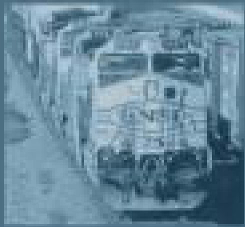

Pre-Decisional
EIS Related

Geotechnical Report Supplement 1

Task 1.5: Phase 1 Preliminary Geotechnical Analysis Report (Submittal No. SCN-5)

REV. 0 15 September 2005

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BECHTEL SAIC COMPANY LLC

Phase 1, Caliente Rail Corridor
Yucca Mountain Project, Nevada
Geotechnical Analysis

Subcontract NN-HC4-00197

15 September 2005

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Project	*YMP Geotechnical Services, Caliente Rail Corridor: Contract No. NN-HC4-00197*		
Regarding	***Preliminary Geotechnical Report, Supplement 1, Rev. 0***		

We are transmitting the following items:

- ☑ Report
- ☐ Drawings
- ☐ Computer Disks
- ☐ Specifications
- ☐ Proposal
- ☐ Samples
- ☐ Other ____________

Copies	Date	Description
10	*15-Sep-05*	*Preliminary Geotechnical Report, Supplement 1, Rev. 0*
5		*CD*

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- ☐ Per your request
- ☐ For your information
- ☐ For review and comment
- ☑ For your files
- ☐ For your approval
- ☐ Documents returned after use by us
- ☐ Please return by ________
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Comments:

This document is the final version of our supplemental geotechnical report, updated for the GF3 and East Busted Butte (EBB) routes, as authorized by Subcontract Change Notice 5 (SCN-5). It incorporates your review comments transmitted on 9 Sep 05 and discussed at our teleconference on 13 Sep 05. This submittal (Number SCN-5) concludes our work under SCN-5.

An electronic version (pdf) of this document is also available on our clients.shanwil.com web site for downloading (contact Kathy Mrotek for name and password).

Signed: *Paul M. Godlewski* (signature)

cc:

Name: *Paul M. Godlewski*

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Preliminary Geotechnical Report
Supplement 1

Phase 1, Caliente Rail Corridor
Yucca Mountain Project, Nevada

Subcontract No. NN-HC4-00197

15 September 2005

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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
BMP	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	cadium
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
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
EIS	Environmental Impact Statement
EOR	engineer of record
EPA	U.S. Environmental Protection Agency
EWDP	Early Warning Drilling Program
F	fluorine
FEIS	Final Environmental Impact Statement

ACRONYMS AND ABBREVIATIONS (cont.)

FHWA	Federal Highway Administration
FOB	free on board
FRA	Federal Railroad Administration
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
MPR	Mineral Potential Report
MRDI	Mineral Resource Development, Inc.
MRDS	mineral resource dataset compiled by U.S. Geological Survey
MS	mineral survey

ACRONYMS AND ABBREVIATIONS (cont.)

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
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)
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
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

ACRONYMS AND ABBREVIATIONS (cont.)

RSS	reinforced soil slopes
S&W	Shannon & Wilson, Inc.
Sb	antimony
Sc	scandium
SCS	Soil Conservation Service
Se	selenium
SFRS	steel fiber-reinforced shotcrete
Sm	samarium
Sn	tin
SPT	Standard Penetration Test
Sr	strontium
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
W	tungsten
WPCP	Water Pollution Control Permit
wt%	weight percent
YMP	Yucca Mountain Project
Zn	zinc

PRELIMINARY GEOTECHNICAL REPORT SUPPLEMENT 1

PHASE 1, CALIENTE RAIL CORRIDOR YUCCA MOUNTAIN PROJECT, NEVADA

1.0 INTRODUCTION

This report is a supplement to the Preliminary Geotechnical Engineering Report (PGR) for the Caliente Rail Corridor (CRC), the preferred route for a rail line to transport spent nuclear fuel and high-level waste to a planned Managed Geologic Repository (MGR) at Yucca Mountain in southern Nevada. The PGR, dated 21 June 2005, summarized the results of preliminary geotechnical engineering evaluations for common line segments and various alternatives within the CRC. The purpose of the PGR is to support route optimization and conceptual design of the proposed rail line, referred to as the Nevada Rail Line (NRL).

Two alternative alignments were developed following completion of the PGR. The Goldfield 3 route (GF3) is 23.2 miles long and winds its way through the eastern portion of the Goldfield Hills mining district before descending into the Mud Lake basin. The Busted Butte East (BBE) alternative is about 7 miles long. It crosses into the Nevada Test Site from the west and runs around the east side of Busted Butte.

This supplemental report summarizes our observations, conclusions, and recommendations that pertain to these alternatives. It also includes revised figures and plates showing the addition of GF3 and BBE. Although it follows the same general outline, this report is not intended to repeat information presented in the PGR. Therefore, the PGR should be referenced for complete discussions of project description and the geotechnical scope of work.

Bechtel SAIC Company, LLC (BSC) issued Subcontract Change Notice No. 5 effective 25 July 2005 to YMP Technical Services Subcontract No. NN-HC4-00197 authorizing us to perform preliminary geotechnical evaluations for the GF3 and BBE alternatives. The final version of this document is submittal No. SCN-5 of this subcontract.

2.0 LITERATURE AND DATA REVIEW

2.1 Review of Existing Project Data

BSC provided geographical information system (GIS) files of the GF3 and BBE alternative alignments. The alignments were added to our existing maps, as shown on the Shaded Relief Map, Plate 1, and the Corridor Location Map, Figure 1. We also overlaid the alignments onto U.S. Geological Survey (USGS) 7.5-minute (1:24,000 scale) and 30- by 60-minute (1:100,000 scale) topographic maps.

2.2 Literature Search and Review

As discussed in the PGR, we performed an extensive literature search and compiled a project bibliography containing 247 reviewed references. These references are listed in Table 1 of the PGR. Key references used to provide geologic information in the GF3 and BBE evaluations included Ashley (1975), Workman (2002), and Potter (2002). We obtained one additional reference for the supplemental evaluations. This reference by Moore (1962) provided information on the alluvium in Jackass Flats near the BBE alternative. This reference is cited in Table 1 of this supplemental report.

3.0 GEOTECHNICAL RECONNAISSANCE

3.1 Goldfield 3 Alternative Alignment

We performed a field reconnaissance of the GF3 alternative from 1 to 6 August 2005. During the reconnaissance, we attempted to access locations with varied geologic conditions and locations of major earthwork features such as deep cuts and high fills. Before the reconnaissance trip, we plotted geologic units on the alignment maps based on our review of the published geologic maps. Locations of earthwork features were based on Microstation plan and profile drawings received from BSC on 1 July 2005. A detailed discussion of field reconnaissance planning, methods, and objectives is presented in the PGR.

The area traversed by GF3 is remote. Only three roads are shown on the USGS maps crossing the alignment; however, we found several unmapped roads that provided four-wheel-drive vehicle access to the alignment. Despite the improved road conditions, we made several hikes from the vehicle to access targeted sites.

3.2 Busted Butte East (BBE) Alternative Alignment

A field reconnaissance of the BBE alternative was specifically excluded from our scope of work. However, we made a reconnaissance trip for an evaluation of conditions on the west side of Busted Butte from 3 to 4 March 2005. At that time, an alternative on the east side of Busted Butte had been withdrawn from consideration. For this preliminary engineering phase of the project, it was our opinion that the published geologic maps, borehole data available from the USGS, and the Nye County Nuclear Waste Repository Project Office (NWRPO) Early Warning Drilling Program (EWDP) and our previous observations in the vicinity of the BBE alternative could be used for the evaluation, so that a new reconnaissance trip on the NTS would not be required. It should be understood, however, that we have not field-checked the geologic conditions specifically along the BBE alternative and that the actual conditions should be verified during a subsequent project phase.

3.3 Detail Maps

The geologic conditions observed during the field reconnaissance are presented in the Detail Maps, Figure 3. An Index and Legend to the Detail Maps is presented in Figure 2. Sheet 2 of Figure 3 shows geologic conditions along the BBE alternative. Sheets 23 through 26 show conditions along the GF3 alternative. From south to north along GF3, the sheets are numbered 24, 25, 23, and 26 to be consistent with the sheet numbers presented in the PGR.

Project stationing for the BBE and GF3 alternatives is based on the NRP plan and profile drawings. The NRP stations increase from Caliente at the east end of the NRL to Yucca Mountain at the west end. This contrasts with the stationing used in the PGR, which is based on Morrison-Knudsen (M-K) alignment maps from 1997. The M-K stationing starts in the vicinity of the MGR at Yucca Mountain. The NRP stations were not available when we performed the work summarized in the PGR. The north and south ends of the GF3 alternative do not connect to nearby alignments shown on the Detail Maps because of recent adjustments in the GF1 alternative and GF5 alternative and common line segments south and east of the GF3 alternative.

For characterization of the soil and rock materials, the alternatives are divided into segments. Segment 86 defines the entire BBE alternative. The GF3 alternative is divided into Segments 87 through 89, numbered sequentially from south to north to be consistent with the segment numbering system used in the PGR. Table 5 summarizes the geographic and geologic conditions within each segment shown on the Detail Maps.

4.0 REGIONAL GEOLOGY AND TECTONIC SETTING

Descriptions of the regional geography, geologic setting, tectonics, seismicity, and hydrogeology are presented in the PGR. The BBE and GF3 alternatives were added to the Regional Geology Compilation Map, Sheet 1 of Plate 2, and the Faults and Seismic Activity Map, Plate 4. No changes were made to the legend for the Regional Geology Compilation Map, Sheet 2 of Plate 2, or the Geologic Cross Sections on Plate 3. Therefore, these sheets are not included with this supplemental report.

5.0 STRATIGRAPHIC NOMENCLATURE AND DESCRIPTION OF GEOLOGIC UNITS

Geologic names for the various units in the CRC have varied over time and by author. Our method and objectives for developing a consistent stratigraphic nomenclature are described in the PGR. Table 2 of the PGR presents the unit names and symbols used in our evaluations and provides a stratigraphic correlation to unit names in most published references. No changes were made to Table 2, but it is included in this supplemental report for reference.

Table 3 describes lithologic and engineering properties of the regional geologic units and stratigraphic units present in the BBE and GF3 alternative areas and shown in the Detail Maps in Figure 3. All of the units described in Table 3 of this report were included in Table 3 of the PGR because no new geologic units were observed along the BBE and GF3 alternatives. Table 3 in this supplemental report provides descriptions of the stratigraphic units that we observed during field reconnaissance specifically along the GF3 alternative. Descriptions of the units in the vicinity of the BBE alternative are based on our review of the published geologic maps, the NWRPO EWDP-18P borehole, and our field reconnaissance of nearby alternatives. The enclosed Table 3 is an abbreviated version of Table 3 in the PGR and is relevant only to conditions along GF3 and BBE. Table 3 in the PGR provides descriptions of unit materials and features observed at locations outside the immediate vicinity of the BBE and GF3 alternatives should be referenced for more generalized, regional descriptions of the units.

Each of the units present along the BBE and GF3 alternatives is described in the following sections. As with Table 3, the descriptions are specific to the GF3 and BBE alternatives. It is important to recognize that lithologic conditions within geologic units can change not only between geographic areas but also within a geographic area. For example, the amount of clayey hydrothermal alteration in unit Ta3 increases markedly from the edges of the Goldfield mining district (crossed by the GF3 and GF4 alternatives) to the center of the district (crossed by the

GF1 alternative). More generalized descriptions of the units that can be applied on a regional basis are provided in Section 5 of the PGR.

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

Holocene and Pleistocene eolian sand ramps flank Busted Butte, Yucca Mountain, Rainier Ridge, Bow Ridge, and Fran Ridge. They consist of loose to medium-dense, brown, fine- to medium-grained sand. Locally, they contain sparse, angular, gravel-sized fragments of volcanic rocks. Lag deposits of gravel are present in places on the surface of these sand ramps.

5.2 Young Quaternary Fine-grained Alluvium (Qayf)

Holocene and latest Pleistocene (?) fine-grained sediments form an apron around the Mud Lake playa, at the southern end of Ralston Valley. Fine-grained sediments at or near the north end of the GF3 alternative consist of very stiff, yellowish-brown, sandy clay. They become soft to very soft during periods of seasonally high precipitation and runoff. At the ground surface, these sediments typically are tan, desiccated, and covered with patches of loose gravel or sheets and mounds of eolian sand. These deposits underlie small to large playa-like areas separated by flats sparsely covered with shrubs or grass.

5.3 Young Quaternary Alluvium (Qay)

Young Quaternary (Holocene and late Pleistocene) alluvium was distinguished during field reconnaissance by (a) the predominance of angular fragments of local volcanic rocks; (b) the absence of calcium carbonate cementing intervals and coating clasts; and (c) the preservation of depositional landforms. This geologic unit is present as small alluvial fans and playa-apron and pediment deposits, and in washes and adjacent floodplain terraces.

Fan alluvium borders Dune, WT-12, and Forlorn Washes and flanks ridges forming Yucca Mountain. This alluvium consists of loose to dense, brown, sandy gravel; silty, sandy gravel; and silty, gravelly sand weakly indurated with calcium carbonate. The sand is fine to medium-grained. The sub-angular to angular, gravel- to boulder-sized clasts are composed of volcanic rocks that crop out nearby. Sand and gravel intervals generally are 5 to 10 feet thick.

Transitional and similar in composition (Bonham and Garside, 1979), young Quaternary playa-apron and pediment deposits on the southwest side of Mud Lake are grouped together for discussion purposes. On the GF3 alternative and in a nearby trench, the playa-apron deposits are composed of clayey sand overlying silty sand. The upper interval consists of scattered to common, gravel- to cobble-sized fragments of volcanic rocks in medium-dense to dense, pinkish- to reddish-brown, clayey, predominantly fine-grained sand. The clayey sand was deposited over mounds and swales in the underlying silty sand and is as much as 2 feet thick. The silty sand is loose to medium-dense, light-grayish-brown, and fine grained. At the edges of the Mud Lake basin, the clayey sand occupies shallow depressions in bedrock. This pediment deposit has a well-developed surface pavement containing sub-rounded to angular, gravel- to boulder-sized clasts of volcanic rocks.

Young Quaternary alluvium in washes and floodplain terraces consists of loose to dense, brown, reddish-brown, and grayish-brown, gravelly, fine- to coarse-grained sand and subordinate sandy gravel. Generally non- to slightly silty, the wash alluvium locally is silty or clayey. Clasts in the alluvium are gravel- to cobble-sized and composed mostly of volcanic rock. Channels contain boulders up to 3 feet in diameter.

5.4 Middle Quaternary Alluvium (Qam)

Middle Quaternary (late to middle Pleistocene) alluvium underlies parts of alluvial fans and older stream terraces in the Busted Butte area. The middle Quaternary alluvium consists of loose to very dense, brown and gray, gravelly sand and sandy gravel, with subordinate cross-bedded, medium- to coarse-grained sand and lenticular beds of cobbles and boulders up to 2 feet in diameter. Surface induration from percolation of rainwater occurs locally.

