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July 19, 2018

Mike Rypien
221 West 5350 South
Ogden, Utah 84405

IGES Project No.: 01272-001

RE: Review of Previously Completed Geologic Hazards Evaluation and Preliminary Geotechnical Investigation for 627 Ogden Canyon Road
Weber County, Utah

References: IGES 2009, *Geologic Hazards Evaluation and Preliminary Geotechnical Investigation,* Mike Rypien's Property, 627 Ogden Canyon, Weber County, Utah, dated July 27, 2009.

Mr. Rypien,

IGES previously completed a Geologic Hazards Evaluation and Preliminary Geotechnical Investigation for 627 Ogden Canyon road in a report dated July 27, 2009, referenced above. The report was completed as a final geologic hazard study, but the geotechnical study was considered preliminary; possibly because the final location of the home may not have been established, but the reason is not clearly stated in the report. The original report did contain complete geotechnical design parameters and recommendations as would be provided in a final report.

IGES was recently provided a final Site Plan that shows the location of the proposed home in the area where the original test pits were completed. The site plan as been attached along with the original test pit location map for the site. Based on our review of the data in the original report and the final proposed location of the home, no additional geotechnical investigation or assessment needs to be completed and the original report may be considered final for the development of the lot located at 627 Ogden Canyon Road.

Sincerely,
IGES, Inc.,

PROFESSIONAL ENGINEER
No. 184125
KENT A. HARTLEY
7/19/18
ELECTRONIC SEAL
STATE OF UTAH

Kent A. Hartley, P.E.
Principal

Attachments: Site Plan for 627 Ogden Canyon Road
Original Geotechnical Map for the Site

IGES

Project Number - 01272-001

Geologic Evaluation and Preliminary Geotechnical Investigation
Mike Rypien
Ogden Canyon
Weber County, Utah

GEOTECHNICAL MAP

Plate
A-2

IGES

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GEOLOGIC HAZARDS EVALUATION AND PRELIMINARY GEOTECHNICAL INVESTIGATION

Mike Rypien's Property
627 Ogden Canyon
Weber County, Utah

IGES Job No. 01272-001

July 27, 2009

Prepared for:

Mike Rypien

IGES

Intermountain GeoEnvironmental Services, Inc.
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Prepared for:

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Ogden, Utah 84405

Geologic Hazards and Preliminary Geotechnical Investigation
627 Ogden Canyon
Weber County, Utah

IGES Job No. 01272-001

Prepared by:

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July 27, 2009

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APPENDICES

1.0 EXECUTIVE SUMMARY

This report presents the results of a geologic hazards evaluation and preliminary geotechnical investigation conducted for the proposed residential cabin and garage to be located at 627 Ogden Canyon near Hermitage, Weber County, Utah. The purposes of this investigation were to evaluate the geologic hazards of the site and provide a preliminary assessment of the subsurface soils for general site grading and the design and construction of foundations, slabs-on-grade, and exterior concrete flatwork.

Based on our observations and geologic literature review, the site is underlain by Holocene alluvial fan material to the west and stream alluvium to the east. However, the upper 2 to 3 feet of soil at test pits 1 and 2 consisted of undocumented fill material. In test pit 1, the fill is believed to be the result of historical activity associated with the railroad up Ogden Canyon in the early 1900's. In test pit 2, the fill consists of mixture of native soils and some organics that have been moved by the present landowner. Underlying the fill in Test Pit 1, the soil consists of medium dense Silty, Clayey SAND (SC-SM).

Based on the subsurface conditions encountered at the site, it is our opinion that the subject site is suitable for the proposed development provided that the recommendations contained in this report are incorporated into the design and construction of the project. The foundations for the proposed structures may consist on conventional shallow spread footings that are founded below the undocumented fill and may be founded either on competent native soils <u>or</u> *entirely* on structural fill. Foundations may be proportioned utilizing a maximum net allowable bearing pressure of 1,800 psf.

We recommend that rock fall hazards be mitigated by 1) Stabilizing the rock source area; removal of unstable rocks (scaling); 2) Slowing or diverting moving rocks; and physical barriers against rock impact around structures such as earthen berms, fences, and retaining walls. Additionally, the Ogden Canyon Canal Conduit, upslope and north of the site should be enhanced, if possible, by further flattening or placing a berm to inhibit rockfall from rock sources above and north of the canal.

NOTE: The scope of services provided within this report is limited to the assessment of the subsurface conditions at the subject site. The executive summary is provided solely for purposes of overview and is not intended to replace the report of which it is part and should not be used separately from the report.

2.0 INTRODUCTION

2.1 PURPOSE AND SCOPE OF WORK

This report presents the results of a geologic hazards evaluation and preliminary geotechnical investigation conducted for the proposed cabin and garage to be located at 627 Ogden Canyon near Hermitage, Utah. The purposes of this investigation were to evaluate the geologic hazards of the site and provide a preliminary assessment of the subsurface soils for general site grading and the design and construction of foundations, slabs-on-grade, and exterior concrete flatwork.

The scope of work completed for this study included a geologic hazards literature review, a site reconnaissance for geologic hazards evaluation, subsurface exploration, soil sampling, laboratory testing, engineering analyses, and preparation of this report. Our services were performed in accordance with our proposal, dated June 17, 2008 and your signed authorization on February 9, 2009.

The recommendations contained in this report are subject to the limitations presented in the "Limitations" section of this report (Section 7.1).

2.2 PROJECT UNDERSTANDING AND DESCRIPTION

The property is located at 627 Ogden Canyon near Hermitage, Utah (see Plate A-1, *Site Vicinity Map*). The subject parcel is bounded on the west by a residence, on the east by undeveloped land, on the north by the Ogden Canyon Canal Conduit, and on the south by State Route 39 (see Plate A-2 *Geotechnical Map*). The site is largely undeveloped except for the presence of a concrete slab for a driveway, culvert along the State Route 39, septic tank, sand volleyball court, and a picnic area.

We understand that this development will consist of two separate structures (cabin and garage) with associated driveway. The proposed structures will be 1-story (no basements) conventional wood-frame buildings. Construction plans were not available for our review; however we anticipate the proposed structures will be founded on conventional/spread footings with slab-on-grade flooring.

3.0 METHODS OF STUDY

3.1 GEOLOGIC HAZARDS LITERATURE REVIEW

A literature review was conducted which consisted of reviewing published and unpublished geologic reports of the area and other available geologic literature and geologic maps pertinent to the site, as indicated in the report and references cited. These references provided background information about the local geologic history of the area and the locations of suspected or known faults. A detailed knowledge of the stratigraphic units expected in the area provided a useful time-stratigraphic framework for interpreting the units exposed in the test pits excavated for the study.

3.2 FIELD INVESTIGATION

A field geologic reconnaissance was conducted to observe existing geologic conditions and to evaluate existing and potential geologic hazards. The findings of the geologic investigation are presented in Section 5.0 of this report.

As a part of this investigation, near surface soil conditions were explored by excavating two test pits across the site. A member of our technical staff visually logged soils in the test pits at the time of excavation in general accordance with the Unified Soil Classification System (USCS). The test pit depths varied from approximately 5 ½ to 8 feet below the existing site grade. Test pit logs are included at the end of this report (Plates A-11 thru A-12) and a *Key to Soil Symbols and Terminology* is also provided as Plate A-13. A discussion of the site conditions is provided in Section 4.0 of this report.

The test pits were excavated with a Case CX36B excavator. Representative soil samples were collected and classified by a member of our technical staff. Relatively undisturbed samples were collected with the use of a U-type hand sampler driven by a 2 lb. sledge hammer. Bulk samples and other disturbed samples were collected and placed in buckets and bags. The samples were carefully packaged and transported to our laboratory for testing.

3.3 LABORATORY INVESTIGATION

Geotechnical laboratory tests were conducted on selected relatively undisturbed and bulk soil samples obtained during our field investigation. The laboratory testing program was designed to evaluate the engineering characteristics of onsite earth materials. Laboratory tests conducted during this investigation include:

- Moisture/Density (ASTM D2937 and D2216)
- Atterberg Limits (ASTM D4318)
- 1-D Swell/Collapse Test (ASTM D2435)
- Direct Shear (ASTM D3080)
- Corrosion Suite -soluble sulfate, soluble chloride, pH, resistivity (AASHTO T288, T 289, and ASTM D 4327)

Results of the in situ dry density and moisture content tests are shown on the test pit logs (Appendix A). The results of remaining laboratory tests are presented on the test pit logs in Appendix A (Plates A-11 through A-12), the test result plates presented in Appendix B (Plates B-1 through B-4) and in the *Summary of Laboratory Test Results Table* (Plate B-5).

3.4 ENGINEERING ANALYSIS

Engineering analyses were performed using soil data obtained from the laboratory test results and empirical correlations from material density, depositional characteristics and classification. Appropriate factors of safety were applied to the results consistent with industry standards and the accepted standard of care.

4.0 GENERALIZED SITE CONDITIONS

4.1 SURFACE CONDITIONS

At the time of our field investigation, no structures were present; however the property does include a concrete slab for a driveway, a culvert along the State Route 39, a septic tank, a sand volleyball court, and a picnic area. Vegetation consists of several mature trees, small trees, and an assortment of grasses and weeds. The site is relatively flat along the canyon floor.

4.2 SUBSURFACE CONDITIONS

The subsurface soil conditions were explored at the subject property by excavating two test pits across the site. Subsurface soil conditions were logged during our field investigation and are included in the test pit logs in Appendix A at the end of this report (Plates A-11 through A-12). The soil and moisture conditions encountered during our investigation are discussed below.

4.2.1 Earth Materials

Based on our observations and geologic literature review, the site is underlain by Holocene alluvial fan material to the west and stream alluvium to the east. However, the upper 2 to 3 feet of soil at test pits 1 and 2 consisted of undocumented fill material. In test pit 1, the fill is believed to be the result of historical activity associated with the railroad up Ogden Canyon in the early 1900's. In test pit 2, the fill consists of a mixture of native soils and some organics that have been moved by the present landowner. Underlying the fill in Test Pit 1, the soil consists of medium dense Silty, Clayey SAND (SC-SM).

The stratification lines shown on the enclosed test pit logs represent the approximate boundary between soil types (Plates A-11 through A-12). The actual in-situ transition may be gradual. Due to the nature and depositional characteristics of the native soils, care should be taken in interpolating subsurface conditions between and beyond the exploration locations.

4.2.2 Strength of Earth Materials

A direct shear test was completed on a relatively "undisturbed" sample retrieved from a depth of 4.5 feet in test pit 1. The test indicated the sample tested had an angle of internal friction of 27° and cohesion of 282 psf (peak strength). The results of the direct shear test are presented in Appendix B (Plate B-4).

4.2.3 Collapsible Soils

Collapse (often referred to as "hydrocollapse") is a phenomena where undisturbed soils exhibit volumetric strain and consolidation upon wetting. Collapsible soils can cause differential settling of structures and roadways. Collapsible soils do not necessarily preclude development and can be mitigated by several methods including over-excavating, deep foundations, and controlling surface drainage and runoff.

One Swell/Collapse test (ASTM D4546 & D5333) was performed on a relatively undisturbed sample of native silt and clay soil. The results of the test suggest that the native soils have minor collapse potential (0.45% strain) and are not a concern for development of the site. The results are presented in Appendix B (Plate B-3).

4.2.4 Groundwater/Moisture Conditions

Groundwater was encountered in all of our exploratory test pits completed for this project.

Test Pit	**Groundwater elevation (depth below the surface)**
1	5.5 feet
2	8 feet

The soil moisture was described as *moist* in all of the test pits. The moisture content generally ranged from 1 to 7% in gravelly soils and 3 to 23% in clayey soils.

Temporary or permanent groundwater may impact construction of below grade structures or utilities planned for the site. Dewatering may be required depending on final construction plans. IGES can provide recommendations for temporary and permanent dewatering once final plans are established.

5.0 GEOLOGIC HAZARDS EVALUATION

5.1 GEOLOGIC SETTING

The site is located, at an elevation of approximately 4,700 to 4800 feet above mean sea level in the Wasatch Range, east of the northern portion of the Salt Lake Basin. The Wasatch Range is the easternmost expression of pronounced Basin and Range extension in north-central Utah. The Salt Lake Basin is a deep, sediment-filled structural basin of Cenozoic age flanked by the Wasatch Range and Wellsville Mountains to the east and the Promontory Mountains, the Spring Hills, and the West Hills to the west (Hintze, 1980; Hintze, 1993).

5.2 STRATIGRAPHY

Geologic units in the study area are mapped as Holocene to Middle Cambrian age (Sorensen and Crittenden, 1979). Bedrock consists of medium- to dark-gray dolomite, olive to greenish-brown shale, medium- to dark-gray limestone, and dark-blue gray, cliff forming limestone and dolomite of the Maxfield Limestone. The bedrock units are covered by Holocene alluvial deposits (*Qal)*, which consist of unconsolidated gravel, sand, and silt deposits in active stream channels and floodplains (Sorensen and Crittenden, 1979). Also, historical disturbed land and fill (Qfd) was found on the property and adjacent properties. A geologic map and description of the geologic units found at the site is included at the end of this report in Appendix A (Plates A-3a and A-3b).

5.3 SEISMICITY AND FAULTING

The site lies within the north-south trending belt of seismicity known as the Intermountain Seismic Belt (ISB) (Hecker, 1993). The ISB extends from northwestern Montana through southwestern Utah. An active fault is defined as a fault that has had activity within the Holocene (<10ka). No active faults are mapped through or immediately adjacent to the site (Black et. al, 2003, and Bryant, 1992). The site is located approximately 3.2 km west of the Ogden Valley Southwestern Margin faults. The East Canyon fault is a normal fault that has a reported rupture length of approximately 18 km and a estimated maximum credible earthquake of magnitude of 6.5 to 7.0 M_s. The fault extends from west of Liberty, Utah to southwest of Huntsville, Utah, passing just east of the Pineview Dam. Poor geomorphic expression suggests the East Canyon fault has a low slip rate, probably on the order of <0.2mm/yr (Black et. al, 2003). The most recent activity on the Ogden Valley Southwestern Margin faults is reported to be middle and late Quaternary (<750ka). The site is also located approximately 6 miles east of the Weber Segment of the Wasatch Fault Zone (Black and others, 2003; Hecker, 1993). Information and evidence regarding surface-faulting recurrence comes from three trench sites: Garner Canyon, East Ogden, and Kaysville (Lund, 2005). The most recent movement along the Weber Segment occurred during Holcene, and there is evidence that as many as 10 to 15 earthquakes have occurred along this segment in the last 15,000 years (Hecker, 1993). The Weber Segment is also the second-longest segment (rupture length of approximately 56 km from end-end) and has a slip rate, probably on the order of <1-5mm/yr (Black et. al, 2003). The Weber Segment may be capable of producing earthquakes as large as magnitude 7.5 (Ms) and has a recurrence interval of approximately 1,200 years (Machette and others, 1989). Some investigators believe that portions of the Weber Segment have experienced two earthquakes with the past ≤1.5 kyr. (Lund, 2005). Analyses of the ground shaking hazard along the Wasatch Front suggest that the Wasatch Fault Zone is the single greatest contributor to the seismic hazard in the Salt Lake City region.

Seismic hazard maps depicting probabilistic ground motions and spectral response have been developed for the United States by the U.S. Geological Survey as part of NEHRP/NSHMP (Frankel et al, 1996). These maps have been incorporated into both *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures* (FEMA, 1997) and the *International Building Code* (IBC) (International Code Council, 2006). Spectral responses for the Maximum Considered Earthquake (MCE) are shown in the table below. These values generally correspond to a two percent probability of exceedance in 50 years (2PE50) for a "firm rock" site. To account for site effects, site coefficients which vary with the magnitude of spectral acceleration are used. Based on our field exploration, it is our opinion that this location is best described as a Site Class C. The spectral accelerations are shown in the table below. The spectral accelerations are calculated based on the site's approximate latitude and longitude of 41.2544° and -111.8739° respectively. Based on IBC, the site coefficients are F_a=1.00 and F_v= 1.33. From this procedure the peak ground acceleration (PGA) is estimated to be 0.484g. The MCE PGA and design response spectrum are presented in Appendix C on Plate C-1.

MCE Seismic Response Spectrum Spectral Acceleration Values for IBC Site Class C [a]	
Site Location: Latitude = 41.2544 N Longitude = -111.8739 W	**Site Class C Site Coefficients: Fa = 1.00 Fv = 1.33**
Spectral Period (sec)	**Response Spectrum Spectral Acceleration (g)**
0.2	1.210xFa = 1.210
1.0	0.467xFv = 0.624
[a] IBC 1615.1.3 recommends scaling the MCE values by 2/3	

to obtain the design spectral response acceleration values.

5.4 OTHER GEOLOGIC HAZARDS

Geologic hazards can be defined as naturally occurring geologic conditions or processes that could present a danger to human life and property. These hazards must be considered before development of the site. There are several hazards in addition to seismicity and faulting that if present at the site, should be considered in the design of roads and critical facilities such as water tanks and structures designed for human occupancy. The other identified geologic hazards considered for this site are rock fall, landslide, stream flooding, shallow groundwater, seismically induced dam failure, canals/ditch flooding, and shallow bedrock. A complete list of potential geologic hazards is included in the *Summary of Geologic Hazards Table* in Appendix C (Plate C-2).

5.4.1 Rock Fall

Rock falls may occur below steep slopes and cliffs from natural weathering and erosion, tree-root growth, and saturation of ground water (Case, 2000). Excavation for a road cut or building can also cause rock falls. Strong ground shaking resulting from seismic activity, rapid snowmelt, intense storms, and wide temperature changes may significantly increase the number of rock fall hazards (Case, 2000). Rock fall source areas and talus deposits, which are the result of rock fall, were observed at or near the base of the rock outcrop during our field investigation. These rock fall hazards directly impact the site, therefore the present rock fall hazard for the subject site would be considered high. The location of the source material for these rock falls can be found on the *Geologic Hazards Map* in Appendix A (Plate A-4).

Various sized cobbles and boulders (from 3' x 4' to fist sized) were observed during our investigation across the ground surface of the property as well as up slope (north) of the property, indicating past rock fall activities. Outcrop of potential rock fall source material was observed up slope (just north) of the property. The site photos included at the end of this report (Plates A-5 to A-10), show these areas of potential rock fall activity or rocks that have already have fallen from a rock fall event. Based on the proximity of the source material, the size of observed rock fall, slopes, benches, and other topography a computer analysis of the rock fall hazard was performed to characterize parameters of the rock fall hazard for mitigation. The computer program "Colorado Rockfall Simulation Program" (Rock and others, 2008) was used to perform the analysis.

Observations of boulders across the site and the use of a rock fall analysis computer program CRSP, indicate that a potential rock fall hazard exists at the site. The predominant size of boulders observed on the site and on slopes above the site were approximately 2 x 2 x 3 feet with the largest boulder observed having a dimension of 3 x 4 x 5 feet. Approximately 50 feet above the site lies the Ogden Canyon Canal Conduit, which appears to be collecting a large portion of rocks falling from a rock outcrop source located just above the canal.

