- Bullfrog Tuff (Miocene)
- Rhyolite of Prospector's Pass (Miocene)
- Tram Tuff (Miocene)
- Grouse Canyon Tuff (Miocene)
- Older basalts (Miocene)
- Lithic Ridge Tuff (Miocene)
- Intrusive facies, Picture Rock (Miocene)
- Rhyolite of Picture Rock (Miocene)
- Late rhyolite of Quartz Mountain (Miocene)
- Tuff of Sleeping Butte (Miocene)
- Middle rhyolite of Quartz Mountain (Miocene)
- Tuff of Tolicha Peak (Miocene)
- Quartz Mountain Tuffs, older tuffs, and sediments (Miocene)
- Rocks of Pavits Spring (Miocene)
- Older Fluvial conglomerates (Miocene and Oligocene)
- Gabbro dikes (Oligocene or late Cretaceous?)
- Granite (Cretaceous)
- Pre-Cenozoic sedimentary rocks, undivided (Paleozoic and late Proterozoic)
- Eleana Formation (Mississippian and late Devonian?)
- Fluorspar Canyon Formation (Devonian)
- Lone Mountain Dolomite (Silurian)
- Roberts Mountains Formation (Silurian)
- Ely Springs Dolomite (Ordovician)
- Eureka Quartzite (Ordovician)
- Antelope Valley Formation (Ordovician)
- Ninemile Formation (Ordovician)
- Goodwin Limestone (Ordovician)
- Nopah Formation, undivided (Cambrian)
- Smoky Member (Cambrian)
- Halfpint Member (Cambrian)
- Dunderberg Shale Member (Cambrian)
- Bonanza King Formation, undivided (Cambrian)
- Banded Mountain Member, Upper part (Cambrian)
- Banded Mountain Member, Lower part (Cambrian)
- Papoose Lake Member (Cambrian)
- Carrara Formation, undivided (Cambrian)
- Carrara Formation, Upper part (Cambrian)
- Carrara Formation, Middle part (Cambrian)
- Carrara Formation, Lower part (Cambrian)
- Zabriskie Quartzite (Cambrian)
- Wood Canyon Formation, undivided (Cambrian and late Proterozoic)
- Wood Canyon Formation, Upper Member (Cambrian)
- Wood Canyon Formation, Lower member (late Proterozoic)
- Unit D of lower member of Wood Canyon Formation (late Proterozoic)
- Unit C of lower member of Wood Canyon Formation (late Proterozoic)
- Unit B of lower member of Wood Canyon Formation (late Proterozoic)
- Unit A of lower member of Wood Canyon Formation (late Proterozoic)
- Stirling Quartzite, E member (late Proterozoic)

④ SECTION A - A' FROM PRELIMINARY GEOLOGIC MAP OF THE GOLDFIELD MINING DISTRICT, NEVADA BY ASHLEY, 1975





PROJECT LOCATION



CALIENTE RAIL CORRIDOR
YUCCA MOUNTAIN PROJECT, NEVADA

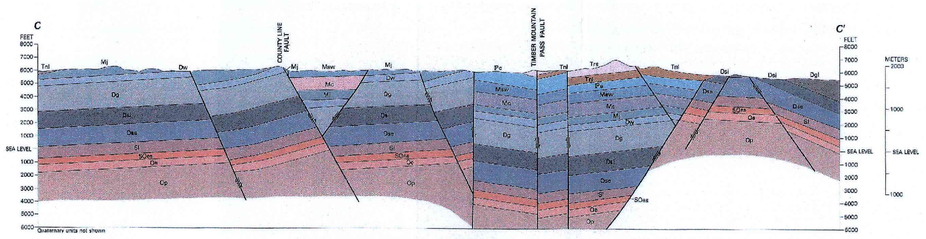
Preliminary Geotechnical Report

GEOLOGIC CROSS-SECTIONS
PLATE 3 (Sheet 1 of 2)

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

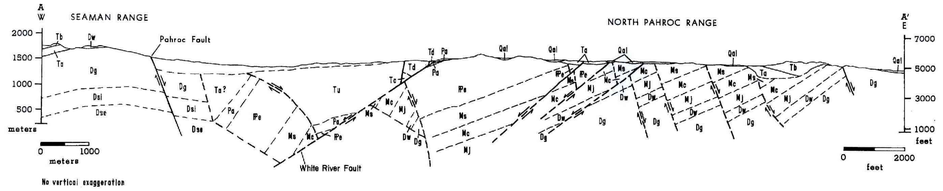
File: E:\21-1-20102\AV_mxd\GEOTECH Report\20102_GEOTECH_Plate-3_Sht-1_Geologic-Cross-Sections.mxd Prepared By: BRL Printing Date: March 14, 2006 Created Using ArcMap 9.1

5 SECTION C - C' FROM GEOLOGIC MAP OF THE SEAMAN RANGE, LINCOLN AND NYE COUNTIES, NEVADA BY DU BRAY AND HURTUBISE, 1994



Tm Rhyolite tuff of the Seaman Range (Oligocene)
Tn Needles Range Group-Lund Formation (Oligocene)
Pe Ely Limestone (Lower Pennsylvanian)
Mscr Scotty Wash Sandstone (Upper Mississippian)
Mc Chainman Shale (Upper Mississippian)
Mj Joana Limestone (Lower Mississippian)
Dw West Range Limestone (Upper Devonian)
Dg Guilmette Limestone (Upper and Middle Devonian)
Dgl Guilmette Limestone-Lower Member (Upper and Middle Devonian)
Ds Simonson Dolomite (Middle Devonian)
Dsy Sevy Dolomite (Lower Devonian)
Sl Laketown Dolomite (Silurian)
SOes Ely Springs Dolomite (Lower Silurian and Upper Ordovician)
Oe Eureka Quartzite (Middle Ordovician)
Op Pogonip Group (Middle and Lower Ordovician)

6 SECTION A - A' FROM SPATIAL AND TEMPORAL RELATIONS OF CENOZOIC VOLCANISM AND EXTENSION IN THE NORTH PAHROC AND SEAMAN RANGES, EASTERN NEVADA, BY TAYLOR, 1990.



EXPLANATION

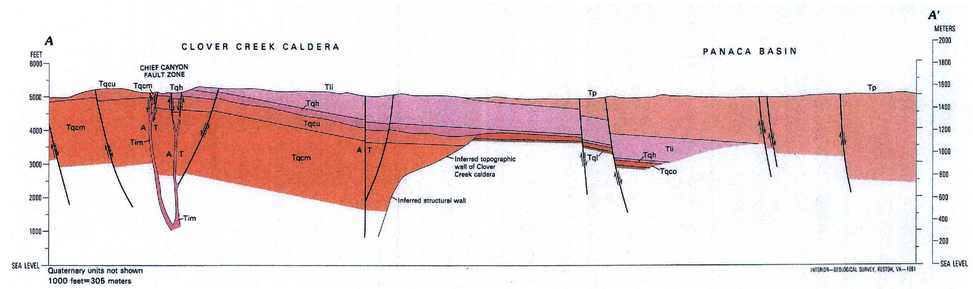
Qal Quaternary
Tu 24 -18 Ma units
Tc 27 - 24 Ma units
Tb 30 - 27 Ma units
Te >30 Ma Tertiary units
Pa Permian Arcturus Fm.
IPe Pennsylvanian Ely Limestone
Ms Mississippian Scotty Wash Quartzite
Mc Mississippian Chainman Shale
Mj Mississippian Joana Limestone
Dw Devonian West Range Limestone
Dg Devonian Guilmette Limestone
Dsl Devonian Simonson Dolomite
Dsm Devonian Sevy Dolomite

by Wanda J. Taylor

7 SECTION F - F' FROM STRUCTURAL GEOLOGY OF THE BLACK CANYON RANGE, THE BLUFFS, AND SOUTHWESTERN HIGHLAND RANGE, LINCOLN COUNTY, NEVADA, BY SLEEPER, 1989

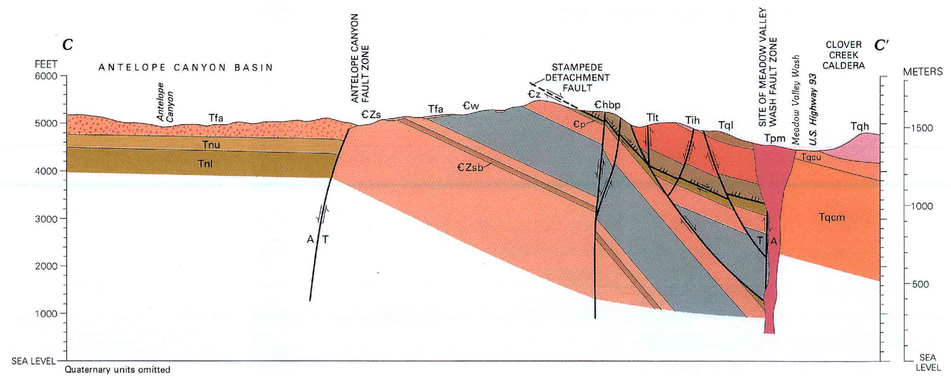
TO VIEW CROSS SECTION SEE: SLEEPER, K.G., 1989, STRUCTURAL GEOLOGY OF THE BLACK CANYON RANGE, THE BLUFFS, AND SOUTHWESTERN HIGHLAND RANGE, LINCOLN COUNTY, NEVADA: FLAGSTAFF, ARIZ., NORTHERN ARIZONA UNIVERSITY, M.S. THESIS, 113 P.

9 SECTION A - A' FROM GEOLOGIC MAP OF THE INDIAN COVE QUADRANGLE, LINCOLN COUNTY, NEVADA, BY ROWLEY AND SCHROBA, 1991



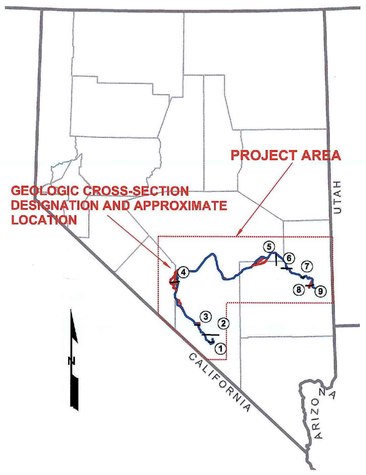
Tp Panaca Formation (Pliocene and upper Miocene)
Tim Porphyry of Meadow Valley Wash (Miocene)
Tli Lava flows of Indian Cove (Miocene)
Tqh Harmony Hills Tuff (Miocene)
Tqcu Upper part of intracaldera facies
Tqcm Main body of intracaldera facies
Tqco Outflow facies
Tol Leach Canyon Formation (Oligocene)

8 SECTION C - C' FROM GEOLOGIC MAP OF THE CHIEF MOUNTAIN QUADRANGLE, LINCOLN COUNTY, NEVADA, BY ROWLEY, ET AL., 1994



Qal Alluvium and colluvium (Holocene and late Pleistocene)
Qamv Main-stream flood-plain alluvium (Holocene and latest Pleistocene?)
Qae Terrace alluvium (middle? and late Pleistocene)
Qt Talus and minor hillslope colluvium (Holocene and late Pleistocene)
Qls Landslide deposits (early Holocene or late Pleistocene)
Qfm Fan alluvium of Meadow Valley (Holocene and latest Pleistocene?)
Qfr Fan alluvium of 11001 Ranch (late Pleistocene)
Qfmv Fan alluvium of Miller Spring Wash (middle Pleistocene)
Qfo Fan alluvium of Osborrow Ranch (middle? and early Pleistocene)
Qfc Fan alluvium of Chief Mountain (early Pleistocene or late Pliocene)
Tfa Fan alluvium of Antelope Canyon (Pliocene)
Tb Basalt (Pliocene)
Tp Panaca Formation (Pliocene and upper Miocene)
Tnu Upper part
Tnl Lower part
Tte Tuff of Etna (Miocene)
Tmh Rhyolite dikes (Miocene or Oligocene)
Tm McCullough Formation (Miocene)
Tvk Volcanic rocks of Klondike Spring (Miocene)
Th Hiko Tuff (Miocene)
Tpm Porphyry of Meadow Valley Wash (Miocene)
Tr Lava flows (Miocene)
Tli Lava flows of Indian Cove (Miocene)
Tqh Harmony Hills Tuff (Miocene)
Tqcu Upper part of intracaldera facies
Tqcm Main body of intracaldera facies
Tqci Intracaldera intrusion
Tqco Outflow facies
Tqss Sweet Tuff Member
Tol Leach Canyon Formation (Oligocene)
Tpa Pahranagat Formation (Miocene)
Tvs Volcanic and sedimentary rocks (Miocene or Oligocene)
Tcc Cobalt Canyon stock (Oligocene)
Tdike Dike
Tlt Lava flow and tuff (Oligocene)
Tth Hole-in-the-Wall Tuff Member
Tsb Saddleback Tuff Member
Tsp Shingle Pass Tuff (Oligocene)
Tmo Monotony Tuff (Oligocene)
Tc Conglomerate (Oligocene, Eocene, or Paleocene)
CHp Highland Peak Formation, undivided (Upper and Middle Cambrian)
Cbe Stop Ridge Member (Middle Cambrian)
Cbw Burnt Canyon Member (Middle Cambrian)
Cbo Barrows Member (Middle Cambrian)
Cw Wood Canyon Formation (Lower Cambrian)
CZs Stirling Quartzite
CZb Basalt lava flow-
CZp Pioche Shale(Middle and Lower Cambrian)
Cz Zabriskie Quartzite (Lower Cambrian)

PROJECT LOCATION



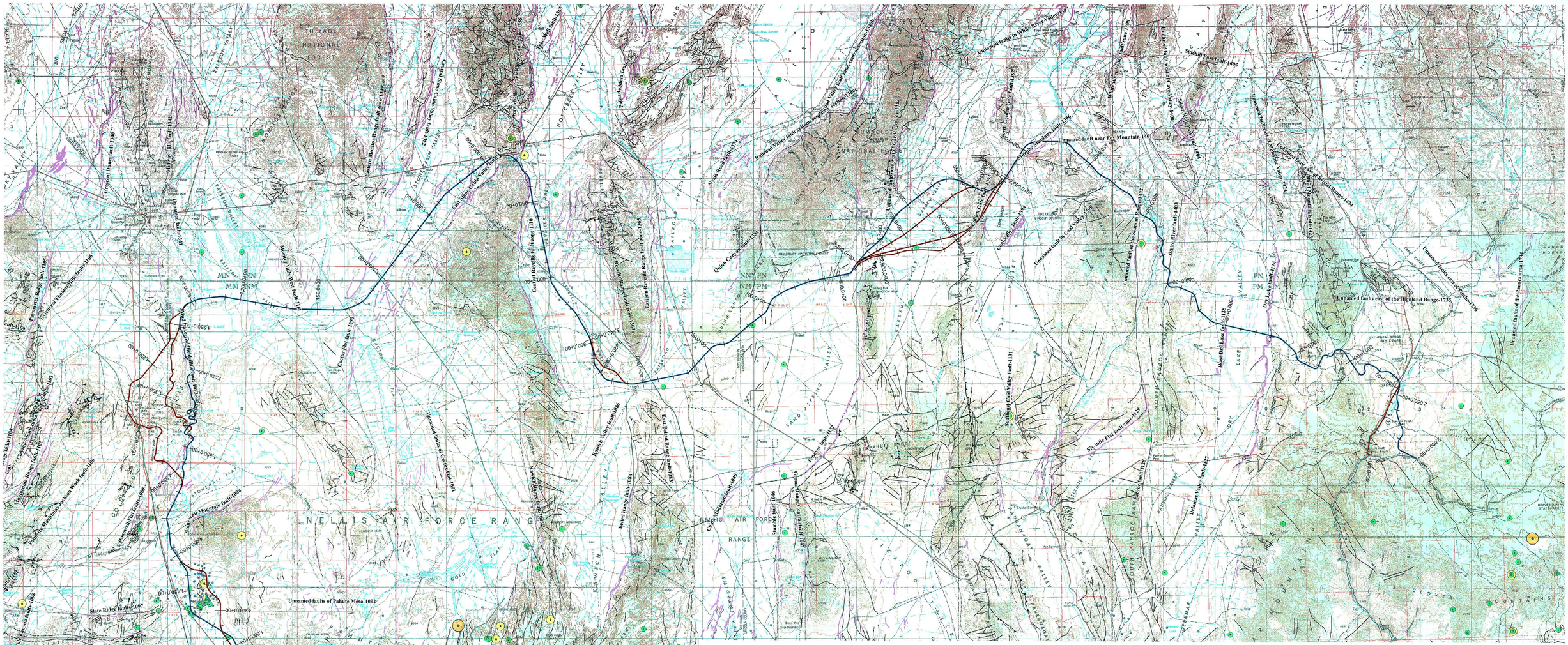
CALIENTE RAIL CORRIDOR
YUCCA MOUNTAIN PROJECT, NEVADA

Preliminary Geotechnical Report

GEOLOGIC CROSS-SECTIONS
PLATE 3 (Sheet 2 of 2)

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

File: E:\21-1-20102\AV_mxd\GEOTECH Report\20102_GEOTECH_Plate-3_Sh-2_Geologic-Cross-Sections.mxd Prepared By: BRL Printing Date: March 14, 2006 Created Using ArcMap 9.1


TOIYABE NATIONAL FOREST
HUMBOLDT NATIONAL FOREST
NELLIS AIR FORCE RANGE
Unnamed faults of Pahute Mesa-1092
Gold Mountain fault-1096
State Ridge fault-1097
Bald Mountain fault-1098
Tolicha Mountain-Tarpey Wash fault-1099
Mudgrass Range fault-1102
Cactus Flat fault-1090
Pinyon Ridge fault-1105
Crescent Dunes fault-1340
Monitor Hills West fault-1111
Coal Valley fault-1121
Sarcobatus Flat fault-zone-1123
Stonewall Mountain fault-1088
Unnamed fault-1341
Unnamed fault-1342
Unnamed fault-1343
Unnamed fault-1344
Unnamed fault-1345
Unnamed fault-1346
Unnamed fault-1347
Unnamed fault-1348
Unnamed fault-1349
Unnamed fault-1350
Unnamed fault-1351
Unnamed fault-1352
Unnamed fault-1353
Unnamed fault-1354
Unnamed fault-1355
Unnamed fault-1356
Unnamed fault-1357
Unnamed fault-1358
Unnamed fault-1359
Unnamed fault-1360
Unnamed

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
SPECIAL INSTRUCTION SHEET

1. QA: N/A
Page 1 of 1

This is a placeholder page for records that cannot be scanned.

2. Record Date	3. Accession Number
07/16/2007	ATTN to: ENG.20070905.0016
4. Author Name(s)	**5. Authorization Organization**
N/A	Shannon & Wilson

6. Title/Description
Geotechnical Report Volume 1 Caliente Rail Corridor, APPENDIX H: Photographs

7. Document Number(s)	8. Version Designator
V0-CY05-NHC4-00197-00009-001	004

9. Document Type	10. Medium
Media	2 ~~CD's~~ DVD's 9/18/07

11. Access Control Code
N/A

12. Traceability Designator
V0-CY05-NHC4-00197-00009-001-004

13. Comments
CD's: 1 Original & 1 copy

Validation of complete file transferred. All files copied. Software used: Corel Photo-Paint 8.0