5.5 Old Quaternary Alluvium (Qao)

Old Quaternary (middle to early Pleistocene) alluvium occurs in the Goldfield Hills as low-gradient pediments overlying bedrock to shallow depths and as dissected alluvial fans. The old Quaternary alluvium consists mostly of unconsolidated to slightly indurated, loose to very dense, grayish- and reddish-brown, gravelly, fine- to coarse-grained sand and silty sand, with subordinate sandy gravel. Gravel intervals contain abundant cobbles and scattered small boulders up to 2 feet in diameter, which are partially to completely coated with calcium carbonate. Generally thin, very dense, white intervals of gravelly sand and sandy gravel cemented with calcium carbonate (calcrete) alternative with the unconsolidated to slightly indurated alluvium. If considered to be rock, the calcrete has moderate to medium-high strength. Desert pavements containing abundant cobbles and boulders are well-developed.

5.6 Quaternary-Tertiary Basalt (QTb)

Pleistocene (?) to Miocene (≤13.5 million years old [Ma]) lava flows, cinder cones, and related feeder dikes occur in both the BBE and GF3 areas. They are especially common in the northern Goldfield Hills. Generally resistant to erosion, basalt flows cap many landmarks, such as Skull

Mountain on the east side of Jackass Flats, and Blackcap Mountain in the east-central Goldfield Hills.

Southwest of Mud Lake, an eroded cinder cone stands between lava flows of the Basalt of Blackcap Mountain (Figure 3, Sheet 23). The eroded cinder cone could be as young as Pleistocene, but it most likely is contemporaneous with the Basalt of Blackcap Mountain, which has been dated as 10.4 to 13.5 Ma (Ashley, 1975). The cinder cone consists of red, partially cemented, vesicular scoria fragments, red to black, ropy ejecta, and colluvium on moderately steep slopes flanking volcanic necks (feeder dikes). The cemented scoria has high strength. The volcanic necks consist of dark-gray, fine- to medium-grained, slightly porphyritic, locally vesicular basalt, with light-colored secondary minerals (amygdules) filling many of the voids. The basalt has very high-strength and closely to widely spaced fractures with strongly vertical orientation. The colluvium consists of hard, light-brown, gravelly clay covered with loose, gravel-sized scoria fragments.

Hills on the west side of Mud Lake consist of basalt (trachyandesite) lava flows and intrusive domes (Figure 3, Sheet 26), which Bonham and Garside (1979) considered to be contemporaneous or comagmatic with the Basalt of Blackcap Mountain. A dome examined at Mud Lake is composed of very high-strength, dark-gray, fine-grained basalt with closely to widely spaced columnar fractures.

Outcrops of the Basalt of Blackcap Mountain in the northern Goldfield Hills generally consist of dark-gray, fine-grained or finely crystalline to medium-grained or slightly porphyritic, locally auto-brecciated basalt to basaltic andesite lava flows, which erode to sub-rounded boulders up to several feet in diameter. Individual lava flows within the stack that comprise this formation are non-vesicular in lower parts, increasingly vesicular upward, and very vesicular at the top. Most vesicular intervals contain white amygdules partially or nearly completely filling voids. These lava flows generally have very high strength, but strength decreases locally to high as fracturing increases. In most places, the rock has closely to widely spaced, rectangular fractures, but fracturing locally is extremely closely spaced (i.e., slabby). The formation forms hills and ridges with moderately steep to steep slopes.

Basalt cropping out in the Yucca Mountain-Busted Butte area includes the 9.5 to 11.3 Ma Basalt of Jackass Flats, Basalt of Kiwi Mesa, and Basalt of Skull Mountain (Warren et al., 1998; Potter et al., 2002). In general, these formations consist of dark-gray to black, fine-grained to slightly porphyritic, variably vesicular and amygdaloidal basalt flows. Because they crop out too far away from or are buried too deeply beneath alignments in the Yucca Mountain-Busted Butte area to impact their design, these formations were not examined during field reconnaissance.

5.7 Tuff of Stonewall Flat (Tst)

The late Miocene (7.5 to 7.6 Ma) Tuff of Stonewall Flat includes the Spearhead and Civet Cat Canyon Members. On the southern flank of the Goldfield Hills, this geologic unit underlies gradually sloping terrain incised by numerous washes and covered in many places by thin pediment deposits of early and middle Pleistocene age. Along the GF3 alternative, the Tuff of Stonewall Flat consists of light-gray, gray, pink, pinkish-beige, light-orange-brown, light-purplish-brown, and purple, nonwelded to densely welded, crystal-rich (except where nonwelded), lithic-rich, trachyte to comendite ash-flow tuff, with very closely to widely spaced fractures. Partially to densely welded tuff has high to very high strength; nonwelded tuff has low to medium-high strength. The tuff weathers and erodes easily where nonwelded, but it becomes more resistant as welding increases. Because of variable welding, this geologic unit forms ledgy slopes and cliffs.

5.8 Timber Mountain Group (Tm)

The Miocene (11.6 to 11.7 Ma) Rainier Mesa Tuff of the Timber Mountain Group crops out on Rainier Ridge, north of Dune Wash, and on Yucca Mountain, south of this wash (Figure 3, Sheet 2). The Rainier Mesa Tuff consists of light-brownish-red to light-reddish-brown and pink, nonwelded to partially welded, crystal-poor, lithic-rich, foliated, trachyte to rhyolite ash-flow tuff, with buff, slightly to highly weathered, bedded ash-fall and reworked tuff at the base of the geologic unit. Outcrops of this geologic unit have moderate to high strength and closely to widely spaced fractures. The rock erodes easily, and because of variable lithology, it forms cliffs, ledges, and slopes.

5.9 Paintbrush Group (Tp)

The Miocene (12.5 to 12.8 Ma) Paintbrush Group, which includes the Tiva Canyon and Topopah Spring Tuffs, forms most of the outcrop at Yucca Mountain. In the Yucca Mountain-Busted Butte area, the Paintbrush Group consists of light-gray to gray, grayish-orange, pinkish- to purplish-gray, pink to grayish-red, maroon, purplish-brown, and light-brown to brownish-black, moderately to densely welded, crystal-poor, variably lithic, variably vesicular (lithophysal), unweathered to moderately weathered, foliated, rhyolite to trachyte ash-flow tuff with subordinate nonwelded to partially welded ash-flow tuff, tuff breccia, bedded tuff, and vitrophyre. Red, reddish-orange, and white, variably indurated, variably altered breccia is common in fault zones. Many fractures in fault zones contain clayey gouge or fillings of silica and carbonate minerals. Moderately to densely welded tuff, tuff breccia, and vitrophyre 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 intervals and extremely close to close adjacent to faults. Because of variable lithology, this geologic unit forms cliffs, ledges, and moderately steep to steep slopes.

5.10 Calico Hills Formation (Tac)

The Miocene (12.9 Ma) Calico Hills Formation consists of 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 in small outcrops on the east side of Busted Butte, this geologic unit is not crossed by the GF3 alternative and was not visited.

5.11 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 in small outcrops on the east side of Busted Butte, this geologic unit is not crossed by the GF3 alternative and was not visited.

5.12 Younger Tertiary Sedimentary and Tuffaceous Rocks (Tsy)

The only member of this regional geologic unit observed during field reconnaissance was the middle Miocene (13 to 16 Ma) Siebert Tuff, which is present from the central Goldfield Hills to the northwest side of Mud Lake. Outcrops of the Siebert Tuff in this area are small, inconspicuous, and commonly associated with Quaternary-Tertiary basalt. Where examined in a wash below a hill composed of the Basalt of Blackcap Mountain, outcrops of the Siebert Tuff consisted entirely of pinkish-beige, nonwelded, lithic-rich, rhyolitic ash-fall (?) tuff. This tuff has medium-high to high strength and closely to medium-spaced fractures. The presence of sedimentary rocks within the Siebert Tuff along the GF3 alternative was not observed during the field reconnaissance.

5.13 Tertiary Rhyolite Lava Flows and Related Intrusives (Tvr)

A small dome of early Miocene (~17 Ma) Brougher Rhyolite underlies Quaternary-Tertiary basalt in a hill on the west side of Mud Lake (Figure 3, Sheet 26). Because the GF3 alternative bypasses this hill, the dome was not visited. In general, however, Brougher Rhyolite domes consist of light-gray, grayish-orange-pink, light-orange, and yellowish-gray, porphyritic rhyolite, which is increasingly glassy and vesicular (lithophysal) toward dome margins (Bonham and Garside, 1979).

The early Miocene (~21 Ma) Rhyolite of Wildhorse Spring has considerable exposure along the GF3 alternative in the central and northern Goldfield Hills. The geologic unit consists of light-gray, porphyritic, unweathered to slightly weathered, rhyolite lava flows with prominent foliation. Outcrops of this geologic unit have very high strength and closely to widely spaced fractures. The Rhyolite of Wildhorse Spring forms prominent hills with cliffs and steep slopes.

5.14 Early Miocene Silicic to Intermediate Ash-flow and Ash-fall Tuff (Tt_3)

In the Goldfield Hills, this geologic unit consists of the ~21 Ma Tuff of Chispa Hills overlain by the ~18 Ma Fraction Tuff (Meda Rhyolite of Ashley, 1975). This geologic unit generally consists of light- to dark-gray, pink, and orange, nonwelded to moderately welded (?), crystal-rich, lithic-rich, strongly foliated, rhyolite to rhyodacite ash-flow tuff. The tuff locally is hydrothermally altered. Outcrops of this geologic unit have medium-high to very high strength and extremely closely to medium-spaced fractures. Because of variable welding and lithology, this geologic unit forms cliffs, ledges, and slopes.

5.15 Older Tertiary Sedimentary Rocks (Tso)

The only member of this regional geologic unit observed during field reconnaissance was fluvial sedimentary rocks deposited in the central Goldfield Hills during early Miocene time (between 21 and 21.5 Ma). These sedimentary rocks consist of sandstone and conglomerate. The sandstone is olive-green, medium-grained, and thinly bedded. It has moderate to medium-high strength and extremely closely to closely spaced fractures. Where observed along the GF3 alternative, the conglomerate was completely weathered to medium-dense to dense colluvium, which consists of gravel to boulder-sized clasts of hydrothermally altered volcanic rocks in purple, green, orange, and white, fine- to medium-grained sand. The older Tertiary sedimentary rocks in the Goldfield Hills fill modern valleys and cover lower slopes of adjacent ridges.

5.16 Early Miocene lava flows and intrusives of intermediate composition (Ta_3)

Early Miocene volcanic rocks of intermediate composition crop out throughout the Goldfield Hills. Included within this extensively faulted geologic unit are the Milltown Andesite, Dacite at Goldfield, Chispa Andesite, andesite megabreccia, and andesite and rhyodacite flows and intrusives in the northern Goldfield Hills. Bonham and Garside (1979) correlate the volcanic rocks in the northern Goldfield Hills with the Milltown Andesite and Dacite at Goldfield, with which they are discussed.

The Milltown Andesite consists mostly of brownish-gray to dark-gray, porphyritic, foliated, andesite to basaltic andesite lava flows. Slightly to moderately altered, these lava flows typically are streaked or mottled orange, white, yellow, and green. The lava flows have moderate to very high strength, with relative strength decreasing as fracturing increases. Fractures are very closely to widely spaced and commonly have mineralized surfaces. The Milltown Andesite locally is brecciated. This breccia consists of gravel- to boulder-sized fragments of dark-gray andesite in a matrix of tan, partially indurated, silty, fine-grained sand and contains extremely closely to medium-spaced fractures.

The Dacite at Goldfield consists of lava flows, subordinate breccia, and related intrusives. The lava flows consist of purple, purplish-gray, and gray, slightly to very hydrothermally altered, porphyritic rhyodacite, with very high strength and extremely closely to widely spaced fractures. An outcrop of breccia consisted of white and reddish-orange-banded, gravel- to cobble-sized fragments of hydrothermally altered rhyodacite, with moderate to high strength and extremely closely to closely spaced fractures. Intrusives consist of equal to sub-equal amounts of felsic minerals, such as plagioclase and quartz, and finer-grained mafic minerals, such as pyroxene and biotite. These intrusives, which appear to range in composition from diorite to quartz diorite, have very high strength and closely to widely spaced fractures.

The andesite megabreccia consists of white, light-gray, orange, and purple, angular clasts of hydrothermally altered volcanic rocks, up to several inches in diameter, in low-strength, variably indurated gouge. The rock has moderate to very high strength and very closely to widely spaced fractures.

No extensive areas of hydrothermal alteration were observed in this geologic unit along the GF3 alternative, but linear, fault-controlled zones of alteration transect the unit Ta3 in numerous places. Mines and prospects follow these fault-controlled zones. Where cut by faults, the geologic unit is oxidized and hydrothermally altered pervasively to orange, white, purple, ochre, and brown, brecciated, shattered, low- to high-strength rock and clayey gouge.

The volcanic rocks in this geologic unit commonly form steep hills that are incised by numerous washes. At the southern edge of the Mud Lake basin, remnants of andesite and rhyodacite flows and intrusives crop out as knobs surrounded by colluvium.

6.0 CHARACTERIZATION OF SOILS WITHIN THE CORRIDOR

Methods used to classify soils during the field reconnaissance and data acquisition from the Soil Survey Geographic Database (SSURGO) are described in the PGR. No soil survey data is available for the area around the BBE alternative. Data downloaded from the SSURGO Database for the GF3 alternative are presented in Table 4.

7.0 GEOLOGIC HAZARDS

The PGR provides discussions of the geologic hazards potentially present throughout the CRC including rock slope hazards, earthquake hazards, surface fissures, surface erosion, mined land subsidence, debris flows, soil collapse, and soils with low bearing capacity. Specific hazards that were identified within the BBE and GF3 segments are listed in Table 6.

8.0 CONCEPTUAL ENGINEERING AND CONSTRUCTION CONSIDERATIONS

Discussions of conceptual engineering considerations for earthwork, stability improvements, and foundations are presented in the PGR and in the Preliminary Geotechnical Design Criteria Manual (G-DCM). These considerations include excavations, cut slopes, embankment fill slopes and materials, subgrade preparations and stabilization, drainage and erosion, and structures (bridges, buildings, retaining walls, and tunnels). No bridges, buildings, or tunnels are planned along the BBE or GF3 alternatives, however, substantial earthwork will be required to construct numerous deep cuts and high fills over 50 feet. Considerations and recommendations specific to the BBE and GF3 alternatives are presented in Table 6.

9.0 CONCLUSIONS

Conceptual geotechnical conclusions and recommendations are presented in Tables 5 and 6 for the GF3 and BBE alternatives. 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 segment along the BBE and GF3 alternatives. 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, and foundation recommendations) for each segment are presented in Table 6.

With regard to significant observations, conclusions, and recommendations for the NRL, we believe that debris flows, proximity to mining areas and mining hazards, and highly altered and low-strength rock mass conditions pose the most concern. However, we do not believe that these man-made and geologic hazards or rock mass conditions are so adverse that a specific alternative or segment within an alternative should be removed from further consideration.

The majority of the soil and rock that will be encountered in excavations along the corridor will be suitable as embankment fill. However, fine-grained alluvium in the vicinity of Mud Lake (GF3), landslide debris (GF1/GF5 and GF4), and highly altered Tertiary volcanic rock (Ta3 cropping out along the GF1/GF5, GF3, and GF4 alternatives) may be unsuitable or require special conditioning prior to use as fill. Bedrock encountered in excavations will also generally be suitable as fill and riprap, although the highly altered Tertiary volcanic deposits in the vicinity of Goldfield will likely be unsuitable because of their high clay content.

We anticipate that all excavations in rock will require drilling and blasting. Older cemented alluvium will likely require ripping, while the remaining alluvial deposits (i.e., alluvial, eolian, colluvial, and landslide deposits), which can be classified as common excavation, can be excavated using conventional excavation techniques and equipment.