The computer program CRSP utilizes parameters associated with the slope profile, ground surface roughness, vegetation, and rock type and size to simulate and analyze the rock hazard. After performing five simulations rolling 300 rocks (either cylindrical or spheres) down the slope at varying intervals, a bounce cumulative probability, velocity, energy, and bounce height was calculated. The following table outlines the results of the analysis with the high of 9 out of 300 rocks (3%) passing the analysis point defined as the project site.

Cumulative Probability (%)	**Velocity (ft/sec)**	**Energy (ft-lb)**	**Bounce Height (ft)**
3	84	487,000	31
3	82	645,000	27
2	83	459,000	27
2	83	738,000	35
1	96	310,000	23

5.4.2 Landslide

There are several types of landslides that should be considered when evaluating geologic hazards at the site. These include shallow debris slides, deep-seated earth or rock slumps or earth flows. This division is based on the degree to which the characteristic features of these landslides are preserved. Historical landslides are characterized by hummocky topography, numerous internal scarps, and chaotic bedding, as well as more recent evidence such as tilted trees, fresh scarps, and damaged roads, utilities, or other structures. The characteristics of younger landslides are similar to those of historic landslides but do not appear to be as recent. The characteristic features of older landslides are morphologically subtle or indistinguishable.

None of these landslide types are reported at the subject site (Harty, 1992) and none were observed on the property during the geologic reconnaissance conducted for this investigation.

However, it should be noted that several shallow landslides (debris slides) have been identified and mapped to the east, west, and south of the subject area (Harty, 1992), indicating the site soils may be susceptible to landsliding if slopes are oversteepened and/or left unvegetated. One small area of sliding was identified just east of the property and north of the Ogden Canyon Canal Conduit and is shown on the *Geologic Hazards Map* in Appendix A (Plate A-4).

5.4.3 Stream flooding

Stream flooding is a hazard related to spring snowmelt, run-off and flash–flooding from summer rainstorms. Flood hazards should be considered when planning for development for critical facilities located in areas having a potential flood risk.

The Ogden River runs approximately east-west just south of the subject site approximately. This river is largely controlled by the Pineview Dam, located approximately 1.6 miles upstream. However, this river may potentially flood following major rainfall events, rapid to extreme snowmelt, or other major runoff events that could require increasing the outflow from the dam. The dam has a reported maximum outflow of 2300 cfs. This outflow value is for the outlet works only; flow over the spillway could increase outflow significantly (U.S. Bureau of Reclamation, dam data available at http://www.usbr.gov/dataweb/dams/ut10132.htm). The design engineer for this site should assess the flooding potential for the stream, as well as the potential high water level for maximum dam releases.

5.4.4 Shallow Groundwater

Shallow groundwater flooding is a hazard that can cause the flooding of subterranean areas where the depth of excavation exceeds the depth of the local water table. Shallow groundwater flooding should be considered when designing habitable structures.

During our subsurface investigation, shallow groundwater was observed at depths ranging from 5.5 to 8 feet below existing grade. It should be anticipated that the groundwater can rise several feet during wet cycles and could impact site development. The contractor should anticipate dewatering trenches and excavations deeper than 5.5 feet. The area identified as a shallow groundwater hazard is shown on the *Geologic Hazards Map* in Appendix A (Plate A-4). The design engineer should also consider groundwater conditions in the design of subterranean structures.

5.4.5 Seismically Induced Dam Failure

The Pineview Dam is located approximately 1.6 miles upstream from the subject site. The dam was built between 1934 -1937, enlarged in 1957, and renovated in 2002-2004. The main trace of the Ogden Valley southwestern margin faults are located approximately 300 feet to the east of the dam. Although the Ogden Valley southwestern margin faults have been documented to have been active within the middle to late Quaternary (<750ka), Holocene-age activity has been ruled out by geologists (Black et. al, 2003). As such, the faults are considered inactive. None-the-less, future activity on the Ogden Valley Southwestern margin faults is possible and should be considered a low risk to the developing site.

5.4.6 Canal/Ditch Flooding

Canal and ditch flooding is a hazard related to the potential failure of canal or ditch embankments. The Ogden Canal runs along the northern margin of the subject site and failure of the embankment could impact the subject site. The embankment for this canal is lined with concrete in the vicinity of the subject site and we anticipate will be reasonably stable. However, failure of the canal embankments, rupture of pipe, or a blockage in the canal could cause flooding and impact the site facilities. Flood hazards from this canal should be considered when planning for development of habitable structures and other critical facilities located in areas having a potential flood risk. Precautions should be taken to prevent erosion or damage to the embankment or other structures in the event of flooding.

5.4.7 Shallow Bedrock

Shallow bedrock is a potential hazard that exists when bedrock is found just below the surface when excavation is planned at the site. It is generally expensive and time consuming to remove. Shallow bedrock should be considered when planning the development of the reservoir and road located within the area subjected to this hazard.

Shallow bedrock consisting of Cambrian rock was observed at the surface just north of the cabin site. It is unlikely that the bedrock will be able to be removed beyond the first 3 to 6 feet with traditional excavation equipment. More specialized equipment, such as a hoe-ram or blasting may be required for excavations into the bedrock.

5.4.8 Snow Avalanche

Snow avalanche can be a hazard in high alpine settings with steep slopes that accumulate appreciable amounts of snow. Avalanches in the Wasatch Front require starting zones with surface slopes of 30°-50°. Snow avalanches detaching and accelerating in such zones will travel across a track with surface slopes of 15°-30°. Once surface slope decreases below 15°, snow is deposited in a run-out zone.

No evidence of prior snow avalanche was observed at the site during our fieldwork or aerial photograph review. However, the potential for avalanche may exist if the necessary conditions are reached. If considered a significant risk additional evaluation should be performed by avalanche experts.

6.0 ENGINEERING CONCLUSIONS AND RECOMMENDATIONS

6.1 GENERAL CONCLUSIONS

Based on the subsurface conditions encountered at the site, it is our opinion that the subject site is suitable for the proposed development provided that the recommendations contained in this report are incorporated into the design and construction of the project. Geologic hazards identified as a risk to the site should be mitigated as recommended. The foundations for the proposed structures may consist on conventional shallow spread footings that are founded below the undocumented fill and may be founded either on competent native soils or *entirely* on structural fill.

Rock fall source areas and talus deposits, which are the result of rock fall, were observed at or near the base of the rock outcrop during our field investigation. These rock fall hazards directly impact the site, therefore the present rock fall hazard for the subject site would be considered high. Mitigation of rock fall hazards can be addressed by several methods consisting of, but not limited to, the following options: 1) Stabilizing the rock source area; removal of unstable rocks (scaling); 2) Slowing or diverting moving rocks; and physical barriers against rock impact around structures such as earthen berms, fences, and retaining walls.

We recommend that IGES inspect the bottom of the foundation excavations prior to the placement of structural fill, steel or concrete to identify any unsuitable soils. If over-excavation is required, the entire structure should be founded on a minimum of 2 foot of structural fill. Undocumented fill material (approximately the upper 3 to 4 feet) was observed during our exploration, probably the result of railroad activity in Ogden Canyon in the early 1900's or the present landowner construction activities. The fill material was found in both test pits 1 and 2 (where the home and garage that will be constructed). Under planned improvements all undocumented fill should be removed and replaced with structural fill.

If subsurface conditions other than those described herein are encountered during construction or if design and layout changes are initiated IGES must be informed so that our recommendations can be reviewed and revised as changes or conditions may require.

The following sub-sections present our recommendations for geologic hazard mitigation, general site grading, design of foundations, slabs-on-grade, lateral earth pressures, and soil corrosion.

6.2 ROCK FALL MITIGATION

Mitigation of rock fall hazards can be addressed by several methods consisting of, but not limited to, the following options: 1) Stabilizing the rock source area; removal of unstable rocks (scaling); 2) Slowing or diverting moving rocks; and physical barriers against rock impact around structures such as earthen berms, fences, and retaining walls. All of the methods require periodic maintenance especially if struck by rocks.

Additional methods that have been used to mitigate rockfall hazards include reinforcing the rear/upslope wall of the structure using reinforced concrete, eliminating, minimizing or armoring windows and door openings on the lowest above-grade story, and placing anchored planters in front of doorways. Another method may include eliminating bedrooms or other habitable space along the above-grade story rear wall and placing mechanical rooms or storage rooms in these areas. Additionally, the Ogden Canyon Canal Conduit, upslope and north of the site should be enhanced, if possible, by further flattening or placing a berm to inhibit rockfall from rock sources above and north of the canal.

6.3 EARTHWORK

Prior to the placement of foundations, general site grading is recommended to provide proper support for foundations, exterior concrete flatwork, and concrete slabs-on-grade. Site grading is also recommended to provide proper drainage and moisture control on the subject property and to aid in preventing differential settlement of foundations as a result of variations in subgrade moisture conditions.

6.3.1 General Site Preparation and Grading

Below proposed structures, fills, and man-made improvements, all vegetation, topsoil, debris, and undocumented fill should be removed. Any existing utilities should be re-routed or protected in-place. Tree roots should be grubbed-out and replaced with engineered fill. The exposed native soils should then be proof-rolled with heavy rubber-tired equipment such as a scraper or loader. Any soft/loose areas identified during proof-rolling should be removed and replaced with structural fill.

6.3.2 Excavations

If soft, loose, or otherwise deleterious earth materials such as undocumented fill are encountered, these soils may require over-excavation and subsequent replacement with structural fill. If required, the excavations should extend a minimum of 1 foot laterally for every foot of depth of over-excavation. Excavations should extend laterally at least two feet beyond slabs-on-grade and pavements. Structural fill should consist of granular materials and should be placed and compacted in accordance with the recommendations contained in this report.

6.3.3 Excavation Stability

The contractor is responsible for site safety, including all temporary trenches excavated at the site and design of any required temporary shoring. The contractor is responsible for providing the "competent person" required by Occupational Safety and Health Administration (OSHA) standards to evaluate soil conditions. Soil types are expected to consist primarily of Type C soils (sandy soils). Close coordination between the competent person and IGES should be maintained to facilitate construction while providing safe excavations.

Based on OSHA guidelines for excavation safety, trenches with vertical walls up to 5 feet in depth may be occupied. Where very moist soil conditions or groundwater is encountered, or when the trench is deeper than 5 feet, we recommend a trench-shield or shoring be used as a protective system to workers in the trench. Sloping the sides at one horizontal to one vertical (1 H:1V) in accordance with OSHA Type C soils may be used as an alternative to shoring or shielding.

6.3.4 Structural Fill and Compaction

All fill placed for the support of structures, flatwork or pavements, should consist of structural fill. Structural fill may consist of excavated onsite native or fill soils and should be a granular material with less 30 percent fines and having an Expansion Index less than 20. Material not meeting the aforementioned criteria may be suitable for use as structural fill; however, such material should be evaluated on a case-by-case basis and should be approved by IGES prior to use. In all cases, structural fill should be relatively free of vegetation and debris, and contain no rocks larger than 4 inches in nominal size (6 inches in greatest dimension).

All structural fill should be placed in maximum 6-inch loose lifts if compacted by small hand-operated compaction equipment, maximum 8-inch loose lifts if compacted by light-duty rollers. Additional lift thickness may be permitted by IGES provided the contractor can demonstrate sufficient compaction can be achieved with the methods used. We recommend that all structural fill be compacted on a horizontal plane, unless otherwise approved by IGES. Structural fill placed beneath footings and pavements should be compacted to at least 95 percent of the MDD as determined by ASTM D-1557. The moisture content should be at or slightly above the OMC for all structural fill. Prior to placing any fill, the excavations should be observed by IGES to confirm that unsuitable materials have been removed. In addition, proper grading should precede placement of fill, as described in the General Site Preparation and Grading subsection of this report.

In addition, all utility trenches backfilled below pavement sections, curb and gutter and concrete flatwork, should be backfilled with structural fill compacted to at least 95 percent of the MDD as determined by ASTM D-1557. All other trenches, including landscape areas, should be backfilled and compacted to approximately 90 percent of the MDD (ASTM D-1557).

Specifications from governing authorities having their own precedence for backfill and compaction should be followed where more stringent.

6.4 FOUNDATIONS

Based on our field observations and laboratory data, the foundations for the proposed structures may consist of conventional shallow spread footings that are founded below the undocumented fill and may be founded either on competent native soils <u>or</u> *entirely* on structural fill. Native/fill transition zones should be avoided. If soft, loose, potentially collapsible, or otherwise deleterious earth materials are exposed in the footing excavations, then the footings should be deepened such that all footings bear on relatively uniform, competent native earth materials. Alternatively, the building pad may be over-excavated a minimum of 2 feet below the bottom of proposed footings and replaced with structural fill, such that the footings bear entirely on a uniform fill blanket.

If required, all fill beneath the foundations should be placed and compacted in accordance with our recommendations contained in Section 6.2.4 of this report. Shallow spread or continuous wall footings constructed *entirely* on competent relatively undisturbed native soil or *entirely* on a minimum of 2 foot of structural fill may be proportioned utilizing a maximum net allowable bearing pressure of **1,800 pounds per square foot (psf)** for dead load plus live load conditions.

All foundations exposed to the full effects of frost should be established at a minimum depth of 30 inches below the lowest adjacent final grade. Interior footings, not subjected to the full effects of frost (i.e., a continuously heated structure), may be established at higher elevations, however, a minimum depth of embedment of 18 inches is recommended for confinement purposes. The minimum recommended footing width is 20 inches for continuous wall footings and 30 inches for isolated spread footings.

6.5 SETTLEMENT

6.5.1 Static Settlement

Static settlement of properly designed and constructed conventional foundations, founded as described above, are anticipated to be on the order of 1 inch or less. Differential settlement is expected to be half of total settlement over a distance of 30 feet.

6.5.2 Dynamic Settlement

Seismically induced settlement consists of dry dynamic settlement (above groundwater) and liquefaction-induced settlement (below groundwater). During a strong seismic event, seismically induced settlement can occur within loose to moderately dense sandy soil due to reduction in volume during, and shortly after, an earthquake event. Settlement caused by ground shaking is often non-uniformly distributed, which can result in differential settlement.

Evaluation of the potential dynamic settlement of native site soils was not performed during our investigation and is beyond the scope of our services for this project.

6.6 EARTH PRESSURES AND LATERAL RESISTANCE

Lateral forces imposed upon conventional foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footing and the supporting soils. In determining the frictional resistance against concrete, a coefficient of friction of 0.40 for sandy soils should be used.

Ultimate lateral earth pressures from natural soils and *granular* backfill acting against retaining walls and buried structures may be computed from the lateral pressure coefficients or equivalent fluid densities presented in the following table:

Condition	Level Backfill	
	Lateral Pressure Coefficient	**Equivalent Fluid Density (pcf)**
Active (Ka)	0.38	44
At-rest (Ko)	0.55	63
Passive (Kp)	2.66	306

These coefficients and densities assume no buildup of hydrostatic pressures. The force of the water should be added to the presented values if hydrostatic pressures are anticipated. Clayey soils drain poorly and may swell upon wetting, thereby greatly increasing lateral pressures acting on earth retaining structures; therefore, clayey soils should not be used as retaining wall backfill. Backfill should consist of either native granular soil or sandy imported material with an Expansion Index (EI) less than 20.

Walls and structures allowed to rotate slightly should use the active condition. If the element is constrained against rotation, the at-rest condition should be used. These values should be used with an appropriate factor of safety against overturning and sliding. A value of 1.5 is typically used. Additionally, if passive resistance is calculated in conjunction with frictional resistance, the passive resistance should be reduced by ½.

6.7 CONCRETE SLABS-ON-GRADE CONSTRUCTION

To minimize settlement and cracking of slabs, and to aid in drainage beneath the concrete floor slabs, all concrete slabs should be founded on a minimum 4-inch layer of compacted gravel overlying competent native earth materials or structural fill. The gravel should consist of free draining gravel or road base with a 3/4-inch maximum particle size and no more than 5 percent passing the No. 200 mesh sieve. The layer should be compacted to at least 95 percent of the MDD as determined by ASTM D-1557. Other earth materials not meeting the criteria above may be suitable for construction; alternate materials should be evaluated on a case-by-case basis and should be approved by IGES.

All concrete slabs should be designed to minimize cracking as a result of shrinkage. Consideration should be given to reinforcing the slab with a welded wire fabric, re-bar, or fibermesh. Slab reinforcement should be designed by the structural engineer. We recommend that concrete be tested to assess that the slump and/or air content is in compliance with the plans and specifications. If slump and/or air content are beyond the recommendations as specified in the plans and specifications, the concrete may not perform as desired. We recommend that concrete be placed in general accordance with the requirements of the American Concrete Institute (ACI).

A moisture barrier (vapor retarder) consisting of 10-mil thick Visqueen (or equivalent) plastic sheeting should be placed below slabs-on-grade where moisture-sensitive floor coverings or equipment is planned. Prior to placing this moisture barrier, any objects that could puncture it, such as protruding gravel or rocks, should be removed from the building pad. Alternatively, the building pad may be covered by two inches of clean sand.

6.8 MOISTURE PROTECTION AND SURFACE DRAINAGE

Moisture should not be allowed to infiltrate into the soils in the vicinity of the foundations. As such, design strategies to minimize ponding and infiltration near the proposed facility should be implemented. We recommend that hand-watering, desert landscaping, or Xeriscape be considered within 5 feet of the foundations. We further recommend roof runoff devices be installed to direct all runoff a minimum of 10 feet away from structures or to storm water runoff areas. Additionally, the ground surface within 10 feet of the structures should be constructed so as to slope a minimum of five percent away. Pavement sections should be constructed to divert surface water off of the pavement into storm drains. Parking strips and roadway shoulder areas should be constructed to prevent infiltration of water into the areas surrounding pavement.

6.9 PRELIMINARY SOIL CORROSION POTENTIAL

Laboratory test results indicate that near surface native soils tested has a sulfate content of <5.2 ppm. Based on this result, the soils are classified as having a low potential for sulfate attack to concrete. We anticipate that conventional Type I/II cement can be used for all of the concrete.

To evaluate the corrosion potential of ferrous metal in contact with onsite native soil, a representative soil sample was tested in our soils laboratory for soil resistivity (AASHTO T288), soluble chloride content, and pH. The tests indicated that the onsite soil tested has a minimum soil resistivity of 2,615 OHM-cm, a soluble chloride content of <5.2, and a pH of 8.7. Based on this result, the onsite native soil is considered **corrosive** to ferrous metal. Consideration should be given to retaining the services of a qualified corrosion engineer to provide an assessment of any metal in contact with existing site soils, particularly ancillary water lines, reinforcing steel, and valves.