THIS IS AN ELECTRONIC
ATTACHMENT

14. RPC Electronic Media Verification

XREF: MOL.20070912.0043

SEP 17 2007 TChurch /BSC-SS

MD5 Validation

```
08/13/2007  06:13p       <DIR>          S46
08/13/2007  06:13p       <DIR>          S47
08/13/2007  06:13p       <DIR>          S48
08/13/2007  06:13p       <DIR>          S49
08/13/2007  06:13p       <DIR>          S50
08/13/2007  06:13p       <DIR>          S51
08/13/2007  06:13p       <DIR>          S52
08/13/2007  06:13p       <DIR>          S53
08/13/2007  06:13p       <DIR>          S54
08/13/2007  06:13p       <DIR>          S55
08/13/2007  06:13p       <DIR>          S56
08/13/2007  06:13p       <DIR>          S57
08/13/2007  06:13p       <DIR>          S58
08/13/2007  06:13p       <DIR>          S59
08/13/2007  06:13p       <DIR>          S60
08/13/2007  06:13p       <DIR>          S61
08/13/2007  06:13p       <DIR>          S62
               0 File(s)              0 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S01

10/31/2006  08:08p       <DIR>          .
08/13/2007  06:13p       <DIR>          ..
10/05/2004  11:06a               540,280 2277_SM208_View to N of old UP bridge.JPG
11/05/2004  01:58p               236,102 2278-2279_SM208_View to SE.jpg
11/10/2004  02:43p               253,444 2280_SM208_Timber piles under old UP
bridge.JPG
11/10/2004  02:47p               284,024 2281_SM208_S pier of Hwy 93 bridge.JPG
11/05/2004  02:02p               263,652 2282-2283_SM209_Hwy 93 bridge.jpg
11/05/2004  02:03p               263,008 2284-2285_SM210_View to SSE toward old UP
bridge.jpg
11/05/2004  02:04p               229,746 2286_SM210_View to SE at old UP
bridge.JPG
10/05/2004  11:46a               438,209 2287_SM210_Hwy 93 bridge.JPG
10/05/2004  11:49a               525,854 2288_SM210_Distant shot of Qc in Meadow
Valley Wash.JPG
11/05/2004  02:09p               278,059 2289-2290_SM210_Old UP bridge on timber
piles.jpg
11/05/2004  02:11p               457,151 2291-2293_SM211_pan SE to S at through
cut on old UP.jpg
10/05/2004  12:11p               479,367 2294_SM211_Hwy 93 bridge just N of
SM211.JPG
11/05/2004  02:13p               240,312 2295-2296_SM211_View to N.jpg
10/05/2004  12:18p               529,026 2297_SM211_Lapilli tuff outcrop.JPG
10/05/2004  12:18p               596,667 2298_SM211_Closeup of Lapilli tuff.JPG
              15 File(s)      5,614,901 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S02

10/31/2006  08:08p       <DIR>          .
08/13/2007  06:13p       <DIR>          ..
10/04/2004  11:23a               503,964 2204_SM195_Qal exposed in wash.JPG
10/04/2004  11:24a               452,084 2205_SM195_Closeup of Qal.JPG
11/05/2004  12:36p               198,142 2206_SM195_15 ft high bank in wash.JPG
10/04/2004  11:47a               451,620 2207_SM196_View to N along old UP
grade.JPG
```

```
11/05/2004  12:38p               168,886 2208_SM196_View to S down old UP
grade.JPG
10/04/2004  11:48a               534,038 2209_SM196.JPG
10/05/2004  12:41p               428,717 2218_SM199_View to S down old UP
grade.JPG
10/05/2004  12:42p               458,141 2219_SM199_View to N up old UP grade.JPG
10/05/2004  12:48p               409,709 2220_SM199_Borrow pit in Qao just SW of
SM199.JPG
11/05/2004  01:11p               266,881 2221-2223_SM199_Cut slopes in Qao over
Tl.jpg
10/05/2004  01:13p               440,286 2224_SM199_Cut slope to S.JPG
11/05/2004  02:11p               457,151 2291-2293_SM211_pan SE to S at through
cut on old UP.jpg
10/05/2004  12:11p               479,367 2294_SM211_Hwy 93 bridge just N of
SM211.JPG
11/05/2004  02:13p               240,312 2295-2296_SM211_View to N.jpg
10/05/2004  12:18p               529,026 2297_SM211_Lapilli tuff outcrop.JPG
10/05/2004  12:18p               596,667 2298_SM211_Closeup of Lapilli tuff.JPG
11/05/2004  02:18p               254,978 2299-2300_SM212_pan E to SE with old UP
grade in center.jpg
              17 File(s)      6,869,969 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S03

10/31/2006  08:08p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
11/08/2004  12:56p               183,538 2235-2236_SM202_View to S down wash at UP
train.jpg
11/10/2004  02:39p               264,655 2237-2238_SM202_View to WSW.jpg
11/10/2004  02:39p               280,551 2239-2240_SM202_View to ESE across
wash.jpg
10/05/2004  03:03p               714,014 2241_SM202_SP and GP soil in wash.JPG
11/05/2004  01:27p               377,653 2242-2244_SM203_View to E across Dutch
Flat.jpg
11/10/2004  02:41p               281,276 2252-2253_SM205_View to SE near bridge
location.jpg
11/10/2004  02:40p               202,070 2254_SM205_View to W down Clover
Creek.JPG
10/05/2004  04:55p               531,396 2255_SM205_Riprap up to 4 ft.JPG
10/05/2004  04:58p               595,478 2256_SM205_Interbedded sands, gravels in
N bank of Clover Creek.JPG
10/05/2004  05:02p               519,538 2257_SM205_Clover Creek bed with cobbles,
boulders up to 3 ft.JPG
10/05/2004  05:09p               470,568 2258_SM205_Signal bungalow at E end
Eccles siding.JPG
10/05/2004  05:10p               462,590 2259_SM205_View to NW.JPG
11/10/2004  02:41p               227,784 2260_SM205_View to SE.JPG
11/10/2004  02:42p               290,553 2261-2262_SM205_Cemented Qay gravels to
NNW.jpg
11/05/2004  01:48p               382,291 2263-2265_SM205_pan from N to NE with Qay
at right, Tt3 at left.jpg
11/10/2004  02:43p               283,447 2266-2268_SM206_View to W-NW.jpg
11/05/2004  01:52p               410,535 2269-2271_SM207_View to N.jpg
10/05/2004  11:01a               728,691 2272_SM207_Angular rock frags in
colluvium.JPG
10/05/2004  11:06a               499,387 2273_SM207_View to SE across Dutch
Flat.JPG
```

```
10/05/2004  11:13a               543,258 2274_SM207_View to E from midslope.JPG
11/10/2004  02:43p               205,066 2275_SM207_View upslope.JPG
11/10/2004  02:42p               157,372 2276_SM207-208_UP tunnel.JPG
              22 File(s)      8,611,711 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S04

10/31/2006  08:08p      <DIR>            .
08/13/2007  06:13p      <DIR>            ..
11/10/2004  02:37p               241,798 2210-2212_SM197_pan from NE to SE.jpg
11/05/2004  12:41p               171,335 2213_SM197_View to N at Tl butte.JPG
11/05/2004  12:44p               154,449 2214-2215_SM198_View to SE.jpg
11/05/2004  12:47p               218,577 2216-2217_SM198_View to SE.jpg
10/05/2004  01:38p               582,730 2225_SM198.JPG
10/05/2004  01:38p               531,750 2226_SM198_Closeup of Tl.JPG
11/05/2004  01:14p               371,863 2227-2230_SM200_pan from WSW to NNW
toward alignment.jpg
11/05/2004  01:16p               386,867 2231-2234_SM201_pan from WSW to NW.jpg
11/05/2004  01:27p               377,653 2242-2244_SM203_View N to NE of S slope
of Miller Bench.jpg
11/10/2004  02:41p               502,642 2245-2249_SM204_pan from NNE to SE at E
slope of wash.jpg
10/05/2004  04:03p               612,920 2250_SM204_Dense SP exposed in wash.JPG
10/05/2004  04:07p               745,739 2251_SM204_Closeup of GP-SP in wash.JPG
              12 File(s)      4,898,323 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S05

10/31/2006  08:08p      <DIR>            .
08/13/2007  06:13p      <DIR>            ..
11/05/2004  12:27p               138,837 2193-2195_SM192_View to NW at Tl
bluff.jpg
11/05/2004  12:29p               204,508 2196-2198_SM193_View to WNW of Smileys
Point.jpg
11/05/2004  12:29p               204,432 2199_SM193_View to N from partway up
slope.JPG
11/05/2004  12:30p               201,651 2200_SM191_View to E of cut.JPG
11/05/2004  12:31p               159,437 2201_SM191_View to N from bottom of
slope.JPG
11/05/2004  12:33p               135,626 2202_SM194_Cut slope along unmapped
private road.JPG
11/05/2004  12:34p               179,964 2203_SM194_Closer view of cut slope.JPG
10/04/2004  11:23a               503,964 2204_SM195_Qal exposed in wash.JPG
10/04/2004  11:24a               452,084 2205_SM195_Closeup of Qal.JPG
11/05/2004  12:36p               198,142 2206_SM195_15 ft high bank in wash.JPG
11/10/2004  02:37p               241,798 2210-2212_SM197_pan from NE to SE.jpg
11/05/2004  12:41p               171,335 2213_SM197_View to N at Tl butte.JPG
11/05/2004  12:44p               154,449 2214-2215_SM198_View to SE.jpg
11/05/2004  12:47p               218,577 2216-2217_SM198_View to SE.jpg
10/05/2004  12:48p               409,709 2220_SM199_Borrow pit in Qao just SW of
SM199.JPG
11/05/2004  01:11p               266,881 2221-2223_SM199_Cut slopes in Qao over
Tl.jpg
10/05/2004  01:38p               582,730 2225_SM198.JPG
10/05/2004  01:38p               531,750 2226_SM198_Closeup of Tl.JPG
              18 File(s)      4,955,874 bytes
```

```
 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S06

10/31/2006  08:08p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
10/04/2004  03:00p               858,467 0195_near SM189_Lakebeds on SW side of
Bennett Springs Wash.JPG
10/04/2004  03:32p               902,430 0196_near SM191_View to N of Tl lakebed
deposits.JPG
11/10/2004  02:33p               164,568 2139-2141_SM182_pan from SE to S toward
alignment.jpg
11/10/2004  02:15p               253,445 2142-2145_SM183_pan SSE to SW.jpg
11/10/2004  02:32p               105,532 2146-2147_SM184_View to NW along
alignment.jpg
11/10/2004  02:19p               148,461 2148-2149_SM184_View to SE.jpg
11/10/2004  02:20p               265,129 2150_SM184_Closeup of cemented gravel.JPG
11/10/2004  02:23p               237,465 2151-2153_SM185_View NE.jpg
11/10/2004  02:27p               127,044 2154-2155_SM186_View SE.jpg
11/10/2004  02:27p               128,236 2156-2157_SM186_View NW.jpg
11/05/2004  11:50a               284,013 2158-2160_SM187_View to W at lakebeds,
Bennett Pass to right.jpg
11/10/2004  02:35p               206,658 2161-2162_SM187A_View to W of Tl lakebeds
with Bennet Pas at rt.jpg
11/05/2004  11:57a               210,529 2163-2164_SM187B_View to SW of Tertiary
lakebeds.jpg
11/10/2004  02:35p               347,186 2165-2169_SM188_pan around curve from N
to E.jpg
11/10/2004  02:35p               360,442 2170-2174_SM188_pan around curve from E
to S.jpg
10/04/2004  01:31p               560,702 2175_SM188_Hard Silt below 8 inches.JPG
11/05/2004  12:07p               160,821 2176_SM188_View to WNW of Tl.JPG
10/04/2004  01:45p               398,313 2177_SM188_Fine-grained soil in roadbed
with surficial gravel.JPG
10/04/2004  02:05p               530,720 2178_SM189_Interbedded hard silt and
sandstone.JPG
10/04/2004  02:18p               488,299 2179_SM189_White silt.JPG
10/04/2004  02:19p               522,990 2180_SM189_Brown silt.JPG
11/05/2004  12:16p               327,386 2181-2184_SM190_Tl deposits.jpg
11/05/2004  12:20p               298,388 2185-2190_SM191_pan from S to W.jpg
11/05/2004  12:21p               120,182 2191_SM191_Bluff below SM191 location,
note sandstone layers.JPG
11/05/2004  12:22p               180,436 2192_SM191_Tl bluff below SM191, note
pediment gravel cover.JPG
11/05/2004  12:27p               138,837 2193-2195_SM192_View to NW at Tl
bluff.jpg
11/05/2004  12:30p               201,651 2200_SM191_View to E of cut.JPG
11/05/2004  12:31p               159,437 2201_SM191_View to N from bottom of
slope.JPG
              28 File(s)      8,687,767 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S07

10/31/2006  08:08p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
11/10/2004  02:05p               463,461 2131-2132_SM181_Horses going up the
pass.jpg
11/10/2004  02:08p               208,243 2133-2134_SM181_View E.jpg
11/10/2004  02:07p               312,213 2135-2136_SM181_View W.jpg
```

```
10/03/2004  11:55a               682,646 2137_SM181_Chp outcrop.JPG
10/03/2004  11:02a               565,675 2138_SM181_Closeup of Chp outcrop.JPG
11/10/2004  02:33p               164,568 2139-2141_SM182_pan from SE to S toward
alignment.jpg
11/10/2004  02:15p               253,445 2142-2145_SM183_pan SSE to SW.jpg
01/07/2006  04:53p             1,870,795 MG100-MG105_AG34_Pan ESE to W from ridge
south of Bennett Pass.jpg
12/03/2005  01:25p             1,096,394 MG107_AG34_View E along alignment.JPG
12/03/2005  01:25p             1,314,573 MG108_AG34_View W along alignment.JPG
12/03/2005  02:00p             1,180,813 MG109_East of AG34_Chp outcrop view N.JPG
12/03/2005  02:21p               878,906 MG110_SM181_View ENE along alignment.JPG
12/03/2005  02:22p               986,322 MG111_SM181_View WSW along alignment.JPG
12/04/2005  10:19a             1,465,222 MG99_AG34_Chp at Bennett Pass.JPG
              14 File(s)     11,443,276 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S08

10/31/2006  08:08p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
11/10/2004  01:44p                89,986 2108-2109_SM178_View to NE.jpg
11/10/2004  01:51p               301,507 2110-2112_SM179_pan from NW to NNW.jpg
11/10/2004  01:50p               577,327 2110-2116_SM179_pan from NW to N.jpg
11/10/2004  01:50p               416,067 2113-2116_SM179_pan from NNW to N.jpg
11/10/2004  01:52p               159,836 2117-2119_SM179_Bennett Pass, Chief Range
at rt, Highland at lt.jpg
10/03/2004  05:34p               678,776 2120_SM180_Existing test pit.JPG
10/03/2004  05:41p               589,330 2121_SM180_Existing test pit.JPG
10/03/2004  05:42p               523,872 2122_SM180_Closeup of Chp breccia.JPG
10/03/2004  05:43p               520,093 2123_SM180_Chp dolomite outcrop.JPG
11/10/2004  01:58p               110,842 2124_SM180_View to E.JPG
11/10/2004  02:31p                92,092 2125-2126_SM180_View to WSW with
powerline and road at right.jpg
10/03/2004  05:57p               597,469 2127_SM180_Limestone outcrop (not
brecciated here) .JPG
11/10/2004  02:03p               302,726 2128-2130_SM180_pan from NE toE from
bennett Pass.jpg
11/10/2004  02:05p               463,461 2131-2132_SM181_Horses going up the
pass.jpg
11/10/2004  02:08p               208,243 2133-2134_SM181_View E.jpg
11/10/2004  02:07p               312,213 2135-2136_SM181_View W.jpg
10/03/2004  11:55a               682,646 2137_SM181_Chp outcrop.JPG
10/03/2004  11:02a               565,675 2138_SM181_Closeup of Chp outcrop.JPG
12/03/2005  02:21p               878,906 MG110_SM181_View ENE along alignment.JPG
12/03/2005  02:22p               986,322 MG111_SM181_View WSW along alignment.JPG
              20 File(s)      9,057,389 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S09

10/31/2006  08:08p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
10/03/2004  03:02p               965,370 0190_SM177_Rhyolitic ash flow tuff
Tvu.JPG
11/10/2004  01:32p               303,503 2095-2096_SM176_N slope of wash just N of
alignment.jpg
10/03/2004  02:35p               612,044 2097_SM176_Closeup of cemented gravel and
cobbles in wash.JPG
11/10/2004  01:35p               343,168 2098-2100_SM177_View ENE.jpg
```

```
10/03/2004  03:18p               542,685 2101_SM177A_View to SW.JPG
10/03/2004  03:21p               438,933 2102_SM177A_View to NE of upper part of
bluff.JPG
10/03/2004  03:25p               714,630 2103_SM177A_Closeup of tuff.JPG
11/10/2004  01:41p               273,980 2104-2106_SM177A_pan to WSW.jpg
10/03/2004  03:34p               566,758 2107_SM177A_Tuff outcrop.JPG
11/10/2004  01:44p                89,986 2108-2109_SM178_View to NE.jpg
11/10/2004  01:51p               301,507 2110-2112_SM179_pan from NW to NNW.jpg
11/10/2004  01:50p               577,327 2110-2116_SM179_pan from NW to N.jpg
11/10/2004  01:50p               416,067 2113-2116_SM179_pan from NNW to N.jpg
11/10/2004  01:52p               159,836 2117-2119_SM179_Bennett Pass, Chief Range
at rt, Highland at lt.jpg
              14 File(s)      6,305,794 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S10

10/31/2006  08:08p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
10/02/2004  02:04p             1,483,404 0173_SM165_Tsm outcrop.JPG
10/02/2004  02:04p             1,483,404 0173_SM165_Tvy outcrop.JPG
10/02/2004  03:02p             1,769,085 0174_SM166_Qao alluvium.JPG
10/02/2004  03:52p             1,049,103 0175_SM167_View to NW of apparent
synclinal fold.JPG
03/25/2005  11:22a             1,729,525 0176-0179_SM167_Pan of folded volcanic
rocks.jpg
10/02/2004  05:13p             1,172,497 0180_SM170_View to NW up wash draining
into stockpond.JPG
10/02/2004  05:18p             1,339,754 0181SM170_View to NW of Qayf in Dry Lake
Valley.JPG
03/25/2005  11:35a               841,541 0182-0183_SM173_View Se up wash.jpg
10/02/2004  11:48a               931,816 0184_SM173_View to NE up wash.JPG
10/03/2004  12:59p             1,169,105 0185_SM174_View to W down wash.JPG
10/03/2004  01:04p             1,705,760 0186_SM174_Closeup of Qao alluvium.JPG
10/03/2004  01:37p             1,210,723 0187_SM175_The Bluffs.JPG
10/03/2004  01:41p             1,726,693 0188_SM175_Closeup of alluvium.JPG
10/03/2004  02:38p               898,265 0189_SM176_N slope of wash.JPG
11/10/2004  12:30p               242,454 2027-2028_SM165_View to NW.jpg
11/10/2004  01:02p               197,888 2029-2030_SM165_View to SE.jpg
10/02/2004  02:11p               695,396 2031_SM165_Weathered tuff outcrop.JPG
10/02/2004  02:12p               636,198 2032_SM165_Boulders on weathered
outcrop.JPG
10/02/2004  02:16p               483,715 2033_SM165_View to W.JPG
11/10/2004  12:39p               238,118 2034-2035_SM166_View to NW.jpg
11/10/2004  12:40p               234,715 2036-2037_SM166_View to SE.jpg
10/02/2004  03:33p               613,682 2038_SM167_Quartzite of Guillmette Fm.JPG
10/02/2004  03:49p               596,696 2039_SM167_Upper limestone beds.JPG
10/02/2004  03:50p               706,670 2040_SM167_Closeup of limestone.JPG
10/02/2004  03:52p               439,414 2041_SM167_AG at upper limestone, lower
quartzite trans.JPG
10/02/2004  04:24p               712,001 2042_SM168_Closeup of SP,GP soil.JPG
11/10/2004  12:46p               210,434 2043-2044_SM169_View to ESE.jpg
11/10/2004  12:47p               236,709 2045-2046_SM169_View to WSW.jpg
10/02/2004  05:09p               574,820 2047_SM170_View to E of channel into
stock pond.JPG
11/10/2004  12:49p               378,885 2048-2050_SM170_pan to S across stock
pond.jpg
10/02/2004  05:09p               700,635 2051_SM170_Closeup of soil.JPG
```

```
10/02/2004  05:14p               494,132 2052_SM170_View to N up channel.JPG
11/10/2004  12:52p               308,811 2053-2054_SM170_Existing test pit along
road near pond.jpg
10/02/2004  11:47a               669,248 2055_SM171_Soil excavated from old test
pit.JPG
10/02/2004  11:47a               600,710 2056_SM171_Hard silt in trench
sidewall.JPG
11/10/2004  12:55p               361,293 2057-2058_SM171_pan to E.jpg
11/10/2004  01:03p               145,143 2059-2060_SM172_View to ESE in Qayf.jpg
11/10/2004  01:03p               161,971 2061-2062_SM172_View to WNW.jpg
11/10/2004  01:00p               170,089 2063-2064_SM173_View to ESE into Dog
Hollow.jpg
11/10/2004  01:04p               139,340 2065-2066_SM173_View to WNW across Dry
Lake Valley.jpg
11/10/2004  01:15p               194,697 2073-2074_SM174_View to NW along
alignment.jpg
11/10/2004  02:28p               179,560 2075-2076_SM174_View to SE.jpg
11/10/2004  01:18p               212,162 2077-2078_SM175_View to ESE from road.jpg
11/10/2004  01:21p               525,198 2079-2083_SM175_pan to NW through Dog
Hollow.jpg
11/10/2004  01:23p               263,661 2084-2086_SM175_View to NNE at The
Bluffs.jpg
11/10/2004  01:28p               231,890 2087-2088_SM176_View to NNW.jpg
10/03/2004  02:20p               476,679 2091_SM176_N slope of wash N of SM176,
note boulders.JPG
11/10/2004  02:29p               200,691 2092-2093_SM176_View to ESE.jpg
10/03/2004  02:29p               676,965 2094_SM176_Calcrete exposed in road.JPG
11/10/2004  01:32p               303,503 2095-2096_SM176_N slope of wash just N of
alignment.jpg
10/03/2004  02:35p               612,044 2097_SM176_Closeup of cemented gravel and
cobbles in wash.JPG
06/09/2005  02:42p               242,597 3271-3272_SM171A_View to W from E end of
fissure known as T.jpg
05/03/2005  04:42p               466,088 3273_SM171A_View to W down Crack.JPG
06/09/2005  02:43p               245,930 3274-3275_SM171A_View to E along
Crack.jpg
06/09/2005  02:44p               336,441 3276-3277_SM171A_View to E from inside
Crack.jpg
06/09/2005  02:45p               261,567 3278-3279_SM171A_View to W from E side
Coyote Wash.jpg
05/03/2005  05:10p               421,732 3280_SM171A_View to E from E side Coyote
Wash.JPG
              57 File(s)     35,311,247 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S11

10/31/2006  08:07p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
03/25/2005  11:56a               725,709 0163-0164_SM159_View to SW of N Pahroc
volcanic peaks.jpg
10/01/2004  11:11a             1,717,516 0165_SM159_Outcrop of Tt2 Harmony Hills
tuff.JPG
10/01/2004  11:00a             1,499,176 0167_SM162_Tt2-Lapilli tuff at Black Rock
Spring.JPG
10/01/2004  11:00a             1,499,176 0167_SM162_Tvt Lapilli tuff at Black Rock
Spring.JPG
10/01/2004  11:01a             1,292,913 0168_SM162_Lapilli tuff.JPG
```

```
10/01/2004  11:06a           1,230,687 0169_SM162_Water tank at Black Rock
Spring.JPG
10/01/2004  11:07a             963,047 0170_SM162_View to SW up wash of bedded
lapilli tuff.JPG
10/01/2004  12:31p           1,211,316 0172_SM164_Tsm outcrop.JPG
10/01/2004  12:31p           1,211,316 0172_SM164_Tvy outcrop.JPG
10/02/2004  03:02p           1,769,085 0174_SM166_Qao alluvium.JPG
11/10/2004  11:57a             136,400 1995-1996_SM159_View back to W at
limestone bedding.jpg
11/10/2004  12:00p             224,039 1997-1998_SM160_View to ESE along
alignment.jpg
11/10/2004  12:02p             211,572 1999-2001_SM160_View to WNW.jpg
11/10/2004  12:03p             204,901 2002_SM160_Calcrete layer.JPG
10/01/2004  05:46p             585,155 2003_SM161_Spring flowing out of fracture
in tuff.JPG
10/01/2004  05:47p             613,691 2004_SM161_Unnamed spring.JPG
10/01/2004  05:47p             547,374 2005_SM161_Unnamed spring.JPG
11/10/2004  12:06p             275,678 2006-2007_SM161_Stock pond N of
spring.jpg
10/01/2004  11:08a             559,202 2008_SM162_Tank at Black Rock Spring.JPG
10/01/2004  11:10a             579,277 2009_SM162_Water discharging from tap.JPG
10/01/2004  11:12a             503,186 2010_SM162_Lapilli tuff adjacent to
spring.JPG
10/01/2004  11:13a             684,612 2011_SM162_Closeup of tuff.JPG
10/01/2004  11:18a             560,505 2012_SM162_Perched boulder in tuff.JPG
10/01/2004  11:19a             565,086 2013_SM162_Water tank.JPG
10/01/2004  11:19a             411,161 2014_SM162_View up wash to SW with
lapilli tuff exposed at right.JPG
11/10/2004  12:12p             152,545 2015-2016_SM163_View to WNW.jpg
11/10/2004  12:14p             180,962 2017-2018_SM163_View to ESE.jpg
10/01/2004  11:04a             609,176 2019_SM163_Closeup of colluvium.JPG
11/10/2004  12:17p             153,197 2020-2021_SM164_View to NW.jpg
11/10/2004  12:17p             208,842 2022-2023_SM164_View to SE.jpg
11/10/2004  12:24p              96,208 2024_SM164_View to N15E.JPG
11/10/2004  12:30p             242,454 2027-2028_SM165_View to NW.jpg
10/02/2004  02:11p             695,396 2031_SM165_Weathered tuff outcrop.JPG
10/02/2004  02:12p             636,198 2032_SM165_Boulders on weathered
outcrop.JPG
              34 File(s)     22,756,758 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S12

10/31/2006  08:07p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
10/01/2004  01:07p           1,203,448 0151_SM152_View W down wash, across White
River Valley.JPG
10/01/2004  01:07p           1,290,941 0152_SM152_View to NW of Qao exposed in N
bank of wash.JPG
10/01/2004  01:13p           1,720,004 0154_SM152_Closeup of Qao.JPG
10/01/2004  02:05p           1,416,017 0155_SM154_View to NW along fault trace,
Ppe at lt, Tt3 at rt.JPG
10/01/2004  02:47p           1,247,178 0157_SM154_View N along fault trace.JPG
10/01/2004  02:47p           1,483,033 0158_SM154_View to NE of limestone in
North Pahroc Range.JPG
10/01/2004  05:11p             877,101 0159_SM158_Ledges of Ely Limestone , Ppe,
looking NW.JPG
```

```
10/01/2004  05:15p               649,101 0160_SM158_View to S of volcanic peaks in
N Pahroc Range.JPG
10/01/2004  05:15p               702,897 0162_SM158_View E into Dry Lake
Valley.JPG
03/25/2005  11:56a               725,709 0163-0164_SM159_View to SW of N Pahroc
volcanic peaks.jpg
10/01/2004  11:56a               459,591 1962_SM151_Old gravel pit in Qao.JPG
10/01/2004  12:21p               511,181 1963_SM152_Qao exposed in N side of
wash.JPG
10/01/2004  12:28p               588,805 1964_SM152_Mixed sed and volc cobbles and
boulders.JPG
10/01/2004  12:33p               696,681 1965_SM152_Closeup of cobbles,
boulders.JPG
11/10/2004  11:16a               298,588 1966-1967_SM153_View to NE, QTg at left,
Tvy at rt.jpg
11/10/2004  11:20a               329,588 1968-1970_SM154_pan to NNE of fault
zone.jpg
10/01/2004  01:41p               727,203 1971_SM154_Closeup of limestone.JPG
10/01/2004  01:41p               644,702 1972_SM154_Closeup of limestone.JPG
11/10/2004  11:25a               158,473 1973_SM154_Bedding in outcrop across
wash.JPG
11/10/2004  11:38a               418,042 1974-1976_SM155_pan to NE.jpg
10/01/2004  02:15p               621,426 1977_SM155_Andesitic boulders.JPG
10/01/2004  02:15p               711,524 1978_SM155_Black andesite and pink
tuff.JPG
10/01/2004  02:21p               665,215 1979_SM155_Fresh surface on pink tuff.JPG
11/10/2004  11:44a               135,580 1980_SM156_View to E at limestone bed.JPG
11/10/2004  11:47a               201,090 1981-1982_SM156_View to N along
alignment.jpg
11/10/2004  11:47a               142,451 1983-1984_SM156_View to S along
alignment.jpg
10/01/2004  03:09p               535,010 1985_SM156_Outcrop E of alignment.JPG
10/01/2004  03:21p               652,798 1986_SM156_Platy limestone colluvium.JPG
10/01/2004  03:47p               541,793 1987_SM157_Limestone outcrop on N side of
road.JPG
11/10/2004  11:54a               202,326 1988-1990_SM158_View to ESE into Dry Lake
Valley.jpg
11/10/2004  11:54a               191,419 1991-1993_SM158_View to WNW toward White
River Valley.jpg
11/10/2004  11:55a               159,515 1994_SM158_View to S in North Pahrocs.JPG
              32 File(s)     20,908,430 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S13

10/31/2006  08:07p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
10/01/2004  01:07p           1,203,448 0151_SM152_View W down wash, across White
River Valley.JPG
10/01/2004  11:56a               459,591 1962_SM151_Old gravel pit in Qao.JPG
10/01/2004  12:21p               511,181 1963_SM152_Qao exposed in N side of
wash.JPG
10/01/2004  12:28p               588,805 1964_SM152_Mixed sed and volc cobbles and
boulders.JPG
10/01/2004  12:33p               696,681 1965_SM152_Closeup of cobbles,
boulders.JPG
11/10/2004  11:16a               298,588 1966-1967_SM153_View to NE, QTg at left,
Tvy at rt.jpg
```

```
               6 File(s)      3,758,294 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S14

10/31/2006  08:07p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
11/10/2004  10:46a               175,205 1951_SM148_View to W toward Hwy 318.JPG
11/10/2004  10:43a               206,397 1952-1953_SM149_View to NW.jpg
11/10/2004  10:44a               174,952 1954-1955_SM149_View to SE.jpg
11/10/2004  10:44a               152,276 1956_SM149_View to W at Hwy 318 cuts.JPG
11/10/2004  10:44a               112,407 1957_SM150_View to S of Hwy 318 cut in Tl
over QTg.JPG
11/10/2004  10:44a               140,107 1958_SM150_View to SE of Hwy 318 cut.JPG
11/10/2004  10:43a               175,407 1959_SM150_View to W of cut slope.JPG
11/10/2004  10:43a               195,684 1960_SM150_Embankment S of cut slope.JPG
11/10/2004  10:44a               176,157 1961_SM150 2 ft flared end CMP S of
cut.JPG
06/08/2005  05:48p               247,008 2882-2884_SM253_Pan to SE.jpg
06/08/2005  05:50p               239,777 2885-2887_SM253_Pan to NW.jpg
04/09/2005  11:50a               738,554 2888_SM253_Silty Sand near Qao.JPG
06/08/2005  05:56p               191,359 2889-2890_SM253_Rye Patch Reservoir, Hwy
318 in bkgrnd.jpg
04/09/2005  12:02p               692,756 2891_SM253_Hard clay - Qc at Rye Patch
Reservoir.JPG
04/09/2005  12:28p               371,471 2892_SM150_Hwy 318 cut slope - Tsy gravel
and Tl interbeds.JPG
04/09/2005  12:29p               402,700 2893_SM150_Cut slope in Tsy and Tl.JPG
06/09/2005  01:04a               165,794 2894-2895_SM254_View to SE.jpg
06/09/2005  01:05a               169,156 2896-2897_SM254_View to NW.jpg
06/09/2005  01:08a               181,504 2899-2900_SM255_View to NW along
alignment.jpg
04/09/2005  01:36p               561,933 2903_SM255_S bank of wash NE of SM255.JPG
04/09/2005  01:37p               717,989 2904_SM255_ Sandy Gravel in S bank of
wash.JPG
04/09/2005  01:41p               607,940 2905_SM255_Cemented Gravel in S bank of
wash.JPG
04/09/2005  01:43p               706,988 2906_SM255_Very stiff sandy Silt in S
bank of wash.JPG
08/30/2004  12:18p               952,406 Coyote in WRV 1.JPG
08/30/2004  12:19p             1,438,621 Coyote in WRV 2.JPG
08/30/2004  12:19p             1,251,994 Coyote in WRV 3.JPG
              26 File(s)     11,146,542 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S15

10/31/2006  08:07p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/22/2004  02:23p             1,027,632 0114_NM37_View to SW.JPG
06/22/2004  02:25p               799,624 0115_NM37_View to the S.JPG
09/30/2004  12:50p             1,160,984 0131_SM123_View E into White River
Valley.JPG
09/30/2004  12:58p             1,047,213 0132_SM123_View WNW of Tsn dipping S into
Timber Mtn Pass.JPG
03/25/2005  02:55p             1,500,766 0134-0138_SM123_Pan SW to NW toward
Timber Mtn Pass.jpg
09/30/2004  01:46p             1,314,131 0139_SM140_View W up wash.JPG
```