Based on our engineering studies and field reconnaissance, we have prepared Table 7, which compares and contrasts the alternatives on the NTS (CS [common segment]7 and BBE) and the alternatives in the vicinity of Goldfield (GF1/GF5, GF3, and GF4). Beginning with the NTS alternatives (BBE and CS7), the principal difference is that the CS7 alignment, although shorter in length than BBE, has significantly greater earthwork impacts and, in particular, large cut excavations exceeding 160 feet deep through Ambush Pass and Bow Ridge. For this reason, the BBE alternative may be preferable to CS7. Of the three alternatives in the vicinity of Goldfield, none is clearly preferable to the other two, although either the GF4 or the GF3 alternative appears to be preferable to the GF1/GF5 alternative. The GF1/GF5 alternative has a preponderance of highly altered, low-strength bedrock; crosses several landslide deposits; and passes through the center of the Goldfield mining district and associated mining hazards. The GF4 and GF3 alternatives skirt around the edges of the mining district resulting in more favorable bedrock conditions and fewer hazards associated with mining activities. In general, the earthwork requirements are less for GF4 than for GF3, although GF4 will require at least five bridges (two grade separations with US 95 and at least three aqueducts). Although a preferred alternative around Goldfield is not readily apparent, it appears that the GF3 alternative has fewer significant geologic hazards.

Subsequent design studies, the actual siting of the track within a selected alignment, will be based on operational considerations (i.e., grade and curvature) as well as geologic and drainage conditions.

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DEX:PMG:WAH/srm

TABLE 1
PROJECT BIBLIOGRAPHY

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TABLE 2
GENERALIZED STRATIGRAPHIC COLUMNS

Geologic Age			**Southwest Nevada Volcanic Field** (Yucca Flat, Rock Valley, Jackass Flats, Yucca Mountain, Crater Flat, Oasis Valley, Pahute Mesa, and Sarcobatus Flat)	**Goldfield and Stonewall Mountain Calderas** (Goldfield Hills, Mount Jackson Ridge, Stonewall Flat, Lida Valley, and Stonewall Mountain)	**Central Nevada Caldera** (Ralston Valley, Cactus Flat, Stone Cabin Valley, Kawich Range, Reveille Valley, Reveille Range, Railroad Valley, and Quinn Canyon Range)	**Indian Peak and Caliente caldera complexes** (Golden Gate, Seaman, North Pahroc, Cedar, and Chief Ranges, Clover Mountains, White River, Dry Lake, and Meadow Valleys)
Era	**Period**	**Epoch**	**Geologic Units**			
CENOZOIC	**Quaternary**	Holocene	Stream channel and floodplain alluvium; eolian, playa, and landslide deposits	Stream channel, floodplain, and fan alluvium, colluvium, and pediment deposits	Stream channel, floodplain, and fan alluvium; eolian, pediment, terrace, and landslide deposits; colluvium	Stream channel, floodplain, and valley floor alluvium; playa, eolian, and landslide deposits
		Pleistocene	Fan alluvium, basin-fill deposits, lacustrine beach deposits, and colluvium			Fan alluvium, terrace, marsh, spring, and lacustrine beach deposits, and colluvium
	Tertiary	Pliocene	Basalt flows and cones of Crater Flat, Oasis Valley, Thirsty Canyon, and Buckboard Mesa	Conglomerate and sandstone	Basalt flows of Reveille Valley and Reveille Range	
					Andesite flows near Clifford Mine and Black Spring	Conglomerate and sandstone
			Basin-fill and caldera-moat-filling sediments		Tuffaceous lacustrine deposits near Clifford Mine	Panaca Formation and White River Narrows unit
		Miocene		Pozo Formation		
			Volcanics of Stonewall Mt	Volcanics of Stonewall Mt		
				Malpais Basalt		
			Rhyolite of Sarcobatus Flat			
			Tuff of Gold Flat			
			Andesite of Sarcobatus Flat			
			Thirsty Canyon Group			
			Rhyolite of Colson Pond			
			Basalt of Black Mountain			
			Older Tertiary basalt	Basalt of Blackcap Mountain		
			Volcanics of Fortymile Canyon		Rhyolite of Cactus Peak	
			Timber Mountain Group	Timber Mountain Group		Steamboat Mountain Fm
			Paintbrush Group			Ox Valley Tuff
			Calico Hills Formation			
			Wahmonie Formation			
			Crater Flat Group			
			Belted Range Group			
			Tram Ridge Group			
			Rocks of Pavits Spring	Siebert Tuff and Mira Basalt		Sedimentary rocks of Newman Canyon
			Volcanics of Quartz Mountain			Tuff of Etna
			Tuff of Yucca Flat			McCullough Formation
			Redrock Valley Tuff			Volcanic rocks of Klondike Sp.
			Panuga Formation			
		Miocene	Titus Canyon Formation		Rhyolite of O'Briens Knob	
				Fraction Tuff	Fraction Tuff	Tuff of Tepee Rocks
					Rhyolite, rhyodacite, and dacite lava flows and intrusions	Hiko Tuff
						Racer Canyon Tuff
						Porphyry of Meadow V. Wash
				Rhyolite of Wildhorse Spring		Dacite to basalt lava flows, flow breccia, and mudflow breccia
				Chispa Andesite		
				Tuff of Chispa Hills		
				Volcaniclastic rocks		
				Dacite at Goldfield		
				Milltown Andesite		Lava flows of Indian Cove
						Harmony Hills Tuff
				Porphyritic rhyodacite		Dacite to basalt lava flows
					Pahranagat Formation	Pahranagat Formation
						Condor Canyon Formation
						Volcanic & sedimentary rocks
		Oligocene				Leach Canyon Formation
						Dacite to basalt lava flows
						Cobalt Canyon stock
					Tuff of Goblin Knobs	Hole-in-the-wall and Hamlight Canyon Tuff Mbrs of Isom Fm
					Shingle Pass Tuff	Shingle Pass Tuff
					Tuff of Antelope Springs	Baldhills Tuff Mbr of Isom Fm
					Monotony Tuff	Monotony Tuff
						Limestone and tuff
						Petroglyph Cliff Tuff and Andesite of Hamilton Spring
					Dacite of Reveille Valley	Lund Formation and Formation of Black Rock Spring
				Sandstorm Formation	Andesite of Reveille Range and southern Reveille Valley	Andesite lava flows, mudflow breccia, tuff, and sedimentary rocks
						Wah Wah Springs Formation
						Lacustrine and fluvial sedimentary rocks, bedded tuff, and andesite lava flow
						Cottonwood Wash Tuff
						Lacustrine and fluvial sedimentary rocks and bedded tuff
					Windous Butte Formation	Windous Butte Formation
				Kendall Tuff	Sandstone and conglomerate	Lacustrine and fluvial sedimentary rocks and bedded tuff
				Vindicator Rhyolite		Andesite of Wheatgrass Spring and ash-flow tuff
						Lacustrine and fluvial sedimentary rocks
		Eocene			Calcareous siltstone and mudstone	Sheep Pass Formation
		Paleocene				

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Era	**Period**	**Epoch**	**Geologic Units**			
MESOZOIC	**Cretaceous**		Granitic rocks	Quartz monzonite and granodiorite		
	Jurassic					
	Triassic					
PALEOZOIC	**Permian**		Tippipah Limestone		Conglomerate, sandstone, argillite, chert, and limestone	Bird Spring Formation and Ely Limestone
	Pennsylvanian					
	Mississippian		Scotty Wash Quartzite		Diamond Peak Formation	Scotty Wash Quartzite
			Chainman Shale		Chainman Shale	Chainman Shale
					Joana Limestone	Joana Limestone
			Eleana Formation		Pilot Shale and Eleana Formation	Pilot Shale
	Devonian		Guilmette Formation		West Range Limestone	West Range Limestone
					Guilmette Formation	Guilmette Formation
			Simonson Dolomite		Simonson Dolomite	Simonson Dolomite
			Sevy Dolomite		Sevy Dolomite	Sevy Dolomite
	Silurian		Laketown Dolomite		Laketown Dolomite	Laketown Dolomite
	Ordovician		Ely Springs Dolomite	Palmetto Formation	Ely Springs Dolomite	Ely Springs Dolomite
			Eureka Quartzite		Eureka Quartzite	Eureka Quartzite
			Pogonip Group		Pogonip Group	Pogonip Group
						House Limestone
	Cambrian		Nopah Formation	Emigrant Formation	Swarbrick Formation	
						Windfall Formation
					Dunderberg Shale	Dunderberg Shale
			Bonanza King Formation		Not exposed	Highland Peak Formation
			Carrara Formation			Chisholm Shale
				Mule Spring Limestone		Lyndon Limestone
				Harkless Formation		Pioche Shale
			Zabriskie Quartzite	Poleta Formation		Prospect Mountain Quartzite
			Wood Canyon Formation	Campito Formation		Wood Canyon Formation
PROTER-OZOIC	**Late**			Deep Spring Formation		
			Stirling Quartzite	Reed Dolomite		Stirling Quartzite
			Johnnie Formation	Wyman Formation		Not exposed
Information Sources			Carr et al, 1996; Warren et al, 1998; Fridrich et al, 1999; Slate et al, 1999; Snow and Lux, 1999; Potter et al, 2002	Albers and Stewart, 1972; Cornwall, 1972; Ashley, 1975; Workman et al, 2002a	Ekren et al, 1971, 1973b; Gardner et al, 1980; Kleinhampl and Ziony, 1985; Whitebread and John, 1992; Best et al, 1993; Martin and Naumann, 1995; Scott et al, 1995a	Sleeper, 1989; Taylor, 1990; Rowley and Shroba, 1991; Best et al, 1992, 1993; duBray and Hurtubise, 1994; Rowley et al, 1994, 1995; Scott et al, 1994, 1995a, 1995b; Swadley and Simonds, 1994a

TABLE 3
DESCRIPTION OF GEOLOGIC UNITS

Combined Unit	Symbol	Included Stratigraphic Units	Age	Lithology	Engineering Description
Quaternary eolian sand ramp deposits	Qe	Not applicable	Holocene to early Pleistocene	Brown, fine- to medium-grained sand, locally containing sparse, angular, gravel-sized fragments of volcanic rock.	Loose to medium-dense SP; underlies low to moderately steep slopes flanking Busted Butte, Yucca Mountain, Rainier Ridge, Bow Ridge, and Fran Ridge.
Young Quaternary fine-grained alluvium	Qayf	Not applicable	Holocene and latest Pleistocene(?)	Yellowish-brown sandy clay; tan, desiccated, and covered with patches of loose gravel or sheets and mounds of eolian sand at land surface.	Very stiff CL; soft when seasonally wet; underlies small to large playa-like areas and intervening sand sheets and mounds stabilized by sparse shrubs.
Young Quaternary alluvium	Qay	Fan alluvium	Holocene and late Pleistocene	Brown sandy gravel, silty, sandy gravel, and silty, gravelly sand, in 5- to 10-ft-thick intervals; sand, fine- to medium-grained; clasts, sub-angular to angular, gravel to boulder-sized, volcanic; weakly indurated with calcium carbonate.	Loose to dense GP, GW-GM, and SW-SM; forms gradual slopes flanking WT-12 and Forlorn Washes.
		Pediment and playa-apron deposits		Pinkish- to reddish-brown and grayish-brown, silty to clayey, predominantly fine-grained sand, with trace to common, angular, gravel to cobble-sized clasts of volcanic rocks.	Loose to dense SM and SC; underlies low slopes flanking Mud Lake playa.
		Wash alluvium		Brown, reddish-brown, and grayish-brown, gravelly, fine- to coarse-grained sand and subordinate sandy gravel; generally non- to slightly silty, but locally silty or clayey; gravel to cobble-sized clasts of volcanic rock at depth; cobbles and boulders to 3-ft diameter in channels.	Loose to dense SW, SP, and subordinate GP; fills washes and adjacent floodplains.
Middle Quaternary alluvium	Qam	Not applicable	Late and middle Pleistocene	Brown and gray, gravelly sand and sandy gravel, with subordinate cross-bedded, medium- to coarse-grained sand and lenticular beds of cobbles and boulders to 2-ft diameter; surface induration from percolation of meteoric water.	Loose to very dense SP and GP; underlies parts of alluvial fans and older stream terraces.
Old Quaternary fan, valley floor, and tributary alluvium	Qao	Pediment and alluvial fan deposits	Middle and early Pleistocene	Unconsolidated to slightly indurated, grayish- and reddish-brown, gravelly, fine- to coarse-grained sand and silty sand, with lenses of sandy gravel and thin intervals of calcrete (white, carbonate-cemented gravelly sand); abundant cobbles and scattered small boulders (to 2-ft diam.) partially to completely coated with calcium carbonate.	Loose to very dense SP, SP-SM, and subordinate GP, with thin layers of low- to moderate-strength (or very dense) calcrete; occurs as low-gradient pediments overlying bedrock to shallow depths and as eroded alluvial fans.
Quaternary-Tertiary basalt	QTb	Cinder cone near Mud Lake	Pleistocene to Miocene (≤13.5 Ma)	An eroded cinder cone located southwest of Mud Lake consists of red, partially cemented, vesicular scoria fragments, red to black, ropy ejecta, and colluvium on moderately steep slopes flanking necks of dark-gray, fine to medium-grained, slightly porphyritic, locally vesicular basalt. Light-colored secondary minerals fill many vesicles in the basalt. The colluvium consists of light-brown, gravelly clay covered by loose, gravel-sized scoria fragments.	Cemented scoria has high strength; the basalt necks have very high strength; and the colluvium is hard CL. The basalt necks have closely to widely spaced fractures. Visual observations and mapped topography delineate an apparently oval extent of the cinder cone crossed by the GF3 alternative (Fig. 3, Sheet 25).
		Basalt of Jackass Flats		Generally dark-gray, fine-grained or finely crystalline to medium-grained or slightly porphyritic, non- to very vesicular, basalt to basaltic andesite lava flows and domes. Most vesicular intervals contain white, secondary minerals (amygdules) partially or nearly completely filling voids.	These lava flows generally have very high strength, but strength decreases locally to high as fracturing increases. In most places, the rock has closely to widely spaced, rectangular fractures, but fracturing locally is extremely closely spaced (i.e., slabby). The lava flows and domes form hills and ridges with moderately steep to steep slopes. The rock commonly erodes to sub-rounded boulders up to several feet in diameter.
		Basalt of Skull Mountain			
		Trachyandesite of Mud Lake			
		Basalt of Blackcap Mountain			
Tuff of Stonewall Flat	Tst	Spearhead and Civet Cat Canyon Members	Late Miocene (7.5-7.6 Ma)	Light-gray, pinkish-beige, pale-orange-brown, light-purplish-brown, and purple, nonwelded to densely welded rhyolitic ash-flow tuff, which is crystal-rich, except where nonwelded, and lithic-rich.	Outcrops of this geologic unit have high to very high strength where partially to densely welded and low to medium-high strength where nonwelded. Fractures are very closely to widely spaced. The rock is slightly to highly weathered and erodes easily where nonwelded, but it is resistant where densely welded. Because of variable welding, this geologic unit forms ledgy slopes and cliffs.