7.0 CLOSURE

7.1 LIMITATIONS

The recommendations contained in this report are based on our limited field exploration, laboratory testing, and understanding of the proposed construction. The subsurface data used in the preparation of this report were obtained from the explorations made for this investigation. It is possible that variations in the soil and groundwater conditions could exist between the points explored. The nature and extent of variations may not be evident until construction occurs. If any conditions are encountered at this site that are different from those described in this report, we should be immediately notified so that we may make any necessary revisions to recommendations contained in this report. In addition, if the scope of the proposed construction changes from that described in this report, IGES should be notified.

This report was prepared in accordance with the generally accepted standard of practice at the time the report was written. No warranty, expressed or implied, is made.

It is the Client's responsibility to see that all parties to the project including the Designer, Contractor, Subcontractors, etc. are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the Contractor's option and risk.

7.2 ADDITIONAL SERVICES

The recommendations made in this report are based on the assumption that an adequate program of tests and observations will be made during construction. IGES staff should be on site to verify compliance with these recommendations. These tests and observations should include, but not necessarily be limited to, the following:

- Observations and testing during site preparation, earthwork and structural fill placement.
- Observation of foundation soils to assess their suitability for footing placement.
- Observation of soft/loose soils over-excavation.
- Observation of temporary excavations and shoring.
- Consultation as may be required during construction.
- Quality control and observation of concrete placement.

We also recommend that project plans and specifications be reviewed by us to verify compatibility with our conclusions and recommendations. Additional information concerning the scope and cost of these services can be obtained from our office.

We appreciate the opportunity to be of service on this project. Should you have any questions regarding the report or wish to discuss additional services, please do not hesitate to contact us at your convenience at (801) 748-4044.

8.0 REFERENCES CITED

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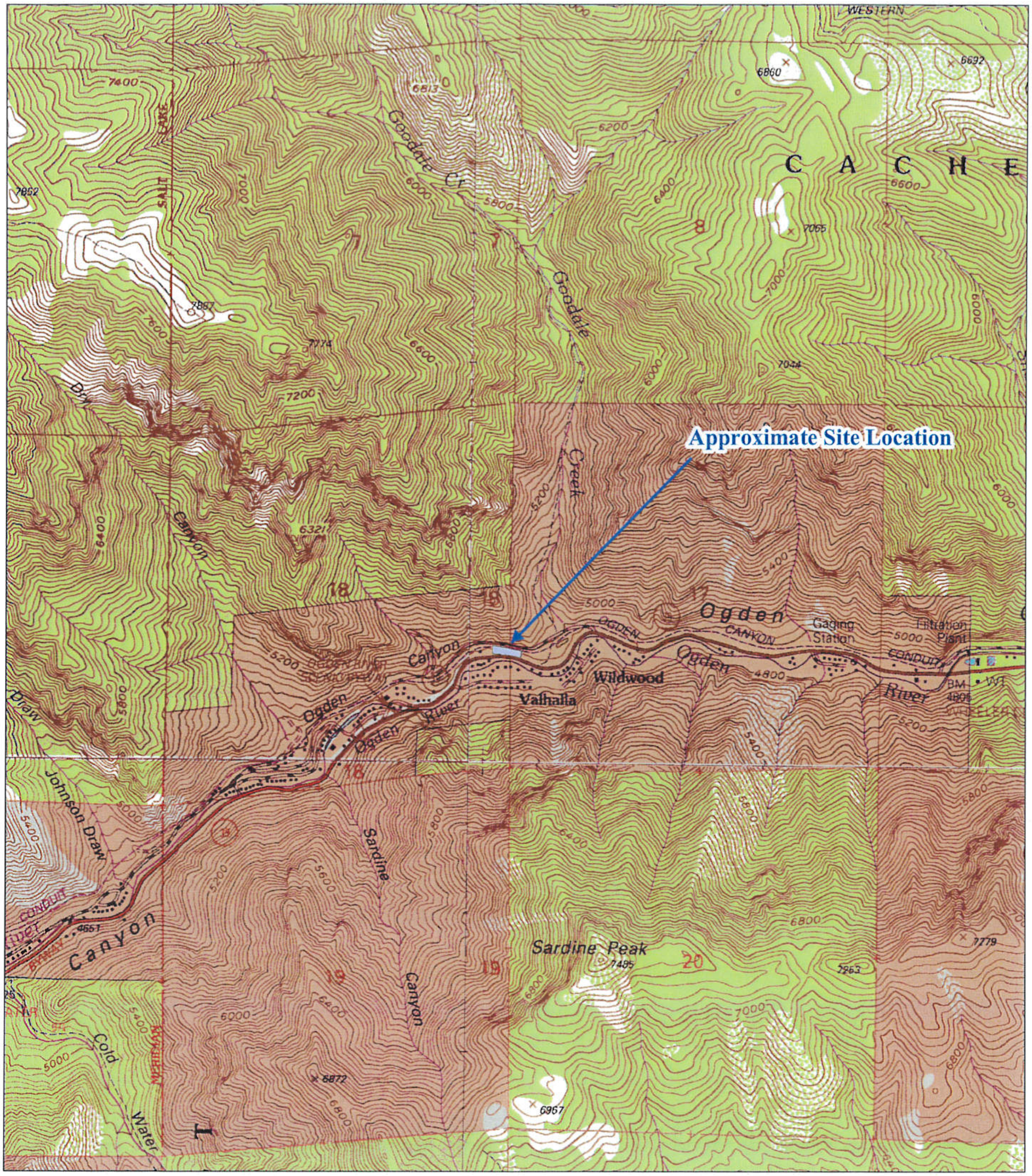
APPENDIX A



BASE MAPS:
OGDEN, NORTH OGDEN, HUNTSVILLE, AND SNOWBASINU.S.G.S. 7.5 MINUTE QUADRANGLES

0 1,550 3,100 6,200 Feet

1:24,000

N

IGES

Project Number - 01272-001

Geologic Evaluation and Preliminary Geologic Investigation
Mike Rypien property
627 Ogden Canyon
Weber County, Utah

SITE VICINITY MAP

Plate

A-1

LEGEND

Site Boundary (Approximate)

Test Pit Locations with Depth of Fill, Depth to Ground Water, and Total Depth of Test Pit

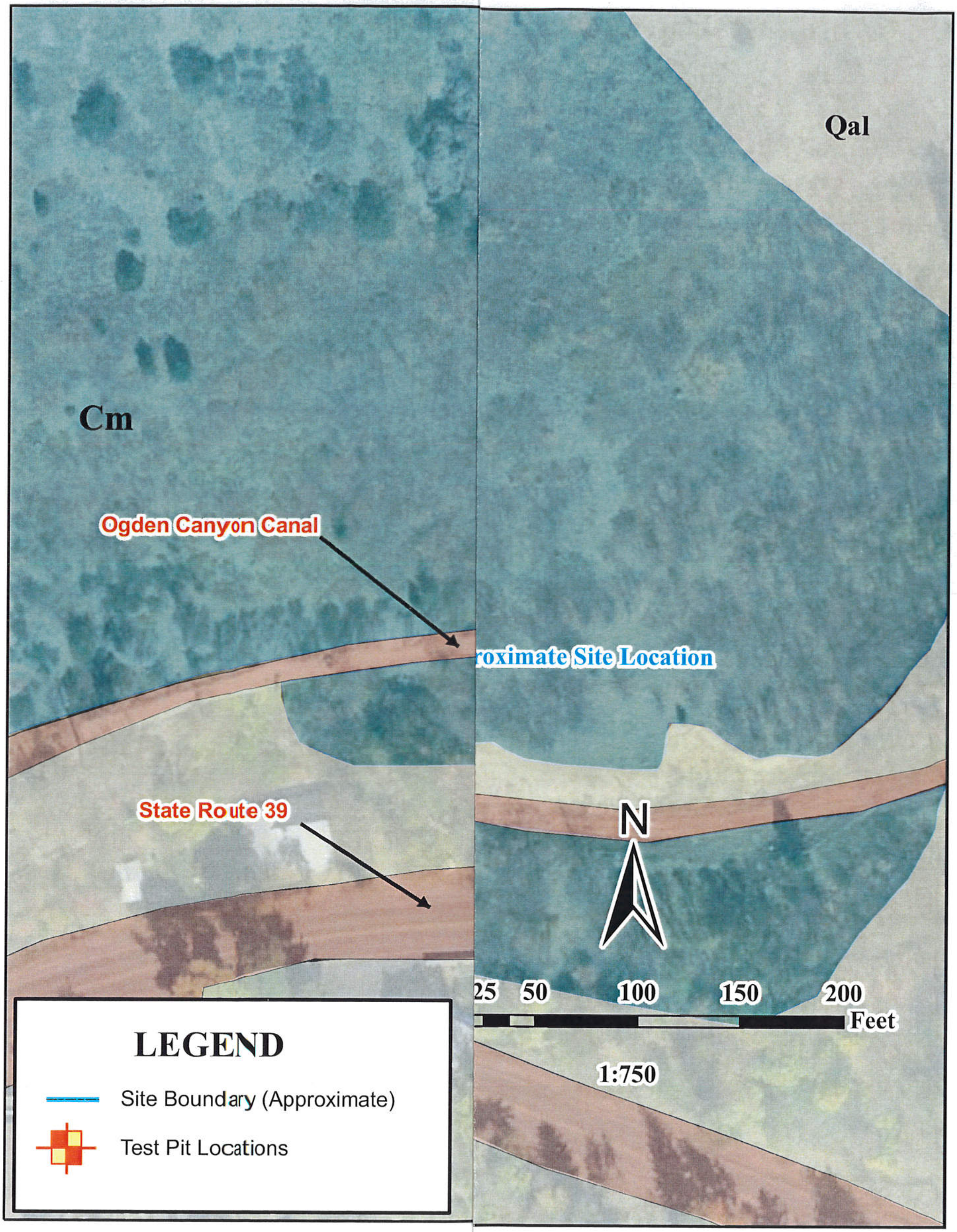
IGES

Project Number - 01272-001

AL MAP

Plate

A-2



IGES

Project Number - 01272-001

GIC MAP

Plate

A-3a

GEOLOGIC MAP DESCRIPTIONS

Qfd	Disturbed land and fill (Historical) – Land disturbed by road and canal construction or any other human activities.
Qal	Alluvial Deposits (Holocene) – Unconsolidated deposits of gravel, sand, and silt in active stream channels and flood plains. Thickness of overall sediment is 0 to 18 feet.
Cm	Maxfield Formation (Middle Cambrian) – Rock divided into thin-bedded ledge forming finely crystalline dolomite, olive drab micaceous shale, and dark-blue gray ledge forming limestone and dolomite.

IGES

Project Number - 01272-001

RDS MAP

Plate

A-4

Rock outcrop of the Maxfield Formation at the west end of the property

Another rock outcrop of Maxfield Formation with Ogden Canyon Canal Conduit near central portion of property

IGES

Project Number – 01272-001

Geologic Hazards Evaluation and Investigation
Mike Rypien
627 Ogden Canyon
Weber County, Utah

SITE PHOTOS

PLATE

A-5

Eastern portion of property with mostly undocumented fill

Possible rock fall on the central portion of property

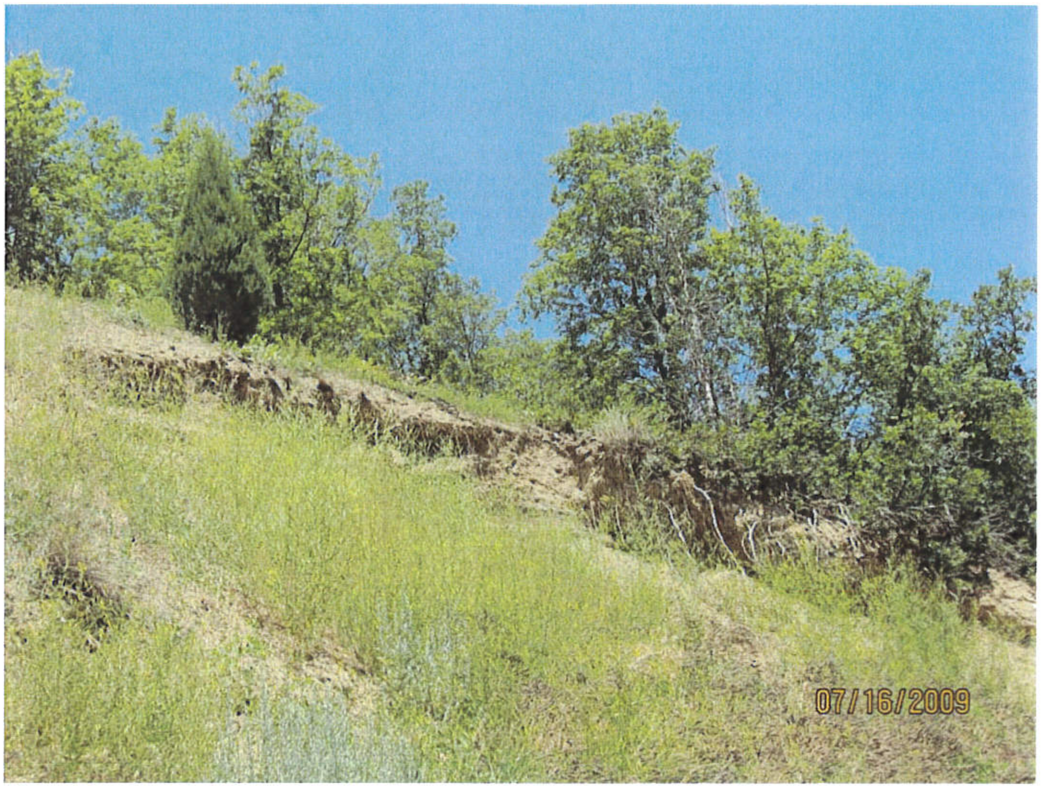
IGES

Project Number – 01272-001

Geologic Hazards Evaluation and Investigation
Mike Rypien
627 Ogden Canyon
Weber County, Utah

SITE PHOTOS

PLATE
A-6



Small landslide slump just northeast of property and
north of Ogden Canyon Canal Conduit

Small rock fall on Ogden Canyon Canal Conduit Road

Large rock from recent rock fall on Ogden Canyon Canal Conduit

Another large rock from recent rock fall on Ogden Canyon Canal Conduit

IGES

Project Number – 01272-001

Geologic Hazards Evaluation and Investigation
Mike Rypien
627 Ogden Canyon
Weber County, Utah

SITE PHOTOS

PLATE

A-8

Loose rock exposed in high wall just north of Ogden Canyon Canal Conduit, northeast of property

Typical vegetation on property just south of Ogden Canyon Canal Conduit

IGES

Project Number – 01272-001

Geologic Hazards Evaluation and Investigation
Mike Rypien
627 Ogden Canyon
Weber County, Utah

SITE PHOTOS

PLATE

A-9

Fractured rock outcrop located just north of Ogden Canyon Canal Conduit

Typical rock outcrop exposed just north of the Ogden
Canyon Canal Conduit above the property

DATE		Geotechnical Investigation		
STARTED:	5/29/09	Mike Rypien	IGES Rep:	CLE
COMPLETED:	5/29/09	627 Ogden Canyon	Rig Type:	CASE CX36B
BACKFILLED:	5/29/09	Hermitage, Utah	Boring Type:	Test Pit
			Project Number:	01272-001

BORING NO: **TP-1**

Sheet 1 of 1

LOCATION

NORTHING | EASTING | ELEVATION

Ogden Canyon

Depth (Meters)	Depth (Feet)	Samples	Water Level	Graphical Log	Unified Soil Classification	MATERIAL DESCRIPTION	N	N*	SPT Blow Count	Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0				CL	Undocumented FILL - Lean CLAY - very soft to soft, moist, dark brown to tan, root traces								
										93	24			
													25	8
						@ 3' Found a Hemingray green glass telegraph insulator					3			
1						@ 3.5' Tan Lean CLAY with old brick fragment							34	16
					CL	Lean CLAY - soft, moist, dark brown, root traces, organics (possible A-Soil Horizon)					23			
					SC-SM	Silty, clayey SAND - loose, very moist, tan-brown, fine-grained, bedded in areas (Ogden River Sediment)				94	25			
	5											29		
			▼			Groundwater Encountered @ 5.5'								
						Bottom of Boring @ 5.5 Feet								
2														
3														

Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit): 10 20 30 40 50 60 70 80 90

N - OBSERVED UNCORRECTED BLOW COUNT * N - UNCORRECTED, EQUIVALENT SPT BLOW COUNT FR - FIELD REFUSAL

IGES

SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY SAMPLER
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- SAMPLE FROM AUGER CUTTINGS

NOTES:

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Plate A - 11

BORING LOG (NEW) (A) (4 LINE HEADER) MIKERYPIEN 01272-001.GPJ IGES.GDT 7/20/09

DATE	
STARTED:	5/29/09
COMPLETED:	5/29/09
BACKFILLED:	5/29/09

Geotechnical Investigation
Mike Rypien
627 Ogden Canyon
Hermitage, Utah

IGES Rep: CLE
Rig Type: CASE CX36B
Boring Type: Test Pit
Project Number: 01272-001

BORING NO: **TP-2**
Sheet 1 of 1

LOCATION
NORTHING EASTING ELEVATION
Ogden Canyon

DEPTH (METERS)	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N*	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit) 10 20 30 40 50 60 70 80 90
0	0				GP	Undocumented FILL - Poorly Graded GRAVEL with Sand and Silt - loose, slightly moist, tan-brown to gray, organics (wood fragments)									
						CONCRETE - cement for front steps									
1					GP-GM	Poorly Graded GRAVEL with Sand and Silt - loose, slightly moist, tan-brown to gray, crude bedding representing different depositional cycles (Alluvial fan/Debris Flow deposits)					2				●
	5														
2												7			
			▼			Groundwater Encountered @ 8'									
						Bottom of Boring @ 8 Feet									
3															

N - OBSERVED UNCORRECTED BLOW COUNT * N - UNCORRECTED, EQUIVALENT SPT BLOW COUNT FR - FIELD REFUSAL

IGES

SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY SAMPLER
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- SAMPLE FROM AUGER CUTTINGS

NOTES:

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Plate
A - 12

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			USCS SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
			SC	CLAYEY SANDS SAND-GRAVEL-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid limit less than 50)		ML	INORGANIC SILTS & VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid limit greater than 50)		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

LOG KEY SYMBOLS

BORING SAMPLE LOCATION

TEST-PIT SAMPLE LOCATION

WATER LEVEL (level after completion)

WATER LEVEL (level where first encountered)

CEMENTATION

DESCRIPTION	DESCRIPTION
WEAKELY	CRUMBLES OR BREAKS WITH HANDLING OR SLIGHT FINGER PRESSURE
MODERATELY	CRUMBLES OR BREAKS WITH CONSIDERABLE FINGER PRESSURE
STRONGLY	WILL NOT CRUMBLE OR BREAK WITH FINGER PRESSURE

OTHER TESTS KEY

C	CONSOLIDATION	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	DS	DIRECT SHEAR
UC	UNCONFINED COMPRESSION	T	TRIAXIAL
S	SOLUBILITY	R	RESISTIVITY
O	ORGANIC CONTENT	RV	R-VALUE
CBR	CALIFORNIA BEARING RATIO	SU	SOLUBLE SULFATES
COMP	MOISTURE/DENSITY RELATIONSHIP	PM	PERMEABILITY
CI	CALIFORNIA IMPACT	-200	% FINER THAN #200
COL	COLLAPSE POTENTIAL	Gs	SPECIFIC GRAVITY
SS	SHRINK SWELL	SL	SWELL LOAD

MODIFIERS

DESCRIPTION	%
TRACE	<5
SOME	5 - 12
WITH	>12

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
DRY	ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
MOIST	DAMP BUT NO VISIBLE WATER
WET	VISIBLE FREE WATER, USUALLY SOIL BELOW WATER TABLE

STRATIFICATION

DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2"
LAYER	1/2 - 12"

DESCRIPTION	THICKNESS
OCCASIONAL	ONE OR LESS PER FOOT OF THICKNESS
FREQUENT	MORE THAN ONE PER FOOT OF THICKNESS

GENERAL NOTES

1. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.
2. No warranty is provided as to the continuity of soil conditions between individual sample locations.
3. Logs represent general soil conditions observed at the point of exploration on the date indicated.
4. In general, Unified Soil Classification designations presented on the logs were evaluated by visual methods only. Therefore, actual designations (based on laboratory tests) may vary.