09/30/2004 01:49p 1,457,234 0141_SM140_View E down wash toward White River.JPG
09/30/2004 01:50p 1,662,602 0142_SM140_Qao exposed in wash.JPG
09/30/2004 02:24p 1,768,389 0143_SM141_Closeup of Qao exposed in wash.JPG
09/30/2004 02:25p 1,234,536 0144_SM141_View E down wash across White River Valley.JPG
09/30/2004 03:38p 931,103 0145_near SM143_View NW of lakebed deposits.JPG
09/30/2004 03:48p 1,502,080 0146_SM143_Miocene lakebeds capped by 15 ft Tsy.JPG
09/30/2004 04:23p 1,533,713 0148_SM143_Closeup of clay and silt comprising Tl lakebeds.JPG
09/30/2004 11:51a 1,170,740 0149_SM147_White River tributary channel.JPG
09/30/2004 11:53a 1,335,131 0150_SM147_Trib wash to White River within 30 ft of main channel.JPG
09/21/2004 11:20a 220,671 1753-1754_SM123_View SE along alignment.jpg
09/21/2004 11:21a 225,734 1755-1756_SM123_View to NW along alignmnent.jpg
09/21/2004 11:41a 362,983 1757-1760_SM123x_From NV 318.jpg
09/21/2004 11:46a 189,983 1761-1762_SM124_View SE along alignment.jpg
09/21/2004 11:46a 202,322 1763-1764_SM124_View NW along alignment.jpg
08/30/2004 02:11p 762,973 1765_SM124_Soil excavated from slope.JPG
08/30/2004 02:12p 422,088 1766_SM124_Qao slope N of road.JPG
09/21/2004 11:50a 192,001 1767-1768_SM125_View W along alignment.jpg
08/30/2004 02:20p 414,609 1769_SM125_View E along alignment.JPG
09/21/2004 11:51a 173,094 1770-1771_SM127_View NE along alignment.jpg
09/21/2004 11:52a 252,574 1772-1773_SM127_View SW along alignment.jpg
09/21/2004 11:53a 215,364 1774-1775_SM128_View NE along alignment.jpg
09/21/2004 11:54a 228,496 1776-1777_SM128_View to SW at bifurcation of GV1 GV2.jpg
08/30/2004 03:17p 546,528 1778_SM128_View S - note lt brown Silt at surface.JPG
08/30/2004 03:18p 660,137 1779_SM128_Closeup of soil.JPG
11/09/2004 11:14a 227,404 1899-1900_SM140_View to WSW.jpg
11/10/2004 10:47a 195,530 1901-1902_SM140_View to ESE.jpg
09/30/2004 01:19p 629,141 1903_SM140_10 ft deep wash.JPG
11/09/2004 11:17a 201,463 1904-1905_SM141_View to NW.jpg
11/09/2004 11:19a 196,924 1906-1907_SM141_View to SE-N Pahrocs at left and Seaman Ran.jpg
11/09/2004 11:21a 229,913 1908-1909_SM141_Hwy 318 cuts at right, Burnt Peak at left.jpg
09/30/2004 02:04p 514,752 1910_SM142_Tl lakebeds exposed in lower 15 ft of wash.JPG
09/30/2004 02:04p 565,125 1911_SM141_Calcrete layers exposed in wash.JPG
09/30/2004 02:23p 410,630 1912_near SM142_Cut in QTg along Hwy 318.JPG

```
11/09/2004  11:27a               254,181 1913-1914_SM143_pan NW to N of Miocene
lakebed deposits.jpg
11/09/2004  11:29a               278,267 1915-1916_SM143_Tl deposits shown in
Photo 1913.jpg
09/30/2004  03:19p               612,185 1917_SM143_CL soil in Tl deposits.JPG
09/30/2004  03:40p               579,647 1918_SM143_Gravel capped ridge - gravel
overlies Tl.JPG
11/09/2004  11:32a               254,160 1919-1920_SM143_View to E across WRV to
Hwy 318 .jpg
11/09/2004  11:35a               129,926 1921-1922_SM144_View to NW.jpg
11/09/2004  11:36a               141,104 1923-1924_SM144_View to SE.jpg
11/09/2004  11:37a               256,441 1925-1926_SM145_View E of Cut slope in
Qao.jpg
09/30/2004  04:59p               451,916 1927_SM145_View to S.JPG
11/09/2004  11:39a               185,418 1928-1929_SM146_View to E and S of cut
slope in Tl.jpg
11/09/2004  11:40a               131,005 1930_SM146_View to S of slope on E side
of road.JPG
11/09/2004  11:42a               119,713 1931_SM146_Tl cut slope on W side of
road.JPG
11/22/2004  05:31p               218,839 1932-1933_SM147_View to NW from Hwy 318
at WR bridge.jpg
11/09/2004  11:44a               202,131 1934-1935_SM147_View to SE.jpg
09/30/2004  11:09a               504,073 1936_SM147_Basalt riprap.JPG
11/10/2004  10:46a               256,136 1937-1938_SM147_pan to S down tributary
to White River.jpg
11/10/2004  10:46a               189,526 1939-1940_SM147_View to S, main channel
of White River at right.jpg
11/10/2004  10:45a               231,399 1941_SM147_Silt in W bank of White
River.JPG
09/30/2004  11:23a               503,094 1942_SM147_V stiff, clayey silt in
bank.JPG
11/10/2004  10:26a               236,110 1943-1944_SM148_View to E.jpg
11/10/2004  10:45a               284,332 1945-1947_SM148_pan to SE.jpg
11/10/2004  10:45a               313,430 1948-1950_SM148_pan to NW.jpg
11/10/2004  10:46a               175,205 1951_SM148_View to W toward Hwy 318.JPG
04/09/2005  01:12p               509,307 2898_SM255_Survey panel.JPG
06/09/2005  01:08a               181,504 2899-2900_SM255_View to NW along
alignment.jpg
06/09/2005  01:09a               164,610 2901-2902_SM255_View to SE along
alignment.jpg
04/09/2005  01:36p               561,933 2903_SM255_S bank of wash NE of SM255.JPG
04/09/2005  01:37p               717,989 2904_SM255_ Sandy Gravel in S bank of
wash.JPG
04/09/2005  01:41p               607,940 2905_SM255_Cemented Gravel in S bank of
wash.JPG
04/09/2005  01:43p               706,988 2906_SM255_Very stiff sandy Silt in S
bank of wash.JPG
              69 File(s)     37,644,826 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S16

10/31/2006  08:07p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
09/21/2004  05:18p               238,324 1706-1707_SM116_View NE.jpg
09/21/2004  05:19p               208,106 1708-1709_SM116_View SW.jpg
```

```
08/29/2004  11:26a           492,004 1710_Near SM116_Roadway and ditch in
Garden Valley.JPG
09/21/2004  05:25p           218,868 1715-1716_SM118_View to SW near GV1.jpg
09/21/2004  05:26p           207,631 1717-1718_SM118_View to NE near GV1.jpg
08/29/2004  11:16a         1,122,956 1719a_Garden Valley.JPG
08/29/2004  11:05a           392,901 1719_Sign in Garden Valley.JPG
09/21/2004  05:28p           224,696 1720-1721_SM119_View NE along GV1.jpg
09/21/2004  05:29p           214,526 1722-1723_SM119_View to SW of
Worthingtons and Quinn Cyn Rng.jpg
08/29/2004  11:21a           703,099 1724_SM119_Qao in ditch along road.JPG
08/29/2004  11:22a           593,084 1725_SM119_Qao in ditch along road.JPG
09/21/2004  11:15a           105,621 1749-1750_SM122_View NE.jpg
09/21/2004  11:15a            92,996 1751-1752_SM122_View SW.jpg
09/21/2004  11:53a           215,364 1774-1775_SM128_View NE along
alignment.jpg
09/21/2004  11:54a           228,496 1776-1777_SM128_View to SW at bifurcation
of GV1 GV2.jpg
08/30/2004  03:17p           546,528 1778_SM128_View S - note lt brown Silt at
surface.JPG
08/30/2004  03:18p           660,137 1779_SM128_Closeup of soil.JPG
09/21/2004  11:57a           207,329 1780-1781_SM129_View WSW along GV3.jpg
09/21/2004  11:59a           225,174 1782-1783_SM129_View ESE.jpg
09/21/2004  11:00a           335,149 1784-1786_SM129_View WNW.jpg
08/30/2004  04:04p           401,824 1787_SM129_View NE along GV3.JPG
08/30/2004  04:05p           429,404 1788_SM129_View SW along GV3.JPG
08/30/2004  04:07p           504,577 1789_SM129_Looking up wash to NW.JPG
09/21/2004  11:04a           319,902 1790-1791_SM130_View S of outcrop along
GV3.jpg
08/30/2004  04:29p           608,253 1792_SM130_Closeup of PPe limestone.JPG
08/30/2004  04:49p           502,100 1793_SM131_View S.JPG
08/30/2004  04:56p           605,471 1794_SM131_Closeup of Tsn tuff.JPG
09/21/2004  11:08a           239,175 1795-1796_SM131_View W of Tsn.jpg
09/21/2004  11:10a           203,234 1797-1798_SM131_Limestone cliffs N of
GV3.jpg
08/30/2004  11:10a           702,083 1815a_AG_A photo of SRM.JPG
08/30/2004  11:07a           788,097 1815b_AG_SM134_View NNW toward Golden
Gate Range.JPG
08/30/2004  11:19a           536,553 1815_SM134_Closeup of Silt.JPG
06/09/2005  01:18a           306,134 2911-2912_SM256_View to N of Dg
outcrop.jpg
04/09/2005  04:22p           597,910 2913_SM256_Jointing in Dg outcrop.JPG
04/09/2005  05:18p           765,132 2920_SM257_Qay - Med dense sandy
Gravel.JPG
04/09/2005  05:19p           727,768 2921_SM257_Calcrete in  wash,may be thin
Qay over Qao.JPG
06/09/2005  01:27a           238,813 2922-2923_SM257_View to N up wash, note
calcrete.jpg
              37 File(s)     15,709,419 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S17

10/31/2006  08:07p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
09/21/2004  05:18p           238,324 1706-1707_SM116_View NE.jpg
09/21/2004  05:19p           208,106 1708-1709_SM116_View SW.jpg
08/29/2004  11:26a           492,004 1710_Near SM116_Roadway and ditch in
Garden Valley.JPG
```

```
08/30/2004  04:49p               502,100 1793_SM131_View S.JPG
08/30/2004  04:56p               605,471 1794_SM131_Closeup of Tsn tuff.JPG
09/21/2004  11:08a               239,175 1795-1796_SM131_View W of Tsn.jpg
09/21/2004  11:10a               203,234 1797-1798_SM131_Limestone cliffs N of
GV3.jpg
06/09/2005  02:01a               224,233 24_SM262_View to ENE down fan.JPG
06/09/2005  01:58a               179,906 25_SM262_View to WSW across Cherry Creek
drainage.JPG
06/09/2005  01:59a               309,087 26_SM262_Qay-north of Cherry Creek.JPG
06/09/2005  01:16a               211,549 2907-2908_SM256_View to SW.jpg
06/09/2005  01:17a               207,038 2909-2910_SM256_View to ESE through gap
into Coal Valley.jpg
06/09/2005  01:18a               306,134 2911-2912_SM256_View to N of Dg
outcrop.jpg
04/09/2005  04:22p               597,910 2913_SM256_Jointing in Dg outcrop.JPG
04/09/2005  04:40p               669,232 2914_SM256_MDp - Pilot Shale outcrop.JPG
04/09/2005  04:41p               624,950 2915_SM256_Pilot Shale outcrop.JPG
06/09/2005  01:22a               203,768 2916-2917_SM257_View to WNW along GV3
across Garden Valley.jpg
06/09/2005  01:23a               240,742 2918-2919_SM257_View to E through gap in
Golden Gate Range.jpg
04/09/2005  05:18p               765,132 2920_SM257_Qay - Med dense sandy
Gravel.JPG
04/09/2005  05:19p               727,768 2921_SM257_Calcrete in  wash,may be thin
Qay over Qao.JPG
06/09/2005  01:27a               238,813 2922-2923_SM257_View to N up wash, note
calcrete.jpg
04/09/2005  05:54p               433,447 2924_SM258_View to S from inside wash.JPG
04/09/2005  05:56p               580,917 2925_SM258_Wet ground and dessication
cracks in wash.JPG
04/09/2005  11:08a               644,548 2926_SM258_Closeup of CL clay in bank of
wash.JPG
06/09/2005  01:31a               203,558 2927-2928_SM258_View to NW.jpg
04/09/2005  11:34a               581,653 2929_SM259_Culvert outlet, view to N.JPG
04/09/2005  11:35a               474,598 2930_SM259_View downstream to S.JPG
04/09/2005  11:38a               383,201 2931_SM259_View to S toward Water Gap.JPG
06/09/2005  01:46a               120,065 2932-2933_SM260_View to ENE.jpg
06/09/2005  01:48a                71,233 2934-2935_SM260_View to WSW.jpg
04/09/2005  12:35p               670,521 2936_SM260_Dense sandy Gravel - Qay.JPG
04/09/2005  01:03p               429,607 2937_SM261_View upstream to NW in Cherry
Creek.JPG
04/09/2005  01:03p               402,710 2938_SM261_S bank of Cherry Creek 10'
high.JPG
04/09/2005  01:08p               608,516 2939_SM261_Sand and Gravel in N bank of
Cherry Creek.JPG
04/09/2005  01:09p               579,817 2940_SM261_Granular soil in N bank.JPG
06/09/2005  01:53a               188,385 2941-2942_SM261_View to SE toward
crossing of Cherry Creek.jpg
06/14/2005  12:53p               992,508 425-427_SM323_Pan N to NE.jpg
06/14/2005  01:04p               837,408 428-429_SM323_View to SW.jpg
06/14/2005  01:05p               622,025 430-431_SM324_View to NE along GV3 across
Cottonwood Creek.jpg
06/14/2005  01:05p               657,415 432-433_SM324_View to SW.jpg
06/14/2005  01:05p               439,961 434_SM324_View upstream from S bank
Cottonwood Creek.JPG
06/14/2005  01:05p               591,402 435-436_SM324_View downstream from S
bank.jpg
```

```
05/05/2005  12:34p           1,468,828 437_SM324_Gravel in S bank Cottonwood
Creek.JPG
06/14/2005  01:06p             626,327 438_SM324_Main channel Cottonwood Creek
flowing along N bank.JPG
06/14/2005  01:06p             787,054 439_SM324_Main channel looking
upstream.JPG
06/14/2005  01:07p             607,288 440-441_SM324_Repaired washout on road
crossing Cottonwood Creek.jpg
12/03/2005  11:51a           1,058,838 MG112_AG36_Silty sand in Qao.JPG
12/03/2005  11:53a             710,193 MG113_AG36_View W along GV3.JPG
12/03/2005  11:54a             913,148 MG114_AG36_View E along GV3.JPG
12/03/2005  12:40p             692,739 MG115_AG37_View NE along GV3.JPG
12/03/2005  12:40p             483,278 MG116_AG37_View SW along GV3.JPG
12/04/2005  10:25a             706,483 MG117_AG37_Alluvium in wash.JPG
              52 File(s)     26,562,347 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S18

10/31/2006  08:06p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
09/21/2004  11:53a             215,364 1774-1775_SM128_View NE along
alignment.jpg
09/21/2004  11:54a             228,496 1776-1777_SM128_View to SW at bifurcation
of GV1 GV2.jpg
08/30/2004  03:17p             546,528 1778_SM128_View S - note lt brown Silt at
surface.JPG
08/30/2004  03:18p             660,137 1779_SM128_Closeup of soil.JPG
09/21/2004  11:57a             207,329 1780-1781_SM129_View WSW along GV3.jpg
09/21/2004  11:59a             225,174 1782-1783_SM129_View ESE.jpg
09/21/2004  11:19a             206,626 1808-1809_SM133_View NE.jpg
09/21/2004  11:21a             195,172 1810-1811_SM133_View SW.jpg
09/21/2004  11:25a             191,133 1812-1814_SM134_Stock pond in Coal
Valley.jpg
08/30/2004  11:07a             788,097 1815b_AG_SM134_View NNW toward Golden
Gate Range.JPG
08/30/2004  11:19a             536,553 1815_SM134_Closeup of Silt.JPG
05/04/2005  12:04p           1,661,192 221_SM295_Closeup of Qay sandy Gravel.JPG
05/04/2005  12:04p           1,222,952 222_SM295_View to N up wash.JPG
              13 File(s)      6,884,753 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S19

10/31/2006  08:06p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
09/21/2004  05:18p             238,324 1706-1707_SM116_View NE.jpg
09/21/2004  05:19p             208,106 1708-1709_SM116_View SW.jpg
08/29/2004  11:26a             492,004 1710_Near SM116_Roadway and ditch in
Garden Valley.JPG
09/21/2004  05:22p             255,700 1711-1712_SM117_View NE along GV2.jpg
09/21/2004  05:24p             213,503 1713-1714_SM117_View to SW along GV2.jpg
09/21/2004  05:33p             232,770 1726-1727_SM120_View ENE along GV2.jpg
09/21/2004  05:34p             225,726 1728-1729_SM120_View WSW along GV2.jpg
08/29/2004  11:56a             423,991 1730_SE of SM120_Qc exposure at stock
pond.JPG
08/29/2004  12:00p             651,950 1731_SM120_Berm around stock pond made of
excavated Qc.JPG
09/21/2004  05:37p             178,949 1732_Heizner earth sculpture.JPG
```

```
08/29/2004  12:18p               394,433 1733_SM121x_View to NE through Water
Gap.JPG
09/21/2004  05:45p               221,179 1734-1736_SM121x_Looking NE into Water
Gap.jpg
09/21/2004  05:46p               249,788 1737_SM121_View to NE in Water Gap.JPG
09/21/2004  05:47p               281,531 1738-1739_SM121_Cherry Creek and Golden
Gate Range.jpg
09/21/2004  05:48p               203,205 1740_SM121_View NE.JPG
09/21/2004  05:50p               191,022 1741-1742_SM121_View SW.jpg
08/30/2004  04:12a               224,484 1743_SM121_N side Cherry Creek.JPG
08/29/2004  12:48p               390,604 1744_SM121_View E in Cherry Creek.JPG
09/21/2004  05:52p               133,643 1745_SM121_DS end of triple 48-inch CMP
under road.JPG
09/21/2004  05:54p               182,827 1746_SM121_Qc in Cherry Creek.JPG
09/21/2004  05:54p               156,433 1747_SM121_US end of culverts.JPG
09/21/2004  11:08a               188,780 1748_SM121_Tension crack along creek.JPG
09/21/2004  11:15a               105,621 1749-1750_SM122_View NE.jpg
09/21/2004  11:15a                92,996 1751-1752_SM122_View SW.jpg
09/21/2004  11:12a               340,903 1799-1801_SM132_View SW.jpg
09/21/2004  11:14a               233,198 1802-1803_SM132_Limestone on S side of
Water Gap.jpg
08/30/2004  05:29p               562,554 1804_SM132_View NW.JPG
09/21/2004  11:17a               292,209 1805-1806_SM132_View NW.jpg
05/04/2005  11:18a             1,091,463 216_SM121_Upstrem end of culverts at
Cherry Creek.JPG
06/09/2005  02:58p             1,125,241 217-218_SM121_Culvert outlets looking
E.jpg
06/09/2005  03:00p             1,029,670 219-220_SM121_Culvert outlets looking
W.jpg
06/09/2005  03:07p               893,360 223-224_SM296_View to N.jpg
06/09/2005  03:08p               674,466 225-226_SM296_View to S.jpg
05/04/2005  12:32p             1,643,687 227_SM296_Closeup of Qayf clay.JPG
06/23/2005  01:55a               933,574 419-421_SM322_View to N across wash
toward GV alignments.jpg
06/23/2005  01:56a               808,495 422-423_SM322_View to NE.jpg
05/05/2005  12:00p             1,741,843 424_SM322_Qc - dense gravelly sand.JPG
              37 File(s)     17,508,232 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S20

10/31/2006  08:06p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/22/2004  12:58p               759,383 0104_NM33_View to N toward GF3.JPG
06/22/2004  12:59p               889,714 0105_NM33_Yellowish gravelly clay altered
rocks.JPG
06/22/2004  01:22p               966,730 0107_NM34_View to S.JPG
06/22/2004  01:23p             1,102,557 0108_NM34_Megabreccia outcrop protruding
from clay soil.JPG
06/22/2004  01:38p             1,072,438 0110_NM33_Spring.JPG
09/21/2004  05:00p               240,864 1694-1695_SM114_View ENE.jpg
09/21/2004  05:01p               197,492 1696_SM114_View WSW.JPG
08/29/2004  05:22p             1,954,983 1697a_SM114_Colluvium.JPG
08/29/2004  04:39p               527,902 1697_SM114_Tt3 outcrop.JPG
09/21/2004  05:08p               476,240 1698-1701_SM115_View ESE.jpg
09/21/2004  05:10p               220,506 1702-1703_SM115_View to SW.jpg
08/29/2004  05:33p               745,950 1704_SM115_SM soil under gravelly desert
pavement.JPG
```

```
08/29/2004  05:59p           1,229,189 1705a_AG_SM115_Outcrop.JPG
08/29/2004  05:59p             876,023 1705b_AG_SM115_Outcrop.JPG
08/29/2004  11:10a           1,825,323 1705c_AG_SM115_Outcrop.JPG
08/29/2004  11:11a           1,417,033 1705d_AG_SM115_Outcrop.JPG
08/29/2004  05:38p             504,009 1705_SM115_Outcrop in butte between SM115
and road.JPG
09/21/2004  05:18p             238,324 1706-1707_SM116_View NE.jpg
              18 File(s)     15,244,660 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S21

10/31/2006  08:06p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
08/28/2004  04:51p             361,859 1641_SM109_Small outcrops of
intrusives.JPG
09/21/2004  04:11p             243,633 1642-1643_SM110_View W along
alignment.jpg
09/21/2004  04:12p             240,468 1644-1646_SM110_View to NE along
alignment.jpg
08/28/2004  05:07p             383,249 1647_SM110_View WSW.JPG
08/28/2004  05:17p             717,747 1648_SM110_Desert pavement and shallow
tuff.JPG
08/28/2004  05:17p             698,553 1649_SM110_Desert pavement and shallow
tuff 2.JPG
09/21/2004  04:16p             317,455 1650_SM110_Tuff exposed in shallow
wash.JPG
09/21/2004  04:18p             460,663 1651-1654_SM110_View SW.jpg
08/28/2004  05:35p             597,855 1655_SM110_Gray tuff with clasts.JPG
08/28/2004  05:36p             464,596 1656_SM110_Orange tuff with void from
cobble.JPG
08/28/2004  05:36p             403,588 1657_SM110_Orange tuff with voids from
boulders.JPG
09/21/2004  04:22p             234,430 1658-1659_SM110_View NE.jpg
09/21/2004  04:23p             270,535 1660-1661_SM110_View NE.jpg
09/21/2004  04:26p             344,369 1662-1664_E of SM110_View NW.jpg
09/21/2004  04:27p             230,443 1665-1666_SM111_View NE along
alignment.jpg
09/21/2004  04:28p             249,996 1667-1668_SM111_View SW.jpg
09/21/2004  04:30p             227,560 1669-1670_SM112_View SW.jpg
09/21/2004  04:31p             254,881 1671-1672_SM112_View NE.jpg
09/21/2004  04:32p             157,704 1674_SM112_View SW.JPG
08/28/2004  12:20p             462,770 1675_SM112_View NE.JPG
09/21/2004  04:35p             124,033 1676-1677_SM113_View SW.jpg
09/21/2004  04:36p             209,365 1678-1679_SM113_View NE.jpg
06/23/2005  05:27a             705,722 637-638_SM348_View to W.jpg
06/23/2005  05:28a             980,654 639-641_SM348_View to NE.jpg
05/07/2005  01:45p             960,166 642_SM348_View to S toward outcrops.JPG
06/23/2005  05:48a             909,564 643-646_SM348_Pan from NW to NE from top
of Tt2 outcrop.jpg
06/23/2005  05:51a           1,343,562 647-649_SM348_Pan from N to NE at
dark.jpg
05/07/2005  01:55p           1,070,174 650_SM348_View to NW at Tt2 outcrop.JPG
05/07/2005  01:55p           1,158,001 651_SM348_View to SE at Tt2 outcrop.JPG
06/23/2005  05:53a             958,036 652-653_SM348_Tt2 outcrops looking SW.jpg
05/07/2005  02:00p           1,386,979 654_SM348_View to E of Tvr rhyolite
outcrop.JPG
05/07/2005  02:01p           1,418,664 655_SM348_View to SSW of Tvr outcrop.JPG
```

```
              32 File(s)     18,547,274 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S22

10/31/2006  08:06p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
08/28/2004  01:37p               556,266 1615_SM105_Reed N Base Triangulation
Station.JPG
08/28/2004  01:44p               655,108 1616_SM105_Reed N Base Triangulation
Station.JPG
09/21/2004  03:50p               261,597 1617-1619_SM106_View NE at pipeline
crossing.jpg
08/28/2004  02:37p               454,295 1620_SM106_View ESE pipeline ascends
slope.JPG
08/28/2004  02:37p               417,165 1621_SM106_View downslope along pipeline
to empty stock pond.JPG
09/21/2004  03:53p               251,806 1622-1624_SM106_View SW along
alignment.jpg
09/21/2004  03:54p               346,540 1625_SM107_Soil in NE slope of wash.JPG
08/28/2004  03:10p               432,835 1626_SM107_NE side of wash.JPG
08/28/2004  03:15p               410,485 1627_SM107_SW side of wash.JPG
09/21/2004  03:55p               269,350 1628-1629_SM107_View up wash to ESE from
unmapped road.jpg
08/28/2004  03:42p               469,450 1630_SM108_View NE across wash.JPG
09/21/2004  04:02p               272,398 1631-1632_SM108_View SW along alignment,
note outcrops.jpg
09/21/2004  04:03p               254,618 1633-1634_SM108_View ENE along
alignment.jpg
09/21/2004  04:05p               259,973 1635-1637_SM108_View S to SW across
wash.jpg
08/28/2004  04:08p               716,582 1638_SM108_Outcrop on N side of wash by
truck.JPG
08/28/2004  04:27p               460,368 1639_SM109_View S across wash toward
alignment.JPG
08/28/2004  04:35p               683,925 1640_SM109_View E of Ta3 outcrop.JPG
08/28/2004  04:51p               361,859 1641_SM109_Small outcrops of
intrusives.JPG
              18 File(s)      7,534,620 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S23

10/31/2006  08:06p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
09/21/2004  03:29p               247,546 1601-1603_SM102_View N and E.jpg
09/21/2004  03:30p               167,711 1604_SM102_Coyote.JPG
09/21/2004  03:31p               164,387 1605_SM102_Coyote.JPG
09/21/2004  03:37p               164,058 1606-1607_SM103_View ENE.jpg
09/21/2004  03:39p               124,256 1608-1609_SM103_View WSW.jpg
08/27/2004  01:33p               229,427 1610_SM103-104_View SE from Deep Well in
RR Valley.JPG
09/21/2004  03:42p               168,822 1611-1612_SM104_View SW at Hwy 375.jpg
09/21/2004  03:43p               175,186 1613-1614_SM104_View NNE.jpg
08/28/2004  01:37p               556,266 1615_SM105_Reed N Base Triangulation
Station.JPG
08/28/2004  01:44p               655,108 1616_SM105_Reed N Base Triangulation