TABLE 3
DESCRIPTION OF GEOLOGIC UNITS

Combined Unit	Symbol	Included Stratigraphic Units	Age	Lithology	Engineering Description
Timber Mountain Group	Tm	Rainier Mesa Tuff	Miocene (11.6-11.7 Ma)	Light-brownish-red to light-reddish-brown and pink, nonwelded to partially welded, crystal-poor, lithic-rich, foliated, rhyolitic ash-flow tuff, with basal buff, slightly to highly weathered, bedded ash-fall and reworked tuff.	Outcrops of this geologic unit have moderate to high strength and closely to widely spaced fractures. The rock erodes easily, and because of variable lithology, it forms cliffs, ledges, and slopes.
Paintbrush Group	Tp	Tiva Canyon Tuff Topopah Spring Tuff	Miocene (12.5-12.8 Ma)	Light-gray to gray, grayish-orange, pinkish- to purplish-gray, pink to grayish-red, maroon, purplish-brown, and light-brown to brownish-black, moderately to densely welded, crystal-poor, variably lithic, variably vesicular (lithophysal), unweathered to moderately weathered, foliated, rhyolite to trachyte ash-flow tuff with subordinate nonwelded to partially welded ash-flow tuff, tuff breccia, bedded tuff, and vitrophyre; red, reddish-orange, and white, variably indurated, variably altered breccia common in fault zones. Many fractures in fault zones contain clayey gouge or fillings of silica and carbonate minerals.	Moderately to densely welded tuff, tuff breccia, and vitrophyre 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 intervals and extremely close to close adjacent to faults. Because of variable lithology, this geologic unit forms cliffs, ledges, and moderately steep to steep slopes.
Calico Hills and Wahmonie Formations	Tac	Calico Hills Formation	Miocene (12.9-13.0 Ma)	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 in small outcrops on the east side of Busted Butte, this geologic unit is not crossed by the GF3 alternative.
		Wahmonie Formation		Variegated, porphyritic andesite to rhyodacite lava flows, flow breccia, mudflow breccia, and bedded tuff, tuff breccia, sandstone, and conglomerate.	
Younger Tertiary sedimentary and tuffaceous rocks	Tsy	Siebert Tuff	Middle Miocene (~13-16 Ma)	Sedimentary rocks might be present in this geologic unit, but in the only observed outcrop, the Siebert Tuff consisted entirely of pinkish-beige, nonwelded, lithic-rich, rhyolitic ash-fall(?) tuff.	At the base of a steep QTb slope and in an adjacent wash, the Siebert Tuff has medium-high to high strength and closely to medium-spaced fractures.
Tertiary rhyolite lava flows and domes	Tvr	Brougher Rhyolite	Early Miocene (17-21 Ma)	Light-gray, grayish-orange-pink, light-orange, and yellowish-gray, crystal-rich, porphyritic, vitric rhyolite domes, very vesicular (lithophysal) toward the margins of domes.	Although present in small outcrops on the west side of Mud Lake, this geologic unit is not crossed by the GF3 alternative.
		Rhyolite of Wildhorse Spring		Light-gray, commonly streaked brown and orange, porphyritic, unweathered to slightly weathered, rhyolite lava flows with xenoliths and prominent foliation.	Outcrops of this geologic unit have very high strength and closely to widely spaced fractures. This geologic unit forms prominent hills with cliffs and steep slopes.
Early Miocene silicic to intermediate ash-flow and ash-fall tuff	Tt3	Fraction Tuff Meda Rhyolite Tuff of Chispa Hills	Early Miocene (~18-21 Ma)	Light-gray, pink, and orange and gray-banded, nonwelded to moderately welded(?), crystal-rich, generally lithic-rich, slightly weathered or altered, strongly foliated, rhyolite to rhyodacite ash-flow tuff.	Outcrops of this geologic unit have medium-high to very high strength and extremely closely to medium-spaced fractures. Because of variable welding and lithology, this geologic unit forms cliffs, ledges, and slopes.
Older Tertiary sedimentary rocks	Tso	Volcaniclastic rocks in Goldfield Hills	Early Miocene (~21-21.5 Ma)	Conglomerate completely weathered to sandy gravel - gravel to boulder-sized clasts of hydrothermally altered volcanic rocks in purple, green, orange, and white, fine to medium-grained sand; and olive-green, medium-grained, thinly bedded sandstone.	Where observed, the conglomerate was weathered completely to medium-dense to dense GP; outcrops of sandstone had moderate to medium-high strength and extremely closely to closely spaced fractures. The geologic unit fills valleys and extends to lower slopes of adjacent ridges.
Early Miocene lava flows and intrusives of intermediate composition	Ta3	Chispa Andesite (Ta) Andesite megabreccia (Tab) Dacite at Goldfield (Td) Milltown Andesite (Tma) Porphyritic rhyodacite (Tmd)	Early Miocene (~21-21.5 Ma)	Generally purplish-gray, brownish-gray, gray, dark-gray, and black, fine-grained to porphyritic, slightly to moderately hydrothermally altered, foliated, rhyodacite, andesite, and basaltic andesite lava flows, subordinate breccia, and minor intrusives. Where hydrothermally altered, rocks are streaked, mottled, or completely discolored orange, white, yellow, green, and purple. In fault zones, rocks are oxidized and hydrothermally altered pervasively, brecciated, shattered (extremely closely to closely fractured), and partly reduced to clayey gouge. Breccia typically consists of angular clasts of hydrothermally altered volcanic rocks, up to several inches in diameter, in variably indurated gouge.	Outcrops of this geologic unit exhibit moderate to very high strength and have extremely closely to widely spaced, mineralized fractures. This unit commonly forms steep hills.

TABLE 4
SOIL SURVEY DATA

NRP Station		Map Unit	Map Unit Name	Component Name	Depth, inches	USDA Texture	USCS Symbol	Engineering Index Properties: >10 inches	3 to10 inches	#4 Sieve	#10 Sieve	#40 Sieve	#200 Sieve	Liquid Limit	Plasticity Index	Physical and Chemical Properties: Saturated Hydraulic Conductivity	Reaction	Salinity (electrical conductivity)	Linear Extensibility (shrink-swell)	Soil Rock and Water Features: Depth to Water Table	Depth to Bedrock	Frost Action Potential	Risk of Corrosion: Concrete	Uncoated Steel	Site Development: Local Roads and Streets (Ease of Excavation, Traffic Supporting Capacity)	Material Source: Sand	Gravel
								Percent Retained		*Percent Passing*				*Percent*	*Percent*	*m M/sec*	*pH*	*m mhos/cm*	*Percent*	*inches*	*inches*						
Busted Butte East (BBE)																											
		No Soil Survey Data Available																									
Goldfield 3 Alternate (GF3)																											
52000+00	52059+00	1141	Unsel-Wardenot-Izo Association	Unsel	0 to 3	Gravelly fine sandy loam	SC	0	0	75-85	55-75	40-60	25-35	25-30	5-10	14-42	7.9-9.0	0.0-4.0	0.0-2.9	--	--	Low	Low	High	Not limited	Fair	Fair
					3 to 15	Gravelly clay loam	SC	0	0	75-85	55-75	45-60	35-45	35-40	15-20	1.4-4	7.4-9.0	0.0-2.0	3.0-5.9								
					15 to 28	Gravelly sandy clay loam	SC	0	0	60-75	50-70	35-50	20-35	20-30	5-10	4-14	8.5-9.0	4.0-8.0	0.0-2.9								
					28-60	Very gravelly loamy sand	GP-GM	0	0	40-50	20-35	10-25	0-10	--	NP	42-141	8.5-9.0	4.0-8.0	0.0-2.9								
				Wardenot	0 to 1	Gravelly loamy sand	SM	0	0	60-80	50-75	30-55	10-20	--	NP	42-141	7.4-9.0	0.0-4.0	0.0-2.9	--	--	Low	Low	High	Somewhat limited	Fair	Fair
					1 to 60	Stratified very gravelly fine sandy loam to extremely cobbly loamy sand	GM	0-5	10-40	25-50	20-45	15-40	5-15	--	NP	42-141	7.4-9.0	0.0-4.0	0.0-2.9								
				Izo	0 to 5	Gravelly sand	SP	0	0-5	75-85	50-75	15-35	0-10	--	NP	141-705	7.9-9.0	0.0-2.0	0.0-2.9	--	--	Low	Low	High	Very limited	Fair	Fair
					5 to 60	Stratified gravelly loamy sand to extremely gravelly coarse sand	GW	0-5	0-15	20-40	15-35	10-20	0-10	--	NP	42-141	7.9-9.0	0.0-4.0	0.0-2.9								
52059+00	52155+00	1930	Stonell-Wardenot-Izo Association	Stonell	0 to 3	Gravelly sandy loam	SM	0	0-5	60-75	55-70	30-60	20-40	20-25	NP-5	14-42	8.5-9.0	8.0-16.0	0.0-2.9	--	--	Low	Low	High	Not limited	Fair	Fair
					3 to 9	Very gravelly clay loam	GC	0	0-5	35-55	25-50	20-40	15-35	25-35	10-15	1.4-4	7.9-9.0	0.0-2.0	0.0-2.9								
					9 to 60	Stratified very gravelly loamy coarse sand to very gravelly sandy loam	GM	0	0-5	35-55	25-50	10-25	5-20	--	NP	42-141	8.5-9.6	4.0-8.0	0.0-2.9								
				Wardenot	0 to 1	Very gravelly sandy loam	GM	0	0-10	45-60	35-55	20-35	10-20	15-20	NP-5	14-42	7.4-9.0	0.0-4.0	0.0-2.9	--	--	Low	Low	High	Somewhat limited	Fair	Fair
					1 to 60	Stratified very gravelly fine sandy loam to extremely cobbly loamy sand	GM	0-5	10-40	25-50	20-45	15-40	5-15	--	NP	42-141	7.4-9.0	0.0-4.0	0.0-2.9								
				Izo	0 to 5	Very gravelly sand	GP-GM	0-5	0-15	35-60	30-50	15-35	0-10	--	NP	141-705	7.9-9.0	0.0-2.0	0.0-2.9	--	--	Low	Low	High	Very limited	Fair	Fair
					5 to 60	Stratified gravelly loamy sand to extremely gravelly coarse sand	GW	0-5	0-15	20-40	15-35	10-20	0-10	--	NP	42-141	7.9-9.0	0.0-4.0	0.0-2.9								
52155+00	52166+00	2141	Advokay-Blacktop Association	Advokay	0 to 5	Gravelly coarse sandy loam	GM	0	0	55-80	50-75	30-55	15-30	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Somewhat limited	Poor	Poor
					5 to 9	Gravelly sandy clay loam	GC	0	0	55-80	50-75	30-55	20-35	30-40	10-15	1.4-4	7.4-8.4	0.0-2.0	3.0-5.9								
					9 to 13	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Blacktop	0 to 6	Very gravelly fine sandy loam	GM	0	5-10	35-60	30-50	20-40	10-25	20-30	NP-5	4-14	7.4-8.4	0.0-4.0	0.0-2.9	--	4-10	Low	Low	High	Very limited	Fair	Fair
					6 to 10	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
52166+00	52224+00	2642	Advokay-Blacktop Association	Advokay	0 to 3	Gravelly sandy loam	GM	0	0	55-80	50-75	30-55	15-30	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					3 to 7	Gravelly sandy clay loam	GC	0	0	55-80	50-75	30-55	20-35	30-40	10-15	1.4-4	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 11	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Blacktop	0 to 7	Very stony fine sandy loam	GM	15-25	15-25	35-65	30-60	20-40	10-25	20-30	NP-5	4-14	7.4-8.4	0.0-4.0	0.0-2.9	--	4-10	Low	Low	High	Very limited	Poor	Poor
					7 to 17	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
52224+00	52227+00	2650	Luning-Wardenot-Izo Association	Luning	0 to 3	Loamy sand	SM	0	0	100	90-100	70-85	20-35	--	NP	42-141	7.4-9.0	0.0-2.0	0.0-2.9	--	--	Low	Low	High	Very limited	Poor	Fair
					3 to 60	Stratified very gravelly coarse sand to sandy loam	SM	0-10	0	75-95	55-90	45-80	10-30	--	NP	42-141	7.9-9.0	0.0-4.0	0.0-2.9								
				Wardenot	0 to 5	Gravelly sandy loam	SM	0	0	60-80	50-75	40-60	20-40	20-25	NP-5	14-42	7.4-9.0	0.0-4.0	0.0-2.9	--	--	Low	Low	High	Very limited	Fair	Fair
					5 to 60	Stratified extremely cobbly loamy sand to very gravelly fine sandy loam	GM	0-5	10-40	25-50	20-45	15-40	5-15	--	NP	42-141	7.4-9.0	0.0-4.0	0.0-2.9								
				Izo	0 to 8	Very gravelly sand	GP	0-5	0-15	35-60	30-50	15-35	0-10	--	NP	141-705	7.9-9.0	0.0-2.0	0.0-2.9	--	--	Low	Low	High	Very limited	Fair	Fair
					8 to 60	Stratified extremely gravelly coarse sand to gravelly sandy loam	GW	0-5	0-15	20-40	15-35	10-20	0-10	--	NP	42-141	7.9-9.0	0.0-4.0	0.0-2.9								
52227+00	52242+00	2642	Advokay-Blacktop Association	Advokay	0 to 3	Gravelly sandy loam	GM	0	0	55-80	50-75	30-55	15-30	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					3 to 7	Gravelly sandy clay loam	GC	0	0	55-80	50-75	30-55	20-35	30-40	10-15	1.4-4	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 11	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Blacktop	0 to 7	Very stony fine sandy loam	GM	15-25	15-25	35-65	30-60	20-40	10-25	20-30	NP-5	4-14	7.4-8.4	0.0-4.0	0.0-2.9	--	4-10	Low	Low	High	Very limited	Poor	Poor
					7 to 17	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
52242+00	52302+00	2741	Blacktop-Downeyville-Tognani Association	Blacktop	0 to 7	Very stony fine sandy loam	GM	15-25	15-25	35-65	30-60	20-40	10-25	20-30	NP-5	4-14	7.4-8.4	0.0-4.0	0.0-2.9	--	4-10	Low	Low	High	Very limited	Poor	Poor
					7 to 17	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								