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT (blows/ft)	MODIFIED CA. SAMPLER (blows/ft)	CALIFORNIA SAMPLER (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
VERY LOOSE	<4	<4	<5	0 - 15	EASILY PENETRATED WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
LOOSE	4 - 10	5 - 12	5 - 15	15 - 35	DIFFICULT TO PENETRATE WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
MEDIUM DENSE	10 - 30	12 - 35	15 - 40	35 - 65	EASILY PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
DENSE	30 - 50	35 - 60	40 - 70	65 - 85	DIFFICULT TO PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
VERY DENSE	>50	>60	>70	85 - 100	PENETRATED ONLY A FEW INCHES WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER

CONSISTENCY - FINE-GRAINED SOIL

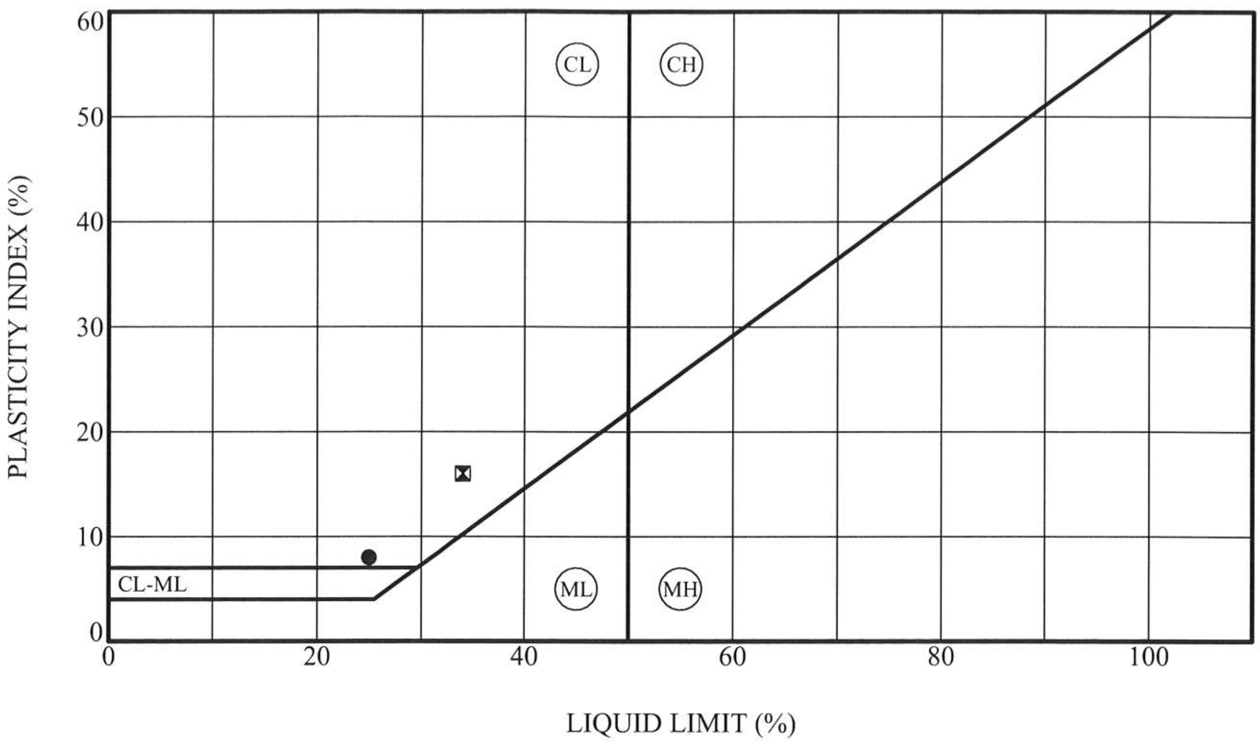
CONSISTENCY	SPT (blows/ft)	TORVANE UNTRAINED SHEAR STRENGTH (tsf)	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)	FIELD TEST
VERY SOFT	<2	<0.125	<0.25	EASILY PENETRATED SEVERAL INCHES BY THUMB. EXUDES BETWEEN THUMB AND FINGERS WHEN SQUEEZED BY HAND.
SOFT	2 - 4	0.125 - 0.25	0.25 - 0.5	EASILY PENETRATED ONE INCH BY THUMB. MOLDED BY LIGHT FINGER PRESSURE.
MEDIUM STIFF	4 - 8	0.25 - 0.5	0.5 - 1.0	PENETRATED OVER 1/2 INCH BY THUMB WITH MODERATE EFFORT. MOLDED BY STRONG FINGER PRESSURE.
STIFF	8 - 15	0.5 - 1.0	1.0 - 2.0	INDENTED ABOUT 1/2 INCH BY THUMB BUT PENETRATED ONLY WITH GREAT EFFORT.
VERY STIFF	15 - 30	1.0 - 2.0	2.0 - 4.0	READILY INDENTED BY THUMBNAIL.
HARD	>30	>2.0	>4.0	INDENTED WITH DIFFICULTY BY THUMBNAIL.

IGES

Key to Soil Symbols and Terminology

Plate A-13

APPENDIX B



	Sample Location	Depth (ft)	LL (%)	PL (%)	PI (%)	Classification
●	**TP-1**	**2.5**	**25**	**17**	**8**	**Lean CLAY (CL)**
⊠	**TP-1**	**3.5**	**34**	**18**	**16**	**Lean CLAY (CL)**

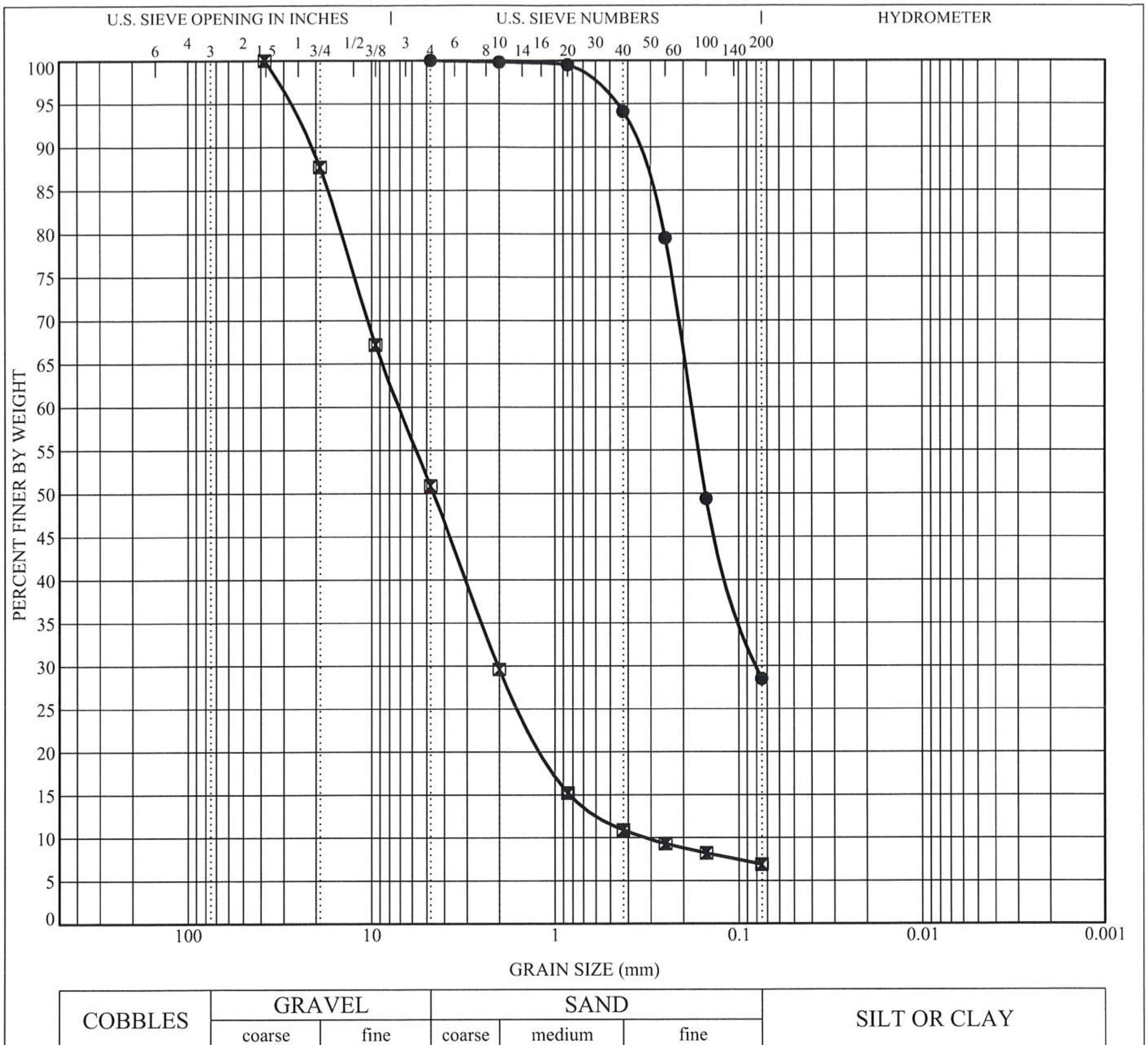
IGES

ATTERBERG LIMITS' RESULTS

Geotechnical Investigation
Mike Rypien
627 Ogden Canyon
Hermitage, Utah
Project Number: 01272-001

Plate

B - 1



Sample Location	Depth	Classification	LL	PL	PI	Cc	Cu
● **TP-1**	**5.0**	**Silty, clayey SAND (SC-SM)**					
⊠ **TP-2**	**7.0**	**Well-graded GRAVEL with silt and sand (GP-GM)**				**1.87**	**22.21**

Sample Loctaion	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **TP-1**	**5.0**	**4.75**	**0.18**	**0.079**		**0.0**	**71.5**	**28.5**	
⊠ **TP-2**	**7.0**	**38.1**	**7.005**	**2.033**	**0.315**	**49.1**	**44.0**	**6.9**	

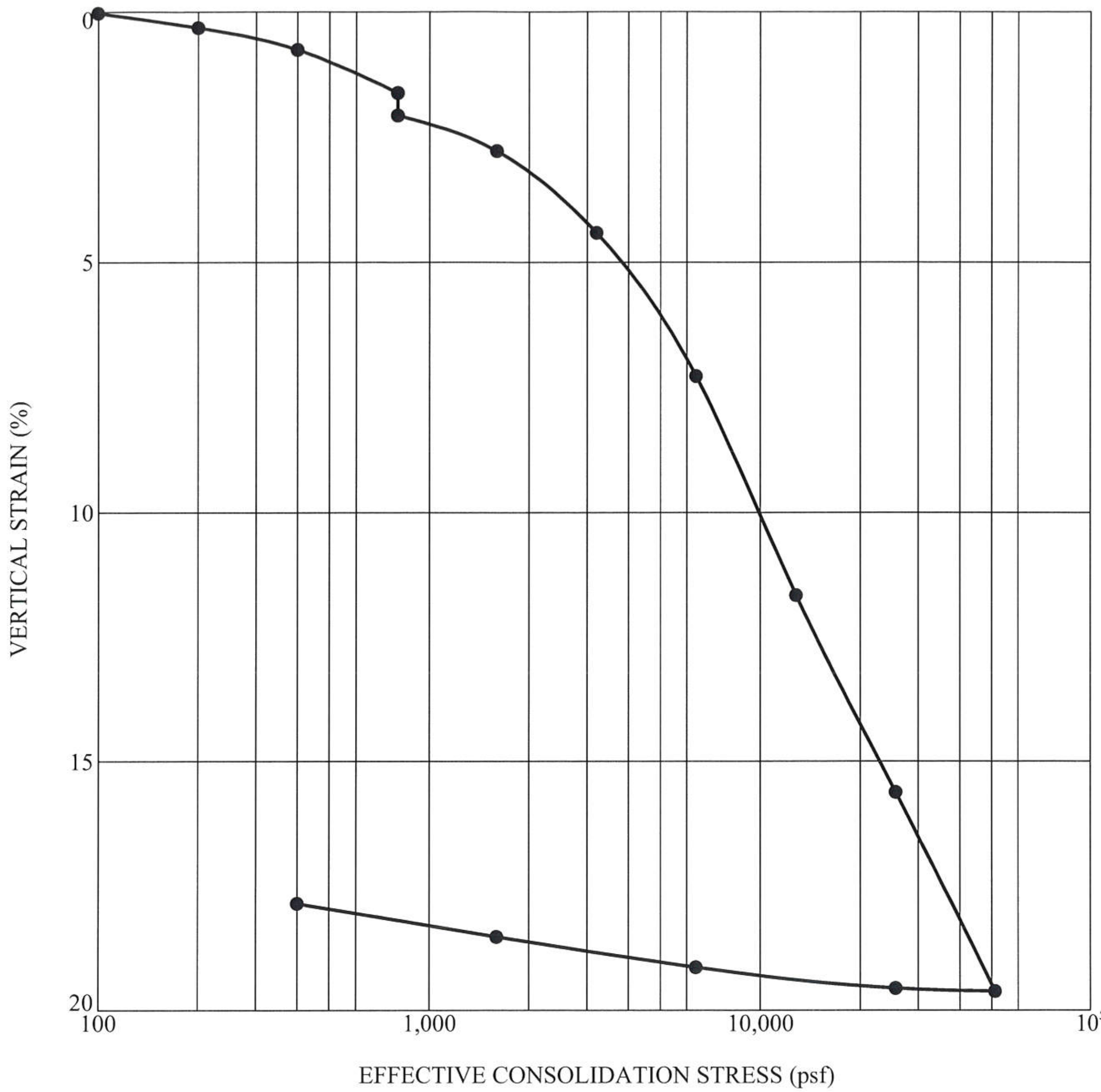
PLATE GSD MIKERYPIEN 01272-001.GPJ IGES.GDT 6/29/09

IGES

GRAIN SIZE DISTRIBUTION

Geotechnical Investigation
Mike Rypien
627 Ogden Canyon
Hermitage, Utah
Project Number: 01272-001

Plate B-2



	Sample Location	Depth (ft)	Classification	γ_d (pcf)	MC (%)	C'_c	C'_r	OCR	Inundation Load (psf)	Swell (%)	Collapse (%)
●	**TP-1**	**1.5**	**Lean CLAY (CL)**	**93**	**24**				**800**		**0.45**

IGES

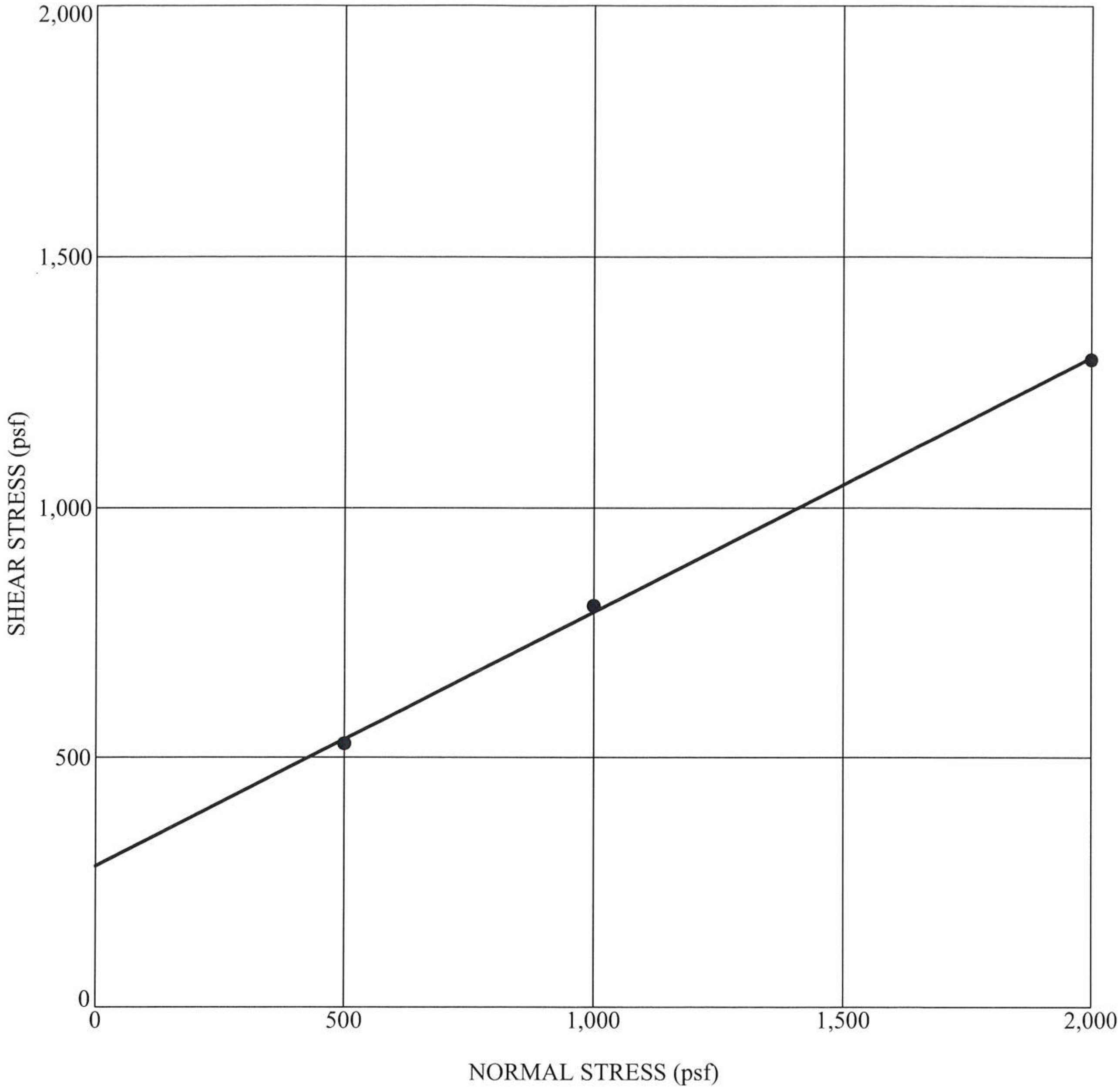
1-D CONSOLIDATION/SWELL/COLLAPSE TEST

Geotechnical Investigation
Mike Rypien
627 Ogden Canyon
Hermitage, Utah
Project Number: 01272-001