Station.JPG
```

```
09/21/2004  03:50p               261,597 1617-1619_SM106_View NE at pipeline
crossing.jpg
08/28/2004  02:37p               454,295 1620_SM106_View ESE pipeline ascends
slope.JPG
08/28/2004  02:37p               417,165 1621_SM106_View downslope along pipeline
to empty stock pond.JPG
09/21/2004  03:53p               251,806 1622-1624_SM106_View SW along
alignment.jpg
              14 File(s)      4,037,630 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S24

10/31/2006  08:06p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
09/20/2004  12:44p               224,156 1569-1570_SM95_View SE.jpg
09/20/2004  12:46p               240,779 1571-1572_SM95_View NW.jpg
08/27/2004  11:03a               357,627 1573_SM96_View NE of QTb.JPG
08/27/2004  11:12a               464,054 1574_SM96_View SE of QTb.JPG
08/27/2004  11:12a               430,413 1575_SM96_View S of QTb.JPG
09/20/2004  12:56p               197,368 1576-1577_SM97_View SE.jpg
09/20/2004  01:00p               201,487 1578-1579_SM97_View NW of basalt
bluffs.jpg
09/20/2004  01:03p               207,402 1580-1581_SM98_View SE along road.jpg
09/20/2004  01:06p               291,523 1582-1584_SM98_View NW.jpg
08/27/2004  11:14a               574,441 1585_SM98_Cut slope in Qao.JPG
08/27/2004  12:04p               504,944 1591_SM100_Ta3.JPG
09/21/2004  03:21p                94,221 1592_SM100_View down canyon.JPG
09/21/2004  03:22p               200,980 1593_SM100_Closeup of Ta3.JPG
09/21/2004  03:23p               123,765 1594_SM100_View down canyon.JPG
09/21/2004  03:25p               183,405 1595-1596_SM101_View E along
alignment.jpg
09/21/2004  03:26p               158,473 1597-1598_SM101_View W along SR3.jpg
              16 File(s)      4,455,038 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S25

10/31/2006  08:06p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
09/20/2004  12:44p               224,156 1569-1570_SM95_View SE.jpg
09/20/2004  12:46p               240,779 1571-1572_SM95_View NW.jpg
08/27/2004  11:03a               357,627 1573_SM96_View NE of QTb.JPG
08/27/2004  11:12a               464,054 1574_SM96_View SE of QTb.JPG
08/27/2004  11:12a               430,413 1575_SM96_View S of QTb.JPG
09/20/2004  01:07p               193,265 1587-1588_SM99_View E.jpg
09/20/2004  01:10p               181,702 1589-1590_SM99_View W.jpg
08/27/2004  12:04p               504,944 1591_SM100_Ta3.JPG
09/21/2004  03:21p                94,221 1592_SM100_View down canyon.JPG
09/21/2004  03:22p               200,980 1593_SM100_Closeup of Ta3.JPG
09/21/2004  03:23p               123,765 1594_SM100_View down canyon.JPG
09/21/2004  03:25p               183,405 1595-1596_SM101_View E along
alignment.jpg
09/21/2004  03:26p               158,473 1597-1598_SM101_View W along SR3.jpg
              13 File(s)      3,357,784 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S26

10/31/2006  08:06p      <DIR>          .
```

```
08/13/2007  06:13p      <DIR>          ..
08/27/2004  03:59p           1,145,358 0099_SM93x_Reveille Mill.JPG
08/27/2004  04:00p           1,281,190 0100_SM93x_Reveille Mill 2.JPG
08/27/2004  04:00p           1,092,050 0101_SM93x_Reveille Mill 3.JPG
08/27/2004  03:11p             425,141 1550_SM93x_Reveille Mill.JPG
08/27/2004  03:11p             437,210 1551_SM93x_Spring at Reveille Mill.JPG
08/27/2004  03:13p             384,272 1552_SM93x_Spring and Mill.JPG
08/27/2004  03:13p             424,592 1553_SM93x_Reveille Mill_View to ENE down
aqueduct.JPG
08/27/2004  03:13p             454,173 1554_SM93x_Reveille Mill aqueduct.JPG
08/27/2004  03:31p             473,225 1555_SM93_View WSW up aqueduct.JPG
08/27/2004  03:31p             448,590 1556_SM93_View ENE down aqueduct.JPG
09/20/2004  05:53p             228,895 1557-1558_SM93_View SSE.jpg
09/20/2004  05:54p             244,868 1559-1560_SM93_View NNW.jpg
08/27/2004  03:36p             428,596 1561_SM93_View WSW from aqueduct
shaft.JPG
08/27/2004  04:05p             398,292 1562_SM93_QTb on E side of Reveille
Valley.JPG
08/27/2004  04:15p             689,059 1563_SM93_Lizard.JPG
08/27/2004  04:15p             486,748 1564_SM94x_QTb outcrop.JPG
09/20/2004  12:40p             197,672 1565-1566_SM94_View SE.jpg
09/20/2004  12:42p             185,974 1567-1568_SM94_View NW.jpg
09/20/2004  12:44p             224,156 1569-1570_SM95_View SE.jpg
09/20/2004  12:46p             240,779 1571-1572_SM95_View NW.jpg
              20 File(s)      9,890,840 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S27

10/31/2006  08:06p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
08/27/2004  02:17p             425,754 1545_SM91_View W toward alignment.JPG
09/20/2004  05:36p             235,619 1546-1547_SM92_View NNE along alignment-
note 20' deep wash.jpg
09/20/2004  05:38p             205,939 1548-1549_SM92_View SSW along
alignment.jpg
08/27/2004  03:31p             473,225 1555_SM93_View WSW up aqueduct.JPG
08/27/2004  03:31p             448,590 1556_SM93_View ENE down aqueduct.JPG
09/20/2004  05:53p             228,895 1557-1558_SM93_View SSE.jpg
09/20/2004  05:54p             244,868 1559-1560_SM93_View NNW.jpg
08/27/2004  03:36p             428,596 1561_SM93_View WSW from aqueduct
shaft.JPG
08/27/2004  04:05p             398,292 1562_SM93_QTb on E side of Reveille
Valley.JPG
08/27/2004  04:15p             689,059 1563_SM93_Lizard.JPG
              10 File(s)      3,778,837 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S28

10/31/2006  08:06p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
08/26/2004  11:29a             562,871 1517_SM89_Black Spring shaft.JPG
08/26/2004  11:30a             432,135 1518_SM89_View E along aqueduct from
Black Spring.JPG
09/16/2004  03:26p             227,978 1519-1520_SM89_View NW.jpg
09/16/2004  03:27p             211,365 1521-1522_SM89_View SE.jpg
08/26/2004  11:46a             514,450 1523_SM89_View W.JPG
08/26/2004  11:46a             408,155 1524_SM89_View E down aqueduct.JPG
```

```
08/27/2004  12:01p               501,910 1525_W of SM90_View W up Cow Cyn
tributary.JPG
08/27/2004  12:22p               448,276 1526_W of SM90_Possible outcrop of
Ta4.JPG
08/27/2004  12:29p               411,984 1527_W of SM90_View NE down Cow Cyn.JPG
09/16/2004  03:36p               299,699 1528-1529_SM90_View SE across Cow Cyn.jpg
09/16/2004  03:38p               242,039 1530-1531_SM90_View E from top of NW cyn
wall.jpg
09/16/2004  03:41p               319,148 1532-1535_SM90_View to E from center of
Cow Cyn.jpg
08/27/2004  01:09p               369,048 1536_S of SM90.JPG
09/16/2004  03:48p               219,446 1537-1538_SM90_View up fan from road.jpg
09/20/2004  05:32p               231,587 1539-1540_S of SM90_View W.jpg
09/20/2004  05:34p               309,575 1541-1544_S of SM90_View E across
Reveille Valley of QTb.jpg
08/27/2004  02:17p               425,754 1545_SM91_View W toward alignment.JPG
06/23/2005  02:11a               862,478 442-443_SM325_View S across Cow
Canyon.jpg
05/06/2005  12:00p             1,841,764 444_SM325_Closeup of gravelly sand.JPG
06/23/2005  02:12a             1,028,390 445-446_SM325_View W from center of
canyon.jpg
06/23/2005  02:14a               792,926 447-448_SM325_View E from center of
canyon.jpg
06/23/2005  02:16a               959,938 449-451_SM325_View S.jpg
06/23/2005  02:17a             1,007,962 452-453_SM325_View N across canyon.jpg
05/06/2005  12:15p             1,387,225 454_SM325_3 ft boulder in main
channel.JPG
06/23/2005  02:20a               776,075 455-456_SM325_View N.jpg
              25 File(s)     14,792,178 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S29

10/31/2006  08:06p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
09/16/2004  02:34p               210,852 1471-1472_SM82_Cut slope, S side Hwy
6.jpg
08/26/2004  11:51a               620,103 1473_SM82_Joint sets in tuff.JPG
08/26/2004  11:54a               445,818 1474_SM82_View W of cut slope, S side Hwy
6.JPG
09/16/2004  02:39p               211,041 1475-1476_SM82_Cut slope on N side Hwy
6.jpg
08/26/2004  12:01p               390,850 1477_SM82_View W along N side cut Hwy
6.JPG
09/16/2004  02:50p               178,070 1484-1485_SM84_View SW.jpg
09/16/2004  02:51p               172,915 1486-1487_SM84_View E.jpg
08/26/2004  03:18p               363,894 1488_SM84_View E of Warm Springs
Summit.JPG
08/26/2004  03:20p               419,900 1489_SM84_View E of Hwy 6 cut slope.JPG
08/26/2004  03:37p               514,890 1490_SM85_Borrow Pit.JPG
08/26/2004  03:40p               536,545 1491_SM85_Exposure in pit.JPG
09/16/2004  02:55p               287,895 1492_SM85_Closeup exposure in pit.JPG
08/26/2004  03:55p               419,229 1493_SM85_View NE from Hwy 6 of borrow
pit.JPG
08/26/2004  03:56p               448,748 1494_SM85_Low angle cut slopes along Hwy
6.JPG
08/26/2004  04:13p               404,407 1495_SM86_View E of Qay cut slope.JPG
08/26/2004  04:13p               455,044 1496_SM86_View E of Qay cut slope.JPG
```

```
08/26/2004  04:50p               511,791 1497_SM87_View S.JPG
09/16/2004  03:06p               288,146 1498-1500_SM87_View SW.jpg
09/16/2004  03:08p               301,069 1501-1503_SM87_View E.jpg
08/26/2004  05:03p               502,920 1504_SM87_View S.JPG
08/26/2004  05:03p               465,811 1505_SM87_View north toward Hwy 6.JPG
08/26/2004  05:05p               686,794 1506_SM87_Soil.JPG
08/26/2004  05:14p               607,271 1507_SM87_Tuff outcrop.JPG
08/26/2004  05:22p               549,984 1508_SM87_Tuff outcrops next to AG.JPG
08/26/2004  05:48p               407,709 1509_SM87_Tuff with various degrees of
weathering.JPG
09/16/2004  03:18p               306,052 1510-1512_SM88_View NW.jpg
09/16/2004  03:19p               253,385 1513-1514_SM88_View SE.jpg
08/26/2004  11:16a               357,647 1515_SM88_View E across Reveille
Valley.JPG
08/26/2004  11:19a               497,474 1516_SM88_View W.JPG
08/26/2004  11:29a               562,871 1517_SM89_Black Spring shaft.JPG
08/26/2004  11:30a               432,135 1518_SM89_View E along aqueduct from
Black Spring.JPG
09/16/2004  03:26p               227,978 1519-1520_SM89_View NW.jpg
09/16/2004  03:27p               211,365 1521-1522_SM89_View SE.jpg
08/26/2004  11:46a               514,450 1523_SM89_View W.JPG
08/26/2004  11:46a               408,155 1524_SM89_View E down aqueduct.JPG
              35 File(s)     14,173,208 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S30

10/31/2006  08:06p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
09/14/2004  04:46a             1,768,430 0073-0076_SM78_SE wall of prospect
trench.jpg
08/25/2004  11:47a             1,539,636 0077_SM78_Boulders in prospect trench.JPG
08/25/2004  11:56a             1,065,286 0078_SM78_Weathered soil horizon.JPG
08/25/2004  11:57a             1,095,885 0079_SM78_View S into trench .JPG
09/13/2004  05:08p               659,242 0080_SM80_Clifford Mine.JPG
09/13/2004  05:16p               751,963 0083-84_SM79_View NE.jpg
09/13/2004  05:19p               797,525 0085-86_SM79_View SW.jpg
08/25/2004  12:16p             1,076,424 0087_SM79_Clifford Mine.JPG
08/25/2004  12:23p               714,526 0089_SM79_claim note.JPG
09/13/2004  05:28p               996,745 0090-91_SM79_View NE.jpg
08/25/2004  12:31p             1,707,666 0092_SM79_claim stakes as found.JPG
08/25/2004  12:36p             1,714,258 0093_SM79_shallow cover over Ta4
bedrock.JPG
08/25/2004  12:48p             1,403,016 0094_SM80_Shaft closest to alignment.JPG
09/14/2004  04:52a               883,877 0095-0096_SM81_View NE.jpg
09/14/2004  04:53a               845,801 0097-0098_SM81_View SW.jpg
09/14/2004  04:09a               216,523 1421_SM68 _Road to Tonopah Test Range
looking S.JPG
09/14/2004  04:12a               219,119 1422-1423_SM69_View NE.jpg
09/14/2004  04:14a               161,580 1424-1425_SM69_View SW.jpg
08/25/2004  12:08p               661,198 1426_SM69_Qayf.JPG
09/14/2004  04:19a               184,673 1427-1428_SM70_View NE.jpg
09/14/2004  04:20a               156,844 1429-1430_SM70_View SW.jpg
08/25/2004  12:50p               371,950 1431_near SM70_Rhyolite plug.JPG
09/14/2004  04:24a               235,671 1432-1433_SM71_Road in Qayf.jpg
09/14/2004  04:26a               205,350 1434-1435_SM72_View NE.jpg
09/14/2004  04:27a               193,337 1436-1437_SM72_View SW.jpg
08/25/2004  02:28p               432,269 1438_SM73_Gravel Pit.JPG
```

```
08/25/2004  02:30p               696,590 1439_SM73_Very dense gravel in pit .JPG
08/25/2004  02:46p               433,574 1440_SM74_Quarry looking SE.JPG
09/13/2004  11:23a               565,831 1441-1445_SM74_Quarry - pan SE to SW.jpg
08/25/2004  02:56p               552,082 1446_SM74_View NW of rhyolite inside
quarry.JPG
08/25/2004  03:10p               445,331 1447_SM74_View S of dacite in quarry.JPG
09/14/2004  04:34a               261,496 1448-1450_SM74_View S of QTb mound.jpg
09/14/2004  04:35a               196,529 1451-1452_SM75_View SW.jpg
09/14/2004  04:36a               181,307 1453-1454_SM75_View NE.jpg
08/25/2004  04:28p               377,746 1455_SM75_View S of Golden Arrow Mine.JPG
08/25/2004  04:44p               444,537 1456_SM75_Grasses in roadway ditch
slope.JPG
09/14/2004  04:39a               223,154 1457-1459_SM76_View NE.jpg
09/14/2004  04:40a               185,937 1460-1461_SM76_View SW.jpg
09/14/2004  04:41a               216,367 1462-1463_SM77_View NE.jpg
09/14/2004  04:42a               242,366 1464-1465_SM77_View SW.jpg
08/25/2004  05:43p               403,576 1466_SM78_NW wall of prospect trench.JPG
09/16/2004  02:34p               210,852 1471-1472_SM82_Cut slope, S side Hwy
6.jpg
08/26/2004  11:51a               620,103 1473_SM82_Joint sets in tuff.JPG
08/26/2004  11:54a               445,818 1474_SM82_View W of cut slope, S side Hwy
6.JPG
09/16/2004  02:39p               211,041 1475-1476_SM82_Cut slope on N side Hwy
6.jpg
08/26/2004  12:01p               390,850 1477_SM82_View W along N side cut Hwy
6.JPG
08/26/2004  12:19p               442,224 1478_SM82_View E of Hwy 6 Fill slope.JPG
09/16/2004  02:43p               256,074 1479-1480_SM83_Rock cut on N side Hwy
6.jpg
09/16/2004  02:44p               394,650 1481_SM83_Closeup of rock in cut
slope.JPG
08/26/2004  12:54p               346,990 1482_SM83_View S of Rock exposure.JPG
08/26/2004  12:57p               511,995 1483_SM83_View W of cut slope.JPG
09/16/2004  02:50p               178,070 1484-1485_SM84_View SW.jpg
09/16/2004  02:51p               172,915 1486-1487_SM84_View E.jpg
08/26/2004  03:18p               363,894 1488_SM84_View E of Warm Springs
Summit.JPG
08/26/2004  03:20p               419,900 1489_SM84_View E of Hwy 6 cut slope.JPG
              55 File(s)     30,450,593 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S31

10/31/2006  08:05p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
08/24/2004  11:49a               780,924 0071_near SM64_Well on Cactus Flats.JPG
09/14/2004  03:58a               220,710 1406-1407_SM64_View W.jpg
09/14/2004  03:59a               214,844 1408-1409_SM64_View E.jpg
09/14/2004  04:00a               198,022 1410-1411_SM65_View E.jpg
09/14/2004  04:01a               197,731 1412-1413_SM65_View W.jpg
09/14/2004  04:03a               194,373 1414-1415_SM66_View W along alignment.jpg
09/14/2004  04:04a               216,104 1416-1417_SM66_View ENE along
alignment.jpg
09/14/2004  04:05a               102,303 1418_SM67_View W.JPG
09/14/2004  04:09a               154,054 1419-1420_SM67_View NE.jpg
09/14/2004  04:09a               216,523 1421_SM68 _Road to Tonopah Test Range
looking S.JPG
              10 File(s)      2,495,588 bytes
```

```
 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S32

10/31/2006  08:05p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
03/24/2005  05:23p               735,501 0065-0066_SM60_View S across Mud Lake.jpg
08/24/2004  05:03p             1,289,649 0068_near SM63_Well in Ralston Valley.JPG
08/24/2004  05:05p               954,995 0069_near SM63_2nd view of well in
Ralston Valley.JPG
08/24/2004  11:49a               780,924 0071_near SM64_Well on Cactus Flats.JPG
09/14/2004  03:46a               195,829 1391-1392_SM59_View E.jpg
09/14/2004  03:48a               204,756 1393-1394_SM59_View W.jpg
08/24/2004  02:48p               632,583 1395_SM59_Silt.JPG
09/14/2004  03:50a               190,269 1396-1398_SM60_N edge Mud lake.jpg
09/14/2004  03:52a               212,932 1399-1400_SM61_View W.jpg
09/14/2004  03:54a               181,440 1401-1402_SM61_View E, Monitor Hills at
left.jpg
08/24/2004  05:00p               598,444 1403_SM62_Qay outcrop.JPG
09/14/2004  03:55a               183,519 1404_SM63_View W.JPG
08/24/2004  05:35p               407,063 1405_SM63_View E.JPG
09/14/2004  03:58a               220,710 1406-1407_SM64_View W.jpg
09/14/2004  03:59a               214,844 1408-1409_SM64_View E.jpg
              15 File(s)      7,003,458 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S33

10/31/2006  08:05p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/22/2004  11:43a               833,874 0133_NM43_Basalt-capped ridge.JPG
03/23/2005  04:38p             1,067,597 0134-0136_NM43_View to south along
GF1.jpg
06/22/2004  12:14p               867,730 0137_NM43-45_Ruts in loose silty
gravel.JPG
03/23/2005  04:41p             1,559,074 0138-0142_NM45_View to N into Mud Lake
basin.jpg
06/22/2004  12:49p             1,073,394 0143_NM45_Truck on alignment.JPG
06/22/2004  12:49p               784,413 0144_NM45_View to S.JPG
06/24/2004  02:49p               424,862 1291-1292_SM45_Cut slope in Qao on Hwy 95
near Ralston.JPG
03/24/2005  02:35p               244,290 1300-1302_SM49_View to N along
alignment.jpg
03/24/2005  02:37p               256,714 1303-1305_SM49_View to S along
alignment.jpg
06/24/2004  05:42p               427,196 1306_SM49_View to NE into Mud Lake basin
.JPG
03/24/2005  02:43p               315,334 1307-1312_SM49_Pan to NE from road below
ridge at SM49.jpg
03/24/2005  02:46p               243,195 1313-1317_SM50_Pan to NE from Mud Lake
floor.jpg
06/24/2004  11:06a               259,920 1318_SM50_View to SE at termination of
gravel at edge of playa.JPG
06/24/2004  11:12a               290,723 1319_SM50_SM.JPG
06/24/2004  11:13a               273,223 1320_SM50_AG.JPG
08/09/2005  01:33p             2,183,651 236_SM397_View to SW along GF3 N of Mud
Lake.JPG
08/10/2005  12:50p             1,058,981 237_SM397_View to NE along GF3.JPG
08/09/2005  01:34p             2,495,526 238_SM397_Clayey sand soil.JPG
```

```
08/09/2005  01:34p         2,827,383 239_SM397_Sandy silt exposed in N side of
trench.JPG
06/23/2005  06:03a           686,130 656-657_SM349_View to E.jpg
06/23/2005  06:04a           836,892 658-659_SM349_View to WSW.jpg
05/08/2005  12:24p           917,430 660_SM349_Typical playa-like soil
conditions.JPG
05/08/2005  12:34p         1,660,340 661_SM349_Stiff to very stiff sandy
clay.JPG
06/23/2005  06:07a         1,154,584 662-664_SM349_Pan to S, note dust storm
over Mud Lake.jpg
05/08/2005  12:51p         1,324,149 665_near SM349_View to SW down basalt
bluffs.JPG
05/19/2005  10:57a           983,022 667-669_SM350_View to N-NE of basalt
bluff.jpg
06/23/2005  06:13a         1,005,333 667-669_SM350_View to NNE at basalt
bluffs.jpg
06/23/2005  06:15a         1,236,032 670-673_SM350_Pan from NE to SE across
Mud Lake.jpg
05/19/2005  10:58a         1,168,419 670-673_SM350_Pan NE to SE across Mud
Lake.jpg
05/19/2005  10:59a           735,005 674-675_SM350_View to S of talus.jpg
05/08/2005  01:27p         1,039,984 676_SM350_Basalt closeup 1.JPG
05/08/2005  01:28p         1,317,153 677_SM350_Basalt closeup 2.JPG
05/08/2005  01:29p         1,259,516 678_SM350_Basalt outcrop.JPG
06/23/2005  06:17a         1,423,088 679-682_SM350_Pan from W to NW from
road.jpg
05/19/2005  10:59a         1,409,757 679-682_SM350_Pan W to NW from road at
basalt bluff.jpg
05/08/2005  02:12p           738,092 683_SM351_Tuff outcrop.JPG
06/23/2005  06:21a         1,150,538 684-687_SM351_Pan from NW to N toward
alignments.jpg
06/23/2005  06:23a           860,733 688-690_SM351_View to E toward Mud
Lake.jpg
05/08/2005  02:28p         1,208,151 691_SM351_Closeup of rock.JPG
05/08/2005  02:28p         1,041,655 692_SM351_Outcrop.JPG
06/23/2005  06:26a           677,683 693-694_SM351_View toward Mud Lake.jpg
05/08/2005  03:24p         1,763,148 700_SM352_8 inches of dense sand over
weathered bedrock.JPG
05/08/2005  03:28p         1,016,608 701_SM352_View to W down wash toward
alignment.JPG
05/08/2005  03:30p         1,307,573 702_SM352A_View to NW of basalt
outcrop.JPG
05/08/2005  03:37p         1,631,742 703_SM352_Outcrop exposed in wash near
alignment crossing.JPG
05/08/2005  03:43p         1,228,140 704_SM352_View to SE of foliation
planes.JPG
05/08/2005  05:39p         1,584,899 710_SM353_Dense sand and gravel with
calcrete layers.JPG
              47 File(s)     49,852,876 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S34

10/31/2006  08:05p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/22/2004  03:53p           887,896 0125_NM40_View to N in valley between
basalt-capped ridges.JPG
06/22/2004  04:58p           861,040 0126_NM41_View to NW.JPG
```

```
03/23/2005  04:20p           1,462,292 0127-0130_NM41_View to S.jpg
03/23/2005  04:24p             809,852 0131-0132_NM42_View to N.jpg
06/22/2004  11:43a             833,874 0133_NM43_Basalt-capped ridge.JPG
03/23/2005  04:38p           1,067,597 0134-0136_NM43_View to south along
GF1.jpg
12/04/2005  02:00p           1,092,872 MG118_NM41_View N along GF1.JPG
12/04/2005  02:01p           1,239,694 MG119_NM41_View S along GF1.JPG
               8 File(s)      8,255,117 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S35

10/31/2006  08:05p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/22/2004  03:00p             997,144 0119_NM37-38_View SE.JPG
06/22/2004  03:19p             929,607 0122_NM39_View to S toward GF1.JPG
06/22/2004  03:20p           1,007,012 0123_NM39_View to N parallel to GF1.JPG
06/22/2004  03:53p           1,010,451 0124_NM40_View to SSW parallel to GF1.JPG
06/22/2004  03:53p             887,896 0125_NM40_View to N in valley between
basalt-capped ridges.JPG
06/24/2004  03:45p             460,094 1293_SM46_Through-cut in altered rocks on
old RR grade.JPG
03/24/2005  02:26p             281,516 1294-1295_SM46_View to N through cut.jpg
06/24/2004  04:05p             487,284 1296_SM47_View to N through cut on old RR
grade near Goldfield.JPG
06/24/2004  04:05p             425,417 1297_SM47_View to S through cut.JPG
06/24/2004  04:17p             512,675 1298_SM48_Embankment fill slope on old RR
grade.JPG
06/24/2004  04:18p             476,770 1299_SM48_View to NW along old RR grade
fill slope.JPG
06/24/2004  11:26a             468,083 1321_SM50-51_Black Butte - W of GF1 at
NM40.JPG
03/24/2005  02:57p             178,788 1322-1323_SM51_View to SE toward GF1.jpg
03/24/2005  02:59p             176,222 1324-1325_SM51_View to NW toward GF1.jpg
06/24/2004  11:44a             423,490 1326_SM51_Tailing piles north of road
.JPG
06/24/2004  11:56a             449,835 1327-1328_SM51_Pronghorn.JPG
12/04/2005  04:09p           1,085,666 MG120_AG40_View NE along GF1.JPG
12/04/2005  04:09p             869,679 MG121_AG40_View SW along GF1.JPG
12/04/2005  04:18p           1,675,449 MG122_AG40_Hydrothermally altered Ta3.JPG
12/04/2005  04:39p           1,184,153 MG123_AG41_View NNE along GF1 open
mineshaft.JPG