TABLE 4
SOIL SURVEY DATA

NRP Station		Map Unit	Map Unit Name	Component Name	Depth, inches	USDA Texture	USCS Symbol	Engineering Index Properties: >10 inches	3 to10 inches	#4 Sieve	#10 Sieve	#40 Sieve	#200 Sieve	Liquid Limit	Plasticity Index	Physical and Chemical Properties: Saturated Hydraulic Conductivity	Reaction	Salinity (electrical conductivity)	Linear Extensibility (shrink-swell)	Soil Rock and Water Features: Depth to Water Table	Depth to Bedrock	Frost Action Potential	Risk of Corrosion: Concrete	Uncoated Steel	Site Development: Local Roads and Streets (Ease of Excavation, Traffic Supporting Capacity)	Material Source: Sand	Gravel
								Percent Retained		Percent Passing				Percent	Percent	μM/sec	pH	μmhos/cm	Percent	inches	inches						
				Downeyville	0 to 4	Very gravelly fine sandy loam	SC-SM	0	5-20	60-70	30-55	25-45	15-30	15-25	NP-10	14-42	7.9-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					4 to 9	Very gravelly fine sandy loam	GC	0-5	10-25	40-60	30-50	25-50	20-40	25-35	10-15	4-14	7.9-9.0	0.0-2.0	0.0-2.9								
					9 to 13	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Tognani	0 to 4	Very cobbly fine sandy loam	GM	0-5	30-40	45-55	40-50	35-45	20-30	20-25	NP-5	14-42	7.9-9.0	0.0-2.0	0.0-2.9	--	5-14	Low	Low	High	Very limited	Poor	Poor
					4 to 14	Very cobbly clay loam	GC	0-5	30-55	30-60	25-55	20-50	20-45	40-50	20-30	0.42-1.4	7.9-8.4	0.0-2.0	3.0-5.9								
					14 to 24	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
52302+00	52430+00	2732	Gabbvally-Tognani-Downeyville Association	Gabbvally	0 to 4	Very gravelly fine sandy loam	GM	0	0-10	50-60	35-45	25-40	15-25	20-25	NP-5	14-42	6.6-7.8	0.0-2.0	0.0-2.9	--	6-14	Moderate	Low	Moderate	Very limited	Poor	Poor
					4 to 12	Very gravelly loam	GC	0-5	0-15	50-60	35-50	25-35	15-25	25-35	5-15	4-14	6.6-7.8	0.0-2.0	0.0-2.9								
					12 to 15	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Tognani	0 to 4	Gravelly fine sandy loam	SM	0-1	0-10	60-75	55-70	45-65	15-45	20-25	NP-5	14-42	7.9-9.0	0.0-2.0	0.0-2.9	--	5-14	Low	Low	High	Very limited	Poor	Poor
					4 to 14	Very cobbly clay loam	GC	0-5	30-55	30-60	25-55	20-50	20-45	40-50	20-30	0.42-1.4	7.9-8.4	0.0-2.0	3.0-5.9								
					14 to 24	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Downeyville	0 to 4	Very gravelly fine sandy loam	SC-SM	0	5-20	60-70	30-55	25-45	15-30	15-25	NP-10	14-42	7.9-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					4 to 9	Very gravelly fine sandy loam	GC	0-5	10-25	40-60	30-50	25-50	20-40	25-35	10-15	4-14	7.9-9.0	0.0-2.0	0.0-2.9								
					9 to 13	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
52430+00	52432+00	2690	Leo-Izo Association	Leo	0 to 4	Gravelly sandy loam	SM	0	0	65-85	50-75	40-60	20-35	15-25	NP-5	14-42	7.9-9.0	0.0-2.0	0.0-2.9	--	--	Low	Low	High	Not limited	Poor	Fair
					4 to 60	Stratified extremely gravelly coarse sand to gravelly fine sandy loam	GM	0-5	0-25	45-60	40-50	15-35	5-20	--	NP-5	42-141	7.9-9.0	0.0-4.0	0.0-2.9								
				Izo	0 to 8	Very gravelly sand	GP	0-5	0-15	35-60	30-50	15-35	0-10	--	NP	141-705	7.9-9.0	0.0-2.0	0.0-2.9	--	--	Low	Low	High	Very limited	Fair	Fair
					8 to 60	Stratified extremely gravelly coarse sand to gravelly sandy loam	GW	0-5	0-15	20-40	15-35	10-20	0-10	--	NP	42-141	7.9-9.0	0.0-4.0	0.0-2.9								
52432+00	52540+00	2254	Tokoper-Downeyville-Espint Association	Tokoper	0 to 3	Very cobbly sandy loam	GM	0-5	30-45	55-75	45-70	30-45	20-30	15-25	NP-5	14-42	7.9-8.4	0.0-4.0	0.0-2.9	--	8-15	Low	Low	High	Very limited	Poor	Poor
					3 to 9	Very gravelly clay loam	GC	0-5	10-25	50-60	40-55	30-45	20-40	30-40	10-15	1.4-4	7.9-9.0	0.0-4.0	3.0-5.9								
					9 to 14	Very gravelly loam	GC-GM	0-5	25-40	30-50	20-40	10-30	5-25	35-35	5-10	4-14	7.9-9.0	0.0-8.0	0.0-2.9								
					14 to 15	Indurated	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
					15 to 25	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Downeyville	0 to 4	Very gravelly fine sandy loam	SC-SM	0	5-20	60-70	30-55	25-45	15-30	15-25	NP-10	14-42	7.9-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					4 to 9	Very gravelly fine sandy loam	GC	0-5	10-25	40-60	30-50	25-50	20-40	25-35	10-15	4-14	7.9-9.0	0.0-2.0	0.0-2.9								
					9 to 13	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Espint	0 to 1	Very gravelly fine sandy loam	GM	0	0-15	35-65	30-50	25-40	10-15	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	6-14	Low	Low	High	Very limited	Poor	Poor
					1 to 7	Gravelly clay	CH	0	0-10	65-90	55-85	45-75	35-60	40-55	20-30	0.42-1.4	7.4-8.4	0.0-2.0	6.0-8.9								
					7 to 17	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
52540+00	52542+00	2690	Leo-Izo Association	Leo	0 to 4	Gravelly sandy loam	SM	0	0	65-85	50-75	40-60	20-35	15-25	NP-5	14-42	7.9-9.0	0.0-2.0	0.0-2.9	--	--	Low	Low	High	Not limited	Poor	Fair
					4 to 60	Stratified extremely gravelly coarse sand to gravelly fine sandy loam	GM	0-5	0-25	45-60	40-50	15-35	5-20	--	NP-5	42-141	7.9-9.0	0.0-4.0	0.0-2.9								
				Izo	0 to 8	Very gravelly sand	GP	0-5	0-15	35-60	30-50	15-35	0-10	--	NP	141-705	7.9-9.0	0.0-2.0	0.0-2.9	--	--	Low	Low	High	Very limited	Fair	Fair
					8 to 60	Stratified extremely gravelly coarse sand to gravelly sandy loam	GW	0-5	0-15	20-40	15-35	10-20	0-10	--	NP	42-141	7.9-9.0	0.0-4.0	0.0-2.9								
52542+00	52587+00	2760	Downeyville-Unsel-Tokoper Association	Downeyville	0 to 4	Very gravelly fine sandy loam	SC-SM	0	5-20	60-70	30-55	25-45	15-30	15-25	NP-10	14-42	7.9-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					4 to 9	Very gravelly fine sandy loam	GC	0-5	10-25	40-60	30-50	25-50	20-40	25-35	10-15	4-14	7.9-9.0	0.0-2.0	0.0-2.9								
					9 to 13	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Unsel	0 to 7	Gravelly sandy loam	SC	0	0	75-85	55-75	40-60	25-35	25-30	5-10	14-42	7.9-9.0	0.0-4.0	0.0-2.9	--	--	Low	Low	High	Somewhat limited	Fair	Fair
					7 to 11	Gravelly clay loam	SC	0	0	75-85	55-75	45-60	35-45	35-40	15-20	1.4-4	7.4-9.0	0.0-2.0	3.0-5.9								
					11 to 20	Gravelly sandy clay loam	SC	0	0	60-75	50-70	35-50	20-35	20-30	5-10	4-14	8.5-9.0	4.0-8.0	0.0-2.9								
					20 to 60	Very gravelly loamy sand	GP	0	0	40-50	20-35	10-25	0-10	--	NP	42-141	8.5-9.0	4.0-8.0	0.0-2.9								
				Tokoper	0 to 3	Very cobbly sandy loam	GM	0-5	30-45	55-75	45-70	30-45	20-30	15-25	NP-5	14-42	7.9-8.4	0.0-4.0	0.0-2.9	--	8-15	Low	Low	High	Very limited	Poor	Poor
					3 to 9	Very gravelly clay loam	GC	0-5	10-25	50-60	40-55	30-45	20-40	30-40	10-15	1.4-4	7.9-9.0	0.0-4.0	3.0-5.9								
					9 to 14	Very gravelly loam	GC-GM	0-5	25-40	30-50	20-40	10-30	5-25	35-35	5-10	4-14	7.9-9.0	0.0-8.0	0.0-2.9								
					14 to 15	Indurated	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
					15 to 25	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
52587+00	52632+00	2682	Espint-Gabbvally-Stewval Association	Espint	0 to 1	Very gravelly fine sandy loam	GM	0	0-15	35-65	30-50	25-40	10-15	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	6-14	Low	Low	High	Very limited		
					1 to 7	Gravelly clay	CH	0	0-10	65-90	55-85	45-75	35-60	40-55	20-30	0.42-1.4	7.4-8.4	0.0-2.0	6.0-8.9								

TABLE 4
SOIL SURVEY DATA

NRP Station		Map Unit	Map Unit Name	Component Name	Depth, inches	USDA Texture	USCS Symbol	Engineering Index Properties: >10 inches (Percent Retained)	3 to10 inches (Percent Retained)	#4 Sieve (Percent Passing)	#10 Sieve (Percent Passing)	#40 Sieve (Percent Passing)	#200 Sieve (Percent Passing)	Liquid Limit (Percent)	Plasticity Index (Percent)	Physical and Chemical Properties: Saturated Hydraulic Conductivity (m M/sec)	Reaction (pH)	Salinity (electrical conductivity) (m mhos/cm)	Linear Extensibility (shrink-swell) (Percent)	Soil Rock and Water Features: Depth to Water Table (inches)	Depth to Bedrock (inches)	Frost Action Potential	Risk of Corrosion: Concrete	Uncoated Steel	Site Development: Local Roads and Streets (Ease of Excavation, Traffic Supporting Capacity)	Material Source: Sand	Gravel
					7 to 17	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Gabbvally	0 to 4	Very gravelly fine sandy loam	GM	0	0-10	50-60	35-45	25-40	15-25	20-25	NP-5	14-42	6.6-7.8	0.0-2.0	0.0-2.9	--	6-14	Moderate	Low	Moderate	Very limited	Poor	Poor
					4 to 12	Very gravelly loam	GC	0-5	0-15	50-60	35-50	25-35	15-25	25-35	5-15	4-14	6.6-7.8	0.0-2.0	0.0-2.9								
					12 to 15	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Stewval	0 to 1	Very gravelly fine sandy loam	GC	0	0-10	35-55	30-45	20-35	10-20	20-25	5-10	14-42	7.4-8.4	0	0.0-2.9	--	4-14	Moderate	Low	Moderate	Very limited	Fair	Poor
					1 to 7	Very gravelly clay loam	GC	0-10	0-25	20-55	15-45	10-35	10-30	30-40	10-20	4-14	7.4-8.4	0	0.0-2.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
52632+00	52651+00	2494	Downeyville-Vindicator-Stewval association	Downeyville	0 to 4	Very gravelly fine sandy loam	SC-SM	0	5-20	60-70	30-55	25-45	15-30	15-25	NP-10	14-42	7.9-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					4 to 9	Very gravelly fine sandy loam	GC	0-5	10-25	40-60	30-50	25-50	20-40	25-35	10-15	4-14	7.9-9.0	0.0-2.0	0.0-2.9								
					9 to 13	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Stewval	0 to 1	Very gravelly fine sandy loam	GC	0	0-10	35-55	30-45	20-35	10-20	20-25	5-10	14-42	7.4-8.4	0	0.0-2.9	--	4-14	Moderate	Low	Moderate	Very limited	Fair	Poor
					1 to 7	Very gravelly clay loam	GC	0-10	0-25	20-55	15-45	10-35	10-30	30-40	10-20	4-14	7.4-8.4	0	0.0-2.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Vindicator	0 to 2	Very gravelly sandy loam	GM	0	0-10	35-55	30-50	20-35	10-20	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Somewhat limited	Poor	Poor
					2 to 7	Very gravelly clay loam	GC	0	0-10	45-60	35-50	30-40	20-35	25-40	10-20	4-14	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
52651+00	52687+00	2682	Espint-Gabbvally-Stewval Association	Espint	0 to 1	Very gravelly fine sandy loam	GM	0	0-15	35-65	30-50	25-40	10-15	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	6-14	Low	Low	High	Very limited		
					1 to 7	Gravelly clay	CH	0	0-10	65-90	55-85	45-75	35-60	40-55	20-30	0.42-1.4	7.4-8.4	0.0-2.0	6.0-8.9								
					7 to 17	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Gabbvally	0 to 4	Very gravelly fine sandy loam	GM	0	0-10	50-60	35-45	25-40	15-25	20-25	NP-5	14-42	6.6-7.8	0.0-2.0	0.0-2.9	--	6-14	Moderate	Low	Moderate	Very limited	Poor	Poor
					4 to 12	Very gravelly loam	GC	0-5	0-15	50-60	35-50	25-35	15-25	25-35	5-15	4-14	6.6-7.8	0.0-2.0	0.0-2.9								
					12 to 15	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Stewval	0 to 1	Very gravelly fine sandy loam	GC	0	0-10	35-55	30-45	20-35	10-20	20-25	5-10	14-42	7.4-8.4	0	0.0-2.9	--	4-14	Moderate	Low	Moderate	Very limited	Fair	Poor
					1 to 7	Very gravelly clay loam	GC	0-10	0-25	20-55	15-45	10-35	10-30	30-40	10-20	4-14	7.4-8.4	0	0.0-2.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
52687+00	52747+00	2494	Downeyville-Vindicator-Stewval association	Downeyville	0 to 4	Very gravelly fine sandy loam	SC-SM	0	5-20	60-70	30-55	25-45	15-30	15-25	NP-10	14-42	7.9-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					4 to 9	Very gravelly fine sandy loam	GC	0-5	10-25	40-60	30-50	25-50	20-40	25-35	10-15	4-14	7.9-9.0	0.0-2.0	0.0-2.9								
					9 to 13	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Stewval	0 to 1	Very gravelly fine sandy loam	GC	0	0-10	35-55	30-45	20-35	10-20	20-25	5-10	14-42	7.4-8.4	0	0.0-2.9	--	4-14	Moderate	Low	Moderate	Very limited	Fair	Poor
					1 to 7	Very gravelly clay loam	GC	0-10	0-25	20-55	15-45	10-35	10-30	30-40	10-20	4-14	7.4-8.4	0	0.0-2.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Vindicator	0 to 2	Very gravelly sandy loam	GM	0	0-10	35-55	30-50	20-35	10-20	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Somewhat limited	Poor	Poor
					2 to 7	Very gravelly clay loam	GC	0	0-10	45-60	35-50	30-40	20-35	25-40	10-20	4-14	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
52747+00	52764+00	2682	Espint-Gabbvally-Stewval Association	Espint	0 to 1	Very gravelly fine sandy loam	GM	0	0-15	35-65	30-50	25-40	10-15	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	6-14	Low	Low	High	Very limited		
					1 to 7	Gravelly clay	CH	0	0-10	65-90	55-85	45-75	35-60	40-55	20-30	0.42-1.4	7.4-8.4	0.0-2.0	6.0-8.9								
					7 to 17	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Gabbvally	0 to 4	Very gravelly fine sandy loam	GM	0	0-10	50-60	35-45	25-40	15-25	20-25	NP-5	14-42	6.6-7.8	0.0-2.0	0.0-2.9	--	6-14	Moderate	Low	Moderate	Very limited	Poor	Poor
					4 to 12	Very gravelly loam	GC	0-5	0-15	50-60	35-50	25-35	15-25	25-35	5-15	4-14	6.6-7.8	0.0-2.0	0.0-2.9								
					12 to 15	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Stewval	0 to 1	Very gravelly fine sandy loam	GC	0	0-10	35-55	30-45	20-35	10-20	20-25	5-10	14-42	7.4-8.4	0	0.0-2.9	--	4-14	Moderate	Low	Moderate	Very limited	Fair	Poor
					1 to 7	Very gravelly clay loam	GC	0-10	0-25	20-55	15-45	10-35	10-30	30-40	10-20	4-14	7.4-8.4	0	0.0-2.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
52764+00	52770+00	2494	Downeyville-Vindicator-Stewval association	Downeyville	0 to 4	Very gravelly fine sandy loam	SC-SM	0	5-20	60-70	30-55	25-45	15-30	15-25	NP-10	14-42	7.9-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					4 to 9	Very gravelly fine sandy loam	GC	0-5	10-25	40-60	30-50	25-50	20-40	25-35	10-15	4-14	7.9-9.0	0.0-2.0	0.0-2.9								
					9 to 13	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Stewval	0 to 1	Very gravelly fine sandy loam	GC	0	0-10	35-55	30-45	20-35	10-20	20-25	5-10	14-42	7.4-8.4	0	0.0-2.9	--	4-14	Moderate	Low	Moderate	Very limited	Fair	Poor
					1 to 7	Very gravelly clay loam	GC	0-10	0-25	20-55	15-45	10-35	10-30	30-40	10-20	4-14	7.4-8.4	0	0.0-2.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Vindicator	0 to 2	Very gravelly sandy loam	GM	0	0-10	35-55	30-50	20-35	10-20	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Somewhat limited	Poor	Poor
					2 to 7	Very gravelly clay loam	GC	0	0-10	45-60	35-50	30-40	20-35	25-40	10-20	4-14	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								