Plate

B-3

PLATE CONSOLIDATION SWELL COLLAPSE MIKERYPIEN 01272-001.GPJ IGES.GDT 6/29/09



	Sample Location	Depth (ft)	Classification	γ_d (pcf)	MC (%)	c (psf)	ϕ (deg)	
●	**TP-1**	**4.5**	**Silty, clayey SAND (SC-SM)**	**94**	**25**	**282**	**27**	

IGES

DIRECT SHEAR TEST

Geotechnical Investigation
Mike Rypien
627 Ogden Canyon
Hermitage, Utah
Project Number: 01272-001

Plate
B-4

SUMMARY OF LABORATORY TEST RESULTS TABLE

Project Name: Beacon Hill **ect Address: 7835 South Holden Street, Midvale** **Project Number: 01259-001**

SAMPLE LOCATION		NATURAL DRY DENSITY (pcf)	NATURAL MOISTURE CONTENT %	GRADATION (%)			ATTERBERG LIMITS		DIRECT SHEAR		SWELL-COLLAPSE		CHEMICAL TESTS			UNIFIED SOILS CLASSIFICATION
Point No.	Depth (ft)			Gravel >#4	Sand	Silt and Clay <#200	Liquid Limit	Plasticity Index	C (psf)	Ø	Collapse (%)	Pressure (psf)	Soluable Sulfate (ppm)	Resistivity (Minimum ohm-cm)	Soluable Chloride (ppm)	
TP- 1	1.5	93.2	24.1								0.45	800				Lean CLAY (CL)
	2.5						25	8								Lean CLAY (CL)
	3		3.3										<5.2	2615	<5.2	Lean CLAY (CL)
	3.5						34	16								Lean CLAY (CL)
	4		23.0													Lean CLAY (CL)
	4.5								282	27						Silty, Clayey SAND (SC-SM)
	5		28.0	0	71.5	28.5										Silty, Clayey SAND (SC-SM)
TP- 2	4		1.8													Poorly graded GRAVEL with Silt and Sand (GP-GM)
	7		6.9	49.1	44	6.9										Poorly graded GRAVEL with Silt and Sand (GP-GM)

Plate B-5

APPENDIX C

SITE GROUND MOTION [IBC SECTION 1613]

Project: **Mike Rypien** **Number:** **01272-001**
Latitude = **41.2544** **Date:** **4/27/09**
Logitude = **-111.8739** **By:** **CLE**

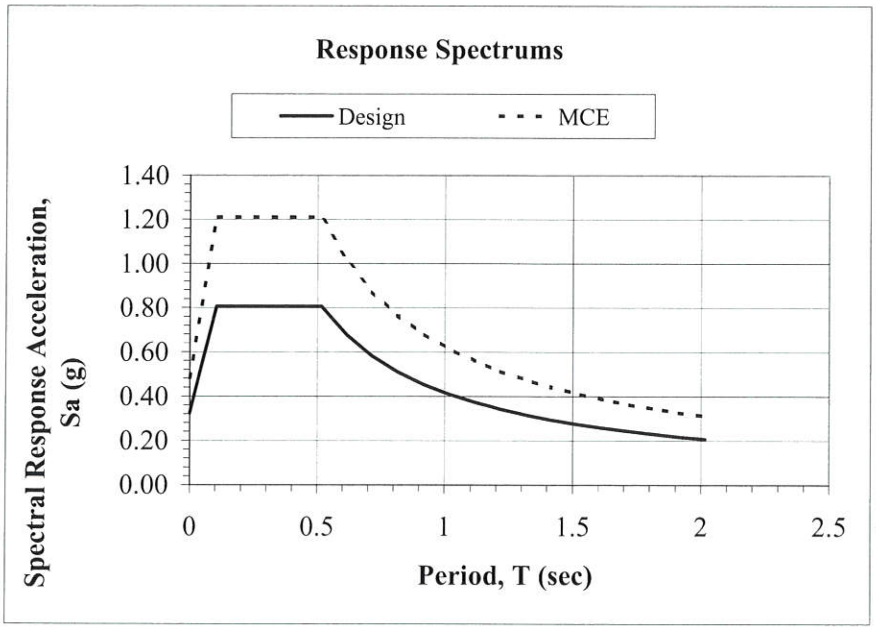
Ss = 1.210 (g) The mapped spectral accleration for short periods [1613.5]
S_1 = 0.469 (g) The mapped spectral accleration for a 1-second period

Site Class = C Table 16.13.5.2
Fa = 1.00 Table 1613.5.3(1)
Fv = 1.33 Table 1613.5.3(2)

S_{MS} = 1.210 $S_{MS} = Fa*Ss$ *The maximum considered E.Q. spectral resonse accelerations
S_{M1} = 0.624 $S_{M1} = Fv*S_1$ for short and 1-second periods [1613.5.3]
MCE/PGA = 0.484 **$0.4*S_{MS}$ [In accordance with 1802.2.7]**

S_{DS} = 0.807 $S_{DS} = 2/3*S_{MS}$ *The design spectral response acceleration
S_{D1} = 0.416 $S_{D1} = 2/3*S_{M1}$ at short and 1-second periods

T_0 = 0.103 $T_0 = 0.2*S_{D1}/S_{DS}$
T_s = 0.516 $T_s = S_{D1}/S_{DS}$ C
ΔT = 0.1 Time step for diagram



T (sec)	Sa (g)	Sa (MCE) (g)
0	0.32	0.48
0.10	0.81	1.21
0.52	0.81	1.21
0.62	0.68	1.01
0.72	0.58	0.87
0.82	0.51	0.77
0.92	0.45	0.68
1.02	0.41	0.61
1.12	0.37	0.56
1.22	0.34	0.51
1.32	0.32	0.47
1.42	0.29	0.44
1.52	0.27	0.41
1.62	0.26	0.39
1.72	0.24	0.36
1.82	0.23	0.34
1.92	0.22	0.33
2.02	0.21	0.31

SUMMARY OF GEOLOGIC HAZARDS

Mike Rypien, Ogden Canyon, Weber County, Utah — **Project Number 01272-001**

Hazard	Hazard Rating*				Further Study Recommended**
	Not Assessed	Probable	Possible	Unlikely	
Earthquake					
Ground Shaking		X			See Geotechnical Report
Surface Faulting				X	
Tectonic Subsidence				X	
Liquefaction				X	
Slope Stability				X	
Flooding (Including Seiche)			X		See Geotechnical Report
Slope Failure					
Rock Fall		X			See Geotechnical Report
Landslide			X		See Geotechnical Report
Debris Flow				X	
Avalanche	X		X		See Geotechnical Report, A
Problem Soils					
Collapsible				X	
Soluble				X	
Expansive				X	
Organic				X	
Piping				X	
Non-Engineered Fill		X			See Geotechnical Report
Erosion				X	
Active Sand Dune				X	
Mine Subsidence				X	
Shallow Bedrock			X		See Geotechnical Report
Shallow Groundwater		X			See Geotechnical Report
Flooding					
Streams			X		See Geotechnical Report
Alluvial Fans				X	
Lakes				X	
Dam Failure			X		See Geotechnical Report
Canals/Ditches			X		See Geotechnical Report
Radon	X				G

* Hazard Rating :
Not assessed - report does not consider this hazard and no inference is made as to the presence or absence of the hazard at the site
Probable -Evidence is strong that the hazard exists and mitigation measures should be taken
Possible - hazard may exist, but the evidence is equivocal, based only on theoretical studies, or was not observed and furthes study is necessary as noted
Unlikely - no evidence was found to indicate that the hazard is present, hazard not known or suspected to be present

Further Study :
E - geotechnical/engineering, H - hydrologic, A - Avalanche, G - Additional detailed geologic hazard study out of the scope of this study

APPENDIX D

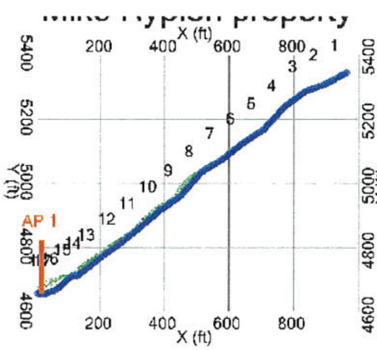
Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rockfall Analysis

PROJECT INFORMATION

Company Name:	IGES
Project Name:	CRSP 5
Station:	
Location:	Ogden Canyon
Analysis By:	CLE
Analysis Case:	
Date:	7/20/09

CRSP was used to determine the expected kinetic energy and bouncing height of falling rocks at various points along the slope. In the analysis, it was assumed that rounded boulders with a maximum diameter of 4.0 feet would impact the rockfall retaining system. For each simulation, the model rolled 300 spherical shaped rocks from a source area at 4660 - 5345 feet. A slope surface roughness of NaN - 0.9, and hardness of NaN - 0.5 were used.



Colorado Rockfall Simulation Program--CRSP 5.0

Analysis Points

AP-1 @ X = 15 ft

INPUT PARAMETERS

Slope Properties

Cells	Roughness	Hardness
1-2	.45	.5
3-5	.925	.5
6-15	.8	.5

Rock Properties

Cells	Number of Rocks	Density	Shape	Size
1-13	150	120	Sphere	2-4
15-16	150	120	Sphere	2-4

Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rockfall Results for Station and Analysis Point 1

Rock Distribution

Rock Size	Rock Number	Start Cell
2-4	150	1-13
2-4	150	15-16

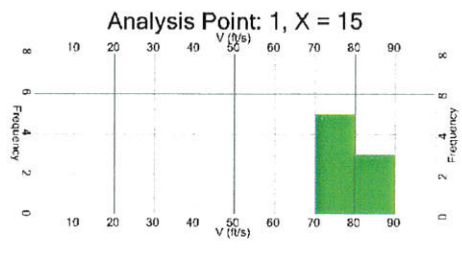
Summary of Results

Max Bounce Ht, ft	Max Energy, ft-kips	Max Velocity, ft/s	Percent Passing
31	487	84	3%

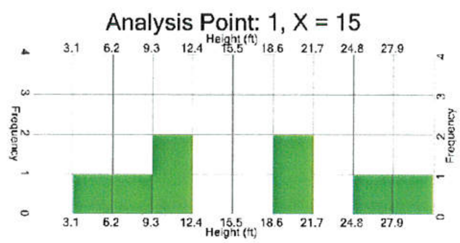
Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rockfall Results for Station and Analysis Point 1

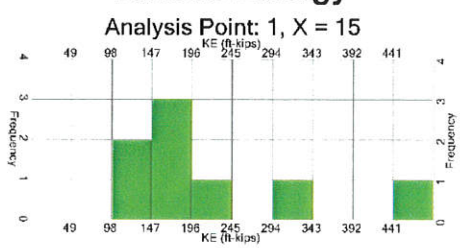
Velocity



Height



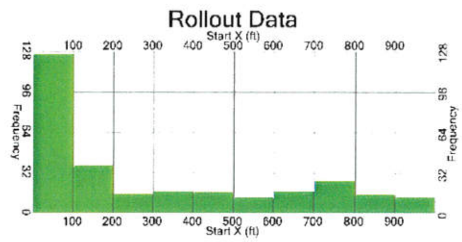
Kinetic Energy

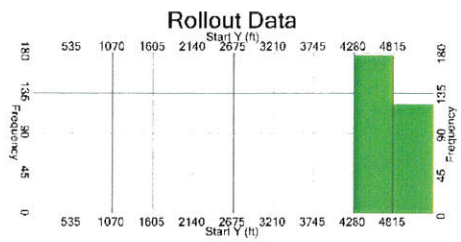


The Developers are not responsible for the reliability of the parameters and improper use of the software.

Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rollout Start Results for Station

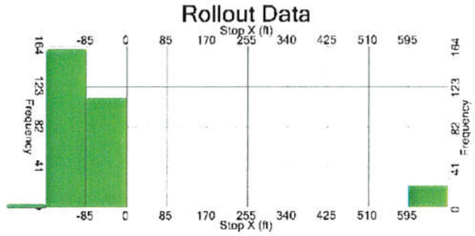


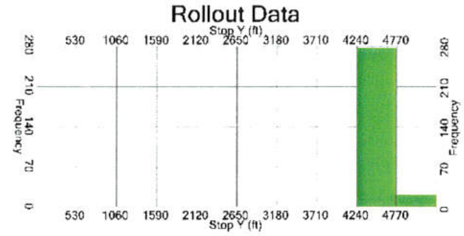


The Developers are not responsible for the reliability of the parameters and improper use of the software.

Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rollout Stop Results for Station





Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	2.2	695				
15	2.6	1084				
15	3.1	1958				
15	3.3	2248				
15	3.9	3821				
15	3.5	2616				
15	2.6	1155				
15	3.8	3345				
15	3.6	2949				
15	2.4	824				
15	4.0	4003	80.7	28.6	7.6	486
15	2.7	1250				
15	3.5	2646	78.3	32.1	11.0	304
15	3.3	2206				
15	3.8	3580				
15	3.2	1993				
15	2.9	1478				
15	3.2	2028				
15	2.8	1399				
15	2.4	874				
15	3.0	1652				
15	3.8	3551				
15	2.9	1496				
15	3.5	2593				
15	3.0	1740				
15	3.9	3673				
15	3.0	1657				
15	2.6	1142				
15	2.4	817				
15	2.8	1328				
15	3.1	1956				
15	3.4	2522				
15	3.8	3571				
15	3.5	2614				
15	3.2	1997				
15	2.7	1223				
15	3.6	2879				
15	2.3	763				
15	2.5	1006				
15	2.5	1005				
15	3.0	1631				
15	2.5	989				
15	2.7	1270				
15	3.7	3214				
15	3.2	2078				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	3.9	3736				
15	2.6	1099				
15	2.3	748				
15	3.3	2262				
15	2.3	718				
15	2.6	1062				
15	2.4	818				
15	2.7	1268	83.1	51.9	27.7	175
15	2.3	795				
15	3.8	3526				
15	2.1	574				
15	2.4	889				
15	2.8	1351				
15	2.1	621				
15	2.8	1397				
15	2.8	1371	77.4	45.7	30.0	163
15	2.8	1414				
15	2.5	1008	75.0	39.7	10.0	104
15	2.2	660				
15	2.5	1023				
15	3.3	2287				
15	2.0	508				
15	2.5	1017				
15	3.9	3829				
15	2.0	504				
15	3.4	2445				
15	3.6	2987				
15	3.7	3187				
15	3.2	1972				
15	2.3	800				
15	3.4	2524				
15	3.7	3263				
15	3.2	2008				
15	3.0	1642				
15	3.7	3225				
15	2.1	587				
15	2.7	1272				
15	3.7	3187				
15	3.4	2457				
15	2.1	611				
15	3.4	2439				
15	3.4	2375				
15	2.4	901				
15	3.7	3159				
15	2.6	1073				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	3.9	3603				
15	3.1	1941				
15	2.1	612				
15	3.7	3144				
15	2.7	1237				
15	3.9	3665				
15	3.1	1919				
15	2.4	859				
15	2.9	1552	80.0	37.1	3.6	182
15	3.4	2414				
15	2.8	1368				
15	2.7	1271				
15	3.9	3741				
15	2.8	1438				
15	2.7	1217				
15	2.9	1588				
15	3.8	3435				
15	2.8	1422				
15	3.9	3607				
15	3.2	2154				
15	3.6	2917				
15	2.8	1318				
15	2.9	1552				
15	2.4	838				
15	3.3	2351				
15	2.7	1221	74.9	41.2	19.2	130
15	2.0	541				
15	2.6	1072				
15	2.9	1548	82.6	46.0	20.7	207
15	3.4	2390				
15	2.6	1153				
15	3.0	1688				
15	2.3	734				
15	2.4	853				
15	4.0	3935				
15	3.7	3177				
15	2.2	694				
15	2.5	931				
15	2.3	738				
15	2.1	565				
15	2.1	561				
15	3.7	3152				
15	3.8	3399				
15	2.4	856				
15	2.6	1145				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	3.1	1786				
15	3.6	2990				
15	2.8	1341				
15	2.6	1070				
15	2.4	847				
15	3.9	3597				
15	2.8	1432				
15	3.0	1684				
15	3.5	2615				
15	2.4	920				
15	3.1	1886				
15	3.1	1859				
15	2.5	995				
15	3.9	3677				
15	2.1	542				
15	3.5	2798				
15	2.1	556				
15	3.9	3715				
15	3.3	2164				
15	3.3	2334				
15	2.0	508				
15	3.5	2589				
15	3.2	1973				
15	3.7	3186				
15	2.5	984				
15	3.1	1920				
15	2.4	873				
15	3.2	2063				
15	3.1	1808				
15	2.5	1035				
15	3.3	2319				
15	3.5	2590				
15	3.0	1675				
15	3.4	2578				
15	4.0	4003				
15	2.9	1488				
15	2.4	854				
15	2.3	796				
15	2.7	1302				
15	3.9	3722				
15	3.9	3664				
15	3.2	2150				
15	2.7	1196				
15	2.8	1395				
15	3.5	2682				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	2.4	833				
15	3.0	1780				
15	2.9	1587				
15	2.6	1152				
15	2.1	565				
15	2.1	545				
15	3.3	2197				
15	3.5	2694				
15	3.7	3238				
15	2.4	878				
15	2.4	860				
15	3.6	2968				
15	3.8	3468				
15	3.9	3759				
15	2.1	614				
15	3.8	3355				
15	3.9	3805				
15	2.2	672				
15	2.7	1238				
15	2.7	1212				
15	2.8	1368				
15	3.9	3860				
15	2.1	586				
15	3.7	3166				
15	2.2	707				
15	2.1	576				
15	3.9	3665				
15	2.8	1349				
15	2.8	1313				
15	3.5	2656				
15	2.7	1295				
15	2.6	1132				
15	3.1	1877				
15	3.3	2264				
15	2.4	899				
15	2.2	688				
15	2.7	1219				
15	2.8	1405				
15	3.3	2253				
15	2.4	828				
15	2.4	895				
15	3.6	2930				
15	2.2	642				
15	2.1	598				
15	2.1	591				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	3.6	2935				
15	2.7	1191				
15	3.0	1685				
15	3.7	3163				
15	2.3	780				
15	3.2	2099				
15	2.2	643				
15	2.3	744				
15	2.5	984				
15	3.6	3030				
15	3.4	2432				
15	2.7	1185				
15	2.5	949				
15	2.5	1011				
15	2.6	1126				
15	3.5	2805				
15	2.8	1405				
15	2.2	650				
15	2.8	1427				
15	2.1	574				
15	3.1	1962				
15	2.8	1327				
15	2.4	848				
15	3.6	2840				
15	3.4	2397				
15	3.5	2718				
15	3.9	3802				
15	3.1	1834				
15	2.3	813				
15	2.8	1427				
15	3.1	1943				
15	3.1	1900				
15	3.6	2942				
15	3.2	2037				
15	3.8	3529				
15	2.4	874				
15	3.0	1740				
15	2.0	535				
15	3.1	1863				
15	2.2	675				
15	2.0	538				
15	3.0	1697				
15	2.4	874				
15	2.8	1338				
15	4.0	3879				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	2.1	589				
15	2.7	1191				
15	3.6	2913				
15	2.6	1057				
15	2.9	1587				
15	2.6	1158				
15	3.5	2782				
15	3.7	3084				
15	2.5	1014				
15	2.1	551				
15	2.7	1301				
15	2.5	1011				
15	3.1	1851				
15	3.4	2434				
15	2.1	560				
15	2.3	720				
15	3.9	3788				
15	3.0	1738				
15	2.0	511				
15	3.2	2090				
15	2.9	1577				
15	2.5	947				
15	3.5	2647				
15	3.0	1732				
15	2.3	725				
15	3.5	2718				
15	3.2	1965				
15	3.4	2509				
15	2.5	1012				
15	3.8	3348				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
2.2	912	5318	835	5288
2.6	949	5339	835	5289
3.1	937	5332	835	5289
3.3	532	5050	127	4717
3.9	456	4974	127	4718
3.5	455	4972	127	4717
2.6	788	5254	34	4660
3.8	251	4811	128	4718
3.6	612	5105	124	4717
2.4	362	4900	128	4717
4.0	708	5174	7	4659
2.7	898	5311	835	5289
3.5	637	5125	2	4657
3.3	568	5072	122	4717
3.8	706	5171	126	4718
3.2	210	4782	128	4717
2.9	382	4918	127	4717
3.2	504	5028	125	4717
2.8	446	4962	126	4717
2.4	242	4803	124	4717
3.0	365	4902	121	4717
3.8	605	5100	126	4718
2.9	165	4747	128	4717
3.5	648	5133	116	4717
3.0	244	4805	119	4717
3.9	480	5001	126	4718
3.0	669	5147	121	4717
2.6	374	4910	128	4717
2.4	898	5311	835	5288
2.8	714	5180	127	4717
3.1	746	5215	126	4717
3.4	720	5186	121	4717
3.8	799	5263	124	4718
3.5	469	4988	120	4717
3.2	732	5199	127	4717
2.7	138	4726	128	4717
3.6	717	5183	115	4717
2.3	728	5195	23	4656
2.5	639	5126	118	4717
2.5	449	4964	128	4717
3.0	256	4813	128	4717
2.5	903	5313	835	5288
2.7	497	5020	124	4717
3.7	325	4870	127	4718
3.2	815	5275	115	4717