12/06/2005  12:20p           1,038,733 MG124_AG41_View SSW along GF1.JPG
12/04/2005  04:40p           2,004,700 MG125_AG41_Hydrothermally altered Ta3.JPG
12/04/2005  04:42p           1,185,427 MG126_AG41_View SE along wash.JPG
01/07/2006  04:57p           1,898,919 MG127-MG130_AG41_Pan SE to NE of
Goldfield Hills from GF1.jpg
12/04/2005  05:02p           1,326,318 MG131_AG42_View E of alluvial fan and
open mineshaft.JPG
12/04/2005  05:26p           1,071,555 MG132_AG43_View NNE along GF1.JPG
12/04/2005  05:26p           1,212,954 MG133_AG43_View S along GF1.JPG
12/04/2005  05:46p           1,256,485 MG134_AG44_View N along GF1 Black
Butte.JPG
12/04/2005  05:46p           1,284,361 MG135_AG44_View ESE along GF1.JPG
12/04/2005  05:47p           1,320,049 MG136_AG44_View E of open mineshaft.JPG
12/04/2005  05:52p           1,504,398 MG137_AG44_Hydrothermally altered Ta3.JPG
12/04/2005  11:21a           1,449,989 MG138_NM35_View SE.JPG
12/04/2005  11:24a           1,334,861 MG139_NM35_View NW Black Butte.JPG
```

```
12/04/2005  11:35a           1,203,223 MG140_AG45_View SE along GF1.JPG
12/04/2005  11:35a           1,321,430 MG141_AG45_View NW along GF1.JPG
12/04/2005  11:35a           1,291,312 MG142_AG45_Silicified Ta3.JPG
12/04/2005  11:39a           1,370,650 MG143A_AG45_Silicified Ta3.JPG
12/04/2005  11:41a           1,270,581 MG143_AG45_Silicified Ta3.JPG
              38 File(s)     38,333,176 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S36

10/31/2006  08:05p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/21/2004  01:14p           1,576,934 0096-0097_NM30_Prospect pit west of
GF1.JPG
06/21/2004  01:48p             766,517 0099_NM31_View to N.JPG
06/21/2004  02:16p             857,061 0100_NM32_View to S toward gap.JPG
03/23/2005  02:28p             434,042 0101_NM32_View to N up valley.JPG
03/23/2005  03:02p             832,584 0112-0113_NM36_View to S toward GF1.jpg
06/22/2004  02:23p           1,027,632 0114_NM37_View to SW.JPG
06/22/2004  02:25p             799,624 0115_NM37_View to the S.JPG
06/22/2004  02:28p             996,836 0117_NM37_View NE.JPG
06/22/2004  03:00p             997,144 0119_NM37-38_View SE.JPG
08/09/2005  04:03p           2,096,743 78-80_SM366_Pan from S to ESE toward
GF3.jpg
08/09/2005  12:56p           2,311,046 82_SM367_Andesite megabreccia Ta3, fault
zone, prospect pit.JPG
08/09/2005  12:56p           2,152,981 84_SM367_Closeup of Ta3 megabreccia.JPG
08/09/2005  12:57p           2,664,002 85_SM367_Ta3 andesite megabreccia
outcrops.JPG
12/04/2005  11:58a             616,434 MG144_AG46_View NW along GF1.JPG
12/04/2005  11:59a             702,727 MG145_AG46_View ESE along GF1.JPG
12/04/2005  12:10p             870,184 MG146_AG46_View S in wash.JPG
12/04/2005  12:11p           1,184,047 MG147_AG46_View W of Goldfield Hills
Dacite.JPG
              17 File(s)     20,886,538 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S37

10/31/2006  08:05p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/21/2004  11:49a             725,293 0091_NM29_View to N along GF1.JPG
06/21/2004  11:49a             735,939 0092_NM29_View to N.JPG
06/21/2004  01:48p             713,413 0098_NM31_View to S.JPG
06/21/2004  01:48p             766,517 0099_NM31_View to N.JPG
03/24/2005  04:28p             232,011 1329-1330_SM52_Sidehillcut and fill on
old RR grade looking N.jpg
06/24/2004  12:09p             445,373 1331_SM52_Sidehill cut and fill slopes
looking S.JPG
03/24/2005  04:31p             255,264 1332-1333_SM52_View to E of cut slope.jpg
               7 File(s)      3,873,810 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S38

10/31/2006  08:05p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/21/2004  11:37a             751,778 0087_NM29_View S to Stonewall Mtn.JPG
03/23/2005  01:56p             560,108 0088-0089_NM29_View to S toward Stonewall
Mtn.jpg
```

```
06/21/2004  11:44a               717,083 0090_NM29_View S at Stonewall Mtn
alluvial fan.JPG
06/21/2004  11:49a               725,293 0091_NM29_View to N along GF1.JPG
06/21/2004  11:49a               735,939 0092_NM29_View to N.JPG
06/21/2004  12:06p             1,291,522 0093_NM29_Lizard 1.JPG
06/21/2004  12:06p             1,389,718 0094_NM29_Lizard 2.JPG
06/21/2004  12:27p             1,408,980 0095_NM29-30_Adit.JPG
03/23/2005  11:55a               233,804 1245-1247_SM35_View to NW down old RR
grade parallel to ali.jpg
03/23/2005  11:57a               196,479 1248-1250_SM35_View to SE.jpg
03/23/2005  11:00a               270,001 1251-1255_SM35_View to SE at Stonewall
Mtn.jpg
03/23/2005  11:06a               282,125 1256-1257_SM36_View to N through cut on
old RR grade.jpg
03/23/2005  11:12a               258,708 1258-1259_SM36_View to S through cut.jpg
06/23/2004  11:42a               512,852 1260_SM36_Cut in highly weathered Tm
tuff.JPG
03/23/2005  11:17a               349,496 1261-1265_SM37_View NNE along old RR
grade.jpg
03/23/2005  11:19a               260,201 1266-1268_SM37_View SSE along old RR
grade.jpg
06/23/2004  12:24p               377,836 1269_SM37_Silt in playa.JPG
03/23/2005  11:23a               234,328 1270-1272_SM38_View to N along
alignment.jpg
03/23/2005  11:24a               211,322 1273-1275_SM38_View to S along
alignment.jpg
03/24/2005  04:41p               234,917 1337-1338_SM54_Through -cut in Qao on old
RR grade looking S.jpg
03/24/2005  04:51p               251,608 1339-1341_SM55_View to S along old RR
grade.jpg
03/24/2005  04:59p               150,514 1342-1343_SM55_View to N along old RR
grade.jpg
03/24/2005  04:58p               163,437 1344_SM56_Fill slope on old RR embankment
on Stonewall Flat.JPG
03/24/2005  04:58p               145,466 1345_SM56_Ralston.JPG
06/23/2005  06:48a               757,147 712-713_SM354_View to WSW.jpg
06/23/2005  06:50a             1,220,946 714-716_SM354_View to SE.jpg
06/23/2005  06:53a               787,284 717-718_SM354A_View to W of Tst tuff.jpg
05/08/2005  12:37p             1,001,372 719_SM354A_Caves in highly weathered
upper Tst layer.JPG
05/08/2005  12:37p             1,409,741 720_SM55_Holes in moderately weathered
lower layer.JPG
05/08/2005  01:00p             1,315,551 721_SM55_Qao gravelly sand.JPG
06/23/2005  06:58a             1,056,053 722-723_SM55_View to S - note boulders up
to 2 ft excavated.jpg
06/23/2005  06:59a               929,608 724-725_SM55_View to E toward GF1.jpg
05/09/2005  01:32p               517,102 747_near SM35_Shutter stuck_Eroded RR
embankment built of Qayf .JPG
05/09/2005  01:32p               500,872 748_near SM35_Shutter stuck_View to S of
eroded Qayf RR emb.JPG
05/09/2005  01:33p               542,842 749_near SM35_Shutter stuck_View to E of
eroded Qayf embankment.JPG
05/09/2005  02:09p             1,452,804 753_SM356_Closeup of Qay soil.JPG
06/23/2005  07:39a             1,181,194 754-756_SM356_Pan from SE to S along
alignment, Alkali Flat.jpg
06/23/2005  07:41a             1,121,214 757-759_SM356_View to N along
alignment.jpg
```

```
12/05/2005  11:19a           1,247,485 MG158_AG51_View N.JPG
12/05/2005  11:19a           1,430,399 MG159_AG51_View S along GF1, GF4,
Stonewall Mountain.JPG
12/05/2005  12:19p           1,023,724 MG160_AG52_View W of Tst.JPG
              41 File(s)     29,208,853 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S39

10/31/2006  08:05p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
08/09/2005  05:39p             883,802 165_SM380_View to NNW along GF3 toward
cut at drainage divide.JPG
08/09/2005  05:41p           1,068,987 166_SM380_View to SSE toward ridge.JPG
08/09/2005  05:47p           1,374,020 167-168_SM381_View to NNE along GF3from
drainage divide.jpg
08/09/2005  05:47p           1,036,861 171_SM381_View to SSE along GF3 toward
basalt ridge.JPG
08/09/2005  01:17p           2,977,971 172_SM381_Closeup of alluvium, note
cemented pieces.JPG
08/09/2005  05:52p           1,313,972 173-176_SM382_Pan from NW to NNW along
GF3 from top of ridge.jpg
08/09/2005  05:54p           1,354,377 177-178_SM382_View to SSE along GF3.jpg
08/09/2005  05:56p           1,667,059 179-180_SM382_View to NE down ridge - QTb
boulders and outcrops.jpg
08/09/2005  01:18p           2,873,194 181_SM382_Closeup of basalt.JPG
08/09/2005  01:19p           2,911,039 182_SM382_Basalt outcrop in lower part of
ridge.JPG
08/09/2005  01:19p           2,991,274 184_SM383_Closeup of Siebert Tuff, Tsy at
base of basalt ridge.JPG
08/09/2005  11:24a           1,339,358 196-197_SM387_View to NE along GF3.jpg
08/09/2005  11:26a           1,201,286 198-199_SM387_View to SSW toward drainage
divide along GF3.jpg
08/09/2005  01:23p           2,976,117 202_SM387_Basalt outcrop.JPG
08/09/2005  01:23p           2,424,908 203_SM387_View to W toward 20' cut for
GF3.JPG
08/09/2005  01:24p           2,361,290 204_SM388_View to NE along GF3.JPG
08/09/2005  01:24p           2,441,616 205_SM388_View to SW along GF3.JPG
08/09/2005  01:24p           2,769,333 206_SM388_Very closely jointed basalt,
looking N.JPG
08/10/2005  11:04a           1,565,667 207-208_SM389_Basalt outcrop in wash.jpg
08/10/2005  11:24a           1,178,511 209-210_SM390_View to NE toward location
of 90' fill across wash.jpg
08/10/2005  11:25a           1,308,188 211_SM391_View to SE along GF3.JPG
08/10/2005  11:27a           1,465,857 212-213_SM391_View to NW along GF3 toward
max fill height of 90'.jpg
08/10/2005  11:28a           1,169,083 214_SM392_View to SE along GF3.JPG
08/09/2005  01:27p           2,086,231 215_SM392_View to NW along GF3.JPG
08/09/2005  01:27p           2,145,760 216_SM392_View to N toward Mud Lake.JPG
08/09/2005  01:28p           2,686,079 217_SM391_Sand and gravel alluvium in
wash.JPG
08/09/2005  01:28p           2,621,283 218_SM391_Basalt outcrop.JPG
08/10/2005  11:39a           1,636,868 219-220_SM393_Pan from S to SSE toward
70' cut location.jpg
08/10/2005  11:42a           2,166,118 221-222_SM393_Pan ENE to SE toward ridge
with 100' cut.jpg
08/10/2005  11:45a           1,906,321 223-224_SM393_Pan NNW to N toward 30'
fill on GF3.jpg
```

```
08/10/2005  11:55a           1,515,594 225-226_SM393_Pan N to NNE at QTb ridge
on GF3.jpg
08/09/2005  01:31p           2,163,305 227_ALG at SM393.JPG
08/09/2005  01:31p           2,342,363 228_SM394_View to NE from top of ridge
near GF3.JPG
08/10/2005  12:03p           1,687,598 229-230_SM394_View to N toward Mud
Lake.jpg
08/09/2005  01:32p           2,226,631 231_SM394_View to SE across GF3, 70' cut
in hill at right.JPG
08/10/2005  12:06p           1,154,002 232-233_SM395_Basalt outcrop on ridge.jpg
08/09/2005  01:33p           2,221,297 234_SM396_View to W toward GF3 along
talus slope below QTb bluff.JPG
08/09/2005  01:33p           2,122,128 235_SM396_View to W at N part of QTb
bluff.JPG
08/09/2005  01:34p           2,827,383 239_SM397_Sandy silt exposed in N side of
trench.JPG
08/10/2005  12:54p           1,221,658 240_SM398_View to SE along GF3.JPG
08/09/2005  01:35p           2,263,388 241_SM398_View to NW along GF3.JPG
08/10/2005  12:56p             890,918 242_SM398_View to E toward Mud Lake.JPG
08/09/2005  01:35p           3,018,490 243_SM398_M dense to dense clayey
sand.JPG
08/10/2005  12:57p           1,039,380 244_SM399_View to SSE along GF3 toward
gap in QTb ridge.JPG
08/10/2005  01:00p           1,782,675 245-246_SM399_View to NW along GF3.jpg
08/10/2005  01:00p             999,274 247_SM399_View to SSE along GF3.JPG
08/10/2005  01:04p           1,875,010 248-249_SM399_View to NE toward basalt
outcrops.jpg
08/10/2005  01:05p           1,732,614 250-251_SM399_View to SW at basalt
outcrops.jpg
08/09/2005  01:38p           2,222,824 252_SM399_Mud Lake through notch in
ridge.JPG
08/09/2005  01:38p           2,303,669 253_SM400_View to NW toward 50' cut
location.JPG
08/10/2005  02:14p           1,633,524 254-255_SM400_View to SE from wash toward
cut location.jpg
08/09/2005  01:39p           3,110,110 256_SM400_Dense silty sand, note cinder
on ground surface.JPG
08/09/2005  01:39p           2,333,516 257_SM400_Scoria outcrop on S side of
wash.JPG
08/09/2005  01:39p           2,241,719 258_SM401_View to NNW along GF3 from top
of ridge on cinder cone.JPG
08/10/2005  02:25p           1,129,917 259_SM401_View to SSE along GF3 .JPG
08/09/2005  01:40p           3,035,261 260_SM401_Cinder desert pavement and hard
gravelly clay.JPG
08/09/2005  01:40p           3,129,295 261_SM401_Scoria outcrop and pieces of
volcanic neck.JPG
08/09/2005  01:40p           2,329,394 262_SM401_View to NW at volcanic neck and
cinders on slope.JPG
08/09/2005  01:41p           2,170,705 263_SM402_View to SSE along GF3 toward
ridge with 30' cut.JPG
08/09/2005  01:41p           2,337,185 264_SM402_View to NNW along GF3 toward
cinder cone.JPG
08/09/2005  01:42p           2,012,755 265_SM402_Looking E at basalst boulders
on ridge.JPG
08/10/2005  02:10p           1,319,167 266-267_SM403_View to NNE along GF3
across wash.jpg
08/09/2005  01:42p           2,353,924 268_SM403_View to NE toward Mud Lake.JPG
```

```
08/10/2005  02:08p         1,365,483 269-270_SM403_View to S along GF3.jpg
08/09/2005  01:43p         2,149,645 271_SM403_Closeup of basalt outcrop.JPG
06/23/2005  01:26a           830,334 397-398_SM318_View to N down wash.jpg
05/19/2005  10:57a           983,022 667-669_SM350_View to N-NE of basalt
bluff.jpg
06/23/2005  06:13a         1,005,333 667-669_SM350_View to NNE at basalt
bluffs.jpg
06/23/2005  06:15a         1,236,032 670-673_SM350_Pan from NE to SE across
Mud Lake.jpg
05/19/2005  10:58a         1,168,419 670-673_SM350_Pan NE to SE across Mud
Lake.jpg
05/19/2005  10:59a           735,005 674-675_SM350_View to S of talus.jpg
05/08/2005  01:27p         1,039,984 676_SM350_Basalt closeup 1.JPG
05/08/2005  01:28p         1,317,153 677_SM350_Basalt closeup 2.JPG
05/08/2005  01:29p         1,259,516 678_SM350_Basalt outcrop.JPG
06/23/2005  06:17a         1,423,088 679-682_SM350_Pan from W to NW from
road.jpg
05/19/2005  10:59a         1,409,757 679-682_SM350_Pan W to NW from road at
basalt bluff.jpg
08/05/2005  03:54p         1,346,545 815_SM391_QTb basalt on E bank of
wash.JPG
08/05/2005  04:01p         1,482,010 816_SM391_QTb on W side of wash.JPG
08/05/2005  04:03p         1,469,590 817_SM391_QTb outcrop, W side of wash.JPG
08/05/2005  05:00p         1,137,989 818_SM395_QTb outcrop below crest of
ridge.JPG
              80 File(s)    146,008,008 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S40

10/31/2006  08:04p    <DIR>          .
08/13/2007  06:13p    <DIR>          ..
06/22/2004  03:00p           997,144 0119_NM37-38_View SE.JPG
06/22/2004  03:19p           929,607 0122_NM39_View to S toward GF1.JPG
06/22/2004  03:20p         1,007,012 0123_NM39_View to N parallel to GF1.JPG
06/22/2004  03:53p         1,010,451 0124_NM40_View to SSW parallel to GF1.JPG
06/22/2004  03:53p           887,896 0125_NM40_View to N in valley between
basalt-capped ridges.JPG
08/09/2005  12:59p         2,419,373 100_SM369_View to SW at SM369 hill.JPG
08/09/2005  12:59p         2,271,526 101_SM370_View to WNW along GF3.JPG
08/09/2005  12:59p         2,227,049 102_SM370_View to NW up road and wash.JPG
08/09/2005  01:00p         2,019,100 103_SM370_View to ESE along GF3.JPG
08/09/2005  01:00p         2,859,030 104_SM370_View to S of Ta3 dacite showing
foliation dipping to S.JPG
08/09/2005  04:27p         1,691,746 105-106_SM370_View to SW toward GF3  on S
side of road.jpg
08/09/2005  01:01p         2,406,491 107_SM370_View to NE in prospect trench
#1.JPG
08/09/2005  01:01p         2,404,568 108_SM370_View to SE in prospect trench
#2.JPG
08/09/2005  01:01p         2,141,748 109_SM371_View to SSE along GF3 in
wash.JPG
08/09/2005  04:30p         1,404,356 110-111_SM371_View to NW along GF3.jpg
08/09/2005  01:02p         3,249,518 112_SM371_Ground surface and soil
conditions.JPG
08/09/2005  01:02p         2,103,599 113_SM372_Andesite megabreccia Ta3
outcrop.JPG
```

```
08/09/2005  04:35p          1,438,851 114-115_SM372_View to SW toward ridge
with 40' cut.jpg
08/09/2005  04:36p          1,454,650 116-117_SM372_View to NE along GF3.jpg
08/09/2005  04:38p          1,362,739 118-119_SM372A_View to SW.jpg
08/09/2005  01:04p          2,338,867 120_SM372A_View to NE along GF3.JPG
08/09/2005  04:44p          1,629,422 121-122_SM373_View to NW across
washes.jpg
08/09/2005  04:49p          2,324,403 123-125_SM373_Pan from SSE to ENE around
GF3 curve.jpg
08/09/2005  01:05p          1,974,581 126_SM373_Milltown Andesite, Ta3 outcrop
in wash.JPG
08/09/2005  01:05p          2,330,690 127_SM373_Closeup of Tma.JPG
08/09/2005  01:06p          2,113,055 128_SM374_View to N toward Willow
Springs.JPG
08/09/2005  01:06p          2,651,732 129_SM374_View to NW at Td outcrop.JPG
08/09/2005  05:01p          1,195,273 130_SM375_View to SW along GF3 in area of
50' fill.JPG
08/09/2005  01:06p          2,225,695 131_SM375_View to NE along GF3.JPG
06/24/2004  11:26a            468,083 1321_SM50-51_Black Butte - W of GF1 at
NM40.JPG
03/24/2005  02:57p            178,788 1322-1323_SM51_View to SE toward GF1.jpg
03/24/2005  02:59p            176,222 1324-1325_SM51_View to NW toward GF1.jpg
06/24/2004  11:44a            423,490 1326_SM51_Tailing piles north of road
.JPG
06/24/2004  11:56a            449,835 1327-1328_SM51_Pronghorn.JPG
08/09/2005  01:07p          2,563,983 132_SM375_View to E at Ta3 rhyodacite
outcrop.JPG
08/09/2005  01:07p          2,054,857 134_SM375A_View to NE.JPG
08/09/2005  05:10p          1,925,906 135-137_SM375A_Pan from SW to W toward
110' fill.jpg
08/09/2005  01:08p          3,396,966 138_SM375B_Milltown Andesite, Ta3 outcrop
looking NW.JPG
08/09/2005  05:13p          1,739,459 139-140_SM376_View to WNW toward wash
with 110' fill.jpg
08/09/2005  01:09p          1,895,751 143_SM376_Andesite, Ta3 outcrop on E side
of road.JPG
08/09/2005  01:09p          2,725,819 144_SM376_Breccia outcrop on W side of
road.JPG
08/09/2005  05:19p          1,826,920 145-146_SM377_Pan SSW to WSW along GF3
curve.jpg
08/09/2005  05:24p          1,903,578 149-150_SM377_View to NE along GF3.jpg
08/09/2005  01:12p          3,171,957 153_SM377_Milltown Andesite, Ta3 outcrop
near ridgeline.JPG
08/09/2005  01:12p          2,636,347 154_SM377_View to N up wash toward 30'
fill.JPG
08/09/2005  01:13p          2,175,295 155_SM378_View to WSW along GF3 toward
SM377 ridge.JPG
08/09/2005  01:13p          2,412,483 156_SM378_View to ENE along GF3.JPG
08/09/2005  01:13p          2,526,012 157_SM378_Gravel exposed in wash.JPG
08/09/2005  01:13p          2,539,343 158_SM379_Rhyodacite, Ta3 outcrop.JPG
08/09/2005  01:14p          2,018,628 160_SM379A_View to WSW along GF3.JPG
08/09/2005  05:31p          1,041,351 161_SM379A_View to SSW at ridge where 75'
cut is planned.JPG
08/09/2005  01:14p          2,352,508 162_SM379A_Closeup of Tma.JPG
08/09/2005  05:32p            937,011 163_SM379A_View to ENE along GF3 toward
curve.JPG
```

```
08/09/2005  01:15p          2,674,417 164_SM379B_Rhyolite of Wildhorse Spring,
Tvr outcrop.JPG
08/09/2005  05:54p          1,354,377 177-178_SM382_View to SSE along GF3.jpg
08/09/2005  11:14a            939,657 187_SM384_View to SW toward GF3 .JPG
08/09/2005  11:12a            912,010 189_SM385_View to SW at Tvr outcrop.JPG
08/09/2005  01:21p          2,291,035 191_SM386_View to NW toward basalt ridge
at SM382.JPG
08/09/2005  01:21p          2,504,819 192_SM386_View to WSW toward GF3.JPG
08/09/2005  11:21a          1,495,980 195_SM385_Possible fault surface.JPG
08/09/2005  03:43p          1,868,186 68-69_SM364_Pan N to NE where GF3 meets
road.jpg
08/09/2005  03:51p          1,704,063 70-71_SM364_Pan SE to S approx along
GF3.jpg
08/09/2005  12:54p          2,754,870 72_SM364_Closeup of Sand soil and cobble
float.JPG
08/09/2005  12:55p          2,315,018 73_SM365_View to SE toward saddle on GF3
Alt.JPG
08/09/2005  03:55p          1,244,795 74-75_SM365_Pan from N to NE.jpg
08/09/2005  12:55p          2,766,176 76_SM365_Tension cracks in disturbed soil
downslope of mine.JPG
08/09/2005  12:55p          2,374,874 77_SM365_Closeup of sandstone in Tso.JPG
08/09/2005  04:03p          2,096,743 78-80_SM366_Pan from S to ESE toward
GF3.jpg
08/09/2005  12:56p          2,311,046 82_SM367_Andesite megabreccia Ta3, fault
zone, prospect pit.JPG
08/09/2005  12:56p          2,152,981 84_SM367_Closeup of Ta3 megabreccia.JPG
08/09/2005  04:09p          1,951,834 86-87_SM368_View to E toward planned cut
along GF3.jpg
08/09/2005  12:57p          2,620,129 89_SM368_View to NE at jointing.JPG
08/09/2005  12:58p          2,659,553 90_SM368_View to SW at jointing.JPG
08/09/2005  12:58p          2,379,865 91_SM369_Closeup of Tt3 dacite.JPG
08/09/2005  12:58p          2,325,308 95_SM369_Ta3 outcrop looking SE along
dominant joint set.JPG
08/09/2005  04:14p          1,042,338 96_SM369_View to SE along GF3 where it
crosses road.JPG
08/09/2005  12:58p          2,313,074 97_SM369_View to WSW from road toward
hill.JPG
12/04/2005  04:09p          1,085,666 MG120_AG40_View NE along GF1.JPG
12/04/2005  04:09p            869,679 MG121_AG40_View SW along GF1.JPG
12/04/2005  04:18p          1,675,449 MG122_AG40_Hydrothermally altered Ta3.JPG
12/04/2005  04:39p          1,184,153 MG123_AG41_View NNE along GF1 open
mineshaft.JPG
12/06/2005  12:20p          1,038,733 MG124_AG41_View SSW along GF1.JPG
12/04/2005  04:40p          2,004,700 MG125_AG41_Hydrothermally altered Ta3.JPG
12/04/2005  04:42p          1,185,427 MG126_AG41_View SE along wash.JPG
01/07/2006  04:57p          1,898,919 MG127-MG130_AG41_Pan SE to NE of
Goldfield Hills from GF1.jpg
12/04/2005  05:02p          1,326,318 MG131_AG42_View E of alluvial fan and
open mineshaft.JPG
12/04/2005  05:26p          1,071,555 MG132_AG43_View NNE along GF1.JPG
12/04/2005  05:26p          1,212,954 MG133_AG43_View S along GF1.JPG
12/04/2005  05:46p          1,256,485 MG134_AG44_View N along GF1 Black
Butte.JPG
12/04/2005  05:46p          1,284,361 MG135_AG44_View ESE along GF1.JPG
12/04/2005  05:47p          1,320,049 MG136_AG44_View E of open mineshaft.JPG
12/04/2005  05:52p          1,504,398 MG137_AG44_Hydrothermally altered Ta3.JPG
12/04/2005  11:21a          1,449,989 MG138_NM35_View SE.JPG
```

```
12/04/2005  11:24a           1,334,861 MG139_NM35_View NW Black Butte.JPG
12/04/2005  11:35a           1,203,223 MG140_AG45_View SE along GF1.JPG
12/04/2005  11:35a           1,321,430 MG141_AG45_View NW along GF1.JPG
12/04/2005  11:35a           1,291,312 MG142_AG45_Silicified Ta3.JPG
12/04/2005  11:39a           1,370,650 MG143A_AG45_Silicified Ta3.JPG
12/04/2005  11:41a           1,270,581 MG143_AG45_Silicified Ta3.JPG
              99 File(s)    176,824,804 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S41

10/31/2006  08:03p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
03/24/2005  04:33p             298,524 1334-1336_SM53_Cut slope in QTb basalt on
old RR grade.jpg
03/24/2005  04:41p             234,917 1337-1338_SM54_Through -cut in Qao on old
RR grade looking S.jpg
08/09/2005  12:41p             667,217 37-39_SM359_Pan N to E from ridge.JPG
08/09/2005  12:48p           2,131,016 40_SM359_View to SW.JPG
08/09/2005  01:57p           2,865,489 42_SM359_Sand with cobbles, boulders.JPG
08/09/2005  12:49p           2,398,192 44_SM360_View to SE down bank of wash.JPG
08/09/2005  12:49p           2,488,716 45_SM360_View to NE approx along GF3.JPG
08/09/2005  02:13p             676,893 46-47_SM361_Tt3 Tuff outcrop.JPG
08/09/2005  12:50p           2,792,800 49_SM361_Tct outcrop.JPG
08/09/2005  02:37p             597,198 51-52_SM362_Pan from N to NW.JPG
08/09/2005  02:41p             845,152 54-56_SM362_Pan from N to E along GF5 and