TABLE 4
SOIL SURVEY DATA

NRP Station		Map Unit	Map Unit Name	Component Name	Depth, inches	USDA Texture	USCS Symbol	Engineering Index Properties: >10 inches	3 to10 inches	#4 Sieve	#10 Sieve	#40 Sieve	#200 Sieve	Liquid Limit	Plasticity Index	Physical and Chemical Properties: Saturated Hydraulic Conductivity	Reaction	Salinity (electrical conductivity)	Linear Extensibility (shrink-swell)	Soil Rock and Water Features: Depth to Water Table	Depth to Bedrock	Frost Action Potential	Risk of Corrosion: Concrete	Uncoated Steel	Site Development: Local Roads and Streets (Ease of Excavation, Traffic Supporting Capacity)	Material Source: Sand	Gravel
								Percent Retained		*Percent Passing*				*Percent*	*Percent*	*m M/sec*	*pH*	*m mhos/cm*	*Percent*	*inches*	*inches*						
52770+00	52783+00	2682	Espint-Gabbvally-Stewval Association	Espint	0 to 1	Very gravelly fine sandy loam	GM	0	0-15	35-65	30-50	25-40	10-15	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	6-14	Low	Low	High	Very limited		
					1 to 7	Gravelly clay	CH	0	0-10	65-90	55-85	45-75	35-60	40-55	20-30	0.42-1.4	7.4-8.4	0.0-2.0	6.0-8.9								
					7 to 17	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Gabbvally	0 to 4	Very gravelly fine sandy loam	GM	0	0-10	50-60	35-45	25-40	15-25	20-25	NP-5	14-42	6.6-7.8	0.0-2.0	0.0-2.9	--	6-14	Moderate	Low	Moderate	Very limited	Poor	Poor
					4 to 12	Very gravelly loam	GC	0-5	0-15	50-60	35-50	25-35	15-25	25-35	5-15	4-14	6.6-7.8	0.0-2.0	0.0-2.9								
					12 to 15	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Stewval	0 to 1	Very gravelly fine sandy loam	GC	0	0-10	35-55	30-45	20-35	10-20	20-25	5-10	14-42	7.4-8.4	0	0.0-2.9	--	4-14	Moderate	Low	Moderate	Very limited	Fair	Poor
					1 to 7	Very gravelly clay loam	GC	0-10	0-25	20-55	15-45	10-35	10-30	30-40	10-20	4-14	7.4-8.4	0	0.0-2.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
52783+00	52816+00	2494	Downeyville-Vindicator-Stewval association	Downeyville	0 to 4	Very gravelly fine sandy loam	SC-SM	0	5-20	60-70	30-55	25-45	15-30	15-25	NP-10	14-42	7.9-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					4 to 9	Very gravelly fine sandy loam	GC	0-5	10-25	40-60	30-50	25-50	20-40	25-35	10-15	4-14	7.9-9.0	0.0-2.0	0.0-2.9								
					9 to 13	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Stewval	0 to 1	Very gravelly fine sandy loam	GC	0	0-10	35-55	30-45	20-35	10-20	20-25	5-10	14-42	7.4-8.4	0	0.0-2.9	--	4-14	Moderate	Low	Moderate	Very limited	Fair	Poor
					1 to 7	Very gravelly clay loam	GC	0-10	0-25	20-55	15-45	10-35	10-30	30-40	10-20	4-14	7.4-8.4	0	0.0-2.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Vindicator	0 to 2	Very gravelly sandy loam	GM	0	0-10	35-55	30-50	20-35	10-20	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Somewhat limited	Poor	Poor
					2 to 7	Very gravelly clay loam	GC	0	0-10	45-60	35-50	30-40	20-35	25-40	10-20	4-14	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
52816+00	52828+00	2731	Gabbvally-Downeyville-Vindicator Association	Gabbvally	0 to 4	Very gravelly fine sandy loam	GM	0	0-10	50-60	35-45	25-40	15-25	20-25	NP-5	14-42	6.6-7.8	0.0-2.0	0.0-2.9	--	6-14	Moderate	Low	Moderate	Very limited	Poor	Poor
					4 to 12	Very gravelly loam	GC	0-5	0-15	50-60	35-50	25-35	15-25	25-35	5-15	4-14	6.6-7.8	0.0-2.0	0.0-2.9								
					12 to 15	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Downeyville	0 to 4	Very gravelly fine sandy loam	SC-SM	0	5-20	60-70	30-55	25-45	15-30	15-25	NP-10	14-42	7.9-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					4 to 9	Very gravelly fine sandy loam	GC	0-5	10-25	40-60	30-50	25-50	20-40	25-35	10-15	4-14	7.9-9.0	0.0-2.0	0.0-2.9								
					9 to 13	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Vindicator	0 to 2	Very gravelly sandy loam	GM	0	0-10	35-55	30-50	20-35	10-20	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Somewhat limited	Poor	Poor
					2 to 7	Very gravelly clay loam	GC	0	0-10	45-60	35-50	30-40	20-35	25-40	10-20	4-14	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
52828+00	52951+00	2494	Downeyville-Vindicator-Stewval association	Downeyville	0 to 4	Very gravelly fine sandy loam	SC-SM	0	5-20	60-70	30-55	25-45	15-30	15-25	NP-10	14-42	7.9-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					4 to 9	Very gravelly fine sandy loam	GC	0-5	10-25	40-60	30-50	25-50	20-40	25-35	10-15	4-14	7.9-9.0	0.0-2.0	0.0-2.9								
					9 to 13	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Stewval	0 to 1	Very gravelly fine sandy loam	GC	0	0-10	35-55	30-45	20-35	10-20	20-25	5-10	14-42	7.4-8.4	0	0.0-2.9	--	4-14	Moderate	Low	Moderate	Very limited	Fair	Poor
					1 to 7	Very gravelly clay loam	GC	0-10	0-25	20-55	15-45	10-35	10-30	30-40	10-20	4-14	7.4-8.4	0	0.0-2.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Vindicator	0 to 2	Very gravelly sandy loam	GM	0	0-10	35-55	30-50	20-35	10-20	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Somewhat limited	Poor	Poor
					2 to 7	Very gravelly clay loam	GC	0	0-10	45-60	35-50	30-40	20-35	25-40	10-20	4-14	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
52951+00	52955+00	2680	Espint-Vindicator Association	Espint	0 to 1	Very gravelly fine sandy loam	GM	0	0-15	35-65	30-50	25-40	10-15	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	6-14	Low	Low	High	Very limited	Poor	Poor
					1 to 7	Gravelly clay	CH	0	0-10	65-90	55-85	45-75	35-60	40-55	20-30	0.42-1.4	7.4-8.4	0.0-2.0	6.0-8.9								
					7 to 17	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Vindicator	0 to 2	Very gravelly sandy loam	GM	0	0-10	35-55	30-50	20-35	10-20	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					2 to 7	Very gravelly clay loam	GC	0	0-10	45-60	35-50	30-40	20-35	25-40	10-20	4-14	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 17	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
52955+00	52963+00	2720	Unsel-Stonell-Veet Association	Unsel	0 to 7	Gravelly sandy loam	SC	0	0	75-85	55-75	40-60	25-35	25-30	5-10	14-42	7.9-9.0	0.0-4.0	0.0-2.9	--	--	Low	Low	High	Not limited	Fair	Fair
					7 to 11	Gravelly clay loam	SC	0	0	75-85	55-75	45-60	35-45	35-40	15-20	1.4-4	7.4-9.0	0.0-2.0	3.0-5.9								
					11 to 20	Gravelly sandy clay loam	SC	0	0	60-75	50-70	35-50	20-35	20-30	5-10	4-14	8.5-9.0	4.0-8.0	0.0-2.9								
					20 to 60	Very gravelly loamy sand	GP	0	0	40-50	20-35	10-25	0-10	--	NP	42-141	8.5-9.0	4.0-8.0	0.0-2.9								
				Stonell	0 to 3	Gravelly sandy loam	SM	0	0-5	60-75	55-70	30-60	20-40	20-25	NP-5	14-42	8.5-9.0	8.0-16.0	0.0-2.9	--	--	Low	Low	High	Not limited	Fair	Poor
					3 to 8	Very gravelly clay loam	GC	0	0-5	35-55	25-50	20-40	15-35	25-35	10-15	1.4-4	7.9-9.0	0.0-2.0	0.0-2.9								
					8 to 60	Stratified very gravelly loamy coarse sand to very gravelly sandy loam	GM	0	0-5	35-55	25-50	10-25	5-20	--	NP	42-141	8.5-9.6	4.0-8.0	0.0-2.9								
				Veet	0 to 5	Very gravelly sandy loam	SM	0	0-10	60-75	30-50	20-45	15-25	15-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	--	Moderate	Low	High	Somewhat limited	Poor	Fair
					5 to 20	Very gravelly sandy loam	GC	0	10-25	40-60	35-55	25-50	15-25	20-25	5-10	4-14	7.4-9.0	0.0-2.0	0.0-2.9								

TABLE 4
SOIL SURVEY DATA

NRP Station		Map Unit	Map Unit Name	Component Name	Depth, inches	USDA Texture	USCS Symbol	Engineering Index Properties: >10 inches	3 to10 inches	#4 Sieve	#10 Sieve	#40 Sieve	#200 Sieve	Liquid Limit	Plasticity Index	Physical and Chemical Properties: Saturated Hydraulic Conductivity	Reaction	Salinity (electrical conductivity)	Linear Extensibility (shrink-swell)	Soil Rock and Water Features: Depth to Water Table	Depth to Bedrock	Frost Action Potential	Risk of Corrosion: Concrete	Uncoated Steel	Site Development: Local Roads and Streets (Ease of Excavation, Traffic Supporting Capacity)	Material Source: Sand	Gravel
								Percent Retained		*Percent Passing*				*Percent*	*Percent*	*m M/sec*	*pH*	*m mhos/cm*	*Percent*	*inches*	*inches*						
					20 to 60	Stratified very gravelly loamy coarse sand to extremely gravelly sandy loam	GM	0	10-25	45-55	30-50	15-30	5-15	--	NP	42-141	7.9-9.0	0.0-2.0	0.0-2.9								
52963+00	52975+00	2680	Espint-Vindicator Association	Espint	0 to 1	Very gravelly fine sandy loam	GM	0	0-15	35-65	30-50	25-40	10-15	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	6-14	Low	Low	High	Very limited	Poor	Poor
					1 to 7	Gravelly clay	CH	0	0-10	65-90	55-85	45-75	35-60	40-55	20-30	0.42-1.4	7.4-8.4	0.0-2.0	6.0-8.9								
					7 to 17	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Vindicator	0 to 2	Very gravelly sandy loam	GM	0	0-10	35-55	30-50	20-35	10-20	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					2 to 7	Very gravelly clay loam	GC	0	0-10	45-60	35-50	30-40	20-35	25-40	10-20	4-14	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 17	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
52975+00	52986+00	2494	Downeyville-Vindicator-Stewval association	Downeyville	0 to 4	Very gravelly fine sandy loam	SC-SM	0	5-20	60-70	30-55	25-45	15-30	15-25	NP-10	14-42	7.9-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					4 to 9	Very gravelly fine sandy loam	GC	0-5	10-25	40-60	30-50	25-50	20-40	25-35	10-15	4-14	7.9-9.0	0.0-2.0	0.0-2.9								
					9 to 13	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Stewval	0 to 1	Very gravelly fine sandy loam	GC	0	0-10	35-55	30-45	20-35	10-20	20-25	5-10	14-42	7.4-8.4	0	0.0-2.9	--	4-14	Moderate	Low	Moderate	Very limited	Fair	Poor
					1 to 7	Very gravelly clay loam	GC	0-10	0-25	20-55	15-45	10-35	10-30	30-40	10-20	4-14	7.4-8.4	0	0.0-2.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0-0.01	--	--	--								
				Vindicator	0 to 2	Very gravelly sandy loam	GM	0	0-10	35-55	30-50	20-35	10-20	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Somewhat limited	Poor	Poor
					2 to 7	Very gravelly clay loam	GC	0	0-10	45-60	35-50	30-40	20-35	25-40	10-20	4-14	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 11	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
52986+00	53067+00	2680	Espint-Vindicator Association	Espint	0 to 1	Very gravelly fine sandy loam	GM	0	0-15	35-65	30-50	25-40	10-15	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	6-14	Low	Low	High	Very limited	Poor	Poor
					1 to 7	Gravelly clay	CH	0	0-10	65-90	55-85	45-75	35-60	40-55	20-30	0.42-1.4	7.4-8.4	0.0-2.0	6.0-8.9								
					7 to 17	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Vindicator	0 to 2	Very gravelly sandy loam	GM	0	0-10	35-55	30-50	20-35	10-20	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					2 to 7	Very gravelly clay loam	GC	0	0-10	45-60	35-50	30-40	20-35	25-40	10-20	4-14	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 17	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
53067+00	53075+00	2641	Advokay-Ardivey--Leo Association	Advokay	0 to 3	Gravelly sandy loam	GM	0	0	55-80	50-75	30-55	15-30	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					3 to 7	Gravelly sandy clay loam	GC	0	0	55-80	50-75	30-55	20-35	30-40	10-15	1.4-4	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 11	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Ardivey	0 to 4	Very gravelly sandy loam	GC-GM	0	0-15	30-55	25-50	15-30	10-20	20-25	5-10	14-42	7.9-9.0	0.0-2.0	0.0-2.9	--	--	Low	Low	High	Very limited	Fair	Fair
					4 to 14	Very gravelly clay loam	GC	0-10	10-25	40-55	30-45	20-40	15-30	25-40	10-20	1.4-4	6.6-8.4	0.0-2.0	0.0-2.9								
					14 to 60	Extremely gravelly loamy sand	GW	0-10	10-45	15-35	10-30	5-20	0-10	--	NP-5	42-141	7.9-9.6	0.0-2.0	0.0-2.9								
				Leo	0 to 4	Gravelly sandy loam	SM	0	0	65-85	50-75	40-60	20-35	15-25	NP-5	14-42	7.9-9.0	0.0-2.0	0.0-2.9	--	--	Low	Low	High	Very limited	Poor	Fair
					4 to 60	Stratified extremely gravelly coarse sand to gravelly fine sandy loam	GM	0-5	0-25	45-60	40-50	15-35	5-20	--	NP-5	42-141	7.9-9.0	0.0-4.0	0.0-2.9								
53075+00	53087+00	2680	Espint-Vindicator Association	Espint	0 to 1	Very gravelly fine sandy loam	GM	0	0-15	35-65	30-50	25-40	10-15	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	6-14	Low	Low	High	Very limited	Poor	Poor
					1 to 7	Gravelly clay	CH	0	0-10	65-90	55-85	45-75	35-60	40-55	20-30	0.42-1.4	7.4-8.4	0.0-2.0	6.0-8.9								
					7 to 17	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Vindicator	0 to 2	Very gravelly sandy loam	GM	0	0-10	35-55	30-50	20-35	10-20	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					2 to 7	Very gravelly clay loam	GC	0	0-10	45-60	35-50	30-40	20-35	25-40	10-20	4-14	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 17	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
53087+00	53099+00	2641	Advokay-Ardivey--Leo Association	Advokay	0 to 3	Gravelly sandy loam	GM	0	0	55-80	50-75	30-55	15-30	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					3 to 7	Gravelly sandy clay loam	GC	0	0	55-80	50-75	30-55	20-35	30-40	10-15	1.4-4	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 11	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Ardivey	0 to 4	Very gravelly sandy loam	GC-GM	0	0-15	30-55	25-50	15-30	10-20	20-25	5-10	14-42	7.9-9.0	0.0-2.0	0.0-2.9	--	--	Low	Low	High	Very limited	Fair	Fair
					4 to 14	Very gravelly clay loam	GC	0-10	10-25	40-55	30-45	20-40	15-30	25-40	10-20	1.4-4	6.6-8.4	0.0-2.0	0.0-2.9								
					14 to 60	Extremely gravelly loamy sand	GW	0-10	10-45	15-35	10-30	5-20	0-10	--	NP-5	42-141	7.9-9.6	0.0-2.0	0.0-2.9								
				Leo	0 to 4	Gravelly sandy loam	SM	0	0	65-85	50-75	40-60	20-35	15-25	NP-5	14-42	7.9-9.0	0.0-2.0	0.0-2.9	--	--	Low	Low	High	Very limited	Poor	Fair
					4 to 60	Stratified extremely gravelly coarse sand to gravelly fine sandy loam	GM	0-5	0-25	45-60	40-50	15-35	5-20	--	NP-5	42-141	7.9-9.0	0.0-4.0	0.0-2.9								
53099+00	53114+00	2680	Espint-Vindicator Association	Espint	0 to 1	Very gravelly fine sandy loam	GM	0	0-15	35-65	30-50	25-40	10-15	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	6-14	Low	Low	High	Very limited	Poor	Poor
					1 to 7	Gravelly clay	CH	0	0-10	65-90	55-85	45-75	35-60	40-55	20-30	0.42-1.4	7.4-8.4	0.0-2.0	6.0-8.9								
					7 to 17	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Vindicator	0 to 2	Very gravelly sandy loam	GM	0	0-10	35-55	30-50	20-35	10-20	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					2 to 7	Very gravelly clay loam	GC	0	0-10	45-60	35-50	30-40	20-35	25-40	10-20	4-14	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 17	Unweathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								