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
3.9	813	5274	118	4718
2.6	910	5317	835	5289
2.3	891	5308	835	5288
3.3	478	4999	118	4717
2.3	813	5273	128	4717
2.6	404	4933	128	4717
2.4	651	5134	113	4717
2.7	767	5238	-3	4675
2.3	427	4949	128	4717
3.8	871	5302	835	5289
2.1	738	5205	118	4717
2.4	574	5075	31	4659
2.8	649	5133	124	4717
2.1	267	4822	128	4717
2.8	330	4873	126	4717
2.8	757	5226	-3	4677
2.8	638	5126	122	4717
2.5	547	5058	4	4657
2.2	272	4826	128	4717
2.5	167	4748	128	4717
3.3	648	5133	118	4717
2.0	856	5296	835	5288
2.5	256	4813	128	4717
3.9	663	5143	127	4718
2.0	158	4741	128	4717
3.4	410	4938	118	4717
3.6	210	4781	127	4717
3.7	388	4923	126	4718
3.2	632	5121	121	4717
2.3	508	5032	121	4717
3.4	226	4793	128	4717
3.7	649	5134	126	4717
3.2	231	4796	128	4717
3.0	253	4811	126	4717
3.7	153	4738	128	4717
2.1	765	5234	116	4717
2.7	615	5107	121	4717
3.7	801	5265	113	4717
3.4	330	4873	126	4717
2.1	198	4773	124	4717
3.4	155	4739	127	4717
3.4	257	4815	128	4717
2.4	168	4750	128	4717
3.7	395	4927	124	4717
2.6	211	4782	128	4717

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
3.9	417	4943	125	4718
3.1	767	5238	115	4717
2.1	570	5072	119	4717
3.7	481	5002	126	4717
2.7	944	5336	835	5289
3.9	781	5250	113	4718
3.1	379	4915	127	4717
2.4	370	4907	128	4717
2.9	501	5025	7	4654
3.4	495	5018	19	4656
2.8	312	4858	126	4717
2.7	300	4849	128	4717
3.9	138	4726	127	4718
2.8	953	5341	835	5289
2.7	409	4936	122	4717
2.9	313	4859	128	4717
3.8	751	5221	117	4717
2.8	774	5244	112	4717
3.9	669	5147	117	4717
3.2	503	5028	123	4717
3.6	713	5179	126	4717
2.8	519	5042	124	4717
2.9	722	5188	121	4717
2.4	751	5220	116	4717
3.3	818	5277	126	4717
2.7	702	5167	-2	4663
2.0	611	5103	120	4717
2.6	885	5306	835	5289
2.9	795	5259	-2	4668
3.4	379	4915	119	4717
2.6	908	5316	835	5289
3.0	777	5246	120	4717
2.3	529	5047	33	4658
2.4	879	5304	835	5288
4.0	258	4815	126	4718
3.7	944	5336	835	5289
2.2	368	4905	128	4717
2.5	178	4757	128	4717
2.3	874	5302	835	5288
2.1	874	5302	835	5288
2.1	166	4747	128	4717
3.7	851	5295	835	5289
3.8	942	5335	835	5289
2.4	336	4877	128	4717
2.6	507	5031	125	4717

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
3.1	453	4970	128	4717
3.6	661	5142	118	4717
2.8	933	5330	835	5289
2.6	744	5212	117	4717
2.4	378	4913	124	4717
3.9	130	4720	128	4718
2.8	602	5096	42	4656
3.0	946	5337	835	5289
3.5	536	5052	119	4717
2.4	783	5251	44	4657
3.1	192	4768	128	4717
3.1	152	4736	128	4717
2.5	213	4783	128	4717
3.9	922	5324	835	5289
2.1	481	5002	118	4717
3.5	107	4716	50	4659
2.1	59	4672	59	4658
3.9	99	4709	48	4658
3.3	43	4667	43	4660
3.3	71	4683	55	4659
2.0	36	4663	36	4660
3.5	73	4684	55	4658
3.2	58	4672	58	4658
3.7	72	4683	54	4657
2.5	57	4672	57	4658
3.1	99	4708	50	4657
2.4	60	4673	60	4659
3.2	47	4668	47	4659
3.1	45	4667	45	4659
2.5	43	4666	43	4660
3.3	37	4664	37	4660
3.5	64	4677	59	4658
3.0	103	4712	51	4658
3.4	93	4703	53	4660
4.0	40	4666	40	4659
2.9	70	4682	57	4659
2.4	94	4703	53	4659
2.3	75	4686	56	4659
2.7	84	4695	51	4657
3.9	50	4669	50	4658
3.9	77	4688	53	4659
3.2	90	4700	53	4658
2.7	33	4662	33	4659
2.8	102	4710	53	4659
3.5	34	4663	34	4660

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
2.4	45	4667	45	4658
3.0	62	4674	62	4660
2.9	107	4715	48	4658
2.6	98	4707	53	4660
2.1	108	4716	50	4660
2.1	74	4684	61	4659
3.3	41	4666	41	4659
3.5	90	4700	53	4657
3.7	39	4665	39	4659
2.4	66	4677	60	4658
2.4	102	4711	52	4658
3.6	63	4676	60	4659
3.8	92	4702	47	4658
3.9	40	4666	40	4659
2.1	83	4692	54	4658
3.8	89	4699	53	4659
3.9	41	4666	41	4659
2.2	100	4709	51	4659
2.7	80	4691	54	4658
2.7	107	4715	45	4660
2.8	52	4670	52	4659
3.9	100	4710	49	4659
2.1	60	4673	60	4659
3.7	103	4712	53	4660
2.2	100	4708	53	4657
2.1	66	4677	61	4659
3.9	62	4675	61	4658
2.8	98	4707	48	4659
2.8	54	4671	54	4659
3.5	106	4715	50	4659
2.7	100	4708	53	4659
2.6	56	4671	56	4657
3.1	106	4714	49	4658
3.3	96	4706	51	4659
2.4	63	4675	61	4659
2.2	57	4672	57	4658
2.7	84	4695	54	4659
2.8	64	4676	60	4659
3.3	89	4699	53	4660
2.4	39	4664	39	4660
2.4	42	4665	42	4659
3.6	69	4681	55	4657
2.2	77	4688	61	4658
2.1	106	4713	61	4657
2.1	64	4675	61	4660

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
3.6	49	4669	49	4660
2.7	82	4692	55	4660
3.0	78	4689	55	4658
3.7	102	4711	52	4660
2.3	107	4714	49	4659
3.2	95	4705	51	4658
2.2	104	4712	61	4658
2.3	87	4696	61	4658
2.5	97	4706	52	4658
3.6	55	4671	55	4660
3.4	38	4664	38	4660
2.7	66	4677	59	4659
2.5	83	4693	54	4658
2.5	50	4669	50	4660
2.6	38	4664	38	4659
3.5	59	4673	59	4659
2.8	75	4686	53	4658
2.2	108	4716	52	4658
2.8	90	4700	50	4658
2.1	45	4667	45	4660
3.1	82	4692	51	4658
2.8	35	4663	35	4660
2.4	51	4669	51	4658
3.6	57	4672	57	4658
3.4	76	4687	54	4658
3.5	56	4672	56	4658
3.9	108	4717	50	4658
3.1	90	4699	52	4659
2.3	33	4662	33	4660
2.8	103	4712	53	4658
3.1	96	4705	53	4660
3.1	104	4713	48	4657
3.6	53	4671	53	4659
3.2	107	4715	52	4658
3.8	91	4702	53	4660
2.4	66	4678	58	4660
3.0	72	4683	54	4657
2.0	34	4662	34	4659
3.1	93	4702	53	4657
2.2	98	4706	61	4658
2.0	89	4698	61	4659
3.0	93	4702	50	4657
2.4	34	4662	34	4659
2.8	66	4678	58	4660
4.0	79	4690	55	4659

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
2.1	53	4670	53	4659
2.7	94	4703	53	4658
3.6	90	4701	51	4658
2.6	45	4667	45	4658
2.9	97	4706	53	4659
2.6	92	4701	49	4659
3.5	54	4671	54	4660
3.7	91	4701	52	4658
2.5	46	4667	46	4659
2.1	93	4702	61	4657
2.7	83	4693	55	4660
2.5	69	4681	56	4657
3.1	73	4684	55	4658
3.4	36	4664	36	4659
2.1	44	4666	44	4660
2.3	85	4695	61	4658
3.9	74	4686	53	4659
3.0	96	4705	50	4659
2.0	57	4671	57	4660
3.2	70	4682	56	4659
2.9	82	4692	53	4659
2.5	58	4672	58	4658
3.5	108	4716	50	4659
3.0	96	4705	50	4657
2.3	103	4712	51	4659
3.5	67	4680	56	4658
3.2	99	4708	50	4660
3.4	102	4711	50	4657
2.5	37	4664	37	4659
3.8	62	4674	62	4660

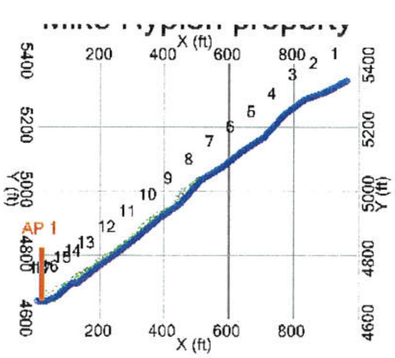
Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rockfall Analysis

PROJECT INFORMATION

Company Name:	IGES
Project Name:	CRSP 5
Station:	
Location:	Ogden Canyon
Analysis By:	CLE
Analysis Case:	
Date:	7/20/09

CRSP was used to determine the expected kinetic energy and bouncing height of falling rocks at various points along the slope. In the analysis, it was assumed that rounded boulders with a maximum diameter of 4.0 feet would impact the rockfall retaining system. For each simulation, the model rolled 300 spherical shaped rocks from a source area at 4660 - 5345 feet. A slope surface roughness of NaN - 0.9, and hardness of NaN - 0.5 were used.



Colorado Rockfall Simulation Program--CRSP 5.0

Analysis Points

AP-1 @ X = 15 ft

INPUT PARAMETERS

Slope Properties

Cells	Roughness	Hardness
1-2	.45	.5
3-5	.925	.5
6-15	.8	.5

Rock Properties

Cells	Number of Rocks	Density	Shape	Size
1-13	150	120	Sphere	2-4
15-16	150	120	Sphere	2-4

Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rockfall Results for Station and Analysis Point 1

Rock Distribution

Rock Size	Rock Number	Start Cell
2-4	150	1-13
2-4	150	15-16

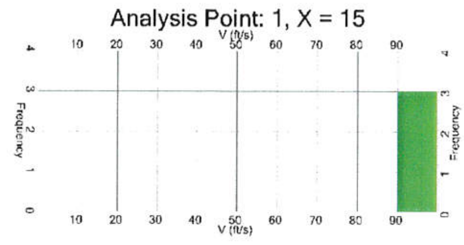
Summary of Results

Max Bounce Ht, ft	Max Energy, ft-kips	Max Velocity, ft/s	Percent Passing
23	310	96	1%

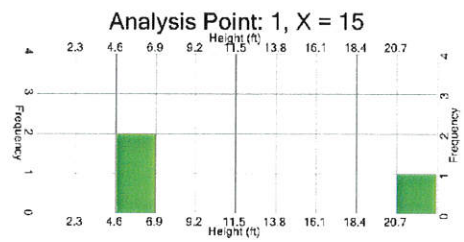
Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rockfall Results for Station and Analysis Point 1

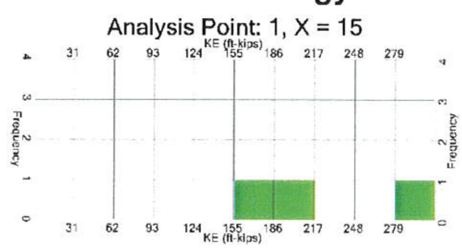
Velocity



Height

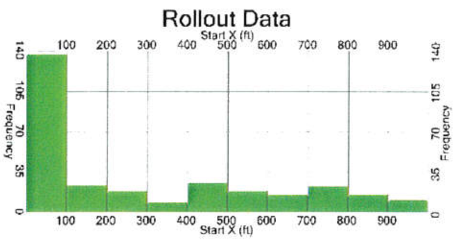


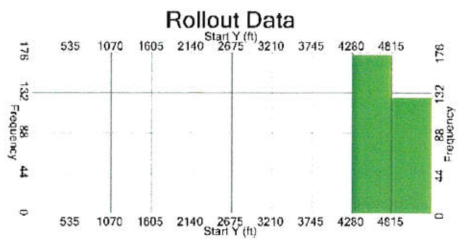
Kinetic Energy



Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rollout Start Results for Station

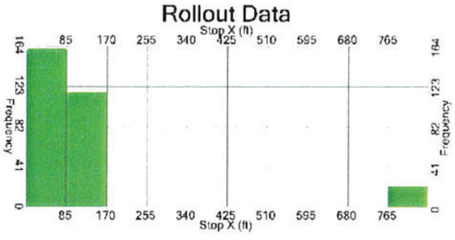


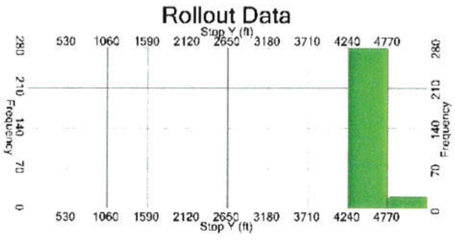


The Developers are not responsible for the reliability of the parameters and improper use of the software.

Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rollout Stop Results for Station





The Developers are not responsible for the reliability of the parameters and improper use of the software.