GF3.JPG
08/09/2005  12:51p           2,926,745 57_SM362_Tuff of Stonewall Flat, Tst.JPG
08/09/2005  02:44p             646,794 58-59_SM362_View to SSW down GF5.JPG
08/09/2005  03:17p           1,711,341 60-61_SM363_View to NE approx along
GF3.jpg
08/09/2005  03:19p           1,437,278 62-63_SM363_View to SW approx along GF3,
Stonewall Mtn at left.jpg
08/09/2005  03:21p           1,649,597 64-65_SM363_Pan from NW to N, Blackcap
Mtn at left.jpg
08/09/2005  12:53p           2,453,732 66_SM363_Ledge of Tst tuff.JPG
08/09/2005  12:53p           2,242,387 67_SM363_Closeup of Tst tuff.JPG
08/09/2005  04:03p           2,096,743 78-80_SM366_Pan from S to ESE toward
GF3.jpg
08/09/2005  12:56p           2,311,046 82_SM367_Andesite megabreccia Ta3, fault
zone, prospect pit.JPG
08/09/2005  12:56p           2,152,981 84_SM367_Closeup of Ta3 megabreccia.JPG
08/09/2005  12:57p           2,664,002 85_SM367_Ta3 andesite megabreccia
outcrops.JPG
              22 File(s)     38,288,760 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S42

10/31/2006  08:03p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/22/2004  11:43a             833,874 0133_NM43_Basalt-capped ridge.JPG
03/23/2005  04:38p           1,067,597 0134-0136_NM43_View to south along
GF1.jpg
06/22/2004  12:14p             867,730 0137_NM43-45_Ruts in loose silty
gravel.JPG
03/23/2005  04:41p           1,559,074 0138-0142_NM45_View to N into Mud Lake
basin.jpg
06/22/2004  12:49p           1,073,394 0143_NM45_Truck on alignment.JPG
```

```
06/22/2004  12:49p               784,413 0144_NM45_View to S.JPG
06/24/2004  02:49p               424,862 1291-1292_SM45_Cut slope in Qao on Hwy 95
near Ralston.JPG
03/24/2005  02:35p               244,290 1300-1302_SM49_View to N along
alignment.jpg
03/24/2005  02:37p               256,714 1303-1305_SM49_View to S along
alignment.jpg
06/24/2004  05:42p               427,196 1306_SM49_View to NE into Mud Lake basin
.JPG
03/24/2005  02:43p               315,334 1307-1312_SM49_Pan to NE from road below
ridge at SM49.jpg
08/09/2005  01:33p             2,183,651 236_SM397_View to SW along GF3 N of Mud
Lake.JPG
08/10/2005  12:50p             1,058,981 237_SM397_View to NE along GF3.JPG
08/09/2005  01:34p             2,495,526 238_SM397_Clayey sand soil.JPG
08/09/2005  01:34p             2,827,383 239_SM397_Sandy silt exposed in N side of
trench.JPG
06/23/2005  06:03a               686,130 656-657_SM349_View to E.jpg
06/23/2005  06:04a               836,892 658-659_SM349_View to WSW.jpg
05/08/2005  12:24p               917,430 660_SM349_Typical playa-like soil
conditions.JPG
05/08/2005  12:34p             1,660,340 661_SM349_Stiff to very stiff sandy
clay.JPG
06/23/2005  06:07a             1,154,584 662-664_SM349_Pan to S, note dust storm
over Mud Lake.jpg
05/08/2005  12:51p             1,324,149 665_near SM349_View to SW down basalt
bluffs.JPG
05/19/2005  10:57a               983,022 667-669_SM350_View to N-NE of basalt
bluff.jpg
06/23/2005  06:13a             1,005,333 667-669_SM350_View to NNE at basalt
bluffs.jpg
06/23/2005  06:15a             1,236,032 670-673_SM350_Pan from NE to SE across
Mud Lake.jpg
05/19/2005  10:58a             1,168,419 670-673_SM350_Pan NE to SE across Mud
Lake.jpg
05/19/2005  10:59a               735,005 674-675_SM350_View to S of talus.jpg
05/08/2005  01:27p             1,039,984 676_SM350_Basalt closeup 1.JPG
05/08/2005  01:28p             1,317,153 677_SM350_Basalt closeup 2.JPG
05/08/2005  01:29p             1,259,516 678_SM350_Basalt outcrop.JPG
06/23/2005  06:17a             1,423,088 679-682_SM350_Pan from W to NW from
road.jpg
05/19/2005  10:59a             1,409,757 679-682_SM350_Pan W to NW from road at
basalt bluff.jpg
05/08/2005  02:12p               738,092 683_SM351_Tuff outcrop.JPG
06/23/2005  06:21a             1,150,538 684-687_SM351_Pan from NW to N toward
alignments.jpg
06/23/2005  06:23a               860,733 688-690_SM351_View to E toward Mud
Lake.jpg
05/08/2005  02:28p             1,208,151 691_SM351_Closeup of rock.JPG
05/08/2005  02:28p             1,041,655 692_SM351_Outcrop.JPG
06/23/2005  06:26a               677,683 693-694_SM351_View toward Mud Lake.jpg
06/23/2005  06:32a               943,444 695-697_SM352_View to NE along alignment
looking across wash.jpg
05/08/2005  03:24p             1,763,148 700_SM352_8 inches of dense sand over
weathered bedrock.JPG
05/08/2005  03:28p             1,016,608 701_SM352_View to W down wash toward
alignment.JPG
```

```
05/08/2005  03:30p           1,307,573 702_SM352A_View to NW of basalt
outcrop.JPG
05/08/2005  03:37p           1,631,742 703_SM352_Outcrop exposed in wash near
alignment crossing.JPG
05/08/2005  03:59p           1,190,418 705_SM352B_Basalt outcrop E of road.JPG
05/08/2005  05:39p           1,584,899 710_SM353_Dense sand and gravel with
calcrete layers.JPG
              44 File(s)     49,691,537 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S43

10/31/2006  08:02p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/09/2005  02:06a             207,543 2943-2944_SM263_View to E along alignment
across Big Wash.jpg
06/09/2005  02:07a             180,119 2945-2946_SM263_View to W along alignment
toward Hwy 95.jpg
06/09/2005  02:08a             241,163 2947-2948_SM263_View upstream from W bank
of Big Wash.jpg
06/09/2005  02:09a             221,128 2949-2950_SM263_View downstream from W
bank of Big Wash.jpg
04/10/2005  01:25p             473,697 2951_SM263_View toward W from inside
wash.JPG
04/10/2005  01:26p             450,367 2952_SM263_View toward E from inside
wash.JPG
04/10/2005  01:29p             619,810 2953_SM263_Qc sand and gravel in Big
Wash.JPG
04/10/2005  01:30p             406,527 2954_SM263_View upstream at boulders in
Big Wash.JPG
04/10/2005  01:35p             671,963 2955_SM263_Qao gravel and sand in W bank
of Big Wash.JPG
06/09/2005  02:15a             202,507 2956-2957_SM264_View to E along alignment
from Hwy 95.jpg
06/09/2005  02:16a             149,406 2958-2959_SM264_View to W from Hwy 95.jpg
06/09/2005  02:18a             232,327 2960-2962_SM264_View to SSE at Hwy 95
bridge location.jpg
04/10/2005  02:13p             648,863 2963_SM264_Qao sand and gravel.JPG
04/10/2005  02:17p             423,268 2964_SM264_View to N of cut slope in
Qao.JPG
06/23/2005  06:33a             653,508 698-699_SM352_View to SW along
alignment.jpg
05/08/2005  03:24p           1,763,148 700_SM352_8 inches of dense sand over
weathered bedrock.JPG
06/23/2005  06:41a             964,335 706-707_SM353_View to NE along
alignment.jpg
06/23/2005  06:42a             944,310 708-709_SM353_View to SW along
alignment.jpg
05/08/2005  05:39p           1,584,899 710_SM353_Dense sand and gravel with
calcrete layers.JPG
05/08/2005  05:49p           1,388,841 711_SM353_Prospect trench.JPG
              20 File(s)     12,427,729 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S44

10/31/2006  08:02p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
```

```
06/09/2005  02:22a          269,692 2965-2966_SM265_View to S - AG standing
on aqueduct.jpg
04/10/2005  02:48p          548,103 2967_SM265_View to W up aqueduct.JPG
06/09/2005  02:26a          232,728 2968-2969_SM265_View to N - aqueduct in
foreground.jpg
06/09/2005  02:28a          262,985 2970-2971_SM266_View to S along alignment
- hammer on aqueduct.jpg
06/09/2005  02:29a          243,505 2972-2973_SM266_View to N along
alignment.jpg
04/10/2005  03:18p          501,128 2974_SM266_View to E down aqueduct.JPG
04/10/2005  03:18p          561,978 2975_SM266_View to W up aqueduct.JPG
04/10/2005  03:24p          638,435 2976_SM266_Weakly cemented Sand in
wash.JPG
06/09/2005  02:33a          175,368 2977-2978_SM266_Malpais Mesa from road S
of SM266.jpg
06/09/2005  02:35a          231,204 2979-2980_SM267_View to N along alignment
- note trash and .jpg
06/09/2005  02:37a          192,604 2981-2982_SM267_View to S along
alignment.jpg
04/10/2005  04:07p          694,073 2983_SM267_Tsy outcrop and trash.JPG
04/10/2005  04:08p          706,731 2984_SM267_Closeup of Tsy - gravelly
Sandstone.JPG
06/09/2005  02:40a          381,922 2985-2986_SM267_Trash in the area.jpg
04/10/2005  04:25p          444,983 2987_SM267_Bike Trailhead sign S of
SM267.JPG
06/09/2005  02:43a          271,496 2988-2991_SM267_Pan to SE toward
Goldfield Hills.jpg
06/09/2005  02:44a          223,905 2992-2993_SM268_View to SE.jpg
06/09/2005  02:45a          206,955 2994-2995_SM268_View to N.jpg
06/09/2005  02:46a          349,700 2996-2998_SM268_View to S at south part
of Malpai Mesa.jpg
04/10/2005  05:43p          480,525 2999_SM268_Tsy outcrop near
Slaughterhouse Spring.JPG
04/10/2005  05:47p          603,930 3000_SM268_Friable Tsy.JPG
04/10/2005  05:47p          471,436 3001_SM268_Tsy outcrop.JPG
04/10/2005  05:55p          566,310 3002_SM268_Adit at Slaughterhouse
Spring.JPG
06/09/2005  02:51a          266,552 3003-3005_SM269_View to W att slides in
Malpais Mesa slope.jpg
06/09/2005  02:53a          215,203 3006-3007_SM269_Malpais Mesa.jpg
06/09/2005  02:54a          271,395 3008-3009_SM269_Malpais Mesa.jpg
06/09/2005  02:55a          217,338 3010_SM270_Rabbit Spring.JPG
04/10/2005  12:00p          443,744 3011_SM270_AG standing on Tsy at Rabbit
Spring.JPG
06/09/2005  02:59a          342,992 3012-3014_SM270_View SE along
alignment.jpg
06/09/2005  03:01a          226,680 3015-3016_SM270_View to NE at bluff above
water tanks.jpg
04/10/2005  12:26p          379,944 3017_SM271_Cut slope at uppermost water
tank.JPG
04/10/2005  12:26p          508,744 3018_SM271_Cut in Tsy sandstone and tuff
beds.JPG
04/10/2005  12:38p          412,982 3019_SM271_Tsy Tuff.JPG
06/09/2005  03:06a          268,261 3020-3022_SM271_View of Goldfield from
upper water tank.jpg
04/10/2005  12:49p          460,099 3023_SM271_Closeup of Tsy beds behind
water tank.JPG
```

```
06/09/2005  03:08a               172,466 3024-3025_SM271_View to SE along
alignment.jpg
06/09/2005  03:10a               148,759 3026_SM271_Malpais Mesa behind Rabbit
Spring.JPG
06/09/2005  03:13a               128,184 3027-3028_SM272_Hill off Spearhead Point
and Pozo Canyon.jpg
06/09/2005  03:15a               157,638 3029-3030_SM272_View up Pozo Canyon.jpg
06/09/2005  03:16a                99,255 3031_SM272_View from road to upper water
tank.JPG
06/09/2005  03:20a               282,606 3032-3034_SM273_View to NW from Hwy
95.jpg
04/11/2005  11:19a               439,992 3035_SM273_W side of basalt quarry.JPG
06/09/2005  03:22a               368,629 3036-3038_SM273_View to N at Hwy 95.jpg
06/09/2005  03:25a               226,116 3039-3040_SM273_View to SE.jpg
06/09/2005  03:26a               191,293 3041-3042_SM273_View to NW along
alignment.jpg
06/09/2005  03:27a               228,229 3043-3044_SM273_View to S.jpg
04/11/2005  11:54a               618,870 3045_SM273_View to S of outcrop and Hwy
95 emb slope.JPG
06/09/2005  03:32a               187,980 3046-3047_SM273_View to SW.jpg
04/11/2005  12:08p               628,776 3048_SM273_Tension cracks in W shoulder
Hwy 95 embankment.JPG
06/09/2005  03:34a               244,626 3049-3051_SM273_View to ENE.jpg
04/11/2005  12:28p               388,590 3052_SM273_Decomposed tuffaceous
sediments exposed in Hwy 95 cut.JPG
              51 File(s)     17,785,639 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S45

10/31/2006  08:02p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/09/2005  03:20a               282,606 3032-3034_SM273_View to NW from Hwy
95.jpg
04/11/2005  11:19a               439,992 3035_SM273_W side of basalt quarry.JPG
06/09/2005  03:22a               368,629 3036-3038_SM273_View to N at Hwy 95.jpg
06/09/2005  03:25a               226,116 3039-3040_SM273_View to SE.jpg
06/09/2005  03:26a               191,293 3041-3042_SM273_View to NW along
alignment.jpg
06/09/2005  03:27a               228,229 3043-3044_SM273_View to S.jpg
04/11/2005  11:54a               618,870 3045_SM273_View to S of outcrop and Hwy
95 emb slope.JPG
06/09/2005  03:32a               187,980 3046-3047_SM273_View to SW.jpg
04/11/2005  12:08p               628,776 3048_SM273_Tension cracks in W shoulder
Hwy 95 embankment.JPG
06/09/2005  03:34a               244,626 3049-3051_SM273_View to ENE.jpg
04/11/2005  12:28p               388,590 3052_SM273_Decomposed tuffaceous
sediments exposed in Hwy 95 cut.JPG
04/11/2005  01:30p               589,108 3053_SM274_Old aerial survey panel.JPG
04/11/2005  01:31p               569,342 3054_SM274_Monument at old survey
panel.JPG
06/09/2005  03:41a               258,842 3055-3057_SM274_View to W along
alignment.jpg
06/09/2005  03:42a               206,384 3058-3059_SM274_View to E along
alignment.jpg
04/11/2005  01:55p               562,777 3060_SM274_Closeup of Tsy ash-fall
tuff.JPG
```

```
06/09/2005  03:45a             234,929 3061-3062_SM274_View to NW of Tsy outcrop
and Myers Mountain.jpg
04/11/2005  02:03p             681,510 3063_SM274_Qay gravelly Sand in wash near
SM274.JPG
06/09/2005  03:48a             220,302 3064-3065_SM275_View to SE along
alignment - Blackcap Mt. behind.jpg
06/09/2005  03:50a             226,954 3066-3067_SM275_View to WSW along
alignment - Mira Mt in ba.jpg
04/11/2005  02:43p             447,689 3068_SM275_View to N at cut slope on old
RR grade.JPG
04/11/2005  02:47p             698,472 3069_SM275_Closeup of tuff exposed in old
RR grade cut slope.JPG
04/11/2005  03:17p             343,799 3070_SM275_View S toward Meda Pass.JPG
06/09/2005  03:55a             200,180 3071-3072_SM276_View to SW toward mine
tailings.jpg
06/09/2005  03:57a             212,644 3073-3074_SM276_View to WNW along
alignment - Myers Mt. at left.jpg
06/09/2005  03:58a             208,256 3075-3076_SM276_View to ESE along
alignment.jpg
04/11/2005  04:09p             403,307 3077_SM276_Prospect just S of
alignment.JPG
04/11/2005  04:14p             656,959 3078_SM276 Loose to med dense sandy fine
Gravel.JPG
04/11/2005  04:17p             406,395 3079_SM276_Blackcap Mountain.JPG
06/09/2005  04:02a             225,776 3080-3081_SM276_View to NW.jpg
04/11/2005  04:24p             751,609 3082_SM276_Closeup of hydrothermally
altered Ta3.JPG
06/09/2005  04:05a             210,450 3083-3084_SM277_Mine and tailings in
Tsy.jpg
04/11/2005  04:57p             453,798 3085_SM277_White tuff at mine.JPG
06/09/2005  04:07a             308,099 3086-3088_SM277_Tsy tuff mine - blocked
adit at left.jpg
04/11/2005  05:24p             705,522 3089_SM277_Brecciated rock at fault zone
just S of SM277.JPG
04/11/2005  05:25p             580,141 3090_SM277_Blocked adit in altered
Tsy.JPG
06/09/2005  04:11a             174,143 3091-3092_SM277_View to SSW down wash.jpg
06/09/2005  04:13a             217,331 3093-3095_SM277_View to NW up wash - note
claim stakes.jpg
04/11/2005  05:55p             719,943 3096_SM277_Qay gravelly Sand in wash.JPG
04/11/2005  11:03a             705,190 3097_SM277A_Closeup of brecciated Ta3 on
E side of wash.JPG
04/11/2005  11:07a             562,523 3098_SM277A_Breccia outcrop.JPG
06/09/2005  04:18a             226,101 3099-3100_SM278_View to S through cut at
Meda Pass.jpg
04/11/2005  11:40a             478,348 3101_SM278_View to N toward Meda Pass.JPG
06/09/2005  04:24a             273,128 3102-3104_SM279_View to S on old RR grade
at cut in Tst.jpg
06/09/2005  04:24a             121,687 3105_SM279_View to S in cut.JPG
04/11/2005  12:03p             479,889 3106_SM279_Jointing in Tst tuff.JPG
06/09/2005  04:26a             158,873 3107_SM279_View to N down cut.JPG
06/09/2005  04:27a             247,817 3108-3109_SM279_Missing bridge on old RR
grade.jpg
12/05/2005  01:27p           1,430,839 MG148_AG47_View S in wash .JPG
12/05/2005  01:28p           1,301,926 MG149_AG47_View N.JPG
12/05/2005  01:28p           1,258,117 MG150_AG47_View S.JPG
12/05/2005  02:02p           1,292,667 MG151_AG47_View N.JPG
```

```
12/05/2005  02:03p           1,215,240 MG152_AG47A_View S.JPG
12/05/2005  02:37p           1,238,769 MG153_AG48_View SSE Stonewall
Mountain.JPG
              54 File(s)     26,271,482 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S46

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
04/11/2005  01:04p             359,262 3110_SM280_View to SE toward Stonewall
Mt. from ol RR grade.JPG
06/09/2005  04:29a             198,038 3111-3112_SM280_View to S from N end of
cut in Tst.jpg
04/11/2005  01:12p             416,559 3113_SM280_View to S at E side of cut.JPG
04/11/2005  01:13p             465,065 3114_SM280_Shot rock at top of cut on E
side.JPG
04/11/2005  01:15p             498,731 3115_SM280_Shotrock placed at top of
slope.JPG
06/09/2005  04:32a             160,747 3116_SM280_Pile of shotrock.JPG
06/23/2005  06:48a             757,147 712-713_SM354_View to WSW.jpg
06/23/2005  06:50a           1,220,946 714-716_SM354_View to SE.jpg
06/23/2005  06:53a             787,284 717-718_SM354A_View to W of Tst tuff.jpg
05/08/2005  12:37p           1,001,372 719_SM354A_Caves in highly weathered
upper Tst layer.JPG
05/08/2005  12:37p           1,409,741 720_SM55_Holes in moderately weathered
lower layer.JPG
05/08/2005  01:00p           1,315,551 721_SM55_Qao gravelly sand.JPG
06/23/2005  06:58a           1,056,053 722-723_SM55_View to S - note boulders up
to 2 ft excavated.jpg
06/23/2005  06:59a             929,608 724-725_SM55_View to E toward GF1.jpg
12/05/2005  02:37p           1,238,769 MG153_AG48_View SSE Stonewall
Mountain.JPG
12/05/2005  03:00p           1,232,694 MG154_AG49_View NNW along old RR
grade.JPG
12/05/2005  03:00p           1,486,355 MG155_AG49_View SE along GF4.JPG
12/05/2005  03:38p           1,274,551 MG156_AG49_View NNE along GF4 and old RR
grade.JPG
12/05/2005  03:40p           1,293,234 MG157_AG49_View W of washout in old RR
grade.JPG
12/05/2005  11:19a           1,247,485 MG158_AG51_View N.JPG
12/05/2005  11:19a           1,430,399 MG159_AG51_View S along GF1, GF4,
Stonewall Mountain.JPG
12/05/2005  12:19p           1,023,724 MG160_AG52_View W of Tst.JPG
              22 File(s)     20,803,315 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S47

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
09/20/2004  11:02a           1,494,961 0182_SM31_Rock cut at fiber optic
trench.JPG
09/20/2004  11:03a           1,138,657 0183_SM31_Outcrop looking SE.JPG
09/20/2004  11:23a           1,143,860 0184_SM31_Looking SE along FOC at fill
location.JPG
03/23/2005  05:43p             200,260 1196-1198_SM29_View to NW along
alignment.jpg
```

```
03/23/2005  05:50p           200,049 1199-1201_SM29_View to SE along
alignment.jpg
06/23/2004  02:17p           367,273 1202_SM29_Basalt outcrop S of Hwy 95.JPG
03/23/2005  05:57p           330,061 1203-1205_SM30_View to NW at cut location
in Tm.jpg
03/23/2005  05:58p           205,283 1206-1207_SM30_Fiber optic bldg between
alignment and Hwy 95.jpg
06/23/2004  03:21p           506,774 1208_SM31_View to N into saddle and
outrcropping Tm .JPG
06/23/2004  03:21p           589,370 1209_SM31_Tm outcrop.JPG
06/23/2004  03:26p           520,782 1210_SM31_View to N into saddle.JPG
03/23/2005  11:06a           323,801 1211-1214_SM31_View to SE along
alignment.jpg
03/23/2005  11:08a           259,707 1215-1217_SM31_View to NW along
alignment.jpg
03/23/2005  11:13a           237,934 1218-1220_SM32_View to NW from Tolicha
Wash.jpg
03/23/2005  11:14a           333,534 1221-1224_SM32_View to NW across wash.jpg
03/23/2005  11:16a           200,986 1225-1226_SM32_Looking up wash at gravel
pits.jpg
06/23/2004  04:40p           495,467 1227_SM32_Slope at south bank of wash.JPG
06/23/2004  04:43p           429,695 1228_SM32_Culvert under Hwy 95.JPG
03/23/2005  11:25a           225,434 1229-1231_SM32_View to SE across Tolicha
Wash.jpg
03/23/2005  11:33a           184,319 1232-1234_SM33_View to SE along
alignment.jpg
03/23/2005  11:34a           201,320 1235-1237_SM33_View to NW at gravel
pit.jpg
06/23/2004  05:18p           434,411 1238_SM33_View into gravel pit.JPG
03/23/2005  11:40a           301,219 1239-1241_SM34_View to NE toward
alignment.jpg
06/23/2004  11:24a           402,151 1242_SM34_View to NE at saddle in
ridge.JPG
03/23/2005  11:00a           270,001 1251-1255_SM35_View to SE at Stonewall
Mtn.jpg
03/23/2005  11:06a           282,125 1256-1257_SM36_View to N through cut on
old RR grade.jpg
03/23/2005  11:12a           258,708 1258-1259_SM36_View to S through cut.jpg
06/23/2004  11:42a           512,852 1260_SM36_Cut in highly weathered Tm
tuff.JPG
03/24/2005  04:51p           251,608 1339-1341_SM55_View to S along old RR
grade.jpg
03/24/2005  04:59p           150,514 1342-1343_SM55_View to N along old RR
grade.jpg
05/09/2005  12:35p           647,263 3319_SM355_Med dense silty sand.JPG
05/08/2005  12:37p         1,409,741 720_SM55_Holes in moderately weathered
lower layer.JPG
05/08/2005  01:00p         1,315,551 721_SM55_Qao gravelly sand.JPG
06/23/2005  06:58a         1,056,053 722-723_SM55_View to S - note boulders up
to 2 ft excavated.jpg
06/23/2005  06:59a           929,608 724-725_SM55_View to E toward GF1.jpg
06/23/2005  07:01a           840,773 726-727_SM30_View to E of bldg foundation
excavation.jpg
05/08/2005  02:28p         1,095,105 728_SM30A_Closeup of basalt.JPG
05/08/2005  02:29p         1,424,672 729_SM30A_Basalt outcrop.JPG
05/08/2005  02:31p           822,102 730_SM30A_View downslope to Hwy 95.JPG
```

```
06/23/2005  07:07a               438,696 731-732_SM30A_View to NE along
alignment.jpg
06/23/2005  07:12a               580,177 733-734_SM30A_View to SW along
alignment.jpg
06/23/2005  07:15a               559,488 735-737_SM30B_View to SW.jpg
06/23/2005  07:15a               337,679 738_739_SM30B_View to NE.jpg
05/08/2005  02:42p             1,242,257 740_SM30_Calcite cement around basalt in
wash.JPG
06/23/2005  07:23a             1,052,907 741-743_SM355_Pan from W to N along
alignments.jpg
06/23/2005  07:24a               824,673 744-746_SM355_View to SE.jpg
              46 File(s)     27,029,861 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S48

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
05/09/2005  02:09p             1,452,804 753_SM356_Closeup of Qay soil.JPG
06/23/2005  07:39a             1,181,194 754-756_SM356_Pan from SE to S along
alignment, Alkali Flat.jpg
06/23/2005  07:41a             1,121,214 757-759_SM356_View to N along
alignment.jpg
06/23/2005  07:54a             1,164,253 770-771_SM357_View to S down wash.jpg
06/23/2005  08:00a               515,298 777-778_SM357A_View to WNW toward
alignment.jpg
               5 File(s)      5,434,763 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S49

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
05/09/2005  02:58p             1,422,190 760_near SM357_Old NTTR boundary sign.JPG
06/23/2005  07:46a             1,266,141 761-763_SM357_View to SE.jpg
06/23/2005  07:48a               950,265 764-765_SM357_View to WNW along BC2
alignment.jpg
05/09/2005  03:34p             1,382,146 769_SM357_View to E at soil exposed in
wash along road.JPG
06/23/2005  07:54a             1,164,253 770-771_SM357_View to S down wash.jpg
06/23/2005  07:56a             1,670,728 772-773_SM357_Med dense gravel.jpg
06/23/2005  07:58a               780,145 774-776_SM357A_View to SE toward BC2.jpg
06/23/2005  08:00a               515,298 777-778_SM357A_View to WNW toward
alignment.jpg
06/23/2005  08:03a               829,998 781-782_SM358A_View to S of S side of
wash.jpg
06/23/2005  08:09a             1,101,408 783-785_SM357B_View to E down main
channel.jpg
06/23/2005  08:11a             1,091,551 786-788_SM357B_View to NNW toward BC2.jpg