TABLE 4
SOIL SURVEY DATA

								Engineering Index Properties								Physical and Chemical Properties				Soil Rock and Water Features			Risk of Corrosion		Site Development	Material Source	
NRP Station		Map Unit	Map Unit Name	Component Name	Depth, inches	USDA Texture	USCS Symbol	>10 inches	3 to10 inches	#4 Sieve	#10 Sieve	#40 Sieve	#200 Sieve	Liquid Limit	Plasticity Index	Saturated Hydraulic Conductivity	Reaction	Salinity (electrical conductivity)	Linear Extensibility (shrink-swell)	Depth to Water Table	Depth to Bedrock	Frost Action Potential	Concrete	Uncoated Steel	Local Roads and Streets (Ease of Excavation, Traffic Supporting Capacity)	Sand	Gravel
								Percent Retained		*Percent Passing*				*Percent*	*Percent*	*m M/sec*	*pH*	*m mhos/cm*	*Percent*	*inches*	*inches*						
53114+00	53224+49	2641	Advokay-Ardivey--Leo Association	Advokay	0 to 3	Gravelly sandy loam	GM	0	0	55-80	50-75	30-55	15-30	20-25	NP-5	14-42	7.4-8.4	0.0-2.0	0.0-2.9	--	4-14	Low	Low	High	Very limited	Poor	Poor
					3 to 7	Gravelly sandy clay loam	GC	0	0	55-80	50-75	30-55	20-35	30-40	10-15	1.4-4	7.4-8.4	0.0-2.0	3.0-5.9								
					7 to 11	Weathered bedrock	--	--	--	--	--	--	--	--	--	0.01-0.42	--	--	--								
				Ardivey	0 to 4	Very gravelly sandy loam	GC-GM	0	0-15	30-55	25-50	15-30	10-20	20-25	5-10	14-42	7.9-9.0	0.0-2.0	0.0-2.9	--	--	Low	Low	High	Very limited	Fair	Fair
					4 to 14	Very gravelly clay loam	GC	0-10	10-25	40-55	30-45	20-40	15-30	25-40	10-20	1.4-4	6.6-8.4	0.0-2.0	0.0-2.9								
					14 to 60	Extremely gravelly loamy sand	GW	0-10	10-45	15-35	10-30	5-20	0-10	--	NP-5	42-141	7.9-9.6	0.0-2.0	0.0-2.9								
				Leo	0 to 4	Gravelly sandy loam	SM	0	0	65-85	50-75	40-60	20-35	15-25	NP-5	14-42	7.9-9.0	0.0-2.0	0.0-2.9	--	--	Low	Low	High	Very limited	Poor	Fair
					4 to 60	Stratified extremely gravelly coarse sand to gravelly fine sandy loam	GM	0-5	0-25	45-60	40-50	15-35	5-20	--	NP-5	42-141	7.9-9.0	0.0-4.0	0.0-2.9								

TABLE 5
GEOLOGIC CONDITIONS WITHIN CORRIDOR SEGMENTS

Alignment Symbol	Segment and Sources of Geologic Data	NRP Stations, (feet from NE end)	Map Sheets	Geographic Description (from SW to NE)	Geology	Lithology of Materials Crossed by or near Rail Alignment	Joints	Engineering Features	Photos
BBE	S86 (Simonds et al, 1995; Potter et al, 2002; Nye County Nuclear Waste Repository Project Office, 2005)	18120+00 - 17750+00, waypoints SM232, 236-237, 241-242, and 246-250; and NM1-3	2	Starting between San Juan Hill and Bow Ridge, just south of Midway Valley, this alternative follows a pass between Bow Ridge and Fran Ridge and emerges in Dune Wash. On the north side of Busted Butte, the route follows Dune Wash nearly to its confluence with Fortymile Wash in Jackass Flats. After curving around the east and south sides of Busted Butte, the route crosses a valley centered on WT-12 and Forlorn Washes. The alternative ends on the south side of Iron Ridge, one of several ridges that make up Yucca Mountain.	Eolian sand ramps of Quaternary age fill a valley between Bow and Rainier Ridges, surround Busted Butte, and flank the southern end of Iron Ridge. Middle to young Quaternary alluvium fills the valleys of Dune, Fortymile, WT-12, and Forlorn Washes, flanks the southern end of Yucca Mountain, and underlies eolian deposits at a shallow depth on the east side of Busted Butte. Most of the bedrock traversed by the BBE alternative belongs to the Paintbrush Group. Rainier Ridge is underlain by the Rainier Mesa Tuff of the Timber Mountain Group. The Calico Hills and Wahmonie Formations crop out on the east side of Busted Butte. Orientations of foliation and fracturing in bedrock are influenced by prominent high-angle faults near the alignment. The NE to NW-striking, NW to SW-dipping Bow Ridge, Paintbrush Canyon, Forlorn Wash, Stagecoach Road, and Iron Ridge Faults, and related faults cross the alignment between Dune Wash and Yucca Mountain. The Busted Butte Fault zone dips NE to SE at angles of 66-83^0 beneath the alignment.	Quaternary eolian sand ramps (Qe): at SM236 & 246, SAND (SP): loose to med.-dense, brown, fine to medium-grained, gravelly desert pavement; Young Quaternary alluvium (Qay): at SM232 & 234, NM1-2, & well EWDP-18P: SANDY GRAVEL (GP), SILTY SANDY GRAVEL (GW-GM), & SILTY GRAVELLY SAND (SW-SM) in 5 to10-ft-thick intervals: loose to dense, brown, sub-angular to angular, gravel to boulder-sized clasts, fine to med.-grained sand; Middle Quaternary alluvium (Qam): at SM250, GRAVELLY SAND (SP) & SANDY GRAVEL (GP): loose to v. dense, brown & gray, with beds of cobbles & boulders to 2 ft diam.; Rainier Mesa Tuff (Tm): at SM242, RHYOLITE ASH-FLOW TUFF: high strength, light-brownish-red, partially welded, lithic-rich, med. to widely spaced fractures; Paintbrush Group (Tp): at NM3; SM237, 247, & 249, RHYOLITE to RHYODACITE ASH-FLOW TUFF: v. high strength, gray, purplish-gray, grayish-orange, & purplish-brown, densely welded, variably lithophysal (vesicular), closely to widely spaced fractures; locally contains vitrophyre, moderate to med.-high strength bedded tuff, & in fault zones, brecciated, shattered rock with gouge.	Tm at SM242: N30^{0}W, 86^{0}SW, dominant; N79^{0}W, 72^{0}SW, dips into alignment; Tp at SM247: N45^{0}W, 65^{0}SW, fault-controlled; Tp at NM3: N 70^0 W, 71^0 SW; N 0-10^0 W, 72-84^0 SW.	S86, mostly fills to 20 ft; cut to 60 feet through ridge composed of Tp in the vicinity of Station 17830+00. Approximately 6,000-ft-long, maximum 100-ft-high fill centered on Station 18078+00.	2729-2735, SM232: WT-12 Wash from Yucca Mountain. (YM) to Busted Butte, Qay in wash; 2750, SM236: Qe, SW Busted Butte; 2751-2755, SM237: Tp, Busted Butte; 2778-2813, 2781-2783, SM241: pan SW from Busted Butte to Yucca Mt; 2784, 2788-2789, SM242: Tm outcrops at Rainier Ridge; 2785-2787, SM242: views NW of Bow and Fran Ridges; 2810-2812, SM246: pan NW of Rainier, Bow, and Fran Ridges; 2813, SM246: Busted Butte Qe ramp; 2814-2820, SM247: Tp in Paintbrush Canyon Fault zone; 2821-2835, SM248-249: topography between Dune Wash and Midway Valley; 2836, SM249: Tp, Bow Ridge; 2837-2839, SM250: Qam, Drill Hole Wash; 0005, nr NM2: view NE of Busted Butte and Jackass Flats; 0006, NM1: view W of Qay fan; 0010-0012, NM1: view N of Iron Ridge Fault zone; 0009, NM2: view NE of Tp outcrop; 0008, nr NM3: view SE of Tp bedded tuff; 0013, NM3: view SE of Tp outcrop.
GF3	S87 (Ashley, 1975; Workman et al, 2002a)	53224+49 - 53085+00, waypoints SM359-363	24	This segment of the GF3 alternative ascends the southeastern flank of the Goldfield Hills in an S-curve. The terrain traversed by the segment slopes gently to the southeast and is crossed by several large, southeast-draining washes.	The late Miocene Tuff of Stonewall Flat crops out in the vicinity of where the GF3 alternative diverges from the GF1 alternative. The initial segment of GF3 mostly traverses the early Miocene Tuff of Chispa Hills. Foliation in the tuff at or near the alignment generally strikes NNW to NW and dips 18-38^0 WSW to SW. Large areas of the tuff are covered by thin pediment deposits, which are inferred to be old Quaternary (early to middle Pleistocene) in age. Washes incised into the tuff and pediment deposits contain young Quaternary (Holocene to late Pleistocene) alluvium.	Young Quaternary wash alluvium (Qay):at SM359, GRAVELLY SAND (SW to SP): loose to medium-dense, grayish-brown, locally silty, sand fine to coarse-grained, becoming less dense with increasing grain size; abundant cobbles and scattered boulders to 2-ft diam.; Old Quaternary pediment deposits (Qao): at SM360, Silty GRAVELLY SAND (SP) with lenses of SANDY GRAVEL (GP): dense, grayish-brown, slightly indurated, sand predominantly coarse grained; abundant cobbles and scattered boulders to 2-ft diam., partly coated with calcium carbonate; well-developed desert pavement; Tuff of Chispa Hills (Tt3): at SM361, RHYOLITIC ASH-FLOW TUFF: high-strength, light-gray, nonwelded, crystal-rich, lithic-rich, slightly weathered, close to medium-spaced fractures; Tuff of Stonewall Flat (Tst): at SM362 & 363, RHYOLITIC ASH-FLOW TUFF: high to very high strength, pinkish-beige & purplish-brown, partially to densely welded, crystal-rich, lithic-rich, extremely closely to widely spaced fractures.	Tst at SM363: N14^{0}W, 85^{0}SW, dominant; N85^{0}E, 81^{0}SE; and an unmeasured low-angle set.	S87, general: cuts and fills to 30 ft; fills to 40 ft in washes.	37-39, SM359 & 45, SM360: views NE of Qao covered Tt3, Ta3 hills in distance; 40 & 42, SM359: Qay in wash; 43-44, SM360: Qao on E bank of wash; 46-49, SM361: Tt3 outcrop; 54-56, SM362: pan NE along GF5 & GF3; 57, SM362: Tst outcrop; 58-59, SM362: pan SW along GF5; 60-61, SM363: pan NE along GF3; 62-62, SM363: pan SW along GF3; 64-65, SM363: pan NW of Tst & Tt3, Ta3 hills & Blackcap Mt in distance; 66-67, SM363: Tst outcrop.
GF3	S88 (Ashley, 1975)	53085+00 - 52650+00, waypoints SM364-379B & 382-386	24 and 25	This segment of the GF3 alternative crosses the Goldfield Hills. In approaching a drainage divide at station 52752+00, the segment maintains design grades by making 4 curves through relatively low hills. The segment descends northwestward from this divide by following valleys between hills. The segment crosses several south-draining washes on the south side of the drainage divide and two northeast-draining washes on the north side of the divide. Numerous mines, prospects, and tailings piles, associated with zones of clayey hydrothermal alteration, are present along the segment. Just east of station 52855+00, Willow Springs issue from a fault cutting volcanic rocks.	This segment mostly traverses early Miocene lava flows, intrusives, and breccia, but it also crosses small areas where early Miocene sedimentary rocks, the early Miocene Meda Rhyolite (in unit Tt3; see description in Ashley, 1975), and the middle Miocene Siebert Tuff (in unit Tsy; see description in segment 89) crop out. The segment traverses young Quaternary (Holocene to late Pleistocene) alluvium where washes are incised into the volcanic rocks. In the first part of the segment, the volcanic rocks consist of the Milltown Andesite, the Dacite at Goldfield, and andesite megabreccia, which are part of unit Ta3. The latter part of the segment alternately traverses unit Ta3 and the Rhyolite of Wildhorse Spring (in unit Tvr). Numerous faults cross this segment, most of which strike NNE to NW and dip 45 - 85^0 ESE to NE.	Young Quaternary wash alluvium (Qay): at SM368, 371, & 378: Slightly silty to clayey, GRAVELLY SAND (SW to SP) & silty to clayey, SANDY GRAVEL (GP to GC): loose to dense, brown, fine to coarse-grained sand, trace to common gravel and cobbles, boulders to 3-ft diam. in channels; Early Miocene sedimentary rocks (Tso): at SM364 & 365: CONGLOMERATE, completely weathered to SANDY GRAVEL (GP): medium-dense to dense, purple and green; gravel to boulder-sized clasts of altered volcanic rocks in fine to medium-grained sand; and SANDSTONE: moderate to medium-high strength, olive-green, medium-grained, thinly bedded, extremely closely to closely spaced fractures;Rhyolite of Wildhorse Spring (Tvr): at SM379B & 385: RHYOLITE LAVA FLOW: v. high strength, light-gray, porphyritic, foliated, extremely closely to widely spaced fractures;Early Miocene rhyodacite to basaltic andesite volcanic rocks (Ta3): at SM367-379A, LAVA FLOWS, BRECCIA, and INTRUSIVES: mod. to v. high strength, gray to black, becoming orange, white, gray, purple, green, and yellow where hydrothermally altered; none to extensive hydrothermal alteration; extremely closely to widely spaced fractures.	Ta3 at SM369: N42^{0}W, 83^{0}NE, dominant; N02^{0}E, 63^{0}NW; N65^{0}E, 35^{0}SE; Ta3 at SM373: N15^{0}E, 41^{0}NW, dominant; N25^{0}W, 56^{0}NE, shear zone; Ta3 at SM376: N58^{0}W, 34^{0}SW, dominant; N84^{0}E, 70^{0}NW; N35^{0}E, 89^{0}NW; Ta3 at SM377: N87^{0}E, 69^{0}SE, dominant; N16^{0}W, 85^{0}NE.	S87, general: cuts and fills to 50 ft; nr SM376 (52850+00 - 52832+00): fill to 110 ft; nr SM378 (52805+00 - 52789+00): fill to 90 ft; nr SM379A & 379B (52789+00 - 52745+00): cuts to 110 ft; south of SM382 (52677+00 - 52660+00): cuts to 70 ft.	68-77, SM364 & 365: Tso between ridges of Ta3; 78-80, SM366: pan SE toward GF3; 82-85, SM367: Tab; 86-87, SM368: pan E along GF3; 89-90, SM368: altered Td; 91, 95, & 97, SM369: Td intrusive; 96 & 100, SM369: views SE & SW along GF3; 101 & 103, SM370: views NW & SE along GF3; 104, SM370: Td; 102, 105-108, SM370: Td cut by faults; 109-111, SM371: views SE & NW along GF3; 112, SM371: wash Qay; 113, SM372: Tab; 114-120, SM372 & 372A: views SW & NE along GF3; 121-125, SM373: pans NW & E along GF3; 126-127, SM373, Tma; 128-129, SM374: altered Td; 130-131, 134-137, SM375 & 375A: views SW & NE along GF3; 132, SM375: Td; 138, SM375B: Tma; 139-140, SM376: pan NW along GF3; 143-144, SM376 & 153-154, SM377: Tma lava flows & breccia; 145-146, 149-150, SM377 & 155-156, SM378: views SW & NE along GF3; 157, SM378: wash Qay; 158, SM379: Td; 160 & 163, SM379A: views SW & NE along GF3; 161, SM379A: Tma ridge along GF3; 162, SM379A: Tma; 164, SM379B: Tvr; 177, SM382: view SE along GF3; 187, SM384: view SW to GF3 between Tvr & Ta3 hills; 188-189, SM385: Tvr; 195, SM385: fault scarp cutting Tvr; 191-193, SM386: views NW to W along GF3.