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	2.2	648				
15	2.6	1118				
15	3.0	1696				
15	2.2	708				
15	2.7	1285				
15	2.5	932				
15	3.9	3789				
15	3.8	3359				
15	3.1	1911				
15	3.0	1618				
15	2.6	1097				
15	2.1	554				
15	2.6	1162				
15	3.4	2498				
15	2.2	650				
15	3.1	1938				
15	2.2	709				
15	2.5	996				
15	2.2	704				
15	3.0	1684				
15	3.1	1917				
15	2.6	1141				
15	3.0	1742				
15	3.6	2912				
15	3.2	1994				
15	2.1	585				
15	3.1	1880	90.7	49.7	22.2	310
15	3.1	1912				
15	3.9	3588				
15	3.8	3316				
15	2.9	1572				
15	2.5	957				
15	2.2	713				
15	4.0	3941				
15	3.1	1914				
15	2.6	1078	95.3	59.3	5.0	191
15	2.5	1021				
15	2.8	1432				
15	3.5	2584				
15	2.2	674				
15	2.6	1103				
15	3.1	1899				
15	2.9	1510				
15	2.0	532				
15	3.7	3282				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	2.8	1334				
15	2.5	925				
15	2.3	732				
15	3.1	1933				
15	3.3	2355				
15	3.8	3326				
15	2.9	1473				
15	2.9	1480				
15	2.8	1385				
15	2.1	623				
15	3.5	2753				
15	2.9	1572				
15	2.6	1079				
15	3.7	3067				
15	2.5	948				
15	3.9	3679				
15	2.2	634				
15	3.6	2953				
15	3.8	3409				
15	2.9	1602				
15	3.2	2151				
15	3.3	2295				
15	2.1	622				
15	3.4	2578				
15	2.9	1470				
15	2.8	1450				
15	3.9	3707				
15	4.0	3964				
15	2.4	874				
15	3.9	3740				
15	2.6	1062				
15	3.8	3329				
15	3.5	2583				
15	3.4	2452				
15	2.4	839				
15	2.1	554				
15	2.4	911				
15	2.1	612				
15	3.5	2583				
15	3.3	2175				
15	3.7	3127				
15	3.1	1895				
15	3.3	2257				
15	3.1	1790				
15	3.1	1821				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	3.0	1646				
15	2.9	1455				
15	2.6	1116				
15	3.8	3410				
15	3.8	3375				
15	3.3	2292				
15	2.7	1307				
15	2.3	767				
15	2.6	1081	93.1	56.5	5.1	181
15	2.8	1359				
15	2.0	522				
15	3.6	2813				
15	3.0	1699				
15	3.1	1787				
15	3.2	2081				
15	3.9	3710				
15	2.7	1245				
15	2.1	587				
15	2.9	1564				
15	2.5	937				
15	3.0	1652				
15	2.9	1495				
15	2.7	1306				
15	3.6	2928				
15	2.4	919				
15	2.1	578				
15	3.2	2152				
15	3.8	3543				
15	3.2	2084				
15	3.1	1920				
15	3.6	3023				
15	3.3	2168				
15	3.9	3801				
15	3.0	1773				
15	2.4	918				
15	2.9	1474				
15	2.3	791				
15	2.9	1503				
15	2.9	1588				
15	2.5	1017				
15	2.6	1127				
15	2.5	1036				
15	2.7	1284				
15	2.7	1172				
15	2.6	1160				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	3.9	3755				
15	3.4	2385				
15	2.8	1328				
15	3.7	3299				
15	2.4	917				
15	2.9	1541				
15	2.4	888				
15	2.1	601				
15	3.8	3431				
15	2.5	1021				
15	2.6	1096				
15	2.1	592				
15	3.9	3796				
15	2.3	723				
15	3.9	3777				
15	2.3	743				
15	3.3	2166				
15	2.3	746				
15	3.4	2521				
15	2.0	510				
15	3.6	2853				
15	2.2	701				
15	2.5	1006				
15	3.2	1999				
15	2.4	867				
15	3.4	2520				
15	2.6	1135				
15	3.6	3004				
15	2.8	1437				
15	2.5	987				
15	2.9	1473				
15	2.8	1364				
15	3.3	2170				
15	2.5	927				
15	2.7	1224				
15	2.9	1514				
15	2.7	1285				
15	3.0	1668				
15	3.8	3347				
15	3.6	3043				
15	2.6	1063				
15	2.2	697				
15	3.1	1930				
15	2.5	1030				
15	2.9	1573				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	3.7	3261				
15	3.2	2030				
15	2.9	1603				
15	3.0	1662				
15	2.0	519				
15	3.5	2655				
15	2.3	733				
15	2.6	1113				
15	2.0	538				
15	2.9	1548				
15	3.8	3583				
15	2.5	982				
15	2.9	1599				
15	3.6	2938				
15	3.6	2920				
15	2.1	555				
15	3.2	2014				
15	2.3	716				
15	3.2	1985				
15	2.5	931				
15	3.8	3389				
15	2.9	1540				
15	2.2	698				
15	3.0	1729				
15	3.0	1750				
15	3.2	2126				
15	3.4	2422				
15	3.7	3098				
15	2.4	918				
15	2.2	690				
15	2.4	921				
15	2.2	694				
15	3.3	2157				
15	3.3	2192				
15	2.3	727				
15	2.8	1401				
15	3.2	2059				
15	2.8	1366				
15	3.0	1642				
15	3.5	2658				
15	3.3	2169				
15	3.7	3312				
15	2.4	912				
15	3.9	3664				
15	3.5	2785				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	2.1	569				
15	2.8	1445				
15	3.1	1873				
15	3.3	2261				
15	2.8	1343				
15	3.4	2395				
15	2.6	1139				
15	2.4	882				
15	4.0	3922				
15	3.4	2577				
15	2.4	887				
15	3.7	3063				
15	3.1	1842				
15	4.0	4009				
15	2.5	1034				
15	2.5	967				
15	3.2	2028				
15	2.9	1566				
15	2.1	549				
15	4.0	3921				
15	2.3	782				
15	2.7	1182				
15	2.7	1208				
15	3.3	2209				
15	3.7	3138				
15	3.9	3849				
15	3.7	3207				
15	2.8	1371				
15	3.8	3329				
15	3.5	2667				
15	2.6	1059				
15	2.8	1419				
15	2.8	1349				
15	2.7	1297				
15	3.2	1993				
15	2.6	1048				
15	3.3	2246				
15	2.9	1498				
15	2.9	1536				
15	3.3	2234				
15	3.0	1679				
15	2.2	674				
15	2.9	1496				
15	3.7	3267				
15	3.4	2541				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	3.0	1639				
15	3.6	2873				
15	3.0	1706				
15	3.9	3682				
15	2.3	733				
15	3.9	3693				
15	3.2	2155				
15	3.8	3549				
15	3.2	1984				
15	2.1	546				
15	3.8	3530				
15	2.1	560				
15	2.0	522				
15	3.2	2083				
15	2.1	577				
15	2.3	766				
15	3.4	2554				
15	3.2	2073				
15	2.4	849				
15	2.9	1538				
15	2.7	1241				
15	3.7	3264				
15	2.6	1139				
15	2.7	1237				
15	2.6	1073				
15	3.0	1662				
15	2.1	609				
15	4.0	3995				
15	2.1	591				
15	3.0	1759				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
2.2	453	4968	128	4717
2.6	902	5313	835	5289
3.0	617	5109	121	4717
2.2	787	5253	126	4717
2.7	483	5004	112	4717
2.5	875	5303	835	5288
3.9	496	5020	127	4718
3.8	954	5342	835	5289
3.1	248	4808	128	4717
3.0	784	5252	43	4660
2.6	640	5127	117	4717
2.1	645	5130	48	4658
2.6	247	4807	128	4717
3.4	950	5340	835	5289
2.2	291	4841	126	4717
3.1	879	5304	835	5289
2.2	550	5060	118	4717
2.5	824	5281	118	4717
2.2	456	4972	126	4717
3.0	496	5019	111	4717
3.1	557	5065	127	4717
2.6	843	5292	835	5289
3.0	489	5011	126	4717
3.6	396	4928	128	4717
3.2	202	4776	128	4717
2.1	767	5236	128	4717
3.1	774	5244	0	4673
3.1	578	5078	115	4717
3.9	501	5026	127	4718
3.8	625	5116	127	4718
2.9	789	5255	24	4655
2.5	731	5198	121	4717
2.2	542	5055	120	4717
4.0	430	4952	122	4718
3.1	449	4965	128	4717
2.6	763	5233	8	4659
2.5	848	5293	835	5288
2.8	690	5160	127	4717
3.5	415	4941	124	4717
2.2	772	5242	126	4717
2.6	747	5215	127	4717
3.1	354	4893	128	4717
2.9	629	5118	126	4717
2.0	949	5338	835	5288
3.7	206	4779	127	4718

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
2.8	558	5065	122	4717
2.5	924	5325	835	5288
2.3	200	4773	126	4717
3.1	545	5058	122	4717
3.3	260	4817	126	4717
3.8	287	4839	125	4718
2.9	233	4797	128	4717
2.9	712	5177	116	4717
2.8	636	5124	126	4717
2.1	361	4899	123	4717
3.5	523	5044	116	4717
2.9	565	5069	126	4717
2.6	477	4997	115	4717
3.7	680	5154	126	4717
2.5	836	5289	835	5288
3.9	468	4988	126	4718
2.2	186	4764	128	4717
3.6	195	4771	128	4717
3.8	621	5112	128	4718
2.9	821	5279	39	4658
3.2	691	5161	119	4717
3.3	456	4973	123	4717
2.1	468	4986	116	4717
3.4	272	4827	125	4717
2.9	954	5341	835	5289
2.8	224	4791	127	4717
3.9	831	5287	123	4718
4.0	177	4758	128	4718
2.4	865	5299	835	5288
3.9	538	5054	125	4718
2.6	238	4801	128	4717
3.8	343	4885	126	4718
3.5	778	5247	120	4717
3.4	645	5131	121	4717
2.4	477	4997	124	4717
2.1	537	5052	123	4717
2.4	360	4899	128	4717
2.1	721	5186	124	4717
3.5	387	4922	127	4717
3.3	544	5057	127	4717
3.7	202	4776	124	4717
3.1	286	4838	128	4717
3.3	756	5226	119	4717
3.1	536	5052	127	4717
3.1	155	4739	127	4717

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
3.0	397	4928	128	4717
2.9	175	4755	126	4717
2.6	561	5067	122	4717
3.8	514	5039	126	4718
3.8	233	4798	126	4718
3.3	773	5243	126	4717
2.7	242	4803	127	4717
2.3	553	5062	118	4717
2.6	712	5177	3	4654
2.8	263	4819	127	4717
2.0	471	4989	115	4717
3.6	316	4862	128	4717
3.0	844	5292	835	5289
3.1	904	5314	835	5289
3.2	899	5311	835	5289
3.9	134	4723	128	4718
2.7	486	5008	32	4656
2.1	725	5191	44	4660
2.9	759	5229	36	4657
2.5	595	5090	113	4717
3.0	924	5325	835	5289
2.9	453	4969	120	4717
2.7	893	5309	835	5289
3.6	448	4965	128	4717
2.4	187	4764	128	4717
2.1	920	5322	835	5288
3.2	724	5190	125	4717
3.8	154	4739	127	4718
3.2	406	4935	128	4717
3.1	655	5137	126	4717
3.6	833	5289	117	4718
3.3	410	4937	128	4717
3.9	637	5126	116	4718
3.0	409	4937	113	4717
2.4	735	5202	124	4717
2.9	798	5262	123	4717
2.3	218	4786	128	4717
2.9	712	5177	116	4717
2.9	153	4738	127	4717
2.5	879	5304	835	5288
2.6	535	5052	125	4717
2.5	449	4965	128	4717
2.7	605	5099	124	4717
2.7	816	5275	128	4717
2.6	923	5324	835	5289

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
3.9	261	4818	126	4718
3.4	742	5210	120	4717
2.8	962	5346	835	5289
3.7	696	5164	125	4717
2.4	683	5155	121	4717
2.9	724	5190	33	4659
2.4	485	5005	124	4717
2.1	465	4983	113	4717
3.8	445	4962	122	4718
2.5	865	5299	835	5288
2.6	198	4773	127	4717
2.1	374	4910	128	4717
3.9	547	5059	121	4718
2.3	212	4782	128	4717
3.9	464	4983	121	4718
2.3	92	4701	61	4660
3.3	83	4693	54	4657
2.3	98	4706	50	4660
3.4	53	4671	53	4659
2.0	82	4691	61	4658
3.6	98	4707	52	4658
2.2	37	4664	37	4659
2.5	91	4700	61	4657
3.2	95	4705	51	4660
2.4	92	4702	51	4659
3.4	73	4684	55	4658
2.6	103	4712	52	4659
3.6	86	4696	52	4657
2.8	64	4675	60	4659
2.5	39	4664	39	4660
2.9	61	4673	61	4659
2.8	81	4692	51	4657
3.3	43	4666	43	4660
2.5	81	4691	54	4659
2.7	66	4678	58	4660
2.9	57	4672	57	4658
2.7	70	4681	56	4658
3.0	48	4668	48	4660
3.8	95	4705	54	4660
3.6	72	4683	55	4659
2.6	68	4679	57	4659
2.2	42	4665	42	4659
3.1	51	4670	51	4659
2.5	71	4682	56	4657
2.9	52	4670	52	4659

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
3.7	96	4705	52	4660
3.2	33	4663	33	4660
2.9	91	4701	52	4658
3.0	51	4669	51	4658
2.0	56	4671	56	4660
3.5	51	4670	51	4659
2.3	75	4685	61	4658
2.6	65	4677	59	4658
2.0	40	4665	40	4660
2.9	47	4668	47	4659
3.8	54	4671	54	4660
2.5	45	4667	45	4658
2.9	92	4702	50	4658
3.6	46	4668	46	4659
3.6	103	4712	50	4660
2.1	48	4668	48	4659
3.2	61	4674	61	4660
2.3	73	4683	61	4659
3.2	94	4703	52	4659
2.5	104	4712	50	4658
3.8	95	4705	51	4660
2.9	106	4714	52	4660
2.2	87	4697	61	4659
3.0	68	4680	57	4660
3.0	50	4669	50	4658
3.2	100	4710	52	4659
3.4	85	4695	54	4660
3.7	43	4667	43	4660
2.4	54	4670	54	4659
2.2	52	4670	52	4658
2.4	76	4687	56	4659
2.2	79	4689	61	4658
3.3	93	4703	49	4658
3.3	73	4684	56	4659
2.3	56	4671	56	4660
2.8	73	4685	55	4660
3.2	97	4706	51	4659
2.8	36	4663	36	4660
3.0	47	4668	47	4659
3.5	72	4683	55	4658
3.3	64	4676	60	4657
3.7	85	4696	53	4657
2.4	101	4709	54	4659
3.9	82	4693	52	4657
3.5	37	4664	37	4660

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
2.1	80	4690	55	4659
2.8	89	4699	54	4659
3.1	32	4662	32	4660
3.3	81	4692	54	4659
2.8	82	4692	53	4660
3.4	67	4679	57	4660
2.6	56	4671	56	4660
2.4	79	4689	55	4658
4.0	92	4702	52	4657
3.4	32	4662	32	4660
2.4	78	4689	54	4658
3.7	83	4693	53	4657
3.1	83	4694	53	4660
4.0	86	4697	54	4659
2.5	52	4670	52	4659
2.5	55	4671	55	4660
3.2	66	4678	57	4657
2.9	63	4675	60	4658
2.1	44	4666	44	4660
4.0	86	4697	52	4658
2.3	60	4673	60	4659
2.7	43	4666	43	4660
2.7	43	4666	43	4660
3.3	88	4698	53	4660
3.7	66	4678	57	4658
3.9	32	4662	32	4659
3.7	76	4688	54	4657
2.8	32	4662	32	4660
3.8	81	4693	55	4660
3.5	68	4680	56	4659
2.6	71	4682	57	4659
2.8	62	4674	62	4660
2.8	68	4680	61	4658
2.7	95	4704	54	4660
3.2	42	4666	42	4660
2.6	81	4691	55	4659
3.3	62	4674	62	4660
2.9	66	4678	59	4660
2.9	42	4666	42	4660
3.3	55	4671	55	4660
3.0	102	4711	61	4659
2.2	56	4671	56	4660
2.9	68	4680	57	4657
3.7	105	4714	50	4659
3.4	51	4670	51	4659

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
3.0	61	4674	61	4660
3.6	34	4663	34	4660
3.0	69	4681	56	4658
3.9	100	4709	51	4659
2.3	41	4665	41	4659
3.9	61	4674	61	4660
3.2	90	4700	52	4658
3.8	51	4670	51	4659
3.2	83	4693	53	4658
2.1	87	4696	61	4660
3.8	99	4708	49	4658
2.1	74	4685	61	4658
2.0	106	4714	61	4657
3.2	93	4703	53	4660
2.1	72	4683	61	4659
2.3	109	4716	61	4658
3.4	97	4706	51	4659
3.2	33	4662	33	4659
2.4	95	4704	51	4659
2.9	108	4716	52	4658
2.7	82	4693	54	4660
3.7	42	4666	42	4660
2.6	67	4679	57	4657
2.7	78	4688	54	4658
2.6	45	4667	45	4658
3.0	107	4715	54	4660
2.1	44	4666	44	4660
4.0	105	4714	52	4660
2.1	89	4698	61	4660
3.0	69	4681	56	4658

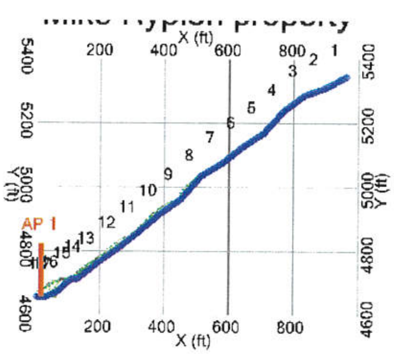
Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rockfall Analysis

PROJECT INFORMATION

Company Name:	IGES
Project Name:	CRSP 5
Station:	
Location:	Ogden Canyon
Analysis By:	CLE
Analysis Case:	
Date:	7/20/09

CRSP was used to determine the expected kinetic energy and bouncing height of falling rocks at various points along the slope. In the analysis, it was assumed that rounded boulders with a maximum diameter of 4.0 feet would impact the rockfall retaining system. For each simulation, the model rolled 300 cylindrical shaped rocks from a source area at 4660 - 5345 feet. A slope surface roughness of NaN - 0.9, and hardness of NaN - 0.5 were used.



Colorado Rockfall Simulation Program--CRSP 5.0

Analysis Points

AP-1 @ X = 15 ft

INPUT PARAMETERS

Slope Properties

Cells	Roughness	Hardness
1-2	.45	.5
3-5	.925	.5
6-15	.8	.5

Rock Properties

Cells	Number of Rocks	Density	Shape	Size
1-13	150	120	Cylinder	2-4
15-16	150	120	Cylinder	2-4

Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rockfall Results for Station and Analysis Point 1

Rock Distribution

Rock Size	Rock Number	Start Cell
2-4	150	1-13
2-4	150	15-16

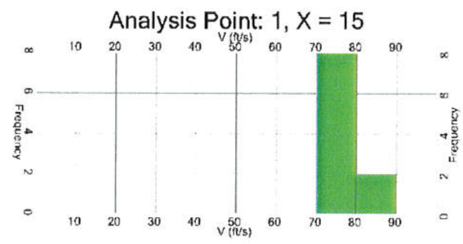
Summary of Results

Max Bounce Ht, ft	Max Energy, ft-kips	Max Velocity, ft/s	Percent Passing
27	645	82	3%

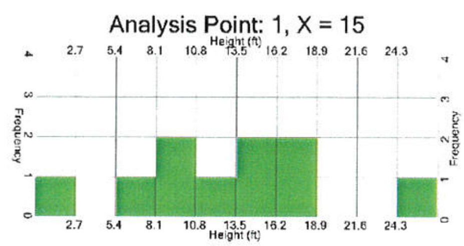
Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rockfall Results for Station and Analysis Point 1

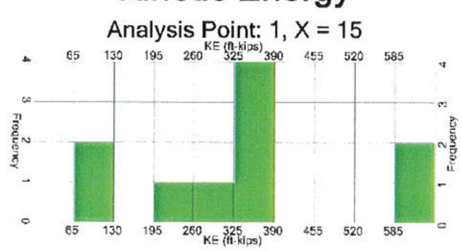
Velocity



Height

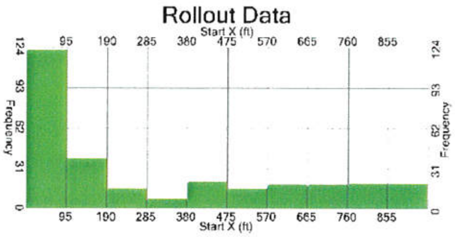


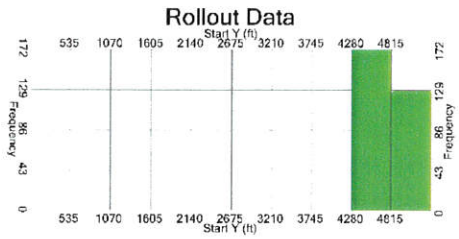
Kinetic Energy



Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rollout Start Results for Station

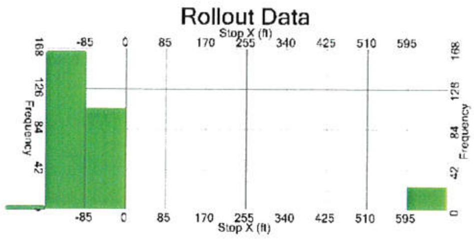


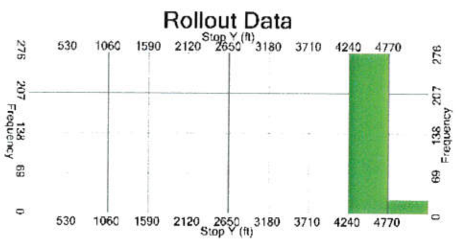


The Developers are not responsible for the reliability of the parameters and improper use of the software.