06/23/2005  08:15a               852,142 792-793_SM357B_View to NE toward BC2.jpg
06/23/2005  08:17a             1,024,502 794-796_SM358_View to SE down wash.jpg
06/23/2005  08:23a             1,645,408 797-800_SM358_View to NE across wash
toward BC2.jpg
05/09/2005  05:07p             1,382,125 802_SM358_Basalt slide block in wash.JPG
06/23/2005  08:30a             1,356,615 807-809_SM358A_View to ESE down wash.jpg
05/09/2005  05:16p               951,740 810_SM358A_View to W across wash.JPG
06/23/2005  08:39a               627,015 811-812_SM358A_View to S across wash.jpg
06/23/2005  08:36a               869,399 813-814_SM358A_View to N up fan.jpg
              19 File(s)     20,883,069 bytes
```

```
 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S50

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
05/09/2005  12:35p               647,263 3319_SM355_Med dense silty sand.JPG
06/23/2005  07:23a             1,052,907 741-743_SM355_Pan from W to N along
alignments.jpg
06/23/2005  07:24a               824,673 744-746_SM355_View to SE.jpg
06/23/2005  07:58a               780,145 774-776_SM357A_View to SE toward BC2.jpg
06/23/2005  08:17a             1,024,502 794-796_SM358_View to SE down wash.jpg
               5 File(s)      4,329,490 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S51

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
03/22/2005  11:38a               279,871 1162-1165_SM24_Pan from E to S.jpg
03/22/2005  11:40a               178,785 1166-1168_SM24_View to NW.jpg
03/22/2005  11:43a               245,907 1169-1171_SM25_View to NW.jpg
03/22/2005  11:45a               328,713 1172-1175_SM25_View to SE.jpg
03/23/2005  05:13p               227,526 1176-1178_SM26_View to NW along
alignment.jpg
03/23/2005  05:15p               331,297 1179-1182_SM26_View to SE along alignment
toward Oasis Mtn.jpg
03/23/2005  05:22p               474,577 1183-1189_SM27_View to NE toward
alignment on old rr grade.jpg
03/23/2005  05:34p               183,269 1190-1191_SM28_View to SE.jpg
03/23/2005  05:36p               354,776 1192-1195_SM28_View to NW along
alignment.jpg
03/23/2005  11:06a               323,801 1211-1214_SM31_View to SE along
alignment.jpg
06/24/2004  01:32p               449,300 1288_SM43_Hwy 95 cut slope in fan
alluvium,near SM26.JPG
06/24/2004  01:33p               475,593 1289_SM43_Cut slope looking N.JPG
06/24/2004  01:55p               499,380 1290_SM44_Looking N at Hwy 95 fill
slope.JPG
06/09/2005  02:16p               118,313 3243-3244_SM294_View to ENE.jpg
06/09/2005  02:17p               204,959 3245-3246_SM294_View to WSW.jpg
04/13/2005  01:02p               330,455 3247_SM294_Old car in wash.JPG
04/13/2005  01:07p               593,217 3248_SM294_Cemented gravel and cobbles in
Tsy outcrop expos.JPG
              17 File(s)      5,599,739 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S52

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
03/22/2005  11:28a               299,435 1101-1103_SM14_View to ESE.jpg
03/22/2005  11:29a               184,369 1104-1105_SM14_View to SSE.jpg
03/22/2005  11:32a               241,510 1106-1108_SM14_View to NW along
alignment.jpg
06/22/2004  01:50p               453,291 1109_near SM14_Outcrop of Ts in Ute
Spring Wash.JPG
06/22/2004  02:04p               398,189 1110_near SM14_Burro standing on QTau.JPG
03/22/2005  11:47a               257,926 1111-1113_SM15_View to NW.jpg
```

```
03/22/2005  11:49a               294,457 1114-1117_SM15_View to SE, Bare Mtn in
back.jpg
06/22/2004  04:20p               520,392 1118_SM16_N side of channel.JPG
03/22/2005  11:57a               303,162 1119-1120_SM16_S side of channel.jpg
06/22/2004  04:22p               398,088 1121_SM16_View upstream.JPG
03/22/2005  11:59a               280,476 1122-1123_SM16_View downstream.jpg
03/22/2005  11:06a               213,065 1124-1126_SM17_View to NW along OV1.jpg
03/22/2005  11:07a               257,908 1127-1129_SM17_View to SE along OV1.jpg
03/22/2005  11:11a               244,012 1130-1132_SM18_View to NW.jpg
03/22/2005  11:12a               234,192 1133-1135_SM18_View to SE.jpg
03/22/2005  11:15a               221,044 1136-1138_SM19_View to NW along OV1.jpg
03/22/2005  11:16a               240,195 1139-1141_SM19_View to SE along OV1.jpg
03/22/2005  11:20a               237,726 1142-1143_SM20_View to SE along OV1 from
tributary wash.jpg
06/22/2004  05:40p               446,898 1144_SM20_View to SE across broad
wash.JPG
03/22/2005  11:25a               285,890 1145-1147_SM21_View to N at Amargosa
River.jpg
03/22/2005  11:27a               415,690 1148-1151_SM21_View to S.jpg
03/22/2005  11:30a               317,117 1152-1155_SM22_View to E and SE toward
OV1 and OV3.jpg
03/22/2005  11:32a               272,175 1156-1158_SM23_View to SE along
alignment.jpg
03/22/2005  11:34a               246,234 1159-1161_SM23_View to NW.jpg
09/14/2004  03:22a               246,588 1384-1386_SM57_Amargosa River view to
NE.jpg
09/14/2004  03:25a               131,299 1387_SM58_Amargosa River view
upstream.JPG
08/23/2004  12:54p               543,249 1388_SM58_Amargosa River-gravel & sand in
channel.JPG
09/14/2004  03:32a               162,382 1389-1390_SM58_Amargosa River view
downstream.jpg
06/09/2005  01:38p               187,903 3189-3190_SM23_View to N along OV3.jpg
06/09/2005  01:39p               176,852 3191-3192_SM23_View to S along
alignment.jpg
04/13/2005  11:37a               697,271 3193_SM23_Tsy sandstone pieces.JPG
04/13/2005  11:38a               687,466 3194_SM23_Sandstone pieces from upper 6-
12 inches.JPG
04/13/2005  12:14p               692,061 3195_SM18_Tsy sandstone outcrop.JPG
              33 File(s)     10,788,512 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S53

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
03/22/2005  11:28a               299,435 1101-1103_SM14_View to ESE.jpg
03/22/2005  11:29a               184,369 1104-1105_SM14_View to SSE.jpg
03/22/2005  11:32a               241,510 1106-1108_SM14_View to NW along
alignment.jpg
06/22/2004  01:50p               453,291 1109_near SM14_Outcrop of Ts in Ute
Spring Wash.JPG
06/22/2004  02:04p               398,189 1110_near SM14_Burro standing on QTau.JPG
03/22/2005  11:30a               317,117 1152-1155_SM22_View to E and SE toward
OV1 and OV3.jpg
03/22/2005  11:32a               272,175 1156-1158_SM23_View to SE along
alignment.jpg
03/22/2005  11:34a               246,234 1159-1161_SM23_View to NW.jpg
```

```
06/09/2005  01:38p               187,903 3189-3190_SM23_View to N along OV3.jpg
06/09/2005  01:39p               176,852 3191-3192_SM23_View to S along
alignment.jpg
04/13/2005  11:37a               697,271 3193_SM23_Tsy sandstone pieces.JPG
04/13/2005  11:38a               687,466 3194_SM23_Sandstone pieces from upper 6-
12 inches.JPG
              12 File(s)      4,161,812 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S54

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/09/2005  01:52p               216,791 3212-3213_SM293_View to NW along
alignment.jpg
06/09/2005  01:53p               194,711 3214-3215_SM293_View to SE along
alignment.jpg
04/13/2005  03:24p               700,070 3216_SM293_Closeup of Qc sand.JPG
06/09/2005  01:55p               214,051 3217-3218_SM293_View upstream to NE.jpg
04/13/2005  04:10p               708,533 3219_SM293A_Closeup of Qao gravel in bank
of wash.JPG
04/13/2005  04:16p               412,026 3220_SM293A_View to NW from ridge SE of
SM293.JPG
06/09/2005  01:59p               196,230 3221-3222_SM293A_View to SE from
ridge.jpg
06/09/2005  02:00p               212,856 3223-3224_SM293B_View to SE along
alignment.jpg
06/09/2005  02:01p               202,157 3225-3226_SM293B_View to NW along
alignment.jpg
04/13/2005  04:40p               651,530 3228_SM293B_Tvr rhyolite outcrop.JPG
04/13/2005  04:46p               617,726 3229_SM293B_Tvr outcrop.JPG
06/09/2005  02:11p               159,013 3230-3231_SM293C_View to NW across
wash.jpg
04/13/2005  05:56p               407,895 3232_SM293C_View to SE along
alignment.JPG
04/13/2005  11:14a               601,036 3233_SM293C_Dense white Sand exposed in W
bank of wash.JPG
04/13/2005  11:22a               742,711 3234_SM293D_Basalt gravel in upper
foot.JPG
06/09/2005  02:11p               154,186 3235-3236_SM293D_View to WNW.jpg
04/13/2005  11:26a               401,004 3237_SM293D_View to SE.JPG
04/13/2005  11:26a               415,843 3238_SM293D_View to S of Colson Pond.JPG
04/13/2005  11:40a               604,351 3239_SM293E_Lizard on Basalt boulder.JPG
04/13/2005  11:42a               387,939 3240_SM293E_QTb basalt outcrop.JPG
06/09/2005  02:14p               123,665 3241_SM293E_QTb basalt along W bank of
wash.JPG
04/13/2005  11:55a               526,512 3242_SM293F_Spring.JPG
              22 File(s)      8,850,836 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S55

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
03/22/2005  11:28a               299,435 1101-1103_SM14_View to ESE.jpg
03/22/2005  11:29a               184,369 1104-1105_SM14_View to SSE.jpg
03/22/2005  11:32a               241,510 1106-1108_SM14_View to NW along
alignment.jpg
```

```
06/22/2004  01:50p               453,291 1109_near SM14_Outcrop of Ts in Ute
Spring Wash.JPG
06/22/2004  02:04p               398,189 1110_near SM14_Burro standing on QTau.JPG
03/22/2005  11:32a               272,175 1156-1158_SM23_View to SE along
alignment.jpg
03/22/2005  11:34a               246,234 1159-1161_SM23_View to NW.jpg
06/09/2005  01:38p               187,903 3189-3190_SM23_View to N along OV3.jpg
06/09/2005  01:39p               176,852 3191-3192_SM23_View to S along
alignment.jpg
04/13/2005  11:37a               697,271 3193_SM23_Tsy sandstone pieces.JPG
04/13/2005  11:38a               687,466 3194_SM23_Sandstone pieces from upper 6-
12 inches.JPG
04/13/2005  12:14p               692,061 3195_SM18_Tsy sandstone outcrop.JPG
06/09/2005  01:43p               273,432 3196-3197_SM292_View to NNE across
wash.jpg
06/09/2005  01:44p               174,711 3198-3199_SM292_View to SSW along
alignment.jpg
04/13/2005  12:55p               578,202 3200_SM292_Closeup of Qam sand.JPG
06/09/2005  01:46p               251,652 3201-3202_SM292_View to N from road in
wash.jpg
06/09/2005  01:47p               219,958 3203-3204_SM292_View to S from road in
wash.jpg
06/09/2005  01:48p               207,583 3205-3206_SM292_View upstream.jpg
06/09/2005  01:48p               232,872 3207-3208_SM292_View downstream.jpg
04/13/2005  01:17p               419,378 3209_SM292_View to S from N abutment.JPG
06/09/2005  01:50p               194,297 3210-3211_SM292_View to NNE from N
abutment.jpg
              21 File(s)      7,088,841 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S56

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/20/2004  11:32a           1,249,986 0053_NM17_Sandstone outcrop.JPG
06/20/2004  11:11a           1,106,883 0055_NM19-20_View to S of Tmar, Tmrf on S
side Beatty Wash.JPG
06/20/2004  11:35a           1,360,589 0056_NM20_Jointing in Tmar.JPG
06/20/2004  11:36a           1,152,270 0057_NM20_Tmar.JPG
03/22/2005  05:21p             975,820 0065-0067_NM19-20_View to S of S side of
Beatty Wash.jpg
03/22/2005  05:03p             283,034 1099-1100_NM19_Tmr exposed on N side
Beatty Wash.jpg
03/22/2005  11:28a             299,435 1101-1103_SM14_View to ESE.jpg
03/22/2005  11:29a             184,369 1104-1105_SM14_View to SSE.jpg
               8 File(s)      6,612,386 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S57

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/20/2004  11:11a           1,106,883 0055_NM19-20_View to S of Tmar, Tmrf on S
side Beatty Wash.JPG
06/20/2004  12:29p           1,538,315 0058-0059_NM21_Tmrf outcrop.JPG
06/20/2004  12:41p           1,032,610 0060_NM21_View N across Beatty Wash.JPG
03/22/2005  05:46p           1,056,584 0061-0062_NM21_View to NNW across Beatty
Wash.jpg
```

```
03/22/2005  05:45p         1,053,739 0063-0064_NM21_View to N across Beatty
Wash.jpg
03/22/2005  05:21p           975,820 0065-0067_NM19-20_View to S of S side of
Beatty Wash.jpg
06/21/2004  12:49p         1,407,480 0069_NM22-23_Closeup of Tmrf.JPG
06/21/2004  12:50p         1,415,569 0070_NM22-23_Tmrf outcrop.JPG
06/21/2004  12:53p         1,427,172 0071_NM22_Tmar Tmrf outcrops at 130' cut
location.JPG
06/21/2004  01:15p         1,288,909 0072_NM22-23_Tmrf outcrop.JPG
03/22/2005  11:04a           959,081 0073-0074_NM24_View to S.jpg
06/21/2004  02:05p         1,122,415 0075_NM25_View to N.JPG
06/21/2004  02:05p         1,043,836 0076_NM25_View to the N.JPG
06/21/2004  02:22p         1,047,998 0077_NM25_View to the N.JPG
06/21/2004  02:23p           934,634 0078-0079_NM26_View to N of Tp exposed in
cliffs.JPG
03/22/2005  11:19a           772,952 0080_NM27_View to SE across faulted Tp
toward Crater Flat .JPG
06/21/2004  02:44p         1,109,749 0081_NM27_View to NW of Tpm outcrops in
Tram Ridge.JPG
06/21/2004  03:11p         1,102,092 0082_NM28_1.JPG
06/21/2004  03:25p           999,110 0083_NM28_2.JPG
06/21/2004  03:25p         1,026,634 0084_NM28_3.JPG
06/21/2004  03:38p         1,188,251 0085_NM28_4.JPG
06/21/2004  03:47p         1,484,607 0086_NM28_5.JPG
03/22/2005  04:37p           290,034 1083-1085_SM11_View to W along
alignment.jpg
03/22/2005  04:39p           233,693 1086-1088_SM11_View to E, note prospects
in Bare Mtn Fault zone.jpg
06/21/2004  04:02p           520,472 1089_SM12_Fault breccia at right,
unaltered tuff at left.JPG
06/21/2004  04:21p           650,848 1090_SM12_Closeup of fault breccia.JPG
03/22/2005  04:50p           411,156 1091-1094_SM13_View to NW.jpg
03/22/2005  04:52p           288,674 1095-1096_SM13_View to SE.jpg
03/22/2005  05:00p           253,537 1097-1098_near SM11_Road cut.jpg
06/09/2005  11:40a           280,670 3122-3124_SM281_View from NE to N.jpg
04/12/2005  12:24p           652,128 3125_SM281_Closeup of Tuff in wash.JPG
06/09/2005  11:42a           155,344 3126-3127_SM282_View to SE.jpg
06/09/2005  11:43a           249,577 3128-3129_SM282_View to NW.jpg
04/12/2005  01:12p           465,229 3130_SM282_Prospect trench E of SM282.JPG
04/12/2005  01:19p           681,601 3131_SM282_Hammer on fault exposed in
prospect trench.JPG
04/12/2005  01:19p           712,173 3132_SM282_Prospect trench looking SW.JPG
04/12/2005  01:21p           634,685 3133_SM282_Closeup of Tpc- Tiva Canyon
Tuff.JPG
06/09/2005  11:48a           244,936 3134-3135_SM283_View to N.jpg
06/09/2005  11:50a           201,795 3136-3137_SM283_View to SW.jpg
04/12/2005  02:15p           608,625 3138_SM284_Closeup of Tiva Canyon Tuff
Tp.JPG
04/12/2005  02:16p           565,279 3139_SM284_Jointing in Tpc.JPG
04/12/2005  02:39p           670,747 3140_SM285_Tiva Canyon Tuff outcrop.JPG
04/12/2005  02:39p           553,827 3141_SM285_Closeup of Tiva Canyon
Tuff.JPG
04/12/2005  02:45p           560,895 3142_SM285_Fault in prospect trench
looking NE.JPG
04/12/2005  02:45p           631,144 3143_SM285_Fault scarp up wash from
SM285.JPG
04/12/2005  03:00p           435,882 3144_SM285_View toward fault scarp.JPG
```

```
04/12/2005  03:02p               672,529 3145_SM285_Slickensides along fault
scarp, rock is a breccia.JPG
06/09/2005  11:58a               346,925 3146-3148_SM286_View to NW from top of
ridge.jpg
06/09/2005  12:00p               404,060 3149-3151_SM286_View to NE toward saddle
at fault.jpg
06/09/2005  12:01p               235,491 3152-3153_SM286_View to SE.jpg
04/12/2005  03:42p               563,218 3154_SM286_View to NE toward alignment
from ridge.JPG
04/12/2005  04:00p               727,508 3155_SM286_Outcrop in saddle - broken up
Tpc in fault zone.JPG
06/09/2005  12:07p               405,377 3156-3158_SM286_View W.jpg
06/09/2005  12:08p               382,101 3159-3161_SM287_View to W down fault
controlled wash.jpg
04/12/2005  04:25p               576,810 3162_SM288_Tpc outcrop.JPG
06/09/2005  12:10p               277,295 3163-3164_SM288_View to W toward
alignment.jpg
04/12/2005  04:38p               651,518 3165_SM288_Knobby weathering pattern in
tuff.JPG
04/12/2005  04:55p               680,872 3166_SM289_Mine in oxidized, brecciated
rock.JPG
06/09/2005  12:13p               362,794 3167-3169_SM289_View to SE.jpg
06/09/2005  12:14p               336,482 3170-3172_SM289_View to NW.jpg
04/12/2005  05:14p               692,447 3173_SM289_Outcrop of Tpt.JPG
06/09/2005  12:17p               261,948 3174-3175_SM290_View to SE toward ridge
and saddle.jpg
06/09/2005  12:18p               230,910 3176-3177_SM290_View to NW toward
alignment.jpg
04/12/2005  05:31p               466,185 3178_SM290_View to E-note track running
up to prospects.JPG
06/09/2005  12:20p               234,598 3179-3180_SM291_View to SE toward ridge
at SM290.jpg
06/09/2005  12:21p               255,901 3181-3182_SM291_View to NW.jpg
06/09/2005  12:22p               344,644 3183-3184_SM291_View to E.jpg
04/12/2005  05:57p               642,896 3185_SM291_Tmrf outcrop.JPG
04/12/2005  11:23a               647,705 3186_SM289_Mine and breccia.JPG
04/12/2005  11:37a               541,875 3187_SM288_Knobby tuff.JPG
04/12/2005  12:06p               400,490 3188_SM281_Mine just N of SM281.JPG
              71 File(s)     47,389,970 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S58

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/19/2004  04:00p               875,872 0022_near NM7_View to S down Crater
Flat.JPG
06/19/2004  04:02p               976,485 0023_near NM7_View to W toward Tram
Ridge.JPG
03/22/2005  04:27p               222,041 1076-1078_SM9_View to NW toward Tram
Ridge.jpg
03/22/2005  04:29p               264,173 1079-1081_SM9_View to SE along alignment,
Yucca Mtn at left.jpg
06/21/2004  01:28p               451,448 1082_SM10_Outcrop of Tmrf.JPG
03/22/2005  04:37p               290,034 1083-1085_SM11_View to W along
alignment.jpg
03/22/2005  04:39p               233,693 1086-1088_SM11_View to E, note prospects
in Bare Mtn Fault zone.jpg
```

```
03/22/2005  05:00p             253,537 1097-1098_near SM11_Road cut.jpg
06/09/2005  11:33a             141,275 3117-3118_NM7_View to SW into Crater
Flat.jpg
06/09/2005  11:35a             226,397 3119-3120_NM7_View to NE.jpg
04/12/2005  11:52a             723,038 3121_NM7_Closeup of very dense Qao
gravel.JPG
06/09/2005  11:40a             280,670 3122-3124_SM281_View from NE to N.jpg
04/12/2005  12:06p             400,490 3188_SM281_Mine just N of SM281.JPG
              13 File(s)      5,339,153 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S59

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
03/22/2005  01:29p             210,098 1045-1046_SM2_View WNW, Black Cone and
Red Cone.jpg
06/20/2004  04:57p             401,483 1047_SM3_Well USW WT-10.JPG
03/22/2005  01:51p             435,142 1048-1050_SM4_View to W of Fatigue Wash
Fault scarp in alluvium.jpg
03/22/2005  01:58p             212,124 1051-1053_SM5_View to NW along alignment
through Crater Flat.jpg
03/22/2005  02:00p             271,314 1054-1056_SM5_View to SE along
alignment.jpg
06/20/2004  05:44p             413,064 1057_SM6_Unmarked well in Crater Flat.JPG
03/22/2005  02:04p             418,982 1058-1063_SM7_View to NW.jpg
03/22/2005  02:09p             269,208 1064-1066_SM7_View to SE.jpg
06/20/2004  11:55a             292,494 1067_near SM8_Nellis perimeter.JPG
03/22/2005  02:21p             218,825 1068-1071_SM8_View to NW.jpg
03/22/2005  02:22p             201,671 1072-1074_SM8_View to SE.jpg
06/20/2004  12:43p             379,073 1075_SM8_View to E of Tmrf ridges.JPG
              12 File(s)      3,723,478 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S60

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/18/2004  04:54p             991,368 0005_NM1_View to NE of Busted Butte and
Jackass Flat.JPG
06/18/2004  11:40a           1,337,758 0008_NM3_View to SE of Qay over Tpc in
wash.JPG
06/18/2004  11:00a           1,047,888 0009_NM2_View to NE of Tpc outcrop at
Stagecoach Rd Fault splay.JPG
06/18/2004  11:03a             942,442 0010-0012_NM3_View to N of Iron Ridge
Fault zone.JPG
06/18/2004  11:35a           1,406,508 0013_NM3_View to SE of Tpc exposed on
Iron Ridge Fault.JPG
03/22/2005  01:42p             364,656 1031-1034_SM1_View to NW across Crater
Flat.jpg
03/22/2005  01:45p             252,638 1035-1037_SM1_View to SE toward Iron
Ridge.jpg
03/22/2005  01:39p             364,035 1038-1041_SM2_View to SE along
alignment.jpg
03/22/2005  01:36p             189,861 1042-1044_SM2_View to NW along
alignment.jpg
03/22/2005  01:29p             210,098 1045-1046_SM2_View WNW, Black Cone and
Red Cone.jpg
06/20/2004  04:57p             401,483 1047_SM3_Well USW WT-10.JPG
```

```
03/22/2005  01:51p               435,142 1048-1050_SM4_View to W of Fatigue Wash
Fault scarp in alluvium.jpg
              12 File(s)      7,943,877 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S61

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
06/18/2004  04:54p               991,368 0005_NM1_View to NE of Busted Butte and
Jackass Flat.JPG
06/18/2004  11:40a             1,337,758 0008_NM3_View to SE of Qay over Tpc in
wash.JPG
06/18/2004  11:00a             1,047,888 0009_NM2_View to NE of Tpc outcrop at
Stagecoach Rd Fault splay.JPG
06/18/2004  11:03a               942,442 0010-0012_NM3_View to N of Iron Ridge
Fault zone.JPG
06/18/2004  11:35a             1,406,508 0013_NM3_View to SE of Tpc exposed on
Iron Ridge Fault.JPG
03/03/2005  03:20p               742,779 2729_SM232_Outcrop of Qay in wash.JPG
03/24/2005  11:48a               254,998 2730-2732_SM232_Pan to N toward
alignment.jpg
03/24/2005  11:50a               226,745 2733-2734_SM232_View to W down Stagecoach
Rd.jpg
03/03/2005  03:29p               532,724 2735_SM232_View to SW down wash.JPG
03/03/2005  03:58p               465,681 2736_SM233_Well WT-12 pad.JPG
03/03/2005  04:14p               702,341 2737_SM234_Qam exposure in  wash.JPG
03/03/2005  04:15p               712,535 2738_SM234_Qam alluvium in wash.JPG
03/24/2005  11:02a               211,752 2739-2740_SM234_View to S - Iron Ridge at
right.jpg
03/24/2005  11:07a               296,107 2741-2743_SM234_View to SE toward W side
Busted Butte.jpg
03/24/2005  11:12a               222,539 2744-2745_SM235_View to SE to Busted
Butte.jpg
03/24/2005  11:15a               181,525 2746-2747_SM235_View to S - Iron Ridge at
right.jpg
03/03/2005  04:43p               555,634 2748_SM235_Closeup of Tpc - Tiva Canyon
tuff.JPG
03/03/2005  04:43p               483,160 2749_SM235_Tpc outcrop.JPG
03/03/2005  05:52p               639,925 2750_SM236_Qe sand between WT-12 road and
SW slope Busted Butte.JPG
03/24/2005  11:24a               324,795 2751-2752_SM237_Qe sand ramps up against
Tpt tuff.jpg
03/03/2005  11:02a               596,196 2753_SM237_Calcite filled joints in
Tpt.JPG
03/24/2005  11:28a               369,447 2754-2755_SM237_Tpt outcrop looking
NE.jpg
03/24/2005  11:29a               179,564 2756-2757_SM238_Muck Pile and North
Portal in background.jpg
03/03/2005  11:19a               357,439 2758_SM238_Closer view of muck pile.JPG
03/24/2005  11:41a               208,247 2759-2761_SM238_View to N.jpg
03/24/2005  11:49a               200,974 2762-2763_SM239_View to S.jpg
03/24/2005  11:48a               194,423 2764-2766_SM239_View to N.jpg
03/03/2005  11:38a               390,973 2767_SM239_View to E toward N end Fran
Ridge.JPG
03/24/2005  11:53a               367,734 2768-2771_SM240_View to E across Midway
Valley.jpg
```