TABLE 5
GEOLOGIC CONDITIONS WITHIN CORRIDOR SEGMENTS

Alignment Symbol	Segment and Sources of Geologic Data	NRP Stations, (feet from NE end)	Map Sheets	Geographic Description (from SW to NE)	Geology	Lithology of Materials Crossed by or near Rail Alignment	Joints	Engineering Features	Photos
GF3	S89 (Ashley, 1975; Bonham and Garside, 1979; Workman et al, 2002a)	52650+00 - 52000+00, waypoints SM380-383 & 387-403	25, 23, and 26	This segment of the GF3 alternative initially cuts through a basalt ridge and crosses a low drainage divide between an ENE draining wash and a northerly draining one. Following the crests of basalt hills and ridges, the route cuts back and forth across the north-draining wash to about station 52425+00. Beyond this point, the alignment swings NW to the base of a basalt plateau and then trends northerly along the base of the plateau. Near the northern end of the plateau, the alignment crosses several eastward projecting basalt ridges and hills and an eroded cinder cone, into which shallow washes are incised. Northwest of ~52246+00, the alignment descends into the Mud Lake basin, where it rejoins the GF1 and GF4 alternatives.	For most of this segment, the alignment traverses Quaternary-Tertiary basalt. Small outcrops of early to middle Miocene Milltown Andesite (in unit Ta3; see description in segment 88), Rhyolite of Wildhorse Spring (Tvr; see description in segment 88), and Siebert Tuff (Tsy) straddle a fault near the start of the segment. This fault strikes N 45^0 W and dips 63^0 NE. Old Quaternary (early to middle Pleistocene) alluvium underlies the low drainage divide near the start of the segment. Young Quaternary (Holocene to late Pleistocene) alluvium fills washes incised into the volcanic rocks, forms a shallow pediment deposit where the alignment enters Mud Lake basin, and comprises a sedimentary apron around Mud Lake playa.	Young Quaternary wash alluvium (Qay): at SM391 & 400, SANDY GRAVEL (GP) and slightly silty, GRAVELLY SAND (SP): loose to dense, brown to reddish-brown, fine to coarse-grained sand, scattered to abundant gravel and cobbles, boulders to 3-ft diam. in channels; Young Quaternary pediment and playa-apron deposits (Qay): at SM397 & 398, CLAYEY to SILTY SAND (SC to SM): loose to dense, reddish- to grayish-brown, mostly fine-grained sand, trace to common gravel and cobbles; Old Quaternary alluvium (Qao): at SM381, Silty, GRAVELLY SAND (SP-SM): med.-dense to v. dense, grayish-brown, mostly fine-grained sand, calcium carbonate seams; Quaternary-Tertiary basalt (QTb): at many sites between SM382 and SM403, BASALT LAVA FLOWS: v. high strength, dark-gray, generally fine-grained, variably vesicular, secondary minerals in many vesicles, extremely closely to widely spaced fractures, erodes to boulders; locally red, partly cemented SCORIA with hard, GRAVELLY CLAY (CL) colluvium, intruded by BASALT necks;Siebert Tuff (Tsy): RHYOLITIC ASH-FALL(?) TUFF: medium-high to high strength, pinkish-beige, nonwelded, lithic-rich, closely to medium-spaced fractures.	QTb at SM382: N42^{0}W, 77^{0}SW; N26^{0}E, 49^{0}SE; and an unmeasured high-angle set; QTb at SM402: N26^{0}W, 84^{0}SW; N45^{0}E, 73^{0}SE; and an unmeasured low-angle set.	S89, general: cuts and fills to 50 ft; at SM382 (52648+00 - 52642+00): cut of 90 ft; nr SM380 (52642+00 - 52630+00): 40-ft fill over a possibly active fault that strikes ~N 45^0 W and dips ~63^0 NE; nr SM394 & 395 (52520+00 - 52464+00): cuts of 70 to 100 ft; nr SM391 &392 (52438+00 - 52340): fill to 90 ft.	173-176, SM382: pan NW along GF3; 179-180, SM382: pan NE of QTb & Tvr hills; 181-182, SM382; 202-203, SM387; 206, SM388; 232-233, SM395; 207-208, SM389; 209-210, SM390; 218, SM391; 271, SM403; 265, SM402; & 248-251, SM399: QTb flows; 184, SM383: Tsy; 165-166, SM 380: views NW & SE along GF3; 167-168, 171, SM381: views NW & SE along GF3; 172, SM381: Qao; 196-199, SM387: pans NE & SW along GF3; 204-205, SM388: views NE & SW along GF3; 219-226, SM393: views SSE to NNW along GF3; 228, SM394: QTb ridge nr GF3; 231, SM394: view SE along GF3; 211-215, SM391-392: views SE & NW along GF3; 217, SM391; & 256, SM400: wash Qay; 234-235, SM396: view NW along GF3; 266-270 SM403: pans NE & S along GF3; 263-264, SM402: views SE & NW along GF3; 258-259, SM401: views NW & SE along GF3; 257, 260-262, SM401 & 400: QTb scoria, basalt necks, & colluvium in eroded cinder cone; 253-255, SM400: views NW & SE along GF3; 245-247, SM399: views NW & SE along GF3; 244, nr SM399: view SE of QTb ridge; 240-241, SM398: views SE & NW along GF3; 243, SM398: pediment Qay; 397-398, SM397: views SW & NE along GF3; 239, SM397: playa apron Qay.

TABLE 6
PRELIMINARY ENGINEERING RECOMMENDATIONS FOR CORRIDOR SEGMENTS

Alignment Identifier	Segment	NRP Station		Map Sheet	Proposed Construction (Construction Impacts Based on NRP Plan and Profiles, Dated 22 July 2005	Major Geologic Feature(s) Impacting Construction	Geologic Unit(s)	Earthwork Recommendations			Structures		
		From	To					Cut Slopes	Fill Slopes	Additional Recommendations	Deep Foundations	Erosion Protection	Additional Recommendations
BBE	S86	18120+00	17750+00	1 & 2	Generally fills to 20 feet. Cut to 60 feet through a ridge in Tp in the vicinity of Station 17830+00. Approximately 6,000-foot-long, maximum 100-foot-high fill centered on Station 18078+00.	(1) Crosses sheared and low-strength rock in fault zones. (2) Fault rupture. (3) Debris flows off alluvial fans.	Eolian Deposits (Qe) Alluvium (Qay, Qam) Rainier Mesa Tuff (Tm) Paintbrush Group (Tp)	2H:1V in Alluvial and Eolian Deposits 1H:1V in Tm and Tp	2H:1V	Embankment fill. Qam may require ripping. Tm and Tp will require drilling and blasting.	None anticipated.	Riprap protection at culvert inlets and outlets and in stream channels below 100-year flood elevation.	
GF3	S87	53224+00	53085+49	24	Generally Cuts and fills to 30 feet. Fills to 40 feet in washes	(1) Mine Subsidence (2) Rockfall	Alluvium (Qay, Qao) Stonewall Mountain Tuff (Tst) Early Miocene Tuff (Tt3)	1H:1V in Tst and Tt3 2H:1V in Alluvium	2H:1V	Possible Embankment fill. Drilling and blasting required in Tt3 and Tst. Qao may require ripping.	None anticipated.	Riprap protection at culvert inlets and outlets and in stream channels below 100-year flood elevation.	
GF3	S88	53085+00	52650+00	24 and 25	Generally cut–and-fills to 50 feet. Local cuts and fills to 90 feet.	(1) Highly variable rock mass engineering properties in the Miocene volcanic deposits. (2) Rockfall hazard where alignment is in proximity to existing slopes and new cut slopes. (3) Debris flows off alluvial fans. (4) Fault rupture (5) Mine Subsidence.	Alluvium (Qay, Qao) Early Miocene sedimentary rocks (Tso) Ryolite of Wildhorse Spring (Tvr) Early Miocene rhyodacite to basaltic andesite volcanic rocks (Ta3)	2H:1V in Qay 1.5H:1V in Tso 1H:1V in Tvr 2H:1V in Ta3 3H:1V in highly alteredTa3	2H:1V in Qay, Tso, & Tvr	Possible embankment fill for all deposits except Ta3. Because of the highly variable rock mass characteristics (degree of alteration) in Ta3, average cut slopes and embankment slopes of 3H:1V are assumed. Flatter cut and fill slopes may be required in Qay in proximity to Mud Lake.	None anticipated.	Riprap protection at culvert inlets and outlets and in stream channels below 100-year flood elevation.	.
GF3	S89	52650+00	52000+00	25, 23, & 26	Generally cut–and-fills to 50 feet. Local cuts and fills to 110 feet.	(1) Rockfall. (2) Fault Rupture, possible Quaternary ground rupture in vicinity of Sta. 52642+00 to 52630+00 (3) Possible embankment erosion where corridor parallels or crosses washes	Alluvium (Qay, Qao) Quaternary – Tertiary basalt (QTb) Siebert Tuff (Tsy)	0.5H:1V in QTb 1H:1V in Tsy 2H:1V in Qay, Qao	2H:1V	Possible embankment fill. Drilling and blasting required in Tst and Tt3.	None anticipated.	Riprap protection at culvert inlets and outlets and in stream channels below 100-year flood elevation.	

TABLE 7
ALIGNMENT SELECTION CONSIDERATIONS

Alternate	Geologic Hazards	Engineering Features	Advantages	Disadvantages
BBE	1. Crosses sheared and low strength rock in fault zones. 2. Fault rupture 3. Erosion along ephemeral streams 4. Debris flows	Generally fills to 20 feet high, which will increase to 100 feet at north end of segment. One cut in rock to 60 feet.	Avoids deep cuts in sheared and low strength rock	Unbalanced cut and fill.
CS7	1. Cut slope instability in sheared and low strength rock in fault zones. 2. Fault rupture 3. Rockfall from natural and new slopes 4. Debris flows	Generally cuts and fills to 15 feet. However, fills to 80 feet near the NTS boundary and across Dune Wash. Major rock cuts to 170 feet anticipated through Ambush Pass and Rainier Ridge	None	Numerous high fills and two deep cuts in rock and soil.
GF1/GF5	1. Preponderance of low strength and highly altered Tertiary volcanic rock. 2. Mine subsidence 3. Fault rupture 4. Landsliding 5. Rockfall from natural and new slopes 6. Debris flows	Several cuts between 30 and 100 feet deep. Numerous fills more than 60 feet high.	1. Less earthwork requirements than GF3. 2. No Structures.	3. Proximity to mining district and associated hazards 4. Concentration of low strength and highly altered Tertiary Volcanics. 5. Route crosses several landslides
GF3	1. Highly variable rock mass conditions in Tertiary volcanic rock. 2. Mine subsidence 3. Fault rupture 4. Rockfall from natural and new slopes 5. Debris flows	Numerous cuts between 30 and 100 feet deep. Numerous fills between 30 and 100 feet high.	1. Further from mining district and associated hazards than GF1/GF5 2. No Structures	Extensive earthwork compared to GF1/Gf5 and GF4
GF4	1. Highly variable rock mass conditions in Tertiary volcanic rock. 2. Mine subsidence 3. Fault rupture 4. Landsliding 5. Rockfall from natural and new slopes 6. Debris flows	Several cuts between 30 and 50 feet deep. Only one cut to 100 feet deep. Two grade separations for US 95 and three aqueduct crossings	1. Further from mining district and associated hazards than GF1/GF5 2. Less earthwork requirements than GF1/GF5 and GF3	1. Route crosses terrain susceptible to landsliding 2. Several structures

Notes:
BBE = Busted Butte East
CS = common segment
GF = Goldfield
NTS = Nevada Test Site

APPENDIX H

PROJECT PHOTOGRAPHS (CD-ROM)