Colorado Rockfall Simulation Program--CRSP 5.0

CRSP Rollout Stop Results for Station





Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	2.9	2230				
15	2.0	795				
15	3.8	5242				
15	2.8	1982				
15	2.2	998				
15	2.8	2103				
15	3.4	3661				
15	2.3	1098				
15	2.2	1072				
15	2.7	1906				
15	3.7	4810				
15	3.2	3200				
15	2.7	1943				
15	2.8	2026	76.5	43.5	26.1	242
15	2.6	1722				
15	2.4	1262				
15	3.8	5052				
15	2.8	2160				
15	2.5	1456				
15	2.8	2164				
15	3.1	2765				
15	2.1	902				
15	2.6	1618				
15	2.9	2386				
15	2.5	1417				
15	3.4	3841				
15	2.6	1751				
15	2.1	921				
15	3.5	4006				
15	2.9	2259				
15	2.2	1028				
15	3.4	3746				
15	3.4	3554				
15	3.0	2583				
15	3.9	5671				
15	2.9	2281				
15	2.8	2095				
15	2.9	2368				
15	2.2	1059				
15	2.6	1603				
15	3.0	2615				
15	4.0	5952				
15	2.9	2302				
15	3.2	3119				
15	2.1	825				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	3.9	5616				
15	2.3	1129				
15	2.8	2073				
15	3.8	5028				
15	3.9	5737				
15	2.1	859				
15	2.7	1884				
15	3.7	4837	81.1	33.3	17.0	638
15	2.6	1588				
15	3.3	3327	76.0	34.7	18.9	382
15	3.1	2943				
15	2.3	1172				
15	2.7	1914				
15	2.2	964				
15	3.1	2911	73.7	32.3	15.3	304
15	2.4	1335				
15	4.0	5846				
15	3.9	5508				
15	2.1	912				
15	3.4	3724				
15	3.9	5634				
15	3.3	3491				
15	4.0	5931				
15	2.2	992	74.6	40.0	2.2	101
15	2.6	1616				
15	3.6	4504				
15	3.4	3726				
15	2.9	2418				
15	2.8	2079				
15	3.7	4663				
15	3.8	5032				
15	2.2	987				
15	3.0	2612				
15	3.9	5595				
15	2.5	1536				
15	3.8	5016				
15	3.9	5649				
15	3.8	5280				
15	2.9	2329				
15	2.6	1729				
15	2.1	819				
15	3.4	3663				
15	2.8	2006				
15	2.5	1415				
15	2.2	974				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	2.6	1585				
15	3.5	4153				
15	3.3	3286	77.0	34.0	13.4	381
15	2.9	2317				
15	2.7	1832				
15	2.5	1400				
15	3.4	3867				
15	2.3	1087				
15	2.7	1881				
15	2.6	1662				
15	2.2	1002				
15	2.0	781				
15	3.8	5255				
15	2.7	1815				
15	2.3	1097				
15	2.6	1754				
15	2.4	1304				
15	3.8	5015				
15	3.9	5506				
15	2.4	1236				
15	2.0	768				
15	2.8	1964				
15	3.9	5568				
15	2.2	959				
15	2.8	2124				
15	2.2	989				
15	2.4	1282				
15	3.5	4100				
15	3.1	2747				
15	3.1	2938	78.6	35.6	9.9	354
15	2.6	1692				
15	2.7	1946				
15	3.5	4210				
15	3.3	3263				
15	3.4	3728				
15	3.6	4427				
15	3.8	5295				
15	2.8	2104				
15	2.9	2353				
15	2.6	1585				
15	2.1	895				
15	3.8	5139				
15	3.8	5224				
15	2.4	1269				
15	2.0	801				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	2.3	1131	75.3	47.7	14.1	126
15	2.0	800				
15	3.3	3332				
15	3.0	2463				
15	3.0	2454				
15	4.0	5994				
15	2.9	2370				
15	2.6	1743				
15	3.8	5245	79.3	29.7	10.2	644
15	3.1	2772	80.1	35.6	5.6	341
15	2.5	1548				
15	2.1	913				
15	3.1	2831				
15	2.0	794				
15	2.7	1814				
15	3.3	3411				
15	2.7	1860				
15	4.0	6025				
15	2.4	1226				
15	2.9	2209				
15	2.9	2221				
15	3.8	5358				
15	2.1	933				
15	2.4	1309				
15	2.7	1919				
15	3.2	3181				
15	2.7	1771				
15	2.9	2268				
15	2.9	2257				
15	3.2	3015				
15	3.6	4451				
15	3.3	3314				
15	3.8	5073				
15	2.3	1076				
15	3.6	4472				
15	3.3	3471				
15	2.7	1773				
15	2.6	1728				
15	3.2	3063				
15	3.7	4816				
15	2.1	917				
15	2.9	2265				
15	3.9	5495				
15	3.8	5136				
15	2.1	824				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	2.9	2311				
15	2.3	1200				
15	3.9	5654				
15	3.6	4410				
15	2.4	1278				
15	3.5	4016				
15	3.0	2623				
15	3.9	5627				
15	3.3	3367				
15	2.2	1054				
15	3.4	3613				
15	2.2	1012				
15	2.7	1823				
15	2.7	1780				
15	2.8	2114				
15	2.3	1104				
15	4.0	5930				
15	3.9	5481				
15	3.9	5446				
15	2.4	1329				
15	3.3	3235				
15	2.5	1400				
15	3.2	3173				
15	3.7	4954				
15	3.4	3679				
15	2.5	1509				
15	3.4	3544				
15	3.0	2571				
15	4.0	5952				
15	2.8	2141				
15	3.0	2421				
15	3.8	5285				
15	2.3	1119				
15	3.8	5084				
15	3.8	5375				
15	3.1	2940				
15	3.0	2608				
15	2.9	2325				
15	2.6	1664				
15	3.7	4769				
15	3.6	4557				
15	3.2	3124				
15	2.4	1262				
15	2.5	1448				
15	2.0	812				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	2.6	1737				
15	2.3	1196				
15	3.7	4849				
15	3.5	4142				
15	3.3	3354				
15	2.9	2189				
15	2.5	1469				
15	3.9	5614				
15	3.5	4215				
15	3.8	5202				
15	3.7	4706				
15	2.5	1456				
15	2.4	1366				
15	2.9	2340				
15	4.0	5950				
15	3.4	3824				
15	3.2	2970				
15	2.3	1223				
15	2.1	852				
15	2.3	1142				
15	3.2	3013				
15	2.4	1357				
15	3.2	3234				
15	3.9	5625				
15	3.8	5361				
15	2.6	1577				
15	3.6	4341				
15	2.8	2025				
15	4.0	5974				
15	2.7	1829				
15	3.3	3247				
15	3.3	3388				
15	2.8	2160				
15	2.3	1147				
15	3.0	2501				
15	2.6	1643				
15	2.9	2353				
15	3.4	3611				
15	3.0	2632				
15	3.8	5211				
15	3.0	2503				
15	3.3	3451				
15	2.3	1074				
15	3.8	5320				
15	3.4	3824				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Kinetics

Analysis Pnt X (ft)	Diameter (ft)	Mass (lbm)	V (ft/s)	W (rad/s)	Height (ft)	KE (ft-kips)
15	2.6	1721				
15	2.3	1186				
15	3.3	3534				
15	3.1	2740				
15	3.5	4176				
15	2.9	2397				
15	2.2	1071				
15	2.1	814				
15	2.3	1128				
15	3.5	4047				
15	2.5	1489				
15	2.6	1678				
15	2.6	1583				
15	2.7	1949				
15	2.6	1708				
15	3.6	4571				
15	2.8	2012				
15	3.9	5684				
15	3.7	4864				
15	3.7	4586				
15	2.7	1958				
15	2.5	1542				
15	2.6	1645				
15	2.2	1017				
15	2.4	1288				
15	2.0	777				
15	2.7	1869				
15	2.4	1320				
15	3.2	3152				
15	2.4	1341				

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
2.9	617	5109	118	4717
2.0	501	5025	27	4654
3.8	459	4977	123	4717
2.8	938	5333	835	5289
2.2	741	5208	25	4654
2.8	910	5317	835	5289
3.4	888	5308	835	5289
2.3	540	5054	124	4717
2.2	432	4952	37	4659
2.7	462	4980	117	4717
3.7	281	4834	126	4718
3.2	720	5187	124	4717
2.7	804	5266	127	4717
2.8	737	5204	-3	4672
2.6	941	5334	835	5289
2.4	459	4976	127	4717
3.8	505	5030	124	4718
2.8	752	5221	113	4717
2.5	896	5310	835	5288
2.8	175	4755	128	4717
3.1	737	5205	120	4717
2.1	374	4910	124	4717
2.6	573	5074	124	4717
2.9	513	5039	124	4717
2.5	343	4884	128	4717
3.4	238	4801	126	4717
2.6	819	5277	123	4717
2.1	893	5309	835	5288
3.5	569	5072	126	4717
2.9	587	5084	125	4717
2.2	142	4729	128	4717
3.4	775	5245	28	4659
3.4	843	5292	835	5289
3.0	876	5303	835	5289
3.9	899	5312	835	5289
2.9	239	4801	128	4717
2.8	383	4918	128	4717
2.9	459	4977	120	4717
2.2	637	5124	123	4717
2.6	137	4724	128	4717
3.0	629	5118	126	4717
4.0	145	4731	128	4718
2.9	656	5138	118	4717
3.2	168	4749	127	4717
2.1	281	4833	128	4717

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
3.9	196	4772	127	4718
2.3	178	4757	126	4717
2.8	617	5108	121	4717
3.8	654	5137	118	4718
3.9	146	4733	127	4718
2.1	849	5293	835	5288
2.7	381	4916	128	4717
3.7	821	5280	-1	4663
2.6	509	5033	127	4717
3.3	585	5083	2	4667
3.1	600	5095	124	4717
2.3	464	4982	39	4660
2.7	466	4985	22	4657
2.2	453	4969	117	4717
3.1	557	5065	3	4662
2.4	320	4865	128	4717
4.0	518	5042	127	4718
3.9	653	5137	126	4718
2.1	935	5331	835	5288
3.4	610	5103	126	4717
3.9	770	5241	127	4718
3.3	520	5043	128	4717
4.0	442	4960	125	4718
2.2	520	5042	11	4656
2.6	179	4758	126	4717
3.6	896	5311	835	5289
3.4	867	5300	835	5289
2.9	658	5139	113	4717
2.8	449	4965	126	4717
3.7	306	4854	127	4717
3.8	869	5301	835	5289
2.2	419	4943	128	4717
3.0	759	5229	126	4717
3.9	908	5317	835	5289
2.5	530	5048	121	4717
3.8	878	5304	835	5289
3.9	473	4994	126	4718
3.8	779	5248	114	4718
2.9	734	5202	111	4717
2.6	437	4956	122	4717
2.1	234	4798	128	4717
3.4	816	5275	125	4717
2.8	415	4941	127	4717
2.5	566	5070	126	4717
2.2	279	4831	128	4717

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
2.6	556	5064	119	4717
3.5	141	4728	128	4717
3.3	649	5134	1	4658
2.9	789	5255	123	4717
2.7	756	5225	126	4717
2.5	771	5241	126	4717
3.4	397	4929	128	4717
2.3	931	5328	835	5288
2.7	824	5281	126	4717
2.6	724	5190	126	4717
2.2	475	4995	115	4717
2.0	208	4780	128	4717
3.8	892	5309	835	5289
2.7	221	4789	128	4717
2.3	837	5289	835	5288
2.6	461	4979	126	4717
2.4	850	5294	835	5288
3.8	211	4783	128	4718
3.9	683	5156	115	4718
2.4	279	4831	126	4717
2.0	945	5336	835	5288
2.8	778	5247	118	4717
3.9	785	5253	126	4718
2.2	739	5206	19	4657
2.8	368	4905	113	4717
2.2	638	5125	124	4717
2.4	753	5222	44	4652
3.5	194	4770	126	4717
3.1	322	4866	127	4717
3.1	659	5140	6	4660
2.6	717	5182	118	4717
2.7	777	5246	121	4717
3.5	650	5134	123	4717
3.3	937	5332	835	5289
3.4	195	4771	128	4717
3.6	723	5189	123	4717
3.8	391	4925	123	4718
2.8	941	5334	835	5289
2.9	678	5152	128	4717
2.6	330	4873	128	4717
2.1	192	4768	128	4717
3.8	283	4836	124	4718
3.8	433	4954	128	4718
2.4	176	4755	127	4717
2.0	417	4942	128	4717

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
2.3	656	5137	-2	4657
2.0	721	5186	118	4717
3.3	557	5065	127	4717
3.0	854	5296	835	5289
3.0	751	5220	115	4717
4.0	761	5231	123	4718
2.9	491	5013	118	4717
2.6	188	4766	128	4717
3.8	611	5104	0	4654
3.1	674	5150	6	4656
2.5	337	4879	128	4717
2.1	696	5163	37	4654
3.1	248	4808	128	4717
2.0	760	5229	124	4717
2.7	910	5317	835	5289
3.3	75	4686	55	4660
2.7	85	4695	54	4659
4.0	95	4705	52	4659
2.4	35	4663	35	4660
2.9	76	4686	61	4657
2.9	101	4710	50	4657
3.8	62	4674	62	4657
2.1	75	4685	61	4658
2.4	86	4696	55	4657
2.7	69	4680	57	4660
3.2	69	4680	56	4657
2.7	63	4675	61	4660
2.9	54	4671	54	4660
2.9	81	4691	61	4660
3.2	69	4681	56	4659
3.6	32	4662	32	4660
3.3	50	4669	50	4658
3.8	43	4667	43	4660
2.3	102	4711	53	4658
3.6	90	4700	52	4659
3.3	81	4692	54	4659
2.7	73	4684	56	4659
2.6	47	4668	47	4659
3.2	67	4679	60	4659
3.7	45	4667	45	4659
2.1	66	4677	61	4660
2.9	68	4679	57	4658
3.9	46	4668	46	4659
3.8	60	4673	60	4659
2.1	77	4688	61	4658

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
2.9	63	4675	61	4657
2.3	58	4672	58	4658
3.9	107	4716	60	4659
3.6	81	4692	53	4658
2.4	66	4678	58	4658
3.5	60	4673	60	4659
3.0	40	4665	40	4659
3.9	85	4695	54	4660
3.3	80	4691	53	4659
2.2	100	4708	61	4660
3.4	60	4673	60	4659
2.2	35	4663	35	4660
2.7	90	4699	50	4660
2.7	33	4662	33	4660
2.8	105	4713	50	4658
2.3	77	4687	56	4660
4.0	33	4663	33	4660
3.9	65	4677	58	4659
3.9	62	4674	62	4660
2.4	45	4667	45	4660
3.3	45	4667	45	4658
2.5	54	4670	54	4659
3.2	41	4666	41	4659
3.7	64	4677	60	4657
3.4	75	4686	54	4660
2.5	79	4690	55	4659
3.4	68	4680	57	4660
3.0	60	4673	60	4659
4.0	76	4688	54	4657
2.8	99	4708	52	4659
3.0	100	4709	50	4660
3.8	59	4673	59	4659
2.3	74	4684	56	4657
3.8	67	4679	57	4659
3.8	99	4708	54	4659
3.1	80	4691	60	4659
3.0	44	4667	44	4660
2.9	95	4704	53	4660
2.6	97	4706	53	4659
3.7	36	4664	36	4659
3.6	84	4695	54	4658
3.2	62	4674	62	4658
2.4	47	4668	47	4659
2.5	50	4669	50	4660
2.0	63	4675	62	4659

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
2.6	64	4676	60	4658
2.3	46	4667	46	4659
3.7	103	4712	50	4660
3.5	44	4667	44	4658
3.3	42	4666	42	4660
2.9	88	4698	52	4658
2.5	37	4663	37	4659
3.9	65	4678	58	4658
3.5	87	4698	53	4657
3.8	45	4668	45	4659
3.7	107	4716	51	4658
2.5	104	4712	51	4660
2.4	97	4706	52	4658
2.9	83	4693	60	4657
4.0	99	4709	50	4658
3.4	63	4675	61	4658
3.2	93	4702	51	4660
2.3	41	4665	41	4659
2.1	91	4700	61	4658
2.3	62	4673	62	4659
3.2	78	4689	53	4658
2.4	103	4711	47	4658
3.2	67	4679	60	4659
3.9	57	4672	57	4658
3.8	47	4668	47	4660
2.6	60	4673	60	4659
3.6	74	4686	54	4657
2.8	100	4708	49	4660
4.0	88	4699	54	4659
2.7	93	4702	52	4658
3.3	37	4664	37	4660
3.3	45	4667	45	4659
2.8	48	4668	48	4659
2.3	42	4665	42	4659
3.0	86	4696	53	4657
2.6	72	4683	61	4658
2.9	98	4707	61	4659
3.4	77	4689	53	4658
3.0	108	4716	61	4660
3.8	83	4694	55	4660
3.0	61	4674	61	4660
3.3	106	4715	50	4658
2.3	42	4665	42	4659
3.8	72	4684	55	4658
3.4	99	4709	48	4657

Colorado Rockfall Simulation Program--CRSP 5.0

OUTPUT STATS

Rollout

Diameter (ft)	Start X (ft)	Start Y (ft)	Stop X (ft)	Stop Y (ft)
2.6	41	4665	41	4659
2.3	107	4715	61	4659
3.3	70	4682	56	4660
3.1	78	4689	54	4659
3.5	95	4705	51	4658
2.9	91	4700	51	4658
2.2	69	4681	61	4658
2.1	48	4668	48	4659
2.3	100	4709	50	4658
3.5	60	4673	60	4659
2.5	84	4694	54	4658
2.6	53	4670	53	4659
2.6	40	4665	40	4659
2.7	37	4664	37	4659
2.6	92	4702	52	4659
3.6	76	4687	55	4660
2.8	49	4668	49	4660
3.9	106	4715	50	4660
3.7	80	4691	52	4658
3.7	101	4710	52	4660
2.7	88	4698	54	4659
2.5	104	4713	61	4659
2.6	53	4670	53	4659
2.2	76	4687	61	4657
2.4	105	4713	50	4658
2.0	100	4708	61	4659
2.7	46	4667	46	4659
2.4	38	4664	38	4659
3.2	95	4704	49	4657
2.4	108	4716	47	4659