03/24/2005 11:56a 204,649 2772-2774_SM240_Pan Se to S down Midway Valley.jpg
03/24/2005 11:58a 320,299 2775-2777_SM240_View to NE to North Pad.jpg
03/24/2005 12:08p 225,985 2778-2780_SM241_View to NE.jpg
03/24/2005 12:08p 218,675 2781-2783_SM241_View to SW.jpg
03/24/2005 12:11p 173,663 2784_SM242_Outcrop of Tmr at S end Rainier Ridge.JPG
03/24/2005 12:14p 188,788 2785-2787_SM242_View to NE toward Bow Ridge.jpg
03/04/2005 12:29p 399,395 2788_SM242_View to N looking into dominant joint set.JPG
03/04/2005 12:35p 478,113 2789_SM242_Closeup of Tmr tuff.JPG
03/25/2005 11:38a 161,423 2790-2791_SM243_Sand ramp on NW side of Busted Butte.jpg
03/25/2005 11:38a 229,751 2792-2793_SM243_Tiva Cyn and Rainier Mesa tuff contact.jpg
03/25/2005 11:38a 248,965 2794_SM243_Closeup of Tmr.JPG
03/25/2005 11:39a 227,494 2795-2796_SM243_View to W along Tmr-Tpc contact.jpg
03/25/2005 11:39a 252,053 2797-2800_SM243_View E.jpg
03/25/2005 11:41a 120,216 2801_SM244_Tmr - Rainier Mesa Tuff outcrop.JPG
03/04/2005 01:53p 545,813 2802_SM244_Closeup of moderate strength Tmr.JPG
03/25/2005 11:43a 291,102 2803-2805_SM244_Pan N to NE, Crest Rd, Rainier and Bow Rdgs.jpg
03/25/2005 11:47a 171,466 2806_SM244_Outcrop of high strength Tmr.JPG
03/04/2005 02:10p 409,928 2807_SM245_Erosion patterns in sand ramp on Busted Butte.JPG
03/04/2005 02:17p 492,085 2808-2809_SM245_Weathered faces on Tpc Tiva Canyon Tuff outcrop.JPG
03/25/2005 12:05p 304,446 2810-2812_SM246_View to NW, Rainier, Bow Rdgs, Fran Rdg at rt.jpg
03/04/2005 02:35p 550,396 2813_SM246_Qe sand on NW side Busted Butte.JPG
03/25/2005 12:19p 155,480 2814_SM247_Highly sheared Tpt near Paintbrush Cyn Fault.JPG
03/25/2005 12:23p 376,752 2815-2817_SM247_Tpt outcrop, note fault gouge.jpg
03/25/2005 12:24p 337,425 2818-2819_SM247_View to SE at shear zone next to notebook.jpg
03/25/2005 12:53p 193,132 2820_SM247_View to WNW at Tpt outcrop.JPG
03/25/2005 12:53p 238,098 2821-2823_SM248_View NNW up Midway Valley, Bow Rdg at lt.jpg
03/25/2005 12:58p 205,971 2824-2826_SM249_Looking SSW from Bow Ridge, Busted Butte at left.jpg
03/25/2005 01:02p 235,450 2827-2829_SM249_View to W across Rainier Ridge.jpg
03/25/2005 01:03p 228,050 2830-2831_SM249_View to NW up Bow Ridge.jpg
03/25/2005 01:09p 239,259 2832-2835_SM249_View to N up E slope Bow Ridge,.jpg
03/04/2005 05:00p 650,235 2836_SM249_Tiva Canyon Tuff Tpc outcrop.JPG

```
03/04/2005  05:46p               442,209 2837_SM250_Exposure of Qam in tributary
to Fortymile Wash.JPG
03/04/2005  05:55p               605,472 2838_SM250_Bedding in Qam.JPG
03/04/2005  05:55p               494,001 2839_SM250_Gravel and sand layers in
Qam.JPG
03/25/2005  02:22p               217,948 2840-2842_SM251_View to S along alignment
from FMF site.jpg
03/25/2005  02:24p               227,938 2843-2845_SM251_View to N from FMF site
in Midway Valley.jpg
03/04/2005  11:45a               436,018 2846_SM252_Tpc outcrop on H Road at north
end Fran Rdg.JPG
03/25/2005  02:34p               229,099 2847-2849_SM252_View to W across Midway
Valley.jpg
03/04/2005  11:54a               561,134 2850_SM252_Notebook on flat dominant
joint face in Tpc outcrop.JPG
03/04/2005  11:57a               337,730 2851_SM252_North Portal and muck pile.JPG
03/04/2005  11:59a               589,392 2852_SM252_Joint sets in Tpc.JPG
              70 File(s)     28,359,699 bytes

 Directory of D:\CalienteGeotechRpt,AppxH-Photos\S62

08/13/2007  06:13p      <DIR>          .
08/13/2007  06:13p      <DIR>          ..
03/03/2005  03:20p               742,779 2729_SM232_Outcrop of Qay in wash.JPG
03/24/2005  11:48a               254,998 2730-2732_SM232_Pan to N toward
alignment.jpg
03/24/2005  11:50a               226,745 2733-2734_SM232_View to W down Stagecoach
Rd.jpg
03/03/2005  03:29p               532,724 2735_SM232_View to SW down wash.JPG
03/03/2005  03:58p               465,681 2736_SM233_Well WT-12 pad.JPG
03/03/2005  04:14p               702,341 2737_SM234_Qam exposure in  wash.JPG
03/03/2005  04:15p               712,535 2738_SM234_Qam alluvium in wash.JPG
03/24/2005  11:02a               211,752 2739-2740_SM234_View to S - Iron Ridge at
right.jpg
03/24/2005  11:07a               296,107 2741-2743_SM234_View to SE toward W side
Busted Butte.jpg
03/24/2005  11:12a               222,539 2744-2745_SM235_View to SE to Busted
Butte.jpg
03/24/2005  11:15a               181,525 2746-2747_SM235_View to S - Iron Ridge at
right.jpg
03/03/2005  04:43p               555,634 2748_SM235_Closeup of Tpc - Tiva Canyon
tuff.JPG
03/03/2005  04:43p               483,160 2749_SM235_Tpc outcrop.JPG
03/03/2005  05:52p               639,925 2750_SM236_Qe sand between WT-12 road and
SW slope Busted Butte.JPG
03/24/2005  11:24a               324,795 2751-2752_SM237_Qe sand ramps up against
Tpt tuff.jpg
03/03/2005  11:02a               596,196 2753_SM237_Calcite filled joints in
Tpt.JPG
03/24/2005  11:28a               369,447 2754-2755_SM237_Tpt outcrop looking
NE.jpg
03/24/2005  11:29a               179,564 2756-2757_SM238_Muck Pile and North
Portal in background.jpg
03/03/2005  11:19a               357,439 2758_SM238_Closer view of muck pile.JPG
03/24/2005  11:41a               208,247 2759-2761_SM238_View to N.jpg
03/24/2005  11:49a               200,974 2762-2763_SM239_View to S.jpg
03/24/2005  11:48a               194,423 2764-2766_SM239_View to N.jpg
```

```
03/03/2005  11:38a           390,973 2767_SM239_View to E toward N end Fran
Ridge.JPG
03/24/2005  11:53a           367,734 2768-2771_SM240_View to E across Midway
Valley.jpg
03/24/2005  11:56a           204,649 2772-2774_SM240_Pan Se to S down Midway
Valley.jpg
03/24/2005  11:58a           320,299 2775-2777_SM240_View to NE to North
Pad.jpg
03/24/2005  12:08p           225,985 2778-2780_SM241_View to NE.jpg
03/24/2005  12:08p           218,675 2781-2783_SM241_View to SW.jpg
03/24/2005  12:11p           173,663 2784_SM242_Outcrop of Tmr at S end
Rainier Ridge.JPG
03/24/2005  12:14p           188,788 2785-2787_SM242_View to NE toward Bow
Ridge.jpg
03/04/2005  12:29p           399,395 2788_SM242_View to N looking into
dominant joint set.JPG
03/04/2005  12:35p           478,113 2789_SM242_Closeup of Tmr tuff.JPG
03/25/2005  11:38a           161,423 2790-2791_SM243_Sand ramp on NW side of
Busted Butte.jpg
03/25/2005  11:38a           229,751 2792-2793_SM243_Tiva Cyn and Rainier Mesa
tuff contact.jpg
03/25/2005  11:38a           248,965 2794_SM243_Closeup of Tmr.JPG
03/25/2005  11:39a           227,494 2795-2796_SM243_View to W along Tmr-Tpc
contact.jpg
03/25/2005  11:39a           252,053 2797-2800_SM243_View E.jpg
03/25/2005  11:41a           120,216 2801_SM244_Tmr - Rainier Mesa Tuff
outcrop.JPG
03/04/2005  01:53p           545,813 2802_SM244_Closeup of moderate strength
Tmr.JPG
03/25/2005  11:43a           291,102 2803-2805_SM244_Pan N to NE, Crest Rd,
Rainier and Bow Rdgs.jpg
03/25/2005  11:47a           171,466 2806_SM244_Outcrop of high strength
Tmr.JPG
03/04/2005  02:10p           409,928 2807_SM245_Erosion patterns in sand ramp
on Busted Butte.JPG
03/04/2005  02:17p           492,085 2808-2809_SM245_Weathered faces on Tpc
Tiva Canyon Tuff outcrop.JPG
03/25/2005  12:05p           304,446 2810-2812_SM246_View to NW, Rainier, Bow
Rdgs, Fran Rdg at rt.jpg
03/04/2005  02:35p           550,396 2813_SM246_Qe sand on NW side Busted
Butte.JPG
03/25/2005  12:19p           155,480 2814_SM247_Highly sheared Tpt near
Paintbrush Cyn Fault.JPG
03/25/2005  12:23p           376,752 2815-2817_SM247_Tpt outcrop, note fault
gouge.jpg
03/25/2005  12:24p           337,425 2818-2819_SM247_View to SE at shear zone
next to notebook.jpg
03/25/2005  12:53p           193,132 2820_SM247_View to WNW at Tpt outcrop.JPG
03/25/2005  12:53p           238,098 2821-2823_SM248_View NNW up Midway
Valley, Bow Rdg at lt.jpg
03/25/2005  12:58p           205,971 2824-2826_SM249_Looking SSW from Bow
Ridge, Busted Butte at left.jpg
03/25/2005  01:02p           235,450 2827-2829_SM249_View to W across Rainier
Ridge.jpg
03/25/2005  01:03p           228,050 2830-2831_SM249_View to NW up Bow
Ridge.jpg
```

```
03/25/2005  01:09p               239,259 2832-2835_SM249_View to N up E slope Bow
Ridge,.jpg
03/04/2005  05:00p               650,235 2836_SM249_Tiva Canyon Tuff Tpc
outcrop.JPG
03/04/2005  05:46p               442,209 2837_SM250_Exposure of Qam in tributary
to Fortymile Wash.JPG
03/04/2005  05:55p               605,472 2838_SM250_Bedding in Qam.JPG
03/04/2005  05:55p               494,001 2839_SM250_Gravel and sand layers in
Qam.JPG
03/25/2005  02:22p               217,948 2840-2842_SM251_View to S along alignment
from FMF site.jpg
03/25/2005  02:24p               227,938 2843-2845_SM251_View to N from FMF site
in Midway Valley.jpg
03/04/2005  11:45a               436,018 2846_SM252_Tpc outcrop on H Road at north
end Fran Rdg.JPG
03/25/2005  02:34p               229,099 2847-2849_SM252_View to W across Midway
Valley.jpg
03/04/2005  11:54a               561,134 2850_SM252_Notebook on flat dominant
joint face in Tpc outcrop.JPG
03/04/2005  11:57a               337,730 2851_SM252_North Portal and muck pile.JPG
03/04/2005  11:59a               589,392 2852_SM252_Joint sets in Tpc.JPG
              65 File(s)     22,633,735 bytes

     Total Files Listed:
           1785 File(s)  1,255,078,425 bytes
            189 Dir(s)               0 bytes free
```